CHAPTER 7

Capital Facilities **Element**

OF THE COMPREHENSIVE PLAN (2016 to 2036)

CAPITAL FACILITIES ELEMENT VISION: *Mount Vernon invests in its capital facilities to support economic development and to enhance neighborhood character while meeting the functional requirements for a growing and changing City. Being able to build new infrastructure and maintain existing facilities requires the City's commitment to fund expansions and maintenance to continue levels-of-service resident's desire.*

Adopted September 14, 2016 with Ordinance 3690

City of MOUNT VERNON

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ACKNOWLEDGEMENTS

Thank you to the City Councils, Planning Commissions and Citizens from 1960 to the present that have contributed to comprehensive planning efforts of the City. This Capital Facilities Element is built upon the foundation of these original plans.

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INTRODUCTION

The Growth Management Act (GMA) requires comprehensive plans include a Capital Facilities Element that addresses the capital facilities needs to adequately support anticipated growth.

Yearly updates to the Capital Improvement Program (CIP) are incorporated into this Element through the annual CIP/budgeting process by the City Council.

To avoid duplication, this element relies heavily on the analyses, Goals, Objectives and Policies contained in the other Elements of the Comprehensive Plan.

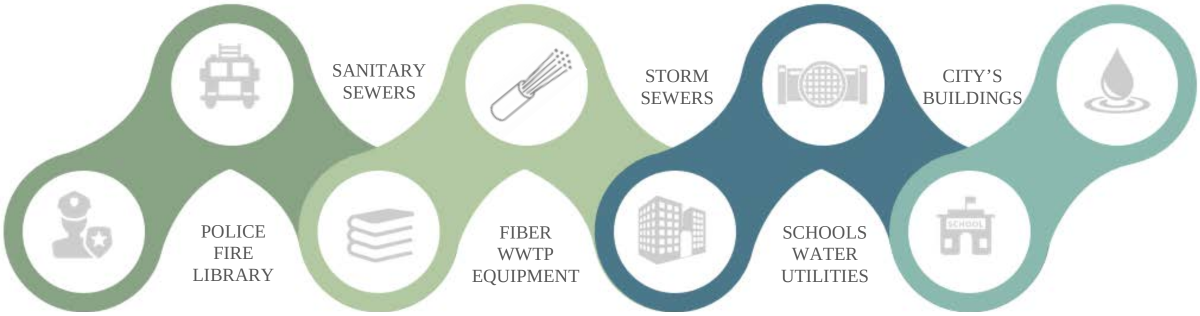
Additionally, infrastructure such as roads and parks are not discussed within this Element because they have separate Elements dedicated to these topics; and as such, they do not need to be repeated within this Element.

The existing and forecasted residential and commercial growth has, and will continue to, place demands on the City's capital facilities.

See the Land Use Element (Chapter 2) for additional information regarding projected growth over the 20-year planning horizon.

Consistent with the GMA requirements this element contains:

+ An inventory of existing capital facilities owned by public entities;
+ A forecast of future needs for such facilities;
+ The proposed locations and capacities of expanded or new facilities;
+ At least a six-year plan that will finance these facilities; and,
+ A plan to reassess the land use element if projected funding falls short of meeting existing and expected needs.

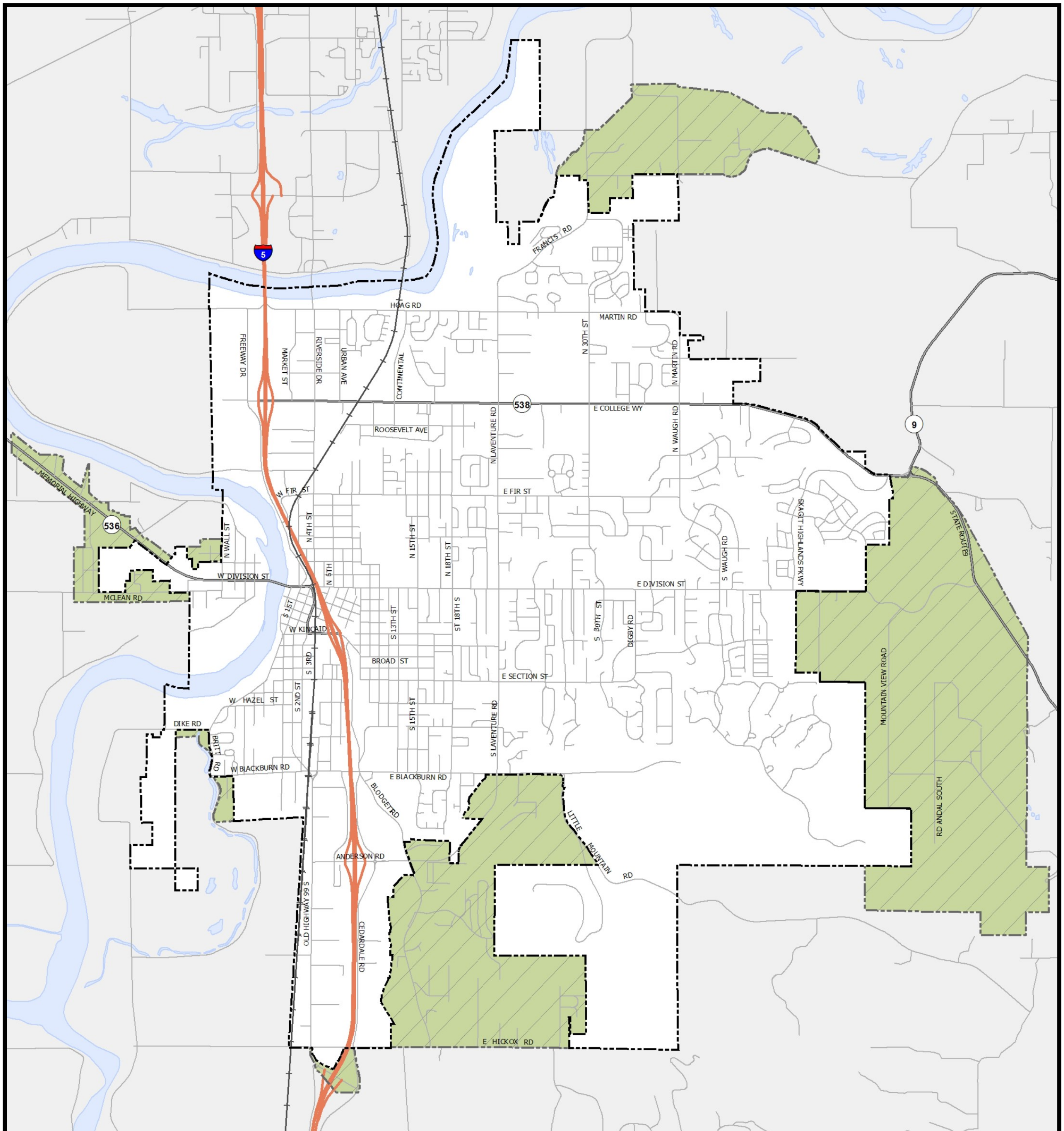


City owned and maintained capital facilities have been inventoried and forecasts of future needs for these facilities has been completed. The City's annually updated and adopted Capital Improvement Plan (CIP) contains a six-year plan to finance City-wide capital facilities. Section 9.0 of this Element contains additional details on the CIP along with contingency measures should projected funding fall short.

Map 1.0 identifies the City limits and existing urban growth areas (UGAs).

This Element addresses the following capital facilities:

CITY OWNED & MAINTAINED:	NON-CITY OWNED & MAINTAINED:
+ Police Department;	+ Public Schools
+ Fire Department;	+ Public Utility District #1 (potable water)
+ Library;	+ Telecommunications (primarily Verizon)
+ Fiberoptics;	+ Electrical (Puget Sound Energy)
+ General Facilities;	+ Natural Gas (Cascade Natural Gas)
+ Utilities (Surfacewater and Wastewater)	+ Skagit County Jail



MAP 1.0: CITY LIMITS AND UGA LOCATIONS

City of MOUNT VERNON

- City Boundary
- City of Mount Vernon Urban Growth Area
- Railroad
- Water Body

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Map by MV GIS 7/5/2016

1.0
POLICE DEPARTMENT

The Police Department's (Department) mission is to consistently seek and find ways to affirmatively promote, preserve, and deliver a feeling of security, safety, and productive, quality service to citizens and visitors of the community.

Several years ago, the Police Department designed a work plan built around the strategic principles of prevention, exchange, adaptability and shared responsibility. Implementation of this work plan has helped solidify the interactions between police, the public, and the various City departments.

The Department's philosophical approach to doing business requires the direct involvement of residents and business owners in identifying and solving problems related to crime, fear of crime, and neighborhood degradation. The Department focuses on a number of key priorities intended to have the greatest chance of impacting outcomes in a desired way. These priorities include rapid response to emergencies, aggressive crime fighting, high visibility, partnering in neighborhood problem solving, creating an atmosphere of trust, transparency, and fairness, emphasizing prevention as the central strategy of operations, and adherence to strict standards of conduct and ethics.

To accomplish the current level of service, the Department maintains a workforce of:

- 45 commissioned officers
- 2 non-commissioned officers
- 1 limited commission officer
- 9.5 support staff
- 50± volunteers

The Department is comprised of two functional areas, or bureaus. These Bureaus (Operations and Services) are each comprised of three Divisions. Division-level oversight is the responsibility of mid-managers; in most cases lieutenants.

Following are the Department's focus areas:

Focus #1: A well-defined public/police partnership to identify and provide effective and appropriate police services. By institutionalizing this practice, the word "community" is merely a descriptor for the Department's policing model. The goal is for "Community" to be a seamless component of policing.

Focus #2: Fully integrated 21st Century technology to complement the traditional methods of policing. This will enhance the Department's ability to efficiently plan for, prevent, and respond to crime, fear, and neighborhood challenges, including those introduced by the e-criminal.

Focus #3: A working relationship with non-traditional partners to address certain calls for service normally handled by publicly funded police agencies and which may be more appropriately handled by the private sector.

Focus #4: Alternative methods to address the increasing homelessness population. To take a dual approach to address this very complex issue, compliance and enforcement efforts and to build relationships with local and regional social and health service providers.

Focus #5: The merging or retooling of certain police functions within the County to improve consistency and effectiveness. Examples might include various administrative services, emergency management, centralized records, property and evidence, and specialized services such as K-9, major crime investigation, covert and tactical operations. It may be feasible to consolidate specialized police services in the county as criminal justice costs increase and a higher, more consistent standard of service is expected.

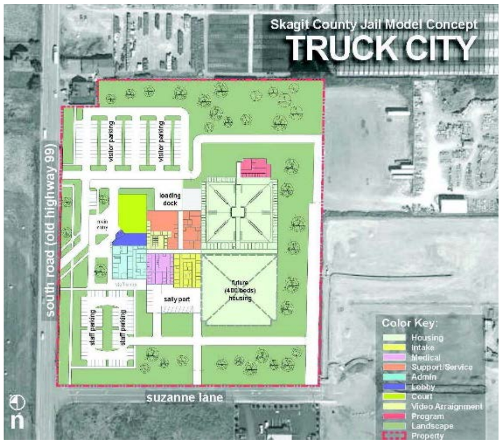
Focus #6: A semi-permanent police presence in all neighborhoods and business districts through "zone deployment". This type of presence is currently well established in the Kulshan Creek and West Hill Neighborhoods and has proven highly effective in reducing crime.

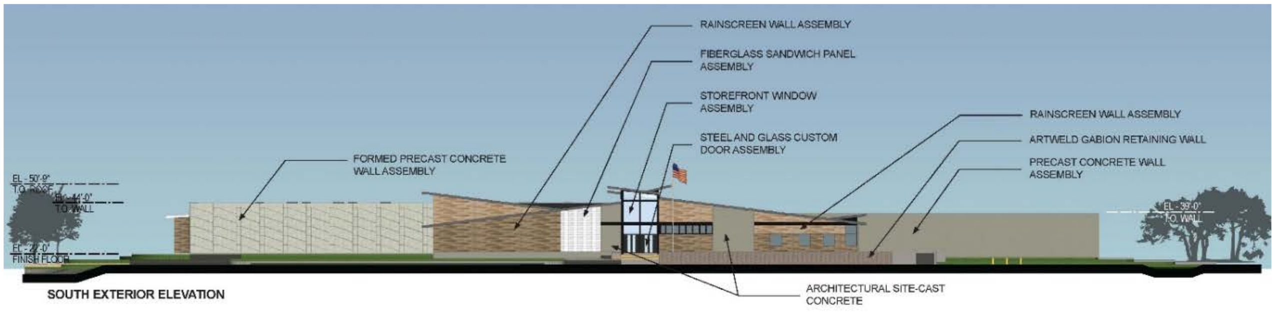
Focus #7: A county-wide collaboration to address violent crime issues affecting our communities. The upsurge in gang activity and violence may be best addressed by forming partnerships among criminal justice agencies, schools, churches, and other community members.

SKAGIT COUNTY JAIL

In 2014 the City and County completed a lengthy process that resulted in the selection of a new site for a larger capacity jail facility. The existing Skagit County Jail, located in Mount Vernon, was planned in the early 1980s and has been seriously overcrowded for years. As of 2016 the new jail is actively under construction and will accommodate 400 inmate beds to start with; but has been designed to allow an additional 400 beds to be constructed when needed in the future.

Below is a map identifying the location of the new jail along with other illustrative materials showing what this facility will look like when it is completed.





Top left, aerial photo of the new Skagit County jail overall property before it was purchased by the County.
Top right, identifies the programing of the new jail facility before it was designed.
Bottom illustration is a plan view of the south elevation of the proposed jail prepared by DLR Group

2.0
FIRE DEPARTMENT

The Mount Vernon Fire Department (MVFD) formed in 1891 as a volunteer firefighting force and has been providing emergency services to the Mount Vernon community for over 100 years.

The MVFD provides services that include: fire suppression, basic life support emergency medical response, operations level hazardous material spill response, limited technical rescue capabilities, fire inspections, public fire safety education and building pre-fire planning. In 2016 City firefighters will respond to approximately 4,900 emergency and non-emergency calls. Current staffing consists of thirty-five career personnel and approximately twenty-five on-call volunteers.

Department personnel respond from three stations strategically located around the geographical center of the city. Each station houses a fire engine staffed with a minimum of two personnel. In addition to the engine companies, Station 1 also houses a brush unit, heavy rescue truck that is staffed by volunteers, as well as a reserve engine and reserve ambulance. Station 2 is home to the ladder truck, the Mount Vernon Medic Unit (M129), Central Valley Medic 2, a reserve engine, and the Battalion Chief. Station 3 has a front line engine and a reserve ambulance. The primary engines, ladder and city ambulance are staffed with career firefighters, and the additional equipment is dependent upon volunteer or career callback staffing. The department provides both Advanced and Basic life support (ALS and BLS), with the goal of consistent ALS response and ambulance transportation capabilities.

Following is a list of the MVFD stations with a description and location of each:

Fire Station No. 1: 9,500 square feet in size with five apparatus bays, a maintenance bay, modern kitchen and sleeping rooms.

Fire Station No. 2: 3,728 square feet in size with apparatus bays, a modern kitchen, a meeting room, administration areas, sleeping rooms and also houses a small museum where the original 1920 LaFrance is on public display.

Fire Station No. 3: 6,644 square feet in size with two apparatus bays, an exercise room, a modern kitchen, a multi-purpose room, a day room, and three sleeping rooms and an administration area.

The MVFD's Strategic Plan contains additional details with regard to levels-of-service, implementation and strategic measures.

3.0
PUBLIC LIBRARY

The Mount Vernon City Library is a 12,122 square foot facility that has been in its present location at 315 Snoqualmie Street since 1954. The facility started at 3,581 square feet, and was been expanded twice (to 10,033 sq. ft. in 1969 and to the present size in 1981). Extensive renovations were completed in 1999, which did not change square footage but greatly improved the appearance and attractiveness of the facility.

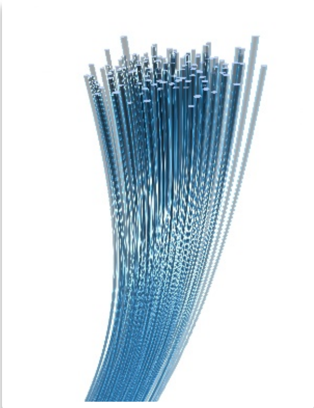
The library's service area boundaries are one and the same with the City of Mount Vernon's boundaries. The library offers free library cards to those who own businesses within city limits and certificated teachers in Mount Vernon. Non-residents of the City of Mount Vernon hold 600± library cards.

The library has a diverse and continually updated collection of approximately 80,000 items, predominantly books but with sizeable numbers of magazines, newspapers, CDs, DVDs, audiobooks and eBooks. A growing collection of Spanish language materials in all formats serves the growing Spanish-speaking population of Mount Vernon.

Programs offered by the library include story times and a Summer Reading Program for children, and monthly evening programs for adults. A strong reference collection and reference staff offer further service to the public. The library has 21 computers available to the public.

The library has 10 full-time and 16 part-time employees.

4.0
CITY FIBEROPTICS



Bandwidth is now an essential commodity, in the same category as power, water, sewer, and other services. For businesses to be effective in our information intensive economy they need bandwidth to be delivered on redundant fiber-optic infrastructure, which provides the speed and, even more essentially, the reliability of constant service.

Mount Vernon has deployed backbone Fiber Infrastructure that has the capacity to provide the foundation for business and local economic growth. With high-speed, high-power connectivity, businesses have greater access to online tools and cloud-based services, enabling them to become more competitive.

Fiber Network provides the foundation for broadband Internet access, VoIP, video-on-demand (VOD), interactive video, medical imaging, Application Service Provider (ASP) services, software as a service (SAAS), cloud computing and data center growth. The network's advanced architecture enables these services to be offered at affordable prices, through the availability of flexible, low cost managed bandwidth services.

The intent of the City's Fiber network is to create a versatile network capable of bringing multi-service networking solutions to the community. This Network is designed not only to support the immediate demand for Internet Access, but also to function as transport for additional services along with interconnecting public agencies for a more efficient cost saving system.

The biggest benefit of fiber is that it can offer much faster speeds over much longer distances than traditional copper-based technologies like DSL and cable.

Fiber optic networks transmit light to connect businesses directly to the Internet with the fastest connection ever offered. At speeds up to 25 times faster (or more) than cable Internet or DSL, fiber optic high speed Internet access makes quick work of downloading music, pictures and videos.

FIBER OPTIC SYSTEM

Mount Vernon has invested in a fiber optic infrastructure and technology with the expectation that with the deployment of such technology comes economic development. The creation of new services and service providers will proliferate, as bandwidth becomes available.

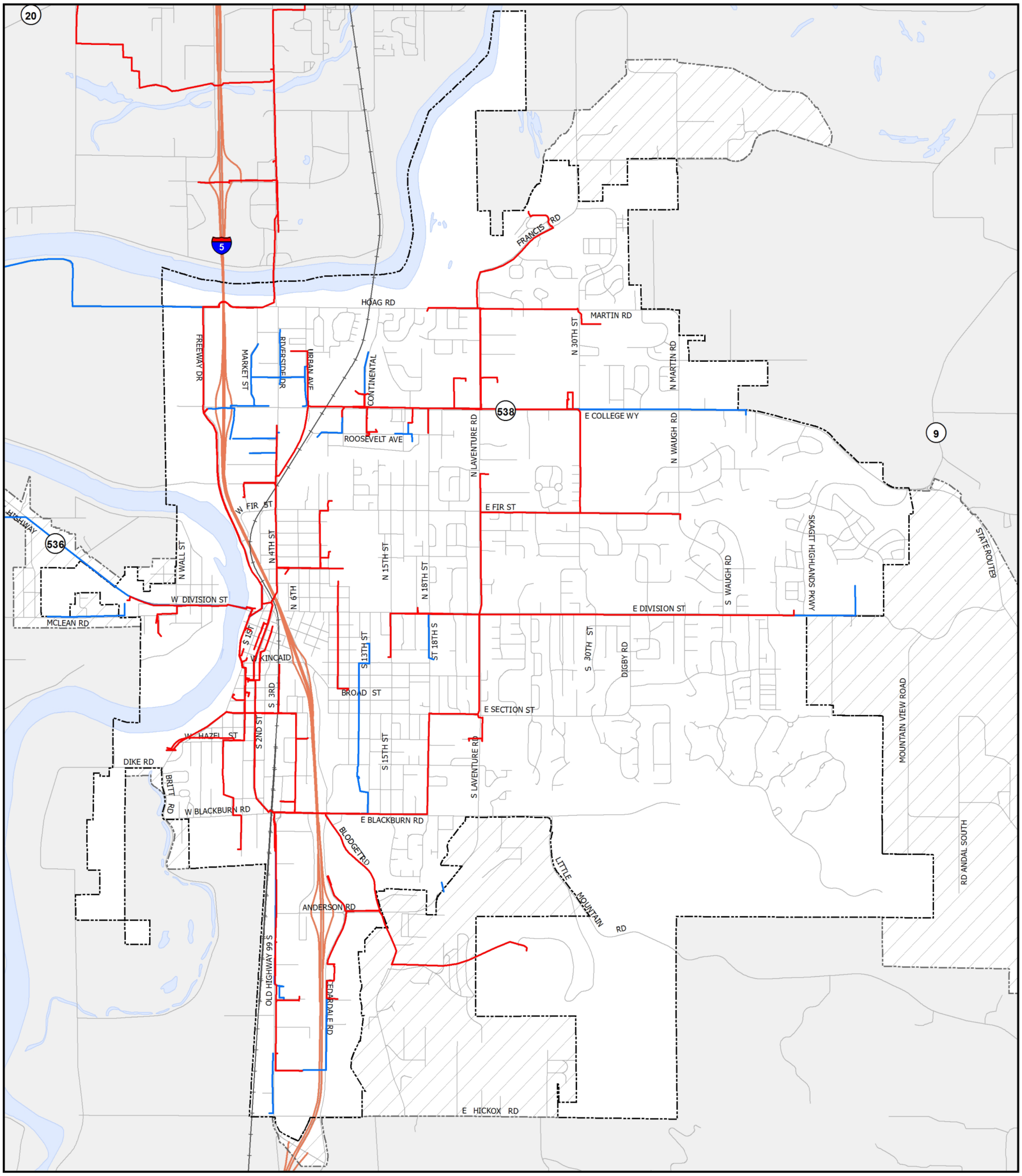
Mount Vernon has designed the Fiber Network to be an Open Service provider Network (OSPN) system allowing as many service providers as possible, to facilitate fair and open competition, and to provide the community's business and residential customers with the greatest diversity of services available, both now and in the future.

The city has partnered with the Port of Skagit. Through these partnerships Fiber Infrastructure has been built out and will continue to be expanded upon throughout Mount Vernon and the Port of Skagit.

The City of Mount Vernon's fiber infrastructure is connected redundantly to a SONNET OC192 buried ring that extends to Vancouver British Columbia to the north and to Seattle to the south and that ring completes going round through the Puget Sound. Once in Seattle the ring is connected to multiple fiber rings in the state. With this capability and redundancy the City has nine providers that can offer data and voice solutions through the fiber, at rates well below what bigger urban areas can provide.

Benefits Expected from the Fiber Network include:

+ Lower cost multi-service network transport for agencies;
+ Increased networking reliability;
+ Faster service;
+ Provide flexible connectivity to meet a variety of needs;
+ Offer innovative, cost effective multi-service networking services;
+ Ability to rapidly respond to dynamic service demands;
+ Flexible bandwidth management;
+ Rapid service deployment;
+ Address a broad range of application and service needs by providing low cost per bit optical transport;
+ The use of Wireless networks, where Fiber doesn't make sense;
+ Cost savings in sharing information and greater efficiencies in access of information;
+ Working with the Public Partners of the Consortium to expand the public agencies communication needs; and,
+ Continue to expand out Fiber and Wireless coverage areas where there is a need.



MAP 2.0: FIBER OPTIC FACILITIES

City of MOUNT VERNON

- Existing Fiber Optic Facilities
- Proposed Fiber Optic Facilities
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

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Map by MV GIS 6/21/2016

5.0
GENERAL FACILITIES & SOLID WASTE

The City has a number of buildings and facilities located throughout the City. Table 5.0 summarizes existing buildings/facilities currently used and maintained. This list does not, however, include all property under the City's ownership. **Map 3.0** identifies the location of the buildings/facilities listed in Table 1.2.

TABLE 5.0: CITY FACILITIES

FACILITY:	ADDRESS:
City Hall	910 Cleveland Ave.
Fire Station #1	901 South 2nd Street
Fire Station #2	1901 North LaVenture Road
Fire Station #3	4701 East Division Street
Library	315 Snoqualmie Street
Municipal Court and Police	1805 Continental Street
Parks and Recreation	1717 South 13th Street
Public Works Administration	1024 Cleveland Ave.
Shops and Storage	405 West Fir Street
Wastewater Plant	1401 Britt Road
Lincoln Commercial Block	712/724 South 1st Street 309 to 321 Kincaid Street
Shop/Storage	419 Milwaukee Street
Kulshan Creek Neighborhood Station	2520 Kulshan Avenue
Riverfront Plaza and Public Bathrooms	420 Gates Street

FLEET VEHICLES AND EQUIPMENT

In 2016 the City has a fleet of 230 vehicles and equipment that are maintained and repaired by City staff. This fleet includes 50 law enforcement vehicles; 26 pieces of heavy equipment; 14 garbage trucks; 18 fire and rescue vehicles; 58 passenger vehicles; as well as 64 trailers, mowers and generators.

SOLID WASTE

The Mount Vernon Solid Waste Division provides weekly solid waste collection service to all residential and commercial customers within the City limits. On average, 76 tons of garbage and yard waste is collected on a daily basis.

In addition, the Solid Waste Division operates and administers the City Yard Waste Drop off Facility where in 2015 they accepted, transported and disposed of 1,796 tons of yard waste.

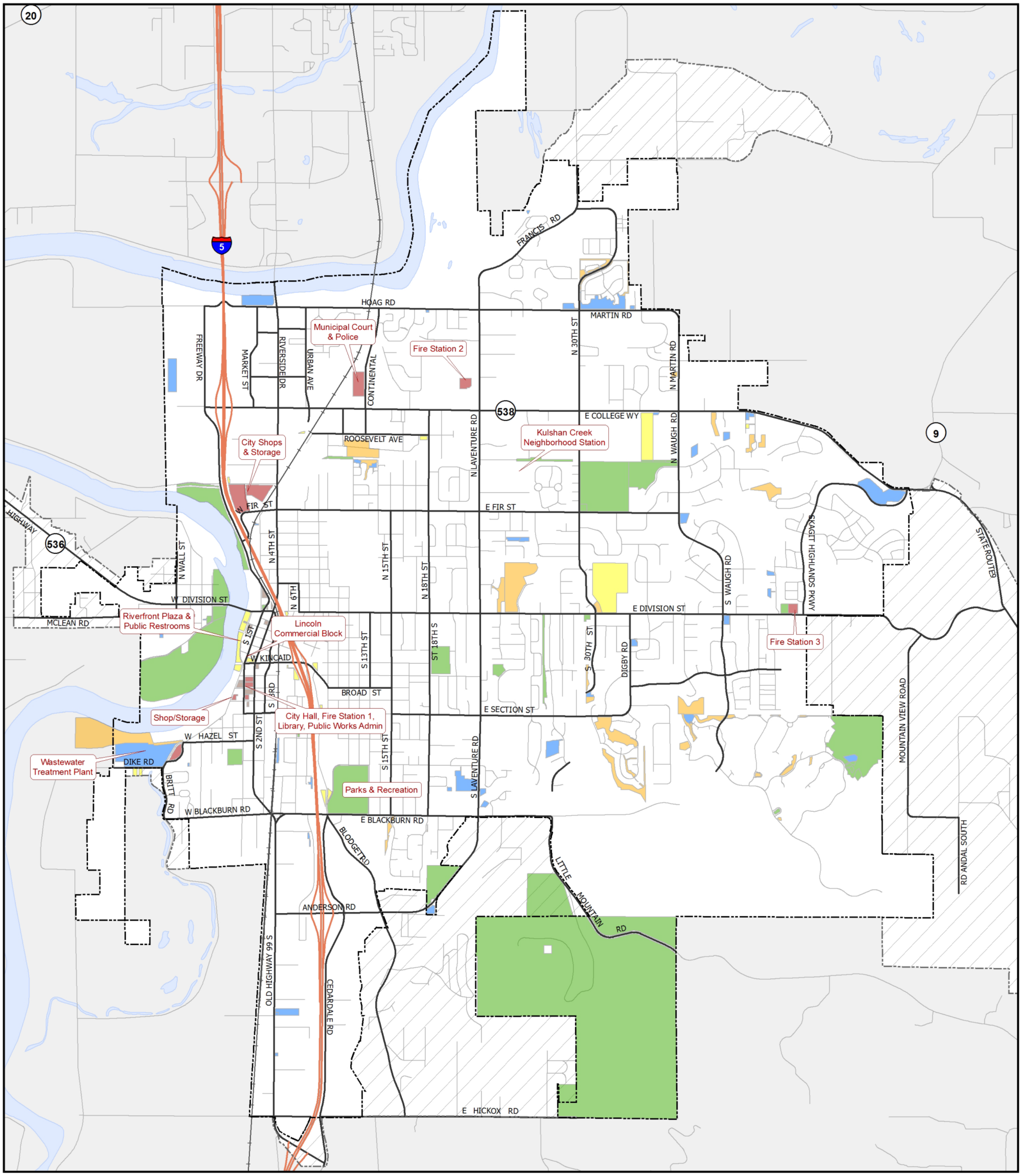
State Law (RCW 70.95) delegates the authority and responsibility for the development of solid waste management plans to counties. Other governing bodies (Cities, Tribes, and Federal agencies) may participate in the County's planning process or conduct their own plans.

State law allows cities to fulfill their solid waste management planning responsibilities in one of three ways:

- By preparing their own plan for integration into the County's plan;
- By participating with the County in preparing a joint plan; or,
- By authorizing the County to prepare a plan that includes the City.

The Skagit County Solid Waste Management Plan (SCWMP) provided a guide for solid waste activities in Skagit County. This document was prepared in response to the Solid Waste Management Act, Chapter 70.95 of the Revised Code of Washington (RCW).

Aerial map showing the City's shop facility located west of Riverside Drive between West Fir Street and Alder Lane



MAP 3.0: CITY PROPERTIES & FACILITIES

City of MOUNT VERNON

City Property Type

- General Operations
- Open Space
- Other
- Park
- Parking
- Utility
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

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Map by MV GIS 6/15/2016

6.0

MOUNT VERNON UTILITIES

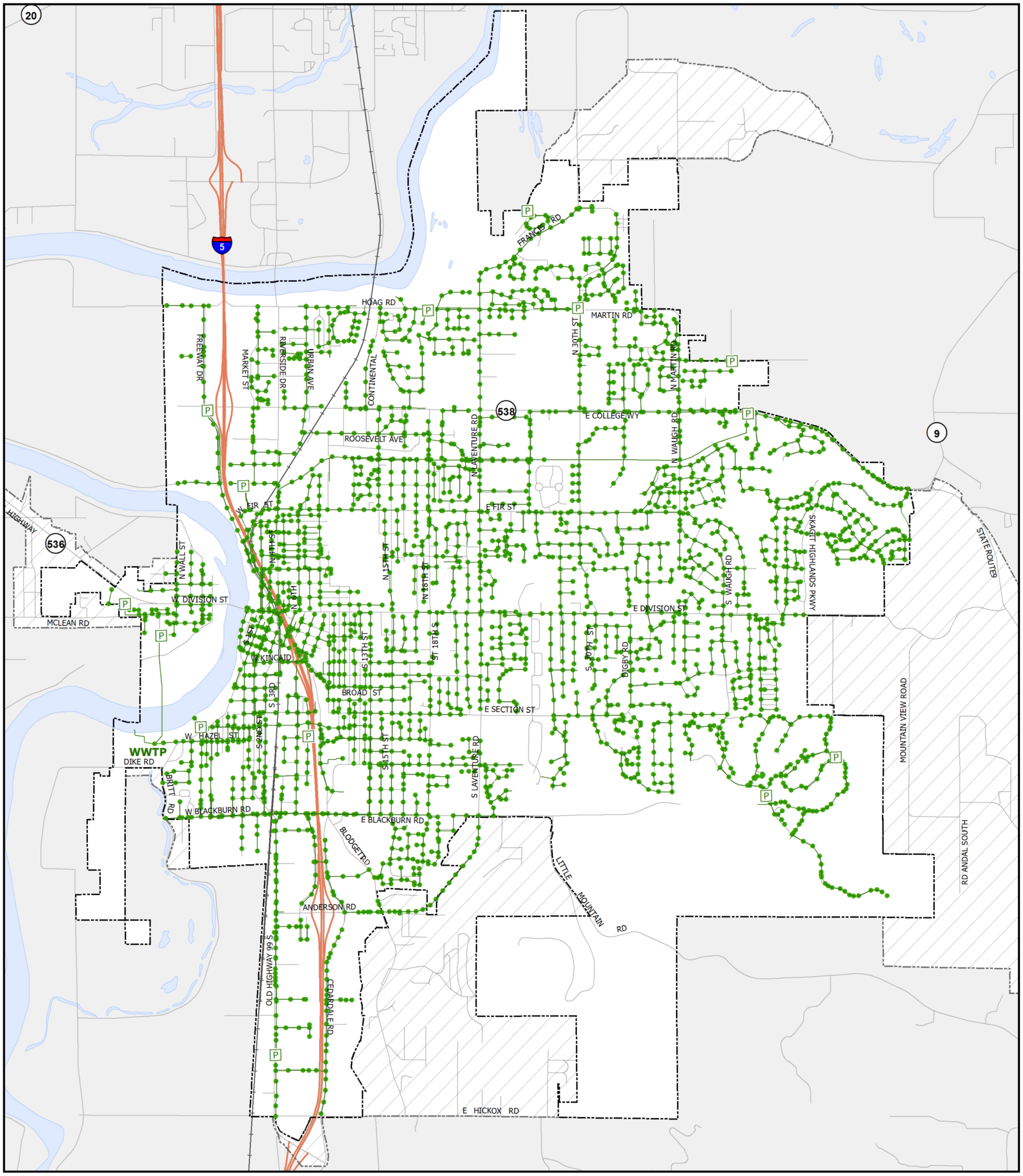
WASTEWATER

The City's Wastewater Utility is responsible for the operation and maintenance of the Wastewater Treatment Plant, 20 Pump Stations; and an extensive collection system with 17 full-time employees.

The City's goal is to minimize water quality degradation and to maintain compliance with the requirements of the City's Washington Department of Ecology Wastewater Discharge Permit. An ongoing program of sewer system repair and replacement, and enforcement of development standards, will contribute to the reduction of combined sewer overflows, sewer system infiltration and exfiltration. These efforts will promote health and safety of the public, protection of the environment, and enhance the economic vitality of the City.

Map 4 identifies the existing wastewater facilities within the City. **Appendix A** contains the following technical documents regarding the City's wastewater facilities. All three documents are hereby adopted by reference.

1. Comprehensive Sewer Plan Update dated February 2003 prepared by HDR Engineering;
2. Comprehensive Sewer Plan Amendment dated April 2004 prepared by HDR Engineering;
3. Urban Growth Area Sewer Service Study dated October 2003 prepared by HDR Engineering; and,
4. Technical Memo Regarding Population and Employment Growth Assumptions dated June 2016 from the Mount Vernon Public Works Director.



MAP 4.0: SANITARY SEWER FACILITIES

City of MOUNT VERNON

- Sanitary Sewer Pump Station
- Sanitary Sewer Manhole
- Sanitary Sewer Main Line
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

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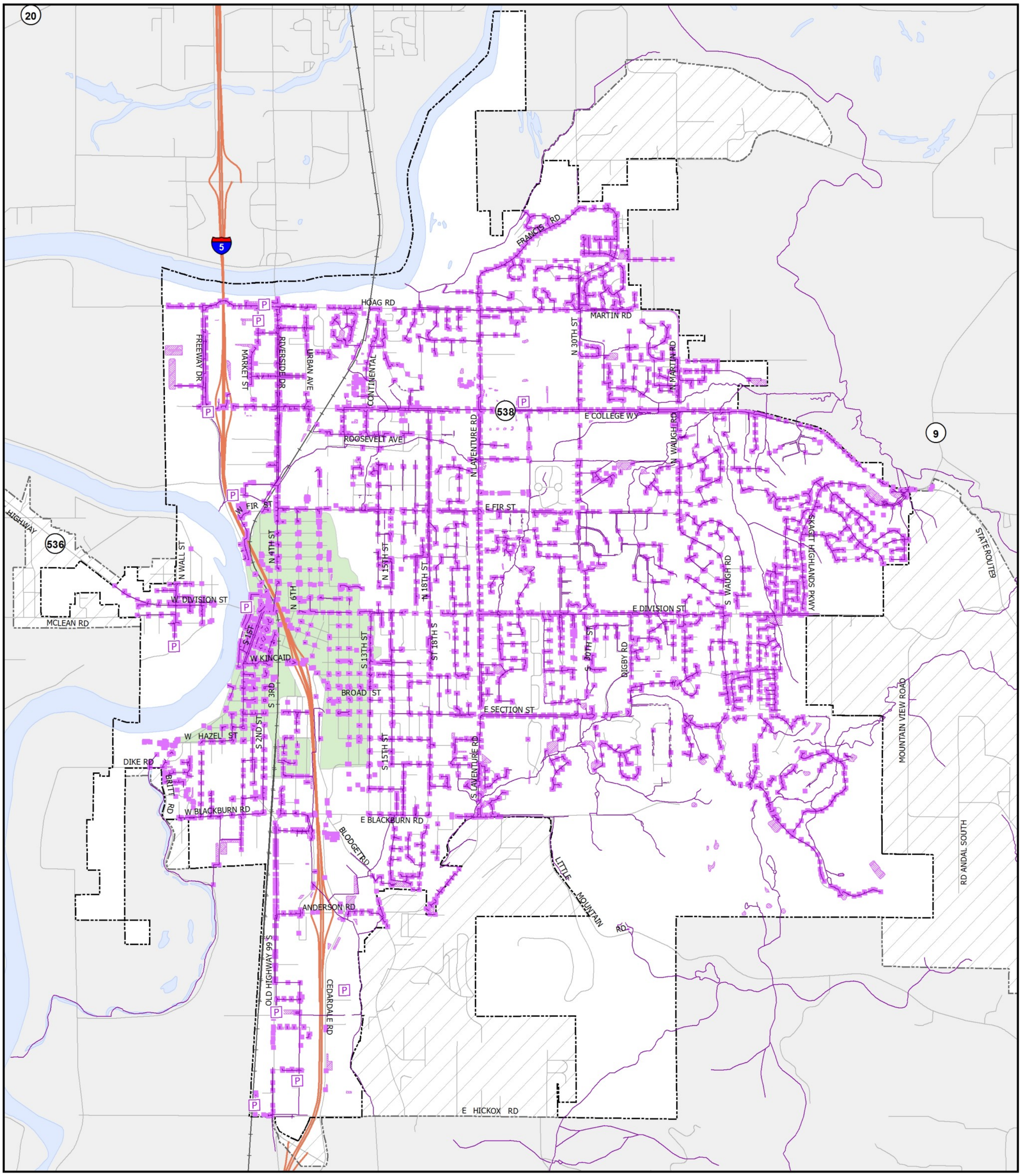
Map by MV GIS 6/13/2016

SURFACE WATER

The Surface Water Utility helps protect the life, health and property of the general public by managing the city's surface water. Specific management efforts protect water quality; control, accommodate and discharge storm runoff; provide for groundwater recharge; control sediment; stabilize erosion; establish monitoring capability; and rehabilitate stream and drainage corridors for hydraulics, aesthetics, and fisheries benefits.

Map 5 identifies major stormwater facilities within the City. **Appendix B** contains the following three technical reports that are hereby adopted by reference as specifically indicated below:

1. Comprehensive Surface Water Management Plan dated November 1995 prepared by R.W. Beck.
2. Comprehensive Stormwater Management Plan Update dated November 2004 prepared by CH2M Hill.
3. Comprehensive Stormwater Management Plan dated August 2009.



MAP 5.0: SURFACE WATER FACILITIES

City of MOUNT VERNON

- Surface Water Pump Station
- Surface Water Structure (CB/MH)
- Surface Water Conveyance Line
- Detention or Water Quality Feature
- Combined Sewer Area
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

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Map by MV GIS 6/15/2016

7.0
PUBLIC SCHOOLS

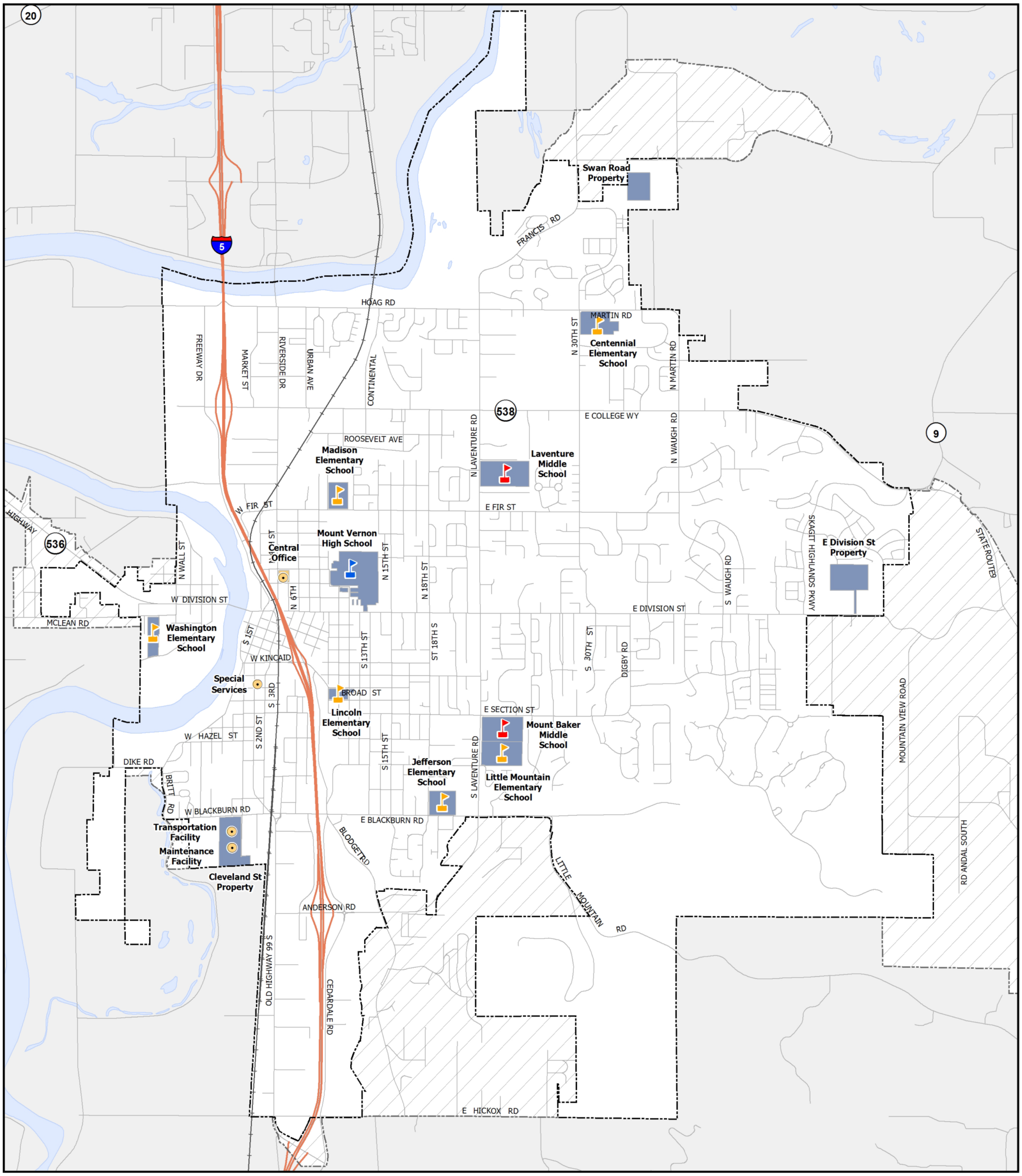
Mount Vernon School District #320 (District) provides public education to the students within the City of Mount Vernon. The district currently has six (6) elementary school sites, two (2) middle school sites and one (1) high school site. The district also has four (4) additional facilities that provide operation support functions to the schools in the form of a central office, a special services office, a transportation facility and a maintenance facility. In addition to the existing school sites the district owns the following seven (7) undeveloped sites:

+ 10-acres on East Division Road;
+ 10-acres on Swan Road;
+ 20 acres on Cleveland Street;
+ 201 Fulton (YMCA lease);
+ Lot, 1106 East Warren, (added to Mount Vernon High School);
+ Lot 1118 East Warren, (added to Mount Vernon High School); and,
+ Parking lot, 1002 South 11th Street (added to Lincoln School).

Mount Vernon School District Goals ensure:

+ Improved student learning;
+ Sound resource management;
+ Effective support systems;
+ Enhanced community partnerships and communications;
+ Quality facilities; and,
+ Participatory decision-making.

Map 6 identifies the location of the district's existing facilities. The district completed a six year capital facilities plan that is adopted by reference to this Element.



MAP 6.0: PUBLIC SCHOOL FACILITIES

City of MOUNT VERNON

- Elementary School
- Middle School
- High School
- Admin / Operations
- MVSD Owned Property
- MVSD Leased Property
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

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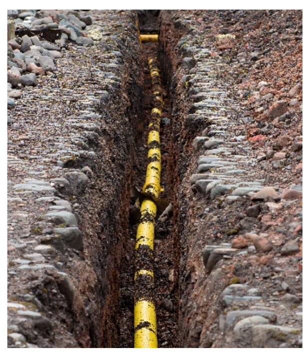
Map by MV GIS 6/15/2016

8.0
NON-CITY UTILITIES



Future non-city utility service within the City of Mount Vernon is discussed within this section. The City coordinates with these utility and service providers to ensure that adequate services will be available to existing and new development. The City recognizes utilities as key components of the infrastructure that provide critical systems and service to maintain quality of life in the City.

Skagit Public Utility District #1 provides potable water within the City, Puget Sound Energy provides electrical service and Cascade Natural Gas provides natural gas. Other utility services including: cable television, telecommunications, conventional telephone, fiber optic cable systems, cellular telephone service, and petroleum products are provided by various private companies.

The Growth Management Act (GMA) requires that a utility element address, "the general location, proposed location, and capacity of all existing and proposed utilities, including, but not limited to electrical lines, telecommunication lines, and natural gas lines. During the 2016 update process staff coordinated with all of the utility providers within the City and requested information with regard to their services. Due to the increased security measures that most utility companies put into place following the terrorist attacks in 2001 several utility companies would not provide detailed information to the City; however, following is the information that the City was able to obtain.

This element contains general goals, objectives and policies; however, it is important to keep in mind that planning for private utilities should be recognized as the primary responsibility of the utility providers. Investor-owned utilities in the State of Washington are regulated by the Washington Utilities and Transportation Commission (WUTC). Utilities under the jurisdiction of the WUTC must provide suitable facilities to supply service-on-demand. State law regulates the rates and charges, services, facilities and practices of utilities. Any change in policy regarding customer charges or the provision of services requires WUTC approval.

WATER

Public Utility District #1 (PUD) of Skagit County is a municipal corporation of the State of Washington, established to conserve the water and power resources of the State for the benefit of the people and to supply public utility service per RCW 54.

The District operates the most expansive water system in Skagit County with almost 22,000 metered services, serving roughly 55,000 people an average of 9 million-gallons of water per day. The majority of the District's services are within the Judy Reservoir System which serves the Cities of Burlington, Mount Vernon and Sedro-Woolley as well as surrounding rural and suburban areas. The District also operates remote water systems including: Fidalgo Island, Alger, Cedargrove, Mountain View, Potlatch Beach, Rockport, and Skagit View Village.

District facilities include nearly 600 miles of pipe, and over 28-million gallons worth of storage volume. A goal of the District's Capital Improvement Plan is replacement of two percent (2%) of the District's pipe annually.

Map 7 contains the approximate locations of the existing and proposed water pipes, tanks, pumps and valves that the PUD maintains.

NATURAL GAS

Cascade Natural Gas (CNG) Corporation provides natural gas service to the City of Mount Vernon. CNG builds, operates and maintains natural gas facilities serving the City of Mount Vernon. CGS is an investor owned utility serving customers throughout the State of Washington.

To serve Mount Vernon, CNG ties into Northwest pipeline near Beaver Lake. A four-and six-inch line serve the City with distribution from sites at McLaughlin and Martin and west of LaVenture Middle school. Their system fully meets existing demand. They currently provide service to approximately 75% of the urban growth areas.

CNG has indicated that they have adequate resources to meet the service needs according to their standards. The City should cooperate with them in:

+ Identifying joint use corridors;
+ Providing early notification of projects; and,
+ Optimizing extension of service to new development.

To serve future growth, the maximum capacity of the existing distribution system can be increased as required by one or more of the following:

A. Increasing distribution and supply pressures in existing lines.
B. Adding new distribution and supply mains for reinforcement.
C. Increasing existing distribution system capacity by replacement with larger sized mains.
D. Adding district regulators from supply mains to provide additional intermediate pressure gas sources to meet the needs of new development.

The location, capacity and timing of these improvements depend greatly on opportunities for expansion and on how quickly the City grows. There are usually several possible routes to connect different parts of the system. The final route taken will depend on right-of-way permitting, environmental impacts, and opportunities to install gas mains with new developments, highway improvements or other utilities.

CNG has an active policy of expanding its supply system to serve additional natural gas customers. CNG's engineering department continually performs load studies to determine CNG's capacity to serve its customers.

Customer hook-up to the distribution system is governed by CNG's tariffs as filed with and approved by the WUTC. Connection to CNG's distribution system is driven by demand, which means that connections cannot be planned in advance; rather connections are initiated by customer requests. CNG also installs service for new construction and conversion from electricity or oil to natural gas.

ELECTRICAL

Puget Sound Energy (PSE) is Washington State's largest and oldest energy utility, serving nearly 1 million electric customers primarily in the Puget Sound region, including the City of Mount Vernon.

Clean, renewable and low-cost hydropower is the backbone of PSE's power supply portfolio. PSE purchases 65% of their electricity, primarily from plants on the mid-Columbia River. The remainder is produced from their own generating facilities located in Washington and Montana.

PSE has a vast transmission system and distribution substation system that serves Mount Vernon. Future transmission systems and distribution substations will continue to be largely development driven.

It is assumed that PSE can provide adequate serves as the City develops. The City should cooperate with PSE in:

+ Design, operation and delivery of service;
+ Under-grounding utility lines; and,
+ Design standards for new electrical substations.

Priority should be given to under-grounding of existing utilities in the downtown area, being consistent with State WUT tariffs. All new development should continue to have utilities placed underground.

TELECOMMUNICATIONS

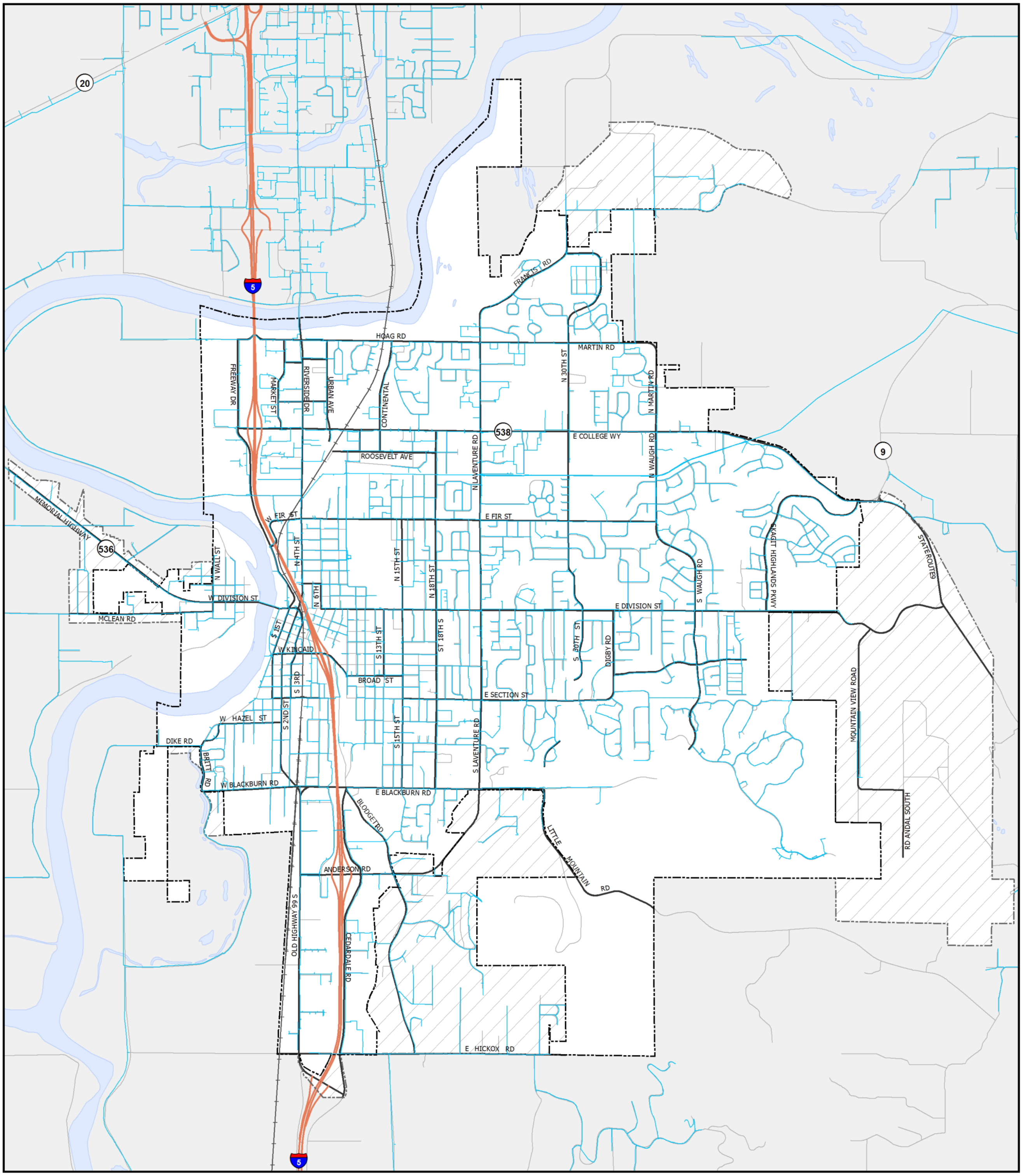
Verizon is the Incumbent Local Exchange Carrier of telecommunications services in Skagit County. All communities in Skagit County, including Mount Vernon, are served by Verizon through a 100% digital switching network supported with a mix of fiber optic and copper cable.

Fiber optic cable connects all Verizon switching offices in the County and is used for transport of data and voice traffic around the county and out to the rest of the world. A majority of the fiber system is redundantly routed which makes the network self-healing in the event of a cable cut, ensuring continuity of service.

Customers with large bandwidth requirements, can arrange for direct fiber connection to their business. Prices vary depending upon the size of fiber connection needed, distance form the existing lines to the customer location and other factors.

Cable is deployed in either aerial or buried paths, depending on factors such as terrain, environmental considerations and local ordinances. Mount Vernon is home to Verizon's first packet switching office in the United States.

Verizon works on site-specific proposals and coordinates activities with other utilities.



MAP 7.0: PUD'S POTABLE WATER FACILITIES

City of MOUNT VERNON

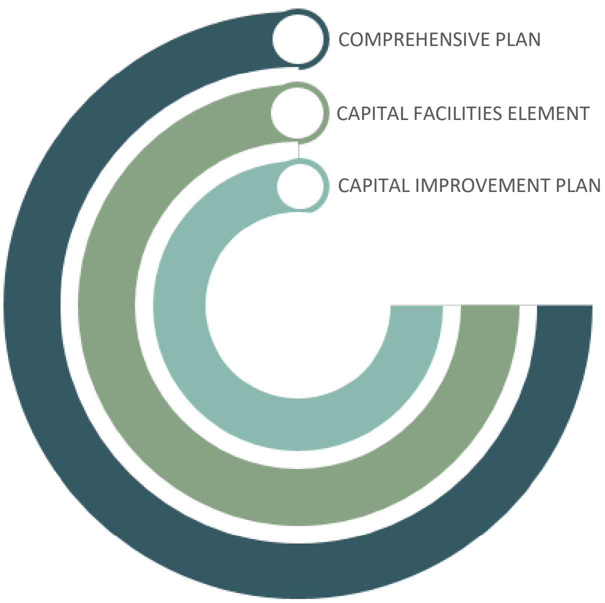
- Skagit PUD Waterline
- Railroad
- City Boundary
- Urban Growth Area
- Water Body

N

0 0.5 1
Miles

Waterline Data Courtesy of Skagit Public Utility District No 1. Map by MV GIS 6/15/2016

9.0
REVENUE



COMPREHENSIVE PLAN: planning document containing Goals, Objectives and Policies to accommodate growth over 20-year timeframes

CAPITAL FACILITIES PLAN OR ELEMENT (CFP): planning document that is part of the 20-year Comprehensive Plan related to capital facilities

CAPITAL IMPROVEMENT PLAN (CIP): 6-year planning document this is part of the CAPITAL FACILITIES PLAN that lists costs and funding methods for capital projects

The City's Capital Improvement Plan (CIP) identifies the location and cost of needed facilities, and the sources of funds that will be used to fund these facilities. Projected funding capacities are evaluated, and sources of public or private funds are identified.

The 2017 to 2022 CIP, is hereby adopted by reference as part of this Capital Facilities Plan Element (CFP) of the Comprehensive Plan and is contained within **Appendix C**. Subsequent yearly amendments to the CIP are also hereby incorporated by reference into this CFP following their adoption by the Mount Vernon City Council.

The purpose of the annual CIP update is to demonstrate that all capital facilities servicing Mount Vernon have been addressed and that capital planning has been, and continues to be, conducted to meet the City's forecasted growth.

The CFP, and related chapters, contain or refer to LOS standards for each public service and facility type. New development is to be served by adequate services and facilities, and the CFP/CIP planning facilitates that coordination. The CFP contains broader goals; whereas the CIP contains specific financial policies that implement the provision of adequate public services and facilities. The CIP is in conformity with, and implements, the goals of the Comprehensive Plan.

Together the CFP and CIP fulfills the Growth Management Act (GMA) requirement of facilities planning.

In addition, they serve as a foundation for City fiscal management and eligibility for grants and loans. The annual CIP provides coordination amongst City departments in terms of planning and coordinating for capital improvements, operating plans of departmental service providers, inter-city facilities, such as the Mount Vernon School District and Skagit Transit, and facility plans of the State, the region, and adjacent local jurisdictions.

Mount Vernon has taken care to coordinate our land use determinations based on these quantifiable, objective measures of service or facility capacity, such as traffic volume capacity per mile of road and acres of park land per capita, or average emergency response times. Mount Vernon has, based on the requirements of RCW 36.70A.070(3)(e) assessed our land use actions based on probable funding shortfalls and have reassessed our land use decisions to meet existing needs and to ensure that the land use element, capital facilities plan element, and financing plan element are coordinated and consistent. The CIP is utilized to plan 6 years of financing that will coordinate the services needs to meet expectations that are foreseen in our comprehensive planning.

CONTINGENCY MEASURES

Even though the City takes care to coordinate land use, level-of-service and capacity measures following are contingency measures the City could take should funding, level-of-service or capacity fall short.

1. The City's level-of-service (LOS) standards could be modified so that some projects no longer have a failing LOS that requires mitigation in the form of capital project(s).
2. The City could allocate additional general fund dollars to pay for capital facility projects.
3. The City could amend the land use assumptions found in the Land Use Element of the Comprehensive Plan to allow less growth thus minimizing LOS failures and the need for capital projects to correct the LOS failures.

10.0

GOALS, OBJECTIVES & POLICIES

The City has created Goals, Objectives & Policies specific to the Capital Facilities Element. These Goals, Objectives & Policies guide the City's decision making process related to capital facility issues. These goals, objectives and policies are as follows.

POLICE DEPARTMENT

CAPITAL FACILITIES GOAL 1: IMPROVE THE COOPERATION AND COORDINATION OF INTER-AGENCY POLICING EFFORTS AFFECTING THE MOUNT VERNON POLICE DEPARTMENT AND COMMUNITY.

OBJECTIVE 1.1: Continue to encourage all Skagit County police agencies to establish a common philosophy of policing, with strategic policies of a similar tone for engaging and involving the community in the delivery of our services and reducing crime, the fear that it creates and neighborhood decay.

OBJECTIVE 1.2: Study the state of police services within Skagit County. Report on what services might yet be combined, added, or deleted in the interest of efficiency and consistent service to the public.

OBJECTIVE 1.3: Develop a county-wide strategy addressing violent crime associated with investigating and monitoring gang activity.

OBJECTIVE 1.4: Support Skagit County in addressing the jail overcrowding issue.

CAPITAL FACILITIES GOAL 2: MAINTAIN DEPARTMENT EFFECTIVENESS AS THE COMMUNITY GROWS IN AREA AND POPULATION.

OBJECTIVE 2.1: Update the Police Department Staffing Plan to reflect projected changes in population and call load.

OBJECTIVE 2.2: Increase the number of police officers to stay at pace with the Staffing Plan.

OBJECTIVE 2.3: Distribute staff to effectively manage the call load and meet the needs of the community.

OBJECTIVE 2.4: Continue to be adaptable and address community issues which develop.

OBJECTIVE 2.5: Increase the CSO staffing to allow for a more efficient response to calls for service.

OBJECTIVE 2.6: Continue to hire officers and support staff which more closely reflects the makeup of our community to improve communication between the Department and the community.

OBJECTIVE 2.7: Continue to plan for increased growth and future planned annexation throughout the City.

OBJECTIVE 2.8: Define and implement a plan for having patrol officers assigned geographic areas.

OBJECTIVE 2.9: Complete a review and evaluate the need to hire a non-sworn employee to serve as a forensics investigator/part time department computer technician.

CAPITAL FACILITIES GOAL 3: PROVIDE EQUIPMENT THAT WILL IMPROVE POLICE CAPABILITY AND KEEP THE DEPARTMENT CURRENT WITH ADVANCEMENTS IN TECHNOLOGY.

OBJECTIVE 3.1: Continue to acquire updated less-lethal equipment as technology in this area improves.

OBJECTIVE 3.2: Efficiently acquire patrol vehicles and other police equipment as necessary.

OBJECTIVE 3.3: Improve officer safety with the acquisition of equipment to assist officers in the performance of their duties.

OBJECTIVE 3.4: Replace the aging and outdated multi-purpose vehicle for major crime scenes, extended investigations, and high risk incidents.

OBJECTIVE 3.5: Add digital capability to our radio system to promote better communication by all law enforcement agencies during emergencies.

OBJECTIVE 3.6: Continue to develop a community camera system that monitors streets, trails, parks, and other public areas.

OBJECTIVE 3.7: Construct an animal kennel and covered parking areas at the existing Police and Court Campus.

CAPITAL FACILITIES GOAL 4: IMPROVE THE GENERAL POLICE RECORDS FUNCTION, TO INCLUDE ISSUES OF STAFFING, ACCESSIBILITY, STORAGE AND RETENTION.

OBJECTIVE 4.1: Utilizing efficient, up to date storage methods, archive police records, and destroy hard copies as allowed by law and/or accreditation standards.

OBJECTIVE 4.2: Modify and implement the General Records Retention Schedule for the Department.

OBJECTIVE 4.3: Study and determine the necessity to increase staffing in the Records Division.

OBJECTIVE 4.4: Crime data is currently sent to Washington Association of Police Chief's and Sheriff's in summary reporting process. Develop a county-wide strategy to report crimes and arrest data using the NIBRS reporting system.

CAPITAL FACILITIES GOAL 5: DEVELOP A RELATIONSHIP BETWEEN THE DEPARTMENT AND RESIDENTS OF MOUNT VERNON THAT FOSTERS OPEN COMMUNICATION AND TRUST ON ISSUES RELATING TO COMMUNITY SAFETY AND SECURITY.

OBJECTIVE 5.1: Maintain the annual Citizen's Police Academy as a mechanism to accomplish the Department's Broad Goals.

OBJECTIVE 5.2: Steadily add neighborhoods to the Block Watch program.

OBJECTIVE 5.3: Utilize communications links such as the Department Web Site, e-mail, e-News, TV10, radio, newspaper, and neighborhood newsletters/notifications to provide educational and emergency information.

OBJECTIVE 5.4: Continue to attract potential police officer entry candidates through a wide range of strategies and tactics.

OBJECTIVE 5.5: Maintain the volunteer programs managed through the Crime Prevention Division which enhances our communication ability with the community, provides valuable feedback, and helps us police the community.

OBJECTIVE 5.6: Continue to develop a partnership with the neighborhoods which fosters two-way open communication, prevention of crime, shared responsibility, and adaptability in how we address and solve community issues which improves community safety.

FIRE DEPARTMENT

CAPITAL FACILITIES GOAL 6: PROVIDE OUR CITIZENS WITH CONSISTENTLY RAPID, EFFECTIVE RESPONSE THAT MINIMIZES THREAT TO LIFE, ENVIRONMENT AND PROPERTY. WE WILL DO THIS WITH PROFESSIONAL STAFFING FOCUSED ON MAXIMIZING THE EFFECTIVENESS OF OUR PERSONNEL, EQUIPMENT, AND TRAINING.

CAPITAL FACILITIES GOAL 7: DEVELOP AND INITIATE ALTERNATIVE SERVICE DELIVERY MODELS THAT INCLUDE A "COMMUNITY PARAMEDIC" PREEMPTIVE CLIENT VISITATION PROGRAM. THIS PROGRAM WILL BE FUNDED BY OUR MEDICAL COMMUNITY.

CAPITAL FACILITIES GOAL 8: REDUCE / MAINTAIN OUR MINIMAL FIRE LOSS FOR BOTH RESIDENTIAL AND COMMERCIAL BUILDINGS, WITH THE ULTIMATE TARGET BEING ZERO LOSS. WE WILL DO THIS THROUGH EMPHASIS ON FIRE PREVENTION, INSPECTING OUR BUSINESSES TO THE GREATEST EXTENT POSSIBLE WITH REDUCED STAFF, AND PROVIDING RAPID, WELL-TRAINED RESPONSE FIRE CALLS.

CAPITAL FACILITIES GOAL 9: EXPAND OUR COOPERATIVE RESPONSE WITH BURLINGTON TO OTHER NEIGHBORING AGENCIES TO ENHANCE OUR RESPONSE CAPABILITIES REDUCING REDUNDANCY WHILE INCREASING OUR FIRE RESPONSE.

CAPITAL FACILITIES GOAL 10: WORK WITH THE SKAGIT VALLEY COLLEGE FIRE PROGRAM TO INTEGRATE STUDENT FIREFIGHTERS INTO OUR DEPARTMENT AS PART OF THEIR LEARNING PROCESS WHILE PROVIDING SUPPORT FUNCTIONS TO CAREER AND VOLUNTEER STAFF.

CAPITAL FACILITIES GOAL 11: AT THE NEXT RATING PERIOD (36 MONTHS), RESTORE THE WSRB RATING TO CLASS 4.

CAPITAL FACILITIES GOAL 12: ACQUIRE FUNDING FROM EMS LEVY TO SUPPORT THE INCREASING DEMAND ON OUR AMBULANCE SERVICES.

LIBRARY

CAPITAL FACILITIES GOAL 13: INCREASE THE PUBLIC'S AWARENESS OF LIBRARY RESOURCES AND SERVICES.

CAPITAL FACILITIES GOAL 14: UPHOLD THE PRINCIPLES OF INTELLECTUAL FREEDOM AND THE PUBLIC'S RIGHT TO KNOW BY PROVIDING CITIZENS OF ALL AGES WITH ACCESS AND GUIDANCE TO INFORMATION AND COLLECTIONS THAT REFLECT ALL POINTS OF VIEW.

CAPITAL FACILITIES GOAL 15: FORM PARTNERSHIPS WITH REGIONAL AND NATIONAL ORGANIZATIONS IN ORDER TO PROVIDE ACCESS TO THE WIDEST POSSIBLE RANGE OF INFORMATION RESOURCES.

CAPITAL FACILITIES GOAL 16: INCREASE CURRENT FUNDING BY STRONGLY PURSUING A BROAD RANGE OF OPTIONS, INCLUDING GRANTS, DONATIONS AND SCHOLARSHIPS.

CAPITAL FACILITIES GOAL 17: CONTINUE PROVIDING HIGH QUALITY PROGRAMMING THAT PROMOTES READING AND LIFELONG LEARNING, AND PROVIDES LEISURE ENTERTAINMENT.

CAPITAL FACILITIES GOAL 18: DEVELOP SPECIALIZED SERVICES THAT ADDRESS COMMUNITY NEEDS AND ARE RESPONSIVE TO CHANGING DEMOGRAPHICS.

CAPITAL FACILITIES GOAL 19: SELECT, TRAIN AND RETAIN STAFF WHO ARE DEDICATED TO SERVING THE NEEDS OF ALL CURRENT AND POTENTIAL CUSTOMERS.

CAPITAL FACILITIES GOAL 20: UTILIZE TECHNOLOGY TO PROVIDE EFFICIENCIES THAT ENHANCE CUSTOMER SERVICE.

CAPITAL FACILITIES GOAL 21: CONTINUE WORKING TOWARD THE FUNDING, DESIGN AND CONSTRUCTION OF A NEW LIBRARY FACILITY THAT WILL BETTER MEET THE NEEDS OF A GROWING POPULATION.

GENERAL FACILITIES

CAPITAL FACILITIES GOAL 22: PROVIDE HEALTHY AND SAFE WORK ENVIRONMENTS FOR EMPLOYEES AND CITIZENS OF MOUNT VERNON.

CAPITAL FACILITIES GOAL 23: PERFORM REQUIRED MAINTENANCE ON BUILDINGS BOTH SCHEDULED AND UNSCHEDULED.

CAPITAL FACILITIES GOAL 24: IMPLEMENT ENERGY CONSERVATION MEASURES THROUGHOUT ALL CITY OF MOUNT VERNON MAINTAINED BUILDINGS. RESPOND TO COMPLAINTS AND MAINTENANCE ISSUES IN A TIMELY MANNER.

CAPITAL FACILITIES GOAL 25: CONTINUE TO PLAN AND IMPLEMENT NEW IDEAS AND MEASURES FOR ALL CITY FACILITIES.

CAPITAL FACILITIES GOAL 26: CONTINUE TO WORK TOWARDS A PROACTIVE APPROACH THEN A REACTIVE ONE.

CAPITAL FACILITIES GOAL 27: PROVIDE WELL TRAINED STAFF TO MONITOR AND MAINTAIN CITY FACILITIES

SOLID WASTE

CAPITAL FACILITIES GOAL 28: PROVIDE FOR THE SOLID WASTE, RECYCLE, AND YARD WASTE DISPOSAL NEEDS OF MOUNT VERNON CITIZENS.

CAPITAL FACILITIES GOAL 29: WORK CLOSELY WITH OTHER DEPARTMENTS, ORGANIZATIONS, AND JURISDICTIONS PROVIDING QUALITY SOLID WASTE DISPOSAL SERVICES.

CAPITAL FACILITIES GOAL 30: WORK CLOSELY WITH SKAGIT COUNTY REGARDING ANY ISSUE AFFECTING THEIR SOLID WASTE DISPOSAL RATE.

CAPITAL FACILITIES GOAL 31: ENHANCE THE PUBLIC'S UNDERSTANDING OF SOLID WASTE DISPOSAL REQUIREMENTS AND ISSUES.

CAPITAL FACILITIES GOAL 32: CONSISTENTLY PROVIDE A SOLID WASTE UTILITY THAT IS EFFICIENTLY ADMINISTERED AND MAINTAINED.

CAPITAL FACILITIES GOAL 33: IMPLEMENT EFFICIENT COLLECTION SYSTEMS TO ADDRESS BOTH RESIDENTIAL AND COMMERCIAL GROWTH.

CAPITAL FACILITIES GOAL 34: WITH THE DEVELOPMENT OF OUR MISSION STATEMENT AND GOALS, WE CONTINUE TO MAINTAIN A CLEAR UNDERSTANDING OF OUR RESPONSIBILITIES TO THE COMMUNITY.

WASTEWATER

CAPITAL FACILITIES GOAL 35: PROVIDE AND MAINTAIN A SANITARY SEWER COLLECTION SYSTEM THAT IS CONSISTENT WITH THE PUBLIC HEALTH AND WATER QUALITY OBJECTIVES OF THE STATE OF WASHINGTON AND THE CITY OF MOUNT VERNON.

OBJECTIVE 35.1: Ensure that the sanitary sewer system is adequate to meet the demands of the community.

Policy 35.1.1: Adequate sewer service capacity should be assured prior to the approval of any new development application.

Policy 35.1.2: Seek broad funding for sanitary sewer services and facilities.

Policy 35.1.3: Development should be conditioned on the orderly and timely provision of sanitary sewers.

Policy 35.1.4: Actively encourage all residents within the City to connect to public sewer.

CAPITAL FACILITIES GOAL 36: CONTINUE TO MAINTAIN COMPLIANCE WITH OUR NPDES (NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM) PERMIT.

CAPITAL FACILITIES GOAL 37: CONTINUE FINE TUNING THE OPERATION AND MAINTENANCE OF THE WASTEWATER TREATMENT PLANT TO INCREASE EFFICIENCY OF OUR TREATMENT PLANT PROCESS.

CAPITAL FACILITIES GOAL 38: CONTINUE EFFORTS IN CONVERTING SANITARY AND STORM PUMP STATIONS TO FIBER OPTIC COMMUNICATIONS.

SURFACE WATER

CAPITA FACILITIES GOAL 39: PROVIDE, MAINTAIN AND UPGRADE SURFACE WATER MANAGEMENT SYSTEMS TO MINIMIZE IMPACTS ON NATURAL SYSTEMS AND TO PROTECT THE PUBLIC, PROPERTY, SURFACE WATER BODIES, AND GROUNDWATER FROM CHANGES IN THE QUANTITY AND QUALITY OF STORMWATER RUNOFF DUE TO LAND USE CHANGES.

OBJECTIVE 39.1: Provide storm drainage collection and discharge systems that protect public and private property and the natural environment. Ensure that existing and future stormwater systems are properly operated and maintained.

Policy 39.1.1: Design storm drainage systems to minimize potential erosion and sedimentation problems, and to preserve natural drainage systems including rivers, streams, flood plains, lakes, ponds and wetlands.

Policy 39.1.2: Seek broad funding for stormwater system improvements.

Policy 39.1.3: Promote and support public education and involvement programs that address surface water management issues.

Policy 39.1.4: Storm and surface water management programs should be coordinated with adjacent local and regional jurisdictions.

CAPITAL FACILITIES GOAL 40: CONTINUE TO BUILD THE SURFACE WATER CIP PROGRAM CONSISTENT WITH THE COMPREHENSIVE SURFACE WATER MANAGEMENT PLAN. DEVELOP SURFACE WATER MANAGEMENT PROGRAMS AND STANDARDS TO ACHIEVE FULL COMPLIANCE WITH FEDERAL, STATE, AND LOCAL WATER QUALITY REGULATIONS. CONTINUE TO WORK ON THE RESTORATION OF THE STORM SEWER SYSTEMS AS PART OF THE "STORM SYSTEM RESTORATION PROGRAM".

NON-CITY OWNED FACILITIES

CAPITAL FACILITY GOAL 41: FACILITATE THE DEVELOPMENT AND MAINTENANCE OF ALL UTILITIES AT THE APPROPRIATE LEVELS OF SERVICE TO ACCOMMODATE THE GROWTH THAT IS ANTICIPATED.

OBJECTIVE 41.1: Provide an adequate level of public utilities to respond to and be consistent with existing and planned land uses within the City.

Policy 41.1.1: Promote the co-location of new public and private utility distribution lines with planned or existing systems that are both above and below ground in joint trenches and/or right-of-way where environmentally, technically, economically and legally feasible. The City understands that some utilities may have unique safety and maintenance requirements which limit their inclusion in joint use corridors.

Policy 41.1.2: Whenever a street replacement or repavement occurs the City shall coordinate with all utilities to ensure that any utility replacement or extension occurs before the street repaving or construction occurs. A five (5) year moratorium on street cuts shall be in place following the replacement or repaving of a street.

Policy 41.1.3: Encourage the appropriate siting, construction, operation, and decommissioning of all utility systems in a manner that reasonably minimizes impacts on adjacent land uses.

Policy 41.1.4: Continue to mandate the coordination of non-emergency utility trenching activities and street repair to reduce impacts on mobility, aesthetics, noise and other disruptions.

Policy 41.1.5: Where appropriate require landscape screening of utilities.

Policy 41.1.6: Identify utility capacity needed to accommodate growth prior to annexation. Do not annex areas where adequate utility capacity cannot be provided.

Policy 41.1.7: Coordinate with utility providers to ensure that the general location of existing and proposed utility facilities is consistent with other elements of the Comprehensive Plan.

OBJECTIVE 41.2: Ensure that non-City managed utilities provide service commensurate with required state and federally mandated service obligations and established safety and welfare standards.

Policy 41.2.1: Coordinate the exchange of data with utility providers. Provide utility providers with current information on development patterns and permit activity within the City. Provide relevant information on population, employment, and development projections.

Policy 41.2.2: New telecommunications and electric utility distribution lines should be installed underground within the City, where practical, in accordance with rules, regulations, and tariffs applicable to the serving utility.

Policy 41.2.3: New, reconstructed or upgraded towers and transmission lines should be designed to minimize aesthetic impacts appropriate to their surroundings whenever practical.

GENERAL CAPITAL FACILITIES

CAPITAL FACILITY GOAL 42: Ensure that an adequate supply and range of public services and capital facilities are available to provide reasonable standards of public health, safety, and quality of life.

OBJECTIVE 42.1: Provide an acceptable level of public services and capital facilities to accommodate anticipated growth

Policy 42.1.1: Assess impacts of residential, commercial and employment growth on public services and facilities in a manner consistent with adopted levels-of-service.

Policy 42.1.2: Ensure that public services and capital facilities needs are addressed in updates to Capital Facilities Plans and Capital Improvement Programs, and development regulations as appropriate.

Policy 42.1.3: Coordinate the review of non-City managed capital facilities plans to ensure consistency with the City Comprehensive Plan.

Policy 42.1.4: Ensure that appropriate funding sources are available to acquire or bond for the provision of needed public services and facilities.

City of MOUNT VERNON

Appendix A

COMPREHENSIVE SEWER PLAN, HDR ENGINEERING (FEBRUARY, 2003)
COMPREHENSIVE SEWER PLAN, HDR ENGINEERING (APRIL, 2004)
UGA SEWER SERVICE STUDY, HDR ENGINEERING (OCTOBER, 2003)
TECHNICAL MEMO, ESCO BELL (JUNE, 2016)

City of Mount Vernon
Comprehensive Sewer Plan Update
February 2003
Final

Prepared for:

City of Mount Vernon

Prepared by:

HDR Engineering, Inc.

EXECUTIVE SUMMARY

INTRODUCTION

The City of Mount Vernon (Mount Vernon) has a Wastewater Utility that plans, designs, constructs, operates and maintains the City's sewerage system, pump stations, and wastewater treatment plant. The Wastewater Utility operates as the Wastewater Division of the Public Works Department.

The Mount Vernon sewerage system consists of approximately 120 miles of sewer pipe ranging in size from 6 inches to 60 inches, 1500 manholes, 11 sewage pumping stations, and a wastewater treatment plant (WWTP). The WWTP provides primary and secondary wastewater treatment utilizing the activated sludge process, with sludge stabilization by anaerobic digestion, and chlorine disinfection. The average daily flow for the year of 2001 was 3.42 MGD. The WWTP average day design flow is 5.6 MGD, with a peak design flow of 12.0 MGD. The WWTP is staffed seven days per week, and monitored during the off hours for critical system failures.

Operation, maintenance, and repair of sewerage system, pump stations and WWTP, is provided by Wastewater Division personnel. Major sewer maintenance equipment includes: two jet/vacuum trucks, video scan equipment mounted in an 18 foot van, utility pickup, and a power rodder. Public Works' Transportation Division provides additional equipment for sewer repair work that includes an excavator, backhoe, rubber tire loader, and dump trucks.

PLANNING

The City of Mount Vernon has recently experienced the same rapid growth that is characteristic of the Puget Sound area. Sewer service is now required for many areas in the City's Urban Service Area outside those that have been studied in previous planning efforts. This growth has significant impact upon the existing and future sewer system and wastewater treatment facilities. Due to growth within the service area and continuing changes in the environmental regulations, the City has initiated planning efforts to address these issues. This has involved the completion of engineering and financial assessments to plan for the future.

The Comprehensive Sewer Plan Update - 2002 addresses the requirements of the existing combined sewer system and the developing sanitary system in order to both accommodate growth and to reduce CSOs. This is in accordance with the Revised Code of Washington (RCW) 35.67.030, which deals with sewer planning, and RCW 90.48.480, which deals with the reduction plans for combined sewer overflows. Several alternatives were evaluated in the preparation of this plan to address both of these needs. Principle concerns in the development of the plan included:

- Health and safety of the public
- Protection of the environment
- Protection of property
- Economic capability of the City

The improvements recommended in the Comprehensive Sewer Plan are consistent with the City's Comprehensive Plan. In preparing the plan, growth and CSOs were addressed together. Many of the improvements shown in the Capital Improvement Program serve both purposes.

SEWER SYSTEM

There are two major components to the sewer system. These include the collection system and the wastewater treatment facility. The collection system includes the combined sewers in the older portions of the system with combined sewer overflows and the newer portions of the collection system which are separate sanitary sewers. Improvements required for the collection system and wastewater treatment facility were determined in the 2002 Comprehensive Plan Update and are presented in this summary.

Combined Sewer Overflows

To protect water quality, the City is taking steps to achieve a reduction in the frequency and volume of untreated sewage discharges to the Skagit River. For several decades, the high flows during rainstorms have exceeded the capacity of the sewer and treatment facilities so the excess must be discharged to the Skagit River. These Combined Sewer Overflows are a legacy of the original sewers constructed in Mount Vernon and many other Northwest communities in the early 1900's which simply transported and dumped both sanitary sewage and storm water runoff directly into the nearest body of water.

The 1989 enlargement of the WWTP, construction of the Kulshan Interceptor in 1996, and construction of the Central CSO Interceptor in 1998 have reduced untreated overflows by more than 100,000,000 gallons annually. State and federal agencies require that significant CSO reductions be made at the earliest possible time.

The City of Mount Vernon has a consent decree with the Department of Ecology (DOE) to implement a multi-phase CSO reduction plan. Phase 1, which was completed in 1998, was construction of in-line storage. This in-line storage provided by the Central CSO Interceptor has dramatically reduced the overflows from 130 events per year down to 8. Phase 2 will add combined sewer flow capacity to the WWTP, and phase 3 (if needed) will construct a dedicated CSO treatment facility. The "Order on Consent" requires Mount Vernon to reduce overflow events to an average of one per year no later that January 1, 2015.

Wastewater Treatment Facility Improvements:

The existing wastewater treatment facility was reviewed for future loading conditions and anticipated future effluent flows. By increasing the hydraulic capacity and making other process improvements, the plant will have the capacity to meet future flows and loadings. In addition, these improvements will reduce the number of combined sewer overflow events. These improvements include:

- Upgrade influent pump station to 24.0 million gallons per day (mgd),
- Construct a headworks, with fine screening, grit removal, disposal, and primary sludge and scum pumping facilities,
- Construct additional primary clarifiers,
- Construct an activated sludge selector basin to improve operational stability,

- Provide chemical feed system for pH control of the activated sludge system,
- Convert the Activated Sludge Pump Station to a Return Activated Sludge (RAS) Pump Station,
- Construct additional secondary clarifiers,
- Convert from chlorine to UV disinfection,
- Upgrade the capacity of the effluent pump station,
- Construct a sodium hypochlorite system for disinfecting reclaimed water for non-potable in-plant use,
- Provide Administration Building improvements, and
- Complete outfall improvements.

On a long-term planning horizon, the WWTP will need additional improvements to meet both hydraulic conveyance requirements and load requirements and anticipated treatment requirements. Anticipated future discharge permit requirements may necessitate modifications to the process to provide nitrification. Improvements to convert the activated sludge system to a nitrification mode, hydraulic improvements, and other process or site improvements are listed as follows:

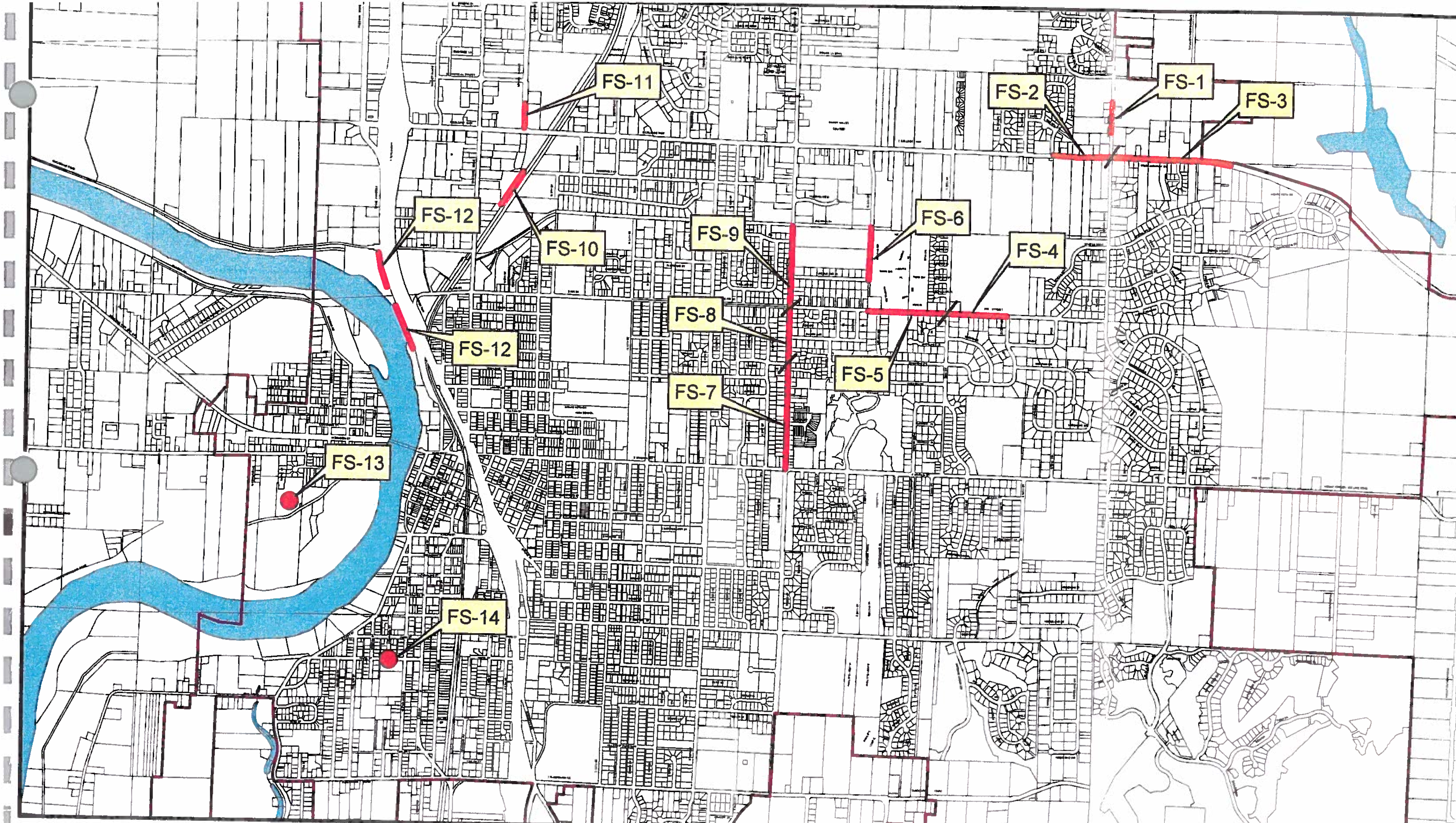
- Convert the Aeration Basin No. 4 to an Activated Sludge Aeration Basin,
- Construct additional Aeration Basins,
- Convert Secondary Clarifier No. 1 to an Aerobic Digester,
- Construct an additional Secondary Clarifier,
- Construct an additional Dissolved Air Floatation Thickener,
- Construct an additional Anaerobic Digester,
- Provide expansion to the existing laboratory,
- Provide odor control, and
- Acquire adjacent land for possible ring dike construction for flood protection, and as an odor and noise buffer.

The proposed wastewater treatment plant improvements are shown on Figure ES-1 and costs for these are presented in Table ES-1, included at the end of this summary.

Sewer System Improvements

The Mount Vernon sewer system totals approximately 120 miles of sewer pipe. Portions of the system were constructed in the early 1900's, and much of the system is 60 years or older. As a part of the Comprehensive Sewer Planning study, the interceptor conveyance system was evaluated to determine improvements that would be required for additional capacity for future growth within the existing service area. These are identified as improvements FS-1 through FS-14, summarized in Table ES-2 and shown on Figure ES-2 included at the end of this summary.

Existing City information was reviewed to determine areas where repair and replacement is recommended. This includes areas within the older combined portion of the sewer system and the typical type of defects identified included structural damage and areas where root intrusion has occurred. These are summarized in Table ES-3 along with estimated repair and replacement costs.



Note: See Table ES-2 for description of improvements

Mount Vernon Comprehensive Sewer Plan

Interceptor Improvements

Date: Dec 2002

Figure No. FS-1

Improvements for future development were determined from a model of the major interceptors of the City. Improvements required for ultimate build-out of the City are identified in the Sewer Comprehensive Plan. These improvements will be required in the future, and timing of the improvements is dependant upon actual growth patterns within the City.

Sewer Service to Areas within Urban Growth Areas

A number of improvements will be required to extend sewer service into the UGA and other developing areas. These are areas within the UGA, but not currently within the City limits. The City is presently initiating a study to determine the necessary improvements needed within each of these four areas to provide sewer service. It is the City's intent to determine the services that will ultimately be required, and then develop a phased approach that can be implemented as the need occurs. This will provide an overall cost effective system from both a capital and operating standpoint.

To allow interim development within the UGA areas that are currently without sewer, the City has adopted sewer development provisions in the City of Mount Vernon Sewer Ordinance Title 13. These provisions allow limited interim commercial and industrial development by permitting use of onsite storage systems, and allow limited residential development with onsite septic systems.

South Mount Vernon

The Mount Vernon Overall Economic Development Plan lists South Mount Vernon Planning as the number one implementation plan priority project. The 1996, Overall Economic Development Plan (OEDP) schedule for implementing the South Mount Vernon plan is 3-6 years. Sewer construction was completed for commercial areas adjacent to Old Highway 99 from Blackburn Road to Hickox Road in 2002. Sewer construction is scheduled for the commercial area adjacent to Cedardale Road from Anderson Road to Hickox Road in 2003. The extension of sewers to residential areas within the South UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

West Mount Vernon

The Plan assumes that areas to the west of Mount Vernon will remain primarily agricultural. The City has reviewed the development potential in West Mount Vernon along Memorial Highway to the UGA boundary. Based on preliminary review it appears that serving this area will require construction of 6,000 feet of gravity sewer and at least one pumping station with 3,000 feet of force main. There may be some opportunity for phasing development; however, the first phase would require construction of the pump station and force main. The collection sewers into the West Mount Vernon pump station and the pump station itself would also need to be evaluated to determine if additional improvements are required. The extension of sewers to residential and commercial areas within the West UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer Interceptors within the City boundary.

North Mount Vernon

Sewer capacity on Francis Road was improved in 2002 and is adequate for projected design flows in the Northern UGA. Sewer alignments and pump station locations for the Northern UGA have not been determined. The extension of sewers to the Northern

UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

East Mount Vernon
A significant portion of the Eastern UGA is tributary to the Big Lake Sewer System (Skagit Public Utility District No. 2). The City of Mount Vernon will coordinate with the PUD No. 2, and other stakeholders to identify and implement an efficient sewer service plan. The Comprehensive Sewer Plan proposes extending sewer along College Way to Highway 9, and South along Highway 9 to Division Street. Development of the Eastern UGA will require construction of regional pumping facilities. Pump stations that do not provide regional service will not be allowed. Sewer alignments and pump station locations for the Eastern UGA have not been determined. The extension of sewers to residential and commercial areas of the Eastern UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

SEWER UTILITY FUNDING

The City adopted a sewer rate ordinance for the years 2000 - 2004. The rate plan covers operation, maintenance, debt payment and debt coverage based on year 2000 projections.
Other funding sources include developer charges for sewer expansion and sewer repair/replacement. The Wastewater Utility is planning a review of service rates and developer charges prior to expiration of the current rate ordinance.

LEVEL OF SERVICE STATEMENT

It is the goal of the City to minimize degradation of water quality and to maintain compliance with the requirements of the City's Washington Department of Ecology Wastewater Discharge Permit. An ongoing program of sewer system repair and replacement, and enforcement of development standards, will contribute to the reduction of combined sewer overflows, sewer system infiltration and exfiltration. These efforts will promote health and safety of the public, protection of the environment, and enhance the economic vitality of the City.

CAPITAL IMPROVEMENT COSTS

Capital improvement program costs for the period from the year 2001 through 2020 are summarized in Table ES-4.

SEPA COMPLIANCE

The City of Mount Vernon has received a SEPA Determination of Non-Significance (DNS) for the Comprehensive Plant Upgrade in November 2000. A copy of the DNS is included in Appendix O.

TABLE ES-1

Recommended Improvements for the Wastewater Treatment Plant	
Improvement	Capital Cost Estimate (1,000)
Influent Pump Station	$1,6000
Headworks	$2,800
Primary Clarifiers	$1,800
Selector Basins	$600
Aeration Basins	$2,700
Chemical Feed System (pH control)	$50
Secondary Clarifiers	$3,600
UV Disinfection[2]	$1,340
Effluent Pump Station	$370
Outfall	$1,200
Sodium Hypochlorite Sytem	$100
DAFT	$400
Anaerobic Digester	$2,500
Odor Control System	$1,300
Administration Building	$500
Laboratory Expansion/Operations Center	$600
Shop and Garage	$500
Flood Protection – 100 year event	$600
Roadways	$250
Drainage Improvements	$50
TOTAL	$23,593

1. ENR Construction Cost Index 6397, October 2001.
2. UV disinfection costs include capital cost of a UV disinfection system and costs for pilot testing for two (2) months.

Table ES-2

Interceptor System Improvements						
ID No.	Location	Between	Year Required	Dia (in)[1]	Length (ft)[1]	Cost ($1,000)[2]
FS-1	Martin Road	Trumpter Rd. and College Way	As required	12	734	135
FS-2	College Way	Martin Rd and 35th Street	As required	15	548	125
FS-3	College Way	Martin Rd to Pump Station	2002	18	2,307	635
FS-4	Fir Street	30th Str. and Comanche Drive	2005	18	980	270
FS-5	Fir Street	30th Str. and 26th Street	2005	18	1,265	350
FS-6	26th Street	Jacqueline Place and Kulshan Avenue	As required	18	690	190
FS-7	LaVenture Road	Division Str. and Cascade Street	As required	10	1,525	235
FS-8	LaVenture Road	Cascade Str. and Fir Street	As required	10	495	75
FS-9	LaVenture Road	Fir Str. and Kushan Avenue	As required	12	1,386	255
FS-10	Alder Lane Interceptor	Burlington Northern Railroad of Roosevelt Avenue	As required	24	600	220
FS-11	Urban Avenue	North of College Way	As required	12	375	70
FS-12	Freeway Drive	River Bend Road and Cameron Way	As required	12	1,309	240
FS-13	West Mount Vernon	Modify Pump Station	As required			150
FS-14	Central CSO Regulator	Add Fail-Safe Gate Operator	2001			30

1. Improvements are based on saturated development, based on the UGA boundary, 100 gpcd, 1, 100 gpad (inflow and infiltration), and L.A. Peaking curve.
2. Costs are based on ENR Cost index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.

TABLE ES-3

Collection System Improvements					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-1	Snoqualmie, MH B29A to MH B29	Root intrusion	Video[2]	Remove roots and Slipline with 300 LB	$20
CS-2	Yard of house 1115 N0. 8th, MH 49 to MH 50	Root intrusion	Video[2]	Remove roots and Slipline with 250 LB	$20
CS-3	So. 7th and Jefferson to So. 7th and Washington, MH 39 to MH 37	Root intrusion	Video[2]	Remove roots and Slipline with 450 LB	$20
CS-4	No. 6th and Lawrence, MH C39 to MH C38	Root intrusion	Video[2]	Remove roots and Slipline with 320 LB	$20
CS-5	Brick Hill, MH 01, North along I-5	Root intrusion	Video[2]	Remove roots and Slipline with 400 LB	$20
CS-6	Blodgett Rd to North of Blackbur, MH 55 to MH 54	Root intrusion	Video[2]	Remove roots and Slipline with 270 LB	$20
CS-7	Kincaid, MH 25, to MH 23	Root intrusion	Video[2]	Remove roots and Slipline with 240 LB	$20
CS-8	So. 20th, North off Section, MH 32 to MH 31	Root intrusion	Video[2]	Remove roots and Slipline with 120 LB	$20
CS-9	Section, MH D33 to between MH D32-D31	Structural Damage	Video[2]	Replace with 420 LF of 8-inch pipe	$50
CS-10	Alley between Douglas and Walter, MH A13 to A05	Structural Damage	Video[2]	Replace with 640 LF of 8-inch pipe	$75
CS-11	107 Cedar to the South, MH F11 to F29	Structural Damage	Video[2]	Replace with 300 LF of 8-inch pipe	$45
CS-12	No. 6th, MHF13 to F14	Structural Damage	Video[2]	Replace with 400 LF of 8	$60
CS-13	Section and Rail Road Ave, MH E17 to E18	Structural Damage	Video[2]	Sport repair-verify grease problem is corrected	$5

Table ES-3 cont.

Collection System Improvements					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-14	Broadway at alley between So. 9th & 10th, MH D41 to D40	Structural Damage	Video[2]	Slipline with 330 LF	$20
CS-15	Broad, east of So. 11th, MH 54 to MH 49	Structural Damage	Video[2]	Replace with 230 LF of 8-inch pipe	$20
CS-16	Line under I-5	Structural Damage	Video[2]	Will require further	--[4]
CS-17	Alley, north of Division, east of No. 11th, MH C66 to C65	Structural Damage	Video[2]	Spot Repair	$5
CS-18	Bernice, east of So. 14th, MH G42 to G41	Structural Damage	Video[2]	Spot Repair	$5
CS-19	So. 3rd and Vera, MH A41 to I42	Structural Damage	Video[2]	Pipe has been	--
CS-20	Lawrence and 7th, MH C73	Structural Damage	Video[2]	Spot Repair	$5
CS-21	1224 12th Str. So, between MH G8 and G11	Structural Damage	Video[2]	Replace with 200 LF of 8-inch pipe	$25
CS-22	117th North 8th Str.	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-23	420 E. Fulton	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-24	919 W. Division	Flooding	Data Base[3]	No improvements-surface flooding problem	--
CS-25	Alley at Carpenter, between So 9th and so. 10th heading north to Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-26	1120 No 16th, 340 ft north of MH M68 on Florence and 16th	Cracked Pipe	Data Base[3]	Spot Repair	$5

Table ES-3 cont.

ID No.	Location	Defect	Defect Identified Via	Improvement	Cost ($1,000)[1]
CS-27	1210 N. 14th, north of Florence and 14th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-28	8th Str. And Evergreen heading north, F18 to F15	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-29	7th and Warren, toward Fulton, MH C73 to C72	Cracked Pipe	Data Base[3]	See 8th Str. Section	--[5]
CS-30	16th and Blackburn heading east 17th, J08 to J09	Obstruction	Data Base[3]	Jet main and monitor flows	--
CS-31	100 Washington-storm line going to SE under I-5, MH C19 to C20	Cracked Pipe	Data Base[3]	Will require further assessment	--[4]
CS-32	Scott's Bookstore, N 1st to N 1st and Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-33	Snoqualmie St. between Cleveland and S 2nd Str. MH B32 to B03	Cracked Pipe	Data Base[3]	Reassess slipline if necessary	--
CS-34	Westside of Christenson Seed West to So 3rd, MH E01 to A39	Infiltration	Data Base[3]	Spot Repair	$5
CS-35	Cleveland and Blackburn to just West of Harrison and Blackbum, MH J11 to J09	Inflitration, Joint problem	Data Base[3]	Slipline 300 LF	$20
CS-36	N Laventure just south of E Fir to N Laventure just north of E Fir, MH N06 to N04	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-37	North of Casecade Str., on N Laventure to S of E Fir on Laventure, MH N08 to N06	Root intrusion	Data Base[3]	Reassess slipline if necessary	--

Table ES-3 cont.

ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-38	N Laventure, Fulton to Cascade, MH N12 to N10	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-39	Hoag Rd., Parkway Dr., to Hoag Rd	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-40	Lind Str. And S. 6th to N on S 6th, MH E76 to E75	Infiltration	Data Base[3]	Spot Repair	$5

[1] Costs are based on ENR Cost Index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.
[2] Defect identified via review of video records.
[3] Defect identified via review of City Sewer Data Base.
[4] Interstate-5 Crossings are estimated at $750,000 for all nine improvements.
[5] 8th Street improvements have been estimated at $1,000,000 to correct the localized surcharging.

Table ES-4

Capital Improvement Program Cost ($1,000)[1]				
Year(s)	Wastewater Conveyance System[1]	Wastewater Treatment Facility[1]	Combined Sewer System Treatment[2]	Total[1]
2001	$570	$0	$0	$570
2002	$635	$350	$0	$985
2003	$1,000	$1,200	$0	$2,200
2004	$750	$11,940	$0	$12,690
2005	$620	$0	$0	$620
2006	--[3]	$0	$0	$0
2011-2020	$2,510	$9,800	$9,100	$21,410
TOTAL	$6,085	$23,290	$9,100	$38,475

1. ENR Construction Cost Index 6397, October 2001.
2. Detailed costs are provided in Chapter 5 and Chapter 10.
3. Improvements during these years are expected to be identified as necessitaty dictates, and costs are included in the future cost estimates.

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ABBREVIATIONS

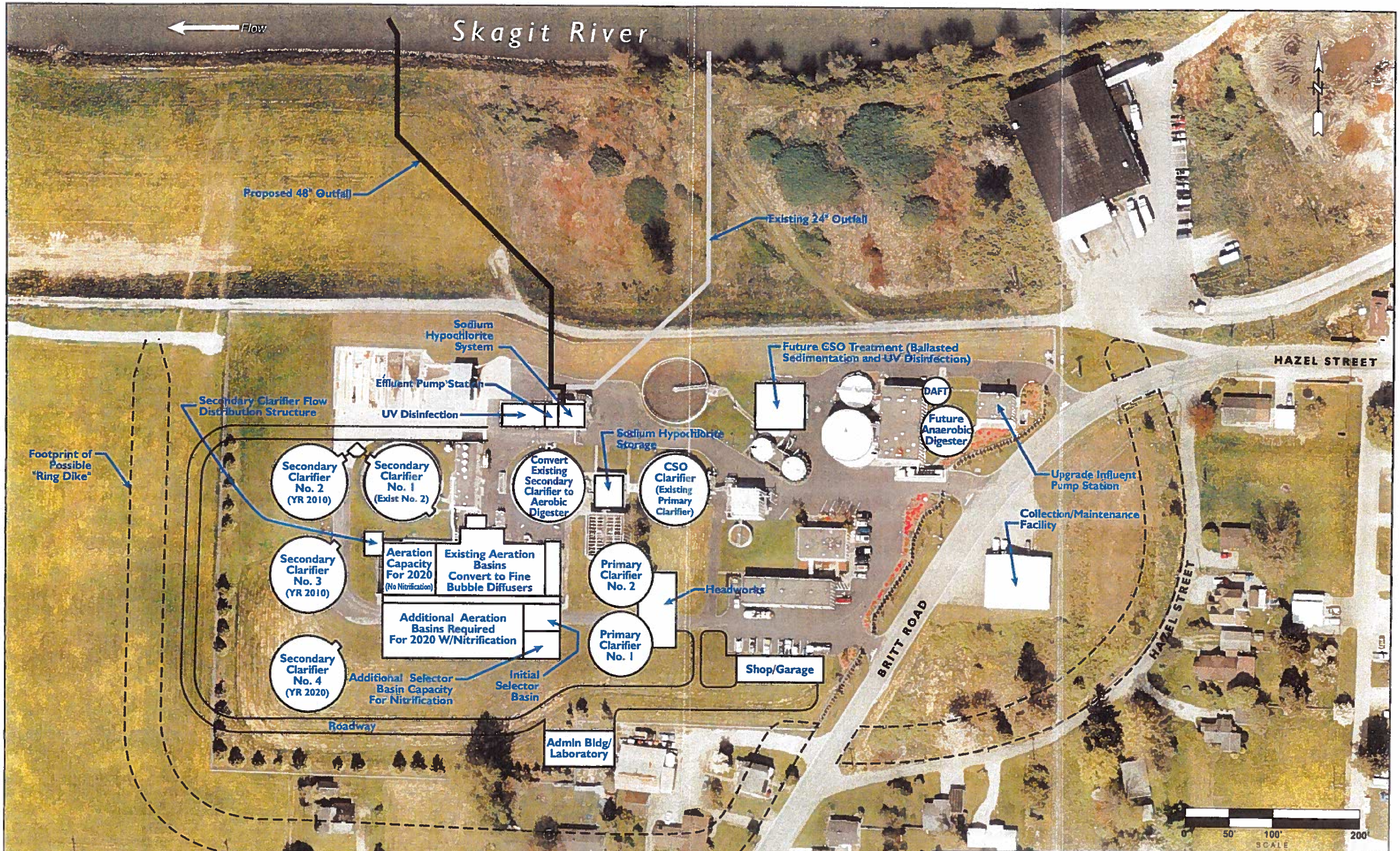
ac	Acre
ADMM	Average Day Maximum Month
AKART	All known, available, and reasonable methods of treatment
BAT	Best Available Technology Economically Achievable
BE/BA	Biological Evaluation/Biological Assessment
BOD	Biochemical Oxygen Demand
BPT	Best Practical Control Technology Currently Available
$CBOD_5$	Carbonaceous 5-day biochemical oxygen demand
cf	Cubic feet
cfs	Cubic feet per second
cfu	Colony forming units
cfu/100 mL	Colony forming units per 100 milliliters
CSO	Combined Sewer Overflow
DAF	Dissolved air flotation
DAFT	Dissolved Air Floatation Thickener
DO	Dissolved oxygen
DOE	Department of Ecology
DVF	Draper Valley Farms, Inc.
EPA	Environmental Protection Agency
FEB	Flow equalization basin
fps	Feet per second
ft/mg	Feet per million gallons
GMA	Growth Management Act
gpad	Gallons per acre per day
gpcd	Gallons per capita per day

ABBREVIATIONS

gpd	Gallons per day
gpd/sf	Gallons per day per square foot
gpm	Gallons per minute
HGL	Hydraulic grade line
hp	Horsepower
HRT	Hydraulic residence time
kcf	1,000 cubic feet
kW	Kilowatt
KWhr	Kilowatt-hour
lb/day	Pounds per day
lb/d-sf	Pounds per day per square foot
lb/hr-sf	Pounds per hour per square foot
LF	Linear foot
LS	Lump sum
mg	Million gallons
mg/L	Milligrams per liter
mgd	Million gallons per day
mL/L/hr	Milliliters per liter per hour
MLSS	Mixed Liquor Suspended Solids
NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
OFR	Overflow Rate
ppcd	Pounds per capita per day
ppd	Pounds per day
psi	Pounds per square inch
RAS	Return activated sludge

ABBREVIATIONS

scfm	Standard cubic foot per minute
sf	Square foot
SRT	Solids residence time
TMDL	Total maximum daily loads
TSS	Total Suspended Solids
UGA	Urban Growth Area
UV	Ultraviolet disinfection
VSS/kcf-d	Volatile suspended solids per 1,000 cubic feet per day
WAC	Washington Administrative Code
WAS	Waste Activated Sludge
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WLA	Waste Load Allocations
WSEL	Water surface elevation
WWTP	Wastewater Treatment Plant



Project Title	Date
MOUNT VERNON COMPREHENSIVE SEWER PLAN	FEBRUARY 2003
Sheet Title: RECOMMENDED WWTP IMPROVEMENTS SITE PLAN	Figure No: ES-1

1. INTRODUCTION

AUTHORIZATION

In May of 2000, the City of Mount Vernon authorized HDR Engineering to proceed with updating the City's Comprehensive Sewer Plan.

PURPOSE

The purpose of this update was to investigate and review the existing wastewater conveyance system and wastewater treatment facility. This included a review of the system operation and development of an improvement plan to meet future system needs. The development of this plan included:

- Reviewing existing flows and loads and estimating future flows and loads.
- Assessing the capability of the existing conveyance system and wastewater treatment plant to meet existing and future flows and loads.
- Develop the least costly system improvements to meet existing and future requirements.

The results of these investigations are presented in this report as a plan for expansion, operation, and maintenance of the wastewater conveyance system and wastewater treatment facility to comply with the requirements of the Washington State Department of Ecology as set forth in their rules and regulations, WAC 173-240 and WAC 173-245.

ACKNOWLEDGEMENTS

The suggestions, contributions, and assistance provided by the City's staff were invaluable in the preparation of this report.

2. SYSTEM DESCRIPTION

SYSTEM BACKGROUND

Mount Vernon, Washington, is situated approximately half way between Seattle and the Canadian Border. It ranks first in size among the major communities in Skagit County.

Potable water supply to Mount Vernon is provided by the Skagit County Public Utility District (PUD) No. 1, the eleventh largest water provider in the State of Washington. Water diverted from the Cultus Mountain streams is stored in the recently upgraded 1.45 billion gallon Judy Reservoir. After Treatment at the Judy Reservoir Water Treatment Plant, finished potable water is supplied to Mount Vernon via the existing transmission pipeline. At present, the Skagit County PUD No. 1 is constructing a Skagit River Pump Facility to provide an alternate raw water supply to the Judy Reservoir, expanding the treatment capacity of the water treatment plant, and constructing of a new transmission line to Mount Vernon.

At present, the maximum pumping capacity to Mount Vernon is 18 million gallons per day. The annual average consumption is estimated to be 7 million gallons per day; the annual peak consumption is 14 million gallons. Basic charge is $11.40 per month per single family dwelling. From 0 to 600 cubic feet the charge is $1.43 per c.f.; over 600 cubic feet the charge is $1.93 per c.f. There is a $10 connection fee, and first-time users are required to make a $100.00 refundable deposit.

The City of Mount Vernon provides the wastewater services and the following sections provide a summary description of the existing system.

OWNERSHIP AND MANAGEMENT

The City of Mount Vernon provides treatment and conveyance of domestic, industrial, and commercial wastewaters within the City's UGA. The one large industrial customer currently served is Draper Valley Farms, Inc. which is a chicken processing facility.

EXISTING FACILITIES INVENTORY

Summary

The existing sewer system consists of both sanitary and combined sewers. The combined sewers are limited to the older portions of the City. Gravity sewers range in size from 6-inch to 60-inch pipes. Combined service area is approximately 2 square miles and the separated service area covers approximately 14 square miles. The total service area is served by approximately 120 miles of pipe. A majority of the pipe materials are concrete, but clay, corrugated metal, and PVC have also been utilized. Major interceptors, pump stations, combined sewer overflow structures, and the wastewater treatment plant are identified below.

Interceptors

The major interceptors in the City are:

- Central Interceptor;
- West Interceptor;
- Kulshan Interceptor;
- Alder Lane Interceptor; and
- Southeast Interceptor.

These convey all flows to the wastewater treatment plant.

Pump Stations

Mount Vernon's wastewater flows are conveyed to the treatment plant through a series of pump stations. The conveyance system pump stations are presented in Table 2-1.

Table 2-1

City of Mount Vernon's Sanitary Sewer System Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Firm Pumping Capacity (gpm)**
Alder Lane	Submersible	4	2,800
East College Way	Submersible	2	380
Hoag Road	Submersible	2	200
Martin Road	Submersible	2	200
Freeway Drive	Submersible	2	350
Maple Way	Wet well/dry well	2	800
West Side No. 2	Submersible /grinder	2	100
Hazel Street	Submersible	2	150

Table 2-1 cont.			
City of Mount Vernon's Sanitary Sewer System Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Firm Pumping Capacity (gpm)**
19th Street	Submersible	2	280
Division Street	Submersible	2	160
Eaglemont Pump Station No.1	Submersible	2	560
Eaglemont Pump Station No.2	Submersible	2	620
South Mount Vernon	Submersible	2	

Combined Sewer Overflow Structures

Overflows from the combined sewer portions of the City are diverted at three overflow structures to two overflow pump stations. The overflow structures are located at First Street and Freeway Drive, Division Street under the Second Street Overpass, and Park Street at Harrison Street. The overflows from the Freeway Drive and Division Street structures flow together to the Division Street Pump Station. Overflows from the Park Street structure flow to the Park Street Pump Station. The overflow pump stations discharge directly to the Skagit River. A detailed description of the CSO system is presented in Chapter 4.

Wastewater Treatment Facility

The existing WWTP liquid stream processes consists of coarse bar screens followed by the Influent Pump Station, which pumps to a comminutor. Flows from the West Mount Vernon Pump Station combine with the influent pump station flows at the comminutor and flow through the primary clarifier. The liquid stream continues to the activated sludge pump station, aeration basins, secondary clarifiers, chlorine mixing chamber, chlorine contact basin, and effluent pump station. Effluent is discharged to the Skagit River via a 24-inch outfall.

The existing WWTP solids stream processes consists of primary sludge thickening (via a gravity thickener) and waste-activated sludge thickening (via a dissolved air floatation thickener), anaerobic digestion, biosolids dewatering via belt filter press, and biosolids storage.

3. Basic Planning Data

The basic planning data used to predict the City's future land use and wastewater flows and loads are presented in this chapter. Population growth projections for the City of Mount Vernon from the Office of Financial Management and the urban growth area define the future needs of the City.

Introduction

The City of Mount Vernon's current Comprehensive Sewer and Combined Sewer Overflow Reduction Plan was adopted by the City Council in 1994 and approved by the Department of Ecology (DOE) in 1995. In October 1995, a Wastewater Treatment Plant Evaluation was prepared that identified improvements that would be required to provide treatment of combined sewer flows as required by the City's Consent Decree with Department of Ecology. The 1995 report also identified treatment plant improvements required to accommodate growth in the service area. Since the publication of the1995 report, the City has constructed the Kulshan Intercepter and the Central CSO Regulator. This pipeline provides inline storage for combined sewer flows that would have otherwise overflowed to the Skagit River. In November 1998 a Draft Wastewater Flow and Organic Load Projection Report was prepared for the City. At the time the 1998 report was developed, less than a year of operational data from the Central CSO Regulator was available.

The following chapter revises the wastewater flow and load projections for the City based on additional operating data.

Related Plans

This Comprehensive Sewer Plan Update builds on the previous studies and plans prepared for the City of Mount Vernon, which include:

- 1994 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan
- 1995 City of Mount Vernon Wastewater Treatment Plant Evaluation
- 1998 Wastewater Flow and Organic Load Projection Report
- 2000 Mount Vernon WWTP Mixing Zone Study

Service Area Characteristics

Background

Mount Vernon has historically provided sewer service within the Urban Growth Area. Increased conveyance and treatment issues are currently being addressed with this study. Recommended improvements for combined sewer overflow issues are addressed in Chapter 4.

Geography

The City of Mount Vernon slopes south and west towards the Skagit River. Interstate 5 runs along the western side of the service area. Levees protect the City from flooding by the Skagit River.

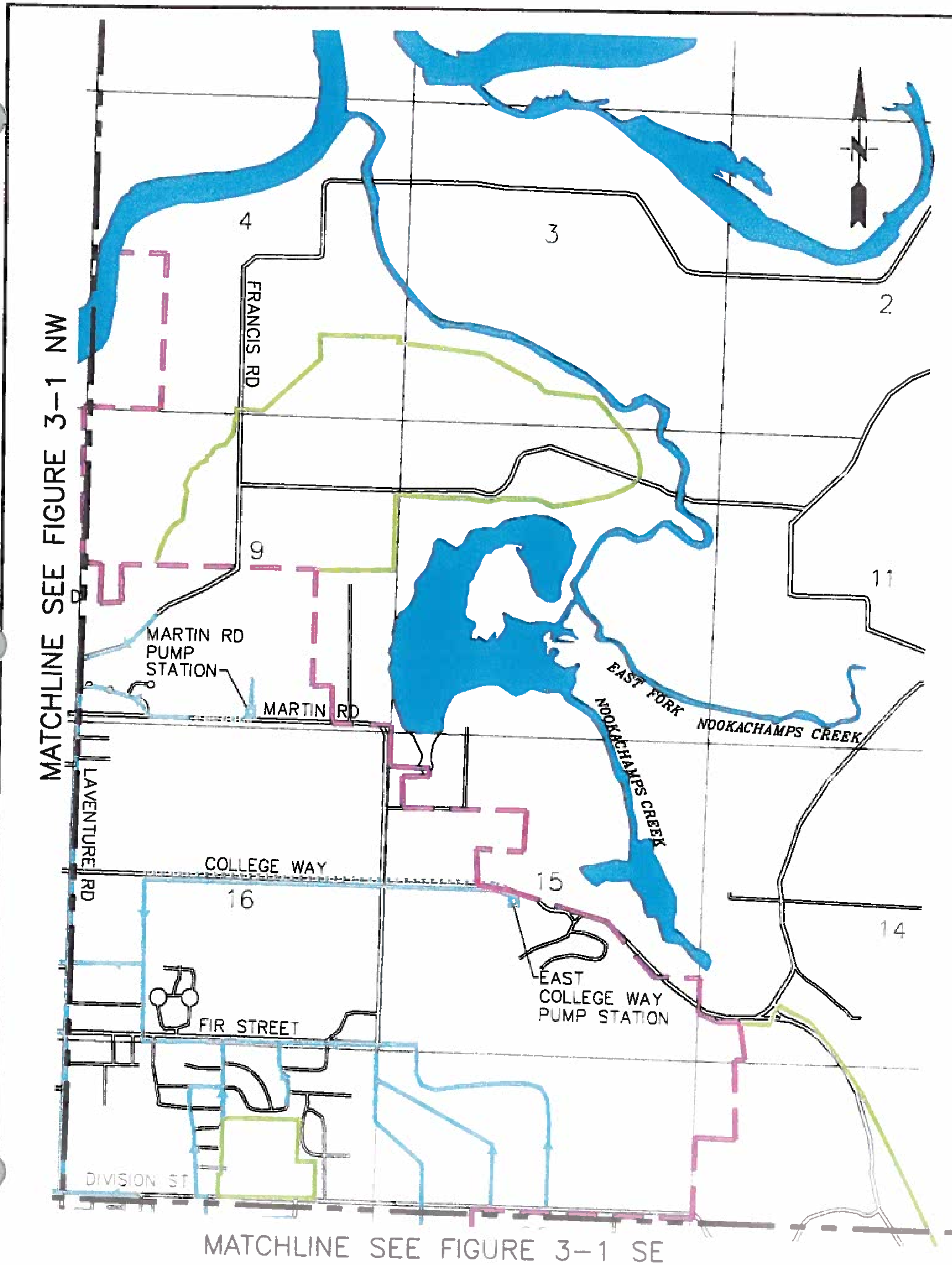
Existing Sewer Service Area

The existing sewer service area is comprised of connections within the City limits and near future service area. Figure 3-1 delineates the existing sewer service area boundary.

UGA Sewer Service Area

The planning period for this study is 20 years, with 10- and 20- year projections starting in 2000.

The future sewer service area is the UGA boundary identified by the Skagit County Comprehensive Plan and is delineated graphically in Figure 3-2.



HDR Engineering, Inc

MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

EXISTING COLLECTION SYSTEM

3-1 NE

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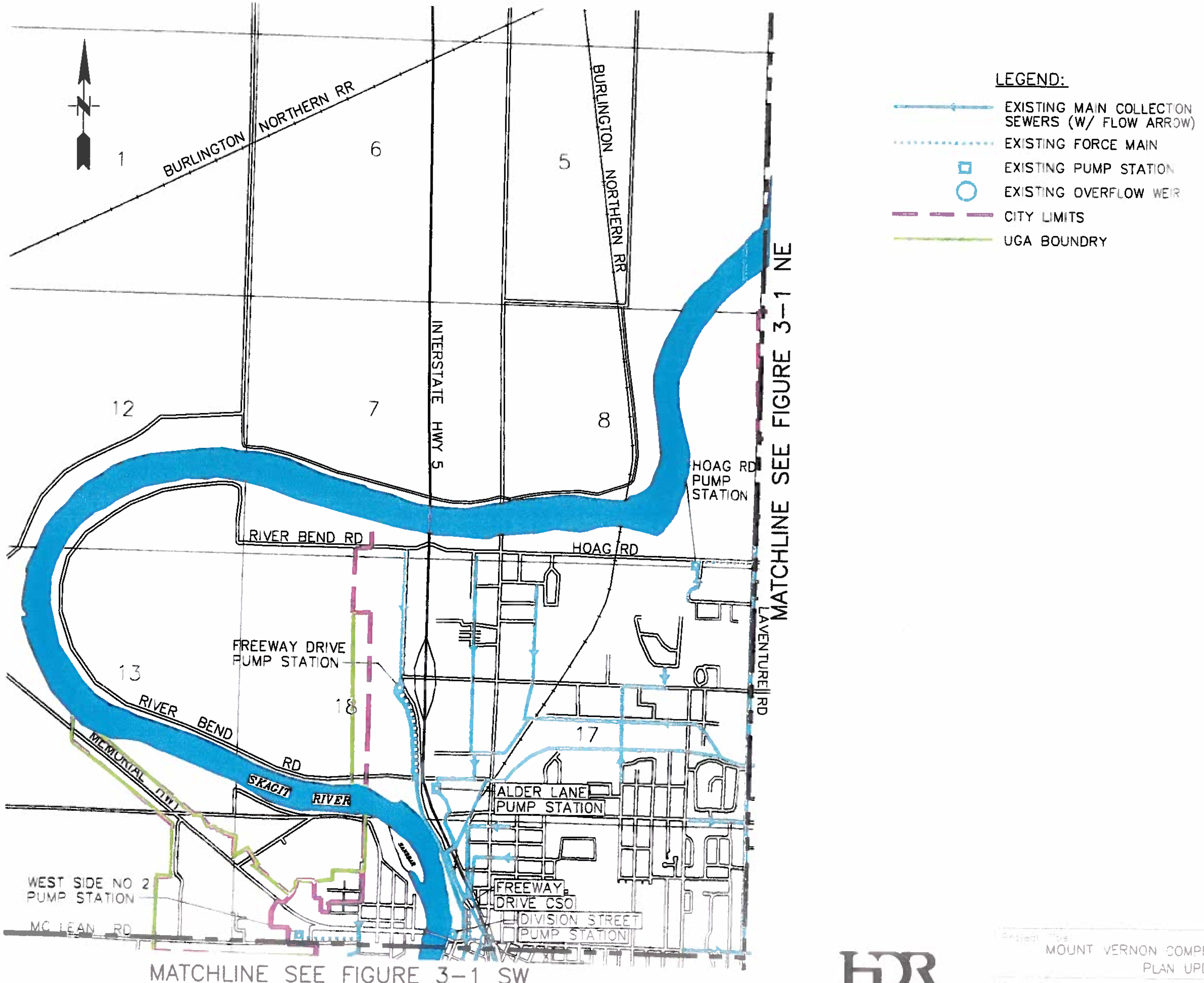
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

EXISTING COLLECTION SYSTEM

3-1 SE



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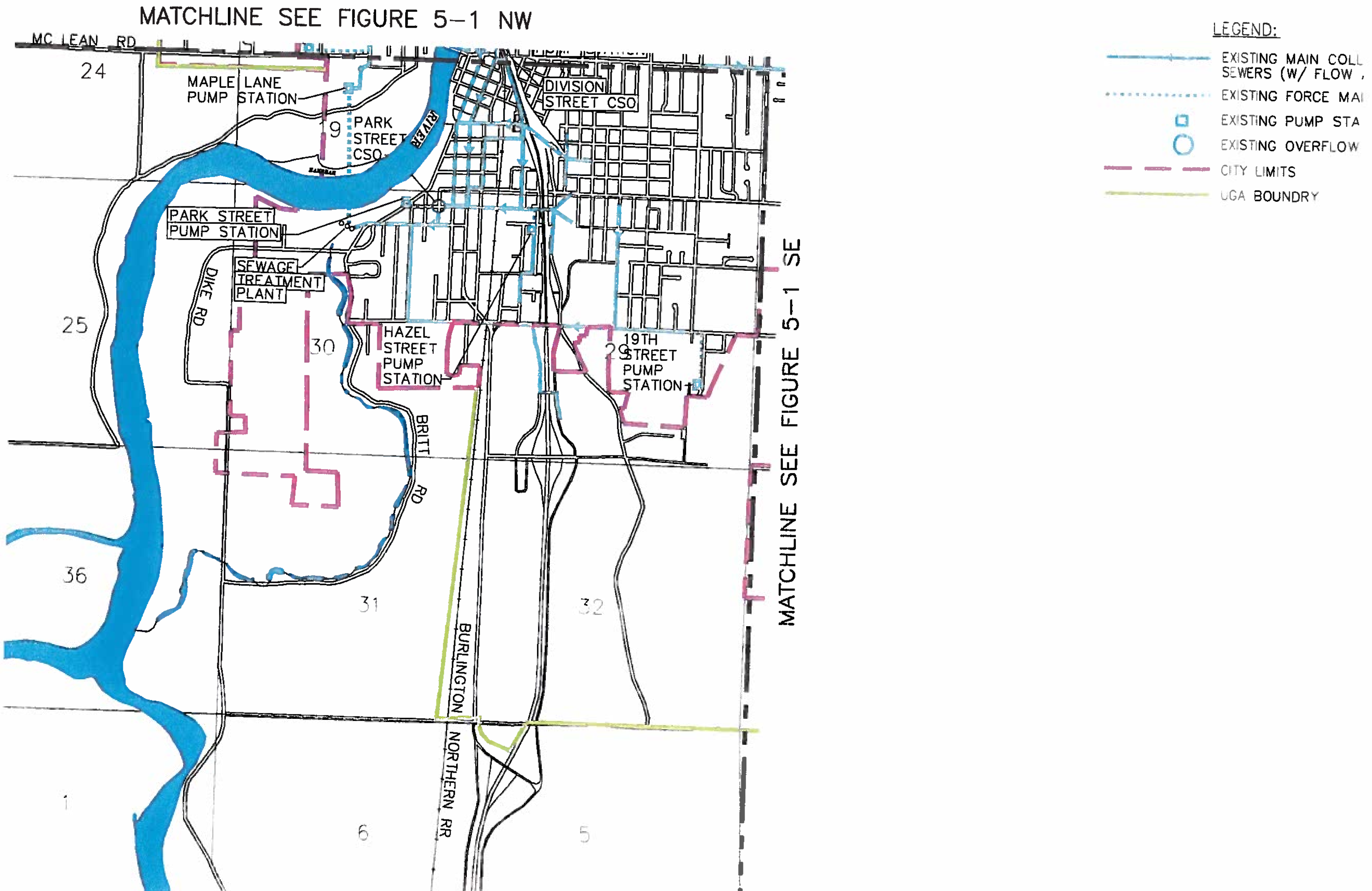
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

EXISTING COLLECTION SYSTEM

3-1 NW



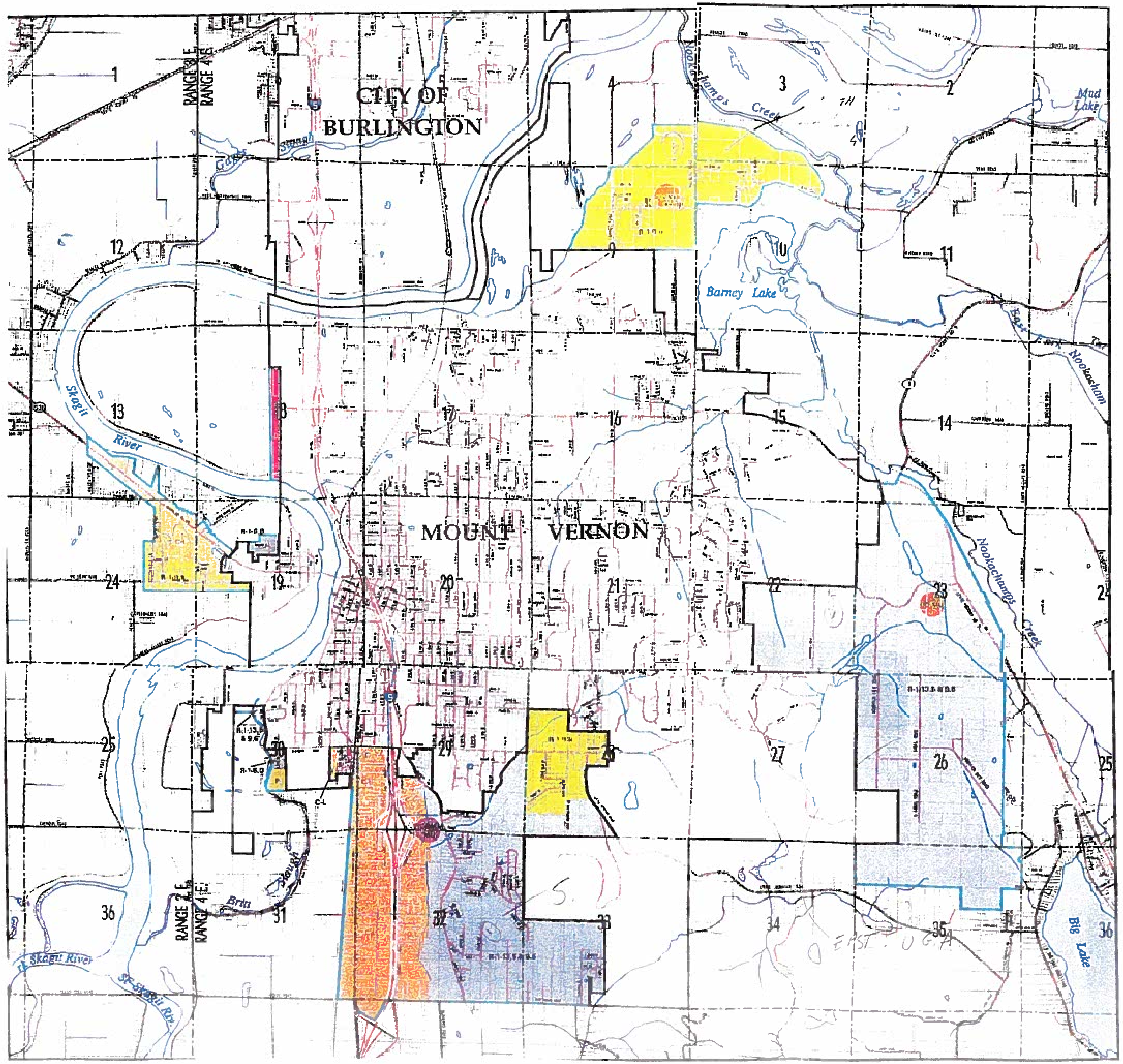
HDR Engineering, Inc

MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

EXISTING COLLECTION SYSTEM

3-1 SW



LEGEND

- Urban Growth Area
- Commerical / Light Industrial
- Commerical
- Public
- R-1-6.0 *
- Planned Commercial Mixed-Use
- Planned Community Mixed-Use
- Planned Neighborhood Mixed-Use
- R-1-7.6 *
- R-1-9.6 *
- R-1-13.5 & 9.6 *
- Incorporated Areas

* Residential densities are at a minimum 4 dwelling units per acre and a maximum lot size of 1/4 acre (10,890 sq. ft.)

The Skagit County Assessor tax lots depicted on this map represent parcel information as of October 5, 2001. For current up to date parcel information the maps available in the Skagit County Assessor office or on the web at www.skagitcounty.net should be consulted.

*August 16, 2001

0 — 1/2 Mile — 1 Mile
Scale in Miles

N W E S

* Release date only. This map incorporates offical map changes up to the release date. Changes made between releases are processed and incorporated into the Comprehensive Plan/Zoning maps on the County's website at www.skagitcounty.net and are also hand-recorded on maps at the Skagit County Planning & Permit Center. Please consult the Planning & Permit Center for a record of these changes. For a record of city annexations, contact the Skagit County Auditor's office.

SKAGIT COUNTY GIS
GIS DIVISION

Figure 3-2

CITY OF MOUNT VERNON URBAN GROWTH AREA

POPULATION PROJECTIONS

The GMA population projections from the Skagit County Comprehensive Plan for the Mount Vernon Urban Growth Area (UGA) were summarized in the 1998 Wastewater Flow and Organic Load Projection Report. These projections are presented in Table 3-1.

TABLE 3-1

City of Mount Vernon Population Projections and Service Area Population Projections		
Year	**City of Mount Vernon GMA Population Projections**	**City of Mount Vernon Service Area Population Projections**
1995	23,416	
1998	26,485 (interpolated)	22,540
2000	28,531	26,232
2005	33,463	29,431[1]
2010	38,396	35,861[1]
2015	43,559	42,292[1]
2020	48,722[1]	48,722[2]

1. Extrapolated from GMA Projections
2. All areas within the GMA are served by 2020

The study noted that the 1998 interpolated population was greater than the population of 22,540 used by the Washington State Department of Revenue. The discrepancy was attributed to the fact that areas within the UGA that are not currently incorporated in the City limits. For wastewater planning purposes it is assumed that all future areas within the UGA will be annexed and the City will provide wastewater service to the projected GMA population by the year 2020. For purposes of estimating current loads, the 2000 population is assumed to be 23,000.

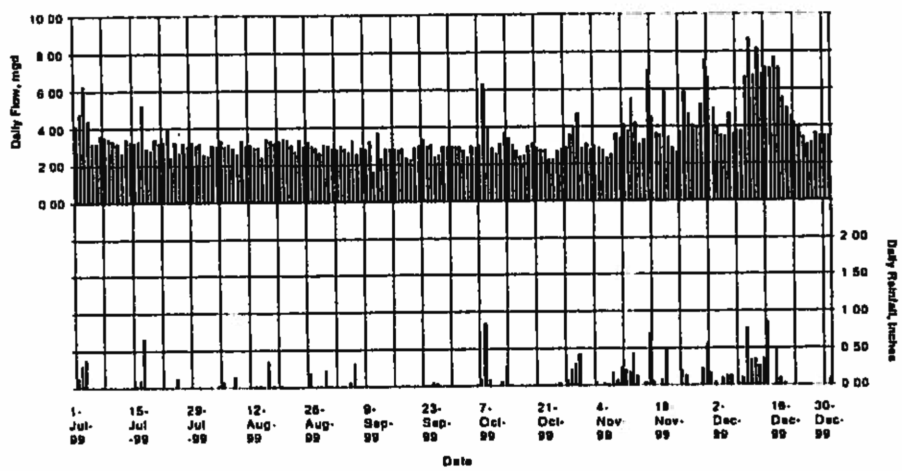
HISTORICAL FLOWS AND LOADS

Wastewater Treatment Plant Flow

Wastewater treatment plant daily flow records from the last five years were reviewed to determine the historical loading. The flow records were compared with daily rainfall to determine the impact of rainfall on plant flows. The rainfall is measured at the wastewater treatment plant. Figure 3-3 illustrates the daily flows with the recorded rainfall for July 1 to

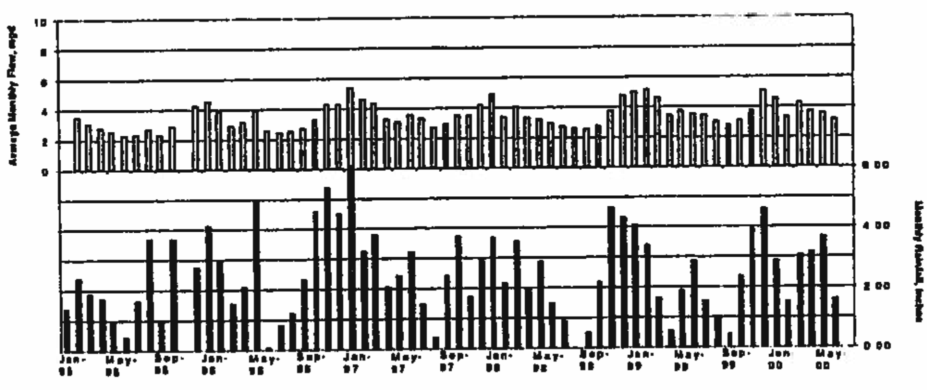
December 31, 1999. This plot illustrates that during late summer the flows reach a base rate of about 2.6 mgd. The plot also illustrates in the dry weather period the five day work week of Draper Valley Farms(DVF), Inc, which discharges from 0.4 to 0.6 mgd when in operation. In November and December rain caused the direct increase in treatment plant flows.

Figure 3-3 Mount Vernon Daily WWTP Flows and Rainfall, July 1 - December 31, 1999



The seasonal trend in flow is observed when average monthly flows are plotted against rainfall as shown in Figure 3-4.

Figure 3-4 City of Mount Vernon Monthly WWTP Flows



Commercial Flow

The 1998 Wastewater Flow and Organic Load Projection Report estimated 0.6 mgd of flow from 638 commercial customers based on water meter readings. Skagit County documented that the existing commercial area in Mount Vernon is 292 acres. The existing commercial loading rate is 2,055 gpd per acre.

Industrial Flow

The major industrial wastewater discharger in Mount Vernon is Draper Valley Farms, Inc. (DVF), a chicken processing facility. The current wastewater discharge, on a monthly basis, is approximately 0.45 mgd.

Domestic Flow

The remaining dry weather flow component after commercial and industrial flows are removed is domestic sanitary flow. The existing domestic flow is estimated as follows:

Total Dry Season Flow		2.62 mgd
	Commercial Flow	- 0.60 mgd
	Industrial Flow	- 0.43 mgd
Total	Domestic Flow	1.59 mgd

Based on an estimated population of 23,000, the current per capita loading rate without infiltration and inflow is 69 gpcd (1.59 mgd/23,000).

Infiltration & Inflow

As rainfall increases there is a corresponding increase in wastewater flows. This extraneous flow is known as infiltration and inflow. Inflow is a direct entry of storm water into the sewer system through direct piping connections such as catch basins, leaking manhole covers, roof gutters, driveway drains and other area drains.

Infiltration is ground water that enters the sewer system through defects or other subsurface connections. Infiltration sources include cracks in pipes, manholes, subsurface foundation drains or even basement and crawl space sump pumps. During heavy rains infiltration may increase rapidly and in a review of flow data this rain induced infiltration may appear to be inflow.

The older portions of Mount Vernon have combined sewers. These sewers were originally designed to convey both storm and sanitary sewer flows. Many parts of the separated system also experience infiltration and inflow.

In addition to the storm water inflow component, these portions of the system are constructed of clay and concrete pipe. Due to their age, materials, and methods of construction, these portions of the system are subject to higher levels of infiltration and inflow. To determine the 'additional infiltration and inflow component,' an evaluation was made to quantify this component. This was computed by subtracting the commercial, industrial, and residential flow components from the maximum monthly flow. The DOE guidelines of 100 gpcd for new sewer systems (including infiltration and inflow) was used to establish the baseline residential flow rate. The 'additional infiltration and inflow component' was then computed as follows:

Maximum Month Flow (January 1997)	5.39 mgd
Commercial Flow	- 0.60 mgd
Industrial Flow (DVF)	- 0.43 mgd
Baseline Residential Flow [23,000 persons x 100 gpcd[1]]	- 2.30 mgd
Additional Infiltration and Inflow Component	2.06 mgd

1. DOE criteria includes normal Infiltration and inflow for a separated sanitary system.

There could be a deterioration of the system that could result in additional infiltration and inflow into the system. However, it is also anticipated that reconstruction of sewers will separate inflow sources and reduce infiltration. For the purposes of planning it is assumed that the current infiltration and inflow rate will remain the same throughout the planning period and improvements will offset infiltration and inflow for the existing system.

Combined Sewer Flows

Mount Vernon has combined sewers in the older portions of the City. The storm drainage connections produce excess flow during storm events. Combined Sewer Overflow (CSO) structures allow flow in excess of the sewer system and treatment plant capacity to be discharged directly to the Skagit River.

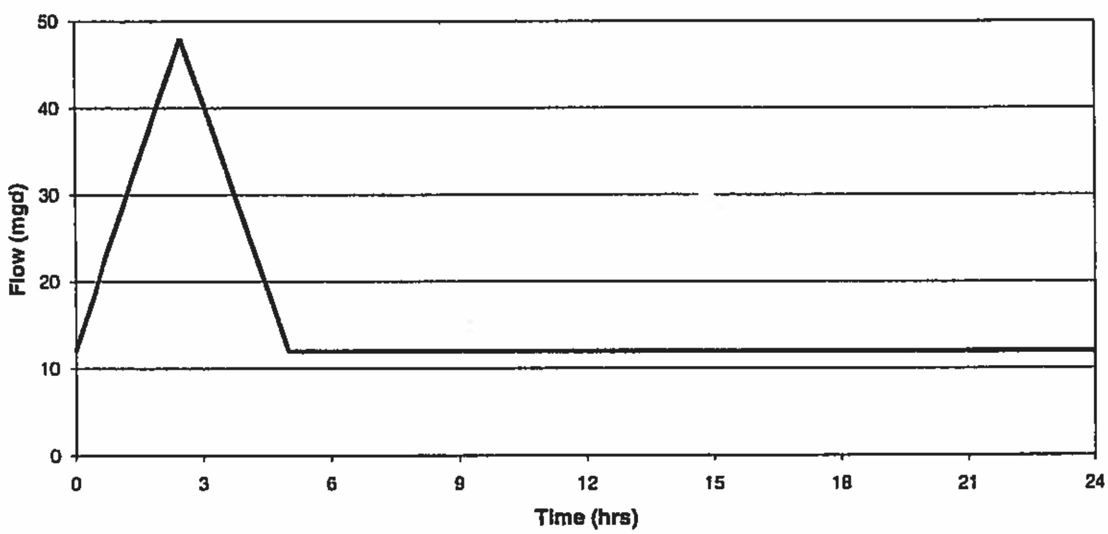
The CSO Baseline for Mount Vernon was established in 1988. It predicted an annual CSO volume of 116.5 MG for the average annual rainfall of 31.95 inches. Based on the 1988 collection system there was a 95 percent confidence that the volume, with an average annual rainfall, would be between 92 MG and 141 MG.

During 1988, flow monitoring allowed determination of not only the CSO Baseline, but also the peak flow rate due to combined flows. During some of the periods of high flow, the peak flow rates were not recorded, but estimates made in the 1994 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan predicted the peak system flow rate at 45 to 50 mgd. In 1997, the City placed the Central CSO Regulator, a 60-inch diameter interceptor, on-line. This has significantly reduced the occurrences of combined sewer overflows. A detailed summary and analysis of recent combined sewer history is presented in Chapter 4.

The May 16, 1988, storm event was estimated to be approximately a two-year storm recurrence. It was selected as a design storm event, and was considered to be reasonably conservative. In the 1995 Wastewater Treatment Plant Evaluation, the peak flow for the May storm event was estimated to be 47 mgd. Combining this flow with the one mgd contributed by the West Mount Vernon Pump Station yields a peak system flow rate of 48 mgd. The affects of the Central CSO Regulator are analyzed in Chapter 9.

Compliance with the DOE consent decree will require limiting untreated overflows to one event per year. To estimate the volume of the stormwater component for the one year storm event, historical CSO data was reviewed. The largest recorded overflow was on May 16, 1988. In the 1995 Wastewater Treatment Plant Evaluation, a detailed analysis of this storm was performed. An idealized combined sewer flow hydrograph was created in that evaluation and is presented in Figure 3-5.

Figure 3-5 Idealized Combined SewerFlow Hydrograph - May 16, 1988



The idealized combined sewer flow hydrograph shows a combined peak flow rate of 48 mgd. The maximum day storm flow component (total volume of storm flow) can be estimated from this hydrograph. The historic maximum day sanitary flows are subtracted from the total volume of flow in 24 hours to obtain the storm flow component as follows:

Total Combined Sewer Flows	15.8 mg
Historical Sanitary Maximum Day Flow	9.2 mg
Storm Flow Component	6.6 mg

The BOD and TSS loads for the storm flow component were estimated by reviewing existing data for CSO events. BODs for the larger storm events typically ranged from 10 to 60 mg/L, and TSS typically ranged from 20 to 100 mg/L. The maximums were applied to the estimated flows to establish the maximum anticipated loads. These are summarized in Table 3-2.

Table 3-2

Combined Sewer Component Flow and Load Projections for 2020		
Component	**Storm Maximum Day[1]**	**Peak Hour[2]**
Flow (mgd)	6.6 mgd	48 mgd
BOD (ppd)	3,300 ppd	-
TSS (ppd)	5,500 ppd	-

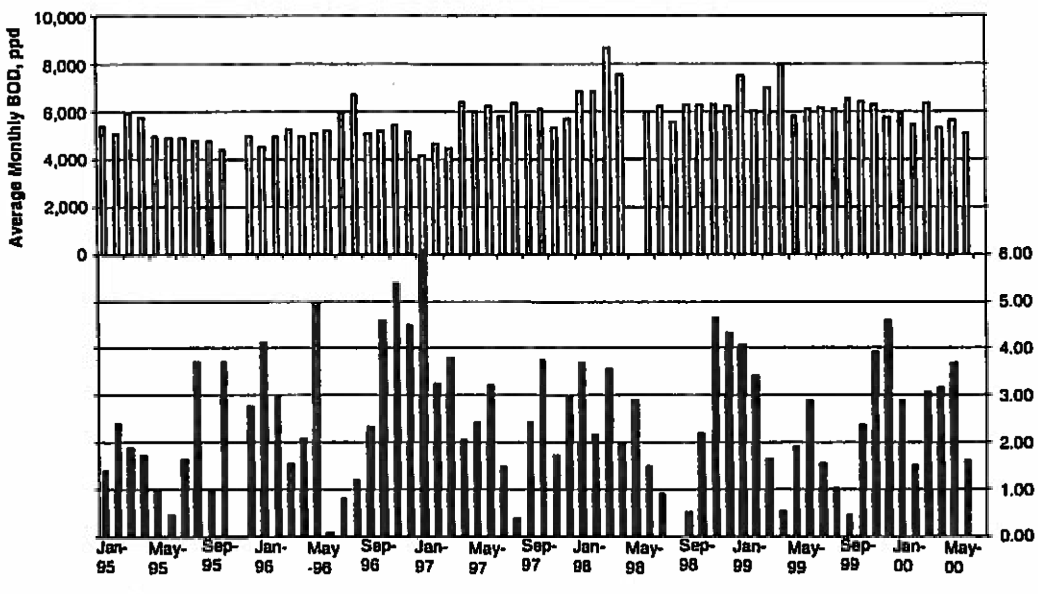
1. Storm flow component estimated from May 16, 1988, storm event.
2. Sanitary and storm components combined flow estimates

Treatment Plant Loading

Biochemical Oxygen Demand (BOD)

Figure 3-6 illustrates the monthly average day BOD loading to the treatment plant from January 1995 to June 2000. There are spikes in the BOD in March and April 1998 and in January, March, and April of 1999. A review of the daily treatment plant data determined that the averages of these months were significantly impacted by one or two days where the reported BOD load to the plant was 10,000 to 20,000 pounds per day. The treatment plant staff noted that there is a sampling problem that occurs during periods of high rainfall that caused the measured BOD concentration of the influent to be higher than actual loads. This assumption was verified by reviewing the BOD concentrations from the effluent from the primary clarifier for these days. Based on this analysis the monthly BOD load to the treatment plant is approximately 6,400 pounds per day.

Figure 3-6 City of Mount Vernon Monthly BOD Loadings



The BOD loading at the plant does not show any correlation with rainfall and the BOD load appears to remain relatively constant year round.

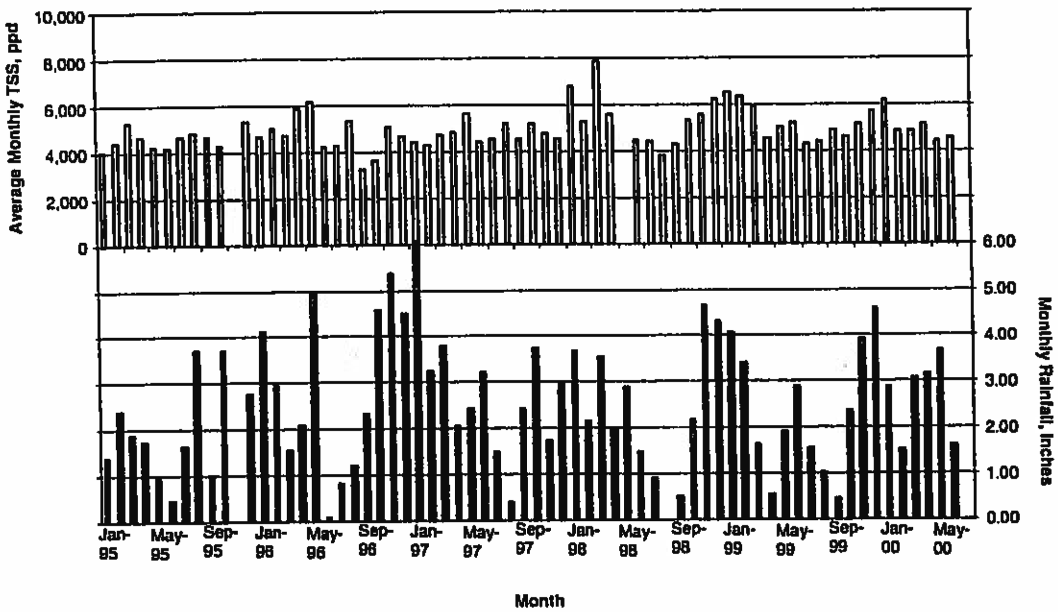
The only current industrial customer, Draper Valley Farms, Inc. (DVF), discharges between 500 and 1,200 ppd of BOD per month. Additional information on these loads Is provided in Chapter 6. Based on previous City discussions with DVF it is assumed that the future flows from the plant could approach 0.75 mgd (Appendix A). Future BOD loads were estimated by increasing from the current discharge permit levels of 1,300 lbs. per day to 1,550 lbs. per day to allow for the increased flows.

The Maximum Month Average Day BOD load to the treatment plant from domestic and commercial sources is approximately 7,900 ppd, without Draper Valley Farms, Inc. This may be due to non-representative samples within the Central Interceptor after a storm event.

Total Suspended Solids (TSS)

Figure 3-7 provides the monthly average day TSS compared with rainfall. The reported TSS loads to the plant in March and December 1998 and in January 1999 through March 1999 were affected by a few days with excessive loads.

Figure 3-7 City of Mount Vernon Monthly TSS Loading



The review of TSS load and rainfall does not appear to show a correlation; however, there likely is some additional solids loading to the plant associated with the first flush of the system with rainfall in the Fall or following an extended dry period. Otherwise, the TSS load appears to remain relatively constant year round. The monthly TSS load to the treatment plant is approximately 5260 ppd.

The TSS load from DVF is typically from 400 to 600 ppd based on an influent concentration of 125 to 150 mg/L. The industrial component for DVF is further reviewed in Chapter 6.

The Maximum Month Average Day TSS load to the treatment plant from domestic and commercial sources is approximately 7,600 ppd, without DVF. This may also be due to settlement of solids and non-representative samples within the Central Interceptor after a storm event.

Ammonia

The historical influent ammonia concentration typically ranged between 10 to 30 mg/L as seen in Figure 3-8. The ammonia loading to the plant in pounds per day is illustrated in Figure 3-9. Similar to BOD and TSS loadings, the total ammonia load to the plant does not seem to be related to rainfall and appears to remain constant through the year. The average month ammonia load to the plant is approximately 550 pounds per day.

Figure 3-8 City of Mount Vernon Ammonia Nitrogen Influent Concentration

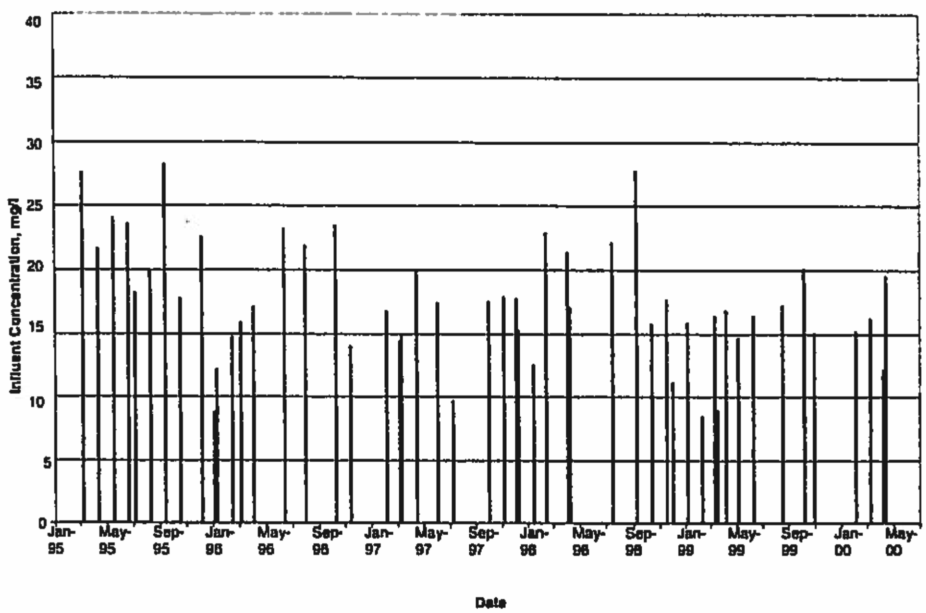
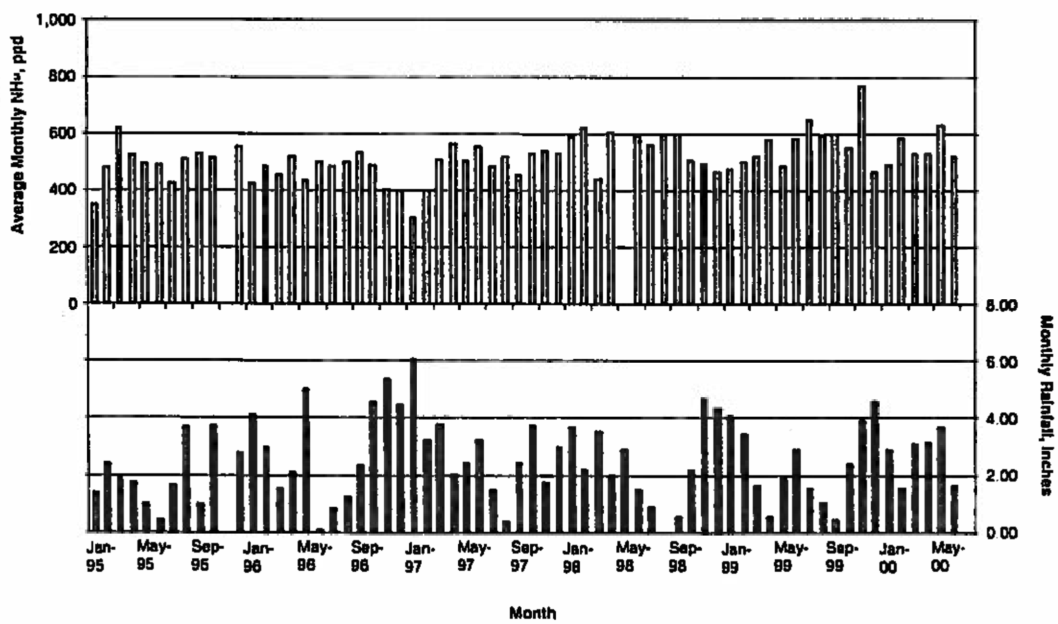


Figure 3-9 City of Mount Vernon Monthly Ammonia Loading



The 1998 Wastewater Flow and Organic Load Projection Report estimated the average daily ammonia concentration from DVF at 22 mg/L. This equates to a total daily load of approximately 84 ppd. The domestic and commercial ammonia load would be 466 ppd.

Summary of Historical Flows and Loads

Table 3-3 summarizes the historical flows for the City. Table 3-4 summarizes the historical loads for the City.

Table 3-3

Historical Flows for the City of Mount Vernon	
Parameter	**Historical Flow**
Per Capita Flow[1]	69 gpd
Commercial Flow	2,055 gpad
Draper Valley Flow	0.46 mgd
Average Annual Day (AAD)	3.7 mgd
Average Day Maximum Month (ADMM)	5.4 mgd
Maximum Day	9.2 mgd

1. Does not include infiltration and inflow

Table 3-4

Historical Average Month Loads for the City of Mount Vernon			
Parameter	**Historical BOD**	**Historical TSS**	**Historical NH_3-N**
Domestic and Commercial Loading	5,200 ppd	4,600 ppd	370 ppd
Domestic and Commercial Per Capita Loading	0.18 ppd/capita	0.16 ppd/capita	0.016 ppd/capita
Commercial Loading w/o Domestic	1,000 ppd[1]	1,000 ppd[2]	100 ppd[3]
Industrial Loading (Draper Valley)	1,200 ppd[4]	660 ppd[5]	84 ppd
Industrial Concentration (Draper Valley)	300 mg/L[4]	160 mg/L[5]	22 mg/L
Total WWTP Loading	6,400 ppd	5,260 ppd	554 ppd

1. Based on 0.6 mgd and BOD concentrations of 200 mg/L
2. Based on 0.6 mgd and TSS concentrations of 200 mg/L
3. Based on 0.6 mgd and NH3 concentrations of 20 mg/L
4. October 1999
5. July 1999

Projected Flows and Loads

Projected flows and loads were developed based upon DOE criteria and historical patterns for the City.

BOD load projections were developed independently for both domestic and commercial flow components. The historical domestic BOD loading has been 0.18 ppcd. This was increased to 0.20 ppcd for future predictions and matches DOE design criteria to be used when this information is not available. Domestic loads were based on 0.20 lbs. per capita per day. Commercial loads were based on a BOD concentration of 200 mg/L.

Similar to the BOD loadings, the TSS load projections were based upon 0.20 ppd/capita for residential loads and commercial contributions of 200 mg/L.

NH_4-N load projections were based upon 0.016 ppd/capita for residential and 20 mg/L for commercial and industrial contributions. Draper Valley Farms, Inc.'s contribution was based on a concentration of 22 mg/L.

Wastewater Treatment Plant Flow

Future flow projections for 2010 and 2020 are based on the estimated population, projected DVF flows, and the future commercial and other industrial loads. This information was obtained from the Skagit County Comprehensive Plan and the 1998 Wastewater Flow and Organic Load Projection Report. Flows from other industrial areas are based on the same flow rate as commercial flow. The future flow projections for these sources are summarized in Table 3-5.

The treatment plant has experienced a maximum influent flow rate of 14.8 mgd which is about 20 percent in excess of the existing peak hour design flow rate. Since the State WAC for CSO reduction requires CSO agencies to maximize the flow to the secondary plant and since the Central CSO regulator provides equalizing storage upstream of the plant it is possible that the treatment plant will experience the peak hydraulic capacity for periods exceeding one day.

Table 3-5

Flow Projections for the City of Mount Vernon

	2010 Projection	2020 Projection	Flow Rate	2010 Flows	2020 Flows
Residential Population	35,861	48,722	100 gpcd	3.59 mgd	4.87 mgd
Commercial Area	500 ac	660 ac	2,055 gpad	1.03 mgd	1.36 mgd
Draper Valley Farms, Inc.	0.75 mgd	0.75 mgd	-	0.75 mgd	0.75 mgd
Other Industrial Area	337 ac	446 ac	2,055 gpad	0.69 mgd	0.92 mgd
Base System Flow				6.06 mgd	7.90 mgd
Additional Inflow and Infiltration Component (ADMM)				2.03 mgd	2.03 mgd
ADMM Flow				8.09 mgd	9.93 mgd
Peak Hour Flow[1]				14.9 mgd[2]	18.3 mgd[3]

1. Peaking factor based on L.A. Peaking Curve, Appendix B.
2. Peaking factor of 2.13.
3. Peaking factor of 2.06.

Organic Loads

Future load projections for 2010 and 2020 are based on the estimated population and future commercial and industrial loads and the projected Draper Valley Farms, Inc. loads. The future projections for these sources are summarized in Table 3-6 to Table 3-8.

Table 3-6

Projected BOD Loadings for the City of Mount Vernon					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential Population	35,861	48,722	0.20 ppd/capita	7,170 ppd	9,740 ppd
Commercial	1.03 mgd	1.36 mgd	200 mg/L	1,720 ppd	2,270 ppd
DVF	0.75 mgd	0.75 mgd	250 mg/L	1,550 ppd[1]	1,550 ppd[1]
Other Industrial	0.69 mgd	0.92 mgd	200 mg/L	1,150 ppd	1,540 ppd
Total				11,590 ppd	15,100 ppd

1. Based on existing discharge permit limit of 1,300 ppd increased by 19% anticipated hydraulic increase provided by DVF.

Table 3-7

Projected TSS Loadings for the City of Mount Vernon					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential Population	35,861	48,722	0.20 ppd/capita	7,172 ppd	9,744 ppd
Commercial	1.03 mgd	1.36 mgd	200 mg/L	1,720 ppd	2,270 ppd
DVF	0.75 mgd	0.75 mgd		890 ppd[1]	890 ppd[1]
Other Industrial	0.69 mgd	0.92 mgd	200 mg/L	1,150 ppd	1,540 ppd
Total				10,932 ppd	14,444 ppd

1. Based on existing discharge permit limit of 750 ppd increased by 19% anticipated hydraulic increase provided by DVF.

Table 3-8

Projected NH_4-N Loadings for the City of Mount Vernon[1]					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential	35,861	48,722	0.016 ppd/capita	574 ppd	780 ppd
Commercial	1.03 mgd	1.36 mgd	20 mg/L	172 ppd	227 ppd
Other Industrial	0.69 mgd	0.92 mgd	20 mg/L	115 ppd	154 ppd
DVF	0.75 mgd	0.75 mgd	22 mg/L	138 ppd	138 ppd
Total				999 ppd	1,299 ppd

1. NH_4-N loading based on influent only. Additional NH_4-N loading to secondary treatment process by internal recycle of anaerobic digester supernatant.

SUMMARY OF PROJECTED FLOWS AND LOADS

The flow and loading projections for the treatment plant were developed in the previous section. These flows and loadings are summarized in Table 3-9. For maximum day and peak hour loadings, concentrations were assumed and loadings were calculated as shown.

Table 3-9

WWTP and CSO Flow and Load Projections				
Year	Parameter	Average Day Maximum Month	Maximum Day	Peak Hour
2010	Flow (mgd)	8.1	11.4	14.9
2010	BOD (ppd)	11,590	14,311	-
2010	TSS (ppd)	10,932	13,500	-
2010	NH4-N (ppd) [1]	999	1,040	-
2020	Flow (mgd)	9.9	13.9	18.3
2020	BOD (ppd)	15,100	17,338	-
2020	TSS (ppd)	14,444	16,600	-
2020	NH4-N (ppd)[1]	1,299	1,261	-
2020	CSO Flow (mgd)	-	6.6[2]	48[3]
2020	CSO BOD (ppd)	-	3,300	-
2020	CSO TSS (ppd)	-	5,500	-

1. NH_4-N loading based on influent only. Additional NH_4-N loading to secondary treatment process by internal recycle of anaerobic digester supernatant.
2. Storm flow component estimated from May 16, 1988, storm event.
3. Total of sanitary and storm component flow estimates

4. Combined Sewer System

Introduction

The State of Washington requires agencies with combined sewers to reduce untreated combined sewer overflows to an average of one event per year. The City of Mount Vernon developed a two phase CSO reduction plan and subsequently entered into a consent decree with the Department of Ecology. The first phase required the City to construct the Central CSO Regulator by December 2000. The second phase requires the City to construct treatment facilities by January 2015 that will reduce the remaining CSOs to one untreated event per year. The Central CSO Regulator was constructed and placed into service December 1997.

Total Maximum Daily Load (TMDL)

The Lower Skagit River has a TMDL limit for both dissolved oxygen (DO) and fecal coliform (see Chapter 7). The limits for DO will not apply during CSO events. The TMDL for fecal coliform will apply to CSOs, but will be determined as a geometric mean. This allows the City of Mount Vernon to have one untreated CSO event per year and remain in compliance. In effect, the TMDL, with regard to CSO events, will be met when all treated CSO flows meet the technology based limits of the NPDES permit (400 cfu/100 mL weekly average) and untreated CSOs are reduced to an average of one event per year.

Existing CSO System

Combined Sewer System

The existing sewer system consists of both sanitary and combined sewers. The combined sewer lines were primarily constructed prior to 1960. They serve approximately 555 acres in the older and downtown areas of Mount Vernon. Flows from the combined area are conveyed to the WWTP, with overflows being conveyed to two pump stations through three overflow structures:

- Freeway Drive Overflow Structure conveys flow to the Division Street Pump Station;
- Division Street Overflow Structure conveys flow to the Division Street Pump Station; and
- Park Street Overflow Structure conveys flows to the Park Street Pump Station.

Combined Sewer Overflow Pump Stations

Two pump stations convey combined sewer overflows to the Skagit River. Table 4-1 describes these pump stations.

Table 4-1

City of Mount Vernon's Combined Sewer Overflow Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Pumping Capacity**[1]
Division Street	Mixed Flow Vertical	3	22,300
Park Street	Wetwell/Drywell Horizontally Mounted Centrifugal	4	5,400 gpm[2]

1. Design pumping rate for all pumps operating.
2. An emergency backup unit is available, with a maximum capacity of approximately 6,500 gpm.

Central CSO Regulator

The Central CSO Regulator is a 60-inch diameter pipeline in downtown Mount Vernon. It provides conveyance and storage of combined and sanitary flows. During dry weather, wastewater flows are conveyed to the WWTP with the CSO Regulator acting as a gravity sewer pipe. During wet weather, the CSO Regulator is designed to store CSOs in the pipe, rather than discharging them to the Skagit River, and convey the wastewater to the WWTP as capacity becomes available. The CSO regulator provides approximately 1.1 million gallons of in-line storage and consists of:

- 6,800 feet of 60-inch concrete pipe;
- 600 feet of 30-inch concrete pipe;
- One flow regulating structure;
- Three flow control structures;
- Three overflow structures; and
- One Valve Structure on Cameron Way.

The CSO regulator is divided into five storage reservoirs, with storage volumes of 200,000 gallons, 197,000 gallons, 287,000 gallons, 285,000 gallons, and 131,000 gallons, for a total storage capacity of 1.1 million gallons.

Central CSO Regulator Hydraulic Performance

The Central CSO Regulator provides conveyance capacity to the wastewater treatment plant for combined sewer flows. The pipeline includes structures that allow excess volume of the pipeline to be used for inline storage of combined sewage. The 1995 Comprehensive Sewer and Combined Sewer Reduction Plan anticipated a reduction of overflows to an estimated 12 events per year.

Since the Central CSO Regulator was placed into service in December 1997, the number of overflow events has been reduced to approximately 8 events per year. The overflows that were documented from November 1998 to August 2000 are summarized in Table 4-2.

Table 4-2

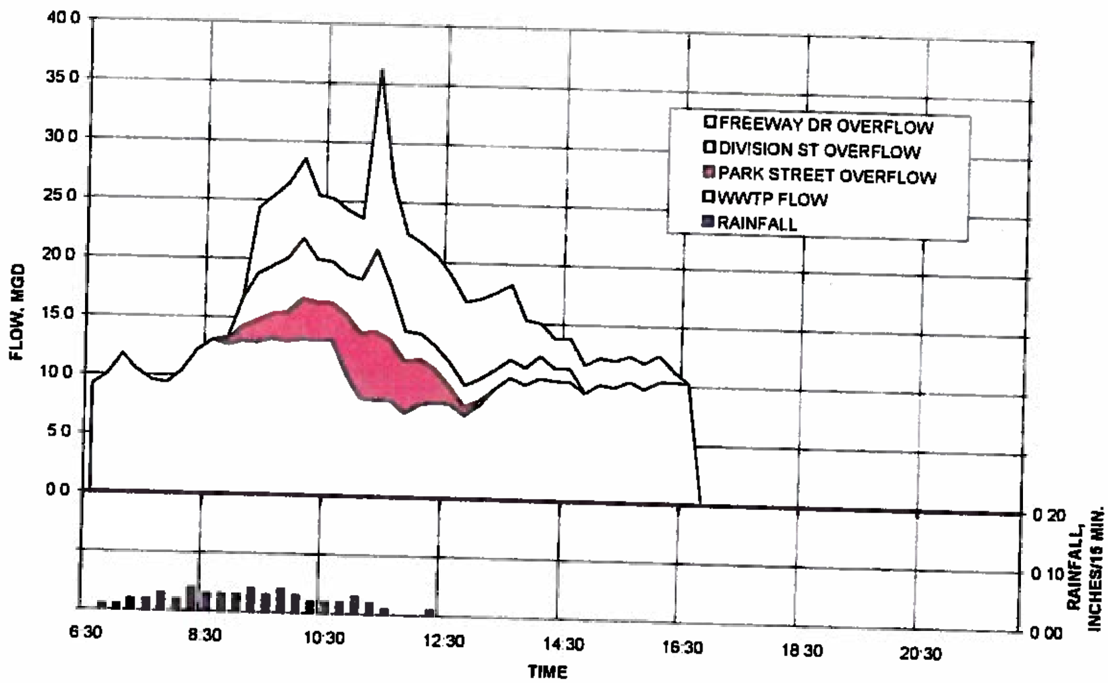
Combined Sewer Overflows from November 1998 to 2000

Date of Overflow	Overflow Volume, gal.	Peak System Flow Rate, mgd[2]	Range of TSS Concentration, mg/L	Range of BOD Concentration, mg/L
Nov 13, 1998	364,000	18.5	39 - 68	18 - 57
Dec 29, 1998	1,845,000	36.2	45 - 84	19 - 27
Jan 10, 1999	2,303,000	27.7	14 - 39	6 - 33
Jan 14, 1999	388,000	14.0	22 - 96	9 - 53
May 7, 1999	44,000	16.5	44 - 54	6
Jun 24, 1999	999,000	31.0	48 - 285	9 - 41
Jan 25, 2000	906,000	21.8	46 - 77	21 - 50
Apr 13, 2000[1]	9,624,000	32.3	N/A	N/A
Aug 18, 2000	396,000	17.4	111 - 119	3 - 4

1. The April 13, 2000 event has estimated flow data and TSS and BOD data were not available due to an equipment failure.
2. The Peak System Flow Rate includes all system flows including the wastewater treatment plant flow and overflows at Park Street Pump Station and Division Street Pump Station.

A cumulative flow hydrograph of the December 29, 1998 overflow event is illustrated in Figure 4-1. This figure illustrates the total sewer system flows including the wastewater treatment plant, overflows at the Park Street Pump Station, and overflows at the Division Street Pump Station.

Figure 4-1 City of Mount Vernon Combined Sewer System Flows, Cumulative Flows for December 29, 1998



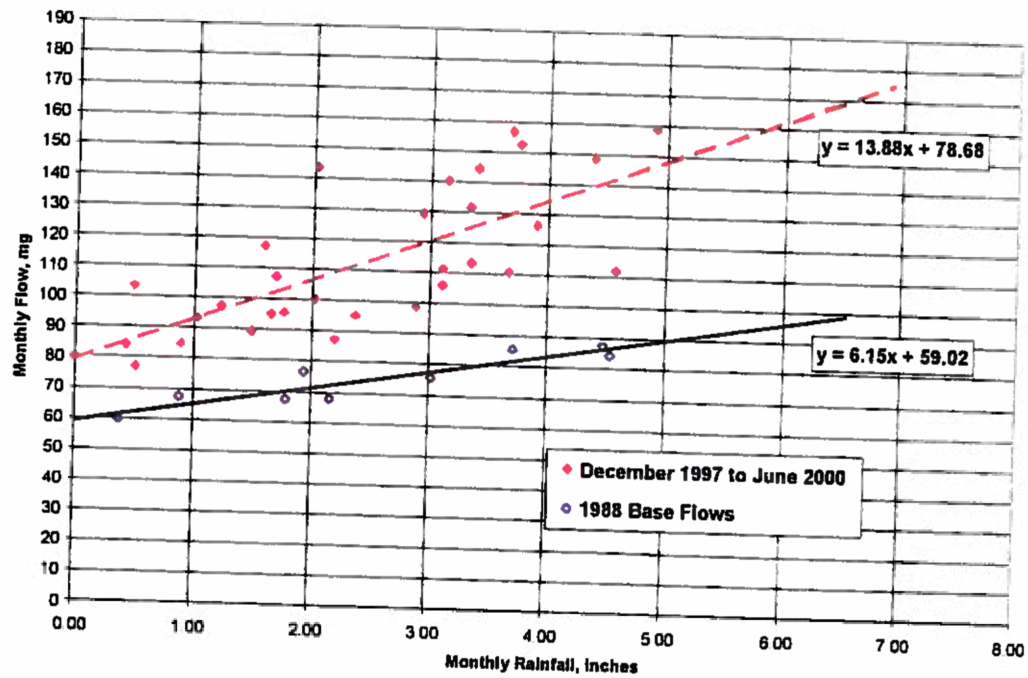
The October 1995 Wastewater Treatment Plant Evaluation evaluated the facilities required based on a peak design system flow rate of 48 mgd. The peak system flow rate observed since the Central CSO Regulator has been in service was 36.2 mgd. A detailed evaluation of the return frequency of this flow rate has not been performed.

For planning purposes it is recommended that 48 mgd continue to be used for a peak system flow rates.

Central CSO Regulator Volume Reduction Performance

The operation of the Central CSO Regulator has resulted in a considerable volume of combined sewage treated at the wastewater treatment plant that would have otherwise overflowed to the Skagit River. Figure 4-2 provides a scatter plot of monthly wastewater treatment plant flows verses monthly rainfall. The two sets of data points include data from 1988 base flows and the current treatment plant data from December 1997 to June 2000. A linear regression line has been provided for each set of data points. The y-intercept of this graph indicates the base sanitary treated at the plant. The increase of almost 20 mg per month reflects the growth that has occurred in the City over the past 12 years. The slope of the linear regression line reflects the volume of storm water per inch of rainfall that is treated at the wastewater treatment plant. The increase in slope reflects the additional combined sewage that is now being treated at the wastewater treatment plant and additional sources of infiltration and inflow.

Figure 4-2 City of Mount Vernon Monthly Flow vs. Rainfall



Using an average annual rainfall of 32.4 inches, the volume of rain induced flow treated at the plant in 1988 was 199 million gallons (32.4 inches per year x 6.15 million gallons/inch). Currently, the projected rain induced flow treated at the treatment plant is 450 million gallons (32.4 inches per year x 13.88 million gallons/inch). This reflects an increase of 251 million gallons per year. In the City's CSO Reduction Plan the estimated annual overflow volume was 116.5 million gallons. This earlier projection could have been in error or the amount of rain induced flow treated at the plant could have increased significantly. Even if the actual annual overflow volume was only 116.5 million gallons, the Central CSO Regulator has reduced the volume of overflows over 94 percent. This is based on a remaining overflow volume of 6 million gallons per year based on the 6 events identified in Table 4-2.

Using a long term antecedent condition index model the volume fraction of excess flow that is directly attributable to infiltration is up to 70 percent. The infiltration percentage is likely even higher because of the inability to distinguish the infiltration and inflow components based on the information that we have. Based on the flow data that is available at this time it is not possible to identify a unit flow hydrograph distinguishing the three major components of combined sewage flows: sanitary sewage, infiltration, and inflow.

Central CSO Regulator Solids Reduction Performance

The concentration of TSS in combined sewer overflows has ranged from 14 mg/L to 285 mg/L; however, the treatment plant personnel have documented that the combined sewage generally has concentrations around 50 mg/L. If the annual combined sewer overflow volume was assumed to be 116.5 million gallons with an average concentration of 50 mg/L volume was assumed to be 116.5 million gallons with an average concentration of 50 mg/L, then the 110.5 million gallon reduction of overflows has reduced the annual total of solids discharged to the Skagit River by 46,000 pounds.

CSO Reduction Treatment Processes

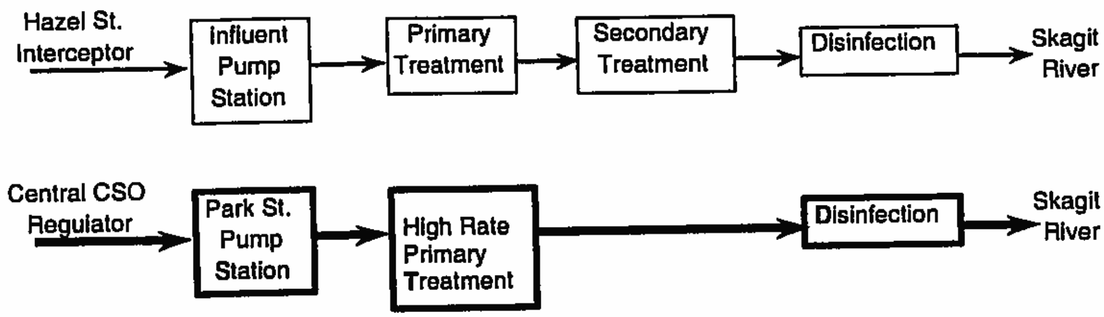
The State of Washington defines CSO treatment as primary treatment that removes at least 50 percent of the total suspended solids (TSS) and an average settlable solids concentration of 0.3 mL/L/hr, with a maximum of 1.9 mL/L/hr. Based on recent CSO treatment projects, the Department of Ecology has interpreted this to be an average annual solids removal requirement.

The 1995 Wastewater Treatment Plant Evaluation identified primary treatment facilities that would be required to reduce overflows to one untreated event per year based in accordance with the City's consent decree. Based on recent CSO treatment projects there are three alternatives for achieving the final reduction requirement in accordance with the consent decree. The primary difference is the level of treatment that is required for the effluent.

Treatment Alternative 1: CSO Treatment Facility

The first alternative would provide treatment for CSOs similar to the one detailed in the 1995 Wastewater Treatment Plant Evaluation. This treatment alternative would meet the 50 percent removal of the total suspended solids as required by WAC 173-245. A process flow schematic is shown in Figure 4-3. To meet the total peak hour capacity requirements of 48 mgd, high rate primary clarification would be provided. This alternative would require that during CSO events, flows from the Central CSO Regulator would remain separate from the flows through the secondary plant. The CSO treatment would include primary treatment, disinfection and discharge through the outfall. After CSO events the process units could be drained back to the secondary plant.

Figure 4-3 Alternative 1 CSO Treatment Facility Schematic



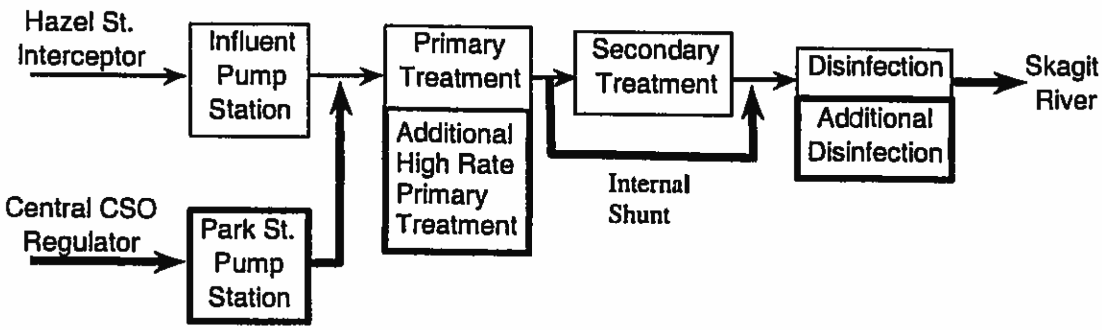
The improvements required for Alternative 1 include:

- Construct conveyance piping from the Park Street Overflow Structure to the Park Street Pump Station.
- Upgrade Park Street Pump Station.
- Construct conveyance piping from Park Street Pump Station to the treatment plant site. This assumes that all or part of the treatment facilities would be located at the secondary treatment plant site.
- Construct primary treatment facilities: Recent experience elsewhere has shown that it is difficult to achieve 50 percent reduction of solids on an event basis with conventional primary treatment when the concentration of the CSO is less than 100 mg/L. High rate clarification using ballasted sedimentation can be used to achieve these requirements. This process could provide greater than 90 percent removal of solids on an event basis.
- Construct dedicated CSO disinfection facilities.
- Construct a CSO outfall dedicated to discharging treated CSOs.

Treatment Alternative 2: Internal Shunt of CSO Flows, Two Pump Stations

The second alternative would increase the flow rate through the secondary plant. This would require that all discharges meet secondary treatment discharge requirements. To protect the secondary process by preventing 'washout' of the secondary clarifiers during an extreme storm event, the Department of Ecology would likely allow internal shunting of primary effluent directly to the disinfection. Since solids in the Central CSO Regulator are lower than in the Hazel Street Interceptor, it would be preferable to internally shunt the Central CSO Regulator flows. A process flow schematic is shown in Figure 4-4.

Figure 4-4 Alternative 2 CSO Treatment Internal Shunt Schematic



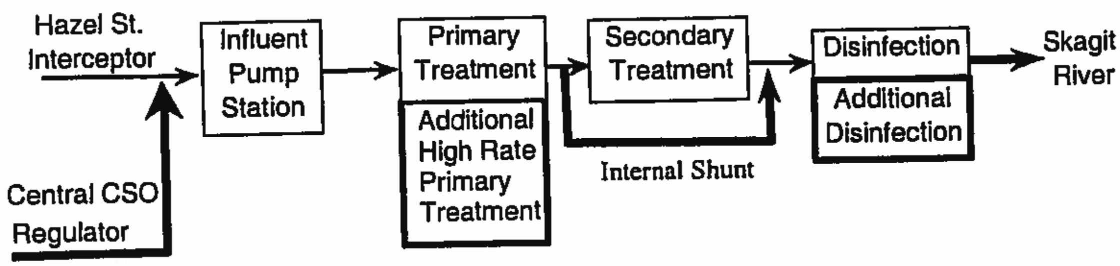
The improvements required for Alternative 2 include:

- Construct conveyance piping from the Park Street Overflow Structure to the Park Street Pump Station.
- Upgrade Park Street Pump Station.
- Construct conveyance piping from Park Street Pump Station to the treatment plant site.
- Construct high rate primary treatment facilities.
- Construct disinfection facilities for both CSO and WWTP flows.
- Construct an outfall to discharging treated CSOs and WWTP effluent. This could be two separate outfalls or a single combined outfall.

Treatment Alternative 3: Internal Shunt of CSO Flows, One Pump Station

The third alternative would increase the flow rate through the secondary plant, similar to alternative 2 except all of the flows are pumped via the WWTP influent pump station. This would require that all discharges meet secondary treatment discharge requirements. An internal shunt of all CSO flows (from both the Central CSO Regulator and the Hazel Street Interceptor) could occur after initial blending of the flows. A process flow schematic is shown in Figure 4-5.

Figure 4-5 Alternative 3 CSO Treatment Internal Shunt Schematic



The improvements required for Alternative 3 include:

- Construct a new influent pump station.
- Construct conveyance piping from Park Street Overflow Structure.
- Construct high rate primary treatment facilities.
- Construct disinfection facilities for both CSO and WWTP flows.
- Construct an outfall to discharging treated CSOs and WWTP effluent. This could be two separate outfalls or a single combined outfall.

Summary of Treatment Alternatives

Table 4-3 presents a summary of the treatment requirements for each Alternative, and the improvements required.

Table 4-3

Summary of CSO Treatment Alternatives		
Alternative No. 1	**Alternative No. 2**	**Alternative No. 3**
Description		
CSO Treatment Facility	Internal Shunt of CSO Flows, Two Pump Stations	Internal Shunt of CSO Flows, One Pump Station
Treatment Requirements		
50 Percent Solids Removal, 0.3 mL/L/hr settlable solids (max of 1.9 mL/L/hr)[1]	NPDES Permit Limits: 30 mg/L BOD and TSS	NPDES Permit Limits: 30 mg/L BOD and TSS
Required Improvements		
High Rate Primary Treatment for CSO flows	High Rate Primary Treatment for CSO flows	High Rate Primary Treatment for CSO flows
Disinfection for CSO flows	Disinfection for CSO flows	Disinfection for CSO flows
Upgrade Influent Pump Station	Upgrade Influent Pump Station	Construct new Influent Pump Station
Upgrade the Park Street Pump Station and replace piping to Park Street Pump Station	Replace piping to Park Street Pump Station	Upgrade Hazel Street Interceptor CSO Regulator to Influent Pump Station
Provide dedicated CSO Outfall	Provide an additional outfall capacity	Upgrade WWTP Outfall or provide an additional outfall capacity
Forcemain from Park Street Pump Station to WWTP	Force Main from Park Street Pump Station to WWTP	

1. Based on NPDES Permit issued to Carkeek CSO Treatment Facility, King County, WA.

CSO Storage

Both in-line, such as the Central CSO Regulator, and off-line storage facilities were considered for the remaining CSO flows. For storage facilities, a large factor of safety should be incorporated to allow the facility to accommodate both short duration high intensity storms and long duration low intensity storms, which may activate all sources of inflow and infiltration. From an idealized hydrograph with a peak of 48 mgd, as previously shown in Figure 3-5, a minimum of 1.0 mg of excess volume would be required to be stored. For CSOs, rainfall patterns, impervious area within the city, and antecedent moisture conditions can affect the actual volume experienced. Because of the variability in these factors, the CSO volume that would be planned for would incorporate a safety factor of 2.0. A CSO storage alternative would require a 2.0 mg storage facility at an estimated cost of $12.0 million

CSO Separation

A portion of the CSO flows in the Mount Vernon sewer system is from inflow sources, such as direct connections of storm drain catch basins. Identification and separation of inflow sources could reduce or eliminate the need for additional storage or CSO treatment facilities. However, identification and removal of direct connections is not always possible. In addition, in many cases the excess flows experienced due to a storm event are from rapid infiltration sources, rather than inflow sources, which are difficult to identify and correct. In the case of Mount Vernon, if excess CSO flows were due to inflow, an area of 136 acres would be connected. In the one-year storm event, inflow is typically due to run-off from paved areas, streets and parking lots that drain to the CSO system. To remove 136 acres of impervious area would require approximately 37 miles of 30 foot wide streets to be identified and disconnected.

Recommended CSO Reduction Treatment Alternative

Treatment Criteria

The two treatment options, separate CSO treatment and internally shunted flows, have different effluent requirements:

- The performance goal of CSO Treatment is removal of 50 percent suspended solids on an annual basis. Additionally, the effluent settleable solids concentration must have an annual average of 0.3 mL/L/hr, with a maximum of 1.9 mL/L/hr.

- Internal Shunt is the name given to the treatment of CSO flows by primary treatment followed by blending with secondary treatment plant flows before disinfection. When flows are internally shunted, the blended effluent from the primary and secondary units must meet the weekly and monthly NPDES permit (BOD and TSS) limits. DOE has permitted this process at other plants in the northwest including King County's West Point Treatment Plant.

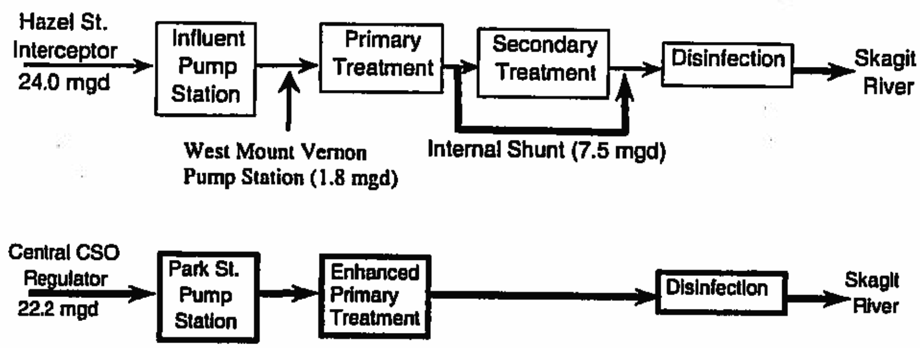
Treatment Recommendation

To meet the total 48 mgd peak hour flow requirements, treatment of CSO flows would be performed similar under either alternative. Primary treatment of CSO flows could be via high rate clarification and disinfection by UV. The typical operating cost of treating all flows via an internal shunt and treating them via a CSO treatment facility is similar. Similar improvements (additional primary treatment process equipment and UV disinfection equipment) are required for all Alternatives. Costs for Alternative no. 3 would be far in excess of either Alternative nos. 1 or 2 since it requires a new pump station (the influent pump station would need to be replaced rather than upgraded) and upgrading the Hazel Street Interceptor. Alternative nos. 1 and 2 would be similar in cost, so the decision of treatment Alternative (internal shunt vs. CSO treatment facility) should be based on treatment requirements.

The Hazel Street Interceptor conveys both combined and sanitary flows to the influent pump station. This interceptor has a capacity of 24.0 mgd. It is recommended that the portion of flows in excess of the peak sanitary flows (18.3 mgd) be internally shunted. This will allow maximization of the WWTP, without the necessity of oversizing all process units to accommodate CSO flows. Furthermore, by internally shunting CSO flows, the blended effluent may be able meet the NPDES permit requirements.

The Central CSO Regulator has lower TSS and BOD than the Hazel Street Interceptor since it conveys only combined sewer flows. It is recommended that wastewater conveyed by the Central CSO Regulator be treated in an independent treatment process. The treatment requirements for this process will be based on CSO treatment requirements (50 percent solids removal on an average annual basis, with an average settleable solids of 0.3 mL/L/hr, and a maximum of 1.9 mL/L/hr). The process flow diagram for these recommendations is presented in Figure 4-6.

Figure 4-6 Recommended Process Schematic Flow Diagram



CSO Reduction Alternatives

The treatment Alternative recommended for the combined flows is composed of two components: An 'Internal Shunt' and CSO Treatment. The 'Internal Shunt' of the Hazel Street Interceptor is discussed in Chapters 7 to 10 under the Wastewater Treatment Plant. Three alternatives for CSO Treatment are presented below.

Alternative 2A: Treat and Disinfect Combined Wastewater at the Park Street Pump Station.

Alternative 2A consists of treatment (high rate clarification) and disinfection (UV) at the Park Street Pump Station location. Improvements required for this alternative include:

- Construct a high rate clarification unit;
- Construct a UV disinfection system;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a CSO effluent pump station; and
- Construct an outfall for this CSO treatment facility effluent.

The estimated capital cost of this alternative is $9.2 million.

Alternative 2B: Treat Combined Wastewater at the Park Street Pump Station and Disinfect at the WWTP.

Alternative 2B consists of treatment (high rate clarification) at the Park Street Pump Station and disinfection (UV) at the WWTP. Improvements required for this alternative include:

- Construct a high rate clarification unit at the Park Street Pump Station;
- Retrofit a UV disinfection system in the existing chlorine contact basin at the WWTP;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a forcemain from Park Street Pump Station to the WWTP;
- Retrofit a CSO effluent pump station in the existing chlorine contact basin; and
- Construct conveyance to the outfall for treated CSO effluent.

The estimated capital cost of this alternative is $9.9 million.

Alternative 2C: Treat and Disinfect Combined Wastewater at the WWTP.

Alternative 2C consists of treatment (high rate clarification) and disinfection (UV) at the WWTP. Improvements required for this alternative include:

- Construct a high rate clarification unit at the WWTP;

- Retrofit a UV disinfection system in the existing chlorine contact basin at the WWTP;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a forcemain from Park Street Pump Station to the WWTP;
- Retrofit a CSO effluent pump station in the existing chlorine contact basin; and
- Construct conveyance to the outfall for treated CSO effluent.

The estimated capital cost of this alternative is $9.6 million.

Comparison of Alternatives

The ***benefits*** of alternative 2A are as follows:

- Capital cost of the project is estimated to be approximately $400,000 less than the other alternatives.

The ***disadvantages*** of alternative 2A are as follows:

- Remote location (away from the WWTP) requiring additional time or staff to maintain and operate;
- Requires construction of a dedicated CSO outfall;
- Limited ability to utilize process equipment for alternate uses (such as WWTP redundancy or effluent polishing during non-CSO periods); and
- Requires permitting and new construction in the flood way, which may be difficult to obtain.

The advantages of alternative 2B are as follows:

- Ability to utilize the UV Disinfection process equipment for redundancy, and during maintenance or repair of the WWTP's UV system; and
- Ability to utilize the WWTP outfall for disposal of treated CSO flows.

The disadvantages of alternative 2B are as follows:

- Remote location (away from the WWTP) of the high rate clarification requires additional time or staff to maintain and operate; and

- Capital cost of the project is estimated to be approximately $400,000 more than alternative 2A.

- Requires permitting and new construction in the flood way, which may be difficult to obtain.

The advantages of alternative 2C are as follows:

- Ability to utilize the UV Disinfection process equipment for redundancy, and during maintenance or repair of the WWTP's UV system; and

- Ability to utilize the WWTP outfall for disposal of treated CSO flows.

The disadvantages of alternative 2C are as follows:

- Capital cost of the project is estimated to be approximately $400,000 more than alternative 2A.

Recommended CSO Reduction Alternative

Alternative 2C is the recommended treatment facility alternative. The differential in cost is easily offset by the potential to utilize both the high rate clarification and UV Disinfection systems as redundant unit processes for the WWTP during non-storm event periods. Table 4-4 summarizes the recommended CSO Reduction Plan.

Table 4-4

Summary of CSO Reduction Plan Improvements		
CSO Reduction Method	**Description/Benefit**	**Required Improvements**
Phase 1	Central CSO Regulator provides inline storage of CSO flows that would have been conveyed to the Skagit River. Stored CSO flows are conveyed to the WWTP as capacity allows for treatment and disposal.	In-line storage. Completed and online, December 1997
Phase 2[1]	The 'Internal Shunt' of Hazel Street Interceptor CSO Flows would allow a peak flow of approximately 7.5 mgd to be continually treated during a storm event. This additional treatment capacity will allow the CSO regulator to act as equalizing in-line storage and further reduce the potential CSO events.	Increase capacity of the influent pump station. Increase capacity of the headworks, primary treatment facilities, disinfection system, effluent pump station, and secondary WWTP outfall for a hydraulic capacity of 25.8 mgd. Add the potential for coagulant addition to the primary clarifier designated for CSO treatment.
Phase 3	The CSO Treatment Facility will be final phase of CSO reduction. It will allow the City meet their consent decree with DOE and reduce CSOs to less than one untreated event per year.	Construct a high rate clarification system with a peak hour capacity of 22.2 mgd. Construct a UV disinfection system Construct a 750 LF of 36-inch sewer. Upgrade Park Street Pump Station Construct 1500 LF of 30-inch force main Construct a CSO effluent pump station Construct conveyance to the secondary effluent outfall[2]

1. Improvements for Phase 2, the Internal Shunt of CSO flows, are included in Chapter 10, Recommended Alternatives.
2. It is assumed that treated CSO flows and the secondary effluent will be combined and discharged through the same outfall.

Phase 3 of the CSO reduction plan is the construction of a CSO treatment facility to reduce untreated CSOs to less than one event per year. A CSO treatment facility is assumed be subject to the following treatment requirements (based on the NPDES discharge permit issued to the Carkeek CSO Treatment Facility, King County, WA):

- Removal of 50 percent suspended solids on an annual basis;
- An annual average of effluent settleable solids concentration of 0.3 mL/L/hr; and
- A maximum effluent settleable solids concentration of 1.9 mL/L/hr.

The key treatment processes of a CSO treatment facility would include high rate clarification for removal of suspended solids, and UV disinfection for disinfection of effluent:

- High rate clarification (HRC) is a physical/chemical process that utilizes high specific gravity ballast material, such as sand, to increase the settling velocities of particulate matter or chemically conditioned floc particles. The benefits of HRC is that it requires a small footprint, has a rapid start-up time, and produces an effluent low in turbidity and suspended solids.
- UV disinfection is the process whereby wastewater is exposed to UV energy which, when absorbed by micro-organisms, damages the nucleic acid preventing reproduction of the organism and eliminating the ability of the micro-organism to cause infections. UV disinfection has benefits over chlorine for CSO applications in that it does not degrade over time, does not require large volume of chlorine to be stored on site, and does not require large contact tanks to be constructed.

The estimated costs for a CSO Treatment Facility for the City of Mount Vernon are presented in Table 4-5. These costs include conveyance of CSOs to the wastewater treatment plant site, construction of CSO treatment facilities, treated CSO disposal, and an estimate of the annual operations and maintenance costs of the CSO Treatment Facility.

Table 4-5

Recommended Improvements for the CSO Treatment Facility[1,2]	
Improvement	**Capital Cost Estimate ($1,000)**
CSO Interceptor	$700
Upgrade Park Street Pump Station	$700
CSO Forcemain	$500
CSO Treatment (High Rate Clarification)	$4,200
CSO Disinfection[3]	$2,200
CSO Effluent Pump Station	$800
CSO Outfall[4]	--[4]
Total Capital Cost	$9,100
Estimated Annual O & M Cost[5]	$8.4 to $9.6

1. Does not include CSO-Phase 2 Improvements, which are incorporated in secondary treatment plant improvements - presented in Chapter 10.
2. CSO Phase 3 Improvements, per DOE Consent Decree, may be required by 2015
3. Based on an estimated transmissivity of the treated CSO effluent.
4. Costs are included in the WWTP single outfall estimate, where both treated CSO flows and secondary effluent are discharged through a single outfall.
5. Based on the average overflow volume for 1998-2000 (5.6 mg), and a cost estimate of $1.50 to $1.75 per 1,000 gallons treated.

5. WASTEWATER COLLECTION SYSTEM

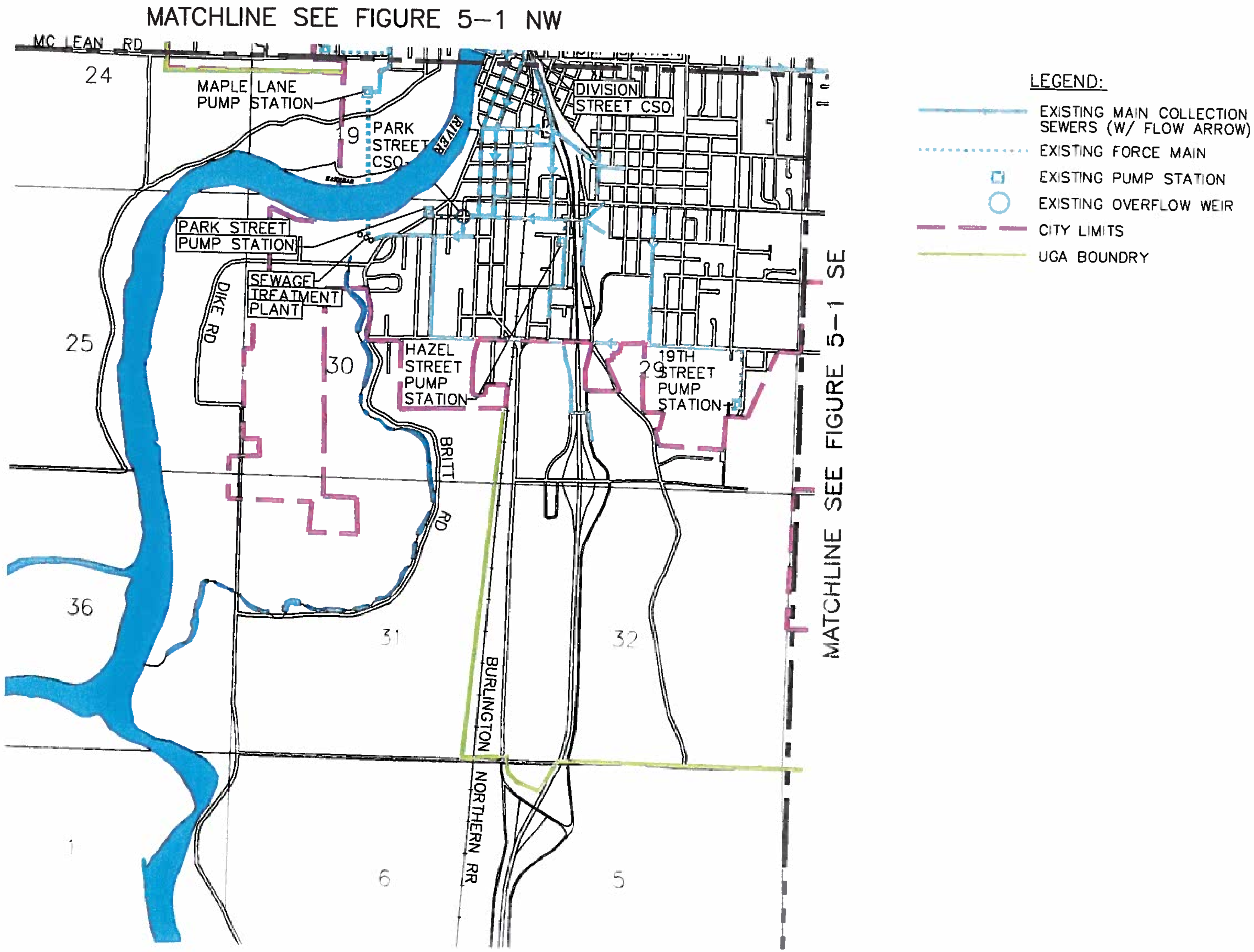
This chapter presents an evaluation of the wastewater collection system. It includes a review of the interceptor system capacity based on projected peak flows, using the population projections presented in Chapter 3. A review of the City's Access database of sewer defects was also completed. The following sections identify system deficiencies, summarize corrective actions and costs required to correct the defects, and future improvements to the interceptor system required for projected growth.

SYSTEM DESCRIPTION

The City of Mount Vernon's wastewater collection system presently serves an area of approximately sixteen square miles. Figure 5-1 shows the major sewer lines, pump stations, and combined sewer overflow structures in the system. The system is composed of approximately 120 miles of pipe ranging from 6-inch to 60-inch diameter. The majority of the wastewater collection system was constructed of concrete pipe. The system pipe materials also include clay, corrugated metal, PVC, and polyethylene.

Portions of the downtown and older areas are served by combined sewers. Separate storm sewers are provided in the newer developed areas. The wastewater collection system was reviewed in 1994 and deficiencies in the system identified. Each year the City has allocated monies to repair known deficiencies.

The wastewater collection system presently includes thirteen pump stations owned and operated by the City, Table 2-1. The City also maintains and operates three combined sewer overflow structures (Freeway Drive, Division Street, and Park Street) and two CSO/storm water pump stations (Division Street and Park Street), see Chapter 4.



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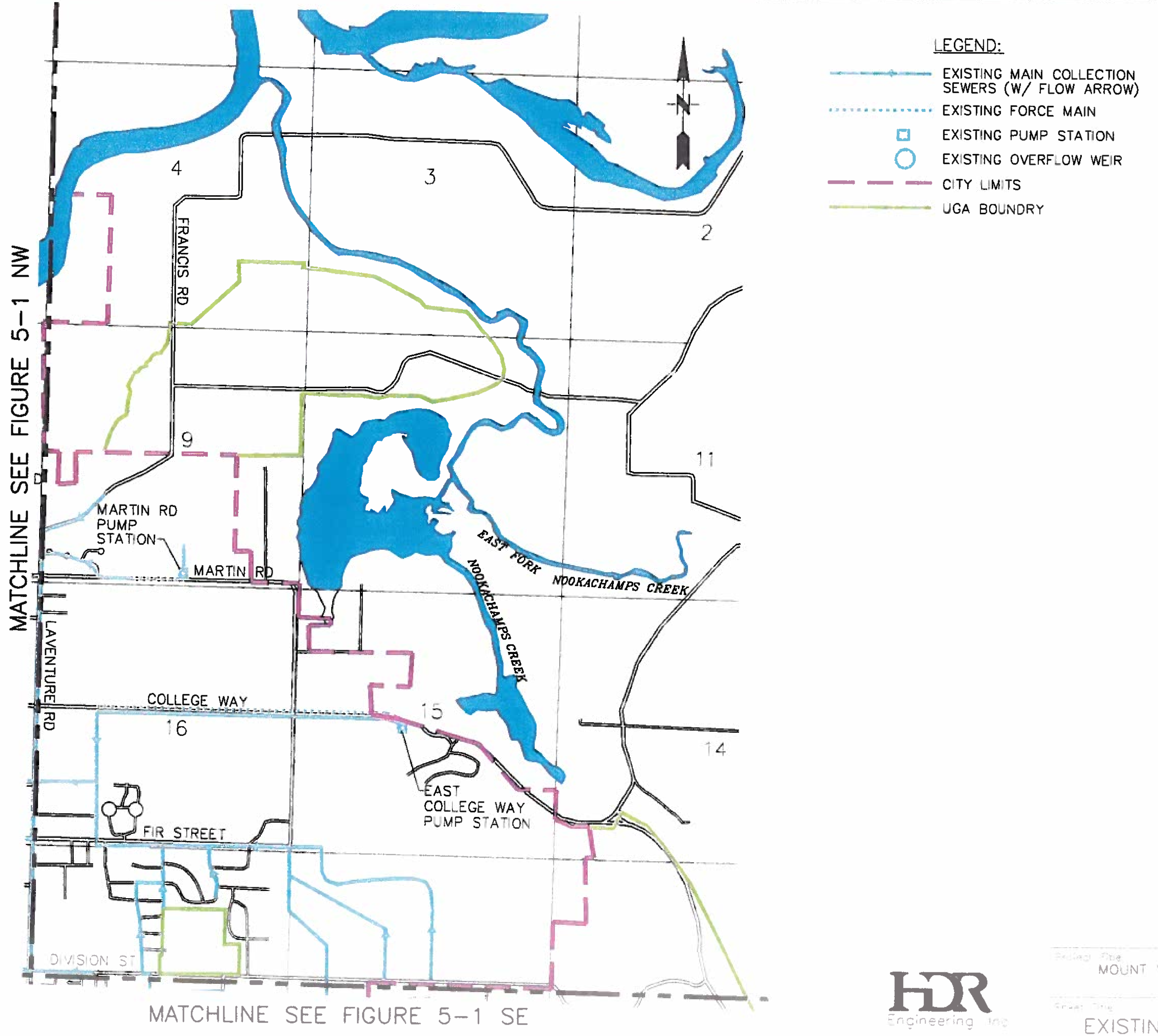
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

EXISTING COLLECTION SYSTEM

5-1 SW



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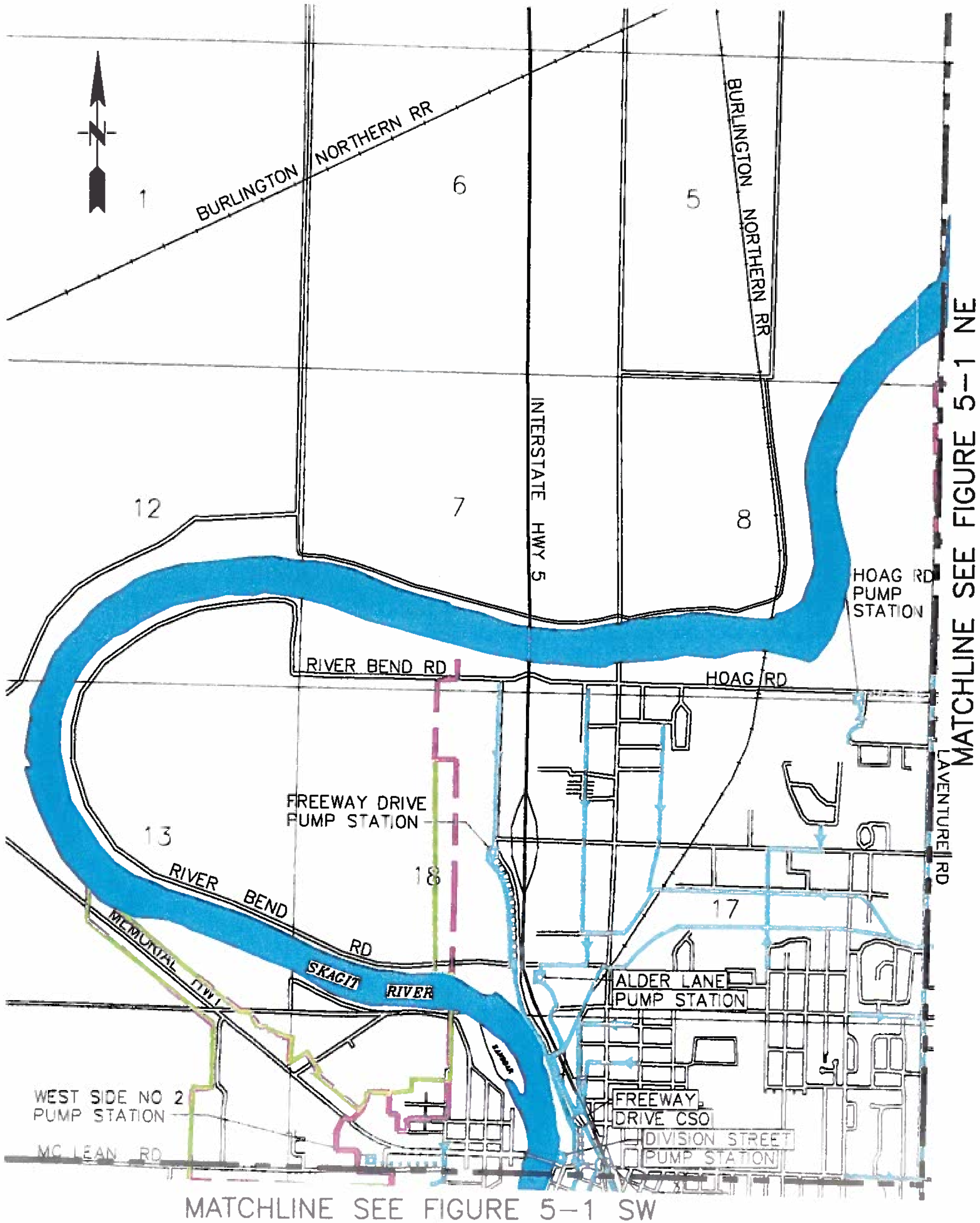
EXISTING COLLECTION SYSTEM

FEBRUARY 2003

5-1 NE



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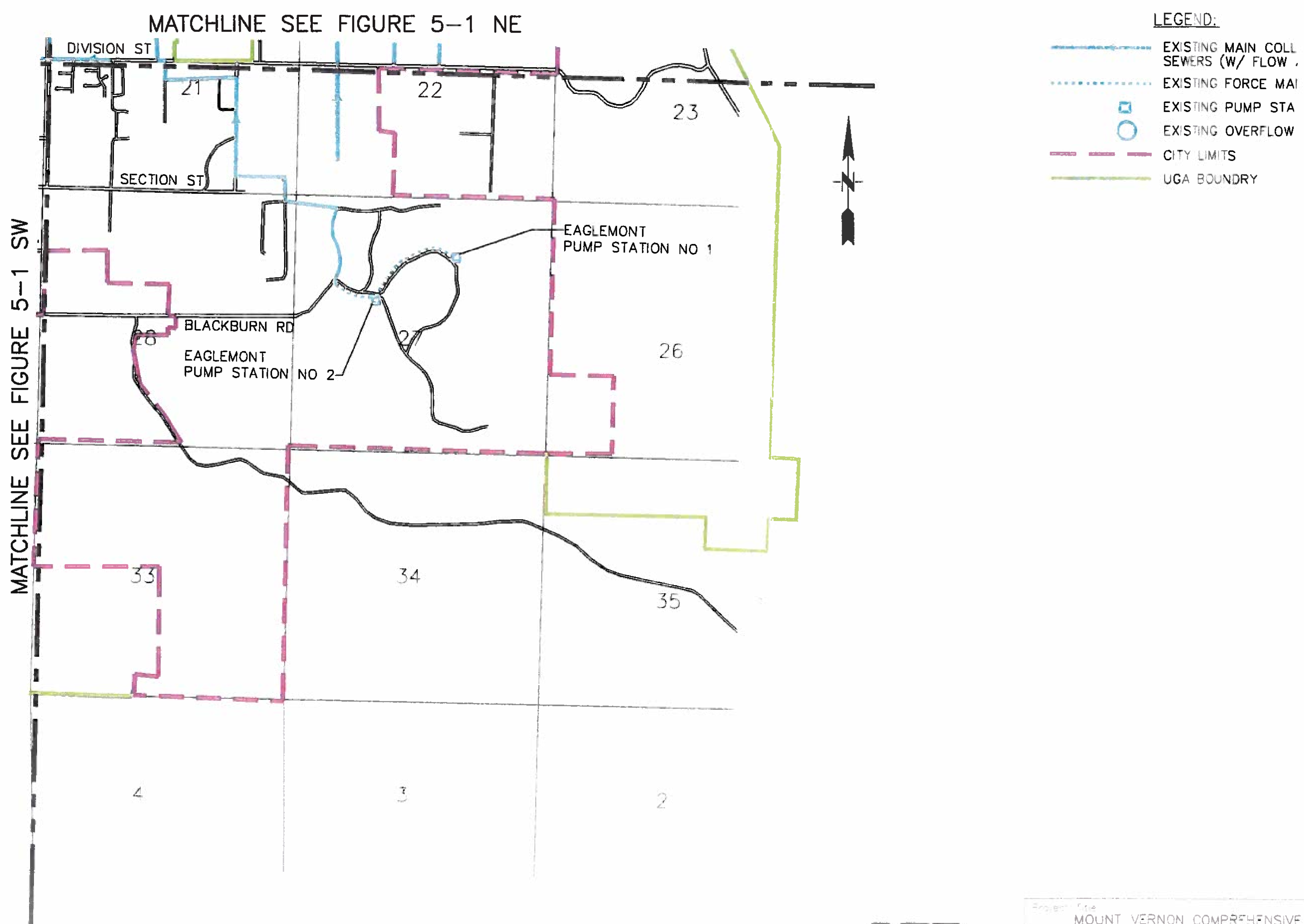
FEBRUARY 2003

EXISTING COLLECTION SYSTEM

5-1 NW



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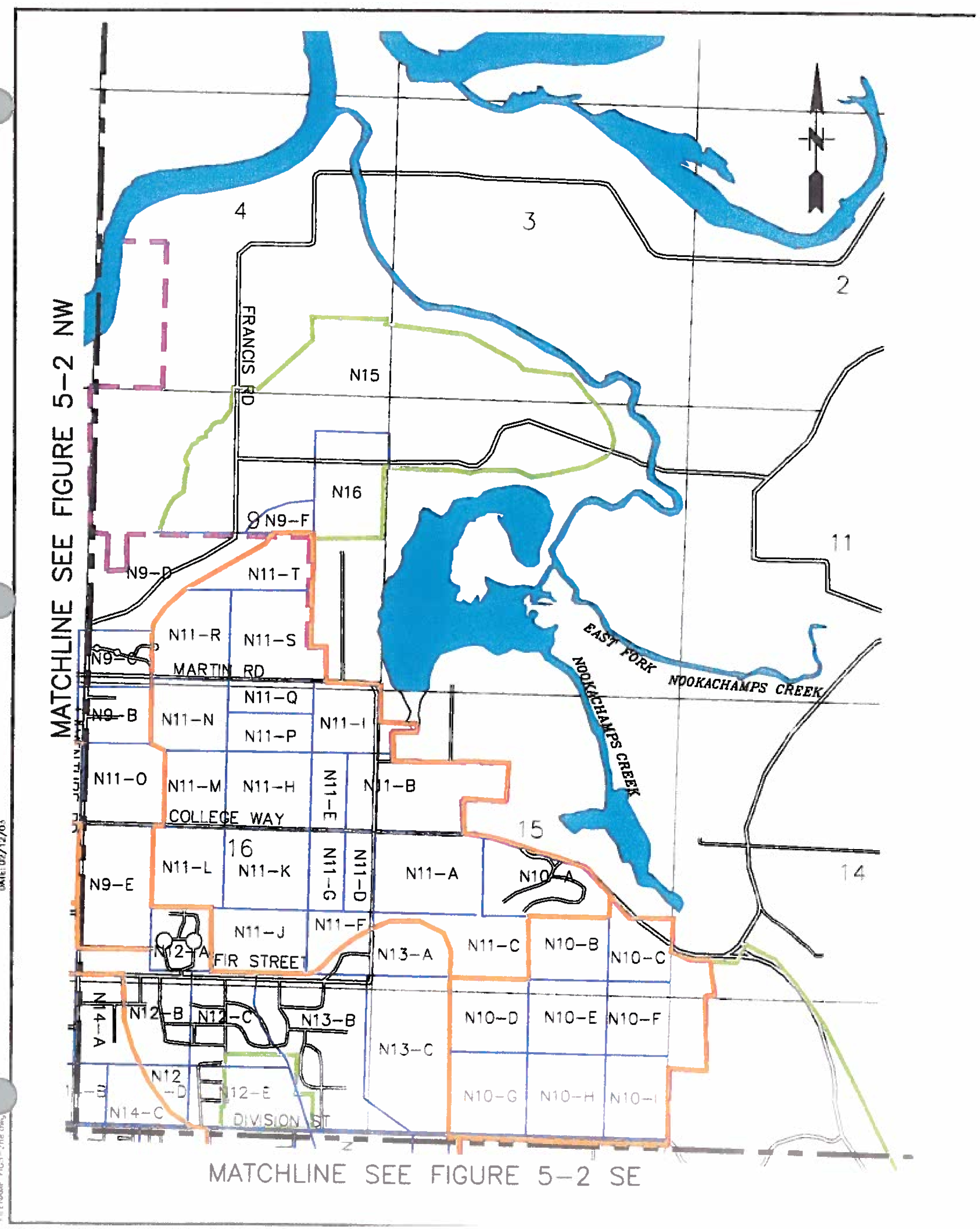
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	FEBRUARY 2003
EXISTING COLLECTION SYSTEM	5-1 SE



Wastewater Collection System Capacity Assessment

Introduction

An analysis of the capacity of existing interceptors and major trunk lines was completed to determine hydraulic limitations within the system that could limit future development. Figure 5-1, presented previously, provides the location of the existing wastewater collection system interceptors. Wastewater flows were developed in Chapter 3, and are based on Skagit County Population Projections for the 20-year planning horizon, through 2020.

Analysis

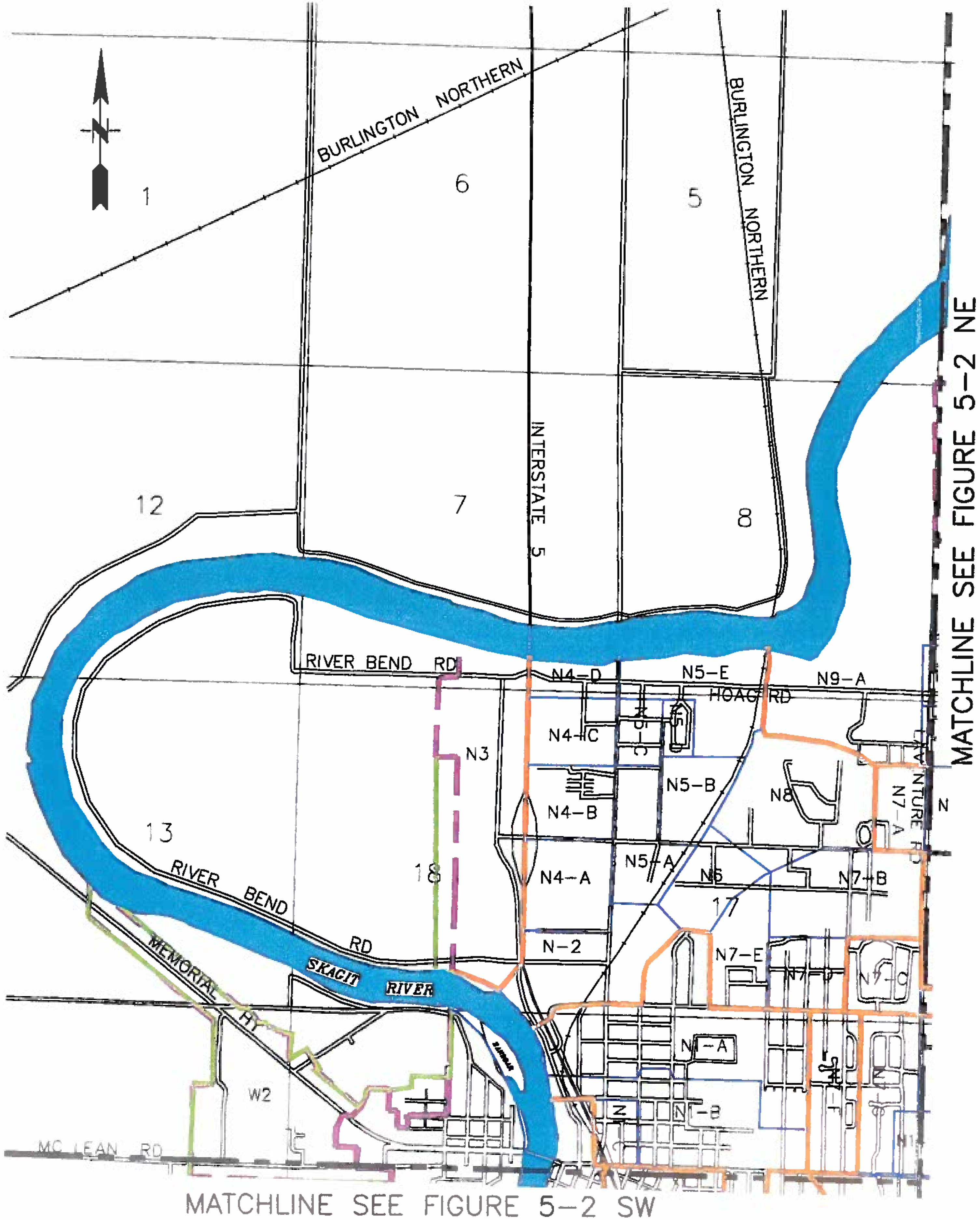
The system analysis was completed by defining the interceptors and major trunk lines. Manhole invert elevations and pipe lengths between manholes in the defined segments were obtained from City utility mapping and previous HYDRA modeling efforts. The analysis was completed by developing flow components for a fully developed UGA for each drainage area, Figure 5-2. Area, population density, and flow contribution assigned to each drainage sub-basin are presented in Appendix C. Flows from each drainage basin were estimated, including infiltration and inflow and peak sanitary flows, based on the following parameters:

Average Daily Per Capita Flow	100 gpcd
Infiltration and Inflow Rates	1,100 gpad
Peaking Factor for Sanitary Flows	L.A. Peaking Curve[1]

1. Fig. 3-6 Ratio of Peak Flow to Average Daily Flow in Los Angeles, ASCE Manual and Report on Engineering Practice No. 60.

The hydraulic capacity of each line segment was determined and compared to the future flows in the pipe. A sample analysis is presented in Appendix D.

In general, the interceptor system has few lines that have or will approach their capacity at full development. Flow monitoring, additional study, and modeling of the interceptors in the northern portions of the collection system would allow a more accurate prediction of when the new interceptors are required. Table 5-1 lists the lines identified by the hydraulic analysis as having limited capacity given the growth projections and the current UGA boundary.



LEGEND

- CITY LIMITS
- UGA BOUNDRY
- SUB-BASIN BOUNDRY
- DRAINAGE BASIN BOUNDRY

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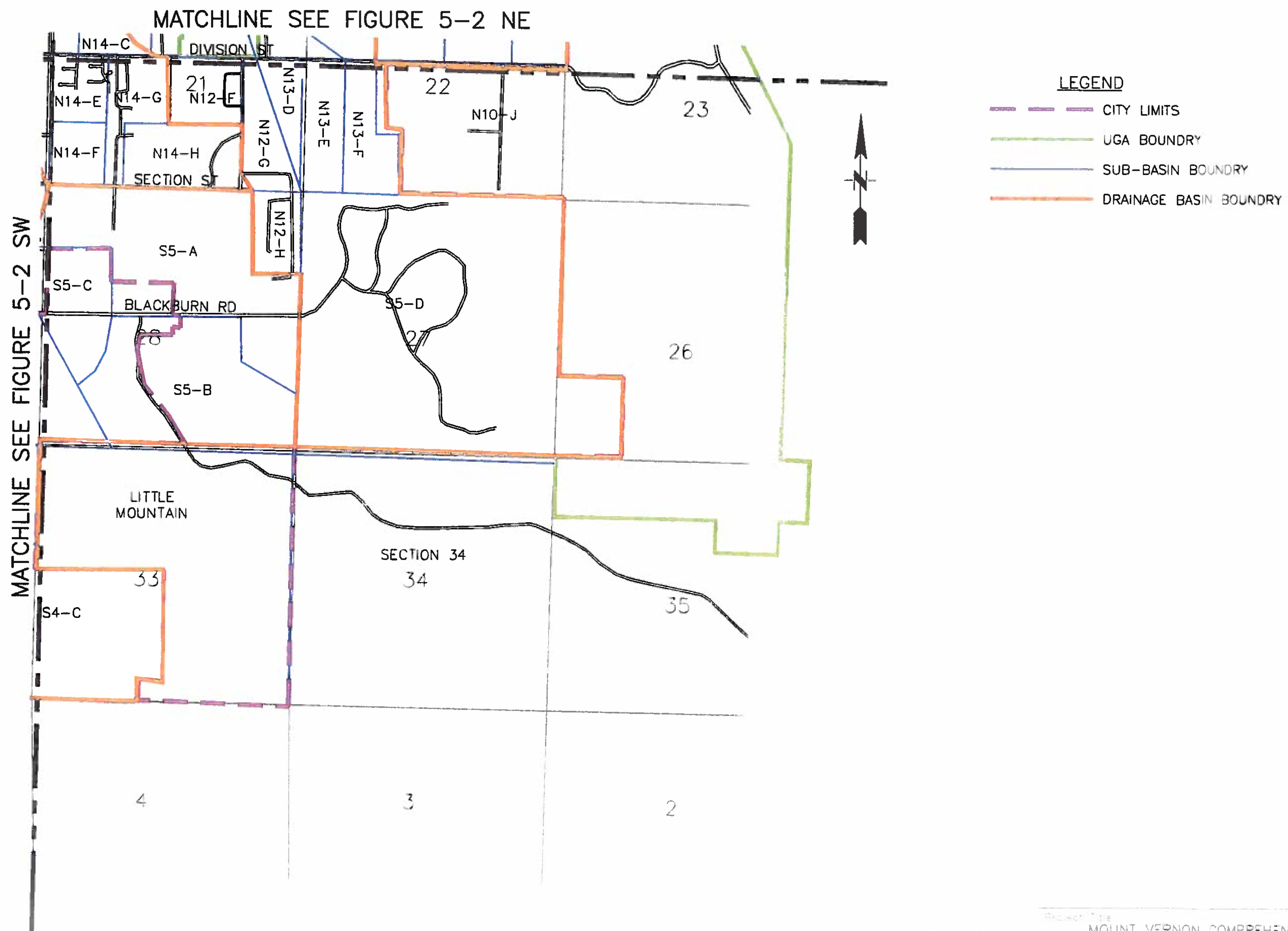
DRAINAGE BASINS

5-2 NW



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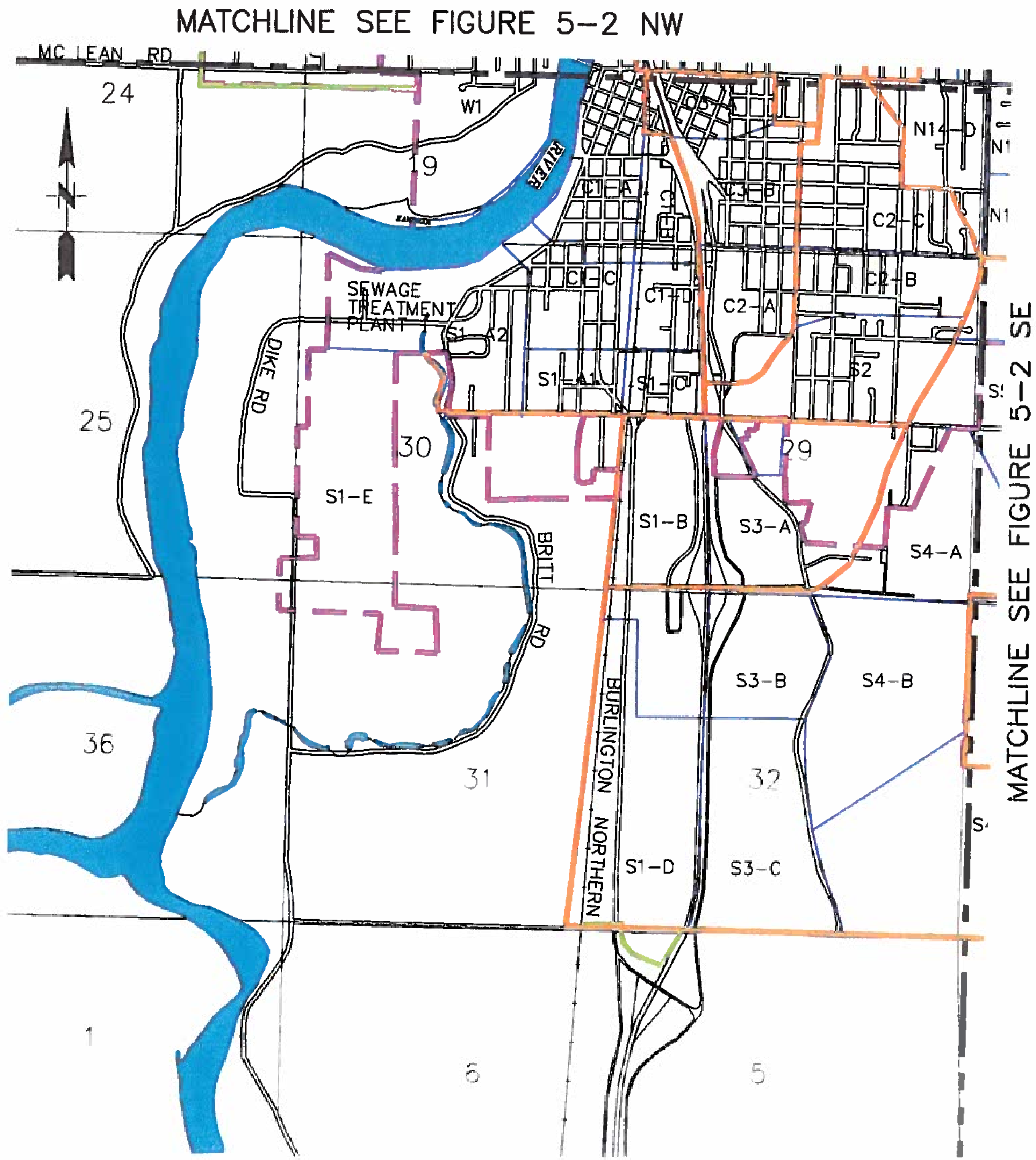
FEBRUARY 2003

DRAINAGE BASINS

5-2 SE



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MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

DRAINAGE BASINS

5-2 SW

DATE: 02/12/03

WASTEWATER COLLECTION SYSTEM CAPACITY ASSESSMENT

Introduction

An analysis of the capacity of existing interceptors and major trunk lines was completed to determine hydraulic limitations within the system that could limit future development. Figure 5-1, presented previously, provides the location of the existing wastewater collection system interceptors. Wastewater flows were developed in Chapter 3, and are based on Skagit County Population Projections for the 20-year planning horizon, through 2020.

Analysis

The system analysis was completed by defining the interceptors and major trunk lines. Manhole invert elevations and pipe lengths between manholes in the defined segments were obtained from City utility mapping and previous HYDRA modeling efforts. The analysis was completed by developing flow components for a fully developed UGA for each drainage area, Figure 5-2. Area, population density, and flow contribution assigned to each drainage sub-basin are presented in Appendix C. Flows from each drainage basin were estimated, including infiltration and inflow and peak sanitary flows, based on the following parameters:

Average Daily Per Capita Flow	100 gpcd
Infiltration and Inflow Rates	1,100 gpad
Peaking Factor for Sanitary Flows	L.A. Peaking Curve[1]

1. Fig. 3-6 Ratio of Peak Flow to Average Daily Flow in Los Angeles, ASCE Manual and Report on Engineering Practice No. 60.

The hydraulic capacity of each line segment was determined and compared to the future flows in the pipe. A sample analysis is presented in Appendix D.

In general, the interceptor system has few lines that have or will approach their capacity at full development. Flow monitoring, additional study, and modeling of the interceptors in the northern portions of the collection system would allow a more accurate prediction of when the new interceptors are required. Table 5-1 lists the lines identified by the hydraulic analysis as having limited capacity given the growth projections and the current UGA boundary.

Table 5-1

Hydraulic Analysis Identified Capacity Limitations at Saturated Development[1]			
Location	**between**	**Comment**	**Interceptor/ Trunk Sewer**
East of City Limits (sections 23 and 26)		Parallel line to College Way Pump Station	Future
East of City Limits (sections 15 and 22)		Parallel line to College Way Pump Station	Future
Martin Road	Trumputer and College Way	Monitor existing 8-inch	College Way
College Way	Martin Road and 35th St	Monitor existing 12-inch	College Way
College Way	Martin Rd to College Way Pump Station	Replace existing 8-inch	College Way
Fir Street	30th St and Comanche Dr	Monitor existing 12-inch	Fir Street
Fir Street	30th Street and 26th Street	Monitor existing 12-inch	Fir Street
26th Street	Jacqueline and Kulshan	Monitor existing 12-inch	Fir Street
26th Street	College Way and Kulshan Avenue	Reroute flows from College Way Pump Station[2]	Fir Street
LaVenture Road	Division Street and Fir Street	Monitor existing 8-inch	LaVenture
LaVenture Road	Fir St and Kulshan Ave	Replace existing 8-inch	LaVenture
LaVenture Road	Fir St and Kulshan Ave	Replace existing 10-inch	LaVenture
Kulshan Interceptor	Minimal slope: 24- and 30-inch pipe	Designed to operate under surcharged conditions.	Kulshan
Burlington Northern Railroad	South of Roosevelt Ave	Replace existing 15-inch	Alder Lane

Hydraulic Analysis Identified Capacity Limitations at Saturated Development[1]			
Location	**between**	**Comment**	**Interceptor/ Trunk Sewer**
Blackburn Road	East of Walter St	Monitor existing 30-inch	Southeast
Walter Street	Blackburn Rd and Hazel St	Monitor existing 30-inch	Southeast
Urban Avenue	North of College Way	Monitor existing 10-inch	Urban Ave
Freeway Drive	River Bend Rd and Cameron Way	Monitor existing 8- and 10-inch	Freeway Dr

1. Based on saturated development within the current GMA at present zoning.
2. Rerouted flows include construction of a forcemain, gravity mains, and upgrading the College Way Pump Station.

Interceptor System Improvements

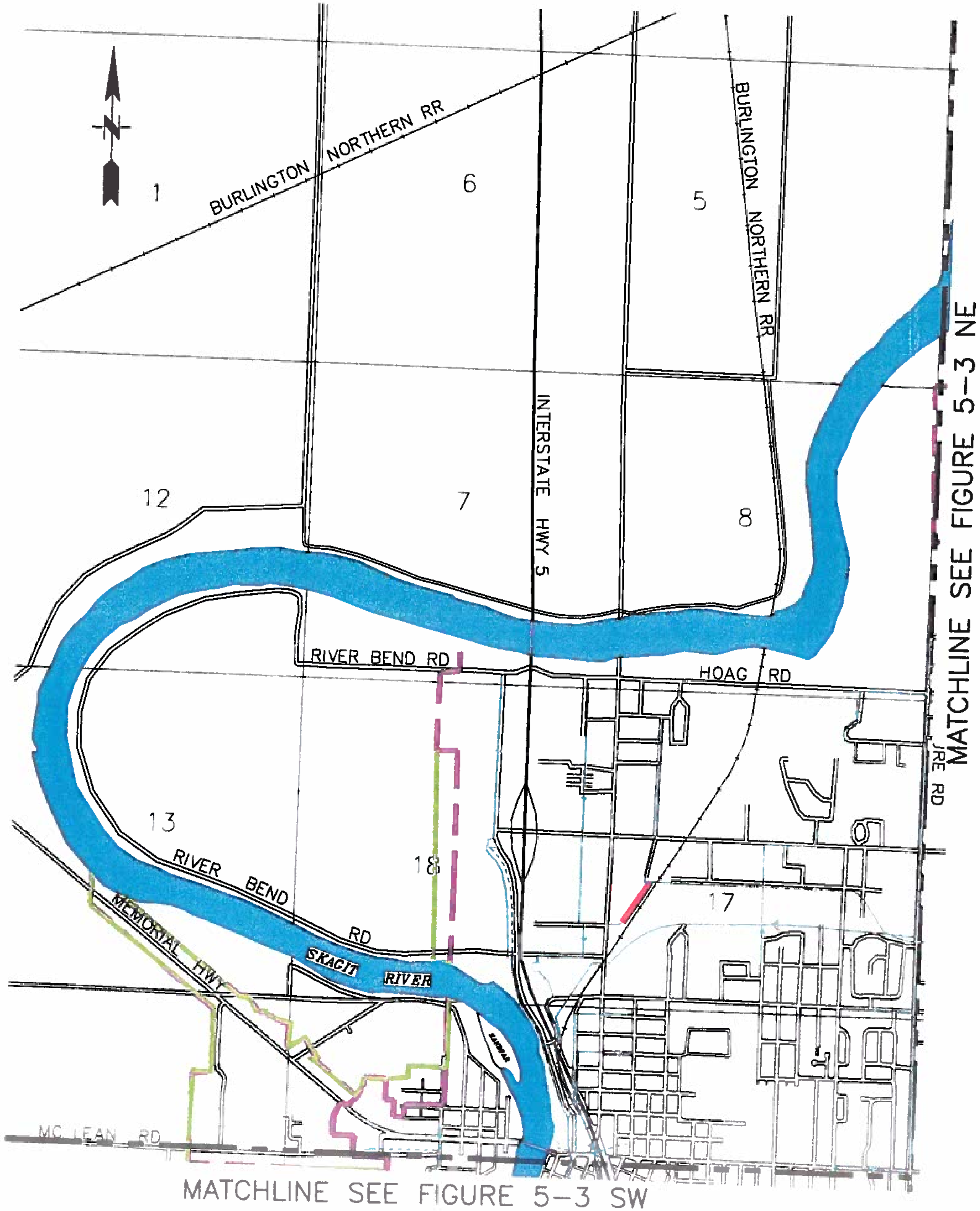
The interceptor system has lines that are predicted to approach capacity as the UGA approaches saturated development. These lines are recommended for monitoring and replacement as warranted. The following sections provide details of each of the interceptors. Table 5-2 summarizes the recommendations for each identified defect. Figure 5-3 presents the improvements to the interceptors and trunk sewer system based on the hydraulic analysis.

Table 5-2

Interceptor System Improvements						
ID No.	**Location**	**between**	**Year Required**	**Dia (in)[1]**	**Length (ft)[1]**	**Cost ($1,000)[2]**
FS-1	Sections 23 and 26		Future	18	1,379	380
FS-2	Sections 15 and 22		Future	18	1,063	295
FS-3	Martin Rd	Trumpter Rd. and College Way	As-Required	12	734	135
FS-4	College Way	Martin Rd. and 35th St.	As-Required	15	548	125
FS-5	College Way	Martin Rd. to Pump Station	2002	18	2,307	635

Interceptor System Improvements						
ID No.	Location	between	Year Required	Dia (in)[1]	Length (ft)[1]	Cost ($1,000)[2]
FS-6	Fir St	30th St. and Comanche Dr.	2005	18	980	270
FS-7	Fir St	30th St. and 26th St.	2005	18	1,265	350
FS-8	26th St	Jacqueline Place and Kulshan Avenue	As-Required	18	690	190
FS-9	26th St	College Way and Kulshan Avenue	As-Required	12	752	140
FS-10	LaVenture Rd	Division St. and Fir St.	As-Required	10	1,525	235
FS-11	LaVenture Rd	Fir St. and Kulshan Ave.	As-Required	10	495	75
FS-12	LaVenture Rd	Fir St. and Kulshan Ave.	As-Required	12	1,386	255
FS-13	Alder Lane Interceptor	Burlington Northern Railroad South of Roosevelt Ave.	As-Required	24	600	220
FS-14	Urban Ave	North of College Way	As-Required	12	375	70
FS-15	Freeway Dr	River Bend Road and Cameron Way	As-Required	12	1,309	240
FS-16	West Mount Vernon	Modify Pump Station	As-Required			150
FS-17	Central CSO Regulator	Add Fail-safe Gate Operator	2001			30

1. Improvements are based on saturated development, based on the UGA boundary, 100 gpcd, 1,100 gpad (inflow and infiltration), and L.A. Peaking curve.
2. Costs are based on ENR Cost index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.



NOTE:

1. IMPROVEMENTS SHOWN HERE ARE THE MINIMUM REQUIRED.

LEGEND:

- FUTURE SYSTEM IMPROVEMENTS
- FUTURE FORCE MAIN
- EXISTING MAIN COLLECTION SEWERS (W/ FLOW ARROWS)
- EXISTING FORCE MAIN
- EXISTING PUMP STATION
- EXISTING OVERFLOW WEIR
- CITY LIMITS
- UGA BOUNDRY

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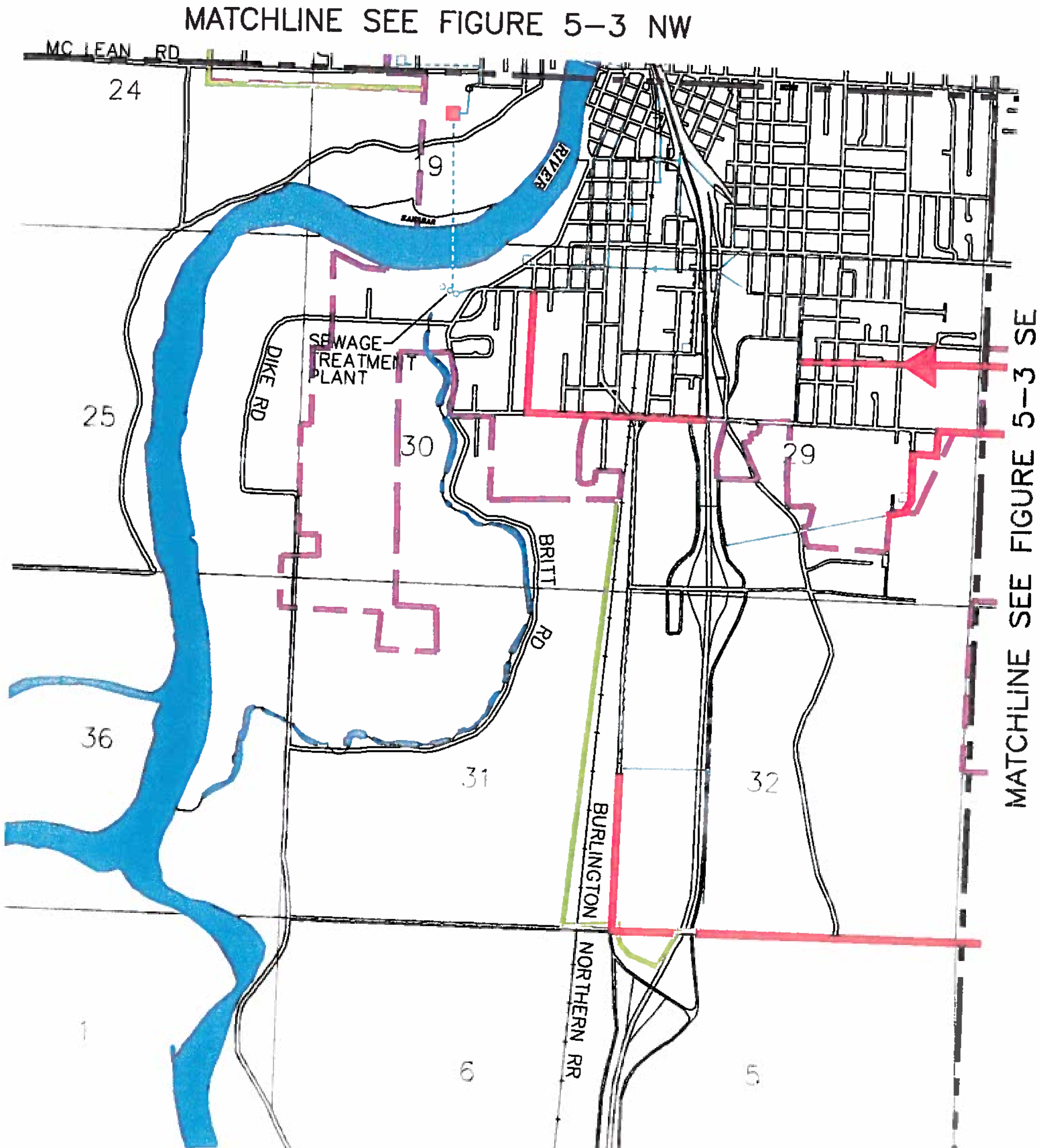
Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date: FEBRUARY 2003

Sheet Title: FUTURE COLLECTION SYSTEM IMPROVEMENTS

Figure No. 5-3 NW



NOTE:

1. IMPROVEMENTS SHOWN HERE ARE THE MINIMUM REQUIRED.

LEGEND:

- FUTURE SYSTEM IMPROVEMENTS
- FUTURE FORCE MAIN
- EXISTING MAIN COLLECTION SEWERS (W/ FLOW ARROWS)
- EXISTING FORCE MAIN
- EXISTING PUMP STATION
- EXISTING OVERFLOW WEIR
- CITY LIMITS
- UGA BOUNDRY

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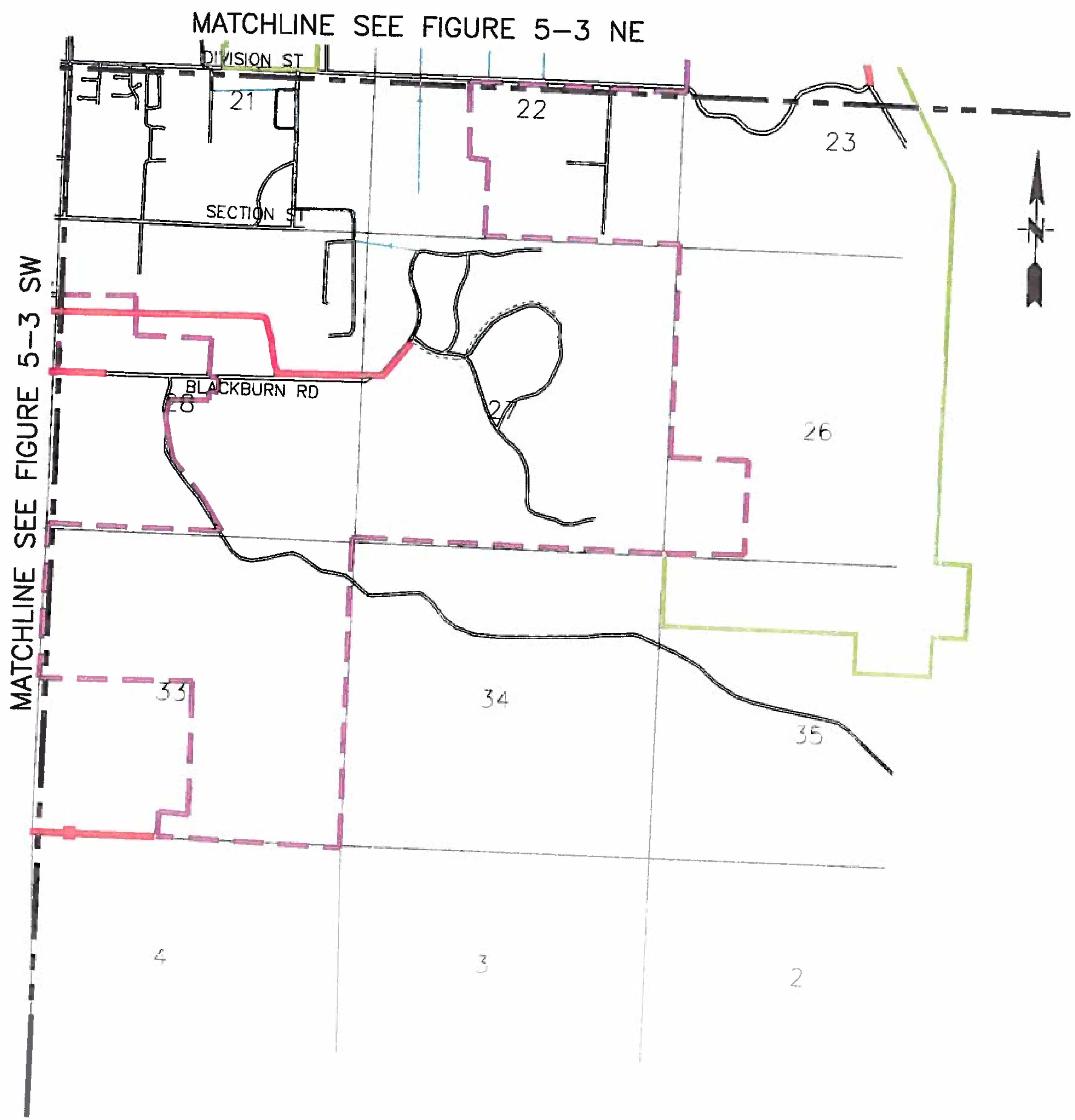
Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	Date: FEBRUARY 2003
Sheet Title: FUTURE COLLECTION SYSTEM IMPROVEMENTS	Figure No: 5-3 SW



NOTE:
1. IMPROVEMENTS SHOWN HERE ARE THE MINIMUM REQUIRED.

LEGEND:
- FUTURE SYSTEM IMPROVEMENTS
- FUTURE FORCE MAIN
- EXISTING MAIN COLLECTION SEWERS (W/ FLOW ARROWS)
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- EXISTING OVERFLOW WEIR
- CITY LIMITS
- UGA BOUNDRY

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MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

FEBRUARY 2003

FUTURE COLLECTION SYSTEM IMPROVEMENTS

5-3 SE

College Way Pump Station Drainage Area

The 1995 Comprehensive Sewer and Combined Overflow Reduction Plan examined alternatives to conveying flows from the College Way Pump Station to the WWTP via the Kulshan Interceptor. The 1995 recommended alternative, two force mains constructed to the terminus of the Kulshan Interceptor, is still the most efficient method of conveying flows from the existing area and future areas. This alternative recommends flows be conveyed to the Kulshan Interceptor through:

- A new College Way Pump Station, as flows dictate; and
- Two 12-inch force mains from the pump station to the Kulshan Interceptor.

The new College Way Pump Station would convey flows from the UGA (sections 23 and 26), from the eastern portion of the City Limits (sections 15 and 22), and allow the Martin Road Pump Station (see LaVenture Trunk Sewer) to be abandoned. The College Way line from Martin Road to the pump station will need to be upgraded from an 8-inch line to an 18-inch line, with approximately 2,300 LF of pipe. The Martin Road conveyance improvement is accounted for in the improvements to the College Way line, which is undersized for future flows, even without the Martin Road Pump Station flows.

The existing 12-inch line on College Way between Martin Road and 35th Street is predicted near capacity with future development. Current flow data is inconclusive, minor storms recorded may not have fully activated all sources of inflow and infiltration. This line should be monitored every 10 years to determine the affects of growth on flows through this area, but should be monitored more frequently if rapid growth occurs or indications of increases in inflow and infiltration are observed. If necessary, the 12-inch line should be replaced with 548 LF of 15-inch. The existing 8-inch line on Martin Road between College Way and Trumpter Road is predicted near capacity with future development. It should be monitored and replaced with 734 LF of 12-inch line as required.

The estimated peak flow discharged from the College Way Pump Station with a single pump discharge is 960 gpm. The 12-inch line on 26th Street is adequate to accept this single pump discharge, but would be surcharged with 2 pumps operating. Since the line on 26th Street is adequate to accept flows from the College Way Pump Station, alternative to this were not considered.

Fir Street Trunk Sewer

The Fir Street and 26th Street Trunk Sewers are composed of 8-inch and 12-inch lines. Many of these lines are predicted near capacity with future flows. They should be monitored and replaced as necessary:

- Monitor Fir Street between 30th Street and Comanche Drive and replace with 980 LF of 18-inch pipe, as required.
- Monitor Fir Street between 26th Street and 30th Street and replace with 1,265 LF of 18-inch pipe, as required.
- Monitor 26th Street between Jacqueline Place and Kulshan Avenue and replace with 690 LF of 18-inch pipe, as required.

LaVenture Trunk Sewer

LaVenture drainage area includes north of Kulshan Creek, along LaVenture, and drainage areas N9 and N15. The existing conveyance includes two pump stations, Hoag Road and Martin Road Pump Stations. As development continues, the interceptor these pump stations discharge to will become overloaded. The Martin Road Pump Station can be abandoned by routing a gravity main from the Martin Road Pump Station to College Way. Martin Road area would be served by a gravity main from the Martin Road Pump Station to the College Way Pump Station, conveying flows via 2,650 LF of new 10-inch pipe and existing lines along College Way from the intersection of College Way and 26th Street to the pump station.

Capacity restrictions in the LaVenture Trunk Sewer exist both north and south of the Kulshan Interceptor. Improvements to the LaVenture Trunk Sewer include both replacement of undersized lines and monitoring of lines predicted to be near capacity:

- Monitor the existing 8-inch line on LaVenture Road between Division Street and Fir Street and replace with a 10-inch line as required.
- Replace the existing 8-inch line on LaVenture Road between Fir Street and Alison Avenue with 495 LF of 10-inch pipe.
- Replace the existing 10-inch line on LaVenture Road between Fir Street and Kulshan Avenue with 1,386 LF of 12-inch pipe.

Kulshan Interceptor

The Kulshan Interceptor is designed to operate in both a gravity flow and surcharged mode, with a capacity in excess of 20 mgd. Future peak flows will exceed the gravity capacity (9.3 mgd) and the interceptor will operate in a surcharged mode.

Alder Lane Interceptor

Alder lane Interceptor consists of 30-inch pipes, with a few 15-inch lines. The two sections of 15-inch pipe, paralleling Burlington Northern Railroad, south of Roosevelt Avenue, limit the capacity of the Alder Lane Interceptor. The remaining 30-inch pipe does not result in limitations. These links should be replaced with 600 LF of 24-inch pipe.

The Alder Lane Pump Station currently consists of four pumps with capacities as follows, based on a normal wet well operating level, C factor of 110, and utilizing both the 10 and 16-inch force mains:

- One Pump Capacity: 4.3 mgd
- Two Pump Capacity: 6.8 mgd
- Three Pump Capacity: 8.9 mgd

Peak flows to the pump station in 2020 are estimated at 4.74 mgd. This flow rate will require two pumps, requiring a minimum of three pumps in the station to provide firm pumping capacity.

Southeast Interceptor

Improvements to the Southeast Interceptor, as identified in the 1995 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan, are different than those recommended in this report, for the UGA boundary has changed in the southern portion of the planning area. Section 34 was included in previous planning studies, but has been omitted from the current UGA. This exclusion changes the predicted future flows and loads entering the Southeast interceptor.

The current mode of operation of the Central CSO Regulator, during periods of high CSO flows, has a beneficial effect of utilizing the Southeast Interceptor for additional storage, yet this could increase the potential that flooding of residences. At projected 2020 flows, of 7.42 mgd, approximately 4.0 ft of headloss to be incurred from the railroad to Hazel Street to the WWTP Influent Pump Station. Depending on the level of downstream surcharging, this level of headloss could cause the hydraulic grade line to be above the ground surface (in affect, sanitary sewer overflows would be possible with downstream surcharging). To prevent this possibility, the following improvements should be implemented prior to increased flows:

- Install a fail safe operator, with a shut mode at failure, at the Harrison Street Vault of the CSO Regulator; and

- Limit the maximum water surface elevation in the influent pump station wet well to 5.5 ft.

West Interceptor

West Mount Vernon is served by the West Interceptor and West Mount Vernon Pump Station. The analysis predicts no limitations in the West Interceptor, however, it does predict a peak flow of 1.8 mgd in the interceptor. This peak flow is in excess of the firm pumping capacity of the West Mount Vernon Pump Station, 1.2 mgd. Flows from the pump station are conveyed to the WWTP via a 10-inch force main. This force main has adequate capacity for excess of 2.8 mgd.

The West Mount Vernon Pump Station will require upgrade as development approaches saturated conditions on the West side.

This pump station is a 'package-type pump station' with a separate wetwell and drywell. Due to space limitations within the drywell, the most cost effective method of increasing capacity may be to convert this to a submersible pump station, similar to most of the other pump stations within the system. The wetwell would be modified, submersible pumps installed, and a valve vault provided. Budget costs for these improvements and associated electrical improvements are with a standby generator unit is $150,000.

Central CSO Regulator

The Central CSO Regulator is designed with excess capacity to serve as inline storage during storm events. There are no capacity limitations in this line. A detailed description and analysis of the Central CSO Regulator is presented in Chapter 4.

Other Trunk Sewer Improvements

Urban Avenue Trunk Sewer, north of College Way, flows are currently conveyed through a 10-inch gravity main. At saturated development, this line is predicted near capacity.

Monitoring of the line is recommended and replacement with 375 LF of 12-inch pipe, as required.

Freeway Drive Trunk Sewer, between River Bend Road and Cameron Way, consists of 8-inch and 10-inch lines. These lines are predicted near capacity with future flows. It is recommended that flow monitoring of these lines occur and replacement with 1,309 LF of 12-inch pipe, as required.

LOCAL ISSUES

1st Street and 8th Street

Many of the sewers in the combined areas are 6 or 8-inch and do not have capacity to convey both sanitary and wet weather flows during extreme storm events. Consequently, backups occur along sections of the sewer that become surcharged during storms. Many of these sewers are over fifty years old and because of deterioration are in need of repair or replacement. One local problem is along North 8th Street between Warren Street and Lawrence. To alleviate the problems in this area the sewers should be replaced with larger sewers as shown in Figure 5-4. The estimated cost for these improvements is $1,000,000.

Where possible the City should consider separating storm water connections from the combined sewer and diverting to storm drainage facilities. Removing the storm water will reduce the peak and volume of flow that is discharged to the treatment plant during storm events. Another option is to provide detention of storm water to reduce the peak discharge rate into the combined system. Separating or detaining flow is particularly beneficial when large areas of impervious surface are removed such as parking lots and large buildings. The City indicated that the Mount Vernon High School is scheduled for renovation. Storm drainage connections from this school could be separated from the combined sewer system or detention structures provided to reduce the peak discharge rate into the combined system.

Separation of Combined Areas

The 1995 CSO Reduction Plan concluded that it was more cost effective to transport and treat combined sewage rather than separate. The reduction improvements identified in the plan provided a method of conveying the combined sewage to the treatment plant and ultimately treatment of excess flows. This approach to achieving the required level of CSO reduction allows combined areas to remain combined.

The CSO Reduction Plan was developed primarily on the observed peak CSO flow rates for the design storm event and subsequently used to establish the CSO baseline. These flows reflected the extent and nature of development within the combined sewered areas. These areas are almost completely built out and any redevelopment would consist of either reconstruction with the same type of land use such as remodeling a single family residence or possibly a change in the type of land use such as converting single family residential to multifamily residential or commercial. Reconstruction could increase the stormwater runoff rate and if drainage is provided by the combined sewer system these changes could result in an increase in CSO baseline.

Stormwater design standards, including the City of Mount Vernon's, typically require new construction to maintain predevelopment runoff rates. This requirement protects downstream stormwater facilities from overloading. This same concept and approach could be applied to the combined sewered areas with predevelopment conditions assumed to be those that existed when the CSO baseline for the Reduction Plan was originally established. Requiring redevelopment to provide detention facilities could maintain peak runoff rate into the combined system.

When redevelopment occurs there is the potential for separating storm water connections from the combined sewer and diverting runoff to storm drainage facilities. Even if storm drainage facilities are not available, disconnection of inflow sources such as roof gutter downspouts could benefit the combined system. If downspout splash blocks are provided in areas with no storm drains the runoff would migrate across yards and eventually could enter the combined sewer through right of way inlet connections; however, the rate of flow would probably be attenuated and would reduce the peak flow impact on the sewer. Disconnecting inflow sources such as downspouts also provides the opportunity for the runoff to infiltrate into the ground.

Recent studies indicate that a significant portion of the excess flow in combined sewer systems is from infiltration. Evidence also indicates that much of this flow originates from private property. When redevelopment occurs in combined sewered areas upgrading side sewer laterals to current design standards and excluding subsurface drainage connections such as foundation drains could provide long term benefits of reducing combined sewer flows.

Redirecting runoff in combined sewered areas to storm drainage facilities could also negatively impact the storm sewer system. The existing storm drainage system may not have adequate capacity to accommodate the additional runoff. Furthermore, increasing the runoff to a storm drainage system from previously combined sewered areas may hamper efforts to maintain water quality of stormwater runoff.

The City should further evaluate the impacts of increased runoff into the combined system from redevelopment and the impacts of separating sewers in the combined areas.

Interstate 5 Crossing

There are several sewer crossings under Interstate 5 that are damaged and need to be replaced or repaired. The repair method will be challenging for the crossings between Kincaid Street and the 2nd Street Overpass because the lines are behind a large retaining wall on the east side of the freeway. The sewers that should be addressed are described below; however, each crossing should be evaluated further to determine the most appropriate repair method. Repair or replacement methods include bore and jack, cure in place, pipe burst, horizontal directional drill, or other rehabilitation technologies may be possible. The estimated costs for repairing all of the Interstate 5 crossings is approximately $750,000, assuming cure in-place lining of existing pipes. See Table 5-3 and Figure 5-5 for the location of the sewers.

Table 5-3

Interstate 5 Crossings		
No.	Location	Condition and Recommended Improvement
1.	Lawrence Street to old Brick Hill Overflow Structure	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. The sewer maps indicate that there is a manhole located on this freeway crossing in the middle of Interstate 5. If the improvements identified in the North 8th Street discussion are constructed the flows in this freeway crossing will be reduced.
2.	Fulton Street to Freeway Drive near Scotts Bookstore	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. The pipe serves an extremely small area so lining the pipe may be desirable. The sewer maps indicate that there is a manhole located on this freeway crossing in the middle of Interstate 5.
3.	From 4th Street dropping under the 2nd Street Overpass	Video tapes of the pipe indicate that the pipe is damaged. The 2nd Street overpass is scheduled to be replaced. This sewer crossing could be suspended from a new bridge. Houses immediately adjacent to the bridge should be evaluated to determine if they can be served by a new suspended bridge crossing.
4.	Division Street	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. It is possible the flow in this line could be routed north to the 2nd Street Overpass crossing.
5.	4th Street and Washington	Video tapes of this sewer pipe have documented damage. The line should be reevaluated and repaired, replaced or lined as necessary. It is also possible that a sewer line could be constructed in the east shoulder of the freeway to intercept these flows and route them south to Kincaid Street.
6.	From Gates Street on the West Side of the Freeway to the Kincaid Street Northbound onramp	This crossing was abandoned during the construction of the Central CSO Regulator.
7.	6th Street and Gates on East Side of Freeway	Condition is unknown. This line crosses under the Kincaid Street Northbound onramp and then flows south to Kincaid. The line should be evaluated and repaired, replaced or lined as necessary.

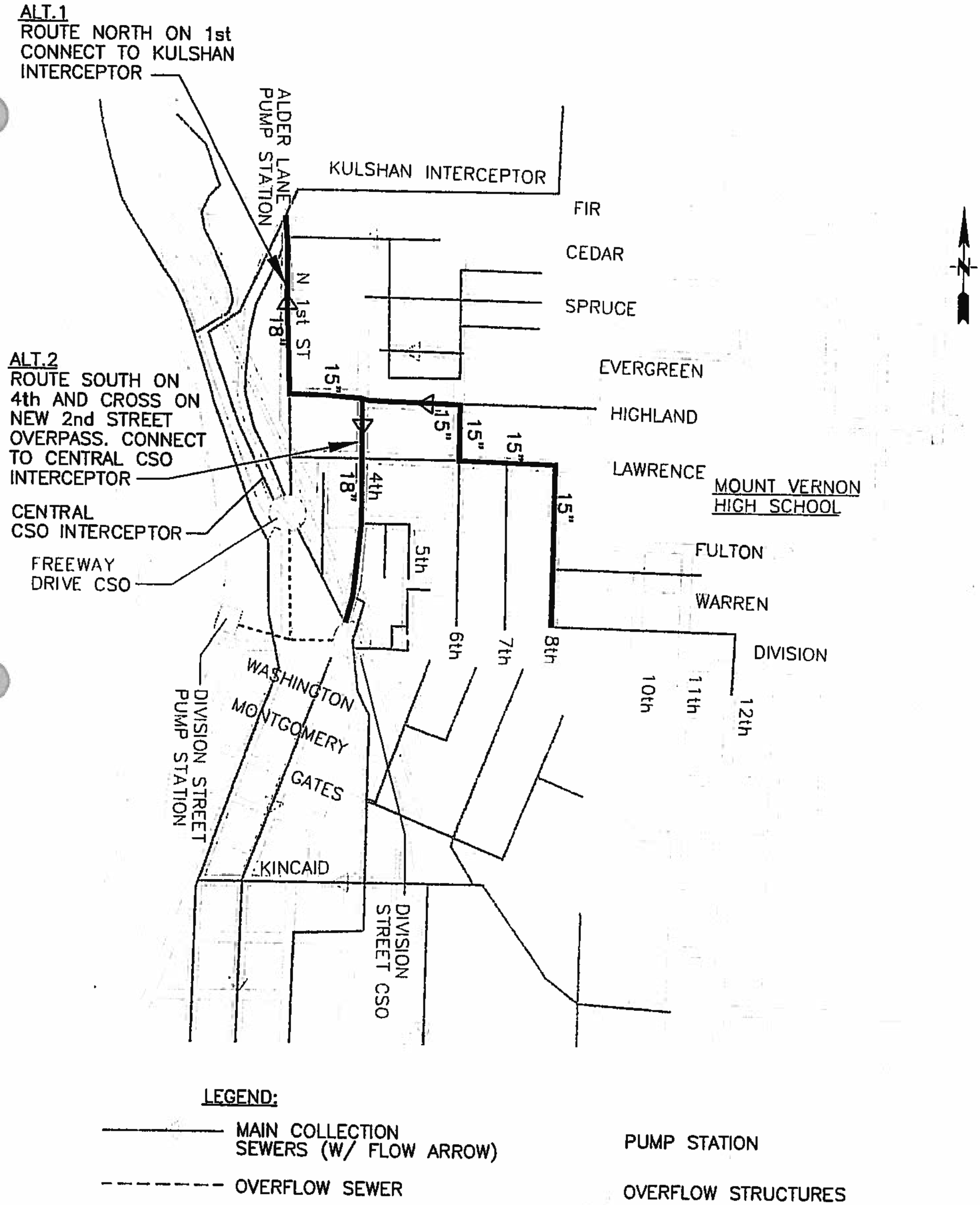
Interstate 5 Crossings		
No.	Location	Condition and Recommended Improvement
		necessary.
8.	Section Street at Wells Nursery	Condition unknown. This 16-inch provides service to only one connection, Wells Nursery. There is also a documented steady flow
9.	Park Street at South Side of Wells Nursery	Condition unknown. The line should be evaluated and repaired, replaced or lined as necessary.

North Fir Street

As development occurs in the property East of 30th Street and North of Division Street conveyance will be required. Conveyance from this area should be connected to the line on 30th Street. The line should be extended up to Division to intercept and offload other local sewers. This extension could also provide service to a future school East of 34th Street and South of Division Street.

Fowler Interceptor

Wastewater from the Eaglemont Development in East Mount Vernon currently discharges to the north and flows to the Kulshan Interceptor. Original plans for this development identified the need to ultimately convey flows to the Fowler Interceptor. This interceptor has been extended partially to the east already. The remainder of the extension should be completed as required by the development of Eaglemont.



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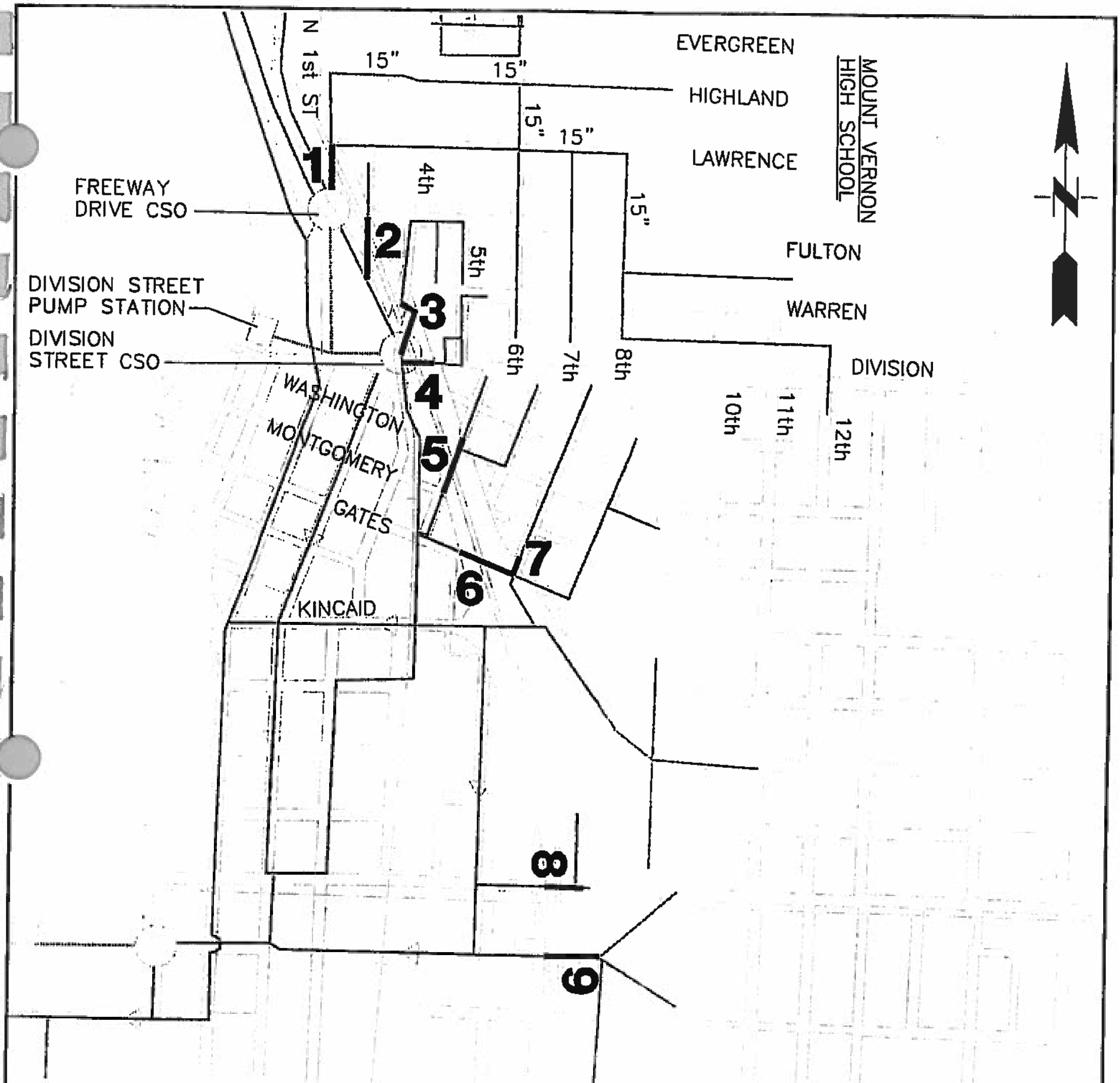
Project Title	Date
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	FEBRUARY 2003
Sheet Title	**Figure No.**
NORTH 8th STREET IMPROVEMENTS	5-4

DATE: 02/12/02
FILENAME: FIG5-4



HDR Engineering, Inc.

Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	Date: FEBRUARY 2003
Sheet Title: INTERSTATE 5 SEWER CROSSINGS	Figure No. 5-5

Freeway Drive Pump Station

This pump station serves the limited development on the west side of Interstate 5 between College Way and the Skagit River. The pump station has adequate capacity to serve the boundaries and current zoning. Any revisions to the zoning or expansions of the service area may require an upgrade to the pump station. The existing pump station and 8-inch force main have a capacity of about 350 gpm. This is about 2 feet per second velocity in the force main. It is reasonable to increase velocities in a force main to about 8 feet per second so additional capacity could be provided by increasing the pumping rate. The sewer beyond the force main discharge may need to be increased to accommodate additional flows.

South Mount Vernon

Service to the area of Anderson Road has been provided by constructing a pump station on Highway 99 South of Anderson Road. Areas on the East side of Interstate 5 will be served by a gravity sewer extending under Interstate 5 approximately halfway between Anderson Road and Hickox Road. There is a small area of south of Little Mountain Park that will need to be provided with a pump station because the grade falls to the east.

WASTEWATER COLLECTION SYSTEM DEFECTS ASSESSMENT

Introduction

The City has three databases that are used to track sewer collection system problems:

- Video Scan, a database record of the TVing of sewer lines;
- Sewage Incident Reports, a database of incidents of water and wastewater on the ground; and
- Sewer Complaints, a database of customer complaints of suspected waters that may or may not be wastewater, and of local problems (i.e. wastewater flooding basement due to plugged side sewer).

Table 5-4 lists major defects identified through the City video records and system database. The City has also compiled a database of customer reported problems, sewage incidents, and historical video inspections. System deficiencies included deteriorating pipes, lines with excessive root intrusion, or lines known to have capacity limitations. Minor defects that can be addressed with spot fixes are discussed in the next section.

Table 5-4

Collection System Improvements					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-1	Snoqualmie, MH B29A to MH B29	Root intrusion	Video[2]	Remove roots and Slipline with 300 LB	$20
CS-2	Yard of house 1115 N0. 8th, MH 49 to MH 50	Root intrusion	Video[2]	Remove roots and Slipline with 250 LB	$20
CS-3	So. 7th and Jefferson to So. 7th and Washington, MH 39 to MH 37	Root intrusion	Video[2]	Remove roots and Slipline with 450 LB	$20
CS-4	No. 6th and Lawrence, MH C39 to MH C38	Root intrusion	Video[2]	Remove roots and Slipline with 320 LB	$20
CS-5	Brick Hill, MH 01, North along I-5	Root intrusion	Video[2]	Remove roots and Slipline with 400 LB	$20
CS-6	Blodgett Rd to North of Blackbur, MH 55 to MH 54	Root intrusion	Video[2]	Remove roots and Slipline with 270 LB	$20
CS-7	Kincaid, MH 25, to MH 23	Root intrusion	Video[2]	Remove roots and Slipline with 240 LB	$20
CS-8	So. 20th, North off Section, MH 32 to MH 31	Root intrusion	Video[2]	Remove roots and Slipline with 120 LB	$20
CS-9	Section, MH D33 to between MH D32-D31	Structural Damage	Video[2]	Replace with 420 LF of 8-inch pipe	$50
CS-10	Alley between Douglas and Walter, MH A13 to A05	Structural Damage	Video[2]	Replace with 640 LF of 8-inch pipe	$75

Table 5-4 cont					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-11	107 Cedar to the South, MH F11 to F29	Structural Damage	Video[2]	Replace with 300 LF of 8-inch pipe	$45
CS-12	No. 6th, MHF13 to F14	Structural Damage	Video[2]	Replace with 400 LF of 8	$60
CS-13	Section and Rail Road Ave, MH E17 to E18	Structural Damage	Video[2]	Sport repair-verify grease problem is corrected	$5
CS-14	Broadway at alley between So. 9th & 10th, MH D41 to D40	Structural Damage	Video[2]	Slipline with 330 LF	$20
CS-15	Broad, east of So. 11th, MH 54 to MH 49	Structural Damage	Video[2]	Replace with 230 LF of 8-Inch pipe	$20
CS-16	Line under I-5	Structural Damage	Video[2]	Will require further	--[4]
CS-17	Alley, north of Division, east of No. 11th, MH C66 to C65	Structural Damage	Video[2]	Spot Repair	$5
CS-18	Bernice, east of So. 14th, MH G42 to G41	Structural Damage	Video[2]	Spot Repair	$5
CS-19	So. 3rd and Vera, MH A41 to I42	Structural Damage	Video[2]	Pipe has been	--
CS-20	Lawrence and 7th, MH C73	Structural Damage	Video[2]	Spot Repair	$5
CS-21	1224 12th Str. So, between MH G8 and G11	Structural Damage	Video[2]	Replace with 200 LF of 8-inch pipe	$25

	and G11			inch pipe	

Table 5-4 cont

ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-22	117th North 8th Str.	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-23	420 E. Fulton	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-24	919 W. Division	Flooding	Data Base[3]	No improvements-surface flooding problem	--
CS-25	Alley at Carpenter, between So 9th and so. 10th heading north to Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-26	1120 No 16th, 340 ft north of MH M68 on Florence and 16th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-27	1210 N. 14th, north of Florence and 14th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-28	8th Str. And Evergreen heading north, F18 to F15	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-29	7th and Warren, toward Fulton, MH C73 to C72	Cracked Pipe	Data Base[3]	See 8th Str. Section	--[5]
CS-30	16th and Blackburn heading east 17th, J08 to J09	Obstruction	Data Base[3]	Jet main and monitor flows	--
CS-31	100 Washington-storm line going to SE under I-5, MH C19 to C20	Cracked Pipe	Data Base[3]	Will require further assessment	--[4]

Table 5-4 cont.					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-32	Scott's Bookstore, N 1st to N 1st and Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-33	Snoqualmie St. between Cleveland and S 2nd Str. MH B32 to B03	Cracked Pipe	Data Base[3]	Reassess slipline if necessary	--
CS-34	Westside of Christenson Seed West to So 3rd, MH E01 to A39	Infiltration	Data Base[3]	Spot Repair	$5
CS-35	Cleveland and Blackburn to just West of Harrison and Blackburn, MH J11 to J09	Infiltration, Joint problem	Data Base[3]	Slipline 300 LF	$20
CS-36	N Laventure just south of E Fir to N Laventure just north of E Fir, MH N06 to N04	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-37	North of Casecade Str., on N Laventure to S of E Fir on Laventure, MH N08 to N06	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-38	N Laventure, Fulton to Cascade, MH N12 to N10	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-39	Hoag Rd., Parkway Dr., to Hoag Rd	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-40	Lind Str. And S. 6th to N on S 6th, MH E76 to E75	Infiltration	Data Base[3]	Spot Repair	$5

[1] Costs are based on ENR Cost Index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.
[2] Defect identified via review of video records.
[3] Defect identified via review of City Sewer Data Base.
[4] Interstate-5 Crossings are estimated at $750,000 for all nine improvements.
[5] 8th Street improvements have been estimated at $1,000,000 to correct the localized surcharging.

Repair and Replacement Program Criteria

The City has annually allocated a budget of $900,000 for sewer repair and replacement. This allocation allows necessary improvements to be scheduled and completed in a timely manner, saving the City monies from costly emergency repairs. Co-ordination with the Pavement Management Plan also allows savings to be realized for the City. A comprehensive repair and replacement program, designed to address improvements in order of importance, is presented in the last section of this chapter, Recommendations.

The City databases were reviewed and the necessary capital improvements identified. Numerous problems are small in nature and can be repaired with spot fixes. These defects should be allotted a nominal sum of $5,000 per location for repair of the problem. Defects that require additional work, including removing roots and sliplining have been allocated a minimum estimated cost of $20,000. The City databases had in excess of 30 records where repairs were required. Table 5-4 presents a summary of the identified projects and the corrections for each problem.

ODOR CONTROL

Odors in the collection system are typically associated with anaerobic conditions. These conditions are a function of ambient temperature, gravity pipe slope, transition structures, inverted siphons, and force mains. Hydrogen sulfide is generated in the wastewater and released to the atmosphere, causing odors and corrosion in the structure where it is released. Typically, in the collection system, prevention or treatment of hydrogen sulfide in the liquid-stream is desirable.

Liquid-stream odor control can be accomplished by numerous chemicals:

- Chlorine, as is currently utilized, is a powerful oxidant that can be supplied either in a gas phase (chlorine gas) or as hypochlorite. It is effective at controlling odors by oxidizing sulfide and killing or inactivating many odor-causing bacteria. Chlorine oxidation requires approximately ten to fifteen pounds of chlorine per pound of sulfide. It's key disadvantage is it's classification as a hazardous substance, which requires consideration of health and safety issue.

- Calcium nitrate is an alternate electron donor. In anaerobic conditions, bacteria preferentially chose nitrate to sulfate as an electron donor, thus sulfide is not produced in the presence of nitrate. Approximately 0.7 to 1.4 pounds of calcium nitrate is required per pound of hydrogen sulfide. Bioxide™ is a commercially available calcium nitrate solution produced by U.S. Filter, Davis Process.

- Other options for chemical oxidation of sulfide include potassium permanganate, hydrogen peroxide, ferrous sulfate, and slug dosing with caustic.

Four options were reviewed for reducing odors in the collection system. These included oxidizing with potassium permanganate, sodium hypochlorite, gaseous chlorine, and the addition of calcium nitrate. Typical costs per pound of sulfide removed were developed for each of these options.

Item	Cost per lb of Sulfide Removed
Potassium Permanganate	\$7 - \$10
Sodium Hypochlorite (12%)	\$3 - \$5
Gaseous Chlorine	\$1 - \$3
Calcium Nitrate	\$2 - \$3

Although gaseous chlorine has the lowest cost per pound of sulfide removed, the handling of gaseous chlorine presents a number of safety related issues, as addressed in Article 80 of the Uniform Fire Code. This requires the provision of containment and scrubber system to treat gases that could leak from the system. Due to the additional regulations and safety concerns, the trend for many utilities is to avoid the use of gaseous chlorine when planning new facilities. Presently the City utilizes the gaseous chlorine system at the wastewater treatment plant to provide a chlorine solution that is pumped to the incoming interceptor of the wastewater treatment plant at Hazel Street and Harrison Street. If gaseous chlorine were not to be used in the future, the use of calcium nitrate would be the next most cost effective method for odor control.

The future plan would be to add calcium nitrate at the more remote locations in the collection system, thereby reducing the production of hydrogen sulfide within the system and the need to add large quantities of chlorine to the interceptor upstream of the wastewater treatment plant.

RECOMMENDATIONS

While some deficiencies in the collection system exist or will exist with projected future growth, not all of them are recommended for repair or replacement. Table 5-5 presents the recommended improvements and a schedule for implementation, correlating to priority of improvement. Improvements to the interceptor system are dependant upon future growth and should be constructed, as identified in Table 5-2, to serve the areas that experience growth.

Table 5-5

Repair and Replacement Program		
Year(s)	ID Tags	Cost ($1,000)
2001	CS-1 through CS-18, CS-20, CS-21, CS-25 through CS-28, CS-32, CS-34, CS-35, and CS-40[1]	$555
2002	FS-5[2]	$635
2003	8th Street Improvements	$1,000
2004	Interstate 5 Crossings	$750[3]
2005	FS-6 and FS-7[2]	$620
2006	Interceptor Improvements	-[4]
2007-2020	FS-1 through FS-4, and FS-8 through FS-17[2]	$2,540
Total		$6,100

1. Improvements identified by the City, Table 5-4.
2. Interceptor System Improvements identified in Table 5-2.
3. Interstate 5 Crossings improvements are identified in Table 5-3.
4. The interceptor improvements identified in Table 5-2, and accounted for in this table in the future (2007-2020) should be designed and constructed as growth dictates.

6. INDUSTRIAL PRETREATMENT

INTRODUCTION

The City of Mount Vernon has one major industrial customer, Draper Valley Farms, Inc. (DVF), which discharges to the City's wastewater collection system. This industrial discharge is regulated by a State Discharge Permit, issued by the State of Washington Department of Ecology (DOE). This permit defines pretreatment requirements for these wastewater discharges to the City's sewer system.

As a part of the comprehensive planning process, the operations at this industry and their pretreatment equipment were reviewed to determine the adequacy of the pretreatment being provided. This included onsite observation of the industrial operation, interviews with operating staff, a review of operating data and compliance with permit requirements, and recommendations for operational plant modifications or improvements to the pretreatment process. This chapter includes description of the poultry plant and associated pretreatment facilities, presentation of wastewater data and wastewater discharge limitations, and a discussion and conclusions regarding the DOE requirements for the processes meeting the criteria for 'All Known, Available, and Reasonable Methods of Treatment (AKART).'

POULTRY PLANT DESCRIPTION

Draper Valley Farms slaughters approximately 90,000 fryer/broiler chickens during two productions shifts. The plant normally operates five days per week with some six-day weeks and one seven-day week each year, at most. The plant is sanitized during the third shift, with an additional "pre-operation" cleanup that starts at midnight on Sundays.

Cooling fans are activated in the receiving area when temperatures reach 65 ° F; while misters are activated when temperatures reach 70 ° F. After the chicken cages are unloaded, pretreated wastewater is recycled to wash the cages before they are returned to the truck.

After the carotid artery of the chicken is cut, the blood is collected in a curbed area and pumped to a holding tank on one of the trucks that hauls inedible material to the off-site renderer. The birds are scalded with steam to allow removal of yellow skin in the plucking machines to yield regionally-desirable white broilers, rather than yellow broilers. Feathers, and the yellow skin, are removed in three mechanical plucking machines in series, with the final machine devoted to feet of the bird. The feathers and skin are directed to one of two inedible trucks. Later the feet are removed and, somewhat unusually, sold as edible product in the United States. Guts, lungs, crops, heads and other inedible materials are directed to a second inedible truck. Giblets are removed and chilled with water for sale. Ultimately the chickens enter a chiller where heat is removed from the carcass with cold water. After chilling, some of the carcasses are directed to an adjacent room for cutting and packaging.

The entire production area is equipped with good areas designated for washing aprons and hands. The use of these areas during breaks, noon and shift changes prevents washing material on the floor into the sewers before it can be removed by dry cleaning.

All refrigerant compressors are air cooled, while cooling towers are used for the ammonia and freon compressors. Water is periodically blown down from the cooling towers to the plant with an automatic timer to prevent a buildup of minerals. This blow down is directed to the plant sewers through a one-inch line.

PRETREATMENT FACILITIES

Wastewater pretreatment facilities consist of primary and secondary screening and dissolved air flotation (DAF) with chemical addition. After feathers are plucked from the birds they drop Into a flume for conveyance to the feather screen. This screen is a rotating, internally-fed screen with openings approximately 1/8 inch in size. Feathers are sent to a press for dewatering and then augured to a truck for hauling to the off-site renderer. Viscera, heads, and other offal drop into a flume for conveyance to the offal screen. This screen is also a rotating, internally-fed screen with openings approximately 1/8 inch in size. Screened offal is augured to a compartment in the inedible truck, separate from the feathers. Underflow from the feather and offal screens is recycled with a pump back to the head end of the feather flume for conveying the feathers. This recycling is acceptable in the feather plucking area, but would not be acceptable in the remainder of the plant after the bird carcasses have been opened. Therefore USDA-required overflow water from the chiller, and other flows from the various processing operations, is utilized to convey the inedible material in the offal flume to the offal screen.

Screen underflow enters a wet pit. In addition to the recycle pump for the feather flume, this wet pit is equipped with a mechanical mixer and three submersible pumps. These three pumps are used to pump the wastewater through three individual forcemains to a secondary screen, although two of these pumps can handle the entire flow, even during the peak hydraulic flow period when the chiller tank is dumped. The secondary screen is a rotating internally-fed screen, with 0.02-inch openings. Screenings from this screen are combined in the inedible truck with the offal.

Since November 1999, a combination of ferric chloride and acid has been injected into each of the three lines to the secondary screen. A pH controller ensures a sufficient quantity of this liquid is added to reduce the pH to approximately 4.1 to 4.5. This pH range is the approxlmate isoelectric (point of least solubility) point of the proteins in the wastewater. After the excess proteins have come out of solution, they are coagulated by the ferric (trivalent iron). Polymer is then added to flocculate the coagulated proteins before the secondary screen underflow enters the subsequent DAF tank.

The above-ground steel DAF tank is approximately 70 ft long, 10 ft wide and 8 ft high, including 6 inches of freeboard. As such, it holds approximately 39,400 gallons. At the maximum allowable daily flow of 630,000 gpd, this results in a detention time of nearly 90 minutes. Secondary screen underflow is divided between four equally-spaced, 8-inch influent lines near the head end of this tank. To create a dissolved air flotation system, a portion of the tank contents is pumped from a line about a foot off the bottom and midway down the tank. A controlled amount of atmospheric air is aspirated into the suction line to this 15-hp recycle pressurization pump. The pump discharge is divided into four lines, each equipped with a back-pressure valve before it combines with one of the DAF influent lines. To drive most of aspirated air into solution, the valves are throttled to yield a back-pressure approximately 90 psi. After passing through the back-pressure valve and combining with the flocculated screen underflow, the dissolved air comes out of solution as small bubbles which attach to flocculated solids to float them to the surface of the DAF tank. Somewhat unusually, four large fans are periodically activated to blow the floating solids to the effluent end of the tank where they are swept into a skimmings hopper with a large paddlewheel. Occasionally, however, the operator has to assist the fans by raking the floating solids to the paddlewheel. After a quiescent period, water is drained from these skimmings and then they are pumped, with an air-operated, double-diaphragm pump to a separate compartment on one of the inedible trucks. After this skimmings compartment becomes full, the remaining skimmings are pumped to a separate skimmings tanker truck. The DAF tank is not equipped with any positive means of settled solids removal; however, the location of the recycle pump suction near the bottom of the DAF tank tends to draw some of these solids off the tank bottom. Nevertheless, a settled sludge layer varying from six inches to two feet had accumulated on the tank bottom when this tank was recently drained for the first time after more than five years.

A reuse pump is located near the DAF recycle pressurization pump to supply DAF tank contents for the initial hose down of the chicken cages and for hosing down the pretreatment and inedible truck areas.

DAF effluent overflows a relatively-short weir plate into a collection launder at the effluent end of the DAF tank. A pH sensor is used to regulate the feed of sodium hydroxide solution to maintain the pH of the effluent in the range of 6 to 7. Pretreated effluent is directed through a sampling and metering manhole before it enters the City sewer system. A 10-inch Palmer Bowlus flume with an ultrasonic level sensor is used to pace a ISCO refrigerated composite sampler. Wastewater billings are based on potable water meter readings, however, because the flume would surcharge in the past when flows exceeded 0.6 mgd.

WASTEWATER DISCHARGE LIMITATIONS

The Washington Department of Ecology (WDOE) has issued a discharge permit for Draper Valley Farms to discharge pretreated wastewater to the City of Mount Vernon sewerage system. This permit is effective until May 29, 2003. Effluent limits contained in this permit are:

EPA Recommendations	Draper Valley Farms Practices
	2. Water to wash station before eviscerating and after cavity splitter ran during noon break.
	3. Water to eviscerating machine ran during noon break.
	4. Water sprays at conveyor into carcass chiller ran during noon break.
	5. Shower at the salvage station wired open to flow continuously.
• Use minimum USDA-approved quantities of water in the scalder and chillers.	• Yes. Checked twice each shift
• Control water use in gizzard splitting and washing equipment.	• Yes
• To reduce the waste loads, dry clean all floors and tables prior to washdown in:	
• Bleeding.	• Yes
• Cutting.	• Yes
• Further processing areas.	• Not applicable
• All other areas where there tend to be material spills.	• Yes
• Minimize the amount of chemicals and detergents to prevent emulsification or solubilizing of solids in the wastewaters.	• Yes
• Stun birds in the killing operation to reduce carcass movement during bleeding.	• Yes
• Confine bleeding and provide for sufficient bleed time.	• Yes
• Recover all collectable blood and transport to rendering in tanks rather than by dumping on top of feathers or offal.	• Yes

EPA Recommendations	Draper Valley Farms Practices
• Consider the reuse of chiller water as makeup water for the scalder.	• No. Rarely, if ever, done in large, modern poultry plants
• Consider steam scalding as an alternative to immersion scalding.	• Not acceptable to USDA that requires 1 quart of water per bird be used in the scalder.
• Recycle screened wastewaters for feather fluming.	• Yes
• Consider dry offal handling as an alternative to fluming.	• No. Rarely, if ever, done in large, modern poultry plants
• Control inventories of raw materials used in further processing so that none of these materials are wasted to the sewer. Spent raw materials should be routed to rendering.	• Not applicable – no further processing
• Treat separately all overflow of cooking broth for grease and solids recovery.	• Not applicable – no cooking at this plant
• Reduce the wastewater from thawing operations.	• Not applicable – no thawing at this plant
• Treat offal truck drainage before sewering. One method is to steam sparge the collected drainage and then screen.	• No. Rarely, if ever, done in large, modern poultry plants
• Avoid overfilling cookers in rendering operation.	• Not applicable – no rendering operation
• Provide and maintain traps in the cooking vapor lines of rendering operations to prevent overflow to the condensers. This is particularly important when the cookers are used to hydrolyze feathers.	• Not applicable – no rendering operation
• Use pretreated poultry processing wastewaters for condensing all cooking vapors in onsite rendering operations.	• Not applicable – no rendering operation.
• Provide bypass controls in rendering operations for controlling pressure reduction rates of cookers after feather hydrolysis.	• Not applicable – no rendering operation

EPA Recommendations	Draper Valley Farms Practices
Stop cooker agitation during cooker pressure bleed-down to prevent or minimize materials carry-over.	Not applicable – no rendering operation
Provide frequent and regularly scheduled maintenance attention for byproduct screening and handling systems throughout the operating day.	Yes
Provide a back-up screen to prevent byproduct from entering municipal waste treatment system.	No. Rarely, if ever, done in large, modern poultry plants
In-plant primary systems—catch basins, skimming tanks, air flotation, etc. - should provide for at least a 30-minute detention time of the wastewater.	Yes – closer to 90 minutes
Provide frequent, regular maintenance attention to air flotation system.	Yes
Dissolved air flotation with pH control and chemical flocculation.	Yes

Methods of "prevention, control and treatment" of wastes discharged from a poultry plant to a municipal treatment system include the following general categories:

- In-plant waste minimization
- Recycle/reuse
- Pretreatment

The previous comparison shows that DVF has implemented virtually all the applicable BPT, New Source and BAT technologies suggested by the EPA for in-plant waste minimization, recycle/reuse and pretreatment, at least as currently practiced by large, modern poultry plants. DVF's recycle and reuse practices are unusually good.

AKART pretreatment requirements cannot be defined for a poultry plant without taking into consideration the municipal wastewater treatment facilities, since wastes can be removed at either location. Some municipalities have expanded their wastewater treatment facilities to accommodate waste loads from poultry plants with physical pretreatment alone, while many cities have required poultry plants to meet discharge limits around domestic strength levels, often around 250-350 mg/L BOD_5 and suspended solids (TSS). These domestic strength limits are about a quarter to a third of discharge levels with physical pretreatment alone. The current BOD_5 concentrations discharged by DVF to the sewer system are 200 to 250 mg/L on a 3 day average. The following is a listing of wastewater pretreatment options for poultry plants, arranged from least effective to most effective:

1. Coarse (1/4" openings) screening.
2. Coarse and fine (0.02" to 0.04" openings) screening.
3. Coarse and fine screening and gravity clarification.
4. Coarse and fine screening and dissolved air flotation.
5. Coarse and fine screening and dissolved air flotation with cationic polymer addition.
6. Coarse and fine screening and dissolved air flotation with cationic and anionic polymer addition.
7. Coarse and fine screening and dissolved air flotation with alum and anionic polymer addition with subsequent caustic addition for effluent pH neutralization, if required.
8. Coarse and fine screening, dissolved air flotation with acidulation to the isoelectric point (pH of least solubility of proteins) and polymer addition for protein coagulation and flocculation with subsequent caustic addition for effluent pH neutralization.
9. Coarse and fine screening and dissolved air flotation with ferric and anionic polymer addition with subsequent caustic addition for effluent pH neutralization, if required.
10. Coarse and fine screening, 24-hr flow equalization, dissolved air flotation with ferric and anionic polymer addition, effluent turbidimeter with provisions to return off-spec effluent back to the 24-hr flow equalization basin (FEB) and caustic addition for effluent pH neutralization, if required.
11. Coarse and fine screening, 24-hr flow equalization, dissolved air flotation with ferric and anionic polymer addition, effluent turbidimeter with provisions to return off-spec effluent back to the 24-hr FEB, caustic addition for effluent pH neutralization, and a 7-day FEB.

After the maximum amount of physical pretreatment, consisting of coarse and fine screening and dissolved air flotation, is achieved, further poultry waste reductions are almost always accomplished with chemical addition. The least effective chemicals for pretreatment yield the most acceptable sludges for rendering. Conversely the most effective chemical for pretreatment, ferric sulfate/chloride, yields a sludge which is difficult to render and seriously degrades the rendered products. Nevertheless DVF uses ferric chloride to meet the required discharge limits. In fact, they also acidulate the wastewater to the isoelectric point for even greater removals. Flow equalization ahead of the chemical pretreatment, monitoring effluent quality and return of off-spec wastewater for retreating, and 7-day flow equalization are additional steps that can be taken to improve the consistency of pretreatment, if necessary. The data shown in Table 6-1 shows the effluent has consistently met the discharge limits after the initial start-up of the new chemical feed system.

Potential Improvements

Although DVF is meeting the requirements of AKART in discharging their pretreated wastewater to the City of Mount Vernon's wastewater treatment system, there are a few enhancements that DVF should consider:

In-Plant Waste Minimization

1. Replace home shower-type nozzles with engineered spray nozzles.
2. Evaluate automating the flow of potable water to the plucking machines, eviscerating machine, and conveyor to the carcass conveyor so it shuts off automatically at noon and during breaks when there are no birds passing through these devices.
3. Continue to train, encourage and monitor plant personnel to turn off water at work stations during breaks and at noon.
4. Continue to ensure all hoses are equipped with press-to-activate nozzles.

Pretreatment

1. Lift station. Consideration should be given to replacing the three existing submersible pumps with three new Gorman Rupp T-series, self-priming pumps. These pumps have excellent solids-passing capability and are easier to maintain since they are not submersible. This pump change would not normally impact effluent quality, but reduced maintenance would offer the operators more time for operation and observation of the remaining pretreatment facilities.

   Regardless of the lift pumps utilized, the three discharge lines from these pumps to the rotating screen should be replaced with one common forcemain. This will eliminate the problems with trying to regulate the feeding of chemicals into each line.

2. Chemical Feed System. The existing chemical feed system was installed as a temporary system, nearly a year ago by reusing existing facilities and installing some makeshift provisions to pilot test the acid/ferric chloride chemical pretreatment scheme. Now that this chemical feed scheme has proven successful, the chemical feed system should be systematically laid out and permanently hard wired and hard piped. As part of this permanent design, the adequacy of the existing chemical metering pumps should be evaluated.

3. Operation and Maintenance. Written operation and maintenance instructions should be developed for the entire pretreatment system from the primary screens through the effluent sampling and metering station. In general, these instructions should developed as simple itemized lists for each piece or pieces of equipment or system. These lists should be laminated and mounted near the relevant equipment with a master copy kept on file.

Currently when the chemical feed system becomes upset, the operators call CESCO, Inc. to come to the plant to correct the problems. Fortunately CESCO, Inc., located in Bellingham, is normally able to quickly respond to this call for help. Nevertheless a written "decision tree", or other program, needs to be developed so DVF operating personnel can diagnose and correct problems.

4. Dissolved Air Flotation System. The existing DAF tank is unusual in that it is equipped with neither a mechanical surface skimmer nor bottom solids removal provisions. Although it produces good effluent quality, consideration should be given to equipping this tank with a chain and flight mechanism as a positive means of sweeping floating material to the paddlewheel for removal. This will eliminate the periodic need for the operator to manually rake the skimmings to the paddlewheel.

DAF tank should be drained and cleaned each weekend.

The overflow weir at the effluent end of the tank is only about half of the width of the tank. During the peak flow period when the carcass chiller is emptied, the increased water depth over this constricted overflow weir causes water to flow into the skimmings trough. To minimize the increase in water depth over the weir and prevent water entering the skimmings trough, the effluent overflow weir should be extended to span as much of DAF tank width as possible.

Lighting for most of the pretreatment facilities is good at night, but the effluent weir is in the shadows. Since it is necessary to observe this area to visually determine the adequacy of the chemical pretreatment, a new light should be installed, or an existing yard light relocated, to illuminate this area. Consideration might also be given to installing a turbidimeter to continuously monitor the turbidity of the effluent and sound an alarm if it reaches a preset level. This has proven successful in monitoring effluent quality at other poultry plants.

Since flotation in the DAF tank is dependent on the recycle pressurization pump, a second pump should be available.

CONCLUSIONS

Based on a review of in-plant waste minimization, recycle/reuse, and wastewater pretreatment practices, Draper Valley Farms is currently meeting AKART requirements with their discharge to the City of Mount Vernon. There are a few in-plant waste minimization practices that should be considered, although they would only result in minor amounts of flow reduction. Recycle/reuse of wastewater by Draper Valley is 'state of the art". There are several pretreatment improvements that should be considered or implemented. These improvements would not appreciably improve effluent quality, but may improve the consistency of maintaining these good results. Draper Valley Farms, Inc. has evaluated the potential improvements previously sited and comments have been included as Appendix E.

7. Existing Wastewater Treatment Plant

System History

The City of Mount Vernon Wastewater Treatment Plant (WWTP) was originally constructed in 1948 and consisted of primary treatment, disinfection, and anaerobic digestion. In 1972, the WWTP was upgraded to secondary treatment with an oxidation tower (biofilter). In 1989, the secondary treatment was converted to an activated sludge process and the biofilter process was taken out of service.

Total Maximum Daily Load

The Department of Ecology has established a Total Maximum Daily Load (TMDL) for the Skagit River to ensure that water quality standards will not be impaired as projected growth occurs. The TMDL exists for both dissolved oxygen (DO) and fecal coliform. It is applied during a critical period and allocates loads to each of the contributing parties. The City of Mount Vernon's wastewater treatment plant is an entity that has a TMDL load allocation for both DO and fecal coliform during a defined critical period.

The TMDL for dissolved oxygen governs the oxygen demanding substances that can be added to the Skagit River. In particular, it defines loadings of carbonaceous 5-day biochemical oxygen demand ($CBOD_5$) and ammonia (NH_3) that can be discharged to the river. The $CBOD_5$ loading can be exchanged with the ammonia loading. The critical period for the DO TMDL is July through October, and the TMDL limits will be imposed during low flow season, defined as July 1 through November 15. The waste load allocations (WLA) for Mount Vernon are 1,902 lbs/day of $CBOD_5$ and 1,188 lbs/day of NH_3-N (alternate WLA are 2,712 lbs/day of $CBOD_5$ and 678 lbs/day of NH_3). WLA are derived as acute limits and interpreted as daily maximum or weekly limit. $CBOD_5$ can measured as BOD_5 with a site specific conversion factor (a conversion factor of 1.125 is used to estimate BOD_5). Table 7-1 summarizes the current TMDL limits for DO for Mount Vernon. If the minimum flow in the river is maintained above the required 6,000 cfs, the daily and weekly TMDL limits may not apply.

Table 7-1

Dissolved Oxygen Total Maximum Daily Load for Mount Vernon for the Skagit River		
Parameter[1]	Average Monthly Limit (lb/day) [3]	Maximum Daily (NH_3)or Weekly (BOD) Limit (lb/day) [4]
CBOD	1,407	1,902
BOD[2]	1,583	2,140
Ammonia as N	922	1,188

1. BOD can be exchanged for ammonia, but the oxygen assimilative capacity provided to Mount Vernon must be maintained.
2. BOD is calculated for CBOD based on a ratio of 1.125.
3. Monthly Average Limits will apply from July through October.
4. Maximum Daily and Weekly Limits will apply when the Skagit River's flow rate falls below 6,000 cfs, measured at USGS gauging station number 12200500, at the highway 99 bridge, upstream of Mount Vernon.

The TMDL for fecal coliform governs the fecal coliform loading to the Skagit River. The critical period for the fecal coliform TMDL is year-round, and the TMDL limits will be imposed during both low and high flow seasons. The waste load allocations (WLA) for Mount Vernon is given as a fecal coliform concentration (rather than a loading) and is equal to the NPDES technology-based permit limits (monthly average of 200 cfu/100 mL).

NPDES PERMIT

A meeting was held with City Staff and representatives of the DOE, on January 9, 2001, to discuss the updated NPDES permit. Minutes of this meeting are included in Appendix F. Department of Ecology has issued a draft NPDES Permit to the City of Mount Vernon. The final permit was issued September 4, 2001 and is included in Appendix G. The new permit will addresses CSOs, TMDLs, and WWTP issues. In addition, the City is required to perform toxicity testing.

The new permit is effective October 1, 2001 and expires on June 30, 2003. The effluent limits specified in the permit are listed in Table 7-2 and Table 7-3.

Table 7-2

NPDES Permit Effluent Limits for Conventional Pollutants for the Mount Vernon WWTP		
Parameter	**Monthly Average**	**Weekly Average**
5-day Biochemical Oxygen Demand (BOD)	30 mg/L 1401 lbs/day	45 mg/L 2102 lbs/day
Total Suspended Solids (TSS)	30 mg/L 1401 lbs/day	45 mg/L 2102 lbs/day
Fecal Coliform Bacteria	200/100mL	400/100mL
PH[1]	Within the range of 6.0 to 9.0	

1. Interim limit is in affect for the duration of the NPDES, after which time a new limit of: within the range of 6.6 to 9.0 will apply.

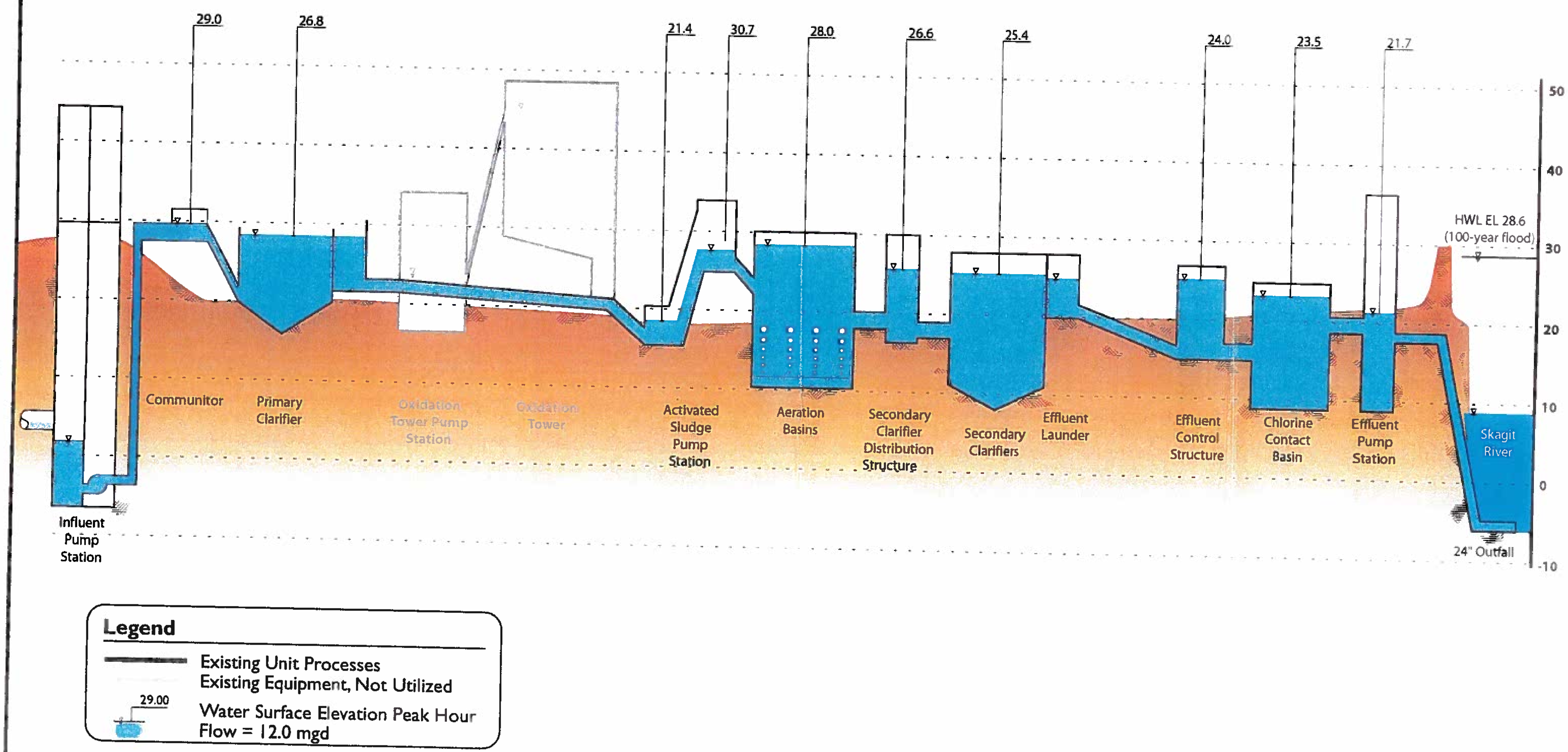
Table 7-3

NPDES Permit Effluent Limits for Chemical Pollutants for the Mount Vernon WWTP		
Parameter	**Average Monthly Limit**	**Maximum Daily Limit**
Total Residual Chlorine	50 μg/L 2.21 lbs/day	100 μg/L
Ammonia-Nitrogen	31 mg/L 1448 lbs/day	41 mg/L
Copper[1]	21.3 μg/L 1.0 lbs/day	35 μg/L
Zinc	88.4 μg/L 4.13 lbs/day	177.4 μg/L

1. Interim limit is in affect for the duration of the draft NPDES, after which time new limits of: Average Day: 9.4 μg/L, 0.44 lbs/day and Maximum Day 16.6 μg/L will apply.

HYDRAULIC PROFILE

The existing WWTP liquid stream processes consists of an influent pump station, screening equipment, primary clarifier, activated sludge pump station, aeration basins, secondary clarifiers, chlorine mixing chamber, chlorine contact basin, and effluent pump station. The hydraulic profile for 12.0 mgd flow (current peak hour capacity) through the existing WWTP is presented in Figure 7-1. The oxidation tower pump station and oxidation tower have been replaced by the activated sludge process and are not currently utilized. Flows from the primary clarifier flow by gravity to the activated sludge pump station.



HDR Engineering, Inc

Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date: FEBRUARY 2003

Sheet Title: EXISTING HYDRAULIC PROFILE

Figure No: 7-1

INFLUENT PUMP STATION

The WWTP is primarily served by an influent pump station, which receives flows from the Hazel Street interceptor (42-inch, 24 mgd gravity capacity). The influent sewer enters the pump station approximately 25 feet below grade. The existing pump station is a caisson construction, consisting of a wet well - dry well configuration. A mechanically-cleaned vertical bar screen (1.0-inch spacing) removes large debris from the influent wastewater. A manual bar screen (1.0-inch spacing) is available as backup to the mechanically-cleaned unit. Flows discharge to the existing comminutor through a 20-inch force main. The pumping units consist of four variable-speed, 40-hp pumps. The pump station has a firm pumping capacity of 10.8 mgd.

WEST MOUNT VERNON PUMP STATION

The WWTP also receives flows from the West Mount Vernon Pump Station. The pump station capacity is 1.2 mgd. Flows enter the WWTP through a 12-inch force main and discharge at the head of the existing comminutor.

HEADWORKS

The headworks of the existing WWTP consists of comminution and de-gritting primary sludge. The comminutors are located downstream of both pump stations, and immediately upstream of the primary clarifier. Grit removal is located downstream of the primary clarifier, where primary sludge is de-gritted.

Comminutor

Comminution at the WWTP is performed by two comminutors, with a capacity of 12.0 mgd.

Grit Removal

The WWTP currently degrits primary sludge. Primary sludge is removed from the primary clarifiers and sent through an existing grit separator. The grit is then stored until it is removed for disposal.

Disposal

Screenings and grit are transported to a county landfill for final disposal.

Primary Clarifier

The existing primary clarifier is an 80-foot-diameter circular tank with a surface area of approximately 5,000 sf and a sidewater depth of 10-foot. It is center well fed with a peripheral effluent launder. It has a peak hour design capacity of 12.0 mgd at a surface loading rate of 2,400 gpd/sf. The water surface elevation (at 12.0 mgd) is 26.81 feet. A parallel unit process does not currently exist for the primary clarifier for backup service.

Oxidation Tower and Oxidation Tower Pump Station

The oxidation tower pump station consists of two (2) 75 hp pumps. The oxidation tower is a 48-FT long, 40-FT wide, and 16-FT deep tower filled with redwood media. Primary effluent was pumped to the top of the tower and trickled down the redwood media. Biofilm on the media removed the organic pollutants from the primary effluent with oxygen provided by natural aeration. This system was taken out of service when the previous plant upgrade was completed, which included aeration basins and appurtenances for the activated sludge process. As a part of this study an analysis was completed to see if it would be cost effective to incorporate this existing plant componenet into a future plant upgrade. It was concluded that this was not cost effective to incorporate this existing plant component into a future plant upgrade. It was also concluded that this was not a cost effective alternative for providing increased treatment capacity.

The oxidation tower should be removed to provide a location for additional required equipment. The costs for removal of the structure will be incorporated into the costs associated with the new equipment that will be placed at this location.

Activated Sludge Process

Activated Sludge Pump Station

The activated sludge pump station conveys primary effluent to the aeration basins. The pump station consists of three screw-lift pumps. Each has a capacity of 8.0 mgd. Two are designated for forward flow (16.0 mgd) and one is designated for return activated sludge (RAS) flow (8.0 mgd).

Aeration Basins

Aeration Basins Nos. 1-3 each have a volume of 0.33 MG, for a total aeration basin volume of 1.0 MG. Aeration Basin No. 4 which has a volume of 0.47 MG, also is available for use as an aeration basin, but will require modifications to the inlet and outlet piping. However, it is currently used as a WAS holding tank, allowing 24-hour wasting and flexibility in operating the dissolved air floatation thickener.

Influent Pump Station

The WWTP is primarily served by an influent pump station, which receives flows from the Hazel Street interceptor (42-inch, 24 mgd gravity capacity). The influent sewer enters the pump station approximately 25 feet below grade. The existing pump station is a caisson construction, consisting of a wet well - dry well configuration. A mechanically-cleaned vertical bar screen (1.0-inch spacing) removes large debris from the influent wastewater. A manual bar screen (1.0-inch spacing) is available as backup to the mechanically-cleaned unit. Flows discharge to the existing comminutor through a 20-inch force main. The pumping units consist of four variable-speed, 40-hp pumps. The pump station has a firm pumping capacity of 10.8 mgd.

West Mount Vernon Pump Station

The WWTP also receives flows from the West Mount Vernon Pump Station. The pump station capacity is 1.2 mgd. Flows enter the WWTP through a 12-inch force main and discharge at the head of the existing comminutor.

Headworks

The headworks of the existing WWTP consists of a comminutor and de-gritting primary sludge. The comminutor is located downstream of both pump stations, and immediately upstream of the primary clarifiers. Grit removal is located downstream of the primary clarifiers, where primary sludge is de-gritted.

Comminutor

Comminution at the WWTP is performed by two comminutors, with a capacity of 12.0 mgd.

Grit Removal

The WWTP currently degrits primary sludge. Primary sludge is removed from the primary clarifiers and sent through an existing grit separator. The grit is then stored until it is removed for disposal.

Disposal

Screenings and grit are transported to a county landfill for final disposal.

Primary Clarifier

The existing primary clarifier is an 80-foot-diameter circular tank with a surface area of approximately 5,000 sf and a sidewater depth of 10-foot. It is center well fed with a peripheral effluent launder. It has a peak hour design capacity of 12.0 mgd at a surface loading rate of 2,400 gpd/sf. The water surface elevation (at 12.0 mgd) is 26.81 feet. A parallel unit process does not currently exist for the primary clarifier for backup service.

Oxidation Tower and Oxidation Tower Pump Station

The oxidation tower pump station consists of two (2) 75 hp pumps. The oxidation tower is a 48-FT long, 40-FT wide, and 1 6-FT deep tower filled with redwood media. Primary effluent was pumped to the top of the tower and trickled down the redwood media. Biofilm on the media removed the organic pollutants from the primary effluent with oxygen provided by natural aeration. This system was taken out of service when the previous plant upgrade was completed, which included aeration basins and appurtenances for the activated sludge process. As a part of this study an analysis was completed to see if it would be cost effective to incorporate this existing plant componenet into a future plant upgrade. It was concluded that this was not cost effective to incorporate this existing plant componenet into a future plant upgrade. It was also concluded that this was not a cost effective alternative for providing increased treatment capacity.

The oxidation tower should be removed to provide a location for additional required equipment. The costs for removal of the structure will be incorporated into the costs associated with the new equipment that will be placed at this location.

Activated Sludge Process

Activated Sludge Pump Station

The activated sludge pump station conveys primary effluent to the aeration basins. The pump station consists of three screw-lift pumps. Each has a capacity of 8.0 mgd. Two are designated for forward flow (1 6.0 mgd) and one is designated for return activated sludge (RAS) flow (8.0 mgd).

Aeration Basins

Aeration Basins Nos. 1-3 each have a volume of 0.33 MG, for a total aeration basin volume of 1.0 MG. Aeration Basin No. 4 which has a volume of 0.47 MG, also is available for use as an aeration basin, but will require modifications to the inlet and outlet piping. However, it is currently used as a WAS holding tank, allowing 24-hour wasting and flexibility in operating the dissolved air floatation thickener.

Aeration Blowers

There are four existing Lamson centrifugal blowers, each rated at 4,100 scfm at 8.5 psi. The maximum air supply with one blower out of service is 12,300 scfm.

Secondary Clarifiers

Secondary clarification is performed with two 85-foot diameter secondary clarifiers. Secondary Clarifier No. 1 has an 11-foot sidewater depth and a peripheral feed. Secondary Clarifier No. 2 has a 15-foot sidewater depth and a more conventional center well feed.

DISINFECTION

The existing disinfection system consists of gaseous chlorine injection followed by a chlorine contact basin. The chlorination equipment, two chlorinators, each have a capacity range of 100 to 2,000 ppd. The chlorine contact basin has a volume of 184,000 gallons, and a contact time of 66 minutes at 4.0 mgd and 22 minutes at 12.0 mgd.

EFFLUENT PUMP STATION

The effluent pump station consists of three 40 hp pumps, each with a capacity of 7.2 mgd. The firm pumping capacity of the station is 12.0 mgd.

The effluent pump station is only necessary when the river's water surface elevation (WSEL) increases due to flood conditions. Under normal conditions (WSEL of 9.20 feet), effluent flows by gravity to the Skagit River. The 100-year flood WSEL is 28.60 feet (based on 1987 WWTP improvement contract documents).

OUTFALL

The existing outfall is a 24-inch diameter, open-ended, ductile iron pipe. The pipe terminates adjacent to the treatment plant at River Mile 10.7 on a well armored slope of the Skagit River. It is located within a small depression in the riverbank. This depression creates an eddy that visibly traps effluent near the shoreline.

SOLIDS TREATMENT

Gravity Thickener

The gravity thickener is designated for primary sludge thickening, before discharge to the anaerobic digester. The tank is 22-foot diameter and has a 10-foot sidewater depth.

Dissolved Air Floatation Thickener (DAFT)

The existing DAFT is a 40-foot diameter tank with an 11-foot sidewater depth. WAS is currently stored in Aeration Basin No. 4 before discharge to the DAFT. Polymer is added to the WAS at the DAFT unit. Thickened WAS is fed to the anaerobic digester.

Anaerobic Digester

The existing anaerobic digester is a 60-foot digester with a 34-foot sidewater depth. It has a volume of 103,200 cf. The digester utilizes a gas mixing system and is provided with a floating cover for gas storage.

Solids Dewatering

Dewatering is accomplished with two 2-meter belt filter presses. Each unit has a capacity of 1,100 pph, for a combined capacity of 2,200 pph. The 75 foot diameter circular tank (original primary clarifier) is used as a holding tank for the biosolids transferred from the primary digester, prior to dewatering via belt filter press.

ODOR CONTROL

To control odors, the City currently doses the liquid stream with chlorine, both in the collection system and at the WWTP. Odors from the solids processes at the WWTP are not treated. The City currently owns the majority of the property around the WWTP, providing an additional buffer zone for dispersing odors.

FACILITIES

Operations Building

The existing operations building consists of two offices, men's and women's lockers, a lunch room, a control room, and a laboratory. The control room has a floor area of approximately 175 sf and contains control panels, computers, and printers. The laboratory has a floor area of approximately 420 sf and includes one fume hood, three sinks, one balance table, one refrigerator, and one incubator.

Shop/Garage

The existing shop/garage consists of four areas:

- 375 sf shop area;
- 70 sf wash room;
- 60 sf storage area; and
- 2,000 sf garage area, divided into 5 bays.

8. WASTEWATER TREATMENT PLANT ANALYSIS

This chapter analyzes the capacity of the existing treatment system and predicts facilities required to meet future flows and loads as presented in Chapter 3, for years 2010 and 2020.

2010 AND 2020 TREATMENT REQUIREMENTS

The Total Maximum Daily Load (TMDL) for the Skagit River in conjunction with the NPDES permit limits determine the concentrations and loadings that can be discharged during the low flow season. The total loadings are based on a sum of loads from the WWTP outfall and the CSO outfalls. These maximum TMDL limits are listed in Table 8-1

Table 8-1

Skagit River BOD and NH_3 TMDL Limits		
Paramet er	**Maximum Daily (NH_3) or Weekly (BOD) TMDL Limit (lb/day)**	**Average Monthly TMDL Limit (lb/day)**
BOD	2140	1583
NH_3	1188	922

The existing effluent flows from the WWTP for 1998 during the TMDL season (July through November) were:

- BOD: Average monthly concentrations from 12 to 20 mg/L, with a maximum weekly concentration of 26 mg/L; and
- NH_3: Average monthly values ranged from 18 to 31 mg/L, with maximum day ammonia concentrations ranging from 22.7 to 43.9 mg/L (July through October of 1999 and 2000).

Future effluent BOD and NH_3 loadings from the WWTP and CSO flows were estimated to determine if TMDL limits would be met. CSO loadings were determined from the largest CSO loading during the TMDL season, which occurred during the August 18, 2000 storm event. Table 8-2 summarizes the projected effluent and CSO loadings to the Skagit River during the TMDL season.

Table 8-2

Estimated BOD_5 and NH_3 Loadings to the Skagit River During the Time Average Monthly TMDL Limits Apply (July - October).				
Year and Location	**Weekly BOD_5 Load (lb/day)**	**Average Monthly BOD_5 Load (lb/day)**	**Maximum Daily NH_3 Load (lb/day)**	**Average Monthly NH_3 Load (lb/day)**
2000 WWTP	752[1]	585[2]	919[3]	666[4]
CSO (August 18, 2000)	11	11	0.3	0.3
Total 2000 Loading	763	596	919	666
2010 WWTP[5]	1,128	878	1,379	999
CSO (August 18, 2000)	11	11	0.3	0.3
Total Estimated 2010 Loading	1,139	889	1,379	999
2020 WWTP[6]	1,379	1,073	1,685	1,222
CSO (August 18, 2000)	11	11	0.3	0.3
Total Estimated 2020 Loading	1,390	1,084	1,685	1,222
TMDL Limit	2,140	1,583	1,188	922
Last Year in Compliance	-[7]	-[7]	2005[8]	2007[8]

1. Maximum weekly BOD load from October 1999
2. Average monthly BOD load from October 1999
3. Maximum day ammonia load from August 2000
4. Average monthly ammonia load from August 2000
5. Based on the ratio of 2000 ADMM to predicted 2010 ADMM
6. Based on the ratio of 2000 ADMM to predicted 2020 ADMM
7. Estimated loadings will be in compliance through 2020
8. Estimated loadings will exceed current TMDL limits. TMDL limits are not expected to change with future permits or studies.

Based on the existing effluent characteristics and the TMDL limits, the WWTP will be required to nitrify, by the summer of 2006, in order to meet future NPDES permit limits. This estimation of when nitrification will be required may vary dependant upon effluent flow rates, WWTP performance, and actual daily ammonia loadings.

INFLUENT PUMP STATION

Pumping Capacity

The firm pumping capacity of the Influent Pump Station is 10.8 mgd. The projected 2010 and 2020 peak hour flows are 14.9 and 18.3 mgd respectively.

City staff have noted problems with the existing pump station configuration. Pump Nos. 2 and 3 are affected by the discharge of the influent wastewater adjacent to the suction inlets for the pumps. The pumps can become air-bound and this can limit discharge capacity.

The maximum capacity of the 42-inch diameter interceptor supplying the wet well is 24 mgd. The pump station and force main should be upgraded to a firm pumping capacity of 24 mgd to maximize the conveyance of wastewater flows (both sanitary and combined sewer flows) to the WWTP. This is consistent with the recommended long term CSO improvements (Alternative 2C) identified in Chapter 4.

Screening

Coarse screening is currently provided in the Influent Pump Station by mechanically-cleaned bar screens with manually-cleaned bar screens as a backup unit.

The plant operating staff has expressed concerns over the operation and maintenance of the manually cleaned bar screen. It is located upstream of the pump station wet well, approximately 24-feet below grade. Screenings must be conveyed from the screen to a location approximately 4-feet above grade.

HEADWORKS

The existing headworks facility consists of a comminution and de-gritting of primary sludge. The City has noted excessive wear on the WWTP process equipment due to grit and debris that could be removed by fine screens and grit chambers.

Comminutor

The purpose of a comminutor is to shred material in the flow stream. A problem associated with this process is that the material often reconstitutes later in the flow stream. A better method is to remove solid materials with fine screens, further process this material in a solids washer to remove organic material, and remove the non-organic material from the flow stream.

Screening

Fine screening is recommended as a replacement to the comminutor. These screens would have three-eighths-inch openings and be mechanically cleaned. They would be placed downstream of all influent flows (WWTP influent pump station and West Mount Vernon Pump Station), and upstream of the recommended grit removal equipment. The parameters used to size fine screens are the peak hour flow.

Grit Removal

The current grit removal system removes grit from the primary sludge. The trend in current grit removal technology is to remove the grit in the flow stream prior to primary clarification. This can be accomplished by settling grit, via centrifugal forces, in a variety of geometrical chambers, circular, square, or rectangular. Removal of grit prior to primary sedimentation allows for flexibility with the primary clarifiers, such as thickening of the primary sludge in the clarifier.

Disposal

Screening (both course and fine) processes can be expected to produce five to ten cubic feet of screening per million gallons of wastewater treated. The volume of screenings to be landfilled can be reduced through washing and compacting. The grit removal process can be expected to produce one to three cubic feet of grit per million gallons of wastewater treated. The presence of organic matter in the grit to be landfilled will be reduced through washing. Odors can be a concern for storage of screenings and grit until final disposal.

CAPACITY ANALYSIS

A capacity analysis was completed which evaluated the primary treatment, secondary treatment, and solids handling facilities. A mass balance model of the entire treatment plant was constructed using HDR's ENVision program. This model incorporates flows and pollutant loads from both influent and internal recycle streams. Process loading conditions derived from the mass balance output were calibrated to standard and historical plant performance data.

Table 8-3 provides a summary of the capacity analysis. The first three columns summarize the existing facilities, volumes and dimensions. The next four columns list the capacity evaluation criteria, the flow rate that each criterion applies to, and the reference. The two columns titled "Value with BOD removal" and "Value with Nitrification" present the predicted process variables from the ENVision model if the 2020 future flows were directed through the existing facilities. The columns titled "Capacity of existing facilities-BOD removal" and "Capacity of existing facilities-Nitrification" list the flow capacities (either maximum month, maximum day or peak hour as indicated in the capacity flow column) for the listed process with BOD removal and with nitrification. The last two columns of the table list the additional facilities that would be required to meet the criteria shown. The largest value under each process is shown in bold. The value in bold will determine the sizing for design of new facilities. Model data summary sheets are included as Appendix H.

The ENVision model was run for each flow and loading condition shown in Table 3-8 and Table 3-9. From the model output, the capacity of the existing facilities was calculated, and new facilities were proposed. For example, the existing primary clarifier was run at maximum month flow conditions (9.9 mgd) the overflow rate was 2,100 gpd/sf as shown in the first row of Table 8-2. Because the criteria listed is 1,000 gpd/sf, the capacity of the existing primary clarifiers is a maximum month flow of [(1,000/2,100) x 9.9] 5 mgd. The existing primary clarifier is 5,000 sf in area. To meet the 2020 maximum month flow condition, a total of 9,900 square feet are required. Therefore, (9,900-5,000) 4,900 sf must be added. Capacities and required volumes and areas of other processes were computed in a similar fashion.

For BOD removal, the model was run at a 4-day SRT, the average SRT of the existing facility. For nitrification analysis, the model was run at a 10-day SRT to ensure full nitrification.

Table 8-3– 2020 Process Capacity Analysis with ENVision Model

Process	Existing Facility Description	Size or Capacity	Criteria Flow	Parameter	Capacity Criteria	Reference	Value with BOD removal[1]	Value with Nitrification[1]	Capacity of existing facilities BOD removal	Capacity of existing facilities Nitrification	Additional Facilities Req'd BOD removal	Additional Facilities Req'd Nitrification
Primary Clarifier	1-primary clarifier	80 ft diameter	MM	OFR	1,000 gpd/sf	DOE Standard	2,100 gpd/sf	Same as BOD	5.0 MGD	Same as BOD	**5,100 sf**	Same as BOD
		10 ft side water depth	PH	OFR	2,500 gpd/sf	DOE Standard	3,800 gpd/sf	Same as BOD	12.5 MGD	Same as BOD	2,400 sf	Same as BOD
		5,000 sf 0.4 MG	MM	HRT	2.5 hr	DOE Standard	0.9 hr	Same as BOD	--	Same as BOD	--	Same as BOD
Aeration Basins	3-plug flow aeration basins	61 ft length, 42 ft width, 17.5 ft SWD	MM	MLSS	2,500 mg/L	Stress testing	3,000 mg/L	6,400 mg/L	8.2 MGD	3.9 MGD	0.2 MG	1.6 MG
		0.33 MG each, 1.0 MG total	MD	MLSS	2,700 mg/L	Stress testing	2,800 mg/L	7,200 mg/L	11.0 MGD	5.2 MGD	--	**1.7 MG**
	1-aeration basin (WAS storage)	61 ft length 60 ft width 17.5 ft SWD 0.5 MG total										
Aeration System—Diffusers	9-inch diameter coarse bubble diffusers		MM	OUR	32 mg/L-hr[2]	HDR Standard	38 mg/L-hr	73 mg/L-hr	8.9 MGD	4.6 MGD	0.4	1.5 MG
			MD	OUR	36 mg/L-hr[2]	HDR Standard	45 mg/L-hr	80 mg/L-hr	8.4 MGD	4.7 MGD	0.4	1.2 MG
			PH	OUR	54 mg/L-hr[2]	HDR Standard	56 mg/L-hr	113 mg/L-hr	18.1 MGD	9.0 MGD	0.1	1.1 MG
Aeration System—Blowers	4-centrifugal	4,100 scfm each	MD	SCFM	12,300	None	5,900 scfm	12,800 scfm	24.0 MGD	13.4 MGD	None	500 scfm
		12,300 scfm with 1 out of service	PH	SCFM	12,300	None	9,000 scfm	16,600 scfm	25.0 MGD	13.6 MGD	None	**4,300 scfm**
Secondary Clarifiers	2-secondary clarifiers	85-ft diameter	MD	HRT	<2 hr	HDR Standard	1.5 hr	1.5 hr	--	Same as BOD	--	Same as BOD
		1-11 ft SWD	PH	HRT								
		1-15 ft SWD 5,700 sf each	PH	OFR	900 gpd/sf	DOEStd 1,200	1,600 gpd/sf	1,600 gpd/sf	10.2 MGD	Same as BOD	**9,000 sf**	Same as BOD
		1-0.47 MGD	MM	SLR	25 lb/d-sf[2]	DOE Standard	28 lb/d-sf	28 lb/d-sf	9.0 MGD	Same as BOD	1,100 sf	Same as BOD
		1-0.64 MGD	MD	SLR	40 lb/d-sf[2]	DOE Standard	32 lb/d-sf	38 lb/d-sf	14.5 MGD	Same as BOD	--	Same as BOD
			PH	SLR	40 lb/d-sf[2]	DOE Standard	51 lb/d-sf	51 lb/d-sf	14.5 MGD	Same as BOD	3,000 sf	Same as BOD
Gravity Thickener	1-thickener	22-ft diameter 10-ft SWD	MM	OFR	700 gpd/sf	DOE Standard	261 gpd/sf	353 gpd/sf	28.2 MGD	19.6 MGD	None	None
DAF Thickener	1- DAF Thickener	40-ft diameter 11 ft SWD 1,260 sf	MM	SLR	2.5 lb/hr-sf	DOE Standard	4.0	3.5	--	5.6 MGD	**750 sf**	**500 sf**
Anaerobic Digester	1-anaerobic digester	60 ft diameter,	MM	SRT	15 days	EPA Standard	28 d	33 d	23 MGD	10 MGD	None	None
		34 ft SWD, 103,400 cf (0.8 MG)	MM	SLR	140 lbVSS/kcf-d	WEF MOP8	80 lbVSS/kcf-d	70 lbVSS/kcf-d	18 MGD	13 MGD	None	None

[1] Values in this column were determined using the ENVision model calibrated to the existing facility.
[2] These values assume conversion to fine bubble diffusers.

DAF-dissolved air flotation
DOE-Department of Ecology
kcf-1000 cubic feet
HRT-hydraulic retention time
MD-maximum day
MG-million gallons
MGD-million gallons per day
MLSS-mixed liquor suspended solids
MM-maximum month average day
OFR-overflow rate
OUR-oxygen uptake rate
PH-peak hour
SCFM-standard cubic feet per minute
SLR-solids loading rate
SRT-solids retention time
SWD-sidewater depth
VSS-volatile suspended solids
WEF-Water Environment Federation

Primary Clarifiers

Primary clarification was evaluated based on both hydraulic residence time (HRT) and overflow rate. The DOE standard for average day maximum month overflow rate is 800-1,200 gpd/sf. A value of 1,000 gpd/sf was used as the design primary clarifier overflow rate (OFR). Similarly, the DOE standard for peak hour OFR is 2000-3000 gpd/sf and 2,500 gpd/sf was used as the design criterion.

DOE recommends an HRT of less than 2.5 hours for primary clarifiers under average day maximum month loading conditions to prevent septic conditions in the clarifier.

The additional primary clarifier area required to meet the peak hour OFR requirement is more than the additional area required to meet the maximum month requirement. It is recommended that the total 2010 primary clarifier area be a minimum of 10,100 sf and the total 2020 primary clarifier area be a minimum of 10,100 sf.

Aeration Basins

Aeration basin volume was evaluated based on MLSS concentrations and oxygen uptake rates. The October 1995 Plant Evaluation presented data on secondary clarifier stress testing. It showed that the deeper of the two secondary clarifiers (Secondary Clarifier No. 2) could handle MLSS concentrations above 3,600 mg/L. Data on MLSS capacity of the shallower clarifier (Secondary Clarifier No. 1) was not presented. The capacity criteria for MLSS are 2,500 mg/L under maximum month loading conditions and 2,700 mg/L under maximum day loading conditions.

Aeration volume was also evaluated based on oxygen uptake rates. Typical oxygen uptake rates for aeration basins with fine bubble diffusers are 32, 36, and 54 mg/L-hr for maximum month, maximum day and peak hour conditions, respectively. The volumes required to meet oxygen uptake rate requirements were all equal to or lower than those required to meet MLSS criteria, therefore the MLSS criteria will be used to determine basin size.

If BOD removal is the treatment goal (no nitrification), then an additional 0.2 MG of aeration volume would be required to meet the future flow and loading conditions. If the existing Aeration Basin No. 4 (0.5 MG) was converted from a WAS holding tank to an aeration facility, no new basin construction would be required, but the coarse bubble diffusers would have to be changed to fine bubble diffusers.

If nitrification is the treatment goal, then an additional 1.7 MG of aeration volume would be required to meet the future flows and loads. Aeration basin 4 could be converted reducing the required aeration basin volume for construction to 1.2 MG. Based on the January 9, 2001, meeting with the City and representatives of DOE, it appears the NPDES permit currently being prepared will not require nitrification, but the future permits could contain these requirements.

If total nitrogen removal were desired (denitrification), then the total aeration volume would increase by approximately 30%. For a total aeration volume of 2.7 MG an additional 0.9 MG may be required for denitrification. Denitrification would lower aeration requirements and increase alkalinity to the downstream processes. At this time, a requirement for denitrification is not anticipated in the next ten years (two permit cycles).

Aeration Blowers

For BOD removal, a total of 6,800 scfm would be needed to meet 2020 peak hour requirements. There are currently four 200 hp centrifigal blowes each rated at a capacity of approximately 4,100 scfm.each. For nitrification, however, 16,600 scfm would be required under 2020 peak hour loading conditions; 4,300 more than 12,300 available.

An additional blower would be required to meet peak hour loads if a redundant blower were to be maintained during peak hour loading conditions for 2020 loadings and operation in the nitrification mode, however this is very conservative criteria and many plants are designed to provide firm blower capacity for the maximum day loadings and total capacity for the peak hour loading conditions. At this time additional blower capacity is not recommended for the year 2020 improvements.

Secondary Clarifiers

The secondary clarifiers were evaluated based on HRT, overflow rate, and solids loading rate. The DOE guideline for secondary clarifier overflow rates is 600 to 800 gpd/sf for average day, maximum month conditions. The DOE recommended maximum overflow rate for peak hour conditions is 1,200 gpd/sf. In this case, since the sewer system is a combined sewer system with storage provided by the Central CSO Regulator, the CSO flows can be stored in the regulator and discharged to the treatment plant over an extended period of time. For this reason, the allowable peak hour loading for the secondary clarifiers was reduced to 900 gpd/sf to prevent the washout of solids during extended periods of high flow resulting from storm events. The total surface area required for 2020 is approximately 20,400 sf.

The DOE standard for secondary clarifier solids loading under average day maximum month conditions is up to 25 lb/d-sf. At peak conditions, DOE lists a peak maximum loading rate of 40 lb/d-sf. The clarifier stress testing indicated that Secondary Clarifier No. 2 is capable of handling at least 25 lb/d-sf and probably higher loading rates. Secondary Clarifier No. 1, however, was capable of only 12 lb/d-sf under test conditions. The areas required to meet all solids loading criteria were less than the 7,600 sf required to meet the 900 gpd/sf OFR sizing criteria. If the existing 85 foot diameter peripheral feed secondary clarifier with the 12 foot sidewater depth was eliminated, the additional surface area required for 2020 would be 14,700 square feet.

Gravity Thickener

DOE recommends 600-800 gpd/sf overflow rate for gravity thickeners. An overflow rate of 700 gpd/sf has been used for this evaluation. Under 2020 future solids loadings, both with and without nitrification the overflow rate is less than 300 gpd/sf and no additional gravity thickening improvements are needed.

If the grit removal is relocated upstream of the primary clarifier, the option of thickening solids within the primary clarifier will also be available. If the grit removal was provided, the gravity thickener would be maintained for backup service.

Dissolved Air Floatation Thickener

The DOE standard for solids loading rate to a DAFT with polymer addition is up to 2.5 lb/hr-sf. The surface area of the existing unit is 1,250 square feet. Under 2020 future loads, an additional 750 sf would be required if BOD was removed or 500 sf if the plant is operated in the nitrification mode. In either case, an additional unit would be required and should also be provided for redundancy.

Anaerobic Digester

The EPA 503 regulations recommend a minimum 15-day SRT in anaerobic digesters to meet Class B requirements. Under future flows, with BOD removal only, the SRT would be 33 days and with nitrification the SRT would be 28 days; well above the 15-day requirement. The Water Environment Federation Manual of Practice recommends anaerobic digesters be loaded at a maximum of 140 lb VSS/kcf-d solids loading. Under future flows and loads, the solids loading would be 80 lb VSS/kcf-d and 70 lb VSS/kcf-d with BOD removal and nitrification, respectively; below the maximum loading of 140 lb VSS/kcf-d. According to the ENVision model, additional digester capacity is not anticipated under 2020 flows and loads.

The City reports hydraulic capacity of the digester is presently limited due to grit deposition at the bottom and a scum layer at the top. Assuming a 30% reduction in available volume, the available SRT would be 19 days for the year 2020 loadings. Additionally, there is limited capacity to store solids when the existing primary digester is taken out of service for cleaning. Presently during digester cleaning, Aeration Basin No. 4 is used as an aerobic digester. A redundant unit process should be considered to alleviate the problems associated with storing biosolids while cleaning the existing digester, and to ensure a hydraulic capacity limitation does not exist in the future.

Solids Dewatering

Solids dewatering is currently performed via two (2) belt filter press. The City operates the presses (based on daily operation of one belt filter press, 1,100 pph) for an average of 2.3 hours per day. Under 2010 flow conditions, the belt filter presses would be required to be operated for 4.2 hours per day. Under 2020 flow conditions, the belt filter presses would be required to be operated for 4.9 hours per day. The existing belt filter presses are adequate and no additional dewatering improvements are needed.

DISINFECTION

Gaseous chlorine is presently used for disinfection of the effluent, followed by dechlorination with sodium bisulfite. Due to the safety concerns over the storage of one ton gaseous chlorine cylinders, the costs of complying with increasingly stringent hazardous materials regulations governing the storage of gaseous chlorine, and the environmental benefits of ultraviolet (UV) disinfection, the City of Mount Vernon decided to evaluate alternative disinfection methods at the WWTP. UV disinfection alternatives are developed in the following chapter.

If gaseous chlorine is eliminated, there would still be a need for chlorine for housekeeping items such as algae control, odor control, and sludge bulking control. In this case a sodium hypochlorite system could be provided for these needs.

EFFLUENT PUMP STATION

The existing effluent pump station is not sized to convey 2010 or 2020 peak hour flow rates to the Skagit River. The pump station should be upgraded to maximize conveyance of effluent from the WWTP. The parameter used to size pumps for the Effluent Pump Station is the peak hour flow and the 100-year water surface elevation of the Skagit River.

OUTFALL

A mixing zone study of the existing WWTP outfall was performed by Cosmopolitan Engineering Group, Inc. in February 2000. This report notes that effluent, when tracked by Rhodamine WT dye, was visibly trapped in a near-shore eddy. Mixing of the effluent and ambient water occurred at the offshore boundary of the eddy. From this analysis, it was determined that modifications to the existing outfall should occur. The flow parameters used to design the outfall are:

Flow Condition	Criteria
• Peak Hour Flow	Hydraulic Capacity
• Maximum Day Flow	Acute Mixing Zone Requirements
• Average Day Maximum Month Flow	Chronic Mixing Zone Requirements

The outfall design also is affected by the NPDES permit limits and the water quality criteria of the receiving water body.

Mixing zones as defined by Mount Vernon's NPDES permit:

Chronic Mixing Zone:

- Shall not exceed greater than 300 feet plus the water depth downstream, or 100 feet upstream;
- Shall not utilize greater than 25 percent of the river flow; and
- Shall not occupy greater than 25 percent of the river width.

Acute Mixing Zone:

- Shall not extend beyond 10 percent of the distance to the chronic mixing zone boundary; and
- Shall not utilize greater than 2.5 percent of the river flow.

Water quality standards for toxicants:

Parameter	Acute Criteria (μg/L)	Chronic Criteria (μg/L)
Chlorine	19	11
Ammonia-N	8,314	1,877
Copper	4.61	3.47
Mercury	2.1	0.012
Lead	13.9	0.54
Silver	0.32	-
Zinc	35.4	32.3

To comply with the mixing zone and water quality criteria, a new or modified outfall will be required. Prior to construction of this improvement, the City will be required to obtain multiple permits. The following is a preliminary listing of anticipated permits/approvals for outfall modifications:

Agency/Jurisdiction	Permit/Approval
• U.S. Army Corps of Engineers[1]	• Section 10/404 Permit • Biological Evaluation/Biological Assessment
• WA Department of Fish and Wildlife	• Hydraulic Project Approval • Priority Habitat Review
• WA Department of Ecology	• Waste Discharge Permit Review (NPDES)[2] • Section 401 Water Quality Certification
• WA Department of Natural Resources	• Aquatic Use Authorization[3]
• City of Mount Vernon	• Shoreline Permit • Floodplain Review • Sensitive/Critical Area Review • SEPA • Dike Setback Variance • Fill and Grading Permit
• Dike District No. 3	• Dike District Approval

1. The U.S. Army Corps of Engineers is now requiring a Biological Evaluation or Biological Assessment for all projects requiring Corps approval. This will trigger consultation with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Chinook salmon, bull trout and bald eagle are known to occur in the project vicinity and will mostly likely, after consultation with NMFS/USFWS, be included in the BE/BA.
2. It is anticipated that the existing NPDES permit will require modification or a new NPDES permit may be required.
3. Any project that is located on state-owned aquatic lands will require authorization from the WDNR. The Skagit River at the outfall location is considered state-owned lands.

A detailed examination of the required permits and an estimated schedule for obtaining permits is presented in Appendix I.

Odor Control

Chlorine is presently injected in the incoming wastewater flow at Hazel Street and Harrison Street. This has been relatively successful, but requires significant quantities of chlorine. The chlorine is presently supplied from the gaseous chlorination system at the WWTP. Typically, chlorine usage at the plant is:

Usage	Approximate Chlorine Usage (ppd)
Disinfection	30
Odor Control	50 to 200
Process Control	100[1]
Maximum Day Usage	330

1. Process control is for filamentous control

In addition to reducing odor potential within the collection and conveyance system, odor control at wastewater treatment facilities often includes treatment of odors in the gaseous phase on site. This includes containment of the gases at the process locations (i.e. covers on tankage where odors occur) or containment of odors within facilities with higher odor (i.e. headworks building). Ventilation is provided to transfer the high odor air to odor treatment units. These can consist of packed tower liquid scrubbers, activated carbon absorption, or biological treatment with compost filters.

After UV disinfection at the WWTP is implemented, gaseous chlorination would eventually be eliminated. Small chlorine requirements for process control would be met with hypochlorite, but meeting high chlorine demands with hypochlorite solution would not only be costly, but would require frequent deliveries with tanker trucks. For this reason, the City may want to consider other options for reducing odor within the collection and conveyance system, such as the use of calcium nitrate.

The long range plan should include the containment and treatment of odors at the process locations with high odors. On September 19, 2000, operating staff were polled, and the unit processes were ranked from high odor potential to a lesser odor potential as follows:

Process	Odor Ranking (3.0 High, 1.0 Low)
Grit Removal System	3.0
Influent Pump Station	2.6
Primary Thickener	2.2
DAF Thickener	2.0
WAS Storage (Aeration Basin No. 4)	1.9

Process	Odor Ranking (3.0 High, 1.0 Low)
Solids Handling Building	1.8
Aeration Basins	1.3
Biosolids Holding Tank	1.2
Primary Clarifier	1.1
Secondary Clarifier	1.0

This is representative of the odor potential experienced at many treatment facilities, with the highest potential at the headworks, followed by solids handling processes, with other processes contributing to a much less extent.

FACILITIES

Operations Building

The existing operations building will not be adequate for the expanding facilities. Additional storage, expanded laboratory facilities, a records storage and archive room, and additional office space will be necessary as the City grows.

Shop/Garage

The existing shop will not allow both the collection system staff and WWTP staff to function efficiently as the City grows. Additional garage space and storage will be required as the City expands.

STAFFING

The existing WWTP staff will not be able to function efficiently as flows and workloads increase over time. The EPA has provided guidance for estimating staffing for a typical WWTP in the March 1973 publication of 'Estimating Staffing for Municipal Wastewater Treatment Facilities.' This estimation is general in nature and is affected by decisions such as the amount of on-site laboratory analysis performed, equipment maintenance, and effluent limits. A detailed breakdown of the calculation is provided in Appendix N.

Based on this estimation, the City of Mount Vernon Wastewater Treatment Plant will need 14 employees by 2010. The following summarizes the time line for staff addition:

Year	Total Number of Staff	Comments
2000	10	Current
2003	11	Add Instrumentation/Electrical Staff
2004	12	Add Maintenance Staff
2007	13	Add Maintenance Staff
2010	14	Add Maintenance & Operations Staff

SUMMARY OF ANALYSES

The additional WWTP capacity required to meet 2010 and 2020 flows and loads are summarized in Table 8-4 and Table 8-5, respectively.

Table 8-4

Summary of Requirements to Meet 2010 Flows and Loads			
Unit Process	**Existing Capacity**	**BOD removal**	**Nitrification**
Influent Pump Station (Firm Capacity)[1]	10.8 mgd	24.0 mgd[1]	24.0 mgd[1]
West Mount Vernon Pump Station (Firm Capacity)	1.2 mgd	1.8 mgd	1.8 mgd
Headworks - Fine Screens and Grit Removal (Total Capacity Required)	None	25.8 mgd[2]	25.8 mgd[2]
Primary Clarifiers (Total Required Surface Area)	5,000 sf	8,300 sf[2]	8,300 sf[2]
Aeration Basins (Total Volume Required)[3]	1.5 MG	1.0 MG	2.2 MG
Blowers (Firm capacity not provided for peak hour loads)	12,300 scfm	5,600 scfm	10,300 scfm
Secondary Clarifiers (Total Required Surface Area)[5]	5,675 sf	16,500 sf	16,600 sf
Disinfection (Total Capacity Required)[6]	Chlorine	25.8 mgd[2]	25.8 mgd[2]
Effluent Pump Station (Firm Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Outfall (Total Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Gravity Thickener (Total Required Surface Area)[7]	380 sf	150 sf	150 sf
DAF Thickener (Total Required Surface Area)[8]	1,250 sf	1,500 sf	1,800 sf
Anaerobic Digester (Total Required Volume)[9]	103 kcf	78 kcf	82 kcf

1. Hydraulic capacity increased to 24 mgd to provide additional CSO treatment capacity for Phase 2 CSO improvements.
2. Hydraulic capacity increased to 25.8 mgd to provide additional CSO treatment capacity for Phase 2 CSO improvements.
3. Existing aeration basin volume includes Aeration Basin No. 4, currently designated as an aerobic digester.
4. With coarse bubble diffusers replaced with fine bubble diffusers.
5. Existing secondary clarifiers include two 85-foot-diameter units, one of which is a peripheral feed unit with an 11-foot sidewater depth. It is anticipated that the 11-foot sidewater depth unit would be taken out of service.
6. Chlorine disinfection is to be replaced by UV disinfection.
7. Gravity thickener is designated for primary sludge thickening.
8. DAF thickener is designated for WAS thickening.
9. Due to the grit buildup and a scum layer in the digester, this is based on only 70% of the 103 kcf is available capacity (72.1 kcf).

Table 8-5

Summary of Requirements to Meet 2020 Flows and Loads			
Unit Process	**Existing Capacity**	**BOD removal**	**Nitrification**
Influent Pump Station (Firm Capacity)[1]	10.8 mgd	24.0 mgd[1]	24.0 mgd[1]
West Mount Vernon Pump Station (Firm Capacity)	1.2 mgd	1.8 mgd	1.8 mgd
Headworks - Fine Screens and Grit Removal (Total Capacity Required)	None	25.8 mgd[2]	25.8 mgd[2]
Primary Clarifiers (Total Required Surface Area)	5,000 sf	10,100 sf[2]	10,100 sf[2]
Aeration Basins (Total Volume Required)[3]	1.5 MG	1.2 MG	2.7 MG
Blowers[4]	12,300 scfm	6,800 scfm	12,500 scfm
Secondary Clarifiers (Total Required Surface Area)[5]	5,675 sf	21,000 sf	21,000 sf
Disinfection (Total Capacity Required)[6]	Chlorine	25.8 mgd[2]	25.8 mgd[2]
Effluent Pump Station (Firm Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Outfall (Total Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Gravity Thickener (Total Required Surface Area)[7]	380 sf	200 sf	200 sf
DAF Thickener (Total Required Surface Area)[8]	1,250 sf	2,000 sf	1,750 sf
Anaerobic Digester (Total Required Volume)[9]	103 kcf	102 kcf	99 kcf

1. Hydraulic capacity increased to 24 mgd to provide additional CSO treatment capacity for Phase 2 CSO improvements.
2. Hydraulic capacity increased to 25.8 mgd to provide additional CSO treatment capacity for Phase 2 CSO improvements.
3. Existing aeration basin volume includes Aeration Basin No. 4, currently designated as an aerobic digester.
4. Coarse bubble diffusers replaced with fine bubble diffusers, firm capacity not provided for peak hour loads.
5. Existing secondary clarifiers include two 85-foot-diameter units, one of which is a peripheral feed unit with an 11-foot sidewater depth. It is anticipated that the 11-foot sidewater depth unit would be taken out of service.
6. Chlorine disinfection is to be replaced by UV disinfection.
7. Gravity thickener is designated for primary biosolids thickening.
8. DAF thickener is designated for WAS thickening.
9. Due to the grit buildup and a scum layer in the digester, this is based on only 70% of the 103 kcf is available capacity (72.1 kcf).

9. Wastewater Treatment Plant Alternatives

Alternatives for unit processes identified deficient in Chapter 8 were developed based on future flows and loads, for years 2010 and 2020. Alternatives developed also were based on assuming that nitrification will eventually be required, as determined in Chapter 8. The following chapter makes recommendation for the preferred alternatives to meet future flows and loads.

Hydraulics

The existing hydraulics of the wastewater treatment plant were presented in Figure 7-1. As noted in Chapter 7, the existing oxidation tower and oxidation tower pump station were functionally replaced by the activated sludge process. An evaluation of alternative hydraulic profiles through the WWTP was performed. The relative costs for each unit process affected was assessed to determine which hydraulic profile was the most cost effective.

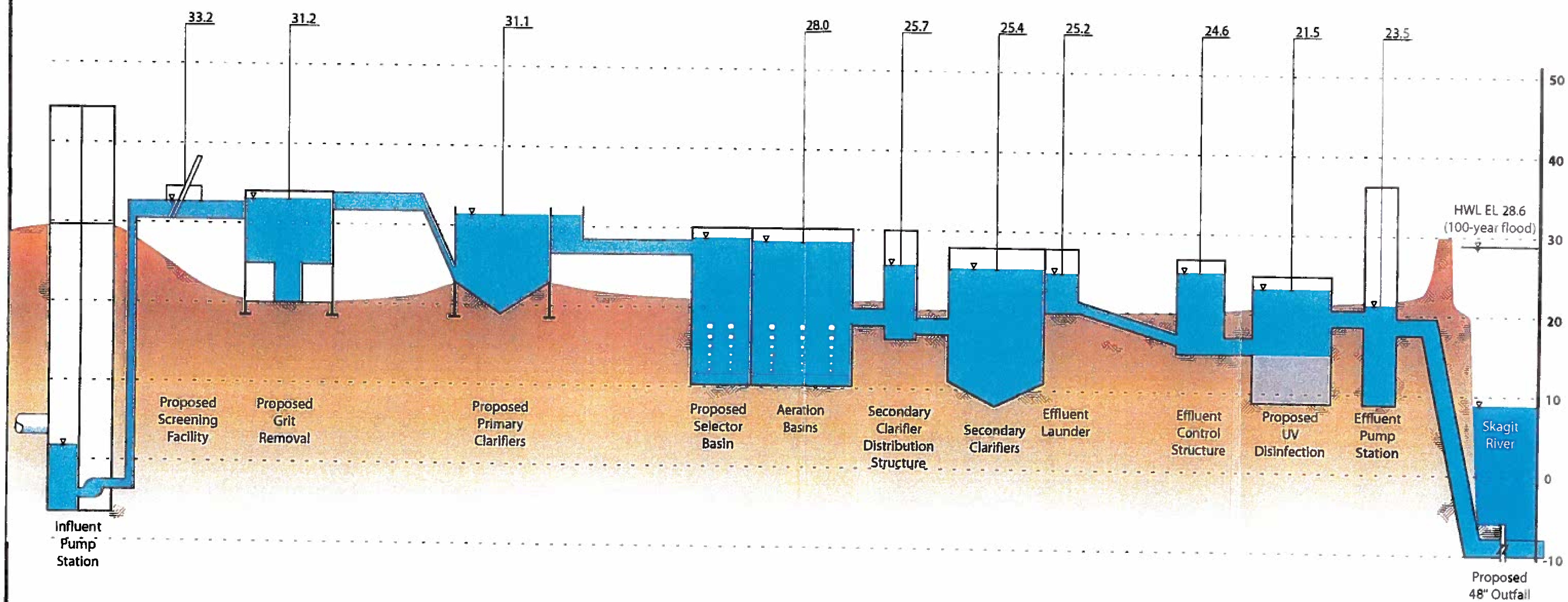
Alternative A - Existing WWTP Hydraulics

Alternative A maintains the existing WWTP hydraulics. With the existing hydraulics, wastewater is pumped from the influent pump station to the comminutor. Wastewater gravity flows through the primary clarifier to the activated sludge pump station. At this lift station, wastewater is raised to approximately 30.8± feet, where it flows by gravity to the effluent pump station. Effluent flows exit the pump station by gravity, unless the river level is elevated, requiring effluent pumping.

Plant capacity can be maintained with the existing hydraulic profile. Replacement of the comminutor with a modern headworks, fine screening and grit removal, can be accomplished within the existing hydraulics. Expansion of the primary clarifiers (addition of 5,600 sf) also can be accomplished within the existing hydraulics. With this hydraulic configuration, the cost estimate for a new headworks and primary clarifiers would be $3.5 and $1.1 million, respectively. This alternative would also require the construction of a new RAS pump station, allowing the existing activated sludge pump station to be utilized for forward flow only. The cost estimate for a new RAS pump station ranges from $600,000 to $800,000. The total cost estimate for this alternative is $5.3 million.

Alternative B - Eliminate Intermediate Pumping

Alternative B eliminates the intermediate pump station (existing activated sludge pump station) for pumping of primary effluent to the aeration basins. The hydraulic grade of the primary clarifiers is raised and the influent pumps are sized for these conditions. The required improvements could be accomplished with this new hydraulic grade, as presented in Figure 9-1. The estimated cost of a new headworks and primary clarifiers is $3.4 and $1.8 million, respectively. This alternative allows the existing activated sludge pump station to be utilized for RAS pumping only. The total cost estimate for this alternative is $5.2 million.



Legend

29.00 Water Surface Elevation Peak Hour Conditions:
All but secondary process= 24 mgd
Secondary process = 18.9 mgd

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Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	Date: FEBRUARY 2003
Sheet Title: PROPOSED HYDRAULIC PROFILE	Figure No: 9-1

INFLUENT PUMP STATION

INTRODUCTION

The existing Influent Pump Station has a firm pumping capacity of 10.8 mgd. There are a number of operating problems associated with this facility as follow:

- During high flow CSO situations, the influent gate is modulated to limit the flow to the pump station to prevent exceeding the capacity of the station. Continuous operation of the modulating gate system depends on interaction of a number of components (flow meter, modulating gate operator and controller) and there is a risk that this flow limit will not always be maintained. There have been occasions when the wetwell has become surcharged requiring cleaning of the grating and walls of the wetwell after the event.

- During high flow conditions, the center two pumps are reported to become "air locked". This may be due to the configuration of the inlet to the wetwell. The flow currently discharges directly between the inlets to Pump Nos. 2 and 3. This "waterfall" between the pump inlets causes significant turbulence and is not a desirable inlet condition.

Upgrade of the Influent Pump Station must address the two items above. The 42-inch diameter influent interceptor to the station has a capacity of 24 mgd. The required peak hour capacity for the year 2010 is 14.9 mgd and for the year 2020 is 18.3 mgd. It is proposed to upgrade the station to a firm pumping capacity of 24 mgd. This additional hydraulic capacity will provide hydraulic capacity to further reduce the number of CSO overflow events (Phase 2 CSO Improvements). Two alternatives were developed for the upgrade of the station. Alternative A would maintain the existing wetwell-drywell configuration and Alternative B would convert the existing drywell to a wetwell and the pumps would be replaced with submersible pumps.

Alternative A - Retrofit Existing Pump Station with new Pumps and Motors

The primary concern with retrofitting the existing station with larger pumping equipment would be to insure that the current wetwell hydraulic problems do not continue. Based on a preliminary review it appears that by raising the operating level in the wetwell and diverting the inflow away from the pump inlets, the problem can be eliminated. Prior to proceeding with this alternative, it is suggested that a physical model be constructed and the before and after conditions simulated to insure the problems are corrected with the proposed modifications. The estimated costs for a physical model are $30,000 to $50,000.

Preliminary sizing of the pumping units was completed and four 100 hp units would be required to provide a firm pumping capacity of 24 mgd. The structure above the drywell presently includes the electrical room and the standby generator room. The present standby generator unit is a 300kW unit which provides emergency power for all essential loads at the plant. Any upgrade to the plant will increase the required standby power. In this case it is suggested to maintain the existing generator unit for the Influent Pump Station, and "offload" other existing essential loads and additional new loads to a new engine-generator unit. The existing 300 kW unit will have adequate capacity for the 100 hp pumps with variable frequency drives. A preliminary plan for this alternative is shown on Figure 9-2, and a section on Figure 9-3. Capital costs for Alternative A were developed and are shown on Table 9-1.

Table 9-1

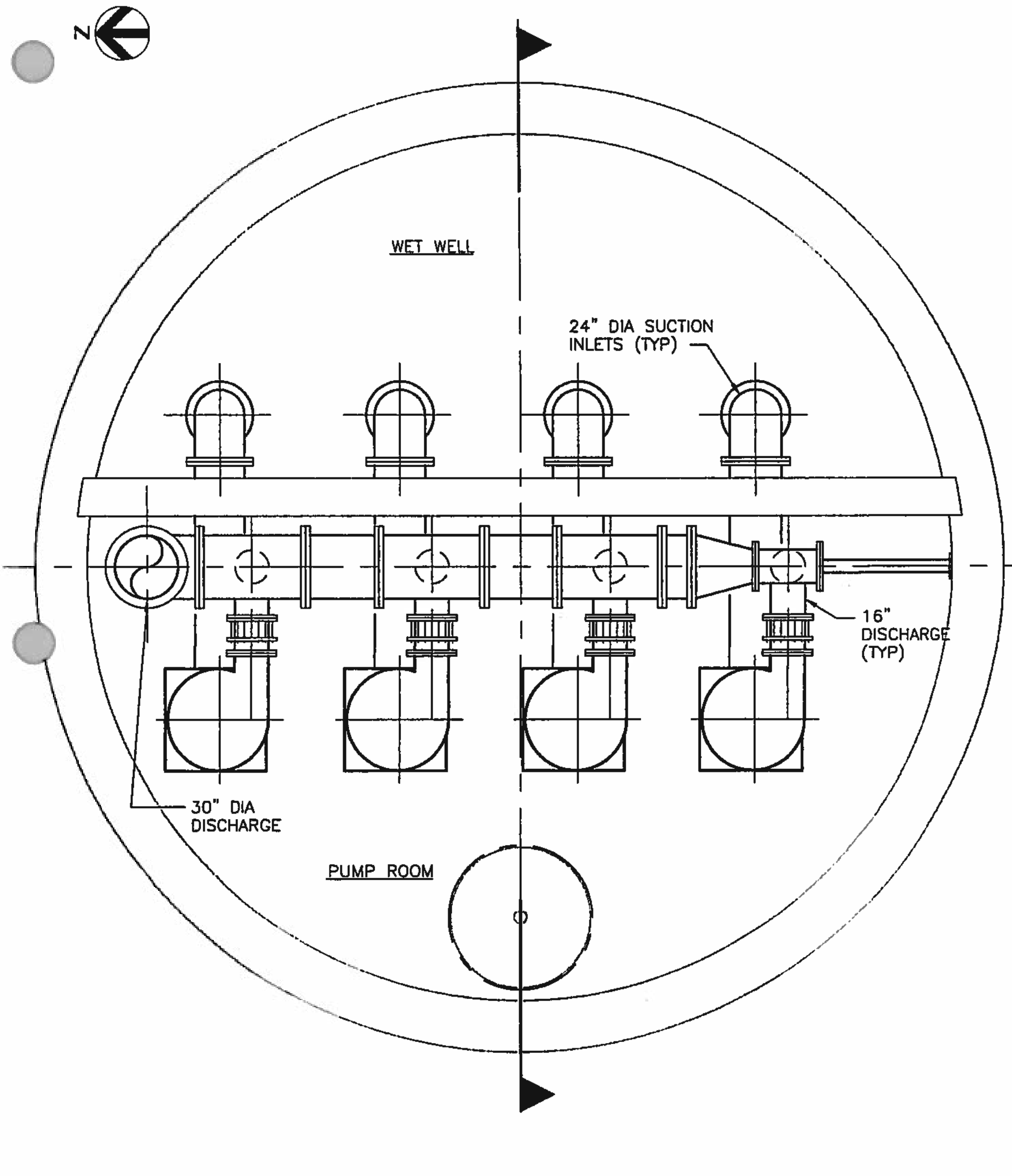
Influent Pump Station: Alternative A Cost Estimate (Upgrading Existing Wetwell/Drywell Pump Station)				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Bypass Pumping	1	LS	$50,000	$50,000
Replace Existing Pumps	4	EA	$65,000	$260,000
Replace Existing Piping	1	LS	$80,000	$80,000
Forcemain	1	LS	$200,000	$200,000
Modify Existing Wetwell	1	LS	$50,000	$50,000
Replace Existing VFDs	4	EA	$40,000	$160,000
Additional Barscreen	1	LS	$200,000	$200,000
Electrical	1	LS	$30,000	$30,000
Subtotal				$1,030,000
Contingency (20%)				$206,000
Indirect Project Costs (30%)				$371,000
Total				$1,606,000

Alternative B - Remodel Existing Pump Station for Submersible Pumps

Alternative B would convert the existing drywell to a wetwell and install submersible pumps. This would require significant structural changes. The existing Electrical Room and Standby Generator Room would be demolished. All of the piping and equipment would be removed from the drywell. A new structure would be provided for the electrical controls and relocation of the standby generator. A valve vault would be constructed adjacent to the new wetwell as shown on Figure 9-4. A section view of this concept is shown on Figure 9-5. Capital costs for Alternative B were developed and are shown in Table 9-2.

Table 9-2

Influent Pump Station: Alternative B Cost Estimate (Convert to Submersible Pump Station)				
Item	Quantit y	Unit	Unit Cost	Cost
Remove existing superstructure	1	LS	$30,000.	$30,000
Remove existing equipment	1	LS	$20,000.	$20,000
Bypass Pumping	1	LS	$50,000.	$50,000
Additional Barscreen	1	LS	$200,000.	$200,000
Modify Drywell	1	LS	$80,000.	$80,000
Valve Vault and Piping	1	LS	$120,000.	$120,000
Forcemain	1	LS	$200,000	$200,000
Electrical Control Building	800	SF	$150.	$120,000
Submersible Pumps	4	EA	$70,000.	$280,000
Modify Existing Wetwell	1	LS	$30,000.	$30,000
VFDs	4	EA	$40,000.	$160,000
Electrical	1	LS	$50,000.	$50,000
Subtotal				$1,340,000
Contingency (20%)				$268,000
Indirect Project Costs (30%)				$482,000
Total				$2,090,000



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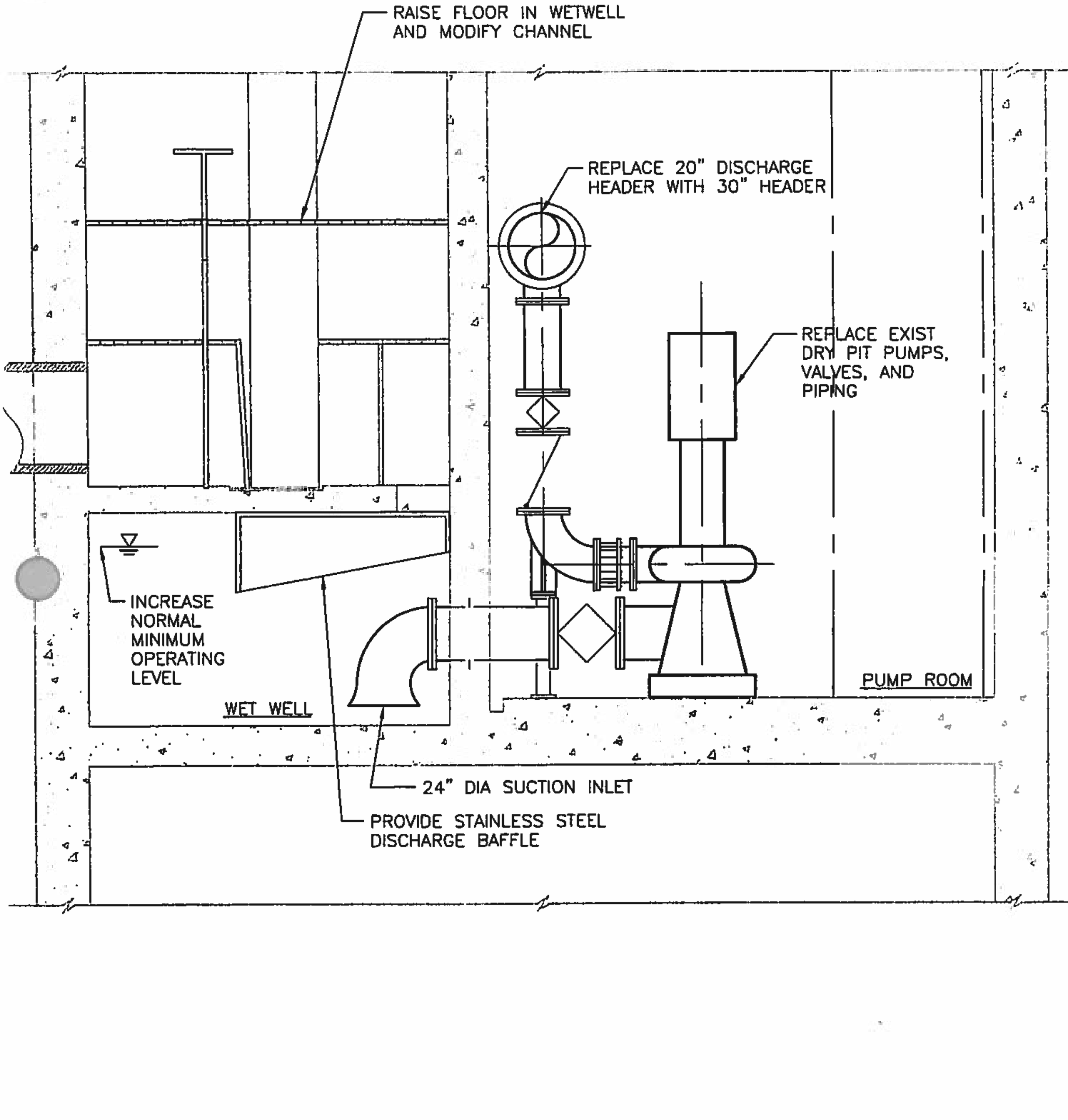
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INFLUENT PUMP STATION UPGRADE ALTERNATIVE A–PLAN

Figure No.
9–2



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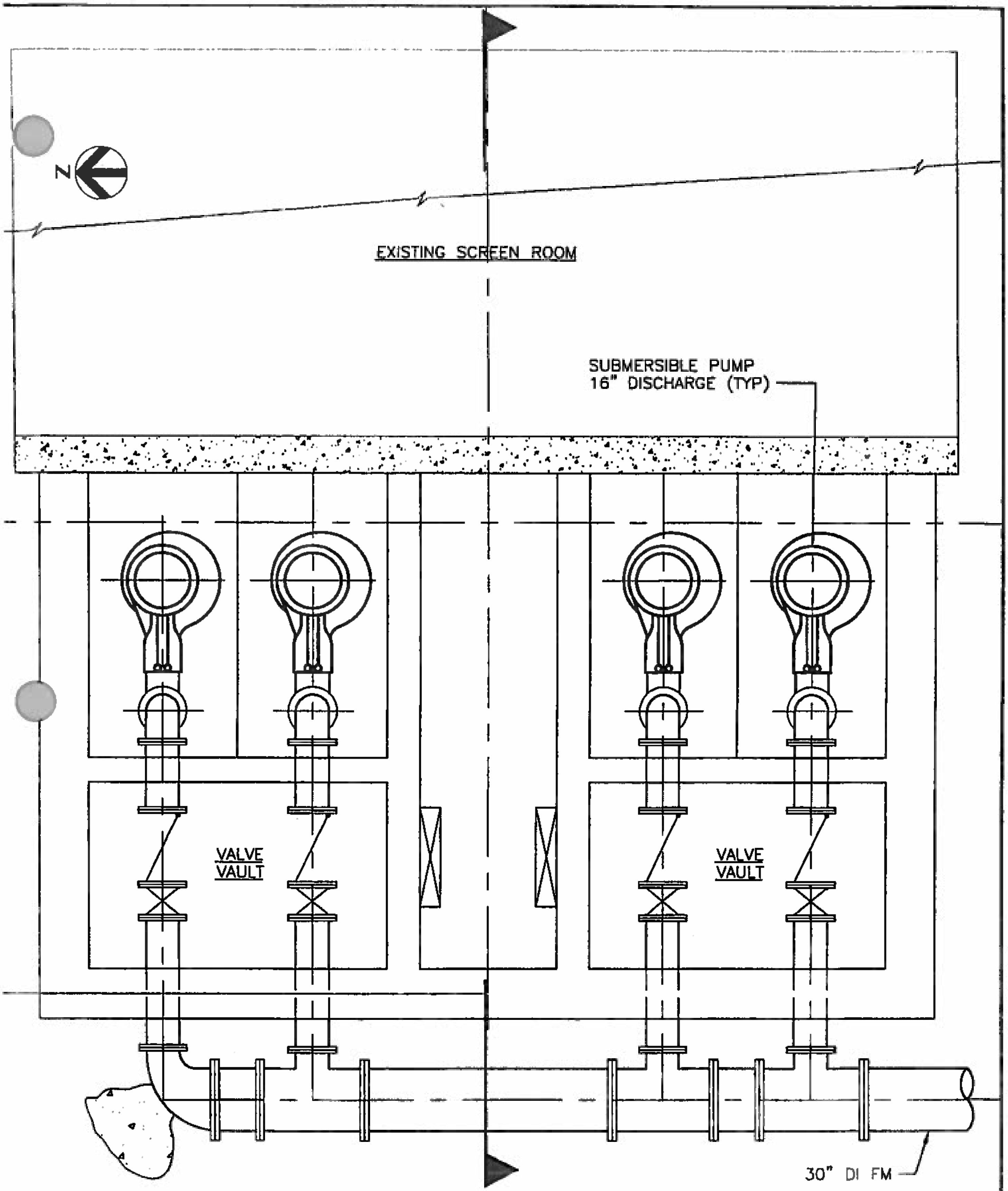

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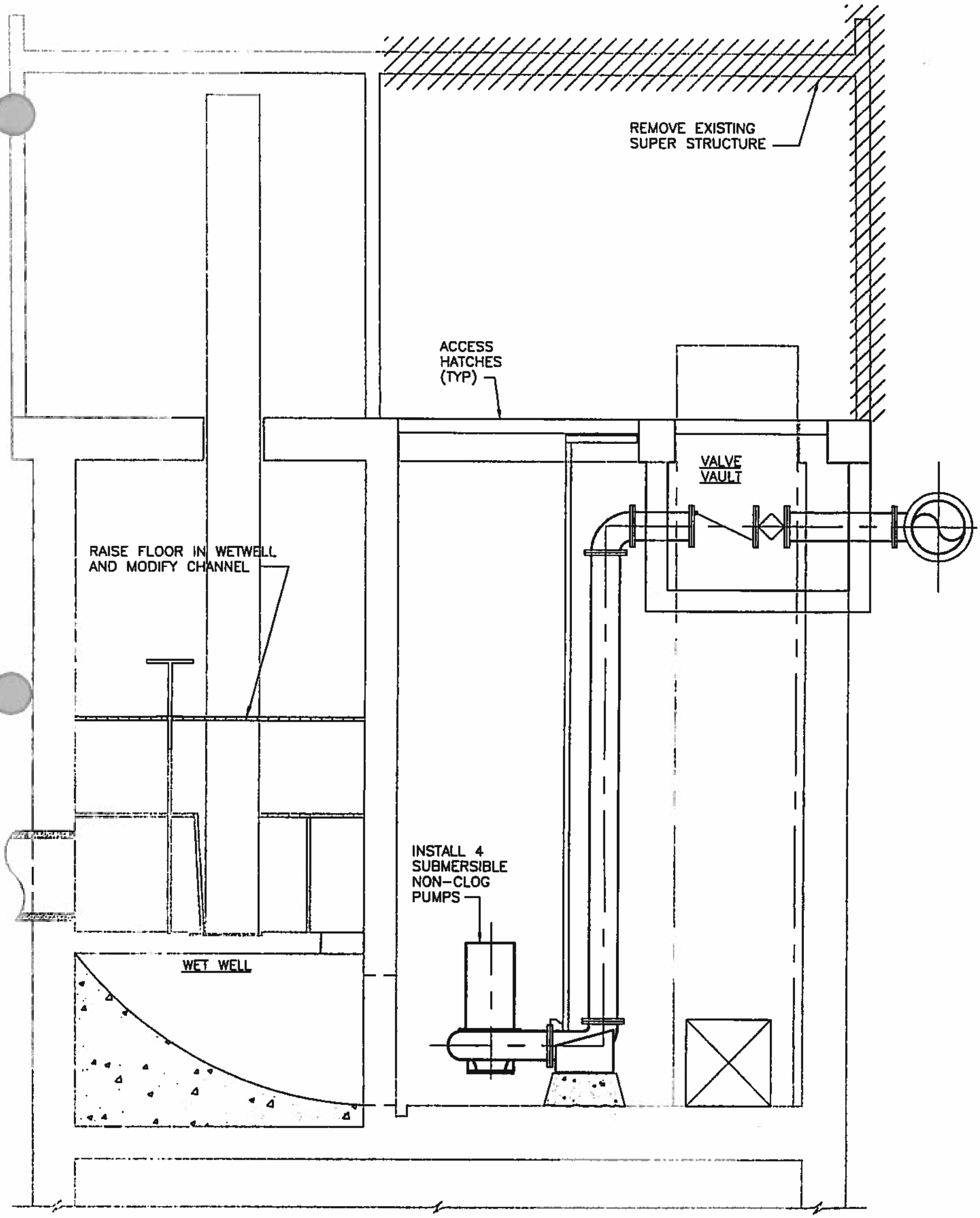
Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	Date: FEBRUARY 2003
Sheet Title: INFLUENT PUMP STATION UPGRADE ALTERNATIVE B–PLAN	Figure No. 9–4



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MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INFLUENT PUMP STATION UPGRADE
ALTERNATIVE B-TYPICAL SECTION

Figure No.
9-5

HEADWORKS

More efficient methods of solids and grit removal (compared to the current practice of de-gritting primary sludge) can be accomplished with modern equipment, as described below. Better screening and grit removal will reduce the wear on downstream process equipment.

Screening

Coarse screening provided upstream of the influent pumps removes larger debris from the liquid waste-stream, but does not remove any debris from the wastewater pumped by the West Mount Vernon Pump Station. To remove plastics, rags, and small rocks from the influent wastewater (from both the Influent Pump Station and the West Mount Vernon Pump Station), fine screens would be required in a Headworks Facility.

Fine screens would have 3/8-inch spacing and be mechanically cleaned. They can be expected to remove approximately 9 ft^3/MG wastewater, or approximately three times the volume of screenings removed by the existing 1-inch coarse screens. The fine screens would be the first unit process treating the entire forward flow of the WWTP. Screenings washing equipment will be provided to remove organic material from the screenings and a screening compactor to reduce the volume to be disposed.

Grit Removal

Alternatives for grit removal from the liquid waste-stream, rather than the primary sludge, include:

Aerated Grit Chambers. Aerated grit chambers trap grit through an air-induced rotation of the wastewater at a velocity of approximately 1 fps. Detention time is typically three to five minutes, with one to five standard cubic feet per minute (scfm) of air per linear foot of basin.

Vortex Grit Chambers. Vortex grit chambers are gravity units that swirl the wastewater causing inorganic matter to settle to the tank hopper section of the unit. The vortex can be created through natural hydraulics or induced by slowly rotating paddles. Grit is removed by pumping it from the hopper section of the unit.

Hydrocyclone Degritters. Hydrocyclone degritters utilize centrifugal forces in a cone shaped unit to separate the grit and wastewater. Wastewater enters and exits in the upper portion of the unit, and a grit containing slurry exits through a small opening near the bottom of the unit. The cyclone process includes a pump as an integral part of the unit, for it depends on a steady liquid stream supply.

Capital and operating costs for each alternative were reviewed. The costs, summarized in Table 9-3, were assessed on a low, moderate, high scale. The flexibility of the grit removal system to accept a wide range of flows was also assessed on the same scale.

Table 9-3

Evaluation of Grit Removal Alternatives				
Alternative	Description	Capital Cost	Annual O & M Cost	Operating Flow Range[1]
1	Aerated Grit Chamber	$1,000,000	$37,000	Low
2	Vortex Grit Chamber	$700,000	$25,000	High
3	Hydrocyclone Degritter	$5,000,000	$90,000	Moderate
1. The operating flow range of the grit removal system to perform acceptably over a wide range of flows.				

Disposal

The existing method of final disposal, to convey grit and screenings to the landfill, is still a viable alternative. A building should be placed around the screenings and grit storage site to contain odor.

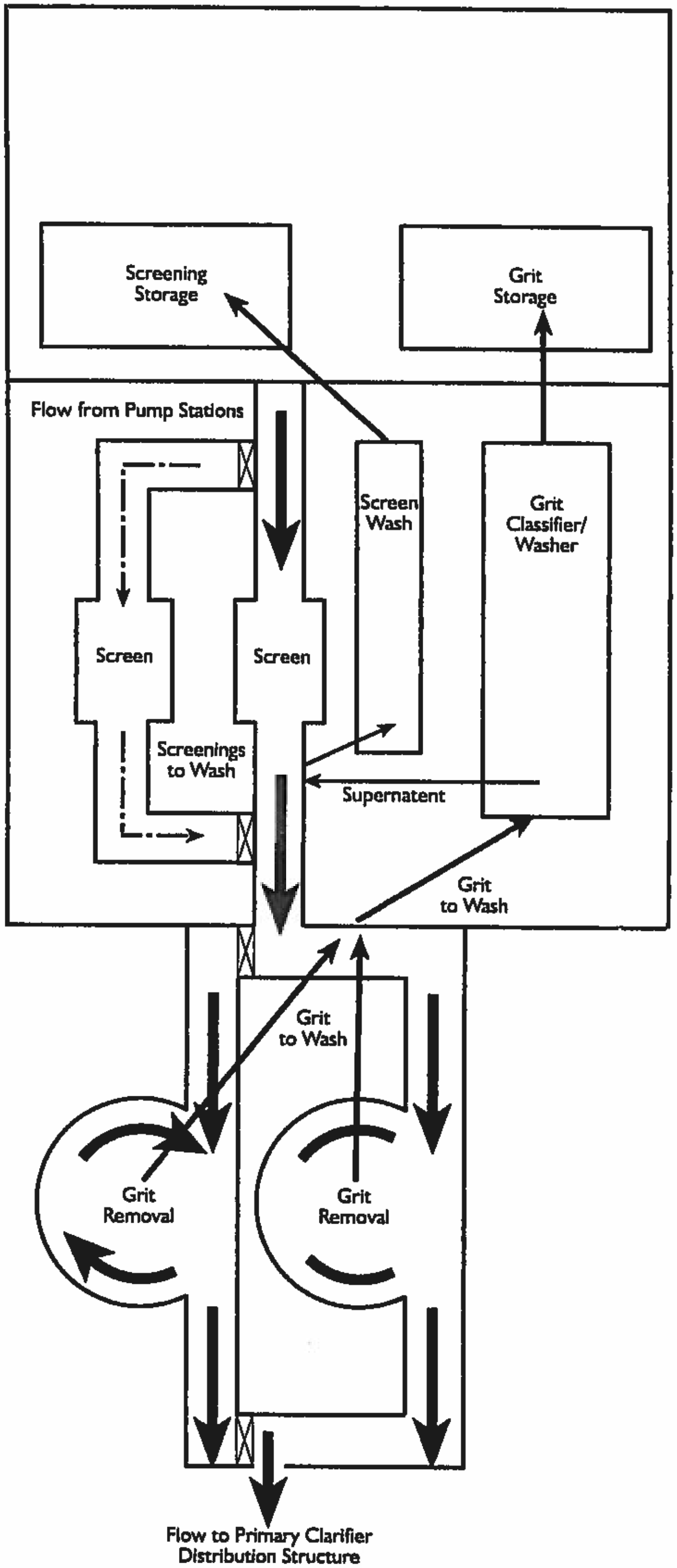
Primary Sludge and Scum Pumping

The installation of two new primary clarifiers will require additional sludge and scum pumping facilities. These should be located within a close proximity to the primary clarifiers and would be installed in the lower floor of the new headworks facility.

Cost Estimate

A typical headworks configuration is shown on Figure 9-6. It has the potential to be placed in one of two locations: Near the Influent Pump Station, or near the Primary Clarifiers. Since the area near the Influent Pump Station is designated for solids treatment, the logical location for a headworks facility is near the primary clarifiers.

The estimated capital cost for a headworks facility (including fine screens, grit removal, primary sludge and scum pumping, and screening and grit storage until final disposal) would be $2.8 million.



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Project Title MOUNT VERNON COMPREHENSIVE SEWER	Date FEBRUARY 2003
Sheet Title PROPOSED HEADWORKS FACILITY	Figure No. 9-6

Primary Clarifiers

Additional primary clarifier capacity should be provided for future flows and to provide redundancy. The hydraulic analysis determined that raising the WSEL of the treatment processes (allowing gravity forward flow) was the most desirable hydraulic profile.

Alternative A - Modify Existing Primary and Add New Primary Clarifier

Alternative A includes modifications to the existing primary clarifier (to raise the water surface elevation) and addition of a second primary clarifier to meet future needs and provide redundancy. Modifications to the existing 5,000 sf primary clarifier would include:

- Raising the sidewalls of the clarifier tank approximately 4.5 feet;
- Raising the effluent weirs; and
- Replacing the clarifier mechanism.

The new primary clarifier would have a larger footprint than the existing primary:

• Diameter:	90-foot	
• Sidewater Depth:	12 feet	
• Design flows:	ADMM:	5.5 mgd
	Peak Hour:	13.8 mgd

Both clarifiers would have WSEL of approximately 31.2± feet. A primary clarifier distribution structure would split flows between the existing and new clarifiers.

Combined sewer flows would be treated in a separate process. An 'internal shunt' would be utilized to process a portion of the combined sewer flows. Flows would be split, with 18.3 mgd (peak hour sanitary flows) to the aeration basins and 7.5 mgd (combined sewer flows) to the disinfection system. This will provide for the Phase 2 CSO Improvements. This flow split would be performed in the aeration basin distribution structure. Effluent blending would take place prior to the disinfection process.

Alternative B - Two New Primary Clarifiers

Alternative B consists of adding two new primary clarifiers to treat sanitary flows and utilizing the existing primary clarifier for CSO flows. Two new primary clarifiers would have the following attributes:

- Diameter: 75-foot
- Sidewater Depth: 12 feet
- Design flows: ADMM: 4.9 mgd

  Peak Hour: 9.2 mgd

Both clarifiers would have WSEL of approximately 31.2± feet. A primary distribution structure would be required, splitting flows between the new clarifiers and the existing clarifier (for CSO treatment).

The existing primary clarifier would be utilized, without modification, for treatment of CSO flows, via the 'internal shunt' mechanism. Utilizing the existing primary for this purpose would yield an HRT of 1.2 hours at 7.5 mgd. Flows would receive primary treatment, and flow by gravity to the disinfection system for effluent blending and disinfection.

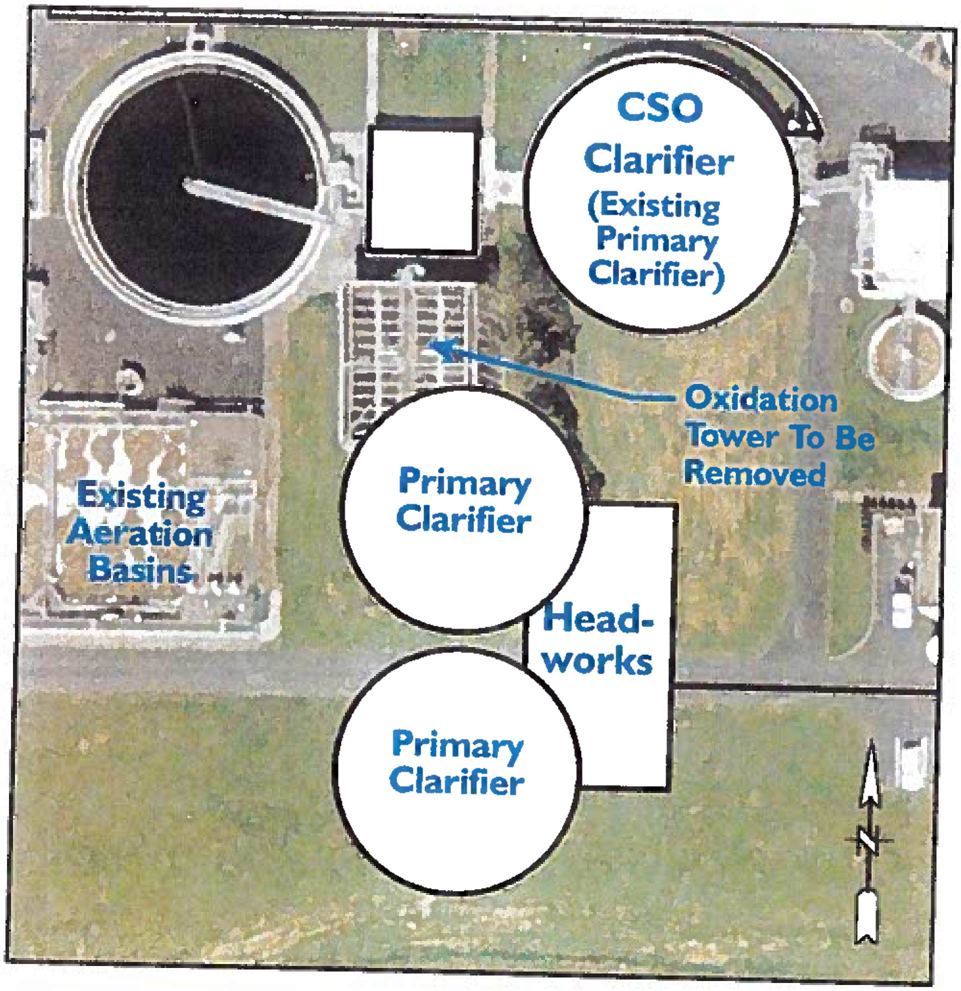
Cost Estimate

Capital and operating costs for each alternative were developed. The capital costs, summarized in Table 9-4, include a 20% contingency and 30% for indirect costs, i.e. sales tax, engineering, administration, and legal.

Table 9-4

Capital Costs ($1,000) for 25.8 mgd Primary Clarifier Alternatives		
Alternative	**Description**	**Capital Cost**
A	Existing and New Clarifier	$1,563
B	Two New Clarifiers	$1,794

The primary clarifiers could be located in a variety of locations, ranging from adjacent to the existing primary clarifier to locations south of the aeration basins and shop/garage. The most logical location for new primary clarifiers is in the location near the existing oxidation tower (adjacent to the existing primary clarifier). A conceptual plan of two additional primary clarifiers and headworks facility is shown on Figure 9-7.



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Project Title: MOUNT VERNON COMPREHENSIVE SEWER	Date: FEBRUARY 2003
Sheet Title: PROPOSED PRIMARY CLARIFIERS	Figure No: 9-7

Activated Sludge Process

Activated Sludge Pump Station/RAS Pump Station

The existing activated sludge pump station is equipped with three screw pumps, each with a capacity of 8 mgd. With the proposed modification to the hydraulic profile the station is no longer necessary for forward flows.

Alternative A - Abandon Activated Sludge Pump Station
For Alternative A, the Activated Sludge Pump Station would be abandoned. This alternative would require a new RAS pump station to be built either at this location or a different site for an estimated cost from $600,000 to $800,000.

Alternative B - Convert Activated Sludge Pump Station to RAS Pump Station
Alternative B would recommend converting the activated sludge pump station to a dedicated RAS pump station. The existing facilities are suited for this conversion because the pump station pumps from an elevation low enough to collect RAS flows and to an elevation where RAS flows could be fed into a selector basin or aeration basin distribution structure.

Typical sizing criteria is to provide 100 percent of the ADMM flow capacity for RAS pumping. The existing station will provide adequate capacity through 2020. For year 2020 flows, the recommended pumping capacity is 9.9 mgd (2020 ADMM). The recommended pumping capacity is far less than the available capacity, so the pump station could be used without modification through 2020.

Selector Basin

When there is an abundance of filamentous organisms in the activated sludge process, the settling characteristics of the biomass is inhibited. The production of a high SVI filamentous bulking sludge results in high effluent solids concentrations and the potential for a permit violation.

There are two approaches to the control of filaments in the activated sludge process. One approach is to chlorinate the RAS at chlorine concentrations of 5 to 10 mg/L to minimize the presence of filamentous sludge. The second approach is to provide a selector basin upstream of the aeration basins to limit the filamentous bacteria population via the biological process.

Alternative A - Chlorinate RAS for Filament Control
Alternative A would control filaments by chlorinating the RAS. This is the current method of filament control and would require no modification. The disadvantages to chlorinating the RAS are as follows:

- Disinfection By-Products (DBP) are formed in the wastewater; and

- Chlorine (which has numerous safety issues) is required.

Alternative B - Construct Selector Basin for Filament Control

Alternative B would provide a selector basin to control filament growth. There are three operating modes for selectors. Aerobic, anoxic, and anaerobic. Depending on the operating mode, the hydraulic retention time recommended is from 10 to 60 minutes. This detention time, combined with the influent BOD concentration, promotes the growth of floc forming bacteria while limiting the growth of filamentous bacteria. The anoxic selector can only be used in a plant that includes nitrification in the activated sludge process, since it requires the nitrates produced in the nitrifying process.

Preliminary sizing was completed for the year 2020 flow conditions. The selector basins could be constructed in two phases. The initial phase would consist of multiple cells with a total volume of 0.3 mg operating in aerobic mode and would accommodate the plant in the 'non-nitrifying' mode. When provisions were made for nitrification, an additional 0.3 mg cell would be added to permit operation in the anoxic mode. These selector basins would be at a water surface of approximately 30 ± ft to maximize flow distribution options. The estimated cost of a selector is $600,000.

Chemical Feed System

The nitrification process will typically reduce alkalinity of the mixed liquor resulting in a reduction of the pH. Plant staff performed a trial operation of the activated sludge process in the nitrification mode and experienced a reduction in pH which approached the NPDES permit limits and the nitrification test was terminated.

To operate in the nitrification mode, a chemical feed system must be provided to provide for pH adjustment. In addition, the proper pH limits must be maintained in the aeration basins to maintain the nitrification process. A chemical feed system should be provided to supply caustic soda. The primary discharge point would be at the inlet to the aeration basins. By controlling the pH at the inlet, permit limits should be able to be maintained in the effluent. In addition to the aeration basin feed point, the caustic soda could also be supplied upstream of the effluent disinfection process. This would provide additional assurance that the effluent pH limits are maintained.

The components for the pH control system would include a caustic soda storage tank with containment protection, two chemical feed pumps, and chemical feed piping to the aeration basin inlet channel and upstream of the existing chlorine contact tank. A budget cost of $50,000 has been included for this improvement.

Aeration System

Electrical costs could be reduced by installing fine bubble diffusers. Overall efficiencies of the fine bubble systems typically exceed the efficiencies of the coarse bubble systems by a factor greater than two. Review was made of overall plant energy usage and energy usage for the aeration system. Average total monthly energy consumption was approximately 250,000 kWhrs and of this, approximately 135,000 kWhrs were used for aeration. This is approximately 54% of the total energy consumption. Aeration energy costs typically range from 45% to 60% of the total plant energy usage, depending on the process and equipment, so this is in the normal range. By converting the diffusers to a fine bubble system, the present estimated annual savings would be approximately $41,000 per year. This is based on current average electrical cost of $0.05 per kWhr. As flows and loads increase and power costs increase, the annual savings would also increase. When the plant eventually provides nitrification, the aeration requirements will increase by a factor of two. The provision of fine bubble diffusers will minimize these future aeration costs. To maximize savings, the City may want to consider completing the installation of the fine bubble diffuser system on a 'fast track' schedule, prior to implementing other improvements.

With the current operating mode (no nitrification), the payback period could range from 5 to 10 years for this improvement, but there are grant programs available that can provide up to 50% funding for the installation of energy saving equipment. These are provided by the power utilities since implementation of energy conservation reduces future demand and the need to construct additional energy sources for the power utility. With a 50% grant, the payback would be in the range of 2 to 5 years, depending on the process (nitrification or not) and current energy costs.

A detailed evaluation was completd to evaluate the replacement of coarse bubble diffuser with fine bubble diffusers and this confirmed the energy savings due to the increased efficiency and confirmed that the existing centrifial blowers that the existing centrifical blowers could be maintained with the proposed aeration system.. A copy of this technical memorandum summarizing this evaluation is included as Appendix M.

Aeration Basins

The aeration basins are currently operated in a BOD removal (no nitrification) mode with coarse bubble diffusers. Fine bubble diffusers offer better oxygen transfer to the wastewater, resulting in more efficient operation and lower operating costs. The activated sludge process can typically be operated in three modes:

- BOD removal
- Nitrification (NH_3 removal)
- Denitrification (NO_3 removal)

The choice of which mode to operate in, and plan for, is typically driven by permit requirements. Mount Vernon's future NPDES permits will be limited by the TMDL of the Skagit River and the toxicity of ammonia to biological organisms in the Skagit River. These limits will require the WWTP to nitrify to meet ammonia limits.

Alternative A - BOD Removal Only

Alternative A provides basin capacity for BOD removal. The existing coarse bubble diffusers would be replaced with fine bubble diffusers to improve efficiency. Fine bubble diffusers have a higher oxygen transfer efficiency than the current coarse bubble diffusers.

This transfer efficiency coupled with a low headloss through the membrane results in a lower power consumption. This alternative would require a total basin capacity of 1.0 mg by 2010 and 1.2 mg by 2020. Aeration Basin No. 4 (0.47 mg) would be utilized as an aeration basin rather than a WAS holding tank or an aerobic digester. The disadvantage of this alternative is that the effluent will not meet anticipated future ammonia limits.

Alternative B - Nitrification

Alternative B would provide basin capacity to nitrify the wastewater, reducing ammonia levels to below anticipated permit limits. To provide nitrification, approximately 2.2 mg of volume would be required for 2010 flows and 2.7 mg for 2020 flows. This would essentially require additional basin capacity to the south of the existing basins. Preliminary layouts developed for the aeration basins were developed based on the capacity analyses and are shown in Figure 9-8.

Aeration for all the basins would be fine bubble diffusers, as explained in alternative A.

Alternative C - Denitrification

Alternative C would provide for denitrification. Denitrification would reduce the nitrate levels in the effluent and should be implemented if nitrate is eventually regulated. At the current time, nitrate is not, and does not appear to be, a nutrient of concern. If the facility were to be sized for denitrification, additional basin volume would be provided to the west of the existing and future phase basins.

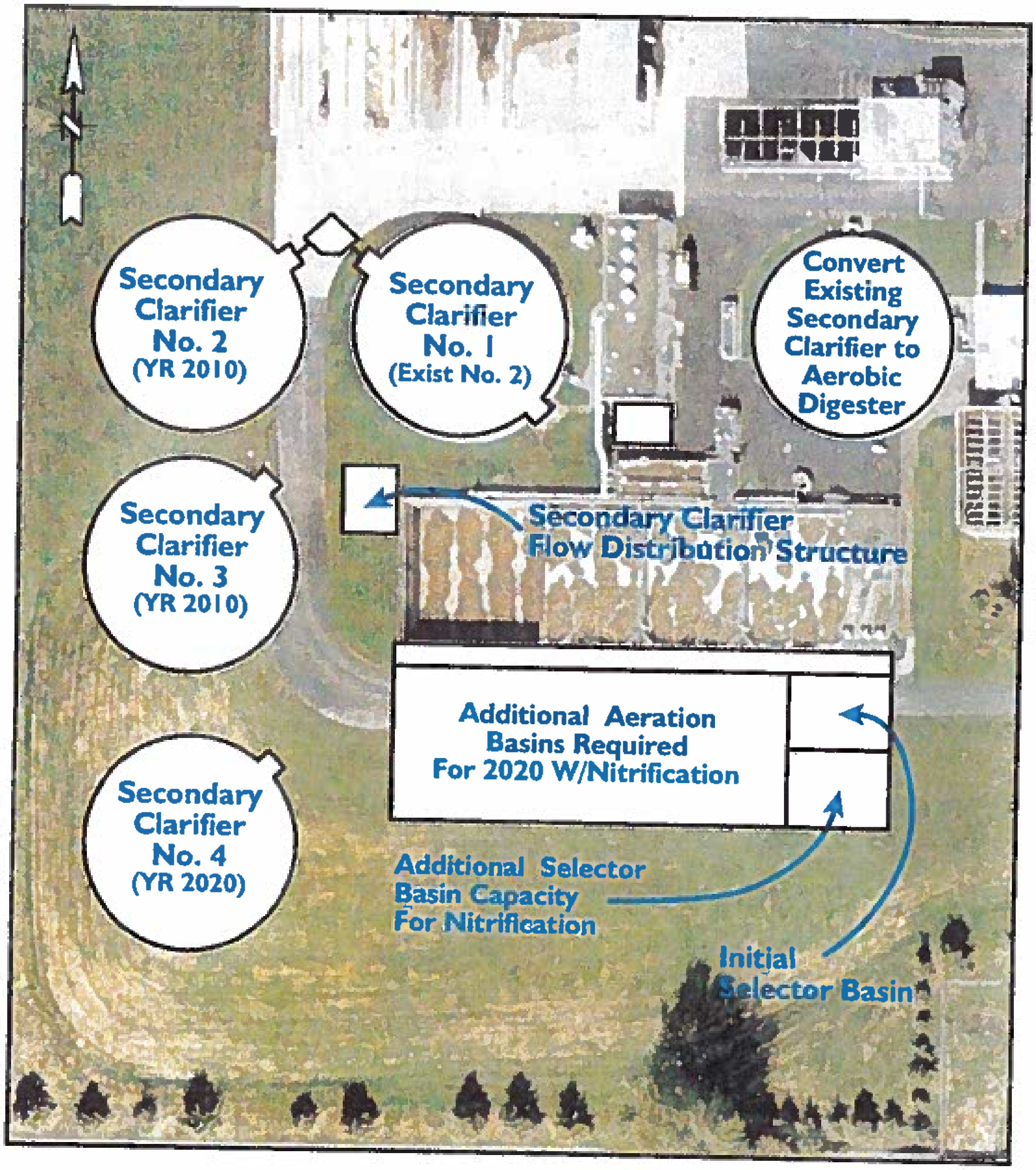
Aeration for the basins would be fine bubble, as explained in alternative A.

Cost Estimates

Total project costs were determined for each alternative as presented in Table 9-5.

Table 9-5

Aeration Basin Improvements' Estimated Project Cost		
Alternative	**Condition**	**Cost**
Alternative A - BOD Removal. Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 without nitrification	$300,000
Alternative B - Additional 1.2 mg Aeration Basin Volume, and Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 with nitrification	$2,700,000
Alternative C - Additional 1.2 mg Aeration Basin Volume for nitrification, 0.9 mg Aeration Basin Volume for denitrification, and Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 with denitrification	$4,600,000
Chemical Feed System (pH control)	Required to operate in nitrification mode	$50,000



HDR Engineering, Inc.

Project Title: MOUNT VERNON COMPREHENSIVE SEWER	Date: FEBRUARY 2003
Sheet Title: PROPOSED AERATION BASINS AND SECONDARY CLARIFIERS	Figure No: 9-8

Secondary Clarifiers

Since existing Secondary Clarifier No. 1 has a relatively shallow sidewater depth (11 ft.) and peripheral feed, this unit was assumed to be taken out of service. It could be used as an aerobic digester (biosolids storage), replacing the function that Aeration Basin No. 4 provided since that will be needed for aeration basin capacity.

Criteria for sizing of secondary clarifiers is typically dependant on both hydraulic loadings (peak hour and average day) and solids loadings. The City of Mount Vernon Sewer System is a combined sewer system which includes "in-line" storage provided by the Central CSO Regulator. This feature minimized overflows to the Skagit river, but also extends the duration of peak flows to the plant. Under this circumstance, the peak hour rating for the clarifier was reduced from 1,200 gpd/sf to 900 gpd/sf. Preliminary sizing was completed for secondary clarifiers based on this criteria. Two additional 85 ft. diameter units would be required for the year 2010 flows with an additional unit provided for the year 2020 flows. Cost for these units are summarized in Table 9-6.

Table 9-6

Cost for Secondary Clarifiers		
Description	**Flow Condition**	**Cost**
Two (2) @ 85-ft-diameter clarifiers and piping and distribution structure	2010	$2,500,00
One (1) @ 85-ft-diameter clarifiers and piping	2020	$1,100,00

The clarifiers can be physically situated in a variety of locations at the WWTP, the suggested location is south or west of the proposed aeration basins. The amount of piping required can be reduced and flow distribution simplified by locating two secondary clarifiers to the north of the aeration basins, and two to the south of the basins. A proposed layout of this configuration is presented previously in Figure 9-8.

DISINFECTION

UV disinfection systems were evaluated to determine the one best suited for the Mount Vernon WWTP. The expected headloss through UV systems is 4 inches to 2.0 feet. The maximum water surface elevation required downstream (at the effluent pump station) is 21.7± feet. The minimum water surface elevation upstream of the UV disinfection system (at the secondary distribution structure) is 25.0± feet. Thus, there is adequate head both upstream and downstream for any UV disinfection system.

Alternative A - Horizontal, Low Pressure System

Alternative A included the review of a conventional horizontal, low pressure system. Due to the large footprint and associated number of bulbs, this was eliminated from further consideration.

Alternative B - Low Pressure, High Intensity System

Alternative B was a horizontal, high intensity, low pressure UV disinfection system. These systems utilize dimensionally similar bulbs to the horizontal, low pressure systems but due to the 100 W bulb rather than the 32 W bulb have a smaller footprint. They have the potential for flow-paced power consumption. Units typically have a turn down ratio of 100 percent to 60 percent. They also have the potential for in-channel cleaning, limiting the number module removal times required for cleaning.

A horizontal, high intensity, low pressure system for Mount Vernon would include approximately 256 lamps and require a peak power requirement of 32 kw. This system can be supplied by multiple manufacturers.

The estimated required dimensions for each channel (requires two channels, one bank per channel), for this system is 18 feet long, 5 feet wide, and 5 feet deep. The overall footprint for installation of this system, including traveling crane, UV disinfection equipment, and peripheral equipment is 32 feet long and 20 feet wide. The manufacturers of UV systems typically provide an automatic level control device to maintain a near constant water surface elevation over the UV lamps. The expected headloss through this system is less than four inches.

Alternative C - Vertical, Low Pressure System

Alternative C was a vertical, low pressure UV systems. Vertical modules typically consist of 40 lamps, five rows with eight lamps per row. Overall, the dimensions are usually 24-inches wide by 30-inches long. A 12-inch space is required between modules in series. Since the lamp can be accessed from the top, vertical modules do not need to be removed to replace a lamp. Typically, cleaning of the quartz sleeves are performed by removing the entire module and immersing it into a cleaning tank, similar to the conventional low pressure systems.

Vertical, low pressure system for Mount Vernon would include approximately 960 lamps, configured as twenty four 40-lamp modules, for a total of 960 lamps. The modules would be arranged in three channels, with eight modules per channel. The peak power required is 48 kW. This system can be supplied by multiple manufacturers.

The estimated required dimensions for each channel (requires three channels, eight banks per channel), for this system is 40 feet long, 2 feet wide, and 5 feet deep. The overall footprint for installation of this system, including traveling crane, UV disinfection equipment, and peripheral equipment is 62 feet long and 18 feet wide. The manufacturers of UV systems typically provide an automatic level control device to maintain a near constant water surface elevation over the UV lamps. The expected headloss through this system is less than 4 inches.

Alternative D - Open Channel, Medium Pressure System

Alternative D was an open channel, medium pressure UV systems composed of a reactor vessel with multiple modules. Modules typically consist of two to eight lamps. The module is designed to raise lamps from the channel to a convenient level outside of the channel for maintenance. Typically, cleaning of the quartz sleeves are performed automatically since fouling of the quartz sleeve occurs rapidly at the operating temperatures.

An open channel, medium pressure system for Mount Vernon would include approximately 48 lamps, configured in one reactor vessel. The reactor would be arranged in one channel. The peak power required is 73.6 kW. This system is proprietary and is supplied by Trojan Technologies.

The estimated required dimensions for the for this system is 36 feet long, 45 inches wide, and 119 inches deep. The overall footprint for installation of this system, including UV disinfection equipment, and peripheral equipment is 44 feet long and 12 feet wide. The expected headloss through this system is one to two feet.

Alternative E - Closed Conduit, Medium Pressure System

Alternative E included the review of a closed conduit, medium pressure system. For the indicated flow conditions, this system was not cost effective and was eliminated from further consideration.

Cost Estimates

Capital and operating costs for each alternative was developed for retrofitting the disinfection system in the existing chlorine contact basin. Alternatives A and E are not presented as they were excluded from additional analysis based on their high capital costs alone. The capital costs, summarized in Table 9-7, include a 20% contingency and 30% for indirect project costs. Operations and maintenance costs were based on 20 years at a 5% interest rate.

Table 9-7

Life Cycle Costs (in $1,000) for 25.8 mgd Disinfection Alternatives					
Alternative	**Description**	**Capital Cost**	**Annual O & M Cost**	**Life Cycle Cost**	**Standby Power Requirements**
B	Horizontal, Low Pressure, High Intensity System	$1,500	$40[1]	$2,000	64 kW
C	Vertical, Low Pressure System	$1,300	$37[1]	$1,760	96 kW
D	Open Channel, Medium Pressure System	$1,340	$69[1]	$2,200	154 kW

1. Power costs at $0.05 per kWhr

The equipment cost for the low pressure systems, Alternatives B and C, are less expensive than that of the medium pressure system, but due to the maintenance requirements, a building enclosure has been included in the capital cost. The open channel medium pressure system (Alternative D) is a system that is self cleaning and due to the reduced maintenance requirements and system configuration is typically installed without an enclosure. Cost for an enclosure have not been included with this alternative.

Although the life cycle costs are similar, the costs for the medium pressure system are greater than the low pressure systems. The advantage of the medium pressure systems are that due to the greater intensities, they can also be used to disinfect primary effluent. In the case of Mount Vernon, this type of system could also be used for the disinfection of the effluent for the Phase 3 CSO improvements. The medium pressure system can be situated in the existing chlorine contact basins, while providing additional space for a CSO disinfection system. Figure 9-9 presents a preliminary layout of a medium pressure UV disinfection system in the existing chlorine contact basin. The low pressure systems offer higher energy efficiency, but typically require more maintenance since more bulbs are required.

Since the life cycle costs for the vertical low pressure is the lowest and the medium pressure system offers the ability to be compatible with future CSO disinfection requirements, for planning purposes, the capital cost for the medium pressure system has been included. Since medium pressure systems are slightly greater than the low pressure systems, final determination should be made in the design phase.

UV Design Issues

The micro-organism identified by the NPDES discharge permit affects the design of a disinfection system. Enterococci are more difficult to inactivate than fecal coliform, which results in a larger system, either higher disinfectant dose or longer exposure time. The current NPDES discharge permit is based on fecal coliform. If the regulations change and the permit's basis for compliance is converted to enterococci, then the disinfection system will need to provide additional disinfection capacity. For a UV disinfection system, additional capacity can be easily incorporated through the addition of more UV bulbs to the system.

Redundancy of UV disinfection systems is provided through multiple channels and back-up power generation. Besides the typical redundancy designed in a UV disinfection system, the City of Mount Vernon, should evaluate designing the CSO Treatment Facility's disinfection system to act as a back-up disinfection system during the design phase of the CSO Treatment Facility.

UV disinfection is affected by UV transmittance (UVT), total suspended solids (TSS) concentration, particle size and composition, and wastewater flow rate. UVT is the major parameter used for sizing UV disinfection systems. Upstream processes, industrial dischargers, and the presence of iron compounds may reduce the UVT. Industrial pre-treatment utilizes ferric chloride as a coagulant, which results in the potential for iron to be conveyed to the UV disinfection system. UVT tests performed on the primary effluent and secondary effluent are included as Appendix J. These tests showed lower than expected UVT. Year-round diurnal UVT tests should be performed prior to design, and/or pilot testing of secondary effluent could be utilized to determine the range of UVT. Pilot testing for two (2) months is estimated to cost approximately $30,000.

SODIUM HYPOCHLORITE SYSTEM

Commercial grade sodium hypochlorite is supplied in a 12.5 percent solution. At 12.5 percent, it rapidly decays (to an 11.0 percent solution in only 30 days). To prevent degradation of the solution, it is recommended that dilution to a 4.0 percent solution occur on site when deliveries are received. Approximately 4,750 gallons of storage would be required to store a month's supply of 4.0 percent solution. In addition to one 5,000 gallon storage tank, ancillary equipment would be required:

- Two 10 gph metering pumps;
- Two 40 gph metering pumps; and
- Three 500 gph transfer pumps.

The sodium hypochlorite system could be located in the existing chlorine feed building, or in a structure adjacent to the existing chlorine facilities. The cost estimate presented anticipates the sodium hypochlorite system will be situated in a room of the existing chlorine facility. A budget of $100,000 has been identified for these improvements.

Effluent Pump Station

The firm pumping capacity of the Effluent Pump Station is 12.0 mgd. Two alternatives were developed to upgraded the Effluent Pump Station to a firm pumping capacity of 25.2 mgd.

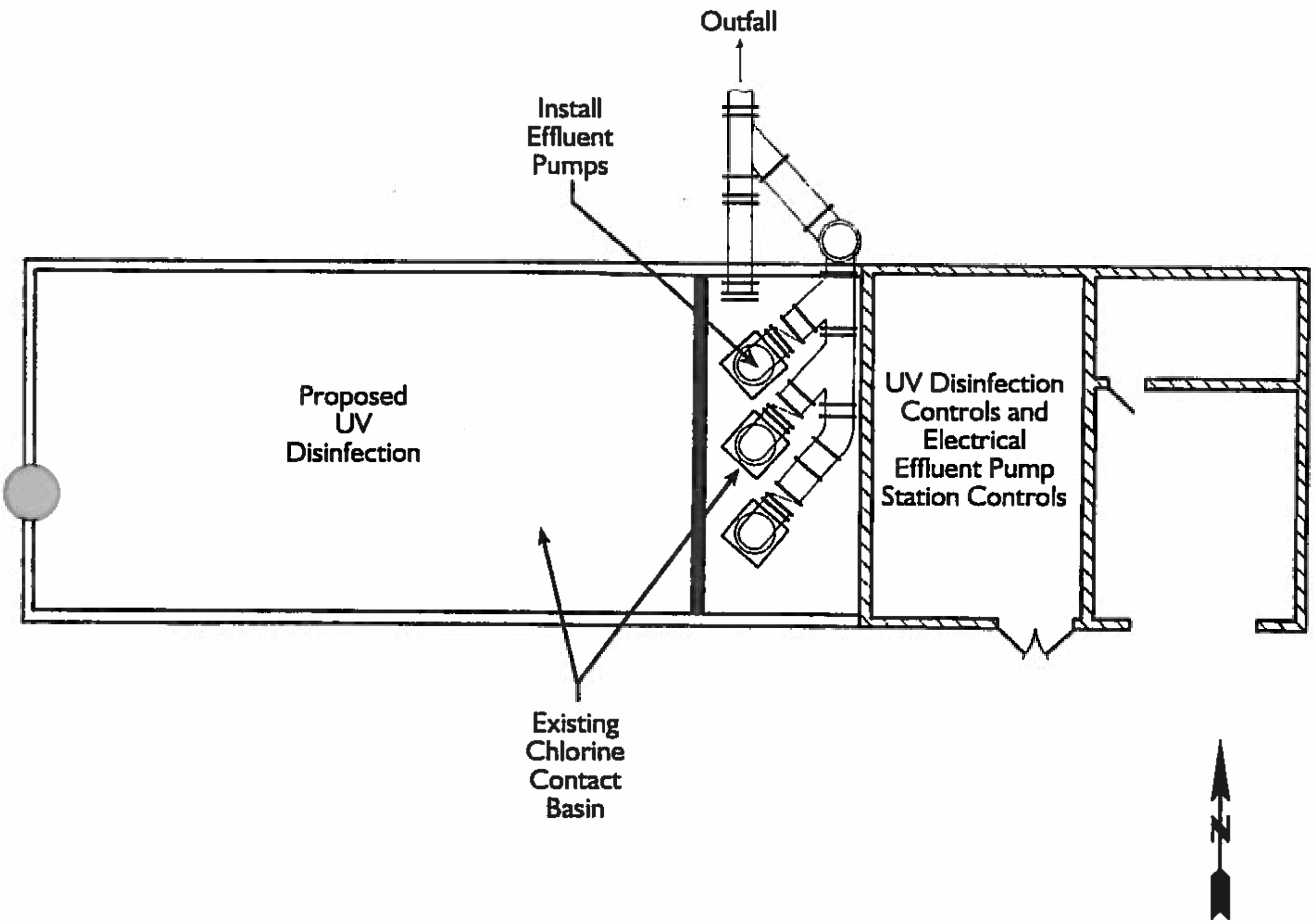
Alternative A - Retrofit Existing Effluent Pump Station

Alternative A considered retrofitting the existing Effluent Pump Station with new pumps, motors, and controls. The existing Effluent Pump Station is presently equipped with 40 hp pumps. The estimated size for these pumps would be 75 hp. There was not adequate space in the existing facility to install these pumps and this alternative was not considered further.

Alternative B - Retrofit Existing Chlorine Contact Basin with Effluent Pump Station

Alternative B would retrofit the Effluent Pump Station into the east end of the existing chlorine contact basin. Three pumps would be placed over the chlorine contact basin, utilizing the basin as a wet well. This alternative requires three 75hp pumps, new motors, and controls. It would also require the effluent piping to the outfall to be reconstructed.

A typical plan view of the existing chlorine contact tanks retrofitted with UV disinfection and an Effluent Pump Station is shown on Figure 9-9. The estimated cost for the Effluent Pump Station is $370,000.



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Project Title	Date
MOUNT VERNON COMPREHENSIVE SEWER	FEBRUARY 2003
Sheet Title	**Figure No.**
UV DISINFECTION AND EFFLUENT PUMP STATION	9-9

OUTFALL

Alternatives were developed to comply with future flows, loads, and discharge requirements for the outfall. For each alternative, for the secondary treatment, the outfall would terminate in an open ended diffuser at a location near the thalweg (approximately 40 feet farther into the river than the existing outfall), at an invert elevation of approximately -10 feet. This would reduce or eliminate the wastewater from being trapped by near shore eddy currents and improve mixing. An analysis of the mixing zone is presented in Appendix K, Mount Vernon WWTP Mixing Zone Study. The initial requirements for the outfall are as follows:

- Capacity for planned upgrade of the WWTP to a peak hour hydraulic capacity of 25.8 mgd;
- Ultimate capacity for the treated CSO flows (48 mgd peak hour flow, per Alternative 2C, Chapter 4);
- Minimize pumped discharges to high water level conditions in the river; and
- Minimize maintenance requirements.

Two general concepts were reviewed. These included a single outfall for both secondary and treated CSO effluent (Alternative A) and two separate outfall pipes (Alternative B). For preliminary sizing criteria, the velocity of flow within the outfall pipe was limited to 6.0 feet per second. This results in a 48-inch pipe for the single pipe option and 36-inch pipes for the two pipe option. [* Note: As of the finalization of this document, Alternative A was selected and designed]

The flow range from minimum day flow in dry weather conditions of approximately 1.6 mgd to the future peak hour CSO flow of 48 mgd is significant. For the single pipe option, multiple diffusers should be assessed to assure adequate mixing for this large flow range. Based on the recommendations of the Outfall Study, multiple diffusers could present increased maintenance requirements for this river discharge situation.

Cost estimates for the single pipe option (Alternative A) are shown in Table 9-8. Cost estimates for the two pipe option (Alternative B) are shown in Table 9-9

The provisions of a single outfall pipe reduces problems associated with multiple outfalls in close proximity:

1. overlapping mixing zones; and
2. multiple pipes would require additional maintenance.

A summary of the advantages and disadvantages for each alternative is presented in Table 9-10.

Table 9-8

Single Pipe Outfall (Alternative A) Cost Estimates				
Item	Quantity	Unit	Unit Cost	Cost ($1,000)
Sheet Pile	1	LS	$250	$250
Effluent Pipe	1	LS	$250	$250
Outfall Pipe	1	LS	$300	$300
Subtotal				$800
Contingency (20%)				$160
Indirect Project Costs (30%)				$240
Total				$1,200

Table 9-9

Two Pipe Outfall (Alternative B) Cost Estimates				
Item	Quantity	Unit	Unit Cost	Cost ($1,000)
Sheet Pile	1	LS	$250	$250
Effluent Pipe	2	LS	$200	$400
Outfall Pipe	2	LS	$250	$500
Subtotal				$1,150
Contingency (20%)				$230
Indirect Project Costs (30%)				$345
Total				$1,725

Table 9-10

Outfall Alternative Advantages and Disadvantages		
Alternative	**Advantages**	**Disadvantages**
Single Pipe	• Lower Capital Cost • Single dilution zone	• Combined effluents would need to be addressed in future NPDES permits
Two Pipe	• Maintains option for separate CSO outfall • Lower maintenance (diffusers not required)	• Greater Capital Cost • Multiple dilution zones in close proximity

The single pipe option is recommended. It has the advantage of a lower capital cost and results in only one dilution zone for both the treated CSOs and the secondary effluent.

DISSOLVED AIR FLOATATION THICKENER

The existing DAFT is provided for WAS thickening and has an area of approximately 1300 SF. An additional 750 SF is required to treat 2020 WAS flows without nitrication (i.e. BOD removal only), and approximate 500 SF with nitrification. However, this estimation is based on the maximum solids loading rate of 2.5 lb/SF/hour from Department of Ecology for WAS thickening with coagulant/polymer. It would be more conservative design a new system at a lower solids loading rate of 2 lb/SF/hour

The existing DAFT is sized to adequately thicken WAS flows through 2009 with nitrification. A new DAFT would be requied by 2009 with or without nitrification. Using the solids loading rate of 2.0 lb/SF/hour, an additional 40-FT diameter unit would be required by the year 2009 to meet the flows from 2009 through 2020. The new unit will be the same size as the existing unit.

The existing solids process equipment is located in the northeast portion of the WWTP site. Location for a future DAFT has been designated between the digester complex and the Influent Pump Station.

ANAEROBIC DIGESTER

An additional digester should be provided to reduce the difficulties associated with cleaning the existing digester. It would provide redundancy and allow existing tankage used for storage of solids to be converted to CSO storage, further reducing overflows. A new digester should be sized similar to the existing digester. The estimated cost of a new 103,400 cf digester is $2,500,000.

The existing anaerobic digester is located in the northeast portion of the WWTP site. Location for a future anaerobic digester has been designated between the digester complex and the Influent Pump Station. This is the logical location for a future anaerobic digester.

ENERGY RECOVERY

Methane gas is a byproduct of the anaerobic digestion process. Currently, the plant produces approximately 30,000 cubic feet (cf) per day. A portion of this gas is used to heat the incoming sludge, and the remainder is flared. Historically, power generation from waste gas was accomplished with internal combustion engines and generators. Due to the minimum sizing requirements for the engine generator units and relatively low electrical power costs, the generation of energy from waste digester gas has been historically limited to facilities much larger than the Mount Vernon WWTP. Based on plant estimates, the quantity flared is approximately 50% of the gas production. Based on a value of 650 BTU per scf, the average amount of waste digester gas currently flared is 10 MBTU per day. This equates to approximately 50 hp, or 37 kW.

In recent years, power costs have increased and there are now newer technologies available for electrical power generation. In addition to conventional internal combustion engine generator units, small turbine units (microturbines) are available.

Another emerging technology is the use of fuel cells. These devices convert hydrogen into electrical power and water. Fuel cell technology for wastewater treatment plants is still in the development phase. Fuel cell technology may become cost effective for the Mount Vernon WWTP in the future, but at this time it is not recommended for consideration.

Another recent technology for cogeneration is the use of microturbines (see Appendix L). Current units are available with capacities of 30 kW. This smaller incremental size creates opportunities for intermediate sized WWTPs to more cost effectively generate electrical power from waste digester gas. Since the WWTPs minimum electrical demand would be less than the capacity of the units, the electrical intertie would be simplified and would operate in a 'grid connect' mode. A preliminary estimate was completed for the installation of a microturbine cogeneration facility at the plant. Three size increments were considered, 30, 60, and 90 kW. The unit would be located adjacent to the Solids Handling Building. The units would be provided with a roof structure. Preliminary cost estimates were developed for 30, 60, and 90 kW facilities as presented in Table 9-11.

Table 9-11

Co-generation with Microturbines Cost Estimates			
Item	Co-generation Capacity		
	30 kW	60 kW	90 kW
Capital Cost	$170,000	$300,000	$390,000
Annual Debt Recovery[1]	$14,000	$24,000	$31,000
Debt Recovery/kWhr[2]	$0.06	$0.05	$0.04
Maintenance Cost/kWhr[3]	$0.03	$0.02	$0.02
Total Power Cost	$0.09	$0.07	$0.06

1. 20 years, interest 5%
2. Based on 90% operating time
3. Includes cost to rebuild unit at 40,000 hrs

Current electrical energy costs average $0.05 per kWhr and preliminary estimates of energy available from the waste digester gas is 40 kW. Depending on interest rates for payback on the capital cost, at this time, it may not be cost effective for the City to install this type of system. Factors that could make this type of system cost effective include:

- Increased electrical energy costs;
- Increased loads to the WWTP and related digester gas production; and
- Available funding (with grant monies to assist with capital cost, the system could be cost effective at current conditions).

ODOR CONTROL

Gas-stream odor control at the WWTP can be accomplished through collection of odorous gases and treatment with scrubbers. Collection of odorous gases occurs through containment or covering unit processes. Containment can be accomplished with a building, such as a headworks building. Covering can be performed with either concrete, aluminum, plastic, or fiberglass, such as covers over the primary clarifiers or influent pump station wet well. Gas-phase odors are collected and treated in one of numerous unit processes: biofilters, chemical scrubbers, packed-bed wet scrubbers, mist scrubbers, or carbon absorbers. The most economical solution for a plant the size of Mount Vernon is typically collection of gases through a combination of covers and containment and treatment with a wet scrubber. An estimated cost for such a system (covers on the primary clarifiers and grit basins, containment of odors in the Influent Pump Station and Headworks building, and treatment with a wet scrubber) is $1,300,000, as presented in Table 9-12. Additional unit processes can be covered to contain all potential odors.

Table 9-12

Odor Control Cost Estimate				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Site Preparation	1	LS	$35,000	$35,000
Primary Clarifier Covers[1]	10,800	SF	$40	$432,000
Grit Basin Covers[1]	630	SF	$40	$25,200
Duct Work		LS	$141,500	$141,500
Packed Tower - Wet Scrubber		LS	$250,000	$250,000
Subtotal				$883,700
Contingency (20%)				$176,700
Indirect Project Costs (30%)				$265,100
Total				$1,325,500

1. Covers include influent and effluent channels and structure

Biosolids Requirements

Subpart D (pathogen and vector attraction reduction) requirements of the 40 CFR Part 503 regulation apply to sewage biosolids, both bulk biosolids and biosolids that is sold or given away in a bag or other container for application to the land, and domestic septage applied to the land or placed on a surface disposal site. There are two basic types of requirements in Subpart D, Class A and Class B. Class A requirements are to reduce biosolids pathogens to below detectable levels. Class B requirements are to ensure that pathogens have been reduced to levels that are unlikely to pose a threat to public health and the environment under the specific use conditions. Regulations also require a reduction in the potential of biosolids to attract vectors, such as rodents, birds, insects, and other organisms that can transport pathogens.

Class B Biosolids

Mount Vernon currently treats the biosolids from the WWTP to Class B standards. Permitting for land application has not been a problem. At this time, there does not appear to be a need to increase the treatment level to Class A. If the situation would change and land application sites were not available, then the City may want to consider providing Class A biosolids.

Class A Biosolids

Mount Vernon is not required to produce Class A Biosolids, but if they chose to treat the biosolids to this level, it can be met by any of the following processes:

- Biosolids can be thermally treated by using a specific time-temperature regime to reduce pathogens. One option is to use a heat drying system to provide heat treatment of the digested dewatered material. With this process, a dewatered biosolids cake enters a heat drying system where thermal energy is added for the evaporation of entrained water. The biosolids are dried to a solids concentration of from 90 to 96 percent and the end product is in the form of a dried pellet. These pellets can then be used as fertilizer. In addition to the capital cost for the system and labor requirements, a large amount of energy is required to dry the biosolids. Based on typical thermal efficiency of the systems, approximately 1,500 BTUs per pound of water evaporated is required. Starting with a solids concentration of 16 percent and drying it to 95 percent would require approximately 16 million BTUs per dry ton of solids. At a cost of $0.90 per Therm for natural gas, this would equate to an energy cost of approximately $150 per dry ton of solids. Allowing a capital cost of $100 per dry ton and a labor cost of approximately $50 per dry ton would result in a total cost of approximately $300 per dry ton for biosolids handling. Based on these costs, this alternative is one of the higher cost options for obtaining Class A biosolids.

- High temperature-high pH treatment is the process also known as alkaline treatment. It exposes biosolids to pHs greater than 12 for greater than 72 hours, and simultaneously has temperatures greater than 52 degrees Celsius for over 12 hours. Air drying is the last step of the process. Drying is performed to provide a solids concentration of greater than 50 percent after the 72 hours of pH-temperature treatment. The unit cost for this process is typically $200 to $250 per dry ton.

- Composting requirements vary depending on the composting process chosen. For an aerated static pile, the temperature must be maintained above 55 degrees Celsius for greater than 3 days. For a windrow composting method, the temperature must be maintained above 55 degrees Celsius for greater than 15 days, with a minimum of five turnings of the windrow. The unit cost for this process is typically $125 to $175 per dry ton.

If the City were to decide in the future to treat biosolids to Class A standards, the recommended option would be to utilize aerated static composting. This has been used by a number of similar sized communities. The advantages are that it is a relatively simple process to maintain and the end product is Class A biosolids, which has a relatively high demand. This unit process would require a capital investment of $860,000 and an annual

O&M cost of $150,000. These costs are above and in addition to the current capital and operation and maintenance costs required in the other sections of this Comprehensive Sewer Plan Update.

FACILITIES

Operations Building

The Existing Administration/Laboratory Building is limited in space for the current operations. The existing laboratory is located within this building, along with the lunch room, lockers/showers and office space. This laboratory is adequate for current needs, but should eventually be expanded.

Based on discussions with City staff, it may be desirable to provide a phased approach to meet future operations building and laboratory requirements. Initialy a new Wastewater Utility Administration Building would be constructed. This would include the following:

- Reception area
- Office space
- Meeting rooms
- Lunch Room
- Mens locker/shower
- Womens locker/shower
- Library

At the same time the the existing Administration/Laboratory building would become the Laboratory/Operations Center. This would include the following:

- Laboratory (no changes to existing laboratory)
- The remainder of the building would become the Operations Center and would include:
    - Operator work areas
    - SCADA system monitoring
    - Plan/Map storage
    - Deliveries

- Library

Preliminary total project cost for the initial initial phase is $600,000.

Additional budget should be provided for long term planning to provide an upgrade of the existing laboratory. At that time the existing Laboratory/Operations Center could be converted to all laboratory facilities and additional Operations Center facilities provided. A preliminary budget of $600,000 for this long term improvement.

Shop/Garage

The existing shop and garage will need to be dedicated to the WWTP in the future. This will necessitate construction of a new garage/vehicle storage building for the collection system equipment and the grounds maintenance equipment. This building should contain five vehicle bays and an area dedicated to maintenance. It should be a minimum 4,000 sf to accommodate the vehicle storage and maintenance. An estimated cost for a 4,000 sf shop/garage is $500,000. based on discussions with plant staff, the primary need for this building is for material and vehicle storage and if required to reduce the cost, a "carport" type covered structure could be provided.

RECLAIMED WATER FEASIBILITY

Background

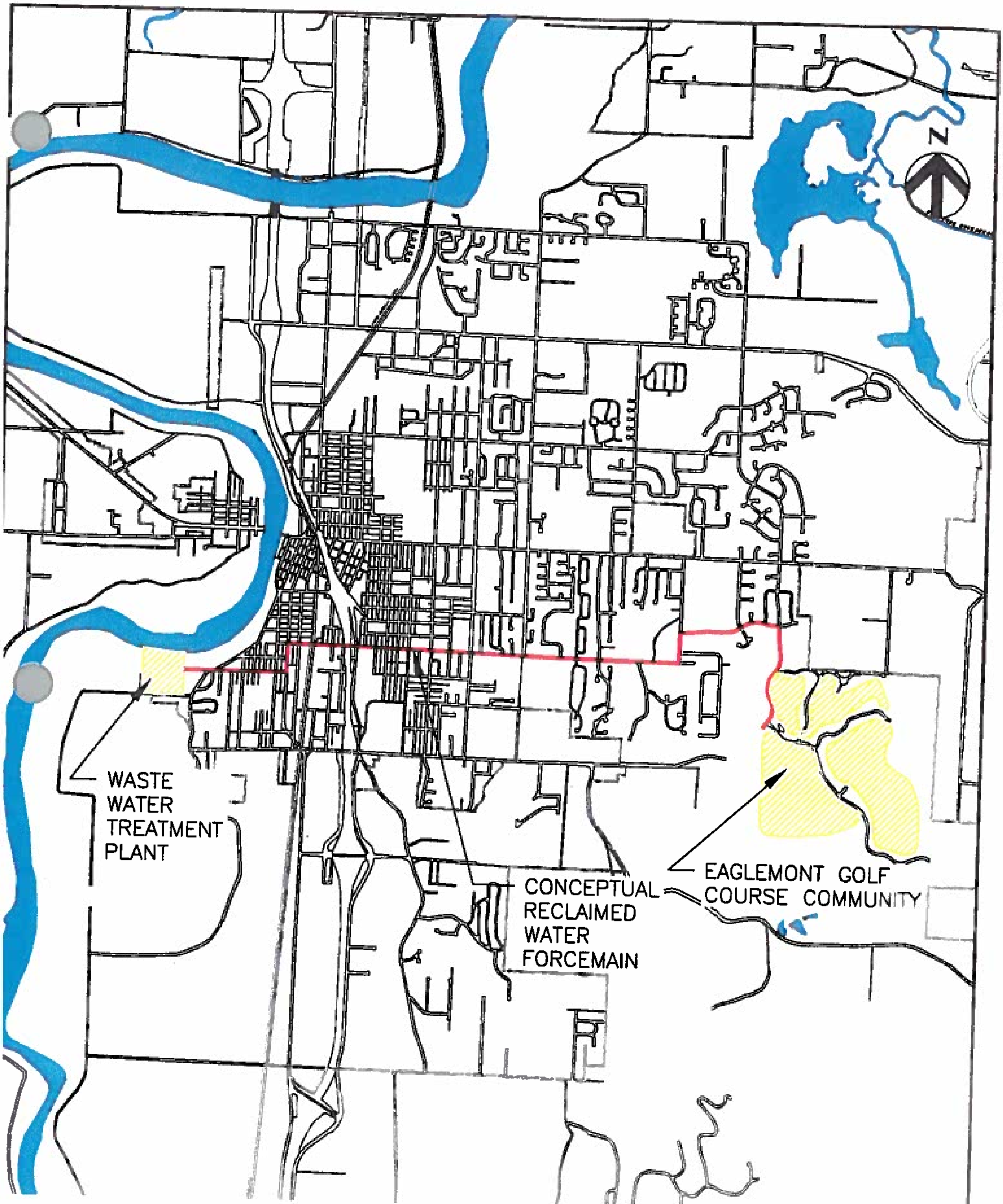
The City of Mount Vernon reviewed the feasibility of wastewater reclamation in its service area. Potential end uses for reclaimed water include urban and agricultural irrigation, and less common applications such as wetland creation, and direct or indirect streamflow augmentation. Table 9-13 lists the anticipated water quality objectives for various potential reclamation end-uses.

Table 9-13

Water Quality Classifications for Reclamation End-Uses									
Water Quality	BOD mg/L	TSS mg/L	Total P mg/L	NH3-N mg/L	TN mg/L	Turb. NTU	TOC mg/L	TDS mg/L	Metals, Organics
Class A	30	30	--	--	--	2	--	--	--
Wetlands	20	20	1	Toxicity	3	2	--	--	Surface2
GW (perculation)	30	30	--	--	10	2	--	--	Site
GW (non-potable)	5	5	--	--	Site	2	--	Site	Site
GW (potable)	5	5	--	--	10	0.1	1	Site	SDWA
Large Stream (marine)	30	30	3 – 5	2 – 3	--	2	--	--	Surface1
Small Stream (marine)	10	10	1 – 2	1	--	2	--	--	Surface1
Large Stream (lake)	30	30	0.1	2 – 3	--	2	Pos	--	Surface1
Small Stream (lake)	10	10	0.1	1	--	2	Pos	--	Surface1
Lake Anticipated	10	10	0.01	1	--	2	--	500	SDWA
Lake Worst Case	10	10	0.01	0.02	0.6	2	2	100	SDWA/BG

Notes:
GW = Groundwater recharge
Pos = Possible limit
Site = Site specific criteria
Surface1 = Surface water standards with mixing zone
Surface2 = Surface water standards with mixing zone
SDWA = Drinking water standards
BG = Background concentrations without mixing zone

At a minimum, the reclaimed water treatment processes must meet Class A water quality standards for oxidation, filtration, and disinfection. Depending on the end uses, additional treatment could be required to meet more stringent nutrients, metals, organics, and turbidities levels.



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Project Title
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
CONCEPTUAL RECLAIMED WATER FORCEMAIN ALIGNMENT

Figure No
9-10

Potential Customer

The Eaglemont Golf Course Community located in SE Mount Vernon was identified as a potential customer for reclaimed water. The Eaglemont community plan encompasses 675 acres. Nearly 60% of this acreage is committed to open space, including the golf course and wetlands, two mini-parks and a five-acre neighborhood park. A beaver pond and nature preserve account for another 30 acres. Reclaimed water could be used to satisfy the irrigation water need, and potentially for maintaining the existing wetlands and ponds.

Treatment Processes Required

The existing Mount Vernon wastewater treatment plant consists of primary treatment, secondary activated sludge system for BOD removal, and disinfection. In order to provide the level of treatment to produce reclaimed water, additional treatment processes for turbidity reduction and additional disinfection would be required. The turbidity reduction would be accomplished by a filtration step utilizing multimedia sand filtration, or membrane filtration such as microfiltration. A separate disinfection process via the ultraviolet (UV) process to meet the reclaimed water standards.

A new reclaimed water pump station and a new force main, approximately 4 miles long, would be required to deliver reclaimed water from the existing wastewater treatment plant to the Eaglemont community. Figure 9-10 shows the proposed conceptual alignment of the reclaimed water forcemain.

The current irrigation water use at the Eaglemont community in the irrigation season is estimated to be 1 MGD on average. A conceptual level cost estimate was developed gpt s 1 mgd reuse plant. Table 9-14 summarizes the capital cost of the conceptual level new reclaimed water treatment system and related distribution infrastructure.

Table 9-14

Estimated Capital Cost of 1 MGD Reclaimed Water Treatment System and Distribution Infrastructure

Component	Capital Cost
Membrane Bioreactor for nutrient removal and membrane filtration	$1,000.000
UV Disinfection System and Pump Station	$500,000
Forcemain	$2,000,000
Subtotal	$3,500,000
Tax (8%)	$280,000
Contingency (35%)	$1,225,000
Total	$5,000,000

Feasibility of Implementing Water Resue in the City of Mount Vernon

At present, the portion of water flow from the municipal supply system used for irrigation in the City of Mount Vernon would not be returned to the Skagit River. If reclaimed water was available for irrigation, the amount of municipal water demand could be reduce proportionally, thereby reducing the diversion of freshwater from the river.

Based on this conceptual cost estimate, using reuse water is not cost effective compared to the use of current muncipal water supply. The higher cost of reuse water is associated with the capital cost of building the new advance watewater treatment facilities and constructing the distribution infrastructure, and the operation and maintenance of such a system. At this time, this is not economically favorable to implement water reuse.

10. Recommended WWTP Alternatives

This chapter presents the recommended alternatives for upgrade to the existing WWTP.

Hydraulics

The alternate WWTP hydraulics is recommended (Alternative B). The advantages include easier access to equipment and pumping forward flows only once. With selection of Alternative B, the existing activated sludge pump station could be designated entirely for RAS pumping.

Influent Pump Station

Pump Station Capacity

Alternative A is the preferred alternative. The existing pump station can be retrofitted with new pumps and motors for approximately $0.6 million less than utilizing submersible pumps. The pump station should be upgraded to 24 mgd with four 75 hp pumps and motors for an estimated cost of $1.6 million. A physical model of the pump station, before and after conditions, should be considered during the pre-design phase to assure that current problems are corrected by the improvements.

Screening

Coarse screening, with 1-inch screen spacing, is recommended to provide protection for the influent pumps. The existing manually-cleaned bar screen should be replaced with a mechanically-cleaned screen, and the existing mechanically-cleaned screen should be utilized as a backup unit. The estimated cost for replacing the manually-cleaned bar screen with a mechanically-cleaned screen is included in the cost estimate of upgrading the influent pump station, see above.

Headworks

A headworks facility would improve the screening and grit removal, protecting downstream process equipment. The estimated cost of a headworks facility is $2.8 million. Details of the recommended headworks are discussed below.

Comminutor

The comminutor is recommended for abandonment.

Fine Screens

Installation of fine screens is recommended. Fine screens should have 3/8-inch spacing and be mechanically-cleaned and provided with washing and compacting equipment.

Grit Removal

A vortex grit removal system is recommended because of the high flexibility coupled with moderate costs. The hydrocyclone de-gritter has both a high capital and operating cost. The aerated grit chamber has low flexibility and a high operating cost.

Disposal

The existing method of disposal is recommended to be continued. It also is recommended that a building be placed around the screenings and grit storage site to prevent unpleasant odors from escaping the site.

PRIMARY CLARIFIERS

Two new (75-foot diameter) clarifiers are recommended. The life cycle costs of the alternatives are relatively equivalent. The two new clarifiers offers advantages that off-sets the minimal cost difference seen over the life of the clarifier. These advantages include:

- Reserves capacity of the existing clarifier for combined sewer flows (for the 'internal shunt');
- Construction cost savings may be realized, as construction sequencing will be less than the cost towhen to modify the existing clarifier; and
- Two clarifiers would provide redundancy for regular maintenance and unexpected circumstances.

The estimated cost of two new clarifiers is $1.8 million.

ACTIVATED SLUDGE PROCESS

The existing activated sludge system is recommended to be converted from the existing BOD removal mode to a nitrification mode. This conversion will necessitate additional aeration basin capacity and blowers. Details of all recommended improvements for the activated sludge process are below:

Activated Sludge Pump Station

The existing activated sludge pump station is recommended to be designated as an RAS pump station. It has 24.0 mgd capacity (firm pumping capacity of 16.0 mgd), which is in excess of 100 percent of the forward flow through the secondary process at 2020 (9.9 mgd).

Selector Basin

A selector basin is recommended for filament control. A selector basin will allow filamentous bulking control without the use of chlorine. It can be constructed adjacent to the RAS pump station and as detailed in Alternative B. This could be constructed in two phases, the second phase incorporated with the addition of nitrification. The total estimated cost for this selector basin is $600,000.

Aeration Basin

Alternative B, nitrification mode, is required to meet anticipated NPDES permit limits, based on the TMDL of the Skagit River and the toxicity testing (which will most likely limit the allowable ammonia concentration). This alternative utilizes the 0.5 mg Aeration Basin No. 4, requires an additional 1.2 mg aeration basin volume, and replaces the coarse bubble diffusers with fine bubble diffusers. The estimated cost for these improvements is $2.7 million, and could be performed in a phased manner over the 20-year planning horizon.

Blowers

Addition of one blower by 2020 is recommended. The existing blowers have capacity to meet aeration requirements until 2010. One additional blower will meet aeration requirements through 2020. The estimated cost of improvements (building expansion, piping modifications, and one additional blower) are estimated at $333,000.

Secondary Clarifiers

The existing Secondary Clarifier No. 1 (peripheral feed clarifier) is recommended for conversion to WAS storage (aerobic digester). By moving the WAS storage from Aeration Basin No. 4 to the inefficient Clarifier No. 1, it opens up aeration basin volume and reduces the additional aeration basin volume required. It also removes an inefficient secondary clarifier, and replaces it with an efficient clarifier.

It is recommended that three additional clarifiers be added. Two clarifiers should be on line by 2010. One clarifier should be on line by 2020. The estimated costs for 2010 are $2.5 million and for 2020 are $1.1 million.

Disinfection

Alternative C, a vertical, low pressure UV disinfection system, has the lowest life cycle cost. It is recommended to replace the existing chlorine disinfection system. While the low pressure UV system is the least costly alternative, there may be advantages to utilizing a medium pressure system, such as locating the CSO treatment disinfection system, secondary effluent disinfection system, and effluent pump stations in the existing chlorine contact basin. The budgetary cost estimate, $1.34 million, for this planning level determination has been estimated as the higher of the costs ($1.30 million for low pressure verses $1.34 million for medium pressure) for a UV disinfection system and will allow the most beneficial disinfection system to be chosen during the design phase.

Sodium Hypochlorite System

A sodium hypochlorite system is recommended to provide chlorine for miscellaneous plant uses. The description of system equipment is presented in Chapter 9. The hypochlorite system's transfer and metering pumps, and storage tank (5,000 gallon) could be located in the existing chlorine room. Ventilation requirements and compliance with Article 80 of the Uniform Fire Code will need to be assessed when utilizing the existing chlorine room. The estimated cost for a sodium hypochlorite system is $100,000.

Effluent Pump Station

It is recommended that the existing effluent pump station be abandoned. The existing pump station can be converted to contain the electrical and controls for the UV disinfection system and the proposed effluent pump station.

A new pump station, Alternative B, consisting of low head pumps, can be incorporated into the existing chlorine contact basin. The downstream portion of the contact basin could be utilized as the wet well of the pump station, and configured to flow by gravity to the outfall under normal operating conditions. The pump station would consist of three low head pumps, with a firm pumping capacity of 25.8 mgd. The actual sizing of the pumps will depend on the design of the outfall, but preliminary sizing estimates 75 hp pumps. The estimated cost for this pump station is $370,000.

Outfall

The recommended outfall improvement is Alternative A. It promotes better dispersion than the existing outfall and maintains effluent flows away from the near shore Eddies. The estimated cost of replacing the outfall, including the piping from the WWTP, is $1,200,000.

DAF Thickener

A new DAFT is recommended to meet the year 2020 loadings. A 40-ft-diameter unit will provide capacity for loadings through 2020. The details for this recommendation are presented in Chapter 8 , and the cost is estimated to be $400,000.

Anaerobic Digester

A new anaerobic digester is recommended to provide redundancy and digester volume while cleaning the existing digester. A 60-ft-diameter unit with a sidewater depth of 34-feet would be adequate to meet redundancy and flow requirements through 2020. The cost is estimated to be $2,500,000.

Odor Control

It is recommended that gas-phase odors be treated at the WWTP. Odors (gas-phase) should be collected from above the influent pump station wet well, headworks building, and primary clarifiers. The gas-phase odors could be treated with wet scrubber and discharged to the atmosphere. The estimated cost for gas-stream treatment of odors by collection and a single scrubber is $1,300,000.

Biosolids Requirements

It is recommended that Mount Vernon continue to treat biosolids to Class B standards. If Mount Vernon were to treat biosolids to Class A standards, it would be recommended to utilize aerated static composting, at a capital investment of approximately $860,000 and an annual operation and maintenance cost of $150,000.

Facilities

Operations Building

A new Operations Building is recommended as a first phase improvement, at an estimated cost of $500,000. During predesign, details the final requirements should be confirmed and the final budget refined.

Shop/Garage

Addition of 4,000 sf of garage/vehicle storage is recommended, at a cost of $500,000. During predesign, details, such as the square feet of garage space, additional shop space, etc. should be determined.

Site Improvements

100-year Flood Protection

The existing dike between the WWTP and the Skagit River will protect the WWTP from inundation of the 25-year flood event (estimate based on conversations with the ACOE). Flows in excess of the 25-year flood event will most likely result in a failure of the existing dike downstream of the WWTP. Backwater affects will result of inundation of the WWTP to a water surface elevation of 28.2-28.3 ±0.5 ft. To provide protection from the 100-year flood event, the WWTP should consider construction of a dike around the entire plant. The estimated costs for a 2,000 LF ring dike are $600,000, including 20% contingency and 30% indirect costs. Actual costs will vary depending upon the necessary site improvements.

Roadways

Modification of the existing WWTP will include construction of new process equipment, modification of old process equipment, and new facilities. Improvements to the site should also be planned for, such as re-routing existing roadways or construction of new roadways. It is estimated that 1,300 LF of new roadway will be required at an estimated cost of $50,000, including 20% contingency and 30% indirect costs. Actual costs will vary depending upon the necessary site improvements.

Drainage

Modification of the existing WWTP will also require improvements to the drainage on site. It is estimated that 11 acres of area will be modified requiring new drainage. An estimated cost of $250,000, including 20% contingency and 30% indirect costs has been budgeted for drainage improvements. Actual costs will vary depending upon the necessary site improvements.

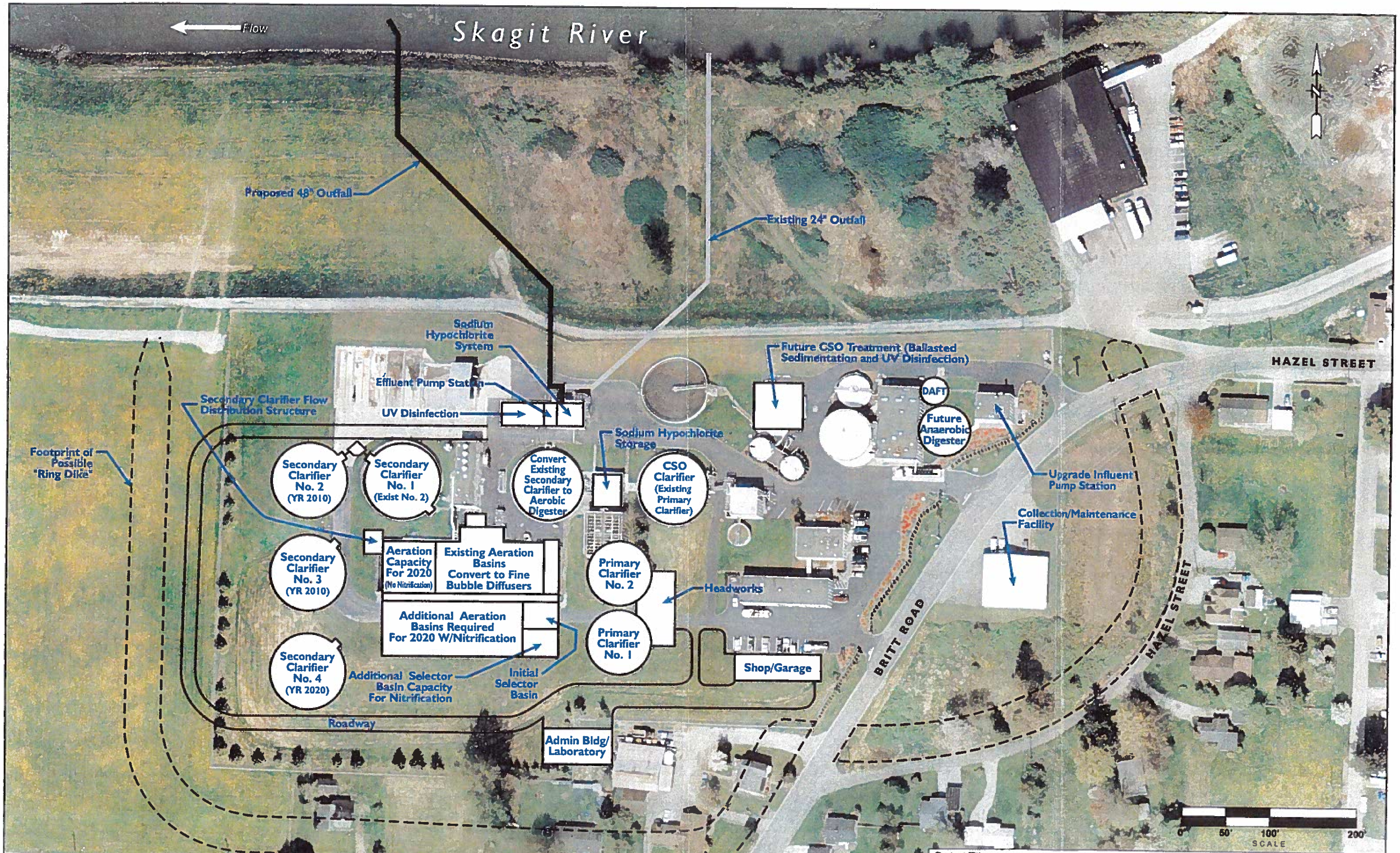
Summary of Recommendations

Table 10-1 presents a summary of the recommended improvements and cost estimates for each WWTP improvement. Table 10-2 presents a summary of the recommended improvements and cost estimates for each CSO Treatment improvement.

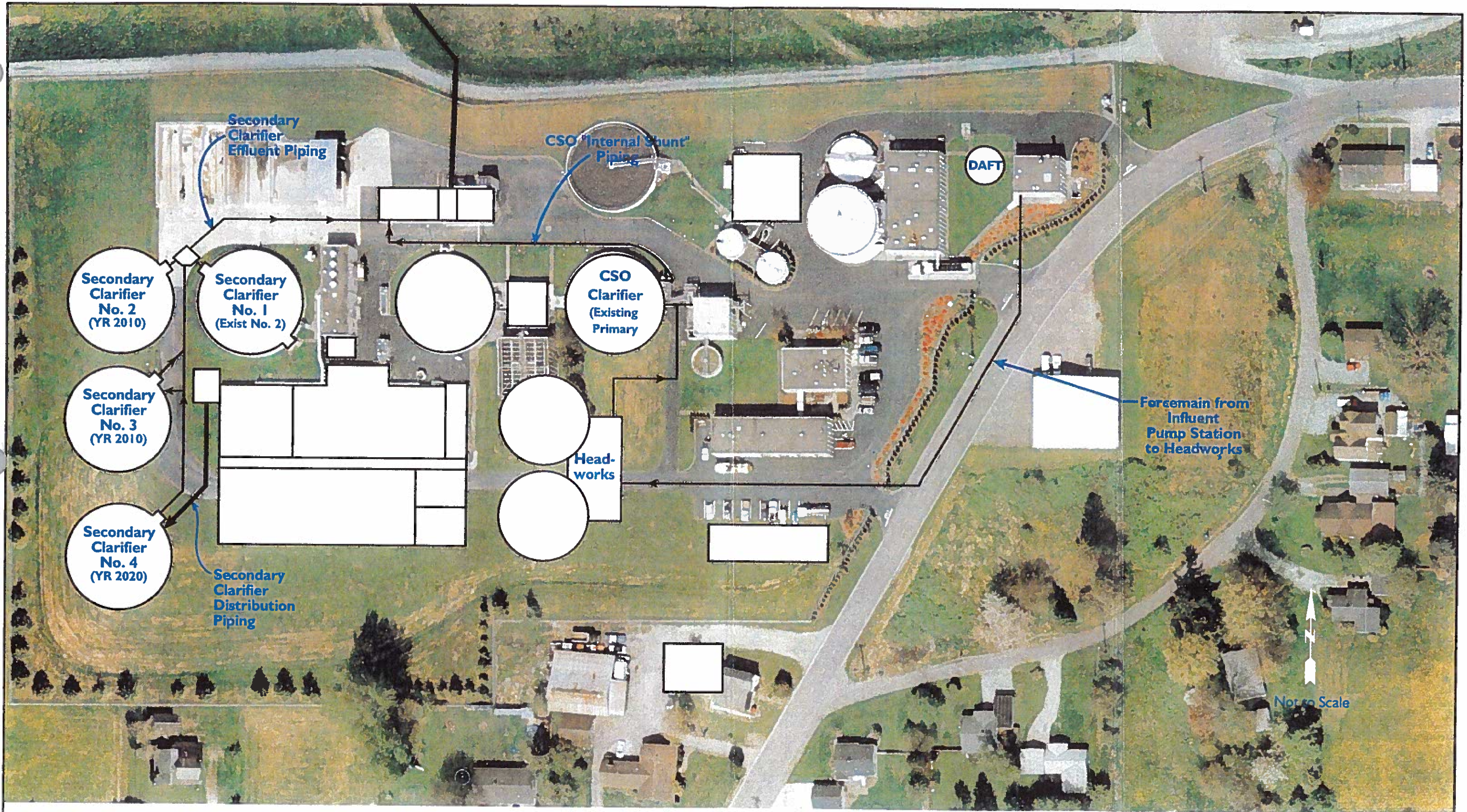
Table 10-1

Recommended Improvements for the Wastewater Treatment Plant	
Improvement	**Capital Cost Estimate ($1,000)**
Influent Pump Station	$1,600
Headworks	$2,800
Primary Clarifiers	$1,800
Selector Basins	$600
Aeration Basins	$2,700
Chemical Feed System (pH control)	$50
Secondary Clarifiers	$3,600
UV Disinfection[2]	$1,340
Effluent Pump Station	$370
Outfall	$1,200
Sodium Hypochlorite System	$100
DAFT	$400
Anaerobic Digester	$2,500
Odor Control System	$1,300
Administration Building	$500
Laboratory Expansion/Operations Center	$600
Shop and Garage	$500
Flood Protection - 100-year event	$600
Roadways	$250
Drainage Improvements	$50
Total	$23,593

1. ENR Construction Cost Index 6397, October 2001.
2. UV disinfection costs include capital cost of a UV disinfection system and costs for pilot testing for two months.



Project Title	Date
MOUNT VERNON COMPREHENSIVE SEWER PLAN	FEBRUARY 2003
Sheet Title	Figure No
RECOMMENDED WWTP IMPROVEMENTS SITE PLAN	10-1



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Project Title: MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE	Date: FEBRUARY 2003
Sheet Title: RECOMMENDED YARD PIPING	Figure No: 10-2

11. CAPITAL IMPROVEMENT PLAN

This chapter presents a summary of the improvements for the City of Mount Vernon as a plan for improvement and expansion. Improvements for the combined sewer system, CSO reduction were developed in Chapter 4. Improvements for the wastewater collection system were developed in Chapter 5. Improvements for the wastewater treatment plant were developed in Chapter 10.

CAPITAL IMPROVEMENT SCHEDULE

A capital improvement schedule is based on improvements necessary for future CSO reduction, collection system improvements and expansion, and wastewater treatment plant improvements and expansion. Table 11-1 presents the recommended capital improvement schedule for the Wastewater Treatment Facility. Table 11-2 presents the recommended capital improvement schedule for CSO Treatment. Table 11-3 presents the recommended capital improvement schedule for the collection system. Table 11-4 presents a summary of all system improvements.

Table 11-1

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)														
Improvement	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**201 1**	**201 2**	**2013**	**2014**	**>2015**
Influent Pump Station				1,600											
Headworks				2,800											
Primary Clarifier				1,800											
Activated Sludge - Fine Bubble Diffusers		300													
Activated Sludge - Selector Basin				300					300						
Activated Sludge - Chemical Feed System (pH control)		50													
Activated Sludge - Additional Aeration Basin Capacity									2,700						
Activated Sludge - Additional Second. Clarifier Capacity				2,500					1,100						
UV Disinfection[1]				1,340											

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
Effluent Pump Station				400											
Outfall			1,200												
Sodium Hypochlorite				100											
DAF Thickener									400						
Additional Anaerobic Digester Capacity									2,500						
Odor Control													1,300		
Administration Building				600											
Laborator/Operation s Center													600		
Shop/Garage				500											
Flood Protection 100-year flood															600
Roadways															250

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
Drainage Improvements															50
Total	0	350	1,200	11,940	0	0	0	0	7,000	0	0	0	1,900	0	900

1. ENR Construction Cost Index 6397, October 2001.
2. Costs for UV disinfection include capital costs and pilot testing costs.

Table 11-2 CSO Treatment Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CSO Treatment - Park Street Conveyance													1,900		
CSO Treatment - High Rate Clarification													4,200		
CSO Treatment - UV Disinfection													2,200		
CSO Treatment - Effluent Pump Station													800		
Total													9,100		

1. ENR Construction Cost Index 6397, October 2001.
3. Costs as presented in Chapter 4, Combined Sewer System

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
FS-1 Sections 23 and 26															380
FS-2 Sections 15 and 22															295
FS-3 Martin Road															135
FS-4 College Way															125
FS-5 College Way		635													
FS-6 Fir Street					270										
FS-7 Fir Street					350										
FS-8 26th Street															190
FS-9 26th Street															140
FS-10 LaVenture Rd															235
FS-11 LaVenture Rd															75
FS-12 LaVenture Rd															255

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
FS-13 Alder Ln Inter.															220
FS-14 Urban Ave															70
FS-15 Freeway Dr															240
FS-16 West Mount Vernon															150
FS-17 Central CSO Regulator	30														
CS-1 Snoqualmie	20														
CS-2 1115 N. 8th	20														
CS-3 S. 7th	20														
CS-4 N 6th	20														
CS-5 Brick Hill	30														
CS-6 Blodgett Rd	20														
CS-7 Kincaid	20														
CS-8 S 20th	20														
CS-9 Section	50														

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CS-10 Douglas/ Walter Alley	75														
CS-11 107 Cedar	45														
CS-12 N 6th	60														
CS-13 Section	5														
CS-14 Broadway	20														
CS-15 Broad St	20														
CS-16 and CS-31 Interstate 5[4]				750											
CS-17 Division Alley	5														
CS-18 Bernice	5														
CS-20 Lawrence	5														
CS-21 1224 12th S	25														
CS-22, CS-23 and CS-29 8th St Improvements			1,00 0												
CS-25 Carpenter Alley	5														

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CS-26 1120 N 16th	5														
CS-27 1210 N 14th	5														
CS-28 8th	5														
CS-32 N 1st	5														
CS-34 Christenson Seed West	5														
CS-35 Cleveland	20														
CS-40 Lind St	5														
Total	570	635	1,00 0	750	620	0	0	0	0	0	0	0	0	0	2,510

1. ENR Construction Cost Index 6397, October 2001.
2. Costs for the I-5 improvements have been estimated at $750,000 for all crossings. Actual cost estimates will vary depending upon the required improvements after all the crossing have been evaluated. See Chapter 5 for additional details..

Table 11-4 Summary of Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	>2015
Wastewater Treatment Facility	0	350	1,200	11,940	0	0	0	0	7,000	0	0	0	1,900	0	900
CSO Treatment													9,100		
Collection System	570	635	1,000	750	620	0	0	0	0	0	0	0	0	0	2,510
Total	570	985	2,200	12,690	620	0	0	0	7,000	0	0	0	11,000	0	3,410

1. ENR Construction Cost Index 6397, October 2001.

Copies of Figures No. 3-1, 5-1, 5-2, and 5-3 can be viewed at the CEDD Department. Copies were not made of these maps because they are oversized maps.

City of Mount Vernon

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DEPT OF ECOLOGY

City of Mount Vernon
Comprehensive Sewer Plan Amendment

April 2004

APPROVED
DEPARTMENT OF ECOLOGY
ENGINEERING MANAGEMENT
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DATE 8/18/05

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CITY OF MOUNT VERNON, WASHINGTON

COMPREHENSIVE SEWER PLAN AMENDMENT

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Date:	**April 22, 2004**
Subject:	**Comprehensive Sewer Plan Amendment**
Project Number:	**09637-006070**

1.0 BACKGROUND

After the latest update to the Mount Vernon Comprehensive Sewer Plan (CSP) was approved by the Washington Department of Ecology (Ecology) in February 2003, the City of Mount Vernon requested that HDR further refine the upgrade concept proposed in the CSP.

The following guidelines were used when refining the upgrade concept:

- Minimize impact on the operations of the existing plant during upgrade construction
- Investigate the feasibility of incorporating new and emerging technologies that could improve treatment efficiencies and reliability
- Explore potential cost savings

Three configurations and several new technologies were investigated as described in the *Alternative Facility Concepts and Layouts* technical memorandum issued in July 2003. The recommendations of this study formed the basis for further evaluation. The feasibility was explored for treating peak storm flows with an innovative high rate clarification process in conjunction with the preferred modified treatment configuration. High rate clarification (HRC) has gained acceptance recently as an effective means of treating peak storm flows and minimizing combined sewer overflows (CSOs). HRC has been accepted as more municipalities pilot test the technology with promising results and as more full-scale facilities are installed throughout the country. This proposed modified treatment scheme fits into and further improves the overall long-term vision of the City of Mount Vernon as originally proposed in the 1991 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan (the 1991 Plan). A separate technical memorandum summarizing the performance of the HRC process during pilot studies in the Pacific Northwest and other parts of the country was issued in November 2003. This technical memorandum is attached as Appendix A.

Subsequent correspondence and meetings with Ecology resulted in conceptual agreement by Ecology for the use of HRC treatment for flows above the maximum month level. Letters to Ecology from the City of Mount Vernon on this issue and related meeting minutes are attached as Appendix B.

A public hearing was held on January 30, 2004 to inform the public about the modified treatment scheme, which would result in an amendment to the City Comprehensive Plan. A copy of the public hearing notice and the project narrative are included as Appendix C.

The purpose of this technical memorandum is to document proposed changes to the upgrade concept for the primary and secondary liquid-stream treatment processes at the City of Mount Vernon Wastewater Treatment Plant. This memorandum focuses on HRC as a new technology and its associated benefits to the City of Mount Vernon.

1.1 Sections Affected in the Comprehensive Sewer Plan Update

The following sections in the February 2003 Comprehensive Sewer Plan are affected by this amendment:

- The 'Combined Sewer Overflow' section, 'Wastewater Treatment Facility Improvements' section, Figure ES-1, Table ES-1, and Table ES-4 of the Executive Summary
- The 'Projected Flows and Loads' section, and Tables 3-5 through 3-9 of Chapter 3 – Basic Planning Data
- The 'Recommended CSO Reduction Alternative' section, Table 4-4 and Table 4-5 of Chapter 4 – Combined Sewer System
- The 'Capacity Analysis' section, Tables 8-3 through 8-5 of Chapter 8 – Wastewater Treatment Plant Analysis
- The 'Primary Clarifiers' section, the 'Activated Sludge Process' section, Figure 10-1, Figure 10-2, and Table 10-1 of Chapter 10 – Recommended WWTP Alternatives
- Table 11-1 and Table 11-2 of Chapter 11 – Capital Improvement Plan

2.0 REVISED PROJECTED FLOWS AND LOADS

Projected flows and loads developed in the CSP were further refined during the Predesign Phase based on recent growth rate. The refined projected flows and loads values served to provide the basis of a BIOWIN computer simulation, to allow further evaluation of the treatment process capacity, and to provide a means of evaluating upgrade options. This section replaces the 'Projected Flows and Loads' section and Tables 3-5 through 3-9 of Chapter 3 – Basic Planning Data of the CSP.

2.1 Revised Projected Flow

Table 1 shows the revised projected flow.

Table 1: Revised Projected Flow (New CSP Table 3-5)

	2010	2015	2020	Build-Out
Average Wet Weather Flow, mgd	4.35	5.14	6.07	10.50
Maximum Month Average Design Flow, mgd	7.26	8.57	10.14	17.80
Peak Daily Flow, mgd	11.40	13.47	15.90	26.78
Peak Hour Flow, mgd	17.00	25.90	25.90	45.10

2.2 Revised Projected Loads

Tables 2 through 4 show the revised projected biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia loads, respectively.

Table 2: Revised Projected Biochemical Oxygen Demand (BOD) Loads (New CSP Table 3-6)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	6,566	7,759	9,163	15,850
Maximum Month, lb/d	8,356	9,863	11,670	20,486
Peak Daily Flow, lb/d	14,261	16,847	19,895	33,502
Peak Hour Flow, lb/d	14,261	16,847	19,895	33,502

Table 3: Revised Projected Total Suspended Solids (TSS) Loads (New CSP Table 3-7)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	6,240	7,373	8,707	15,062
Maximum Month, lb/d	8,840	10,435	12,347	21,674
Peak Daily Flow, lb/d	13,501	15,948	18,834	31,715
Peak Hour Flow, lb/d	13,501	15,948	18,834	31,715

Table 4: Revised Projected Ammonia Loads (New CSP Table 3-8)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	762	900	1,063	1,839
Maximum Month, lb/d	951	1,122	1,328	2,331
Peak Daily Flow, lb/d	1,046	1,235	1,459	2,456
Peak Hour Flow, lb/d	1,046	1,235	1,459	2,456

3.0 MODIFICATION TO CSO REDUCTION PLAN

This section replaces The 'Recommended CSO Reduction Alternative' section, Table 4-4 and Table 4-5 of Chapter 4 – Combined Sewer System in the CSP.

3.1 Long-Term Vision of CSO Reduction Plan

On April 11, 1996, an Order on Consent was issued by the Washington Department of Ecology and signed by the City of Mount Vernon to implement the vision of the CSO Reduction Plan. The vision of the CSO Reduction Plan is to provide a combination of storage facilities and peak storm flow treatment facilities to achieve the greatest reasonable reduction of CSOs. This means limiting the frequency of untreated CSOs to an average of no more than one per year, per requirement of Chapter 90.48.480 of the Revised Code of Washington (RCW).

The CSO Reduction Plan proposed in the 1991 Plan consisted of a 3-phase approach. In Phase 1, it was proposed that inline storage be provided for CSO flows that would have been discharged to the Skagit River. Stored CSO flows are conveyed to the wastewater treatment plant (WWTP) for treatment and disposal as capacity allows. The City concluded Phase 1 of the CSO Reduction Plan when the Central CSO Regulator was completed and put online in December 1997. The Central CSO Regulator has a volume of close to 1 million gallons and the storage capacity ranges between 0.6 and 0.8 million gallons, depending on the volume used in conveyance of storm flow. Installation of the Central CSO Regulator was projected to reduce overflows to 12 events per year; however, the overflows event from 1998 to 2003 has averaged 8 per year.

Phase 2 of the originally proposed CSO Reduction Plan consists of upgrading the WWTP treatment capacity to accommodate the combined maximum conveyance capacity (25.8 mgd) of the Hazel Street Interceptor and the West Mount Vernon Pump Station. A total of 18.3 mgd would receive full secondary treatment after building of new aeration basins, while 7.5 mgd of peak storm flow would be treated separately in a CSO clarifier. The existing primary clarifier would be converted to a CSO clarifier after new primary clarifiers are constructed upstream of the upgraded secondary treatment units. Details of the original CSO and WWTP secondary treatment upgrade are discussed in Section 3.2 and Section 4.1, respectively.

Innovative HRC technology for treating peak storm flows has recently matured, and the Central CSO Regulator has been successful in reducing CSOs to a level beyond the original expectation. In light of these factors, the CSP amendment seeks to implement this technology at Phase 2 with the goal of successfully reducing CSOs to less than one untreated event per year during this phase. By maximizing capacity of the existing aeration basin and utilizing the enhanced performance of two proposed 6 mgd HRC units, it would be possible to achieve a lower pollutant loading to the Skagit River with the revised treatment scheme. Details of the proposed changes to the CSO upgrades, proposed changes to the WWTP secondary treatment upgrades, and mass balance analyses are presented in Section 3.3, Section 4.2, and Section 5.0, respectively.

It was proposed in the 2003 Comprehensive Sewer Plan Update that HRC technology be implemented during Phase 3 to increase the combined treatment capacity of the WWTP to 48 mgd; this would reduce CSOs to less than one untreated event per year. Depending on the performance of the revised Phase 2 upgrade, the number and capacities of extra HRC units may be further revised in the future. At present, it is proposed that two more 6-mgd HRC units be installed, bringing the total to four units with a total HRC capacity of 24 mgd.

Monitoring the performance of the Central CSO Regulator system through 2010 will provide an additional six years of flow data. The data collected will be used to further refine the CSO compliance alternative and optimize the ultimate execution of the Phase 2 and Phase 3 CSO Reduction Plan.

3.2 CSO Reduction Plan Improvement Proposed in the Comprehensive Sewer Plan

In the February 2003 Comprehensive Sewer Plan Update, the following upgrades were proposed for installation between 2004 and 2009:

- The Influent Pump Station would be upgraded to handle a flow of 24 mgd. The West Mount Vernon Pump Station would be upgraded to handle a flow of 1.8 mgd. The peak flow to the wastewater treatment plant would be 25.8 mgd.
- The new headworks (fine screens and degritting) would be sized to handle the combined peak flow of 25.8 mgd.
- Two new 75-foot-diameter primary clarifiers would be built to handle a peak flow of 9.2 mgd each (18.3 mgd total). The primary effluent would then be treated by the upgraded secondary treatment process (18.3 mgd capacity).
- The existing primary clarifier would be converted to a CSO clarifier for CSO treatment via the internal shunt mechanism to treat the remaining 7.5 mgd flow that would not be treated by secondary treatment.
- Effluent from the secondary treatment process (18.3 mgd) and the CSO clarifier (7.5 mgd) would be blended at the disinfection facility for disinfection and disposal via a common outfall.

The following upgrades were proposed for the next and final phase of the CSO Reduction Plan in 2013, as described in Chapter 4 of the Comprehensive Sewer Plan Update:

- Park Street Pump Station would be upgraded to separately convey CSO and storm flow.
- CSOs would be pumped to the WWTP via a new CSO force main to a new HRC system for treatment. The proposed peak hour HRC treatment capacity was 22.2 mgd.
- The HRC effluent would be disinfected by an ultraviolet (UV) disinfection system and pumped to the treatment plant outfall for final disposal.

3.3 Proposed Modification to CSO Reduction Plan Improvement

The following modifications to the CSO Reduction Plan were proposed:

- Two 6 mgd HRC modules would be installed at the WWTP to handle flows above the maximum capacity of the secondary treatment process. It is proposed that the HRC modules be installed prior to January 1, 2015. The combined treatment capacity of the upgraded system would be sufficient to handle the projected 2020 peak hour flow of 25.9 mgd.

- The HRC effluent would be disinfected and blended with the disinfected secondary effluent before final disposal via the treatment plant outfall.
- Beyond 2020, two more HRC modules could be installed at the WWTP, together with other improvements in the liquid-stream treatment, to provide a combined treatment capacity sufficient to handle the projected build-out peak hour flow of 45.1 mgd.

4.0 MODIFICATIONS TO LIQUID-STREAM TREATMENT UPGRADE

This section replaces the following sections in the CSP: the 'Primary Clarifiers' section, the 'Activated Sludge Process' section, Figure 10-1, Figure 10-2, and Table 10-1 of Chapter 10 – Recommended WWTP Alternatives.

4.1 Liquid-Stream Treatment Upgrade Proposed in the Comprehensive Sewer Plan

The upgrades to the Influent Pump Station, West Mount Vernon Pump Station, headworks, and primary treatment proposed in the February 2003 Comprehensive Sewer Plan Update were summarized in Section 3.1. Proposed improvements to the secondary treatment process include:

- New selector basins for filament control would be added in two phases. The selector basins would be operated in aerobic mode in the first phase to accommodate the non-nitrifying mode of the plant. In the second phase, additional tanks would be installed and the selector basins would be operated in anoxic mode to accommodate the anticipated nitrifying mode of the plant.
- The existing 0.5 million gallon Aeration Basin No. 4 would be used for secondary treatment instead of for waste activated sludge (WAS) storage.
- The existing coarse bubble diffusers would be replaced with fine bubble membrane disc diffusers to improve aeration efficiency.
- An additional 1.2 million gallons of aeration basin tankage would be added in the second phase improvement. This would allow the secondary treatment to achieve full nitrification, reducing the occasional ammonia peak from solids treatment internal recycle, and thus complying with the discharge permit requirement.
- The existing Secondary Clarifier No. 1 would be taken offline and would be converted to WAS storage.
- Two new 85 foot diameter clarifiers and distribution structure would be added by 2010. A third new 85 foot diameter clarifier would be added by 2020.

4.2 Proposed Modification to Liquid-Stream Treatment Upgrade

Based on the revised projected flows and loads, several BIOWIN computer simulations were conducted to: (a) analyze existing secondary treatment system capacity, and (b) evaluate options for upgrading the existing secondary process to provide sufficient capacity for the projected future flows and loads.

The following changes are proposed:

- Sufficient fine-screen capacity would be installed to handle the projected 2020 peak hour flow of 25.9 mgd. An additional channel would be constructed for installation of a third screen to handle build-out peak flows.
- Flow splitting to HRC would be installed upstream of the degritting system. The high rate clarification process manufacturers indicate that degritting is not required upstream of the HRC.

- Degritting system capacity would be sized to match the maximum flow of 16.4 mgd to secondary treatment.
- Two new 80 foot diameter primary clarifiers would be constructed to handle maximum flow to secondary treatment.
- The internal recycle from solids treatment processes would be routed to the re-aeration zone of the aeration basin.
- The original coarse bubble diffusers were replaced with fine bubble membrane disc diffusers in December 2002.
- An interim change was made in operation of the treatment plant in mid June, 2003. Aeration Basin 4 has been converted from WAS storage to an anoxic zone and the secondary treatment process is operated in the Modified Ludzack Ettinger (MLE) mode for nitrification and denitrification. Aeration Basin 1 is currently being used as WAS storage instead of Basin 4. In the proposed upgrade, Aeration Basin 1 will be divided into a re-aeration basin and anoxic basin. The re-aeration basin is designed to handle the periodic ammonia loading spikes from the solids treatment internal recycle and to maintain the effluent ammonia level within the discharge permit requirement. Basins 2 through 4 will be used as aerobic basins. Between 2020 and build-out, space will be allocated for an additional aeration basin.
- Based on the results of the BIOWIN computer simulations, the maximum capacity of the existing aeration basin, with the Aeration Basin No. 4 back in operation, was estimated to be sufficient to treat the projected 2020 peak day flow of 15.9 mgd and 0.5 mgd of internal recycle flow from solids treatment processes. Flow above this level (16.4 mgd) would be diverted to the HRC system for enhanced primary treatment.
- The new 1.2 million gallon aeration basin would be delayed until after Phase 2 and would be designed at a later date to handle the projected build-out peak day flow.
- Two new 85 foot diameter secondary clarifiers would be installed by 2015. Of the two existing secondary clarifiers, the peripheral feed Secondary Clarifier No. 1 would be removed from service. A total of three (two new and one existing) would be in service by 2015. Space for two more 85 foot diameter secondary clarifiers would be allocated for the build-out scenario to bring the total number of clarifiers in operation to five.

5.0 REVISED MASS BALANCES

Mass balances were prepared based on the results of the BIOWIN computer simulations. The mass balances compared the amount of projected pollutants discharged into the Skagit River by: (a) the CSP-proposed treatment scheme, and (b) the modified treatment scheme proposed in the CSP amendment. The years compared were 2005, 2010, 2015, and 2020. The revised flow projection indicates that re-routing of excess peak flow around primary treatment units and the secondary biological treatment unit would occur under the peak hour flow scenarios in 2015 and 2020. Results of mass balances for these two scenarios for both treatment schemes are presented in Figure 1 and Figure 2.

The following assumptions were used in preparing the mass balances:

- The CSP treatment scheme could treat up to 18.3 mgd of peak hour flow before re-routing is needed. Excess peak flow above 18.3 mgd would be re-routed to a dedicated CSO clarifier for primary treatment. Secondary effluent would be blended with the CSO clarifier effluent before discharge.
- The treatment scheme proposed in the amendment could treat up to 16.4 mgd of peak hour flow before re-routing is needed. Excess peak flow above 16.4 mgd would be re-routed to a dedicated HRC for enhanced primary treatment. Secondary effluent would be blended with the HRC effluent before discharge.
- The primary clarifier is anticipated to have a BOD removal efficiency of 35 percent, a TSS removal efficiency of 55 percent, and an ammonium (NH_4) removal efficiency of 0 percent.
- The CSO clarifier originally proposed in the CSP is anticipated to have the same performance as the primary clarifier (35 percent BOD removal, 55 percent TSS removal, and 0 percent NH4 removal).
- The high rate clarifier is anticipated to have an enhanced BOD removal efficiency of 60 percent, an enhanced TSS removal efficiency of 80 percent, and an NH_4 removal efficiency of 0 percent.
- Both the secondary biological treatment unit in the CSP treatment scheme and the secondary biological treatment unit in the amendment treatment scheme are anticipated to produce an effluent with 10 milligrams per liter (mg/L) of BOD, 15 mg/L of TSS, and 4 mg/L of NH_4, based on BIOWIN computer simulation results.

As shown in Figure 1 and Figure 2, the amendment treatment scheme is anticipated to discharge significantly lower BOD (979 lb/d in 2015 and 1,141 lb/d in 2020) and TSS (1,247 lb/d and 1,442 lb/d in 2020) loadings, and a similar amount (within 30 lb/d difference in 2015 and 2020) of NH_4 loading into the Skagit River as compared with the CSP treatment scheme. The effluent qualities of either treatment scheme would satisfy the anticipated future National Pollutant Discharge Elimination System (NPDES) requirement. However, the amendment treatment scheme would provide a net positive environmental benefit over the CSP treatment scheme based on the results of the mass balance analyses.

Figure 1: Amendment Option

Influent		2015	2020
Flow	mgd	25.90	25.90
BOD Load	lb/d	16847	19895
BOD Conc	mg/L	78.0	92.1
TSS Load	lb/d	15948	18834
TSS Conc	mg/L	73.8	87.2
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.7	6.8

Plant Drain Recycle		2015	2020
Flow	mgd	0.51	0.61
BOD Load	lb/d	233	275
BOD Conc	mg/L	54.3	54.3
TSS Load	lb/d	221	261
TSS Conc	mg/L	51.6	51.6
NH4 Load	lb/d	0	0
NH4 Conc	mg/L	0.0	0.0

Influent + Solids Treatment Recycle		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	17080	20170
BOD Conc	mg/L	77.5	91.2
TSS Load	lb/d	16170	19095
TSS Conc	mg/L	73.4	86.4
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.6	6.6

1° Clarification		2015	2020
Flow	mgd	16.40	16.40
Inf BOD	lb/d	10605	12479
	mg/L	77.5	91.2
Eff BOD	lb/d	6893	8112
	mg/L	50.4	59.3
Inf TSS	lb/d	10039	11814
	mg/L	73.4	86.4
Eff TSS	lb/d	4518	5316
	mg/L	33.0	38.9
Inf NH4	lb/d	767	903
	mg/L	5.6	6.6
Eff NH4	lb/d	767	903
	mg/L	5.6	6.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%

ACTIFLO High Rate Clarification		2015	2020
Flow	mgd	10.01	10.11
Inf BOD	lb/d	6475	7691
	mg/L	77.5	91.2
Eff BOD	lb/d	2590	3076
	mg/L	31.0	36.5
Inf TSS	lb/d	6130	7281
	mg/L	73.4	86.4
Eff TSS	lb/d	1226	1456
	mg/L	14.7	17.3
Inf NH4	lb/d	468	556
	mg/L	5.6	6.6
Eff NH4	lb/d	468	556
	mg/L	5.6	6.6
Efficiencies			
BOD	%	60%	60%
TSS	%	80%	80%
NH4	%	0%	0%
Vs CSP Treated CSO Effluent			
BOD	lb/d	-820	-983
TSS	lb/d	-1009	-1204
NH4	lb/d	34	39

Dewatering Filtrate Recycle		2015	2020
Flow	mgd	0.00	0.00
BOD Load	lb/d	0	0
BOD Conc	mg/L	NA	NA
TSS Load	lb/d	0	0
TSS Conc	mg/L	NA	NA
NH4 Load	lb/d	180	213
NH4 Conc	mg/L	NA	NA

Reaeration		2015	2020
Flow	mgd	0.00	0.00
Inf BOD	lb/d	0	0
	mg/L	NA	NA
Eff BOD	lb/d	0	0
	mg/L	NA	NA
Inf TSS	lb/d	0	0
	mg/L	NA	NA
Eff TSS	lb/d	0	0
	mg/L	NA	NA
Inf NH4	lb/d	180	213
	mg/L	NA	NA
Eff NH4	lb/d	18	21
	mg/L	NA	NA
Efficiencies			
BOD	%	NA	NA
TSS	%	NA	NA
NH4	%	90%	90%

Activated Sludge		2015	2020
Flow	mgd	16.40	16.40
Inf BOD	lb/d	6893	8112
	mg/L	50.4	59.3
Eff BOD	lb/d	1368	1368
	mg/L	10.0	10.0
Inf TSS	lb/d	4518	5316
	mg/L	33.0	38.9
Eff TSS	lb/d	2052	2052
	mg/L	15.0	15.0
Inf NH4	lb/d	785	924
	mg/L	5.7	6.8
Eff NH4	lb/d	547	547
	mg/L	4.0	4.0
Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	30%	41%
Applied to Secondary			
BOD	lb/d	6893	8112
TSS	lb/d	4518	5316
NH4	lb/d	947	1115
Removed by Secondary			
BOD	lb/d	5525	6744
TSS	lb/d	2466	3265
NH4	lb/d	400	568
Overall Secondary Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	42%	51%
Vs CSP Secondary Effluent			
BOD	lb/d	-158	-158
TSS	lb/d	-238	-238
NH4	lb/d	-63	-63

Blended Effluent		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	3958	4444
BOD Conc	mg/L	18.0	20.1
TSS Load	lb/d	3278	3508
TSS Conc	mg/L	14.9	15.9
NH4 Load	lb/d	1015	1103
NH4 Conc	mg/L	4.6	5.0
Total Applied			
BOD	lb/d	17080	20170
TSS	lb/d	16170	19095
NH4	lb/d	1415	1672
Total Removed			
BOD	lb/d	13122	15726
TSS	lb/d	12892	15587
NH4	lb/d	400	568
Total Efficiencies			
BOD	%	77%	78%
TSS	%	80%	82%
NH4	%	28%	34%
Vs CSP Blended Effluent			
BOD	lb/d	-979	-1141
TSS	lb/d	-1247	-1442
NH4	lb/d	-30	-25

Figure 2: CSP Option

Influent		2015	2020
Flow	mgd	25.90	25.90
BOD Load	lb/d	16847	19895
BOD Conc	mg/L	78.0	92.1
TSS Load	lb/d	15948	18834
TSS Conc	mg/L	73.8	87.2
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.7	6.8

Plant Drain Recycle		2015	2020
Flow	mgd	0.51	0.61
BOD Load	lb/d	233	275
BOD Conc	mg/L	54.3	54.3
TSS Load	lb/d	221	261
TSS Conc	mg/L	51.6	51.6
NH4 Load	lb/d	180	213
NH4 Conc	mg/L	42.0	42.0

Influent + Solids Treatment Recycle		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	17080	20170
BOD Conc	mg/L	77.5	91.2
TSS Load	lb/d	16170	19095
TSS Conc	mg/L	73.4	86.4
NH4 Load	lb/d	1415	1672
NH4 Conc	mg/L	6.4	7.6

1° Clarification		2015	2020
Flow	mgd	18.30	18.30
Inf BOD	lb/d	11833	13925
	mg/L	77.5	91.2
Eff BOD	lb/d	7692	9051
	mg/L	50.4	59.3
Inf TSS	lb/d	11203	13183
	mg/L	73.4	86.4
Eff TSS	lb/d	5041	5932
	mg/L	33.0	38.9
Inf NH4	lb/d	981	1154
	mg/L	6.4	7.6
Eff NH4	lb/d	981	1154
	mg/L	6.4	7.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%

CSO Clarification		2015	2020
Flow	mgd	8.11	8.21
Inf BOD	lb/d	5247	6245
	mg/L	77.5	91.2
Eff BOD	lb/d	3410	4059
	mg/L	50.4	59.3
Inf TSS	lb/d	4967	5912
	mg/L	73.4	86.4
Eff TSS	lb/d	2235	2660
	mg/L	33.0	68.9
Inf NH4	lb/d	435	518
	mg/L	6.4	7.6
Eff NH4	lb/d	435	518
	mg/L	6.4	7.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%
Vs Amendment ACTIFLO Effluent			
BOD	lb/d	820	983
TSS	lb/d	1009	1204
NH4	lb/d	-34	-39

Activated Sludge		2015	2020
Flow	mgd	18.30	18.30
Inf BOD	lb/d	7692	9051
	mg/L	50.4	59.3
Eff BOD	lb/d	1526	1526
	mg/L	10.0	10.0
Inf TSS	lb/d	5041	5932
	mg/L	33.0	38.9
Eff TSS	lb/d	2289	2289
	mg/L	15.0	15.0
Inf NH4	lb/d	981	1154
	mg/L	6.4	7.6
Eff NH4	lb/d	610	610
	mg/L	4.0	4.0
Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	38%	47%
Applied to Secondary			
BOD	lb/d	7692	9051
TSS	lb/d	5041	5932
NH4	lb/d	981	1154
Removed by Secondary			
BOD	lb/d	6165	7525
TSS	lb/d	2752	3643
NH4	lb/d	370	544
Overall Secondary Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	38%	47%
Vs Amendment Secondary Effluent			
BOD	lb/d	158	158
TSS	lb/d	238	238
NH4	lb/d	63	63

Blended Effluent		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	4937	5585
BOD Conc	mg/L	22.4	25.3
TSS Load	lb/d	4525	4950
TSS Conc	mg/L	20.5	22.4
NH4 Load	lb/d	1045	1128
NH4 Conc	mg/L	4.7	5.1
Total Applied			
BOD	lb/d	17080	20170
TSS	lb/d	16170	19095
NH4	lb/d	1415	1672
Total Removed			
BOD	lb/d	12143	14585
TSS	lb/d	11645	14145
NH4	lb/d	370	544
Total Efficiencies			
BOD	%	71%	72%
TSS	%	72%	74%
NH4	%	26%	33%
Vs Amendment Blended Effluent			
BOD	lb/d	979	1141
TSS	lb/d	1247	1442
NH4	lb/d	30	25

6.0 CONCLUSIONS

The Comprehensive Sewer Plan Amendment seeks to include an HRC option to treat peak storm flow at the WWTP. The capacity of the existing aeration basin would be maximized to provide peak flow capacity of 16.4 mgd for full secondary treatment, without construction of new aeration basins.

Based on results of the BIOWIN computer simulation using the revised flow projections, it is anticipated that the small reduction (1.9 mgd) in full secondary treatment capacity is more than compensated by the additional HRC capacity of 12 MGD and the enhanced treatment efficiency of the HRC technology over the conventional primary-type CSO clarifier described in the original proposal.

The amendment treatment scheme is anticipated to discharge significantly lower BOD (979 lb/d in 2015 and 1,141 lb/d in 2020) and TSS (1,247 lb/d and 1,442 lb/d in 2020) loadings, and a similar amount (within 30 lb/d difference in 2015 and 2020) of NH_4 loading into the Skagit River as compared with the CSP treatment scheme. The effluent qualities of either treatment scheme would satisfy the anticipated future National Pollutant Discharge Elimination System (NPDES) requirement. However, the amendment treatment scheme would provide a net positive environmental benefit over the CSP treatment scheme based on the results of the mass balance analyses.

The City would also be prudent to continue to monitor the performance of the Central CSO Regulator system through 2010 to provide an additional six years of flow data. The data collected will be used to further refine the CSO compliance alternative and optimize the ultimate execution of the Phase 2 and Phase 3 CSO Reduction Plan.

APPENDIX A

Alternative Peak Flow Treatment

CITY OF MOUNT VERNON, WASHINGTON

WASTEWATER TREAMENT PLANT UPGRADE

PREDESIGN TECHNICAL MEMORANDUM

Prepared by:	Kenneth Hui, PE
Reviewed by:	Dan Olson, PE John Koch, PE
Date:	November 2003
Subject:	High Rate Clarification Pilot Testing Performance Summary
Project Number:	09637-006070

1.0 INTRODUCTION

Full-scale high rate clarification (HRC) systems for treatment of combined sewer overflows (CSOs) or sanitary sewer overflows (SSOs) have been installed in various parts of the country. The two major players in HRC systems are USFilter (Actiflo® system) and Ondeo (DensaDeg® system). A selected installation list of full-scale HRC systems in North America is shown in the appendix.

Five cities or counties in Washington and Oregon have conducted pilot studies of one or both types of HRC systems in the past five years. Summaries of these pilot studies are included in the appendix. Pilot study performances conducted across the United States are also included in the appendix as summary tables.

At present, there is one full-scale HRC system in Bremerton, Washington. It has been in operation since 2002.

Table 1 shows the performance summary of HRC pilot studies conducted in the Pacific Northwest.

Table 1: Performance Summary of HRC Pilot Studies in the Pacific Northwest

Location	HRC Unit	Coagulant	Dosage (mg/L)	Eff TBOD (mg/L)	% Removal	Eff TSS (mg/L)	% Removal	Startup Time to Steady State	Overflow Rate (gpm/sf)
Bremerton	A	Ferric Chloride	15 to 45	47	63%	9	71%	10 min to 5 NTU	55
King County	A	Ferric Chloride	110	48	78%	15	94%	10 to 15 min	60
		PACl	34	51	63%	11	96%		60
		Alum	110	45	74%	11	94%		60
Salem	A	Ferric Chloride	40 to 50	NA	NA	NA	>85%	<20[a]	80
		PACl	20	NA	NA	NA	NA		NA
		Alum	80	NA	NA	NA	85%		30
		ACH	20	NA	NA	NA	90%	<10[a]	100
Tacoma	A	Ferric Chloride	100	112	62%	6	98%	10 to 15 min	60
		PACl	45	31	70%	17	87%		60
Portland	A	Ferric Chloride	58	141	41%	5.2	97%	20 min	20
		Alum	120	210	36%	6	96%		40

Location	HRC Unit	Coagulant	Dosage (mg/L)	Eff TBOD (mg/L)	% Removal	Eff TSS (mg/L)	% Removal	Startup Time to Steady State	Overflow Rate (gpm/sf)
Bremerton	D	Ferric Chloride	60	167	61%	21	85%	75 to 95 min to 5 NTU	20 to 30
King County	D	Ferric Chloride	40	NA	NA	11	96%	20 to 55 min	30
		PACl	40	206[b]	57%	41	81%		30
		Alum	60	250[b]	71%	54	87%		30
Salem	D	Ferric Chloride	40	NA	59%	NA	87%		30 to 40
		PACl	30	NA	59%	NA	87%		30 to 40
		Alum	60	NA	59%	NA	87%		30 to 40
		ACH	15	NA	59%	NA	87%	1.5 to 2 hours	30 to 40

Legend: A = ACTIFLO;D = DensaDeg

Note a: Overflow rate not specified for start up test

Note b: COD Value

APPENDIX:

High Rate Clarification

Selected Installation List and Summaries of Pilot Studies

SUMMARIES OF HIGH RATE CLARIFICATION PILOT STUDIES

EXECUTIVE SUMMARY

- Five cities or counties in the Pacific Northwest have experience in pilot testing high rate clarification (Actiflo® and/or DensaDeg® system) in the past five years. They are: the City of Portland, Oregon; City of Tacoma, Washington; City of Salem, Oregon; City of Bremerton, Washington; and King County, Washington.
- In studies where both technologies were tested, effluent qualities from Actiflo® and DensaDeg® were similar.
- Actiflo® could achieve a similar level of treatment at twice the surface overflow rate of DensaDeg® (60 to 80 gpm/ft^2 for Actiflo® and 30 to 40 gpm/ft^2 for DensaDeg®). The size of a similar-capacity Actiflo® system could be half that of a DensaDeg® system.
- In the King County pilot study, DensaDeg® required less ferric and less alum as coagulant than was required by the Actiflo® system treating similar influent. Polyaluminum chloride (PACl) dosages for both systems were similar.
- In the City of Salem pilot study, DensaDeg® and Actiflo® required similar dosages in all four coagulants tested (ferric, alum, PACl, and aluminum chlorhydrate).
- DensaDeg® utilizes recycled sludge as ballast to accelerate settling. Actiflo® requires micro-sand as ballast to accelerate settling.
- Actiflo® produces a dilute sludge stream. The result of the King County study indicated that the sludge from the Actiflo® pilot plant had a solids concentration of approximately 0.6 percent. DensaDeg® produces a thickened sludge stream. The result of the Bremerton study indicated that the sludge from the DensaDeg® pilot plant had a solids concentration of 2 percent. If sludge from high rate clarification is to be treated separately, Actiflo® sludge may require a gravity thickener before digestion or dewatering. However, if sludge from high rate clarification could be discharged back to the sewer for handling by remote facilities or back to the front end of the primary clarifier for handling by onsite facilities, then the thickening step may not be necessary for Actiflo®. DensaDeg® sludge requires lower degree of thickening.
- Actiflo® has a much shorter startup (both dry and wet) time than DensaDeg®. Results from five pilot studies showed that Actiflo® required 10 to 20 minutes for dry or wet start. Results from three pilot studies showed that DensaDeg® required 55 to 120 minutes for dry start, and 20 to 75 minutes for wet start.
- At present, there is one full-scale Actiflo® installation in the Pacific Northwest in Bremerton, Washington. There is no full-scale DensaDeg® installation in the Pacific Northwest.

FULL SCALE HIGH RATE CLARIFICATION PROCESS
NORTH AMERICAN SELECTED INSTALLATION LIST

Actiflo®

Treatment of Combined or Sanitary Sewer Overflows (CSO or SSO)

- St. Bernard, Louisiana, 10 mgd[1] (2001)
- Lawrence, Kansas, 40 mgd (2002)
- Bremerton, Washington, 10 mgd (2002)
- Fort Smith, Arizona, 31 mgd (2003)

Side Stream Treatment (Wastewater Treatment Application)

- Burlington, Canada, 5.8 mgd (2001)
- Santa Fe, California, 4 mgd (2002)

DensaDeg® (various models)

Primary Treatment

- Laval Station De Lapiniere, Quebec, Canada, 160 mgd (1998)
- Beloeil, Quebec, Canada, 15 mgd (1997)
- Saint-Jean Sur Richelieu, Quebec, Canada, 31 mgd (1996)
- Repentigny, Quebec, Canada, 14 mgd (1996)
- Saint-Eustache, Quebec, Canada, 14 mgd (1991)
- Sherbrooke, Quebec, Canada, 38 mgd (1988 to 1991)
- Puebla Station De Barranca Del Conde, Mexico, 11 mgd (2001)
- Puebla Station De San Francisco, Mexico, 34 mgd (2001)
- Puebla Station D' Atoyac Sur, Mexico, 14 mgd (2001)
- Puebla Station D' Alseseca Sur, Mexico, 23 mgd (2001)
- Breckenridge, Colorado, 2 mgd (1998)

[1] million gallons per day

BREMERTON Actiflo® HIGH RATE CLARIFICATION PROCESS
PILOT TESTING SUMMARY – CDM, FEBRUARY 2000

Pilot Test Information:

Duration:	December 8, 1999 to December 16, 1999
Test Flow:	320 gallons per minute (gpm)
Test Overflow Rate:	55 gallons per minute per square foot (gpm/ft^2)
Polymer Type:	Unknown
Polymer Dosage:	0.5 to 1.0 milligrams per liter (mg/L)
Coagulant Type:	Ferric chloride
Coagulant Dosage:	15 to 45 mg/L
Startup Time to Peak Efficiency:	10 minutes to reach 5 NTU (5 minutes to reach 15 NTU)

Performance:

Parameters	Influent	Effluent	Removal (percent)
Turbidity, Nephelometric Turbidity Unit (NTU)	22	3	86
Total Suspended Solids (TSS), mg/L	31	9[a]	71
Total biochemical oxygen demand (TBOD), mg/L	127	47[b]	63
Soluble biochemical oxygen demand (SBOD), mg/L	70	38	46[b]
Insoluble biochemical oxygen demand (BOD), mg/L	57	9	84
Phosphorus, mg/L	2	0.1	95

[a] Bremerton Primary effluent TSS and BOD at 90 mg/L and 70 mg/L, respectively
[b] Probably due to removal of BOD in colloidal size range

Recommended Preliminary Design Criteria:

Initial Design Overflow Rate:	43 gpm/ft^2
Ultimate Design Overflow Rate:	60 gpm/ft^2

Note: The initial design overflow rate of 43 gpm/ft^2 will allow the unit to be operated at an overflow rate of up to 60 gpm/ft^2 in the future for higher treatment capacity without expanding the facility.

Department of Ecology (DOE) Comments on Pilot Study Report:

- The report needed to address why only one overflow rate of 55 gpm/ft^2 was selected for this pilot test.
- The report needed to justify how the recommended design overflow rate was selected and why the same unit would be expected to achieve the treatment goal at a higher overflow rate.
- The report needed to justify how a one-week short-term study could be valid for full-scale plant design.
- Whole effluent toxicity (WET), ammonia or fecal coliform test data were requested.

BREMERTON DensaDeg® HIGH RATE CLARIFICATION PROCESS
PILOT TESTING SUMMARY – ONDEO, MARCH TO APRIL 2000

Pilot Test Information:

Duration:	March to April 2000
Test Flow:	No Data
Test Overflow Rate:	20 to 30 gpm/ft^2
Sludge Recycle:	3 and 4 percent of influent flow
Polymer Type Tested:	LT 22S LT 27 (Percol 727) Erpac AS 47 Erpac AS 45 Cytec A100 Cytec 1596
Polymer Selected:	Percol 727 (ultra-high molecular weight, anionic, acrylamide polymer from Ciba Giegy)
Polymer Dosage:	2 mg/L
Coagulant Type:	Ferric chloride
Coagulant Dosage:	60 mg/L
Startup Time to Peak Efficiency:	Dry start at 55 minutes to reach 15 NTU (35 minutes to fill and 20 minutes to reach 15 NTU) Dry start at 95 minutes to reach 5 to 10 NTU (35 minutes to fill and 60 minutes to reach 5 to 10 NTU) Wet start at 40 minutes to reach 15 NTU Wet start at 75+ minutes to reach 5 to 10 NTU

Performance:

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	79	9	89
TSS, mg/L	147	21	85
TBOD, mg/L	437	167	61
SBOD, mg/L	127	92	28
Insoluble BOD, mg/L	310	75	76
Phosphorus, mg/L	No Data	No Data	No Data

KING COUNTY Actiflo® HIGH RATE CLARIFICATION PROCESS

PILOT TESTING SUMMARY – HDR, JUNE 2002

Pilot Test Information:

Duration:	August 27, 2001 to October 5, 2001
Test Flow:	310 to 350 gpm
Test Overflow Rate:	53.4 to 60.3 gpm/ft^2
Polymer Type Tested:	M155 anionic dry polymer by CIBA Specialty Chemical
	E700 cationic dry polymer by Polydyne
	AE1125 anionic liquid polymer by BetzDearborn
Polymer Selected:	M155 anionic dry polymer by CIBA Specialty Chemical
Polymer Dosage:	0.75 to 0.95 mg/L
Coagulant Type:	Ferric chloride
	PACI
	Alum
Coagulant Dosage:	60 to 110 mg/L ferric chloride
	17 to 34 mg/L PACI
	60 to 110 mg/L alum
Startup Time to Peak Efficiency:	Dry start at 15 minutes
	Wet start at 10 minutes

Ferric Chloride (110mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	148	4.9	97
TSS, mg/L	264	15	94
TBOD, mg/L	217	48	78
SBOD, mg/L	78	42	46
Insoluble BOD, mg/L	139	6	96
Total chemical oxygen demand (COD), mg/L	838	260	69
Phosphorus, mg/L	2.64	0.25	91

PACl (34 mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	166	2.7	98
TSS, mg/L	249	11	96
TBOD, mg/L	136	51	63
SBOD, mg/L	70	42	40
Insoluble BOD, mg/L	66	9	86
Total COD, mg/L	648	180	72
Phosphorus, mg/L	2.58	0.09	97

Alum (110 mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	123	3.7	97
TSS, mg/L	197	11	94
TBOD, mg/L	174	45	74
SBOD, mg/L	72	38	47
Insoluble BOD, mg/L	102	7	93
Total COD, mg/L	894	262	71
Phosphorus, mg/L	2.94	0.24	92

Recommended Preliminary Design Criteria

Injection Tank Detention Time:	1 min
Maturation Tank Detention Time:	3 min
Overflow Rate:	60 gpm/ft^2

Other Findings

- Estimated sand loss during the pilot study was 250 pounds per million gallons produced. According to the manufacturer, the pilot plant was not operated to minimize sand loss. Under full-scale optimal conditions, sand loss would be in the range of 8 to 12 pounds per million gallons of water treated.
- Sludge concentrations ranged between 3,900 and 8,020 mg/L. The overall average sludge concentration for all testing stages was 6,000 mg/L (0.6 percent). This concentration is considered to be dilute compared to conventional primary sludge, which is typically in the range of 20,000 to 40,000 mg/L (2 to 4 percent).

KING COUNTY DensaDeg® 4D HIGH RATE CLARIFICATION PROCESS PILOT TESTING SUMMARY – HDR, JUNE 2002

Pilot Test Information:

Duration:	October 22, 2001 to February 8, 2002
Test Flow:	86 to 215 gpm
Test Overflow Rate:	20 to 50 gpm/ft^2
Sludge Recycle:	3 and 5 percent of influent flow
Polymer Type Tested:	Magnafloc LT22S cationic high molecular weight dry polyacrylamides
	Nalco IC34 anionic high molecular weight emulsion polymer
Polymer Selected:	Nalco IC34
Polymer Dosage:	1.0 mg/L
Coagulant Type:	Ferric chloride
	PACl
	Alum
Coagulant Dosage:	10 to 60 mg/L ferric chloride
	10 to 60 mg/L PACl
	20 to 60 mg/L Alum
Startup Time to Peak Efficiency:	Dry start 55 minutes
	Wet start 20 minutes

Ferric Chloride (40 mg/L) Performance (1 mg/L Polymer) (30 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	88	4	96%
TSS, mg/L	258	11	96%
TBOD, mg/L	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	No Data	No Data	No Data
Phosphorus, mg/L	4.25	0.65	85%

PACl (40 mg/L) Performance (1 mg/L Polymer) (30 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	120	11	91%
TSS, mg/L	219	41	81%
TBOD, mg/L	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	484	206	57%
Phosphorus, mg/L	No Data	No Data	No Data

Alum Performance (1 mg/L polymer) (30 gpm/ft^2):

Parameters	Coag. Dose	Influent	Effluent	Removal
Turbidity, NTU	40 mg/L	96	9	90%
TSS, mg/L	60 mg/L	417[a]	54	87%
TBOD, mg/L	No Data	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data	No Data
Total COD, mg/L	60 mg/L	876	250	71%
Phosphorus, mg/L	40 mg/L	2.66	0.76	71%

[a] Based on test records, during an alum dose of 60 mg/L, the influent turbidity was only 40 NTU. It seems highly unusual to have a TSS of 417 mg/L with a turbidity of only 40 NTU. Also, during pilot testing of Actiflo®, the influent TSS concentration was in the range of 200 to 250 mg/L with corresponding turbidity of 120 to 170 NTU.

Recommended Preliminary Design Criteria:

Reaction Tank Detention Time:	7 minutes
Clarifier Detention Time:	10 minutes
Overflow Rate:	30 gpm/ft^2

Summary of Findings:

- The King County DensaDeg® 4D high rate clarification process pilot test protocol is organized differently from the King County Actiflo® high rate clarification process pilot test protocol. As a result, the pilot study results are presented differently. An attempt was made to summarize the DensaDeg® 4D performance with influent conditions as close as possible to the Actiflo® testing conditions. However, it was impossible to match all the influent conditions.
- In general, based on the recommended preliminary design criteria, the full-scale DensaDeg® 4D system will be two to three times larger in size than the corresponding Actiflo® system with the same treatment capacity.
- The dry start and wet start times for the DensaDeg® 4D system are estimated to be 3.7 times and 2 times higher than the corresponding start times for a similar Actiflo® system. In a side stream wet weather flow treatment scenario, the shorter startup time for the Actiflo® treatment process provides greater flexibility of operations.
- Using ferric chloride ($FeCl_3$) as a coagulant, the DensaDeg® 4D system has similar turbidity and TSS removal performance as the Actiflo® system, but a slightly lower phosphorus removal performance. There is no information on DensaDeg® 4D BOD and COD removal using $FeCl_3$ as coagulant. Optimum test $FeCl_3$ dosage for the DensaDeg® 4D system is approximately one-third of the optimum test dosage for Actiflo® system.
- Using PACl as a coagulant, the DensaDeg® 4D system has a lower (10 to 15 percent lower) performance in turbidity, TSS, and COD removal compared with the Actiflo® system at the **same dosage**. There is no information on DensaDeg® 4D BOD removal using PACl as a coagulant.
- Using alum as a coagulant, the DensaDeg® 4D system has about a 10 percent lower performance in turbidity removal at one-third the alum dosage compared with the Actiflo® system. DensaDeg® 4D TSS removal performance could not be compared accurately due to significantly different influent TSS concentrations. There is no DensaDeg® 4D BOD removal information. The DensaDeg® 4D system has similar COD removal performance as the Actiflo® system at about one-half of the alum dose. The DensaDeg® 4D system has a lower (20 percent lower) performance in phosphorus removal compared with the Actiflo® system at one-third the alum dose.
- Actiflo® produces a more dilute sludge stream than DensaDeg 4D®. There was no direct measurement of sludge information from DensaDeg® 4D during the pilot study.

PILOT TESTING OF Actiflo®, DensaDeg®, AND UV DISINFECTION
CITY OF SALEM, WILLOW LAKE WASTEWATER TREATMENT PLANT
SUMMARY – BRIAN MATSON, CAROLLO ENGINEERS, WEFTEC 2002

Background Information:

- The Willow Lake Wastewater Treatment Plant (WLTP) serves 200,000 people. It has a treatment capacity of 105 mgd. The conveyance system has a capacity of 155 mgd.
- Winter sanitary flow can peak at 300 mgd. The City is required to eliminate SSOs resulting from 5-year storm in winter and 10-year storm in summer by 2010.
- Investigate use of pretreatment, high rate clarification (HRC), and ultraviolet (UV) disinfection at peak excess flow treatment facilities (PEFTFs) remotely at existing SSO sites or at the WLTP.
- Two successive years of wet weather pilot testing at the WLTP for a total of 19 weeks of tests.
- Based on the results, the City is prepared to begin permitting and predesign efforts for a full-scale PEFTF that will treat up to 160 mgd of dilute wastewater at a point where SSOs are currently discharged.

Equipment Tested:

- Actiflo® tested in 2001 and 2002
- DensaDeg® tested in 2002
- Trojan Technologies UV-4000 medium pressure UV system tested in 2001 and 2002
- WEDECO Ideal Horizons Tak55 2-1/143x3 CW low pressure, high output UV system tested in 2002.

HRC Sampling and Analysis:

- Developed BOD:COD ratio allowing COD be used for benchmarking organic removal efficiency
- Collected sufficient BOD analysis to check the variability of BOD:COD ratio

UV Sampling and Analysis:

- Sample collection by plant staff. Split samples were collected for quality control and correlation between methods.
- Analysis of TSS and UV transmittance performed by plant staff and UV vendor personnel.
- *E.Coli* enumeration performed by plant staff using Most Probable Number (MPN) method and UV vendor personnel by membrane filtration method.
- During dose response runs, grab samples collected in triplicate at each UV dose for *E. Coli* enumeration.
- During extended durations of UV runs, automatic lamp sleeve cleaning was disengaged with lamps being wiped clean only at the conclusion of the data collection period.

Influent Dilution:

- Influent dilution using well water was needed for entire six weeks of 2001 testing and at times during 2002 testing due to insufficient rainfall. Dilution water was obtained from a reserve well. Well water provided more alkalinity than the actual dilute influent.
- De-ionized (DI) water was used as dilution water during bench-scale testing and better reflects alkalinity of the actual dilute influent.

Wastewater Characterization:

- Samples of SSO from two overflow locations were collected over five events and compared to the WLTP samples. The results indicated that SSO water is similar to WLTP influent at its most dilute state, with the exception of higher fluoride concentration at the WLTP than at the SSO sites.
- Industrial discharges from several semiconductor manufacturing sources and a latex paint manufacturer caused elevated fluoride and silica concentration, and turbidity spikes of up to 200 NTU. These industrial discharges exerted additional coagulant demand and affected coagulation chemistry.

Coagulants Used and Bench Scale Optimized Dosage:

Coagulant (with 1 mg/L of dry anionic M155 polymer)	Most Dilute Wastewater (BOD and TSS at 40 to 50 mg/L and alkalinity at 50 mg/L)		Least Dilute Wastewater (BOD and TSS at 100 mg/L and alkalinity at 100 mg/L)	
	Range	Optimum	Range	Optimum
Ferric, mg/L	30 – 50	40	40 – 70	60
Alum, mg/L	25 – 35	30	60 – 100	80
Aluminum Chlorhydrate (ACH), mg/L	10 – 15	12	10 – 20	15
Polyaluminum Chloride (PACl), mg/L	20 – 30	25	N/A	N/A

Mitigation of Sand Binding in Actiflo® in Presence of Latex Paint:

- Using alum as a coagulant, microsand ballast became bound together with polymer to form larger gelatinous floc in the clarifier hopper in the presence of latex paint and could no longer be pumped through the hydro-cyclone and returned to the process.
- Sand binding was mitigated by using ferric chloride as a coagulant, or by using ACH or PACl with increased coagulation contact time prior to polymer addition.
- DensaDeg® was not affected by latex paint.

Actiflo® Performance:

Chemical Dosages

- Optimum dose of dry polymers (M725, M155) was 0.5 to 0.6 mg/L for aluminum-based coagulants. Higher doses caused sand binding. Dosage increased to 1 mg/L for ferric.
- Optimum liquid polymer (AE1125) dose was 2.0 mg/L for both iron and aluminum-based coagulants.
- 40 to 50 mg/L of Ferric, 80 mg/L of Alum, 10 to 20 mg/L of ACH, or 20 mg/L of PACl, all of which are within the ranges of bench scale dosages.

Performance at Different Surface Overflow Rate and Coagulant

- When alum was used as a coagulant, TSS removal efficiency was lower than 85 percent if surface overflow rate was higher than 30 gpm/ft^2. Coagulant contact time was not kept constant at higher surface overflow rate.
- When ferric was used as a coagulant, TSS removal efficiency remained higher than 85 percent even if surface overflow rate was 80 gpm/ft^2. Coagulant contact time was between 4 to 8 seconds.
- If coagulant is injected further upstream in influent piping to provide 40+ seconds of contact time, use of ACH as coagulant can achieve close to 90 percent of TSS removal even at a surface overflow rate of 100 gpm/ft^2.
- At a surface overflow rate of 60 gpm/ft^2, with a 5-second ferric contact time or a 43-second ACH contact time, TSS removal efficiency of 85 to 90 percent and BOD removal efficiency of 50 to 70 percent could be achieved.
- Provided sufficient coagulation time, TSS and BOD removal performance similar to that at a surface overflow rate of 60 gpm/ft^2; could be achieved at a higher surface overflow rate of between 80 and 120 gpm/ft^2.

Startup Time

- Less than 20 minutes was required for the unit to complete a dry startup using ferric as a coagulant. Less than 10 minutes was required for the unit to complete a dry startup using ACH as a coagulant.

DensaDeg® Performance:

Chemical Dosages

- Percol 727 polymer was used at a dose of 1.5 mg/L; Nalclear 8173 polymer was used at a dose of 2.0 mg/L.
- 40 mg/L of ferric, 60 mg/L of alum, 15 mg/L of ACH, or 30 mg/L of PACl, all of which are within the ranges of bench scale dosages.
- Sludge recycle at 3.5 and 7 percent of influent flow

Performance at Different Surface Overflow Rate and Coagulant

- Greater than 2 minutes of coagulant contact time was provided for all surface overflow rates tested.
- To achieve 80 to 85 percent TSS removal, surface overflow rates should be limited to 40 gpm/ft^2. Performance deteriorated rapidly at 50 gpm/ft^2 and solids were washed out of the clarifier ultimately leading to a process failure. Performance at 30 gpm/ft^2 was marginally better than that at 40 gpm/ft^2.
- The reactor solids concentration must reach 600 mg/L to achieve acceptable effluent TSS level (around 5 mg/L) if aluminum-based coagulant is used. This solids concentration could be achieved if the surface overflow rate was between 30 and 40 gpm/ft^2.
- A lower reactor solids concentration of 400 mg/L can achieve the same performance if ferric coagulant is used.
- At surface overflow rate of 30 to 40 gpm/ft^2, TSS removal of 87 percent, COD removal of 67 percent, and BOD removal of 59 percent were achieved.
- TSS removal dropped from 78 percent at a surface overflow rate of 50 gpm/ft^2 to 2 percent at 55 gpm/ft^2. Solids started to wash out of the clarifier at this surface overflow rate. After failure occurred, the surface overflow rate was reduced to 40 gpm/ft^2 and the process could not regain performance to pre-failure level even after one hour of operation at the lower surface overflow rate.

Startup Time

- For both ferric and ACH, the dry startup time is between 1.5 and 2 hours at a surface overflow rate of 30 to 40 gpm/ft^2.

UV Disinfection:

Water Quality

	UVT[1] (%)	**TSS (mg/L)**	**Turbidity (NTU)**	***E.coli*** **(per 100 mL) (geometric mean of composite samples taken)**
Screened Raw Influent	40 – 50	40 – 100	70 – 200	1,000,000+
Actiflo® Effluent (using ACH or PACl)	70 – 80	3 – 10	2 – 5	10,000 – 100,000
DensaDeg® Effluent (using ACH or PACl)	70 – 80	6 – 28	4 – 10	10,000 – 100,000

[1]Ultraviolet transmission

Collimated Beam Evaluation of HRC Effluent

- Six runs were conducted. Five runs showed a UV dose of 10 to 40 milli-joules per square centimeter (mJ/cm^2) can reach the target level of less than 126 *E.coli* per 100 mL. One run showed a UV dose of 70 mJ/cm^2 would be required to achieve the target level. It was concluded that a UV dose of 30 to 40 mJ/cm^2 would be sufficient to provide disinfection to HRC effluent.

Pilot Dose Response Curves of HRC Effluent

- The UV dose response curve for Actiflo® effluent with ferric coagulant demonstrated that the disinfection goal of 126 *E.coli* per 100 mL was unattainable even at UV doses greater than 100 mJ/cm^2 due to high absorbance of ferric iron in the carryover floc. Only when UV dose was elevated to approximately 200 mJ/cm^2 did the number of *E.coli* drop below 126 per 100 mL.
- When aluminum-based coagulant was used, the Trojan medium pressure system could meet the geometric mean of 126 per 100 mL in all but three samples at UV doses which ranged from 20 to 50 mJ/cm^2.
- The results of the WEDECO pilot runs indicated that the disinfection goal of 126 *E.coli* per 100 mL was met at a calculated dose of 21 mJ/cm^2.
- The HRC effluent quality corresponded with the water quality of the collimated beam runs with 70 to 84 percent UVT, 3 to 9 mg/L of TSS, and less than 6 NTU.

TACOMA Actiflo® PILOT STUDY SUMMARY
USFilter, FEBRUARY 1999

Pilot Test Information:

Duration:	February 15, 1999 to March 5, 1999
Test Flow:	660 gpm
Test Overflow Rate:	60 gpm/ft^2
Polymer Type:	Allied Colloids 725
Polymer Dosage:	1.5 to 1.6 mg/L
Coagulant Type	Ferric chloride
	PACl
Coagulant Dosage:	70 to 100 mg/L of ferric chloride
	17 to 65 mg/L of PACl
Startup Time to Peak Efficiency:	Wet Start at 10 to 15 minutes

Ferric (100 mg/L) Performance (average 1.25 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	91	6	93%
TSS, mg/L	305	6	98%
TBOD, mg/L	294	112	62%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	689	182	74%
Phosphorus, mg/L	No Data	No Data	No Data

PACl (45 mg/L) Performance (average 1.5 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	67	1.5	98%
TSS, mg/L	135	17	87%
TBOD, mg/L	102	31	70%
SBOD, mg/L	28	25	11%
Insoluble BOD, mg/L	74	6	92%
Total COD, mg/L	260	80	69%
Phosphorus, mg/L	No Data	No Data	No Data

Effect of Surface Overflow Rate on Process Performance (45 mg/L PACl and 1.5 mg/L Polymer):

	40 gpm/ft^{2} (a) (percent)	60 gpm/ft^{2} (percent)	80 gpm/ft^{2} (b) (percent)
Turbidity Removal	97	97	97
TSS Removal	93	91	90
COD Removal	69	65	70

[a] Influent flow reduced to lower surface overflow rate, thus increasing coagulation time.
[b] Influent flow was kept the same as the 60-gpm/ft^{2} trial and surface overflow rate was increased by blocking off 33 percent of the clarifier area, thus keeping the coagulation time the same as the 60-gpm/ft^{2} trial.

Summary of Findings

- The performance of Actiflo® with the optimum coagulant and polymer dosage was consistent at surface overflow rates from 40 gpm/ft^{2} to 80 gpm/ft^{2}.
- Sludge solids content from 0.33 to 0.55 percent.
- Over the long term run (nine days of continuous running), the Actiflo® pilot unit's effluent deteriorated during five time periods. These time periods coincided with experimentation involving the use of a streaming current controller (SCC) to automatically adjust coagulant dose. A full-scale peak wet weather flow facility at this time would not be operated with an SCC until long-term experience has proven its reliability. The CSO Actiflo® plant in Colombier, Switzerland operates with a constant coagulant dose that allows the plant to accept influent with fluctuating characteristics and still produce an effluent quality within permitted limits.

CITY OF PORTLAND Actiflo® PILOT STUDY
BROWN AND CALDWELL, MAY 1998

Pilot Test Information:

Duration:	December 1997
Test Flow:	No Data
Test Overflow Rate:	20 to 60 gpm/ft^2
Polymer Type:	Allied Colloids LT25
Polymer Dosage:	0.75 mg/L
Coagulant Type:	Ferric chloride Alum
Coagulant Dosage:	50 to 75 mg/L of ferric chloride 120 mg/L of alum
Startup Time to Peak Efficiency:	Wet start at 20 minutes (at 20 gpm/ft^2)

Ferric (58 mg/L) Performance (average 0.75 mg/L Polymer) (20 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	135	5	96%
TSS, mg/L	165	5.2	97%
TBOD, mg/L	238	141	41%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	520	270	48%
Phosphorus, mg/L	5.0	0.1	98%
Copper, micrograms per liter (µg/L)	93	20	78%
Zinc, µg/L	105	58	45%
Lead, µg/L	6	0.8	87%

Alum (120 mg/L) Performance (average 0.75 mg/L Polymer) (40 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	120	12	90%
TSS, mg/L	140	6	96%
TBOD, mg/L	330	210	36%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	600	380	37
Phosphorus, mg/L	4	0.5	91%
Copper, µg/L	45	25	45%
Zinc, µg/L	124	27	78%
Lead, µg/L	5.7	0.4	93%

Summary of Findings:

- Effluent quality was strongly dependent on operating pH, with significantly lower effluent contaminant concentrations at a pH value lower than 6.5 for both ferric and alum coagulants.
- The attempt to complete a mass balance calculation for sludge production was unsuccessful. The sludge flow rate data may be incorrect.
- Limited data suggested that organic material did not accumulate on the sand particles. Conditions in the rapid mix tank and hydro-cyclone may be sufficient to scour the sand.
- There is a strong correlation between the BOD and COD data collected.
- Dosage of ferric chloride was expressed as mg/L of iron (Fe) instead of mg/L of ferric chloride ($FeCl_3$). Also, overflow rate was expressed in gallons per day per square foot (gpd/ft^2) instead of gallons per minute per square foot (gpm/ft^2).

OTHER Actiflo® PILOT STUDY PERFORMANCE IN WASTEWATER / WET WEATHER TREATMENT

Location	Study Date	Overflow Rate (gpm/ft^2)	Coagulant Type	Coagulant Dose (mg/L)	Polymer Type	Polymer Dose (mg/L)	TSS Removal	BOD Removal	COD Removal	Phosphorus Removal
Galveston, TX	3/98	20 – 40	Ferric Chloride	75 – 125	LT25	1.0 – 1.5	80 – 97%	60 – 80%	65 – 90%	No Data
Cincinnati, OH	4/98	30 – 60	Ferric Chloride	20 – 100	Allied Colloids 725	1.0 – 1.5	80 – 90%	40 – 90%	30 – 80%	90 – 99%
Fort Worth, TX	10/98	50 – 80	Ferric Sulphate	77	Allied Colloids 725	1.0	86%	56%	No Data	95%
Jefferson County, AL	10/98	40 – 80	Ferric Chloride	40 – 80	Allied Colloids 725	0.85	85 – 100%	20 – 60%	No Data	No Data
Port Clinton, OH	7/99	20 – 40	Ferric Chloride	75 – 125	Allied Colloids 725	1.0	80 – 97%	40 – 60%	45 – 70%	No Data
Belleville, IL	5/00	60 – 75	Ferric Chloride	30 – 75	Allied Colloids 725	0.75	80 – 95%	60 – 85%	45 – 80%	No Data
Little Rock, AR	8/00	30 – 60	Ferric Chloride	65 – 85	Allied Colloids 725	1.25	86 – 99%	50 – 85%	No Data	No Data
Independence, MO	9/2000	60	Ferric Chloride	40	Ciba Percol 725	0.75 – 1.25	90%	47 – 90%	41 – 90%	No Data

DensaDeg® 4D PILOT STUDY PERFORMANCE IN WASTEWATER / WET WEATHER TREATMENT

Location	Study Date	Overflow Rate (gpm/ft^2)	Coagulant Type	Coagulant Dose (mg/L)	Polymer Type	Polymer Dose (mg/L)	TSS Removal	BOD Removal	COD Removal	Phosphorus Removal
Birmingham, AL	6/98-8/98 (CSO)	29 – 59	Fe	45	Percol 727	1.5	86%	47%	No Data	No Data
Fort Worth, TX	10/98-12/98 (CSO)	30 – 60	Fe	70 – 150	Percol 727	0.75 – 1.75	86%	47%	No Data	No Data
26th Ward, NYC	7/99-8/99 (CSO)	25 – 55	Fe	52 – 63	Percol 727	1.4 – 1.8	70%	58%	No Data	No Data
Halifax, Nova Scotia	11/99-6/00 (1^{O} Inf)	10 – 33	Fe/Al/PACl	18-25 Fe 4-8 Al 8-10 PACl	AS34/ Percol 727	1.0 – 1.2	71%	71%	No Data	No Data
San Francisco, CA	1/00-2/00 (CSO)	30 – 45	Fe	70 – 90	Percol 727	2.0	85%	64%	No Data	No Data
Little Rock, AR	8/00 (1^{O} Inf & Eff)	20 – 40	FE	60	Percol 727	1.5	85 – 89%	72 – 77%	No Data	No Data
Chesterfield, VA	8/02 (1^{O} Eff)	20 – 30	Fe	120	Nalclear 8173	1.5 – 2.5	75%	49%	No Data	No Data

HDR

APPENDIX B

November 13, 2003 Washington Department of Ecology Meeting Minutes

HDR | ONE COMPANY *Many Solutions*℠

Meeting Notes

Subject:	Peak Flow Treatment Alternatives for the Wastewater Treatment Facilities – DOE Meeting		
Client:	City of Mount Vernon		
Project:	Wastewater Treatment Plant Upgrade - Predesign	Project No:	09637-06070
Meeting Date:	November 13, 2003, 10:00 am - noon	Meeting Location:	Department of Ecology Offices Northwest Regional Office 3190 160th Avenue SE Bellevue, WA
Notes by:	Dan Olson		

Attendees:

Kevin C. Fitzpatrick, DOE Water Quality Program Section Manager
Bernard Jones, DOE Water Quality Program
Mark Henley, DOE Brightwater Facility Engineer
Walt Enquist, City of Mount Vernon – Wastewater Utility Supervisor
John Koch, HDR – Lead Design Engineer
JB Neethling, HDR – Process Design Expert
Dan Olson, HDR - Project Manager

Topics Discussed, Purpose of meeting:

Discuss attached letter to DOE, dated November 12, 2003, regarding improvements to Mount Vernon WWTP. In that letter and in this meeting, we ask for DOE's opinion on "approval of and proceeding with" improvements somewhat different than that included in the Comprehensive Plan. Specifically, we discussed whether Mount Vernon should pursue the treatment facilities improvement with peak flows (CSO) through a high rate clarification process followed by blending with secondary influent and disinfection. This would include dropping the peak flow secondary treatment down from 24 to 16.4 MGD (max, without nitrification) and installing high rate clarification for treatment of peak flows.
As a goal, we wanted DOE to conceptually approve the change in improvement plans and give direction on how to successfully accomplish the proposed revision to the City of Mount Vernon Comprehensive Plan.
To facilitate discussion, we gave a presentation to further support the proposal and to request direction from DOE on next steps in proceeding with the proposed course of action.

Meeting Notes:
Note: The text of the referenced letter is inserted at the end of these minutes. The presentation is attached in hard copy in the project files.

Kevin and Bernard were present at the beginning of the meeting with Mark coming in after about 30 minutes. Mark's arrival gave us an opportunity to go over most of the presentation twice, which appeared to be very helpful.

Kevin Comment at outset: The EPA blending policy is not the WA DOE policy! WA DOE has a team of 6 to 8 engineers working on a blending policy at this time and expect it to be out mid 2004. It will not be as lenient as the EPA proposal.

Dan, John and JB made a presentation to Bernard, Kevin and Mark outlining suggested changes to the improvement plan contained in the Comprehensive Plan. Dan presented slides one and two as introduction and then John and JB continued through the process discussions, site layout change discussions and into the question and answer time. The question and answer session that followed is documented below. The letter and slides are attached as part of the meeting minutes.

Kevin Q: Clarify total flows through secondary.
JB and John A: JB stated 17, clarified by John to be 16.4 max, BOD only and 15.5 nitrified.

Bernard Q: Do you plan on having redundancy with the high rate clarification (HRC)?
John A: Yes. Initially looking at two 6 MGD units, expandable with time to (total through plant) 50 MGD.

Bernard Q: How do pilot study results show the system results under stress?
JB A: Remarkably stable on Russian River. Incoming NTU varies from 2 to 600 and effluent NTU went from 1 to 2. John A: Most sensitive area is chemical injection system.

Kevin Q: Where are you splitting flow from secondary to HRC? How determined?
All A: Take max through plant secondary at 16.4 MGD and over that to HRC. Compare to the calculated 2020 ADMM flow and design plant to handle that or better, rest through HRC. Can take the 2020 ADMM flow without the second aeration basin.

Bernard Comment: DOE may require a long-term control / monitoring plan.

Dan Q: What steps does DOE see to accomplish this for Mount Vernon?
Kevin A: Just do a Comp Plan revision. This is a long-term control measure, and he (DOE) likes to hear about the long-term thinking of CSO planning in conjunction with the secondary treatment facilities.

Kevin Q: How much work has Mount Vernon done in the collection system to reduce CSO's and to separate CSO flows from sanitary?

Walt A, John, Dan A: Walt and John and Dan described the success of the CSO reduction plan. Walt noted the work the City is doing with separating flows where possible and the thinking about possibilities for the future (Second Street Bridge example given). He noted that the City had reduced CSO overflows by 90% with the 60" interceptor, completed in 1999. He also noted that this proposal was aimed at making a similar level of improvement – from 7 per year now to max 1 per year.

Kevin Comment: Kevin noted that he likes to see the separation work going on and noted that this proposal is much better than others they have seen trying to do much less.

Kevin Q: Does Mount Vernon have a Storm Water Utility? Does this Utility have a source of funds to assist in this project?

Walt A: Yes, City does have a Storm Water Utility, formed in 1996. No funds available in this Utility. Walt noted that the Storm Water Utility has been controversial. Kevin and Mark noted that as a normal problem with Storm Water Utilities.

Mark Q: Would your planned secondary capacity for 2020 be equal to the 2020 ADMM flow?

JB and Dan A: Yes, Comp plan projection is 9.9 MGD ADMM and plan is for over 10 MGD, without the second aeration basin, but making modifications described in presentation. JB noted that the design is for a peak flow of close to 17 (incl. recycle).

Kevin Comment: Don't see a problem with going this way. Treating the sanitary flows at all times, treating all combined flows with only one overflow per year. Don't see a problem.

Kevin Q: Have you done an economic analysis of adding more storage as opposed to HRC?

Walt, Dan and John A: Yes. Walt explained that the initial Comprehensive Sewer Combined Sewer Overflow Reduction Plan did an analysis of reduction alternatives, including separation, in-line storage, and treatment alternatives. We also described the interceptor project and costs associated with that project.

Kevin Comment: Here are the general provisions of the current DRAFT blending policy for WA DOE. "You can't hold me to these, as it is still a draft".

1. To allow blending in design, Community may have to complete I/I program including I/I study, meeting standards for inflow (not applicable to combined). The Community cannot use blending as a way around the I/I improvements.
2. There must be a net environmental benefit, a net reduction in discharge to the environment. A net improvement in annual average and maximum month BOD and TSS discharge.
    a. Kevin noted that, because Mount Vernon is treating the CSO flows that are currently happening, the City should be able to easily demonstrate that.
3. Combined Sewer systems are being categorically exempted from the blending policy. They are being treated under the CSO regulations instead.
4. The Blending policy is primarily focused on newer systems that do not include CSO components.
5. With flow blending, assume additional permit requirements and monitoring.
    a. Limits
    b. Study on soluble BOD
    c. Monitoring for parameters – soluble BOD, metals
    d. WET test for toxicity on blended flows – twice annually, quarterly max.
    e. Record keeping on each bypass
6. Must operate secondary process up to 100% <u>before</u> bypass. This is required to assure a net environmental benefit. Blending process puts more responsibilities on Operators.

Mark Q: What assumptions did your analysis use on ballasted sedimentation for mass balance?
JB A: 50% BOD removal and 80% TSS removal
Mark Comment: That's reasonable.

7. Permit limits must be met at all times.
8. pH limits must be met at all times.
9. There will be an annual assessment / report from flow blending – continued demonstration of environmental benefit.
10. DOE is looking at a separate policy for existing combined systems and CSO.

Kevin and Mark Joint Comment: Your actions on this request need to be the Comp Plan amendment request and the public hearing. The draft policy does not come into play.
You would want to demonstrate a net environmental benefit through analysis. Indicate with a mass balance that you would meet you r effluent quality. You should have your inputs and outputs as part of the revision. If secondary capacity is $\geq$ max month, you are fine. You cannot treat less than max month through secondary. It is not AKART if less. If you are treating max month at 100% and trying to eliminate CSO's, that is good. Mark noted "Good!" Kevin repeated "Good"!

Bernard Q (to Kevin): How will the DOE or EPA policy development impact this request?

Kevin A: Not at all. Just put this through a comp plan revision process, with the associated public hearing. The proposed policies have no bearing on this.

Bernard Comment: This is new technology, so that is your reason for this comp plan revision.

Kevin and Bernard Comment: Can proceed with this direction if you are:

1. Treating maximum month flow through secondary processes.
2. You meet current permit requirements.

Bernard Q: What schedule do you have for Comp Plan approval?

John and Dan A: Have to talk with Walt (time for City to think). Plan on submitting revision in January or late December with approval in First Quarter of 2004.

Bernard Comment: Good. Submit this as new technology.

Mark Q: When was current Comp Plan approved?

Dan A: February 2003. It is a bit embarrassing, but the technology and the regulations were just not quite there when we did the work (most Comp Plan work complete by mid 2002). Not comfortable at the time with this kind of proposal.

Kevin and Bernard Comment: No need to for embarrassment. New technology and receptivity by regulators is just coming on – note policy work just drafted.

John Q: Do we have a go ahead on this approach?

Bernard and Kevin Comment: Go with this. See no problem with conditional approval of ballasted sedimentation. Watch plant performance for 18 months and then follow with final approval. Note that the plant will not experience anything close to design flows in that 18 months, so may want to force it some way to test.

Mark Comment: You should think about separate disinfection of the secondary and ballasted sedimentation flow streams. UV not too effective for ballasted sedimentation.

Kevin Comment: You should look at the security component, as that is very applicable for wastewater facilities. The legislation will come out soon for that. Especially for the chlorine equipment if you go that way.

Dan Comment: We have thought about the UV issue with HRC and will be discussing that with the City, now that we have conceptual approval to go with HRC.

Kevin Comment: Suggest you have Storm Water Utility ratepayers pick up some of the cost for this improvement – but then they are the same folks.

Dan Q: Can you suggest some funding opportunities for the City to fund part of this project, especially the CSO component?

Bernard A: The City WWTP was funded before, so not likely to get funds again. If UV is included in new plant, funds maybe available. Submit an application for items considered new.

Some financial opportunities were discussed – Mount Vernon being a phase II storm water community. May have funds there.

The meeting ended at 11:45 with Bernard noting that he would expect our request for the Comp Plan amendment in the near future. He sees no problem with approval of that amendment in the first quarter of 2004.

Action/Notes:

1. Now that we have conceptual agreement by DOE for using high rate clarification for peak flows (above Average Day, Maximum Month), Walt and the City of Mount Vernon to confirm internally that integrating the CSO component of the Comprehensive Plan into the WWTP project is the way they want to go. This will be the first step, leading to the others below.
2. Upon approval by City, Dan to confirm intentions with letter to DOE from Walt. Dan will meet with Bernard to go over draft of confirmation letter before finalizing letter and sending to Walt for use.
3. Dan will present cost impacts to the City in combining the two projects. This will help in item 4 below. The construction cost impacts include - not building certain parts of the Secondary system, building the high rate clarification treatment and cost savings of integrating components of the two systems (pumping, disinfection).
4. City and HDR to agree on supplement to existing contract to include scope CSO project work.
5. Following 4 above, HDR to pursue Comprehensive Comp Plan amendment with DOE
6. Proceed with rest of contract as shown, leaving the second aeration basin out of the plan.

TEXT OF LETTER TO DOE - November 12, 2003

Mr. Bernard Jones, P.E.
Department of Ecology Northwest Regional Office
3190 160th Avenue SE
Bellevue WA 98008-5452

Re: City of Mount Vernon Comprehensive Plan Update

Dear Mr. Jones,

Thank you for agreeing to meet with us on November 13, 2003 to discuss proposed improvements to the City's Wastewater Treatment Plant. We appreciate the opportunity to present our recent thinking on what improvements to make in our current upgrade and why we should change somewhat from what is shown in our Comprehensive Plan.

The City of Mount Vernon (City) puts a high priority on water quality in the Skagit River as well as on effective use of ratepayer's dollars. To achieve those goals, we believe a modification to the Comprehensive Plan is warranted for the reasons outlined below.

1. The City has one of nine CSO systems in the State and, as such, the flows in our system are highly influenced by rainfall events. The City's system has recorded flows in excess of 35 MGD when the flow to the wastewater treatment plant, Park Street and Division Street overflows are totalized. These peak flows are usually only a few hours in duration. We have carefully analyzed the quality of the flows in our system, including the CSO flows, for the past ten years. Water quality data from these high flow events indicate that the BOD and suspended solids components are very dilute, usually less than 30 mg/l. The high flows, coupled with the low BOD and SS, can interfere with our secondary treatment processes.

2. Both flows and loadings in the City system have increased at a lower rate since 2000, when compared to the years prior to 2000. This is due to changes in growth patterns, collection system improvements to reduce inflow and infiltration, and better pretreatment of industrial wastes by Draper Valley Farms. Average dry weather flow for 2003 is 2.67 MGD and the projected average dry weather flow for 2020 is 4.8 MGD based on the growth patterns and flow data since 1999.

3. Regulators are thinking progressively about the benefits of blending in certain limited situations, as evidenced by EPA's recent draft policy and six principles on blending. I commend you and your co-workers at DOE and EPA on looking seriously at blending as a viable option for treatment facilities such as Mount Vernon's. This draft policy recognizes the need for some flexibility in regulation to achieve the best overall treatment result for the environment. We note that several Western Washington treatment plants are considering this method of achieving water quality goals. For your information, we have attached a brief summary of pilot study results from plants at Bremerton, King County, Tacoma, Salem and Portland, Oregon.

4. The City is working aggressively toward reducing untreated combined sewer overflows to the Skagit River to one event or less per year. As evidence, the number of untreated CSO events to the Skagit River has been reduced from 90 per year to less than 10 per year since the beginning of 1999. This reduction in untreated CSO events is a direct result of the City's commitment to maintain water quality in the Skagit River. In December of 1998 the City completed construction of a 60-inch CSO storage interceptor that allowed the City to make that 90% reduction in overflow events. The WWTP improvement upgrade plan we will present in our meeting and over the next several weeks should allow us to make another 90% reduction in overflows, bringing the City into compliance with the consent order, perhaps earlier than the stipulated 2015 timeframe.

As you know, the City's current Comprehensive Plan contemplated a complete secondary plant that is double the current capacity, both at average day, max month and at peak hour (24 MGD). Given the reasons above, and with your early support of this direction, the City will begin a process to modify the comprehensive plan.

In short, the City proposes to increase the current plant influent capacity of nitrified maximum month flow to 10.0 MGD during the summer months with a peak day nitrified capacity of 15.5 MGD. These flows are above the stated 2020 flows in the Comprehensive Plan of 9.9 maximum month and 13.9 peak day, but are lower than the planned plant capacity of 24 MGD. We would replace the remaining capacity with a high rate clarification process that is more suitable and more cost effective for the dilute flows experienced during storm events. We believe this will meet our permit requirements, satisfy the six principles listed in EPA's draft blending policy and provide additional benefits as described below.

What this means as far as changes to the Comprehensive Plan is that we propose not building the second aeration basin, instead replacing it with a high rate clarification process (i.e. Actiflo or Densadeg). We will continue, as planned, with the new headworks, primary clarifiers, secondary clarifiers, support buildings, site work and pump stations. We also propose implementing seasonal nitrification and the solids processing improvements contemplated in the Comprehensive Plan. One other impact of this change will be a review of the planned UV disinfection to determine its effectiveness with the high rate clarification effluent.

To support this proposal, HDR has completed plant process modeling and capacity analyses. Using a dynamic simulation model, Biowin, the flows and loads to the treatment plant were analyzed with the ultimate goal of determining the capacity of the existing secondary system while maintaining effluent ammonia of less than 5 mg/l at a wastewater temperature of 10 Degrees C. With three secondary clarifiers and two primary clarifiers (as planned in the Comprehensive Plan), the maximum month plant capacity, including internal recycle is 10.0 MGD with a peak day capacity of 15.5 MGD. This configuration will yield a plant effluent in the range of 10 mg/l BOD and SS and 5 mg/l maximum day (<5 mg/l average) ammonia. We propose that the flows above 13.5 MGD be screened, de-gritted and treated with enhanced sedimentation. The enhanced sedimentation process will typically provide SS reduction in the range of 80 to 90% and BOD reduction in the range of 50 to 70%. Our water quality analyses over the past ten years show typical influent BOD and SS concentrations during flows above 13.5 MGD to be less than 35 mg/l and 30 mg/l respectfully. With a blended effluent and anticipated BOD and SS reduction through enhanced sedimentation, the combined total effluent from the treatment facility will be less than 30 mg/l. Prior to discharge to the Skagit River, the combined effluent will be disinfected.

We believe there are many benefits to this proposal. All of them support our two primary goals of high water quality in the Skagit River, including meeting all of our permit requirements, and effective use of ratepayer dollars. In summary, they are:

- The City can incorporate CSO planning into the current project and plan to increase the delivery of wet weather flows to the treatment facility. This will allow the City to treat a higher overall volume of wastewater.
- The WWTP can meet permit requirements with a higher overall flow than the plan outlined in the Comprehensive Plan.
- This approach provides better protection for the biological treatment units from peak flows experienced during storm events.
- This approach provides for more effective use of ratepayer funds.
- The City has the opportunity to meet their consent decree on CSO flows earlier than the 2015 requirement. Should we decide to do that, it would eliminate discharge of raw sewage during those overflow events.

We believe that the proposed process scenario described above will provide an overall high quality total effluent to the Skagit River, provide the maximum level of treatment at the lowest cost and will make the most effective use of dollars paid by the ratepayers of the City of Mount Vernon.

We look forward to our meeting of November 13, 2003 to discuss this proposal in more detail.

Sincerely,

Walt Enquist, Wastewater Utility Supervisor

January 28, 2004
City Comprehensive Plan Amendment Application
Wastewater Utility Element
Project Narrative

The City of Mount Vernon adopted a Comprehensive Sewer Plan (CSP) February 2003. This proposed amendment addresses changes to the CSP long range needs and expected costs for wastewater treatment plant (WWTP) improvements, sewer repair, sewer replacement, and sewer extensions city wide and in the unincorporated urban growth areas.

The City has initiated pre-design work to further refine work included in the CSP. The CSP includes plans to upgrade and expand the wastewater treatment plant WWTP by 2008. The pre-design report will be incorporated into the CSP and the City Comprehensive Plan. The pre-design work includes upgrading the WWTP, Combined Sewer System, and increasing plant organic and hydraulic capacity. The pre-design report includes a recommendation to include High Rate Clarification (HRC) of wet weather flows. HRC of wet weather flows is presented as a means of complying with an agreement with DOE to reduce Combined Sewer Overflows. This agreement requires Mount Vernon to reduce overflow events to an average of one per year no later than January 1, 2015.

The size of the WWTP is approximately 17 acres. Recommendations to expand the WWTP site, if any, will be identified in the pre-design report. Zoning changes at the WWTP, if any, will be public or commercial/limited industrial which are consistent with current WWTP zoning. Impacts, if any, will be addressed through the SEPA process.

The amendment application is consistent with the stated community vision to "expand the economy to support growth, but not compromise the surrounding environment".

The recommendations and costs identified in the CSP will be incorporated into the City Capital Improvement Plan (CIP).

Expansion of the WWTP and sewer infrastructure is essential to the health, safety, and welfare of the City and areas of the lower Skagit River Basin. The City is required through state and federal rules to provide wastewater services to assure water quality regulations are met as the City grows. The proposed amendment is consistent with the goals of Mount Vernon and Skagit County to maintain the quality of the Skagit River and surrounding environment. This amendment enables the City to expand in accordance with density zonings thereby reducing potential detriment to adjacent property owners that can be caused by failing on-site sewage systems. The amendment generally enhances the City's ability to manage City development in accordance with City and community goals.

APPENDIX C

January 30, 2004 Public Hearing Notice

CITY OF MOUNT VERNON
NOTICE OF APPLICATION FOR COMPREHENSIVE PLAN AMENDMENTS

The City of Mount Vernon is accepting applications for 2004 comprehensive plan amendments. Applications for 2004 amendments must be filed with the City of Mount Vernon Development Services Department by 4:00 p.m., January 30, 2004. Applications must be complete in order to be accepted. Application forms, requirements and procedures are available at the City of Mount Vernon Development Services Department, located at 910 Cleveland Avenue, Mount Vernon, WA 98273. For further information, please call Gloria Rivera or Jenefer Creamer at (360) 336-6214.

Published December 16, 2003 and January 07, 2004.

CERTIFICATION PAGE

For

City of Mount Vernon
Comprehensive Sewer Plan Update
#09637-005-002

The engineering material and data contained in this Comprehensive Sewer Plan were prepared under the supervision and direction of the undersigned, whose seal as registered professional engineers are affixed below.

James C. Peterson,
Supervising Engineer

Richard D. Olson,
Project Manager

City of Mount Vernon
Comprehensive Sewer Plan Update
February 2003
Final

Prepared for:

City of Mount Vernon

Prepared by:

HDR Engineering, Inc.

EXECUTIVE SUMMARY

INTRODUCTION

The City of Mount Vernon (Mount Vernon) has a Wastewater Utility that plans, designs, constructs, operates and maintains the City's sewerage system, pump stations, and wastewater treatment plant. The Wastewater Utility operates as the Wastewater Division of the Public Works Department.

The Mount Vernon sewerage system consists of approximately 120 miles of sewer pipe ranging in size from 6 inches to 60 inches, 1500 manholes, 11 sewage pumping stations, and a wastewater treatment plant (WWTP). The WWTP provides primary and secondary wastewater treatment utilizing the activated sludge process, with sludge stabilization by anaerobic digestion, and chlorine disinfection. The average daily flow for the year of 2001 was 3.42 MGD. The WWTP average day design flow is 5.6 MGD, with a peak design flow of 12.0 MGD. The WWTP is staffed seven days per week, and monitored during the off hours for critical system failures.

Operation, maintenance, and repair of sewerage system, pump stations and WWTP, is provided by Wastewater Division personnel. Major sewer maintenance equipment includes: two jet/vacuum trucks, video scan equipment mounted in an 18 foot van, utility pickup, and a power rodder. Public Works' Transportation Division provides additional equipment for sewer repair work that includes an excavator, backhoe, rubber tire loader, and dump trucks.

PLANNING

The City of Mount Vernon has recently experienced the same rapid growth that is characteristic of the Puget Sound area. Sewer service is now required for many areas in the City's Urban Service Area outside those that have been studied in previous planning efforts. This growth has significant impact upon the existing and future sewer system and wastewater treatment facilities. Due to growth within the service area and continuing changes in the environmental regulations, the City has initiated planning efforts to address these issues. This has involved the completion of engineering and financial assessments to plan for the future.

The Comprehensive Sewer Plan Update - 2002 addresses the requirements of the existing combined sewer system and the developing sanitary system in order to both accommodate growth and to reduce CSOs. This is in accordance with the Revised Code of Washington (RCW) 35.67.030, which deals with sewer planning, and RCW 90.48.480, which deals with the reduction plans for combined sewer overflows. Several alternatives were evaluated in the preparation of this plan to address both of these needs. Principle concerns in the development of the plan included:

- Health and safety of the public
- Protection of the environment
- Protection of property
- Economic capability of the City

The improvements recommended in the Comprehensive Sewer Plan are consistent with the City's Comprehensive Plan. In preparing the plan, growth and CSOs were addressed together. Many of the improvements shown in the Capital Improvement Program serve both purposes.

SEWER SYSTEM

There are two major components to the sewer system. These include the collection system and the wastewater treatment facility. The collection system includes the combined sewers in the older portions of the system with combined sewer overflows and the newer portions of the collection system which are separate sanitary sewers. Improvements required for the collection system and wastewater treatment facility were determined in the 2002 Comprehensive Plan Update and are presented in this summary.

Combined Sewer Overflows

To protect water quality, the City is taking steps to achieve a reduction in the frequency and volume of untreated sewage discharges to the Skagit River. For several decades, the high flows during rainstorms have exceeded the capacity of the sewer and treatment facilities so the excess must be discharged to the Skagit River. These Combined Sewer Overflows are a legacy of the original sewers constructed in Mount Vernon and many other Northwest communities in the early 1900's which simply transported and dumped both sanitary sewage and storm water runoff directly into the nearest body of water.

The 1989 enlargement of the WWTP, construction of the Kulshan Interceptor in 1996, and construction of the Central CSO Interceptor in 1998 have reduced untreated overflows by more than 100,000,000 gallons annually. State and federal agencies require that significant CSO reductions be made at the earliest possible time.

The City of Mount Vernon has a consent decree with the Department of Ecology (DOE) to implement a multi-phase CSO reduction plan. Phase 1, which was completed in 1998, was construction of in-line storage. This in-line storage provided by the Central CSO Interceptor has dramatically reduced the overflows from 130 events per year down to 8. Phase 2 will add combined sewer flow capacity to the WWTP, and phase 3 (if needed) will construct a dedicated CSO treatment facility. The "Order on Consent" requires Mount Vernon to reduce overflow events to an average of one per year no later that January 1, 2015.

Wastewater Treatment Facility Improvements:

The existing wastewater treatment facility was reviewed for future loading conditions and anticipated future effluent flows. By increasing the hydraulic capacity and making other process improvements, the plant will have the capacity to meet future flows and loadings. In addition, these improvements will reduce the number of combined sewer overflow events. These improvements include:

- Upgrade influent pump station to 24.0 million gallons per day (mgd),
- Construct a headworks, with fine screening, grit removal, disposal, and primary sludge and scum pumping facilities,
- Construct additional primary clarifiers,
- Construct an activated sludge selector basin to improve operational stability,

- Provide chemical feed system for pH control of the activated sludge system,
- Convert the Activated Sludge Pump Station to a Return Activated Sludge (RAS) Pump Station,
- Construct additional secondary clarifiers,
- Convert from chlorine to UV disinfection,
- Upgrade the capacity of the effluent pump station,
- Construct a sodium hypochlorite system for disinfecting reclaimed water for non-potable in-plant use,
- Provide Administration Building improvements, and
- Complete outfall improvements.

On a long-term planning horizon, the WWTP will need additional improvements to meet both hydraulic conveyance requirements and load requirements and anticipated treatment requirements. Anticipated future discharge permit requirements may necessitate modifications to the process to provide nitrification. Improvements to convert the activated sludge system to a nitrification mode, hydraulic improvements, and other process or site improvements are listed as follows:

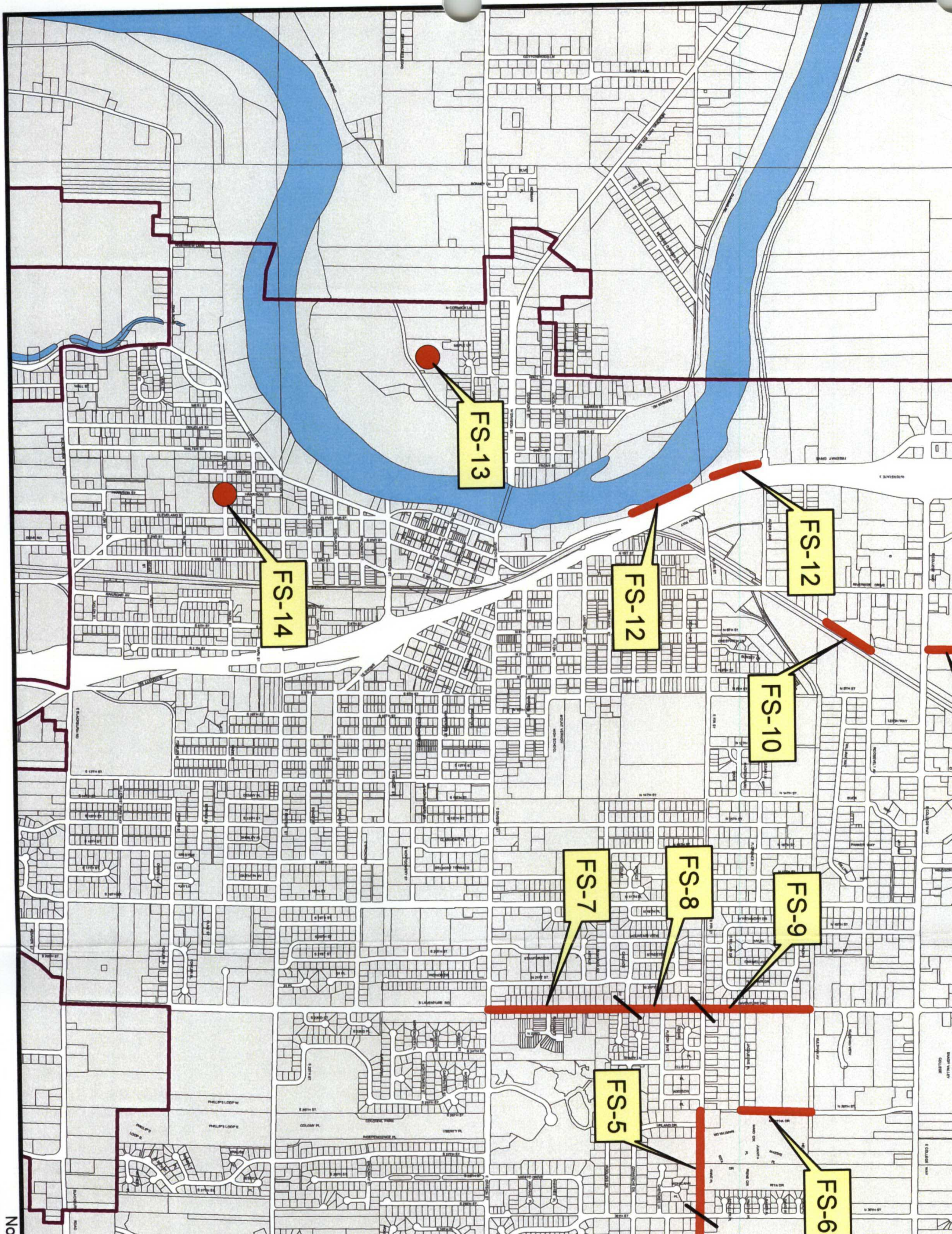
- Convert the Aeration Basin No. 4 to an Activated Sludge Aeration Basin,
- Construct additional Aeration Basins,
- Convert Secondary Clarifier No. 1 to an Aerobic Digester,
- Construct an additional Secondary Clarifier,
- Construct an additional Dissolved Air Floatation Thickener,
- Construct an additional Anaerobic Digester,
- Provide expansion to the existing laboratory,
- Provide odor control, and
- Acquire adjacent land for possible ring dike construction for flood protection, and as an odor and noise buffer.

The proposed wastewater treatment plant improvements are shown on Figure ES-1 and costs for these are presented in Table ES-1, included at the end of this summary.

Sewer System Improvements

The Mount Vernon sewer system totals approximately 120 miles of sewer pipe. Portions of the system were constructed in the early 1900's, and much of the system is 60 years or older. As a part of the Comprehensive Sewer Planning study, the interceptor conveyance system was evaluated to determine improvements that would be required for additional capacity for future growth within the existing service area. These are identified as improvements FS-1 through FS-14, summarized in Table ES-2 and shown on Figure ES-2 included at the end of this summary.

Existing City information was reviewed to determine areas where repair and replacement is recommended. This includes areas within the older combined portion of the sewer system and the typical type of defects identified included structural damage and areas where root intrusion has occurred. These are summarized in Table ES-3 along with estimated repair and replacement costs.



FS-13
FS-14
FS-12
FS-12
FS-10
FS-7
FS-8
FS-9
FS-5
FS-6

Improvements for future development were determined from a model of the major interceptors of the City. Improvements required for ultimate build-out of the City are identified in the Sewer Comprehensive Plan. These improvements will be required in the future, and timing of the improvements is dependant upon actual growth patterns within the City.

Sewer Service to Areas within Urban Growth Areas

A number of improvements will be required to extend sewer service into the UGA and other developing areas. These are areas within the UGA, but not currently within the City limits. The City is presently initiating a study to determine the necessary improvements needed within each of these four areas to provide sewer service. It is the City's intent to determine the services that will ultimately be required, and then develop a phased approach that can be implemented as the need occurs. This will provide an overall cost effective system from both a capital and operating standpoint.

To allow interim development within the UGA areas that are currently without sewer, the City has adopted sewer development provisions in the City of Mount Vernon Sewer Ordinance Title 13. These provisions allow limited interim commercial and industrial development by permitting use of onsite storage systems, and allow limited residential development with onsite septic systems.

South Mount Vernon

The Mount Vernon Overall Economic Development Plan lists South Mount Vernon Planning as the number one implementation plan priority project. The 1996, Overall Economic Development Plan (OEDP) schedule for implementing the South Mount Vernon plan is 3-6 years. Sewer construction was completed for commercial areas adjacent to Old Highway 99 from Blackburn Road to Hickox Road in 2002. Sewer construction is scheduled for the commercial area adjacent to Cedardale Road from Anderson Road to Hickox Road in 2003. The extension of sewers to residential areas within the South UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

West Mount Vernon

The Plan assumes that areas to the west of Mount Vernon will remain primarily agricultural. The City has reviewed the development potential in West Mount Vernon along Memorial Highway to the UGA boundary. Based on preliminary review it appears that serving this area will require construction of 6,000 feet of gravity sewer and at least one pumping station with 3,000 feet of force main. There may be some opportunity for phasing development; however, the first phase would require construction of the pump station and force main. The collection sewers into the West Mount Vernon pump station and the pump station itself would also need to be evaluated to determine if additional improvements are required. The extension of sewers to residential and commercial areas within the West UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

North Mount Vernon

Sewer capacity on Francis Road was improved in 2002 and is adequate for projected design flows in the Northern UGA. Sewer alignments and pump station locations for the Northern UGA have not been determined. The extension of sewers to the Northern

UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

East Mount Vernon
A significant portion of the Eastern UGA is tributary to the Big Lake Sewer System (Skagit Public Utility District No. 2). The City of Mount Vernon will coordinate with the PUD No. 2, and other stakeholders to identify and implement an efficient sewer service plan. The Comprehensive Sewer Plan proposes extending sewer along College Way to Highway 9, and South along Highway 9 to Division Street. Development of the Eastern UGA will require construction of regional pumping facilities. Pump stations that do not provide regional service will not be allowed. Sewer alignments and pump station locations for the Eastern UGA have not been determined. The extension of sewers to residential and commercial areas of the Eastern UGA will be developer or LID funded. Full build-out of the UGA will require improvements to sewer interceptors within the City boundary.

SEWER UTILITY FUNDING

The City adopted a sewer rate ordinance for the years 2000 - 2004. The rate plan covers operation, maintenance, debt payment and debt coverage based on year 2000 projections.
Other funding sources include developer charges for sewer expansion and sewer repair/replacement. The Wastewater Utility is planning a review of service rates and developer charges prior to expiration of the current rate ordinance.

LEVEL OF SERVICE STATEMENT

It is the goal of the City to minimize degradation of water quality and to maintain compliance with the requirements of the City's Washington Department of Ecology Wastewater Discharge Permit. An ongoing program of sewer system repair and replacement, and enforcement of development standards, will contribute to the reduction of combined sewer overflows, sewer system infiltration and exfiltration. These efforts will promote health and safety of the public, protection of the environment, and enhance the economic vitality of the City.

CAPITAL IMPROVEMENT COSTS

Capital improvement program costs for the period from the year 2001 through 2020 are summarized in Table ES-4.

SEPA COMPLIANCE

The City of Mount Vernon has received a SEPA Determination of Non-Significance (DNS) for the Comprehensive Plant Upgrade in November 2000. A copy of the DNS is included in Appendix O.

TABLE ES-1

Recommended Improvements for the Wastewater Treatment Plant	
Improvement	**Capital Cost Estimate (1,000)**
Influent Pump Station	$1,6000
Headworks	$2,800
Primary Clarifiers	$1,800
Selector Basins	$600
Aeration Basins	$2,700
Chemical Feed System (pH control)	$50
Secondary Clarifiers	$3,600
UV Disinfection[2]	$1,340
Effluent Pump Station	$370
Outfall	$1,200
Sodium Hypochlorite Sytem	$100
DAFT	$400
Anaerobic Digester	$2,500
Odor Control System	$1,300
Administration Building	$500
Laboratory Expansion/Operations Center	$600
Shop and Garage	$500
Flood Protection – 100 year event	$600
Roadways	$250
Drainage Improvements	$50
TOTAL	$23,593

1. ENR Construction Cost Index 6397, October 2001.
2. UV disinfection costs include capital cost of a UV disinfection system and costs for pilot testing for two (2) months.

Table ES-2

Interceptor System Improvements						
ID No.	Location	Between	Year Required	Dia (in)[1]	Length (ft)[1]	Cost ($1,000)[2]
FS-1	Martin Road	Trumpter Rd. and College Way	As required	12	734	135
FS-2	College Way	Martin Rd and 35th Street	As required	15	548	125
FS-3	College Way	Martin Rd to Pump Station	2002	18	2,307	635
FS-4	Fir Street	30th Str. and Comanche Drive	2005	18	980	270
FS-5	Fir Street	30th Str. and 26th Street	2005	18	1,265	350
FS-6	26th Street	Jacqueline Place and Kulshan Avenue	As required	18	690	190
FS-7	LaVenture Road	Division Str. and Cascade Street	As required	10	1,525	235
FS-8	LaVenture Road	Cascade Str. and Fir Street	As required	10	495	75
FS-9	LaVenture Road	Fir Str. and Kushan Avenue	As required	12	1,386	255
FS-10	Alder Lane Interceptor	Burlington Northern Railroad of Roosevelt Avenue	As required	24	600	220
FS-11	Urban Avenue	North of College Way	As required	12	375	70
FS-12	Freeway Drive	River Bend Road and Cameron Way	As required	12	1,309	240
FS-13	West Mount Vernon	Modify Pump Station	As required			150
FS-14	Central CSO Regulator	Add Fail-Safe Gate Operator	2001			30

1. Improvements are based on saturated development, based on the UGA boundary, 100 gpcd, 1, 100 gpad (inflow and infiltration), and L.A. Peaking curve.
2. Costs are based on ENR Cost index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.

TABLE ES-3

Collection System Improvements					
ID No.	**Location**	**Defect**	**Defect identified Via**	**Improvement**	**Cost ($1,000)[1]**
CS-1	Snoqualmie, MH B29A to MH B29	Root intrusion	Video[2]	Remove roots and Slipline with 300 LB	$20
CS-2	Yard of house 1115 N0. 8th, MH 49 to MH 50	Root intrusion	Video[2]	Remove roots and Slipline with 250 LB	$20
CS-3	So. 7th and Jefferson to So. 7th and Washington, MH 39 to MH 37	Root intrusion	Video[2]	Remove roots and Slipline with 450 LB	$20
CS-4	No. 6th and Lawrence, MH C39 to MH C38	Root intrusion	Video[2]	Remove roots and Slipline with 320 LB	$20
CS-5	Brick Hill, MH 01, North along I-5	Root intrusion	Video[2]	Remove roots and Slipline with 400 LB	$20
CS-6	Blodgett Rd to North of Blackbur, MH 55 to MH 54	Root intrusion	Video[2]	Remove roots and Slipline with 270 LB	$20
CS-7	Kincaid, MH 25, to MH 23	Root intrusion	Video[2]	Remove roots and Slipline with 240 LB	$20
CS-8	So. 20th, North off Section, MH 32 to MH 31	Root intrusion	Video[2]	Remove roots and Slipline with 120 LB	$20
CS-9	Section, MH D33 to between MH D32-D31	Structural Damage	Video[2]	Replace with 420 LF of 8-inch pipe	$50
CS-10	Alley between Douglas and Walter, MH A13 to A05	Structural Damage	Video[2]	Replace with 640 LF of 8-inch pipe	$75
CS-11	107 Cedar to the South, MH F11 to F29	Structural Damage	Video[2]	Replace with 300 LF of 8-inch pipe	$45
CS-12	No. 6th, MHF13 to F14	Structural Damage	Video[2]	Replace with 400 LF of 8	$60
CS-13	Section and Rail Road Ave, MH E17 to E18	Structural Damage	Video[2]	Sport repair-verify grease problem is corrected	$5

Table ES-3 cont.

Collection System Improvements					
ID No.	**Location**	**Defect**	**Defect identified Via**	**Improvement**	**Cost ($1,000)[1]**
CS-14	Broadway at alley between So. 9th & 10th, MH D41 to D40	Structural Damage	Video[2]	Slipline with 330 LF	$20
CS-15	Broad, east of So. 11th, MH 54 to MH 49	Structural Damage	Video[2]	Replace with 230 LF of 8-inch pipe	$20
CS-16	Line under I-5	Structural Damage	Video[2]	Will require further	--[4]
CS-17	Alley, north of Division, east of No. 11th, MH C66 to C65	Structural Damage	Video[2]	Spot Repair	$5
CS-18	Bernice, east of So. 14th, MH G42 to G41	Structural Damage	Video[2]	Spot Repair	$5
CS-19	So. 3rd and Vera, MH A41 to I42	Structural Damage	Video[2]	Pipe has been	--
CS-20	Lawrence and 7th, MH C73	Structural Damage	Video[2]	Spot Repair	$5
CS-21	1224 12th Str. So, between MH G8 and G11	Structural Damage	Video[2]	Replace with 200 LF of 8-inch pipe	$25
CS-22	117th North 8th Str.	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-23	420 E. Fulton	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-24	919 W. Division	Flooding	Data Base[3]	No improvements-surface flooding problem	--
CS-25	Alley at Carpenter, between So 9th and so. 10th heading north to Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-26	1120 No 16th, 340 ft north of MH M68 on Florence and 16th	Cracked Pipe	Data Base[3]	Spot Repair	$5

Table ES-3 cont.

ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-27	1210 N. 14th, north of Florence and 14th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-28	8th Str. And Evergreen heading north, F18 to F15	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-29	7th and Warren, toward Fulton, MH C73 to C72	Cracked Pipe	Data Base[3]	See 8th Str. Section	--[5]
CS-30	16th and Blackburn heading east 17th, J08 to J09	Obstruction	Data Base[3]	Jet main and monitor flows	--
CS-31	100 Washington-storm line going to SE under I-5, MH C19 to C20	Cracked Pipe	Data Base[3]	Will require further assessment	--[4]
CS-32	Scott's Bookstore, N 1st to N 1st and Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-33	Snoqualmie St. between Cleveland and S 2nd Str. MH B32 to B03	Cracked Pipe	Data Base[3]	Reassess slipline if necessary	--
CS-34	Westside of Christenson Seed West to So 3rd, MH E01 to A39	Infiltration	Data Base[3]	Spot Repair	$5
CS-35	Cleveland and Blackburn to just West of Harrison and Blackburn, MH J11 to J09	Inflitration, Joint problem	Data Base[3]	Slipline 300 LF	$20
CS-36	N Laventure just south of E Fir to N Laventure just north of E Fir, MH N06 to N04	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-37	North of Casecade Str., on N Laventure to S of E Fir on Laventure, MH N08 to N06	Root intrusion	Data Base[3]	Reassess slipline if necessary	--

Table ES-3 cont.

ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-38	N Laventure, Fulton to Cascade, MH N12 to N10	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-39	Hoag Rd., Parkway Dr., to Hoag Rd	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-40	Lind Str. And S. 6th to N on S 6th, MH E76 to E75	Infiltration	Data Base[3]	Spot Repair	$5

[1] Costs are based on ENR Cost Index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.
[2] Defect identified via review of video records.
[3] Defect identified via review of City Sewer Data Base.
[4] Interstate-5 Crossings are estimated at $750,000 for all nine improvements.
[5] 8th Street Improvements have been estimated at $1,000,000 to correct the localized surcharging.

Table ES-4

Capital Improvement Program Cost ($1,000)[1]				
Year(s)	Wastewater Conveyance System[1]	Wastewater Treatment Facility[1]	Combined Sewer System Treatment[2]	Total[1]
2001	$570	$0	$0	$570
2002	$635	$350	$0	$985
2003	$1,000	$1,200	$0	$2,200
2004	$750	$11,940	$0	$12,690
2005	$620	$0	$0	$620
2006	--[3]	$0	$0	$0
2011-2020	$2,510	$9,800	$9,100	$21,410
TOTAL	$6,085	$23,290	$9,100	$38,475

1. ENR Construction Cost Index 6397, October 2001.
2. Detailed costs are provided in Chapter 5 and Chapter 10.
3. Improvements during these years are expected to be identified as necessitaty dictates, and costs are included in the future cost estimates.

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ABBREVIATIONS

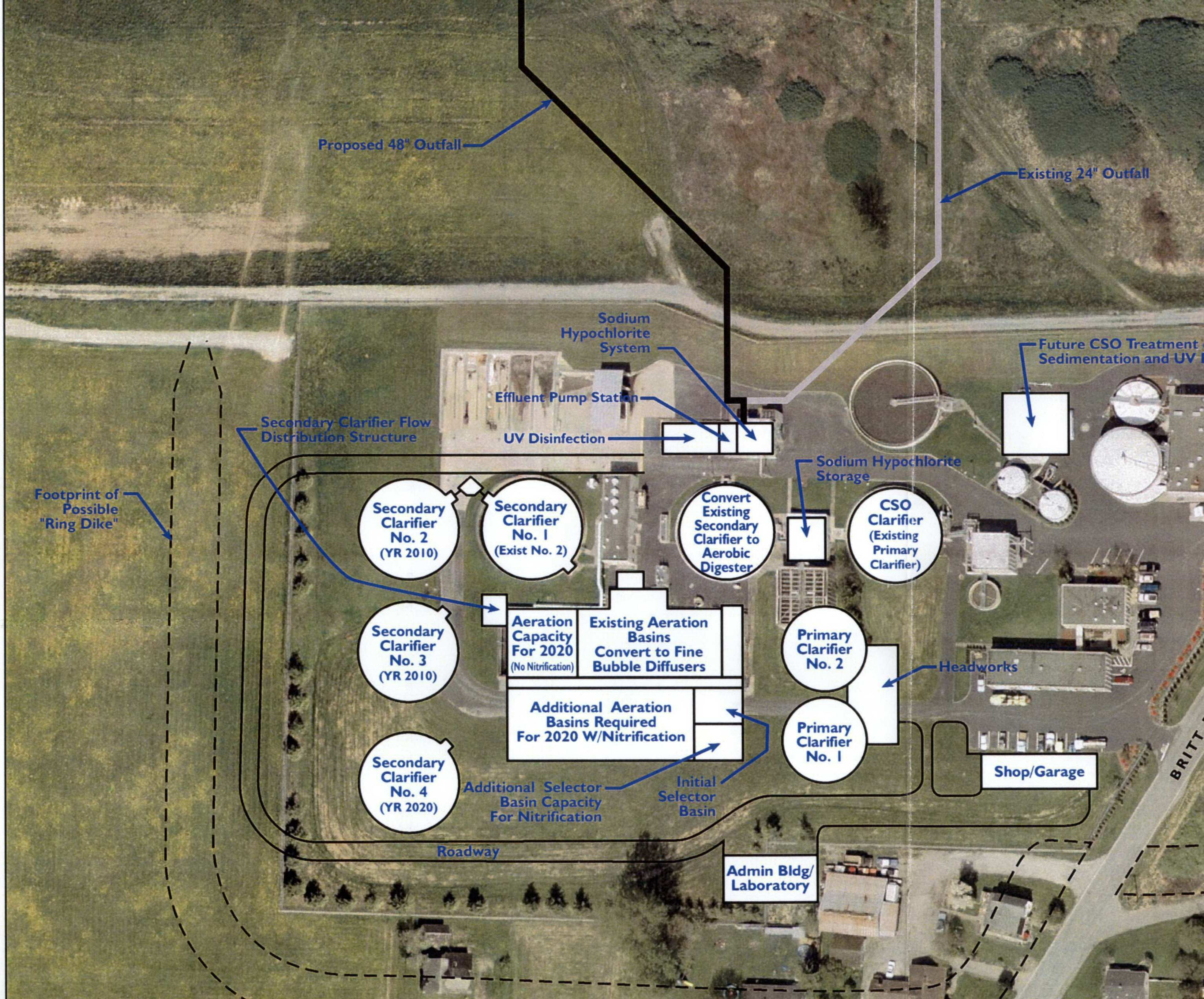
ac	Acre
ADMM	Average Day Maximum Month
AKART	All known, available, and reasonable methods of treatment
BAT	Best Available Technology Economically Achievable
BE/BA	Biological Evaluation/Biological Assessment
BOD	Biochemical Oxygen Demand
BPT	Best Practical Control Technology Currently Available
$CBOD_5$	Carbonaceous 5-day biochemical oxygen demand
cf	Cubic feet
cfs	Cubic feet per second
cfu	Colony forming units
cfu/100 mL	Colony forming units per 100 milliliters
CSO	Combined Sewer Overflow
DAF	Dissolved air flotation
DAFT	Dissolved Air Floatation Thickener
DO	Dissolved oxygen
DOE	Department of Ecology
DVF	Draper Valley Farms, Inc.
EPA	Environmental Protection Agency
FEB	Flow equalization basin
fps	Feet per second
ft/mg	Feet per million gallons
GMA	Growth Management Act
gpad	Gallons per acre per day
gpcd	Gallons per capita per day

Abbreviations

gpd	Gallons per day
gpd/sf	Gallons per day per square foot
gpm	Gallons per minute
HGL	Hydraulic grade line
hp	Horsepower
HRT	Hydraulic residence time
kcf	1,000 cubic feet
kW	Kilowatt
KWhr	Kilowatt-hour
lb/day	Pounds per day
lb/d-sf	Pounds per day per square foot
lb/hr-sf	Pounds per hour per square foot
LF	Linear foot
LS	Lump sum
mg	Million gallons
mg/L	Milligrams per liter
mgd	Million gallons per day
mL/L/hr	Milliliters per liter per hour
MLSS	Mixed Liquor Suspended Solids
NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
OFR	Overflow Rate
ppcd	Pounds per capita per day
ppd	Pounds per day
psi	Pounds per square inch
RAS	Return activated sludge

ABBREVIATIONS

scfm	Standard cubic foot per minute
sf	Square foot
SRT	Solids residence time
TMDL	Total maximum daily loads
TSS	Total Suspended Solids
UGA	Urban Growth Area
UV	Ultraviolet disinfection
VSS/kcf-d	Volatile suspended solids per 1,000 cubic feet per day
WAC	Washington Administrative Code
WAS	Waste Activated Sludge
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WLA	Waste Load Allocations
WSEL	Water surface elevation
WWTP	Wastewater Treatment Plant



Proposed 48" Outfall
Existing 24" Outfall
Sodium Hypochlorite System
Future CSO Treatment
Sedimentation and UV
Effluent Pump Station
Secondary Clarifier Flow Distribution Structure
UV Disinfection
Sodium Hypochlorite Storage
Footprint of Possible "Ring Dike"
Secondary Clarifier No. 2 (YR 2010)
Secondary Clarifier No. 1 (Exist No. 2)
Convert Existing Secondary Clarifier to Aerobic Digester
CSO Clarifier (Existing Primary Clarifier)
Secondary Clarifier No. 3 (YR 2010)
Aeration Capacity For 2020 (No Nitrification)
Existing Aeration Basins Convert to Fine Bubble Diffusers
Primary Clarifier No. 2
Headworks
Additional Aeration Basins Required For 2020 W/Nitrification
Primary Clarifier No. 1
Secondary Clarifier No. 4 (YR 2020)
Additional Selector Basin Capacity For Nitrification
Initial Selector Basin
Shop/Garage
Roadway
Admin Bldg/ Laboratory
BRITT

1. INTRODUCTION

AUTHORIZATION

In May of 2000, the City of Mount Vernon authorized HDR Engineering to proceed with updating the City's Comprehensive Sewer Plan.

PURPOSE

The purpose of this update was to investigate and review the existing wastewater conveyance system and wastewater treatment facility. This included a review of the system operation and development of an improvement plan to meet future system needs. The development of this plan included:

- Reviewing existing flows and loads and estimating future flows and loads.
- Assessing the capability of the existing conveyance system and wastewater treatment plant to meet existing and future flows and loads.
- Develop the least costly system improvements to meet existing and future requirements.

The results of these investigations are presented in this report as a plan for expansion, operation, and maintenance of the wastewater conveyance system and wastewater treatment facility to comply with the requirements of the Washington State Department of Ecology as set forth in their rules and regulations, WAC 173-240 and WAC 173-245.

ACKNOWLEDGEMENTS

The suggestions, contributions, and assistance provided by the City's staff were invaluable in the preparation of this report.

2. SYSTEM DESCRIPTION

SYSTEM BACKGROUND

Mount Vernon, Washington, is situated approximately half way between Seattle and the Canadian Border. It ranks first in size among the major communities in Skagit County.

Potable water supply to Mount Vernon is provided by the Skagit County Public Utility District (PUD) No. 1, the eleventh largest water provider in the State of Washington. Water diverted from the Cultus Mountain streams is stored in the recently upgraded 1.45 billion gallon Judy Reservoir. After Treatment at the Judy Reservoir Water Treatment Plant, finished potable water is supplied to Mount Vernon via the existing transmission pipeline. At present, the Skagit County PUD No. 1 is constructing a Skagit River Pump Facility to provide an alternate raw water supply to the Judy Reservoir, expanding the treatment capacity of the water treatment plant, and constructing of a new transmission line to Mount Vernon.

At present, the maximum pumping capacity to Mount Vernon is 18 million gallons per day. The annual average consumption is estimated to be 7 million gallons per day; the annual peak consumption is 14 million gallons. Basic charge is $11.40 per month per single family dwelling. From 0 to 600 cubic feet the charge is $1.43 per c.f.; over 600 cubic feet the charge is $1.93 per c.f. There is a $10 connection fee, and first-time users are required to make a $100.00 refundable deposit.

The City of Mount Vernon provides the wastewater services and the following sections provide a summary description of the existing system.

OWNERSHIP AND MANAGEMENT

The City of Mount Vernon provides treatment and conveyance of domestic, industrial, and commercial wastewaters within the City's UGA. The one large industrial customer currently served is Draper Valley Farms, Inc. which is a chicken processing facility.

EXISTING FACILITIES INVENTORY

Summary

The existing sewer system consists of both sanitary and combined sewers. The combined sewers are limited to the older portions of the City. Gravity sewers range in size from 6-inch to 60-inch pipes. Combined service area is approximately 2 square miles and the separated service area covers approximately 14 square miles. The total service area is served by approximately 120 miles of pipe. A majority of the pipe materials are concrete, but clay, corrugated metal, and PVC have also been utilized. Major interceptors, pump stations, combined sewer overflow structures, and the wastewater treatment plant are identified below.

Interceptors

The major interceptors in the City are:

- Central Interceptor;
- West Interceptor;
- Kulshan Interceptor;
- Alder Lane Interceptor; and
- Southeast Interceptor.

These convey all flows to the wastewater treatment plant.

Pump Stations

Mount Vernon's wastewater flows are conveyed to the treatment plant through a series of pump stations. The conveyance system pump stations are presented in Table 2-1.

Table 2-1

City of Mount Vernon's Sanitary Sewer System Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Firm Pumping Capacity (gpm)**
Alder Lane	Submersible	4	2,800
East College Way	Submersible	2	380
Hoag Road	Submersible	2	200
Martin Road	Submersible	2	200
Freeway Drive	Submersible	2	350
Maple Way	Wet well/dry well	2	800
West Side No. 2	Submersible /grinder	2	100
Hazel Street	Submersible	2	150

Table 2-1 cont.			
City of Mount Vernon's Sanitary Sewer System Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Firm Pumping Capacity (gpm)**
19^{th} Street	Submersible	2	280
Division Street	Submersible	2	160
Eaglemont Pump Station No.1	Submersible	2	560
Eaglemont Pump Station No.2	Submersible	2	620
South Mount Vernon	Submersible	2	

Combined Sewer Overflow Structures

Overflows from the combined sewer portions of the City are diverted at three overflow structures to two overflow pump stations. The overflow structures are located at First Street and Freeway Drive, Division Street under the Second Street Overpass, and Park Street at Harrison Street. The overflows from the Freeway Drive and Division Street structures flow together to the Division Street Pump Station. Overflows from the Park Street structure flow to the Park Street Pump Station. The overflow pump stations discharge directly to the Skagit River. A detailed description of the CSO system is presented in Chapter 4.

Wastewater Treatment Facility

The existing WWTP liquid stream processes consists of coarse bar screens followed by the Influent Pump Station, which pumps to a comminutor. Flows from the West Mount Vernon Pump Station combine with the influent pump station flows at the comminutor and flow through the primary clarifier. The liquid stream continues to the activated sludge pump station, aeration basins, secondary clarifiers, chlorine mixing chamber, chlorine contact basin, and effluent pump station. Effluent is discharged to the Skagit River via a 24-inch outfall.

The existing WWTP solids stream processes consists of primary sludge thickening (via a gravity thickener) and waste-activated sludge thickening (via a dissolved air floatation thickener), anaerobic digestion, biosolids dewatering via belt filter press, and biosolids storage.

3. Basic Planning Data

The basic planning data used to predict the City's future land use and wastewater flows and loads are presented in this chapter. Population growth projections for the City of Mount Vernon from the Office of Financial Management and the urban growth area define the future needs of the City.

Introduction

The City of Mount Vernon's current Comprehensive Sewer and Combined Sewer Overflow Reduction Plan was adopted by the City Council in 1994 and approved by the Department of Ecology (DOE) in 1995. In October 1995, a Wastewater Treatment Plant Evaluation was prepared that identified improvements that would be required to provide treatment of combined sewer flows as required by the City's Consent Decree with Department of Ecology. The 1995 report also identified treatment plant improvements required to accommodate growth in the service area. Since the publication of the1995 report, the City has constructed the Kulshan Intercepter and the Central CSO Regulator. This pipeline provides inline storage for combined sewer flows that would have otherwise overflowed to the Skagit River. In November 1998 a Draft Wastewater Flow and Organic Load Projection Report was prepared for the City. At the time the 1998 report was developed, less than a year of operational data from the Central CSO Regulator was available.

The following chapter revises the wastewater flow and load projections for the City based on additional operating data.

Related Plans

This Comprehensive Sewer Plan Update builds on the previous studies and plans prepared for the City of Mount Vernon, which include:

- 1994 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan
- 1995 City of Mount Vernon Wastewater Treatment Plant Evaluation
- 1998 Wastewater Flow and Organic Load Projection Report
- 2000 Mount Vernon WWTP Mixing Zone Study

Service Area Characteristics

Background

Mount Vernon has historically provided sewer service within the Urban Growth Area. Increased conveyance and treatment issues are currently being addressed with this study. Recommended improvements for combined sewer overflow issues are addressed in Chapter 4.

Geography

The City of Mount Vernon slopes south and west towards the Skagit River. Interstate 5 runs along the western side of the service area. Levees protect the City from flooding by the Skagit River.

Existing Sewer Service Area

The existing sewer service area is comprised of connections within the City limits and near future service area. Figure 3-1 delineates the existing sewer service area boundary.

UGA Sewer Service Area

The planning period for this study is 20 years, with 10- and 20- year projections starting in 2000.

The future sewer service area is the UGA boundary identified by the Skagit County Comprehensive Plan and is delineated graphically in Figure 3-2.

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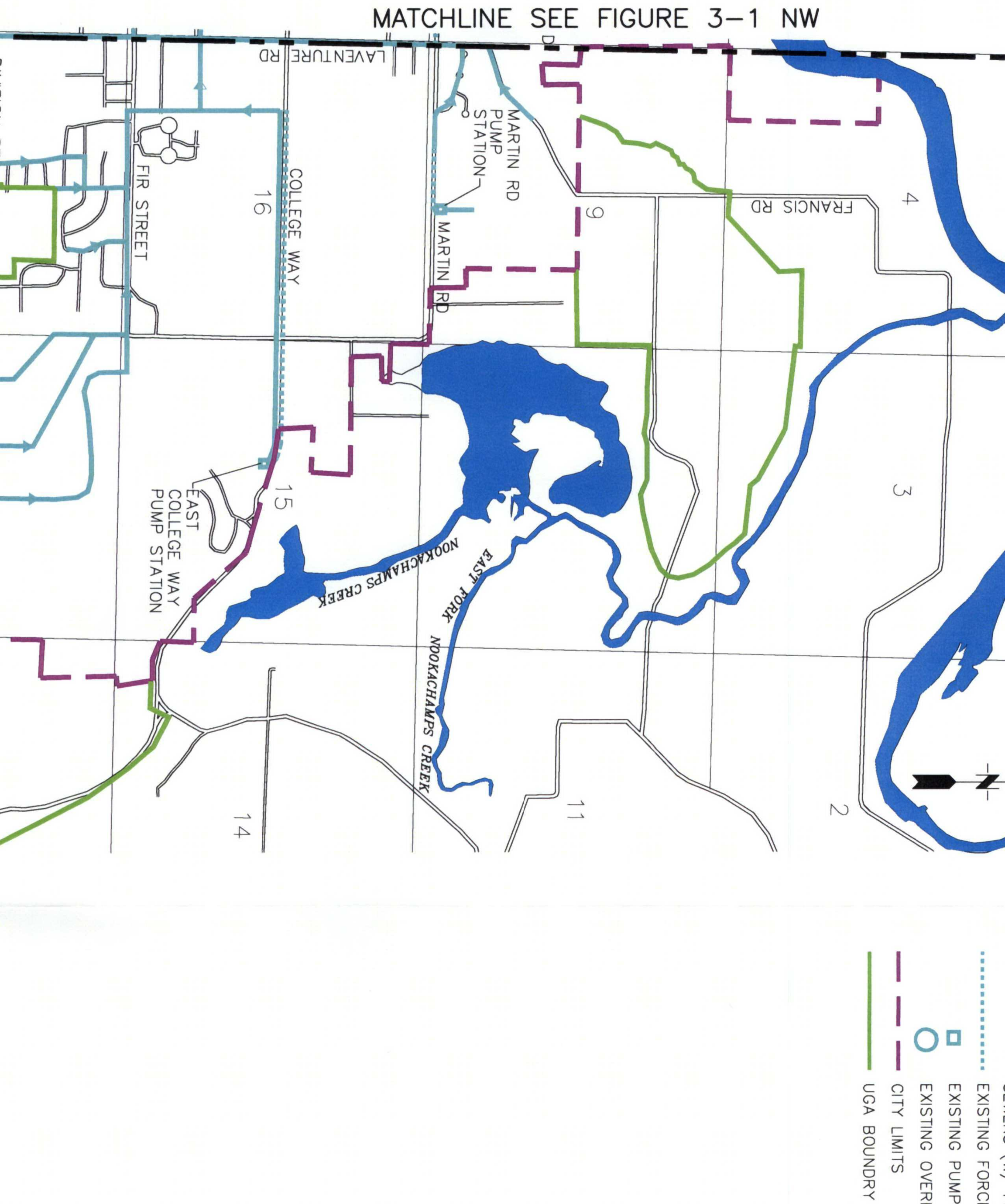
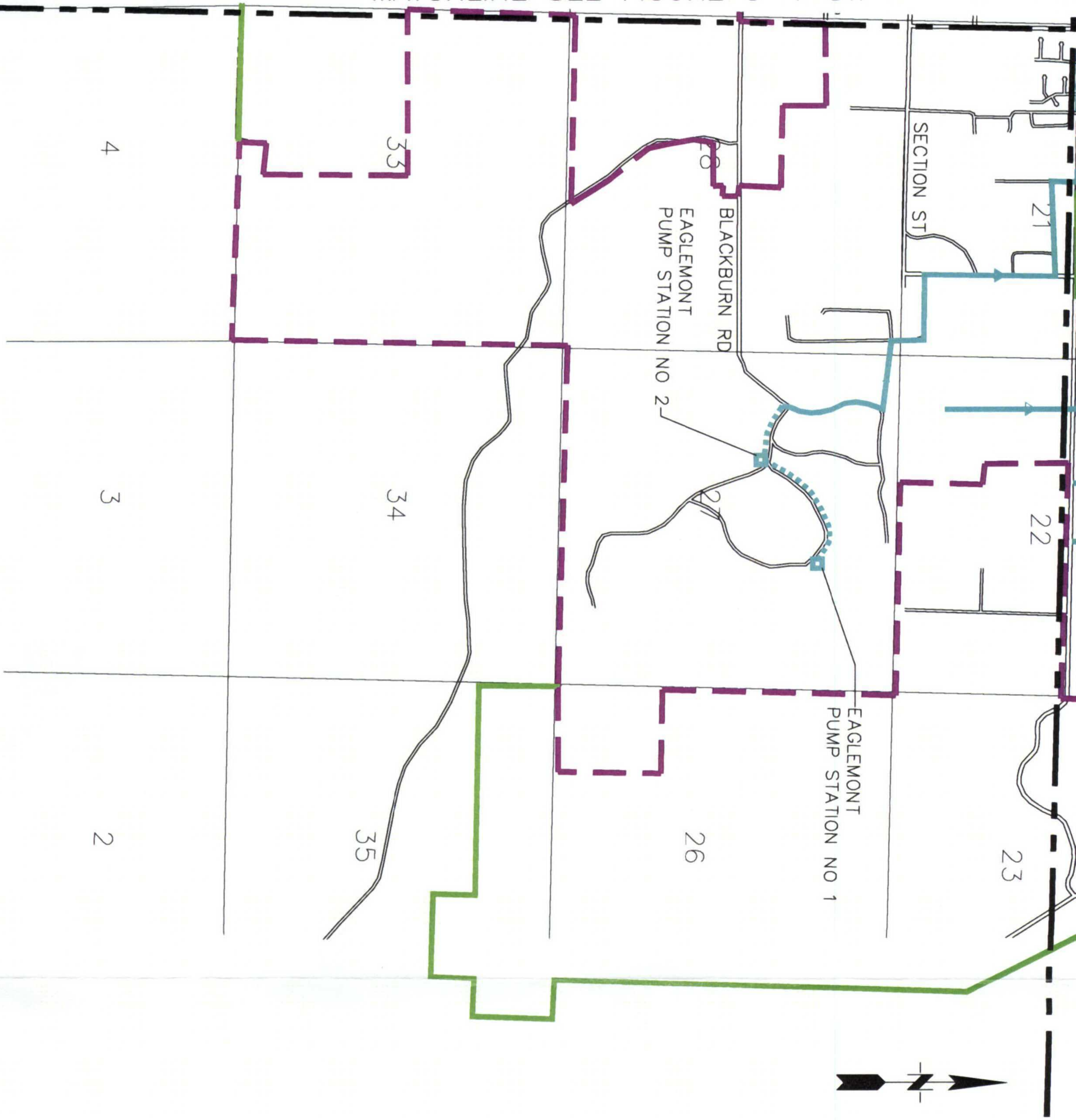


MATCHLINE SEE FIGURE 3-1 NW
LAVENTURE RD
MARTIN RD PUMP STATION
FIR STREET
COLLEGE WAY
MARTIN RD
FRANCIS RD
EAST COLLEGE WAY PUMP STATION
NOOKACHAMPS CREEK
EAST FORK NOOKACHAMPS CREEK
16
9
4
15
3
14
11
2
EXISTING FORC
EXISTING PUMP
EXISTING OVER
CITY LIMITS
UGA BOUNDRY

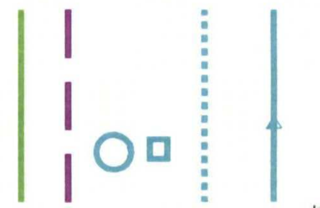
DATE: 02/12/03

MATCHLINE SEE FIGURE 3-1 SW



DATE: 02/17/03

MATCHLINE SEE FIGURE 3-1 NE



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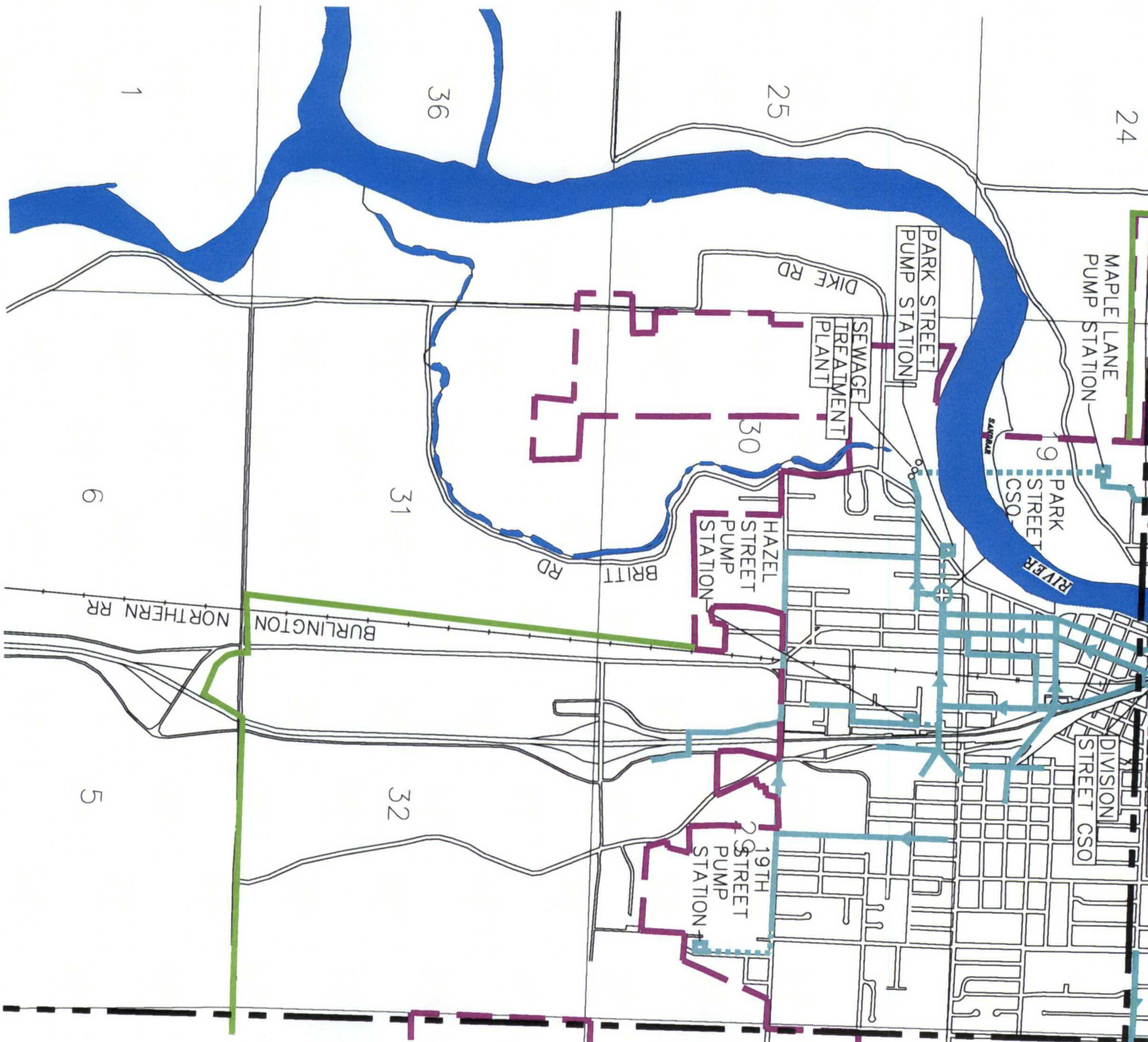
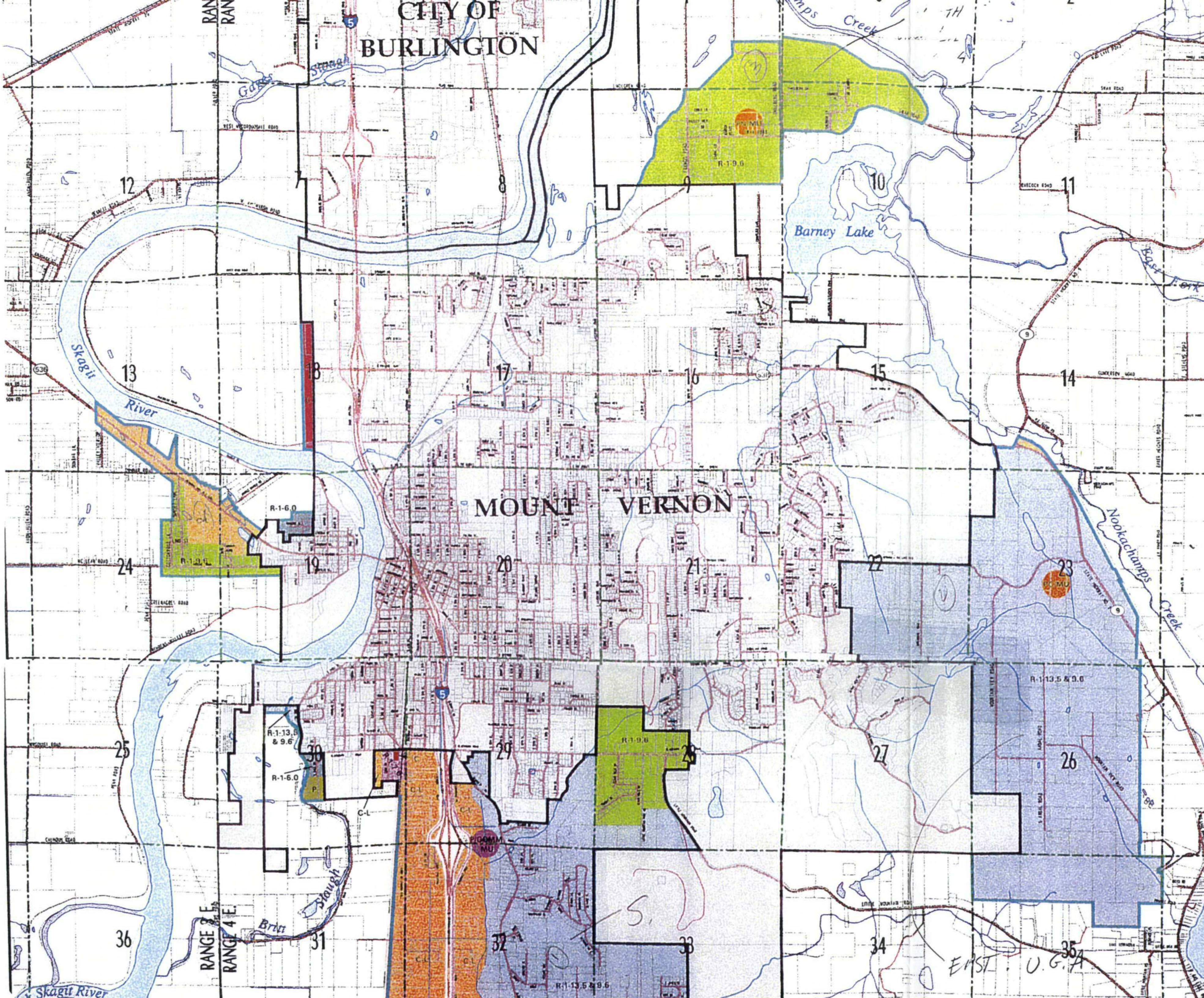


MATCHLINE SEE FIGURE 5–1 SE


CITY OF BURLINGTON
MOUNT VERNON
Skagit River
Barney Lake
Nookachamps Creek
Britt Slough
RANGE 3 E.
RANGE 4 E.
R-1-9.6
R-1-6.0
R-1-13.5 & 9.6
C-L
P
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EAST U.G.A

Population Projections

The GMA population projections from the Skagit County Comprehensive Plan for the Mount Vernon Urban Growth Area (UGA) were summarized in the 1998 Wastewater Flow and Organic Load Projection Report. These projections are presented in Table 3-1.

TABLE 3-1

City of Mount Vernon Population Projections and Service Area Population Projections		
Year	**City of Mount Vernon GMA Population Projections**	**City of Mount Vernon Service Area Population Projections**
1995	23,416	
1998	26,485 (interpolated)	22,540
2000	28,531	26,232
2005	33,463	29,431[1]
2010	38,396	35,861[1]
2015	43,559	42,292[1]
2020	48,722[1]	48,722[2]

1. Extrapolated from GMA Projections
2. All areas within the GMA are served by 2020

The study noted that the 1998 interpolated population was greater than the population of 22,540 used by the Washington State Department of Revenue. The discrepancy was attributed to the fact that areas within the UGA that are not currently incorporated in the City limits. For wastewater planning purposes it is assumed that all future areas within the UGA will be annexed and the City will provide wastewater service to the projected GMA population by the year 2020. For purposes of estimating current loads, the 2000 population is assumed to be 23,000.

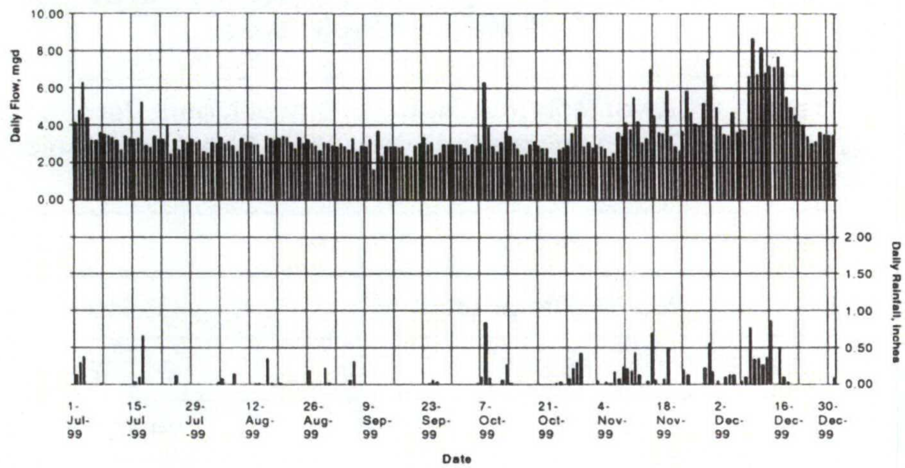
Historical Flows and Loads

Wastewater Treatment Plant Flow

Wastewater treatment plant daily flow records from the last five years were reviewed to determine the historical loading. The flow records were compared with daily rainfall to determine the impact of rainfall on plant flows. The rainfall is measured at the wastewater treatment plant. Figure 3-3 illustrates the daily flows with the recorded rainfall for July 1 to

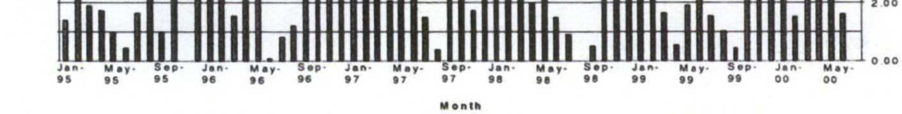
December 31, 1999. This plot illustrates that during late summer the flows reach a base rate of about 2.6 mgd. The plot also illustrates in the dry weather period the five day work week of Draper Valley Farms(DVF), Inc, which discharges from 0.4 to 0.6 mgd when in operation. In November and December rain caused the direct increase in treatment plant flows.

Figure 3-3 Mount Vernon Daily WWTP Flows and Rainfall, July 1 - December 31, 1999



The seasonal trend in flow is observed when average monthly flows are plotted against rainfall as shown in Figure 3-4.

Figure 3-4 City of Mount Vernon Monthly WWTP Flows



Commercial Flow

The 1998 Wastewater Flow and Organic Load Projection Report estimated 0.6 mgd of flow from 638 commercial customers based on water meter readings. Skagit County documented that the existing commercial area in Mount Vernon is 292 acres. The existing commercial loading rate is 2,055 gpd per acre.

Industrial Flow

The major industrial wastewater discharger in Mount Vernon is Draper Valley Farms, Inc. (DVF), a chicken processing facility. The current wastewater discharge, on a monthly basis, is approximately 0.45 mgd.

Domestic Flow

The remaining dry weather flow component after commercial and industrial flows are removed is domestic sanitary flow. The existing domestic flow is estimated as follows:

Total Dry Season Flow	2.62 mgd
Commercial Flow	- 0.60 mgd
Industrial Flow	- 0.43 mgd
Total Domestic Flow	1.59 mgd

Based on an estimated population of 23,000, the current per capita loading rate without infiltration and inflow is 69 gpcd (1.59 mgd/23,000).

Infiltration & Inflow

As rainfall increases there is a corresponding increase in wastewater flows. This extraneous flow is known as infiltration and inflow. Inflow is a direct entry of storm water into the sewer system through direct piping connections such as catch basins, leaking manhole covers, roof gutters, driveway drains and other area drains.

Infiltration is ground water that enters the sewer system through defects or other subsurface connections. Infiltration sources include cracks in pipes, manholes, subsurface foundation drains or even basement and crawl space sump pumps. During heavy rains infiltration may increase rapidly and in a review of flow data this rain induced infiltration may appear to be inflow.

The older portions of Mount Vernon have combined sewers. These sewers were originally designed to convey both storm and sanitary sewer flows. Many parts of the separated system also experience infiltration and inflow.

In addition to the storm water inflow component, these portions of the system are constructed of clay and concrete pipe. Due to their age, materials, and methods of construction, these portions of the system are subject to higher levels of infiltration and inflow. To determine the 'additional infiltration and inflow component,' an evaluation was made to quantify this component. This was computed by subtracting the commercial, industrial, and residential flow components from the maximum monthly flow. The DOE guidelines of 100 gpcd for new sewer systems (including infiltration and inflow) was used to establish the baseline residential flow rate. The 'additional infiltration and inflow component' was then computed as follows:

Maximum Month Flow (January 1997)	5.39 mgd
Commercial Flow	- 0.60 mgd
Industrial Flow (DVF)	- 0.43 mgd
Baseline Residential Flow [23,000 persons x 100 gpcd[1]]	- 2.30 mgd
Additional Infiltration and Inflow Component	2.06 mgd

1. DOE criteria includes normal infiltration and inflow for a separated sanitary system.

There could be a deterioration of the system that could result in additional infiltration and inflow into the system. However, it is also anticipated that reconstruction of sewers will separate inflow sources and reduce infiltration. For the purposes of planning it is assumed that the current infiltration and inflow rate will remain the same throughout the planning period and improvements will offset infiltration and inflow for the existing system.

Combined Sewer Flows

Mount Vernon has combined sewers in the older portions of the City. The storm drainage connections produce excess flow during storm events. Combined Sewer Overflow (CSO) structures allow flow in excess of the sewer system and treatment plant capacity to be discharged directly to the Skagit River.

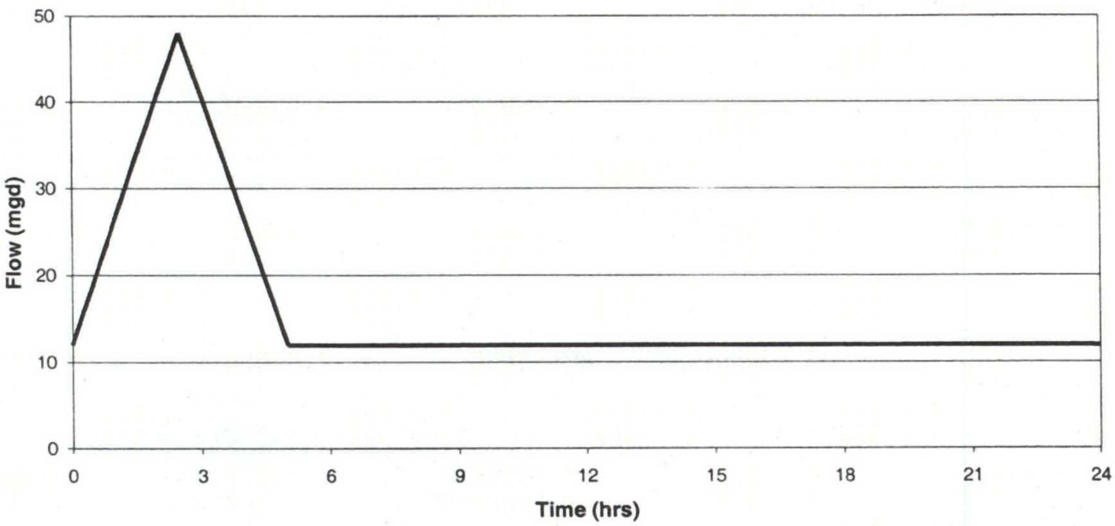
The CSO Baseline for Mount Vernon was established in 1988. It predicted an annual CSO volume of 116.5 MG for the average annual rainfall of 31.95 inches. Based on the 1988 collection system there was a 95 percent confidence that the volume, with an average annual rainfall, would be between 92 MG and 141 MG.

During 1988, flow monitoring allowed determination of not only the CSO Baseline, but also the peak flow rate due to combined flows. During some of the periods of high flow, the peak flow rates were not recorded, but estimates made in the 1994 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan predicted the peak system flow rate at 45 to 50 mgd. In 1997, the City placed the Central CSO Regulator, a 60-inch diameter interceptor, on-line. This has significantly reduced the occurrences of combined sewer overflows. A detailed summary and analysis of recent combined sewer history is presented in Chapter 4.

The May 16, 1988, storm event was estimated to be approximately a two-year storm recurrence. It was selected as a design storm event, and was considered to be reasonably conservative. In the 1995 Wastewater Treatment Plant Evaluation, the peak flow for the May storm event was estimated to be 47 mgd. Combining this flow with the one mgd contributed by the West Mount Vernon Pump Station yields a peak system flow rate of 48 mgd. The affects of the Central CSO Regulator are analyzed in Chapter 9.

Compliance with the DOE consent decree will require limiting untreated overflows to one event per year. To estimate the volume of the stormwater component for the one year storm event, historical CSO data was reviewed. The largest recorded overflow was on May 16, 1988. In the 1995 Wastewater Treatment Plant Evaluation, a detailed analysis of this storm was performed. An idealized combined sewer flow hydrograph was created in that evaluation and is presented in Figure 3-5.

Figure 3-5 Idealized Combined SewerFlow Hydrograph - May 16, 1988



The idealized combined sewer flow hydrograph shows a combined peak flow rate of 48 mgd. The maximum day storm flow component (total volume of storm flow) can be estimated from this hydrograph. The historic maximum day sanitary flows are subtracted from the total volume of flow in 24 hours to obtain the storm flow component as follows:

Total Combined Sewer Flows	15.8 mg
Historical Sanitary Maximum Day Flow	9.2 mg
Storm Flow Component	6.6 mg

The BOD and TSS loads for the storm flow component were estimated by reviewing existing data for CSO events. BODs for the larger storm events typically ranged from 10 to 60 mg/L, and TSS typically ranged from 20 to 100 mg/L. The maximums were applied to the estimated flows to establish the maximum anticipated loads. These are summarized in Table 3-2.

Table 3-2

Combined Sewer Component Flow and Load Projections for 2020		
Component	**Storm Maximum Day[1]**	**Peak Hour[2]**
Flow (mgd)	6.6 mgd	48 mgd
BOD (ppd)	3,300 ppd	-
TSS (ppd)	5,500 ppd	-

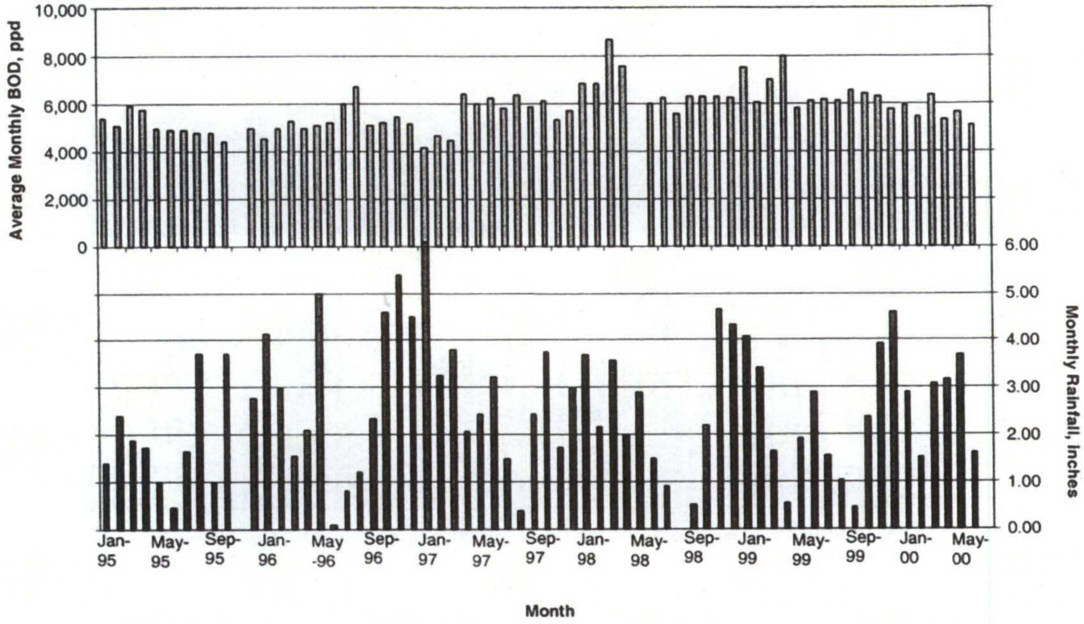
1. Storm flow component estimated from May 16, 1988, storm event.
2. Sanitary and storm components combined flow estimates

Treatment Plant Loading

Biochemical Oxygen Demand (BOD)

Figure 3-6 illustrates the monthly average day BOD loading to the treatment plant from January 1995 to June 2000. There are spikes in the BOD in March and April 1998 and in January, March, and April of 1999. A review of the daily treatment plant data determined that the averages of these months were significantly impacted by one or two days where the reported BOD load to the plant was 10,000 to 20,000 pounds per day. The treatment plant staff noted that there is a sampling problem that occurs during periods of high rainfall that caused the measured BOD concentration of the influent to be higher than actual loads. This assumption was verified by reviewing the BOD concentrations from the effluent from the primary clarifier for these days. Based on this analysis the monthly BOD load to the treatment plant is approximately 6,400 pounds per day.

Figure 3-6 City of Mount Vernon Monthly BOD Loadings



The BOD loading at the plant does not show any correlation with rainfall and the BOD load appears to remain relatively constant year round.

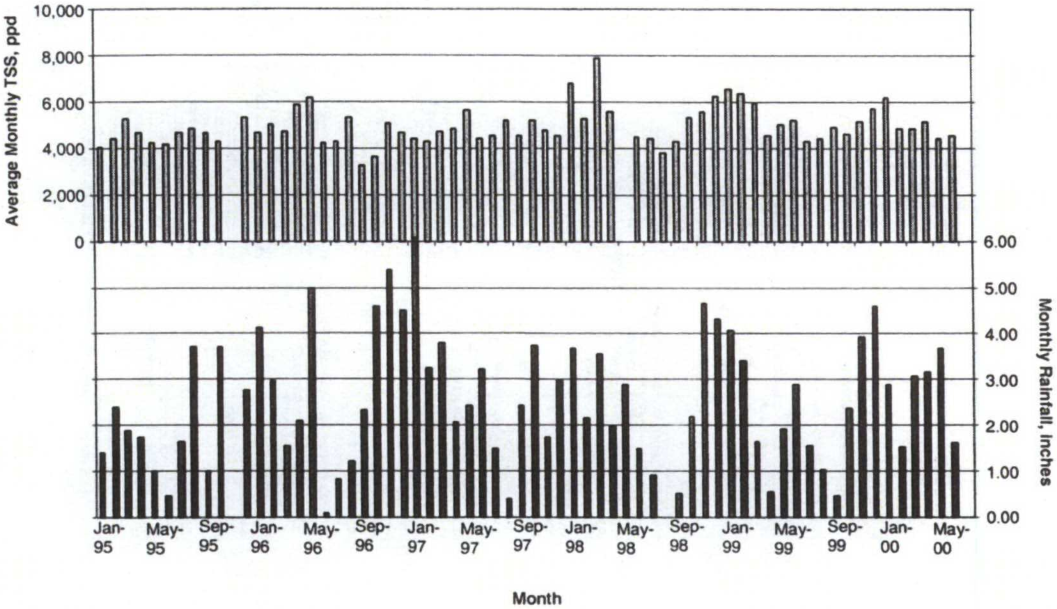
The only current industrial customer, Draper Valley Farms, Inc. (DVF), discharges between 500 and 1,200 ppd of BOD per month. Additional information on these loads is provided in Chapter 6. Based on previous City discussions with DVF it is assumed that the future flows from the plant could approach 0.75 mgd (Appendix A). Future BOD loads were estimated by increasing from the current discharge permit levels of 1,300 lbs. per day to 1,550 lbs. per day to allow for the increased flows.

The Maximum Month Average Day BOD load to the treatment plant from domestic and commercial sources is approximately 7,900 ppd, without Draper Valley Farms, Inc. This may be due to non-representative samples within the Central Interceptor after a storm event.

Total Suspended Solids (TSS)

Figure 3-7 provides the monthly average day TSS compared with rainfall. The reported TSS loads to the plant in March and December 1998 and in January 1999 through March 1999 were affected by a few days with excessive loads.

Figure 3-7 City of Mount Vernon Monthly TSS Loading



The review of TSS load and rainfall does not appear to show a correlation; however, there likely is some additional solids loading to the plant associated with the first flush of the system with rainfall in the Fall or following an extended dry period. Otherwise, the TSS load appears to remain relatively constant year round. The monthly TSS load to the treatment plant is approximately 5260 ppd.

The TSS load from DVF is typically from 400 to 600 ppd based on an influent concentration of 125 to 150 mg/L. The industrial component for DVF is further reviewed in Chapter 6.

The Maximum Month Average Day TSS load to the treatment plant from domestic and commercial sources is approximately 7,600 ppd, without DVF. This may also be due to settlement of solids and non-representative samples within the Central Interceptor after a storm event.

Ammonia

The historical influent ammonia concentration typically ranged between 10 to 30 mg/L as seen in Figure 3-8. The ammonia loading to the plant in pounds per day is illustrated in Figure 3-9. Similar to BOD and TSS loadings, the total ammonia load to the plant does not seem to be related to rainfall and appears to remain constant through the year. The average month ammonia load to the plant is approximately 550 pounds per day.

Figure 3-8 City of Mount Vernon Ammonia Nitrogen Influent Concentration

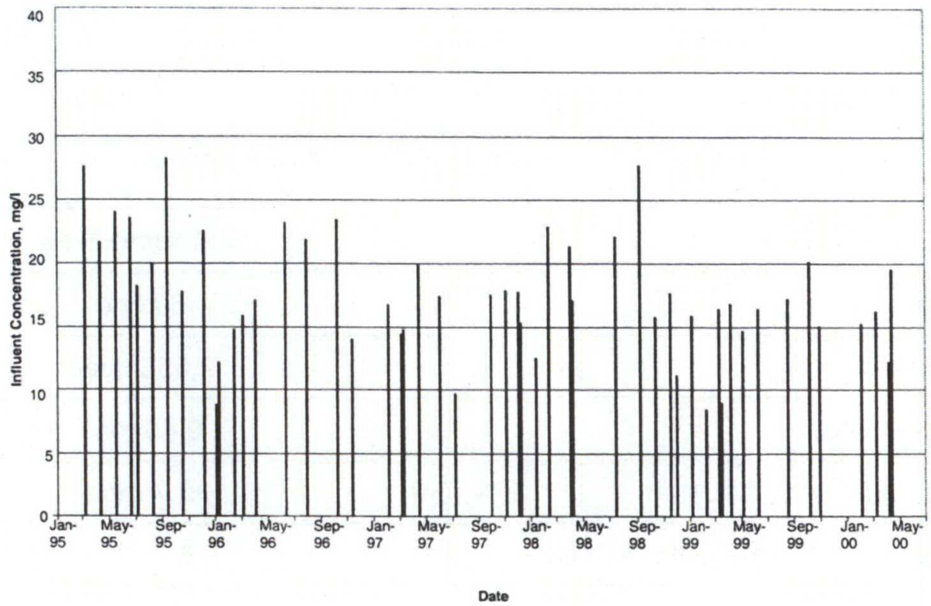
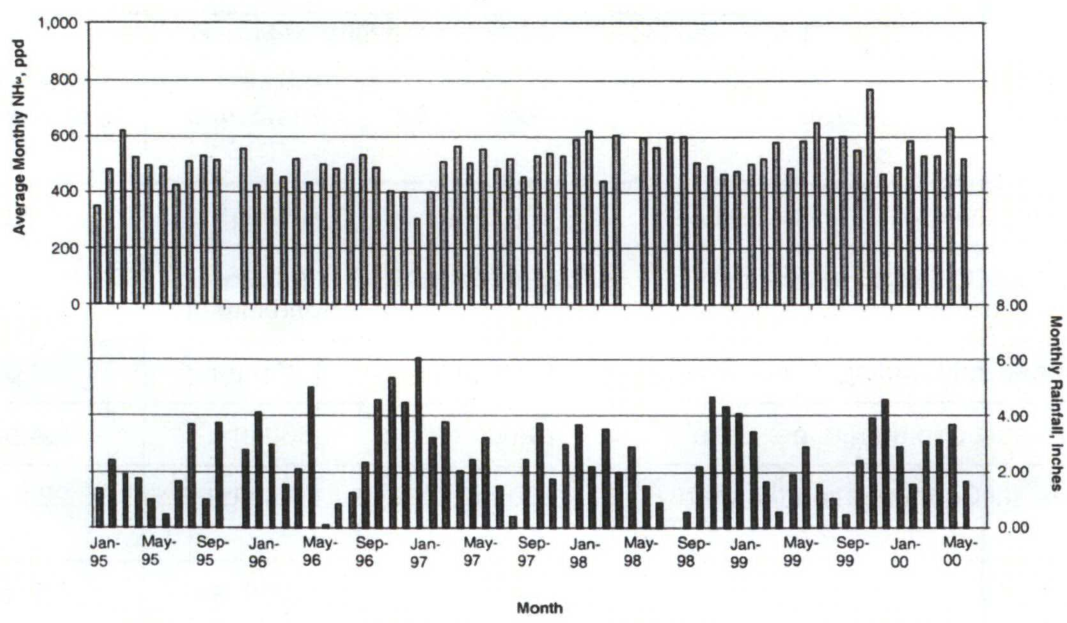


Figure 3-9 City of Mount Vernon Monthly Ammonia Loading



The 1998 Wastewater Flow and Organic Load Projection Report estimated the average daily ammonia concentration from DVF at 22 mg/L. This equates to a total daily load of approximately 84 ppd. The domestic and commercial ammonia load would be 466 ppd.

Summary of Historical Flows and Loads

Table 3-3 summarizes the historical flows for the City. Table 3-4 summarizes the historical loads for the City.

Table 3-3

Historical Flows for the City of Mount Vernon	
Parameter	**Historical Flow**
Per Capita Flow[1]	69 gpd
Commercial Flow	2,055 gpad
Draper Valley Flow	0.46 mgd
Average Annual Day (AAD)	3.7 mgd
Average Day Maximum Month (ADMM)	5.4 mgd
Maximum Day	9.2 mgd

1. Does not include infiltration and inflow

Table 3-4

Historical Average Month Loads for the City of Mount Vernon			
Parameter	**Historical BOD**	**Historical TSS**	**Historical NH_3-N**
Domestic and Commercial Loading	5,200 ppd	4,600 ppd	370 ppd
Domestic and Commercial Per Capita Loading	0.18 ppd/capita	0.16 ppd/capita	0.016 ppd/capita
Commercial Loading w/o Domestic	1,000 ppd[1]	1,000 ppd[2]	100 ppd[3]
Industrial Loading (Draper Valley)	1,200 ppd[4]	660 ppd[5]	84 ppd
Industrial Concentration (Draper Valley)	300 mg/L[4]	160 mg/L[5]	22 mg/L
Total WWTP Loading	6,400 ppd	5,260 ppd	554 ppd

1. Based on 0.6 mgd and BOD concentrations of 200 mg/L
2. Based on 0.6 mgd and TSS concentrations of 200 mg/L
3. Based on 0.6 mgd and NH3 concentrations of 20 mg/L
4. October 1999
5. July 1999

PROJECTED FLOWS AND LOADS

Projected flows and loads were developed based upon DOE criteria and historical patterns for the City.

BOD load projections were developed independently for both domestic and commercial flow components. The historical domestic BOD loading has been 0.18 ppcd. This was increased to 0.20 ppcd for future predictions and matches DOE design criteria to be used when this information is not available. Domestic loads were based on 0.20 lbs. per capita per day. Commercial loads were based on a BOD concentration of 200 mg/L.

Similar to the BOD loadings, the TSS load projections were based upon 0.20 ppd/capita for residential loads and commercial contributions of 200 mg/L.

NH_4-N load projections were based upon 0.016 ppd/capita for residential and 20 mg/L for commercial and industrial contributions. Draper Valley Farms, Inc.'s contribution was based on a concentration of 22 mg/L.

Wastewater Treatment Plant Flow

Future flow projections for 2010 and 2020 are based on the estimated population, projected DVF flows, and the future commercial and other industrial loads. This information was obtained from the Skagit County Comprehensive Plan and the 1998 Wastewater Flow and Organic Load Projection Report. Flows from other industrial areas are based on the same flow rate as commercial flow. The future flow projections for these sources are summarized in Table 3-5.

The treatment plant has experienced a maximum influent flow rate of 14.8 mgd which is about 20 percent in excess of the existing peak hour design flow rate. Since the State WAC for CSO reduction requires CSO agencies to maximize the flow to the secondary plant and since the Central CSO regulator provides equalizing storage upstream of the plant it is possible that the treatment plant will experience the peak hydraulic capacity for periods exceeding one day.

Table 3-5

Flow Projections for the City of Mount Vernon					
	2010 Projection	**2020 Projection**	**Flow Rate**	**2010 Flows**	**2020 Flows**
Residential Population	35,861	48,722	100 gpcd	3.59 mgd	4.87 mgd
Commercial Area	500 ac	660 ac	2,055 gpad	1.03 mgd	1.36 mgd
Draper Valley Farms, Inc.	0.75 mgd	0.75 mgd	-	0.75 mgd	0.75 mgd
Other Industrial Area	337 ac	446 ac	2,055 gpad	0.69 mgd	0.92 mgd
Base System Flow				6.06 mgd	7.90 mgd
Additional Inflow and Infiltration Component (ADMM)				2.03 mgd	2.03 mgd
ADMM Flow				8.09 mgd	9.93 mgd
Peak Hour Flow[1]				14.9 mgd[2]	18.3 mgd[3]

1. Peaking factor based on L.A. Peaking Curve, Appendix B.
2. Peaking factor of 2.13.
3. Peaking factor of 2.06.

Organic Loads

Future load projections for 2010 and 2020 are based on the estimated population and future commercial and industrial loads and the projected Draper Valley Farms, Inc. loads. The future projections for these sources are summarized in Table 3-6 to Table 3-8.

Table 3-6

Projected BOD Loadings for the City of Mount Vernon					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential Population	35,861	48,722	0.20 ppd/capita	7,170 ppd	9,740 ppd
Commercial	1.03 mgd	1.36 mgd	200 mg/L	1,720 ppd	2,270 ppd
DVF	0.75 mgd	0.75 mgd	250 mg/L	1,550 ppd[1]	1,550 ppd[1]
Other Industrial	0.69 mgd	0.92 mgd	200 mg/L	1,150 ppd	1,540 ppd
Total				11,590 ppd	15,100 ppd

1. Based on existing discharge permit limit of 1,300 ppd increased by 19% anticipated hydraulic increase provided by DVF.

Table 3-7

Projected TSS Loadings for the City of Mount Vernon					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential Population	35,861	48,722	0.20 ppd/capita	7,172 ppd	9,744 ppd
Commercial	1.03 mgd	1.36 mgd	200 mg/L	1,720 ppd	2,270 ppd
DVF	0.75 mgd	0.75 mgd		890 ppd[1]	890 ppd[1]
Other Industrial	0.69 mgd	0.92 mgd	200 mg/L	1,150 ppd	1,540 ppd
Total				10,932 ppd	14,444 ppd

1. Based on existing discharge permit limit of 750 ppd increased by 19% anticipated hydraulic increase provided by DVF.

Table 3-8

Projected NH_4-N Loadings for the City of Mount Vernon[1]					
Load Source	Projected Population/Flow		Average Daily Loading	Projected Loads	
	2010	2020		2010	2020
Residential	35,861	48,722	0.016 ppd/capita	574 ppd	780 ppd
Commercial	1.03 mgd	1.36 mgd	20 mg/L	172 ppd	227 ppd
Other Industrial	0.69 mgd	0.92 mgd	20 mg/L	115 ppd	154 ppd
DVF	0.75 mgd	0.75 mgd	22 mg/L	138 ppd	138 ppd
Total				999 ppd	1,299 ppd

1. NH_4-N loading based on influent only. Additional NH_4-N loading to secondary treatment process by internal recycle of anaerobic digester supernatant.

SUMMARY OF PROJECTED FLOWS AND LOADS

The flow and loading projections for the treatment plant were developed in the previous section. These flows and loadings are summarized in Table 3-9. For maximum day and peak hour loadings, concentrations were assumed and loadings were calculated as shown.

Table 3-9

WWTP and CSO Flow and Load Projections				
Year	**Parameter**	**Average Day Maximum Month**	**Maximum Day**	**Peak Hour**
2010	Flow (mgd)	8.1	11.4	14.9
2010	BOD (ppd)	11,590	14,311	-
2010	TSS (ppd)	10,932	13,500	-
2010	NH4-N (ppd) [1]	999	1,040	-
2020	Flow (mgd)	9.9	13.9	18.3
2020	BOD (ppd)	15,100	17,338	-
2020	TSS (ppd)	14,444	16,600	-
2020	NH4-N (ppd) [1]	1,299	1,261	-
2020	CSO Flow (mgd)	-	6.6 [2]	48 [3]
2020	CSO BOD (ppd)	-	3,300	-
2020	CSO TSS (ppd)	-	5,500	-

1. NH_4-N loading based on influent only. Additional NH_4-N loading to secondary treatment process by internal recycle of anaerobic digester supernatant.
2. Storm flow component estimated from May 16, 1988, storm event.
3. Total of sanitary and storm component flow estimates

4. Combined Sewer System

Introduction

The State of Washington requires agencies with combined sewers to reduce untreated combined sewer overflows to an average of one event per year. The City of Mount Vernon developed a two phase CSO reduction plan and subsequently entered into a consent decree with the Department of Ecology. The first phase required the City to construct the Central CSO Regulator by December 2000. The second phase requires the City to construct treatment facilities by January 2015 that will reduce the remaining CSOs to one untreated event per year. The Central CSO Regulator was constructed and placed into service December 1997.

Total Maximum Daily Load (TMDL)

The Lower Skagit River has a TMDL limit for both dissolved oxygen (DO) and fecal coliform (see Chapter 7). The limits for DO will not apply during CSO events. The TMDL for fecal coliform will apply to CSOs, but will be determined as a geometric mean. This allows the City of Mount Vernon to have one untreated CSO event per year and remain in compliance. In effect, the TMDL, with regard to CSO events, will be met when all treated CSO flows meet the technology based limits of the NPDES permit (400 cfu/100 mL weekly average) and untreated CSOs are reduced to an average of one event per year.

Existing CSO System

Combined Sewer System

The existing sewer system consists of both sanitary and combined sewers. The combined sewer lines were primarily constructed prior to 1960. They serve approximately 555 acres in the older and downtown areas of Mount Vernon. Flows from the combined area are conveyed to the WWTP, with overflows being conveyed to two pump stations through three overflow structures:

- Freeway Drive Overflow Structure conveys flow to the Division Street Pump Station;
- Division Street Overflow Structure conveys flow to the Division Street Pump Station; and
- Park Street Overflow Structure conveys flows to the Park Street Pump Station.

Combined Sewer Overflow Pump Stations

Two pump stations convey combined sewer overflows to the Skagit River. Table 4-1 describes these pump stations.

Table 4-1

City of Mount Vernon's Combined Sewer Overflow Pump Stations			
Pump Station	**Type**	**No. of Pumps**	**Pumping Capacity**[1]
Division Street	Mixed Flow Vertical	3	22,300
Park Street	Wetwell/Drywell Horizontally Mounted Centrifugal	4	5,400 gpm[2]

1. Design pumping rate for all pumps operating.
2. An emergency backup unit is available, with a maximum capacity of approximately 6,500 gpm.

Central CSO Regulator

The Central CSO Regulator is a 60-inch diameter pipeline in downtown Mount Vernon. It provides conveyance and storage of combined and sanitary flows. During dry weather, wastewater flows are conveyed to the WWTP with the CSO Regulator acting as a gravity sewer pipe. During wet weather, the CSO Regulator is designed to store CSOs in the pipe, rather than discharging them to the Skagit River, and convey the wastewater to the WWTP as capacity becomes available. The CSO regulator provides approximately 1.1 million gallons of in-line storage and consists of:

- 6,800 feet of 60-inch concrete pipe;
- 600 feet of 30-inch concrete pipe;
- One flow regulating structure;
- Three flow control structures;
- Three overflow structures; and
- One Valve Structure on Cameron Way.

The CSO regulator is divided into five storage reservoirs, with storage volumes of 200,000 gallons, 197,000 gallons, 287,000 gallons, 285,000 gallons, and 131,000 gallons, for a total storage capacity of 1.1 million gallons.

Central CSO Regulator Hydraulic Performance

The Central CSO Regulator provides conveyance capacity to the wastewater treatment plant for combined sewer flows. The pipeline includes structures that allow excess volume of the pipeline to be used for inline storage of combined sewage. The 1995 Comprehensive Sewer and Combined Sewer Reduction Plan anticipated a reduction of overflows to an estimated 12 events per year.

Since the Central CSO Regulator was placed into service in December 1997, the number of overflow events has been reduced to approximately 8 events per year. The overflows that were documented from November 1998 to August 2000 are summarized in Table 4-2.

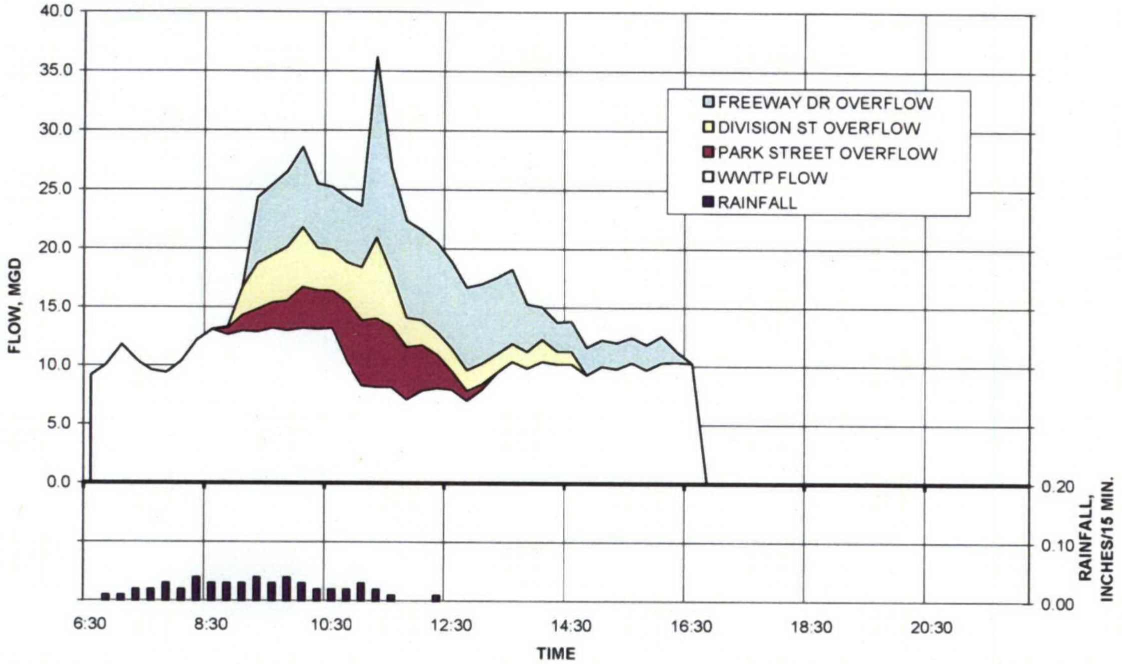
Table 4-2

Combined Sewer Overflows from November 1998 to 2000				
Date of Overflow	**Overflow Volume, gal.**	**Peak System Flow Rate, mgd[2]**	**Range of TSS Concentration, mg/L**	**Range of BOD Concentration, mg/L**
Nov 13, 1998	364,000	18.5	39 - 68	18 - 57
Dec 29, 1998	1,845,000	36.2	45 - 84	19 - 27
Jan 10, 1999	2,303,000	27.7	14 - 39	6 - 33
Jan 14, 1999	388,000	14.0	22 - 96	9 - 53
May 7, 1999	44,000	16.5	44 - 54	6
Jun 24, 1999	999,000	31.0	48 - 285	9 - 41
Jan 25, 2000	906,000	21.8	46 - 77	21 - 50
Apr 13, 2000[1]	9,624,000	32.3	N/A	N/A
Aug 18, 2000	396,000	17.4	111 - 119	3 - 4

1. The April 13, 2000 event has estimated flow data and TSS and BOD data were not available due to an equipment failure.
2. The Peak System Flow Rate includes all system flows including the wastewater treatment plant flow and overflows at Park Street Pump Station and Division Street Pump Station.

A cumulative flow hydrograph of the December 29, 1998 overflow event is illustrated in Figure 4-1. This figure illustrates the total sewer system flows including the wastewater treatment plant, overflows at the Park Street Pump Station, and overflows at the Division Street Pump Station.

Figure 4-1 City of Mount Vernon Combined Sewer System Flows, Cumulative Flows for December 29, 1998



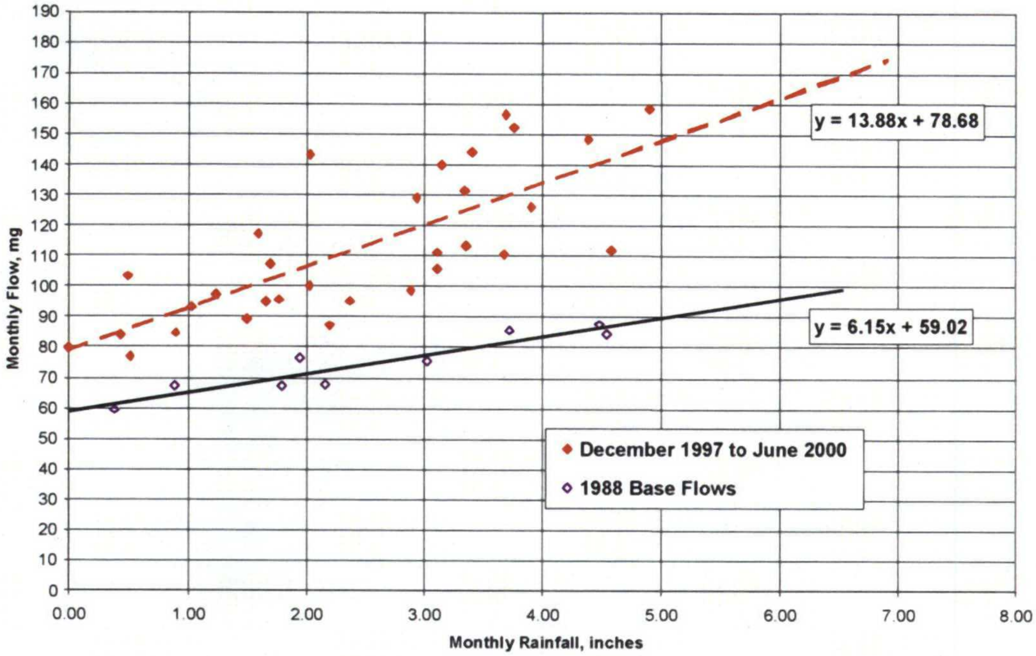
The October 1995 Wastewater Treatment Plant Evaluation evaluated the facilities required based on a peak design system flow rate of 48 mgd. The peak system flow rate observed since the Central CSO Regulator has been in service was 36.2 mgd. A detailed evaluation of the return frequency of this flow rate has not been performed.

For planning purposes it is recommended that 48 mgd continue to be used for a peak system flow rates.

Central CSO Regulator Volume Reduction Performance

The operation of the Central CSO Regulator has resulted in a considerable volume of combined sewage treated at the wastewater treatment plant that would have otherwise overflowed to the Skagit River. Figure 4-2 provides a scatter plot of monthly wastewater treatment plant flows verses monthly rainfall. The two sets of data points include data from 1988 base flows and the current treatment plant data from December 1997 to June 2000. A linear regression line has been provided for each set of data points. The y-intercept of this graph indicates the base sanitary treated at the plant. The increase of almost 20 mg per month reflects the growth that has occurred in the City over the past 12 years. The slope of the linear regression line reflects the volume of storm water per inch of rainfall that is treated at the wastewater treatment plant. The increase in slope reflects the additional combined sewage that is now being treated at the wastewater treatment plant and additional sources of infiltration and inflow.

Figure 4-2 City of Mount Vernon Monthly Flow vs. Rainfall



Using an average annual rainfall of 32.4 inches, the volume of rain induced flow treated at the plant in 1988 was 199 million gallons (32.4 inches per year x 6.15 million gallons/inch). Currently, the projected rain induced flow treated at the treatment plant is 450 million gallons (32.4 inches per year x 13.88 million gallons/inch). This reflects an increase of 251 million gallons per year. In the City's CSO Reduction Plan the estimated annual overflow volume was 116.5 million gallons. This earlier projection could have been in error or the amount of rain induced flow treated at the plant could have increased significantly. Even if the actual annual overflow volume was only 116.5 million gallons, the Central CSO Regulator has reduced the volume of overflows over 94 percent. This is based on a remaining overflow volume of 6 million gallons per year based on the 6 events identified in Table 4-2.

Using a long term antecedent condition index model the volume fraction of excess flow that is directly attributable to infiltration is up to 70 percent. The infiltration percentage is likely even higher because of the inability to distinguish the infiltration and inflow components based on the information that we have. Based on the flow data that is available at this time it is not possible to identify a unit flow hydrograph distinguishing the three major components of combined sewage flows: sanitary sewage, infiltration, and inflow.

Central CSO Regulator Solids Reduction Performance

The concentration of TSS in combined sewer overflows has ranged from 14 mg/L to 285 mg/L; however, the treatment plant personnel have documented that the combined sewage generally has concentrations around 50 mg/L. If the annual combined sewer overflow volume was assumed to be 116.5 million gallons with an average concentration of 50 mg/L, volume was assumed to be 116.5 million gallons with an average concentration of 50 mg/L, then the 110.5 million gallon reduction of overflows has reduced the annual total of solids discharged to the Skagit River by 46,000 pounds.

CSO Reduction Treatment Processes

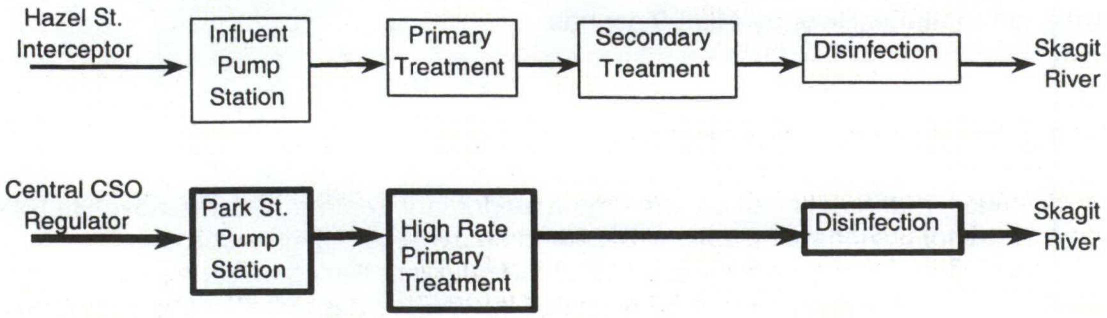
The State of Washington defines CSO treatment as primary treatment that removes at least 50 percent of the total suspended solids (TSS) and an average settlable solids concentration of 0.3 mL/L/hr, with a maximum of 1.9 mL/L/hr. Based on recent CSO treatment projects, the Department of Ecology has interpreted this to be an average annual solids removal requirement.

The 1995 Wastewater Treatment Plant Evaluation identified primary treatment facilities that would be required to reduce overflows to one untreated event per year based in accordance with the City's consent decree. Based on recent CSO treatment projects there are three alternatives for achieving the final reduction requirement in accordance with the consent decree. The primary difference is the level of treatment that is required for the effluent.

Treatment Alternative 1: CSO Treatment Facility

The first alternative would provide treatment for CSOs similar to the one detailed in the 1995 Wastewater Treatment Plant Evaluation. This treatment alternative would meet the 50 percent removal of the total suspended solids as required by WAC 173-245. A process flow schematic is shown in Figure 4-3. To meet the total peak hour capacity requirements of 48 mgd, high rate primary clarification would be provided. This alternative would require that during CSO events, flows from the Central CSO Regulator would remain separate from the flows through the secondary plant. The CSO treatment would include primary treatment, disinfection and discharge through the outfall. After CSO events the process units could be drained back to the secondary plant.

Figure 4-3 Alternative 1 CSO Treatment Facility Schematic



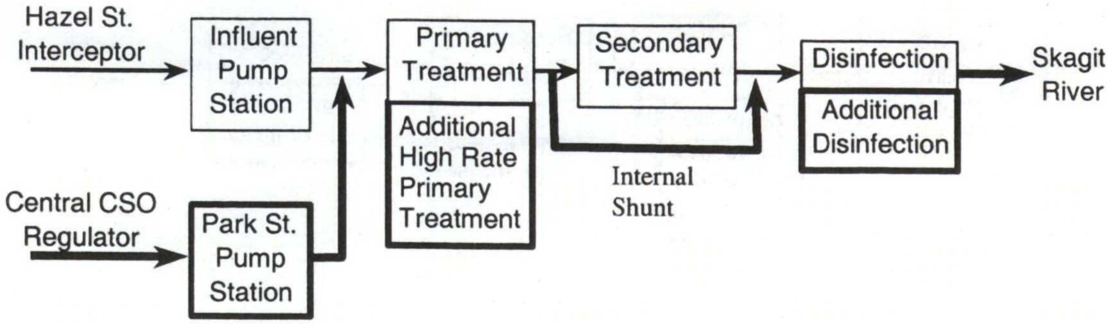
The improvements required for Alternative 1 include:

- Construct conveyance piping from the Park Street Overflow Structure to the Park Street Pump Station.
- Upgrade Park Street Pump Station.
- Construct conveyance piping from Park Street Pump Station to the treatment plant site. This assumes that all or part of the treatment facilities would be located at the secondary treatment plant site.
- Construct primary treatment facilities: Recent experience elsewhere has shown that it is difficult to achieve 50 percent reduction of solids on an event basis with conventional primary treatment when the concentration of the CSO is less than 100 mg/L. High rate clarification using ballasted sedimentation can be used to achieve these requirements. This process could provide greater than 90 percent removal of solids on an event basis.
- Construct dedicated CSO disinfection facilities.
- Construct a CSO outfall dedicated to discharging treated CSOs.

Treatment Alternative 2: Internal Shunt of CSO Flows, Two Pump Stations

The second alternative would increase the flow rate through the secondary plant. This would require that all discharges meet secondary treatment discharge requirements. To protect the secondary process by preventing 'washout' of the secondary clarifiers during an extreme storm event, the Department of Ecology would likely allow internal shunting of primary effluent directly to the disinfection. Since solids in the Central CSO Regulator are lower than in the Hazel Street Interceptor, it would be preferable to internally shunt the Central CSO Regulator flows. A process flow schematic is shown in Figure 4-4.

Figure 4-4 Alternative 2 CSO Treatment Internal Shunt Schematic



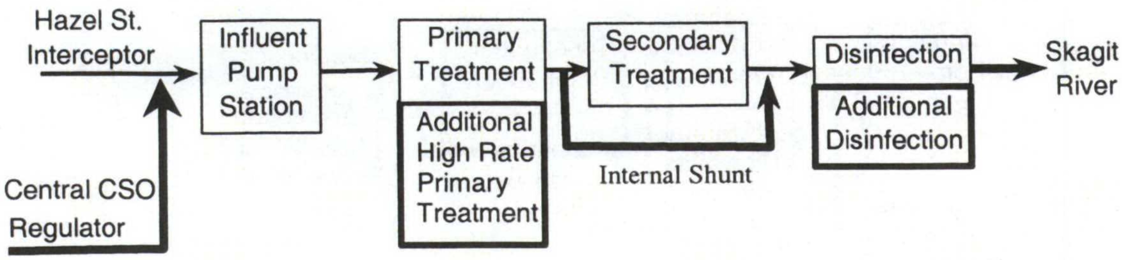
The improvements required for Alternative 2 include:

- Construct conveyance piping from the Park Street Overflow Structure to the Park Street Pump Station.
- Upgrade Park Street Pump Station.
- Construct conveyance piping from Park Street Pump Station to the treatment plant site.
- Construct high rate primary treatment facilities.
- Construct disinfection facilities for both CSO and WWTP flows.
- Construct an outfall to discharging treated CSOs and WWTP effluent. This could be two separate outfalls or a single combined outfall.

Treatment Alternative 3: Internal Shunt of CSO Flows, One Pump Station

The third alternative would increase the flow rate through the secondary plant, similar to alternative 2 except all of the flows are pumped via the WWTP influent pump station. This would require that all discharges meet secondary treatment discharge requirements. An internal shunt of all CSO flows (from both the Central CSO Regulator and the Hazel Street Interceptor) could occur after initial blending of the flows. A process flow schematic is shown in Figure 4-5.

Figure 4-5 Alternative 3 CSO Treatment Internal Shunt Schematic



The improvements required for Alternative 3 include:

- Construct a new influent pump station.
- Construct conveyance piping from Park Street Overflow Structure.
- Construct high rate primary treatment facilities.
- Construct disinfection facilities for both CSO and WWTP flows.
- Construct an outfall to discharging treated CSOs and WWTP effluent. This could be two separate outfalls or a single combined outfall.

Summary of Treatment Alternatives

Table 4-3 presents a summary of the treatment requirements for each Alternative, and the improvements required.

Table 4-3

Summary of CSO Treatment Alternatives		
Alternative No. 1	**Alternative No. 2**	**Alternative No. 3**
Description		
CSO Treatment Facility	Internal Shunt of CSO Flows, Two Pump Stations	Internal Shunt of CSO Flows, One Pump Station
Treatment Requirements		
50 Percent Solids Removal, 0.3 mL/L/hr settlable solids (max of 1.9 mL/L/hr)[1]	NPDES Permit Limits: 30 mg/L BOD and TSS	NPDES Permit Limits: 30 mg/L BOD and TSS
Required Improvements		
High Rate Primary Treatment for CSO flows	High Rate Primary Treatment for CSO flows	High Rate Primary Treatment for CSO flows
Disinfection for CSO flows	Disinfection for CSO flows	Disinfection for CSO flows
Upgrade Influent Pump Station	Upgrade Influent Pump Station	Construct new Influent Pump Station
Upgrade the Park Street Pump Station and replace piping to Park Street Pump Station	Replace piping to Park Street Pump Station	Upgrade Hazel Street Interceptor CSO Regulator to Influent Pump Station
Provide dedicated CSO Outfall	Provide an additional outfall capacity	Upgrade WWTP Outfall or provide an additional outfall capacity
Forcemain from Park Street Pump Station to WWTP	Force Main from Park Street Pump Station to WWTP	

1. Based on NPDES Permit issued to Carkeek CSO Treatment Facility, King County, WA.

CSO Storage

Both in-line, such as the Central CSO Regulator, and off-line storage facilities were considered for the remaining CSO flows. For storage facilities, a large factor of safety should be incorporated to allow the facility to accommodate both short duration high intensity storms and long duration low intensity storms, which may activate all sources of inflow and infiltration. From an idealized hydrograph with a peak of 48 mgd, as previously shown in Figure 3-5, a minimum of 1.0 mg of excess volume would be required to be stored. For CSOs, rainfall patterns, impervious area within the city, and antecedent moisture conditions can affect the actual volume experienced. Because of the variability in these factors, the CSO volume that would be planned for would incorporate a safety factor of 2.0. A CSO storage alternative would require a 2.0 mg storage facility at an estimated cost of $12.0 million

CSO Separation

A portion of the CSO flows in the Mount Vernon sewer system is from inflow sources, such as direct connections of storm drain catch basins. Identification and separation of inflow sources could reduce or eliminate the need for additional storage or CSO treatment facilities. However, identification and removal of direct connections is not always possible. In addition, in many cases the excess flows experienced due to a storm event are from rapid infiltration sources, rather than inflow sources, which are difficult to identify and correct. In the case of Mount Vernon, if excess CSO flows were due to inflow, an area of 136 acres would be connected. In the one-year storm event, inflow is typically due to run-off from paved areas, streets and parking lots that drain to the CSO system. To remove 136 acres of impervious area would require approximately 37 miles of 30 foot wide streets to be identified and disconnected.

Recommended CSO Reduction Treatment Alternative

Treatment Criteria

The two treatment options, separate CSO treatment and internally shunted flows, have different effluent requirements:

- The performance goal of CSO Treatment is removal of 50 percent suspended solids on an annual basis. Additionally, the effluent settleable solids concentration must have an annual average of 0.3 mL/L/hr, with a maximum of 1.9 mL/L/hr.

- Internal Shunt is the name given to the treatment of CSO flows by primary treatment followed by blending with secondary treatment plant flows before disinfection. When flows are internally shunted, the blended effluent from the primary and secondary units must meet the weekly and monthly NPDES permit (BOD and TSS) limits. DOE has permitted this process at other plants in the northwest including King County's West Point Treatment Plant.

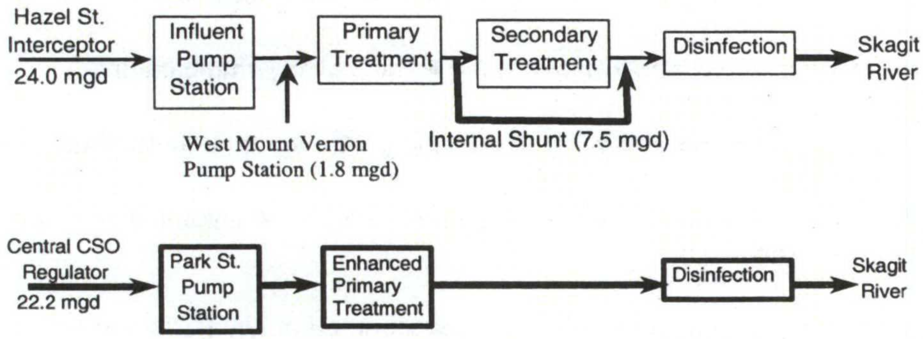
Treatment Recommendation

To meet the total 48 mgd peak hour flow requirements, treatment of CSO flows would be performed similar under either alternative. Primary treatment of CSO flows could be via high rate clarification and disinfection by UV. The typical operating cost of treating all flows via an internal shunt and treating them via a CSO treatment facility is similar. Similar improvements (additional primary treatment process equipment and UV disinfection equipment) are required for all Alternatives. Costs for Alternative no. 3 would be far in excess of either Alternative nos. 1 or 2 since it requires a new pump station (the influent pump station would need to be replaced rather than upgraded) and upgrading the Hazel Street Interceptor. Alternative nos. 1 and 2 would be similar in cost, so the decision of treatment Alternative (internal shunt vs. CSO treatment facility) should be based on treatment requirements.

The Hazel Street Interceptor conveys both combined and sanitary flows to the influent pump station. This interceptor has a capacity of 24.0 mgd. It is recommended that the portion of flows in excess of the peak sanitary flows (18.3 mgd) be internally shunted. This will allow maximization of the WWTP, without the necessity of oversizing all process units to accommodate CSO flows. Furthermore, by internally shunting CSO flows, the blended effluent may be able meet the NPDES permit requirements.

The Central CSO Regulator has lower TSS and BOD than the Hazel Street Interceptor since it conveys only combined sewer flows. It is recommended that wastewater conveyed by the Central CSO Regulator be treated in an independent treatment process. The treatment requirements for this process will be based on CSO treatment requirements (50 percent solids removal on an average annual basis, with an average settleable solids of 0.3 mL/L/hr, and a maximum of 1.9 mL/L/hr). The process flow diagram for these recommendations is presented in Figure 4-6.

Figure 4-6 Recommended Process Schematic Flow Diagram



CSO Reduction Alternatives

The treatment Alternative recommended for the combined flows is composed of two components: An 'Internal Shunt' and CSO Treatment. The 'Internal Shunt' of the Hazel Street Interceptor is discussed in Chapters 7 to 10 under the Wastewater Treatment Plant. Three alternatives for CSO Treatment are presented below.

Alternative 2A: Treat and Disinfect Combined Wastewater at the Park Street Pump Station.

Alternative 2A consists of treatment (high rate clarification) and disinfection (UV) at the Park Street Pump Station location. Improvements required for this alternative include:

- Construct a high rate clarification unit;
- Construct a UV disinfection system;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a CSO effluent pump station; and
- Construct an outfall for this CSO treatment facility effluent.

The estimated capital cost of this alternative is $9.2 million.

Alternative 2B: Treat Combined Wastewater at the Park Street Pump Station and Disinfect at the WWTP.

Alternative 2B consists of treatment (high rate clarification) at the Park Street Pump Station and disinfection (UV) at the WWTP. Improvements required for this alternative include:

- Construct a high rate clarification unit at the Park Street Pump Station;
- Retrofit a UV disinfection system in the existing chlorine contact basin at the WWTP;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a forcemain from Park Street Pump Station to the WWTP;
- Retrofit a CSO effluent pump station in the existing chlorine contact basin; and
- Construct conveyance to the outfall for treated CSO effluent.

The estimated capital cost of this alternative is $9.9 million.

Alternative 2C: Treat and Disinfect Combined Wastewater at the WWTP.

Alternative 2C consists of treatment (high rate clarification) and disinfection (UV) at the WWTP. Improvements required for this alternative include:

- Construct a high rate clarification unit at the WWTP;

- Retrofit a UV disinfection system in the existing chlorine contact basin at the WWTP;
- Construct a 36-inch diameter sewer from the Park Street Overflow Structure to the Park Street Pump Station;
- Upgrade Park Street Pump Station to separate and convey CSO and storm flows;
- Construct a forcemain from Park Street Pump Station to the WWTP;
- Retrofit a CSO effluent pump station in the existing chlorine contact basin; and
- Construct conveyance to the outfall for treated CSO effluent.

The estimated capital cost of this alternative is $9.6 million.

Comparison of Alternatives

The ***benefits*** of alternative 2A are as follows:

- Capital cost of the project is estimated to be approximately $400,000 less than the other alternatives.

The ***disadvantages*** of alternative 2A are as follows:

- Remote location (away from the WWTP) requiring additional time or staff to maintain and operate;
- Requires construction of a dedicated CSO outfall;
- Limited ability to utilize process equipment for alternate uses (such as WWTP redundancy or effluent polishing during non-CSO periods); and
- Requires permitting and new construction in the flood way, which may be difficult to obtain.

The advantages of alternative 2B are as follows:

- Ability to utilize the UV Disinfection process equipment for redundancy, and during maintenance or repair of the WWTP's UV system; and
- Ability to utilize the WWTP outfall for disposal of treated CSO flows.

The disadvantages of alternative 2B are as follows:

- Remote location (away from the WWTP) of the high rate clarification requires additional time or staff to maintain and operate; and

- Capital cost of the project is estimated to be approximately $400,000 more than alternative 2A.

- Requires permitting and new construction in the flood way, which may be difficult to obtain.

The advantages of alternative 2C are as follows:

- Ability to utilize the UV Disinfection process equipment for redundancy, and during maintenance or repair of the WWTP's UV system; and

- Ability to utilize the WWTP outfall for disposal of treated CSO flows.

The disadvantages of alternative 2C are as follows:

- Capital cost of the project is estimated to be approximately $400,000 more than alternative 2A.

Recommended CSO Reduction Alternative

Alternative 2C is the recommended treatment facility alternative. The differential in cost is easily offset by the potential to utilize both the high rate clarification and UV Disinfection systems as redundant unit processes for the WWTP during non-storm event periods. Table 4-4 summarizes the recommended CSO Reduction Plan.

Table 4-4

Summary of CSO Reduction Plan Improvements		
CSO Reduction Method	**Description/Benefit**	**Required Improvements**
Phase 1	Central CSO Regulator provides inline storage of CSO flows that would have been conveyed to the Skagit River. Stored CSO flows are conveyed to the WWTP as capacity allows for treatment and disposal.	In-line storage. Completed and online, December 1997
Phase 2[1]	The 'Internal Shunt' of Hazel Street Interceptor CSO Flows would allow a peak flow of approximately 7.5 mgd to be continually treated during a storm event. This additional treatment capacity will allow the CSO regulator to act as equalizing in-line storage and further reduce the potential CSO events.	Increase capacity of the influent pump station. Increase capacity of the headworks, primary treatment facilities, disinfection system, effluent pump station, and secondary WWTP outfall for a hydraulic capacity of 25.8 mgd. Add the potential for coagulant addition to the primary clarifier designated for CSO treatment.
Phase 3	The CSO Treatment Facility will be final phase of CSO reduction. It will allow the City meet their consent decree with DOE and reduce CSOs to less than one untreated event per year.	Construct a high rate clarification system with a peak hour capacity of 22.2 mgd. Construct a UV disinfection system Construct a 750 LF of 36-inch sewer. Upgrade Park Street Pump Station Construct 1500 LF of 30-inch force main Construct a CSO effluent pump station Construct conveyance to the secondary effluent outfall[2]

1. Improvements for Phase 2, the Internal Shunt of CSO flows, are included in Chapter 10, Recommended Alternatives.
2. It is assumed that treated CSO flows and the secondary effluent will be combined and discharged through the same outfall.

Phase 3 of the CSO reduction plan is the construction of a CSO treatment facility to reduce untreated CSOs to less than one event per year. A CSO treatment facility is assumed be subject to the following treatment requirements (based on the NPDES discharge permit issued to the Carkeek CSO Treatment Facility, King County, WA):

- Removal of 50 percent suspended solids on an annual basis;
- An annual average of effluent settleable solids concentration of 0.3 mL/L/hr; and
- A maximum effluent settleable solids concentration of 1.9 mL/L/hr.

The key treatment processes of a CSO treatment facility would include high rate clarification for removal of suspended solids, and UV disinfection for disinfection of effluent:

- High rate clarification (HRC) is a physical/chemical process that utilizes high specific gravity ballast material, such as sand, to increase the settling velocities of particulate matter or chemically conditioned floc particles. The benefits of HRC is that it requires a small footprint, has a rapid start-up time, and produces an effluent low in turbidity and suspended solids.
- UV disinfection is the process whereby wastewater is exposed to UV energy which, when absorbed by micro-organisms, damages the nucleic acid preventing reproduction of the organism and eliminating the ability of the micro-organism to cause infections. UV disinfection has benefits over chlorine for CSO applications in that it does not degrade over time, does not require large volume of chlorine to be stored on site, and does not require large contact tanks to be constructed.

The estimated costs for a CSO Treatment Facility for the City of Mount Vernon are presented in Table 4-5. These costs include conveyance of CSOs to the wastewater treatment plant site, construction of CSO treatment facilities, treated CSO disposal, and an estimate of the annual operations and maintenance costs of the CSO Treatment Facility.

Table 4-5

Recommended Improvements for the CSO Treatment Facility[1,2]	
Improvement	**Capital Cost Estimate ($1,000)**
CSO Interceptor	$700
Upgrade Park Street Pump Station	$700
CSO Forcemain	$500
CSO Treatment (High Rate Clarification)	$4,200
CSO Disinfection[3]	$2,200
CSO Effluent Pump Station	$800
CSO Outfall[4]	--[4]
Total Capital Cost	$9,100
Estimated Annual O & M Cost[5]	$8.4 to $9.6

1. Does not include CSO-Phase 2 Improvements, which are incorporated in secondary treatment plant improvements - presented in Chapter 10.
2. CSO Phase 3 Improvements, per DOE Consent Decree, may be required by 2015
3. Based on an estimated transmissivity of the treated CSO effluent.
4. Costs are included in the WWTP single outfall estimate, where both treated CSO flows and secondary effluent are discharged through a single outfall.
5. Based on the average overflow volume for 1998-2000 (5.6 mg), and a cost estimate of $1.50 to $1.75 per 1,000 gallons treated.

5. WASTEWATER COLLECTION SYSTEM

This chapter presents an evaluation of the wastewater collection system. It includes a review of the interceptor system capacity based on projected peak flows, using the population projections presented in Chapter 3. A review of the City's Access database of sewer defects was also completed. The following sections identify system deficiencies, summarize corrective actions and costs required to correct the defects, and future improvements to the interceptor system required for projected growth.

SYSTEM DESCRIPTION

The City of Mount Vernon's wastewater collection system presently serves an area of approximately sixteen square miles. Figure 5-1 shows the major sewer lines, pump stations, and combined sewer overflow structures in the system. The system is composed of approximately 120 miles of pipe ranging from 6-inch to 60-inch diameter. The majority of the wastewater collection system was constructed of concrete pipe. The system pipe materials also include clay, corrugated metal, PVC, and polyethylene.

Portions of the downtown and older areas are served by combined sewers. Separate storm sewers are provided in the newer developed areas. The wastewater collection system was reviewed in 1994 and deficiencies in the system identified. Each year the City has allocated monies to repair known deficiencies.

The wastewater collection system presently includes thirteen pump stations owned and operated by the City, Table 2-1. The City also maintains and operates three combined sewer overflow structures (Freeway Drive, Division Street, and Park Street) and two CSO/storm water pump stations (Division Street and Park Street), see Chapter 4.

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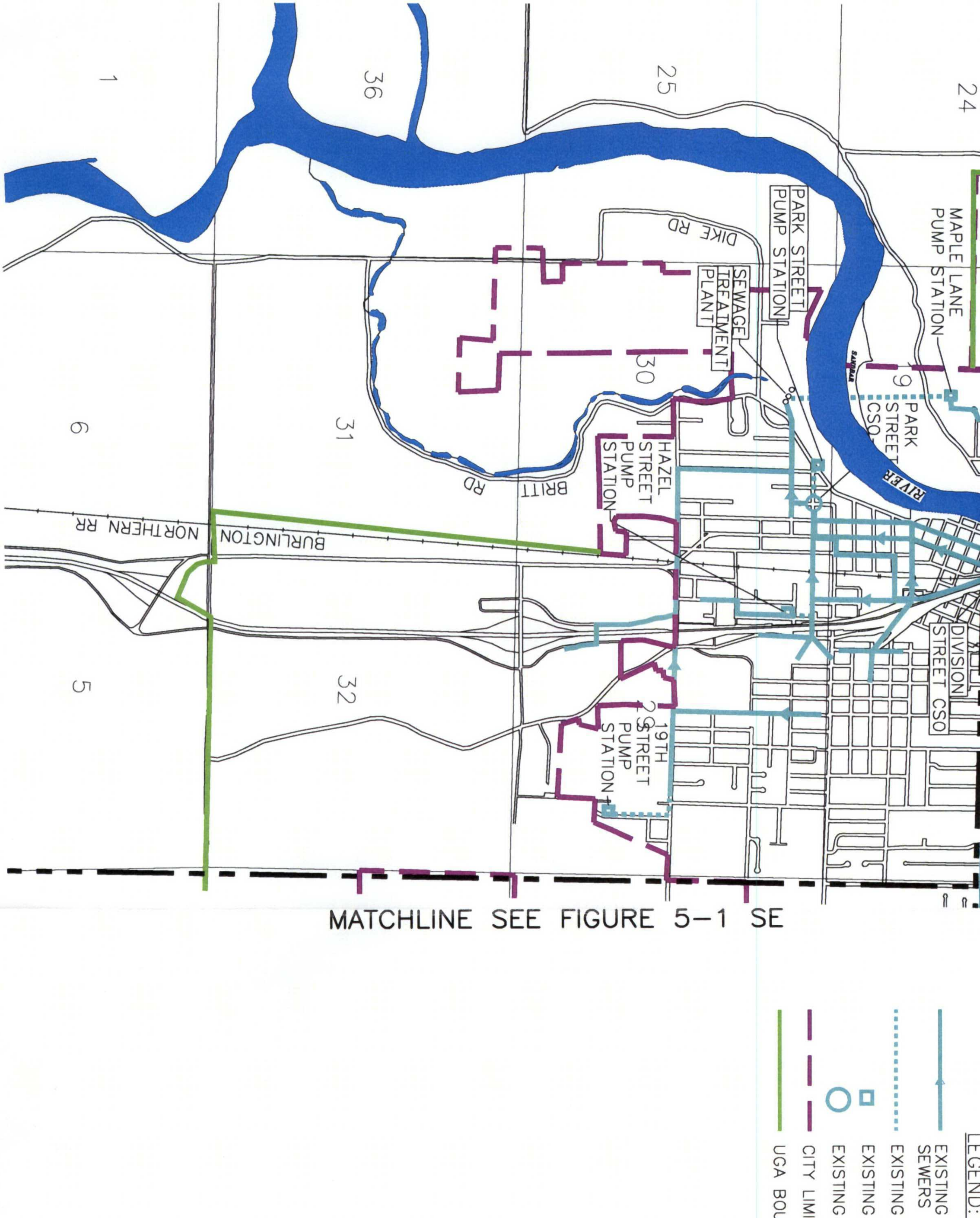
1
36
25
24
6
31
30
29
5
32
DIKE RD
BRITT RD
BURLINGTON NORTHERN RR
RIVER
PARK STREET PUMP STATION
MAPLE LANE PUMP STATION
SEWAGE TREATMENT PLANT
PARK STREET CSO
HAZEL STREET PUMP STATION
DIVISION STREET CSO
19TH STREET PUMP STATION
MATCHLINE SEE FIGURE 5-1 SE
LEGEND:
EXISTING SEWERS
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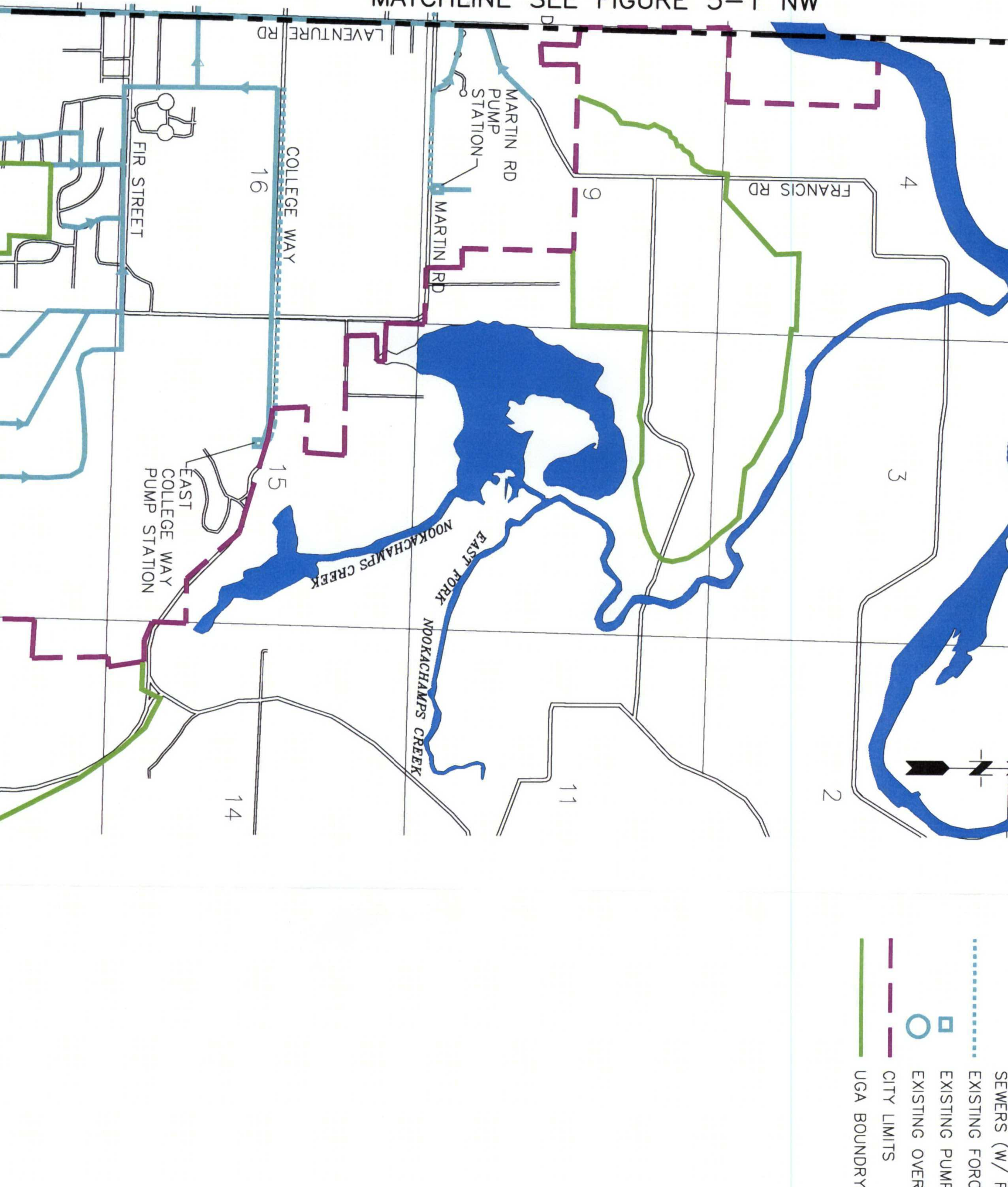
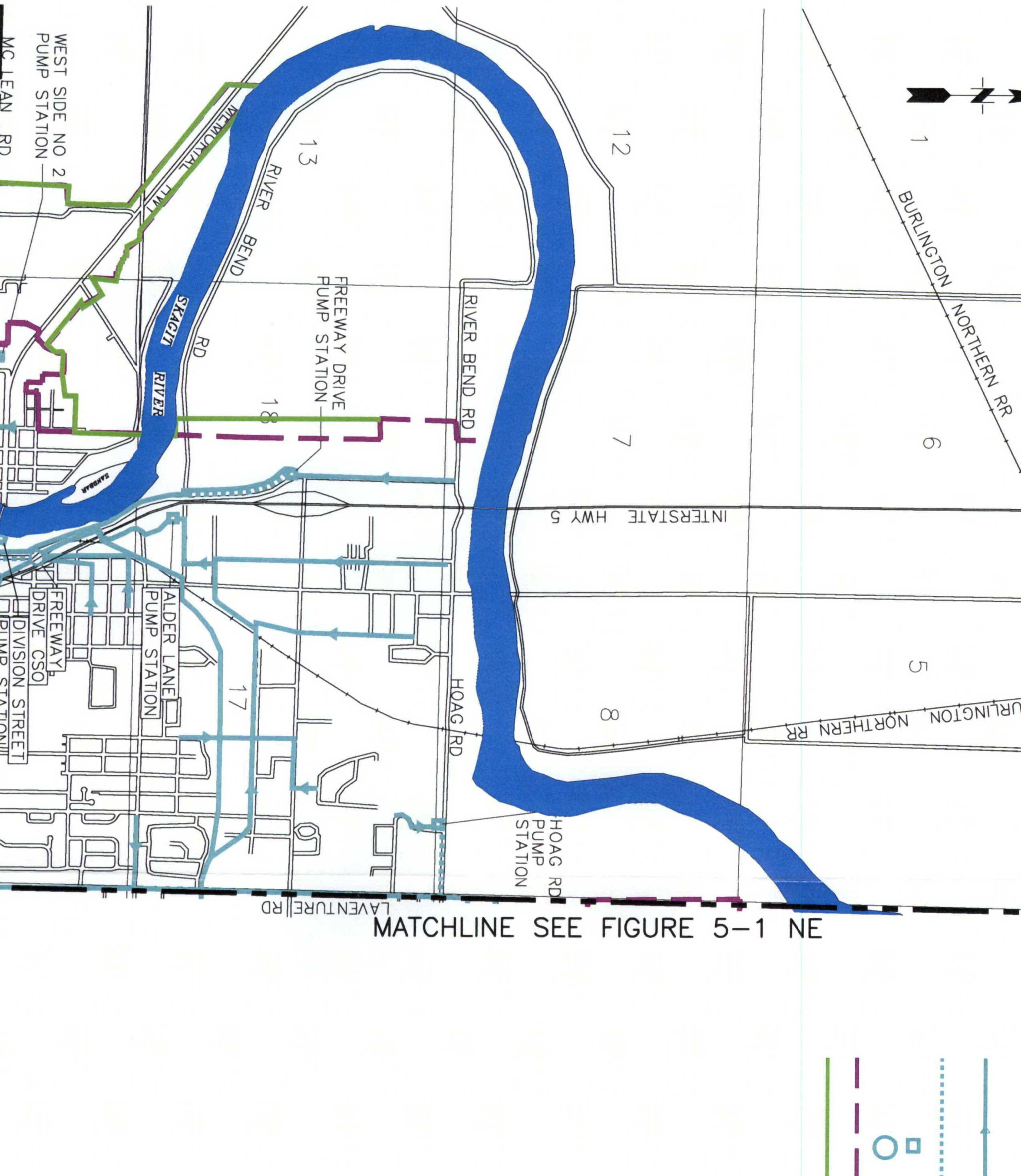
MATCHLINE SEE FIGURE 5-1 NW




WEST SIDE NO 2 PUMP STATION
MC LEAN RD
MEMORIAL HWY
13
RIVER BEND RD
12
1
BURLINGTON NORTHERN RR
FREEWAY DRIVE PUMP STATION
RIVER BEND RD
SKAGIT RIVER
18
7
6
SANDBAR
INTERSTATE HWY 5
FREEWAY DRIVE CSO
DIVISION STREET PUMP STATION
ALDER LANE PUMP STATION
17
HOAG RD
8
5
BURLINGTON NORTHERN RR
HOAG RD PUMP STATION
LAVENTURE RD
MATCHLINE SEE FIGURE 5-1 NE

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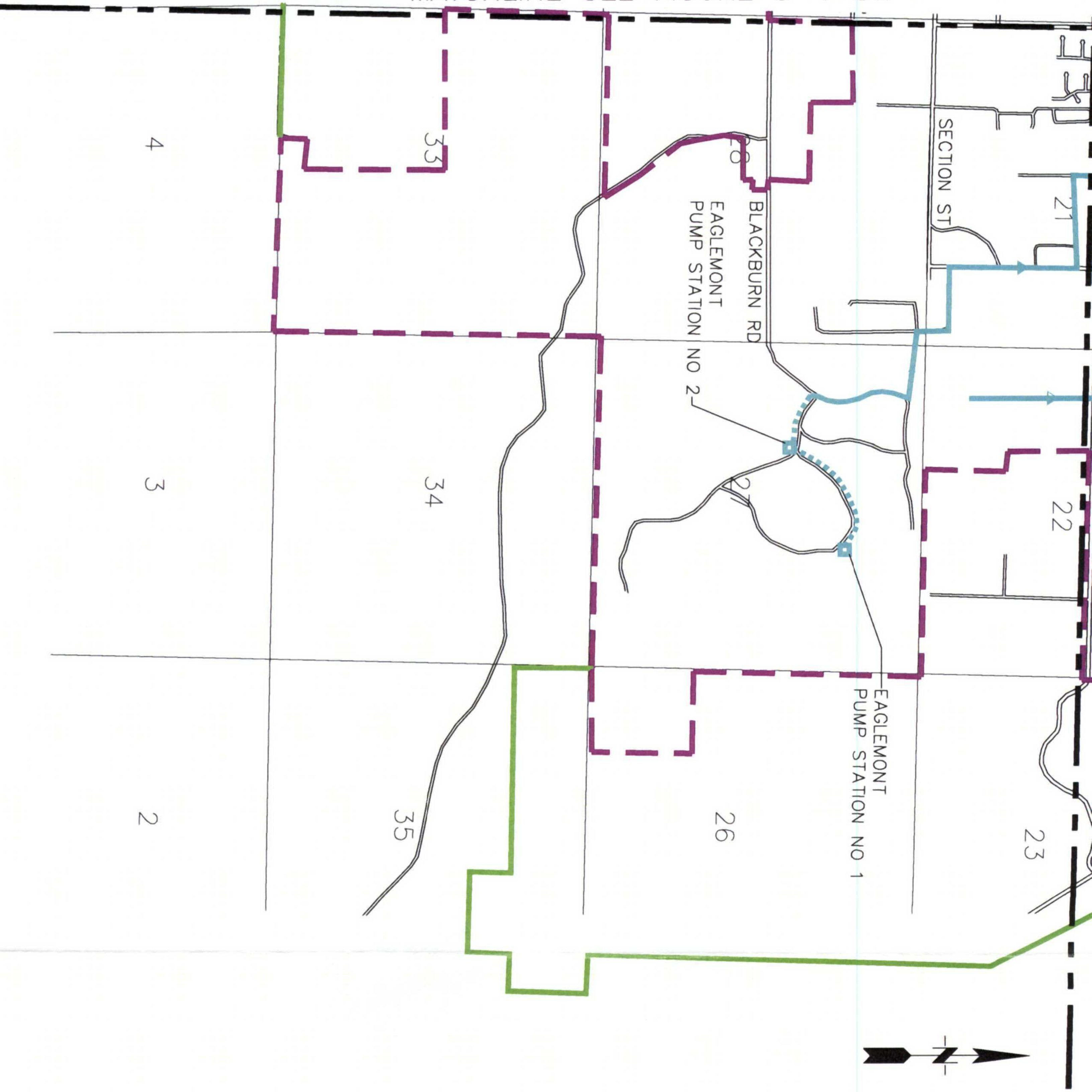
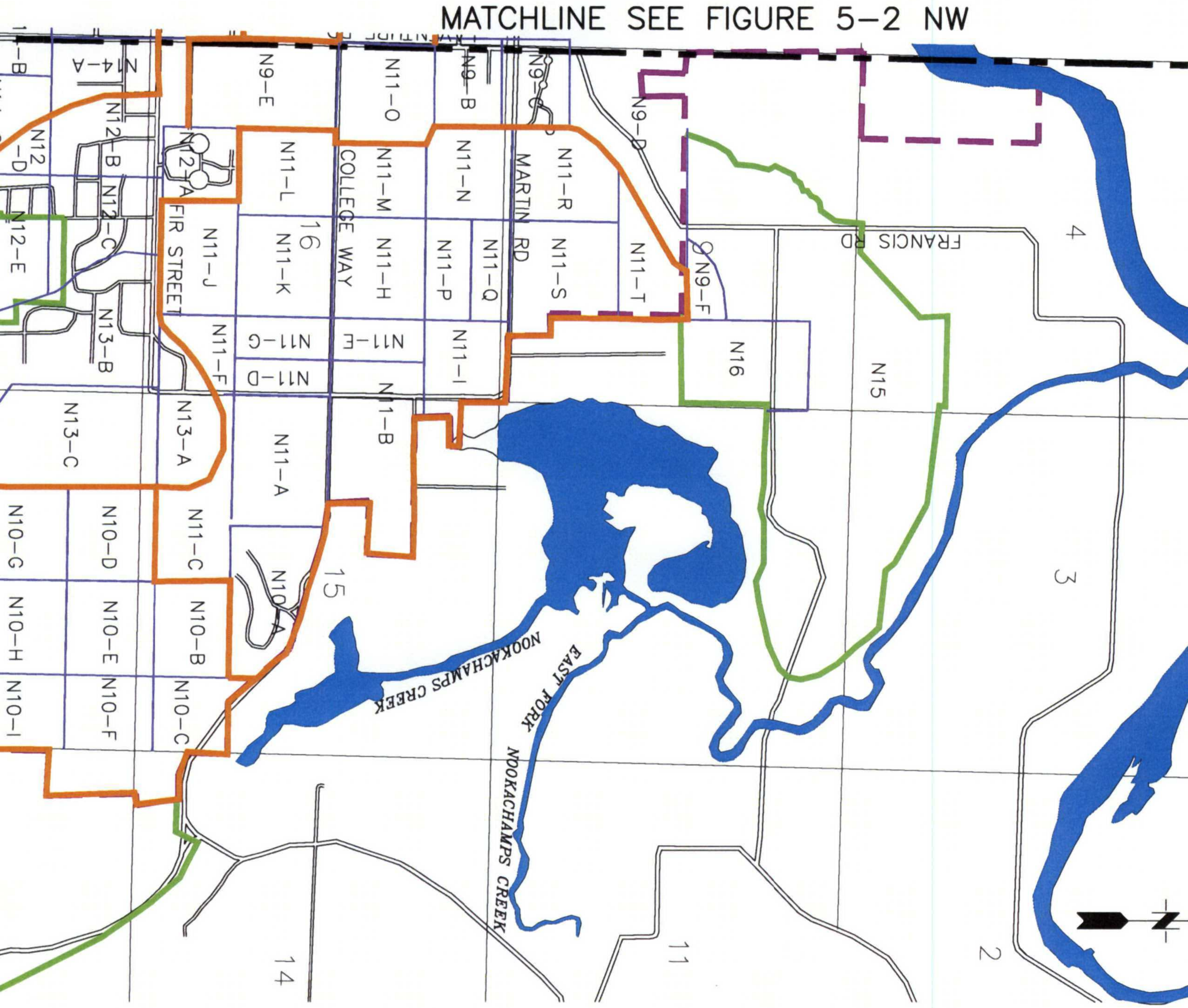
MATCHLINE SEE FIGURE 5-1 SW





Introduc

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Analysis

The system ana
Manhole invert e
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analysis was co
drainage area, F
drainage sub-ba
estimated, inclu
parameters:

Average Daily P

Infiltration and I

Peaking Factor

1. Fig. 3-6 Ra
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The hydraulic ca
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In general, the i
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MATCHLINE SEE FIGURE 5–2 NE

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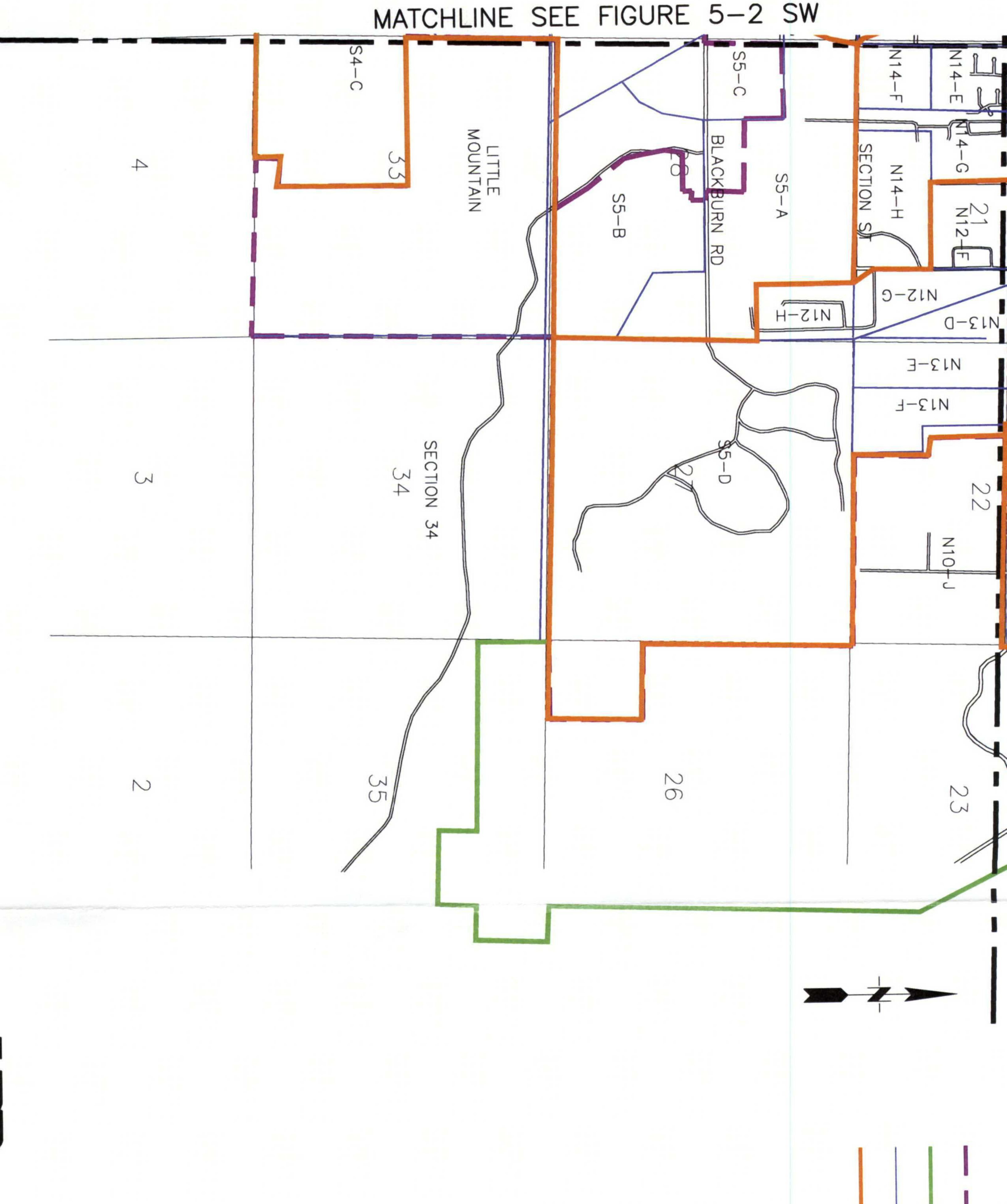
MATCHLINE SEE FIGURE 5-2 SW
S4-C
LITTLE MOUNTAIN
S5-C
BLACKBURN RD
S5-A
S5-B
SECTION ST
N14-F
N14-E
N14-G
N14-H
N12-F
N12-G
N12-H
N13-D
N13-E
N13-F
SECTION 34
S5-D
N10-J
4
3
2
33
34
35
26
21
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23

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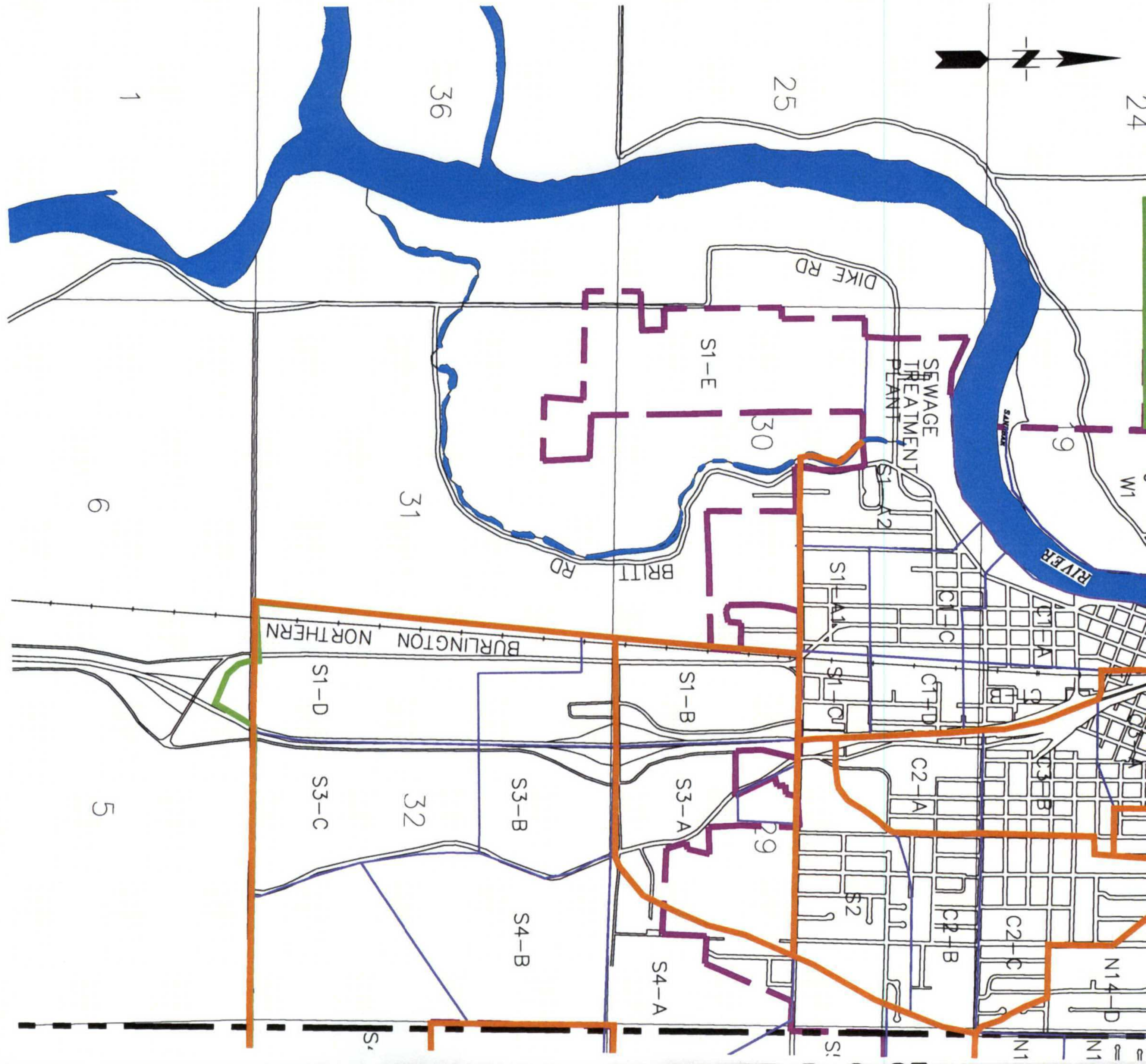
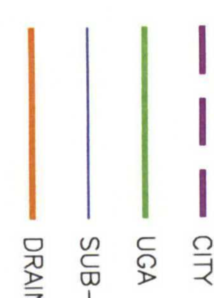


MATCHLINE SEE FIGURE 5-2 SE



WASTEWATER COLLECTION SYSTEM CAPACITY ASSESSMENT

Introduction

An analysis of the capacity of existing interceptors and major trunk lines was completed to determine hydraulic limitations within the system that could limit future development. Figure 5-1, presented previously, provides the location of the existing wastewater collection system interceptors. Wastewater flows were developed in Chapter 3, and are based on Skagit County Population Projections for the 20-year planning horizon, through 2020.

Analysis

The system analysis was completed by defining the interceptors and major trunk lines. Manhole invert elevations and pipe lengths between manholes in the defined segments were obtained from City utility mapping and previous HYDRA modeling efforts. The analysis was completed by developing flow components for a fully developed UGA for each drainage area, Figure 5-2. Area, population density, and flow contribution assigned to each drainage sub-basin are presented in Appendix C. Flows from each drainage basin were estimated, including infiltration and inflow and peak sanitary flows, based on the following parameters:

Average Daily Per Capita Flow	100 gpcd
Infiltration and Inflow Rates	1,100 gpad
Peaking Factor for Sanitary Flows	L.A. Peaking Curve[1]

1. Fig. 3-6 Ratio of Peak Flow to Average Daily Flow in Los Angeles, ASCE Manual and Report on Engineering Practice No. 60.

The hydraulic capacity of each line segment was determined and compared to the future flows in the pipe. A sample analysis is presented in Appendix D.

In general, the interceptor system has few lines that have or will approach their capacity at full development. Flow monitoring, additional study, and modeling of the interceptors in the northern portions of the collection system would allow a more accurate prediction of when the new interceptors are required. Table 5-1 lists the lines identified by the hydraulic analysis as having limited capacity given the growth projections and the current UGA boundary.

Table 5-1

Hydraulic Analysis Identified Capacity Limitations at Saturated Development[1]			
Location	**between**	**Comment**	**Interceptor/ Trunk Sewer**
East of City Limits (sections 23 and 26)		Parallel line to College Way Pump Station	Future
East of City Limits (sections 15 and 22)		Parallel line to College Way Pump Station	Future
Martin Road	Trumputer and College Way	Monitor existing 8-inch	College Way
College Way	Martin Road and 35th St	Monitor existing 12-inch	College Way
College Way	Martin Rd to College Way Pump Station	Replace existing 8-inch	College Way
Fir Street	30th St and Comanche Dr	Monitor existing 12-inch	Fir Street
Fir Street	30th Street and 26th Street	Monitor existing 12-inch	Fir Street
26th Street	Jacqueline and Kulshan	Monitor existing 12-inch	Fir Street
26th Street	College Way and Kulshan Avenue	Reroute flows from College Way Pump Station[2]	Fir Street
LaVenture Road	Division Street and Fir Street	Monitor existing 8-inch	LaVenture
LaVenture Road	Fir St and Kulshan Ave	Replace existing 8-inch	LaVenture
LaVenture Road	Fir St and Kulshan Ave	Replace existing 10-inch	LaVenture
Kulshan Interceptor	Minimal slope: 24- and 30-inch pipe	Designed to operate under surcharged conditions.	Kulshan
Burlington Northern Railroad	South of Roosevelt Ave	Replace existing 15-inch	Alder Lane

Hydraulic Analysis Identified Capacity Limitations at Saturated Development[1]			
Location	**between**	**Comment**	**Interceptor/ Trunk Sewer**
Blackburn Road	East of Walter St	Monitor existing 30-inch	Southeast
Walter Street	Blackburn Rd and Hazel St	Monitor existing 30-inch	Southeast
Urban Avenue	North of College Way	Monitor existing 10-inch	Urban Ave
Freeway Drive	River Bend Rd and Cameron Way	Monitor existing 8- and 10-inch	Freeway Dr

1. Based on saturated development within the current GMA at present zoning.
2. Rerouted flows include construction of a forcemain, gravity mains, and upgrading the College Way Pump Station.

Interceptor System Improvements

The interceptor system has lines that are predicted to approach capacity as the UGA approaches saturated development. These lines are recommended for monitoring and replacement as warranted. The following sections provide details of each of the interceptors. Table 5-2 summarizes the recommendations for each identified defect. Figure 5-3 presents the improvements to the interceptors and trunk sewer system based on the hydraulic analysis.

Table 5-2

Interceptor System Improvements						
ID No.	**Location**	**between**	**Year Required**	**Dia (in)[1]**	**Length (ft)[1]**	**Cost ($1,000)[2]**
FS-1	Sections 23 and 26		Future	18	1,379	380
FS-2	Sections 15 and 22		Future	18	1,063	295
FS-3	Martin Rd	Trumpter Rd. and College Way	As-Required	12	734	135
FS-4	College Way	Martin Rd. and 35th St.	As-Required	15	548	125
FS-5	College Way	Martin Rd. to Pump Station	2002	18	2,307	635

Interceptor System Improvements						
ID No.	Location	between	Year Required	Dia (in)[1]	Length (ft)[1]	Cost ($1,000)[2]
FS-6	Fir St	30th St. and Comanche Dr.	2005	18	980	270
FS-7	Fir St	30th St. and 26th St.	2005	18	1,265	350
FS-8	26th St	Jacqueline Place and Kulshan Avenue	As-Required	18	690	190
FS-9	26th St	College Way and Kulshan Avenue	As-Required	12	752	140
FS-10	LaVenture Rd	Division St. and Fir St.	As-Required	10	1,525	235
FS-11	LaVenture Rd	Fir St. and Kulshan Ave.	As-Required	10	495	75
FS-12	LaVenture Rd	Fir St. and Kulshan Ave.	As-Required	12	1,386	255
FS-13	Alder Lane Interceptor	Burlington Northern Railroad South of Roosevelt Ave.	As-Required	24	600	220
FS-14	Urban Ave	North of College Way	As-Required	12	375	70
FS-15	Freeway Dr	River Bend Road and Cameron Way	As-Required	12	1,309	240
FS-16	West Mount Vernon	Modify Pump Station	As-Required			150
FS-17	Central CSO Regulator	Add Fail-safe Gate Operator	2001			30

1. Improvements are based on saturated development, based on the UGA boundary, 100 gpcd, 1,100 gpad (inflow and infiltration), and L.A. Peaking curve.
2. Costs are based on ENR Cost index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.

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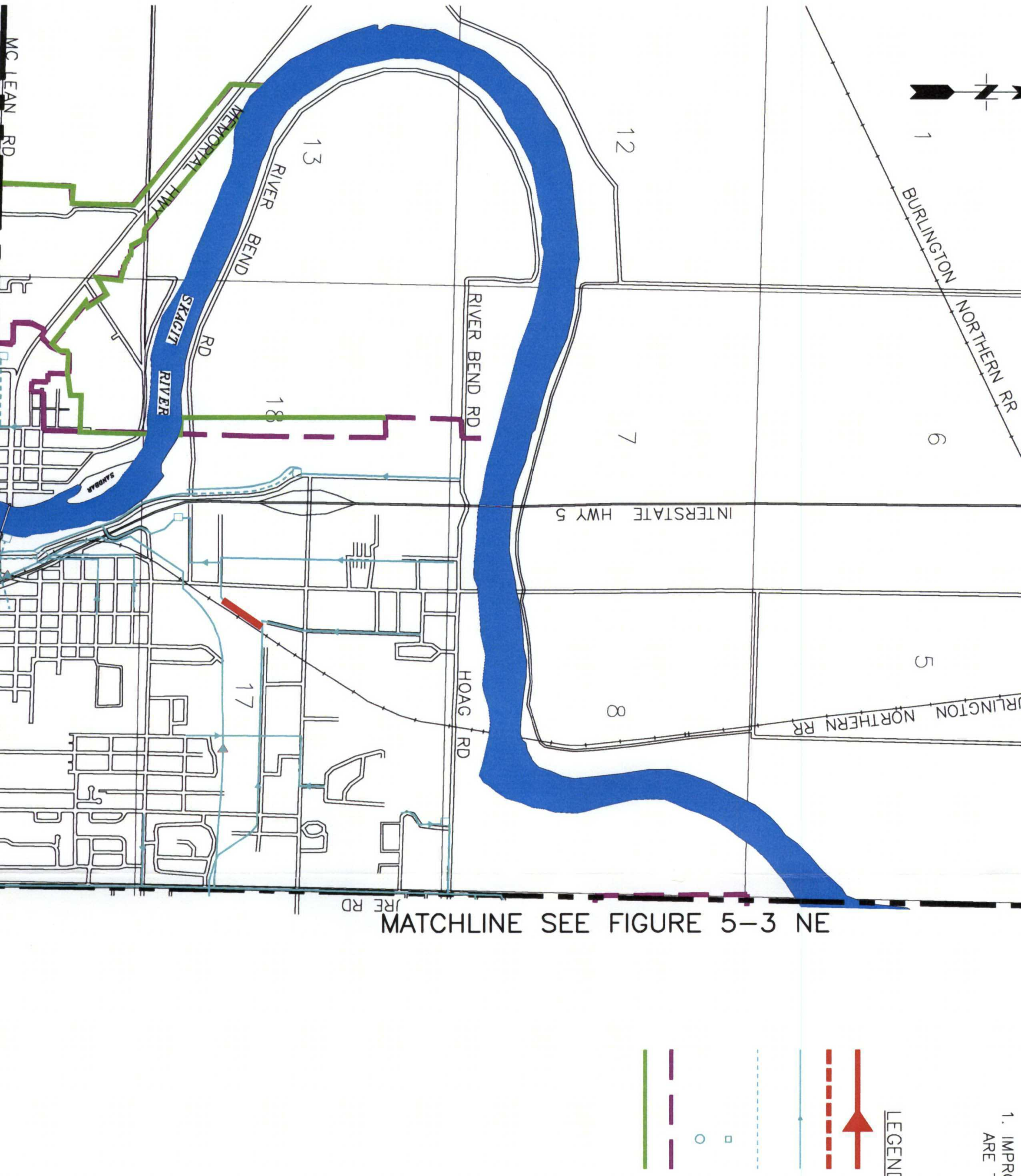
MC LEAN RD
MEMORIAL HWY
RIVER BEND RD
SKAGIT RIVER
SANDBAR
RIVER BEND RD
INTERSTATE HWY 5
HOAG RD
BURLINGTON NORTHERN RR
NORTHERN RR
13
12
1
18
7
6
17
8
5
MATCHLINE SEE FIGURE 5-3 NE
LEGEND

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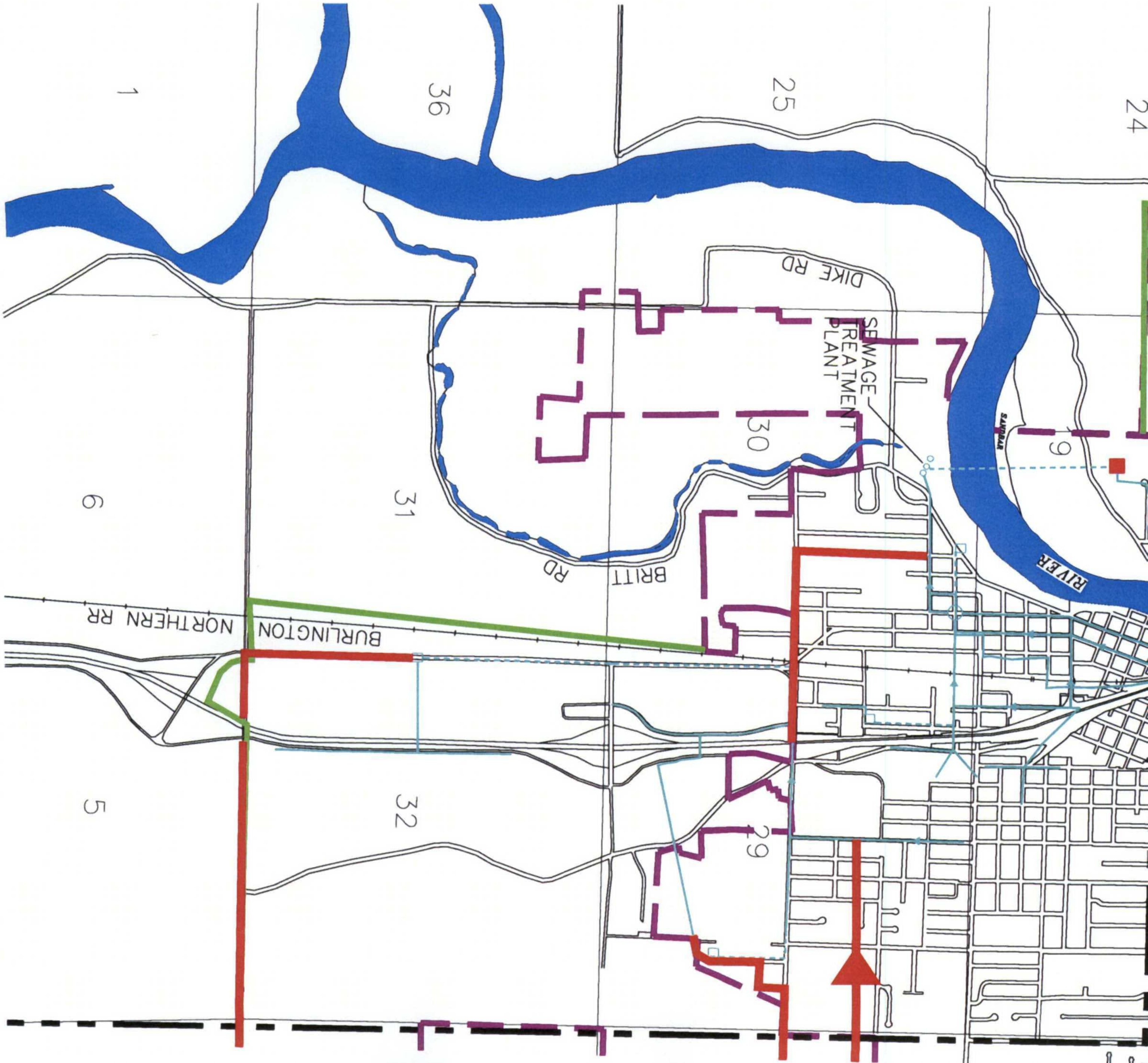
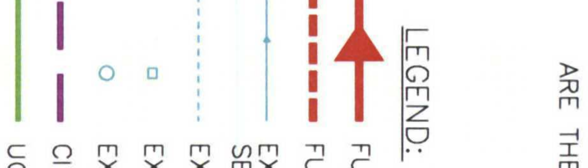


MATCHLINE SEE FIGURE 5-3 SE



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MATCHLINE SEE FIGURE 5-3 SW

College Way Pump Station Drainage Area

The 1995 Comprehensive Sewer and Combined Overflow Reduction Plan examined alternatives to conveying flows from the College Way Pump Station to the WWTP via the Kulshan Interceptor. The 1995 recommended alternative, two force mains constructed to the terminus of the Kulshan Interceptor, is still the most efficient method of conveying flows from the existing area and future areas. This alternative recommends flows be conveyed to the Kulshan Interceptor through:

- A new College Way Pump Station, as flows dictate; and
- Two 12-inch force mains from the pump station to the Kulshan Interceptor.

The new College Way Pump Station would convey flows from the UGA (sections 23 and 26), from the eastern portion of the City Limits (sections 15 and 22), and allow the Martin Road Pump Station (see LaVenture Trunk Sewer) to be abandoned. The College Way line from Martin Road to the pump station will need to be upgraded from an 8-inch line to an 18-inch line, with approximately 2,300 LF of pipe. The Martin Road conveyance improvement is accounted for in the improvements to the College Way line, which is undersized for future flows, even without the Martin Road Pump Station flows.

The existing 12-inch line on College Way between Martin Road and 35th Street is predicted near capacity with future development. Current flow data is inconclusive, minor storms recorded may not have fully activated all sources of inflow and infiltration. This line should be monitored every 10 years to determine the affects of growth on flows through this area, but should be monitored more frequently if rapid growth occurs or indications of increases in inflow and infiltration are observed. If necessary, the 12-inch line should be replaced with 548 LF of 15-inch. The existing 8-inch line on Martin Road between College Way and Trumpter Road is predicted near capacity with future development. It should be monitored and replaced with 734 LF of 12-inch line as required.

The estimated peak flow discharged from the College Way Pump Station with a single pump discharge is 960 gpm. The 12-inch line on 26th Street is adequate to accept this single pump discharge, but would be surcharged with 2 pumps operating. Since the line on 26th Street is adequate to accept flows from the College Way Pump Station, alternative to this were not considered.

Fir Street Trunk Sewer

The Fir Street and 26th Street Trunk Sewers are composed of 8-inch and 12-inch lines. Many of these lines are predicted near capacity with future flows. They should be monitored and replaced as necessary:

- Monitor Fir Street between 30th Street and Comanche Drive and replace with 980 LF of 18-inch pipe, as required.
- Monitor Fir Street between 26th Street and 30th Street and replace with 1,265 LF of 18-inch pipe, as required.
- Monitor 26th Street between Jacqueline Place and Kulshan Avenue and replace with 690 LF of 18-inch pipe, as required.

LaVenture Trunk Sewer

LaVenture drainage area includes north of Kulshan Creek, along LaVenture, and drainage areas N9 and N15. The existing conveyance includes two pump stations, Hoag Road and Martin Road Pump Stations. As development continues, the interceptor these pump stations discharge to will become overloaded. The Martin Road Pump Station can be abandoned by routing a gravity main from the Martin Road Pump Station to College Way. Martin Road area would be served by a gravity main from the Martin Road Pump Station to the College Way Pump Station, conveying flows via 2,650 LF of new 10-inch pipe and existing lines along College Way from the intersection of College Way and 26th Street to the pump station.

Capacity restrictions in the LaVenture Trunk Sewer exist both north and south of the Kulshan Interceptor. Improvements to the LaVenture Trunk Sewer include both replacement of undersized lines and monitoring of lines predicted to be near capacity:

- Monitor the existing 8-inch line on LaVenture Road between Division Street and Fir Street and replace with a 10-inch line as required.

- Replace the existing 8-inch line on LaVenture Road between Fir Street and Alison Avenue with 495 LF of 10-inch pipe.

- Replace the existing 10-inch line on LaVenture Road between Fir Street and Kulshan Avenue with 1,386 LF of 12-inch pipe.

Kulshan Interceptor

The Kulshan Interceptor is designed to operate in both a gravity flow and surcharged mode, with a capacity in excess of 20 mgd. Future peak flows will exceed the gravity capacity (9.3 mgd) and the interceptor will operate in a surcharged mode.

Alder Lane Interceptor

Alder lane Interceptor consists of 30-inch pipes, with a few 15-inch lines. The two sections of 15-inch pipe, paralleling Burlington Northern Railroad, south of Roosevelt Avenue, limit the capacity of the Alder Lane Interceptor. The remaining 30-inch pipe does not result in limitations. These links should be replaced with 600 LF of 24-inch pipe.

The Alder Lane Pump Station currently consists of four pumps with capacities as follows, based on a normal wet well operating level, C factor of 110, and utilizing both the 10 and 16-inch force mains:

- One Pump Capacity: 4.3 mgd
- Two Pump Capacity: 6.8 mgd
- Three Pump Capacity: 8.9 mgd

Peak flows to the pump station in 2020 are estimated at 4.74 mgd. This flow rate will require two pumps, requiring a minimum of three pumps in the station to provide firm pumping capacity.

Southeast Interceptor

Improvements to the Southeast Interceptor, as identified in the 1995 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan, are different than those recommended in this report, for the UGA boundary has changed in the southern portion of the planning area. Section 34 was included in previous planning studies, but has been omitted from the current UGA. This exclusion changes the predicted future flows and loads entering the Southeast interceptor.

The current mode of operation of the Central CSO Regulator, during periods of high CSO flows, has a beneficial effect of utilizing the Southeast Interceptor for additional storage, yet this could increase the potential that flooding of residences. At projected 2020 flows, of 7.42 mgd, approximately 4.0 ft of headloss to be incurred from the railroad to Hazel Street to the WWTP Influent Pump Station. Depending on the level of downstream surcharging, this level of headloss could cause the hydraulic grade line to be above the ground surface (in affect, sanitary sewer overflows would be possible with downstream surcharging). To prevent this possibility, the following improvements should be implemented prior to increased flows:

- Install a fail safe operator, with a shut mode at failure, at the Harrison Street Vault of the CSO Regulator; and

- Limit the maximum water surface elevation in the influent pump station wet well to 5.5 ft.

West Interceptor

West Mount Vernon is served by the West Interceptor and West Mount Vernon Pump Station. The analysis predicts no limitations in the West Interceptor, however, it does predict a peak flow of 1.8 mgd in the interceptor. This peak flow is in excess of the firm pumping capacity of the West Mount Vernon Pump Station, 1.2 mgd. Flows from the pump station are conveyed to the WWTP via a 10-inch force main. This force main has adequate capacity for excess of 2.8 mgd.

The West Mount Vernon Pump Station will require upgrade as development approaches saturated conditions on the West side.

This pump station is a 'package-type pump station' with a separate wetwell and drywell. Due to space limitations within the drywell, the most cost effective method of increasing capacity may be to convert this to a submersible pump station, similar to most of the other pump stations within the system. The wetwell would be modified, submersible pumps installed, and a valve vault provided. Budget costs for these improvements and associated electrical improvements are with a standby generator unit is $150,000.

Central CSO Regulator

The Central CSO Regulator is designed with excess capacity to serve as inline storage during storm events. There are no capacity limitations in this line. A detailed description and analysis of the Central CSO Regulator is presented in Chapter 4.

Other Trunk Sewer Improvements

Urban Avenue Trunk Sewer, north of College Way, flows are currently conveyed through a 10-inch gravity main. At saturated development, this line is predicted near capacity.

Monitoring of the line is recommended and replacement with 375 LF of 12-inch pipe, as required.

Freeway Drive Trunk Sewer, between River Bend Road and Cameron Way, consists of 8-inch and 10-inch lines. These lines are predicted near capacity with future flows. It is recommended that flow monitoring of these lines occur and replacement with 1,309 LF of 12-inch pipe, as required.

LOCAL ISSUES

1st Street and 8th Street

Many of the sewers in the combined areas are 6 or 8-inch and do not have capacity to convey both sanitary and wet weather flows during extreme storm events. Consequently, backups occur along sections of the sewer that become surcharged during storms. Many of these sewers are over fifty years old and because of deterioration are in need of repair or replacement. One local problem is along North 8th Street between Warren Street and Lawrence. To alleviate the problems in this area the sewers should be replaced with larger sewers as shown in Figure 5-4. The estimated cost for these improvements is $1,000,000.

Where possible the City should consider separating storm water connections from the combined sewer and diverting to storm drainage facilities. Removing the storm water will reduce the peak and volume of flow that is discharged to the treatment plant during storm events. Another option is to provide detention of storm water to reduce the peak discharge rate into the combined system. Separating or detaining flow is particularly beneficial when large areas of impervious surface are removed such as parking lots and large buildings. The City indicated that the Mount Vernon High School is scheduled for renovation. Storm drainage connections from this school could be separated from the combined sewer system or detention structures provided to reduce the peak discharge rate into the combined system.

Separation of Combined Areas

The 1995 CSO Reduction Plan concluded that it was more cost effective to transport and treat combined sewage rather than separate. The reduction improvements identified in the plan provided a method of conveying the combined sewage to the treatment plant and ultimately treatment of excess flows. This approach to achieving the required level of CSO reduction allows combined areas to remain combined.

The CSO Reduction Plan was developed primarily on the observed peak CSO flow rates for the design storm event and subsequently used to establish the CSO baseline. These flows reflected the extent and nature of development within the combined sewered areas. These areas are almost completely built out and any redevelopment would consist of either reconstruction with the same type of land use such as remodeling a single family residence or possibly a change in the type of land use such as converting single family residential to multifamily residential or commercial. Reconstruction could increase the stormwater runoff rate and if drainage is provided by the combined sewer system these changes could result in an increase in CSO baseline.

Stormwater design standards, including the City of Mount Vernon's, typically require new construction to maintain predevelopment runoff rates. This requirement protects downstream stormwater facilities from overloading. This same concept and approach could be applied to the combined sewered areas with predevelopment conditions assumed to be those that existed when the CSO baseline for the Reduction Plan was originally established. Requiring redevelopment to provide detention facilities could maintain peak runoff rate into the combined system.

When redevelopment occurs there is the potential for separating storm water connections from the combined sewer and diverting runoff to storm drainage facilities. Even if storm drainage facilities are not available, disconnection of inflow sources such as roof gutter downspouts could benefit the combined system. If downspout splash blocks are provided in areas with no storm drains the runoff would migrate across yards and eventually could enter the combined sewer through right of way inlet connections; however, the rate of flow would probably be attenuated and would reduce the peak flow impact on the sewer. Disconnecting inflow sources such as downspouts also provides the opportunity for the runoff to infiltrate into the ground.

Recent studies indicate that a significant portion of the excess flow in combined sewer systems is from infiltration. Evidence also indicates that much of this flow originates from private property. When redevelopment occurs in combined sewered areas upgrading side sewer laterals to current design standards and excluding subsurface drainage connections such as foundation drains could provide long term benefits of reducing combined sewer flows.

Redirecting runoff in combined sewered areas to storm drainage facilities could also negatively impact the storm sewer system. The existing storm drainage system may not have adequate capacity to accommodate the additional runoff. Furthermore, increasing the runoff to a storm drainage system from previously combined sewered areas may hamper efforts to maintain water quality of stormwater runoff.

The City should further evaluate the impacts of increased runoff into the combined system from redevelopment and the impacts of separating sewers in the combined areas.

Interstate 5 Crossing

There are several sewer crossings under Interstate 5 that are damaged and need to be replaced or repaired. The repair method will be challenging for the crossings between Kincaid Street and the 2nd Street Overpass because the lines are behind a large retaining wall on the east side of the freeway. The sewers that should be addressed are described below; however, each crossing should be evaluated further to determine the most appropriate repair method. Repair or replacement methods include bore and jack, cure in place, pipe burst, horizontal directional drill, or other rehabilitation technologies may be possible. The estimated costs for repairing all of the Interstate 5 crossings is approximately $750,000, assuming cure in-place lining of existing pipes. See Table 5-3 and Figure 5-5 for the location of the sewers.

Table 5-3

Interstate 5 Crossings		
No.	Location	Condition and Recommended Improvement
1.	Lawrence Street to old Brick Hill Overflow Structure	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. The sewer maps indicate that there is a manhole located on this freeway crossing in the middle of Interstate 5. If the improvements identified in the North 8th Street discussion are constructed the flows in this freeway crossing will be reduced.
2.	Fulton Street to Freeway Drive near Scotts Bookstore	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. The pipe serves an extremely small area so lining the pipe may be desirable. The sewer maps indicate that there is a manhole located on this freeway crossing in the middle of Interstate 5.
3.	From 4th Street dropping under the 2nd Street Overpass	Video tapes of the pipe indicate that the pipe is damaged. The 2nd Street overpass is scheduled to be replaced. This sewer crossing could be suspended from a new bridge. Houses immediately adjacent to the bridge should be evaluated to determine if they can be served by a new suspended bridge crossing.
4.	Division Street	Condition is unknown. The line should be evaluated and repaired, replaced or lined as necessary. It is possible the flow in this line could be routed north to the 2nd Street Overpass crossing.
5.	4th Street and Washington	Video tapes of this sewer pipe have documented damage. The line should be reevaluated and repaired, replaced or lined as necessary. It is also possible that a sewer line could be constructed in the east shoulder of the freeway to intercept these flows and route them south to Kincaid Street.
6.	From Gates Street on the West Side of the Freeway to the Kincaid Street Northbound onramp	This crossing was abandoned during the construction of the Central CSO Regulator.
7.	6th Street and Gates on East Side of Freeway	Condition is unknown. This line crosses under the Kincaid Street Northbound onramp and then flows south to Kincaid. The line should be evaluated and repaired, replaced or lined as necessary.

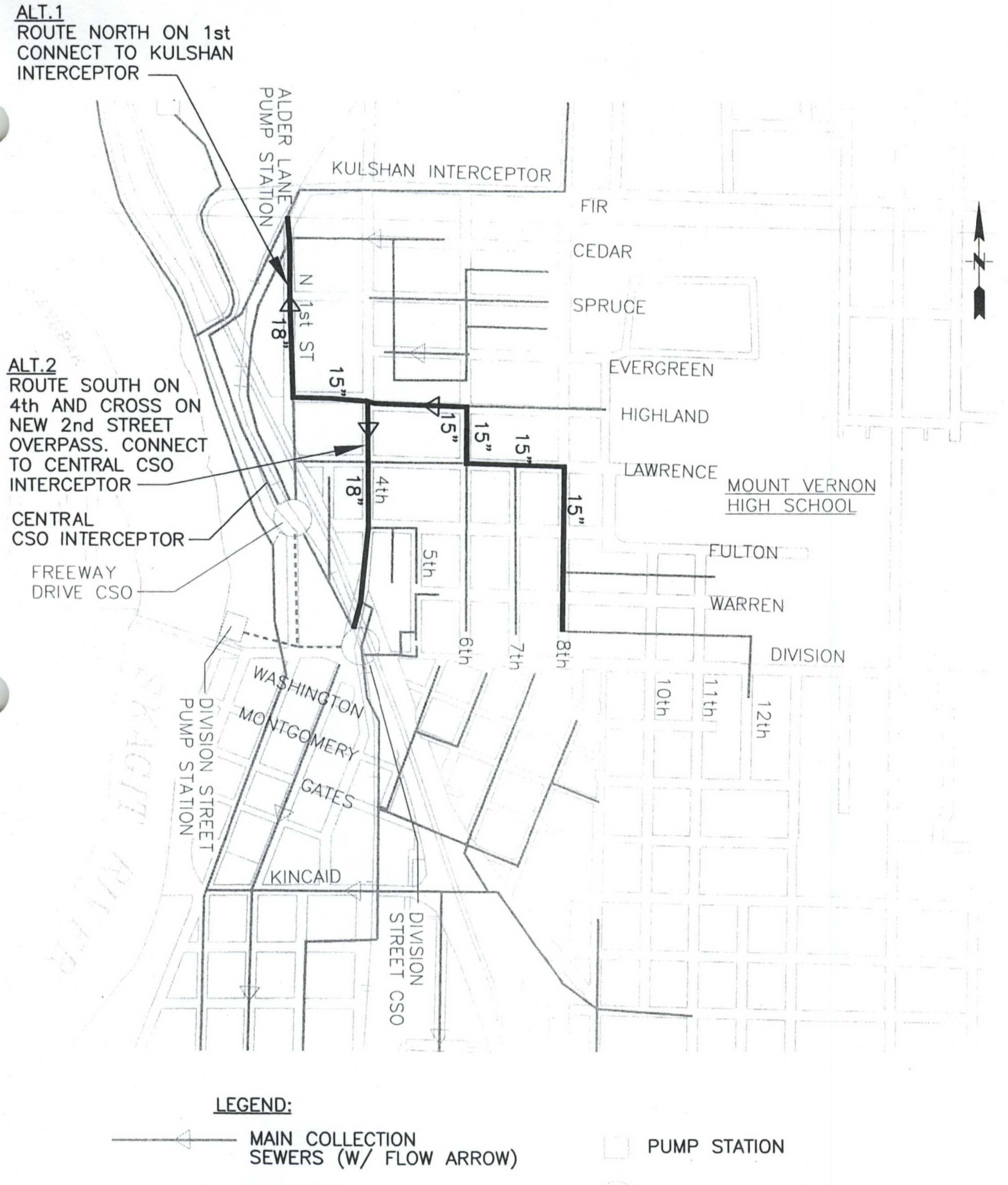
Interstate 5 Crossings		
No.	Location	Condition and Recommended Improvement
		necessary.
8.	Section Street at Wells Nursery	Condition unknown. This 16-inch provides service to only one connection, Wells Nursery. There is also a documented steady flow
9.	Park Street at South Side of Wells Nursery	Condition unknown. The line should be evaluated and repaired, replaced or lined as necessary.

North Fir Street

As development occurs in the property East of 30th Street and North of Division Street conveyance will be required. Conveyance from this area should be connected to the line on 30th Street. The line should be extended up to Division to intercept and offload other local sewers. This extension could also provide service to a future school East of 34th Street and South of Division Street.

Fowler Interceptor

Wastewater from the Eaglemont Development in East Mount Vernon currently discharges to the north and flows to the Kulshan Interceptor. Original plans for this development identified the need to ultimately convey flows to the Fowler Interceptor. This interceptor has been extended partially to the east already. The remainder of the extension should be completed as required by the development of Eaglemont.



HDR
Engineering, Inc.

Project Title
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
NORTH 8th STREET IMPROVEMENTS

Figure No.
5–4

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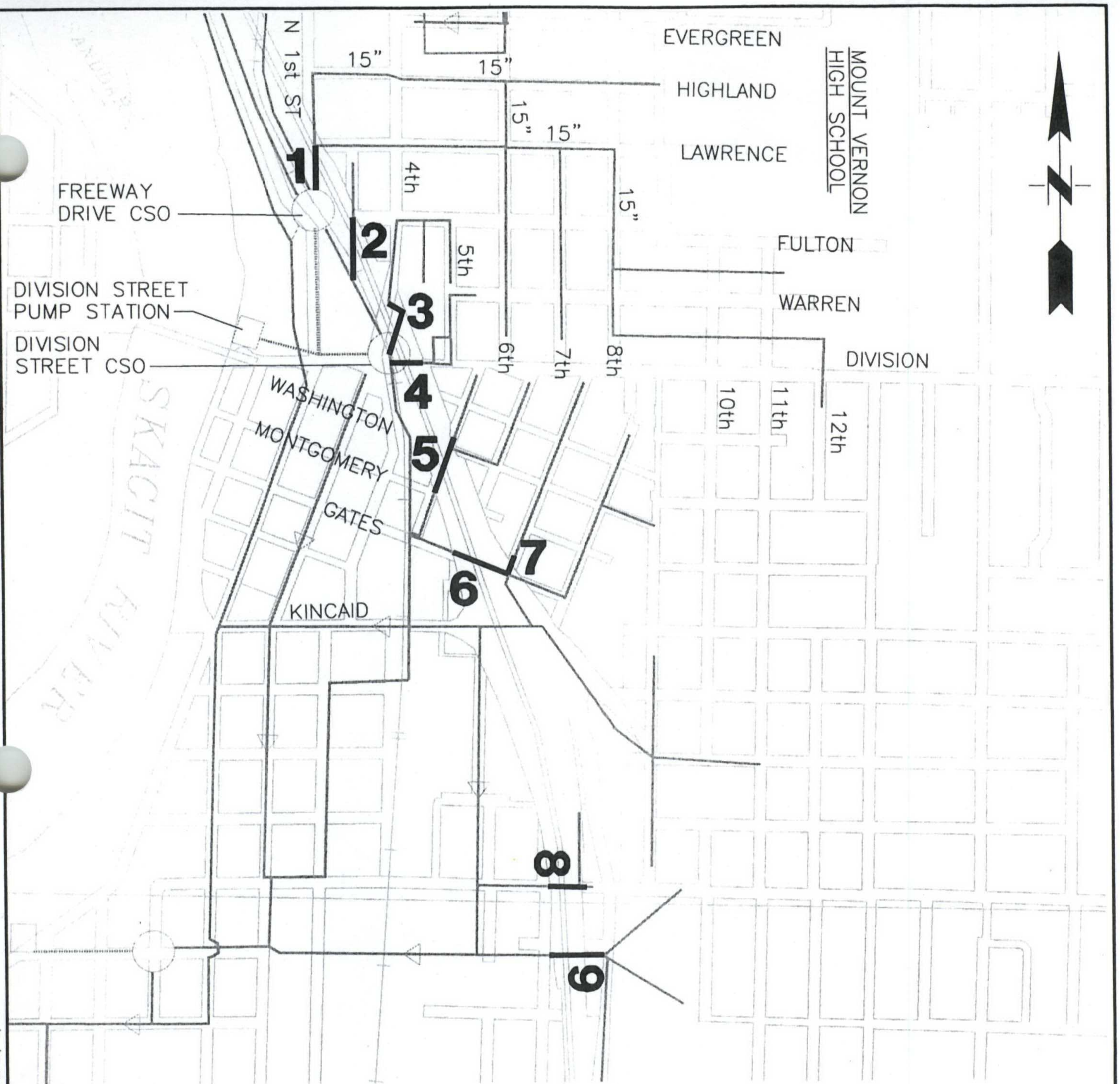


HDR Engineering, Inc.

Project Title
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INTERSTATE 5 SEWER CROSSINGS

Figure No.
5–5

Freeway Drive Pump Station

This pump station serves the limited development on the west side of Interstate 5 between College Way and the Skagit River. The pump station has adequate capacity to serve the boundaries and current zoning. Any revisions to the zoning or expansions of the service area may require an upgrade to the pump station. The existing pump station and 8-inch force main have a capacity of about 350 gpm. This is about 2 feet per second velocity in the force main. It is reasonable to increase velocities in a force main to about 8 feet per second so additional capacity could be provided by increasing the pumping rate. The sewer beyond the force main discharge may need to be increased to accommodate additional flows.

South Mount Vernon

Service to the area of Anderson Road has been provided by constructing a pump station on Highway 99 South of Anderson Road. Areas on the East side of Interstate 5 will be served by a gravity sewer extending under Interstate 5 approximately halfway between Anderson Road and Hickox Road. There is a small area of south of Little Mountain Park that will need to be provided with a pump station because the grade falls to the east.

WASTEWATER COLLECTION SYSTEM DEFECTS ASSESSMENT

Introduction

The City has three databases that are used to track sewer collection system problems:

- Video Scan, a database record of the TVing of sewer lines;
- Sewage Incident Reports, a database of incidents of water and wastewater on the ground; and
- Sewer Complaints, a database of customer complaints of suspected waters that may or may not be wastewater, and of local problems (i.e. wastewater flooding basement due to plugged side sewer).

Table 5-4 lists major defects identified through the City video records and system database. The City has also compiled a database of customer reported problems, sewage incidents, and historical video inspections. System deficiencies included deteriorating pipes, lines with excessive root intrusion, or lines known to have capacity limitations. Minor defects that can be addressed with spot fixes are discussed in the next section.

Table 5-4

Collection System Improvements					
ID No.	**Location**	**Defect**	**Defect identified Via**	**Improvement**	**Cost ($1,000)**[1]
CS-1	Snoqualmie, MH B29A to MH B29	Root intrusion	Video[2]	Remove roots and Slipline with 300 LB	$20
CS-2	Yard of house 1115 NO. 8th, MH 49 to MH 50	Root intrusion	Video[2]	Remove roots and Slipline with 250 LB	$20
CS-3	So. 7th and Jefferson to So. 7th and Washington, MH 39 to MH 37	Root intrusion	Video[2]	Remove roots and Slipline with 450 LB	$20
CS-4	No. 6th and Lawrence, MH C39 to MH C38	Root intrusion	Video[2]	Remove roots and Slipline with 320 LB	$20
CS-5	Brick Hill, MH 01, North along I-5	Root intrusion	Video[2]	Remove roots and Slipline with 400 LB	$20
CS-6	Blodgett Rd to North of Blackbur, MH 55 to MH 54	Root intrusion	Video[2]	Remove roots and Slipline with 270 LB	$20
CS-7	Kincaid, MH 25, to MH 23	Root intrusion	Video[2]	Remove roots and Slipline with 240 LB	$20
CS-8	So. 20th, North off Section, MH 32 to MH 31	Root intrusion	Video[2]	Remove roots and Slipline with 120 LB	$20
CS-9	Section, MH D33 to between MH D32-D31	Structural Damage	Video[2]	Replace with 420 LF of 8-inch pipe	$50
CS-10	Alley between Douglas and Walter, MH A13 to A05	Structural Damage	Video[2]	Replace with 640 LF of 8-inch pipe	$75

Table 5-4 cont					
ID No.	**Location**	**Defect**	**Defect identified Via**	**Improvement**	**Cost ($1,000)[1]**
CS-11	107 Cedar to the South, MH F11 to F29	Structural Damage	Video[2]	Replace with 300 LF of 8-inch pipe	$45
CS-12	No. 6th, MHF13 to F14	Structural Damage	Video[2]	Replace with 400 LF of 8	$60
CS-13	Section and Rail Road Ave, MH E17 to E18	Structural Damage	Video[2]	Sport repair-verify grease problem is corrected	$5
CS-14	Broadway at alley between So. 9th & 10th, MH D41 to D40	Structural Damage	Video[2]	Slipline with 330 LF	$20
CS-15	Broad, east of So. 11th, MH 54 to MH 49	Structural Damage	Video[2]	Replace with 230 LF of 8-inch pipe	$20
CS-16	Line under I-5	Structural Damage	Video[2]	Will require further	--[4]
CS-17	Alley, north of Division, east of No. 11th, MH C66 to C65	Structural Damage	Video[2]	Spot Repair	$5
CS-18	Bernice, east of So. 14th, MH G42 to G41	Structural Damage	Video[2]	Spot Repair	$5
CS-19	So. 3rd and Vera, MH A41 to I42	Structural Damage	Video[2]	Pipe has been	--
CS-20	Lawrence and 7th, MH C73	Structural Damage	Video[2]	Spot Repair	$5
CS-21	1224 12th Str. So, between MH G8 and G11	Structural Damage	Video[2]	Replace with 200 LF of 8-inch pipe	$25

	and G11			inch pipe	

Table 5-4 cont

ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-22	117th North 8th Str.	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-23	420 E. Fulton	Flooding	Data Base[3]	See 8th Str. Section[3]	--[5]
CS-24	919 W. Division	Flooding	Data Base[3]	No improvements- surface flooding problem	--
CS-25	Alley at Carpenter, between So 9th and so. 10th heading north to Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-26	1120 No 16th, 340 ft north of MH M68 on Florence and 16th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-27	1210 N. 14th, north of Florence and 14th	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-28	8th Str. And Evergreen heading north, F18 to F15	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-29	7th and Warren, toward Fulton, MH C73 to C72	Cracked Pipe	Data Base[3]	See 8th Str. Section	--[5]
CS-30	16th and Blackburn heading east 17th, J08 to J09	Obstruction	Data Base[3]	Jet main and monitor flows	--
CS-31	100 Washington- storm line going to SE under I-5, MH C19 to C20	Cracked Pipe	Data Base[3]	Will require further assessment	--[4]

Table 5-4 cont.					
ID No.	Location	Defect	Defect identified Via	Improvement	Cost ($1,000)[1]
CS-32	Scott's Bookstore, N 1st to N 1st and Division	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-33	Snoqualmie St. between Cleveland and S 2nd Str. MH B32 to B03	Cracked Pipe	Data Base[3]	Reassess slipline if necessary	--
CS-34	Westside of Christenson Seed West to So 3rd, MH E01 to A39	Infiltration	Data Base[3]	Spot Repair	$5
CS-35	Cleveland and Blackburn to just West of Harrison and Blackburn, MH J11 to J09	Inflitration, Joint problem	Data Base[3]	Slipline 300 LF	$20
CS-36	N Laventure just south of E Fir to N Laventure just north of E Fir, MH N06 to N04	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-37	North of Casecade Str., on N Laventure to S of E Fir on Laventure, MH N08 to N06	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-38	N Laventure, Fulton to Cascade, MH N12 to N10	Cracked Pipe	Data Base[3]	Spot Repair	$5
CS-39	Hoag Rd., Parkway Dr., to Hoag Rd	Root intrusion	Data Base[3]	Reassess slipline if necessary	--
CS-40	Lind Str. And S. 6th to N on S 6th, MH E76 to E75	Infiltration	Data Base[3]	Spot Repair	$5

[1] Costs are based on ENR Cost Index of 6390 (October 2001), and include restoration, 25% for legal, administration, and engineering costs, 7.8% for sales tax, and a 20% contingency.
[2] Defect identified via review of video records.
[3] Defect identified via review of City Sewer Data Base.
[4] Interstate-5 Crossings are estimated at $750,000 for all nine improvements.
[5] 8th Street Improvements have been estimated at $1,000,000 to correct the localized surcharging.

Repair and Replacement Program Criteria

The City has annually allocated a budget of $900,000 for sewer repair and replacement. This allocation allows necessary improvements to be scheduled and completed in a timely manner, saving the City monies from costly emergency repairs. Co-ordination with the Pavement Management Plan also allows savings to be realized for the City. A comprehensive repair and replacement program, designed to address improvements in order of importance, is presented in the last section of this chapter, Recommendations.

The City databases were reviewed and the necessary capital improvements identified. Numerous problems are small in nature and can be repaired with spot fixes. These defects should be allotted a nominal sum of $5,000 per location for repair of the problem. Defects that require additional work, including removing roots and sliplining have been allocated a minimum estimated cost of $20,000. The City databases had in excess of 30 records where repairs were required. Table 5-4 presents a summary of the identified projects and the corrections for each problem.

ODOR CONTROL

Odors in the collection system are typically associated with anaerobic conditions. These conditions are a function of ambient temperature, gravity pipe slope, transition structures, inverted siphons, and force mains. Hydrogen sulfide is generated in the wastewater and released to the atmosphere, causing odors and corrosion in the structure where it is released. Typically, in the collection system, prevention or treatment of hydrogen sulfide in the liquid-stream is desirable.

Liquid-stream odor control can be accomplished by numerous chemicals:

- Chlorine, as is currently utilized, is a powerful oxidant that can be supplied either in a gas phase (chlorine gas) or as hypochlorite. It is effective at controlling odors by oxidizing sulfide and killing or inactivating many odor-causing bacteria. Chlorine oxidation requires approximately ten to fifteen pounds of chlorine per pound of sulfide. It's key disadvantage is it's classification as a hazardous substance, which requires consideration of health and safety issue.

- Calcium nitrate is an alternate electron donor. In anaerobic conditions, bacteria preferentially chose nitrate to sulfate as an electron donor, thus sulfide is not produced in the presence of nitrate. Approximately 0.7 to 1.4 pounds of calcium nitrate is required per pound of hydrogen sulfide. Bioxide™ is a commercially available calcium nitrate solution produced by U.S. Filter, Davis Process.

* Other options for chemical oxidation of sulfide include potassium permanganate, hydrogen peroxide, ferrous sulfate, and slug dosing with caustic.

Four options were reviewed for reducing odors in the collection system. These included oxidizing with potassium permanganate, sodium hypochlorite, gaseous chlorine, and the addition of calcium nitrate. Typical costs per pound of sulfide removed were developed for each of these options.

Item	Cost per lb of Sulfide Removed
Potassium Permanganate	\$7 - \$10
Sodium Hypochlorite (12%)	\$3 - \$5
Gaseous Chlorine	\$1 - \$3
Calcium Nitrate	\$2 - \$3

Although gaseous chlorine has the lowest cost per pound of sulfide removed, the handling of gaseous chlorine presents a number of safety related issues, as addressed in Article 80 of the Uniform Fire Code. This requires the provision of containment and scrubber system to treat gases that could leak from the system. Due to the additional regulations and safety concerns, the trend for many utilities is to avoid the use of gaseous chlorine when planning new facilities. Presently the City utilizes the gaseous chlorine system at the wastewater treatment plant to provide a chlorine solution that is pumped to the incoming interceptor of the wastewater treatment plant at Hazel Street and Harrison Street. If gaseous chlorine were not to be used in the future, the use of calcium nitrate would be the next most cost effective method for odor control.

The future plan would be to add calcium nitrate at the more remote locations in the collection system, thereby reducing the production of hydrogen sulfide within the system and the need to add large quantities of chlorine to the interceptor upstream of the wastewater treatment plant.

RECOMMENDATIONS

While some deficiencies in the collection system exist or will exist with projected future growth, not all of them are recommended for repair or replacement. Table 5-5 presents the recommended improvements and a schedule for implementation, correlating to priority of improvement. Improvements to the interceptor system are dependant upon future growth and should be constructed, as identified in Table 5-2, to serve the areas that experience growth.

Table 5-5

Repair and Replacement Program		
Year(s)	**ID Tags**	**Cost ($1,000)**
2001	CS-1 through CS-18, CS-20, CS-21, CS-25 through CS-28, CS-32, CS-34, CS-35, and CS-40[1]	$555
2002	FS-5[2]	$635
2003	8th Street Improvements	$1,000
2004	Interstate 5 Crossings	$750[3]
2005	FS-6 and FS-7[2]	$620
2006	Interceptor Improvements	-[4]
2007-2020	FS-1 through FS-4, and FS-8 through FS-17[2]	$2,540
Total		$6,100

1. Improvements identified by the City, Table 5-4.
2. Interceptor System Improvements identified in Table 5-2.
3. Interstate 5 Crossings Improvements are identified in Table 5-3.
4. The interceptor improvements identified in Table 5-2, and accounted for in this table in the future (2007-2020) should be designed and constructed as growth dictates.

6. Industrial Pretreatment

Introduction

The City of Mount Vernon has one major industrial customer, Draper Valley Farms, Inc. (DVF), which discharges to the City's wastewater collection system. This industrial discharge is regulated by a State Discharge Permit, issued by the State of Washington Department of Ecology (DOE). This permit defines pretreatment requirements for these wastewater discharges to the City's sewer system.

As a part of the comprehensive planning process, the operations at this industry and their pretreatment equipment were reviewed to determine the adequacy of the pretreatment being provided. This included onsite observation of the industrial operation, interviews with operating staff, a review of operating data and compliance with permit requirements, and recommendations for operational plant modifications or improvements to the pretreatment process. This chapter includes description of the poultry plant and associated pretreatment facilities, presentation of wastewater data and wastewater discharge limitations, and a discussion and conclusions regarding the DOE requirements for the processes meeting the criteria for 'All Known, Available, and Reasonable Methods of Treatment (AKART).'

Poultry Plant Description

Draper Valley Farms slaughters approximately 90,000 fryer/broiler chickens during two productions shifts. The plant normally operates five days per week with some six-day weeks and one seven-day week each year, at most. The plant is sanitized during the third shift, with an additional "pre-operation" cleanup that starts at midnight on Sundays.

Cooling fans are activated in the receiving area when temperatures reach 65 $^{\circ}$ F; while misters are activated when temperatures reach 70 $^{\circ}$F. After the chicken cages are unloaded, pretreated wastewater is recycled to wash the cages before they are returned to the truck.

After the carotid artery of the chicken is cut, the blood is collected in a curbed area and pumped to a holding tank on one of the trucks that hauls inedible material to the off-site renderer. The birds are scalded with steam to allow removal of yellow skin in the plucking machines to yield regionally-desirable white broilers, rather than yellow broilers. Feathers, and the yellow skin, are removed in three mechanical plucking machines in series, with the final machine devoted to feet of the bird. The feathers and skin are directed to one of two inedible trucks. Later the feet are removed and, somewhat unusually, sold as edible product in the United States. Guts, lungs, crops, heads and other inedible materials are directed to a second inedible truck. Giblets are removed and chilled with water for sale. Ultimately the chickens enter a chiller where heat is removed from the carcass with cold water. After chilling, some of the carcasses are directed to an adjacent room for cutting and packaging.

The entire production area is equipped with good areas designated for washing aprons and hands. The use of these areas during breaks, noon and shift changes prevents washing material on the floor into the sewers before it can be removed by dry cleaning.

All refrigerant compressors are air cooled, while cooling towers are used for the ammonia and freon compressors. Water is periodically blown down from the cooling towers to the plant with an automatic timer to prevent a buildup of minerals. This blow down is directed to the plant sewers through a one-inch line.

Pretreatment Facilities

Wastewater pretreatment facilities consist of primary and secondary screening and dissolved air flotation (DAF) with chemical addition. After feathers are plucked from the birds they drop into a flume for conveyance to the feather screen. This screen is a rotating, internally-fed screen with openings approximately 1/8 inch in size. Feathers are sent to a press for dewatering and then augured to a truck for hauling to the off-site renderer. Viscera, heads, and other offal drop into a flume for conveyance to the offal screen. This screen is also a rotating, internally-fed screen with openings approximately 1/8 inch in size. Screened offal is augured to a compartment in the inedible truck, separate from the feathers. Underflow from the feather and offal screens is recycled with a pump back to the head end of the feather flume for conveying the feathers. This recycling is acceptable in the feather plucking area, but would not be acceptable in the remainder of the plant after the bird carcasses have been opened. Therefore USDA-required overflow water from the chiller, and other flows from the various processing operations, is utilized to convey the inedible material in the offal flume to the offal screen.

Screen underflow enters a wet pit. In addition to the recycle pump for the feather flume, this wet pit is equipped with a mechanical mixer and three submersible pumps. These three pumps are used to pump the wastewater through three individual forcemains to a secondary screen, although two of these pumps can handle the entire flow, even during the peak hydraulic flow period when the chiller tank is dumped. The secondary screen is a rotating internally-fed screen, with 0.02-inch openings. Screenings from this screen are combined in the inedible truck with the offal.

Since November 1999, a combination of ferric chloride and acid has been injected into each of the three lines to the secondary screen. A pH controller ensures a sufficient quantity of this liquid is added to reduce the pH to approximately 4.1 to 4.5. This pH range is the approximate isoelectric (point of least solubility) point of the proteins in the wastewater. After the excess proteins have come out of solution, they are coagulated by the ferric (trivalent iron). Polymer is then added to flocculate the coagulated proteins before the secondary screen underflow enters the subsequent DAF tank.

The above-ground steel DAF tank is approximately 70 ft long, 10 ft wide and 8 ft high, including 6 inches of freeboard. As such, it holds approximately 39,400 gallons. At the maximum allowable daily flow of 630,000 gpd, this results in a detention time of nearly 90 minutes. Secondary screen underflow is divided between four equally-spaced, 8-inch influent lines near the head end of this tank. To create a dissolved air flotation system, a portion of the tank contents is pumped from a line about a foot off the bottom and midway down the tank. A controlled amount of atmospheric air is aspirated into the suction line to this 15-hp recycle pressurization pump. The pump discharge is divided into four lines, each equipped with a back-pressure valve before it combines with one of the DAF influent lines. To drive most of aspirated air into solution, the valves are throttled to yield a back-pressure approximately 90 psi. After passing through the back-pressure valve and combining with the flocculated screen underflow, the dissolved air comes out of solution as small bubbles which attach to flocculated solids to float them to the surface of the DAF tank. Somewhat unusually, four large fans are periodically activated to blow the floating solids to the effluent end of the tank where they are swept into a skimmings hopper with a large paddlewheel. Occasionally, however, the operator has to assist the fans by raking the floating solids to the paddlewheel. After a quiescent period, water is drained from these skimmings and then they are pumped, with an air-operated, double-diaphragm pump to a separate compartment on one of the inedible trucks. After this skimmings compartment becomes full, the remaining skimmings are pumped to a separate skimmings tanker truck. The DAF tank is not equipped with any positive means of settled solids removal; however, the location of the recycle pump suction near the bottom of the DAF tank tends to draw some of these solids off the tank bottom. Nevertheless, a settled sludge layer varying from six inches to two feet had accumulated on the tank bottom when this tank was recently drained for the first time after more than five years.

A reuse pump is located near the DAF recycle pressurization pump to supply DAF tank contents for the initial hose down of the chicken cages and for hosing down the pretreatment and inedible truck areas.

DAF effluent overflows a relatively-short weir plate into a collection launder at the effluent end of the DAF tank. A pH sensor is used to regulate the feed of sodium hydroxide solution to maintain the pH of the effluent in the range of 6 to 7. Pretreated effluent is directed through a sampling and metering manhole before it enters the City sewer system. A 10-inch Palmer Bowlus flume with an ultrasonic level sensor is used to pace a ISCO refrigerated composite sampler. Wastewater billings are based on potable water meter readings, however, because the flume would surcharge in the past when flows exceeded 0.6 mgd.

WASTEWATER DISCHARGE LIMITATIONS

The Washington Department of Ecology (WDOE) has issued a discharge permit for Draper Valley Farms to discharge pretreated wastewater to the City of Mount Vernon sewerage system. This permit is effective until May 29, 2003. Effluent limits contained in this permit are:

Parameter	Maximum consecutive 3-Day Average	Daily Maximum
	(rolling average)	
Flow	N/A	0.63 mgd
BOD_5	1300 lb/day	N/A
TSS	750 lb/day	N/a
FOG	N/A	100 mg/L
PH	5.0 to 11.0	

At the maximum flow of 0.63 mgd, 1300 lb/day of BOD_5 equates to a concentration near 250 mg/L, while 750 lb/day of TSS yields a concentration of 143 mg/L. However production day flows are often around 0.55 mgd, which results in allowable BOD_5 and TSS concentrations around 285 mg/L and 165 mg/L, respectively.

WASTEWATER DATA

Average monthly flow, BOD and suspended solids for the wastewater from DVF for the 14 months from May 1999 through July 2000 are presented in Table 6-1.

Table 6-1

Historical Flows and Loads for Draper Valley Farms, Inc.			
Month	**Average Monthly Flow (mgd)**	**Average Monthly BOD (lbs/day)**	**Average Monthly SS (lbs/day)**
May-99	0.491	953	523
Jun-99	0.505	1065	552
Jul-99	0.495	1179	658
Aug-99	0.502	1088	598
Sep-99	0.452	1022	541
Oct-99	0.484	1208	598
Nov-99	0.408	940	396
Dec-99	0.334	783	381
Jan-00	0.5	901	470
Feb-00	0.424	889	505
Mar-00	0.425	699	528

Historical Flows and Loads for Draper Valley Farms, Inc.			
Month	Average Monthly Flow (mgd)	Average Monthly BOD (lbs/day)	Average Monthly SS (lbs/day)
Apr-00	0.454	480	403
May-00	0.429	872	547
Jun-00	0.39	484	354
Jul-00	0.408	678	462

In November 1999, Draper Valley Farms switched pretreatment chemical supply companies. The new company, CESCO Chemicals, Inc., made the temporary revisions necessary to feed ferric chloride and acid to improve protein recovery. After an initial startup period, much better results have been achieved. The most significant reductions have been in the average daily BOD discharges to the system. As shown Figure 6-1, monthly average discharges exceeded 1200 lbs. per day in October 1999 and have averaged less than 700 pounds per day for the period from December 1999 through July 2000. Average monthly suspended solids loadings are shown on Figure 6-2.

Figure 6-1 DVF Wastewater Discharges - BOD (lbs. per day)

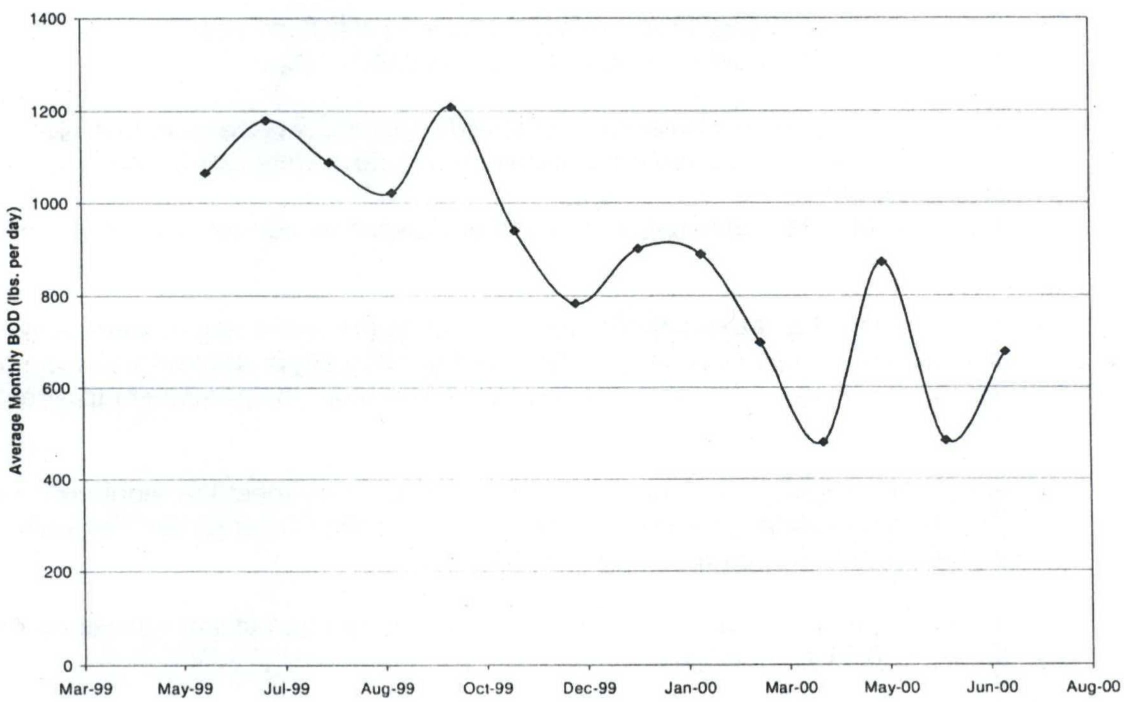
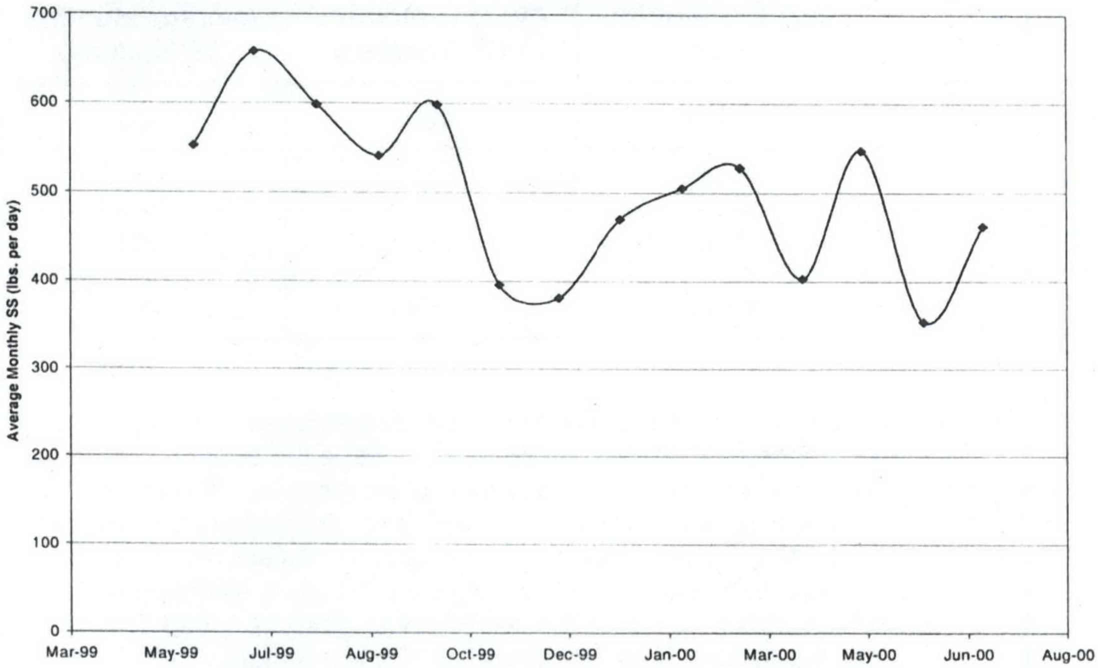


Figure 6-2 DVF Wastewater Discharges -Suspended Solids (lbs. per day)



AKART

Chapter 173-216 of the Washington Administrative Code (WAC) defines the State Waste Discharge Permit Program. Section 73-216-110 of the WAC states:

> "Any permit issued by the department shall specify conditions necessary to prevent and control waste discharges into the waters of the state, including the following, whenever applicable:
> All known, available, and reasonable methods of prevention, control, and treatment;"

The acronym of AKART has been adopted for Subsection (a) of this requirement. AKART is not specifically defined for the case of a poultry plant discharging pretreated wastewater to a city's sewerage system for treatment and disposal. Therefore the purpose of this section is to:

1. Define what is required for Draper Valley Farms (DVF) to meet the requirements of AKART as they discharge pretreated wastewater to the City of Mount Vernon's sewerage system for treatment and discharge.

2. Determine whether the existing pretreatment discharge permit limits are appropriate for these AKART technologies.

Although AKART is not specifically defined for the case of a poultry plant discharging pretreated wastewater to a city's sewerage system for treatment and disposal, in 1975 the EPA published a document entitled Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Poultry Segment of the Meat Product and Rendering Process Point Source Category. That document identified "Best Practicable Control Technology Currently Available" (BPT), "New Source Control Technology" (New Source), and "Best Available Technology Economically Achievable" (BAT). That document was written for poultry plants with direct wastewater discharges, but portions of those technology lists are still relevant to the definition of AKART for this particular case, even though 25 years old. Relevant portions of the EPA recommendations were compared with the DVF practices:

EPA Recommendations	**Draper Valley Farms Practices**
• Appoint a person with specific responsibility for water management. This person should have reasonable powers to enforce improvements in water and waste management.	• Yes
• Make all employees aware of good water management practices and encourage them to apply these practices.	• Yes
• Install and monitor flow meters in all major water use areas.	• Yes
• Determine or estimate water use and waste load strength from principal sources.	• Yes
• Control and minimize flow of freshwater at major outlets by installing properly-sized spray nozzles and by regulating pressure on supply lines.	• Yes
• Install "demand" valves on all freshwater outlets.	• Yes, with the exception of an open hose without a nozzle near the inside/outside spray cabinet.
• Install press-to-operate valves on hand washers.	• No, but minimal number of hand washers
• Use high-pressure, low-volume spray nozzles or steam-augmented systems for plant washdown.	• Yes. Separate high-pressure (approx. 500 psi) sanitation system
• Shut off all unnecessary water flow during work breaks.	• Generally yes, except as follows 1. Water to foot plucking machine ran during noon break; other plucking machines ran less.

EPA Recommendations	Draper Valley Farms Practices
	2. Water to wash station before eviscerating and after cavity splitter ran during noon break.
	3. Water to eviscerating machine ran during noon break.
	4. Water sprays at conveyor into carcass chiller ran during noon break.
	5. Shower at the salvage station wired open to flow continuously.
• Use minimum USDA-approved quantities of water in the scalder and chillers.	• Yes. Checked twice each shift
• Control water use in gizzard splitting and washing equipment.	• Yes
• To reduce the waste loads, dry clean all floors and tables prior to washdown in:	
• Bleeding.	• Yes
• Cutting.	• Yes
• Further processing areas.	• Not applicable
• All other areas where there tend to be material spills.	• Yes
• Minimize the amount of chemicals and detergents to prevent emulsification or solubilizing of solids in the wastewaters.	• Yes
• Stun birds in the killing operation to reduce carcass movement during bleeding.	• Yes
• Confine bleeding and provide for sufficient bleed time.	• Yes
• Recover all collectable blood and transport to rendering in tanks rather than by dumping on top of feathers or offal.	• Yes

EPA Recommendations	Draper Valley Farms Practices
• Consider the reuse of chiller water as makeup water for the scalder.	• No. Rarely, if ever, done in large, modern poultry plants
• Consider steam scalding as an alternative to immersion scalding.	• Not acceptable to USDA that requires 1 quart of water per bird be used in the scalder.
• Recycle screened wastewaters for feather fluming.	• Yes
• Consider dry offal handling as an alternative to fluming.	• No. Rarely, if ever, done in large, modern poultry plants
• Control inventories of raw materials used in further processing so that none of these materials are wasted to the sewer. Spent raw materials should be routed to rendering.	• Not applicable – no further processing
• Treat separately all overflow of cooking broth for grease and solids recovery.	• Not applicable – no cooking at this plant
• Reduce the wastewater from thawing operations.	• Not applicable – no thawing at this plant
• Treat offal truck drainage before sewering. One method is to steam sparge the collected drainage and then screen.	• No. Rarely, if ever, done in large, modern poultry plants
• Avoid overfilling cookers in rendering operation.	• Not applicable – no rendering operation
• Provide and maintain traps in the cooking vapor lines of rendering operations to prevent overflow to the condensers. This is particularly important when the cookers are used to hydrolyze feathers.	• Not applicable – no rendering operation
• Use pretreated poultry processing wastewaters for condensing all cooking vapors in onsite rendering operations.	• Not applicable – no rendering operation.
• Provide bypass controls in rendering operations for controlling pressure reduction rates of cookers after feather hydrolysis.	• Not applicable – no rendering operation

EPA Recommendations	Draper Valley Farms Practices
• Stop cooker agitation during cooker pressure bleed-down to prevent or minimize materials carry-over.	• Not applicable – no rendering operation
• Provide frequent and regularly scheduled maintenance attention for byproduct screening and handling systems throughout the operating day.	• Yes
• Provide a back-up screen to prevent byproduct from entering municipal waste treatment system.	• No. Rarely, if ever, done in large, modern poultry plants
• In-plant primary systems—catch basins, skimming tanks, air flotation, etc. - should provide for at least a 30-minute detention time of the wastewater.	• Yes – closer to 90 minutes
• Provide frequent, regular maintenance attention to air flotation system.	• Yes
• Dissolved air flotation with pH control and chemical flocculation.	• Yes

Methods of "prevention, control and treatment" of wastes discharged from a poultry plant to a municipal treatment system include the following general categories:

- In-plant waste minimization
- Recycle/reuse
- Pretreatment

The previous comparison shows that DVF has implemented virtually all the applicable BPT, New Source and BAT technologies suggested by the EPA for in-plant waste minimization, recycle/reuse and pretreatment, at least as currently practiced by large, modern poultry plants. DVF's recycle and reuse practices are unusually good.

AKART pretreatment requirements cannot be defined for a poultry plant without taking into consideration the municipal wastewater treatment facilities, since wastes can be removed at either location. Some municipalities have expanded their wastewater treatment facilities to accommodate waste loads from poultry plants with physical pretreatment alone, while many cities have required poultry plants to meet discharge limits around domestic strength levels, often around 250-350 mg/L BOD_5 and suspended solids (TSS). These domestic strength limits are about a quarter to a third of discharge levels with physical pretreatment alone. The current BOD_5 concentrations discharged by DVF to the sewer system are 200 to 250 mg/L on a 3 day average. The following is a listing of wastewater pretreatment options for poultry plants, arranged from least effective to most effective:

1. Coarse (1/4" openings) screening.
2. Coarse and fine (0.02" to 0.04" openings) screening.
3. Coarse and fine screening and gravity clarification.
4. Coarse and fine screening and dissolved air flotation.
5. Coarse and fine screening and dissolved air flotation with cationic polymer addition.
6. Coarse and fine screening and dissolved air flotation with cationic and anionic polymer addition.
7. Coarse and fine screening and dissolved air flotation with alum and anionic polymer addition with subsequent caustic addition for effluent pH neutralization, if required.
8. Coarse and fine screening, dissolved air flotation with acidulation to the isoelectric point (pH of least solubility of proteins) and polymer addition for protein coagulation and flocculation with subsequent caustic addition for effluent pH neutralization.
9. Coarse and fine screening and dissolved air flotation with ferric and anionic polymer addition with subsequent caustic addition for effluent pH neutralization, if required.
10. Coarse and fine screening, 24-hr flow equalization, dissolved air flotation with ferric and anionic polymer addition, effluent turbidimeter with provisions to return off-spec effluent back to the 24-hr flow equalization basin (FEB) and caustic addition for effluent pH neutralization, if required.
11. Coarse and fine screening, 24-hr flow equalization, dissolved air flotation with ferric and anionic polymer addition, effluent turbidimeter with provisions to return off-spec effluent back to the 24-hr FEB, caustic addition for effluent pH neutralization, and a 7-day FEB.

After the maximum amount of physical pretreatment, consisting of coarse and fine screening and dissolved air flotation, is achieved, further poultry waste reductions are almost always accomplished with chemical addition. The least effective chemicals for pretreatment yield the most acceptable sludges for rendering. Conversely the most effective chemical for pretreatment, ferric sulfate/chloride, yields a sludge which is difficult to render and seriously degrades the rendered products. Nevertheless DVF uses ferric chloride to meet the required discharge limits. In fact, they also acidulate the wastewater to the isoelectric point for even greater removals. Flow equalization ahead of the chemical pretreatment, monitoring effluent quality and return of off-spec wastewater for retreating, and 7-day flow equalization are additional steps that can be taken to improve the consistency of pretreatment, if necessary. The data shown in Table 6-1 shows the effluent has consistently met the discharge limits after the initial start-up of the new chemical feed system.

POTENTIAL IMPROVEMENTS

Although DVF is meeting the requirements of AKART in discharging their pretreated wastewater to the City of Mount Vernon's wastewater treatment system, there are a few enhancements that DVF should consider:

In-Plant Waste Minimization

1. Replace home shower-type nozzles with engineered spray nozzles.
2. Evaluate automating the flow of potable water to the plucking machines, eviscerating machine, and conveyor to the carcass conveyor so it shuts off automatically at noon and during breaks when there are no birds passing through these devices.
3. Continue to train, encourage and monitor plant personnel to turn off water at work stations during breaks and at noon.
4. Continue to ensure all hoses are equipped with press-to-activate nozzles.

Pretreatment

1. Lift station. Consideration should be given to replacing the three existing submersible pumps with three new Gorman Rupp T-series, self-priming pumps. These pumps have excellent solids-passing capability and are easier to maintain since they are not submersible. This pump change would not normally impact effluent quality, but reduced maintenance would offer the operators more time for operation and observation of the remaining pretreatment facilities.

Regardless of the lift pumps utilized, the three discharge lines from these pumps to the rotating screen should be replaced with one common forcemain. This will eliminate the problems with trying to regulate the feeding of chemicals into each line.

2. Chemical Feed System. The existing chemical feed system was installed as a temporary system, nearly a year ago by reusing existing facilities and installing some makeshift provisions to pilot test the acid/ferric chloride chemical pretreatment scheme. Now that this chemical feed scheme has proven successful, the chemical feed system should be systematically laid out and permanently hard wired and hard piped. As part of this permanent design, the adequacy of the existing chemical metering pumps should be evaluated.
3. Operation and Maintenance. Written operation and maintenance instructions should be developed for the entire pretreatment system from the primary screens through the effluent sampling and metering station. In general, these instructions should developed as simple itemized lists for each piece or pieces of equipment or system. These lists should be laminated and mounted near the relevant equipment with a master copy kept on file.

Currently when the chemical feed system becomes upset, the operators call CESCO, Inc. to come to the plant to correct the problems. Fortunately CESCO, Inc., located in Bellingham, is normally able to quickly respond to this call for help. Nevertheless a written "decision tree", or other program, needs to be developed so DVF operating personnel can diagnose and correct problems.

4. Dissolved Air Flotation System. The existing DAF tank is unusual in that it is equipped with neither a mechanical surface skimmer nor bottom solids removal provisions. Although it produces good effluent quality, consideration should be given to equipping this tank with a chain and flight mechanism as a positive means of sweeping floating material to the paddlewheel for removal. This will eliminate the periodic need for the operator to manually rake the skimmings to the paddlewheel.

DAF tank should be drained and cleaned each weekend.

The overflow weir at the effluent end of the tank is only about half of the width of the tank. During the peak flow period when the carcass chiller is emptied, the increased water depth over this constricted overflow weir causes water to flow into the skimmings trough. To minimize the increase in water depth over the weir and prevent water entering the skimmings trough, the effluent overflow weir should be extended to span as much of DAF tank width as possible.

Lighting for most of the pretreatment facilities is good at night, but the effluent weir is in the shadows. Since it is necessary to observe this area to visually determine the adequacy of the chemical pretreatment, a new light should be installed, or an existing yard light relocated, to illuminate this area. Consideration might also be given to installing a turbidimeter to continuously monitor the turbidity of the effluent and sound an alarm if it reaches a preset level. This has proven successful in monitoring effluent quality at other poultry plants.

Since flotation in the DAF tank is dependent on the recycle pressurization pump, a second pump should be available.

CONCLUSIONS

Based on a review of in-plant waste minimization, recycle/reuse, and wastewater pretreatment practices, Draper Valley Farms is currently meeting AKART requirements with their discharge to the City of Mount Vernon. There are a few in-plant waste minimization practices that should be considered, although they would only result in minor amounts of flow reduction. Recycle/reuse of wastewater by Draper Valley is 'state of the art". There are several pretreatment improvements that should be considered or implemented. These improvements would not appreciably improve effluent quality, but may improve the consistency of maintaining these good results. Draper Valley Farms, Inc. has evaluated the potential improvements previously sited and comments have been included as Appendix E.

7. EXISTING WASTEWATER TREATMENT PLANT

SYSTEM HISTORY

The City of Mount Vernon Wastewater Treatment Plant (WWTP) was originally constructed in 1948 and consisted of primary treatment, disinfection, and anaerobic digestion. In 1972, the WWTP was upgraded to secondary treatment with an oxidation tower (biofilter). In 1989, the secondary treatment was converted to an activated sludge process and the biofilter process was taken out of service.

TOTAL MAXIMUM DAILY LOAD

The Department of Ecology has established a Total Maximum Daily Load (TMDL) for the Skagit River to ensure that water quality standards will not be impaired as projected growth occurs. The TMDL exists for both dissolved oxygen (DO) and fecal coliform. It is applied during a critical period and allocates loads to each of the contributing parties. The City of Mount Vernon's wastewater treatment plant is an entity that has a TMDL load allocation for both DO and fecal coliform during a defined critical period.

The TMDL for dissolved oxygen governs the oxygen demanding substances that can be added to the Skagit River. In particular, it defines loadings of carbonaceous 5-day biochemical oxygen demand ($CBOD_5$) and ammonia (NH_3) that can be discharged to the river. The $CBOD_5$ loading can be exchanged with the ammonia loading. The critical period for the DO TMDL is July through October, and the TMDL limits will be imposed during low flow season, defined as July 1 through November 15. The waste load allocations (WLA) for Mount Vernon are 1,902 lbs/day of $CBOD_5$ and 1,188 lbs/day of NH_3-N (alternate WLA are 2,712 lbs/day of $CBOD_5$ and 678 lbs/day of NH_3). WLA are derived as acute limits and interpreted as daily maximum or weekly limit. $CBOD_5$ can measured as BOD_5 with a site specific conversion factor (a conversion factor of 1.125 is used to estimate BOD_5). Table 7-1 summarizes the current TMDL limits for DO for Mount Vernon. If the minimum flow in the river is maintained above the required 6,000 cfs, the daily and weekly TMDL limits may not apply.

Table 7-1

Dissolved Oxygen Total Maximum Daily Load for Mount Vernon for the Skagit River		
Parameter[1]	**Average Monthly Limit (lb/day)** [3]	**Maximum Daily (NH_3)or Weekly (BOD) Limit (lb/day)** [4]
CBOD	1,407	1,902
BOD[2]	1,583	2,140
Ammonia as N	922	1,188

1. BOD can be exchanged for ammonia, but the oxygen assimilative capacity provided to Mount Vernon must be maintained.
2. BOD is calculated for CBOD based on a ratio of 1.125.
3. Monthly Average Limits will apply from July through October.
4. Maximum Daily and Weekly Limits will apply when the Skagit River's flow rate falls below 6,000 cfs, measured at USGS gauging station number 12200500, at the highway 99 bridge, upstream of Mount Vernon.

The TMDL for fecal coliform governs the fecal coliform loading to the Skagit River. The critical period for the fecal coliform TMDL is year-round, and the TMDL limits will be imposed during both low and high flow seasons. The waste load allocations (WLA) for Mount Vernon is given as a fecal coliform concentration (rather than a loading) and is equal to the NPDES technology-based permit limits (monthly average of 200 cfu/100 mL).

NPDES Permit

A meeting was held with City Staff and representatives of the DOE, on January 9, 2001, to discuss the updated NPDES permit. Minutes of this meeting are included in Appendix F. Department of Ecology has issued a draft NPDES Permit to the City of Mount Vernon. The final permit was issued September 4, 2001 and is included in Appendix G. The new permit will addresses CSOs, TMDLs, and WWTP issues. In addition, the City is required to perform toxicity testing.

The new permit is effective October 1, 2001 and expires on June 30, 2003. The effluent limits specified in the permit are listed in Table 7-2 and Table 7-3.

Table 7-2

NPDES Permit Effluent Limits for Conventional Pollutants for the Mount Vernon WWTP		
Parameter	**Monthly Average**	**Weekly Average**
5-day Biochemical Oxygen Demand (BOD)	30 mg/L 1401 lbs/day	45 mg/L 2102 lbs/day
Total Suspended Solids (TSS)	30 mg/L 1401 lbs/day	45 mg/L 2102 lbs/day
Fecal Coliform Bacteria	200/100mL	400/100mL
PH[1]	Within the range of 6.0 to 9.0	

1. Interim limit is in affect for the duration of the NPDES, after which time a new limit of: within the range of 6.6 to 9.0 will apply.

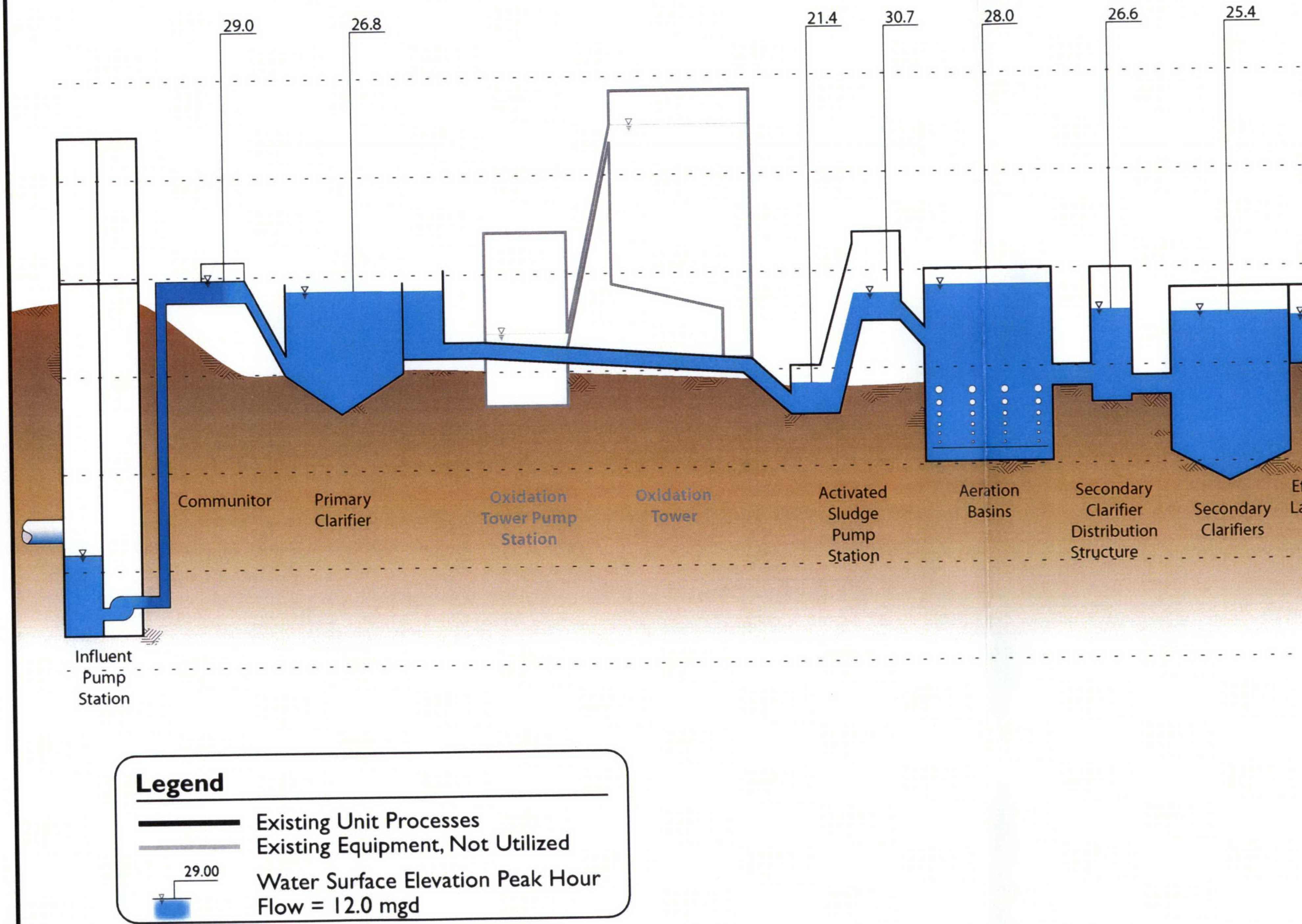
Table 7-3

NPDES Permit Effluent Limits for Chemical Pollutants for the Mount Vernon WWTP		
Parameter	**Average Monthly Limit**	**Maximum Daily Limit**
Total Residual Chlorine	50 μg/L 2.21 lbs/day	100 μg/L
Ammonia-Nitrogen	31 mg/L 1448 lbs/day	41 mg/L
Copper[1]	21.3 μg/L 1.0 lbs/day	35 μg/L
Zinc	88.4 μg/L 4.13 lbs/day	177.4 μg/L

1. Interim limit is in affect for the duration of the draft NPDES, after which time new limits of: Average Day: 9.4 μg/L, 0.44 lbs/day and Maximum Day 16.6 μg/L will apply.

HYDRAULIC PROFILE

The existing WWTP liquid stream processes consists of an influent pump station, screening equipment, primary clarifier, activated sludge pump station, aeration basins, secondary clarifiers, chlorine mixing chamber, chlorine contact basin, and effluent pump station. The hydraulic profile for 12.0 mgd flow (current peak hour capacity) through the existing WWTP is presented in Figure 7-1. The oxidation tower pump station and oxidation tower have been replaced by the activated sludge process and are not currently utilized. Flows from the primary clarifier flow by gravity to the activated sludge pump station.



29.0
26.8
21.4
30.7
28.0
26.6
25.4
Communitor
Primary Clarifier
Oxidation Tower Pump Station
Oxidation Tower
Activated Sludge Pump Station
Aeration Basins
Secondary Clarifier Distribution Structure
Secondary Clarifiers
Influent Pump Station
Legend
Existing Unit Processes
Existing Equipment, Not Utilized
29.00
Water Surface Elevation Peak Hour Flow = 12.0 mgd

Influent Pump Station

The WWTP is primarily served by an influent pump station, which receives flows from the Hazel Street interceptor (42-inch, 24 mgd gravity capacity). The influent sewer enters the pump station approximately 25 feet below grade. The existing pump station is a caisson construction, consisting of a wet well - dry well configuration. A mechanically-cleaned vertical bar screen (1.0-inch spacing) removes large debris from the influent wastewater. A manual bar screen (1.0-inch spacing) is available as backup to the mechanically-cleaned unit. Flows discharge to the existing comminutor through a 20-inch force main. The pumping units consist of four variable-speed, 40-hp pumps. The pump station has a firm pumping capacity of 10.8 mgd.

West Mount Vernon Pump Station

The WWTP also receives flows from the West Mount Vernon Pump Station. The pump station capacity is 1.2 mgd. Flows enter the WWTP through a 12-inch force main and discharge at the head of the existing comminutor.

Headworks

The headworks of the existing WWTP consists of comminution and de-gritting primary sludge. The comminutors are located downstream of both pump stations, and immediately upstream of the primary clarifier. Grit removal is located downstream of the primary clarifier, where primary sludge is de-gritted.

Comminutor

Comminution at the WWTP is performed by two comminutors, with a capacity of 12.0 mgd.

Grit Removal

The WWTP currently degrits primary sludge. Primary sludge is removed from the primary clarifiers and sent through an existing grit separator. The grit is then stored until it is removed for disposal.

Disposal

Screenings and grit are transported to a county landfill for final disposal.

Primary Clarifier

The existing primary clarifier is an 80-foot-diameter circular tank with a surface area of approximately 5,000 sf and a sidewater depth of 10-foot. It is center well fed with a peripheral effluent launder. It has a peak hour design capacity of 12.0 mgd at a surface loading rate of 2,400 gpd/sf. The water surface elevation (at 12.0 mgd) is 26.81 feet. A parallel unit process does not currently exist for the primary clarifier for backup service.

Oxidation Tower and Oxidation Tower Pump Station

The oxidation tower pump station consists of two (2) 75 hp pumps. The oxidation tower is a 48-FT long, 40-FT wide, and 16-FT deep tower filled with redwood media. Primary effluent was pumped to the top of the tower and trickled down the redwood media. Biofilm on the media removed the organic pollutants from the primary effluent with oxygen provided by natural aeration. This system was taken out of service when the previous plant upgrade was completed, which included aeration basins and appurtenances for the activated sludge process. As a part of this study an analysis was completed to see if it would be cost effective to incorporate this existing plant componenet into a future plant upgrade. It was concluded that this was not cost effective to incorporate this existing plant component into a future plant upgrade. It was also concluded that this was not a cost effective alternative for providing increased treatment capacity.

The oxidation tower should be removed to provide a location for additional required equipment. The costs for removal of the structure will be incorporated into the costs associated with the new equipment that will be placed at this location.

Activated Sludge Process

Activated Sludge Pump Station

The activated sludge pump station conveys primary effluent to the aeration basins. The pump station consists of three screw-lift pumps. Each has a capacity of 8.0 mgd. Two are designated for forward flow (16.0 mgd) and one is designated for return activated sludge (RAS) flow (8.0 mgd).

Aeration Basins

Aeration Basins Nos. 1-3 each have a volume of 0.33 MG, for a total aeration basin volume of 1.0 MG. Aeration Basin No. 4 which has a volume of 0.47 MG, also is available for use as an aeration basin, but will require modifications to the inlet and outlet piping. However, it is currently used as a WAS holding tank, allowing 24-hour wasting and flexibility in operating the dissolved air floatation thickener.

Influent Pump Station

The WWTP is primarily served by an influent pump station, which receives flows from the Hazel Street interceptor (42-inch, 24 mgd gravity capacity). The influent sewer enters the pump station approximately 25 feet below grade. The existing pump station is a caisson construction, consisting of a wet well - dry well configuration. A mechanically-cleaned vertical bar screen (1.0-inch spacing) removes large debris from the influent wastewater. A manual bar screen (1.0-inch spacing) is available as backup to the mechanically-cleaned unit. Flows discharge to the existing comminutor through a 20-inch force main. The pumping units consist of four variable-speed, 40-hp pumps. The pump station has a firm pumping capacity of 10.8 mgd.

West Mount Vernon Pump Station

The WWTP also receives flows from the West Mount Vernon Pump Station. The pump station capacity is 1.2 mgd. Flows enter the WWTP through a 12-inch force main and discharge at the head of the existing comminutor.

Headworks

The headworks of the existing WWTP consists of a comminutor and de-gritting primary sludge. The comminutor is located downstream of both pump stations, and immediately upstream of the primary clarifiers. Grit removal is located downstream of the primary clarifiers, where primary sludge is de-gritted.

Comminutor

Comminution at the WWTP is performed by two comminutors, with a capacity of 12.0 mgd.

Grit Removal

The WWTP currently degrits primary sludge. Primary sludge is removed from the primary clarifiers and sent through an existing grit separator. The grit is then stored until it is removed for disposal.

Disposal

Screenings and grit are transported to a county landfill for final disposal.

PRIMARY CLARIFIER

The existing primary clarifier is an 80-foot-diameter circular tank with a surface area of approximately 5,000 sf and a sidewater depth of 10-foot. It is center well fed with a peripheral effluent launder. It has a peak hour design capacity of 12.0 mgd at a surface loading rate of 2,400 gpd/sf. The water surface elevation (at 12.0 mgd) is 26.81 feet. A parallel unit process does not currently exist for the primary clarifier for backup service.

OXIDATION TOWER AND OXIDATION TOWER PUMP STATION

The oxidation tower pump station consists of two (2) 75 hp pumps. The oxidation tower is a 48-FT long, 40-FT wide, and 16-FT deep tower filled with redwood media. Primary effluent was pumped to the top of the tower and trickled down the redwood media. Biofilm on the media removed the organic pollutants from the primary effluent with oxygen provided by natural aeration. This system was taken out of service when the previous plant upgrade was completed, which included aeration basins and appurtenances for the activated sludge process. As a part of this study an analysis was completed to see if it would be cost effective to incorporate this existing plant componenet into a future plant upgrade. It was concluded that this was not cost effective to incorporate this existing plant componenet into a future plant upgrade. It was also concluded that this was not a cost effective alternative for providing increased treatment capacity.

The oxidation tower should be removed to provide a location for additional required equipment. The costs for removal of the structure will be incorporated into the costs associated with the new equipment that will be placed at this location.

ACTIVATED SLUDGE PROCESS

Activated Sludge Pump Station

The activated sludge pump station conveys primary effluent to the aeration basins. The pump station consists of three screw-lift pumps. Each has a capacity of 8.0 mgd. Two are designated for forward flow (16.0 mgd) and one is designated for return activated sludge (RAS) flow (8.0 mgd).

Aeration Basins

Aeration Basins Nos. 1-3 each have a volume of 0.33 MG, for a total aeration basin volume of 1.0 MG. Aeration Basin No. 4 which has a volume of 0.47 MG, also is available for use as an aeration basin, but will require modifications to the inlet and outlet piping. However, it is currently used as a WAS holding tank, allowing 24-hour wasting and flexibility in operating the dissolved air floatation thickener.

Aeration Blowers

There are four existing Lamson centrifugal blowers, each rated at 4,100 scfm at 8.5 psi. The maximum air supply with one blower out of service is 12,300 scfm.

Secondary Clarifiers

Secondary clarification is performed with two 85-foot diameter secondary clarifiers. Secondary Clarifier No. 1 has an 11-foot sidewater depth and a peripheral feed. Secondary Clarifier No. 2 has a 15-foot sidewater depth and a more conventional center well feed.

DISINFECTION

The existing disinfection system consists of gaseous chlorine injection followed by a chlorine contact basin. The chlorination equipment, two chlorinators, each have a capacity range of 100 to 2,000 ppd. The chlorine contact basin has a volume of 184,000 gallons, and a contact time of 66 minutes at 4.0 mgd and 22 minutes at 12.0 mgd.

EFFLUENT PUMP STATION

The effluent pump station consists of three 40 hp pumps, each with a capacity of 7.2 mgd. The firm pumping capacity of the station is 12.0 mgd.

The effluent pump station is only necessary when the river's water surface elevation (WSEL) increases due to flood conditions. Under normal conditions (WSEL of 9.20 feet), effluent flows by gravity to the Skagit River. The 100-year flood WSEL is 28.60 feet (based on 1987 WWTP improvement contract documents).

OUTFALL

The existing outfall is a 24-inch diameter, open-ended, ductile iron pipe. The pipe terminates adjacent to the treatment plant at River Mile 10.7 on a well armored slope of the Skagit River. It is located within a small depression in the riverbank. This depression creates an eddy that visibly traps effluent near the shoreline.

SOLIDS TREATMENT

Gravity Thickener

The gravity thickener is designated for primary sludge thickening, before discharge to the anaerobic digester. The tank is 22-foot diameter and has a 10-foot sidewater depth.

Dissolved Air Floatation Thickener (DAFT)

The existing DAFT is a 40-foot diameter tank with an 11-foot sidewater depth. WAS is currently stored in Aeration Basin No. 4 before discharge to the DAFT. Polymer is added to the WAS at the DAFT unit. Thickened WAS is fed to the anaerobic digester.

Anaerobic Digester

The existing anaerobic digester is a 60-foot digester with a 34-foot sidewater depth. It has a volume of 103,200 cf. The digester utilizes a gas mixing system and is provided with a floating cover for gas storage.

Solids Dewatering

Dewatering is accomplished with two 2-meter belt filter presses. Each unit has a capacity of 1,100 pph, for a combined capacity of 2,200 pph. The 75 foot diameter circular tank (original primary clarifier) is used as a holding tank for the biosolids transferred from the primary digester, prior to dewatering via belt filter press.

Odor Control

To control odors, the City currently doses the liquid stream with chlorine, both in the collection system and at the WWTP. Odors from the solids processes at the WWTP are not treated. The City currently owns the majority of the property around the WWTP, providing an additional buffer zone for dispersing odors.

Facilities

Operations Building

The existing operations building consists of two offices, men's and women's lockers, a lunch room, a control room, and a laboratory. The control room has a floor area of approximately 175 sf and contains control panels, computers, and printers. The laboratory has a floor area of approximately 420 sf and includes one fume hood, three sinks, one balance table, one refrigerator, and one incubator.

Shop/Garage

The existing shop/garage consists of four areas:

- 375 sf shop area;
- 70 sf wash room;
- 60 sf storage area; and
- 2,000 sf garage area, divided into 5 bays.

8. Wastewater Treatment Plant Analysis

This chapter analyzes the capacity of the existing treatment system and predicts facilities required to meet future flows and loads as presented in Chapter 3, for years 2010 and 2020.

2010 and 2020 Treatment Requirements

The Total Maximum Daily Load (TMDL) for the Skagit River in conjunction with the NPDES permit limits determine the concentrations and loadings that can be discharged during the low flow season. The total loadings are based on a sum of loads from the WWTP outfall and the CSO outfalls. These maximum TMDL limits are listed in Table 8-1

Table 8-1

Skagit River BOD and NH_3 TMDL Limits		
Parameter	**Maximum Daily (NH_3) or Weekly (BOD) TMDL Limit (lb/day)**	**Average Monthly TMDL Limit (lb/day)**
BOD	2140	1583
NH_3	1188	922

The existing effluent flows from the WWTP for 1998 during the TMDL season (July through November) were:

- BOD: Average monthly concentrations from 12 to 20 mg/L, with a maximum weekly concentration of 26 mg/L; and
- NH_3: Average monthly values ranged from 18 to 31 mg/L, with maximum day ammonia concentrations ranging from 22.7 to 43.9 mg/L (July through October of 1999 and 2000).

Future effluent BOD and NH_3 loadings from the WWTP and CSO flows were estimated to determine if TMDL limits would be met. CSO loadings were determined from the largest CSO loading during the TMDL season, which occurred during the August 18, 2000 storm event. Table 8-2 summarizes the projected effluent and CSO loadings to the Skagit River during the TMDL season.

Table 8-2

Estimated BOD_5 and NH_3 Loadings to the Skagit River During the Time Average Monthly TMDL Limits Apply (July - October).				
Year and Location	**Weekly BOD_5 Load (lb/day)**	**Average Monthly BOD_5 Load (lb/day)**	**Maximum Daily NH_3 Load (lb/day)**	**Average Monthly NH_3 Load (lb/day)**
2000 WWTP	752[1]	585[2]	919[3]	666[4]
CSO (August 18, 2000)	11	11	0.3	0.3
Total 2000 Loading	763	596	919	666
2010 WWTP[5]	1,128	878	1,379	999
CSO (August 18, 2000)	11	11	0.3	0.3
Total Estimated 2010 Loading	1,139	889	1,379	999
2020 WWTP[6]	1,379	1,073	1,685	1,222
CSO (August 18, 2000)	11	11	0.3	0.3
Total Estimated 2020 Loading	1,390	1,084	1,685	1,222
TMDL Limit	2,140	1,583	1,188	922
Last Year in Compliance	-[7]	-[7]	2005[8]	2007[8]

1. Maximum weekly BOD load from October 1999
2. Average monthly BOD load from October 1999
3. Maximum day ammonia load from August 2000
4. Average monthly ammonia load from August 2000
5. Based on the ratio of 2000 ADMM to predicted 2010 ADMM
6. Based on the ratio of 2000 ADMM to predicted 2020 ADMM
7. Estimated loadings will be in compliance through 2020
8. Estimated loadings will exceed current TMDL limits. TMDL limits are not expected to change with future permits or studies.

Based on the existing effluent characteristics and the TMDL limits, the WWTP will be required to nitrify, by the summer of 2006, in order to meet future NPDES permit limits. This estimation of when nitrification will be required may vary dependant upon effluent flow rates, WWTP performance, and actual daily ammonia loadings.

INFLUENT PUMP STATION

Pumping Capacity

The firm pumping capacity of the Influent Pump Station is 10.8 mgd. The projected 2010 and 2020 peak hour flows are 14.9 and 18.3 mgd respectively.

City staff have noted problems with the existing pump station configuration. Pump Nos. 2 and 3 are affected by the discharge of the influent wastewater adjacent to the suction inlets for the pumps. The pumps can become air-bound and this can limit discharge capacity.

The maximum capacity of the 42-inch diameter interceptor supplying the wet well is 24 mgd. The pump station and force main should be upgraded to a firm pumping capacity of 24 mgd to maximize the conveyance of wastewater flows (both sanitary and combined sewer flows) to the WWTP. This is consistent with the recommended long term CSO improvements (Alternative 2C) identified in Chapter 4.

Screening

Coarse screening is currently provided in the Influent Pump Station by mechanically-cleaned bar screens with manually-cleaned bar screens as a backup unit.

The plant operating staff has expressed concerns over the operation and maintenance of the manually cleaned bar screen. It is located upstream of the pump station wet well, approximately 24-feet below grade. Screenings must be conveyed from the screen to a location approximately 4-feet above grade.

HEADWORKS

The existing headworks facility consists of a comminution and de-gritting of primary sludge. The City has noted excessive wear on the WWTP process equipment due to grit and debris that could be removed by fine screens and grit chambers.

Comminutor

The purpose of a comminutor is to shred material in the flow stream. A problem associated with this process is that the material often reconstitutes later in the flow stream. A better method is to remove solid materials with fine screens, further process this material in a solids washer to remove organic material, and remove the non-organic material from the flow stream.

Screening

Fine screening is recommended as a replacement to the comminutor. These screens would have three-eighths-inch openings and be mechanically cleaned. They would be placed downstream of all influent flows (WWTP influent pump station and West Mount Vernon Pump Station), and upstream of the recommended grit removal equipment. The parameters used to size fine screens are the peak hour flow.

Grit Removal

The current grit removal system removes grit from the primary sludge. The trend in current grit removal technology is to remove the grit in the flow stream prior to primary clarification. This can be accomplished by settling grit, via centrifugal forces, in a variety of geometrical chambers, circular, square, or rectangular. Removal of grit prior to primary sedimentation allows for flexibility with the primary clarifiers, such as thickening of the primary sludge in the clarifier.

Disposal

Screening (both course and fine) processes can be expected to produce five to ten cubic feet of screening per million gallons of wastewater treated. The volume of screenings to be landfilled can be reduced through washing and compacting. The grit removal process can be expected to produce one to three cubic feet of grit per million gallons of wastewater treated. The presence of organic matter in the grit to be landfilled will be reduced through washing. Odors can be a concern for storage of screenings and grit until final disposal.

CAPACITY ANALYSIS

A capacity analysis was completed which evaluated the primary treatment, secondary treatment, and solids handling facilities. A mass balance model of the entire treatment plant was constructed using HDR's ENVision program. This model incorporates flows and pollutant loads from both influent and internal recycle streams. Process loading conditions derived from the mass balance output were calibrated to standard and historical plant performance data.

Table 8-3 provides a summary of the capacity analysis. The first three columns summarize the existing facilities, volumes and dimensions. The next four columns list the capacity evaluation criteria, the flow rate that each criterion applies to, and the reference. The two columns titled "Value with BOD removal" and "Value with Nitrification" present the predicted process variables from the ENVision model if the 2020 future flows were directed through the existing facilities. The columns titled "Capacity of existing facilities-BOD removal" and "Capacity of existing facilities-Nitrification" list the flow capacities (either maximum month, maximum day or peak hour as indicated in the capacity flow column) for the listed process with BOD removal and with nitrification. The last two columns of the table list the additional facilities that would be required to meet the criteria shown. The largest value under each process is shown in bold. The value in bold will determine the sizing for design of new facilities. Model data summary sheets are included as Appendix H.

The ENVision model was run for each flow and loading condition shown in Table 3-8 and Table 3-9. From the model output, the capacity of the existing facilities was calculated, and new facilities were proposed. For example, the existing primary clarifier was run at maximum month flow conditions (9.9 mgd) the overflow rate was 2,100 gpd/sf as shown in the first row of Table 8-2. Because the criteria listed is 1,000 gpd/sf, the capacity of the existing primary clarifiers is a maximum month flow of [(1,000/2,100) x 9.9] 5 mgd. The existing primary clarifier is 5,000 sf in area. To meet the 2020 maximum month flow condition, a total of 9,900 square feet are required. Therefore, (9,900-5,000) 4,900 sf must be added. Capacities and required volumes and areas of other processes were computed in a similar fashion.

For BOD removal, the model was run at a 4-day SRT, the average SRT of the existing facility. For nitrification analysis, the model was run at a 10-day SRT to ensure full nitrification.

Process	Existing Facility Description	Size or Capacity	Criteria Flow	Parameter	Capacity Criteria	Reference	Value with BOD removal[1]	Value with Nitrification[1]
Primary Clarifier	1-primary clarifier	80 ft diameter 10 ft side water depth 5,000 sf	MM PH	OFR OFR	1,000 gpd/sf 2,500 gpd/sf	DOE Standard DOE Standard	2,100 gpd/sf 3,800 gpd/sf	Same as BOD Same as BOD
		0.4 MG	MM	HRT	2.5 hr	DOE Standard	0.9 hr	Same as BOD
Aeration Basins	3-plug flow aeration basins	61 ft length, 42 ft width, 17.5 ft SWD	MM	MLSS	2,500 mg/L	Stress testing	3,000 mg/L	6,400 mg/L
		0.33 MG each, 1.0 MG total	MD	MLSS	2,700 mg/L	Stress testing	2,800 mg/L	7,200 mg/L
	1-aeration basin (WAS storage)	61 ft length 60 ft width 17.5 ft SWD 0.5 MG total						
Aeration System—Diffusers	9-inch diameter coarse bubble diffusers		MM MD PH	OUR OUR OUR	32 mg/L-hr[2] 36 mg/L-hr[2] 54 mg/L-hr[2]	HDR Standard HDR Standard HDR Standard	38 mg/L-hr 45 mg/L-hr 56 mg/L-hr	73 mg/L-hr 80 mg/L-hr 113 mg/L-hr
Aeration System—Blowers	4-centrifugal	4,100 scfm each 12,300 scfm with 1 out of service	MD PH	SCFM SCFM	12,300 12,300	None None	5,900 scfm 9,000 scfm	12,800 scfm 16,600 scfm
Secondary Clarifiers	2-secondary clarifiers	85-ft diameter 1-11 ft SWD 1-15 ft SWD 5,700 sf each	MD PH PH	HRT HRT OFR	<2 hr 900 gpd/sf	HDR Standard DOEStd 1,200	1.5 hr 1,600 gpd/sf	1.5 hr 1,600 gpd/sf
		1-0.47 MGD 1-0.64 MGD	MM MD PH	SLR SLR SLR	25 lb/d-sf[2] 40 lb/d-sf[2] 40 lb/d-sf[2]	DOE Standard DOE Standard DOE Standard	28 lb/d-sf 32 lb/d-sf 51 lb/d-sf	28 lb/d-sf 38 lb/d-sf 51 lb/d-sf
Gravity Thickener	1-thickener	22-ft diameter 10-ft SWD	MM	OFR	700 gpd/sf	DOE Standard	261 gpd/sf	353 gpd/sf
DAF Thickener	1- DAF Thickener	40-ft diameter 11 ft SWD 1,260 sf	MM	SLR	2.5 lb/hr-sf	DOE Standard	4.0	3.5
Anaerobic Digester	1-anaerobic digester	60 ft diameter, 34 ft SWD, 103,400 cf (0.8 MG)	MM MM	SRT SLR	15 days 140 lbVSS/kcf-d	EPA Standard WEF MOP8	28 d 80 lbVSS/kcf-d	33 d 70 lbVSS/kcf-d

[1] *Values in this column were determined using the ENVision model calibrated to the existing facility.*

[2] *These values assume conversion to fine bubble diffusers.*

DAF-dissolved air flotation
DOE-Department of Ecology
kcf-1000 cubic feet
HRT-hydraulic retention time
MD-maximum day
MG-million gallons
MGD-million gallons per day
MLSS-mixed liquor suspended solids
MM-maximum month average day
OFR-overflow rate
OUR-oxygen uptake rate
PH-peak hour
SCFM-standard cubic feet per minute
SLR-solids loading rate
SRT-solids retention time
SWD-sidewater depth
VSS-volatile suspended solids
WEF-Water Environment Federation

Primary Clarifiers

Primary clarification was evaluated based on both hydraulic residence time (HRT) and overflow rate. The DOE standard for average day maximum month overflow rate is 800-1,200 gpd/sf. A value of 1,000 gpd/sf was used as the design primary clarifier overflow rate (OFR). Similarly, the DOE standard for peak hour OFR is 2000-3000 gpd/sf and 2,500 gpd/sf was used as the design criterion.

DOE recommends an HRT of less than 2.5 hours for primary clarifiers under average day maximum month loading conditions to prevent septic conditions in the clarifier.

The additional primary clarifier area required to meet the peak hour OFR requirement is more than the additional area required to meet the maximum month requirement. It is recommended that the total 2010 primary clarifier area be a minimum of 10,100 sf and the total 2020 primary clarifier area be a minimum of 10,100 sf.

Aeration Basins

Aeration basin volume was evaluated based on MLSS concentrations and oxygen uptake rates. The October 1995 Plant Evaluation presented data on secondary clarifier stress testing. It showed that the deeper of the two secondary clarifiers (Secondary Clarifier No. 2) could handle MLSS concentrations above 3,600 mg/L. Data on MLSS capacity of the shallower clarifier (Secondary Clarifier No. 1) was not presented. The capacity criteria for MLSS are 2,500 mg/L under maximum month loading conditions and 2,700 mg/L under maximum day loading conditions.

Aeration volume was also evaluated based on oxygen uptake rates. Typical oxygen uptake rates for aeration basins with fine bubble diffusers are 32, 36, and 54 mg/L-hr for maximum month, maximum day and peak hour conditions, respectively. The volumes required to meet oxygen uptake rate requirements were all equal to or lower than those required to meet MLSS criteria, therefore the MLSS criteria will be used to determine basin size.

If BOD removal is the treatment goal (no nitrification), then an additional 0.2 MG of aeration volume would be required to meet the future flow and loading conditions. If the existing Aeration Basin No. 4 (0.5 MG) was converted from a WAS holding tank to an aeration facility, no new basin construction would be required, but the coarse bubble diffusers would have to be changed to fine bubble diffusers.

If nitrification is the treatment goal, then an additional 1.7 MG of aeration volume would be required to meet the future flows and loads. Aeration basin 4 could be converted reducing the required aeration basin volume for construction to 1.2 MG. Based on the January 9, 2001, meeting with the City and representatives of DOE, it appears the NPDES permit currently being prepared will not require nitrification, but the future permits could contain these requirements.

If total nitrogen removal were desired (denitrification), then the total aeration volume would increase by approximately 30%. For a total aeration volume of 2.7 MG an additional 0.9 MG may be required for denitrification. Denitrification would lower aeration requirements and increase alkalinity to the downstream processes. At this time, a requirement for denitrification is not anticipated in the next ten years (two permit cycles).

Aeration Blowers

For BOD removal, a total of 6,800 scfm would be needed to meet 2020 peak hour requirements. There are currently four 200 hp centrifigal blowes each rated at a capacity of approximately 4,100 scfm.each. For nitrification, however, 16,600 scfm would be required under 2020 peak hour loading conditions; 4,300 more than 12,300 available.

An additional blower would be required to meet peak hour loads if a redundant blower were to be maintained during peak hour loading conditions for 2020 loadings and operation in the nitrification mode, however this is very conservative criteria and many plants are designed to provide firm blower capacity for the maximum day loadings and total capacity for the peak hour loading conditions. At this time additional blower capacity is not recommended for the year 2020 improvements.

Secondary Clarifiers

The secondary clarifiers were evaluated based on HRT, overflow rate, and solids loading rate. The DOE guideline for secondary clarifier overflow rates is 600 to 800 gpd/sf for average day, maximum month conditions. The DOE recommended maximum overflow rate for peak hour conditions is 1,200 gpd/sf. In this case, since the sewer system is a combined sewer system with storage provided by the Central CSO Regulator, the CSO flows can be stored in the regulator and discharged to the treatment plant over an extended period of time. For this reason, the allowable peak hour loading for the secondary clarifiers was reduced to 900 gpd/sf to prevent the washout of solids during extended periods of high flow resulting from storm events. The total surface area required for 2020 is approximately 20,400 sf.

The DOE standard for secondary clarifier solids loading under average day maximum month conditions is up to 25 lb/d-sf. At peak conditions, DOE lists a peak maximum loading rate of 40 lb/d-sf. The clarifier stress testing indicated that Secondary Clarifier No. 2 is capable of handling at least 25 lb/d-sf and probably higher loading rates. Secondary Clarifier No. 1, however, was capable of only 12 lb/d-sf under test conditions. The areas required to meet all solids loading criteria were less than the 7,600 sf required to meet the 900 gpd/sf OFR sizing criteria. If the existing 85 foot diameter peripheral feed secondary clarifier with the 12 foot sidewater depth was eliminated, the additional surface area required for 2020 would be 14,700 square feet.

Gravity Thickener

DOE recommends 600-800 gpd/sf overflow rate for gravity thickeners. An overflow rate of 700 gpd/sf has been used for this evaluation. Under 2020 future solids loadings, both with and without nitrification the overflow rate is less than 300 gpd/sf and no additional gravity thickening improvements are needed.

If the grit removal is relocated upstream of the primary clarifier, the option of thickening solids within the primary clarifier will also be available. If the grit removal was provided, the gravity thickener would be maintained for backup service.

Dissolved Air Floatation Thickener

The DOE standard for solids loading rate to a DAFT with polymer addition is up to 2.5 lb/hr-sf. The surface area of the existing unit is 1,250 square feet. Under 2020 future loads, an additional 750 sf would be required if BOD was removed or 500 sf if the plant is operated in the nitrification mode. In either case, an additional unit would be required and should also be provided for redundancy.

Anaerobic Digester

The EPA 503 regulations recommend a minimum 15-day SRT in anaerobic digesters to meet Class B requirements. Under future flows, with BOD removal only, the SRT would be 33 days and with nitrification the SRT would be 28 days; well above the 15-day requirement. The Water Environment Federation Manual of Practice recommends anaerobic digesters be loaded at a maximum of 140 lb VSS/kcf-d solids loading. Under future flows and loads, the solids loading would be 80 lb VSS/kcf-d and 70 lb VSS/kcf-d with BOD removal and nitrification, respectively; below the maximum loading of 140 lb VSS/kcf-d. According to the ENVision model, additional digester capacity is not anticipated under 2020 flows and loads.

The City reports hydraulic capacity of the digester is presently limited due to grit deposition at the bottom and a scum layer at the top. Assuming a 30% reduction in available volume, the available SRT would be 19 days for the year 2020 loadings. Additionally, there is limited capacity to store solids when the existing primary digester is taken out of service for cleaning. Presently during digester cleaning, Aeration Basin No. 4 is used as an aerobic digester. A redundant unit process should be considered to alleviate the problems associated with storing biosolids while cleaning the existing digester, and to ensure a hydraulic capacity limitation does not exist in the future.

Solids Dewatering

Solids dewatering is currently performed via two (2) belt filter press. The City operates the presses (based on daily operation of one belt filter press, 1,100 pph) for an average of 2.3 hours per day. Under 2010 flow conditions, the belt filter presses would be required to be operated for 4.2 hours per day. Under 2020 flow conditions, the belt filter presses would be required to be operated for 4.9 hours per day. The existing belt filter presses are adequate and no additional dewatering improvements are needed.

DISINFECTION

Gaseous chlorine is presently used for disinfection of the effluent, followed by dechlorination with sodium bisulfite. Due to the safety concerns over the storage of one ton gaseous chlorine cylinders, the costs of complying with increasingly stringent hazardous materials regulations governing the storage of gaseous chlorine, and the environmental benefits of ultraviolet (UV) disinfection, the City of Mount Vernon decided to evaluate alternative disinfection methods at the WWTP. UV disinfection alternatives are developed in the following chapter.

If gaseous chlorine is eliminated, there would still be a need for chlorine for housekeeping items such as algae control, odor control, and sludge bulking control. In this case a sodium hypochlorite system could be provided for these needs.

EFFLUENT PUMP STATION

The existing effluent pump station is not sized to convey 2010 or 2020 peak hour flow rates to the Skagit River. The pump station should be upgraded to maximize conveyance of effluent from the WWTP. The parameter used to size pumps for the Effluent Pump Station is the peak hour flow and the 100-year water surface elevation of the Skagit River.

OUTFALL

A mixing zone study of the existing WWTP outfall was performed by Cosmopolitan Engineering Group, Inc. in February 2000. This report notes that effluent, when tracked by Rhodamine WT dye, was visibly trapped in a near-shore eddy. Mixing of the effluent and ambient water occurred at the offshore boundary of the eddy. From this analysis, it was determined that modifications to the existing outfall should occur. The flow parameters used to design the outfall are:

Flow Condition	Criteria
• Peak Hour Flow	Hydraulic Capacity
• Maximum Day Flow	Acute Mixing Zone Requirements
• Average Day Maximum Month Flow	Chronic Mixing Zone Requirements

The outfall design also is affected by the NPDES permit limits and the water quality criteria of the receiving water body.

Mixing zones as defined by Mount Vernon's NPDES permit:

Chronic Mixing Zone:

- Shall not exceed greater than 300 feet plus the water depth downstream, or 100 feet upstream;
- Shall not utilize greater than 25 percent of the river flow; and
- Shall not occupy greater than 25 percent of the river width.

Acute Mixing Zone:

- Shall not extend beyond 10 percent of the distance to the chronic mixing zone boundary; and
- Shall not utilize greater than 2.5 percent of the river flow.

Water quality standards for toxicants:

Parameter	Acute Criteria (μg/L)	Chronic Criteria (μg/L)
Chlorine	19	11
Ammonia-N	8,314	1,877
Copper	4.61	3.47
Mercury	2.1	0.012
Lead	13.9	0.54
Silver	0.32	-
Zinc	35.4	32.3

To comply with the mixing zone and water quality criteria, a new or modified outfall will be required. Prior to construction of this improvement, the City will be required to obtain multiple permits. The following is a preliminary listing of anticipated permits/approvals for outfall modifications:

Agency/Jurisdiction	Permit/Approval
• U.S. Army Corps of Engineers[1]	• Section 10/404 Permit
	• Biological Evaluation/Biological Assessment
• WA Department of Fish and Wildlife	• Hydraulic Project Approval
	• Priority Habitat Review
• WA Department of Ecology	• Waste Discharge Permit Review (NPDES)[2]
	• Section 401 Water Quality Certification
• WA Department of Natural Resources	• Aquatic Use Authorization[3]
• City of Mount Vernon	• Shoreline Permit
	• Floodplain Review
	• Sensitive/Critical Area Review
	• SEPA
	• Dike Setback Variance
	• Fill and Grading Permit
• Dike District No. 3	• Dike District Approval

1. The U.S. Army Corps of Engineers is now requiring a Biological Evaluation or Biological Assessment for all projects requiring Corps approval. This will trigger consultation with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Chinook salmon, bull trout and bald eagle are known to occur in the project vicinity and will mostly likely, after consultation with NMFS/USFWS, be included in the BE/BA.
2. It is anticipated that the existing NPDES permit will require modification or a new NPDES permit may be required.
3. Any project that is located on state-owned aquatic lands will require authorization from the WDNR. The Skagit River at the outfall location is considered state-owned lands.

A detailed examination of the required permits and an estimated schedule for obtaining permits is presented in Appendix I.

ODOR CONTROL

Chlorine is presently injected in the incoming wastewater flow at Hazel Street and Harrison Street. This has been relatively successful, but requires significant quantities of chlorine. The chlorine is presently supplied from the gaseous chlorination system at the WWTP. Typically, chlorine usage at the plant is:

Usage	Approximate Chlorine Usage (ppd)
Disinfection	30
Odor Control	50 to 200
Process Control	100[1]
Maximum Day Usage	330

1. Process control is for filamentous control

In addition to reducing odor potential within the collection and conveyance system, odor control at wastewater treatment facilities often includes treatment of odors in the gaseous phase on site. This includes containment of the gases at the process locations (i.e. covers on tankage where odors occur) or containment of odors within facilities with higher odor (i.e. headworks building). Ventilation is provided to transfer the high odor air to odor treatment units. These can consist of packed tower liquid scrubbers, activated carbon absorption, or biological treatment with compost filters.

After UV disinfection at the WWTP is implemented, gaseous chlorination would eventually be eliminated. Small chlorine requirements for process control would be met with hypochlorite, but meeting high chlorine demands with hypochlorite solution would not only be costly, but would require frequent deliveries with tanker trucks. For this reason, the City may want to consider other options for reducing odor within the collection and conveyance system, such as the use of calcium nitrate.

The long range plan should include the containment and treatment of odors at the process locations with high odors. On September 19, 2000, operating staff were polled, and the unit processes were ranked from high odor potential to a lesser odor potential as follows:

Process	Odor Ranking (3.0 High, 1.0 Low)
Grit Removal System	3.0
Influent Pump Station	2.6
Primary Thickener	2.2
DAF Thickener	2.0
WAS Storage (Aeration Basin No. 4)	1.9

Process	Odor Ranking (3.0 High, 1.0 Low)
Solids Handling Building	1.8
Aeration Basins	1.3
Biosolids Holding Tank	1.2
Primary Clarifier	1.1
Secondary Clarifier	1.0

This is representative of the odor potential experienced at many treatment facilities, with the highest potential at the headworks, followed by solids handling processes, with other processes contributing to a much less extent.

FACILITIES

Operations Building

The existing operations building will not be adequate for the expanding facilities. Additional storage, expanded laboratory facilities, a records storage and archive room, and additional office space will be necessary as the City grows.

Shop/Garage

The existing shop will not allow both the collection system staff and WWTP staff to function efficiently as the City grows. Additional garage space and storage will be required as the City expands.

STAFFING

The existing WWTP staff will not be able to function efficiently as flows and workloads increase over time. The EPA has provided guidance for estimating staffing for a typical WWTP in the March 1973 publication of 'Estimating Staffing for Municipal Wastewater Treatment Facilities.' This estimation is general in nature and is affected by decisions such as the amount of on-site laboratory analysis performed, equipment maintenance, and effluent limits. A detailed breakdown of the calculation is provided in Appendix N.

Based on this estimation, the City of Mount Vernon Wastewater Treatment Plant will need 14 employees by 2010. The following summarizes the time line for staff addition:

Year	Total Number of Staff	Comments
2000	10	Current
2003	11	Add Instrumentation/Electrical Staff
2004	12	Add Maintenance Staff
2007	13	Add Maintenance Staff
2010	14	Add Maintenance & Operations Staff

Summary of Analyses

The additional WWTP capacity required to meet 2010 and 2020 flows and loads are summarized in Table 8-4 and Table 8-5, respectively.

Table 8-4

Summary of Requirements to Meet 2010 Flows and Loads			
Unit Process	**Existing Capacity**	**BOD removal**	**Nitrification**
Influent Pump Station (Firm Capacity)[1]	10.8 mgd	24.0 mgd[1]	24.0 mgd[1]
West Mount Vernon Pump Station (Firm Capacity)	1.2 mgd	1.8 mgd	1.8 mgd
Headworks - Fine Screens and Grit Removal (Total Capacity Required)	None	25.8 mgd[2]	25.8 mgd[2]
Primary Clarifiers (Total Required Surface Area)	5,000 sf	8,300 sf[2]	8,300 sf[2]
Aeration Basins (Total Volume Required)[3]	1.5 MG	1.0 MG	2.2 MG
Blowers (Firm capacity not provided for peak hour loads)	12,300 scfm	5,600 scfm	10,300 scfm
Secondary Clarifiers (Total Required Surface Area)[5]	5,675 sf	16,500 sf	16,600 sf
Disinfection (Total Capacity Required)[6]	Chlorine	25.8 mgd[2]	25.8 mgd[2]
Effluent Pump Station (Firm Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Outfall (Total Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Gravity Thickener (Total Required Surface Area)[7]	380 sf	150 sf	150 sf
DAF Thickener (Total Required Surface Area)[8]	1,250 sf	1,500 sf	1,800 sf
Anaerobic Digester (Total Required Volume)[9]	103 kcf	78 kcf	82 kcf

1. Hydraulic capacity increased to 24 mgd to provide additional CSO treatment capacity for Phase 2 CSO Improvements.
2. Hydraulic capacity increased to 25.8 mgd to provide additional CSO treatment capacity for Phase 2 CSO Improvements.
3. Existing aeration basin volume includes Aeration Basin No. 4, currently designated as an aerobic digester.
4. With coarse bubble diffusers replaced with fine bubble diffusers.
5. Existing secondary clarifiers include two 85-foot-diameter units, one of which is a peripheral feed unit with an 11-foot sidewater depth. It is anticipated that the 11-foot sidewater depth unit would be taken out of service.
6. Chlorine disinfection is to be replaced by UV disinfection.
7. Gravity thickener is designated for primary sludge thickening.
8. DAF thickener is designated for WAS thickening.
9. Due to the grit buildup and a scum layer in the digester, this is based on only 70% of the 103 kcf is available capacity (72.1 kcf).

Table 8-5

Summary of Requirements to Meet 2020 Flows and Loads			
Unit Process	**Existing Capacity**	**BOD removal**	**Nitrification**
Influent Pump Station (Firm Capacity)[1]	10.8 mgd	24.0 mgd[1]	24.0 mgd[1]
West Mount Vernon Pump Station (Firm Capacity)	1.2 mgd	1.8 mgd	1.8 mgd
Headworks - Fine Screens and Grit Removal (Total Capacity Required)	None	25.8 mgd[2]	25.8 mgd[2]
Primary Clarifiers (Total Required Surface Area)	5,000 sf	10,100 sf[2]	10,100 sf[2]
Aeration Basins (Total Volume Required)[3]	1.5 MG	1.2 MG	2.7 MG
Blowers[4]	12,300 scfm	6,800 scfm	12,500 scfm
Secondary Clarifiers (Total Required Surface Area)[5]	5,675 sf	21,000 sf	21,000 sf
Disinfection (Total Capacity Required)[6]	Chlorine	25.8 mgd[2]	25.8 mgd[2]
Effluent Pump Station (Firm Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Outfall (Total Capacity Required)	12.0 mgd	25.8 mgd[2]	25.8 mgd[2]
Gravity Thickener (Total Required Surface Area)[7]	380 sf	200 sf	200 sf
DAF Thickener (Total Required Surface Area)[8]	1,250 sf	2,000 sf	1,750 sf
Anaerobic Digester (Total Required Volume)[9]	103 kcf	102 kcf	99 kcf

1. Hydraulic capacity increased to 24 mgd to provide additional CSO treatment capacity for Phase 2 CSO Improvements.
2. Hydraulic capacity increased to 25.8 mgd to provide additional CSO treatment capacity for Phase 2 CSO Improvements.
3. Existing aeration basin volume includes Aeration Basin No. 4, currently designated as an aerobic digester.
4. Coarse bubble diffusers replaced with fine bubble diffusers, firm capacity not provided for peak hour loads.
5. Existing secondary clarifiers include two 85-foot-diameter units, one of which is a peripheral feed unit with an 11-foot sidewater depth. It is anticipated that the 11-foot sidewater depth unit would be taken out of service.
6. Chlorine disinfection is to be replaced by UV disinfection.
7. Gravity thickener is designated for primary biosolids thickening.
8. DAF thickener is designated for WAS thickening.
9. Due to the grit buildup and a scum layer in the digester, this is based on only 70% of the 103 kcf is available capacity (72.1 kcf).

9. Wastewater Treatment Plant Alternatives

Alternatives for unit processes identified deficient in Chapter 8 were developed based on future flows and loads, for years 2010 and 2020. Alternatives developed also were based on assuming that nitrification will eventually be required, as determined in Chapter 8. The following chapter makes recommendation for the preferred alternatives to meet future flows and loads.

Hydraulics

The existing hydraulics of the wastewater treatment plant were presented in Figure 7-1. As noted in Chapter 7, the existing oxidation tower and oxidation tower pump station were functionally replaced by the activated sludge process. An evaluation of alternative hydraulic profiles through the WWTP was performed. The relative costs for each unit process affected was assessed to determine which hydraulic profile was the most cost effective.

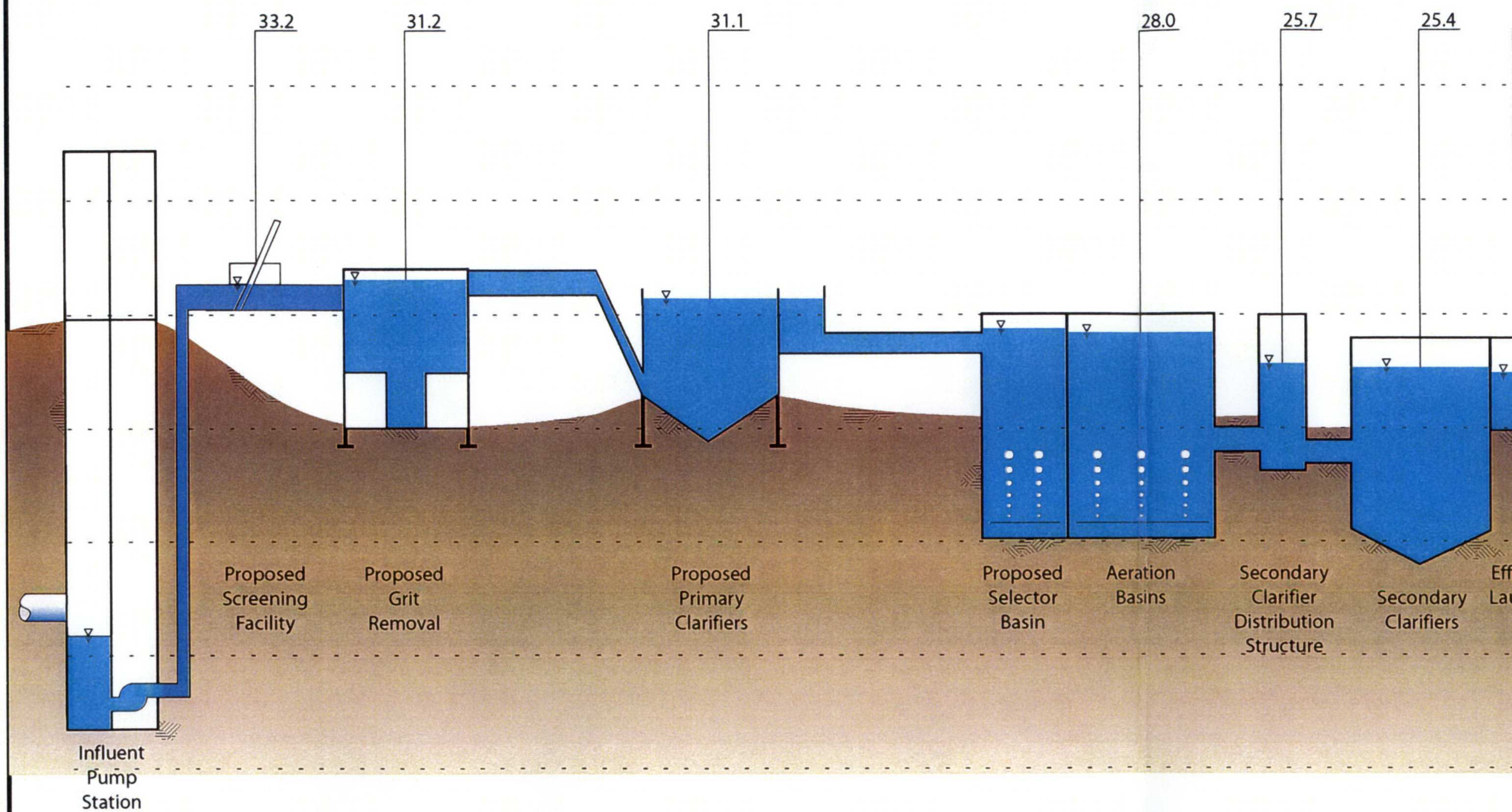
Alternative A - Existing WWTP Hydraulics

Alternative A maintains the existing WWTP hydraulics. With the existing hydraulics, wastewater is pumped from the influent pump station to the comminutor. Wastewater gravity flows through the primary clarifier to the activated sludge pump station. At this lift station, wastewater is raised to approximately 30.8± feet, where it flows by gravity to the effluent pump station. Effluent flows exit the pump station by gravity, unless the river level is elevated, requiring effluent pumping.

Plant capacity can be maintained with the existing hydraulic profile. Replacement of the comminutor with a modern headworks, fine screening and grit removal, can be accomplished within the existing hydraulics. Expansion of the primary clarifiers (addition of 5,600 sf) also can be accomplished within the existing hydraulics. With this hydraulic configuration, the cost estimate for a new headworks and primary clarifiers would be $3.5 and $1.1 million, respectively. This alternative would also require the construction of a new RAS pump station, allowing the existing activated sludge pump station to be utilized for forward flow only. The cost estimate for a new RAS pump station ranges from $600,000 to $800,000. The total cost estimate for this alternative is $5.3 million.

Alternative B - Eliminate Intermediate Pumping

Alternative B eliminates the intermediate pump station (existing activated sludge pump station) for pumping of primary effluent to the aeration basins. The hydraulic grade of the primary clarifiers is raised and the influent pumps are sized for these conditions. The required improvements could be accomplished with this new hydraulic grade, as presented in Figure 9-1. The estimated cost of a new headworks and primary clarifiers is $3.4 and $1.8 million, respectively. This alternative allows the existing activated sludge pump station to be utilized for RAS pumping only. The total cost estimate for this alternative is $5.2 million.



Legend

29.00

Water Surface Elevation Peak Hour Conditions:
All but secondary process= 24 mgd
Secondary process = 18.9 mgd

INFLUENT PUMP STATION

INTRODUCTION

The existing Influent Pump Station has a firm pumping capacity of 10.8 mgd. There are a number of operating problems associated with this facility as follow:

- During high flow CSO situations, the influent gate is modulated to limit the flow to the pump station to prevent exceeding the capacity of the station. Continuous operation of the modulating gate system depends on interaction of a number of components (flow meter, modulating gate operator and controller) and there is a risk that this flow limit will not always be maintained. There have been occasions when the wetwell has become surcharged requiring cleaning of the grating and walls of the wetwell after the event.

- During high flow conditions, the center two pumps are reported to become "air locked". This may be due to the configuration of the inlet to the wetwell. The flow currently discharges directly between the inlets to Pump Nos. 2 and 3. This "waterfall" between the pump inlets causes significant turbulence and is not a desirable inlet condition.

Upgrade of the Influent Pump Station must address the two items above. The 42-inch diameter influent interceptor to the station has a capacity of 24 mgd. The required peak hour capacity for the year 2010 is 14.9 mgd and for the year 2020 is 18.3 mgd. It is proposed to upgrade the station to a firm pumping capacity of 24 mgd. This additional hydraulic capacity will provide hydraulic capacity to further reduce the number of CSO overflow events (Phase 2 CSO Improvements). Two alternatives were developed for the upgrade of the station. Alternative A would maintain the existing wetwell-drywell configuration and Alternative B would convert the existing drywell to a wetwell and the pumps would be replaced with submersible pumps.

Alternative A - Retrofit Existing Pump Station with new Pumps and Motors

The primary concern with retrofitting the existing station with larger pumping equipment would be to insure that the current wetwell hydraulic problems do not continue. Based on a preliminary review it appears that by raising the operating level in the wetwell and diverting the inflow away from the pump inlets, the problem can be eliminated. Prior to proceeding with this alternative, it is suggested that a physical model be constructed and the before and after conditions simulated to insure the problems are corrected with the proposed modifications. The estimated costs for a physical model are $30,000 to $50,000.

Preliminary sizing of the pumping units was completed and four 100 hp units would be required to provide a firm pumping capacity of 24 mgd. The structure above the drywell presently includes the electrical room and the standby generator room. The present standby generator unit is a 300kW unit which provides emergency power for all essential loads at the plant. Any upgrade to the plant will increase the required standby power. In this case it is suggested to maintain the existing generator unit for the Influent Pump Station, and "offload" other existing essential loads and additional new loads to a new engine-generator unit. The existing 300 kW unit will have adequate capacity for the 100 hp pumps with variable frequency drives. A preliminary plan for this alternative is shown on Figure 9-2, and a section on Figure 9-3. Capital costs for Alternative A were developed and are shown on Table 9-1.

Table 9-1

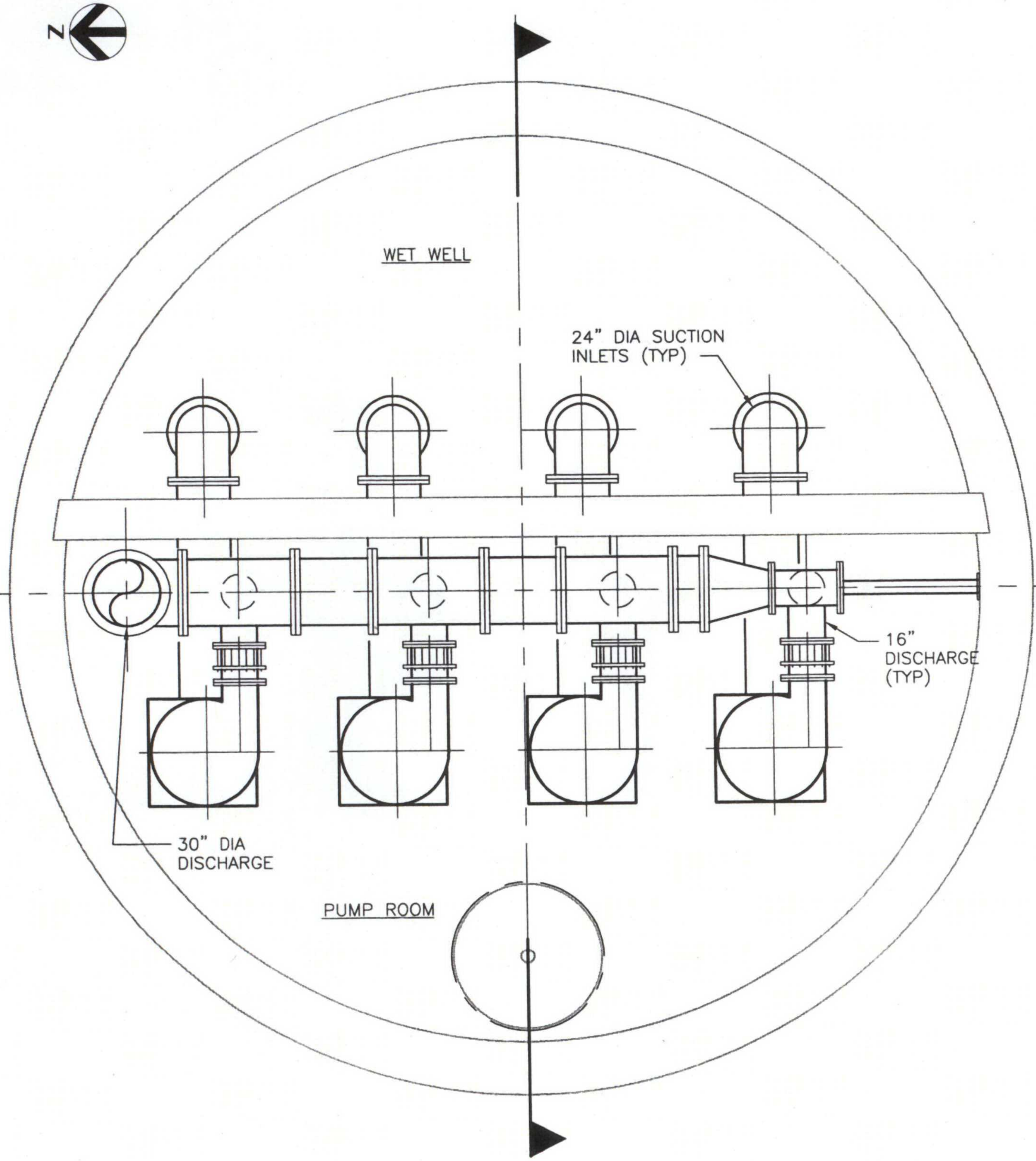
Influent Pump Station: Alternative A Cost Estimate (Upgrading Existing Wetwell/Drywell Pump Station)				
Item	**Quantit y**	**Unit**	**Unit Cost**	**Cost**
Bypass Pumping	1	LS	$50,000	$50,000
Replace Existing Pumps	4	EA	$65,000	$260,000
Replace Existing Piping	1	LS	$80,000	$80,000
Forcemain	1	LS	$200,000	$200,000
Modify Existing Wetwell	1	LS	$50,000	$50,000
Replace Existing VFDs	4	EA	$40,000	$160,000
Additional Barscreen	1	LS	$200,000	$200,000
Electrical	1	LS	$30,000	$30,000
Subtotal				$1,030,000
Contingency (20%)				$206,000
Indirect Project Costs (30%)				$371,000
Total				$1,606,000

Alternative B - Remodel Existing Pump Station for Submersible Pumps

Alternative B would convert the existing drywell to a wetwell and install submersible pumps. This would require significant structural changes. The existing Electrical Room and Standby Generator Room would be demolished. All of the piping and equipment would be removed from the drywell. A new structure would be provided for the electrical controls and relocation of the standby generator. A valve vault would be constructed adjacent to the new wetwell as shown on Figure 9-4. A section view of this concept is shown on Figure 9-5. Capital costs for Alternative B were developed and are shown in Table 9-2.

Table 9-2

Influent Pump Station: Alternative B Cost Estimate (Convert to Submersible Pump Station)				
Item	**Quantit y**	**Unit**	**Unit Cost**	**Cost**
Remove existing superstructure	1	LS	$30,000.	$30,000
Remove existing equipment	1	LS	$20,000.	$20,000
Bypass Pumping	1	LS	$50,000.	$50,000
Additional Barscreen	1	LS	$200,000.	$200,000
Modify Drywell	1	LS	$80,000.	$80,000
Valve Vault and Piping	1	LS	$120,000.	$120,000
Forcemain	1	LS	$200,000	$200,000
Electrical Control Building	800	SF	$150.	$120,000
Submersible Pumps	4	EA	$70,000.	$280,000
Modify Existing Wetwell	1	LS	$30,000.	$30,000
VFDs	4	EA	$40,000.	$160,000
Electrical	1	LS	$50,000.	$50,000
Subtotal				$1,340,000
Contingency (20%)				$268,000
Indirect Project Costs (30%)				$482,000
Total				$2,090,000



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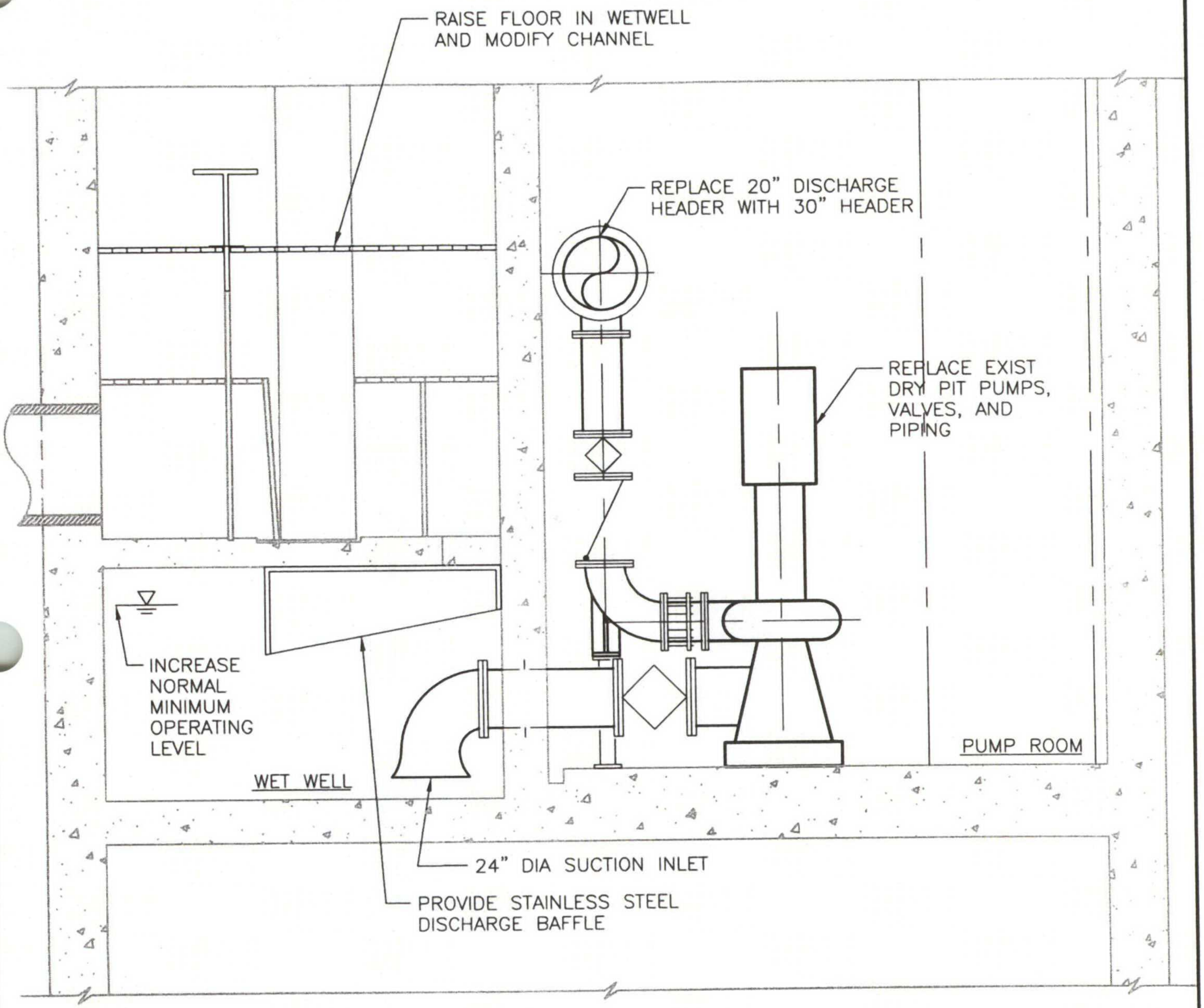
Project Title
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INFLUENT PUMP STATION UPGRADE ALTERNATIVE A-PLAN

Figure No.
9-2

FILENAME: FIG9-2



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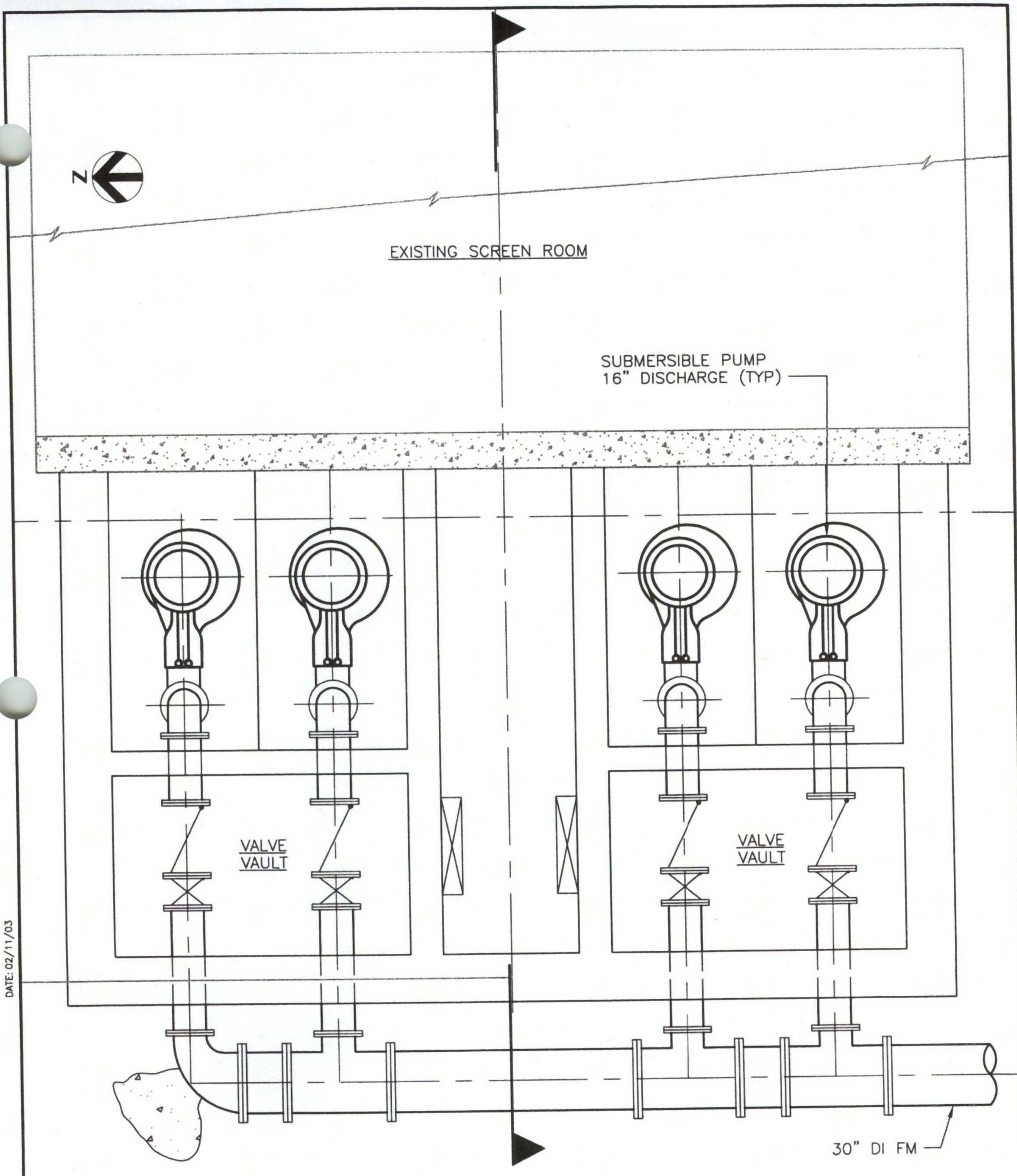
MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INFLUENT PUMP STATION UPGRADE ALTERNATIVE A–TYPICAL SECTION

Figure No.
9–3



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MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
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Sheet Title
INFLUENT PUMP STATION UPGRADE ALTERNATIVE B–PLAN

Figure No.
9–4

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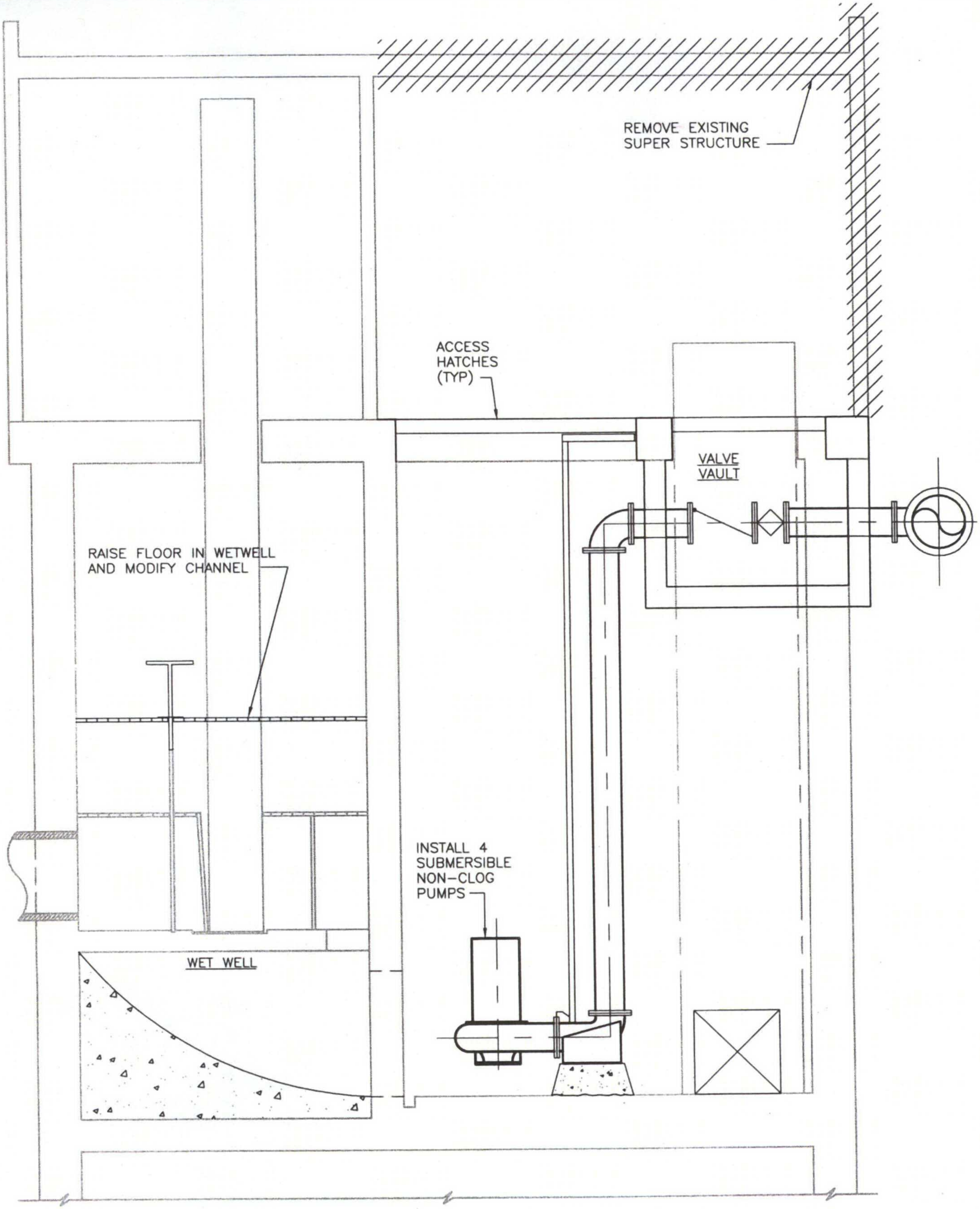

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MOUNT VERNON COMPREHENSIVE SEWER PLAN UPDATE

Date
FEBRUARY 2003

Sheet Title
INFLUENT PUMP STATION UPGRADE
ALTERNATIVE B–TYPICAL SECTION

Figure No.
9–5

DATE: 02/11/03

FILENAME: FIG9-5.DWG

HEADWORKS

More efficient methods of solids and grit removal (compared to the current practice of de-gritting primary sludge) can be accomplished with modern equipment, as described below. Better screening and grit removal will reduce the wear on downstream process equipment.

Screening

Coarse screening provided upstream of the influent pumps removes larger debris from the liquid waste-stream, but does not remove any debris from the wastewater pumped by the West Mount Vernon Pump Station. To remove plastics, rags, and small rocks from the influent wastewater (from both the Influent Pump Station and the West Mount Vernon Pump Station), fine screens would be required in a Headworks Facility.

Fine screens would have 3/8-inch spacing and be mechanically cleaned. They can be expected to remove approximately 9 ft^3/MG wastewater, or approximately three times the volume of screenings removed by the existing 1-inch coarse screens. The fine screens would be the first unit process treating the entire forward flow of the WWTP. Screenings washing equipment will be provided to remove organic material from the screenings and a screening compactor to reduce the volume to be disposed.

Grit Removal

Alternatives for grit removal from the liquid waste-stream, rather than the primary sludge, include:

Aerated Grit Chambers. Aerated grit chambers trap grit through an air-induced rotation of the wastewater at a velocity of approximately 1 fps. Detention time is typically three to five minutes, with one to five standard cubic feet per minute (scfm) of air per linear foot of basin.

Vortex Grit Chambers. Vortex grit chambers are gravity units that swirl the wastewater causing inorganic matter to settle to the tank hopper section of the unit. The vortex can be created through natural hydraulics or induced by slowly rotating paddles. Grit is removed by pumping it from the hopper section of the unit.

Hydrocyclone Degritters. Hydrocyclone degritters utilize centrifugal forces in a cone shaped unit to separate the grit and wastewater. Wastewater enters and exits in the upper portion of the unit, and a grit containing slurry exits through a small opening near the bottom of the unit. The cyclone process includes a pump as an integral part of the unit, for it depends on a steady liquid stream supply.

Capital and operating costs for each alternative were reviewed. The costs, summarized in Table 9-3, were assessed on a low, moderate, high scale. The flexibility of the grit removal system to accept a wide range of flows was also assessed on the same scale.

Table 9-3

Evaluation of Grit Removal Alternatives				
Alternative	**Description**	**Capital Cost**	**Annual O & M Cost**	**Operating Flow Range[1]**
1	Aerated Grit Chamber	$1,000,000	$37,000	Low
2	Vortex Grit Chamber	$700,000	$25,000	High
3	Hydrocyclone Degritter	$5,000,000	$90,000	Moderate
1. The operating flow range of the grit removal system to perform acceptably over a wide range of flows.				

Disposal

The existing method of final disposal, to convey grit and screenings to the landfill, is still a viable alternative. A building should be placed around the screenings and grit storage site to contain odor.

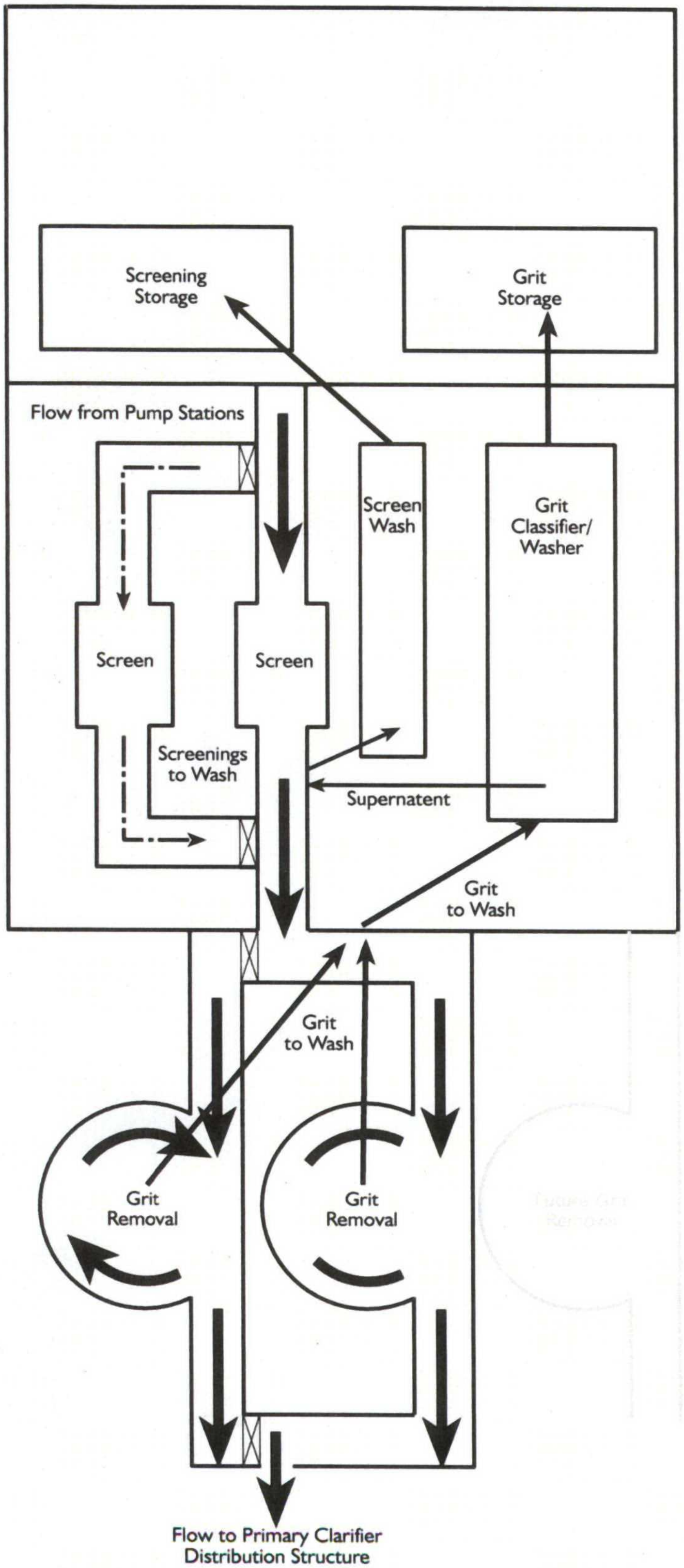
Primary Sludge and Scum Pumping

The installation of two new primary clarifiers will require additional sludge and scum pumping facilities. These should be located within a close proximity to the primary clarifiers and would be installed in the lower floor of the new headworks facility.

Cost Estimate

A typical headworks configuration is shown on Figure 9-6. It has the potential to be placed in one of two locations: Near the Influent Pump Station, or near the Primary Clarifiers. Since the area near the Influent Pump Station is designated for solids treatment, the logical location for a headworks facility is near the primary clarifiers.

The estimated capital cost for a headworks facility (including fine screens, grit removal, primary sludge and scum pumping, and screening and grit storage until final disposal) would be $2.8 million.



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Project Title	Date
MOUNT VERNON COMPREHENSIVE SEWER	FEBRUARY 2003
Sheet Title	**Figure No.**
PROPOSED HEADWORKS FACILITY	9-6

Primary Clarifiers

Additional primary clarifier capacity should be provided for future flows and to provide redundancy. The hydraulic analysis determined that raising the WSEL of the treatment processes (allowing gravity forward flow) was the most desirable hydraulic profile.

Alternative A - Modify Existing Primary and Add New Primary Clarifier

Alternative A includes modifications to the existing primary clarifier (to raise the water surface elevation) and addition of a second primary clarifier to meet future needs and provide redundancy. Modifications to the existing 5,000 sf primary clarifier would include:

- Raising the sidewalls of the clarifier tank approximately 4.5 feet;
- Raising the effluent weirs; and
- Replacing the clarifier mechanism.

The new primary clarifier would have a larger footprint than the existing primary:

•	Diameter:	90-foot	
•	Sidewater Depth:	12 feet	
•	Design flows:	ADMM:	5.5 mgd
		Peak Hour:	13.8 mgd

Both clarifiers would have WSEL of approximately 31.2± feet. A primary clarifier distribution structure would split flows between the existing and new clarifiers.

Combined sewer flows would be treated in a separate process. An 'internal shunt' would be utilized to process a portion of the combined sewer flows. Flows would be split, with 18.3 mgd (peak hour sanitary flows) to the aeration basins and 7.5 mgd (combined sewer flows) to the disinfection system. This will provide for the Phase 2 CSO Improvements. This flow split would be performed in the aeration basin distribution structure. Effluent blending would take place prior to the disinfection process.

Alternative B - Two New Primary Clarifiers

Alternative B consists of adding two new primary clarifiers to treat sanitary flows and utilizing the existing primary clarifier for CSO flows. Two new primary clarifiers would have the following attributes:

- Diameter: 75-foot
- Sidewater Depth: 12 feet
- Design flows: ADMM: 4.9 mgd

  Peak Hour: 9.2 mgd

Both clarifiers would have WSEL of approximately 31.2± feet. A primary distribution structure would be required, splitting flows between the new clarifiers and the existing clarifier (for CSO treatment).

The existing primary clarifier would be utilized, without modification, for treatment of CSO flows, via the 'internal shunt' mechanism. Utilizing the existing primary for this purpose would yield an HRT of 1.2 hours at 7.5 mgd. Flows would receive primary treatment, and flow by gravity to the disinfection system for effluent blending and disinfection.

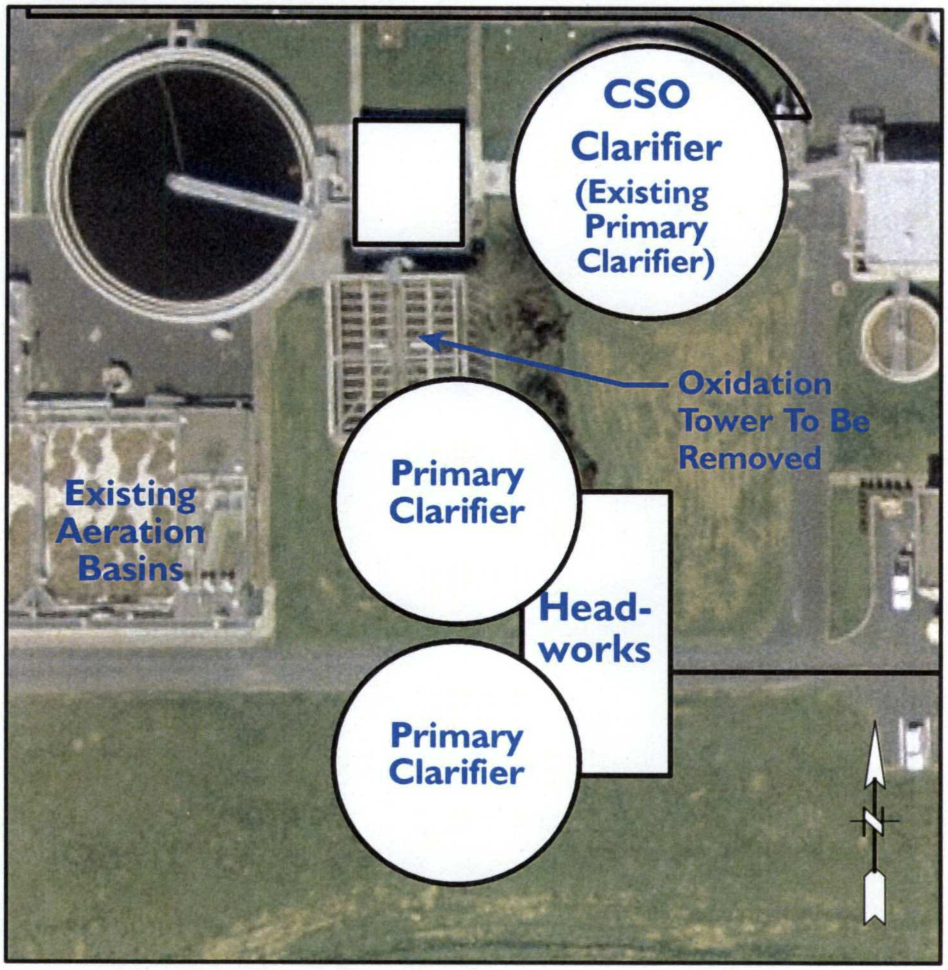
Cost Estimate

Capital and operating costs for each alternative were developed. The capital costs, summarized in Table 9-4, include a 20% contingency and 30% for indirect costs, i.e. sales tax, engineering, administration, and legal.

Table 9-4

Capital Costs ($1,000) for 25.8 mgd Primary Clarifier Alternatives		
Alternative	**Description**	**Capital Cost**
A	Existing and New Clarifier	$1,563
B	Two New Clarifiers	$1,794

The primary clarifiers could be located in a variety of locations, ranging from adjacent to the existing primary clarifier to locations south of the aeration basins and shop/garage. The most logical location for new primary clarifiers is in the location near the existing oxidation tower (adjacent to the existing primary clarifier). A conceptual plan of two additional primary clarifiers and headworks facility is shown on Figure 9-7.



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Project Title	MOUNT VERNON COMPREHENSIVE SEWER	Date: FEBRUARY 2003
Sheet Title	PROPOSED PRIMARY CLARIFIERS	Figure No. 9-7

ACTIVATED SLUDGE PROCESS

Activated Sludge Pump Station/RAS Pump Station

The existing activated sludge pump station is equipped with three screw pumps, each with a capacity of 8 mgd. With the proposed modification to the hydraulic profile the station is no longer necessary for forward flows.

Alternative A - Abandon Activated Sludge Pump Station
For Alternative A, the Activated Sludge Pump Station would be abandoned. This alternative would require a new RAS pump station to be built either at this location or a different site for an estimated cost from $600,000 to $800,000.

Alternative B - Convert Activated Sludge Pump Station to RAS Pump Station
Alternative B would recommend converting the activated sludge pump station to a dedicated RAS pump station. The existing facilities are suited for this conversion because the pump station pumps from an elevation low enough to collect RAS flows and to an elevation where RAS flows could be fed into a selector basin or aeration basin distribution structure.

Typical sizing criteria is to provide 100 percent of the ADMM flow capacity for RAS pumping. The existing station will provide adequate capacity through 2020. For year 2020 flows, the recommended pumping capacity is 9.9 mgd (2020 ADMM). The recommended pumping capacity is far less than the available capacity, so the pump station could be used without modification through 2020.

Selector Basin

When there is an abundance of filamentous organisms in the activated sludge process, the settling characteristics of the biomass is inhibited. The production of a high SVI filamentous bulking sludge results in high effluent solids concentrations and the potential for a permit violation.

There are two approaches to the control of filaments in the activated sludge process. One approach is to chlorinate the RAS at chlorine concentrations of 5 to 10 mg/L to minimize the presence of filamentous sludge. The second approach is to provide a selector basin upstream of the aeration basins to limit the filamentous bacteria population via the biological process.

Alternative A - Chlorinate RAS for Filament Control
Alternative A would control filaments by chlorinating the RAS. This is the current method of filament control and would require no modification. The disadvantages to chlorinating the RAS are as follows:

- Disinfection By-Products (DBP) are formed in the wastewater; and
- Chlorine (which has numerous safety issues) is required.

Alternative B - Construct Selector Basin for Filament Control

Alternative B would provide a selector basin to control filament growth. There are three operating modes for selectors. Aerobic, anoxic, and anaerobic. Depending on the operating mode, the hydraulic retention time recommended is from 10 to 60 minutes. This detention time, combined with the influent BOD concentration, promotes the growth of floc forming bacteria while limiting the growth of filamentous bacteria. The anoxic selector can only be used in a plant that includes nitrification in the activated sludge process, since it requires the nitrates produced in the nitrifying process.

Preliminary sizing was completed for the year 2020 flow conditions. The selector basins could be constructed in two phases. The initial phase would consist of multiple cells with a total volume of 0.3 mg operating in aerobic mode and would accommodate the plant in the 'non-nitrifying' mode. When provisions were made for nitrification, an additional 0.3 mg cell would be added to permit operation in the anoxic mode. These selector basins would be at a water surface of approximately 30 ± ft to maximize flow distribution options. The estimated cost of a selector is $600,000.

Chemical Feed System

The nitrification process will typically reduce alkalinity of the mixed liquor resulting in a reduction of the pH. Plant staff performed a trial operation of the activated sludge process in the nitrification mode and experienced a reduction in pH which approached the NPDES permit limits and the nitrification test was terminated.

To operate in the nitrification mode, a chemical feed system must be provided to provide for pH adjustment. In addition, the proper pH limits must be maintained in the aeration basins to maintain the nitrification process. A chemical feed system should be provided to supply caustic soda. The primary discharge point would be at the inlet to the aeration basins. By controlling the pH at the inlet, permit limits should be able to be maintained in the effluent. In addition to the aeration basin feed point, the caustic soda could also be supplied upstream of the effluent disinfection process. This would provide additional assurance that the effluent pH limits are maintained.

The components for the pH control system would include a caustic soda storage tank with containment protection, two chemical feed pumps, and chemical feed piping to the aeration basin inlet channel and upstream of the existing chlorine contact tank. A budget cost of $50,000 has been included for this improvement.

Aeration System

Electrical costs could be reduced by installing fine bubble diffusers. Overall efficiencies of the fine bubble systems typically exceed the efficiencies of the coarse bubble systems by a factor greater than two. Review was made of overall plant energy usage and energy usage for the aeration system. Average total monthly energy consumption was approximately 250,000 kWhrs and of this, approximately 135,000 kWhrs were used for aeration. This is approximately 54% of the total energy consumption. Aeration energy costs typically range from 45% to 60% of the total plant energy usage, depending on the process and equipment, so this is in the normal range. By converting the diffusers to a fine bubble system, the present estimated annual savings would be approximately $41,000 per year. This is based on current average electrical cost of $0.05 per kWhr. As flows and loads increase and power costs increase, the annual savings would also increase. When the plant eventually provides nitrification, the aeration requirements will increase by a factor of two. The provision of fine bubble diffusers will minimize these future aeration costs. To maximize savings, the City may want to consider completing the installation of the fine bubble diffuser system on a 'fast track' schedule, prior to implementing other improvements.

With the current operating mode (no nitrification), the payback period could range from 5 to 10 years for this improvement, but there are grant programs available that can provide up to 50% funding for the installation of energy saving equipment. These are provided by the power utilities since implementation of energy conservation reduces future demand and the need to construct additional energy sources for the power utility. With a 50% grant, the payback would be in the range of 2 to 5 years, depending on the process (nitrification or not) and current energy costs.

A detailed evaluation was completd to evaluate the replacement of coarse bubble diffuser with fine bubble diffusers and this confirmed the energy savings due to the increased efficiency and confirmed that the existing centrifial blowers that the existing centrifical blowers could be maintained with the proposed aeration system.. A copy of this technical memorandum summarizing this evaluation is included as Appendix M.

Aeration Basins

The aeration basins are currently operated in a BOD removal (no nitrification) mode with coarse bubble diffusers. Fine bubble diffusers offer better oxygen transfer to the wastewater, resulting in more efficient operation and lower operating costs. The activated sludge process can typically be operated in three modes:

- BOD removal
- Nitrification (NH_3 removal)
- Denitrification (NO_3 removal)

The choice of which mode to operate in, and plan for, is typically driven by permit requirements. Mount Vernon's future NPDES permits will be limited by the TMDL of the Skagit River and the toxicity of ammonia to biological organisms in the Skagit River. These limits will require the WWTP to nitrify to meet ammonia limits.

Alternative A - BOD Removal Only

Alternative A provides basin capacity for BOD removal. The existing coarse bubble diffusers would be replaced with fine bubble diffusers to improve efficiency. Fine bubble diffusers have a higher oxygen transfer efficiency than the current coarse bubble diffusers.

This transfer efficiency coupled with a low headloss through the membrane results in a lower power consumption. This alternative would require a total basin capacity of 1.0 mg by 2010 and 1.2 mg by 2020. Aeration Basin No. 4 (0.47 mg) would be utilized as an aeration basin rather than a WAS holding tank or an aerobic digester. The disadvantage of this alternative is that the effluent will not meet anticipated future ammonia limits.

Alternative B - Nitrification

Alternative B would provide basin capacity to nitrify the wastewater, reducing ammonia levels to below anticipated permit limits. To provide nitrification, approximately 2.2 mg of volume would be required for 2010 flows and 2.7 mg for 2020 flows. This would essentially require additional basin capacity to the south of the existing basins. Preliminary layouts developed for the aeration basins were developed based on the capacity analyses and are shown in Figure 9-8.

Aeration for all the basins would be fine bubble diffusers, as explained in alternative A.

Alternative C - Denitrification

Alternative C would provide for denitrification. Denitrification would reduce the nitrate levels in the effluent and should be implemented if nitrate is eventually regulated. At the current time, nitrate is not, and does not appear to be, a nutrient of concern. If the facility were to be sized for denitrification, additional basin volume would be provided to the west of the existing and future phase basins.

Aeration for the basins would be fine bubble, as explained in alternative A.

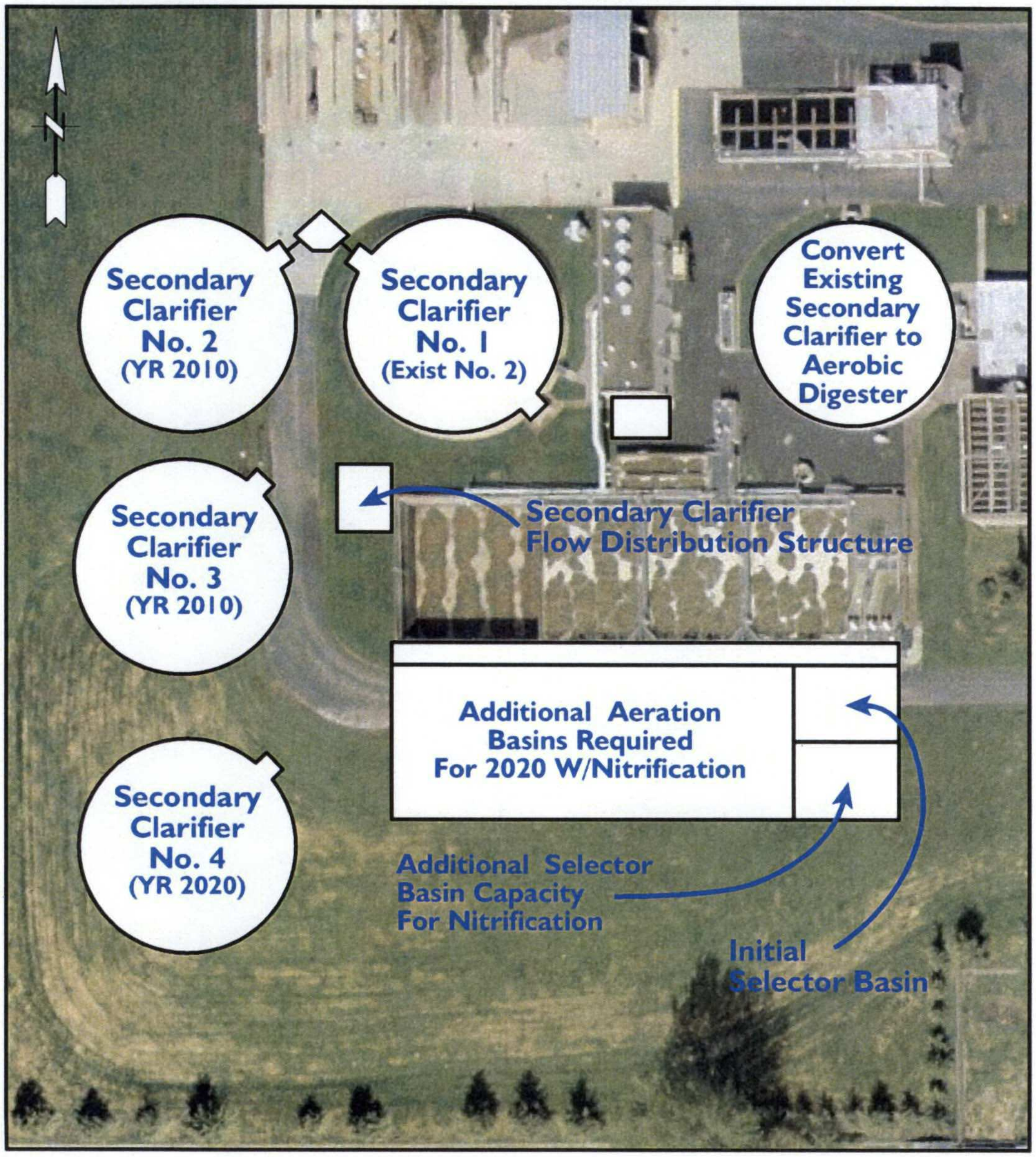
Cost Estimates

Total project costs were determined for each alternative as presented in Table 9-5.

Table 9-5

Aeration Basin Improvements' Estimated Project Cost

Alternative	Condition	Cost
Alternative A - BOD Removal. Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 without nitrification	$300,000
Alternative B - Additional 1.2 mg Aeration Basin Volume, and Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 with nitrification	$2,700,000
Alternative C - Additional 1.2 mg Aeration Basin Volume for nitrification, 0.9 mg Aeration Basin Volume for denitrification, and Retrofit Existing Aeration Basins with Fine Bubble Diffusers	2020 with denitrification	$4,600,000
Chemical Feed System (pH control)	Required to operate in nitrification mode	$50,000



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Project Title
MOUNT VERNON COMPREHENSIVE SEWER

Date
FEBRUARY 2003

Sheet Title
PROPOSED AERATION BASINS AND SECONDARY CLARIFIERS

Figure No.
9-8

Secondary Clarifiers

Since existing Secondary Clarifier No. 1 has a relatively shallow sidewater depth (11 ft.) and peripheral feed, this unit was assumed to be taken out of service. It could be used as an aerobic digester (biosolids storage), replacing the function that Aeration Basin No. 4 provided since that will be needed for aeration basin capacity.

Criteria for sizing of secondary clarifiers is typically dependant on both hydraulic loadings (peak hour and average day) and solids loadings. The City of Mount Vernon Sewer System is a combined sewer system which includes "in-line" storage provided by the Central CSO Regulator. This feature minimized overflows to the Skagit river, but also extends the duration of peak flows to the plant. Under this circumstance, the peak hour rating for the clarifier was reduced from 1,200 gpd/sf to 900 gpd/sf. Preliminary sizing was completed for secondary clarifiers based on this criteria. Two additional 85 ft. diameter units would be required for the year 2010 flows with an additional unit provided for the year 2020 flows. Cost for these units are summarized in Table 9-6.

Table 9-6

Cost for Secondary Clarifiers		
Description	**Flow Condition**	**Cost**
Two (2) @ 85-ft-diameter clarifiers and piping and distribution structure	2010	$2,500,00
One (1) @ 85-ft-diameter clarifiers and piping	2020	$1,100,00

The clarifiers can be physically situated in a variety of locations at the WWTP, the suggested location is south or west of the proposed aeration basins. The amount of piping required can be reduced and flow distribution simplified by locating two secondary clarifiers to the north of the aeration basins, and two to the south of the basins. A proposed layout of this configuration is presented previously in Figure 9-8.

DISINFECTION

UV disinfection systems were evaluated to determine the one best suited for the Mount Vernon WWTP. The expected headloss through UV systems is 4 inches to 2.0 feet. The maximum water surface elevation required downstream (at the effluent pump station) is 21.7± feet. The minimum water surface elevation upstream of the UV disinfection system (at the secondary distribution structure) is 25.0± feet. Thus, there is adequate head both upstream and downstream for any UV disinfection system.

Alternative A - Horizontal, Low Pressure System

Alternative A included the review of a conventional horizontal, low pressure system. Due to the large footprint and associated number of bulbs, this was eliminated from further consideration.

Alternative B - Low Pressure, High Intensity System

Alternative B was a horizontal, high intensity, low pressure UV disinfection system. These systems utilize dimensionally similar bulbs to the horizontal, low pressure systems but due to the 100 W bulb rather than the 32 W bulb have a smaller footprint. They have the potential for flow-paced power consumption. Units typically have a turn down ratio of 100 percent to 60 percent. They also have the potential for in-channel cleaning, limiting the number module removal times required for cleaning.

A horizontal, high intensity, low pressure system for Mount Vernon would include approximately 256 lamps and require a peak power requirement of 32 kw. This system can be supplied by multiple manufacturers.

The estimated required dimensions for each channel (requires two channels, one bank per channel), for this system is 18 feet long, 5 feet wide, and 5 feet deep. The overall footprint for installation of this system, including traveling crane, UV disinfection equipment, and peripheral equipment is 32 feet long and 20 feet wide. The manufacturers of UV systems typically provide an automatic level control device to maintain a near constant water surface elevation over the UV lamps. The expected headloss through this system is less than four inches.

Alternative C - Vertical, Low Pressure System

Alternative C was a vertical, low pressure UV systems. Vertical modules typically consist of 40 lamps, five rows with eight lamps per row. Overall, the dimensions are usually 24-inches wide by 30-inches long. A 12-inch space is required between modules in series. Since the lamp can be accessed from the top, vertical modules do not need to be removed to replace a lamp. Typically, cleaning of the quartz sleeves are performed by removing the entire module and immersing it into a cleaning tank, similar to the conventional low pressure systems.

Vertical, low pressure system for Mount Vernon would include approximately 960 lamps, configured as twenty four 40-lamp modules, for a total of 960 lamps. The modules would be arranged in three channels, with eight modules per channel. The peak power required is 48 kW. This system can be supplied by multiple manufacturers.

The estimated required dimensions for each channel (requires three channels, eight banks per channel), for this system is 40 feet long, 2 feet wide, and 5 feet deep. The overall footprint for installation of this system, including traveling crane, UV disinfection equipment, and peripheral equipment is 62 feet long and 18 feet wide. The manufacturers of UV systems typically provide an automatic level control device to maintain a near constant water surface elevation over the UV lamps. The expected headloss through this system is less than 4 inches.

Alternative D - Open Channel, Medium Pressure System

Alternative D was an open channel, medium pressure UV systems composed of a reactor vessel with multiple modules. Modules typically consist of two to eight lamps. The module is designed to raise lamps from the channel to a convenient level outside of the channel for maintenance. Typically, cleaning of the quartz sleeves are performed automatically since fouling of the quartz sleeve occurs rapidly at the operating temperatures.

An open channel, medium pressure system for Mount Vernon would include approximately 48 lamps, configured in one reactor vessel. The reactor would be arranged in one channel. The peak power required is 73.6 kW. This system is proprietary and is supplied by Trojan Technologies.

The estimated required dimensions for the for this system is 36 feet long, 45 inches wide, and 119 inches deep. The overall footprint for installation of this system, including UV disinfection equipment, and peripheral equipment is 44 feet long and 12 feet wide. The expected headloss through this system is one to two feet.

Alternative E - Closed Conduit, Medium Pressure System

Alternative E included the review of a closed conduit, medium pressure system. For the indicated flow conditions, this system was not cost effective and was eliminated from further consideration.

Cost Estimates

Capital and operating costs for each alternative was developed for retrofitting the disinfection system in the existing chlorine contact basin. Alternatives A and E are not presented as they were excluded from additional analysis based on their high capital costs alone. The capital costs, summarized in Table 9-7, include a 20% contingency and 30% for indirect project costs. Operations and maintenance costs were based on 20 years at a 5% interest rate.

Table 9-7

Life Cycle Costs (in $1,000) for 25.8 mgd Disinfection Alternatives					
Alternative	**Description**	**Capital Cost**	**Annual O & M Cost**	**Life Cycle Cost**	**Standby Power Requirements**
B	Horizontal, Low Pressure, High Intensity System	$1,500	$40[1]	$2,000	64 kW
C	Vertical, Low Pressure System	$1,300	$37[1]	$1,760	96 kW
D	Open Channel, Medium Pressure System	$1,340	$69[1]	$2,200	154 kW
1. Power costs at $0.05 per kWhr					

The equipment cost for the low pressure systems, Alternatives B and C, are less expensive than that of the medium pressure system, but due to the maintenance requirements, a building enclosure has been included in the capital cost. The open channel medium pressure system (Alternative D) is a system that is self cleaning and due to the reduced maintenance requirements and system configuration is typically installed without an enclosure. Cost for an enclosure have not been included with this alternative.

Although the life cycle costs are similar, the costs for the medium pressure system are greater than the low pressure systems. The advantage of the medium pressure systems are that due to the greater intensities, they can also be used to disinfect primary effluent. In the case of Mount Vernon, this type of system could also be used for the disinfection of the effluent for the Phase 3 CSO improvements. The medium pressure system can be situated in the existing chlorine contact basins, while providing additional space for a CSO disinfection system. Figure 9-9 presents a preliminary layout of a medium pressure UV disinfection system in the existing chlorine contact basin. The low pressure systems offer higher energy efficiency, but typically require more maintenance since more bulbs are required.

Since the life cycle costs for the vertical low pressure is the lowest and the medium pressure system offers the ability to be compatible with future CSO disinfection requirements, for planning purposes, the capital cost for the medium pressure system has been included. Since medium pressure systems are slightly greater than the low pressure systems, final determination should be made in the design phase.

UV Design Issues

The micro-organism identified by the NPDES discharge permit affects the design of a disinfection system. Enterococci are more difficult to inactivate than fecal coliform, which results in a larger system, either higher disinfectant dose or longer exposure time. The current NPDES discharge permit is based on fecal coliform. If the regulations change and the permit's basis for compliance is converted to enterococci, then the disinfection system will need to provide additional disinfection capacity. For a UV disinfection system, additional capacity can be easily incorporated through the addition of more UV bulbs to the system.

Redundancy of UV disinfection systems is provided through multiple channels and back-up power generation. Besides the typical redundancy designed in a UV disinfection system, the City of Mount Vernon, should evaluate designing the CSO Treatment Facility's disinfection system to act as a back-up disinfection system during the design phase of the CSO Treatment Facility.

UV disinfection is affected by UV transmittance (UVT), total suspended solids (TSS) concentration, particle size and composition, and wastewater flow rate. UVT is the major parameter used for sizing UV disinfection systems. Upstream processes, industrial dischargers, and the presence of iron compounds may reduce the UVT. Industrial pre-treatment utilizes ferric chloride as a coagulant, which results in the potential for iron to be conveyed to the UV disinfection system. UVT tests performed on the primary effluent and secondary effluent are included as Appendix J. These tests showed lower than expected UVT. Year-round diurnal UVT tests should be performed prior to design, and/or pilot testing of secondary effluent could be utilized to determine the range of UVT. Pilot testing for two (2) months is estimated to cost approximately $30,000.

Sodium Hypochlorite System

Commercial grade sodium hypochlorite is supplied in a 12.5 percent solution. At 12.5 percent, it rapidly decays (to an 11.0 percent solution in only 30 days). To prevent degradation of the solution, it is recommended that dilution to a 4.0 percent solution occur on site when deliveries are received. Approximately 4,750 gallons of storage would be required to store a month's supply of 4.0 percent solution. In addition to one 5,000 gallon storage tank, ancillary equipment would be required:

- Two 10 gph metering pumps;
- Two 40 gph metering pumps; and
- Three 500 gph transfer pumps.

The sodium hypochlorite system could be located in the existing chlorine feed building, or in a structure adjacent to the existing chlorine facilities. The cost estimate presented anticipates the sodium hypochlorite system will be situated in a room of the existing chlorine facility. A budget of $100,000 has been identified for these improvements.

EFFLUENT PUMP STATION

The firm pumping capacity of the Effluent Pump Station is 12.0 mgd. Two alternatives were developed to upgraded the Effluent Pump Station to a firm pumping capacity of 25.2 mgd.

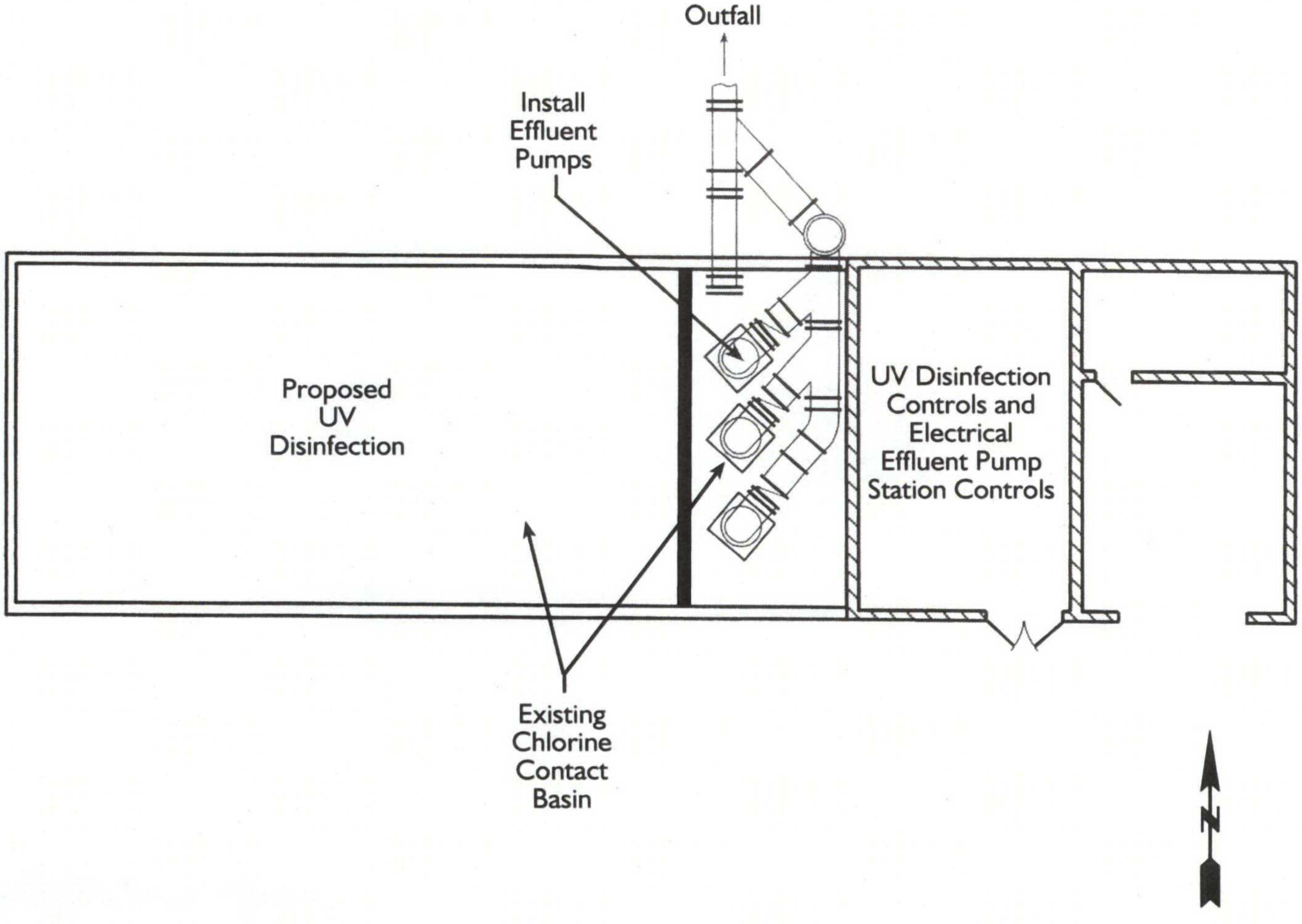
Alternative A - Retrofit Existing Effluent Pump Station

Alternative A considered retrofitting the existing Effluent Pump Station with new pumps, motors, and controls. The existing Effluent Pump Station is presently equipped with 40 hp pumps. The estimated size for these pumps would be 75 hp. There was not adequate space in the existing facility to install these pumps and this alternative was not considered further.

Alternative B - Retrofit Existing Chlorine Contact Basin with Effluent Pump Station

Alternative B would retrofit the Effluent Pump Station into the east end of the existing chlorine contact basin. Three pumps would be placed over the chlorine contact basin, utilizing the basin as a wet well. This alternative requires three 75hp pumps, new motors, and controls. It would also require the effluent piping to the outfall to be reconstructed.

A typical plan view of the existing chlorine contact tanks retrofitted with UV disinfection and an Effluent Pump Station is shown on Figure 9-9. The estimated cost for the Effluent Pump Station is $370,000.



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Project Title MOUNT VERNON COMPREHENSIVE SEWER	Date FEBRUARY 2003
Sheet Title UV DISINFECTION AND EFFLUENT PUMP STATION	Figure No. 9-9

OUTFALL

Alternatives were developed to comply with future flows, loads, and discharge requirements for the outfall. For each alternative, for the secondary treatment, the outfall would terminate in an open ended diffuser at a location near the thalweg (approximately 40 feet farther into the river than the existing outfall), at an invert elevation of approximately -10 feet. This would reduce or eliminate the wastewater from being trapped by near shore eddy currents and improve mixing. An analysis of the mixing zone is presented in Appendix K, Mount Vernon WWTP Mixing Zone Study. The initial requirements for the outfall are as follows:

- Capacity for planned upgrade of the WWTP to a peak hour hydraulic capacity of 25.8 mgd;
- Ultimate capacity for the treated CSO flows (48 mgd peak hour flow, per Alternative 2C, Chapter 4);
- Minimize pumped discharges to high water level conditions in the river; and
- Minimize maintenance requirements.

Two general concepts were reviewed. These included a single outfall for both secondary and treated CSO effluent (Alternative A) and two separate outfall pipes (Alternative B). For preliminary sizing criteria, the velocity of flow within the outfall pipe was limited to 6.0 feet per second. This results in a 48-inch pipe for the single pipe option and 36-inch pipes for the two pipe option. [* Note: As of the finalization of this document, Alternative A was selected and designed]

The flow range from minimum day flow in dry weather conditions of approximately 1.6 mgd to the future peak hour CSO flow of 48 mgd is significant. For the single pipe option, multiple diffusers should be assessed to assure adequate mixing for this large flow range. Based on the recommendations of the Outfall Study, multiple diffusers could present increased maintenance requirements for this river discharge situation.

Cost estimates for the single pipe option (Alternative A) are shown in Table 9-8. Cost estimates for the two pipe option (Alternative B) are shown in Table 9-9

The provisions of a single outfall pipe reduces problems associated with multiple outfalls in close proximity:

1. overlapping mixing zones; and
2. multiple pipes would require additional maintenance.

A summary of the advantages and disadvantages for each alternative is presented in Table 9-10.

Table 9-8

Single Pipe Outfall (Alternative A) Cost Estimates				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost ($1,000)**
Sheet Pile	1	LS	$250	$250
Effluent Pipe	1	LS	$250	$250
Outfall Pipe	1	LS	$300	$300
Subtotal				$800
Contingency (20%)				$160
Indirect Project Costs (30%)				$240
Total				$1,200

Table 9-9

Two Pipe Outfall (Alternative B) Cost Estimates				
Item	**Quantity**	**Unit**	**Unit Cost**	**Cost ($1,000)**
Sheet Pile	1	LS	$250	$250
Effluent Pipe	2	LS	$200	$400
Outfall Pipe	2	LS	$250	$500
Subtotal				$1,150
Contingency (20%)				$230
Indirect Project Costs (30%)				$345
Total				$1,725

Table 9-10

Outfall Alternative Advantages and Disadvantages		
Alternative	**Advantages**	**Disadvantages**
Single Pipe	• Lower Capital Cost • Single dilution zone	• Combined effluents would need to be addressed in future NPDES permits
Two Pipe	• Maintains option for separate CSO outfall • Lower maintenance (diffusers not required)	• Greater Capital Cost • Multiple dilution zones in close proximity

The single pipe option is recommended. It has the advantage of a lower capital cost and results in only one dilution zone for both the treated CSOs and the secondary effluent.

Dissolved Air Floatation Thickener

The existing DAFT is provided for WAS thickening and has an area of approximately 1300 SF. An additional 750 SF is required to treat 2020 WAS flows without nitrication (i.e. BOD removal only), and approximate 500 SF with nitrification. However, this estimation is based on the maximum solids loading rate of 2.5 lb/SF/hour from Department of Ecology for WAS thickening with coagulant/polymer. It would be more conservative design a new system at a lower solids loading rate of 2 lb/SF/hour

The existing DAFT is sized to adequately thicken WAS flows through 2009 with nitrification. A new DAFT would be requied by 2009 with or without nitrification. Using the solids loading rate of 2.0 lb/SF/hour, an additional 40-FT diameter unit would be required by the year 2009 to meet the flows from 2009 through 2020. The new unit will be the same size as the existing unit.

The existing solids process equipment is located in the northeast portion of the WWTP site. Location for a future DAFT has been designated between the digester complex and the Influent Pump Station.

Anaerobic Digester

An additional digester should be provided to reduce the difficulties associated with cleaning the existing digester. It would provide redundancy and allow existing tankage used for storage of solids to be converted to CSO storage, further reducing overflows. A new digester should be sized similar to the existing digester. The estimated cost of a new 103,400 cf digester is $2,500,000.

The existing anaerobic digester is located in the northeast portion of the WWTP site. Location for a future anaerobic digester has been designated between the digester complex and the Influent Pump Station. This is the logical location for a future anaerobic digester.

ENERGY RECOVERY

Methane gas is a byproduct of the anaerobic digestion process. Currently, the plant produces approximately 30,000 cubic feet (cf) per day. A portion of this gas is used to heat the incoming sludge, and the remainder is flared. Historically, power generation from waste gas was accomplished with internal combustion engines and generators. Due to the minimum sizing requirements for the engine generator units and relatively low electrical power costs, the generation of energy from waste digester gas has been historically limited to facilities much larger than the Mount Vernon WWTP. Based on plant estimates, the quantity flared is approximately 50% of the gas production. Based on a value of 650 BTU per scf, the average amount of waste digester gas currently flared is 10 MBTU per day. This equates to approximately 50 hp, or 37 kW.

In recent years, power costs have increased and there are now newer technologies available for electrical power generation. In addition to conventional internal combustion engine generator units, small turbine units (microturbines) are available.

Another emerging technology is the use of fuel cells. These devices convert hydrogen into electrical power and water. Fuel cell technology for wastewater treatment plants is still in the development phase. Fuel cell technology may become cost effective for the Mount Vernon WWTP in the future, but at this time it is not recommended for consideration.

Another recent technology for cogeneration is the use of microturbines (see Appendix L). Current units are available with capacities of 30 kW. This smaller incremental size creates opportunities for intermediate sized WWTPs to more cost effectively generate electrical power from waste digester gas. Since the WWTPs minimum electrical demand would be less than the capacity of the units, the electrical intertie would be simplified and would operate in a 'grid connect' mode. A preliminary estimate was completed for the installation of a microturbine cogeneration facility at the plant. Three size increments were considered, 30, 60, and 90 kW. The unit would be located adjacent to the Solids Handling Building. The units would be provided with a roof structure. Preliminary cost estimates were developed for 30, 60, and 90 kW facilities as presented in Table 9-11.

Table 9-11

Co-generation with Microturbines Cost Estimates			
Item	Co-generation Capacity		
	30 kW	60 kW	90 kW
Capital Cost	$170,000	$300,000	$390,000
Annual Debt Recovery[1]	$14,000	$24,000	$31,000
Debt Recovery/kWhr[2]	$0.06	$0.05	$0.04
Maintenance Cost/kWhr[3]	$0.03	$0.02	$0.02
Total Power Cost	$0.09	$0.07	$0.06

1. 20 years, interest 5%
2. Based on 90% operating time
3. Includes cost to rebuild unit at 40,000 hrs

Current electrical energy costs average $0.05 per kWhr and preliminary estimates of energy available from the waste digester gas is 40 kW. Depending on interest rates for payback on the capital cost, at this time, it may not be cost effective for the City to install this type of system. Factors that could make this type of system cost effective include:

- Increased electrical energy costs;
- Increased loads to the WWTP and related digester gas production; and
- Available funding (with grant monies to assist with capital cost, the system could be cost effective at current conditions).

ODOR CONTROL

Gas-stream odor control at the WWTP can be accomplished through collection of odorous gases and treatment with scrubbers. Collection of odorous gases occurs through containment or covering unit processes. Containment can be accomplished with a building, such as a headworks building. Covering can be performed with either concrete, aluminum, plastic, or fiberglass, such as covers over the primary clarifiers or influent pump station wet well. Gas-phase odors are collected and treated in one of numerous unit processes: biofilters, chemical scrubbers, packed-bed wet scrubbers, mist scrubbers, or carbon absorbers. The most economical solution for a plant the size of Mount Vernon is typically collection of gases through a combination of covers and containment and treatment with a wet scrubber. An estimated cost for such a system (covers on the primary clarifiers and grit basins, containment of odors in the Influent Pump Station and Headworks building, and treatment with a wet scrubber) is $1,300,000, as presented in Table 9-12. Additional unit processes can be covered to contain all potential odors.

Table 9-12

Odor Control Cost Estimate

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation	1	LS	$35,000	$35,000
Primary Clarifier Covers[1]	10,800	SF	$40	$432,000
Grit Basin Covers[1]	630	SF	$40	$25,200
Duct Work		LS	$141,500	$141,500
Packed Tower - Wet Scrubber		LS	$250,000	$250,000
Subtotal				$883,700
Contingency (20%)				$176,700
Indirect Project Costs (30%)				$265,100
Total				$1,325,500

1. Covers include influent and effluent channels and structure

BIOSOLIDS REQUIREMENTS

Subpart D (pathogen and vector attraction reduction) requirements of the 40 CFR Part 503 regulation apply to sewage biosolids, both bulk biosolids and biosolids that is sold or given away in a bag or other container for application to the land, and domestic septage applied to the land or placed on a surface disposal site. There are two basic types of requirements in Subpart D, Class A and Class B. Class A requirements are to reduce biosolids pathogens to below detectable levels. Class B requirements are to ensure that pathogens have been reduced to levels that are unlikely to pose a threat to public health and the environment under the specific use conditions. Regulations also require a reduction in the potential of biosolids to attract vectors, such as rodents, birds, insects, and other organisms that can transport pathogens.

Class B Biosolids

Mount Vernon currently treats the biosolids from the WWTP to Class B standards. Permitting for land application has not been a problem. At this time, there does not appear to be a need to increase the treatment level to Class A. If the situation would change and land application sites were not available, then the City may want to consider providing Class A biosolids.

Class A Biosolids

Mount Vernon is not required to produce Class A Biosolids, but if they chose to treat the biosolids to this level, it can be met by any of the following processes:

- Biosolids can be thermally treated by using a specific time-temperature regime to reduce pathogens. One option is to use a heat drying system to provide heat treatment of the digested dewatered material. With this process, a dewatered biosolids cake enters a heat drying system where thermal energy is added for the evaporation of entrained water. The biosolids are dried to a solids concentration of from 90 to 96 percent and the end product is in the form of a dried pellet. These pellets can then be used as fertilizer. In addition to the capital cost for the system and labor requirements, a large amount of energy is required to dry the biosolids. Based on typical thermal efficiency of the systems, approximately 1,500 BTUs per pound of water evaporated is required. Starting with a solids concentration of 16 percent and drying it to 95 percent would require approximately 16 million BTUs per dry ton of solids. At a cost of $0.90 per Therm for natural gas, this would equate to an energy cost of approximately $150 per dry ton of solids. Allowing a capital cost of $100 per dry ton and a labor cost of approximately $50 per dry ton would result in a total cost of approximately $300 per dry ton for biosolids handling. Based on these costs, this alternative is one of the higher cost options for obtaining Class A biosolids.

- High temperature-high pH treatment is the process also known as alkaline treatment. It exposes biosolids to pHs greater than 12 for greater than 72 hours, and simultaneously has temperatures greater than 52 degrees Celsius for over 12 hours. Air drying is the last step of the process. Drying is performed to provide a solids concentration of greater than 50 percent after the 72 hours of pH-temperature treatment. The unit cost for this process is typically $200 to $250 per dry ton.

- Composting requirements vary depending on the composting process chosen. For an aerated static pile, the temperature must be maintained above 55 degrees Celsius for greater than 3 days. For a windrow composting method, the temperature must be maintained above 55 degrees Celsius for greater than 15 days, with a minimum of five turnings of the windrow. The unit cost for this process is typically $125 to $175 per dry ton.

If the City were to decide in the future to treat biosolids to Class A standards, the recommended option would be to utilize aerated static composting. This has been used by a number of similar sized communities. The advantages are that it is a relatively simple process to maintain and the end product is Class A biosolids, which has a relatively high demand. This unit process would require a capital investment of $860,000 and an annual

O&M cost of $150,000. These costs are above and in addition to the current capital and operation and maintenance costs required in the other sections of this Comprehensive Sewer Plan Update.

Facilities

Operations Building

The Existing Administration/Laboratory Building is limited in space for the current operations. The existing laboratory is located within this building, along with the lunch room, lockers/showers and office space. This laboratory is adequate for current needs, but should eventually be expanded.

Based on discussions with City staff, it may be desirable to provide a phased approach to meet future operations building and laboratory requirements. Initialy a new Wastewater Utility Administration Building would be constructed. This would include the following:

- Reception area
- Office space
- Meeting rooms
- Lunch Room
- Mens locker/shower
- Womens locker/shower
- Library

At the same time the the existing Administration/Laboratory building would become the Laboratory/Operations Center. This would include the following:

- Laboratory (no changes to existing laboratory)
- The remainder of the building would become the Operations Center and would include:
    - Operator work areas
    - SCADA system monitoring
    - Plan/Map storage
    - Deliveries

- Library

Preliminary total project cost for the initial initial phase is $600,000.

Additional budget should be provided for long term planning to provide an upgrade of the existing laboratory. At that time the existing Laboratory/Operations Center could be converted to all laboratory facilities and additional Operations Center facilities provided. A preliminary budget of $600,000 for this long term improvement.

Shop/Garage

The existing shop and garage will need to be dedicated to the WWTP in the future. This will necessitate construction of a new garage/vehicle storage building for the collection system equipment and the grounds maintenance equipment. This building should contain five vehicle bays and an area dedicated to maintenance. It should be a minimum 4,000 sf to accommodate the vehicle storage and maintenance. An estimated cost for a 4,000 sf shop/garage is $500,000. based on discussions with plant staff, the primary need for this building is for material and vehicle storage and if required to reduce the cost, a "carport" type covered structure could be provided.

RECLAIMED WATER FEASIBILITY

Background

The City of Mount Vernon reviewed the feasibility of wastewater reclamation in its service area. Potential end uses for reclaimed water include urban and agricultural irrigation, and less common applications such as wetland creation, and direct or indirect streamflow augmentation. Table 9-13 lists the anticipated water quality objectives for various potential reclamation end-uses.

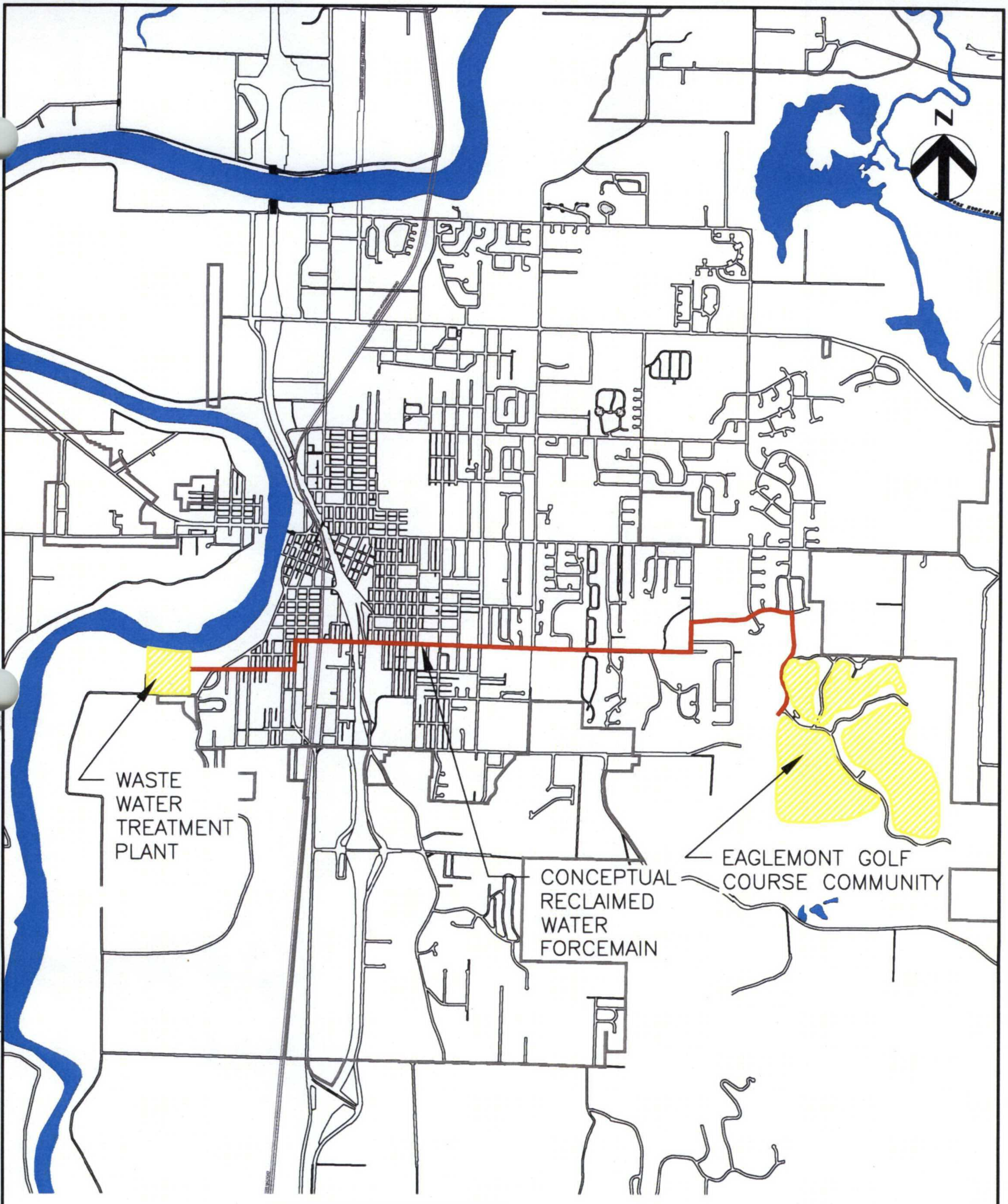
Table 9-13

Water Quality Classifications for Reclamation End-Uses

Water Quality	BOD mg/L	TSS mg/L	Total P mg/L	NH3-N mg/L	TN mg/L	Turb. NTU	TOC mg/L	TDS mg/L	Metals, Organics
Class A	30	30	- -	- -	- -	2	- -	- -	- -
Wetlands	20	20	1	Toxicity	3	2	- -	- -	Surface2
GW (perculation)	30	30	- -	- -	10	2	- -	- -	Site
GW (non-potable)	5	5	- -	- -	Site	2	- -	Site	Site
GW (potable)	5	5	- -	- -	10	0.1	1	Site	SDWA
Large Stream (marine)	30	30	3 – 5	2 – 3	- -	2	- -	- -	Surface1
Small Stream (marine)	10	10	1 – 2	1	- -	2	- -	- -	Surface1
Large Stream (lake)	30	30	0.1	2 – 3	- -	2	Pos	- -	Surface1
Small Stream (lake)	10	10	0.1	1	- -	2	Pos	- -	Surface1
Lake Anticipated	10	10	0.01	1	- -	2	- -	500	SDWA
Lake Worst Case	10	10	0.01	0.02	0.6	2	2	100	SDWA/BG

Notes:
GW = Groundwater recharge
Pos = Possible limit
Site = Site specific criteria
Surface1 = Surface water standards with mixing zone
Surface2 = Surface water standards with mixing zone
SDWA = Drinking water standards
BG = Background concentrations without mixing zone

At a minimum, the reclaimed water treatment processes must meet Class A water quality standards for oxidation, filtration, and disinfection. Depending on the end uses, additional treatment could be required to meet more stringent nutrients, metals, organics, and turbidities levels.



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CONCEPTUAL RECLAIMED WATER FORCEMAIN ALIGNMENT

Figure No.
9–10

DATE: 02/11/03

FILENAME: FIG9-10

Potential Customer

The Eaglemont Golf Course Community located in SE Mount Vernon was identified as a potential customer for reclaimed water. The Eaglemont community plan encompasses 675 acres. Nearly 60% of this acreage is committed to open space, including the golf course and wetlands, two mini-parks and a five-acre neighborhood park. A beaver pond and nature preserve account for another 30 acres. Reclaimed water could be used to satisfy the irrigation water need, and potentially for maintaining the existing wetlands and ponds.

Treatment Processes Required

The existing Mount Vernon wastewater treatment plant consists of primary treatment, secondary activated sludge system for BOD removal, and disinfection. In order to provide the level of treatment to produce reclaimed water, additional treatment processes for turbidity reduction and additional disinfection would be required. The turbidity reduction would be accomplished by a filtration step utilizing multimedia sand filtration, or membrane filtration such as microfiltration. A separate disinfection process via the ultraviolet (UV) process to meet the reclaimed water standards.

A new reclaimed water pump station and a new force main, approximately 4 miles long, would be required to deliver reclaimed water from the existing wastewater treatment plant to the Eaglemont community. Figure 9-10 shows the proposed conceptual alignment of the reclaimed water forcemain.

The current irrigation water use at the Eaglemont community in the irrigation season is estimated to be 1 MGD on average. A conceptual level cost estimate was developed gpt s 1 mgd reuse plant. Table 9-14 summarizes the capital cost of the conceptual level new reclaimed water treatment system and related distribution infrastructure.

Table 9-14

Estimated Capital Cost of 1 MGD Reclaimed Water Treatment System and Distribution Infrastructure	
Component	**Capital Cost**
Membrane Bioreactor for nutrient removal and membrane filtration	$1,000.000
UV Disinfection System and Pump Station	$500,000
Forcemain	$2,000,000
Subtotal	$3,500,000
Tax (8%)	$280,000
Contingency (35%)	$1,225,000
Total	$5,000,000

Feasibility of Implementing Water Resue in the City of Mount Vernon

At present, the portion of water flow from the municipal supply system used for irrigation in the City of Mount Vernon would not be returned to the Skagit River. If reclaimed water was available for irrigation, the amount of municipal water demand could be reduce proportionally, thereby reducing the diversion of freshwater from the river.

Based on this conceptual cost estimate, using reuse water is not cost effective compared to the use of current muncipal water supply. The higher cost of reuse water is associated with the capital cost of building the new advance watewater treatment facilities and constructing the distribution infrastructure, and the operation and maintenance of such a system. At this time, this is not economically favorable to implement water reuse.

10. Recommended WWTP Alternatives

This chapter presents the recommended alternatives for upgrade to the existing WWTP.

Hydraulics

The alternate WWTP hydraulics is recommended (Alternative B). The advantages include easier access to equipment and pumping forward flows only once. With selection of Alternative B, the existing activated sludge pump station could be designated entirely for RAS pumping.

Influent Pump Station

Pump Station Capacity

Alternative A is the preferred alternative. The existing pump station can be retrofitted with new pumps and motors for approximately $0.6 million less than utilizing submersible pumps. The pump station should be upgraded to 24 mgd with four 75 hp pumps and motors for an estimated cost of $1.6 million. A physical model of the pump station, before and after conditions, should be considered during the pre-design phase to assure that current problems are corrected by the improvements.

Screening

Coarse screening, with 1-inch screen spacing, is recommended to provide protection for the influent pumps. The existing manually-cleaned bar screen should be replaced with a mechanically-cleaned screen, and the existing mechanically-cleaned screen should be utilized as a backup unit. The estimated cost for replacing the manually-cleaned bar screen with a mechanically-cleaned screen is included in the cost estimate of upgrading the influent pump station, see above.

Headworks

A headworks facility would improve the screening and grit removal, protecting downstream process equipment. The estimated cost of a headworks facility is $2.8 million. Details of the recommended headworks are discussed below.

Comminutor

The comminutor is recommended for abandonment.

Fine Screens

Installation of fine screens is recommended. Fine screens should have 3/8-inch spacing and be mechanically-cleaned and provided with washing and compacting equipment.

Grit Removal

A vortex grit removal system is recommended because of the high flexibility coupled with moderate costs. The hydrocyclone de-gritter has both a high capital and operating cost. The aerated grit chamber has low flexibility and a high operating cost.

Disposal

The existing method of disposal is recommended to be continued. It also is recommended that a building be placed around the screenings and grit storage site to prevent unpleasant odors from escaping the site.

PRIMARY CLARIFIERS

Two new (75-foot diameter) clarifiers are recommended. The life cycle costs of the alternatives are relatively equivalent. The two new clarifiers offers advantages that off-sets the minimal cost difference seen over the life of the clarifier. These advantages include:

- Reserves capacity of the existing clarifier for combined sewer flows (for the 'internal shunt');
- Construction cost savings may be realized, as construction sequencing will be less than the cost towhen to modify the existing clarifier; and
- Two clarifiers would provide redundancy for regular maintenance and unexpected circumstances.

The estimated cost of two new clarifiers is $1.8 million.

ACTIVATED SLUDGE PROCESS

The existing activated sludge system is recommended to be converted from the existing BOD removal mode to a nitrification mode. This conversion will necessitate additional aeration basin capacity and blowers. Details of all recommended improvements for the activated sludge process are below:

Activated Sludge Pump Station

The existing activated sludge pump station is recommended to be designated as an RAS pump station. It has 24.0 mgd capacity (firm pumping capacity of 16.0 mgd), which is in excess of 100 percent of the forward flow through the secondary process at 2020 (9.9 mgd).

Selector Basin

A selector basin is recommended for filament control. A selector basin will allow filamentous bulking control without the use of chlorine. It can be constructed adjacent to the RAS pump station and as detailed in Alternative B. This could be constructed in two phases, the second phase incorporated with the addition of nitrification. The total estimated cost for this selector basin is $600,000.

Aeration Basin

Alternative B, nitrification mode, is required to meet anticipated NPDES permit limits, based on the TMDL of the Skagit River and the toxicity testing (which will most likely limit the allowable ammonia concentration). This alternative utilizes the 0.5 mg Aeration Basin No. 4, requires an additional 1.2 mg aeration basin volume, and replaces the coarse bubble diffusers with fine bubble diffusers. The estimated cost for these improvements is $2.7 million, and could be performed in a phased manner over the 20-year planning horizon.

Blowers

Addition of one blower by 2020 is recommended. The existing blowers have capacity to meet aeration requirements until 2010. One additional blower will meet aeration requirements through 2020. The estimated cost of improvements (building expansion, piping modifications, and one additional blower) are estimated at $333,000.

Secondary Clarifiers

The existing Secondary Clarifier No. 1 (peripheral feed clarifier) is recommended for conversion to WAS storage (aerobic digester). By moving the WAS storage from Aeration Basin No. 4 to the inefficient Clarifier No. 1, it opens up aeration basin volume and reduces the additional aeration basin volume required. It also removes an inefficient secondary clarifier, and replaces it with an efficient clarifier.

It is recommended that three additional clarifiers be added. Two clarifiers should be on line by 2010. One clarifier should be on line by 2020. The estimated costs for 2010 are $2.5 million and for 2020 are $1.1 million.

Disinfection

Alternative C, a vertical, low pressure UV disinfection system, has the lowest life cycle cost. It is recommended to replace the existing chlorine disinfection system. While the low pressure UV system is the least costly alternative, there may be advantages to utilizing a medium pressure system, such as locating the CSO treatment disinfection system, secondary effluent disinfection system, and effluent pump stations in the existing chlorine contact basin. The budgetary cost estimate, $1.34 million, for this planning level determination has been estimated as the higher of the costs ($1.30 million for low pressure verses $1.34 million for medium pressure) for a UV disinfection system and will allow the most beneficial disinfection system to be chosen during the design phase.

Sodium Hypochlorite System

A sodium hypochlorite system is recommended to provide chlorine for miscellaneous plant uses. The description of system equipment is presented in Chapter 9. The hypochlorite system's transfer and metering pumps, and storage tank (5,000 gallon) could be located in the existing chlorine room. Ventilation requirements and compliance with Article 80 of the Uniform Fire Code will need to be assessed when utilizing the existing chlorine room. The estimated cost for a sodium hypochlorite system is $100,000.

Effluent Pump Station

It is recommended that the existing effluent pump station be abandoned. The existing pump station can be converted to contain the electrical and controls for the UV disinfection system and the proposed effluent pump station.

A new pump station, Alternative B, consisting of low head pumps, can be incorporated into the existing chlorine contact basin. The downstream portion of the contact basin could be utilized as the wet well of the pump station, and configured to flow by gravity to the outfall under normal operating conditions. The pump station would consist of three low head pumps, with a firm pumping capacity of 25.8 mgd. The actual sizing of the pumps will depend on the design of the outfall, but preliminary sizing estimates 75 hp pumps. The estimated cost for this pump station is $370,000.

Outfall

The recommended outfall improvement is Alternative A. It promotes better dispersion than the existing outfall and maintains effluent flows away from the near shore Eddies. The estimated cost of replacing the outfall, including the piping from the WWTP, is $1,200,000.

DAF Thickener

A new DAFT is recommended to meet the year 2020 loadings. A 40-ft-diameter unit will provide capacity for loadings through 2020. The details for this recommendation are presented in Chapter 8 , and the cost is estimated to be $400,000.

Anaerobic Digester

A new anaerobic digester is recommended to provide redundancy and digester volume while cleaning the existing digester. A 60-ft-diameter unit with a sidewater depth of 34-feet would be adequate to meet redundancy and flow requirements through 2020. The cost is estimated to be $2,500,000.

Odor Control

It is recommended that gas-phase odors be treated at the WWTP. Odors (gas-phase) should be collected from above the influent pump station wet well, headworks building, and primary clarifiers. The gas-phase odors could be treated with wet scrubber and discharged to the atmosphere. The estimated cost for gas-stream treatment of odors by collection and a single scrubber is $1,300,000.

Biosolids Requirements

It is recommended that Mount Vernon continue to treat biosolids to Class B standards. If Mount Vernon were to treat biosolids to Class A standards, it would be recommended to utilize aerated static composting, at a capital investment of approximately $860,000 and an annual operation and maintenance cost of $150,000.

Facilities

Operations Building

A new Operations Building is recommended as a first phase improvement, at an estimated cost of $500,000. During predesign, details the final requirements should be confirmed and the final budget refined.

Shop/Garage

Addition of 4,000 sf of garage/vehicle storage is recommended, at a cost of $500,000. During predesign, details, such as the square feet of garage space, additional shop space, etc. should be determined.

SITE IMPROVEMENTS

100-year Flood Protection

The existing dike between the WWTP and the Skagit River will protect the WWTP from inundation of the 25-year flood event (estimate based on conversations with the ACOE). Flows in excess of the 25-year flood event will most likely result in a failure of the existing dike downstream of the WWTP. Backwater affects will result of inundation of the WWTP to a water surface elevation of 28.2-28.3 ±0.5 ft. To provide protection from the 100-year flood event, the WWTP should consider construction of a dike around the entire plant. The estimated costs for a 2,000 LF ring dike are $600,000, including 20% contingency and 30% indirect costs. Actual costs will vary depending upon the necessary site improvements.

Roadways

Modification of the existing WWTP will include construction of new process equipment, modification of old process equipment, and new facilities. Improvements to the site should also be planned for, such as re-routing existing roadways or construction of new roadways. It is estimated that 1,300 LF of new roadway will be required at an estimated cost of $50,000, including 20% contingency and 30% indirect costs. Actual costs will vary depending upon the necessary site improvements.

Drainage

Modification of the existing WWTP will also require improvements to the drainage on site. It is estimated that 11 acres of area will be modified requiring new drainage. An estimated cost of $250,000, including 20% contingency and 30% indirect costs has been budgeted for drainage improvements. Actual costs will vary depending upon the necessary site improvements.

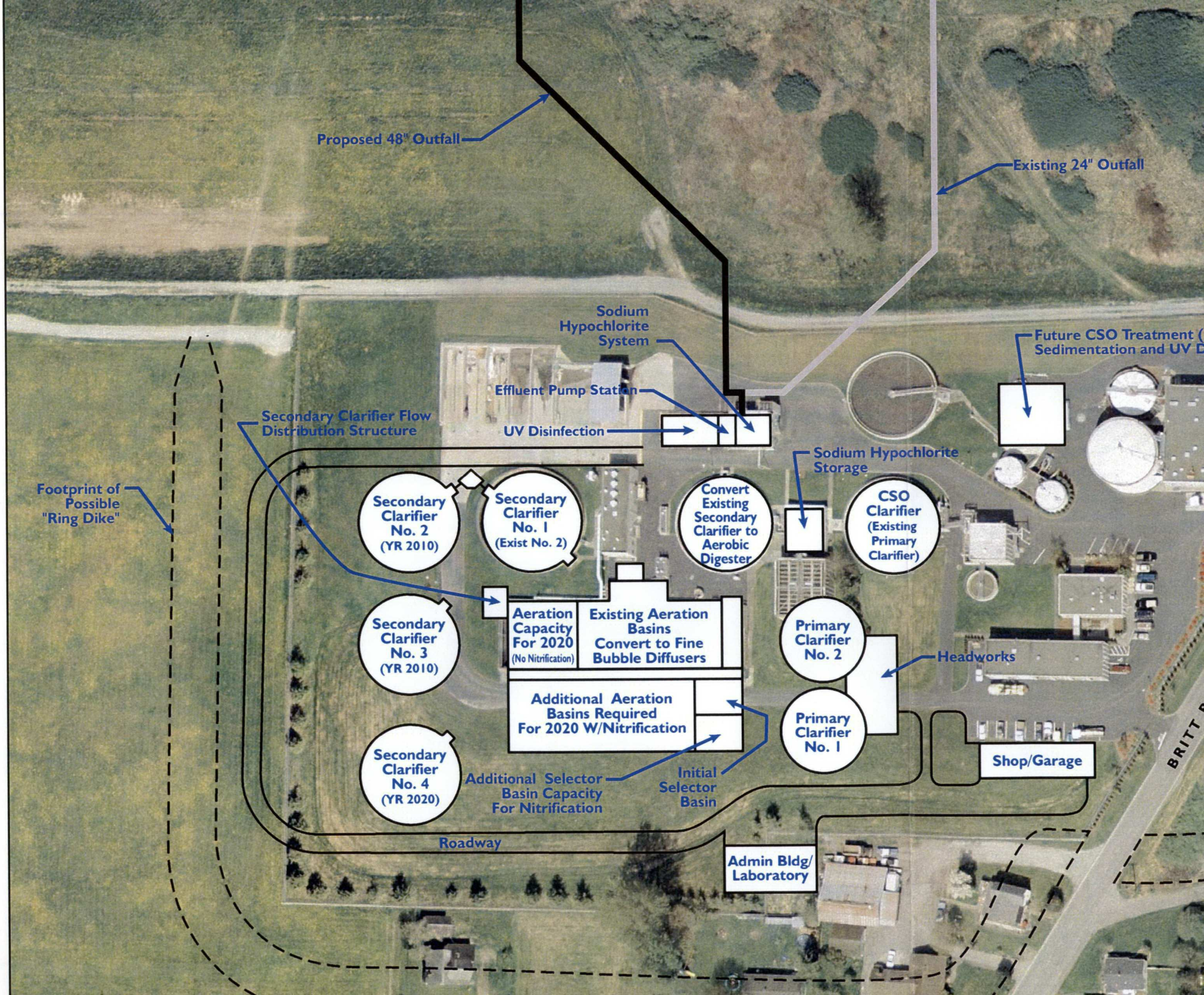
SUMMARY OF RECOMMENDATIONS

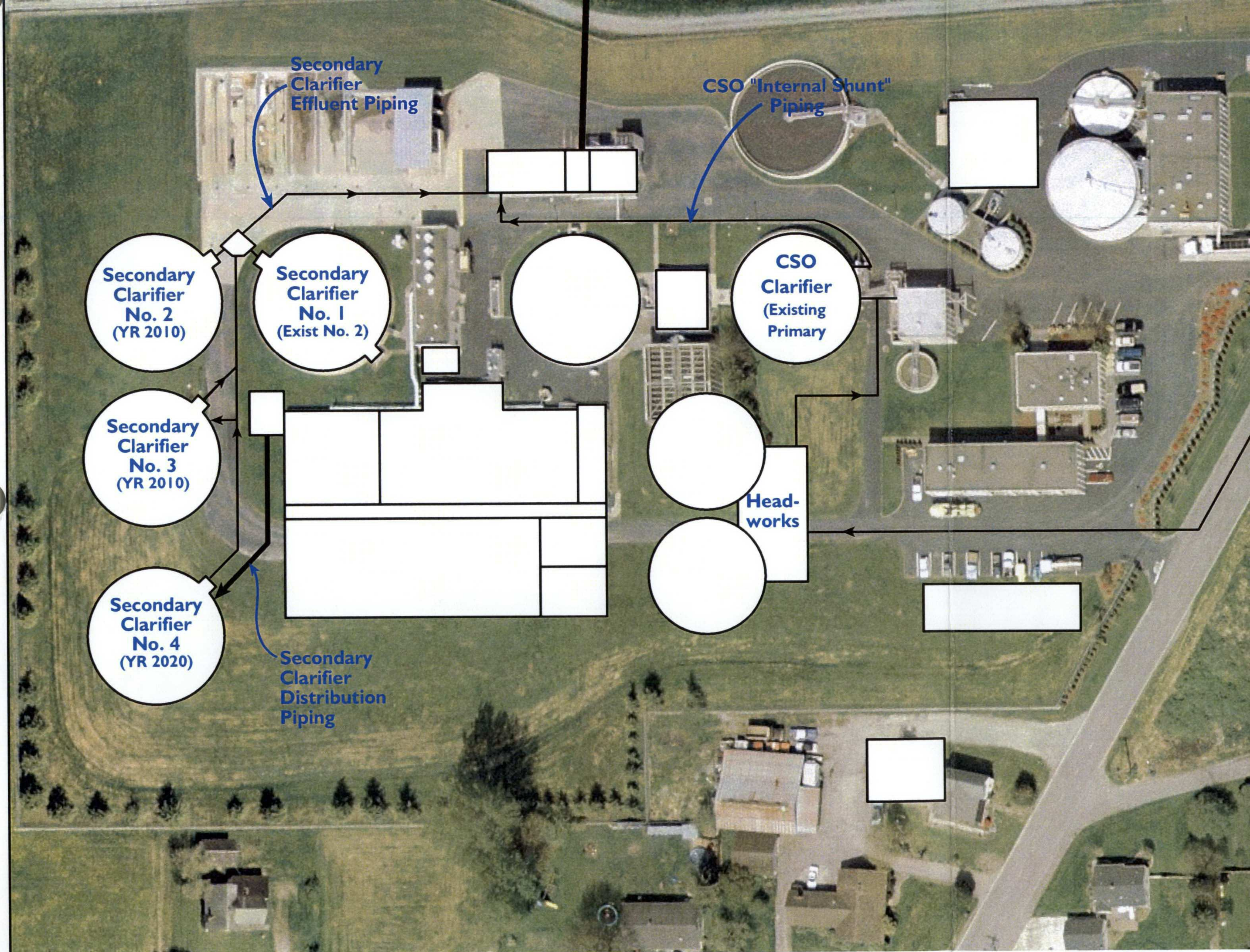
Table 10-1 presents a summary of the recommended improvements and cost estimates for each WWTP improvement. Table 10-2 presents a summary of the recommended improvements and cost estimates for each CSO Treatment improvement.

Table 10-1

Recommended Improvements for the Wastewater Treatment Plant	
Improvement	**Capital Cost Estimate ($1,000)**
Influent Pump Station	$1,600
Headworks	$2,800
Primary Clarifiers	$1,800
Selector Basins	$600
Aeration Basins	$2,700
Chemical Feed System (pH control)	$50
Secondary Clarifiers	$3,600
UV Disinfection[2]	$1,340
Effluent Pump Station	$370
Outfall	$1,200
Sodium Hypochlorite System	$100
DAFT	$400
Anaerobic Digester	$2,500
Odor Control System	$1,300
Administration Building	$500
Laboratory Expansion/Operations Center	$600
Shop and Garage	$500
Flood Protection - 100-year event	$600
Roadways	$250
Drainage Improvements	$50
Total	$23,593

1. ENR Construction Cost Index 6397, October 2001.
2. UV disinfection costs include capital cost of a UV disinfection system and costs for pilot testing for two months.


Proposed 48" Outfall
Existing 24" Outfall
Sodium Hypochlorite System
Future CSO Treatment (
Sedimentation and UV D
Effluent Pump Station
Secondary Clarifier Flow Distribution Structure
UV Disinfection
Sodium Hypochlorite Storage
Footprint of Possible "Ring Dike"
Secondary Clarifier No. 2 (YR 2010)
Secondary Clarifier No. 1 (Exist No. 2)
Convert Existing Secondary Clarifier to Aerobic Digester
CSO Clarifier (Existing Primary Clarifier)
Secondary Clarifier No. 3 (YR 2010)
Aeration Capacity For 2020 (No Nitrification)
Existing Aeration Basins Convert to Fine Bubble Diffusers
Primary Clarifier No. 2
Headworks
Additional Aeration Basins Required For 2020 W/Nitrification
Primary Clarifier No. 1
Secondary Clarifier No. 4 (YR 2020)
Additional Selector Basin Capacity For Nitrification
Initial Selector Basin
Shop/Garage
Roadway
Admin Bldg/ Laboratory
BRITT



Secondary Clarifier Effluent Piping
CSO "Internal Shunt" Piping
Secondary Clarifier No. 2 (YR 2010)
Secondary Clarifier No. 1 (Exist No. 2)
CSO Clarifier (Existing Primary
Secondary Clarifier No. 3 (YR 2010)
Head-works
Secondary Clarifier No. 4 (YR 2020)
Secondary Clarifier Distribution Piping

11. Capital Improvement Plan

This chapter presents a summary of the improvements for the City of Mount Vernon as a plan for improvement and expansion. Improvements for the combined sewer system, CSO reduction were developed in Chapter 4. Improvements for the wastewater collection system were developed in Chapter 5. Improvements for the wastewater treatment plant were developed in Chapter 10.

Capital Improvement Schedule

A capital improvement schedule is based on improvements necessary for future CSO reduction, collection system improvements and expansion, and wastewater treatment plant improvements and expansion. Table 11-1 presents the recommended capital improvement schedule for the Wastewater Treatment Facility. Table 11-2 presents the recommended capital improvement schedule for CSO Treatment. Table 11-3 presents the recommended capital improvement schedule for the collection system. Table 11-4 presents a summary of all system improvements.

Table 11-1

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
Influent Pump Station				1,600											
Headworks				2,800											
Primary Clarifier				1,800											
Activated Sludge - Fine Bubble Diffusers		300													
Activated Sludge - Selector Basin				300					300						
Activated Sludge - Chemical Feed System (pH control)		50													
Activated Sludge - Additional Aeration Basin Capacity									2,700						
Activated Sludge - Additional Second. Clarifier Capacity				2,500					1,100						
UV Disinfection[1]				1,340											

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
Effluent Pump Station				400											
Outfall			1,200												
Sodium Hypochlorite				100											
DAF Thickener									400						
Additional Anaerobic Digester Capacity									2,500						
Odor Control													1,300		
Administration Building				600											
Laborator/Operation s Center													600		
Shop/Garage				500											
Flood Protection 100-year flood															600
Roadways															250

Table 11-1 WWTP Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	>2015
Drainage Improvements															50
Total	0	350	1,200	11,940	0	0	0	0	7,000	0	0	0	1,900	0	900

1. ENR Construction Cost Index 6397, October 2001.
2. Costs for UV disinfection include capital costs and pilot testing costs.

Table 11-2 CSO Treatment Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CSO Treatment - Park Street Conveyance													1,900		
CSO Treatment - High Rate Clarification													4,200		
CSO Treatment - UV Disinfection													2,200		
CSO Treatment - Effluent Pump Station													800		
Total													9,100		

1. ENR Construction Cost Index 6397, October 2001.
3. Costs as presented in Chapter 4, Combined Sewer System

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
FS-1 Sections 23 and 26															380
FS-2 Sections 15 and 22															295
FS-3 Martin Road															135
FS-4 College Way															125
FS-5 College Way		635													
FS-6 Fir Street					270										
FS-7 Fir Street					350										
FS-8 26th Street															190
FS-9 26th Street															140
FS-10 LaVenture Rd															235
FS-11 LaVenture Rd															75
FS-12 LaVenture Rd															255

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
FS-13 Alder Ln Inter.															220
FS-14 Urban Ave															70
FS-15 Freeway Dr															240
FS-16 West Mount Vernon															150
FS-17 Central CSO Regulator	30														
CS-1 Snoqualmie	20														
CS-2 1115 N. 8th	20														
CS-3 S. 7th	20														
CS-4 N 6th	20														
CS-5 Brick Hill	30														
CS-6 Blodgett Rd	20														
CS-7 Kincaid	20														
CS-8 S 20th	20														
CS-9 Section	50														

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CS-10 Douglas/ Walter Alley	75														
CS-11 107 Cedar	45														
CS-12 N 6th	60														
CS-13 Section	5														
CS-14 Broadway	20														
CS-15 Broad St	20														
CS-16 and CS-31 Interstate 5[4]				750											
CS-17 Division Alley	5														
CS-18 Bernice	5														
CS-20 Lawrence	5														
CS-21 1224 12th S	25														
CS-22, CS-23 and CS-29 8th St Improvements			1,00 0												
CS-25 Carpenter Alley	5														

Table 11-3 Collection System Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	201 1	201 2	2013	2014	>2015
CS-26 1120 N 16th	5														
CS-27 1210 N 14th	5														
CS-28 8th	5														
CS-32 N 1st	5														
CS-34 Christenson Seed West	5														
CS-35 Cleveland	20														
CS-40 Lind St	5														
Total	570	635	1,00 0	750	620	0	0	0	0	0	0	0	0	0	2,510

1. ENR Construction Cost Index 6397, October 2001.
2. Costs for the I-5 improvements have been estimated at $750,000 for all crossings. Actual cost estimates will vary depending upon the required improvements after all the crossing have been evaluated. See Chapter 5 for additional details..

Table 11-4 Summary of Capital Improvement Schedule 2000-2020 ($1,000)

Improvement	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	>2015
Wastewater Treatment Facility	0	350	1,200	11,940	0	0	0	0	7,000	0	0	0	1,900	0	900
CSO Treatment													9,100		
Collection System	570	635	1,000	750	620	0	0	0	0	0	0	0	0	0	2,510
Total	570	985	2,200	12,690	620	0	0	0	7,000	0	0	0	11,000	0	3,410

1. ENR Construction Cost Index 6397, October 2001.

Appendix A
Draper Valley Farms, Inc.
20-year Flow Projections

DRAPER VALLEY
F•A•R•M•S

Exhibit B

Ph: 360-424-7947 800-562-2012 Fx: 360-424-1666
CORPORATE OFFICES
P.O. Box 838 - 1000 Jason Lane, Mount Vernon, WA 98273

July 15, 1998

RECEIVED
CITY OF MT. VERNON
JUL 17 1998
WASTE WATER TREATMENT

Dear Mr. Dan Eisses,

RE: Load Projection for Draper Valley Farms over the next 20 years

Our projection could be as high as 140 birds per minute at five gallons a bird, fifteen hours a day, for a total of 630,000 gallons.

Sixty five million birds are processed in Washington and Oregon per year. Draper Valley is currently processing 22-25 million of those birds per year. We are capable of processing 30 million birds per year. As the population rises over the next twenty years, our production could go up as well. If this takes place, 630,000 gallons would escalate to 750,000 gallons.

The processing procedures are regulated by the USDA. These procedures include birds per day and the amount of water needed to process each bird. Therefore it is not always possible to project future uses and needs.

Sincerely,

John Jefferson

Appendix B
L. A. Peaking Curve

SANITARY FLOW PEAKING FACTORS VS. DAILY FLOW CURVE

The peaking factor curve shown in Figure B-1 was developed by the Bureau of Engineering of the City of Los Angeles.[1]

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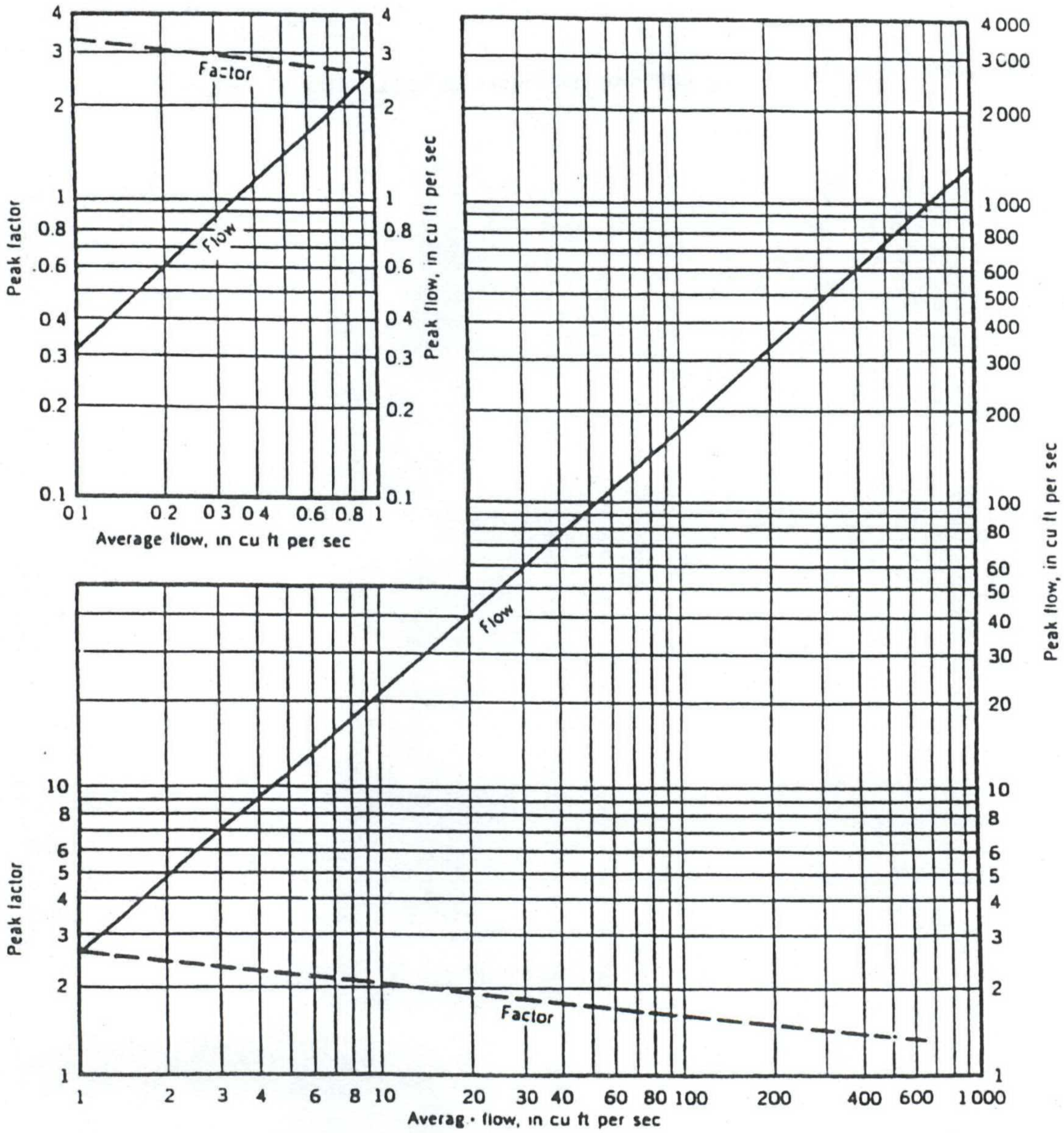
[1]City of Los Angeles, Bureau of Engineering. *ASCE-Manuals and Reports on Engineering Practice No. 37*, "Design and Construction of Sanitary and Storm Sewer." 1979.

QUANTITY OF SANITARY SEWAGE



Ratio of peak flow to average daily flow in Los Angeles.
(Cfs × 1.7 = cu m/min.)

Figure B-1
Sanitary Flow Peaking Factors vs. Daily Flow Curve

APPENDIX C
CITY OF MOUNT VERNON'S BASIN DELINEATION
FOR
HYDRAULIC MODELING

City of Mount Vernon
09637-005-002
3849

Basin Delineation	Area (ac)	Density (c/ac)	Infiltration Rate (gpad)	Contribution per capita (gpd)	Comment
N10-A, EAST END	42.5	6.04	1,100	100	
N10-J	208	8.9	1,100	100	
N10-G	34	8.9	1,100	100	
N10-H	40	8.9	1,100	100	
N10-I	40	8.9	1,100	100	
N10-D	34	8.9	1,100	100	
N10-E	40	8.9	1,100	100	
N10-F	40	8.9	1,100	100	
N10-B	40	8.9	1,100	100	
N10-C	40	8.9	1,100	100	
N11-C	71	3.55	1,100	100	
N16	119	8.91	1,100	100	
N11-Q	20	0	1,100	100	
N11-I	42	5.83	1,100	100	
N11-T	42.7	7.75	1,100	100	
N11-S	43.4	7.96	1,100	100	
N11-R	38	10.06	1,100	100	
N11-P	20	8.82	1,100	100	
N11-L	40	20.1	1,100	100	
N11-N	30	17.48	1,100	100	
N11-J	48.7	1.76	1,100	100	
N11-K	40	14.66	1,100	100	
N11-M	40	14.09	1,100	100	
N11-F	27.4	7.24	1,100	100	
N11-G	20	11.26	1,100	100	
N11-H	20	11.45	1,100	100	
N11-D	20	13.12	1,100	100	
N11-E	20	5.94	1,100	100	
N11-A	24	13.47	1,100	100	
N11-B	38	5.82	1,100	100	
N10-A, WEST END	20	6.04	1,100	100	
N13-F	61.2	6.33	1,100	100	
N13-C	89.7	4.8	1,100	100	
N13-A	48.7	5.03	1,100	100	
N13-E	49.4	6.4	1,100	100	
N13-D	20.7	6.3	1,100	100	
N13-B	92.7	4.6	1,100	100	
N12-H	52.9	8.9	1,100	100	
N12-G	54.6	8.3	1,100	100	
N12-F	51.2	5.7	1,100	100	
N12-E, PART	20	8.9	1,100	100	
N12-D, PART	14.9	8.9	1,100	100	
N12-E, PART	44.5	8.9	1,100	100	
N12-C	52.1	4	1,100	100	
N12-B	35.7	5.5	1,100	100	
SMALL SIDE AREA	8.8	6.4	1,100	100	
N12-A	30.5	10.3	1,100	100	
N14-H	71.1	9	1,100	100	
N14-G	46.5	6.6	1,100	100	
N14-E	8	10	1,100	100	
N14-C	22.7	8.9	1,100	100	
N14-E	24	10	1,100	100	

Basin Delineation	Area (ac)	Density (c/ac)	Infiltration Rate (gpad)	Contribution per capita (gpd)	Comment
N14-F	37.2	16.9	1,100	100	
N14-E	6	20	1,100	100	
N14-D	59.9	14.9	1,100	100	
N14-B	36.8	23.2	1,100	100	
N14-A	28.8	11.2	1,100	100	
N7-G	46.2	15.2	1,100	100	
N9-E, PART	42	3	1,100	100	
N15	370	8.9	1,100	100	
N9-F	20	8.9	1,100	100	
N9-D	78.2	8.9	1,100	100	
N9-C	30.5	7.2	1,100	100	
N9-A	117.1	8.1	1,100	100	
N9-B	41.8	17	1,100	100	
N11-O, COLLEGE	90	2.2	1,100	100	
N9-E, PART	43.2	15	1,100	100	
N7-C	38.7	8.9	1,100	100	
N7-A	25.2	23	1,100	100	
N7-B	69.4	14.5	1,100	100	
N7-F	51.3	7.1	1,100	100	
N7-D	41.3	8.6	1,100	100	
N7-E	33.1	8.6	1,100	100	
N8,	55.7	20.55	1,100	100	Commercial at 2,055 gpad
N8,	60	20.55	1,100	100	Commercial at 2,055 gpad
N6,	45.7	164.11	1,100	100	Draper valley at 0.75 mgd
N5-E	54.3	10.8	1,100	100	
N5-D	15.2	8.6	1,100	100	
N5-C	26.2	13.3	1,100	100	
N5-B	35.6	13.2	1,100	100	
N5-A,	43.4	13.2	1,100	100	
N4-A	8	13.3	1,100	100	
N4-B	45	16.06	1,100	100	
N4-C	45	13.3	1,100	100	
N4-D	27	9.2	1,100	100	
N2,	25	12.9	1,100	100	
N2,	10	0	1,100	100	
C2-C	119	6.05	1,100	100	
C2-B	65.9	4.46	1,100	100	
S5-D	640	3.1	1,100	100	
S5-A	302	8.9	1,100	100	
S5-B	203	9.1	1,100	100	
S5-C	97	8.8	1,100	100	
S4-A	120	8.9	1,100	100	
S4-B	154	8.9	1,100	100	
S4-C	280	8.8	1,100	100	
S3-A	134	8.9	1,100	100	
S3-B	70	8.9	1,100	100	
S3-C	151	8.9	1,100	100	
S1-D	138	8.9	1,100	100	
S1-B	137.2	7.14	1,100	100	
S2	104.2	5.9	1,100	100	
S1-C	26.4	5.6	1,100	100	
S1-A, EAST	48	9.6	1,100	100	
S1-A, WEST	84.3	6.2	1,100	100	
C3-B, SOUTH	29	6.08	1,100	100	
C3-B, NORTH	38.8	8.8	1,100	100	
C3-A, EAST	25.5	6.9	1,100	100	
C3-A, WEST	14.9	3.94	1,100	100	
N1-A	149.5	6.05	1,100	100	

Basin Delineation	Area (ac)	Density (c/ac)	Infiltration Rate (gpad)	Contribution per capita (gpd)	Comment
N1-B	109.7	6.11	1,100	100	
N1-C, TO DIVISION	19.7	7.6	1,100	100	
N3	151.2	14.1	1,100	100	
C1-A,	15	5.12	1,100	100	
C1-A,	71	16.6	1,100	100	
C2-A	70.4	3.82	1,100	100	
C1-D	30.1	4.9	1,100	100	
C1-B	28.9	18.4	1,100	100	
C1-C,	22	23.2	1,100	100	
C1-C,	44.7	4.4	1,100	100	
WEST MV, W1-A	108	5.7	1,100	100	
WEST MV, W1-B	220	8.9	1,100	100	
WEST MV, W2	200	8.6	1100	100	
SECTION 8/4	200	8.6	1100	100	
SECTION 23	560	8.6	1100	100	
SECTION 26	560	8.6	1100	100	

APPENDIX D
HYDRAULIC ANALYSIS OUTPUT OF THE CITY OF MOUNT VERNON'S WASTEWATER COLLECTION SYSTEM

City of Mount Vernon
09637-005-002
3849

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	*****	COLLEGE	WAY	PUMP	STATIO	DRAIN	AREA									
	COLLEGE	WAY,	EAST	OF	PUMP	STATION										
N10-A, SEC 23, 26	90.00	84.00	72.53	71.57	175	8	0.0055	42.50	0.00	0.00	1.279	0.989	2.60	3.85	0.58	666.02
	83.50	76.50	71.57	69.80	99	8	0.0179	0.00	1.28	0.99	0.000	0.000	2.60	3.85	1.04	368.92
	76.50	61.00	69.80	55.00	160	8	0.0925	0.00	1.28	0.99	0.000	0.000	2.60	3.85	2.38	162.19
	61.00	58.50	55.00	50.60	270	8	0.0163	0.00	1.28	0.99	0.000	0.000	2.60	3.85	1.00	386.42
	58.50	47.00	50.60	37.40	270	8	0.0489	0.00	1.28	0.99	0.000	0.000	2.60	3.85	1.73	223.10
	47.00	40.00	37.40	29.44	405	8	0.0197	0.00	1.28	0.99	0.000	0.000	2.60	3.85	1.09	351.86
HOL	1								1.28	0.99						
UNDEVELOPED AREA	EAST	OF	TOWN,	SECTIONS	N10	B	THRU									
N10-J	90	84	392	386	1300	12	0.0046	208.00	0.00	0.00	0.229	0.185	3.04	0.79	1.56	50.59
N10-G,H,I	84	77	386	350	2600	12	0.0138	114.00	0.23	0.19	0.125	0.101	2.93	1.19	2.71	44.02
N10-D,E,F	77	61	350	225	1400	12	0.0893	114.00	0.35	0.29	0.125	0.101	2.85	1.58	6.88	23.02
N10-B,C	61	59	225	62	600	12	0.2717	80.00	0.48	0.39	0.088	0.071	2.80	1.85	12.00	15.45
	59	47	62	40	1900	12	0.0116	0.00	0.57	0.46	0.000	0.000	2.80	1.85	2.48	74.85
HOL	2								0.57	0.46						
	WAUGH	RD	SOUTH													
N11-C,D,A	66.00	59.00	55.00	48.54	322	8	0.0201	115.00	0.00	0.00	0.127	0.084	3.25	0.40	1.11	36.02
	59.00	54.50	48.54	43.80	316	8	0.015	0.00	0.13	0.08	0.000	0.000	3.25	0.40	0.96	41.65
	54.50	52.50	43.80	42.38	284	8	0.005	0.00	0.13	0.08	0.000	0.000	3.25	0.40	0.55	72.15
	52.50	52.50	42.38	41.14	248	8	0.005	0.00	0.13	0.08	0.000	0.000	3.25	0.40	0.55	72.15
	52.50	50.00	41.14	38.61	211	8	0.012	0.00	0.13	0.08	0.000	0.000	3.25	0.40	0.86	46.59
HOL	3								0.13	0.08						
	WAUGH	RD	NORTH													
N16, N11-Q, N11-I	61.00	53.00	50.60	44.12	432	8	0.015	181.00	0.00	0.00	0.199	0.131	3.13	0.61	0.96	63.53
	53.00	51.00	44.12	41.71	344	8	0.007	0.00	0.20	0.13	0.000	0.000	3.13	0.61	0.65	92.96
	51.00	46.50	41.71	39.78	287	8	0.0067	0.00	0.20	0.13	0.000	0.000	3.13	0.61	0.64	94.88
	46.50	47.50	39.70	38.98	103	8	0.007	0.00	0.20	0.13	0.000	0.000	3.13	0.61	0.65	93.06
	47.50	50.00	38.98	38.61	247	12	0.0015	0.00	0.20	0.13	0.000	0.000	3.13	0.61	0.89	68.19
HOL	4								0.20	0.13						
	30TH	ROW														
N11-T	147.00	130.00	139.93	122.93	1000	8	0.017	42.7	0.00	0.00	0.047	0.033	3.49	0.16	1.02	15.95
	130.00	125.00	122.93	118.15	281	8	0.017	0.00	0.05	0.03	0.000	0.000	3.49	0.16	1.02	15.94
	125.00	115.00	118.15	110.13	277	8	0.029	0.00	0.05	0.03	0.000	0.000	3.49	0.16	1.33	12.22
	115.00	106.00	110.13	104.74	270	8	0.02	0.00	0.05	0.03	0.000	0.000	3.49	0.16	1.10	14.72
N11-S,R,P	106.00	80.00	104.74	60.00	2700	8	0.0166	101.40	0.05	0.03	0.112	0.090	3.14	0.55	1.01	54.40
HOL	5								0.16	0.12						
	COLLEGE	WAY,	26TH	TO	WAUGH	RD										

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	COLLEGE	WAY,	WAUGH	RD TO	PUMP	STA										
	COLLEGE	WAY	PUMP	STATION												
N11-L,N	79.00	73.50	69.57	65.00	330	8	0.0138	70.00	0.00	0.00	0.077	0.133	3.13	0.49	0.92	53.56
	73.50	71.50	65.00	62.34	380	8	0.007	0.00	0.08	0.13	0.000	0.000	3.13	0.49	0.65	75.33
	71.50	67.50	62.34	59.67	380	10	0.007	0.00	0.08	0.13	0.000	0.000	3.13	0.49	1.19	41.47
REC 5	67.50	65.50	59.67	56.67	428	10	0.007	0.00	0.24	0.26	0.000	0.000	2.95	0.99	1.19	83.75
	65.50	61.00	56.67	52.77	390	12	0.01	0.00	0.24	0.26	0.000	0.000	2.95	0.99	2.30	43.12
	61.00	58.00	52.77	48.87	390	12	0.01	0.00	0.24	0.26	0.000	0.000	2.95	0.99	2.30	43.12
N11-F,G,H	58.00	54.50	48.87	46.10	302	12	0.0092	67.40	0.24	0.26	0.074	0.065	2.90	1.24	2.21	56.27
N11-J,K	54.50	54.00	46.10	45.30	88	12	0.0091	88.70	0.31	0.32	0.098	0.067	2.85	1.51	2.20	68.95
N11-M	54.00	50.00	45.30	41.90	400	12	0.0085	40.00	0.41	0.39	0.044	0.056	2.81	1.70	2.12	80.20
N11-E	50.00	51.50	41.90	40.29	268	12	0.006	20.00	0.45	0.45	0.022	0.012	2.80	1.75	1.78	98.32
	51.50	50.00	40.29	38.61	280	12	0.006	0.00	0.47	0.46	0.000	0.000	2.80	1.75	1.78	98.38
REC 3,4 & N11-B	50.00	48.00	38.61	37.17	360	8	0.004	38.00	0.80	0.67	0.042	0.022	2.70	2.71	0.49	548.58
	50.00	45.00	37.17	35.79	345	8	0.004	0.00	0.84	0.69	0.000	0.000	2.70	2.71	0.49	548.58
	45.00	43.00	35.79	34.39	350	8	0.004	0.00	0.84	0.69	0.000	0.000	2.70	2.71	0.49	548.58
	43.00	43.50	34.39	32.99	350	8	0.004	0.00	0.84	0.69	0.000	0.000	2.70	2.71	0.49	548.58
N10-A, WEST END	43.50	42.00	32.99	31.59	350	8	0.004	20	0.84	0.69	0.022	0.012	2.69	2.76	0.49	558.98
	42.00	39.50	31.59	30.53	265	8	0.004	0.00	0.86	0.71	0.000	0.000	2.69	2.76	0.49	558.98
	39.50	40.00	30.53	29.44	272	8	0.004	0.00	0.86	0.71	0.000	0.000	2.69	2.76	0.49	558.47
REC 1,2	40.00	40.00	29.44	29.29	15	8	0.01	0.00	2.71	2.15	0.000	0.000	2.40	7.88	0.78	1008.68
HOL	6	-----------------	FLOWS	FROM	COLLEGE	WAY	PUMP	1120.00	2.71	2.15						
	***********	DRAINAGE	AREA	N13	********************************											
	WAUGH	RD	AND	RIDGE	WAY											
	FIR	ST.,	WAUGH	TO	COMANCHE											
N13-F	384.00	374.00	374.03	364.64	220	8	0.0427	61.2	0.00	0.00	0.067	0.039	3.45	0.20	1.61	12.45
	374.00	358.00	364.64	349.14	345	8	0.0449	0.00	0.07	0.04	0.000	0.000	3.45	0.20	1.66	12.13
	358.00	356.00	349.14	347.82	330	8	0.004	0.00	0.07	0.04	0.000	0.000	3.45	0.20	0.49	40.66
	356.00	354.00	347.82	346.17	415	8	0.004	0.00	0.07	0.04	0.000	0.000	3.45	0.20	0.49	40.79
	354.00	341.00	346.17	333.50	300	8	0.0422	0.00	0.07	0.04	0.000	0.000	3.45	0.20	1.61	12.51
	341.00	335.00	333.50	327.10	290	8	0.0221	0.00	0.07	0.04	0.000	0.000	3.45	0.20	1.16	17.31
	335.00	331.00	327.10	324.88	250	8	0.0089	0.00	0.07	0.04	0.000	0.000	3.45	0.20	0.74	27.29
	331.00	308.00	324.88	299.42	128	8	0.1989	0.00	0.07	0.04	0.000	0.000	3.45	0.20	3.48	5.77
	308.00	290.00	299.42	282.22	312	8	0.0551	0.00	0.07	0.04	0.000	0.000	3.45	0.20	1.83	10.95
	290.00	275.00	282.22	268.15	335	8	0.042	0.00	0.07	0.04	0.000	0.000	3.45	0.20	1.60	12.55
	275.00	211.00	268.15	200.40	485	8	0.1397	0.00	0.07	0.04	0.000	0.000	3.45	0.20	2.92	6.88
N13-C	211.00	193.00	200.40	184.95	125	8	0.1236	89.7	0.07	0.04	0.099	0.043	3.25	0.43	2.75	15.73
	193.00	180.00	184.95	175.03	216	8	0.0459	0.00	0.17	0.08	0.000	0.000	3.25	0.43	1.67	25.81
	180.00	162.00	175.03	154.00	363	8	0.0579	0.00	0.17	0.08	0.000	0.000	3.25	0.43	1.88	22.98
	162.00	130.00	154.00	124.00	400	8	0.075	0.00	0.17	0.08	0.000	0.000	3.25	0.43	2.14	20.20
	130.00	122.00	124.00	113.18	135	8	0.0801	0.00	0.17	0.08	0.000	0.000	3.25	0.43	2.21	19.54
	122.00	97.00	113.18	86.50	334	12	0.0799	0.00	0.17	0.08	0.000	0.000	3.25	0.43	6.51	6.64
N13-A	97.00	94.00	86.50	85.38	460	12	0.0024	48.7	0.17	0.08	0.054	0.024	3.18	0.56	1.14	49.11
HOL	7								0.22	0.11						
	DIVISION,	37TH	TO	SIOUX	DR.											
	SIOUX,	SHOSHONE	TO	FIR	ST											
	FIR	ST.,COMAN	TO	30TH												
N13-E	356.00	352.00	345.70	341.60	82	8	0.05	49.4	0.00	0.00	0.054	0.032	3.50	0.16	1.75	9.45
	352.00	311.00	341.60	300.48	380	8	0.1082	0.00	0.05	0.03	0.000	0.000	3.50	0.16	2.57	6.42

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
N13-D	311.00	297.00	300.48	283.10	378	8	0.046	20.7	0.05	0.03	0.023	0.013	3.41	0.23	1.67	13.70
	297.00	287.00	283.10	276.45	145	8	0.0459	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.67	13.71
	287.00	276.00	276.45	269.45	350	8	0.02	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.10	20.77
	276.00	254.00	269.45	244.95	350	8	0.07	0.00	0.08	0.04	0.000	0.000	3.41	0.23	2.07	11.10
	254.00	247.00	244.95	238.05	220	8	0.0314	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.38	16.58
	247.00	242.00	238.05	235.08	120	8	0.0248	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.23	18.67
	242.00	222.00	235.08	213.42	430	8	0.0504	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.75	13.09
	222.00	208.00	213.42	201.96	200	8	0.0573	0.00	0.08	0.04	0.000	0.000	3.41	0.23	1.87	12.27
	208.00	184.00	201.96	171.26	270	8	0.1137	0.00	0.08	0.04	0.000	0.000	3.41	0.23	2.63	8.71
N13-B	184.00	170.00	171.26	162.22	460	8	0.0197	92.7	0.08	0.04	0.102	0.043	3.24	0.46	1.09	42.15
	170.00	163.00	162.22	153.20	140	8	0.0644	0.00	0.18	0.09	0.000	0.000	3.24	0.46	1.98	23.28
	163.00	136.00	153.20	127.45	250	8	0.103	0.00	0.18	0.09	0.000	0.000	3.24	0.46	2.51	18.41
	136.00	130.00	127.45	118.96	65	8	0.1306	0.00	0.18	0.09	0.000	0.000	3.24	0.46	2.82	16.35
	130.00	108.00	118.96	98.16	150	8	0.1387	0.00	0.18	0.09	0.000	0.000	3.24	0.46	2.91	15.87
	108.00	94.00	98.16	85.38	240	8	0.0533	0.00	0.18	0.09	0.000	0.000	3.24	0.46	1.80	25.61
REC 7	94.00	94.00	85.38	84.73	320	12	0.002	0.00	0.40	0.19	0.000	0.000	3.03	0.98	1.04	94.89
	94.00	94.00	84.73	84.08	330	12	0.002	0.00	0.40	0.19	0.000	0.000	3.03	0.98	1.02	96.36
	94.00	94.00	84.08	83.43	330	12	0.002	0.00	0.40	0.19	0.000	0.000	3.03	0.98	1.02	96.36
HOL	8								0.40	0.19						
	***********	DRAINAGE	AREA	N12	******************************											
	DIVISION,	ABOUT	32ND	TO	MANITO											
	MANITO	DR.,	DIVISION	TO	THE	NORTH										
N12-H,G,F	231.00	230.00	220.61	218.85	290	8	0.0061	158.70	0.00	0.00	0.175	0.122	3.15	0.56	0.61	91.62
	230.00	225.00	218.85	216.00	280	8	0.0102	0.00	0.17	0.12	0.000	0.000	3.15	0.56	0.79	70.75
	225.00	219.00	216.00	208.09	340	8	0.0233	0.00	0.17	0.12	0.000	0.000	3.15	0.56	1.19	46.79
	219.00	212.00	208.09	203.01	140	8	0.0363	0.00	0.17	0.12	0.000	0.000	3.15	0.56	1.49	37.47
	212.00	205.00	203.01	198.89	405	8	0.0102	0.00	0.17	0.12	0.000	0.000	3.15	0.56	0.79	70.77
	205.00	192.00	198.89	181.91	310	8	0.0548	0.00	0.17	0.12	0.000	0.000	3.15	0.56	1.83	30.50
	192.00	175.00	181.91	161.78	340	8	0.0592	0.00	0.17	0.12	0.000	0.000	3.15	0.56	1.90	29.33
N12-E	175.00	141.00	161.78	128.01	320	8	0.1055	20	0.17	0.12	0.022	0.018	3.11	0.63	2.54	24.85
	141.00	132.00	128.01	118.02	320	8	0.0312	0.00	0.20	0.14	0.000	0.000	3.11	0.63	1.38	45.69
N12-D	132.00	132.00	118.02	115.93	530	8	0.0039	14.9	0.20	0.14	0.016	0.013	3.09	0.68	0.49	139.59
HOL	9								0.21	0.15						
	30TH	ST.,	TO	FIR	ST.											
	FIR	ST.,	30TH	TO	26TH											
	26TH,	FIR	TO	KULSHAN												
N12-E	163.00	132.00	155.45	115.93	380	8	0.104	44.5	0.00	0.00	0.049	0.040	3.44	0.19	2.52	7.35
REC 9, N12-C	132.00	107.00	115.93	91.93	400	8	0.06	52.1	0.26	0.19	0.057	0.021	3.00	0.96	1.91	50.13
	107.00	94.00	91.93	83.43	400	8	0.0213	0.00	0.32	0.21	0.000	0.000	3.00	0.96	1.14	84.24
REC 8	94.00	94.00	83.43	82.10	665	12	0.002	0.00	0.72	0.41	0.000	0.000	2.83	1.87	1.03	181.64
	94.00	92.00	82.10	81.26	420	12	0.002	0.00	0.72	0.41	0.000	0.000	2.83	1.87	1.03	181.64
N12-B	92.00	92.00	81.26	79.78	180	12	0.0082	35.7	0.72	0.41	0.039	0.020	2.82	1.96	2.09	93.88
	92.00	87.00	79.78	77.52	205	12	0.011	0.00	0.76	0.43	0.000	0.000	2.82	1.96	2.42	81.08
SM SD AREA	87.00	83.00	77.52	72.20	490	12	0.0109	8.8	0.76	0.43	0.010	0.006	2.82	1.98	2.40	82.70
	83.00	78.00	72.20	68.75	690	12	0.005	0.00	0.77	0.43	0.000	0.000	2.82	1.98	1.63	121.87
HOL	10	-----------------	SAVE	FIR	ST.	FLOWS			0.77	0.43						
	PARK	VILLAGE	DEVELOPMENT													0.00
N12-A	77.00	78.00	69.58	68.89	230	8	0.003	30.5	0.00	0.00	0.034	0.031	3.50	0.14	0.43	33.56

City of Mount Vernon Comprehensive Sewer Plan Update

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	78.00	78.00	68.89	68.75	70	8	0.002	0.00	0.03	0.03	0.000	0.000	3.50	0.14	0.35	41.10
HOL	11	----------------	SAVE	PARK	VILLAGE	FLOWS			0.03	0.03						
	***********	COMBINATI	OF	AREAS	N11,	N12	AND	N13								
	26TH,	COLLEGE	TO	KULSHAN												
	KULSHAN	ROW,	26TH	TO	LAVENTURE											
REC 6	83.00	80.00	74.17	72.86	330	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.45	543.00
	80.00	78.00	72.86	71.60	315	8	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	0.49	1594.86
	78.00	77.00	71.60	70.34	315	8	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	0.49	1594.86
	77.00	78.00	70.34	69.14	300	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.46	540.93
	78.00	78.00	69.14	68.75	25	12	0.0156	0.00	2.71	2.15	0.000	0.000	2.40	7.88	2.88	273.91
	78.00	79.00	68.75	67.44	330	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.45	543.00
	79.00	79.00	67.44	66.12	330	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.46	540.93
	79.00	78.00	66.12	64.81	330	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.45	543.00
	78.00	76.00	64.81	63.50	330	12	0.004	0.00	2.71	2.15	0.000	0.000	2.40	7.88	1.45	543.00
HOL	12	<--------	HOLD	ALL	FLOWS	FROM	KULSHA	AY	2.71	2.15						
	***********	DRAINAGE	AREA	N14	**********************************											
	DIVISION	ST.,	TRAILOR	PARK	TO	25TH										
N14-H,G	200.00	190.00	189.02	182.11	280	10	0.0247	117.60	0.00	0.00	0.129	0.095	3.21	0.43	2.22	19.50
N14-E	190.00	187.00	182.11	176.61	360	10	0.0153	8	0.13	0.09	0.009	0.008	3.19	0.47	1.75	26.63
N14-C	187.00	187.00	176.62	176.33	60	10	0.0048	22.7	0.14	0.10	0.025	0.020	3.15	0.55	0.98	55.84
N14-E	187.00	188.00	176.33	175.10	310	10	0.004	24	0.16	0.12	0.026	0.024	3.10	0.64	0.89	72.29
	188.00	189.00	175.10	173.93	295	10	0.004	0.00	0.19	0.15	0.000	0.000	3.10	0.64	0.89	72.31
	189.00	189.00	173.93	173.00	60	10	0.0155	0.00	0.19	0.15	0.000	0.000	3.10	0.64	1.76	36.58
HOL	13								0.19	0.15						
	LAVENTUR	KINCAID	TO	DIVISION												
	LAVENTUR	DIVISION	TO	FIR												
	LAVENTUR	FIR	TO	KULSHAN												
N14-F	203.00	200.00	192.48	191.43	225	8	0.0047	37.2	0.00	0.00	0.041	0.063	3.32	0.25	0.53	46.80
N14-E	200.00	199.00	191.43	190.00	285	8	0.005	6	0.04	0.06	0.007	0.012	3.28	0.29	0.55	52.92
	199.00	195.00	190.00	186.00	400	8	0.01	0.00	0.05	0.07	0.000	0.000	3.28	0.29	0.78	37.48
	195.00	190.00	186.00	178.10	395	8	0.02	0.00	0.05	0.07	0.000	0.000	3.28	0.29	1.10	26.50
	190.00	190.00	178.10	173.00	60	8	0.085	0.00	0.05	0.07	0.000	0.000	3.28	0.29	2.28	12.86
REC 13 & N14-D	190.00	178.00	173.00	165.87	325	8	0.0219	59.9	0.24	0.22	0.066	0.089	2.90	1.21	1.16	104.27
	178.00	171.00	165.87	159.25	300	8	0.0221	0.00	0.30	0.31	0.000	0.000	2.90	1.21	1.16	103.97
	171.00	156.00	159.25	146.00	600	8	0.0221	0.00	0.30	0.31	0.000	0.000	2.90	1.21	1.16	103.93
	156.00	155.00	146.00	143.00	113	8	0.0265	0.00	0.30	0.31	0.000	0.000	2.90	1.21	1.27	94.78
N14-B	155.00	148.00	143.00	138.00	187	8	0.0267	36.8	0.30	0.31	0.040	0.085	2.84	1.47	1.28	115.07
	148.00	108.00	138.00	95.00	657	8	0.0654	0.00	0.34	0.40	0.000	0.000	2.84	1.47	2.00	73.55
N14-A	108.00	97.00	95.00	84.00	495	8	0.0222	28.8	0.34	0.40	0.032	0.032	2.82	1.58	1.16	136.07
N7-G	97.00	89.00	84.00	77.77	366	10	0.017	46.2	0.38	0.43	0.051	0.070	2.78	1.81	1.85	98.15
N9-E	89.00	78.00	77.77	65.50	720	10	0.017	42	0.43	0.50	0.046	0.013	2.77	1.89	1.85	102.31
	78.00	66.00	65.50	63.40	300	10	0.007	0.00	0.47	0.51	0.000	0.000	2.77	1.89	1.18	159.63
HOL	14								0.47	0.51						
	***********	DRAINAGE	BASIN	N9	******************************											
	FRANCIS	ROAD														
	N.	LAVENTURE	TO	HOAG	ROAD											
	N.	LAVENTURE	HOAG	RD	TO	COLLEGE										

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	LAVENTUR	COLLEGE	TO	KULSHAN												
N15, N9-F,D	130.00	122.00	124.10	115.10	200	12	0.0058	468.20	0.00	0.00	0.515	0.417	2.83	1.69	1.75	96.57
	122.00	113.00	115.10	105.84	300	12	0.0111	0.00	0.52	0.42	0.000	0.000	2.83	1.69	2.43	69.80
	113.00	105.00	105.84	98.70	350	12	0.004	0.00	0.52	0.42	0.000	0.000	2.83	1.69	1.46	116.28
	105.00	92.00	98.78	88.97	300	12	0.004	0.00	0.52	0.42	0.000	0.000	2.83	1.69	1.46	116.28
	130.00	122.00	124.10	115.10	348	12	0.004	0.00	0.52	0.42	0.000	0.000	2.83	1.69	1.46	116.28
	122.00	113.00	115.10	105.84	350	12	0.0048	0.00	0.52	0.42	0.000	0.000	2.83	1.69	1.60	106.15
	113.00	105.00	105.84	98.70	168	12	0.0218	0.00	0.52	0.42	0.000	0.000	2.83	1.69	3.40	49.81
	105.00	92.00	98.78	88.97	158	12	0.0125	0.00	0.52	0.42	0.000	0.000	2.83	1.69	2.57	65.78
N9-C	92.00	96.00	88.97	88.17	440	15	0.008	30.5	0.52	0.42	0.034	0.022	2.81	1.78	3.73	47.75
	96.00	97.00	88.17	86.22	395	15	0.008	0.00	0.55	0.44	0.000	0.000	2.81	1.78	3.73	47.75
N9-A, SEC 4	97.00	98.00	86.22	85.32	320	15	0.008	317.1	0.55	0.44	0.349	0.267	2.69	2.80	3.73	74.87
	98.00	97.00	85.22	84.66	330	15	0.008	0.00	0.90	0.71	0.000	0.000	2.69	2.80	3.73	74.87
N9-B	97.00	98.00	84.66	84.00	320	15	0.008	41.8	0.90	0.71	0.046	0.071	2.67	3.01	3.73	80.70
	98.00	99.00	84.00	83.34	320	15	0.008	0.00	0.94	0.78	0.000	0.000	2.67	3.01	3.73	80.70
	99.00	97.00	83.34	82.68	320	15	0.008	0.00	0.94	0.78	0.000	0.000	2.67	3.01	3.73	80.70
	97.00	94.00	82.68	82.02	320	15	0.008	0.00	0.94	0.78	0.000	0.000	2.67	3.01	3.73	80.70
	94.00	90.00	82.02	79.38	320	15	0.008	0.00	0.94	0.78	0.000	0.000	2.67	3.01	3.73	80.70
N11-O	90.00	86.00	79.38	73.86	320	15	0.008	90	0.94	0.78	0.099	0.020	2.66	3.16	3.73	84.63
	86.40	81.00	74.30	71.70	329.52	18	0.0079	0.00	1.04	0.80	0.000	0.000	2.66	3.16	6.03	52.40
N9-E	81.00	77.20	71.70	68.90	328.5	18	0.0085	43.2	1.04	0.80	0.048	0.065	2.64	3.36	6.27	53.65
	77.20	75.80	68.90	66.30	331.56	18	0.0078	0.00	1.09	0.86	0.000	0.000	2.64	3.36	6.01	55.93
	75.80	76.60	66.30	63.60	319.65	18	0.0084	0.00	1.09	0.86	0.000	0.000	2.64	3.36	6.24	53.89
	76.60	76.74	63.60	63.35	26.2	18	0.0095	0.00	1.09	0.86	0.000	0.000	2.64	3.36	6.63	50.70
HOL	15								1.09	0.86						
	***********	KULSHAN	INTERCEPTOR	*****************************												
	KULSHAN	ROW	INTERCEPTOR													
REC 10,11	76.50	78.87	70.36	68.95	350	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.70	16.51
	78.87	78.24	68.95	68.55	100.5	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.63	16.61
	78.24	79.20	68.55	67.12	356.38	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.68	16.55
	79.20	77.59	67.12	65.92	300	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.66	16.57
	77.59	77.30	65.92	64.72	300	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.66	16.57
	77.30	76.50	64.72	63.52	300	27	0.004	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.66	16.57
	76.50	76.74	63.52	63.35	41.27	27	0.0041	0.00	0.80	0.46	0.000	0.000	2.80	2.10	12.85	16.33
	76.74	69.63	63.35	60.47	240.28	24	0.012	0.00	0.80	0.46	0.000	0.000	2.80	2.10	16.01	13.11
N7-C, REC 12, 14, 15	69.63	69.14	60.47	58.40	57.55	24	0.036	38.7	5.07	3.99	0.043	0.034	2.24	14.12	27.73	50.91
N7-F	69.14	68.44	58.40	55.97	67.45	24	0.036	51.3	5.11	4.02	0.056	0.036	2.23	14.24	27.75	51.33
	68.44	67.32	55.97	55.64	83.25	24	0.004	0.00	5.17	4.06	0.000	0.000	2.23	14.24	9.21	154.74
	67.32	61.50	55.64	53.83	453.2	24	0.004	0.00	5.17	4.06	0.000	0.000	2.23	14.24	9.24	154.16
	61.50	61.50	53.83	52.36	367.74	24	0.004	0.00	5.17	4.06	0.000	0.000	2.23	14.24	9.24	154.10
	61.50	65.00	52.36	52.21	38.85	24	0.0039	0.00	5.17	4.06	0.000	0.000	2.23	14.24	9.09	156.79
	65.00	61.43	52.21	52.02	46.27	24	0.0041	0.00	5.17	4.06	0.000	0.000	2.23	14.24	9.37	152.04
	61.43	49.56	52.02	43.65	500	24	0.0167	0.00	5.17	4.06	0.000	0.000	2.23	14.24	18.92	75.30
	49.56	38.81	43.65	33.00	440.72	24	0.0242	0.00	5.17	4.06	0.000	0.000	2.23	14.24	22.73	62.67
	38.81	32.85	33.00	27.29	361.24	24	0.0158	0.00	5.17	4.06	0.000	0.000	2.23	14.24	18.38	77.49
	32.85	31.16	27.29	27.01	275.45	24	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	4.66	305.58
	31.16	32.50	27.01	24.50	209.99	24	0.012	0.00	5.17	4.06	0.000	0.000	2.23	14.24	15.99	89.11
	32.50	36.50	24.50	24.12	381.41	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.37	170.24
	36.50	34.99	24.12	23.74	372.66	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.47	168.27
	34.99	34.00	23.74	23.40	348.28	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.28	171.98

City of Mount Vernon Comprehensive Sewer Plan Update

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	34.00	34.00	23.40	23.05	348.28	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.40	169.50
	34.00	34.00	23.05	22.65	400	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.38	169.92
	34.00	31.50	22.65	22.48	169.62	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.39	169.73
	31.50	29.11	22.48	22.03	446.98	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.41	169.35
	29.11	29.02	22.03	21.76	272.14	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.35	170.59
	29.02	33.15	21.76	21.58	179.72	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.39	169.79
	33.15	32.48	21.58	21.64	338.72	30	-0.0002	0.00	5.17	4.06	0.000	0.000	2.23	14.24	#NUM!	#NUM!
	32.48	32.80	21.64	21.13	114.06	30	0.0045	0.00	5.17	4.06	0.000	0.000	2.23	14.24	17.73	80.36
	32.80	32.00	21.13	21.02	104.85	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.59	165.90
	32.00	32.00	21.02	20.82	203.42	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.31	171.37
	32.00	31.58	20.82	20.54	278.43	30	0.001	0.00	5.17	4.06	0.000	0.000	2.23	14.24	8.41	169.45
HOL	16								5.17	4.06						
	KULSHAN	CREEK	INTERCEPTOR													
	66.00	52.00	63.40	45.41	342	10	0.0526	0.00	0.00	0.00	0.000	0.000	#NUM!	#NUM!	3.25	#NUM!
	52.00	48.00	45.41	40.99	135	10	0.0327	0.00	0.00	0.00	0.000	0.000	#NUM!	#NUM!	2.56	#NUM!
	48.00	46.00	40.99	37.46	107.5	10	0.0328	0.00	0.00	0.00	0.000	0.000	#NUM!	#NUM!	2.57	#NUM!
	46.00	38.00	37.46	30.58	210	10	0.0328	0.00	0.00	0.00	0.000	0.000	#NUM!	#NUM!	2.56	#NUM!
	38.00	37.00	30.58	29.84	72	12	0.0103	0.00	0.00	0.00	0.000	0.000	#NUM!	#NUM!	2.33	#NUM!
N7-A	37.00	36.00	29.84	26.00	350	12	0.011	25.2	0.00	0.00	0.028	0.058	3.34	0.22	2.41	9.18
N7-B	36.00	30.00	26.00	22.32	335	12	0.011	69.40	0.03	0.06	0.076	0.101	3.08	0.59	2.41	24.55
	30.00	34.00	22.32	21.72	130	30	0.0046	0.00	0.10	0.16	0.000	0.000	3.08	0.59	18.01	3.29
	34.00	30.00	21.72	21.35	130	30	0.0028	0.00	0.10	0.16	0.000	0.000	3.08	0.59	14.14	4.19
HOL	17								0.10	0.16						
	14TH	ROW,	RR	TRACKS	TO	ROOSEVELT										
N7-D,E	31.00	24.00	18.03	16.70	330	10	0.004	74.40	0.00	0.00	0.082	0.064	3.32	0.29	0.90	32.71
	24.00	25.00	16.70	15.39	330	10	0.004	0.00	0.08	0.06	0.000	0.000	3.32	0.29	0.89	32.96
HOL	18								0.08	0.06						
	ROOSEVEI	18TH	TO	RR	TRACKS											
REC 17	28.00	28.00	21.35	20.40	190	15	0.005	0.00	0.10	0.16	0.000	0.000	3.08	0.59	2.95	20.07
	28.00	26.00	20.40	18.73	330	15	0.0051	0.00	0.10	0.16	0.000	0.000	3.08	0.59	2.97	19.95
	26.00	25.00	18.73	17.06	334	15	0.005	0.00	0.10	0.16	0.000	0.000	3.08	0.59	2.95	20.07
	25.00	25.00	17.06	15.39	334	15	0.005	0.00	0.10	0.16	0.000	0.000	3.08	0.59	2.95	20.07
REC 18	25.00	27.00	15.39	15.12	270	21	0.001	0.00	0.19	0.22	0.000	0.000	2.99	0.85	3.24	26.30
N8, COMMERCIAL	27.00	25.00	15.12	14.74	380	21	0.001	115.70	0.19	0.22	0.127	0.238	2.80	1.60	3.24	49.50
	25.00	23.00	14.74	14.48	325	21	0.0008	0.00	0.31	0.46	0.000	0.000	2.80	1.60	2.90	55.35
	23.00	26.00	14.48	14.22	325	21	0.0008	0.00	0.31	0.46	0.000	0.000	2.80	1.60	2.90	55.35
N6, COMMERCIAL	26.00	25.00	14.22	13.96	325	21	0.0008	45.7	0.31	0.46	0.050	0.750	2.55	3.45	2.90	119.11
	25.00	27.00	13.96	13.70	325	21	0.0008	0.00	0.36	1.21	0.000	0.000	2.55	3.45	2.90	119.11
HOL	19								0.36	1.21						
	***********	AREA	N5	**												
	URBAN	AVE,	HOAG	TO	ROOSEVELT											
N5-E	30.00	30.00	22.01	19.73	570	8	0.004	54.3	0.00	0.00	0.060	0.059	3.34	0.26	0.49	51.73
N5-D,C	30.00	28.00	19.73	18.83	450	12	0.002	41.40	0.06	0.06	0.046	0.048	3.18	0.44	1.03	43.16
	28.00	28.00	18.83	17.96	435	12	0.002	0.00	0.11	0.11	0.000	0.000	3.18	0.44	1.03	43.16
N5-B	28.00	27.00	17.96	16.81	575	12	0.002	35.6	0.11	0.11	0.039	0.047	3.09	0.62	1.03	60.07
	27.00	27.00	16.81	16.06	375	10	0.002	0.00	0.14	0.15	0.000	0.000	3.09	0.62	0.63	97.69
	27.00	26.00	16.06	15.24	410	15	0.002	0.00	0.14	0.15	0.000	0.000	3.09	0.62	1.87	33.13

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
N5-A,	26.00	26.00	15.24	15.13	50	15	0.0022	43.4	0.14	0.15	0.048	0.057	3.01	0.83	1.96	42.17
	26.00	25.00	15.13	14.49	320	15	0.002	0.00	0.19	0.21	0.000	0.000	3.01	0.83	1.87	44.23
	25.00	26.00	14.49	13.88	305	15	0.002	0.00	0.19	0.21	0.000	0.000	3.01	0.83	1.87	44.23
	26.00	26.00	13.88	13.70	90	15	0.002	0.00	0.19	0.21	0.000	0.000	3.01	0.83	1.87	44.23
HOL	20								0.19	0.21						
	***********	AREA	N4	-	SKAGIT	VALLE	MALL,									
	MARKET	ST.	AND	ROW												
N4-A	28.00	26.00	21.00	19.47	385	8	0.004	8	0.00	0.00	0.009	0.011	3.78	0.05	0.49	9.96
N4-B	27.00	26.00	19.47	18.32	385	10	0.003	45	0.01	0.01	0.050	0.072	3.25	0.33	0.77	42.34
	26.00	26.00	18.32	17.48	380	12	0.0022	0.00	0.06	0.08	0.000	0.000	3.25	0.33	1.08	30.26
	26.00	26.00	17.48	16.75	332	12	0.0022	0.00	0.06	0.08	0.000	0.000	3.25	0.33	1.08	30.35
N4-C	26.00	26.00	16.75	16.16	385	15	0.0015	45	0.06	0.08	0.050	0.060	3.11	0.55	1.63	33.74
	26.00	26.00	16.16	15.84	181	15	0.0018	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.76	31.41
	26.00	26.00	15.84	15.52	200	15	0.0016	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.67	33.02
	26.00	26.00	15.52	15.18	212	15	0.0016	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.67	32.98
	26.00	26.00	15.18	14.84	212	15	0.0016	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.67	32.98
	26.00	26.00	14.84	14.32	325	15	0.0016	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.67	33.02
	26.00	26.00	14.32	13.93	244	15	0.0016	0.00	0.11	0.14	0.000	0.000	3.11	0.55	1.67	33.03
N4-D	26.00	26.00	13.93	13.70	144	15	0.0016	27	0.11	0.14	0.030	0.025	3.07	0.65	1.67	39.03
	26.00	26.00	13.70	13.27	269	15	0.0016	0.00	0.14	0.17	0.000	0.000	3.07	0.65	1.67	39.02
	26.00	26.00	13.27	12.71	350	15	0.0016	0.00	0.14	0.17	0.000	0.000	3.07	0.65	1.67	39.00
HOL	21								0.14	0.17						
	***********	AREA	N2,													
	ALDER	LANE	INTERCEPTOR													
REC 19, 20	27.00	24.00	13.70	13.52	300	15	0.0006	0.00	0.56	1.42	0.000	0.000	2.51	4.12	1.02	402.91
	24.00	24.00	13.52	13.34	300	15	0.0006	0.00	0.56	1.42	0.000	0.000	2.51	4.12	1.02	402.91
	24.00	24.00	13.34	13.11	383	30	0.0006	0.00	0.56	1.42	0.000	0.000	2.51	4.12	6.50	63.43
	24.00	24.00	13.11	13.06	20	30	0.0025	0.00	0.56	1.42	0.000	0.000	2.51	4.12	13.26	31.09
	24.00	24.00	13.06	12.91	250	30	0.0006	0.00	0.56	1.42	0.000	0.000	2.51	4.12	6.49	63.45
	24.00	24.00	12.91	12.71	333	30	0.0006	0.00	0.56	1.42	0.000	0.000	2.51	4.12	6.50	63.42
REC 21	24.00	24.00	12.71	12.45	325	30	0.0008	0.00	0.69	1.59	0.000	0.000	2.48	4.63	7.50	61.78
N2,	24.00	24.00	12.45	12.05	500	30	0.0008	25	0.69	1.59	0.028	0.032	2.47	4.73	7.50	63.10
N2,	24.00	24.00	12.05	11.85	250	30	0.0008	10	0.72	1.62	0.011	0.000	2.47	4.74	7.50	63.24
HOL	22								0.73	1.62						
	ALDER	LANE	PUMP	STATION												
	SOUTH	EAST	INTERCEPTOR,	TO	FOWLER											
C2-C	178.15	177.43	169.95	167.23	330	10	0.0082	119	0.00	0.00	0.131	0.072	3.29	0.37	1.29	28.58
	177.35	176.95	167.15	164.55	330	10	0.0079	0.00	0.13	0.07	0.000	0.000	3.29	0.37	1.26	29.23
C2-B	176.60	175.32	164.00	162.68	328.9	18	0.004	65.9	0.13	0.07	0.072	0.029	3.20	0.53	4.30	12.26
	175.32	173.75	162.68	161.34	335.6	18	0.004	0.00	0.20	0.10	0.000	0.000	3.20	0.53	4.29	12.30
HOL	23								0.20	0.10						
	FOWLER	INTERCEPTOR														
	SE	INT.,	FOWLER	TO	BLACKBURN											
S5-D	170.00	170.00	164.60	163.66	314	15	0.003	640	0.00	0.00	0.704	0.198	3.02	1.30	2.28	57.06
	172.00	172.00	163.66	162.83	277	15	0.003	0.00	0.70	0.20	0.000	0.000	3.02	1.30	2.29	57.03
	172.00	172.00	162.83	162.68	52	15	0.0029	0.00	0.70	0.20	0.000	0.000	3.02	1.30	2.24	58.13
	174.00	172.00	162.68	161.92	253	15	0.003	0.00	0.70	0.20	0.000	0.000	3.02	1.30	2.29	56.96

City of Mount Vernon Comprehensive Sewer Plan Update

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
REC 23	173.75	172.50	161.34	159.86	371.1	18	0.004	0.00	0.91	0.30	0.000	0.000	2.91	1.78	4.29	41.54
	172.50	171.65	159.86	158.74	280	18	0.004	0.00	0.91	0.30	0.000	0.000	2.91	1.78	4.29	41.48
	171.65	166.29	158.74	157.37	342.5	18	0.004	0.00	0.91	0.30	0.000	0.000	2.91	1.78	4.29	41.48
	166.29	160.85	157.37	154.65	339.6	18	0.008	0.00	0.91	0.30	0.000	0.000	2.91	1.78	6.08	29.31
HOL	25								0.91	0.30						
	SMALL	PUMP	STATION	ON	BLACKBURN											
	SE	INT.,	BLACKBURN													
REC 25, S5-A,B,C	160.85	145.26	154.60	139.00	398.4	15	0.0392	602.00	0.91	0.30	0.662	0.539	2.65	3.79	8.26	45.86
	145.26	126.70	139.00	120.24	187.6	12	0.1	0.00	1.57	0.84	0.000	0.000	2.65	3.79	7.28	52.03
	126.70	90.00	120.24	82.68	282.4	12	0.133	0.00	1.57	0.84	0.000	0.000	2.65	3.79	8.40	45.11
	90.00	57.81	82.68	52.98	330	12	0.09	0.00	1.57	0.84	0.000	0.000	2.65	3.79	6.91	54.84
	57.81	54.50	52.98	50.70	22.8	12	0.1	0.00	1.57	0.84	0.000	0.000	2.65	3.79	7.28	52.03
	54.50	33.24	50.70	29.64	234	12	0.09	0.00	1.57	0.84	0.000	0.000	2.65	3.79	6.91	54.84
	33.24	31.00	27.66	25.38	22.8	12	0.1	0.00	1.57	0.84	0.000	0.000	2.65	3.79	7.28	52.03
	31.00	21.80	25.38	10.65	147.3	12	0.1	0.00	1.57	0.84	0.000	0.000	2.65	3.79	7.28	52.03
	21.80	17.45	9.15	8.85	299.2	30	0.001	0.00	1.57	0.84	0.000	0.000	2.65	3.79	8.39	45.13
	17.45	16.50	8.85	8.45	396.5	30	0.001	0.00	1.57	0.84	0.000	0.000	2.65	3.79	8.42	44.99
HOL	26								1.57	0.84						
	MT.	VERNON	RD	S.												
	SE	INT.,	BLACKBURN	AT	RR											
REC 26, S4-ABC,S3-ABC,S1-BD	16.50	22.76	8.45	8.27	178	30	0.001	1184.20	1.57	0.84	1.303	1.027	2.44	7.42	8.43	88.01
	22.76	23.00	8.27	8.15	121	30	0.001	0.00	2.87	1.87	0.000	0.000	2.44	7.42	8.35	88.87
	23.00	17.28	8.15	8.02	131	30	0.001	0.00	2.87	1.87	0.000	0.000	2.44	7.42	8.35	88.85
	17.28	16.13	8.02	7.83	188.9	30	0.001	0.00	2.87	1.87	0.000	0.000	2.44	7.42	8.41	88.25
	16.13	14.50	7.83	7.45	378.3	30	0.001	0.00	2.87	1.87	0.000	0.000	2.44	7.42	8.40	88.31
	14.50	13.77	7.45	7.17	275.2	30	0.001	0.00	2.87	1.87	0.000	0.000	2.44	7.42	8.46	87.75
	13.77	14.37	7.17	6.83	279.8	30	0.0012	0.00	2.87	1.87	0.000	0.000	2.44	7.42	9.24	80.29
	14.37	15.36	6.83	6.61	282.6	30	0.0008	0.00	2.87	1.87	0.000	0.000	2.44	7.42	7.40	100.31
	15.36	15.36	6.61	6.60	11	30	0.0009	0.00	2.87	1.87	0.000	0.000	2.44	7.42	7.99	92.83
HOL	27								2.87	1.87						
	BLACKBUR	ROAD														
S2	160.85	149.56	146.25	144.56	348	8	0.0049	104.2	0.00	0.00	0.115	0.061	3.33	0.32	0.54	58.64
	149.56	118.15	144.56	113.63	310	8	0.0998	0.00	0.11	0.06	0.000	0.000	3.33	0.32	2.47	12.94
	118.15	68.21	113.63	62.54	439	8	0.1164	0.00	0.11	0.06	0.000	0.000	3.33	0.32	2.66	11.98
	68.21	53.65	62.54	49.65	142	8	0.0908	0.00	0.11	0.06	0.000	0.000	3.33	0.32	2.35	13.56
	53.65	33.29	49.65	30.34	214	8	0.0902	0.00	0.11	0.06	0.000	0.000	3.33	0.32	2.35	13.60
	33.29	20.37	25.04	11.64	223	8	0.0601	0.00	0.11	0.06	0.000	0.000	3.33	0.32	1.91	16.67
	20.37	17.45	11.64	10.55	276	8	0.0039	0.00	0.11	0.06	0.000	0.000	3.33	0.32	0.49	65.02
S1-C	17.45	16.05	10.55	9.89	272	12	0.0024	26.4	0.11	0.06	0.029	0.015	3.27	0.39	1.13	34.65
	16.05	16.96	9.89	9.60	125	12	0.0023	0.00	0.14	0.08	0.000	0.000	3.27	0.39	1.11	35.44
	16.96	21.34	9.60	9.34	124	12	0.0021	0.00	0.14	0.08	0.000	0.000	3.27	0.39	1.05	37.28
	21.34	17.28	9.34	9.03	305	12	0.001	0.00	0.14	0.08	0.000	0.000	3.27	0.39	0.73	53.54
S1-A,	17.28	16.13	9.03	8.71	190	12	0.0017	48	0.14	0.08	0.053	0.046	3.15	0.58	0.95	61.54
	16.13	15.65	8.71	8.62	108	12	0.0008	0.00	0.20	0.12	0.000	0.000	3.15	0.58	0.66	87.48
	15.65	14.50	8.62	8.02	270	12	0.0022	0.00	0.20	0.12	0.000	0.000	3.15	0.58	1.09	53.57
	14.50	13.77	8.02	7.67	276	15	0.0013	0.00	0.20	0.12	0.000	0.000	3.15	0.58	1.49	39.11
	13.77	14.37	7.67	7.38	180	15	0.0016	0.00	0.20	0.12	0.000	0.000	3.15	0.58	1.68	34.70
	14.37	15.36	7.38	7.21	272	15	0.0006	0.00	0.20	0.12	0.000	0.000	3.15	0.58	1.04	55.71

City of Mount Vernon Comprehensive Sewer Plan Update

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	15.36	15.36	7.21	6.60	11	15	0.0555	0.00	0.20	0.12	0.000	0.000	3.15	0.58	9.83	5.91
SE INT, WALTER - - - - REC 27	15.36	15.30	6.60	6.11	496.9	30	0.001	0.00	3.07	1.99	0.000	0.000	2.42	7.88	8.32	94.67
	15.30	15.50	6.11	5.63	480	30	0.001	0.00	3.07	1.99	0.000	0.000	2.42	7.88	8.38	94.02
	15.50	17.95	5.63	5.13	500	30	0.001	0.00	3.07	1.99	0.000	0.000	2.42	7.88	8.38	94.02
	17.95	17.47	5.13	4.63	497.8	30	0.001	0.00	3.07	1.99	0.000	0.000	2.42	7.88	8.40	93.81
HOL	28	INTERSECT	OF	HAZEL	AND	VALTER			3.07	1.99						
	DOUGLAS															
S1-A,	17.50	17.20	6.60	6.32	220	16	0.0013	84.3	0.00	0.00	0.093	0.052	3.37	0.27	1.77	15.19
	17.20	17.00	6.32	6.12	220	16	0.0009	0.00	0.09	0.05	0.000	0.000	3.37	0.27	1.50	17.98
	17.00	17.50	6.12	6.02	210	16	0.0005	0.00	0.09	0.05	0.000	0.000	3.37	0.27	1.08	24.84
	17.50	17.50	6.02	5.64	320	16	0.0012	0.00	0.09	0.05	0.000	0.000	3.37	0.27	1.71	15.73
	17.50	18.00	5.64	5.56	320	16	0.0003	0.00	0.09	0.05	0.000	0.000	3.37	0.27	0.78	34.28
	18.00	18.50	5.56	5.30	320	16	0.0008	0.00	0.09	0.05	0.000	0.000	3.37	0.27	1.41	19.02
	18.50	19.50	5.30	5.28	260	16	8E-05	0.00	0.09	0.05	0.000	0.000	3.37	0.27	0.43	61.80
	19.50	17.76	5.06	4.26	80	16	0.01	0.00	0.09	0.05	0.000	0.000	3.37	0.27	4.96	5.42
HOL	29	INTERSECT	OF	HAZEL	AND	OUGLAS			0.09	0.05						
	C3-B															
	6TH	ST.	TRUNK,	SOUTH	OF	KINCAID										
C3-B, SOUTH	138.60	124.49	129.91	117.29	300	12	0.0421	29	0.00	0.00	0.032	0.018	3.65	0.10	4.72	2.04
C3-B, NORTH	122.00	85.00	116.67	80.00	300	12	0.1222	38.8	0.03	0.02	0.043	0.034	3.37	0.25	8.05	3.09
	85.00	37.00	80.00	32.00	380	12	0.1263	0.00	0.07	0.05	0.000	0.000	3.37	0.25	8.18	3.04
	37.00	35.00	32.00	30.00	450	21	0.0044	0.00	0.07	0.05	0.000	0.000	3.37	0.25	6.83	3.65
C3-A, EAST	35.00	35.00	30.00	19.00	20	21	0.55	25.5	0.07	0.05	0.028	0.018	3.30	0.33	75.95	0.44
C3-A, WEST	35.00	23.00	19.00	17.85	250	12	0.0046	14.9	0.10	0.07	0.016	0.006	3.27	0.37	1.56	23.39
	23.00	22.00	17.85	14.50	130	12	0.0258	0.00	0.12	0.08	0.000	0.000	3.27	0.37	3.70	9.88
	23.00	21.00	14.50	12.89	850	15	0.0019	0.00	0.12	0.08	0.000	0.000	3.27	0.37	1.82	20.11
	21.00	20.00	12.89	12.34	500	15	0.0011	0.00	0.12	0.08	0.000	0.000	3.27	0.37	1.38	26.39
	20.00	19.00	12.34	10.90	350	18	0.0041	0.00	0.12	0.08	0.000	0.000	3.27	0.37	4.35	8.39
HOL	30								0.12	0.08						
	AREA	N1-A														
N1-A	43.00	41.00	30.00	28.00	125	15	0.016	149.5	0.00	0.00	0.164	0.090	3.23	0.46	5.28	8.64
	41.00	39.00	28.00	26.00	290	15	0.0069	0.00	0.16	0.09	0.000	0.000	3.23	0.46	3.47	13.16
	39.00	37.00	26.00	24.00	350	22	0.0057	0.00	0.16	0.09	0.000	0.000	3.23	0.46	8.76	5.21
	37.00	36.00	24.00	22.00	330	15	0.0061	0.00	0.16	0.09	0.000	0.000	3.23	0.46	3.25	14.04
	32.50	32.00	21.00	19.50	150	15	0.01	0.00	0.16	0.09	0.000	0.000	3.23	0.46	4.18	10.93
HOL	31								0.16	0.09						
	AREA	N1-B														
N1-B	35.00	35.00	24.00	19.50	200	15	0.0225	109.7	0.00	0.00	0.121	0.067	3.30	0.34	6.26	5.46
REC 31	32.00	31.00	19.50	19.00	70	15	0.0071	0.00	0.29	0.16	0.000	0.000	3.08	0.77	3.53	21.83
HOL	32								0.29	0.16						
	DIVISION	ST.	CSO	INTERCEPTOR												
N1-C	25.00	25.00	20.00	19.00	300	20	0.0033	19.7	0.00	0.00	0.022	0.028	3.54	0.12	5.19	2.30
	25.00	25.00	19.00	18.00	220	20	0.0045	0.00	0.02	0.03	0.000	0.000	3.54	0.12	6.06	1.97
	25.00	25.00	16.40	15.40	200	30	0.005	0.00	0.02	0.03	0.000	0.000	3.54	0.12	18.75	0.64
HOL	33	TO CSO REGULATOR							0.02	0.03						

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	FROM	ALDER	LANE	PUMP	STATION											
	CAMERON	WAY	-	ALDER	LANE	DISCHARGE										
REC 22	27.70	25.42	23.10	22.80	200	27	0.0015	0.00	0.73	1.62	0.000	0.000	2.47	4.74	7.75	61.17
	25.42	28.00	22.80	22.53	180	27	0.0015	0.00	0.73	1.62	0.000	0.000	2.47	4.74	7.75	61.17
	28.00	31.00	22.53	22.02	470	27	0.0011	0.00	0.73	1.62	0.000	0.000	2.47	4.74	6.59	71.92
	31.00	31.00	22.02	21.29	90	27	0.0081	0.00	0.73	1.62	0.000	0.000	2.47	4.74	18.03	26.31
	31.00	33.00	21.29	20.86	180	27	0.0024	0.00	0.73	1.62	0.000	0.000	2.47	4.74	9.78	48.47
HOL	34	<-------	HOLD	FLOWS	FROM	ALDER	LANE		0.73	1.62						
	2ND	ST.														
C1-A,	22.00	22.00	15.50	15.00	280	18	0.0018	15	0.00	0.00	0.017	0.008	3.87	0.05	2.87	1.61
	22.00	22.00	15.00	14.50	280	18	0.0018	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.87	1.61
	22.00	22.00	14.50	14.00	210	18	0.0024	0.00	0.02	0.01	0.000	0.000	3.87	0.05	3.31	1.39
	22.00	22.00	14.00	13.60	250	18	0.0016	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.72	1.70
	22.00	22.00	13.60	13.30	180	18	0.0017	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.77	1.67
	22.00	22.00	13.30	13.00	350	18	0.0009	0.00	0.02	0.01	0.000	0.000	3.87	0.05	1.99	2.32
	22.00	22.00	13.00	12.50	330	18	0.0015	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.64	1.75
	22.00	22.00	12.50	12.00	330	18	0.0015	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.64	1.75
	22.00	22.00	11.50	11.00	330	18	0.0015	0.00	0.02	0.01	0.000	0.000	3.87	0.05	2.64	1.75
	22.00	22.00	11.00	10.00	260	18	0.0038	0.00	0.02	0.01	0.000	0.000	3.87	0.05	4.21	1.10
HOL	35	TO CSO REGULATOR							0.02	0.01						
	AREA	N3	-	FREEWAY	DRIVE											
	NORTH	1ST	STREET,	FREEWAY	TO	DIVISION										
	DOWNTOW	1ST	STREET,	DIVISION	TO	KINCAID										
	CLEVELAN	KINCAID	TO	PARK	ST.											
	CLEVELAN	PARK	TO	HAZEL												
N3	34.00	34.00	26.97	26.07	321	8	0.0028	151.2	0.00	0.00	0.166	0.213	3.00	0.81	0.41	195.01
	34.00	34.00	26.07	25.14	332	12	0.0028	0.00	0.17	0.21	0.000	0.000	3.00	0.81	1.22	66.17
	34.00	34.00	25.14	24.22	329	10	0.0028	0.00	0.17	0.21	0.000	0.000	3.00	0.81	0.75	107.70
	34.00	34.00	24.22	23.30	329	10	0.0028	0.00	0.17	0.21	0.000	0.000	3.00	0.81	0.75	107.70
	34.00	34.00	23.30	22.30	330	10	0.003	0.00	0.17	0.21	0.000	0.000	3.00	0.81	0.78	103.46
REC 34	33.00	30.80	20.86	20.48	250	27	0.0015	0.00	0.90	1.83	0.000	0.000	2.44	5.38	7.80	68.90
	30.80	33.20	20.48	20.03	300	27	0.0015	0.00	0.90	1.83	0.000	0.000	2.44	5.38	7.75	69.36
	32.20	32.00	20.03	19.32	280	27	0.0025	0.00	0.90	1.83	0.000	0.000	2.44	5.38	10.08	53.34
	32.00	31.00	19.32	19.07	420	27	0.0006	0.00	0.90	1.83	0.000	0.000	2.44	5.38	4.88	110.10
	31.00	28.00	19.07	18.51	380	27	0.0015	0.00	0.90	1.83	0.000	0.000	2.44	5.38	7.68	69.97
	28.00	28.50	18.51	18.03	300	27	0.0016	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.01	67.16
	28.50	28.50	18.03	17.93	50	27	0.002	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.95	60.07
	28.00	28.00	17.62	17.00	170	24	0.0036	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.83	60.89
	25.50	24.50	17.68	17.13	186	24	0.003	0.00	0.90	1.83	0.000	0.000	2.44	5.38	7.95	67.63
	24.50	24.00	17.13	16.37	238	24	0.0032	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.26	65.08
	24.00	24.00	16.37	15.52	265	24	0.0032	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.28	64.93
	24.00	24.20	15.52	14.73	245.9	24	0.0032	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.29	64.88
	24.20	23.50	14.73	13.93	244	24	0.0033	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.37	64.22
	23.50	22.20	13.93	13.13	248	24	0.0032	0.00	0.90	1.83	0.000	0.000	2.44	5.38	8.30	64.75
C1-A	22.20	21.10	12.63	12.00	330	30	0.0019	71	0.90	1.83	0.078	0.118	2.43	5.71	11.58	49.31
	21.10	20.60	12.00	11.36	331	30	0.0019	0.00	0.98	1.95	0.000	0.000	2.43	5.71	11.66	48.99
	20.60	20.00	11.36	10.68	247	30	0.0028	0.00	0.98	1.95	0.000	0.000	2.43	5.71	13.91	41.06
	20.00	18.10	10.68	10.04	325	30	0.002	0.00	0.98	1.95	0.000	0.000	2.43	5.71	11.76	48.55
	18.10	17.50	10.04	9.12	297	27	0.0031	0.00	0.98	1.95	0.000	0.000	2.43	5.71	11.14	51.26

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
	20.00	20.00	11.60	11.50	20	27	0.005	0.00	0.98	1.95	0.000	0.000	2.43	5.71	14.15	40.35
	19.50	19.50	9.12	8.05	340	24	0.0031	0.00	0.98	1.95	0.000	0.000	2.43	5.71	8.20	69.63
HOL	36								0.98	1.95						
	KINCAID STREET, I5 TO BNRR															
REC 30	27.80	23.40	22.60	15.99	104	30	0.0636	0.00	0.12	0.08	0.000	0.000	3.27	0.37	66.83	0.55
	23.40	22.50	15.99	13.63	530	30	0.0045	0.00	0.12	0.08	0.000	0.000	3.27	0.37	17.69	2.07
	22.50	22.00	13.63	13.20	40	30	0.0108	0.00	0.12	0.08	0.000	0.000	3.27	0.37	27.49	1.33
HOL	37															
	CSO REGULATOR - CAMERON WAY TO HAZEL															
REC 16, 33, 35	30.19	31.29	20.41	19.92	322.85	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.58	21.89
	31.29	31.66	19.92	19.41	333.28	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.85	21.80
	31.66	32.00	19.41	18.96	297.58	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.46	21.93
	32.00	31.21	18.96	18.69	177.42	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.67	21.86
	31.21	31.00	18.69	18.67	12	60	0.0017	0.00	5.21	4.10	0.000	0.000	2.23	14.35	68.72	20.89
	31.00	31.00	18.67	18.12	367.21	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.15	22.03
	31.00	31.00	18.12	18.07	36.08	60	0.0014	0.00	5.21	4.10	0.000	0.000	2.23	14.35	62.66	22.90
	31.00	28.90	18.07	17.98	55.33	60	0.0016	0.00	5.21	4.10	0.000	0.000	2.23	14.35	67.89	21.14
	28.90	31.00	17.98	17.36	416.02	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	64.98	22.09
	31.00	26.00	17.36	17.18	29.49	60	0.0061	0.00	5.21	4.10	0.000	0.000	2.23	14.35	131.51	10.91
	26.00	26.00	17.18	17.10	8	60	0.01	0.00	5.21	4.10	0.000	0.000	2.23	14.35	168.33	8.53
	26.00	26.00	17.10	16.54	187.47	60	0.003	0.00	5.21	4.10	0.000	0.000	2.23	14.35	92.00	15.60
	26.00	26.00	16.54	16.35	62.8	60	0.003	0.00	5.21	4.10	0.000	0.000	2.23	14.35	92.59	15.50
	26.00	26.00	16.35	16.31	8	60	0.005	0.00	5.21	4.10	0.000	0.000	2.23	14.35	119.03	12.06
	26.00	26.00	16.31	15.77	121.18	60	0.0045	0.00	5.21	4.10	0.000	0.000	2.23	14.35	112.37	12.77
	26.00	26.00	15.77	15.32	100	60	0.0045	0.00	5.21	4.10	0.000	0.000	2.23	14.35	112.92	12.71
	26.00	26.00	15.32	15.01	87.69	60	0.0035	0.00	5.21	4.10	0.000	0.000	2.23	14.35	100.08	14.34
	26.00	26.00	15.01	14.82	54.24	60	0.0035	0.00	5.21	4.10	0.000	0.000	2.23	14.35	99.63	14.41
	26.00	24.50	14.82	14.08	458.07	60	0.0016	0.00	5.21	4.10	0.000	0.000	2.23	14.35	67.66	21.21
REC 37	24.50	24.00	14.08	12.10	475	60	0.0042	0.00	5.21	4.10	0.000	0.000	2.23	14.35	108.68	13.21
	24.00	24.00	12.10	11.06	388.06	60	0.0027	0.00	5.21	4.10	0.000	0.000	2.23	14.35	87.14	16.47
	24.00	24.00	11.06	9.95	303.31	60	0.0037	0.00	5.21	4.10	0.000	0.000	2.23	14.35	101.83	14.09
	24.00	24.00	9.95	8.80	533.69	60	0.0022	0.00	5.21	4.10	0.000	0.000	2.23	14.35	78.14	18.37
	24.00	24.00	8.80	7.91	421.82	60	0.0021	0.00	5.21	4.10	0.000	0.000	2.23	14.35	77.32	18.56
	24.00	24.00	7.91	7.67	53.29	60	0.0045	0.00	5.21	4.10	0.000	0.000	2.23	14.35	112.96	12.71
	24.00	24.00	7.67	7.62	8	60	0.0062	0.00	5.21	4.10	0.000	0.000	2.23	14.35	133.08	10.79
	24.00	24.00	7.62	7.08	207.36	60	0.0026	0.00	5.21	4.10	0.000	0.000	2.23	14.35	85.90	16.71
	24.00	18.90	7.08	6.56	347.53	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.11	22.04
	18.90	18.00	6.56	6.51	37	60	0.0014	0.00	5.21	4.10	0.000	0.000	2.23	14.35	61.88	23.19
	18.00	17.60	6.51	6.08	286	60	0.0015	0.00	5.21	4.10	0.000	0.000	2.23	14.35	65.27	21.99
REC 36	17.60	17.70	6.08	5.67	233	60	0.0018	0.00	6.18	6.05	0.000	0.000	2.13	19.07	70.61	27.01
C1-C,	17.70	17.70	5.67	5.21	312.86	60	0.0015	22	6.18	6.05	0.024	0.051	2.13	19.19	64.54	29.73
	17.70	17.40	5.21	5.14	33.3	42	0.0021	0.00	6.21	6.10	0.000	0.000	2.13	19.19	29.81	64.37
	17.40	17.70	5.14	4.70	294.76	42	0.0015	0.00	6.21	6.10	0.000	0.000	2.13	19.19	25.12	76.39
	17.70	17.20	4.70	4.30	270	42	0.0015	0.00	6.21	6.10	0.000	0.000	2.13	19.19	25.03	76.68
HOL	38								6.21	6.10						
	I-5	XING	AT	WELLS	NURSEI	PARK										
	HAZEL,	CLEVELAND	TO	WWTP												
C2-A	18.00	18.00	14.00	13.00	310	18	0.0032	70.4	0.00	0.00	0.077	0.027	3.54	0.17	3.86	4.48

City of Mount Vernon Comprehensive Sewer Plan Update

Drainage Segment	1 Upstream MH GRD	2 Down-stream MH GRD	3 Up-stream MH IE	4 Down-stream MH IE	5 Length	6 Dia-meter	7 Slope	13 Service Area (ac)	14 Upstream Infilt (mgd)	15 Upstream Avg San (mgd)	16 Infilt (mgd)	17 Avg San Flow (mgd)	18 Peak Factor	19 Peak Flow (mgd)	20 Avail Cap (mgd)	21 Percent Utilized
C1-D	18.00	18.90	13.00	12.20	280	18	0.0029	30.1	0.08	0.03	0.033	0.015	3.43	0.25	3.63	6.98
C1-B	18.90	19.00	12.20	12.10	470	21	0.0002	28.9	0.11	0.04	0.032	0.053	3.21	0.45	1.49	29.93
	19.00	19.50	12.10	12.00	400	21	0.0002	0.00	0.14	0.09	0.000	0.000	3.21	0.45	1.62	27.61
	19.50	19.50	12.00	11.90	150	21	0.0007	0.00	0.14	0.09	0.000	0.000	3.21	0.45	2.64	16.91
	19.50	19.00	11.90	11.80	140	21	0.0007	0.00	0.14	0.09	0.000	0.000	3.21	0.45	2.74	16.33
	19.00	19.00	11.80	11.70	140	21	0.0007	0.00	0.14	0.09	0.000	0.000	3.21	0.45	2.74	16.33
	19.00	18.00	11.70	11.60	140	21	0.0007	0.00	0.14	0.09	0.000	0.000	3.21	0.45	2.74	16.33
	17.53	17.40	8.83	7.20	357.98	30	0.0046	0.00	0.14	0.09	0.000	0.000	3.21	0.45	17.89	2.50
	17.40	17.40	7.20	5.97	269.62	30	0.0046	0.00	0.14	0.09	0.000	0.000	3.21	0.45	17.91	2.50
REC 28, 38	17.47	17.78	4.32	4.19	132.8	42	0.001	0.00	9.42	8.18	0.000	0.000	2.05	26.21	20.35	128.83
	17.78	17.80	4.19	4.06	101.7	42	0.0013	0.00	9.42	8.18	0.000	0.000	2.05	26.21	23.25	112.74
	17.80	17.80	4.06	4.03	34.8	42	0.0009	0.00	9.42	8.18	0.000	0.000	2.05	26.21	19.09	137.29
REC 29	17.80	19.50	4.03	3.66	300	42	0.0012	0.00	9.51	8.23	0.000	0.000	2.05	26.40	22.84	115.59
	19.50	19.50	3.46	3.40	40	42	0.0015	0.00	9.51	8.23	0.000	0.000	2.05	26.40	25.18	104.82
	20.00	20.00	3.30	2.97	224	42	0.0015	0.00	9.51	8.23	0.000	0.000	2.05	26.40	24.96	105.76
	20.00	20.00	2.87	2.60	178	42	0.0015	0.00	9.51	8.23	0.000	0.000	2.05	26.40	25.33	104.23
	20.00	20.00	2.50	2.00	39	42	0.0128	0.00	9.51	8.23	0.000	0.000	2.05	26.40	73.63	35.85
END									9.51	8.23						
WEST MOUNT VERNON PUMP STATION																
WEST MV-W1-A, W2	18	18	14	13	310	18	0.0032	528.00	0.00	0.00	0.581	0.429	2.82	1.79	3.86	46.47
END																

APPENDIX E
DRAPER VALLEY FARMS, INC.
DRAFT INDUSTRIAL PRETREATMENT REPORT COMMENTS

JAN 02 2000

DALE K. ROUNDY

ATTORNEYS AT LAW

506 NORTH MAIN
P.O. BOX 1500
COUPEVILLE, WASHINGTON 98239
Telephone: 360•678•6200
Facsimile: 360•678•2298

E-mail: roundy @whidbey.net

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Employment Relations
Commercial Transactions
Construction
Estate Planning
Probate
Municipal
Civil Litigation
Condemnation

Dale K. Roundy

Michael L. Charneski
Of Counsel

Nanette E. Streubel
Paralegal

December 20, 2000

RECEIVED
CITY OF MT. VERNON

DEC 28 2000

WASTE WATER TREATMENT

Walt Enquist
City of Mount Vernon
Waste Water Utility
Post Office Box 809
Mount Vernon, Washington 98273

Re: **Draper Valley Farms, Inc.**
Draft Industrial Pretreatment Report

Dear Walt:

Draper Valley Farms has received and reviewed the draft Industrial Pretreatment Report prepared by HDR Engineering dated October, 2000 and has asked that I forward to you the enclosed copy of the draft containing Draper Valley Farms' comments.

On an overall basis, the Company feels that the draft report provides a fair and thorough review of the Company's pretreatment system. In addition to the Company's comments are shown on the draft, the Company has asked me to point out that the "potential improvement" listed at Section VIII(A)(2) has been evaluated and it has been determined that automating the flow would be extremely expensive and not necessarily more effective than manual shut off of the water flow. The Company has also considered the recommendation found at VIII(B)(1) concerning the submersible pumps and has determined that regular monitoring of the systems by Company personnel will allow for proper maintenance and control of the lift station and the proper feeding of chemicals. Neither of these comments require a modification to the draft report, but the Company did want you to be aware of the action they have taken in these two specific areas.

Draper Valley Farms looks forward to receiving the final report. Thank you for your efforts in arranging to have HDR Engineering provide its

Re: **Draper Valley Farms, Inc.**
Draft Industrial Pretreatment Report

assessment and recommendations concerning the sewer treatment system and the Company's pretreatment facilities. Best wishes for the holidays!

Sincerely,

Dale K. Roundy

DKR:nes
Enclosure
cc: John Jefferson, Draper Valley Farms, Inc.

APPENDIX F
MEETING MINUTES FROM JANUARY 9, 2001, MEETING BETWEEN CITY OF MOUNT VERNON STAFF, DEPARTMENT OF ECOLOGY REPRESENTATIVES, AND HDR ENGINEERING

City of Mount Vernon
Department of Ecology Meeting
Draft

Date:	**January 9, 2001**
Time:	**10:00 am to 1:00 pm**
Location:	**Engineering Conference Room**
Purpose of Meeting:	**Discussion of Wastewater Permitting & Planning Issues**

Attendance:

Jerry Shervey & Bernard Jones, Department of Ecology
Brad Einfeld & Jason Sharpley, HDR Engineering
Bill Fox, Cosmopolitan Engineering
Walt Enquist, City of Mount Vernon, Wastewater
Bill Fullner, City of Mount Vernon, Wastewater
John Buckley, City of Mount Vernon Public Works
Michele Garcia, City of Mount Vernon, Admin. Assistant

Discussion Items:

1. **Revised Mixing Zone Model Results:** Bill Fox distributed a report on his modeling results. His results differed from Jerry Shervey's because of a CFS to MGD conversion over site by Jerry Shervey and discrepancies in effluent metals data. Jerry said he would check his figures and rerun the model. Bill Fullner said he would confirm the metals data and find out where differing numbers originated. Jerry said that there would definitely be limits for several metals, including copper, which would be difficult to meet. He suggested that Mount Vernon research ultra clean sampling and testing methods.

   Mount Vernon will need to request a compliance schedule to meet the NPDES limits proposed. This can be done during the NPDES draft review process. Jerry may include a compliance schedule with the draft permit.

2. **Draft Sewer Comprehensive Plan – Flow Projections:** Brad Einfeld reviewed the allowance for present I&I for the combined system. Brad distributed a Flow Analysis showing the flow components and calculations used to determine the I&I component. Much discussion was held regarding summer and winter flows and infiltration and inflow allowances. Brad explained that the City has a combined sewer/storm system and this creates a high I & I component. Jerry Shervey was concerned that the 5.39 mgd from January 1997 was not an accurate representation of the current Average Day Maximum Month (ADMM) flow. Jerry was concerned that the flow was skewed during the initial operation of the CSO regulator. Walt pointed out that in 1999 the rainfall was near average and the CSO regulator was being operated in accordance with design assumptions with a ADMM flow of 5.11 mgd. In 2000 the rainfall was 30% below average with an ADMMW flow of 4.52 mgd. It was agreed that 5.39 is a reasonable number for current ADMM flow conditions.

Jerry agreed with the flow projections Brad presented in the Flow Analysis.

3. **Wastewater Treatment Plant Flow Re-Rating:** SEPA is just about finished. Walt Enquist stated that he would add river improvement information.

4. **NPDES Requirements for 85% BOD & TSS Reduction During Times of Dilute Influent:** Exemption in affect only from November through June.

5. **The CSO Baseline Flow referenced in the Consent Order is based on the Comprehensive Sewer Plan (Will this be Mount Vernon's baseline through January 1, 2015?):** Mount Vernon's baseline will not change from what was has been established in the 1995 Comprehensive Sewer and Combined Sewer Overflow reduction plan, figure V-16. This will be included in the NPDES Fact Sheet.

6. **Will the NPDES permit include an exchange ratio for Ammonia/CBOD:** This can't be included in the permit, but can be revised during the NPDES renewal process.

7. **BOD or CBOD – Will Mount Vernon have the option of selecting one or the other:** Yes. If the City chooses to use CBOD then they will have to submit a formal request to do so. Jerry will need to know which option the City chooses for the next permit cycle.

8. **Does DOE have discretion in setting the effluent pH limit? Is pH 6.0 mandatory? pH adjustment will be necessary during periods of nitrification:** The DOE does not have discretion in changing the effluent pH limit. pH limit of 6.0 may get higher.

9. **Will TMDL limits apply during occasions when storm events occur and the river flow remains below 6000 cfs i.e. September or October storm when overflows could occur and river is below 6000 cfs):** Data will have to be reviewed to determine total daily load for historical information (plant + CSO's) under these conditions. Daily limits will apply when river flows are below 6000 cfs. Monthly limits will apply during TMDL periods (July through October), regardless of flow.

10. **Funding outlook for CSO improvements, and anti-degradation improvements:** Bernard stated that grant funding is unlikely, however, loan options are a possibility. Review time for facility plans could be from 30 – 60 days.

Facility plan is about 95% complete and should be ready in 1 – 3 weeks.

John Buckley inquired as to the status of where the outfall design proposal is currently. Brad Einfeld stated that it will be submitted to the City the week of January 16. The preliminary design will address, issues i.e., as to whether to use one pipe or two, etc.

DNR Easement is supposed to expire on July 31, 2001. Bill Fox will provide support for DNR easement permit during the application process.

If there are any inaccuracies or misunderstandings, please contact Walt Enquist at (360) 336-6219.

Appendix G
National Pollutant Discharge Elimination System Permit for the City of Mount Vernon

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

September 4, 2001

CERTIFIED MAIL
7001 0320 0000 4654 0972

The Honorable Skye Richendrfer
Mayor, City of Mt. Vernon
PO Box 809
Mt. Vernon, WA 98273

Dear Mayor Richendrfer:

RE: NPDES Permit Issuance
City of Mount Vernon Wastewater Treatment Plant; Permit No. WA-002407-4
Expiration Date: June 30, 2003

Under the provisions of Chapter 90.48 RCW Water Pollution Control Laws as amended and the Federal Water Pollution Control Act (The Clean Water Act) Title 33 United States Code, Section 1251 et seq., the enclosed NPDES Permit No. WA-002407-4 is hereby issued to the City of Mount Vernon Wastewater Treatment Plant located at 1401 Britt Road, Mount Vernon, Washington (Skagit County).

The permit authorizes the Permittee to discharge secondary treated and disinfected effluent into the Skagit River subject to the terms and conditions of the permit.

Pursuant to RCW 90.48.465, a permit fee will be assessed. Semi-annual notices for payment will be mailed to you from our office in Olympia.

Any person feeling aggrieved by this NPDES permit may obtain review thereof by application, within 30 days of receipt of this permit, to the Washington Pollution Control Hearings Board, Post Office Box 40903, Olympia, WA 98504-0903. Concurrently, a copy of the application must be sent to the Department of Ecology, Post Office Box 47600, Olympia, WA 98504-7600. These procedures are consistent with the provisions of Chapter 43.21B RCW and the rules and regulations adopted thereunder.

Any appeal must contain the following in accordance with the rules of the hearings board:

a) The appellant's name and address;
b) The date and number of the permit appealed;
c) A description of the substance of the permit, that is the subject of the appeal;
d) A clear, separate, and concise statement of every error alleged to have been committed;
e) A clear and concise statement of facts which the requester relies to sustain his or her statements of error;
f) A statement setting forth the relief sought; and
g) A copy of the order, decision, or application appealed from.

An application for permit renewal must be made at least 180 days prior to the expiration date of this permit. Copies of the Discharge Monitoring Report (DMR) forms have been forwarded to Walt Enquist, Wastewater Superintendent along with a copy of the permit. If at any time during the term of this permit a question should arise regarding the permit or discharge, or if there is a significant change in the discharge or operation, please contact Bernard Jones at (425) 649-7146.

Sincerely,

Kevin C. Fitzpatrick
Water Quality Section Manager
Northwest Regional Office

KCF:tm
Enclosures

cc: Mr. Walt Enquist, Wastewater Utility Supervisor
Bev Poston, Permit Fee Unit
Laura Fricke, Municipal Unit Supervisor
Bernard Jones, Facility Manager
Chris Smith, WPLCS
Central Files: WQ 1.1, WA-002407-4

Issuance Date: September 4, 2001
Effective Date: October 1, 2001
Expiration Date: June 30, 2003

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
WASTE DISCHARGE PERMIT No. WA-002407-4

State of Washington
DEPARTMENT OF ECOLOGY
Northwest Regional Office
3190 – 160th Avenue SE
Bellevue, WA 98008-5452

In compliance with the provisions of
The State of Washington Water Pollution Control Law
Chapter 90.48 Revised Code of Washington
and
The Federal Water Pollution Control Act
(The Clean Water Act)
Title 33 United States Code, Section 1251 et seq.

City of Mount Vernon
P. O. Box 809
Mount Vernon, Washington 98273

Plant Location: 1401 Britt Road Mount Vernon, WA	Receiving Water: Skagit River
Water Body I.D. No.: WA-03-1010	Discharge Location – Outfall #1: Latitude: 48° 24' 48" N Longitude: 122° 20' 06" W
Plant Type: Publicly owned municipal wastewater treatment plant -- conventional mixed activated sludge	

is authorized to discharge in accordance with the special and general conditions that follow.

Kevin C Fitzpatrick

Kevin C. Fitzpatrick
Water Quality Section Manager
Northwest Regional Office
Washington State Department of Ecology

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GENERAL CONDITIONS

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions of this permit for additional submittal requirements.

Permit Section	Submittal	Frequency	First Submittal Date
S2.A	Discharge Monitoring Report	Monthly	November 15, 2001
S2.A	Discharge Summary Report	Monthly	November 15, 2001
S2.B	Priority Pollutant Metals	Quarterly, begin with 4th quarter of 2001	February 15, 2002
S2.F	Metals Sampling and Analysis Report	One time only	By January 1, 2002 (sample by 12-30-01)
S3.G	Compliance Progress Report	Annually	April 1, 2002
S6.F	Industrial User Survey – submit with application for permit renewal	1/permit cycle	December 30, 2002
S8.A, S8.F	Acute Toxicity Characterization Reports	Quarterly for one year, begin with 4th quarter of 2001	December 30, 2001 (sample by 10-30-01)
S8.C, S8.F	Acute Toxicity Compliance Monitoring Reports	Quarterly, if required	Depends on test results
S9.A, S9.F	Chronic Toxicity Characterization Data	Twice per year, begin with 2nd half of 2001	December 30, 2001 (sample by 10-30-01)
S9.C, S9.F	Chronic Toxicity Compliance Monitoring Reports	Twice per year, if required	Depends on test results
S10.B	CSO Sampling Plan update	1/permit cycle	November 1, 2001
S10.B	Annual CSO Report	Annually	April 1, 2002
S10.C	CSO Plan amendment	1/permit cycle	December 30, 2002
G7.	Application for Permit Renewal	1/permit cycle	December 30, 2002

Other submittals may be required as a consequence of treatment system failure or bypass, construction or maintenance activities, additional loading to the plant, or other conditions contained in this permit.

SPECIAL CONDITIONS

S1. DISCHARGE LIMITATIONS

A. Effluent Limitations

All discharges and activities authorized by this permit shall be consistent with the terms and conditions of this permit. The discharge of any of the following pollutants at a concentration or mass in excess of that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

Beginning on the effective date of this permit and lasting through the expiration date, the Permittee is authorized to discharge municipal wastewater from Outfall #1 subject to the limitations listed in Tables S1.1 and S1.2 of this condition:

The limits for pH and copper are subject to a compliance schedule – the Permittee shall report annually to the Department on progress towards meeting the final effluent limits (see S3.G). Interim limits as shown below shall be in effect during the term of this permit. The Permittee shall report to the Department by June 30, 2003, how the final limits for pH and copper will be met. The report may be incorporated in a facility plan, engineering report, or submitted as a separate document. See S8 and S9 for standards and requirements for whole effluent toxicity testing.

Table S1.1: Basic Effluent Limitations[a] at OUTFALL #1

Parameter	Average Monthly	Average Weekly
5-day Biochemical Oxygen Demand[b] (BOD_5)	30 mg/L, 1401 lbs./day	45 mg/L, 2102 lbs./day
Total Suspended Solids[b] (TSS)	30 mg/L, 1401 lbs./day	45 mg/L, 2102 lbs./day
Fecal Coliform Bacteria	200 cfu /100 mL	400 cfu /100 mL
pH (interim)	shall not be outside the range 6.0 to 9.0	
pH[c]	*shall not be outside the range 6.6 to 9.0*	
Parameter	**Average Monthly**	**Maximum Daily**
NH_3-N (as N)	31 mg/L, 1448 lbs./day	41 mg/L
Copper (interim limit)	21.3 ug/L, 1 lbs./day	35 ug/L
copper[c]	*9.4 ug/L, 0.44 lbs./day*	*16.6 ug/L*
Zinc	88.4 ug/L, 4.13 lbs./day	177.4 ug/L
Total Residual Chlorine	0.05 mg/L, 2.21 lbs./day	0.1 mg/L

[a]The average monthly and weekly effluent limitations are based on the arithmetic mean of the samples taken with the exception of fecal coliform, which is based on the geometric mean.

[b]The average monthly effluent concentration for BOD_5 and TSS shall not exceed 30 mg/L or 20 percent of the respective monthly average influent concentrations, whichever is more stringent.

[c]Final limit. The interim limit shall be in effect during the term of this permit.

The average monthly limitations in Table S1.2 shall be in effect for the months of July, August, September, and October. The maximum daily limitations in Table S1.2 shall be in effect from July 1 to November 15 on any day that the average flow for the day of the Skagit River is below 6000 cubic feet per second. Skagit River flow is the flow measured at US Geological Survey (USGS) gauging station number 12200500 named "Skagit River near Mount Vernon" and listed by USGS as located at Latitude 48° 26' 42" and Longitude 122° 20' 03". The maximum daily limitations shall be in effect if the flow data is unavailable for this station.

Table S1.2: Low River Flow Effluent Limitations[a] at OUTFALL #1 from July 1 to November 15.

Parameter	Average Monthly[a]	Maximum Daily[b]
Ammonia as Nitrogen (N)	922 lbs./day	1188 lbs./day

[a]The average monthly limitations are based on the arithmetic mean of the samples taken. The average monthly ammonia limit listed here is in effect for the months of July, August, September, and October.

[b]The maximum daily limit applies on any day that the average flow for the day of the Skagit River is below 6000 cubic feet per second.

B. Mixing Zone Descriptions

The boundaries of the mixing zone are limited to 307 feet downstream of the outfall diffuser. The estimated dilution factor is 35 to 1.

The zone of acute criteria exceedance is limited to 31 feet downstream of the outfall diffuser. The estimated dilution factor is 5 to 1.

S2. MONITORING REQUIREMENTS

The Permittee shall monitor the wastewater according to the schedule in Table S2A.1 throughout the year and increase the monitoring frequency as shown in Table S2A.2 from July 1 through November 15. Sampling frequencies listed as quarterly, twice per year, and once per year shall be based on the calendar year (January through March, April through June, etc.)

A. Compliance Monitoring

Table S2A.1: Base Monitoring Requirements – applicable throughout the year

Tests	Sample Point	Minimum Sampling Frequency	Sample Type
Flow (MGD)	influent effluent	continuous continuous	on-line on-line
BOD_5	influent effluent	3/week 3/week	24-hour composite 24-hour composite
TSS	influent final effluent	3/week 3/week	24-hour composite 24-hour composite
Fecal Coliform Bacteria	final effluent	5/week	Grab
pH	final effluent	daily	Grab
Ammonia	final effluent	1/week	24-hour composite
Total Residual Chlorine	final effluent	5/week	Grab
Copper	final effluent	2/month, at least one (1) week apart	24-hour composite
Zinc	final effluent	2/month, at least one (1) week apart	24-hour composite
Acute whole effluent toxicity[1]	final effluent	1/3 months	24-hour composite
Chronic whole effluent toxicity[2]	final effluent	1/6 months	24-hour composite

[1]See permit section S8 for requirements for acute whole effluent toxicity testing.

[2]See permit section S9 for requirements for chronic whole effluent toxicity testing.

Table S2A.2: Additional Low River Flow Monitoring Requirements for summer season (applicable from July 1 through November 15)			
Tests	**Sample Point**	**Minimum Sampling Frequency**	**Sample Type**
Ammonia as N	effluent	3/week	24-hour composite
Report concentration and mass discharge for ammonia. Effluent ammonia and BOD_5 samples shall be taken during the same 24-hour period and from the same location. Note the requirement for checking and reporting daily receiving water flows in S3.B			

B. Characterization Monitoring

The Permittee shall perform the following effluent characterizations. These samples shall be taken together at one time; one of the quarterly metals samples shall be collected at the same time as the other samples required here. The grab sample for volatile organics shall be collected during the time the 24-hour composites are collected. The copper and zinc data to satisfy this requirement may be used to meet the sampling requirements in S2A1.

Tests	Sample Location	Sampling Frequency	Sample Type
Priority Pollutant Metals [1]	final effluent	1 per quarter	24-hour composite
Mercury[2]	final effluent	1 per quarter	24-hour composite
Organics: Acid extractable Base-Neutral Pesticides Polychlorinated-Biphenyles	final effluent	1 per year	24-hour composite
Volatile Organics	final effluent	1 per year	grab

[1]Priority pollutant metals shall include: Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Thallium, and Zinc. Analysis shall be by Standard Method number 200.7 - Inductively Coupled Plasma (ICP) or other method that provides lower detection levels than ICP.

[2] Mercury analysis shall be by Standard Method number 245.1 or 245.2 using cold vapor extraction. The method detection level (MDL) for mercury is 0.2 ug/L using cold vapor extraction absorption spectrometry and method number 245.1 or 245.2 from 40 CFR 136. The quantitation level (QL) for mercury is 1 ug/L (5 x MDL).

C. Sampling and Analytical Procedures

Samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions affecting effluent quality.

Sampling and analytical methods used to meet the water and wastewater monitoring requirements specified in this permit shall conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 or to the latest revision of *Standard Methods for the Examination of Water and Wastewater* (APHA), unless otherwise specified in this permit or approved in writing by the Department of Ecology (Department).

D. Flow Measurement

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the quantity of flows monitored as required in S1. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements are consistent with the accepted industry standard for that type of device. Frequency of calibration shall be in conformance with manufacturer's recommendations and at a minimum frequency of at least one calibration per year. Calibration records shall be maintained for at least three (3) years.

E. Laboratory Accreditation

All monitoring data required by the Department shall be prepared by a laboratory registered or accredited under the provisions of, *Accreditation of Environmental Laboratories*, Chapter 173-50 WAC. Flow, temperature, settleable solids, conductivity, and internal process control parameters are exempt from this requirement. Crops, soils, and hazardous waste data are exempted from this requirement pending accreditation of laboratories for analysis of these media by the Department.

F. Metals Sampling and Analysis Report

By January 1, 2002, the Permittee shall submit a report to the Department on quality assurance and quality control measures for sampling and analyzing the concentrations of metals in the effluent. The report shall provide details on sampling equipment, sampling procedures, and laboratory analysis methods to minimize contamination of samples collected to meet the monitoring requirements for copper, zinc, and other priority pollutant metals. These measures shall be instituted for all sampling and analysis related to reporting the concentrations of metals in the effluent required by this permit.

S3. REPORTING AND RECORDKEEPING REQUIREMENTS

The Permittee shall submit reports, keep records, and provide notification in accordance with the following conditions. The falsification of information submitted to the Department shall constitute a violation of the terms and conditions of this permit.

A. Reporting

The first monitoring period begins on the effective date of the permit. Monitoring results shall be submitted monthly. Monitoring data obtained during the previous month shall be summarized and reported on forms provided by or approved by the Department (the Department's monthly report form and EPA form No. 3320-1). Submit reports so that they arrive at the Department's office no later than the 15th day of the month following the completed monitoring period, unless otherwise specified in this permit. The reports shall be sent to the Department of Ecology, 3190 – 160th Avenue SE, Bellevue, Washington 98008-5452.

Priority pollutant, copper, and zinc analysis data shall be submitted no later than forty-five (45) days following the monitoring period.

All lab reports providing data for organic and metal parameters shall include the following information: sampling date, sample location, date of analysis, parameter name, CAS number, analytical method/number, method detection limit (MDL), lab practical quantitation limit (PQL), reporting units and concentration detected.

B. Reporting Receiving Water Flows

From August 1 to November 15 the Permittee shall record and report the average daily flow of the Skagit River as measured and reported for US Geological Survey (USGS) gauging station number 12200500 named "Skagit River near Mount Vernon" and listed by USGS as located at Latitude 48° 26' 42" and Longitude 122° 20' 03". The flow shall be reported on the DMR forms provided by the Department. This information is available on the World Wide Web at http://wwwdwatcm.wr.usgs.gov/rt-cgi/gen_stn_pg?station=12200500.

In the event that USGS fails to record or report this flow, the Permittee is not required to report the flow so long as the Permittee notifies the Department within five (5) days that the flow data is not available.

The Permittee may propose alternative methodologies for obtaining the flows for obtaining and reporting Skagit River flows during the low flow months. These proposals shall be submitted in writing for approval by the Department.

C. Records Retention

The Permittee shall retain records of all monitoring information for a minimum of three (3) years. Such information shall include all calibration and maintenance records and all original recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by the Director.

D. Recording of Results

For each measurement or sample taken, the Permittee shall record the following information: (1) the date, exact place, method, and time of sampling; (2) the individual who performed the sampling or measurement; (3) the dates the analyses were performed; (4) who performed the analyses; (5) the analytical techniques or methods used; and (6) the results of all analyses.

E. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit using test procedures specified in this permit, then the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Permittee's self-monitoring reports.

F. Noncompliance Notification

In the event the Permittee is unable to comply with any of the permit terms and conditions due to any cause, the Permittee shall:

1. Immediately take action to stop, contain, and cleanup unauthorized discharges or otherwise stop the violation, and correct the problem;

2. Repeat sampling and analysis of any violation and submit the results to the Department within thirty (30) days after becoming aware of the violation;

3. Immediately notify the Department of the failure to comply; and

4. Submit a detailed, written report to the Department within thirty (30) days (five [5] days for upsets and bypasses), unless requested earlier by the Department. The report should describe the nature of the violation, corrective action taken and/or planned, steps to be taken to prevent a recurrence, results of the re-sampling, and any other pertinent information.

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply.

G. Compliance Progress Report

By April 1 of each year the Permittee shall submit an annual report covering for the previous year the progress made towards meeting the final effluent limits for copper and pH. The report should be limited to describing major milestones such as progress on or completion of facility plans, construction plans, or actual construction. This requirement shall lapse when the Permittee informs the Department that all final limits in the permit can be complied with.

S4. FACILITY LOADING

A. Design Criteria

The wet season design criteria for the permitted treatment facility are as follows:

Average flow for the maximum month	5.6 MGD
Influent BOD_5 loading for maximum month	8130 lbs./day
Influent TSS loading for maximum month	7181 lbs./day

The dry season design criteria for the permitted treatment facility are as follows:

Average flow for the maximum month	4.8 MGD
Influent BOD_5 loading for maximum month	8922 lbs./day
Influent TSS loading for maximum month	7181 lbs./day

B. Plans for Maintaining Adequate Capacity

When the actual flow or waste load reaches 85 percent of any one of the design criteria in S4.A for three (3) consecutive months, projected increases would reach design capacity within five (5) years, the Permittee shall submit a plan and schedule for continuing to maintain capacity at the facility sufficient to achieve the effluent limitations and other conditions of this permit. This plan shall address any of the following actions or any others necessary to meet this objective.

1. Analysis of the present design including the introduction of any process modifications that would establish the ability of the existing facility to achieve the effluent limits and other requirements of this permit at specific levels in excess of the existing design criteria specified in paragraph A above.

2. Reduction or elimination of excessive infiltration and inflow of uncontaminated ground and surface water into the sewer system.

3. Limitation on future sewer extensions or connections or additional waste load.

4. Modification or expansion of facilities necessary to accommodate increased flow or wasteland.

5. Reduction of industrial or commercial flows or waste loads to allow for increasing sanitary flow or waste load.

Engineering documents associated with the plan must meet the requirements of WAC 173-240-060, "Engineering Report," and be approved by the Department prior to any construction. The plan shall specify any contracts, ordinances, methods for financing, or other arrangements necessary to achieve this objective.

C. Notification of New or Altered Sources

The Permittee shall submit written notice to the Department whenever any new discharge or increase in volume or change in character of an existing discharge into the sewer is proposed which: (1) would interfere with the operation of, or exceed the design capacity of, any portion of the collection or treatment system; (2) is not part of an approved general sewer plan or approved plans and specifications; or would be subject to pretreatment standards under 40 CFR Part 403 and Section 307(b) of the Clean Water Act. This notice shall include an evaluation of the system's ability to adequately transport and treat the added flow and/or waste load.

S5. OPERATION AND MAINTENANCE

The Permittee shall at all times be responsible for the proper operation and maintenance of any facilities or systems of control installed to achieve compliance with the terms and conditions of the permit.

A. Certified Operator

An operator certified for at least a Class 3 plant by the State of Washington shall be in responsible charge of the day-to-day operation of the wastewater treatment plant. An operator certified for at least a Class 2 plant shall be in charge during all regularly scheduled shifts.

B. O & M Program

The Permittee shall institute an adequate operation and maintenance program for their entire sewage system. Maintenance records shall be maintained on all major electrical and mechanical components of the treatment plant, as well as the sewage system and pumping stations. Such records shall clearly specify the frequency and type of maintenance recommended by the manufacturer and shall show the frequency and type of maintenance performed. These maintenance records shall be available for inspection at all times.

C. Short-term Reduction

If a Permittee contemplates a reduction in the level of treatment that would cause a violation of permit discharge limitations on a short-term basis for any reason, and such reduction cannot be avoided, the Permittee shall give written notification to the Department, if possible, thirty (30) days prior to such activities, detailing the reasons for, length of time of, and the potential effects of the reduced level of treatment. This notification does not relieve the Permittee of their obligations under this permit.

D. Electrical Power Failure

The Permittee is responsible for maintaining adequate safeguards to prevent the discharge of untreated wastes or wastes not treated in accordance with the requirements of this permit during electrical power failure at the treatment plant and/or sewage lift stations either by means of alternate power sources, standby generator, or retention of inadequately treated wastes. The Permittee shall maintain Reliability Class II (EPA 430-99-74-001) at the wastewater treatment plant, which requires primary sedimentation and disinfection.

E. Prevent Connection of Inflow

The Permittee shall strictly enforce their sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system in those areas where connection to the storm drain system are available.

F. Bypass Procedures

The Permittee shall immediately notify the Department of any spill, overflow, or bypass from any portion of the collection or treatment system.

The bypass of wastes from any portion of the treatment system is prohibited unless one of the following conditions (1, 2, or 3) applies:

1. Unavoidable Bypass -- Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   If the resulting bypass from any portion of the treatment system results in noncompliance with this permit, the Permittee shall notify the Department in accordance with condition S3.E "Noncompliance Notification."

2. Anticipated Bypass That Has the Potential to Violate Permit Limits or Conditions -- Bypass is authorized by an administrative order issued by the Department. The Permittee shall notify the Department at least thirty (30) days before the planned date of bypass. The notice shall contain: (1) a description of the bypass and its cause; (2) an analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing; (3) a cost-effectiveness analysis of alternatives including comparative resource damage assessment; (4) the minimum and maximum duration of bypass under each alternative; (5) a recommendation as to the preferred alternative for conducting the bypass; (6) the projected date of bypass initiation; (7) a statement of compliance with SEPA; (8) if a water quality criteria exceedance is unavoidable, a request for modification of water quality standards as provided for in WAC 173-201A-110, and (9) steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

   For probable construction bypasses, the need to bypass is to be identified as early in the planning process as possible. The analysis required above shall be considered during preparation of the engineering report or facilities plan and plans and specifications and shall be included to the extent practical. In cases where the probable need to bypass is determined early, continued analysis is necessary up to and including the construction period in an effort to minimize or eliminate the bypass.

   The Department will consider the following prior to issuing an administrative order:

   a. If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of the permit.

   b. If there are feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

   c. If the bypass is planned and scheduled to minimize adverse effects on the public and the environment.

   After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, the Department will approve or deny the request. The public shall be notified and given an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Approval of a request to bypass will be by administrative order issued by the Department under RCW 90.48.120.

3. Bypass For Essential Maintenance Without the Potential to Cause Violation of Permit Limits or Conditions -- Bypass is authorized if it is for essential maintenance and does not have the potential to cause violations of limitations or other conditions of the permit, or adversely impact public health as determined by the Department prior to the bypass.

G. Operations and Maintenance Manual

The approved Operations and Maintenance Manual (O&M) shall be kept available at the treatment plant. The operation and maintenance manual shall contain the plant process control monitoring schedule. The Permittee shall update the manual for new procedures and equipment as appropriate.

S6. PRETREATMENT

A. General Requirements

The Permittee shall work cooperatively with the Department to ensure that all commercial and industrial users of the wastewater treatment system are in compliance with the pretreatment regulations promulgated in 40 CFR Part 403 and any additional pretreatment regulations that may be promulgated under Section 307(b) and reporting requirements under Section 308 of the Federal Clean Water Act.

B. Discharge Authorization Required

Significant commercial or industrial operations shall not be allowed to discharge wastes to the Permittee's sewerage system until they have received prior authorization from the Department in accordance with chapter 90.48 RCW and chapter 173-216 WAC, as amended. The Permittee shall immediately notify the Department of any proposed new sources, as defined in 40 CFR 403.3(k), from significant commercial or industrial operations.

C. Prohibited Discharges

In accordance with 40 CFR 403.5(a), a nondomestic discharger may not introduce into the Permittee's sewerage system any pollutant(s) that cause pass through or interference.

D. Specific Prohibitions

In accordance with 40 CFR 403.5(b), the following nondomestic discharges shall not be discharged into the Permittee's sewerage treatment system.

1. Pollutants that create a fire or explosion hazard in the POTW (including, but not limited to waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centigrade using the test methods specified in 40 CFR 261.21).

2. Pollutants that will cause corrosive structural damage to the Publicly Owned Treatment Works (POTW), but in no case discharges with pH lower than 5.0 standard units, unless the works are specifically designed to accommodate such discharges.

3. Solid or viscous pollutants in amounts that could cause obstruction to the flow in sewers or otherwise interfere with the operation of the POTW.

4. Any pollutant, including oxygen-demanding pollutants, (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the POTW.

5. Heat in amounts that will inhibit biological activity in the POTW resulting in interference, but in no case heat in such quantities such that the temperature at the POTW exceeds 40° C (104° F) unless the Department, upon request of the Permittee, approves, in writing, alternate temperature limits.

6. Petroleum oil, nonbiodegradable cutting oil, or products of mineral origin in amounts that will cause interference or pass through.

7. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity which may cause acute worker health and safety problems.

8. Any trucked or hauled pollutants, except at discharge points designated by the Permittee.

9. Wastewater prohibited to be discharged to the POTW by the Dangerous Waste Regulations (Chapter 173-303 WAC), unless authorized under the Domestic Sewage Exclusion (WAC 173-303-071).

10. All of the following are prohibited from discharge to the POTW unless approved in writing by the Department:

    a. Non-contact cooling water in significant volumes.

    b. Stormwater, and other direct inflow sources.

    c. Wastewater significantly affecting system hydraulic loading, which do not require treatment, or would not be afforded a significant degree of treatment by the system.

E. Notification of Industrial User Violations

The Permittee shall notify the Department in writing if any nondomestic user violates the prohibitions listed in S7.C and S7.D above.

F. Industrial User Survey

The Permittee shall prepare a list of industrial users to be submitted with the NPDES application required by Condition G.7. The list shall include any facility that meets any of the following criteria:

1. Discharges wastewater from a process regulated under the Pretreatment Categorical Standards contained in Subchapter N of Chapter I, Part 40 of the Code of Federal Regulations. Examples of categorical industrial users include electroplaters, anodizers, conversion coaters, electrical component manufacturers, printed circuit board manufacturers, semi-conductor manufacturers, chemical formulators/manufacturers, pharmaceutical manufacturers, soap and detergent manufacturers, paperboard manufacturers, petroleum refiners, iron and steel manufacturers, battery manufacturers, non-ferrous metal manufacturers, ferroalloy manufacturers, porcelain enamelers, steam electric generators, leather tanneries, coil coaters, foundries, aluminum formers, copper formers, and electrical component manufacturers.

2. Discharges 25,000 gpd or more of process wastewater to the sewer system.

3. Discharges priority or toxic pollutants in significant amounts.

4. Industrial food processors and agricultural product dischargers with significant loading to the treatment plant.

For each discharger listed, the Permittee will specify the volume of the discharge and the pollutants or types of chemicals contained in the discharge.

The Department may require the Permittee to perform other activities (e.g., sewer use ordinance and local limits development), which are necessary for the proper administration of the state pretreatment program.

S7. RESIDUAL SOLIDS

Residual solids include screenings, grit, scum, primary sludge, waste activated sludge and other solid waste. The Permittee shall store and handle all residual solids in such a manner so as to prevent their entry into state ground or surface waters. The Permittee shall not discharge leachate from residual solids to state surface or ground waters.

S8. ACUTE TOXICITY TESTING

A. Effluent Characterization

The Permittee shall conduct acute toxicity testing on the final effluent to determine the presence and amount of acute (lethal) toxicity. The two acute toxicity tests listed below shall be conducted on each sample taken for effluent characterization.

Effluent characterization for acute toxicity shall be conducted quarterly for one (1) year. Acute toxicity testing shall follow protocols, monitoring requirements, and quality assurance/quality control procedures specified in this section. A dilution series consisting of a minimum of five concentrations (including the ACEC of 20% effluent) and a control shall be used to estimate the concentration lethal to 50% of the organisms (LC_{50}). The percent survival in 100% effluent shall also be reported.

Testing shall begin by October 30, 2001. A written report shall be submitted to the Department within sixty (60) days after the sample date.

Acute toxicity tests shall be conducted with the following species and protocols:

1. Fathead minnow, Pimephales promelas (96-hour static-renewal test, method: EPA/600/4-90/027F).

2. Daphnid, Ceriodaphnia dubia, Daphnia pulex, or Daphnia magna (48-hour static test, method: EPA/600/4-90/027F). The Permittee shall choose one of the three species and use it consistently throughout effluent characterization.

B. Effluent Limit for Acute Toxicity

The Permittee has an effluent limit for acute toxicity if, after completing one year of effluent characterization, either:

(1) The median survival of any species in 100% effluent is below 80%, or

(2) Any one test of any species exhibits less than 65% survival in 100% effluent.

If an effluent limit for acute toxicity is required by subsection B at the end of one year of effluent characterization, the Permittee shall immediately complete all applicable requirements in subsections C, D, and F.

If no effluent limit is required by subsection B at the end of one year of effluent characterization, then the Permittee shall complete all applicable requirements in subsections E and F.

The ACEC means the maximum concentration of effluent during critical conditions at the boundary of the zone of acute criteria exceedance assigned pursuant to WAC 173-201A-100. **The effluent limit for acute toxicity is no acute toxicity detected in a test concentration of 20% effluent, which represents the acute critical effluent concentration (ACEC).**

In the event of failure to pass the test described in subsection C of this section for compliance with the effluent limit for acute toxicity, the Permittee is considered to be in compliance with all permit requirements for acute whole effluent toxicity as long as the requirements in subsection D are being met to the satisfaction of the Department.

If no effluent limit is required by subsection B at the end of one year of effluent characterization, then the Permittee shall stop effluent characterization and begin to conduct the activities in subsection E.

C. Monitoring for Compliance With an Effluent Limit for Acute Toxicity

Monitoring to determine compliance with the effluent limit shall be conducted quarterly for the remainder of the permit term using each of the species listed in subsection A on a rotating basis and performed using at a minimum 100% effluent, the ACEC of 20% effluent, and a control. The Permittee shall schedule the toxicity tests in the order listed in the permit unless the Department notifies the Permittee in writing of another species rotation schedule. The percent survival in 100% effluent shall be reported for all compliance monitoring.

Compliance with the effluent limit for acute toxicity means no statistically significant difference in survival between the control and the test concentration representing the ACEC. The Permittee shall immediately implement subsection D if any acute toxicity test conducted for compliance monitoring determines a statistically significant difference in survival between the control and the ACEC using hypothesis testing at the 0.05 level of significance (Appendix H, EPA/600/4-89/001). If the difference in survival between the control and the ACEC is less than 10%, the hypothesis test shall be conducted at the 0.01 level of significance.

D. Response to Noncompliance With an Effluent Limit for Acute Toxicity

If the Permittee violates the acute toxicity limit in subsection B, the Permittee shall begin additional compliance monitoring within one week from the time of receiving the test results. This additional monitoring shall be conducted weekly for four consecutive weeks using the same test and species as the failed compliance test. Testing shall determine the LC_{50} and effluent limit compliance. The discharger shall return to the original monitoring frequency in subsection C after completion of the additional compliance monitoring.

If the Permittee believes that a test indicating noncompliance will be identified by the Department as an anomalous test result, the Permittee may notify the Department that the compliance test result might be anomalous and that the Permittee intends to take only one additional sample for toxicity testing and wait for notification from the Department before completing the additional monitoring required in this subsection. The notification to the Department shall accompany the report of the compliance test result and identify the reason for considering the compliance test result to be anomalous. The Permittee shall complete all of the additional monitoring required in this subsection as soon as possible after notification by the Department that the compliance test result was not anomalous. If the one additional sample fails to comply with the effluent limit for acute toxicity, then the Permittee shall proceed without delay to complete all of the additional monitoring required in this subsection. The one additional test result shall replace the compliance test result upon determination by the Department that the compliance test result was anomalous.

If all of the additional compliance monitoring conducted in accordance with this subsection complies with the permit limit, the Permittee shall search all pertinent and recent facility records (operating records, monitoring results, inspection records, spill reports, weather records, production records, raw material purchases, pretreatment records, etc.) and submit a report to the Department on possible causes and preventive measures for the transient toxicity event which triggered the additional compliance monitoring.

If toxicity occurs in violation of the acute toxicity limit during the additional compliance monitoring, the Permittee shall submit a Toxicity Identification/Reduction Evaluation (TI/RE) plan to the Department. The TI/RE plan submittal shall be within sixty (60) days after the sample date for the fourth additional compliance monitoring test. If the Permittee decides to forgo the rest of the additional compliance monitoring tests required in this subsection because one of the first three additional compliance monitoring tests failed to meet the acute toxicity limit, then the Permittee shall submit the TI/RE plan within sixty (60) days after the sample date for the first additional monitoring test to violate the acute toxicity limit. The TI/RE plan shall be based on WAC 173-205-100(2) and shall be implemented in accordance with WAC 173-205-100(3).

E. Monitoring When There Is No Permit Limit for Acute Toxicity

Recent WET testing results are required as part of the permit application. WET Tests that are less than two years old based on the sample collection date at the time the next permit application is due at the Department shall be considered recent. If the Permittee lacks two recent WET test results at the time the permit application (Condition G7), then they shall test final effluent at six month intervals prior to submission of the application for permit renewal in order to provide recent test results. All species used in the initial acute effluent characterization or substitutes approved by the Department shall be used and results submitted to the Department as a part of the permit renewal application process.

F. Sampling and Reporting Requirements

1. All reports for effluent characterization or compliance monitoring shall be submitted in accordance with the most recent version of Department of Ecology Publication #WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* in regards to format and content. Reports shall contain bench sheets and reference toxicant results for test methods. If the lab provides the toxicity test data on floppy disk for electronic entry into the Department's database, then the Permittee shall send the disk to the Department along with the test report, bench sheets, and reference toxicant results.

2. Testing shall be conducted on 24-hour composite effluent samples. Composite samples taken for toxicity testing shall be cooled to 4 degrees Celsius while being collected and shall be sent to the lab immediately upon completion. Samples must be below 8° C at receipt. The lab shall begin the toxicity testing as soon as possible but no later than 36 hours after sampling was ended. The lab shall store all samples at 4° C in the dark from receipt until completion of the test.

3. All samples and test solutions for toxicity testing shall have water quality measurements as specified in Department of Ecology Publication #WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* or most recent version thereof.

4. All toxicity tests shall meet quality assurance criteria and test conditions in the most recent versions of the EPA manual listed in subsection A and the Department of Ecology Publication #WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria.* If test results are determined to be invalid or anomalous by the Department, testing shall be repeated with freshly collected effluent.

5. Control water and dilution water shall be laboratory water meeting the requirements of the EPA manual listed in subsection A or pristine natural water of sufficient quality for good control performance.

6. The whole effluent toxicity tests shall be run on an unmodified sample of final effluent.

7. The Permittee may choose to conduct a full dilution series test during compliance monitoring in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the ACEC of 20% effluent.

8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing, and do not comply with the acute statistical power standard of 29% as defined in WAC 173-205-020, must be repeated on a fresh sample with an increased number of replicates to increase the power.

S9. CHRONIC TOXICITY TESTING

A. Effluent Characterization

The Permittee shall conduct chronic toxicity testing on the final effluent. The two chronic toxicity tests listed below shall be conducted on each sample taken for effluent characterization.

Freshwater Chronic Toxicity Test Species		Method
Fathead minnow	*Pimephales promelas*	EPA/600/4-91/002
Water flea	*Ceriodaphnia dubia*	EPA/600/4-91/002

The first test shall begin by October 30, 2001, and the second test shall be conducted in the first half of 2002. A written report shall be submitted to the Department within sixty (60) days after the sample date for each test.

The Permittee shall conduct chronic toxicity testing during effluent characterization on a series of at least five concentrations of effluent in order to determine appropriate point estimates. This series of dilutions shall include the ACEC of 20% effluent and the CCEC of 3% effluent. The Permittee shall compare the ACEC to the control using hypothesis testing at the 0.05 level of significance as described in Appendix H, EPA/600/4-89/001.

B. Effluent Limit for Chronic Toxicity

After completion of effluent characterization, the Permittee has an effluent limit for chronic toxicity if any test conducted for effluent characterization shows a significant difference between the control and the ACEC of 20% effluent at the 0.05 level of significance using hypothesis testing (Appendix H, EPA/600/4-89/001) and shall complete all applicable requirements in subsections C, D, and F.

If no significant difference is shown between the ACEC of 20% effluent and the control in any of the chronic toxicity tests, the Permittee has no effluent limit for chronic toxicity and only subsections E and F apply.

The effluent limit for chronic toxicity is no toxicity detected in a test concentration representing the chronic critical effluent concentration of 3% effluent (CCEC).

In the event of failure to pass the test described in subsection C. of this section for compliance with the effluent limit for chronic toxicity, the Permittee is considered to be in compliance with all permit requirements for chronic whole effluent toxicity as long as the requirements in subsection D are being met to the satisfaction of the Department.

The CCEC means the maximum concentration of effluent allowable at the boundary of the mixing zone assigned in Condition S2 pursuant to WAC 173-201A-100. The CCEC equals 3% effluent.

C. Monitoring for Compliance With an Effluent Limit for Chronic Toxicity

Monitoring to determine compliance with the effluent limit shall be conducted biannually for the remainder of the permit term using each of the species listed in subsection A above on a rotating basis and performed using at a minimum the CCEC, the ACEC, and a control. The Permittee shall schedule the toxicity tests in the order listed in the permit unless the Department notifies the Permittee in writing of another species rotation schedule.

Compliance with the effluent limit for chronic toxicity means no statistically significant difference in response between the control and the test concentration representing the CCEC. The Permittee shall immediately implement subsection D. if any chronic toxicity test conducted for compliance monitoring determines a statistically significant difference in response between the control and the CCEC using hypothesis testing at the 0.05 level of significance (Appendix H, EPA/600/4-89/001). If the difference in response between the control and the CCEC is less than 20%, the hypothesis test shall be conducted at the 0.01 level of significance.

In order to establish whether the chronic toxicity limit is eligible for removal from future permits, the Permittee shall also conduct this same hypothesis test (Appendix H, EPA/600/4-89/001) to determine if a statistically significant difference in response exists between the ACEC and the control.

D. Response to Noncompliance With an Effluent Limit for Chronic Toxicity

If a toxicity test conducted for compliance monitoring under subsection C. determines a statistically significant difference in response between the CCEC and the control, the Permittee shall begin additional compliance monitoring within one (1) week from the time of receiving the test results. This additional monitoring shall be conducted monthly for three (3) consecutive months using the same test and species as the failed compliance test. Testing shall be conducted using a series of at least five effluent concentrations and a control in order to be able to determine appropriate point estimates. One of these effluent concentrations shall equal the CCEC and be compared statistically to the nontoxic control in order to determine compliance with the effluent limit for chronic toxicity as described in subsection C. The discharger shall return to the original monitoring frequency in subsection C after completion of the additional compliance monitoring.

If the Permittee believes that a test indicating noncompliance will be identified by the Department as an anomalous test result, the Permittee may notify the Department that the compliance test result might be anomalous and that the Permittee intends to take only one additional sample for toxicity testing and wait for notification from the Department before completing the additional monitoring required in this subsection. The notification to the Department shall accompany the report of the compliance test result and identify the reason for considering the compliance test result to be anomalous. The Permittee shall complete all of the additional monitoring required in this subsection as soon as possible after notification by the Department that the compliance test result was not anomalous. If the one additional sample fails to comply with the effluent limit for chronic toxicity, then the Permittee shall proceed without delay to complete all of the additional monitoring required in this subsection. The one additional test result shall replace the compliance test result upon determination by the Department that the compliance test result was anomalous.

If all of the additional compliance monitoring conducted in accordance with this subsection complies with the permit limit, the Permittee shall search all pertinent and recent facility records (operating records, monitoring results, inspection records, spill reports, weather records, production records, raw material purchases, pretreatment records, etc.) and submit a report to the Department on possible causes and preventive measures for the transient toxicity event which triggered the additional compliance monitoring.

If toxicity occurs in violation of the chronic toxicity limit during the additional compliance monitoring, the Permittee shall submit a Toxicity Identification/Reduction Evaluation (TI/RE) plan to the Department within sixty (60) days after test results are final. The TI/RE plan shall be based on WAC 173-205-100(2) and shall be implemented in accordance with WAC 173-205-100(3).

E. Monitoring When There Is No Permit Limit for Chronic Toxicity

Recent WET testing results are required as part of the permit application. WET Tests that are less than two years old based on the sample collection date at the time the next permit application is due at the Department shall be considered recent. If the Permittee lacks two recent WET test results at the time the permit application (Condition G7), then they shall test final effluent at six month intervals prior to submission of the application for permit renewal in order to provide recent test results. All species used in the initial chronic effluent characterization or substitutes approved by the Department shall be used and results submitted to the Department as a part of the permit renewal application process.

F. Sampling and Reporting Requirements

1. All reports for effluent characterization or compliance monitoring shall be submitted in accordance with the most recent version of Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* in regards to format and content. Reports shall contain bench sheets and reference toxicant results for test methods. If the lab provides the toxicity test data on floppy disk for electronic entry into the Department's database, then the Permittee shall send the disk to the Department along with the test report, bench sheets, and reference toxicant results.

2. Testing shall be conducted on 24-hour composite effluent samples. Samples taken for toxicity testing shall be cooled to 4 degrees Celsius while being collected and shall be sent to the lab immediately upon completion. The lab shall begin the toxicity testing as soon as possible but no later than thirty-six (36) hours after sampling was ended.

3. All samples and test solutions for toxicity testing shall have water quality measurements as specified in Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* or most recent version thereof.

4. All toxicity tests shall meet quality assurance criteria and test conditions in the most recent versions of the EPA manual listed in subsection A. and the Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria*. If test results are determined to be invalid or anomalous by the Department, testing shall be repeated with freshly collected effluent.

5. Control water and dilution water shall be laboratory water meeting the requirements of the EPA manual listed in subsection A or pristine natural water of sufficient quality for good control performance.

6. The whole effluent toxicity tests shall be run on an unmodified sample of final effluent.

7. The Permittee may choose to conduct a full dilution series test during compliance monitoring in order to determine dose response. In this case, the series must have a minimum of five effluent concentrations and a control. The series of concentrations must include the ACEC and the CCEC.

8. All whole effluent toxicity tests, effluent screening tests, and rapid screening tests that involve hypothesis testing and do not comply with the chronic statistical power standard of 39% as defined in WAC 173-205-020 must be repeated on a fresh sample with an increased number of replicates to increase the power.

S10. COMBINED SEWER OVERFLOWS

A. Operations

The table below lists combined sewer overflows (CSOs) outfalls, from which a dilute mixture of untreated sewage and rainwater is discharged as a result of precipitation events. These outfalls are hydraulically connected and may discharge simultaneously. Discharges from these sites are prohibited except as a result of precipitation events. The Permittee shall minimize the amount of flow and levels of pollutants discharged at these locations by prudent operation of the CSO storage system and sewage treatment plant.

Each outfall shall have a sign posted advising the public of the potential discharge of untreated sewage and phone numbers of City representatives who will provide additional information about the CSOs.

OUTFALL	CSO DESIGNATION	LATITUDE	LONGITUDE
002	Park Street	48° 24' 50" N	122° 20' 15" W
003	Division Street	48° 25' 10" N	122° 20' 15" W

B. Combined Sewer Overflow Monitoring and Annual Report

The Permittee shall submit an annual CSO Report covering the previous calendar year to the Department by April 1 each year that complies with the requirements of WAC 173-245-090(1):

1. Detail the past year's frequency and volume of combined sewage discharged from each CSO discharge site.
2. Explain the CSO reduction accomplishments of the previous year.
3. List the projects associated with CSO reduction planned for the next year.
4. If there is an increase in the annual baseline volume or frequency of CSO discharges, then the City shall propose a project and schedule to reduce that CSO site or group of sites to or below the baseline condition.

At least once per year, the Permittee shall obtain composite samples that are representative of the CSO discharge(s) to estimate BOD_5 and TSS levels of those discharges at the three different overflow points in the CSO storage system. Sampling is only required for those overflow points that actually do overflow. At least once per year, the Permittee shall obtain grab samples from the Skagit River to estimate the fecal coliform bacteria levels upstream and downstream of the CSO outfalls. This sampling of the Skagit River shall only be required for overflow episodes that occur during daylight hours on weekdays. Results of this monitoring shall be submitted with the annual CSO report.

The Permittee shall maintain a current CSO sampling plan that explains how these monitoring and characterization requirements are met. Within three (3) months of the permit issuance date, the Permittee shall submit an update of the sampling plan that was submitted to the Department as part of the 1999 annual CSO report. The Permittee shall update or revise the sampling plan as necessary or if requested by the Department.

C. Combined Sewer Overflow Reduction Plan Amendment

In conjunction with the application for renewal of this permit, the Permittee shall submit an amendment of its CSO Reduction Plan to the Department for review. The amendment provide brief summaries of:

1. An assessment of the CSO reduction plan to date.
2. Changes or refinements to the original CSO reduction plan.
3. List of projects scheduled over the next five years that contribute to meeting the control mechanisms proposed in the CSO reduction plan.

D. Compliance Schedule

The Permittee shall continue with planning and engineering efforts to comply with the provisions of Order On Consent No. DE 96WQ-N105 and reduce the frequency of CSO events to an average of one per year no later than January 1, 2015.

GENERAL CONDITIONS

G1. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to the Department shall be signed and certified.

A. All permit applications shall be signed by either a principal executive officer or a ranking elected official.

B. All reports required by this permit and other information requested by the Department shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by a person described above and submitted to the Department, and

2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

C. Changes to authorization. If an authorization under paragraph B.2. above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of B.2. must be submitted to the Department prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section shall make the following certification:

"I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G2. RIGHT OF ENTRY

The Permittee shall allow an authorized representative of the Department, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records must be kept under the terms and conditions of this permit;

B. To have access to and copy at reasonable times any records that must be kept under the terms of the permit;

C. To inspect at reasonable times any monitoring equipment or method of monitoring required in the permit;

D. To inspect at reasonable times any collection, treatment, pollution management, or discharge facilities; and

E. To sample at reasonable times any discharge of pollutants.

G3. PERMIT ACTIONS

This permit shall be subject to modification, suspension, or termination, in whole or in part by the Department for any of the following causes:

A. Violation of any permit term or condition;

B. Obtaining a permit by misrepresentation or failure to disclose all relevant facts;

C. A material change in quantity or type of waste disposal;

D. A material change in the condition of the waters of the state; or

E. Nonpayment of fees assessed pursuant to RCW 90.48.465.

The Department may also modify this permit, including the schedule of compliance or other conditions, if it determines good and valid cause exists, including promulgation or revisions of regulations or new information.

G4. REPORTING A CAUSE FOR MODIFICATION

The Permittee shall submit a new application, or a supplement to the previous application, along with required engineering plans and reports, whenever a material change in the quantity or type of discharge is anticipated which is not specifically authorized by this permit. This application shall be submitted at least sixty (60) days prior to any proposed changes. Submission of this application does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G5. PLAN REVIEW REQUIRED

Prior to constructing or modifying any wastewater control facilities, an engineering report and detailed plans and specifications shall be submitted to the Department for approval in accordance with Chapter 173-240 WAC. Engineering reports, plans, and specifications should be submitted at least one hundred and eighty (180) days prior to the planned start of construction. Facilities shall be constructed and operated in accordance with the approved plans.

G6. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in the permit shall be construed as excusing the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G7. DUTY TO REAPPLY

The Permittee must apply for permit renewal at least one hundred and eighty (180) days prior to the specified expiration date of this permit. A new authorization letter for signature authority as described in G1.B shall be submitted with the application.

G8. REMOVED SUBSTANCES

Collected screenings, grit, solids, sludge, filter backwash, or other pollutants removed in the course of treatment or control of wastewater shall not be re-suspended or reintroduced to the final effluent stream for discharge to state waters.

G9. TOXIC POLLUTANTS

If any applicable toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Clean Water Act for a toxic pollutant and that standard or prohibition is more stringent than any limitation upon such pollutant in the permit, the Department shall institute proceedings to modify or revoke and reissue the permit to conform to the new toxic effluent standard or prohibition.

G10. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G11. ADDITIONAL MONITORING

The Department may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

G12. PAYMENT OF FEES

The Permittee shall submit payment of fees associated with this permit as assessed by the Department. The Department may revoke this permit if the permit fees established under Chapter 173-224 WAC are not paid.

G13. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be and be deemed to be a separate and distinct violation.

FACT SHEET FOR NPDES PERMIT WA-002407-4

City of Mount Vernon Wastewater Treatment Plant

SUMMARY

Changes to the sewer system since 1993 and new information about the outfall and receiving water have all led to significant changes to the permit conditions. The amount of dilution estimated for the outfall has been reduced based on an outfall study provided by the Permittee. The Department finalized a TMDL study for the lower Skagit River to set maximum discharge levels for ammonia, BOD_5, and fecal coliform bacteria to the lower Skagit River. Combined sewer overflows (CSOs) have been reduced by about 90% by storing flows for treatment at the WWTP. The Department approved a revision to plant capacity. Chemical dechlorination was added to the treatment system to remove chlorine from the effluent. Planning mandated under the State's Growth Management Act has provided a basis for revising projected need for increased plant capacity. The City is preparing a new facilities plan to address the need for additional capacity and compliance with new water quality-based requirements.

The outfall study concluded that a new outfall is needed to provide increased future capacity, process treated combined sewage flows from the plant, and enhance the dilution of effluent in the immediate vicinity of the outfall.

New water quality-based limits for ammonia, pH, copper, and zinc are in the permit. The new copper and pH limits can not be met based on previous data collected at the plan, so the Department imposed interim limits for these pollutants. The permit requires a sampling plan for metals to ensure that data provided on metals concentrations is reliable. The plant has no facilities to adjust pH to meet the pH limit. The permit provides two (2) years to plan for how the copper and pH limits will be met.

The permit requires whole effluent toxicity testing to characterize the effluent to obtain current information using the standards in Ecology rules enacted since the last permit was issued.

The plant capacity has been revised based on actual operating conditions and stress testing at the plant. Flow capacity is increased by 40% to 5.6 MGD and organic capacity is reduced by 46% to 8130 lbs./day for the maximum month in the winter.

The permit incorporates the waste load allocations derived from the Lower Skagit Total Maximum Daily Load Submittal Report (Ecology, 2000) to maintain compliance with dissolved oxygen standards by limiting summertime discharge of pounds of ammonia. The Skagit River currently complies with dissolved oxygen standards.

Specific process control testing requirements have been removed; that testing is to be done per the plant operations and maintenance manual.

An industrial user survey is required with the next permit submittal.

CSO testing requirements are added – CSO overflows have been reduced significantly; sampling and flow measure capabilities for CSOs have been added to the control system. The requirement to remove 85% of influent BOD_5 and TSS concentration has been relaxed to 80% because transporting CSO flows to the plant reduces influent strength.

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INTRODUCTION

The Federal Clean Water Act (FCWA, 1972, and later modifications, 1977, 1981, and 1987) established water quality goals for the navigable (surface) waters of the United States. One of the mechanisms for achieving the goals of the Clean Water Act is the National Pollutant Discharge Elimination System of permits (NPDES permits), which is administered by the Environmental Protection Agency (EPA). The EPA has delegated responsibility to administer the NPDES permit program to the State of Washington on the basis of Chapter 90.48 RCW which defines the Department of Ecology's authority and obligations in administering the wastewater discharge permit program.

The regulations adopted by the State include procedures for issuing permits (Chapter 173-220 WAC), technical criteria for discharges from municipal wastewater treatment facilities (Chapter 173-221 WAC), water quality criteria for surface and ground waters (Chapters 173-201A and 200 WAC), and sediment management standards (Chapter 173-204 WAC). These regulations require that a permit be issued before discharge of wastewater to waters of the state is allowed. The regulations also establish the basis for effluent limitations and other requirements which are to be included in the permit. One of the requirements (WAC 173-220-060) for issuing a permit under the NPDES permit program is the preparation of a draft permit and an accompanying fact sheet. Public notice of the availability of the draft permit is required at least thirty (30) days before the permit is issued (WAC 173-220-050). The fact sheet and draft permit are available for review (see <u>Appendix A--Public Involvement</u> of the fact sheet for more detail on the public notice procedures).

The fact sheet and draft permit have been reviewed by the Permittee. Errors and omissions identified in this review have been corrected before going to public notice. After the public comment period has closed, the Department will summarize the substantive comments and the response to each comment. The summary and response to comments will become part of the file on the permit, and parties submitting comments will receive a copy of the Department's response. The fact sheet will not be revised. Comments and the resultant changes to the permit will be summarized in Appendix E--Response to Comments.

GENERAL INFORMATION	
Applicant	City of Mount Vernon
Facility Name and Address	City of Mount Vernon Wastewater Treatment Plant 1401 Britt Road Mount Vernon, Washington 98273
Responsible Official	The Honorable Skye Richendrfer - Mayor City of Mount Vernon P O B 809 Mount Vernon, WA 98273 phone 360-336-6219

GENERAL INFORMATION	
Facility Contacts	Walter Enquist – Superintendent, (360) 336-6219 Bill Fullner – Process Analyst, (360) 336-6219 fax: (360) 424-8749 John W. Buckley – Public Works Director, (360)336-6204
Type of Treatment	Secondary biological treatment (conventional mixed activated sludge, chlorine disinfection, chemical de-chlorination, anaerobic sludge digestion)
Plant Discharge Location – Outfall 1	Skagit River Latitude: 48° 28' 04" N Longitude: 122° 18' 30" W
CSO Discharge Locations – Outfall 2 (Park Street) – Outfall 3 (Division St.)	Skagit River Latitude: 48° 24' 50" N Longitude: 122° 20' 15" W Latitude: 48° 25' 10" N Longitude: 122° 20' 15" W
Water Body ID Number	WA-03-1010

BACKGROUND INFORMATION

DESCRIPTION OF THE FACILITY

HISTORY

The City of Mount Vernon's sewerage system dates from the early 1900's. Combined sanitary and storm sewers served the area of Mount Vernon constructed prior to about 1948; combined sewer discharges into the Skagit River occurred at the foot of Division and Park Streets. This waste flow was intercepted and diverted to a primary treatment plant constructed in 1948.

In the late 1960's, the State required an upgrade of the plant to provide secondary treatment. At the time there were no federal secondary treatment standards. Accordingly, a secondary plant was designed to achieve the State standard at that time of 85% BOD and 90% TSS removal. The plant configuration after a 1972 upgrade included a primary clarifier, an oxidation tower (biofilter), a secondary clarifier, an anaerobic digester, chlorine disinfection, and a sludge thickener. Construction of that facility was completed in 1974.

During the middle of the 1970's, the plant performed adequately and achieved the effluent limits specified in the City's NPDES permit. The population of the City increased by almost 50% during the 1970's. Industrial loading increased substantially. The quality of the effluent from the plant deteriorated as the influent BOD loading increased. By the early 1980's, the plant failed to meet effluent discharge standards because it was hydraulically overloaded. Mount Vernon had to upgrade the plant again. This expansion and upgrade of the WWTP was completed in the fall of 1989 to increase capacity and improve performance.

During the early 1990's, the City provided for meeting State regulations to reduce combined sewer overflows (CSO). In 1998, Mount Vernon put the Central CSO Regulator into service. This facility was constructed as the first phase of reducing CSO overflow events to an average of once per year. The CSO Regulator system is composed of one mile of 5-foot diameter sewer pipe around the old downtown area. The system stores wet weather flows for eventual discharge to the treatment plant and provides flow measurement and CSO sampling capability. This regulator was designed to reduce overflows by about 90% and provide design information to meet the once per year overflow standard by 2015.

The Department conducted a Total Maximum Daily Load study on the lower Skagit River during the 1990's. The results of the study provide limitations on the output of the plant to the river based on the Department's estimate of how much oxygen demanding pollutants can be discharged to the lower Skagit without violating state standards for dissolved oxygen in the lower river. The study results provide limits for $CBOD_5$ (or BOD_5) and ammonia needed to continue meeting state water quality standards for dissolved oxygen in the receiving water.

COLLECTION SYSTEM STATUS

The primary source of waste water tributary to the facility is domestic sewage from residential and light commercial activities in the City of Mount Vernon. The collection system tributary to the plant is composed of separate sanitary sewers and combined storm water and sanitary sewers (CSO) from the older sections of the town. The sewer system and pump stations are maintained and repaired promptly when breakdowns occur. The plant is directly influenced by precipitation events.

TREATMENT PROCESSES

The 1989 plant upgrade was based on a design population of 28,500. The 2000 Census lists the actual population as 26,300. The 1989 upgrade included the following additions: three aeration basins, an aerobic digester, a secondary clarifier, a dissolved-air-flotation thickener, an anaerobic digester, and a belt filter press. The plant flow scheme also includes a bar screen, an influent pump station, and two comminutors prior to the primary clarifier. A flow chart for the plant processes is shown on the following page.

Influent sewage enters the plant below ground, and then is pumped up to the headworks. From there, sewage flows to the primary clarifiers where solids settle out. Then sewage flows to another set of basins where flows mix with a bacterial mass while under aeration (conventional mixed activated sludge treatment process). The mixed liquor flows from the aeration basins to the secondary clarifiers where the organic solids settle out. The secondary clarifier effluent is disinfected by injecting chlorine in a flash mixer. Chlorine is chemically removed with sodium bisulfite after disinfection. Disinfected effluent is discharged to the Skagit River via a submerged outfall pipe. During high river flows the effluent is pumped to the river.

Sludge generated during the treatment process is thickened by a dissolved-air flotation thickener and routed to the primary anaerobic digester. Digested sludge is further thickened in the supernatant tank and by belt presses. Methane gas is recovered from the anaerobic digestion tank and is used as a heating source. Digested sludge is applied to farmland in eastern Washington.

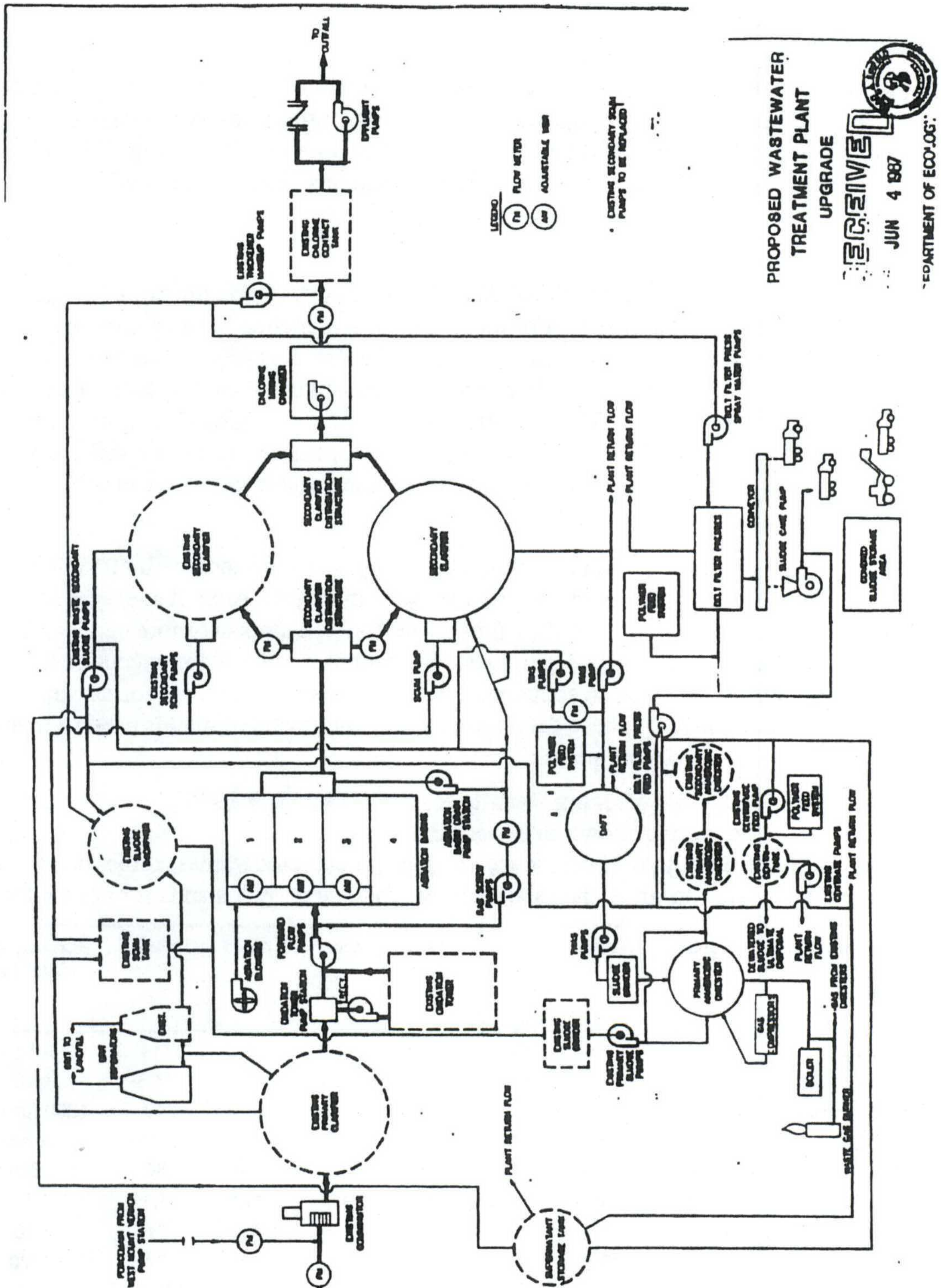

Figure 1: Schematic of the WWTP based on approved design in 1987

DISCHARGE OUTFALL

Secondary treated and disinfected effluent is discharged from the facility via a 24-inch ductile iron outfall pipe into the Skagit River. Two CSO outfalls are located upstream of the WWTP outfall, one at the Division Street Bridge about ¾ mile upstream of the WWTP outfall and the other near the end of Park Street less than ¼ mile upstream of the WWTP outfall.

RESIDUAL SOLIDS

This treatment facility removes solids at the headworks (screenings), in the primary and secondary clarifiers, and as part of the routine maintenance of the equipment (rags, scum, and other debris). The solids (the sludge without the debris) are processed into biosolids using anaerobic digestion (microbial digestion in large tanks for greater than 20 days) and are then pressed to remove water. The biosolids are hauled to Douglas County for land application on farm fields owned by Boulder Park, Inc. The biosolids are used as a soil amendment for growing crops. Grit, rags, scum, and screenings are drained and disposed of as solid waste at the Roosevelt landfill.

The facility monitors the quality of the biosolids in accordance with 40 CFR 503, the federal regulations for sludge processing and biosolids disposal. Annual averages of monitoring results for the period of 1993-99 are shown in Table 1. Pollutants are more concentrated in the sludge samples than in wastewater discharges. Numerical standards for exceptional quality biosolids are listed for comparison to actual results. Exceptional quality biosolids can be distributed to the public for garden use. These data demonstrate low levels of metals present in the biosolids produced at the treatment plant.

Table 1: Sludge Monitoring Results for 1994 Through 1999.
The values shown are annual averages.

Values marked with an *asterisk are averages of detected values, some of these values were below the detection limit. ND stands for not detected. NA stands for not analyzed.

All units are mg/Kg dry weight	1993	1994	1995	1996	1997	1998	1999	Except Qual Standard
Arsenic	ND	ND	ND	*3.8	*3.9	*3.3	*14	41
Cadmium	ND	*3	4.7	5.1	*3.6	*4	*3.3	39
Chromium	59	47	36	47	39	43	40	1200 (deleted)
Copper	443	385	317	348	255	267	309	1500
Lead	*84	*104	102	129	105	90	80	300
Mercury	3.4	*6	*2.2	2.2	1.9	*1.5	1.1	17
Molybdenum	NA	*12	*1.7	*5.5	8.9	*8.3	*7	18
Nickel	*61	*35	42	67	47	38	34	420
Selenium	ND	ND	ND	*7.6	*3.7	*7	*5.2	100
Zinc	623	533	599	747	593	576	574	2800

PERMIT STATUS

The previous permit for this facility was issued in June 1993 and expired in June 1998. The previous permit placed effluent limitations on 5-day Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), pH, Fecal Coliform Bacteria, chlorine, and copper. The copper limit was removed from the permit in 1995 when the Department obtained new information that showed ambient levels of copper in the Skagit River were significantly lower than levels reported by USGS during the 1980's.

An application for permit renewal was submitted to the Department on December 16, 1997, and the permit was subsequently extended by the Department.

SUMMARY OF COMPLIANCE WITH THE PREVIOUS PERMIT

The facility received its last inspection on June 23, 1999; this was an inspection primarily focused on the CSO control system.

Based on Discharge Monitoring Reports (DMRs) submitted to the Department and inspections conducted by the Department during the last five years, the Permittee has complied with the permit conditions and effluent limitations except for the effluent violations listed in Table 2. The violations in January 1998 are due to processing high flows through the WWTP instead of discharging CSOs directly to the Skagit River. Initial operation of the CSO control system attempted to process more dilute influent than the plant was capable of sustaining. The violation in 1999 was due to high flows through the plant. The chlorine violation in 1995 was due to extended high flows through the WWTP over the entire month. Plant staff have worked diligently at meeting permit limitations and fixing any problems that occur.

Table 2: Violations of Permit Conditions.

parameter	duration	unit	reported value	limit	date
SOLIDS, TOTAL SUSPENDED	7-day average	LBS/DAY	1763	1501	Dec-99
BOD, 5-DAY (20 DEG. C)	30-day average	MG/L	36	30	Jan-98
SOLIDS, TOTAL SUSPENDED	30-day average	LBS/DAY	3222	1001	Jan-98
SOLIDS, SUSPENDED, % REMOVAL	30-day average	PERCENT	52	85	Jan-98
BOD, 5-DAY (20 DEG. C)	7-day average	LBS/DAY	4281	1501	Jan-98
BOD, 5-DAY (20 DEG. C)	30-day average	LBS/DAY	1851	1001	Jan-98
SOLIDS, TOTAL SUSPENDED	30-day average	MG/L	72	30	Jan-98
SOLIDS, TOTAL SUSPENDED	7-day average	MG/L	193	45	Jan-98
BOD, 5-DAY PERCENT REMOVAL	30-day average	PERCENT	73	85	Jan-98
BOD, 5-DAY (20 DEG. C)	7-day average	MG/L	70	45	Jan-98
SOLIDS, TOTAL SUSPENDED	7-day average	LBS/DAY	8896	1501	Jan-98
CHLORINE, TOTAL RESIDUAL	30-day average	LBS/DAY	19.2	15.6	Nov-95
CHLORINE, TOTAL RESIDUAL	30-day average	MG/L	0.5	0.47	Nov-95

The WWTP plant has also exceeded 85% of the facility design criteria listed in the previous permit on numerous instances over the last five years; these excursions are not permit violations.

In 1996, the City submitted an engineering analysis to the Department that revised the design criteria for the plant based on performance and stress testing.

WASTEWATER CHARACTERIZATION

The concentration of pollutants in the discharge was reported in the NPDES application and in discharge monitoring reports. The effluent is characterized as follows:

Table 3: Wastewater Characterization for 1999.

Parameter	Annual Average	Highest Monthly Average Value	Permit Limit
BOD_5	16 mg/L 530 lbs./day	23 mg/L 867 lbs./day	30 mg/L 1001 lbs./day
TSS	12 mg/L 446 lbs./day	20 mg/L 899 lbs./day	30 mg/L 1001 lbs./day
Fecal Coliform Bacteria	15 CFU/100mL (median)	93 CFU/100mL	200 CFU/100mL

pH varied from 6.9 to 7.0 standard units

Influent pollutant loading and flow volume are important considerations for complying with secondary treatment standards at the WWTP. The permit requires that the City begin planning when either flows or waste loads reach 85% of the plant's capacity. The City submitted a re-evaluation of plant capacity in 1996 (RW Beck, 1995).

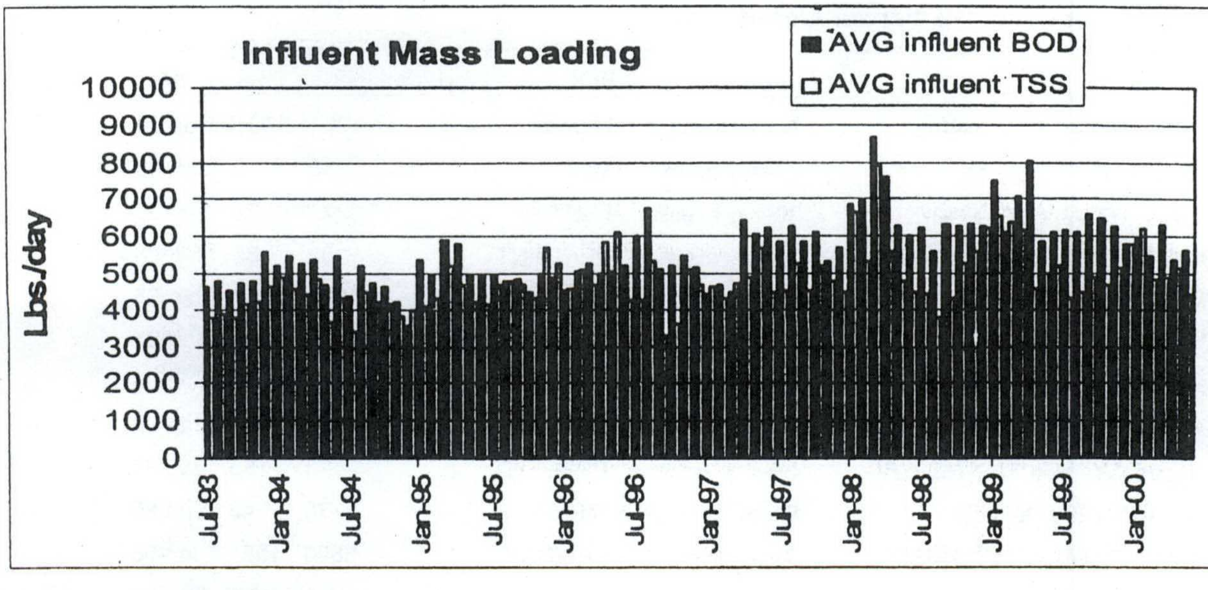

Figure 2: Influent Mass Loading.
The plant was originally rated with a capacity of 15,000 lbs./day of BOD and 7,800 lbs./day of TSS. The design capacity for BOD_5 loading has been recalcuated as 8,130 lbs./day for the wet season.

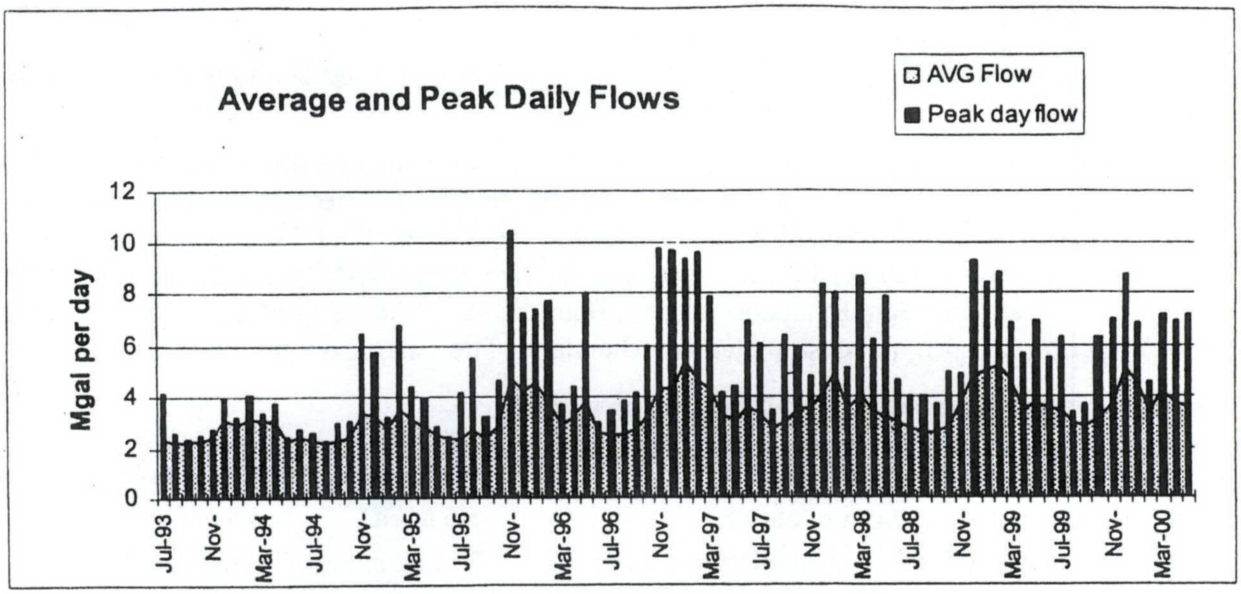

Figure 3: Average Monthly and Peak Daily Flows Through the WWTP. The original wet season design capacity was 4.0 MGD, the design capacity has been recalculated as 5.6 MGD.

The plant monitoring records indicate that the plant has not yet reached its design loading, but flows from December 1998 through February 1999 exceeded 85% of design (4.76 MGD average monthly flow) for three (3) consecutive months. The City is currently planning for treating increased flows as required by condition S4 of the permit.

PROPOSED PERMIT LIMITATIONS

Federal and State regulations require that effluent limitations set forth in a NPDES permit must be either technology- or water quality-based. Technology-based limitations for municipal discharges are set by regulation (40 CFR 133, and Chapters 173-220 and 173-221 WAC). Water quality-based limitations are based upon compliance with the Surface Water Quality Standards (Chapter 173-201A WAC), Ground Water Standards (Chapter 173-200 WAC), Sediment Quality Standards (Chapter 173-204 WAC), or the National Toxics Rule (Federal Register, Volume 57, No. 246, Tuesday, December 22, 1992.) The most stringent of these types of limits must be chosen for each of the parameters of concern. Each of these types of limits is described in more detail below.

The limits in this permit are based in part on information received in the application. The effluent constituents in the application were evaluated on a technology- and water quality-basis. The limits necessary to meet the rules and regulations of the State of Washington were determined and included in this permit. Ecology does not develop effluent limits for all pollutants that may be reported on the application as present in the effluent. Some pollutants are not treatable at the concentrations reported, are not controllable at the source, are not listed in regulation, and do not have a reasonable potential to cause a water quality violation. If significant changes occur in any constituent, as described in 40 CFR 122.42(a), the Permittee is required to notify the Department of Ecology.

DESIGN CRITERIA

In accordance with WAC 173-220-150 (1)(g), flows or waste loadings shall not exceed approved design criteria.

The original hydraulic and organic design criteria for this treatment facility were set based on the plant design as listed in the Contract No.4 Wastewater Facilities Project, Wastewater Treatment Plant for City of Mount Vernon, WA by RW Beck & Associates. That Facility Plan was approved by the Department on May 20, 1987. Those criteria have been revised based on the Mount Vernon Wastewater Treatment Plant Evaluation (R. W. Beck, 1995). The TSS criteria are taken from the previous permit and original design plans for the plant. The criteria are as follows:

Table 4: Design Standards for Mount Vernon WWTP.

Design Standards for wet months	**Wet season**	**Dry season**
Average Flow for the maximum month	5.6 MGD	4.8 MGD
Average Influent BOD_5 for the maximum month	8130 lbs./day	8920 lbs./day
Average Influent TSS for the maximum month	7800 lbs./day	7800 lbs./day

This plant has experienced a peak flow of 12 MGD during one CSO episode; effluent quality degraded to nearly beyond permit limits during that episode.

TECHNOLOGY-BASED EFFLUENT LIMITATIONS

Municipal wastewater treatment plants are a category of discharger for which technology-based effluent limits have been promulgated by federal and state regulations. These effluent limitations are given in the Code of Federal Regulations (CFR) 40 CFR Part 133 (federal) and in Chapter 173-221 WAC (state). These regulations are performance standards that constitute all known available and reasonable methods of prevention, control, and treatment for municipal wastewater.

The following technology-based limits for pH, fecal coliform, BOD_5, and TSS are taken from Chapter 173-221 WAC; the % removal requirements have been relaxed per WAC 173-221-050 (3) at the request of the Permittee due to treating CSO flows in the plant:

Table 5: Technology-based Limits.

Parameter	Limit
pH:	shall be within the range of 6 to 9 standard units.
Fecal Coliform Bacteria	Monthly Geometric Mean = 200 organisms/100 mL Weekly Geometric Mean = 400 organisms/100 mL
BOD_5 (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed twenty percent (20%) of the average influent concentration Average Weekly Limit = 45 mg/L
TSS (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed twenty percent (20%) of the average influent concentration Average Weekly Limit = 45 mg/L

The following technology-based mass limits for BOD_5 and TSS are based on WAC 173-220-130(3)(b) and 173-221-030(11)(b).

Monthly effluent mass loadings (lbs./day) were calculated as the maximum monthly design flow (5.6 MGD) x Concentration limit (30 mg/L) x 8.34 (conversion factor) = 1401 lbs./day.

The weekly average effluent mass loading is calculated as 1.5 x monthly loading = 2102 lbs./day.

The percent removal requirement for BOD_5 and TSS was relaxed because the WWTP processes CSO flows, that is sewage diluted by rainwater. Relaxing the removal percentage to 80% is based on BPJ. The influent strength regularly drops to about 150 mg/L. 15% of 150 mg/L is 22.5 mg/L; 20% of 150 mg/L is 30 mg/L. Removing 80% of the low strength influent during CSO episodes corresponds to the technology-based limits for effluent BOD_5 and TSS.

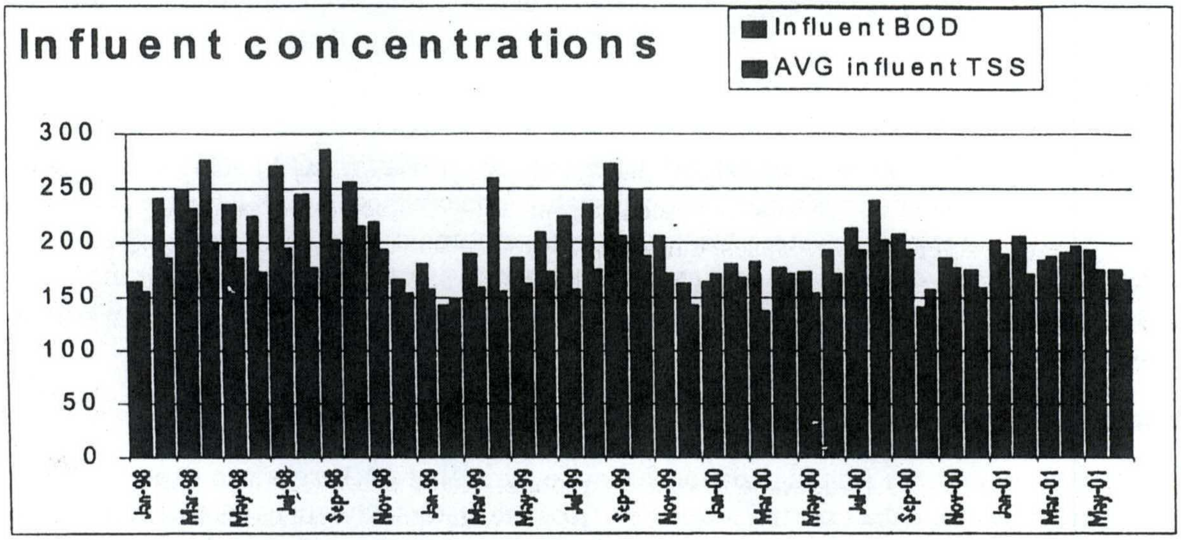

Figure 4: Influent TSS and BOD concentrations since CSO transport to the WWTP was initiated in 1998.

SURFACE WATER QUALITY-BASED EFFLUENT LIMITATIONS

In order to protect existing water quality and preserve the designated beneficial uses of Washington's surface waters, WAC 173-201A-060 states that waste discharge permits shall be conditioned such that the discharge will meet established Surface Water Quality Standards. The Washington State Surface Water Quality Standards (Chapter 173-201A WAC) is a state regulation designed to protect the beneficial uses of the surface waters of the state. Water quality-based effluent limitations may be based on an individual waste load allocation (WLA) or on a WLA developed during a basin-wide total maximum daily loading study (TMDL).

Numerical Criteria for the Protection of Aquatic Life

"Numerical" water quality criteria are numerical values set forth in the State of Washington's Water Quality Standards for Surface Waters (Chapter 173-201A WAC). They specify the levels of pollutants allowed in a receiving water while remaining protective of aquatic life. Numerical criteria set forth in the Water Quality Standards are used along with chemical and physical data for the wastewater and receiving water to derive the effluent limits in the discharge permit. When surface water quality-based limits are more stringent or potentially more stringent than technology-based limitations, they must be used in a permit.

Numerical Criteria for the Protection of Human Health

The state was issued 91 numeric water quality criteria for the protection of human health by the U.S. EPA (EPA, 1992). These criteria are designed to protect humans from cancer and other diseases and are primarily applicable to fish and shellfish consumption and drinking water from surface waters.

Narrative Criteria

In addition to numerical criteria, "narrative" water quality criteria (WAC 173-201A-030) limit toxic, radioactive, or deleterious material concentrations below those which have the potential to adversely affect characteristic water uses, cause acute or chronic toxicity to biota, impair aesthetic values, or adversely affect human health. Narrative criteria protect the specific beneficial uses of all fresh (WAC 173-201A-130) and marine (WAC 173-201A-140) waters in the State of Washington.

Antidegradation

The State of Washington's Antidegradation Policy requires that discharges into a receiving water shall not further degrade the existing water quality of the water body. In cases where the natural conditions of a receiving water are of lower quality than the criteria assigned, the natural conditions shall constitute the water quality criteria. Similarly, when the natural conditions of a receiving water are of higher quality than the criteria assigned, the natural conditions shall constitute the water quality criteria. More information on the State Antidegradation Policy can be obtained by referring to WAC 173-201A-070.

The Department has reviewed existing records and is unable to determine if ambient water quality is either higher or lower than the designated classification criteria given in Chapter 173-201A WAC; therefore, the Department will use the designated classification criteria for this water body in the proposed permit. The discharges authorized by this proposed permit will not cause a loss of beneficial uses.

Critical Conditions

Surface water quality-based limits are derived for the water body's critical condition, which represents the receiving water and waste discharge condition with the highest potential for adverse impact on the aquatic biota, human health, and existing or characteristic water body uses.

The following technology-based mass limits for BOD_5 and TSS are based on WAC 173-220-130(3)(b) and 173-221-030(11)(b).

Monthly effluent mass loadings (lbs./day) were calculated as the maximum monthly design flow (5.6 MGD) x Concentration limit (30 mg/L) x 8.34 (conversion factor) = 1401 lbs./day.

The weekly average effluent mass loading is calculated as 1.5 x monthly loading = 2102 lbs./day.

The percent removal requirement for BOD_5 and TSS was relaxed because the WWTP processes CSO flows, that is sewage diluted by rainwater. Relaxing the removal percentage to 80% is based on BPJ. The influent strength regularly drops to about 150 mg/L. 15% of 150 mg/L is 22.5 mg/L; 20% of 150 mg/L is 30 mg/L. Removing 80% of the low strength influent during CSO episodes corresponds to the technology-based limits for effluent BOD_5 and TSS.

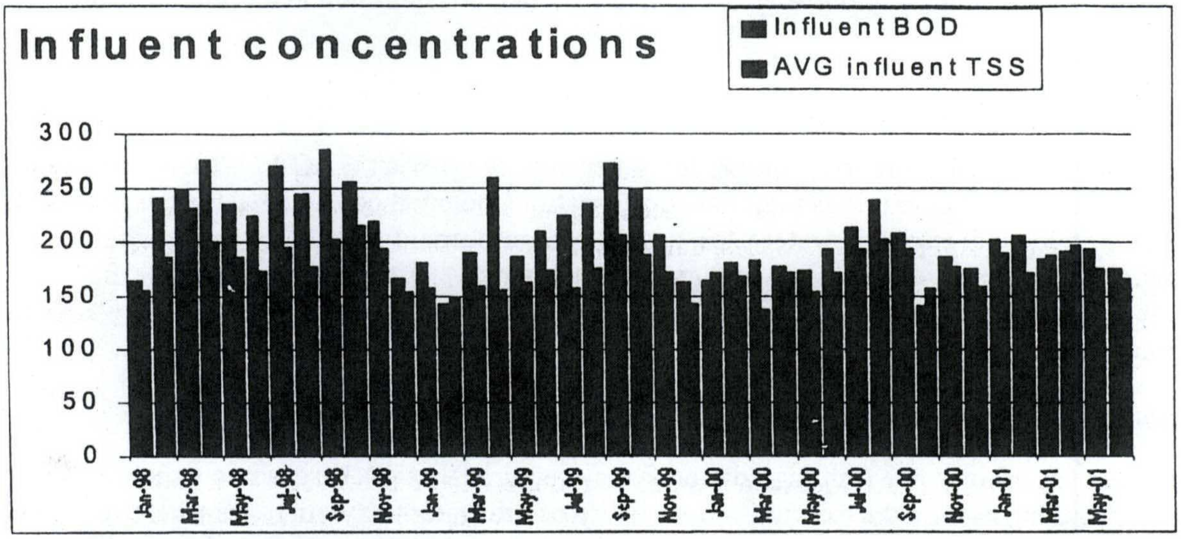

Figure 4: Influent TSS and BOD concentrations since CSO transport to the WWTP was initiated in 1998.

SURFACE WATER QUALITY-BASED EFFLUENT LIMITATIONS

In order to protect existing water quality and preserve the designated beneficial uses of Washington's surface waters, WAC 173-201A-060 states that waste discharge permits shall be conditioned such that the discharge will meet established Surface Water Quality Standards. The Washington State Surface Water Quality Standards (Chapter 173-201A WAC) is a state regulation designed to protect the beneficial uses of the surface waters of the state. Water quality-based effluent limitations may be based on an individual waste load allocation (WLA) or on a WLA developed during a basin-wide total maximum daily loading study (TMDL).

Mixing Zones

The Water Quality Standards allow the Department of Ecology to authorize mixing zones around a point of discharge in establishing surface water quality-based effluent limits. Both "acute" and "chronic" mixing zones may be authorized for pollutants that can have a toxic effect on the aquatic environment near the point of discharge. The concentration of pollutants at the boundary of these mixing zones may not exceed the numerical criteria for that type of zone. Mixing zones can only be authorized for discharges that are receiving all known, available, and reasonable methods of prevention, control, and treatment (AKART) and in accordance with other mixing zone requirements of WAC 173-201A-100.

The National Toxics Rule (EPA, 1992) allows the chronic mixing zone to be used to meet human health criteria.

Description of the Receiving Water

The facility discharges treated wastewater to the Skagit River, which is designated as a Class A receiving water in the vicinity of the treatment plant outfall. CSO outfalls are located within one mile upstream of the treatment plant outfall. Characteristic uses include the following: water supply (domestic, industrial, agricultural); stock watering; fish migration; fish rearing, spawning and harvesting; wildlife habitat; primary contact recreation; sport fishing; boating and aesthetic enjoyment; commerce and navigation.

Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

Surface Water Quality Criteria

Applicable criteria are defined in Chapter 173-201A WAC for aquatic biota. In addition, U.S. EPA has promulgated human health criteria for toxic pollutants (EPA, 1992). Criteria for this discharge are summarized below:

Fecal Coliforms	100 organisms/100 mL maximum geometric mean
Dissolved Oxygen	8 mg/L minimum
Temperature	18 degrees Celsius maximum or incremental increases above background
pH	6.5 to 8.5 standard units
Turbidity	less than 5 NTUs above background
Toxics	No toxics in toxic amounts (see Appendix C for numeric criteria for toxics of concern for this discharge)

CONSIDERATION OF SURFACE WATER QUALITY-BASED LIMITS FOR NUMERIC CRITERIA

Pollutant concentrations in the proposed discharge exceed water quality criteria with technology-based controls which the Department has determined to be AKART. A mixing zone is authorized in accordance with the geometric configuration, flow restriction, and other restrictions for mixing zones in Chapter 173-201A WAC and is defined as follows:

The dilution factors of effluent to receiving water that occur within these zones have been determined at the critical condition by the use of method of Fischer et al. – the Department's Rivplume model spreadsheet. The City of Mount Vernon submitted a study of the mixing characteristics at the wastewater treatment plant outfall, (Cosmopolitan, 2000) that included acute and chronic dilution factors for the current outfall. Based on the dye study and field measurements in that report, the Department calibrated the model and used the calibrated model to estimate acute and chronic dilution factors for the outfall (see Appendix C for the spreadsheet outputs). The mixing zone study concluded that the outfall must be improved to provide for compliance with State water quality standards as effluent flows increase. The estimated dilution associated with this discharge has reduced significantly in relation to the previous permit. The dilution factors have been determined to be:

Table 6: Estimated Dilution Factors for the WWTP Outfall into the Skagit River.

	Acute	Chronic
Aquatic Life	5:1	35:1
Human Health, Carcinogen	[redacted]	Use 35:1
Human Health, Non-carcinogen	[redacted]	Use 35:1

Pollutants in an effluent may affect the aquatic environment near the point of discharge (near-field) or at a considerable distance from the point of discharge (far-field). Toxic pollutants, for example, are near-field pollutants--their adverse effects diminish rapidly with mixing in the receiving water. Conversely, a pollutant such as BOD is a far-field pollutant whose adverse effect occurs away from the discharge even after dilution has occurred. Thus, the method of calculating water quality-based effluent limits varies with the point at which the pollutant has its maximum effect.

The derivation of water quality-based limits also takes into account the variability of the pollutant concentrations in both the effluent and the receiving water.

The Department analyzed the capacity of the lower Skagit River for pollutants discharged from point sources that have significant impact on dissolved oxygen levels in the water column. These pollutants are $CBOD_5$ or BOD_5 and ammonia (as NH_3-N). The results of the study are documented in three Department of Ecology documents: Lower Skagit Total Maximum Daily Load Data Summary (Ecology, 1996); Lower Skagit Total Maximum Daily Load Water Quality Study (Ecology, 1997); and Lower Skagit Total Maximum Daily Load Submittal Report (Ecology, 2000). Final waste load allocations (WLAs) and permit limitations for the City of Mount Vernon WWTP are listed in the latter publication and are shown in the following table.

Table 7: WLAs and Corresponding Permit Limits for the WWTP.

	Time in effect	$CBOD_5$ (lbs./day)	BOD_5 (lbs./day)	NH_3-N (lbs./day)
Alternative WLAs – for future use	*July 1 to Nov. 15*	*2712*	*3051*	*678*
WLAs	July 1 to Nov. 15	1902	2140	1188
Monthly average limit	July 1 to Oct. 31	1407	1583	922
Maximum daily (NH_3) or weekly (BOD_5 or $CBOD_5$)	July 1 to Nov. 15	1902	2140	1188

The alternative WLAs in the first row of the table demonstrate trading reduced ammonia output for increased BOD_5 output; this exchange provides for increased flows due to population growth offset by constructing new treatment facilities capable of treating for reduced ammonia levels. The permit contains permit limits based on waste load allocations with higher ammonia and lower BOD_5.

The permit shows limits for both BOD_5 or $CBOD_5$, the Permittee may measure either one to demonstrate compliance. The BOD_5 test, the measure used historically for the plant, also measures the influence of ammonia on oxygen uptake to a limited extent. The $CBOD_5$ test suppresses the influence of ammonia on oxygen uptake in the laboratory. BOD_5 testing is required for other reasons, $CBOD_5$ testing may be employed to more precisely demonstrate compliance with the WLAs derived in the Skagit TMDL.

Temperature--The impact of the discharge on the temperature of the receiving water was modeled by simple mixing analysis at critical condition. The receiving water temperature at the critical condition is 15.2° C and the effluent temperature is 20° C. The predicted resultant temperature at the boundary of the chronic mixing zone is 15.3° C and the incremental rise is 0.1° C.

Under critical conditions there is no predicted violation of the temperature standard; no effluent limitation for temperature was placed in the permit.

pH--The impact of pH and temperature were modeled using the calculations from EPA, 1988 (see Appendix C). The input variables were dilution factor 35:1, upstream temperature 15.2° C, upstream pH 7.7, upstream alkalinity 20 (as mg $CaCO_3$/L), effluent temperature 20° C, a range of effluent pH values, and effluent alkalinity 195 (as mg $CaCO_3$/L).

Under critical conditions there was a prediction of a violation of the pH criteria for the receiving water. An effluent limit of 6.6 to 9.0 for pH was found to meet the water quality criterion for pH. These limits are included in the permit with a compliance schedule that requires plans for meeting the limits to be submitted by June 30, 2003. The plant lacks the equipment to meet this new limitation at this time. An interim limit of 6.0 to 9.0, the technology-based limit is used as an interim limit.

Fecal Coliform--The lower Skagit River is listed on the State's 303d list (waters that fail to meet standards) for fecal coliform bacteria. The Lower Skagit Total Maximum Daily Load Water Quality Study (Ecology, 1997) concluded that compliance with the technology-based limit for fecal coliform was an appropriate waste load allocation for bacteria at the WWTP outfall. Reduction of CSO events at the Mount Vernon CSO outfalls to once per year is a sufficient reduction in bacteria output to return the lower Skagit to compliance with the bacteria standard (coupled with reductions in other sources outside of the City of Mount Vernon).

Toxic Pollutants--Federal regulations (40 CFR 122.44) require NPDES permits to contain effluent limits for toxic chemicals in an effluent whenever there is a reasonable potential for those chemicals to exceed the surface water quality criteria. This process occurs concurrently with the derivation of technology-based effluent limits. Facilities with technology-based effluent limits defined in regulation are not exempted from meeting the Water Quality Standards for Surface Waters or from having surface water quality-based effluent limits.

The following toxics were detected in the discharge: ammonia, copper, zinc, BHC-gamma (lindane), bis(2-ethylhexyl) phthalate, chloroform, and cyanide. The Department conducted an analysis with procedures given in EPA, 1991, to determine if there was a reasonable potential for any of these pollutants to exceed water quality standards outside of the mixing zones during critical conditions (see Appendix C). Effluent limitations are required for any pollutants with potential to exceed standards. The critical condition in this case occurs during the fall. The parameters used in the critical condition modeling are as follows: acute dilution factor 5:1, chronic dilution factor 35:1, receiving water temperature 15.4° C, pH of 7.8, and receiving water hardness 25 (as mg $CaCO_3$/L).

Water quality criteria for metals in Chapter 173-201A WAC are based on the dissolved fraction of the metal.

Effluent limits were derived for copper, zinc, ammonia, and chlorine, which were determined to have a reasonable potential to cause a violation of the Water Quality Standards. Chlorine is used to disinfect the effluent, then is chemically neutralized. Effluent limits were calculated using methods from EPA, 1991, as shown in Appendix C. The ammonia-N water quality criteria are taken from the mixing zone study (Cosmopolitan, 2000). That report derived the ammonia criteria based on ambient conditions during the summer and fall months from 1992 to 1997. Ammonia limits are based on a normal distribution instead of the lognormal distribution frequently used to model discharges because the data follows the normal distribution. The resultant effluent limits are as follows [8.34 x 5.6 MGD x concentration limit (mg/L) = mass limit]:

Table 8: Water Quality-Based Limits to Meet Numerical Water Quality Standards.

Parameter	Average Monthly Limit	Maximum Daily Limit
NH_3-N (as N)	30 mg/L, 1400 lbs./day	41 mg/L
copper	9.4 ug/L, 0.44 lbs./day	16.6 ug/L
zinc	88.4 ug/L, 4.13 lbs./day	177.4 ug/L
chlorine	47.4 ug/L, 2.21 lbs./day	95.0 ug/L

The permit contains a compliance schedule for meeting the water quality-based limits for copper. The WWTP has collected extensive data on copper levels in the effluent (see Appendix C). The WWTP can not meet the copper limit based on the data collected from 1993 to 1995; the mean copper level in the effluent during that period was 18 ug/L. The City has submitted an analysis of effluent limitations for several metals and dilution available by modifying the outfall. That report concluded that modifying the outfall is necessary to meet water quality standards for several parameters as WWTP flows increase. The City has no industrial dischargers that discharge metals. The Department also will require that the City submit a sampling plan to assure that reported values of trace metals are as accurate as possible. An interim copper limitation based on previous sampling by the facility is included in the permit to assure the level of copper discharged does not increase.

The interim limit was calculated with the spreadsheet used for other permit limitations, but the 98% maximum of 35 ug/L was entered as a WLA (maximum amount allowed to be discharged, then limits were calculated from that WLA). The calculation yielded limits of 21 ug/L monthly average and 35 ug/L daily maximum. Note that copper is present in multivitamin supplements at a level of 1,000 ug per tablet and copper pipe is commonly used in household plumbing.

The Permittee may provide data clearly demonstrating the seasonal partitioning of the dissolved metal in the ambient water in relation to an effluent discharge. Water quality criteria for metals in Chapter 173-201A WAC are based on the dissolved fraction of the metal. Metals criteria may be adjusted on a site-specific basis when data is available clearly demonstrating the seasonal partitioning in the ambient water in relation to an effluent discharge.

Metals criteria may also be adjusted using the water effects ratio approach established by USEPA, as generally guided by the procedures in USEPA Water Quality Standards Handbook, December 1983, as supplemented or replaced.

WHOLE EFFLUENT TOXICITY

The Water Quality Standards for Surface Waters require that the effluent not cause toxic effects in the receiving waters. Many toxic pollutants cannot be detected by commonly available detection methods. However, toxicity can be measured directly by exposing living organisms to the wastewater in laboratory tests and measuring the response of the organisms. Toxicity tests measure the aggregate toxicity of the whole effluent, and therefore this approach is called whole effluent toxicity (WET) testing. Some WET tests measure acute toxicity (death is the endpoint) and other WET tests measure chronic toxicity (growth, reproduction, and mortality are measured as endpoints).

The Department sets performance standards and effluent limits (shown in Table 9) in Chapter 173-205 WAC. A Permittee that meets the performance standards during effluent characterization or during routine testing required in a permit does not receive permit limits. If a Permittee fails to meet a performance standard, they receive limits for WET and perform routine testing during a permit cycle. Acute WET and chronic WET are treated as two separate limits, so a Permittee can receive a limit for acute WET, chronic WET, or both. When the Permittee meets the performance standard for a period of three (3) years during the routine testing, then the effluent limit can be removed from the permit.

Table 9: Performance Criteria and Limits for WET.
NOEC means no observable effects concentration.

Test description	Performance criteria in state regulation	Permit limit
96-hour fathead minnow acute toxicity	Median of 80% and minimum of 65% survival required in 100% effluent.	Median of 80% and minimum of 65% survival required in 20% effluent.
48-hour daphnid acute toxicity test	Median of 80% and minimum of 65% survival required in 100% effluent.	Median of 80% and minimum of 65% survival required in 20% effluent.
7-day fathead minnow survival and growth test	NOEC equal to or greater than 20% effluent	NOEC equal to or greater than 3% effluent
Chronic (>7-days) Ceriodaphnia survival and reproduction test	NOEC equal to or greater than 20% effluent	NOEC equal to or greater than 3% effluent

Acute toxicity tests measure mortality as the significant response to the toxicity of the effluent. Dischargers who monitor their wastewater with acute toxicity tests are providing an indication of the potential lethal effect of the effluent to organisms in the receiving environment.

Chronic toxicity tests measure various sublethal toxic responses such as retarded growth or reduced reproduction. Chronic toxicity tests often involve either a complete life cycle test of an organism with an extremely short life cycle or a partial life cycle test on a critical stage of one of a test organism's life cycles. Organism survival is also measured in some chronic toxicity tests.

Accredited WET testing laboratories have the proper WET testing protocols, data requirements, and reporting format. Accredited laboratories are knowledgeable about WET testing and capable of calculating an NOEC, LC_{50}, EC_{50}, IC_{25}, etc. All accredited labs have been provided the most recent version of the Department of Ecology Publication # WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria,* which is referenced in the permit. Any Permittee interested in receiving a copy of this publication may call the Ecology Publications Distribution Center (360-407-7472) for a copy. Ecology recommends that Permittees send a copy of the acute or chronic toxicity sections(s) of their permits to their laboratory of choice.

The Permittee's effluent has been determined to have the potential to contain toxic chemicals. Effluent tests for acute and chronic toxicity were conducted during the previous permit term. Tables 10 & 11 show the test results. These tests are dated and were not necessarily conducted in accordance with state regulation (The regulation covering WET testing was promulgated after the 1993 permit was issued.). In accordance with WAC 173-205, the Permittee conducts a WET effluent characterization for the following reasons:

- Toxicity was detected during previous WET tests.
- Average plant flows have increased since the previous tests were conducted. The acute and chronic dilution factors have been revised significantly based on new information. A dechlorination system was added to the treatment system in 1998.
- Some testing was done with species that are not used in the current regulation and the test data is old.

Table 10: Mt. Vernon WWTP Acute WET Test Results as % Survival in 100% Effluent.

Lab	Test	Species	Sample Date	Test Date	Protocol	Duration	% Survival
WANCA	KJOH380	Rainbow Trout	7/26/1993	7/27/1993	EPAA 91	96 hours	90
WAPTL	KJOH383	Fathead Minnow	9/20/1993	9/21/1993	EPAF 89	96 hours	2.5
WANCA	KJOH382	Rainbow Trout	10/25/1993	10/26/1993	EPAA 91	96 hours	75
WAPTL	KJOH385	Fathead Minnow	4/25/1994	4/26/1994	EPAF 89	96 hours	0
WAPTL	KJOH387	Fathead Minnow	6/14/1994	6/15/1994	EPAF 89	96 hours	0
WAPTL	AQTX1558	*Daphnia pulex*	11/4/1997	11/4/1997	EPAA 91	48 hours	95
WAPTL	AQTX1818	Fathead Minnow	5/19/1998	5/19/1998	EPAA 91	96 hours	97.5

Table 11: Mt. Vernon WWTP Chronic WET Test Results as NOEC/LOEC in % Effluent.

Lab	Test	Species	Sample Date	Test Date	Protocol	End Point	NOEC	LOEC
WAPTL	KJOH381	*Ceriodaphnia dubia*	8/23/1993	8/24/1993	EPAF 89	7d Proportion Survived	50	100
						Reproduction	25	50
WAPTL	KJOH383	Fathead Minnow	9/20/1993	9/21/1993	EPAF 89	7d Proportion Survived	25	50
						Mean Weight	50	100
						Mean Biomass	25	50
WAPTL	KJOH384	*Ceriodaphnia dubia*	3/14/1994	3/15/1994	EPAF 89	7d Proportion Survived	50	100
						Reproduction	25	50
WAPTL	KJOH385	Fathead Minnow	4/25/1994	4/26/1994	EPAF 89	7d Proportion Survived	50	100
						Mean Weight	25	50
						Mean Biomass	25	50
WAPTL	KJOH386	*Ceriodaphnia dubia*	5/31/1994	6/1/1994	EPAF 89	7d Proportion Survived	50	100
						Reproduction	50	100
WAPTL	KJOH387	Fathead Minnow	6/14/1994	6/15/1994	EPAF 89	7d Proportion Survived	25	50
						Mean Weight	12.5	25
						Mean Biomass	6.25	12.5

Lab	Test	Species	Sample Date	Test Date	Protocol	End Point	NOEC	LOEC
WAAVO	AQTX1561	Fathead Minnow	10/14/1997	10/14/1997	EPAF 94	7d Proportion Survived	10	100
						Mean Weight	100	> 100
						Mean Biomass	10	100
WAAVO	AQTX1560	*Ceriodaphnia dubia*	10/21/1997	10/21/1997	EPAF 94	7d Proportion Survived	10	100
						Reproduction	5	10

If the WET performance criteria in Table 9 are met during the one-year WET characterization, then no additional tests are required. If the Permittee fails to meet the performance criteria during the characterization testing, then routine WET testing is required to show compliance with effluent limits. If the permit limits are not met, then the Permittee is required to increase testing frequency, locate the source of the toxicity, and eliminate it. Additional characterization tests may be required for the next permit application.

The acute toxicity limit is set relative to the zone of acute criteria exceedance (acute mixing zone) established in accordance with WAC 173-201A-100. The acute critical effluent concentration (ACEC) is the concentration of effluent existing at the boundary of the acute mixing zone during critical conditions. This value is 20% (1/5) effluent. The acute toxicity limit is no statistically significant difference in test organism survival between the ACEC, 20% of the effluent, and the control.

The chronic toxicity limit is set relative to the mixing zone established in accordance with WAC 173-201A-100. The chronic critical effluent concentration (CCEC) is the concentration of effluent existing at the boundary of the mixing zone during critical conditions. This value is 3% (1/35) effluent. Monitoring for compliance with a chronic toxicity limit is accomplished by conducting a chronic toxicity test using a sample of effluent diluted to equal the CCEC and comparing test organism response in the CCEC to organism response in nontoxic control water. The Permittee is in compliance with the chronic toxicity limit if there is no statistically significant difference in test organism response between the CCEC of 3% effluent and the control.

If the Permittee makes process or material changes which, in the Department's opinion, results in an increased potential for effluent toxicity, then the Department may require additional effluent characterization in a regulatory order, by permit modification, or in the permit renewal. Toxicity is assumed to have increased if WET testing conducted for submission with a permit application fails to meet the performance standards in WAC 173-205-020, "whole effluent toxicity performance standard." The Permittee may demonstrate to the Department that changes have not increased effluent toxicity by performing additional WET testing after the time the process or material changes have been made.

HUMAN HEALTH

Washington's water quality standards now include 91 numeric health-based criteria that must be considered in NPDES permits. These criteria were promulgated for the state by the U.S. EPA in its National Toxics Rule (Federal Register, Volume 57, No. 246, Tuesday, December 22, 1992).

The Department has determined that the effluent is likely to have chemicals of concern for human health. The discharger's high priority status is based on the discharger's status as a major discharger.

A determination of the discharge's potential to cause an exceedance of the water quality standards was conducted as required by 40 CFR 122.44(d). The reasonable potential determination was evaluated with procedures given in the Technical Support Document for Water Quality-Based Toxics Control (EPA/505/2-90-001) and the Department's Permit Writer's Manual (Ecology Publication 92-109, July 1994). The determination indicated that the discharge has no reasonable potential to cause a violation of water quality standards, thus an effluent limit is not warranted.

SEDIMENT QUALITY

The Department has been unable to determine at this time the potential for this discharge to cause a violation of sediment quality standards. The Department has not set specific chemical criteria for freshwater sediments. The treatment system employed is designed to remove significant portions of solids, so sediment deposition from this discharge is unlikely. If the Department determines in the future that there is a potential for violation of the Sediment Quality Standards, an order will be issued to require the Permittee to demonstrate that either the point of discharge is not an area of deposition or, if the point of discharge is a depositional area, that there is not an accumulation of toxics in the sediments.

COMPARISON OF EFFLUENT LIMITS WITH THE EXISTING PERMIT ISSUED in 1993

Parameter	Limits in 1993 permit	Proposed technology-based Limits	Proposed WQ toxicity Limits	Proposed TMDL Limits
BOD_5 (November through June)	monthly average 30 mg/L, 1000 lbs./day weekly maximum 45 mg/L, 1500 lbs./day	**monthly average** **30 mg/L, 1401 lbs./day** **weekly maximum** **45 mg/L, 2102 lbs./day**	Not applicable	Not applicable
BOD_5 (July through October)	monthly average 30 mg/L, 1000 lbs./day weekly maximum 45 mg/L, 1500 lbs./day	**monthly average** **30 mg/L, 1401 lbs./day** **weekly maximum** **45 mg/L, 2102 lbs./day**	Not applicable	monthly average 1583 lbs./day weekly maximum 2140 lbs./day
Ammonia as NH_3-N (November through June)	Not applicable	Not applicable	**monthly average** **30 mg/L, 1400 lbs./day** **daily maximum** **41 mg/L**	Not applicable
Ammonia as NH_3-N (July through October)	Not applicable	Not applicable	**monthly average** **30 mg/L,** 1400 lbs./day **daily maximum** **41 mg/L**	**monthly average** **922 lbs./day** **daily maximum** **1188 lbs./day**
TSS	monthly average 30 mg/L, 1000 lbs./day weekly maximum 45 mg/L, 1500 lbs./day	monthly average 30 mg/L, 1401 lbs./day weekly maximum 45 mg/L, 2102 lbs./day	Not applicable	Not applicable
pH	shall be within the range of 6 to 9 standard units	shall be within the range of 6.0 to 9 standard units	**shall be within the range of 6.6 to 9 standard units**	Not applicable

Parameter	Limits in 1993 permit	Proposed technology-based Limits	Proposed WQ toxicity Limits	Proposed TMDL Limits
Fecal Coliform Bacteria	monthly average 200/100 mL weekly maximum 400/100 mL	**monthly average 200/100 mL weekly maximum 400/100 mL**	Not applicable	monthly average 200/100 mL weekly maximum 400/100 mL
Total Residual Chlorine	(Interim) 0.5 mg/L monthly average 0.75 mg/L weekly maximum	Not applicable	**monthly average 0.05 mg/L, 2.2 lbs./day daily maximum 0.10 mg/L**	Not applicable
Copper (interim)	none	Not applicable	**monthly average 21 ug/L, 0.98 lbs./day daily maximum 35 ug/L**	Not applicable
Copper	monthly average 28 ug/L daily maximum 48 ug/L	Not applicable	**monthly average 9.4 ug/L, 0.44 lbs./day daily maximum 16.6 ug/L**	Not applicable
Zinc	none	Not applicable	**monthly average 88.4 ug/L, 4.13 lbs./day daily maximum 177.4 ug/L**	Not applicable

(Note: The copper limit in the 1993 permit was removed by modification.)

MONITORING REQUIREMENTS

Monitoring, recording, and reporting are required (WAC 173-220-210 and 40 CFR 122.41) to verify that the treatment process is functioning correctly and the effluent limitations are being achieved.

Monitoring of sludge quantity and quality is necessary to determine the appropriate uses of the sludge. Sludge monitoring is required by the current state and local solid waste management program and also by EPA under 40 CFR 503.

The monitoring schedule is detailed in the proposed permit under Condition S.2. Specified monitoring frequencies take into account the quantity and variability of discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring. The required monitoring frequency is consistent with agency guidance given in the current version of Ecology's *Permit Writer's Manual* (July 1994) for an activated sludge plant with annual average design flow 2.0 to 5.0 MGD.

WET testing frequencies are also based on Ecology's *Permit Writer's Manual.* The discharge meets a Rank 4 that calls for four acute and two chronic WET tests per year. The effluent contains low levels of toxic pollutants listed in Appendix D of 40 CFR Part 122 (15 points), has had toxicity detected in past tests (10 points), has an average annual flow between 0.5 and 12.5 MGD (10 points), and has a CCEC between 2% and 4% effluent (10 points). This yields a score of (15+10) x (10+10) = 500; Rank 4 runs from 100 to 750 points in the *Permit Writer's Manual.*

LAB ACCREDITATION

With the exception of certain parameters, the permit requires all monitoring data to be prepared by a laboratory registered or accredited under the provisions of Chapter 173-50 WAC, *Accreditation of Environmental Laboratories.* The laboratory at this facility is accredited for fecal coliform, ammonia, BOD_5, TSS, Total Residual Chlorine, and pH.

OTHER PERMIT CONDITIONS

REPORTING AND RECORDKEEPING

The conditions of S3. are based on the authority to specify any appropriate reporting and record keeping requirements to prevent and control waste discharges (WAC 273-220-210).

PREVENTION OF FACILITY OVERLOADING

Overloading of the treatment plant is a violation of the terms and conditions of the permit. To prevent this from occurring, RCW 90.48.110 and WAC 173-220-150 require the Permittee to take the actions detailed in proposed permit requirement S.4. to plan expansions or modifications before existing capacity is reached and to report and correct conditions that could result in new or increased discharges of pollutants.

OPERATION AND MAINTENANCE (O&M)

The proposed permit contains condition S.5. as authorized under RCW 90.48.110, WAC 173-220-150, Chapter 173-230 WAC, and WAC 173-240-080. It is included to ensure proper operation and regular maintenance of equipment, and to ensure that adequate safeguards are taken so that constructed facilities are used to their optimum potential in terms of pollutant capture and treatment.

RESIDUAL SOLIDS HANDLING

To prevent water quality problems, the Permittee is required in permit condition S7. to store and handle all residual solids (grit, screenings, scum, sludge, and other solid waste) in accordance with the requirements of RCW 90.48.080 and State Water Quality Standards.

The final use and disposal of sewage sludge from this facility is regulated by U.S. EPA under 40 CFR 503. The disposal of other solid waste is under the jurisdiction of the local health department where the material is disposed of.

PRETREATMENT

The Department administers the pretreatment program for this WWTP. Under this delegation of authority, the Department writes and issues wastewater discharge permits for significant industrial users (SIUs) discharging to the City of Mount Vernon sewer system. The City may refuse to accept industrial discharges to their system. The Permittee may request delegation from the Department to manage their own pretreatment program at any time.

Currently two industrial users discharge to the Mount Vernon WWTP. Draper Valley Farms processes chickens and discharges wash water to the system. Hallmark Refining reclaims photo finishing liquids and discharges trace levels of metals to the system.

Federal requirements for a Pretreatment Program are contained in Title 40, part 403, of the Code of Federal Regulations. State requirements for the discharge of nondomestic wastewater to a public sewer system are set Chapter 173-216 WAC. The Department requires SIUs and other industrial dischargers to obtain a State Waste Discharge Permit prior to discharging to the sewer system. The State regulation exempts wastewater discharges that are similar in character to domestic wastewater from the permit requirement. The Department has the final authority to determine whether a permit is required of an industrial or commercial discharger. Any industrial or commercial facility that discharges wastewater generated should contact the Department to determine if a permit is required. Industrial dischargers are required to apply for a discharge permit sixty (60) days prior to commencing discharge (WAC 173-216-110). The permit requires that the City notify the Department of any new or previously undetected industrial discharges immediately to assure compliance with these requirements.

The permit requires the Permittee to provide a list of industrial users with the next permit application. Methods for generating the list may include review of business tax licenses in the area, water billing records, local telephone directories, and connection authorization records. The City of Mount Vernon should require that the various city departments involved with issuing building permits or performing inspections of commercial and industrial facilities be aware of the requirements for obtaining a state permit for wastewater discharges. The pretreatment program protects the treatment plant from breakdowns caused by toxic discharges to the sewer system.

The permit prohibits the POTW from authorizing or permitting an industrial discharger to discharge certain types of waste into the sanitary sewer. These prohibitions are taken directly from 40 CFR Part 403 and WAC 173-216-060. The prohibitions are included to prevent pass through or interference, upset of the plant processes, damage to the collection or treatment system, hazardous conditions for plant personnel and the public. Discharge of water that does not need treatment in a POTW is prohibited except under exceptional circumstances.

COMBINED SEWER OVERFLOWS (CSOs)

In 1996 the City of Mount Vernon entered into Order on Consent DE 96WQ-N105 in which the City agreed to a schedule to reduce CSOs to once per year by the year 2015. The City has remained in compliance with the order. The City completed a comprehensive sewer plan including long term plans for correcting overflows. They designed and constructed the Central CSO Interceptor to store CSO flows for treatment at the WWTP in 1998. That project also installed flow measure and sampling equipment on the CSO control structure to provide information for measuring and characterizing CSO episodes. Mount Vernon submits an annual report to summarize CSO discharge quantities and reduction related accomplishments to the Department. Data from annual CSO reports is summarized in Table 12.

Table 12: Summary of CSO Discharge from 1996 to 2000.

	Total Annual Flow (MG)	Total Number of Events	Annual Precipitation	Comments
Baseline[1]	116	130	32.0	Estimated average before CSO controls in place, CSO episodes are precipitation dependent.
1996	124	Unknown	34.4	No direct data flow or event count available.
1997	119	About 89	33.7	Event Count Based on Division Street
1998	17	4	33.4	CSO controls went online in March 1998
1999	11	7	37.2	Operational controls of CSO Regulator in tandem with WWTP refined. Sampling provided data on overflow characteristics.
2000	12	3	24	Sampling provided data on overflow characteristics.

[1] Baseline is from Comprehensive Sewer and Combined Sewer Overflow Reduction Plans for City of Mount Vernon, R.W. Beck, 1991.

The impact of the Mount Vernon CSOs on water quality in the Skagit River has been significantly reduced by the improvements constructed over the last five years. Sampling of CSOs in 1999 averaged a BOD_5 concentration of 24 mg/L and TSS concentration of 50 mg/L based on composite samples from the overflows. City staff sampled fecal coliform bacteria immediately upstream of the CSO discharges at the Division Street Bridge and then downstream of the CSO outfalls and immediately upstream of the WWTP outfall. The differences between the two measurements ranged from 150 to 1400 cfu per 100 mL. The downstream values ranged from 230 to 1483 cfu per 100 mL. The BOD_5 concentration of the CSO generally meets the secondary treatment standard of 30 mg/L monthly average, 45 mg/L weekly maximum. The TSS concentration sometimes exceeds the standard of 30 mg/L monthly average, 45 mg/L weekly maximum. The fecal coliform bacteria concentration in the river is elevated during CSO events, but the reduction in volume and duration of the events provide significant improvement in water quality.

Other measures cited by the City in reducing the quantity and impact of CSOs on the Skagit River are installation of separate storm and sanitary pipes in conjunction with major street improvement projects, household and small business hazardous waste collection, street sweeping, and new equipment purchases to enhance the function and reliability of the CSO transport system.

The text of ORDER ON CONSENT No. DE 96WQ-N105 is included in Appendix D. Remaining milestones in the Order are:

- Upgrade the Park Street Pump Station with new pumps (Improvement number CA-1a) no later than January 1, 2015.
- Upgrade wastewater treatment plant to provide treatment/storage of CSO flows to reduce overflow events to an average of one per year no later than January 1, 2015.

In accordance with RCW 90.48.480 and Chapter 173-245 WAC, proposed permit Condition S10 requires the Permittee to submit an annual Combined Sewer Overflow (CSO) report and to update its CSO reduction plan at the time of permit renewal. Condition S10 also includes requirements for sampling CSO discharges at least once per year, although sampling for bacteria levels in the Skagit River is required only if the samples can be collected safely. The permit also requires the Permittee to maintain notification signs at the CSO outfalls.

GENERAL CONDITIONS

General Conditions are based directly on state and federal law and regulations and have been standardized for all individual municipal NPDES permits issued by the Department.

Condition G1 requires responsible officials or their designated representatives to sign submittals to the Department. Condition G2 requires the Permittee to allow the Department to access the treatment system, production facility, and records related to the permit. Condition G3 specifies conditions for modifying, suspending, or terminating the permit. Condition G4 requires the Permittee to apply to the Department prior to increasing or varying the discharge from the levels stated in the permit application. Condition G5 requires the Permittee to construct, modify, and operate the permitted facility in accordance with approved engineering documents. Condition G6 prohibits the Permittee from using the permit as a basis for violating any laws, statutes, or regulations. Conditions G7 relates to permit renewal. Condition G8 prohibits the reintroduction of removed substances back into the effluent. Condition G9 states that the Department will modify or revoke and reissue the permit to conform to more stringent toxic effluent standards or prohibitions. Condition G10 incorporates by reference all other requirements of 40 CFR 122.41 and 122.42. Condition G11 notifies the Permittee that additional monitoring requirements may be established by the Department. Condition G12 requires the payment of permit fees. Condition G13 describes the penalties for violating permit conditions.

PERMIT ISSUANCE PROCEDURES

PERMIT MODIFICATIONS

The Department may modify this permit to impose numerical limitations, if necessary, to meet Water Quality Standards, Sediment Quality Standards, or Ground Water Standards, based on new information obtained from sources such as inspections, effluent monitoring, outfall studies, and effluent mixing studies. The Department may also modify the permit to reflect changes or improvements to the treatment facilities.

The Department may also modify this permit as a result of new or amended state or federal regulations.

RECOMMENDATION FOR PERMIT ISSUANCE

This proposed permit meets all statutory requirements for authorizing a wastewater discharge, including those limitations and conditions believed necessary to protect human health, aquatic life, and the beneficial uses of waters of the State of Washington. The Department proposes that this permit be issued for two (2) years.

REFERENCES FOR TEXT AND APPENDICES

Cosmopolitan Engineering Group

2000. Mount Vernon WWTP Mixing Zone Study. Unpublished report to the Department of Ecology from the City of Mount Vernon.

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1991. Wastewater Engineering, Treatment, Disposal, and Reuse. Third Edition.

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1995. Mount Vernon Wastewater Treatment Plant Evaluation. Unpublished engineering report submitted to the Department of Ecology by the City of Mount Vernon.

1991. Comprehensive Sewer and Combined Sewer Overflow Reduction Plans for City of Mount Vernon. Unpublished technical report submitted to the Department of Ecology by the City of Mount Vernon.

Washington State Department of Ecology.

1994. Permit Writer's Manual. Publication Number 92-109

2000. Lower Skagit River Dissolved Oxygen Total Maximum Daily Load Submittal Report. Publication Number 00-10-031.

2000. Lower Skagit River Fecal Coliform Total Maximum Daily Load Submittal Report. Publication Number 00-10-010.

Wright, R.M., and A.J. McDonnell.

1979. In-stream Deoxygenation Rate Prediction. Journal Environmental Engineering Division, ASCE. 105(EE2). (Cited in EPA 1985 op.cit.)

APPENDIX A--PUBLIC INVOLVEMENT INFORMATION

The Department has tentatively determined to reissue a permit to the applicant listed on page one of this fact sheet. The permit contains conditions and effluent limitations which are described in the rest of this fact sheet.

Public Notice of Application (PNOA) was published on November 22, 1997, and November 29, 1997, in the *Skagit Valley Herald* to inform the public that an application had been submitted and to invite comment on the reissuance of this permit.

The Department will publish a Public Notice of Draft (PNOD) on date, in name of publication to inform the public that a draft permit and fact sheet are available for review. Interested persons are invited to submit written comments regarding the draft permit. The draft permit, fact sheet, and related documents are available for inspection and copying between the hours of 8:00 a.m. and 5:00 p.m. weekdays, by appointment, at the regional office listed below. Written comments should be mailed to:

Water Quality Permit Coordinator
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

Any interested party may comment on the draft permit or request a public hearing on this draft permit within the thirty (30) day comment period to the address above. The request for a hearing shall indicate the interest of the party and the reasons why the hearing is warranted. The Department will hold a hearing if it determines there is a significant public interest in the draft permit (WAC 173-220-090). Public notice regarding any hearing will be circulated at least thirty (30) days in advance of the hearing. People expressing an interest in this permit will be mailed an individual notice of hearing (WAC 173-220-100).

The Department will consider all comments received within thirty (30) days from the date of public notice of draft indicated above, in formulating a final determination to issue, revise, or deny the permit. The Department's response to all significant comments is available upon request and will be mailed directly to people expressing an interest in this permit.

Further information may be obtained from the Department by telephone, 425-649-7215, or by writing to the address listed above.

This permit and fact sheet were written by Gerald Shervey, PE, Water Quality Engineer.

APPENDIX B--GLOSSARY

Acute Toxicity--The lethal effect of a pollutant on an organism that occurs within a short period of time, usually 48 to 96 hours.

AKART--An acronym for "all known, available, and reasonable methods of prevention, control, and treatment."

Ambient Water Quality--The existing environmental condition of the water in a receiving water body.

Ammonia--Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Average Monthly Discharge Limitation--The highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month (except in the case of fecal coliform). The daily discharge is calculated as the average measurement of the pollutant over the day.

Average Weekly Discharge Limitation--The highest allowable average of daily discharges over a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. The daily discharge is calculated as the average measurement of the pollutant over the day.

Best Management Practices (BMPs)--Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural, and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD_5--Determining the Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD_5 is used in modeling to measure the reduction of dissolved oxygen in a receiving water after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass--The intentional diversion of waste streams from any portion of a treatment facility.

Chlorine--Chlorine is used to disinfect wastewaters of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Chronic Toxicity--The effect of a pollutant on an organism over a relatively long time, often 1/10 of an organism's life span or more. Chronic toxicity can measure survival, reproduction or growth rates, or other parameters to measure the toxic effects of a compound or combination of compounds.

Clean Water Act (CWA)--The Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

Combined Sewer Overflow (CSO)--The event during which excess combined sewage flow caused by inflow is discharged from a combined sewer, rather than conveyed to the sewage treatment plant because either the capacity of the treatment plant or the combined sewer is exceeded.

Compliance Inspection - Without Sampling--A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

Compliance Inspection - With Sampling--A site visit to accomplish the purpose of a Compliance Inspection - Without Sampling and as a minimum, sampling and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the percent removal requirement. Additional sampling may be conducted.

Composite Sample--A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing a minimum of four discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

Construction Activity--Clearing, grading, excavation, and any other activity which disturbs the surface of the land. Such activities may include road building, construction of residential houses, office buildings, or industrial buildings, and demolition activity.

Critical Condition--The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

Dilution Factor--A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the effluent fraction, e.g., a dilution factor of 10 means the effluent comprises 10% by volume and the receiving water 90%.

Engineering Report--A document which thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report shall contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria--Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample--A single sample or measurement taken at a specific time or over as short period of time as is feasible.

Industrial User--A discharger of wastewater to the sanitary sewer which is not sanitary wastewater or is not equivalent to sanitary wastewater in character.

Industrial Wastewater--Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

Infiltration and Inflow (I/I)--"Infiltration" means the addition of ground water into a sewer through joints, the sewer pipe material, cracks, and other defects. "Inflow" means the addition of precipitation-caused drainage from roof drains, yard drains, basement drains, street catch basins, etc., into a sewer.

Interference--A discharge which, alone or in conjunction with a discharge or discharges from other sources, both:

Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and

Therefore is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) [including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA], sludge regulations appearing in 40 CFR Part 507, the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.

Major Facility--A facility discharging to surface water with an EPA rating score of >80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Maximum Daily Discharge Limitation--The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.

Method Detection Level (MDL)--The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is above zero and is determined from analysis of a sample in a given matrix containing the analyte.

Minor Facility--A facility discharging to surface water with an EPA rating score of <80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Mixing Zone--A volume that surrounds an effluent discharge within which water quality criteria may be exceeded. The area of the authorized mixing zone is specified in a facility's permit and follows procedures outlined in State regulations (Chapter 173-201A WAC).

National Pollutant Discharge Elimination System (NPDES)--The NPDES (Section 402 of the Clean Water Act) is the Federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the State of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/State permits issued under both State and Federal laws.

Pass Through--A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation), or which is a cause of a violation of State water quality standards.

pH--The pH of a liquid measures its acidity or alkalinity. A pH of 7 is defined as neutral, and large variations above or below this value are considered harmful to most aquatic life.

Potential Significant Industrial User--A potential significant industrial user is defined as an Industrial User which does not meet the criteria for a Significant Industrial User, but which discharges wastewater meeting one or more of the following criteria:

a. Exceeds 0.5 % of treatment plant design capacity criteria and discharges <25,000 gallons per day; or

b. Is a member of a group of similar industrial users which, taken together, have the potential to cause pass through or interference at the POTW (e.g., facilities which develop photographic film or paper, and car washes).

The Department may determine that a discharger initially classified as a potential significant industrial user should be managed as a significant industrial user.

Quantitation Level (QL)--A calculated value five times the MDL (method detection level).

Significant Industrial User (SIU)--

1) All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; and

2) Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, non-contact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority* on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].

Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority* may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.

*The term "Control Authority" refers to the Washington State Department of Ecology in the case of non-delegated POTWs or to the POTW in the case of delegated POTWs.

State Waters--Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, wetlands, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater--That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, inter-flow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-based Effluent Limit--A permit limit that is based on the ability of a treatment method to reduce the pollutant.

Total Suspended Solids (TSS)--Total suspended solids are the particulate materials in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Upset--An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

Water Quality-based Effluent Limit--A limit on the concentration or mass of an effluent parameter that is intended to prevent the concentration of that parameter from exceeding its water quality criterion after it is discharged into a receiving water.

APPENDIX C--TECHNICAL CALCULATIONS

Several of the Excel® spreadsheet tools used to evaluate a discharger's ability to meet Washington State water quality standards can be found on the Department's homepage at http.www:wa.gov.ecology.

Tables 11 and 12 show the estimate of dilution provided during critical conditions near the outlet of the WWTP outfall in the Skagit River. The table reflects the calculations for the spread of a plume from a point source in a river with boundary effects from the shoreline based on the method of Fischer et al. (1979) with correction for the effective origin of effluent. The calculations are based on the procedures and formulas cited in Mixing in Inland and Coastal Waters by Fischer, et al., 1979. New York: Academic Press. This procedure is also cited by EPA in the Technical Support Document for Water Quality-based Toxics Control, U.S. EPA, March 1991 (EPA/505/2-90-001).

Table 13: Chronic Dilution Estimation from Fischer.

INPUT	calibrate	1999 flows	2015 flow
1. Effluent Discharge Rate (MGD):	3.2	3.5	8.1
1. Effluent Discharge Rate (cfs):	4.93	5.41	12.52
2. Receiving Water Characteristics Downstream From Waste Input			
Stream Depth (ft):	8.00	6.75	6.75
Stream Velocity (fps):	1.40	1.10	1.10
Channel Width (ft):	400.00	400	400
Stream Slope (ft/ft) or Manning roughness "n":	0.029	0.029	0.029
0 if slope or 1 if Manning "n" in previous cell:	1	1	1
3. Discharge Distance From Nearest Shoreline (ft):	14	12	12
4. Location of Point of Interest to Estimate Dilution			
Distance Downstream to Point of Interest (ft):	200	306	306
Distance From Nearest Shoreline (ft):	14	5	5
5. Transverse Mixing Coefficient Constant (usually 0.6):	0.6	0.6	0.6
6. Original Fischer Method (enter 0) or *Effective Origin* Modification (enter 1)	0	0	0

OUTPUT			
1. Source Conservative Mass Input Rate			
Concentration of Conservative Substance (%):	100.00	100.00	100.00
Source Conservative Mass Input Rate (cfs*%):	493.00	541.00	1,252.00
2. Shear Velocity			
Shear Velocity based on slope (ft/sec):	#N/A	#N/A	#N/A
Shear Velocity based on Manning "n":			
using Prasuhn equations 8-26 and 8-54 assuming			
hydraulic radius equals depth for wide channel			
Darcy-Weisbach friction factor "f":	0.049	0.052	0.052
Shear Velocity from Darcy-Weisbach "f" (ft/sec):	0.109	0.088	0.088
Selected Shear Velocity for next step (ft/sec):	0.109	0.088	0.088
3. Transverse Mixing Coefficient (ft2/sec):	0.525	0.358	0.358
4. Plume Characteristics Accounting for Shoreline Effect (Fischer *et al.*, 1979)			
Co	1.10E-01	1.82E-01	4.22E-01
x'	4.69E-04	6.22E-04	6.22E-04
y'o	3.50E-02	3.00E-02	3.00E-02
y' at point of interest	3.50E-02	1.25E-02	1.25E-02
Solution using superposition equation (Fischer eqn 5.9)			
Term for n= -2	0.00E+00	0.00E+00	0.00E+00
Term for n= -1	0.00E+00	0.00E+00	0.00E+00
Term for n= 0	1.07E+00	1.37E+00	1.37E+00
Term for n= 1	0.00E+00	0.00E+00	0.00E+00
Term for n= 2	0.00E+00	0.00E+00	0.00E+00
Upstream Distance from Outfall to *Effective Origin* of Effluent Source (ft)	#N/A	#N/A	#N/A
Effective Distance Downstream from Effluent to Point of Interest (ft)	200.00	306.00	306.00
x' Adjusted for *Effective Origin*	4.69E-04	6.22E-04	6.22E-04
C/Co (dimensionless)	1.40E+01	1.55E+01	1.55E+01
Concentration at Point of Interest (Fischer Eqn 5.9)	1.54E+00	2.82E+00	6.52E+00
Unbounded Plume Width at Point of Interest (ft)	48.980	56.445	56.445
Unbounded Plume half-width (ft)	24.490	28.222	28.222
Distance from near shore to discharge point (ft)	14.00	12.00	12.00
Distance from far shore to discharge point (ft)	386.00	388.00	388.00
Plume width bounded by shoreline (ft)	38.49	40.22	40.22
Approximate Downstream Distance to Complete Mix (ft):	158,990	185,074	185,074
Theoretical Dilution Factor at Complete Mix:	908.722	548.983	237.220
Calculated Flux-Average Dilution Factor Across Entire Plume Width:	87.442	55.204	23.854
Calculated Dilution Factor at Point of Interest:	65	35	15
Field measured dilution	65		

Table 14: Acute Dilution Estimation from Fischer.

	calibrate	1999 flow	2015 flow
1. Effluent Discharge Rate (MGD):	3.2	6.4	
1. Effluent Discharge Rate (cfs):	4.93	9.90	19.80
2. Receiving Water Characteristics Downstream From Waste Input			
Stream Depth (ft):	8.00	6.75	6.75
Stream Velocity (fps):	1.30	1.20	1.20
Channel Width (ft):	400.00	400.00	400.00
Stream Slope (ft/ft) or Manning roughness "n":	0.021	0.021	0.021
0 if slope or 1 if Manning "n" in previous cell:	1	1	1
3. Discharge Distance From Nearest Shoreline (ft):	14	14	14
4. Location of Point of Interest to Estimate Dilution			
Distance Downstream to Point of Interest (ft):	31	31	31
Distance From Nearest Shoreline (ft):	14	14	14
5. Transverse Mixing Coefficient Constant (usually 0.6):	0.23	0.23	0.23
6. Original Fischer Method (enter 0) or *Effective Origin* Modification (enter 1)	0	0	0
1. Source Conservative Mass Input Rate			
Concentration of Conservative Substance (%):	100.00	100.00	100.00
Source Conservative Mass Input Rate (cfs*%):	493.00	990.00	1,980.00
2. Shear Velocity			
Shear Velocity based on slope (ft/sec):	#N/A	#N/A	#N/A
Shear Velocity based on Manning "n":			
using Prasuhn equations 8-26 and 8-54 assuming			
hydraulic radius equals depth for wide channel			
Darcy-Weisbach friction factor "f":	0.026	0.027	0.027
Shear Velocity from Darcy-Weisbach "f" (ft/sec):	0.074	0.070	0.070
Selected Shear Velocity for next step (ft/sec):	0.074	0.070	0.070
3. Transverse Mixing Coefficient (ft2/sec):	0.135	0.108	0.108
4. Plume Characteristics Accounting for Shoreline Effect (Fischer *et al.*, 1979)			
Co	1.19E-01	3.06E-01	6.11E-01
x'	2.02E-05	1.75E-05	1.75E-05
y'o	3.50E-02	3.50E-02	3.50E-02
y' at point of interest	3.50E-02	3.50E-02	3.50E-02
Solution using superposition equation (Fischer eqn 5.9)			
Term for n= -2	0.00E+00	0.00E+00	0.00E+00
Term for n= -1	0.00E+00	0.00E+00	0.00E+00
Term for n= 0	1.00E+00	1.00E+00	1.00E+00
Term for n= 1	0.00E+00	0.00E+00	0.00E+00
Term for n= 2	0.00E+00	0.00E+00	0.00E+00
Upstream Distance from Outfall to *Effective Origin* of Effluent Source (ft)	#N/A	#N/A	#N/A
Effective Distance Downstream from Effluent to Point of Interest (ft)	31.00	31.00	31.00
x' Adjusted for *Effective Origin*	2.02E-05	1.75E-05	1.75E-05
C/Co (dimensionless)	6.28E+01	6.74E+01	6.74E+01
Concentration at Point of Interest (Fischer Eqn 5.9)	7.45E+00	2.06E+01	4.12E+01
Unbounded Plume Width at Point of Interest (ft)	10.160	9.465	9.465
Unbounded Plume half-width (ft)	5.080	4.733	4.733
Distance from near shore to discharge point (ft)	14.00	14.00	14.00
Distance from far shore to discharge point (ft)	386.00	386.00	386.00
Plume width bounded by shoreline (ft)	10.16	9.47	9.47
Approximate Downstream Distance to Complete Mix (ft):	572,758	659,871	659,871
Theoretical Dilution Factor at Complete Mix:	843.813	327.273	163.636
Calculated Flux-Average Dilution Factor Across Entire Plume Width:	21.433	7.744	3.872
Calculated Dilution Factor at Point of Interest:	13	5	2
Field measured dilution	13		

Statistical analysis of ammonia concentrations measured at the WWTP for the last 5 years.

Ammonia data, statistical evaluation, and limit calculations are shown below. Ammonia limitations were derived using normal statistics (normal shaped bell curve). The histogram shows the tendency of ammonia concentration sample results to be normally distributed – the data peak is in the center of the distribution and 'tails' off on either end of the distribution. Data submitted by the Permittee is listed in Table 13.

Statistics for normal distribution of ammonia concentrations	
Mean	22.77
Standard Error	0.65
Median	23
Mode	24
Standard Deviation (SD)	**6.0**
Sample Variance (V)	**36.3**
Kurtosis	-0.48
Skewness	0.15
Range	29
Minimum	9
Maximum	38
Z_{99}	2.326
Z_{95}	1.645

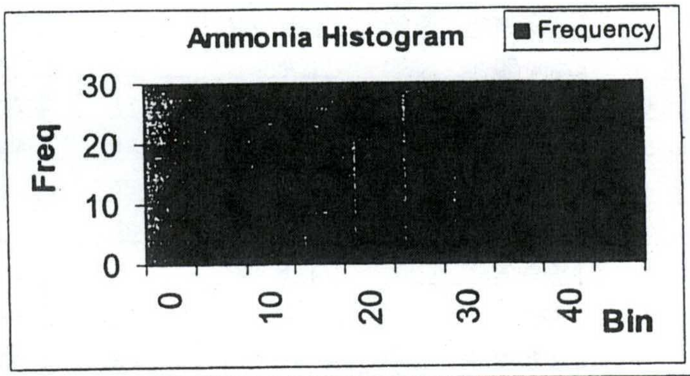

Figure 5: Frequency histogram for ammonia exhibits a bell shaped curve shape, distribution of ammonia data follows the normal distribution, not the lognormal. The data is shown at the end of this section.

Effluent ammonia concentrations follow a normal distribution; Figure 4 shows that the data are symmetrically distributed around the mean. Permit limit calculations using a lognormal distribution do not model the effluent at well as one using a normal distribution. Based on the procedure by EPA, 1991, in Appendix E-5, the derivation of permit limitations for data that is normally distributed is as follows.

From the Water Quality-Based Permit Limitations Spreadsheet (Table 8), the waste load allocations for ammonia are WLA_a=41, WLA_c=65. The long term averages (LTA) needed to meet the WLAs are: $LTA_a = WLA_a - (Z_{99} \times SD) = 41 - (2.326 \times 6) = 27$; for $LTA_c = WLA_c - (Z_{99} \times SD) = 65 - (2.326 \times 6) = 51$. The acute LTA is more limiting. The maximum daily limit is equal to the acute WLA = **MDL = 41 mg/L**. The average monthly limit, the average of all individual values measured for the month that should not be exceeded to assure that the WLA is not exceeded is **AML** = LTA_a + (Variance/# samples per month)$^{1/2} \times Z_{95} = 27 + (36.3/9)^{1/2} \times 1.645 =$ **30 mg/L.**

Table 15: Ammonia Data from the WWTP.

Month	Concentration (mg/L)	Month	Concentration (mg/L)	Month	Concentration (mg/L)	Month	Concentration (mg/L)
Mar-93	16.4	Feb-95	20	Nov-96	21	Aug-98	24
Apr-93	16.6	Mar-95	29	Dec-96	13	Sep-98	31
May-93	17.3	Apr-95	25	Jan-97	9	Oct-98	23
Jun-93	22.9	May-95	26	Feb-97	19	Nov-98	18
Jul-93	21.7	Jun-95	33	Mar-97	17	Dec-98	18
Aug-93	24.9	Jul-95	34	Apr-97	26	Jan-99	16
Sep-93	28.1	Aug-95	35	May-97	27	Feb-99	16
Oct-93	25.5	Sep-95	38	Jun-97	24	Mar-99	21
Nov-93	28.1	Oct-95	16	Jul-97	16	Apr-99	24
Dec-93	24.5	Nov-95	19	Aug-97	24	May-99	17
Jan-94	21.4	Dec-95	21	Sep-97	27	Jun-99	23
Mar-94	22.3	Jan-96	13	Oct-97	27	Jul-99	15
May-94	31.8	Feb-96	17	Nov-97	18	Aug-99	23
Jun-94	29.4	Mar-96	26	Dec-97	13	Sep-99	30
Jul-94	22	Apr-96	21	Jan-98	19	Oct-99	30
Aug-94	33.3	May-96	24	Feb-98	27	Nov-99	18
Sep-94	17.6	Jun-96	31	Mar-98	13	Dec-99	14
Oct-94	24.5	Jul-96	31	Apr-98	15	Jan-00	22
Nov-94	21	Aug-96	31	May-98	14	Feb-00	26
Dec-94	16	Sep-96	28	Jun-98	23	Mar-00	23
Jan-95	24	Oct-96	25	Jul-98	22	Apr-00	26
						May-00	31

Statistical analysis of copper concentrations

Mt Vernon Effluent Copper data

date	tot. rec. copper (ug/L)	Ln
7/14/1993	11	2.40
7/27/1993	19	2.94
8/9/1993	11	2.40
8/22/1993	10	2.30
9/4/1993	17	2.83
9/17/1993	13	2.56
10/13/1993	23	3.14
10/26/1993	27	3.30
11/8/1993	27	3.30
11/21/1993	25	3.22
12/4/1993	15	2.71
12/17/1993	27	3.30
1/12/1994	20	3.00
1/25/1994	14	2.64
2/7/1994	23	3.14
2/20/1994	13	2.56
3/5/1994	13	2.56
3/18/1994	16	2.77
3/31/1994	16.9	2.83
4/13/1994	14	2.64
4/26/1994	20	3.00
5/9/1994	28	3.33
5/22/1994	20	3.00
6/17/1994	28	3.33
6/30/1994	34	3.53
7/5/1995	21	3.04
7/10/1995	20	3.00
7/18/1995	10.6	2.36
7/25/1995	18.9	2.94
8/5/1994	10.6	2.36
8/15/1995	10.9	2.39
9/16/1994	27.1	3.30
9/29/1994	13	2.56
10/12/1994	10	2.30
10/25/1994	17.6	2.87
11/7/1994	22.3	3.10
11/20/1994	10	2.30
12/16/1994	10	2.30
12/29/1994	10	2.30
1/11/1995	10.6	2.36
1/24/1995	13.7	2.62

Statistical output for logarithmic distribution

	ln	antilog
Mean	2.80	17.62
Standard Error	0.06	
coeff variation	0.13	**0.38**
Median	2.83	
Mode	2.30	
Standard Deviation	0.37	
Sample Variance	0.14	42.38
Kurtosis	-1.26	
Skewness	0.13	
Range	1.22	
Minimum	2.30	
Maximum	3.53	
Sum	114.83	
Count	41.00	
Confidence Level(95.000%)	0.11	

Raw Data Summary	
min	10
max	34
Count	41

Bin	*Frequenc*
10 to	5
14 to	13
18 to	5
22 to	7
26 to	4
30 to	6
34 to	1
38	0

Expected max concentrations based on lognormal distribution

Confidence interval	Total recov. max conc.	dissolved max conc.
95% CI	30.2	26.0
96% CI	31.4	27.1
97% CI	33.0	28.4
98% CI	**35.1**	30.3
99% CI	38.9	33.5

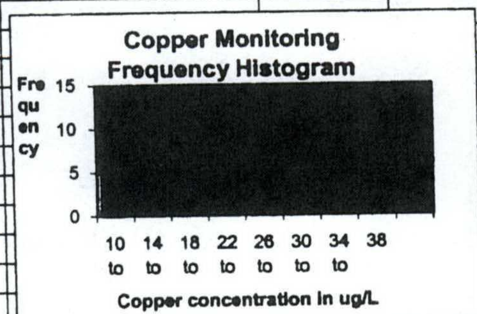

Table 16: Results of copper testing and statistical analysis. The 98% maximum of 35 mg/L and CV of 0.38 were used in Table 15 to calculate interim limits. The frequency histogram shows the asymmetrical shape of a lognormal distribution. The maximum value for permit limitations selected was 35 ug/L and was based on BPJ of the author. It is slightly higher than the maximum measured, but is the maximum value predicted for the data at 98% confidence.

Table 17: This spreadsheet calculates water quality-based permit limits based on the two value steady state model using the State Water Quality Standards contained in WAC 173-201A. The procedure and calculations are done per the procedure in Technical Support Document for Water Quality-based Toxics Control, U.S. EPA, March 1991 (EPA/505/2-90-001) on page 99.

Parameter	Acute Dil'n Factor	Chronic Dil'n Factor	Metal Criteria Translator Acute	Metal Criteria Translator Chronic	Ambient Concentration ug/L	Water Quality Standard Acute ug/L	Water Quality Standard Chronic ug/L	Average Monthly Limit (AML) ug/L	Maximum Daily Limit (MDL) ug/L	Comments	WLA Acute ug/L	WLA Chronic ug/L	LTA Acute ug/L	LTA Chronic ug/L	LTA Coeff. Var. (CV) decimal	Limiting LTA ug/L	Coeff. Var. (CV) decimal	# of Samples per Month n
NH3-N (in mg/L)	5	35			0.023	8.31	1.88	18.4	41.5	not used	41	65.02	13.3	34.3	0.60	13.3	0.60	8.00
copper	5	35	1.00	1.00	0.5500	4.61	3.47	12.8	20.9		21	102.82	9.5	67.5	0.38	9.5	0.38	4.00
zinc	5	35	1.00	1.00	0.0200	35.36	32.29	88.4	177.4		177	1129.35	56.7	595.7	0.60	56.7	0.60	4.00
chlorine	5	35				19.00	11.00	47.4	95.0		95	385.00	30.5	203.1	0.60	30.5	0.60	4.00
NH3-N (in mg/L)	10	35			0.023	8.31	1.88	41.3	82.9	informational	83	65.02	26.6	34.3	0.60	26.6	0.60	4.00
copper	10	35	1.00	1.00	0.5500	4.61	3.47	18.6	32.8	informational	41	102.82	13.2	54.2	0.60	13.2	0.45	4.00
mercury	10	35	0.85	0.85		2.10	0.012	0.4	0.8	informational	21	0.42	6.7	0.2	0.60	0.2	0.60	4.00
lead	10	35	0.47	0.47		13.88	0.54	33.3	66.7	informational	139	18.93	44.6	10.0	0.60	10.0	0.60	4.00
silver	10	35	0.85			0.32	1000.00	1.9	3.8	informational	3	35000.00	1.0	18460.2	0.60	1.0	0.60	4.00
zinc	10	35	1.00	1.00	0.0200	35.36	32.29	176.9	354.8	informational	353	1129.35	113.5	595.7	0.60	113.5	0.60	4.00
Copper (interim)								**21.3**	**35.0**		35	1000	15.9	656.9	0.38	15.9	0.38	

Table 18: Calculation of pH of a mixture of two flows. Ecology model PH-MIX.WK1. Based on the procedure in EPA's DESCON program (EPA, 1988. Technical Guidance on Supplementary Stream Design Conditions for Steady State Modeling. USEPA Office of Water, Washington, D.C.)

Input data is taken from the Lower Skagit TMDL Data Summary (Ecology Report #96-345), Mount Vernon WWTP DMRs, the Mount Vernon WWTP Mixing Zone Study (Cosmospolitan Engineering Group, 2000), and the Department's ambient monitoring records from 1994 to present for the Skagit River.					try 100:1 dilution	comments
INPUT *********	range	**********	**********	***********		
1. UPSTREAM CHARACTERISTICS						
Upstream Discharge (cfs) [at 35:1 dil, effluent Q * 35]		122.5	122.5	122.5	350.0	
Upstream Temperature (deg C)	1.4 to 15.4	15.2	15.2	15.2	15.2	90%ile from Cosmopolitan, 2000
Upstream pH	8.1 to 6.7	7.7	7.7	6.7	7.7	90%ile from Cosmopolitan, 2000
Upstream Alkalinity (mg CaCO3/L)	20 to 25	20.0	20.0	20.0	20.0	
2. EFFLUENT CHARACTERISTICS						
Effluent Discharge (cfs)		3.5	3.5	3.5	3.5	
Effluent Temperature (deg C)		20.0	20.0	20.0	20.0	lower skagit TMDL dry season
Effluent pH	6.1 to 7.8	**6.6**	**6.5**	**9.0**	**6.2**	DMRs
Effluent Alkalinity (mg CaCO3/L)		195.0	195.0	195.0	195.0	1 sample, lower skagit TMDL
OUTPUT *********						
1. IONIZATION CONSTANTS						
Upstream pKa		6.4	6.4	6.4	6.4	
Effluent pKa		6.4	6.4	6.4	6.4	
2. IONIZATION FRACTIONS						
Upstream Ionization Fraction		1.0	1.0	0.7	1.0	
Effluent Ionization Fraction		0.6	0.6	1.0	0.4	
3. TOTAL INORGANIC CARBON						
Upstream Total Inorganic Carbon (mg CaCO3/L)		21.0	21.0	30.5	21.0	
Effluent Total Inorganic Carbon (mg CaCO3/L)		313.0	343.6	195.5	491.5	
4. DOWNSTREAM MIXED FLOW CONDITIONS						
Mixture Temperature (deg C)		15.3	15.3	15.3	15.2	
Mixture Alkalinity (mg CaCO3/L)		24.9	24.9	24.9	21.7	
Mixture Total Inorganic Carbon (mg CaCO3/L)		29.2	30.0	35.0	25.7	
Mixture pKa		6.4	6.4	6.4	6.4	
pH of Mixture		7.2	7.1	6.8	7.2	
change at edge of mixing zone limited to 0.5		**0.5**	**0.6**	**-0.1**	**0.5**	
Calculations predict that pH lower than 6.6 violates WQ standard by inducing change greater than 0.5						

Table 19: This spreadsheet calculates the reasonable potential to exceed State Water Quality Standards for a small number of samples. The procedure and calculations are done per the procedure in Technical Support Document for Water Quality-based Toxics Control, U.S. EPA, March 1991 (EPA/505/2-90-001) on page 56.

This spreadsheet calculates the reasonable potential to exceed state water quality standards for a small number of samples. The procedure and calculations are done per the procedure Technical Support Document for Water Quality-based Toxics ContrU.S. EPA, March, 1991 (EPA/505/2-90-001) on page 56. User input columns are shown with red headings. Corrected formulas in col G and H on 5/98 (GB)

				State Water Quality Standard		Max concentration at edge of...			CALCULATIONS							
	Metal Criteria Translator as decimal	Metal Criteria Translator as decimal	Ambient Concentration (metals as dissolved)	Acute	Chronic	Acute Mixing Zone	Chronic Mixing Zone	LIMIT REQ'D?	Effluent percentile value		Max effluent conc. measured (metals as total recoverable)	Coeff Variation		# of samples	Multiplier	Acute Dil'n Factor
Parameter	Acute	Chronic	ug/L	ug/L	ug/L	ug/L	ug/L			Pn	ug/L	CV	s	n		
NH3-N (in mg/L)			0.0150	8.31	1.8800	8.81	1.27	YES	0.95	0.972	44.00	0.60	0.55	104	1.00	5
copper	1.00	1.00	0.5500	4.61	3.47	7.81	1.59	YES	0.95	0.957	37.00	0.45	0.43	68	1.00	5
mercury	0.85	0.85		2.10	0.012	0.31	0.04	YES	0.95	0.717	1.00	0.60	0.55	9	1.81	5
lead	0.47	0.47	0.0200	13.88	0.54	0.35	0.07	NO	0.95	0.717	2.00	0.60	0.55	9	1.81	5
silver	0.85			0.32	1000.00	6.16	1.04	YES	0.95	0.717	20.00	0.60	0.55	9	1.81	5
zinc	1.00	1.00	9.3000	35.36	32.29	46.41	14.60	YES	0.95	0.717	108.00	0.60	0.55	9	1.81	5
BHC - GAMMA 58899 4P (Lindane)				2.0	0.08	0.02	0.00	NO	0.95	0.717	0.06	0.60	0.55	9	1.81	5
BIS(2-ETHYLHEXYL) PHTHALATE 117817 13B				940.0	3.0	15.22	2.17	NO	0.95	0.717	42.00	0.60	0.55	9	1.81	5
CHLOROFORM 67663 11V				28900.0	1240.0	1.12	0.16	NO	0.95	0.717	3.10	0.60	0.55	9	1.81	5
CYANIDE 57125 14M				22.0	5.2	9.42	1.35	NO	0.95	0.717	26.00	0.60	0.55	9	1.81	5

Values entered for mercury, lead, and silver are the detection limit at the laboratory performing the analysis. These analytes were not detected in the effluent. If present, they are at levels below these values. No permit limit is derived for these analytes.

APPENDIX D--ORDER ON CONSENT NO. DE 96WQ-N105

The text of the Order on Consent No. DE 96WQ-N105 follows. The order was effective on April 11, 1996. It was signed by the Honorable Skye Richendrfer, Mayor, City of Mount Vernon and John H Glynn, Supervisor, Water Quality, Washington Department of Ecology Northwest Regional Office.

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

THE MATTER OF THE COMPLIANCE BY	)	
THE CITY OF MOUNT VERNON	)	
with Chapter 90.48 RCW and the Rules and	)	ORDER ON CONSENT
Regulations of the Department of Ecology	)	No. DE 96WQ-N105

I. INTRODUCTION

This order is issued to the City of Mount Vernon (the City) by the State of Washington Department of Ecology (the Department), pursuant to Chapter 90.48 of the Revised Code of Washington (RCW), otherwise known as the Water Pollution Control Act. The RCW 90.48.260 designates the Department as the state water pollution control agency for all purposes of the Federal Clean Water Act (CWA) and grants complete authority to administer a National Pollutant Discharge Elimination System (NPDES) permit program. The Department is authorized to issue permits, which include effluent treatment and limitation requirements, as well as inspection, monitoring, and reporting requirements. The Department may terminate or modify permits as well as perform enforcement.

This order is being issued with the cooperation of the City to fulfill the legal requirements of Chapter 173-245 of the Washington Administrative Code (WAC). The purpose of those requirements is to reduce the environmental impact of combined stormwater and raw sewage discharges on the waters of the State of Washington.

II. FACTS REGARDING THIS CASE

A. On June 16, 1993, the Department of Ecology issued NPDES Permit No. WA-022407-4 to the City of Mount Vernon.

B. Chapter 90.48.480 of the RCW requires the submittal of a plan and schedule to achieve the greatest reasonable reduction of combined sewer overflows (CSOs) at the earliest possible date. *The City of Mount Vernon Comprehensive Sewer and Combined Sewer Overflow Reduction Plan (The Plan)* was submitted in April of 1991. *The Plan* met this requirement and was approved by the Department on June 20 of 1995. *The Plan* was adopted by the City Council in December of 1995.

C. Chapter 173-245 of Washington Administrative Code (WAC) defines the "greatest reasonable reduction of combined sewer overflows" as limiting the frequency of untreated CSOs to an average of no more than one per year. In approving *The Plan*, the Department has determined that the City will be making a good faith effort to achieve this goal. If the current standards are revised, this Consent Order may be renegotiated if requested by either party.

D. Special Condition S11. of NPDES Permit No. WA-022407-4 requires the submittal of annual CSO Reports to the Department, in accordance with WAC 173-245-090.

E. *The Plan* provides for both in-line and reservoir storage of CSO flows prior to treatment at the Mount Vernon Wastewater Treatment Plant. The plan requires construction of an oversized sewer interceptor line to transport and store the majority of CSO flows within the next four years and construction of additional treatment capacity at the treatment plant by the year 2015. Final design of the treatment facilities is dependent on installation of monitoring equipment in the sewer interceptor line.

F. The transfer of CSO flows to the Mount Vernon Wastewater Treatment Plant (WWTP) will dilute the biochemical oxygen demand (BOD) and total suspended solids (TSS) concentration of the influent. This may prevent the WWTP from meeting the current NPDES requirement to remove 85% of these pollutants from the incoming wastestream.

G. The transfer of CSO flows to the Mount Vernon WWTP will result in a substantial increase in grit entering the facility. The increase in grit may result in a reduction in the calculated percentage reduction in volatile solids in digested sludge resulting in failure to meet vector attraction reduction requirements.

H. The increase in flow through the plant will result in decreased chlorination contact time in the WWTP.

I. The Department may relax the NPDES permit limits for percent removal requirements for conventional pollutants based on engineering submittals and in accordance with State and Federal regulations related to dilute influents and standards for CSO reduction and treatment.

J. The increase in flow through the plant is expected to exceed the 85%-of-design, wet weather design flow during wet weather months.

K. The City is proceeding to comply with permit condition S4.B, Plans for Maintaining Adequate Capacity, by submitting an engineering report that assesses the existing capacity of the Mount Vernon WWTP and identifies improvements to increase the capacity sufficiently to treat increased CSO flows to the plant. The draft report entitled *Mount Vernon Wastewater Treatment Plant Evaluation* dated July 1995, was submitted for comment on October 26, 1995. The City will have satisfied permit condition S4.B for the additional flows from CSO transport as they are currently estimated and condition S4.D, Capacity Assessment, when the Department approves the final report.

III. COMPLETION SCHEDULE FOR CSO REDUCTION

The City of Mount Vernon shall reduce the combined sewer overflows in its wastewater collection system as outlined in Table I-1 of *the Plan* and described as "Related to CSO Reduction." Work shall be completed as follows:

A. Complete construction of the central interceptor (Improvement numbers CA-1b, CA-1-c, CA-1-d, October 1994 revision) no later than December 31, 2000.

B. Provide modulating controller for the motor operated sluice gate at the manhole upstream from the wastewater treatment plant influent pump station (Improvement number T-2) no later than December 31, 2000.

C. Upgrade the Park Street Pump Station with new pumps (Improvement number CA-1a) no later than January 1, 2015.

D. Upgrade wastewater treatment plant to provide treatment/storage of CSO flows to reduce overflow events to an average of one per year no later than January 1, 2015.

IV. MONITORING AND REPORTING

A. Estimate the frequency and volume of CSO discharges from the Park Street and Division Street Pump Stations until new monitoring devices are installed during construction of the central interceptor projects.

B. Record frequency and volume of CSO discharges as soon as construction of portions of the Central interceptor allow. Direct recording of frequency and volume of CSO discharges shall commence no later than December 31, 2000.

C. Provide annual CSO reports for the previous calendar year to the Department of Ecology no later than March 31 each year. The reports shall comply with the requirements of WAC 173-245-090 (1):

1. Detail the past year's frequency and volume of combined sewage discharged from each CSO discharge site.

2. Explain the CSO reduction accomplishments of the previous year.

3. List the projects associated with CSO reduction planned for the next year.

4. If there is an increase in the annual baseline volume or frequency of CSO discharges described in *the Plan* (Figure 5-16), then the City shall propose a project and schedule to reduce that CSO site or group of sites to or below the baseline condition.

D. In conjunction with the City's application for renewal of its NPDES permit, provide an amendment to its CSO Reduction Plan addressing the elements of WAC 173-245-090(2).

V. FACILITY OPERATION

A. The wastewater treatment plant, sewage collection system, pump stations, and all other facilities associated with wastewater collection, treatment, and discharge shall be operated so as to minimize the discharge of untreated combined sewage to waters of the state while meeting the conditions of NPDES permit number WA-002407-4.

B. No discharge of sanitary sewage as defined WAC 173-245 shall occur from CSO outfalls during dry weather.

C. Discharges from the CSO outfalls shall not exceed the baseline values described in *the Plan* (Figure 5-16).

VI. NOTIFICATION OF NONCOMPLIANCE

The City shall promptly notify Ecology of any occurrence which may result in noncompliance with the requirements of the Consent Order which is caused by circumstances beyond the City's control which could not be overcome by due diligence. Such notification shall state the nature of the anticipated noncompliance, the reasons therefore, the expected duration of the noncompliance and any mitigating actions taken.

VII. JUDICIAL REVIEW

In the event that the City fails, without sufficient cause, to comply with any of the terms of this Consent Order, the Order may be enforced pursuant to the powers vested in Ecology by law. No party, other than Ecology, will bring any legal action except as allowed herein to appeal, challenge, or construe any portion of this Consent Order.

VIII. STIPULATIONS

By the signatures appearing below, the City of Mount Vernon hereby consents and agrees to:

A. The issuance of the Order;

B. Perform and comply with the City's obligations as specified in the Order; and

Not appeal, contest, or legally challenge the issuance of the Consent Order or Ecology's jurisdiction to enforce this Consent Order.

APPENDIX E--RESPONSE TO COMMENTS

DISCHARGE MONITORING REPORT (DMR) INSTRUCTIONS

To avoid processing delays and the need to resubmit your DMR's, please comply with the following requirements:

- Enter the monitoring period at the top of the form. Monitoring periods consist of a calendar month or months (quarterly reporting). (For example, July 1-July 31, not June 27-July 27)

- The forms must be received at the Department of Ecology Northwest Regional Office by the date specified in your permit. Address the envelope to the attention of Chris Smith, WPLCS Coordinator, 3190 160th Avenue SE, Bellevue, WA 98008-5452.

- All entries on the forms must be in ink or typewritten. The forms must be signed in ink by the responsible official for the facility or by a person who has been designated authority to do so in writing by the responsible official. The Department must have a record of the designation letter on file to accept signatures by persons other than the responsible official.

- Circle permit violations and provide a written explanation of the cause of the violation and remedies used to correct the problem. The number of violations must be entered on the DMR form under the "No. Ex" column on the right side of the DMR form. See the instructions on the back of the DMR form for details on how to fill in that column.

- Failure to report the results of tests required by your permit is a permit violation. If your facility did not discharge during the monitoring period, indicate by checking the box in the upper right hand corner for no discharge. Items that are not required for the monitoring period (such as tests done once per quarter) should be labeled "NA" for not applicable.

If you encounter difficulty using the enclosed form, contact your facility manager. Enclosed are double sided forms. Keep at least one blank form to photocopy. You are responsible for keeping forms on hand for use at your facility.

Questions; contact Chris Smith, WPLCS Coordinator, (425) 649-7214.

Permit ... e/Address
Include Na.../Location (if different)

NAME CITY OF MOUNT VERNON #665

ADDRESS POB 809

MOUNT VERNON WA 98273

FACILITY WASTEWATER TREATMENT PLANT

LOCATION 1401 BRITT ROAD

NATIONAL ... NT DISCHARGE ELIMINATION SYSTEM

DISCHARGE MONITORING REPORT (*DMR*)

WA-002407-4	001
PERMIT NUMBER	DISCHARGE NUMBER

MONITORING PERIOD

	YEAR	MO	DAY		YEAR	MO	DAY
FROM				TO			

NOTE: Read in ... efore completing this fo....

Discharge Location	
Lat	48° 24' 48" N
Long	122° 20' 6" W
NO DISCHARGE	

Parameter		QUANTITY OR LOADING Average	QUANTITY OR LOADING Maximum	Units	QUALITY OR CONCENTRATION Minimum	QUALITY OR CONCENTRATION Average	QUALITY OR CONCENTRATION Maximum	Units	No. of Exceed-ances	Frequency of Analysis	Sample Type
FLOW	Sample Measurement			MGD	*******	*******	*******	***		07/07	CONT.
	Permit Requirement	REPORT	REPORT		*******	*******	*******				
BOD5	Sample Measurement			lb/day	*******			mg/L		03/07	24 HC
	Permit Requirement	1401	2102		*******	30	45				
TSS	Sample Measurement			lb/day	*******			mg/L		03/07	24 HC
	Permit Requirement	1401	2102		*******	30	45				
BOD_5 PERCENT REMOVAL	Sample Measurement	*******	*******		*******		*******	%		1/MONTH	CALC.
	Permit Requirement	*******	*******		*******	80%	*******				
TSS PERCENT REMOVAL	Sample Measurement	*******	*******		*******		*******	%		1/MONTH	CALC.
	Permit Requirement	*******	*******		*******	80%	*******				
FECAL COLIFORM BACTERIA	Sample Measurement	*******	*******	***	*******			#/100 ml		05/07	GRAB
	Permit Requirement	*******	*******		*******	200	400				
pH	Sample Measurement	*******	*******	***		*******		STD. UNITS		07/07	GRAB
	Permit Requirement	*******	*******		6.0	*******	9.0				
TOTAL RESIDUAL CHLORINE	Sample Measurement		*******	lb/day	*******			mg/L		05/07	GRAB
	Permit Requirement	2.21	*******		*******	0.05	0.10				
COPPER (TOTAL RECOVERABLE)	Sample Measurement		*******	lb/day	*******			ug/L		02/30	24 HC
	Permit Requirement	1.00	*******		*******	21.3	35				
ZINC (TOTAL RECOVERABLE)	Sample Measurement		*******	lb/day	*******			ug/L		02/30	24 HC
	Permit Requirement	4.13	*******		*******	88.4	177.4				
AMMONIA NH_3-N (as N)	Sample Measurement		*******	lb/day	*******			mg/L		01/07	24 HC
	Permit Requirement	1448	*******		*******	31	41				

yr mo day

Parameter		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				No. of Exceed-ances	Frequency of Analysis	Sample Type
		Average	Maximum	Units	Minimum	Average	Maximum	Units			
SEASONAL LIMITS THAT APPLY ONLY JULY 1 TO October 31											
AMMONIA NH_3-N (as N)	Sample Measurement			lb/day	*******	*******	*******			03/07	24 HC
	Permit Requirement	922	REPORT		*******	*******	*******				
SEASONAL LIMITS THAT APPLY ONLY WHEN SKAGIT RIVER FLOW IS BELOW 6000 CFS FROM JULY 1 TO NOVEMBER 15 Report the number of days the flow is below 6000 cfs for the reporting period >>> ______											
AMMONIA NH_3-N (as N)	Sample Measurement	*******		lb/day	*******	*******	*******			03/07	24 HC
	Permit Requirement	*******	1188		*******	*******	*******				

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER			TELEPHONE	DATE
TYPED OR PRINTED	I CERTIFY UNDER PENALTY OF LAW THAT THIS DOCUMENT AND ALL ATTACHMENTS WERE PREPARED UNDER MY DIRECTION OR SUPERVISION IN ACCORDANCE WITH A SYSTEM DESIGNED TO ASSURE THAT QUALIFIED PERSONNEL PROPERLY GATHER AND EVALUATE THE INFORMATION SUBMITTED. BASED ON MY INQUIRY OF THE PERSON OR PERSONS WHO MANAGE THE SYSTEM, OR THOSE PERSONS DIRECTLY RESPONSIBLE FOR GATHERING THE INFORMATION, THE INFORMATION SUBMITTED IS, TO THE BEST OF MY KNOWLEDGE AND BELIEF, TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT FOR KNOWING VIOLATIONS.	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	( ) AREA CODE NUMBER	/ / YEAR MO DAY

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

Appendix I
City of Mount Vernon WWTP
Outfall Permits and Schedule Assessment

MOUNT VERNON WASTEWATER TREATMENT PLANT
OUTFALL MODIFICATIONS
PERMITTING EVALUATION

The City of Mount Vernon (City) owns and operates the Mount Vernon Wastewater Treatment Plant (WWTP) that provides activated sludge secondary treatment and anaerobic sludge digestion. The WWTP discharges through an existing open-ended outfall located along the bank of the Skagit River within the City's jurisdictional boundary. The City is evaluating modifications to its existing discharge system to improve effluent mixing and compliance with water quality standards.

Based on experience of the City of Burlington Public Works when doing work associated with their Wastewater Treatment Plant, ***in-water work in the Skagit River will most likely be limited to July through mid-September*** through the Corps authorization or Hydraulic Project approval (Garrett 2000).

A permitting evaluation is presented below and is based on a new discharge pipe, open trench crossing of the dike, and extending the outfall to the thalweg of the Skagit River. It has also been assumed for the purposes of this evaluation that there are no wetland impacts.

U.S. Army Corps of Engineers Section 10/404

Authorization from the U.S. Army Corps of Engineers (Corps) will be required for maintenance of the existing outfall or construction of a new outfall. It is possible that the project would be authorized under Nationwide Permit 7 – Outfall Structures and Maintenance which specifically allows "construction of outfall structures and associated intake structures where the effluent from the outfall is authorized, conditionally authorized, or specifically exempted, or is otherwise in compliance with regulations issued under the National Pollution Discharge Elimination System program" (Corps 2000a).

Because of recent Endangered Species Act (ESA) listings, the Corps is now requiring a Biological Evaluation/Biological Assessment (BE/BA) for all projects requiring Corps approval Corps 2000b). This will trigger consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). It is also recommended that the Washington Department of Fish and Wildlife (WDFW) be contacted for their Priority Habitat Species Lists so that they can be incorporated into the BE/BA. Chinook salmon, bull trout and bald eagle are known to occur in the project vicinity and will most likely, after consultation with NMFS/USFWS/WDFW, be included in the BE/BA.

It is now estimated that with the large backlog of projects under review, it could take 18-24 months for an authorization to be issued by the Corps. A Joint Aquatic Resource Permit Application (JARPA) and supporting documentation (i.e., BE/BA, conceptual design drawings, etc.) should be submitted as soon as outfall design is nearly complete.

In most cases, the Corps will adopt the State Environmental Policy Act (SEPA) document to satisfy National Environmental Policy Act (NEPA) review. The SEPA determination will need to be made at the time of JARPA submittal.

Washington Department of Fish and Wildlife

A Hydraulic Project Approval (HPA) is required from the Washington Department of Fish and Wildlife (WDFW) for any work below the ordinary high water mark of the Skagit River. The JARPA can be used to apply for the HPA. Applications must include general plans for the overall project and include complete plans and specifications for the proper protection of fish.

WDFW would typically issue the HPA within 45 days of receiving the completed JARPA. However, they have recently determined that they may liable if they issue an HPA that would result in a take of an ESA-listed species. To address that liability, WDFW is proposing to develop a programmatic ESA compliance agreement for the Hydraulic Project Approval program (WDFW 2000). Until their agreement is in place, review of the JARPA and issuance of the HPA may take longer than 45 days.

Washington Department of Ecology

NPDES Permit: The discharge of pollutants into the state's surface waters is regulated through National Pollutant Discharge Elimination System (NPDES) permits. The Washington Department of Ecology (Ecology) issues these permits under authority delegated by the U.S. Environmental Protection Agency. Permits typically place limits on the quantity and concentration of pollutants that may be discharged. NPDES permits are required for wastewater discharges to surface waters. It is assumed that the existing NPDES permit for the outfall discharge will require modification or a new NPDES permit may be required. It could take between 180 days to one year for an individual permit depending on the complexity of the issues. Modification of an existing permit may take less time

401 Water Quality Certification: An individual 401 Water Quality Certification may be required from Ecology. Application can be made with the JARPA and review can be concurrent with the Corps review. The 401 Water Quality Certification must be issued within one year of submittal or will be considered waived.

Washington Department of Natural Resources

Any project that is located on state-owned aquatic lands will require authorization from the Washington Department of Natural Resources (WDNR). For the purposes of this evaluation, it has been assumed that the outfall is located on state-owned lands. Application for an Aquatic Lease can take up to one year to be issued.

City of Mount Vernon

State Environmental Policy Act (SEPA): As a non-federal governmental agency, the City of Mount Vernon will be the lead agency for SEPA. It is anticipated that an Environmental Checklist will be prepared and a Determination of Nonsignificance (DNS) issued. Because of the need to submit with the Corps Permit, the SEPA review needs to be completed very early in the permitting process.

Shoreline Substantial Development Permit: All activities within 200 feet of the Skagit River (including in-water work) are subject to Shoreline Substantial Development Permit review. The City of Mount Vernon (City) requires a pre-application conference to occur prior to application submittal (other applications can be included in this review). Once the application is submitted, the City will review the application and prepare a Notice of Technically Complete Application. A Shoreline Permit is subject to a public hearing before a Hearing Examiner and must be scheduled within 60 days of the notice of complete application. The City will issue a Notice of Decision on the project, typically 120 calendar days from the Notice of Technically Complete Application (Mt. Vernon 2000).

Dike Setback Variance: Because this project will involve construction within the dike setback restriction area along the Skagit River, a variance from the provisions of the Mount Vernon Municipal Code, Section 15.36.270, will be required. The variance will be approved by a hearing examiner and will run concurrent with the Shoreline Substantial Development Permit process. The hearing examiner shall consider all technical evaluations, relevant factors, and criteria presented in 15.36.150(D) 1 through 11.

Critical Areas/Floodplain Review: Specific projects impacts have not been determined, however, critical areas and floodplain review are two areas that are likely for this project. Although the project will be located in a floodplain, it is not anticipated that the project will impact the floodplain. A review of applicable approvals/permits will be determined once impacts are known.

Fill and Grading Permit: A fill and grading permit will be required for the open trenching required for the 800 feet of discharge pipe. The application can be submitted after the land use permitting process (shorelines) is complete.

Dike District #3 Approval

The installation of the new discharge pipe will require an open-cut crossing of the dike along the Skagit River. The dikes in the project area are subject to review by Dike District #3 (Eisses 2000). It is anticipated that the open-cut crossing of the dikes will be allowed by the Dike District. Mount Vernon will need to submit final plans and specifications for review and approval prior to work associated with the dikes. The Dike District meets once a month, but can meet more frequently if needed (Smith 2000).

References

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Mt. Vernon 2000. City of Mount Vernon, Community and Economic Development Department Land Use Permit Processing Procedures. www.mount-vernon.wa.us/ced/landuse.htm. September 25, 2000.

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WDFW 2000. Washington Department of Fish and Wildlife. ESA Compliance Report. www.wa.gov/wdfw/hab/hpa/hpahcp.htm.

Appendix J
Mount Vernon WWTP
UV Transmittance Test Results

TROJAN TECHNOLOGIES INC.
3020 Gore Road
London, Ontario
N5V 4T7 CANADA
Telephone: (519) 457-3400
Facsimile: (519) 457-3030

WATER ANALYSIS REPORT

To: Victoria Falvo

Project Name: Mount Vernon, WA

Rep: Wm. H. Reilly & Co.

Sample #: S01-2878 to S01-2881

Engineer: HDR Engineering

Sample Source: Mount Vernon Wastewater Utility

Parameters Analyzed: UV Transmittance-whole sample, UV Transmittance – filtered & TSS

Process: Conventional Activated Sludge

Date sample taken: June 04, 2001

Sample Treatment: No Additives

Date sample analysed: June 06, 2001

Disinfection Limits: 200 Fecal Coliform/100mL

SAMPLE NO.	SAMPLE DESCRIPTION	%T	%T FILTERED	TSS (PPM)	MEAN PARTICLE SIZE (MICRONS)	%PARTICLES >31MICRONS
S01-2878	Primary Effluent, flow @ 3.31 June 04, 2001	14	26	81	-	-
S01-2879	Primary Effluent, flow @ 3.31, PSA June 04, 2001	-	-	-	23.4	22.5
S01-2880	Final Effluent, flow @ 3.31 June 04, 2001	62	64	3	-	-
S01-2881	Final Effluent, flow @ 3.31, PSA June 04, 2001	-	-	-	31.6	37.3

Comments:

[signature]

Certified by J. Faber,
Team Leader, Analytical Services

Appendix K
Mount Vernon WWTP Mixing Zone Study

City of Mount Vernon

Mount Vernon WWTP Mixing Zone Study

Prepared for:

City of Mount Vernon
1401 Britt Road
Mount Vernon, Washington 98273

Prepared by:

Cosmopolitan Engineering Group
117 South 8th Street
Tacoma, Washington 98402

February 2000
MTV002

General Instructions

f form has been partially completed by preprinting, disregard instructions directed at entry of that information already preprinted.

Enter *"Permittee Name/Mailing Address* (and facility name/location, if different)," *"Permit Number,"* and *"Discharge Number"* where indicated. (A separate form is required for each discharge.)

3. Enter dates beginning and ending *"Monitoring Period"* covered by form where indicated.

4. Enter each *"Parameter"* as specified in monitoring requirements of permit.

5. Enter *"Sample Measurement"* data for each parameter under *"Quantity"* and *"Quality"* in units specified in permit. *"Average"* is normally arithmetic average (geometric average for bacterial parameters) of all sample measurements for each parameter obtained during *"Monitoring Period"; "Maximum"* and *"Minimum"* are normally extreme high and low measurements obtained during *"Monitoring Period."* **(Note to municipals with secondary treatment requirement:** Enter 30-day average of sample measurements under *"Average,"* and enter maximum 7-day average of sample measurements obtained during monitoring period under *"Maximum."*)

6. Enter *"Permit Requirement"* for each parameter under *"Quantity"* and *"Quality"* as specified in permit.

7. Under *"No. of Exceedances"* enter number of sample measurements during monitoring period that exceed maximum (and/or minimum or 7-day average and monthly average as appropriate) permit requirement for each parameter. If none, enter *"O."*

8. Enter *"Frequency of Analysis"* both as *"Sample Measurement"* (actual frequency of sampling and analysis used during monitoring period) and as *"Permit Requirement"* specified in permit. (e.g., Enter *"Cont,"* for continuous monitoring, *"1/7"* for one day per week, *"1/30"* for one day per month, *"1/90"* for one day per quarter, etc.)

9. Enter *"Sample Type"* both as *"Sample Measurement"* (actual sample type used during monitoring period) and as *"Permit Requirement,"* (e.g., Enter *"Grab"* for individual sample, *"24HC"* for 24-hour composite, *"N/A"* for continuous monitoring, etc.)

10. Where violations of permit requirements are reported, attach a brief explanation to describe cause and corrective actions taken, and reference each violation by date.

If "no discharge" occurs during monitoring period, check the *"No Discharge"* box in the upper right-hand corner of page 1.

12. Enter *"Name/Title of Principal Executive Officer"* with *"Signature of Principal Executive Officer of Authorized Agent," "Telephone Number,"* and *"Date"* at bottom of form.

13. Mail signed Report to Office(s) by date(s) specified in permit. Retain copy for your records.

14. More detailed instructions for use of this *Discharge Monitoring Report (DMR)* form may be obtained from Office(s) specified in permit.

Legal Notice

This report is required by law (33 U.S.C. 1318; 40 C.F.R. 125.27). Failure to report or failure to report truthfully can result in civil penalties not to exceed $10,000 per day of violation; or in criminal penalties not to exceed $25,000 per day of violation, or by imprisonment for not more than one year, or by both.

APPENDIX H
ENVISION MODEL DATA SUMMARY SHEETS FOR THE CITY OF MOUNT VERNON WASTEWATER TREATMENT PLANT

UnitProc	Parameter	Condition	Range	Limit	Unit	Comment	Source
Primary Clarifiers	OFR	MM15	800-1200	1,000	gpd/sf		DOE Standard
Primary Clarifiers	OFR	PH15	2000-3000	2,500	gpd/sf		DOE Standard
Primary Clarifiers	HRT	MM15	2.5	2.5	hr		DOE Standard
Aeration Basins	MLSS	MM15		2,500	mg/L	assumes existing 11 SWD clarifier is not used	Stress Testing
Aeration Basins	MLSS	MD15		2,700	mg/L	assumes existing 11 SWD clarifier is not used	Stress Testing
Aeration System	OUR	MM15		45	mg/L/h	Based on fine bubble diffusers	HDR Standard
Aeration System	OUR	MD15		50	mg/L/h	Based on fine bubble diffusers	HDR Standard
Aeration System	OUR	PH15		75	mg/L/h	Based on fine bubble diffusers	HDR Standard
Blower	SCFM	MD15		12,300	scfm	4@4,100 scfm, assume 1 out of service	Installed firm capacity
Blower	SCFM	PH15		12,300	scfm	4@4,100 scfm, assume 1 out of service	Installed firm capacity
Secondary Clarifiers	HRT	MD15		2	hr	With RAS - sustained load	HDR Standard
Secondary Clarifiers	HRT	PH15		2	hr	With RAS - sustained load	HDR Standard
Secondary Clarifiers	OFR	PH15		900	gpd/sf	Parameter lowered due to clarifier concern	DOE Peak Criteria Rate is 1200
Secondary Clarifiers	SLR	MM15		25	lb/d/sf	assumes existing 11 SWD clarifier is not used	DOE Standard
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Secondary Clarifiers	SLR	PH15		40	lb/d/sf	assumes existing 11 SWD clarifier is not used	DOE Standard
DAF Thickeners	SLR	MM15	1-2.5	2.5	lb/d/sf	Design criteria sheet says 1 pph w/o polymer, 2 pph	DOE Standard for DAF with polymer
Anaerobic Digester	HRT	MM15	15	15	d		EPA Sludge regulations
Anaerobic Digester	SLR	MM15	120-160	140	lb VSS/1000 cf/d		WEF MOP8
Gravity Thickener	OFR	MM15	600-800	700	gpd/sf		DOE Standard

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SECTION 1:
INTRODUCTION

1.1 BACKGROUND

The City of Mount Vernon owns and operates the Mount Vernon Wastewater Treatment Plant (WWTP) under NPDES permit No. WA-002407-4. The treatment plant provides activated sludge secondary treatment and anaerobic sludge digestion. The plant was upgraded in 1989 to a design population of 28,500. A Wastewater Comprehensive Plan was completed in 1998, with a projected sewered population of 43,560 in 2015, plus additional commercial and industrial sources.

1.2 SKAGIT RIVER TMDL

Ecology completed the *Lower Skagit River Total Maximum Daily Load Water Quality Study* (Pickett, 1997), which included a model of dissolved oxygen in the Skagit River from RM 24.6 (near Sedro Woolley) to RM 0.0 (Puget Sound). The report recommended wasteload allocations of BOD and ammonia for each of the municipal WWTPs in the lower river. The model has been revised based on subsequent field data collected in 1998, and the recommended wasteload allocations have been modified.

1.3 NPDES PERMIT RENEWAL

The Department of Ecology is expected to renew Mount Vernon's NPDES permit in 2000. According to Ecology, the permit will include effluent limits for ammonia and BOD derived from the revised Skagit River TMDL model (personal communication with Jerry Shervey, 1999). The permit may also include effluent limits based on compliance with water quality standards within authorized mixing zones.

1.4 PURPOSE

This study assesses effluent mixing for the existing open-ended outfall located along the bank of the Skagit River. The study also evaluates the need for and benefit of an outfall extension and/or addition of a diffuser to improve effluent mixing and compliance with water quality standards.

The purpose of this study is to establish the following for several outfall improvement alternatives:

- Water quality-based effluent limits for the next NPDES permit
- Projected effluent limits for 2015 effluent flows

This study satisfies the *Engineering Report* requirements for outfalls specified in WAC 173-280-060(d), (e), and (l). The results of this study will be incorporated into *the 2000 Comprehensive Sewer Plan Update* and *Wastewater Facility Plan* currently being developed by HDR Engineering.

1.5 SEASONAL SCOPE

The analysis of outfall alternatives, effluent mixing and water quality impacts is limited to the low flow period of the Skagit River, which occurs between July and October. This is the period when the river is most vulnerable to water quality impacts from the discharge of toxicants and oxygen demanding wastes from the WWTP. It is also the period when the TMDL wasteload allocations for BOD and ammonia will apply.

The City of Mount Vernon will be constructing improvements in their collection system to reduce CSO discharges. These improvements will increase peak effluent flows from the treatment plant during the wet season. These improvements may require construction of a larger outfall or a second outfall. The need for a second outfall and the associated wet weather water quality impacts are not evaluated in this report. Because peak flows are not established, engineering design criteria for outfall improvements are also not evaluated in the report. These design issues would be addressed during predesign if an outfall improvement is implemented.

SECTION 2:
DESIGN CRITERIA

2.1 EFFLUENT FLOWS

Existing and projected effluent flows for the critical dry weather period are shown in Table 1. Maximum monthly average flows are used for assessing chronic toxicity, and maximum daily flows are used for acute toxicity (Ecology, 1992). The 1999 effluent flows are based on a review of the last five years' Daily Monitoring Reports for August through October. This is the record that Ecology will use to establish water quality-based effluent limits in the next NPDES permit. The 2015 flows are conservative estimates based on the *1998 Comprehensive Plan*. The 2015 flows will be re-evaluated or verified by HDR Engineering in the *2000 Comprehensive Sewer Plan Update*.

Table 1 Design Effluent Flow Rates for July through October

Planning Year	Maximum Month (mgd)	Maximum Day (mgd)
1999	3.51	6.38
2015	8.13	12.86

2.2 WATER QUALITY STANDARDS

The Skagit River is rated Class A fresh water according to the Washington State Water Quality Standards WAC 173-201A. The toxic substances that typically appear in municipal wastewater effluent include chlorine, ammonia, and metals. The numerical standards for these parameters are provided in Table 2.

The water quality standards for ammonia are based on ambient pH and temperature. The ammonia standards shown in Table 2 are the 5th percentile of the water quality criteria calculated for July through October ambient monitoring data collected by Ecology near Mount Vernon from 1991 through 1997. Metals criteria are based on an ambient hardness of 25 mg/L as $CaCO_3$. Ambient water quality data and criteria worksheets are provided in Appendix A.

Table 2 Water Quality Standards for Toxicants

Parameter	Acute Criteria (µg/L)	Chronic Criteria (µg/L)
Chlorine	19	11
Ammonia-N	8,314	1,877
Copper	4.61	3.47
Mercury	2.1	0.012
Lead	13.9	0.54
Silver	0.32	–
Zinc	35.4	32.3

2.3 MIXING ZONES

The Mount Vernon NPDES permit authorizes acute and chronic mixing zones, which are described in WAC 173-201A-100. The allowed mixing zone for chronic water quality criteria:

- shall not exceed greater than 300 feet plus the water depth downstream, or 100 feet upstream
- shall not utilize greater than 25 percent of the river flow
- shall not occupy greater than 25 percent of the river width

The allowed mixing zone for acute water quality criteria:

- shall not extend beyond 10 percent of the distance to the chronic mixing zone boundary
- shall not utilize greater than 2.5 percent of the river flow

SECTION 3: EXISTING OUTFALL

3.1 DESCRIPTION

The Mount Vernon WWTP discharges secondary-treated effluent to the Skagit River at RM 10.7. The existing outfall for the Mount Vernon WWTP consists of a 24-inch diameter, Class 5 ductile iron restrained joint pipe. The pipe is open-ended, discharging at the river's edge at a depth of 8 feet. The outfall profile for the river section is shown in Figure 1.

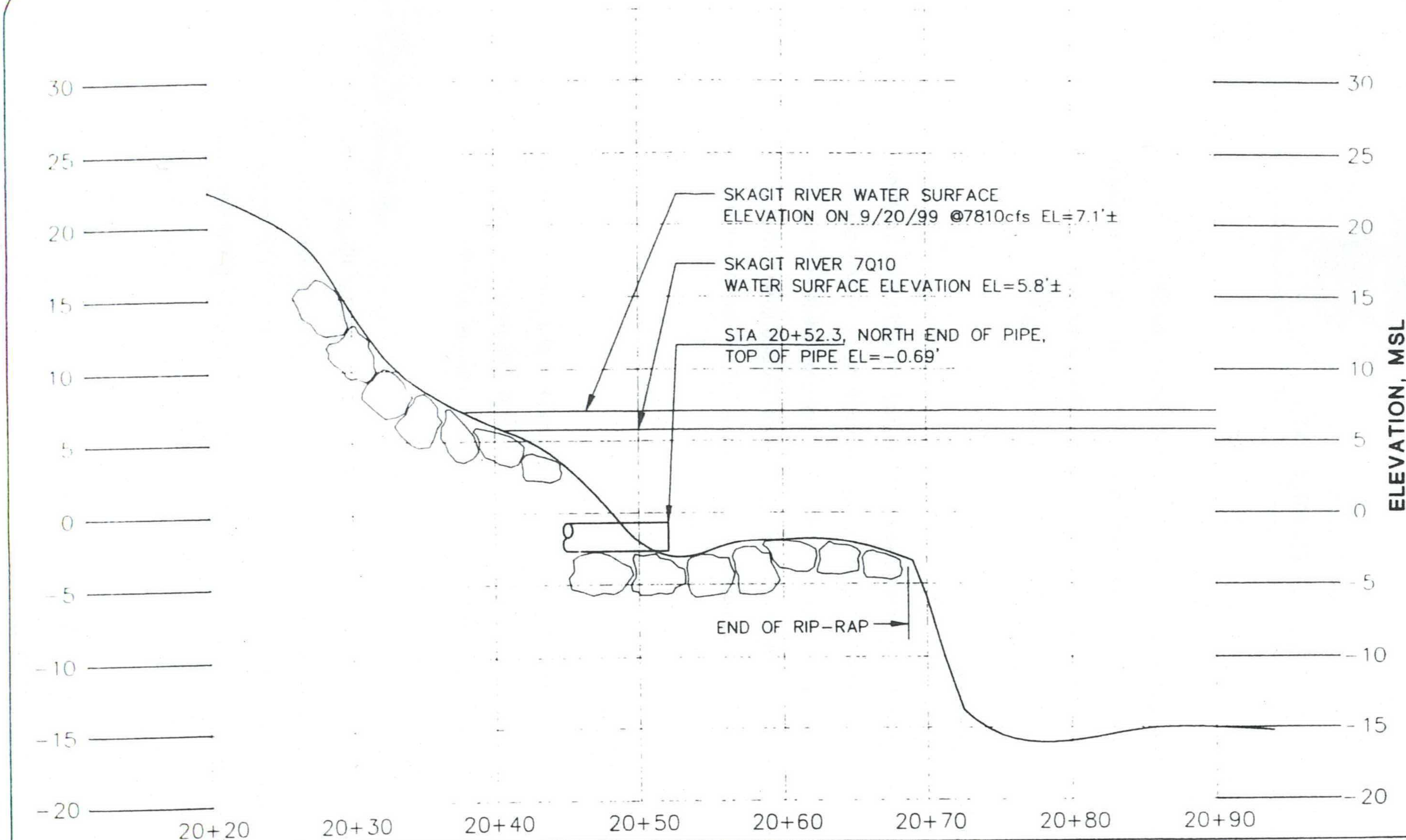
3.2 OUTFALL INSPECTION

The outfall was visually inspected by divers during a field study conducted on September 20, 1999. The outfall was found intact and generally as shown in Figure 1. There are no joints exposed, and the terminus has a plain end. The outfall is well armored along the slope and at the terminus. However, there is an abrupt 8-foot vertical drop-off located approximately 15 feet offshore of the terminus, which is not shown on the drawings. The divers report is furnished in Appendix B.

3.3 DISCHARGE EDDY

The outfall is located within a small depression in the riverbank in plan view. This depression creates an eddy (or gyre) that is visibly trapping effluent near the shoreline. Rhodamine WT dye was injected into the effluent for approximately 30 minutes on October 5, 1999, to confirm current effluent concentrations along the shoreline.

The dye was clearly visible in the eddy formed in the riverbank depression. Photos are provided in Figure 2. Approximate locations of the outfall and acute mixing zone boundaries have been superimposed on the photos. Effluent was visibly trapped within the eddy. The mixing of effluent with ambient water occurred at the offshore boundary of the eddy, where there was strong turbulence between the circulating eddy and the ambient flow.



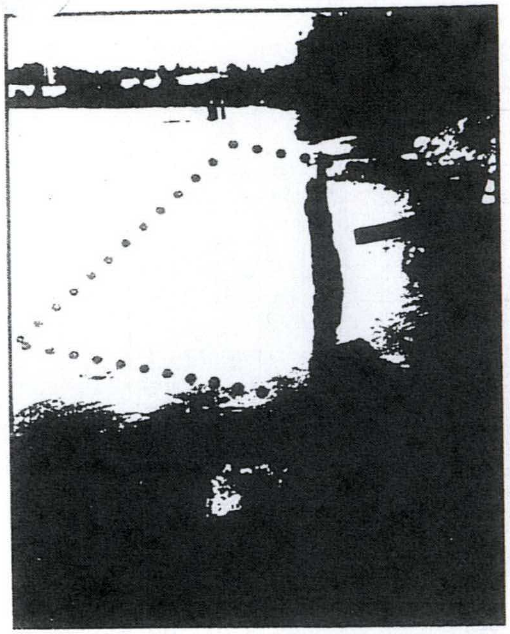
FILE: MTV002 JOB: MTV002F1

ENGINEERING GROUP
Civil, Environmental and Recreational Consulting

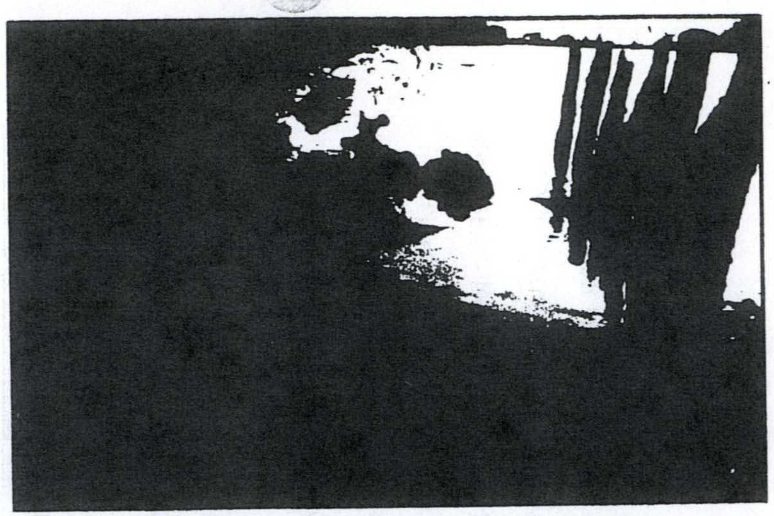
SCALES:
1" = 10' HOR
1" = 10' VER

Figure 1 Existing Outfall Profile

Scale 10 = 1'-0"
P:\MTV002\Graphics\File MTV002F1.DWG
Date 2/10/2000 12:59 P.M.

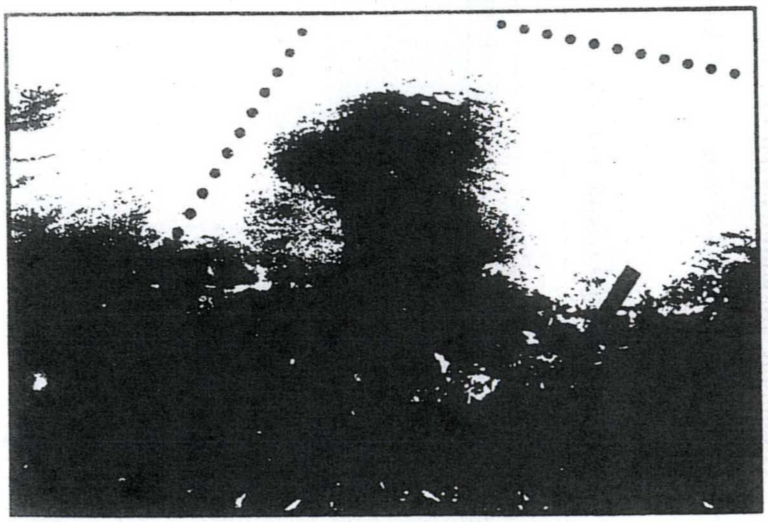


50 feet downstream looking upstream

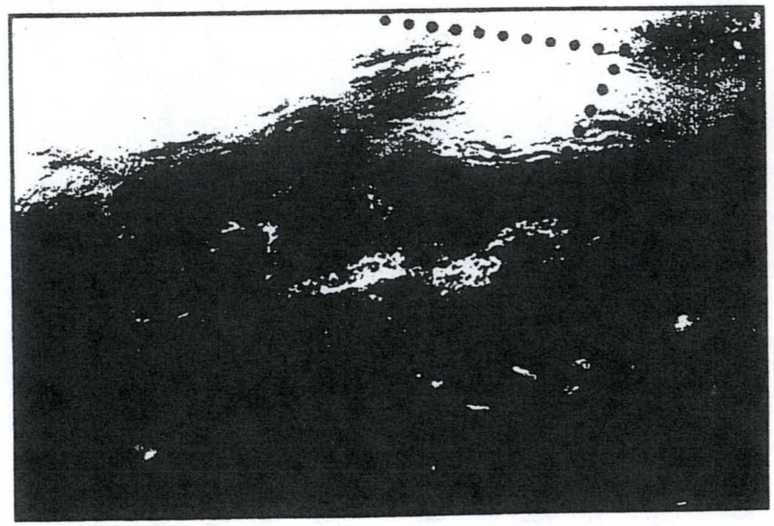


50 feet downstream looking downstream

Legend:
- (solid bar) Outfall
- (dotted line) Acute Mixing Zone



Outfall to downstream AMZ boundary



Outfall to upstream AMZ boundary

Figure 2 Effluent Plume Photos October 5, 1999

SECTION 4:
FIELD STUDIES

4.1 VELOCITY AND DEPTH

Velocity and depth measurements were obtained on September 20, 1999. Depth measurements were a combination of direct soundings and acoustic soundings taken over the entire cross-section. Cross-section data are plotted in Figure 3.

4.1.1 Low Tide Measurements

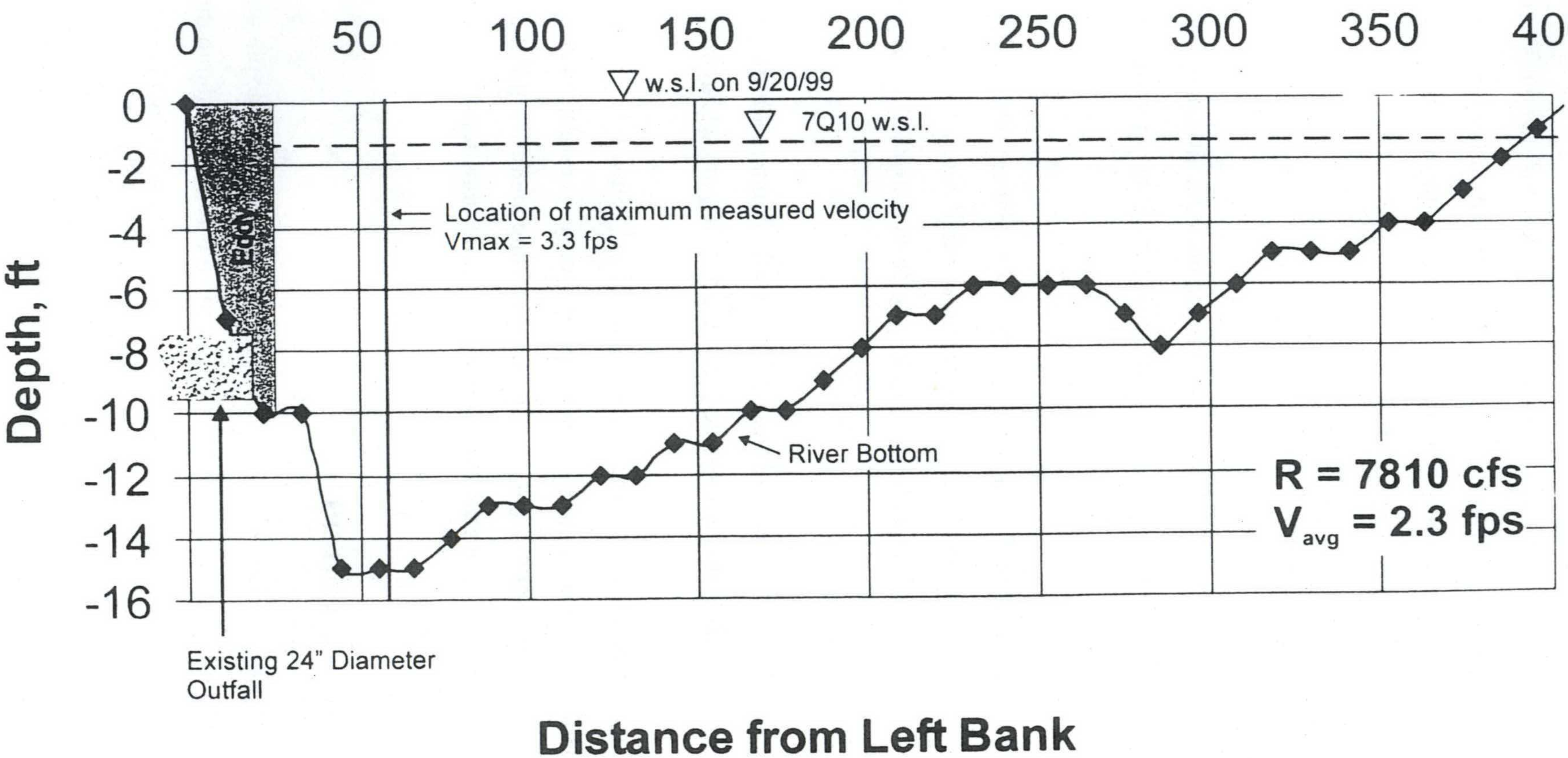
Velocity measurements were obtained at maximum 10-foot intervals for the 80 feet nearest the shoreline with a Swoffer current meter with digital readout. Readings were obtained at 20, 60 and 80 percent of the depth. Readings were taken during low tide between 13:30 and 14:30 on September 20, when the Skagit River discharge measured at USGS Station 12200500 near Mount Vernon was 7,810 cfs. Readings were repeated at 17:30 when there was some tidal influence; however, river discharge had increased to approximately 9,800 cfs at that point.

Velocity measurements are summarized in Table 3. The maximum depth-averaged velocity was approximately 3.3 fps, and the average was calculated from the cross-section as 2.3 fps.

Table 3 Current Speed Measurements – September 20, 1999

Distance from Left Bank (ft)	Depth (ft)	Velocity (fps)			
		20% Depth	60% Depth	80% Depth	Average
5	3.3	–	1.36	–	1.4
10	7	1.17	1.43	1.21	1.3
18	12	1.73	1.96	1.40	1.7
28	11	2.33	2.28	2.31	2.3
38	15	2.58	2.65	–	2.6
48	15	2.72	3.15	–	2.9
58	14	3.10	3.04	2.70	3.0
78	13	3.54	3.40	2.98	3.3

Figure 3
Skagit River Cross-Section 9/20/99



Velocity measurements were not obtained within the eddy surrounding the outfall because the direction of the currents within the eddy was very unsteady. Based on visual observations, the currents inside the eddy were vigorous, but produced little negligible net downstream movement of the effluent or exchange with ambient waters.

4.1.2 High Tide Measurements

The Skagit River at the Mount Vernon WWTP has a very slight tidal influence at high tides. The high tide raises the water surface slightly, but there is no flow stoppage or current reversal, and no salt wedge is present.

The field studies were conducted on September 20, 1999, because there was a high tide in Skagit Bay at 3:30 p.m. The highest tide level was observed at the outfall site, 10.7 miles from Skagit Bay, at approximately 5:30 p.m. Water surface elevation rose an estimated 1.2 feet from the earlier low tide measurements.

River discharge at Mount Vernon typically increases in late afternoon, including this field study. River discharge at Station 12200500 increased to 9,290 cfs at 5:30 p.m. on September 20, 1999.

Velocity measurements were slightly higher than those observed at low tide. Peak velocity was approximately 3.4 feet per second, and the cross-sectional average is estimated at 2.5 feet per second. Since the velocity and depth were greater during the late afternoon tides, the low tide depth and velocity measurements are selected as the critical conditions for dilution modeling and setting water quality-based limits.

4.2 EFFLUENT TRACER STUDIES

Effluent concentrations were measured on October 5, 1999, within the visible plume trapped in the previously discussed eddy. Rhodamine WT fluorescent dye was injected into the effluent for approximately 30 minutes at a constant rate, and plume samples were taken with a Niskin bottle sampler. Fluorescence of effluent and river samples was measured in a laboratory with a Turner Model 10 fluorometer.

Temperature was also used as a tracer. Temperature was measured in effluent and in the river with a SeaBird Model SBE-16. The temperature data are shown in Figure 4 and Appendix C.

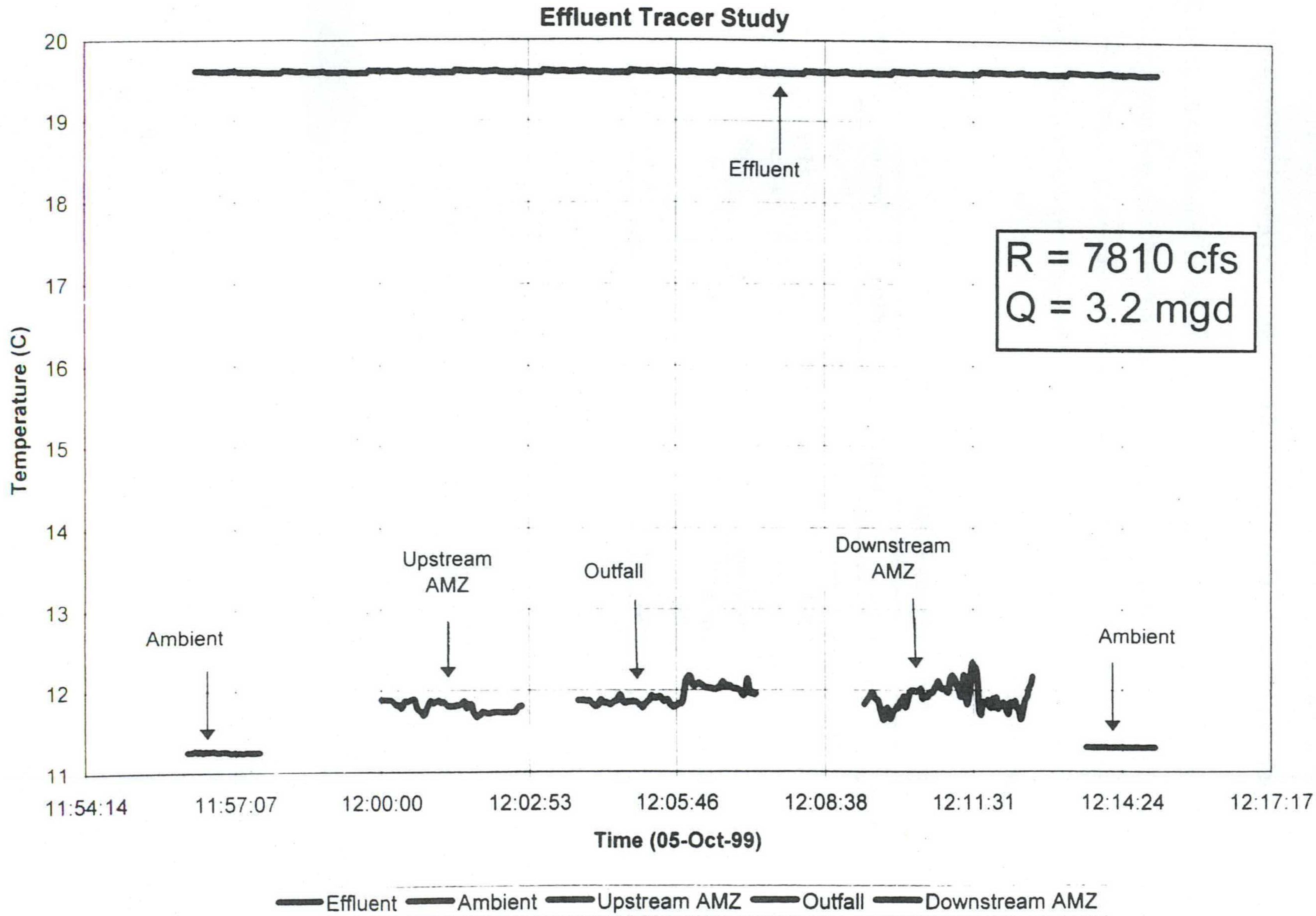
The results of the tracer studies are provided in Table 4. The results indicate that the dilution factor at both the upstream and downstream acute mixing zone boundaries was approximately 13:1 at the time of the study. The effluent flow rate during the study was 3.2 mgd and the river discharge was 7,810 cfs measured at USGS Station 12200500, the same discharge as during the September 20 field study.

Table 4 Tracer Study Results – October 5, 1999

Tracer	Location	Effluent	Ambient	Measured	Dilution
Rhodamine WT Dye	Upstream AMZ	117 ppb	0	9.9 ppb	11.8
	Outfall			24.4 ppb	4.8
	Downstream AMZ			9.1 ppb	12.9
	200'± Downstream			1.8 ppb	65
Temperature	Upstream AMZ	19.6°C	11.3°C	11.9°C	13
	Outfall			12.1°C	10
	Downstream AMZ			11.9°C	13

AMZ = Acute Mixing Zone boundary

Figure 4
Temperature Tracer Study Data



SECTION 5: MIXING ZONE MODELING

5.1 OUTFALL ALTERNATIVES

The objective of modifying the existing outfall would be to inject effluent where it would not be trapped in the shoreline eddies. The current outfall is located at an outside bend in the river, where historical cross-sections and aerial photos furnished by Skagit County and the Corps of Engineers reveal that the thalweg has been relatively stable along the left bank. The proposed project would extend the outfall approximately 40 feet from its present location to a terminus near the thalweg. The profile is shown schematically in Figure 5.

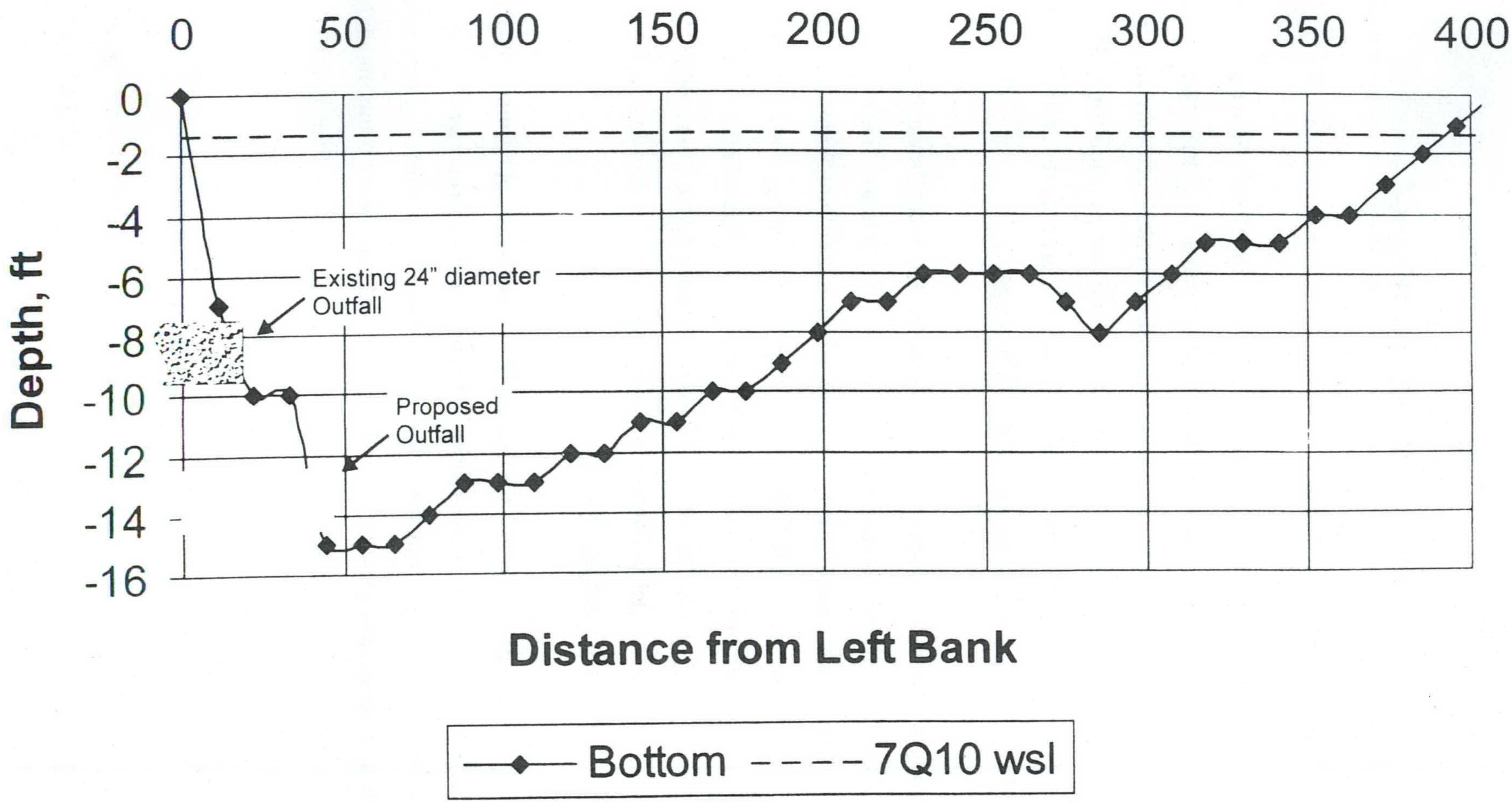
The outfall could include a multi-port diffuser. However, the maximum acute and chronic dilution factors allowed in the mixing zone regulations are limited to a fixed percent of the ambient river flow. A diffuser may actually achieve a higher dilution factor at the mixing zone boundary than allowed by the WAC. Base on preliminary modeling, it is anticipated that the maximum allowable dilution could be achieved with an open-ended outfall located at the thalweg with an upward nozzle trajectory. Diffusers are undesirable from a reliability standpoint because of the potential for debris damage and plugging ports. Therefore, an open-ended discharge is the preferred discharge alternative.

The required hydraulic design criteria for the outfall extension are not currently available due to the ongoing facility planning for CSO control. Therefore, this report does not include a detailed engineering evaluation of the outfall alternatives. Pipe material, diameter, alignment and profile, anchoring and armoring would be considered during a predesign phase if this option is selected and would be coordinated with the CSO improvements. The need for a diffuser would also be confirmed during this phase.

5.2 DILUTION MODEL SELECTION

The NPDES *Permit Writer's Manual* (Ecology, 1992) and the Orange Book (Ecology, 1998) describe several models appropriate for the river environment. The models PLUMES, CORMIX and RIVPLUM5 have been considered for this application.

Figure 5
Proposed Outfall Extension Schematic



PLUMES was used to evaluate the nearfield hydrodynamics of the discharge plume. This model provides a preliminary recommendation that a new outfall at the thalweg should be angled up at 45 degrees in order to disperse the effluent vertically. Model output comparing horizontal discharge to 45 degrees is provided in Appendix D. However, the PLUMES model was not used for dilution prediction because the model does not adequately consider the boundary conditions.

CORMIX was not selected for this application because it would not accurately simulate the existing discharge located in the eddy. It has little flexibility to adjust parameters for calibration to observed condition, and is not convenient to use because of the input file format.

RIVPLUM5 was chosen for this application for several reasons. It is the preferred model in rivers for point source discharges if the effluent plume is vertically mixed, which was demonstrated using the PLUMES model if the port is angled upward. RIVPLUM5 is conservative in that the initial velocity and buoyancy of the discharge are neglected. In addition, it is a spreadsheet model that can be run economically for multiple simulations. Finally, there are several options available to allow calibration to plume concentrations observed in the October 5 tracer studies for the existing outfall.

5.3 CRITICAL AMBIENT CONDITIONS

The *Permit Writer's Manual* stipulates that mixing zone dilution factors be calculated at the 7-day low flow with a 10-year recurrence interval (7Q10) derived from river discharge data. The 7Q10 discharge for the USGS Station Skagit River near Mount Vernon has been established at 5,030 cfs (Cosmopolitan Engineering Group, 1999).

Thalweg. Current speed and water depth are adjusted from the 7,810 cfs discharge observed September 20, 1999, to the 7Q10 discharge by the following method:

- The critical hydraulic condition is the non-tidally influenced (low tide) period as described in Section 4.1.
- 7Q10 water depth is lower than observed by approximately 1.3 feet, based on the rating curve for the USGS Station Skagit River near Mount Vernon.

- The average current speed of 2.3 fps observed on September 20 is reduced to 1.8 fps for 7Q10 conditions based on the reduced cross-sectional area.

The projected 7Q10 water surface is shown on Figures 3 and 5.

Eddy. Currents within the eddy are vigorous, but do not produce corresponding dilution factors due to recirculation or trapping of effluent, known as reflux. Dilution of the effluent plume occurs through turbulent entrainment along the outer edge of the eddy. Therefore, the flux of ambient water available to dilute the effluent is less than suggested by the speed of the currents within the eddy. The effective current for modeling the existing discharge is established empirically by adjusting current speed in RIVPLUM5 until the dilution predicted at the acute mixing zone boundary matches that observed in the tracer studies. The result is an artificial current speed of 0.1 fps for the October 5 tracer study, adjusted to 0.9 fps for the 7Q10 condition. The RIVPLUM5 model output for the calibration case is provided in Table 5. The shear velocity and transverse mixing coefficient are also artificial, reflecting the thorough mixing that occurs within the eddy.

5.4 DILUTION MODEL PREDICTIONS

RIVPLUM5 mod. . results for the 1999 effluent flows are provided in Table 6. The proposed outfall extension would increase the acute dilution from 4.5 to 38.2 at the acute mixing zone boundary. However, even with the extended outfall the maximum allowable acute dilution would be limited to 13.8 due to the 2.5 percent of ambient flow limitation (see Section 2.3) as shown below:

$$Q_{eff} = Peak\ Day\ Effluent\ Flow = 6.38\ mgd = 9.83\ cfs$$

$$R = 2.5\%\ of\ 7Q10 = (0.025)(5030) = 125.8\ cfs$$

$$DF = Dilution\ Factor = \frac{Q_{eff} + R}{Q_{eff}}$$

$$= \frac{9.83 + 125.8}{9.83}$$

$$= 13.8$$

Therefore, the proposed open-ended outfall extension would increase the acute dilution factor from 4.5 to 13.8. The chronic dilution factor would increase from 26 to 220. Since the actual dilution factors at the downstream mixing zone boundary exceed the maximum allowable dilution as illustrated in the equation above, the lack of a need for a diffuser is confirmed.

RIVPLUM5 model results for the 2015 projected flows are provided in Table 7. The proposed outfall extension would increase chronic dilution from 11.2 with the current outfall to 95 for the proposed extension. Acute dilution would increase from 2.2 to 19.0 at the acute mixing zone boundary. However, the maximum allowable dilution would be limited to 7.3 due to the 2.5 percent of ambient flow limitation, as illustrated below:

$$Q_{eff} = 12.86\ mgd = 19.8\ cfs$$

$$R = (0.025)(5030) = 125.8\ cfs$$

$$DF = \frac{Q_{eff} + R}{Q_{eff}} = \frac{19.8 + 125.8}{19.8} = 7.3$$

Table 5. RIVPLUM5 Calibration for October 5, 1999 Tracer Study

Spread of a plume from a point source in a river with boundary effects from the shoreline
based on the method of Fischer *et al.* (1979) with correction for the effective origin of effluent

Revised 25-Nov-97

	05-Oct-99 Chronic	05-Oct-99 Acute
INPUT		
Skagit River Flow (cfs)	7810	7810
1 Effluent Discharge Rate (cfs)	4 93	4 93
2 Receiving Water Characteristics Downstream From Waste Input		
Stream Depth (ft)	8 00	8 00
Stream Velocity (fps)	0 10	0 10
Channel Width (ft)	200 0	200 0
Stream Slope (ft/ft) or Manning roughness "n"	0 007	0 007
0 if slope or 1 if Manning "n" in previous cell	0	0
3 Discharge Distance From Nearest Shoreline (ft)	0	0
4 Location of Point of Interest to Estimate Dilution		
Distance Downstream to Point of Interest (ft)	308	30 8
Distance From Nearest Shoreline (ft)	0	0
5 Transverse Mixing Coefficient Constant (usually 0 6)	0 6	0 6
6 Original Fischer Method (enter 0) or *Effective Origin* Modification (enter 1)	0	0
[illegible]		
1 Source Conservative Mass Input Rate		
Concentration of Conservative Substance (%)	100 00	100 00
Source Conservative Mass Input Rate (cfs*%)	493 00	493 00
2 Shear Velocity		
Shear Velocity based on slope (ft/sec)	1 343	1 343
Shear Velocity based on Manning "n"		
using Prasuhn equations 8-26 and 8-54 assuming		
hydraulic radius equals depth for wide channel		
Darcy-Weisbach friction factor "f"	#N/A	#N/A
Shear Velocity from Darcy-Weisbach "f" (ft/sec)	#N/A	#N/A
Selected Shear Velocity for next step (ft/sec)	1 343	1 343
3 Transverse Mixing Coefficient (ft2/sec)	6 446	6 446
4 Plume Characteristics Accounting for Shoreline Effect (Fischer *et al.* 1979)		
Co	3 08E+00	3 08E+00
x'	4 96E-01	4 96E-02
y'o	0 00E+00	0 00E+00
y' at point of interest	0 00E+00	0 00E+00
Solution using superposition equation (Fischer eqn 5 9)		
Term for n= -2	6 32E-04	1 99E-35
Term for n= -1	2 67E-01	3 55E-09
Term for n= 0	2 00E+00	2 00E+00
Term for n= 1	2 67E-01	3 55E-09
Term for n= 2	6 32E-04	1 99E-35
Upstream Distance from Outfall to *Effective Origin* of Effluent Source (ft)	#N/A	#N/A
Effective Distance Downstream from Effluent to Point of Interest (ft)	308 00	30 80
x' Adjusted for *Effective Origin*	4 96E-01	4 96E-02
C/Co (dimensionless)	1 01E+00	2 53E+00
Concentration at Point of Interest (Fischer Eqn 5 9)	3 13E+00	7 80E+00
Unbounded Plume Width at Point of Interest (ft)	797 043	252 047
Unbounded Plume half-width (ft)	398 522	126 024
Distance from near shore to discharge point (ft)	0 00	0 00
Distance from far shore to discharge point (ft)	200 00	200 00
Plume width bounded by shoreline (ft)	200 00	126 02
Approximate Downstream Distance to Complete Mix (ft)	248	248
Theoretical Dilution Factor at Complete Mix	32 5	32 5
Calculated Flux-Average Dilution Factor Across Entire Plume Width	32 5	20 5
Calculated Dilution Factor at Point of Interest	**32 0**	**12.8**
Maximum Allowable Dilution Factor (based on volume	397 0	40 6

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Table 6. RIVPLUM5 Results for 1999 Effluent Flows

Spread of a plume from a point source in a river with boundary effects from the shoreline based on the method of Fischer *et al.* (1979) with correction for the effective origin of effluent

Revised 25-Nov-97

	1999 Flow Shore Outfall Chronic	1999 Flow Shore Outfall Acute	1999 Flow Extended Outfall Chronic	1999 Flow Extended Outfall Acute
INPUT				
Skagit River Flow (cfs)	5030	5030	5030	5030
1 Effluent Discharge Rate (cfs)	5 41	9 83	5 41	9 83
2 Receiving Water Characteristics Downstream From Waste Input				
Stream Depth (ft)	6 75	6 75	13 00	13 00
Stream Velocity (fps)	0 09	0 09	1 80	1 80
Channel Width (ft)	400 0	400 0	400 0	400 0
Stream Slope (ft/ft) or Manning roughness "n"	0 007	0 007	0 035	0 035
0 if slope or 1 if Manning "n" in previous cell	0	0	1	1
3 Discharge Distance From Nearest Shoreline (ft)	0	0	40	40
4 Location of Point of Interest to Estimate Dilution				
Distance Downstream to Point of Interest (ft)	308	30 8	302 1	30 2
Distance From Nearest Shoreline (ft)	0	0	40	40
5 Transverse Mixing Coefficient Constant (usually 0.6)	0 6	0 6	0 6	0 6
6 Original Fischer Method (enter 0) or *Effective Origin* Modification (enter 1)	0	0	0	0
[illegible]				
1 Source Conservative Mass Input Rate				
Concentration of Conservative Substance (%)	100 00	100.00	100.00	100 00
Source Conservative Mass Input Rate (cfs*%)	540 54	982.52	540 54	982.52
2 Shear Velocity				
Shear Velocity based on slope (ft/sec)	1 233	1 233	#N/A	#N/A
Shear Velocity based on Manning "n"				
using Prasuhn equations 8-26 and 8-54 assuming				
hydraulic radius equals depth for wide channel				
Darcy-Weisbach friction factor "f"	#N/A	#N/A	0 060	0 060
Shear Velocity from Darcy-Weisbach "f" (ft/sec)	#N/A	#N/A	0 156	0 156
Selected Shear Velocity for next step (ft/sec)	1 233	1 233	0 156	0 156
3 Transverse Mixing Coefficient (ft2/sec)	4 996	4 996	1 220	1 220
4 Plume Characteristics Accounting for Shoreline Effect (Fischer *et al.*, 1979)				
Co	2 22E+00	4 04E+00	5 78E-02	1 05E-01
x'	1 07E-01	1 07E-02	1 28E-03	1 28E-04
y'o	0 00E+00	0 00E+00	1 00E-01	1 00E-01
y' at point of interest	0 00E+00	0 00E+00	1 00E-01	1 00E-01
Solution using superposition equation (Fischer eqn 5 9)				
Term for n= -2	1 10E-16	5 24E-163	0 00E+00	0 00E+00
Term for n= -1	1 72E-04	4 52E-41	0 00E+00	0 00E+00
Term for n= 0	2 00E+00	2 00E+00	1 00E+00	1 00E+00
Term for n= 1	1 72E-04	4 52E-41	1 64E-275	0 00E+00
Term for n= 2	1 10E-16	5 24E-163	0 00E+00	0 00E+00
Upstream Distance from Outfall to *Effective Origin* of Effluent Source (ft)	#N/A	#N/A	#N/A	#N/A
Effective Distance Downstream from Effluent to Point of Interest (ft)	308 00	30 80	302 10	30 20
x' Adjusted for *Effective Origin*	1 07E-01	1 07E-02	1 28E-03	1 28E-04
C/Co (dimensionless)	1 73E+00	5 46E+00	7 89E+00	2 49E+01
Concentration at Point of Interest (Fischer Eqn 5 9)	3 84E+00	2 21E+01	4 55E-01	2 62E+00
Unbounded Plume Width at Point of Interest (ft)	739 641	233 895	80 961	25 598
Unbounded Plume half-width (ft)	369 821	116 948	40 480	12 799
Distance from near shore to discharge point (ft)	0 00	0 00	40 00	40 00
Distance from far shore to discharge point (ft)	400 00	400 00	360 00	360 00
Plume width bounded by shoreline (ft)	369 82	116 95	80 48	25 60
Approximate Downstream Distance to Complete Mix (ft)	1 153	1 153	76 457	76 457
Theoretical Dilution Factor at Complete Mix	45 0	24 7	1731 6	952 7
Calculated Flux-Average Dilution Factor Across Entire Plume Width	41 6	7 2	348 4	61 0
Calculated Dilution Factor at Point of Interest	**26 0**	**4.5**	**219.5**	38 2
Maximum Allowable Dilution Factor (based on volume)	233 6	13 8	233 6	**13.8**

Table 7. RIVPLUM5 Results for 2015 Effluent Flows

Spread of a plume from a point source in a river with boundary effects from the shoreline
b.. .d on the method of Fischer *et al.* (1979) with correction for the effective origin of effluent

Revised 25-Nov-97

	2015 Flow Shore Outfall Chronic	2015 Flow Shore Outfall Acute	2015 Flow Extended Outfall Chronic	2015 Flow Extended Outfall Acute
INPUT				
Skagit River Flow (cfs)	5030	5030	5030	5030
1 Effluent Discharge Rate (cfs)	12 52	19 80	12 52	19 80
2 Receiving Water Characteristics Downstream From Waste Input				
Stream Depth (ft)	6 75	6 75	13 00	13 00
Stream Velocity (fps)	0 09	0 09	1 80	1 80
Channel Width (ft)	400 0	400 0	400 0	400 0
Stream Slope (ft/ft) or Manning roughness "n"	0 007	0 007	0 035	0 035
0 if slope or 1 if Manning "n" in previous cell	0	0	1	1
3 Discharge Distance From Nearest Shoreline (ft)	0	0	40	40
4 Location of Point of Interest to Estimate Dilution				
Distance Downstream to Point of Interest (ft)	308	30 8	302 1	30 2
Distance From Nearest Shoreline (ft)	0	0	40	40
5 Transverse Mixing Coefficient Constant (usually 0 6)	0 6	0 6	0 6	0 6
6 Original Fischer Method (enter 0) or *Effective Origin* Modification (enter 1)	0	0	0	0
OUTPUT				
1 Source Conservative Mass Input Rate				
Concentration of Conservative Substance (%)	100 00	100 00	100.00	100 00
Source Conservative Mass Input Rate (cfs*%)	1,252 02	1,980 44	1,252 02	1,980 44
2 Shear Velocity				
Shear Velocity based on slope (ft/sec)	1 233	1 233	#N/A	#N/A
Shear Velocity based on Manning "n" using Prasuhn equations 8-26 and 8-54 assuming hydraulic radius equals depth for wide channel				
Darcy-Weisbach friction factor "f"	#N/A	#N/A	0 060	0 060
Shear Velocity from Darcy-Weisbach "f" (ft/sec)	#N/A	#N/A	0 156	0 156
Selected Shear Velocity for next step (ft/sec)	1 233	1 233	0 156	0 156
3 Transverse Mixing Coefficient (ft2/sec)	4 996	4 996	1 220	1 220
4 Plume Characteristics Accounting for Shoreline Effect (Fischer *et al.* 1979)				
Co	5 15E+00	8 15E+00	1 34E-01	2 12E-01
x'	1 07E-01	1 07E-02	1 28E-03	1 28E-04
y'o	0 00E+00	0 00E+00	1 00E-01	1 00E-01
y' at point of interest	0 00E+00	0 00E+00	1 00E-01	1 00E-01
Solution using superposition equation (Fischer eqn 5 9)				
Term for n= -2	1 10E-16	5 24E-163	0 00E+00	0 00E+00
Term for n= -1	1 72E-04	4 52E-41	0 00E+00	0 00E+00
Term for n= 0	2 00E+00	2 00E+00	1 00E+00	1 00E+00
Term for n= 1	1 72E-04	4 52E-41	1 64E-275	0 00E+00
Term for n= 2	1 10E-16	5 24E-163	0 00E+00	0 00E+00
Upstream Distance from Outfall to *Effective Origin* of Effluent Source (ft)	#N/A	#N/A	#N/A	#N/A
Effective Distance Downstream from Effluent to Point of Interest (ft)	308 00	30 80	302 10	30 20
x' Adjusted for *Effective Origin*	1 07E-01	1 07E-02	1 28E-03	1 28E-04
C/Co (dimensionless)	1 73E+00	5 46E+00	7 89E+00	2 49E+01
Concentration at Point of Interest (Fischer Eqn 5 9)	8 89E+00	4 45E+01	1 06E+00	5 28E+00
Unbounded Plume Width at Point of Interest (ft)	739 641	233 895	80 961	25 598
Unbounded Plume half-width (ft)	369 821	116 948	40 480	12 799
Distance from near shore to discharge point (ft)	0 00	0 00	40 00	40 00
Distance from far shore to discharge point (ft)	400 00	400 00	360 00	360 00
Plume width bounded by shoreline (ft)	369 82	116 95	80 48	25 60
Approximate Downstream Distance to Complete Mix (ft)	1 153	1 153	76 457	76 457
Theoretical Dilution Factor at Complete Mix	19 4	12 3	747 6	472 6
Calculated Flux-Average Dilution Factor Across Entire Plume Width	[illegible]	3 6	150 4	30 2
Calculated Dilution Factor at Point of Interest	11 2	2.2	94.8	19 0
Maximum Allowable Dilution Factor (based on volume)	101 4	7 3	101 4	7.3

SECTION 6:
WATER QUALITY-BASED EFFLUENT LIMITATIONS

6.1 REASONABLE POTENTIAL TO EXCEED WATER QUALITY STANDARDS

The *reasonable potential to exceed water quality standards* is a standard statistical test developed by EPA and adopted by Ecology (1992) to establish the need for effluent limitations in NPDES permits. The method establishes a maximum expected concentration for toxicants based on effluent data available for the discharge. The predicted concentration at acute and chronic mixing zone boundaries is determined based on the dilution factors and ambient concentrations. If acute and chronic water quality standards are met by this test, then no effluent limitations are required to be placed in the NPDES permit. If there is a reasonable potential to exceed standards, then a permit limit for that parameter is required.

Table 8 displays the reasonable potential evaluation for the 1999 flows and existing effluent data for toxicants. The results demonstrate that effluent limits will be required for ammonia, copper, lead, silver and zinc in the next NPDES permit if the outfall is not extended. If the outfall is extended, only silver would have a reasonable potential to exceed water quality standards.

Table 9 shows the reasonable potential evaluation for the 2015 flows and existing effluent data. The results indicate that effluent limits will be required for all the detected toxicants in the next NPDES permit if the outfall remains unchanged. If the outfall is extended, only copper, lead and silver would have a reasonable potential to exceed water quality standards.

Table 8 Reasonable Potential to Exceed Water Quality Standards – 1999 Effluent Flows

Dry Season Flow - Existing Outfall											
							Mixing Zone		WQ Std.		
Toxicant	Max Eff	CV	n	Mult.	Ambient	MEC	Acute	Chronic	Acute	Chronic	Limit Req'd?
Cl2	50	0.6	730	1.0	0	50	11.1	1.9	13	7.5	no
NH3-N	45400	0.6	104	1.0	22	45400	10106	1767	8314	1877	YES
Cu	37	0.45	68	1.0	0.55	37	8.65	1.95	4.61	3.47	YES
Hg	ND								2.1	0.012	no
Pb	19	0.6	12	2.8	0.02	53.2	11.84	2.07	13.9	0.54	YES
Ag	3	0.6	12	2.8	0	8.4	1.87		0.32		YES
Zn	64	0.6	12	2.8	9.3	179.2	47.1	15.8	35.4	32.3	YES

Acute Dilution = 4.5
Chronic Dilution = 26

Dry Season Flow - Proposed Outfall Extension											
							Mixing Zone		WQ Std.		
Toxicant	Max Eff	CV	n	Mult.	Ambient	MEC	Acute	Chronic	Acute	Chronic	Limit Req'd?
Cl2	50	0.6	730	1.0	0	50	3.6	0.2	13	7.5	no
NH3-N	45400	0.6	104	1.0	22	45400	3310	229	8314	1877	no
Cu	37	0.45	68	1.0	0.55	37	3.19	0.72	4.61	3.47	no
Hg	ND								2.1	0.012	no
Pb	19	0.6	12	2.8	0.02	53.2	3.87	0.26	13.9	0.54	no
Ag	3	0.6	12	2.8	0	8.4	0.61	0.04	0.32		YES
Zn	64	0.6	12	2.8	9.3	179.2	21.6	10.1	35.4	32.3	no

Acute Dilution = 13.8
Chronic Dilution = 219

All units are µg/L

Table 9 **Reasonable Potential to Exceed Water Quality Standards – 2015 Effluent Flows**

Dry Season Flow - Existing Outfall											
							Mixing Zone		WQ Std.		Limit Req'd?
Toxicant	Max Eff	CV	n	Mult.	Ambient	MEC	Acute	Chronic	Acute	Chronic	
Cl2	50	0.6	730	1.0	0	50	22.7	4.5	13	7.5	YES
NH3-N	45400	0.6	104	1.0	22	45400	20648	4074	8314	1877	YES
Cu	37	0.45	68	1.0	0.55	37	17.12	3.80	4.61	3.47	YES
Hg	ND								2.1	0.012	no
Pb	19	0.6	12	2.8	0.02	53.2	24.19	4.77	13.9	0.54	YES
Ag	3	0.6	12	2.8	0	8.4	3.82		0.32		YES
Zn	64	0.6	12	2.8	9.3	179.2	86.5	24.5	35.4	32.3	YES

Acute Dilution = 2.2
Chronic Dilution = 11.2

Dry Season Flow - Proposed Outfall Extension											
							Mixing Zone		WQ Std.		Limit Req'd?
Toxicant	Max Eff	CV	n	Mult.	Ambient	MEC	Acute	Chronic	Acute	Chronic	
Cl2	50	0.6	730	1.0	0	50	6.8	0.5	13	7.5	no
NH3-N	45400	0.6	104	1.0	22	45400	6238	501	8314	1877	no
Cu	37	0.45	68	1.0	0.55	37	5.54	0.93	4.61	3.47	YES
Hg	ND								2.1	0.012	no
Pb	19	0.6	12	2.8	0.02	53.2	7.30	0.58	13.9	0.54	YES
Ag	3	0.6	12	2.8	0	8.4	1.15	0.09	0.32		YES
Zn	64	0.6	12	2.8	9.3	179.2	32.6	11.1	35.4	32.3	no

Acute Dilution = 7.3
Chronic Dilution = 94.8

All units are µg/L

6.2 NPDES PERMIT LIMITS

NPDES permit effluent limits are derived using methods developed by EPA and adopted by Ecology (1992). Permit limit worksheets are provided in Appendix E. The effluent limits for toxicants with a reasonable potential to exceed standards are summarized in Table 10. These limits would apply during the months July through October when river discharge is low, and would be in addition to ammonia and BOD limitations derived from the TMDL. Limits for 1999 and 2015 effluent flows are shown separately.

Table 10 Water Quality-Based NPDES Permit Limits (July-October)

1999 FLOWS	Existing Outfall		Proposed Outfall Extension	
	Daily Maximum	Monthly Average	Daily Maximum	Monthly Average
Ammonia-N, mg/L	37.3	16.6		
Copper, µg/L	18.8	12.9		
Lead, µg/L	22.2	15.2		
Silver, µg/L	1.4	1.0	4.4	3.0
Zinc, µg/L	127	87		

2015 FLOWS	Existing Outfall		Proposed Outfall Extension	
	Daily Maximum	Monthly Average	Daily Maximum	Monthly Average
Ammonia-N, mg/L	18.3	8.1		
Copper, µg/L	9.5	6.5	30.2	20.7
Lead, µg/L	9.6	6.6	81	55
Silver, µg/L	0.7	0.5	2.3	1.6
Zinc, µg/L	66	46		

NOTE: Blanks indicate no limit required.

SECTION 7: REFERENCES

Ecology, 1992. *Permit Writer's Manual.* Washington State Department of Ecology Publication No. 92-109.

Ecology, 1998. *Criteria for Sewage Works Design (Orange Book).* Washington State Department of Ecology.

Pickett, 1997. *Lower Skagit River Total Maximum Daily Load Water Quality Study.* Washington State Department of Ecology Publication No. 97-326a.

COSMOPOLITAN ENGINEERING GROUP

Appendix A

Ambient Water Quality Data and Ammonia Criteria Worksheet

Civil, Environmental, and Recreational Consulting

WASHINGTON STATE
DEPT. OF ECOLOGY

/ Conditions & Trends / River and Stream WQ Monitoring

Station 03A060

AMBIENT MONITORING DATA

Station 03A060
Water Quality Data Summary - Metals

Last updated 28-May-1998

1995 (03A060)	Mercury (micrograms/ Liter)	Cadmium (micrograms/ Liter)	Zinc (micrograms/ Liter)	Lead (micrograms/ Liter)	Chromium (micrograms/ Liter)	Copper (micrograms/ Liter)	Nickel (micrograms/ Liter)	Hardness** (milligrams/ Liter)
03/22/1995		0.030u	0.400u	0.020u		0.460p	0.689	28
01/18/1995		0.020u	0.550p	0.020u		0.360p	0.620	29

*Data qualifiers: u, j - estimated value k - actual value known to be less p - too numerous to count v - contamination in the blankt x - high background count

1994 (03A060)	Mercury (micrograms/ Liter)	Cadmium (micrograms/ Liter)	Zinc (micrograms/ Liter)	Lead (micrograms/ Liter)	Chromium (micrograms/ Liter)	Copper (micrograms/ Liter)	Nickel (micrograms/ Liter)	Hardness** (milligrams/ Liter)
11/16/1994		0.040u	1.900p	0.020u		0.546	1.000u	27
09/20/1994		0.040u	1.000u	0.020u		0.280p	1.000u	23
07/19/1994		0.040u	9.340p	0.020u		0.290p	1.000u	20
05/17/1994		0.040u	1.000u	0.023p		0.348p	1.000u	22

*Data qualifiers: u, j - estimated value k - actual value known to be less p - too numerous to count v - contamination in the blankt x - high background count

** Hardness (salt concentration) is factored into the water quality criteria for all of the metals except mercury.

Washington State Department of Ecology
Please send comments to stba461@ecy.wa.gov

WASHINGTON STATE
DEPT. OF ECOLOGY

/ Conditions & Trends / River and Stream WQ Monitoring

AMBIENT MONITORING DATA

Station 03A060
Six Year Water Quality Data Summary

Last updated 26-May-1998

Metals data is also available for this station

Station name	Class	Latitude	Longitude	Elevation (ft)	River mile	Watershed(s)	External mapping li
Skagit R nr Mount Vernon	A	48 26 42.0	122 20 03.0	14	15.9	Skagit/Stillaguamish	Tiger Mapping Service M

Years-monitored history *Note: Data for years not presented here are available on request: See Requesting additional data.*

98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•		•	•	•	•	•	•	•	•	•

1997 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
09/23/19	0730	11300	12.6	44	10.4	96.4	7.4	15	14	0.079	0.010u	0.028	0.005u
08/20/1997	0720	13300	13.0	42	10.3	97.3	7.6	3	23	0.042	0.013	0.028	0.005u
07/23/1997	0735	26200	10.6	39	10.4	92.0	7.5	14	31	0.067	0.010u	0.038	0.005u
06/18/1997	0735	57800	8.0	32	11.7	97.7	7.7	130j	246	0.198j	0.010uj	0.052j	0.006
05/21/1997	0740	28400	6.6	40	11.6	93.9	7.5	11	32	0.088	0.011	0.045	0.005u
04/23/1997	0725	24700	6.5	52	11.6	93.7	7.6	3	27	0.213	0.038	0.068	0.005u
03/19/1997	0735	38400	4.2	39	12.6	95.6	7.2	32	389	0.480	0.023	0.275j	0.005u
02/19/1997	0750	25600	4.0	52	12.6	95.7	7.4	40	26	0.241	0.010u	0.078	0.005
01/22/1997	0805	29600	5.1	47	12.3	96.0	7.4	4s	53	0.210	0.010u	0.044	0.005u

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1996 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/17/1996	0825	13900	5.3	61	12.5	96.7	7.5	3	11	0.227	0.014	0.027	0.005u
11/20/1996	0825	16200	4.3	55	12.1	92.0	7.7	8	10	0.158	0.010u	0.010u	0.005u

Date	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
10/23/1996	0805	21000	7.5	41	11.2	92.3	7.4	73	48	0.211	0.010u	0.046	0.005u
09/18/1996	0740	9960	11.6	76	10.8	97.3	7.4	14	10	0.077	0.010u	0.014	0.005u
08/21/1996	0725	7280	13.5	53	10.1	94.9	7.5	15	9	0.068	0.010u	0.022	0.005u
07/24/1996	0750	15500	14.6	44	10.2	99.5	7.6	13x	11	0.033	0.010u	0.014	0.005u
06/19/1996	0715	16800	10.3	46	11.3	99.2	7.6	5	8	0.074	0.010u	0.015	0.005u
05/22/1996	0800	17700	8.5	52	11.6	98.6	7.3	20	10	0.121	0.010u	0.010u	0.005u
04/24/1996	0705	36100	6.9	41	11.7	96.0	7.4	59	340	0.245	0.010u	0.252	0.005u
03/20/1996	0745	16000	6.3	60	12.2	97.5	7.1	10	11	0.119	0.010u	0.014	0.005u
02/21/1996	0735	26200	5.6	47	12.2	97.9	7.7	2	36	0.160	0.010u	0.037	0.005u
01/24/1996	0810	19200	4.1	58	12.4	95.2	7.3	22	7	0.208	0.010u	0.016	0.005u

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1995 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/19/1995	0735	25100	6.2	52	12.0	96.0	7.5	4	38	0.159	0.010u	0.020	0.005u
11/21/1995	0745	34500	7.0	58	11.6	93.5	7.2	7s	90	0.185	0.010u	0.079	0.005u
10/18/1995	0745	32800	8.9	39	11.2	93.6	7.4	40	100	0.227	0.010u	0.076	0.005u
09/20/1995	0905	8700	13.7	55	10.2	95.2	7.6	27	14	0.075	0.010u	0.010u	0.007
08/23/1995	0910	9460	14.3	54	10.2	97.2	7.7	11	8	0.091	0.010u	0.010u	0.005u
07/19/1995	0900	13500	15.2	40	9.9	96.6	8.1	16	21	0.083	0.022	0.019	0.005u
06/21/1995	0910	13100	11.0	45	11.1	99.3	7.6	20	6	0.106	0.010u	0.018	0.005u
05/17/1995	0740	24600	9.1	42	11.2	96.2	7.5	10	383	0.080	0.010u	0.010u	0.005u
04/19/1995	0905	10100	7.1	67	11.9	98.0	7.2	8	8	0.144	0.010u	0.022	0.005u
03/22/1995	0900	21200	5.1	54	12.2	97.2	7.2	8s	11	0.163	0.010u	0.010	0.005u
02/22/1995	0930	40800	4.8	43	12.6	96.4		26s	95	0.203	0.010u	0.082	0.005u
01/18/1995	0930	18700	5.0	60	12.4	97.4	7.3	6s	12	0.214	0.010u	0.048	0.005u

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1994 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/21/1994	0950	51700	5.0	36	12.4	96.0	7.4	54s	248	0.266	0.010u	0.210	0.005u
11/16/1994	1100	13700	7.5	58	11.5	96.4	7.4	13	15	0.197	0.010u	0.010u	0.010k
10/19/1994	1010	4340	10.4	67	10.8	95.7	7.5	5	3	0.094	0.010u	0.010k	0.010k
09/20/1994	1440	8560	14.9	54	10.4	101.6	7.5	59	36	0.075	0.010k	0.026	0.010k
08/16/1994	1335	10600	15.7	46	10.1	100.7	7.6	31	146	0.085	0.010k	0.103	0.010k
07/19/1994	1355	11700	15.1	41	10.3	101.4		1	13	0.079	0.010k	0.014	0.010k

06/21/1994	1350	13500	14.2	44	10.3	99.3	7.5	1	6	0.079	0.010k	0.010k	0.010k
05/17/1994	1445	15300	12.1	46	10.1	93.2	7.3	15	7	0.010k	0.010k	0.010k	0.010k
04/19/1994	1410	19700	8.1	40	11.3	94.5	7.4	21	18	0.124	0.010k	0.010k	0.010k
03/22/1994	1345	15600	4.2	58	12.4	95.1	7.4	22	13	0.271	0.010k	0.010k	0.010k
02/22/1994	1405	10400	5.5	65	12.6	99.4	7.5	15	7	0.325	0.012	0.011	0.010k
01/1[illegible]994	1330	17500	5.7	59	12.1	95.0		2	12	0.240	0.010k	0.010k	0.010k

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1993 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/ 25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/ 100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/20/1993	1335	12600	5.6	61	12.4	97.0	7.8	1	9	0.268	0.045	0.010k	0.010k
11/16/1993	1510	8510	8.1	60	11.4	95.6	7.5	15	7	0.143	0.010k	0.010k	0.010k
10/19/1993	1340	5570	11.4	60	11.0	98.5	7.6	4	4	0.150	0.011	0.010k	0.010k
09/22/1993	0850	7430	11.7	52	11.1	100.1	7.8	10	10				0.010k
08/18/1993	0855	9390	14.2	45	10.4	99.6	7.4	34	32		0.011	0.023	0.010k
07/21/1993	0840	21500	12.0	30	10.6	97.1	7.3	[redacted]	111		0.010k	0.036	0.010k
06/23/1993	0930	16500	10.2	37	11.0	95.8	7.3	12	14		0.010k	0.010k	0.010k
05/19/1993	0830	26800	10.7	32	11.3	100.8	8.1	15	74		0.010k	0.031	0.010k
04/21/1993	0900	8720	8.2	58	11.4	95.8	7.8	4	7		0.013	0.010k	0.010
03/17/1993	0845	10100	4.6	55	12.4	96.5	7.5	5	11		0.020	0.018	0.010k
02/17/1993	0925	12200	1.4	59	13.5	94.0	7.3	3k	12		0.015	0.015	0.010k
01/20/1993	0850	9190	3.5	67	13.2	101.7	7.6	3	23		0.015	0.015	0.010k

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1992 (03A060)	Time	Flow (CFS)	Temperature (C)	Conductivity (umhos/ 25c)	Oxygen (mg/L)	Oxygen Saturation (%)	pH	Fecal Coliforms (colonies/ 100ml)	Suspended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/16/1992	0910	11900	5.0	57	12.8	99.3	7.4	4	25		0.010	0.012	0.010k
11/18/1992	0840	14200	9.0	48	11.3	96.2	7.5	6	33		0.010k	0.020	0.010k
10/21/1992	0920	11700	10.9	45	10.5	94.9	7.3	84	84		0.027	0.049	0.010k
09/23/1992	0745	6600	14.1	44	9.9	96.1	7.6	43x	77		0.044	0.061	0.010k
08/19/1992	0850	9680	15.4	46	9.8	96.1	7.4	11	1230		0.010k	0.737	0.010
07/22/1992	0750	11700	13.4	43	9.9	94.3	7.2	80	130		0.026	0.095	0.010k
06/17/1992	1050	10700	11.0	50	10.7	95.4	7.3	13	7		0.012	0.015	0.010k
05/20/1992	1020	15400	10.1	43	11.1	97.2	7.1	8	6		0.010k	0.010k	0.010k
04/22/1992	0950	10300	8.5	52	11.4	96.0	7.4	51	17		0.014	0.019	0.010k
03/18/1992	0950	13500	6.4	58	11.8	93.8	7.4	4	8		0.010k	0.010	0.010k

02/19/1992	0910	17800	5.0	55	12.1	93.8	7.2	6	12		0.019	0.013	0.010k
01/22/1992	0845	16300	5.2	57	12.5	96.7	7.4	5	2		0.016	0.019	0.010k

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

1991 (03A060)	Time	Flow (CFS)	Tem-perature (C)	Conduc-tivity (umhos/ 25c)	Oxygen (mg/L)	Oxygen Satura-tion (%)	pH	Fecal Coliforms (colonies/ 100ml)	Sus-pended Solids (mg/L)	Total Persulfate Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (mg/L)	Dissolved Soluble Phosphorus (mg/L)
12/11/1991	0740	22900	6.2	55	11.8	95.8	7.1	13	21		0.020	0.024	0.010k
11/13/1991	0810	26300	9.8	39	11.4	99.8	7.3	37	120		0.041	0.083	0.010k
10/23/1991	0800	7300	9.7	50	11.1	96.3	7.3	32	13		0.011	0.014	0.010k

■ *result fails water quality criteria* Data qualifiers: u, j - estimated value k - actual value known to be less s - spreader x - high background

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AMBIENT DATA AND AMMONIA-N CRITERIA (SUMMER)

Date	Ambient Temp (C)	Ambient pH	Ambient NH3-N (ug/L)	Fta	FTc	FPH	RATIO	pKa	fraction	Acute NH3-N Criteria (ug/L)	Chronic NH3-N Criteria (ug/L)
23-Sep-97	12.6	7.4	10	1.667	1.667	1.600	20.202	9.642	0.569%	14,068	2,143
20-Aug-97	13	7.6	13	1.622	1.622	1.305	15.631	9.629	0.927%	10,890	2,144
23-Jul-97	10.6	7.5	10	1.914	1.914	1.435	17.886	9.709	0.614%	12,673	2,180
23-Oct-96	7.5	7.4	10	2.371	2.371	1.600	20.202	9.816	0.383%	14,722	2,242
18-Sep-96	11.6	7.4	10	1.786	1.786	1.600	20.202	9.676	0.527%	14,177	2,159
21-Aug-96	13.5	7.5	10	1.567	1.567	1.435	17.886	9.612	0.767%	12,395	2,132
24-Jul-96	14.6	7.6	10	1.452	1.452	1.305	15.631	9.576	1.047%	10,778	2,122
18-Oct-95	8.9	7.4	10	2.153	2.153	1.600	20.202	9.767	0.427%	14,518	2,211
20-Sep-95	13.7	7.6	10	1.545	1.545	1.305	15.631	9.605	0.978%	10,839	2,134
23-Aug-95	14.3	7.7	10	1.483	1.483	1.201	13.500	9.586	1.285%	9,343	2,129
19-Jul-95	15.2	8.1	22	1.393	1.413	1.000	13.500	9.556	3.382%	4,536	1,020
19-Oct-94	10.4	7.5	10	1.941	1.941	1.435	17.886	9.716	0.604%	12,695	2,184
20-Sep-94	14.9	7.5	10	1.422	1.422	1.435	17.886	9.566	0.852%	12,284	2,113
16-Aug-94	15.7	7.6	10	1.346	1.413	1.305	15.631	9.540	1.136%	10,711	2,009
19-Jul-94	15.1	7.6	10	1.403	1.413	1.305	15.631	9.559	1.087%	10,746	2,101
19-Oct-93	11.4	7.6	11	1.811	1.811	1.305	15.631	9.682	0.821%	11,020	2,169
22-Sep-93	11.7	7.8	10	1.774	1.774	1.118	13.500	9.672	1.324%	8,132	1,854
18-Aug-93	14.2	7.4	11	1.493	1.493	1.600	20.202	9.589	0.643%	13,912	2,119
21-Jul-93	12	7.3	10	1.738	1.738	1.807	22.518	9.662	0.433%	15,735	2,150
21-Oct-92	10.9	7.3	27	1.875	1.875	1.807	22.518	9.699	0.397%	15,877	2,170
23-Sep-92	14.1	7.6	44	1.503	1.503	1.305	15.631	9.592	1.008%	10,811	2,128
19-Aug-92	15.4	7.4	10	1.374	1.413	1.600	20.202	9.549	0.704%	13,809	2,046
22-Jul-92	13.4	7.2	26	1.578	1.578	2.068	24.773	9.615	0.383%	17,114	2,126
23-Oct-91	9.7	7.3	11	2.037	2.037	1.807	22.518	9.740	0.362%	16,046	2,193

	Temp (C)	pH	NH3-N (ug/L)
100%-ile	15.7	8.1	44.0
95%-ile	15.4	7.8	26.9
90%-ile	15.2	7.7	24.8

	Acute NH3-N Criteria (ug/L)	Chronic NH3-N Criteria (ug/L)
0%-ile	4,536	1,020
5%-ile	8,314	1,877
10%-ile	9,753	2,020

COSMOPOLITAN
ENGINEERING
GROUP

Appendix B

Inspection Dive Report

Civil, Environmental,

and Recreational

Consulting

COSMOPOLITAN ENGINEERING GROUP

Appendix C

Tracer Study Data

Civil, Environmental, and Recreational Consulting

Printed on Recycled Paper

Memorandum

ENGINEERING GROUP

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Tacoma, WA 98402

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DATE: September 21, 1999

TO: File MTV001

FROM: Bill Fox, Cosmopolitan Engineering

RE: Mount Vernon WWTP Outfall Inspection Dive

Merita Trohimovich and I conducted a dive inspection of the Mount Vernon WWTP outfall at 16:30 on September 20, 1999. The river discharge was 8870 cfs and stage was 11.58 ft measured at USGS station 12200500 near Mount Vernon.

The outfall is located within a small depression in the riverbank. There is a clearly visible eddy formed in the depression. The effluent was more turbid than the ambient water, and was visible within the eddy.

The configuration of the outfall, adjacent shoreline, eddy and visible effluent plume are shown on the attached drawing.

<u>Dive Log</u>

Current speed during the dive was 2 to 3 fps. We entered the water from upstream and conducted the inspection from a tether line.

Visibility was 6 ft outside the effluent plume, and near zero inside the plume.

The outfall was easily found, in excellent condition, and armored with riprap generally as shown on the drawings. The outfall is 24-inch class 5 ductile iron pipe with a plain end. There was only about 3 feet showing at the crown and none at the invert.

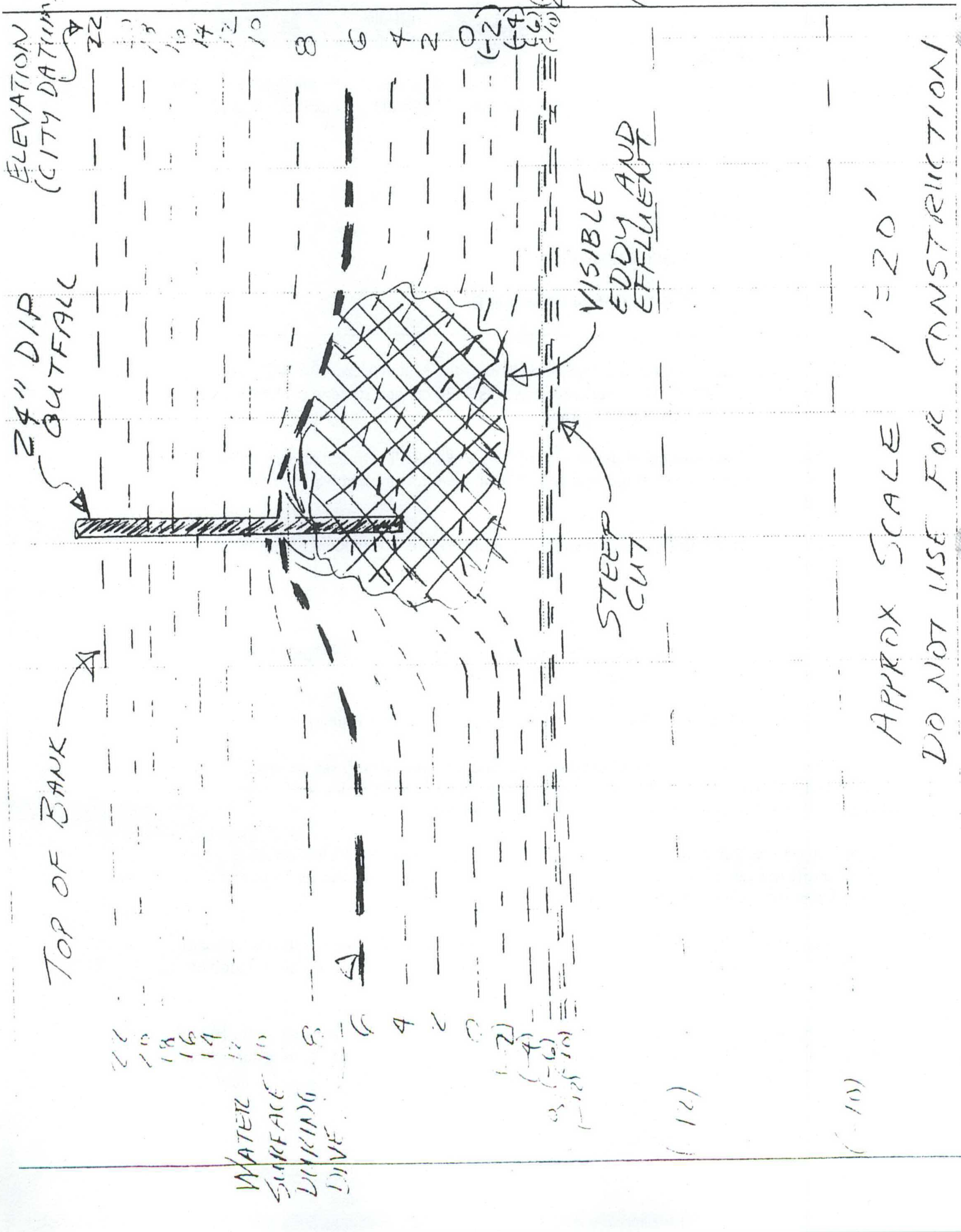
The pipe invert was 8 ft deep. There was a flat shelf for approximately 15 feet offshore, with a sharp drop-off to a depth of 18 feet. There has been some cutting of the deeper section of riverbank that has reduced the horizontal apron offshore of the outfall.

The riverbank was a relatively stable combination of riprap and mud. The riverbed offshore of the drop-off was a uniform coarse sand and rounded gravel bottom, which was clearly mobile sediment.

Global diving inspected the outfall in 1995 and found an 8-inch diameter log about 1 ft offshore of the pipe terminus. The same obstruction was observed in the same configuration during our inspection. There was considerable wood debris upstream and (especially) downstream of the outfall.

COSMOPOLITAN ENGINEERING GROUP

Job Name: Mt. Vernon Dive Report
Sheet: 10 of
Job Number: MTV001
Checked:
By: FOX
Date: 9/21/99
Date:



Effluent Dye
Injection 10/5/98

Approx 0.5 L Rhodamine
WT @ 23.8% Sol'n
disch to CCC wier
overflow over 5.5 min

Effl. Q = 3.2 mgd
Time = 1233 start
Effl sample # 24, 40

River/mz Samples 12:38-12:45±

Sample Sta	Bottle #	Desc
1	21	b.g.
2	22	u.s. amz
3	23	outfall
4	25	d.s. amz
5	26	Between piling + shore
6	27	cmz (300'±)
4	28	
2	29	

Photos 12:45-48±

Large Cone - outfall
Small Cones - us + ds amz

Dye o/b, dispersing 12:58
" " 13:04

River Flows

1200 hrs 10/4/99 Q = 6590 cfs

1245 hrs 10/5/99 Q = 7810 cfs

10/6/98

MTV/OU1

Dye Study Results from 10/5

Station	Bottle #	Conc	Dilution
Effl.	24	114	—
Effl.	40	120	—
1	21	0	
2	22	10.1	11.6
3	23	24.4	4.8
4	25	9.6	12.2
5	26	9.9	11.8
6	27	1.8	65
4	28	8.6	13.6
2	29	9.7	12.1

Note: Fluoro zeroed to sample #21

WWTP Effluent

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv00.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:15:56
* ds
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 0  10/05  11:34:39   samples 0 to 65 sample rate = 1 scan e
very 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 66
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [db]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 66
# span 1 = 15.2434, 19.6248
# span 2 = 0.0169, 0.4008
# span 3 = -0.331, 0.642
# span 4 = -16.77677, 37.60287
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 11:34:39
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

```
# datcnv_date = Oct 05 1999 17:20:21, 4.233
# datcnv_in = MTV00.HEX SBE19.CON
# datcnv_skipover = 0
# file_type = ascii
*END*
```

	Temp (C)				
1	18.7773	0.0920	-0.304	-0.14406	0.000e+00
2	19.0572	0.1915	-0.016	-0.14296	0.000e+00
3	19.3360	0.2947	0.246	-0.14188	0.000e+00
4	19.6138	0.4008	0.489	-0.14081	0.000e+00
5	19.6248	0.3768	0.498	-0.14079	0.000e+00
6	19.6201	0.3761	0.507	-0.14081	0.000e+00
7	19.6193	0.3673	0.489	-0.14082	0.000e+00
8	19.6201	0.3519	0.489	-0.14083	0.000e+00
9	19.6209	0.3523	0.507	-0.14083	0.000e+00
10	19.6153	0.3523	0.498	-0.14085	0.000e+00
11	19.6169	0.3503	0.507	-0.14084	0.000e+00
12	19.6122	0.3442	0.507	-0.14086	0.000e+00
13	19.6106	0.3443	0.507	-0.14087	0.000e+00
14	19.6122	0.3441	0.507	-0.14086	0.000e+00
15	19.6122	0.3445	0.507	-0.14086	0.000e+00
16	19.6153	0.3446	0.507	-0.14085	0.000e+00
17	19.6146	0.3457	0.507	-0.14086	0.000e+00
18	19.6146	0.3463	0.507	-0.14085	0.000e+00
19	19.6130	0.3469	0.516	-0.14086	0.000e+00
20	19.6074	0.3374	0.570	37.60287	0.000e+00
21	19.6043	0.3420	0.597	20.02945	0.000e+00
22	19.6082	0.3378	0.597	6.93941	0.000e+00
23	19.6074	0.3387	0.624	-4.73907	0.000e+00
24	19.6082	0.3377	0.624	-16.77677	0.000e+00
25	19.6130	0.3378	0.633	-3.97828	0.000e+00
26	19.6138	0.3383	0.633	-0.62769	0.000e+00
27	19.6146	0.3376	0.624	0.04049	0.000e+00
28	19.6177	0.3362	0.633	0.22212	0.000e+00
29	19.6193	0.3374	0.633	0.27583	0.000e+00
30	19.6130	0.3389	0.633	0.32756	0.000e+00
31	19.6043	0.3364	0.633	0.38237	0.000e+00
32	19.6027	0.3356	0.624	0.42163	0.000e+00
33	19.6051	0.3355	0.633	0.43823	0.000e+00
34	19.6027	0.3352	0.633	0.40520	0.000e+00
35	19.6003	0.3354	0.633	0.37638	0.000e+00
36	19.5988	0.3355	0.633	0.35573	0.000e+00
37	19.6019	0.3353	0.633	0.33917	0.000e+00
38	19.5972	0.3351	0.633	0.34541	0.000e+00
39	19.6051	0.3351	0.633	0.32888	0.000e+00
40	19.6067	0.3351	0.642	0.32688	0.000e+00
41	19.6043	0.3351	0.633	0.32468	0.000e+00
42	19.6059	0.3350	0.633	0.29994	0.000e+00
43	19.6043	0.3348	0.633	0.28445	0.000e+00

Ambient
(30' Upstream,
outside of eddy)

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv01.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:16:00
* ds
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 1  10/05  11:56:12   samples 66 to 110 sample rate = 1 scan
 every 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 45
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [d' ]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 45
# span 1 = 11.2469, 11.7168
# span 2 = 0.0251, 0.0299
# span 3 = -0.196, 0.435
# span 4 = -5.48483, 55.37061
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 11:56:12
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

```
# datcnv_date = Oct 05 1999 17:22:07, 4.233
# datcnv_in = MTV01.HEX SBE19.CON
# datcnv_skipover = 0
# file_type = ascii
*END*
```

	Temp (C)				
1	11.2630	0.0274	0.336	-0.17606	0.000e+00
2	11.2621	0.0270	0.336	-0.17606	0.000e+00
3	11.2612	0.0266	0.345	-0.17607	0.000e+00
4	11.2603	0.0262	0.345	-0.17607	0.000e+00
5	11.2790	0.0259	0.354	-0.17598	0.000e+00
6	11.2754	0.0257	0.345	-0.17600	0.000e+00
7	11.2612	0.0259	0.309	-0.17607	0.000e+00
8	11.2772	0.0262	0.354	-0.17599	0.000e+00
9	11.2674	0.0257	0.345	-0.17604	0.000e+00
10	11.2567	0.0257	0.354	-0.17609	0.000e+00
11	11.2737	0.0262	0.426	-0.17601	0.000e+00
12	11.2692	0.0263	0.417	-0.17603	0.000e+00
13	11.2630	0.0266	0.435	-0.17606	0.000e+00
14	11.2701	0.0266	0.435	-0.17602	0.000e+00
15	11.2728	0.0270	0.426	-0.17601	0.000e+00
16	11.2745	0.0270	0.408	-0.17600	0.000e+00
17	11.2665	0.0270	0.417	-0.17604	0.000e+00
18	11.2612	0.0271	0.417	-0.17607	0.000e+00
19	11.2585	0.0272	0.408	-0.17608	0.000e+00
20	11.2621	0.0254	0.408	55.37061	0.000e+00
21	11.2630	0.0254	0.417	50.35672	0.000e+00
22	11.2647	0.0254	0.426	37.36404	0.000e+00
23	11.2674	0.0253	0.435	18.70280	0.000e+00
24	11.2612	0.0254	0.417	-5.48483	0.000e+00
25	11.2576	0.0254	0.417	4.18658	0.000e+00
26	11.2478	0.0256	0.426	9.18046	0.000e+00
27	11.2514	0.0254	0.426	11.78544	0.000e+00
28	11.2567	0.0254	0.417	12.11961	0.000e+00
29	11.2496	0.0253	0.426	12.21503	0.000e+00
30	11.2505	0.0252	0.426	12.05850	0.000e+00
31	11.2523	0.0253	0.435	11.81044	0.000e+00
32	11.2523	0.0254	0.426	11.89470	0.000e+00
33	11.2469	0.0252	0.426	11.77371	0.000e+00
34	11.2496	0.0257	0.435	11.62116	0.000e+00
35	11.2540	0.0251	0.435	11.51490	0.000e+00
36	11.2540	0.0254	0.426	11.43368	0.000e+00
37	11.2532	0.0254	0.426	11.37877	0.000e+00
38	11.2487	0.0253	0.426	11.35576	0.000e+00
39	11.2540	0.0255	0.426	11.31835	0.000e+00
40	11.2523	0.0255	0.426	11.31003	0.000e+00
41	11.2532	0.0254	0.417	11.30499	0.000e+00
42	11.2532	0.0256	0.264	11.27297	0.000e+00
43	11.2540	0.0262	-0.196	11.23033	0.000e+00

Upstream AMZ
(in Eddy)

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv02.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:16:03
* cs
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 2  10/05  12:00:00   samples 111 to 193 sample rate = 1 sca
n every 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 83
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [db]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 83
# span 1 = 11.6728, 11.8930
# span 2 = 0.0394, 0.0476
# span 3 = -0.097, 0.859
# span 4 = -6.88572, 57.50526
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 12:00:00
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

datcnv_date = Oct 05 1999 17:20:55, 4.233
datcnv_in = MTV02.HEX SBE19.CON
datcnv_skipover = 0
file_type = ascii
END

	Temp (c)				
1	11.8859	0.0475	0.390	-0.17300	0.000e+00
2	11.8856	0.0475	0.381	-0.17300	0.000e+00
3	11.8853	0.0475	0.381	-0.17300	0.000e+00
4	11.8851	0.0475	0.381	-0.17301	0.000e+00
5	11.8824	0.0474	0.381	-0.17302	0.000e+00
6	11.8833	0.0474	0.363	-0.17301	0.000e+00
7	11.8833	0.0472	0.372	-0.17301	0.000e+00
8	11.8692	0.0469	0.372	-0.17308	0.000e+00
9	11.8427	0.0464	0.372	-0.17321	0.000e+00
10	11.8223	0.0459	0.381	-0.17331	0.000e+00
11	11.8232	0.0457	0.381	-0.17330	0.000e+00
12	11.8232	0.0461	0.345	-0.17330	0.000e+00
13	11.7826	0.0462	0.300	-0.17350	0.000e+00
14	11.8117	0.0461	0.336	-0.17336	0.000e+00
15	11.8683	0.0460	0.363	-0.17309	0.000e+00
16	11.8656	0.0459	0.363	-0.17310	0.000e+00
17	11.8647	0.0461	0.300	-0.17310	0.000e+00
18	11.8789	0.0461	0.318	-0.17303	0.000e+00
19	11.8868	0.0459	0.318	-0.17300	0.000e+00
20	11.8903	0.0476	0.327	57.50526	0.000e+00
21	11.8930	0.0422	0.318	44.66419	0.000e+00
22	11.8047	0.0424	0.318	32.46619	0.000e+00
23	11.7640	0.0428	0.327	15.24481	0.000e+00
24	11.7481	0.0409	0.318	-6.88572	0.000e+00
25	11.7321	0.0400	0.327	5.17053	0.000e+00
26	11.6958	0.0399	0.327	8.22862	0.000e+00
27	11.7242	0.0434	0.327	9.43698	0.000e+00
28	11.7905	0.0446	0.327	9.97058	0.000e+00
29	11.8276	0.0474	0.327	10.22698	0.000e+00
30	11.8745	0.0475	0.327	10.34811	0.000e+00
31	11.8603	0.0469	0.318	10.39361	0.000e+00
32	11.8435	0.0460	0.318	10.35348	0.000e+00
33	11.8586	0.0460	0.327	10.31285	0.000e+00
34	11.8692	0.0464	0.327	10.30028	0.000e+00
35	11.8762	0.0464	0.327	10.29826	0.000e+00
36	11.8497	0.0462	0.327	10.33440	0.000e+00
37	11.8577	0.0447	0.318	10.33379	0.000e+00
38	11.8559	0.0459	0.318	10.30568	0.000e+00
39	11.8329	0.0458	0.318	10.31703	0.000e+00
40	11.8100	0.0447	0.318	10.31417	0.000e+00
41	11.8055	0.0446	0.327	10.31228	0.000e+00
42	11.8064	0.0445	0.327	10.29597	0.000e+00
43	11.8064	0.0447	0.327	10.29914	0.000e+00

44	11.8073	0.0444	0.327	10.29167	0.000e+00
45	11.8117	0.0445	0.327	10.30858	0.000e+00
46	11.8153	0.0443	0.327	10.31235	0.000e+00
47	11.8197	0.0453	0.327	10.30220	0.000e+00
48	11.8365	0.0453	0.327	10.30232	0.000e+00
49	11.8603	0.0460	0.327	10.31520	0.000e+00
50	11.8577	0.0441	0.327	10.31449	0.000e+00
51	11.7826	0.0435	0.318	10.33927	0.000e+00
52	11.8312	0.0455	0.327	10.27913	0.000e+00
53	11.8126	0.0446	0.318	10.29065	0.000e+00
54	11.8250	0.0421	0.327	10.29682	0.000e+00
55	11.7383	0.0394	0.318	10.30043	0.000e+00
56	11.6932	0.0408	0.318	10.27233	0.000e+00
57	11.6728	0.0395	0.246	10.28250	0.000e+00
58	11.6958	0.0401	0.255	10.30443	0.000e+00
59	11.6994	0.0398	0.300	10.30810	0.000e+00
60	11.7366	0.0425	0.723	10.36161	0.000e+00
61	11.7224	0.0430	0.804	10.36810	0.000e+00
62	11.7277	0.0422	0.822	10.35227	0.000e+00
63	11.7162	0.0416	0.831	10.34125	0.000e+00
64	11.7153	0.0414	0.840	10.31915	0.000e+00
65	11.7197	0.0416	0.840	10.32336	0.000e+00
66	11.7277	0.0418	0.840	10.33065	0.000e+00
67	11.7313	0.0418	0.840	10.36480	0.000e+00
68	11.7313	0.0418	0.840	10.35681	0.000e+00
69	11.7295	0.0415	0.849	10.35646	0.000e+00
70	11.7313	0.0418	0.840	10.36391	0.000e+00
71	11.7339	0.0414	0.840	10.35678	0.000e+00
72	11.7286	0.0413	0.840	10.37679	0.000e+00
73	11.728[illegible]	0.0397	0.849	10.37922	0.000e+00
74	11.7277	0.0396	0.859	10.36102	0.000e+00
75	11.7304	0.0403	0.859	10.35612	0.000e+00
76	11.7313	0.0401	0.849	10.35408	0.000e+00
77	11.7304	0.0404	0.859	10.37424	0.000e+00
78	11.7321	0.0410	0.849	10.38329	0.000e+00
79	11.7348	0.0413	0.849	10.41131	0.000e+00
80	11.7675	0.0430	0.426	10.40425	0.000e+00
81	11.7941	0.0443	0.336	10.43076	0.000e+00
82	11.8020	0.0446	0.255	10.42686	0.000e+00
83	11.8073	0.0449	-0.097	10.44808	0.000e+00

Outfall
Station

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv03.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:16:07
* ds
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 3  10/05  12:03:50   samples 194 to 298 sample rate = 1 sca
n every 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 105
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [db]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 105
# span 1 = 11.7878, 12.1731
# span 2 = 0.0391, 0.0649
# span 3 = -0.106, 1.967
# span 4 = -6.53347, 58.00916
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 12:03:50
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

datcnv_date = Oct 05 1999 17:21:05, 4.233
datcnv_in = MTV03.HEX SBE19.CON
datcnv_skipover = 0
file_type = ascii
END

	Temp(C)				
1	11.8744	0.0472	0.417	-0.17306	0.000e+00
2	11.8750	0.0472	0.372	-0.17305	0.000e+00
3	11.8756	0.0472	0.399	-0.17305	0.000e+00
4	11.8762	0.0471	0.372	-0.17305	0.000e+00
5	11.8727	0.0469	0.408	-0.17307	0.000e+00
6	11.8674	0.0468	0.399	-0.17309	0.000e+00
7	11.8682	0.0465	0.390	-0.17309	0.000e+00
8	11.8682	0.0465	0.417	-0.17309	0.000e+00
9	11.8356	0.0463	0.390	-0.17324	0.000e+00
10	11.8241	0.0465	0.408	-0.17330	0.000e+00
11	11.8046	0.0467	0.408	-0.17339	0.000e+00
12	11.8082	0.0467	0.408	-0.17338	0.000e+00
13	11.8179	0.0466	0.408	-0.17333	0.000e+00
14	11.8788	0.0465	0.417	-0.17304	0.000e+00
15	11.8744	0.0465	0.417	-0.17306	0.000e+00
16	11.8497	0.0465	0.408	-0.17318	0.000e+00
17	11.8444	0.0465	0.408	-0.17320	0.000e+00
18	11.8453	0.0467	0.408	-0.17320	0.000e+00
19	11.8303	0.0465	0.408	-0.17327	0.000e+00
20	11.8258	0.0463	0.408	58.00916	0.000e+00
21	11.8364	0.0490	0.417	41.49201	0.000e+00
22	11.8594	0.0512	0.417	30.14261	0.000e+00
23	11.8682	0.0485	0.417	14.20154	0.000e+00
24	11.8744	0.0499	0.417	-6.53347	0.000e+00
25	11.9300	0.0465	0.408	6.91425	0.000e+00
26	11.9389	0.0451	0.408	8.98707	0.000e+00
27	11.8691	0.0445	0.408	9.73130	0.000e+00
28	11.8470	0.0447	0.417	10.03564	0.000e+00
29	11.8444	0.0453	0.408	10.17070	0.000e+00
30	11.8576	0.0457	0.417	10.25404	0.000e+00
31	11.8559	0.0458	0.408	10.28222	0.000e+00
32	11.8568	0.0462	0.417	10.32325	0.000e+00
33	11.8647	0.0468	0.408	10.32004	0.000e+00
34	11.8612	0.0461	0.408	10.34738	0.000e+00
35	11.8559	0.0445	0.408	10.32042	0.000e+00
36	11.8444	0.0442	0.408	10.28966	0.000e+00
37	11.8214	0.0441	0.255	10.28947	0.000e+00
38	11.8091	0.0431	0.381	10.25828	0.000e+00
39	11.7878	0.0441	0.597	10.23347	0.000e+00
40	11.8303	0.0391	0.804	10.21477	0.000e+00
41	11.8373	0.0455	0.813	10.25212	0.000e+00
42	11.8709	0.0467	0.813	10.01530	0.000e+00
43	11.8806	0.0473	0.813	10.04302	0.000e+00

44	11.9300	0.0482	0.804	10.13246	0.000e+00
45	11.9194	0.0482	0.804	10.26084	0.000e+00
46	11.9044	0.0483	0.804	10.40714	0.000e+00
47	11.9089	0.0486	0.813	10.36554	0.000e+00
48	11.9142	0.0485	0.804	10.29680	0.000e+00
49	11.9194	0.0488	0.813	10.26046	0.000e+00
50	11.9071	0.0486	0.804	10.26557	0.000e+00
51	11.8656	0.0473	0.813	10.26958	0.000e+00
52	11.8709	0.0472	0.804	10.25696	0.000e+00
53	11.8815	0.0470	0.813	10.24992	0.000e+00
54	11.8797	0.0467	0.804	10.26381	0.000e+00
55	11.8258	0.0461	0.813	10.29424	0.000e+00
56	11.8135	0.0453	0.804	10.24928	0.000e+00
57	11.7940	0.0447	0.804	10.24125	0.000e+00
58	11.8126	0.0447	0.804	10.24848	0.000e+00
59	11.8135	0.0449	0.804	10.29502	0.000e+00
60	11.8338	0.0454	0.804	10.32556	0.000e+00
61	11.8364	0.0454	0.804	10.33593	0.000e+00
62	11.8409	0.0455	0.696	10.33926	0.000e+00
63	11.9203	0.0498	0.633	10.24946	0.000e+00
64	12.1027	0.0556	0.399	10.24309	0.000e+00
65	12.1511	0.0601	0.219	10.39355	0.000e+00
66	12.1731	0.0631	1.526	10.36519	0.000e+00
67	12.1652	0.0630	1.949	10.27197	0.000e+00
68	12.0755	0.0560	1.949	10.20092	0.000e+00
69	12.0543	0.0554	1.949	10.13420	0.000e+00
70	12.0605	0.0556	1.949	10.12324	0.000e+00
71	12.0790	0.0555	1.949	10.16038	0.000e+00
72	12.0895	0.0554	1.949	10.17919	0.000e+00
73	12.0702	0.0558	1.949	10.21356	0.000e+00
74	12.0614	0.0547	1.949	10.22540	0.000e+00
75	12.0438	0.0531	1.949	10.26033	0.000e+00
76	12.0288	0.0538	1.949	10.20798	0.000e+00
77	12.0288	0.0539	1.949	10.19453	0.000e+00
78	12.0244	0.0529	1.949	10.20913	0.000e+00
79	12.0226	0.0566	1.958	10.19437	0.000e+00
80	12.0147	0.0649	1.949	10.29117	0.000e+00
81	12.0138	0.0549	1.958	10.30467	0.000e+00
82	12.0138	0.0553	1.949	10.36304	0.000e+00
83	12.0332	0.0556	1.967	10.25792	0.000e+00
84	12.0270	0.0548	1.949	10.22043	0.000e+00
85	12.0869	0.0554	1.958	10.20730	0.000e+00
86	12.1054	0.0555	1.949	10.18623	0.000e+00
87	12.0587	0.0550	1.949	10.27951	0.000e+00
88	12.0605	0.0584	1.958	10.26696	0.000e+00
89	12.0534	0.0564	1.958	10.36176	0.000e+00
90	12.0534	0.0541	1.958	10.25852	0.000e+00
91	12.0323	0.0551	1.958	10.22364	0.000e+00

Downstream AMZ

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv04.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:16:12
* ds
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 4  10/05  12:09:23   samples 299 to 397 sample rate = 1 sca
n every 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 99
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [db]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 99
# span 1 = 11.6350, 12.3411
# span 2 = 0.0358, 0.0639
# span 3 = 0.102, 0.922
# span 4 = -6.89082, 57.64636
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 12:09:23
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

\# datcnv_date = Oct 05 1999 17:21:19, 4.233
\# datcnv_in = MTV04.HEX SBE19.CON
\# datcnv_skipover = 0
\# file_type = ascii
END

	Temp (C)				
1	11.8270	0.0441	0.336	-0.17329	0.000e+00
2	11.8588	0.0447	0.327	-0.17313	0.000e+00
3	11.8906	0.0452	0.327	-0.17298	0.000e+00
4	11.9224	0.0457	0.318	-0.17283	0.000e+00
5	11.9621	0.0477	0.327	-0.17263	0.000e+00
6	11.9682	0.0490	0.336	-0.17260	0.000e+00
7	11.9083	0.0489	0.327	-0.17289	0.000e+00
8	11.8827	0.0473	0.327	-0.17302	0.000e+00
9	11.8765	0.0467	0.318	-0.17305	0.000e+00
10	11.7837	0.0464	0.318	-0.17349	0.000e+00
11	11.7032	0.0462	0.246	-0.17388	0.000e+00
12	11.6350	0.0467	0.192	-0.17421	0.000e+00
13	11.6731	0.0420	0.237	-0.17403	0.000e+00
14	11.7793	0.0430	0.255	-0.17352	0.000e+00
15	11.7687	0.0436	0.246	-0.17357	0.000e+00
16	11.6500	0.0434	0.255	-0.17414	0.000e+00
17	11.6881	0.0421	0.255	-0.17396	0.000e+00
18	11.7395	0.0415	0.255	-0.17371	0.000e+00
19	11.7589	0.0416	0.246	-0.17362	0.000e+00
20	11.8023	0.0454	0.246	57.64636	0.000e+00
21	11.7837	0.0431	0.246	42.12441	0.000e+00
22	11.8668	0.0451	0.246	30.23681	0.000e+00
23	11.8765	0.0467	0.246	14.03427	0.000e+00
24	11.9197	0.0463	0.246	-6.89082	0.000e+00
25	11.7934	0.0428	0.246	6.26562	0.000e+00
26	11.8597	0.0470	0.246	8.63644	0.000e+00
27	11.9400	0.0491	0.255	9.46818	0.000e+00
28	11.9947	0.0502	0.246	9.83076	0.000e+00
29	11.9938	0.0508	0.255	9.99883	0.000e+00
30	11.9965	0.0512	0.255	10.09522	0.000e+00
31	11.9850	0.0501	0.246	10.12463	0.000e+00
32	11.9947	0.0506	0.246	10.10317	0.000e+00
33	12.0044	0.0515	0.246	10.11705	0.000e+00
34	12.0167	0.0484	0.201	10.14611	0.000e+00
35	11.8994	0.0493	0.417	10.15982	0.000e+00
36	11.9294	0.0481	0.570	10.12168	0.000e+00
37	11.9277	0.0480	0.570	10.23004	0.000e+00
38	11.9206	0.0487	0.570	10.28168	0.000e+00
39	11.9753	0.0495	0.579	10.30607	0.000e+00
40	11.9718	0.0491	0.579	10.27623	0.000e+00
41	11.9744	0.0500	0.570	10.16893	0.000e+00
42	12.0335	0.0531	0.579	10.07172	0.000e+00
43	12.0661	0.0572	0.579	10.17347	0.000e+00

44	12.1162	0.0556	0.579	10.27532	0.000e+00
45	12.0705	0.0524	0.579	10.35009	0.000e+00
46	12.0211	0.0517	0.579	10.32435	0.000e+00
47	12.0158	0.0522	0.579	10.23621	0.000e+00
48	12.0220	0.0512	0.579	10.21550	0.000e+00
49	11.9815	0.0483	0.588	10.22160	0.000e+00
50	11.9735	0.0541	0.579	10.21629	0.000e+00
51	12.1356	0.0626	0.579	10.21601	0.000e+00
52	12.1839	0.0605	0.579	10.33339	0.000e+00
53	12.1672	0.0561	0.579	10.37713	0.000e+00
54	12.1338	0.0523	0.543	10.29480	0.000e+00
55	12.0599	0.0523	0.354	10.20515	0.000e+00
56	12.0247	0.0472	0.606	10.17730	0.000e+00
57	11.9259	0.0461	0.904	10.11584	0.000e+00
58	11.9303	0.0459	0.913	10.04643	0.000e+00
59	12.1892	0.0569	0.913	9.99419	0.000e+00
60	11.9524	0.0420	0.913	10.29884	0.000e+00
61	11.8270	0.0454	0.904	10.26501	0.000e+00
62	11.9418	0.0505	0.913	10.26957	0.000e+00
63	12.1839	0.0596	0.913	10.27766	0.000e+00
64	12.3411	0.0639	0.913	10.35491	0.000e+00
65	12.3034	0.0626	0.913	10.51292	0.000e+00
66	12.2867	0.0604	0.922	10.44613	0.000e+00
67	12.1743	0.0562	0.913	10.33920	0.000e+00
68	11.7598	0.0390	0.922	10.32189	0.000e+00
69	11.6970	0.0406	0.913	10.07608	0.000e+00
70	11.8562	0.0453	0.895	10.07048	0.000e+00
71	11.8482	0.0453	0.904	10.23130	0.000e+00
72	11.8376	0.0456	0.795	10.31453	0.000e+00
73	11.8818	0.0466	0.723	10.39600	0.000e 00
74	11.7996	0.0442	0.777	10.42394	0.000e+00
75	11.7890	0.0428	0.768	10.34118	0.000e+00
76	11.8994	0.0469	0.768	10.31611	0.000e+00
77	11.7890	0.0446	0.759	10.42671	0.000e+00
78	11.9109	0.0459	0.768	10.34462	0.000e+00
79	11.7740	0.0429	0.768	10.44234	0.000e+00
80	11.8288	0.0436	0.768	10.35959	0.000e+00
81	11.8332	0.0454	0.786	10.36762	0.000e+00
82	11.8509	0.0439	0.795	10.43334	0.000e+00
83	11.8226	0.0435	0.795	10.42811	0.000e+00
84	11.7465	0.0371	0.795	10.46337	0.000e+00
85	11.7111	0.0399	0.759	10.37751	0.000e+00
86	11.8482	0.0429	0.750	10.40116	0.000e+00
87	11.8129	0.0436	0.750	10.46787	0.000e+00
88	11.8314	0.0457	0.705	10.49657	0.000e+00
89	11.8694	0.0440	0.480	10.52747	0.000e+00
90	11.7819	0.0436	0.336	10.51229	0.000e+00
91	11.7619	0.0358	0.363	10.45151	0.000e+00

Repeat Upstream
Ambient

```
* Sea-Bird SBE 19 Data File:
* FileName = \SBE19\mtv05.HEX
* Software Version 4.233
* Temperature SN = 2678
* Conductivity SN = 2678
* System UpLoad Time = Oct 05 1999 17:16:17
* ds
* SEACAT PROFILER V3.1b SN 2678   10/05/99  17:16:13.118
* strain gauge pressure sensor: S/N = 184559,  range = 100 psia,
tc = -183
* Narrow Range Conductivity
* clk = 32768.547   iop = 176   vmain = 11.5   vlith = 5.0
* mode = PROFILE  ncasts = 6
* sample rate = 1 scan every 2.0 seconds
* minimum raw conductivity frequency for pump turn on = 2727 hertz
* pump delay = 33 seconds
* samples = 440   free = 115645   lwait = 10 msec
* SW1 = C8   battery cutoff = 7.3 volts
* number of voltages sampled = 2
* logdata = NO
* S>
* cast 5  10/05  12:13:41   samples 398 to 439 sample rate = 1 sca
n every 2.0 seconds  stop = switch off
# nquan = 6
# nvalues = 42
# units = metric
# name 0 = scan: scan number
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = sal: salinity, PSS-78 [PSU]
# name 3 = pr: pressure [db]
# name 4 = oxMg/L: oxygen [mg/l]
# name 5 = flag:  0.000e+00
# span 0 = 1, 42
# span 1 = 11.2969, 11.3450
# span 2 = 0.0251, 0.0264
# span 3 = -0.250, 1.093
# span 4 = -6.76392, 59.61066
# span 5 = 0.000e+00, 0.000e+00
# interval = seconds: 0.5
# start_time = Oct 05 1999 12:13:41
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0  temperature, 2678, 12 Jun 99
# sensor 1 = Frequency 1  conductivity, 2678, 12 Jun 99, cpcor = -
9.5700e-08
# sensor 2 = Extrnl Volt  0  oxygen, current, 230792, 16 Jun 99
# sensor 3 = Extrnl Volt  1  oxygen, temperature, 230792, 16 Jun 9
9
# sensor 4 = Pressure Voltage, 184559, 15 Jun 99
```

```
# datcnv_date = Oct 05 1999 17:21:32, 4.233
# datcnv_in = MTV05.HEX SBE19.CON
# datcnv_skipover = 0
# file_type = ascii
*END*
```

	Temp (C)				
1	11.3032	0.0254	0.940	-0.17588	0.000e+00
2	11.3020	0.0255	1.093	-0.17589	0.000e+00
3	11.3008	0.0255	1.084	-0.17589	0.000e+00
4	11.2996	0.0255	1.093	-0.17590	0.000e+00
5	11.2978	0.0254	1.084	-0.17591	0.000e+00
6	11.2996	0.0255	1.093	-0.17590	0.000e+00
7	11.2987	0.0255	1.084	-0.17590	0.000e+00
8	11.2996	0.0254	1.093	-0.17590	0.000e+00
9	11.2996	0.0255	1.093	-0.17590	0.000e+00
10	11.3005	0.0255	1.093	-0.17589	0.000e+00
11	11.3005	0.0254	1.093	-0.17589	0.000e+00
12	11.3005	0.0255	1.093	-0.17589	0.000e+00
13	11.2996	0.0255	1.084	-0.17590	0.000e+00
14	11.2987	0.0255	1.093	-0.17590	0.000e+00
15	11.2978	0.0255	1.084	-0.17591	0.000e+00
16	11.2969	0.0255	1.084	-0.17591	0.000e+00
17	11.2969	0.0256	1.084	-0.17591	0.000e+00
18	11.2978	0.0255	1.084	-0.17591	0.000e+00
19	11.2969	0.0255	1.084	-0.17591	0.000e+00
20	11.2978	0.0254	1.084	59.61066	0.000e+00
21	11.2987	0.0255	1.084	43.69612	0.000e+00
22	11.3005	0.0257	1.084	31.56132	0.000e+00
23	11.2969	0.0254	1.084	14.87854	0.000e+00
24	11.2978	0.0252	1.084	-6.76392	0.000e+00
25	11.2987	0.0258	1.084	6.77195	0.000e+00
26	11.2978	0.0254	1.084	9.32846	0.000e+00
27	11.2969	0.0252	1.084	10.15285	0.000e+00
28	11.2987	0.0254	1.084	10.47029	0.000e+00
29	11.2969	0.0252	1.084	10.61240	0.000e+00
30	11.2996	0.0253	1.084	10.65239	0.000e+00
31	11.2996	0.0256	1.093	10.68680	0.000e+00
32	11.2969	0.0254	1.084	10.72113	0.000e+00
33	11.2978	0.0252	1.093	10.72328	0.000e+00
34	11.2987	0.0255	1.084	10.73520	0.000e+00
35	11.2969	0.0256	1.084	10.72589	0.000e+00
36	11.2969	0.0255	1.084	10.72098	0.000e+00
37	11.2996	0.0252	1.093	10.70381	0.000e+00
38	11.2987	0.0251	1.084	10.68842	0.000e+00
39	11.2987	0.0254	1.093	10.70228	0.000e+00
40	11.2996	0.0254	0.868	10.69926	0.000e+00
41	11.2996	0.0256	-0.124	10.72718	0.000e+00
42	11.3450	0.0264	-0.250	10.61829	0.000e+00

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Appendix D

PLUMES Model Output

Civil, Environmental, and Recreational Consulting

Printed on Recycled Paper

6.38 mgd

Nov 10, 1999, 10: 9: 8 WED PROGRAM PLUMES, Ed 3.1, 8/7/95 Case: 1 of 1

Title Mount Vernon WWTP Outfall nonlinear

tot flow	# ports	port flow	spacing	effl sal	effl temp	far inc	far dis
0.2795	1	0.2795	1000	0.0	19.6	10	100
port dep	port dia	plume dia	total vel	horiz vel	vertl vel	asp coeff	print frq
3.962	0.4572	0.4089	2.128	1.505	1.505	0.10	25
port elev	ver angle	cont coef	effl den	poll conc	decay	Froude #	Roberts F
0.3	45	0.8	-1.65105	100	0	29.56	46610
hor angle	red space	p amb den	p current	far dif	far vel	K:vel/cur	Stratif #
90	1000.0	-0.360913	0.5486	0.0003	0.5486	3.879	0.000
depth	current	density	salinity	temp	amb conc	N (freq)	red grav.
0.0	0.5486	-0.360913	0	11.3		0.000	0.01267
4.0	0.5486	-0.360913	0	11.3		buoy flux	puff-ther
						3.542E-06	5.668
						jet-plume	jet-cross
						11.38	1.406
						plu-cross	jet-strat
						0.02145	
						plu-strat	

hor dis>=

CORMIX1 flow category algorithm is turned off.

45 deg -90 to 90 deg range

Help: F1. Quit: <esc>. Configuration:ATNOO. FILE: MTV.VAR;

UM INITIAL DILUTION CALCULATION (nonlinear mode)

plume dep m	plume dia m	poll conc	dilution	hor dis m	
3.962	0.4089	100.0	1.000	0.000	
3.859	0.4766	84.09	1.189	0.1068	
3.752	0.5552	70.71	1.414	0.2252	
3.642	0.6446	59.46	1.681	0.3576	
3.528	0.7454	50.00	1.998	0.5056	
3.412	0.8582	42.05	2.376	0.6711	
3.294	0.9836	35.36	2.826	0.8572	
3.174	1.122	29.73	3.360	1.068	
3.051	1.273	25.00	3.996	1.310	
2.924	1.438	21.02	4.752	1.590	
2.792	1.618	17.68	5.650	1.921	
2.653	1.811	14.87	6.719	2.317	
2.506	2.021	12.50	7.990	2.797	
2.349	2.246	10.51	9.502	3.385	
2.180	2.490	8.839	11.30	4.113	
1.997	2.753	7.433	13.44	5.019	
1.799	3.036	6.250	15.98	6.153	
1.620	3.292	5.403	18.48	7.325	-> surface hit

6.38 mgd

Nov 10, 1999, 10: 8:49 WED PROGRAM PLUMES, Ed 3.1, 8/7/95 Case: 1 of 1
Title Mount Vernon WWTP Outfall nonlinear

tot flow	# ports	port flow	spacing	effl sal	effl temp	far inc	far dis
0.2795	1	0.2795	1000	0.0	19.6	10	100
port dep	port dia	plume dia	total vel	horiz vel	vertl vel	asp coeff	print frq
3.962	0.4572	0.4089	2.128	2.128	0.000	0.10	25
port elev	ver angle	cont coef	effl den	poll conc	decay	Froude #	Roberts F
0.3	0	0.8	-1.65105	100	0	29.56	46610
hor angle	red space	p amb den	p current	far dif	far vel	K:vel/cur	Stratif #
90	1000.0	-0.360913	0.5486	0.0003	0.5486	3.879	0.000
depth	current	density	salinity	temp	amb conc	N (freq)	red grav.
0.0	0.5486	-0.360913	0	11.3		0.000	0.01267
4.0	0.5486	-0.360913	0	11.3		buoy flux	puff-ther
						3.542E-06	5.668
						jet-plume	jet-cross
						11.38	1.406
						plu-cross	jet-strat
						0.02145	
						plu-strat	

hor dis>=

CORMIX1 flow category algorithm is turned off.
-1.65105 sigma-t, 998.349 kg/m3, 0.998349 gm/cm3. -100 to ~200 sigma-t range
Help: F1. Quit: <esc>. Configuration:ATNO0. FILE: MTV.VAR;
UM INITIAL DILUTION CALCULATION (nonlinear mode)

plume dep m	plume dia m	poll conc	dilution	hor dis m	
3.962	0.4089	100.0	1.000	0.000	
3.962	0.4736	84.09	1.189	0.2038	
3.962	0.5483	70.71	1.414	0.4401	
3.961	0.6011	63.29	1.579	0.6132	-> bottom hit
3.961	0.6327	59.46	1.681	0.7191	-> bottom hit
3.960	0.72[illegible]	50.00	1.998	1.050	-> bottom hit
3.959	0.8335	42.05	2.376	1.442	-> bottom hit
3.957	0.9514	35.36	2.826	1.910	-> bottom hit
3.954	1.082	29.73	3.360	2.471	-> bottom hit
3.950	1.226	25.00	3.996	3.148	-> bottom hit
3.943	1.384	21.02	4.752	3.968	-> bottom hit
3.934	1.557	17.68	5.650	4.971	-> bottom hit
3.921	1.745	14.87	6.719	6.204	-> bottom hit
3.902	1.950	12.50	7.990	7.731	-> bottom hit
3.875	2.173	10.51	9.502	9.633	-> bottom hit
3.836	2.415	8.839	11.30	12.02	-> bottom hit
3.781	2.678	7.433	13.44	15.02	-> bottom hit
3.703	2.962	6.250	15.98	18.80	-> bottom hit
3.599	3.270	5.256	19.00	23.39	-> bottom hit
3.464	3.604	4.420	22.60	28.76	-> bottom hit
3.298	3.966	3.716	26.87	34.94	-> bottom hit
3.099	4.359	3.125	31.96	41.97	-> bottom hit
2.865	4.785	2.628	38.01	49.92	-> bottom hit
2.606	5.229	2.225	44.88	58.50	-> surface hit -> bottom h

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Appendix E

Water Quality-Based Effluent Limit Worksheets

Civil, Environmental, and Recreational Consulting

Printed on Recycled Paper

Ammonia
1999 Flows
Existing Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	8.314
Chronic (n-day) Criteria:	1.877
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.027
Upstream Concentration for Chronic Condition (7Q10):	0.027
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	4.500
Chronic Receiving Water Dilution Factor at 7Q10:	26.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	8

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	37.319
Chronic (n1-day) WLA:	48.127
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	11.982
LTA for Chronic (n1-day) WLA:	25.384
Most Limiting LTA (minimum of acute and chronic):	11.982
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.0440
Daily Maximum Permit Limit:	**37.319**
Monthly Average Permit Limit:	**16.553**

Ammonia
2015 Flows
Existing Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

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1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	8.314
Chronic (n-day) Criteria:	1.877
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.027
Upstream Concentration for Chronic Condition (7Q10):	0.027
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	8

Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	18.258
Chronic (n1-day) WLA:	20.747
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	5.862
LTA for Chronic (n1-day) WLA:	10.943
Most Limiting LTA (minimum of acute and chronic):	5.862
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2	0.0440
Daily Maximum Permit Limit:	**18.258**
Monthly Average Permit Limit:	**8.09**

Ammonia
2015 Flows
Existing Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	8.314
Chronic (n-day) Criteria:	1.877
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.022
Upstream Concentration for Chronic Condition (7Q10):	0.022
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	8

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	18.264
Chronic (n1-day) WLA:	20.798
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	5.864
LTA for Chronic (n1-day) WLA:	10.970
Most Limiting LTA (minimum of acute and chronic):	5.864
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.0440
Daily Maximum Permit Limit:	**18.264**
Monthly Average Permit Limit:	**8.101**

Copper
1999 Flows
Existing Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

[redacted]

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	4.610
Chronic (n-day) Criteria:	3.470
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.550
Upstream Concentration for Chronic Condition (7Q10):	0.550
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	4.500
Chronic Receiving Water Dilution Factor at 7Q10:	26.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

[redacted]

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	18.820
Chronic (n1-day) WLA:	76.470
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	6.043
LTA for Chronic (n1-day) WLA:	40.333
Most Limiting LTA (minimum of acute and chronic):	6.043
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**18.820**
Monthly Average Permit Limit:	**12.901**

Copper
2015 Flows
Existing Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	4.610
Chronic (n-day) Criteria:	3.470
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.550
Upstream Concentration for Chronic Condition (7Q10):	0.550
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	9.482
Chronic (n1-day) WLA:	33.254
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	3.045
LTA for Chronic (n1-day) WLA:	17.539
Most Limiting LTA (minimum of acute and chronic):	3.045
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**9.482**
Monthly Average Permit Limit:	**6.500**

Copper
2015 Flows
Extended Outfall

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	4.610
Chronic (n-day) Criteria:	3.470
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.550
Upstream Concentration for Chronic Condition (7Q10):	0.550
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	7.300
Chronic Receiving Water Dilution Factor at 7Q10:	94.800
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	30.188
Chronic (n1-day) WLA:	277.366
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	9.693
LTA for Chronic (n1-day) WLA:	146.292
Most Limiting LTA (minimum of acute and chronic):	9.693
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**30.188**
Monthly Average Permit Limit:	**20.694**

Lead
Existing Outfall
1999 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	13.900
Chronic (n-day) Criteria:	0.540
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.020
Upstream Concentration for Chronic Condition (7Q10):	0.020
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	4.500
Chronic Receiving Water Dilution Factor at 7Q10:	26.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	62.480
Chronic (n1-day) WLA:	13.540
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	20.061
LTA for Chronic (n1-day) WLA:	7.141
Most Limiting LTA (minimum of acute and chronic):	7.141
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**22.242**
Monthly Average Permit Limit:	**15.246**

Lead
Existing Outfall
2015 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	13.900
Chronic (n-day) Criteria:	0.540
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.020
Upstream Concentration for Chronic Condition (7Q10):	0.020
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	30.556
Chronic (n1-day) WLA:	5.844
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	9.811
LTA for Chronic (n1-day) WLA:	3.082
Most Limiting LTA (minimum of acute and chronic):	3.082
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**9.600**
Monthly Average Permit Limit:	**6.581**

Lead
Extended Outfall
2015 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

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1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	13.900
Chronic (n-day) Criteria:	0.540
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.020
Upstream Concentration for Chronic Condition (7Q10):	0.020
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	7.300
Chronic Receiving Water Dilution Factor at 7Q10:	94.800
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

---

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	101.344
Chronic (n1-day) WLA:	49.316
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	32.540
LTA for Chronic (n1-day) WLA:	26.011
Most Limiting LTA (minimum of acute and chronic):	26.011
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**81.010**
Monthly Average Permit Limit:	**55.531**

Silver
Existing Outfall
1999 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

[redacted]

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	0.320
Chronic (n-day) Criteria:	0.320
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.000
Upstream Concentration for Chronic Condition (7Q10):	0.000
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	4.500
Chronic Receiving Water Dilution Factor at 7Q10:	26.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

[redacted]

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	1.440
Chronic (n1-day) WLA:	8.320
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	0.462
LTA for Chronic (n1-day) WLA:	4.388
Most Limiting LTA (minimum of acute and chronic):	0.462
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**1.440**
Monthly Average Permit Limit:	**0.98[illegible]**

Silver
Existing Outfall
2015 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	0.320
Chronic (n-day) Criteria:	0.320
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.000
Upstream Concentration for Chronic Condition (7Q10):	0.000
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	0.704
Chronic (n1-day) WLA:	3.584
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	0.226
LTA for Chronic (n1-day) WLA:	1.890
Most Limiting LTA (minimum of acute and chronic):	0.226
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**0.704**
Monthly Average Permit Limit:	**0.483**

Silver
Extended Outfall
1999 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	0.320
Chronic (n-day) Criteria:	0.320
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.000
Upstream Concentration for Chronic Condition (7Q10):	0.000
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	13.800
Chronic Receiving Water Dilution Factor at 7Q10:	219.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	4.416
Chronic (n1-day) WLA:	70.080
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	1.418
LTA for Chronic (n1-day) WLA:	36.963
Most Limiting LTA (minimum of acute and chronic):	1.418
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**4.416**
Monthly Average Permit Limit:	**3.02**

Silver
Extended Outfall
2015 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	0.320
Chronic (n-day) Criteria:	0.320
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	0.000
Upstream Concentration for Chronic Condition (7Q10):	0.000
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	7.300
Chronic Receiving Water Dilution Factor at 7Q10:	94.800
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	2.336
Chronic (n1-day) WLA:	30.336
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	0.750
LTA for Chronic (n1-day) WLA:	16.000
Most Limiting LTA (minimum of acute and chronic):	0.750
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**2.336**
Monthly Average Permit Limit:	**1.601**

Existing Outfall
1999 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.

(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	35.400
Chronic (n-day) Criteria:	32.300
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	9.300
Upstream Concentration for Chronic Condition (7Q10):	9.300
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	4.500
Chronic Receiving Water Dilution Factor at 7Q10:	26.000
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
6. Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	126.750
Chronic (n1-day) WLA:	607.300
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	40.697
LTA for Chronic (n1-day) WLA:	320.310
Most Limiting LTA (minimum of acute and chronic):	40.697
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**126.750**
Monthly Average Permit Limit:	**86.88**

Zinc
Existing Outfall
2015 Flows

Water Quality-Based Permit Limits for acute and chronic criteria.
(based on EPA/505/2-90-001 Box 5-2).

Based on Lotus File WQBP2.WK1 Revised 19-Oct-93

1. Water Quality Standards (Concentration)	
Acute (one-hour) Criteria:	35.400
Chronic (n-day) Criteria:	32.300
2. Upstream Receiving Water Concentration	
Upstream Concentration for Acute Condition (7Q10):	9.300
Upstream Concentration for Chronic Condition (7Q10):	9.300
3. Dilution Factors (1/{Effluent Volume Fraction})	
Acute Receiving Water Dilution Factor at 7Q10:	2.200
Chronic Receiving Water Dilution Factor at 7Q10:	11.200
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4
Number of samples (n2) required per month for monitoring:	1

1. Z Statistics	
LTA Derivation (99%tile):	2.326
Daily Maximum Permit Limit (99%tile):	2.326
Monthly Average Permit Limit (95%tile):	1.645
2. Calculated Waste Load Allocations (WLA's)	
Acute (one-hour) WLA:	66.720
Chronic (n1-day) WLA:	266.900
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)	
Sigma^2:	0.3075
Sigma^2-n1:	0.0862
LTA for Acute (1-hour) WLA:	21.423
LTA for Chronic (n1-day) WLA:	140.772
Most Limiting LTA (minimum of acute and chronic):	21.423
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)	
Sigma^2-n2:	0.3075
Daily Maximum Permit Limit:	**66.720**
Monthly Average Permit Limit:	**45.736**

APPENDIX L
WATERWORLD™ ARTICLE ON MICROTURBINES

WaterWorld™

Serving the Municipal Water/Wastewater Industry

City Uses Microturbines to Generate Electricity from Biogas

By JOHN K. STECKEL JR.

The City of Allentown (PA) Wastewater Treatment Plant has begun a project to reduce energy and operational costs by using microturbine technology to convert biogas into electricity and heat for use in the treatment process.

The 40 mgd Allentown wastewater treatment plant serves all or parts of 14 townships and bor[illegible]ths in addition to the City of Allentown. The [illegible] population in the area served is about [illegible]5,000. The plant's biogas is collected from two primary digesters and one secondary digester. Each digester is 80 feet in diameter and is a floating-cover type, equipped with a gas recirculation system for mixing. The external heating system maintains the primary digesters at about 100°F and the secondary digester at about 80°F.

PPL Spectrum – a subsidiary of PPL Corp. – is working with the city on the project, which has the goal of supplying about 18 percent of the plant's electrical power. Design work began in September 2000 and construction started in November. Equipment was delivered in mid-December. Work continues as of this date. The system is expected to be fully on-line by the end of February 2001.

Samples of the gas produced in the digesters were analyzed to determine composition by volume and BTU content. The gas composition was about 65 percent CH_4 and about 30 percent CO_2. The BTU calculation resulted in a value of about 630 BTU per cubic foot.

Plant personnel take daily readings of the gas volume produced in the digesters. For this project, calendar year 1999 was used as the baseline period. Daily gas production ranged from [illegible]4,000 cubic feet to 309,200 cubic feet. Annual [illegible]ction was slightly more than 78.6 million [illegible]c feet, or an average of 215,300 cubic feet per day.

Currently, the treatment plant uses digester gas for heating sludge and for heating several plant buildings. The plant has two large dual-fuel (methane and natural gas) boilers that provide hot water for sludge heating, and three smaller dual-fuel boilers for building heat. When sufficient digester gas is not available to meet the loads, the plant uses natural gas. About 35 percent of the gas produced was used for heating in 1999. The remaining 65 percent was sent to two waste burners on the roof of the digester control building.

During the baseline period, the plant's electrical demand varied from 1,275 kW to 2,325 kW. Values above 1,500 kW occur rarely and for short periods when flows are high due to rain. Annual electricity consumption was 13.7 million kilowatt-hours and cost was $850,000, resulting in a blended average cost of 6.2 cents per kilowatt-hour. During the same period, annual natural gas consumption was 20,750 therms at a cost of $16,600. Average cost of gas was 80 cents per therm.

Microturbine Technology

The generating equipment selected for this application is manufactured by Capstone Turbine Corp. A total of 12 systems are being installed at the treatment plant. Each system is a compact, low-emission power generator capable of providing up to 30 kW of electric power. Each system incorporates a compressor, recuperator, combustor, turbine and permanent magnet generator. The rotating components are mounted on a single shaft, supported by patented air bearings that rotate at up to 96,000 rpm. The generator is cooled by airflow into the gas turbine, thus eliminating the need for liquid cooling. The output of the system is variable frequency AC power.

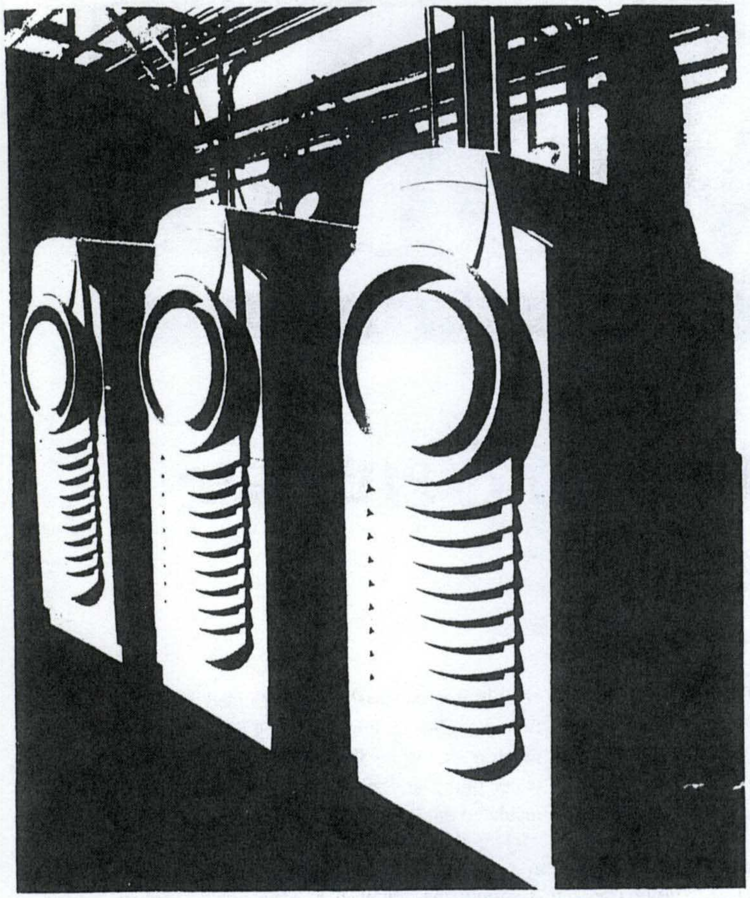
Each microturbine exhausts more than 65 percent of its input energy in a clean, hot gas. A total of three heat recovery systems are being installed. Each system will convert the exhaust energy of four microturbines to hot water. Each heat recovery system consists of an extruded aluminum-finned exchanger core, exchanger enclosure with integral divertor valve for exhaust gas bypass, water pump and associated piping, controls and insulated enclosure.

Hot water from the three heat recovery systems will be piped to existing hot water headers that supply the sludge heat exchangers. Heating loads in the various buildings will continue to be supplied by the dual fuel boilers.

The gas collection system captures digester gas at a low pressure. In order to be used by the microturbines, the gas must be compressed. A fuel gas booster system, manufactured by Copeland, has been designed to increase gas pressure for the microturbines. The system is based on Copeland's proprietary Scroll technology.

The microturbines and their associated equipment are located in a new pavilion near the digesters. The pavilion includes an electrical distribution panel that will provide individual circuit breaker protection for each turbine. A duct bank has been constructed from the new pavilion to a pull box on the existing duct bank system. A new feeder has been installed from the turbine pavilion to the plant's main substation. This arrangement will allow the microturbines to displace utility power for any plant loads, up to their capacity.

Since the plant's minimum electric demand of 1,275 kW is well in excess of the microturbines' capacity (nominally 360 kW total for the 12 microturbines to be installed), there is no need for an interconnection arrangement with the local utility to export power to the grid. The microturbines will operate in a grid connect mode, i.e. only when utility power is available. In the event of a blackout, the microturbines will shut down. Since the plant is served by two feeder lines from the local electric utility, once the plant's substation is switched to the alternate supply line, the microturbines will restart and reload.



The City of Allentown Wastewater Treatment Plant plans to install 12 microturbines manufactured by Capstone Turbine Corp. Each unit is capable of converting biogas into 30 kW of electric power.

Microturbine Operation

Daily gas production varies significantly. The system was designed to use as much of the available gas as possible, but operate the microturbines as baseload units. Since the microturbines come in 30 kW building blocks, staff had flexibility to match the number of microturbines to the pattern of gas production at the facility.

The 12 microturbines being installed will use about 191,500 cubic feet of gas per day at full capacity. An analysis shows that this minimum level of gas will be available over 60 percent of the days. On other days, the generation output of the microturbines will be limited by the availability of fuel. Overall use of the gas in the turbines averages about 87 percent. In addition, about 4 percent of the gas will be used in the boilers to meet the thermal needs of the plant.

The loss in microturbine output due to fuel availability is expected to be about 2 percent of the full-load hours. The impact of scheduled and unscheduled maintenance on the various components of the microturbine system is expected to reduce full-load hours by 5 percent per year. Using a net electrical output from the system of 300 kW, designers expect the annual electrical production to be 2.4 million kilowatt-hours, or 18 percent of the plant's needs.

The microturbine system also will produce hot water that will meet about 96 percent of the plant's thermal requirements. The heat output from the microturbine system is more than adequate to meet this load, except on the coldest winter days. Designers expect about 3 percent of the thermal requirement to be met by excess digester gas that cannot be used by the microturbines and about 1 percent of the thermal requirements to be met by natural gas. Heat output from the microturbines will exceed plant needs the vast majority of the time, particularly in the summer period. About 40 percent of the available heat from the system will be wasted and could potentially be of some use.

Performance contracting

The use of microturbine technology to generate electric power and heat from digester biogas at Allentown has involved a number of technical and financial risks, as well as a significant up-front investment. The city's use of Performance Contracting with PPL Spectrum provided the means to address these issues and allow the project to move forward.

Under the performance contract, PPL Spectrum will assume all performance risks related to the new equipment and guarantee savings from the project. A 10-year municipal lease, with a bond-comparable interest rate, provides the up-front investment. The city includes monthly payments in its operating budget. The reduction in utility costs, guaranteed by PPL Spectrum, provides money for the payments and net savings in the city's operating budget.

PPL Spectrum expects the microturbine project to result in savings for the city of $25,000 per year or $250,000 over the length of the 10-year contract. After the 10-year period, the up-front investment will have been repaid and net savings to the city will increase to $150,000 per year.

Conclusions

Power production from digester gas has been successful at very large waste treatment plants or large regional solids-processing operations that use anaerobic digesters. Typically, modified combustion gas turbines or internal combustion engine/generator sets have been used with fairly sophisticated pretreatment of the digester gas. Because of the costs involved in such a project, recovery of waste gas to produce electricity at a plant the size of Allentown has been neither practical nor cost effective.

Now, with the use of emerging microturbine technology, PPL Spectrum believes power production from digester gas represents a cost-effective alternative that can be used for economic and environmental benefits at many mid-sized municipal waste treatment plant operations.

This project provides some clear benefits to the City of Allentown and its residents. Reduced emissions from the plant's waste gas burners and the local power plant will provide an environmental benefit. The economic value of this project to the city and its sewage treatment customers is driven by the conversion of a no-cost resource, wasted digester gas, into electricity and heat, which both have value.

Electricity costs are second to personnel costs in the plant's operating budget. The opportunity to displace almost 20 percent of the treatment plant's annual electricity consumption – or $165,000 per year – is a substantial economic benefit.

The benefits shown by PPL Spectrum in the City of Allentown project can be achieved at similar sized facilities across the country. The number of microturbines can be varied to match each plant's gas production levels. In addition, the use of performance contracting provides a means to manage the performance and financial risks for the municipality. WW

***About the Author:** As a Principal for PPL Spectrum since 1995, John K. Steckel Jr. is responsible for the delivery of Energy Management Services to the government and health care sectors. Steckel led the development of a team of energy professionals that have proposed over $30 million of energy driven projects. He has developed energy projects for hospitals, colleges & universities, schools, and government entities. These projects have included a wide variety of technologies, including lighting retrofits, HVAC improvements, energy efficient drives, pumps and motors, combined heat and power projects, water conservation measures and energy management systems.*

APPENDIX M

TECHNICAL MEMORNADUM

AERATION BASIN UPGRADE

City of Mount Vernon
Aeration Basin Upgrade
Draft Memorandum

Date: October 11, 2001

To: Walt Enquist

cc: John Buckley

From: Brad Einfeld
Monika Blassino

Subject: Mount Vernon Wastewater Treatment Plant Aeration Basin Upgrade.

BACKGROUND

Mount Vernon Wastewater Treatment Plant currently operates four aeration basins with coarse bubble diffusers. Three basins are used in the activated sludge secondary treatment process and the fourth for WAS storage. Due to increased energy costs, the City of Mount Vernon will implement changes to the aeration basins, by installing fine bubble diffusers in all aeration tanks. Fine bubble aeration is significantly more effective in oxygen transfer, therefore less energy is needed to provide the wastewater with the required oxygen. The sections below summarize existing and proposed systems as well as findings regarding power savings attained by replacing coarse bubble diffusers with a fine bubble diffuser system.

EXISTING SYSTEM

The existing system contains four basins, including three equal sized smaller basins and one larger basin. The total volume for all four basins is 196,000 CF, when depth of water is 18 feet. A schematic diagram of the aeration basin configuration is included in Appendix A. Currently the basins operate on a coarse bubble diffuser system with a standard oxygen transfer efficiency of approximately 15.1%.

Four 200 hp centrifugal blowers (Lamson model 1257-AD) are available to supply air to the basins. At current loadings, however, typically only one blower is used. Figure 1 shows coarse bubble head loss curve for current conditions. The current operating range for coarse bubble system is 3,000 SCFM to 4,300 SCFM. The operating curve for these blowers was used for power requirement analysis and it can be found in Appendix B.

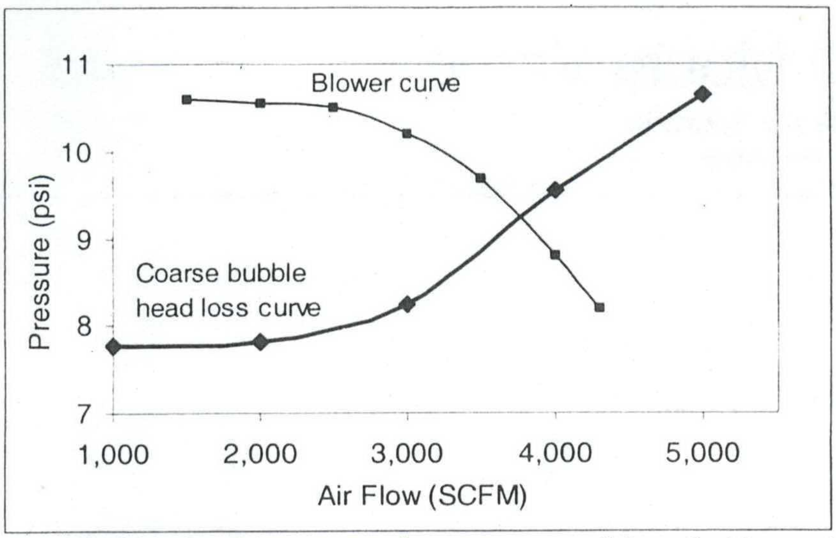


Figure 1: Coarse bubble head loss curve for current conditions (without nitrification).

PROPOSED SYSTEM

The proposed system will utilize the existing basins and blowers and replace the coarse bubble diffusers with fine bubble diffusers. As with coarse bubble diffusers, the fine bubble system will only utilize one blower. Experimental data shows that fine bubble diffusers have standard oxygen transfer efficiency of 37.3%, or up to 2.5 times that of coarse bubble diffusers. For this analysis an increase in efficiency of 2.0 was used. Pertinent information for the fine bubble system obtained from the supplier is provided in Appendix C. Under current conditions, the anticipated blower operating range for air supply for fine bubble diffusers is 1,400 SCFM to 1,700 SCFM. The projected fine bubble head loss curve is shown in Figure 2.

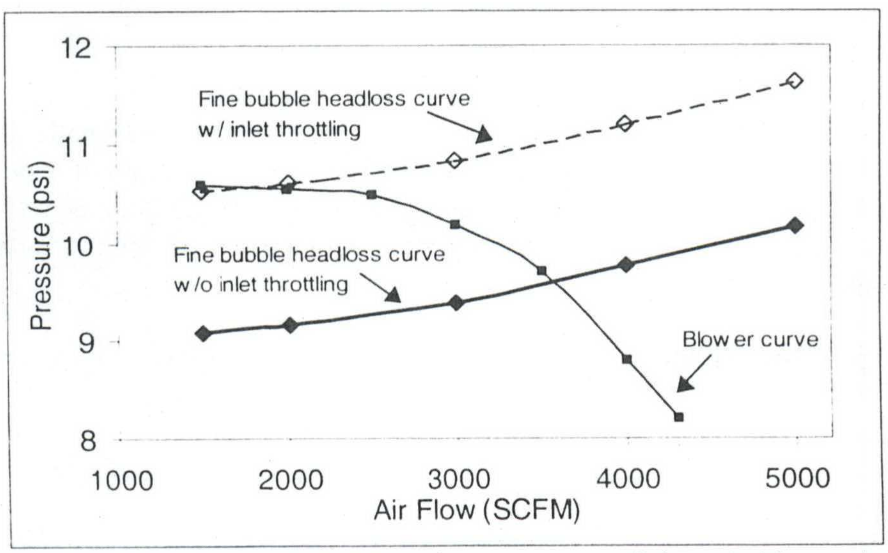


Figure 2: Projected fine bubble head loss curve for current conditions (without nitrification).

As a part of the wastewater treatment plant upgrade, City of Mount Vernon is planning to employ nitrification operations in their system by summer 2002. This upgrade is significant from the point of view of aeration because addition of nitrification to the process will increase the oxygen requirements by as much as 100%. For this analysis an increase in oxygen requirement of 50 % was used. The following analysis shows energy requirements under the existing conditions and conditions with nitrification included.

POWER CONSUMPTION ANALYSIS

To estimate present oxygen demand for the coarse bubble system, hourly power requirements were obtained from Mount Vernon Wastewater Treatment Plant. For this analysis eleven typical days (with average BOD loadings) were chosen from year 2000 operational data. Power requirements were adjusted for blower motor as well as for variable frequency drive (VFD) efficiencies. Operating airflows were determined from manufacturer's blower curves. For the proposed fine bubble system, airflows were reduced by 50% in order to obtain new power requirements. Figure 3 shows existing power requirements for the coarse bubble diffuser system and new requirements for the fine bubble diffuser system. Power consumption is reduced by approximately 30 %, when using fine bubble diffuser system and the conservative assumption of 50 % air demand increase.

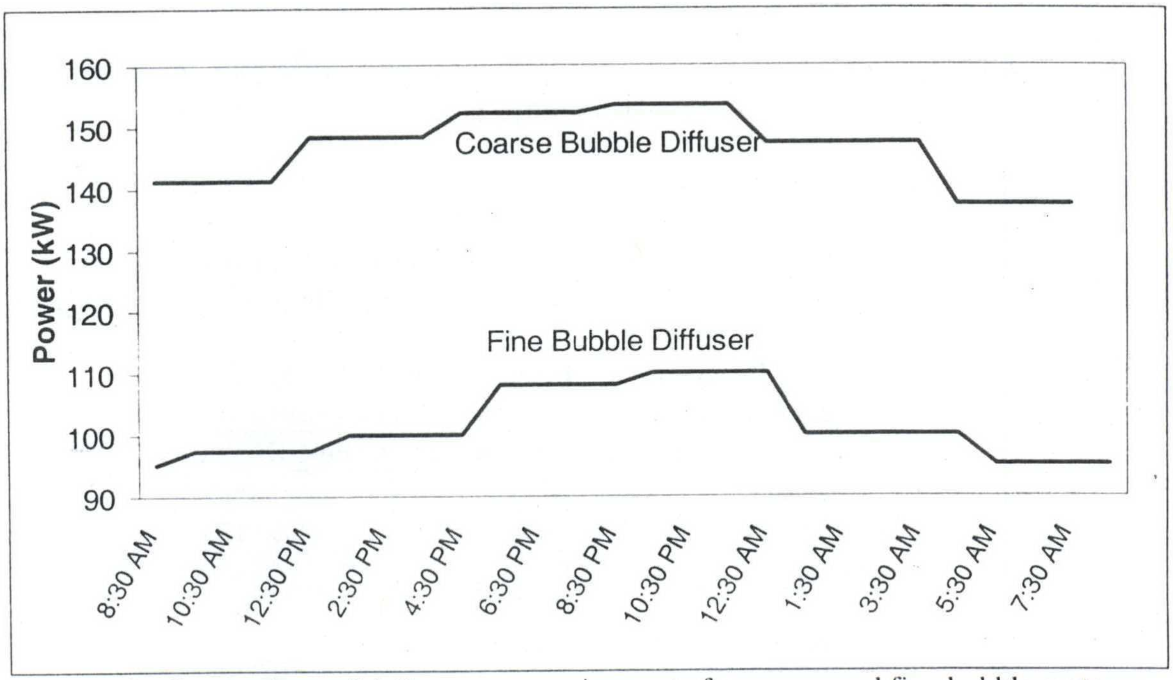


Figure 3: Comparison of daily power requirements for coarse and fine bubble systems (without nitrification).

A similar analysis was performed for a treatment process providing nitrification. To be conservative, a 50% increase in air demand was assumed. It is important to mention that for the coarse bubble system two blowers would have to be utilized to accommodate increase in air demand, whereas fine bubble system would still operate on one blower. Figure 4 shows the daily power requirements for both coarse and fine bubble systems with nitrification. By implementing the fine bubble diffuser system, average power consumption is lowered by 47 %.

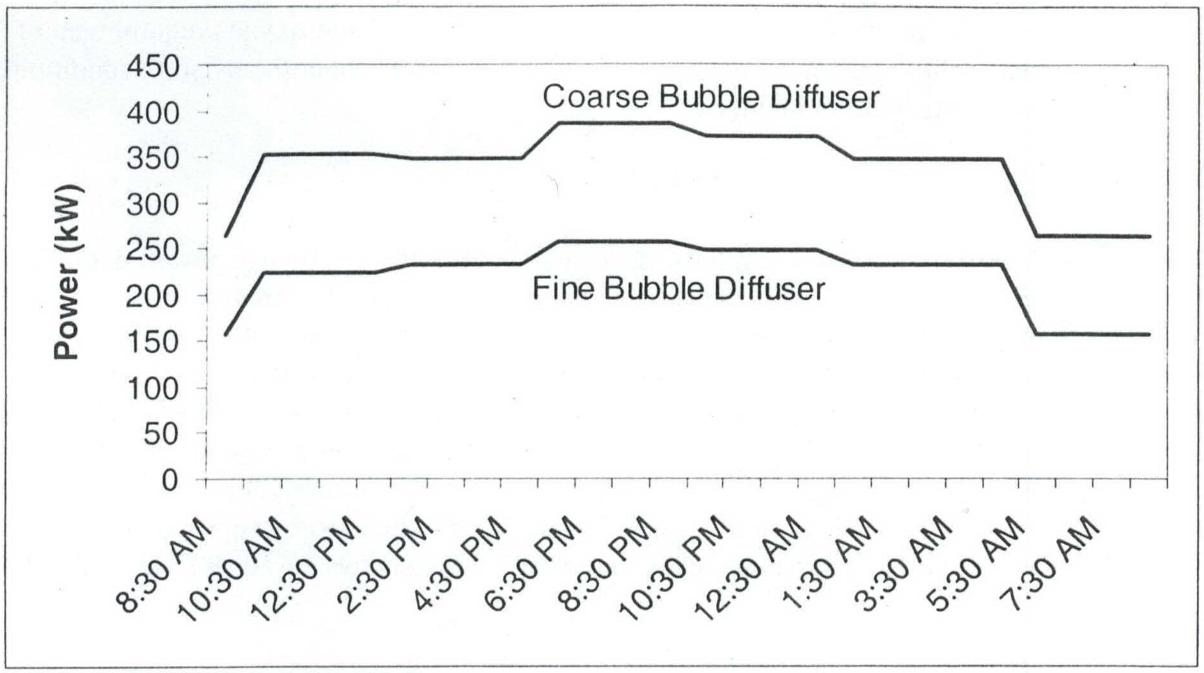


Figure 4: Comparison of daily power requirements for coarse and fine bubble systems (with nitrification).

COST ESTIMATES

Based on existing conditions, by implementing fine bubble aeration, the annual power savings will exceed $23,000. Table 1 shows comparisons of fine and coarse bubble aeration systems.

Table 1: Comparisons of fine and coarse bubble systems for existing aeration basin conditions (no nitrification).

	Coarse Bubble Diffuser	Fine Bubble Diffuser
Existing BOD loading	5,065 lb/d	5,065 lb/d
Power Required	1,284,437 kWh/yr	892,118 kWh/yr
Annual Cost ($0.06/kWh)	$77,070	$53,500
Total Projected Savings per year: $23,570		

After implementation of the nitrification process, the annual power savings will increase to more than $55,000 (Table 2).

Table 2: Comparisons of fine and coarse bubble systems for existing aeration basin conditions (with nitrification).

	Coarse Bubble Diffuser	Fine Bubble Diffuser
Existing BOD loading	5,065 lb/d	5,065 lb/d
Power Required	1,968,810 kWh/yr	1,048,572 kWh/yr
Annual Cost ($0.06/kWh)	$118,128	$62,914
Total Projected Savings per year: $55,214		

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
S4-B (7)	8.0	1500	8	LF	$ 177	$ 265,500	$ 23,364	$ 115,546	$ 101,102	**$ 510,000**
S4-B (8)	12.0	1300	8	LF	$ 192	$ 249,600	$ 21,965	$ 108,626	$ 95,048	**$ 480,000**
S4-C (1)	8.0	700	8	LF	$ 177	$ 123,900	$ 10,903	$ 53,921	$ 47,181	**$ 240,000**
S4-C (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-C (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-C (5)	8.0	700	8	LF	$ 177	$ 123,900	$ 10,903	$ 53,921	$ 47,181	**$ 240,000**
S4-C (4)	8.0	550	8	LF	$ 177	$ 97,350	$ 8,567	$ 42,367	$ 37,071	**$ 190,000**
S4-C (6)	16.0	1250	8	LF	$ 205	$ 256,250	$ 22,550	$ 111,520	$ 97,580	**$ 490,000**
S4-C (7)	18.5	1350	8	LF	$ 177	$ 238,950	$ 21,028	$ 103,991	$ 90,992	**$ 460,000**
S4-C (8)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S4-C (9)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S3-C (1)	12.0	1300	12	LF	$ 223	$ 289,900	$ 25,511	$ 126,164	$ 110,394	**$ 560,000**
S3-C (2)	11.0	1000	12	LF	$ 223	$ 223,000	$ 19,624	$ 97,050	$ 84,918	**$ 430,000**
S3-C (3)	16.0	900	12	LF	$ 223	$ 200,700	$ 17,662	$ 87,345	$ 76,427	**$ 390,000**
S3-C (4)	8.0	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S3-C (5)	9.0	1200	12	LF	$ 223	$ 267,600	$ 23,549	$ 116,460	$ 101,902	**$ 510,000**
S3-C (6)	13.8	1100	12	LF	$ 223	$ 245,300	$ 21,586	$ 106,755	$ 93,410	**$ 470,000**
S1-D (1)	8.0	1100	15	LF	$ 270	$ 297,000	$ 26,136	$ 129,254	$ 113,098	**$ 570,000**
S1-D (2)	8.0	800	10	LF	$ 216	$ 172,800	$ 15,206	$ 75,203	$ 65,802	**$ 330,000**
S1-D (3)	8.0	1150	10	LF	$ 216	$ 248,400	$ 21,859	$ 108,104	$ 94,591	**$ 480,000**
PS 1/S4-C & 300 lf FM		770		GPM	$ 780	$ 600,600	$ 52,853	$ 261,381	$ 228,708	**$ 1,150,000**
PS 2/S4-A2 & 1,300 lf FM		150		GPM	$ 5,000	$ 750,000	$ 66,000	$ 326,400	$ 285,600	**$ 1,430,000**
						$ 10,510,000				**$ 20,230,000**
West UGA							$ -	$ -	$ -	
W2-A (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
W2-A (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
W2-A (3)	8.3	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
W2-A (4)	9.3	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	**$ 360,000**
W2-A (5)	10.5	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	**$ 370,000**
W2-A (6)	11.5	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	**$ 370,000**
W2-A (7)	8.3	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	**$ 380,000**
W2-B (1)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
W2-B (2)	10.0	800	8	LF	$ 185	$ 148,000	$ 13,024	$ 64,410	$ 56,358	**$ 290,000**
W2-B (3)	13.0	800	8	LF	$ 192	$ 153,600	$ 13,517	$ 66,847	$ 58,491	**$ 300,000**
W2-B (4)	16.2	800	8	LF	$ 205	$ 164,000	$ 14,432	$ 71,373	$ 62,451	**$ 320,000**
W2-B (5)	18.2	800	8	LF	$ 205	$ 164,000	$ 14,432	$ 71,373	$ 62,451	**$ 320,000**
W2-B (6)	16.5	500	8	LF	$ 205	$ 102,500	$ 9,020	$ 44,608	$ 39,032	**$ 200,000**
W2-B (7)	13.0	500	8	LF	$ 192	$ 96,000	$ 8,448	$ 41,779	$ 36,557	**$ 190,000**
PS 1/W2-A & 600 lf FM		550		GPM	$ 1,000	$ 550,000	$ 48,400	$ 239,360	$ 209,440	**$ 1,050,000**
						$ 2,820,000				**$ 5,440,000**
East UGA										
E-13	9.0	4500	8	LF	$ 185	$ 832,500	$ 73,260	$ 362,304	$ 317,016	**$ 1,590,000**
E-11 (1)	15.0	3000	8	LF	$ 205	$ 615,000	$ 54,120	$ 267,648	$ 234,192	**$ 1,180,000**
E-11 (2)	8.0	2300	8	LF	$ 177	$ 407,100	$ 35,825	$ 177,170	$ 155,024	**$ 780,000**
E-15	8.0	2500	8	LF	$ 177	$ 442,500	$ 38,940	$ 192,576	$ 168,504	**$ 850,000**
E-14(1)	8.0	2000	8	LF	$ 177	$ 354,000	$ 31,152	$ 154,061	$ 134,803	**$ 680,000**
E-12	8.0	3000	8	LF	$ 177	$ 531,000	$ 46,728	$ 231,091	$ 202,205	**$ 1,020,000**
E-14(2)	8.0	2200	8	LF	$ 177	$ 389,400	$ 34,267	$ 169,467	$ 148,284	**$ 750,000**
E-8 (2)	8.0	1900	8	LF	$ 177	$ 336,300	$ 29,594	$ 146,358	$ 128,063	**$ 650,000**
E-8 (1)	8.0	2300	10	LF	$ 187	$ 430,100	$ 37,849	$ 187,180	$ 163,782	**$ 820,000**
E-8 (3)	8.0	4800	15	LF	$ 237	$ 1,137,600	$ 100,109	$ 495,084	$ 433,198	**$ 2,170,000**
E-8 (4)	13.0	2000	15	LF	$ 255	$ 510,000	$ 44,880	$ 221,952	$ 194,208	**$ 980,000**
E-3 (1)	10.0	1200	8	LF	$ 185	$ 222,000	$ 19,536	$ 96,614	$ 84,538	**$ 430,000**
E-3 (2)	10.0	1200	8	LF	$ 185	$ 222,000	$ 19,536	$ 96,614	$ 84,538	**$ 430,000**

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
E-1 (1)	11.3	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	**$ 370,000**
E-1 (2)	10.0	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	**$ 360,000**
E-1 (3)	8.7	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	**$ 360,000**
E-6	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	**$ 380,000**
E-9 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
E-9 (2)	8.0	1250	8	LF	$ 177	$ 221,250	$ 19,470	$ 96,288	$ 84,252	**$ 430,000**
E-9 (3)	8.0	1250	8	LF	$ 177	$ 221,250	$ 19,470	$ 96,288	$ 84,252	**$ 430,000**
E-7	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
E-4 (1)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	**$ 410,000**
E-4 (2)	15.3	1100	8	LF	$ 205	$ 225,500	$ 19,844	$ 98,138	$ 85,870	**$ 430,000**
E-4 (3)	15.3	1000	8	LF	$ 205	$ 205,000	$ 18,040	$ 89,216	$ 78,064	**$ 400,000**
E-4 (4)	13.5	1100	12	LF	$ 238	$ 261,800	$ 23,038	$ 113,935	$ 99,693	**$ 500,000**
E-1 (4)	12.5	2300	15	LF	$ 255	$ 586,500	$ 51,612	$ 255,245	$ 223,339	**$ 1,120,000**
E-1 (5)	11.5	3600	15	LF	$ 255	$ 918,000	$ 80,784	$ 399,514	$ 349,574	**$ 1,750,000**
N10-C (1)	18.0	4000	15	LF	$ 270	$ 1,080,000	$ 95,040	$ 470,016	$ 411,264	**$ 2,060,000**
E-2	8.0	1500	8	LF	$ 177	$ 265,500	$ 23,364	$ 115,546	$ 101,102	**$ 510,000**
N10-H	8.0	1750	8	LF	$ 177	$ 309,750	$ 27,258	$ 134,803	$ 117,953	**$ 590,000**
N10-E	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N10-C (2)	8.0	1400	8	LF	$ 177	$ 247,800	$ 21,806	$ 107,843	$ 94,362	**$ 480,000**
E-5 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
E-5 (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
E-5 (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
E-10				LF	$ -	$ -	$ -	$ -	$ -	**$ -**
PS 1/East UGA &4,300 lf FM		1770		GPM	$ 1,550	$ 2,743,500	$ 241,428	$ 1,193,971	$ 1,044,725	**$ 5,230,000**
						$ 15,720,000				**$ 30,110,000**

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost [1]	Taxes (8.8%)	Contingency [2] (40%)	Engineering and Administration Costs [3] (25%)	Project Cost [4]

Notes:

(1) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting & relocating existing utilities, dewatering, and traffic control.

(2) The construction contingency is an allowance for additional costs not identified in the planning phase and may include utility crossings or unique soil conditions.

(3) Engineering and Administration costs include engineering and design, permitting fees, and City management costs.

(4) Project Costs include taxes (8.8%), contingency (40%), and engineering and administration costs (25%).

APPENDIX D

Related Documents

City of Mount Vernon
Development Services

910 Cleveland Avenue
Post Office Box 809
Mount Vernon, WA 98273

Phone (360) 336-6214
FAX (360) 336-6283
E-Mail DS@ci.mount-vernon.wa.us
www.ci.mount-vernon.wa.us

August 22, 2003

Chris Parsons
Community, Trade and Economic Development
Growth Management Division
P.O. Box 48300
Olympia, Washington 98504-8300

Dear Chris:

I have enclosed for your information an update to **Mount Vernon's Comprehensive Sewer Plan** adding some additional specificity regarding service to the Urban Growth area. We will be taking this to the Planning Commission and City Council for public hearing later in October.

If you have any questions, please give me a call.

Sincerely,

Elizabeth Sjostrom

Elizabeth Sjostróm
Economic Development Planner

Encl.

City of Mount Vernon

Wastewater Division

1401 Britt Road
Mount Vernon, WA 98273-6511

Phone (360) 336-6219
FAX (360) 424-8749
E-Mail mvwwtp@ci.mount-vernon.wa.us
www.ci.mount-vernon.wa.us

August 25, 2003

Bernard Jones
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

Subject: Notification of sewer line extensions, including pump stations.

Dear Mr. Jones:

In accordance with WAC 173-240-030(5), the City of Mount Vernon is providing notice of planning for sewer pipe extensions, including pump stations in the urban growth area. The sewer expansion areas are shown in Figure 1 attached. The extension plan is in conformance with the Comprehensive Sewer Plan approved by Ecology on March 4, 2003.

If you have any questions on this matter please contact Walt Enquist at (360) 336-6219.

Sincerely,

Walt Enquist

Walt Enquist
Wastewater Utility Supervisor

Attachments

cc: John Buckley, Pubic Works Director
Elizabeth Sjostrom, Economic Development P
NPDES File

F:\Winword\WALT\COMP-PLA\UGA Amendment 2003\DOE Notifica

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

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OFFICIAL USE — BELLEVUE WA 98008

Postage	$ .37
Certified Fee	2.30
Return Receipt Fee (Endorsement Required)	1.75
Restricted Delivery Fee (Endorsement Required)	—
Total Postage & Fees	$ 4.42

Postmark Here: MOUNT VERNON WA 98273, AUG 25 2003, Clerk: KGV4KM, 08/25/03, USPS

Sent To: Bernard Jones
Department of Ecology
Street, Apt. No.; or PO Box No.: Northwest Regional Office
3190 160th Avenue SE
City, State, ZIP+4: Bellevue, WA 98008-5452

PS Form 3800, April 2002 — See Reverse for Instructions

RECOMMENDATIONS

For conditions described above the kWh savings for replacing a coarse bubble system with a fine bubble system would be approximately 920,000 kWh, or about $55,000 annually. Currently, the approximated cost of the installed project is $222,424 (Table 3).

An evaluation was made for a Puget Sound Energy Grant. Based on the analysis above the installed measure cost/annual kWh would be $0.24, and Puget Sound Energy funding of 50% can be anticipated. A completed PSE Grant Application is included in Appendix D.

Table 3: Estimates Cost for Installed System.

Aeration Diffusers (with Sales Tax)	$116,424[1]
Installation (with Sales Tax)	$ 43,000
Engineering, Bidding, Construction Administration	$ 43,000
Contingency (Approximately 10 %)	$ 20,000
	$ 222,424

[1] Based on bid of October 8, 2001.

Appendix N
Staffing calculations

By:	Bob Bower, HDR Engineering
Date:	March 15,2003
Plant:	City of Mount Vernon
Location:	Mount Vernon, WA
Version:	2
Type:	Conventional activated sludge with nitrification
Design flow (ADMM):	8.1 mgd in 2010, note 4.

Step 1 - Determine Adjustments for Local Conditions

		Adjustment (%)					
Category	**Discussion**	Oper.	Maint.	Supv.	Clerical	Lab	Yard
Plant layout	Average						
Unit Processes	Standard Equipment						
Level of Treatment	Secondary						
Removal Requirements	Nitrification/Partial Denit.	5%				10%	
Industrial Wastes	Constant						
Productivity	Average						
Climate	Moderate						
Training	Certification						
SCADA	Monitoring & Control	-5%	5%				
Automatic Sampling	Influent and Effluent	-5%				-5%	
Offsite Lab	Receiving Water Only					-10%	
Offsite Maintenance	Minimal		-5%				
Age of Equipment	50% old, 50% new		5%				
Total		-5%	5%	0%	0%	-5%	0%

Step 2 - Determine Annual Manhours for an Average Plant

Nominal flow	8	mgd
Productivity	1,500	hrs/year

Note 1

			Annual Labor Hours					
Category	**Comment**		Oper.	Maint.	Supv.	Clerical	Lab	Yard
Supervisory	Note 2				2,100			
Clerical						650		
Laboratory	Lab staff + operators						2,000	
Yardwork								1,850
Raw sewage pumping	Note 2		600	440				
Screening			750	36				
Primary treatment			1,800	460				
Grit removal			625	54				
Primary sludge thickening			320	320				
Aeration			1,400	1,600				
Sec. Clar., RAS, WAS			1,600	390				
UV disinfection	Est. for chlorination		310	390				
WAS thickening			1,200	950				
Anaerobic digestion			775	290				
Dewatering	Note 3	0.4	666					
CSO Outfall O&M				208				
(8hr/day x 4day/wk x 52 wk/yr)	1,664	0.3		499				
Subtotal hours			10,046	5,637	2,100	650	2,000	1,850
Step 3 - Apply Adjustment Factors			-502	282	0	0	-100	0
Total hours	21,962		9,543	5,919	2,100	650	1,900	1,850

Step 4 - Staff Requirement

Staff calculated by category	14.6	6.4	3.9	1.4	0.4	1.3	1.2
Staff calculated by total hours	14.6						

Step 5 - Recommendation

Staff requirement: 14.5

Reference: **Estimating Staffing for Municipal Wastewater Treatment Plants**, EPA MO-1.

Notes:
1. Excludes sick leave, vacation and holidays (total 29 days) and assumes 6.5 hr/day productive work, 5 days/week
2. Excludes collection system O&M (sewers and lift stations) and time for Engineering, Planning, Construction Management.
3. Dewatering runtime (hr/yr) calculated as shown. Operation labor at 0.4 hr/hr and maintenance at 0.3 hr/hr runtime.
4. Flow from final comp plan. Excludes CSO facilities that are a future phase. This analysis only address through the year 2010.

APPENDIX O
DETERMINATION OF NON-SIGNIFICANCE (DNS)

City of Mount Vernon Community & Economic Development
1002 Cleveland Street
Post Office Box 809
Mount Vernon, WA 98273
Phone (360) 336-6214
FAX (360) 336-6283
E-Mail mvced@ci.mount-vernon.wa.us
www.ci.mount-vernon.wa.us/

DETERMINATION OF NON-SIGNIFICANCE (DNS)

DESCRIPTION OF PROPOSAL: Proposed amendment to the City of Mount Vernon Comprehensive Plan to include an updated Comprehensive Sewer Plan, providing capital facilities planning and needs assessment.

APPLICANT: City of Mount Vernon

LOCATION OF PROPOSAL: City-wide

LEAD AGENCY: Mount Vernon Community and Economic Development Department

The lead agency for this proposal has determined that it does not have a probable adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

This DNS is issued under 197-11-340(2); the lead agency will not act on this proposal for 14 days from the date below. Comments must be submitted by December 11, 2000.

RESPONSIBLE PERSON: Rick Cisar
POSITION/TITLE: Community and Economic Development Director
ADDRESS: P. O. Box 809, Mount Vernon, WA 98273
PHONE: (360) 336-6214

RESPONSIBLE PERSON: Rick Cisar
POSITION/TITLE: Community and Economic Development Director
ADDRESS: P. O. Box 809, Mount Vernon, WA 98273
PHONE: (360) 336-6214

DATE 11/14/2000 SIGNATURE [signature]

Published November 27, 2000.
DNS 00-30
Sent to: Ecology, CTED

DETERMINATION OF NON-SIGNIFICANCE (DNS)

DESCRIPTION OF PROPOSAL: Proposed amendment to the City of Mount Vernon Comprehensive Plan to include an updated Comprehensive Sewer Plan, providing capital facilities planning and needs assessment.

APPLICANT: City of Mount Vernon

LOCATION OF PROPOSAL: City-wide

LEAD AGENCY: Mount Vernon Community and Economic Development Department

The lead agency for this proposal has determined that it does not have a probable adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

This DNS is issued under 197-11-340(2); the lead agency will not act on this proposal for 14 days from the date below. Comments must be submitted by December 11, 2000.

RESPONSIBLE PERSON: Rick Cisar
POSITION/TITLE: Community and Economic Development Director
ADDRESS: P. O. Box 809, Mount Vernon, WA 98273
PHONE: (360) 336-6214

Published November 27, 2000.

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City of Mount Vernon

Urban Growth Area Sewer Service Study

October 2003

Prepared by:

HDR

CERTIFICATION PAGE

FOR

City of Mount Vernon
Urban Growth Area Sewer Service Study
Project No. 000 000 000 005237 002

The engineering material and data contained in this Report were prepared under the supervision and direction of the undersigned, whole seal as registered professional engineer is affixed below.

Eric C.M. Bergstrom
Supervising Engineer

City of Mount Vernon

Urban Growth Area Sewer Service Study
Technical Memorandum

Date: October 15, 2003

To: Walt Enquist, Fred Buckenmeyer

From: Eric Bergstrom

Subject: Urban Growth Area Sewer Service Study

INTRODUCTION AND OBJECTIVE

The City is required to establish a plan to provide sewer service to properties within the Urban Growth Area (UGA). This study identifies at a planning level the facilities that would be required to provide sewer service to four major areas within the UGA. These UGA areas are situated to the north, south, east and west of City limits and as illustrated in Figure 1. The areas vary in size from 175 to 1,400 acres.

DRAINAGE BASIN DELINEATION

Each of the UGA service areas shown in Figure 1 was divided into a number of drainage basins. The drainage basins were delineated based on contour and mapping data provided by City of Mt. Vernon geographical information system (GIS) as well as some field reconnaissance. Figures 2, 3, 4, and 5 show the approximate drainage basin boundaries within north, south, east and west UGAs, respectively. Each drainage basin is designated an ID such as E-12, which serves to clarify new sewer locations. The first letter of basin ID refers to a specific UGA, i.e. S for south etc. The basin ID's follow a format set forth in the *City of Mount Vernon Comprehensive Sewer Plan Update*, February 2003.

DESIGN FLOWS

Design flows from each of the drainage basins were estimated based on an assumed population density of 2.5 persons per house and a house density of 4 houses per acre. Average daily flow per capita was assumed to be 100 gallons. Consistent with Comprehensive Sewer Plan, a peaking factor was applied to predict peak daily sanitary flow. The peaking factor for the sanitary flows at any point in the system is based on the following equation:

$$PF = -0.6 \log Q + 2.6$$

where,

PF	peaking factor
Q	average sanitary flow in million gallons per day (mgd)

Inflow and infiltration (I&I), is independent of sanitary flow and is assumed to be 1,100 gallons per acre per day (gpda). The sanitary sewer peaking factor is not applied to the allowance for I&I.

Table 1 summarizes the drainage basins and calculated average and peak flow for each basin.

Table 1
Drainage Basins Flows

Drainage Basin ID[1]	Basin Area (acres)	Estimated Population[2]	Average Sanitary Flow (gpm)	Peaking Factor	Inflow and Infiltration (gpm)	Peak Design Flow (gpm)
North UGA						
N11-T	26	260	18	3.6	20	84
N15-A	101	1007	70	3.2	77	300
N15-B	132	1320	92	3.1	101	388
N15-C	64	640	44	3.3	49	196
N15-D	59	590	41	3.3	45	182
N16	47	469	33	3.4	36	146
N9-F	25	249	17	3.6	19	80
South UGA						
S1-D	141	1407	98	3.1	107	411
S3-A1	69	689	48	3.3	53	211
S3-A2	167	1672	116	3.1	128	484
S3-B2	84	835	58	3.2	64	252
S3-C	139	1389	96	3.1	106	407
S4-A1	66	661	46	3.3	50	202
S4-A2	99	988	69	3.2	75	295
S4-B	124	1236	86	3.1	94	364
S4-C	274	2737	190	2.9	209	767
S5-B	185	1854	129	3.0	142	533
East UGA						
E-1	209	2088	145	3.0	160	596
E-10	172	1718	119	3.1	131	496
E-11	90	896	62	3.2	68	269
E-12	104	1044	73	3.2	80	311
E-13	129	1286	89	3.1	98	378
E-14	86	861	60	3.2	66	259
E-15	40	400	28	3.4	31	126
E-2	35	347	24	3.5	27	110
E-3	42	416	29	3.4	32	131
E-4	90	903	63	3.2	69	271
E-5	57	575	40	3.3	44	177
E-6	28	285	20	3.5	22	92
E-7	63	633	44	3.3	48	194
E-8	178	1782	124	3.0	136	513
E-9	140	1400	97	3.1	107	410
N10-C	37	375	26	3.5	29	119
N10-E	44	439	30	3.4	34	138
N10-H	55	548	38	3.4	42	169
West UGA						
W1	178	1781	124	3.0	136	513
W2-A	98	977	68	3.2	75	292
W2-B	75	751	52	3.3	57	228

(1) See Figures 2 through 5 for drainage basin designations in each UGA.
(2) Saturated development.

SEWER LAYOUT AND SIZING

Figures 6, 7, 8, and 9 illustrate proposed sewer locations within the UGAs. Where possible, proposed sewers were located in existing right-of-ways. In several locations proposed sewers are shown outside of right-of-way boundaries where these routes provide a more cost effective alignment. Some sewers are shown outside the boundary of the East UGA in order maximize the natural drainage of the area. For this study it was assumed that the sewers outside the UGA boundaries are strictly for conveyance and there are no service connections along the alignment. The piping shown on the figures only includes trunk sewers and interceptors. Small collector sewers that would serve individual properties generally have not been identified.

After proposed alignment of interceptors and major trunk lines was established, grade elevations at approximately 1,000-foot intervals were established based on City's contour mapping. For the purposes of this study it was assumed that the minimum pipe depth to the invert would be 8 feet below grade. In some cases, in order to provide greater slope to improve the flow, greater depths of pipe were assumed. The hydraulic analysis of proposed sewers was completed based on fully developed UGAs for each individual drainage basin. In the model the flows from the drainage basin or portions of the drainage basin are routed into the upstream end of pipe segments.

PROPOSED IMPROVEMENTS

Based on the UGA evaluation proposed sewer improvements were identified. Table 2 summarizes the improvements proposed for each UGA. For detailed list of improvements refer to Appendix A. Figures 6 through 9 illustrate the location of the sewers, forcemains and pump stations and show sewer sizing within each basin.

Table 2
Summary of Proposed Improvements for all UGAs

UGA	Sewer (linear feet)	Pump Stations (ea)	Force Main (linear feet)
North	22,000	3	5,000
South	45,000	2	2,000
East	53,000	1	5,000
West	12,000	1	800

Improvement S3-A2 (1) extends sewer service to intercept flows from basin S4-A2. Initially, sewer service in this basin can be served through SE-A2 (1). Ultimately, as the basin development proceeds, sewer flows will need to be routed down the proposed interceptor on the south side of Maddox Creek and includes sewer segments S4-A1 (1), (2), and (3) so that the sewers on South 19th Street do not become overloaded. The City should monitor flows in the sewer to determine when sewer segments S4-A1 (1), (2), and (3) are required.

Pump station S4-A2 PS1 has been identified at the end of Crosby Drive because the grade to the west may be excessive for a gravity sewer. It may be feasible to extend a gravity sewer to the west and connect to proposed sewer segments S4-A1 (1), (2), and (3) and the City should evaluate the potential for extending gravity service to Crosby Drive as development proceeds.

COST ESTIMATES

Construction Costs

Construction costs for the facilities required to provide sewer service to the Urban Growth Areas were based on cost established in the Comprehensive Sewer Plan Update as well as King County's cost estimating software TABULA. TABULA is a free software developed to estimate costs for sewer projects in the King County area. Use of TABULA allows for cost analysis that is always consistent. The costs can be adjusted to present day values using the ENR cost indexes and/or escalated to future years by using an annual projected inflation multiplier. The inflation multiplier can be defined in the program as any chosen percentage, however, 3 percent is commonly used. An effective 1.13 multiplier was used in the analysis to account for increase in construction cost from 1999 to the end of 2003.

For an example of TABULA's assumptions and item cost breakdown see Appendix B. Note that all assumptions can be defined within the program to better suit a specific project. Table 3 lists costs of pipe, at varying depths, based on TABULA. See Appendix C, column 7, for construction costs for major items associated with each UGA. Costs listed in Table 5 are also construction costs.

The construction costs include excavation and native backfill based on depth and pipe size, standard trench safety, backfill and pipe zone fill, manholes at average spacing of 500 feet, protecting/relocating average complexity utilities, minimal dewatering, traffic control for light traffic conditions, complete pavement restoration for width of trench, and mobilization/demobilization (10 percent of total). These particular costs do not include land acquisition or easements as these elements are difficult to define at the planning stages of design.

Table 3
Construction Cost Estimate Summary Table

Sewer Depth (ft)	Construction Cost per Liner Foot of Sewer								
	8-inch	10-inch	12-inch	15-inch	18-inch	24-inch	27-inch	30-inch	36-inch
8	$177	$187	$207	$237	$258	$316	$341	$385	$452
10	$185	$195	$215	$246	$267	$327	$351	$396	$465
12	$192	$203	$223	$255	$276	$337	$362	$408	$477
15	$205	$216	$238	$270	$292	$355	$381	$429	$500

Notes:
1) Costs are for year 2003.
2) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting/relocating existing utilities, dewatering, and traffic control.

The costs listed in Table 3 do not include taxes, construction contingency, or engineering and administration costs, which are briefly described below.

Contingency
The construction contingency is an allowance for additional costs not identified in the planning phase. Generally, these costs are not identified because they are unknown at the planning stages of the project. The contingency costs may include complex utility crossings, unique soil conditions, traffic control for heavy traffic conditions, land acquisition, easements, and other unidentified costs. See Appendix C, column 9, for contingency costs on construction costs for major items associated with each UGA.

Engineering and Administration
Engineering and administration costs include engineering and design, permitting process and fees, and City construction management costs. See Appendix C, column 10, for engineering and administration costs on construction costs for major items associated with each UGA.

Project Cost
Project costs include construction costs with an escalation for the following items:

- Sales Tax – 8.8 percent
- Contingency – 40 percent
- Engineering and Administration – 25 percent.

The major construction items and respective costs associated with each UGA are presented in Appendix C. See column 11 of Appendix C, for project costs on construction costs for major items associated with each UGA. Note that Figures 6 through 9 identify individual pipe segments, which are listed in Appendix C. The approximate construction and project costs estimated for each of the UGAs are summarized in Table 4. They include gravity and forcemain piping costs as well as pump station costs.

Table 4
Approximate UGA Construction and Project Costs

Urban Growth Area	Construction Cost (1) (2003)	Project Cost (2) (2003)
North	$6,030,000	$11,580,000
South	$10,510,000	$20,230,000
East	$15,720,000	$30,110,000
East (+ 1,200 ac) (3)	$8,540,000	$16,270,000
East (+ 5,600 ac) (3)	$12,840,000	$24,450,000
West	$2,820,000	$5,440,000

Notes:
(1) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting & relocating existing utilities, dewatering, and traffic control.
(2) Project costs include sales tax, contingency (unidentified item, such as complex utilities, soil conditions, traffic control, land acquisition, easements, etc.), and engineering and administration costs (engineering and design, permitting, management, etc.).
(3) The expended East service area is described in the proceeding section. Costs for additional 1,200 and 5,600 acres assumes PS1-E, E-8 (4), E-1(4), E-1(5), and N10-C(1) improvements only.

EXPANDED EAST SERVICE AREA

There is potential that sewer service may be provided east of the UGA. The impacts of this service on the sewer sizing within the City was evaluated for different size drainage areas to the east. Table 5 summarizes the impact on the existing sewers within the City along with the sizing of new facilities identified within this study.

Table 5
Expanded Service Area Impacts on Sewer Sizing

Improvement	Sewer Length (linear feet)	Assumed Slope (ft/ft)	Urban Growth Area Service			1,200 Additional Acres			5,600 Additional Acres		
			Design Flows (mgd)	Pipe Size (in)	Construction Cost [4] (million dollars)	Design Flows (mgd)	Pipe Size (in)	Construction Cost (million dollars)	Design Flows (mgd)	Pipe Size (in)	Construction Cost (million dollars)
PS1 - E	--	--	2.5	--	$2.74 [1]	6.6	--	$4.50 [1]	20.1	--	$7.01 [1]
Forcemain	4,300	--	2.5	12	--	6.6	24[5]	--	20.1	36[5]	--
E-8 (4)	2,000	0.008	2.5	15	$0.51	6.6	24	$0.67	20.1	36	$0.95
E-1 (4)	2,300	0.016	2.7	15	$0.59	7.3	24	$0.78	20.9	36	$1.10
E-1 (5)	3,600	0.007	2.7	15	$0.92	7.3	24	$1.21	20.9	36	$1.72
N10-C (1)	4,000	0.016	4.7	15	$1.08	8.3	24	$1.38	21.8	36	$2.06
East College Way Pump Station	--	--	9.6	--		13.3	--		24.4	--	
East College Way Pump Station Forcemain	6,300	--	9.6 [2]	24		13.3	30		24.4	36	
Kulshan Interceptor	6,860	0.006	18.9 [2]	24 & 30 [3]	--	22.5	30		35.1	36	

Notes:
(1) Cost Includes FM.
(2) Existing flows plus East UGA flows.
(3) Existing piping at capacity is approximately 18 mgd.
(4) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting/relocating existing utilities, dewatering, and traffic control.
(5) Multiple forcemains could be constructed with this effective pipe size diameter.

Note that costs listed Table 5 are construction costs only. See Appendix B for cost escalations to arrive at project costs.

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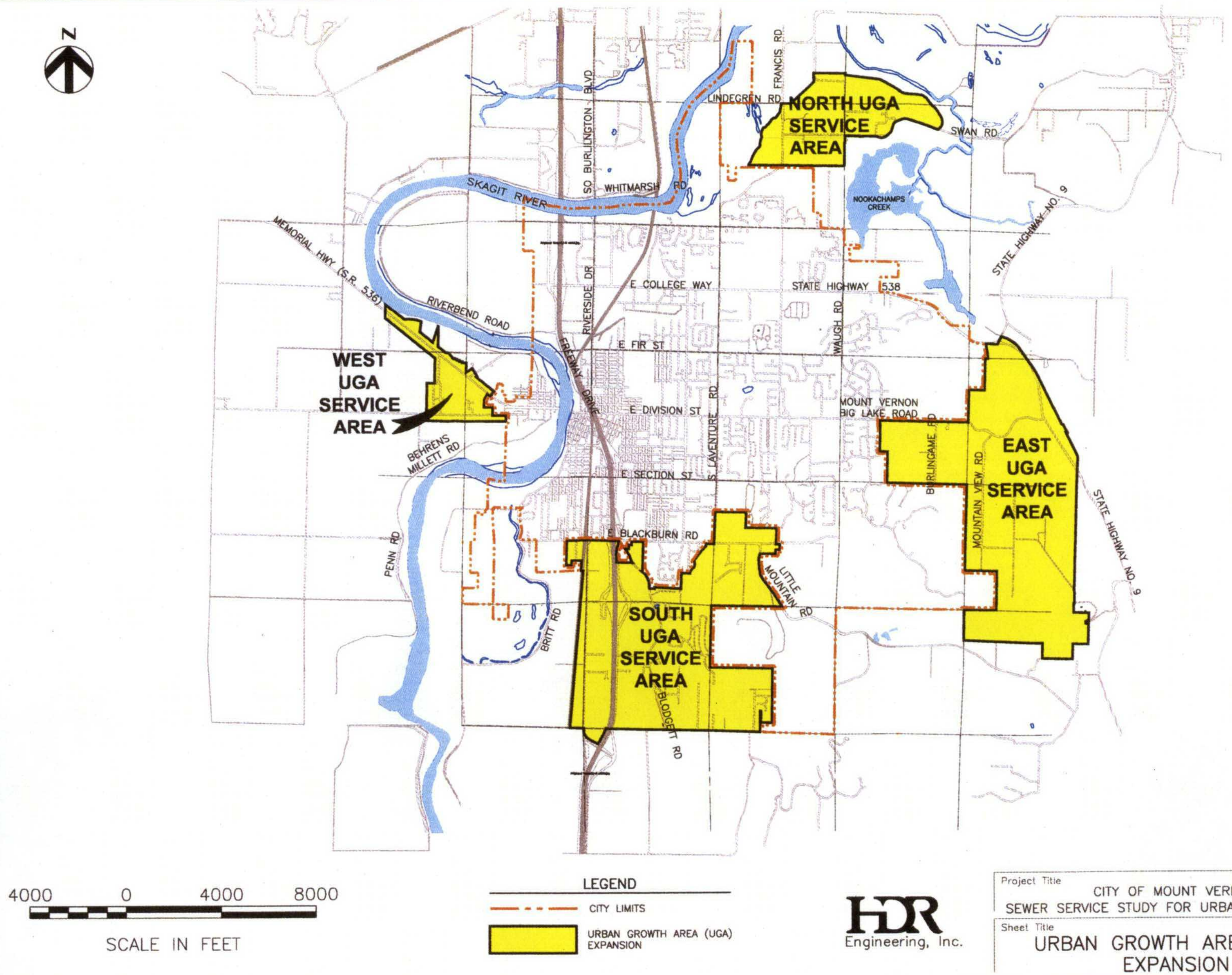


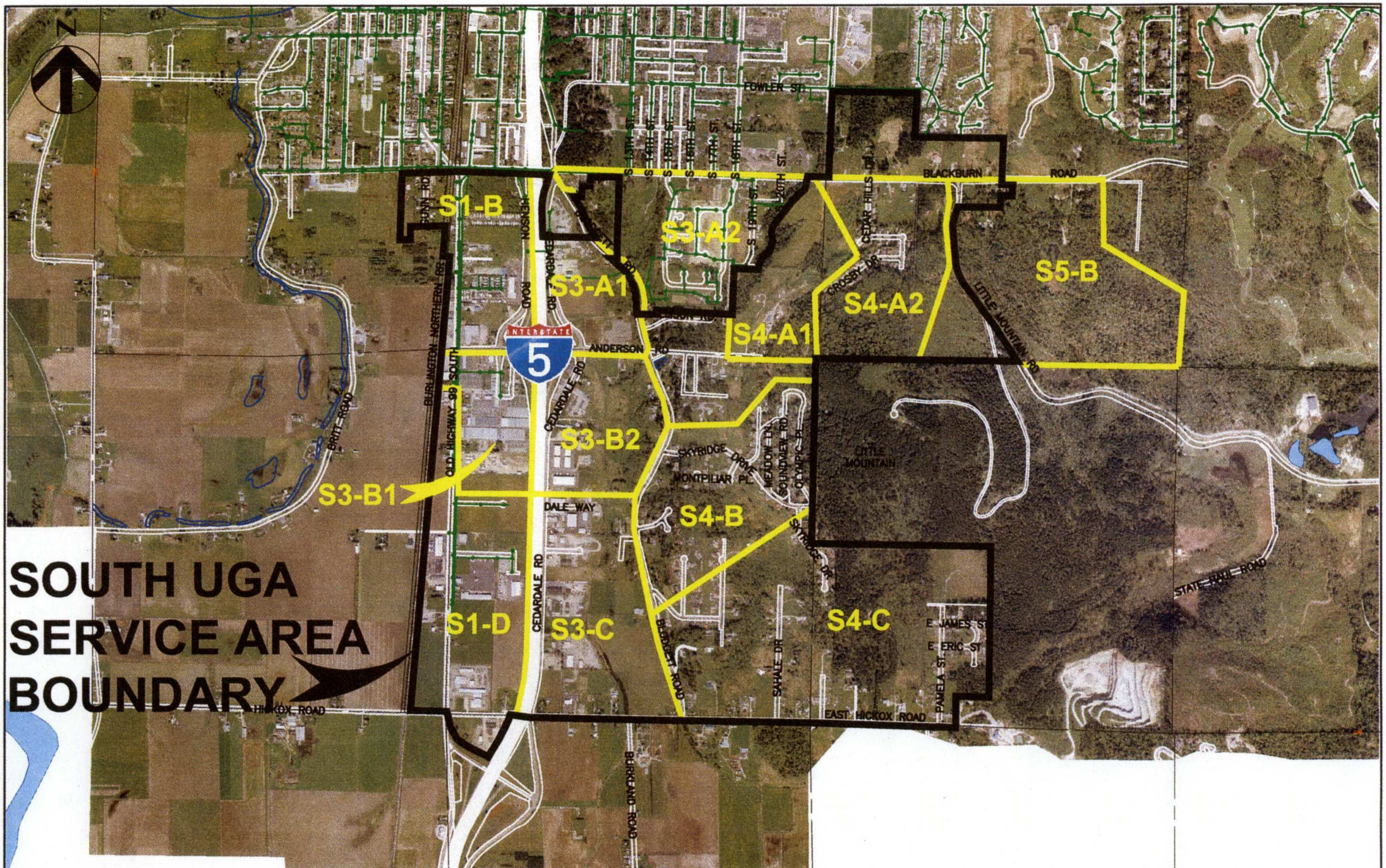
LEGEND

CITY LIMITS

URBAN GROWTH AREA (UGA) EXPANSION

HDR Engineering, Inc.

Project Title: CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA	Date: SEPTEMBER 2003
Sheet Title: URBAN GROWTH AREA (UGA) EXPANSION	Figure No. 1



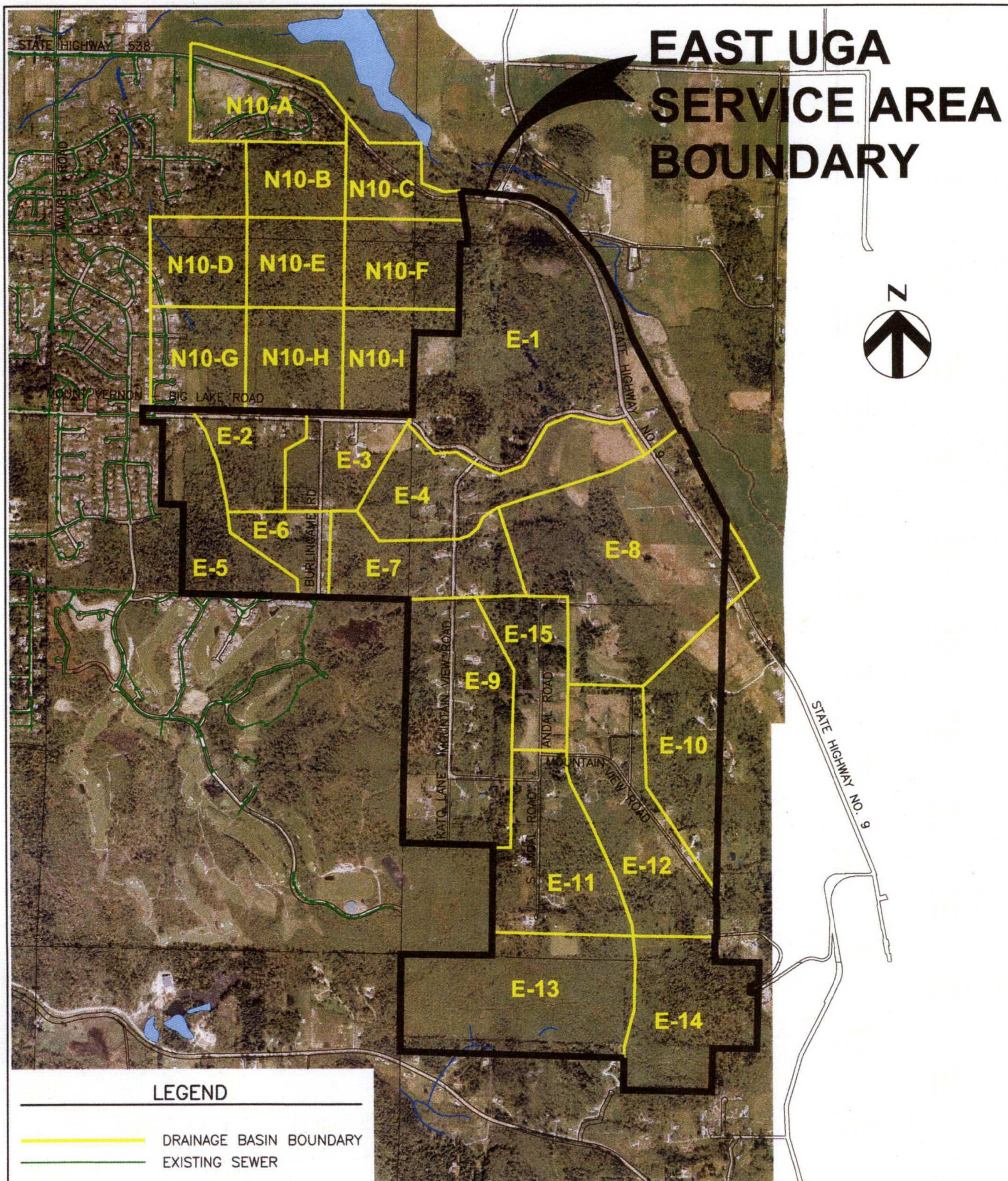
LEGEND

(yellow line)	DRAINAGE BASIN BOUNDARY
(green line)	EXISTING SEWER

HDR Engineering, Inc.

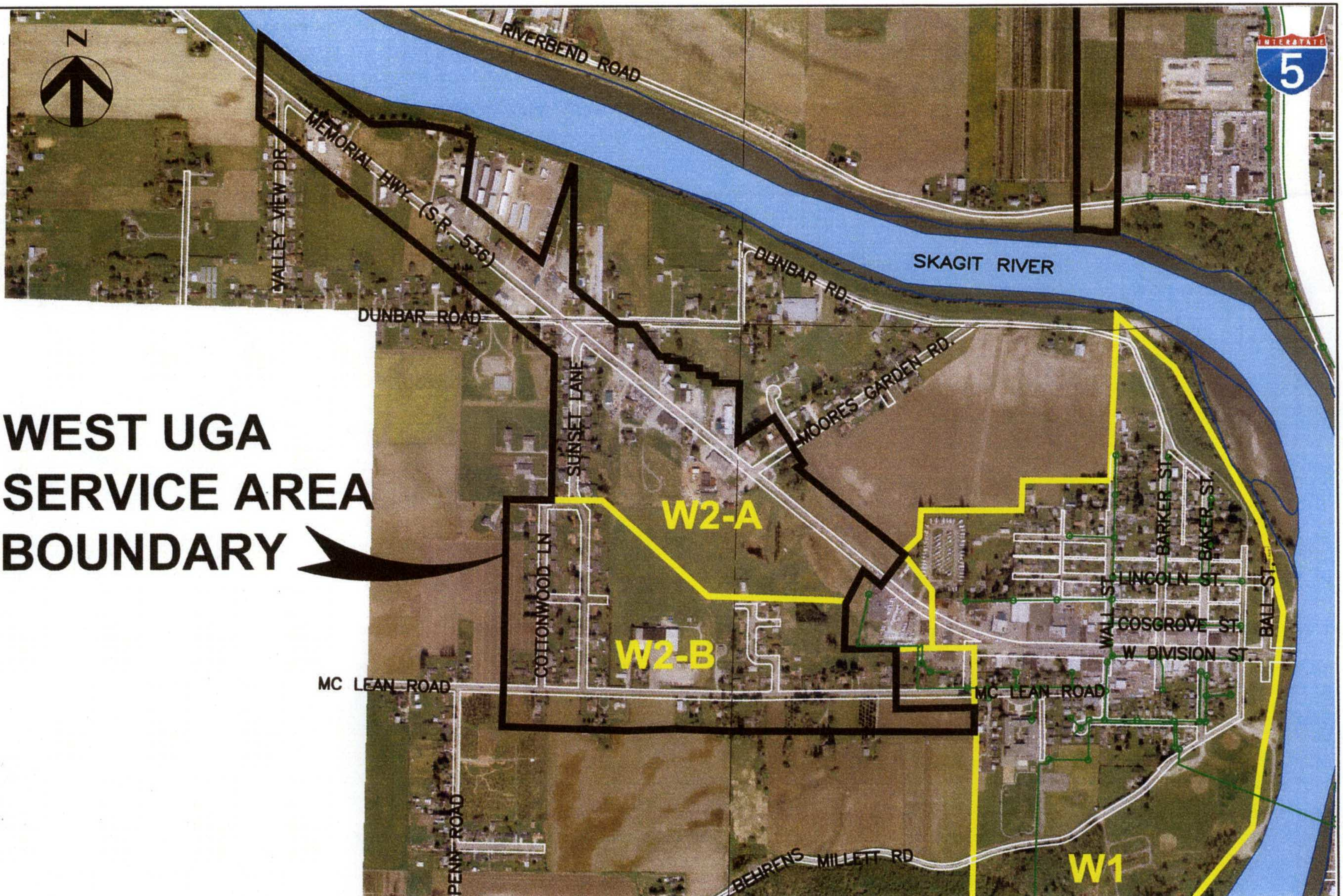
Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA	Figure No.	3
Sheet Title	URBAN GROWTH AREA (UGA) SOUTH SERVICE AREA DRAINAGE BASINS	Date	SEPTEMBER 2003
		Scale	1" = 2000'

MV-UGA-SOUTH-FIG3.dwg 09/12/03 GUNDY



HDR Engineering, Inc.	Project Title: CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA	Figure No. 4
		Date: AUGUST 2003
	Sheet Title: URBAN GROWTH AREA (UGA) DRAINAGE BASINS EAST SERVICE AREA	Scale: 1" = 2000'

MV-UGA-EAST-FIG5A.dwg 08/20/03 BLUMENFELD



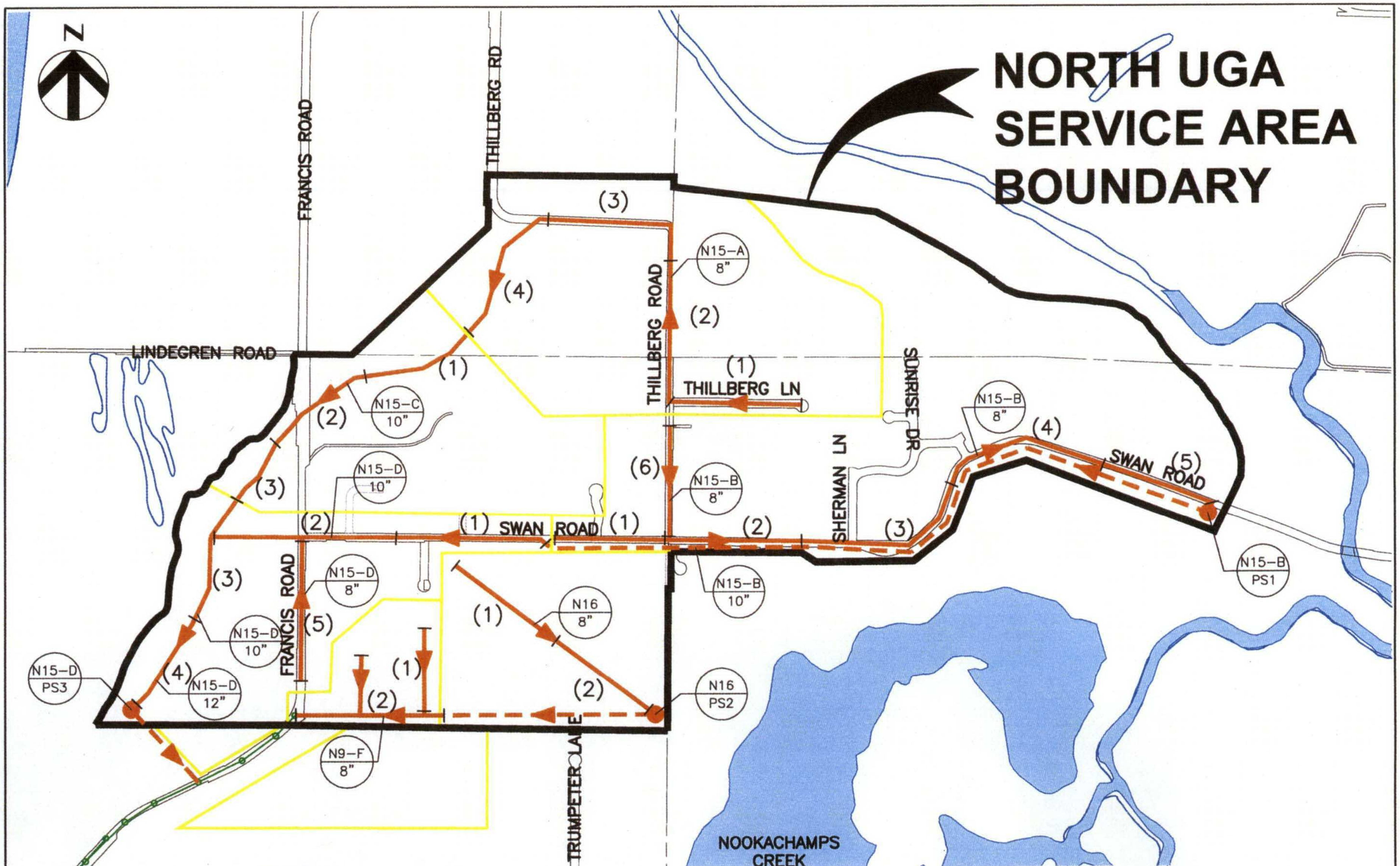
LEGEND

(yellow line)	DRAINAGE BASIN BOUNDARY
(green line)	EXISTING SEWER

HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA	Figure No.	5
Sheet Title	URBAN GROWTH AREA (UGA) WEST SERVICE AREA DRAINAGE BASINS	Date	AUGUST 2003
		Scale	1" = 1000'

MV-UGA-WEST-FIG5.dwg 08/20/03 BLUMENFELD



LEGEND

DRAINAGE BASIN BOUNDARY	PROPOSED PUMP STATION
EXISTING SEWER	DIRECTION OF FLOW
PROPOSED SEWER	
PROPOSED SEWER FORCEMAIN	
DRAINAGE BASIN ID / PIPE SIZE B/W TICKS OR PUMP STA # (N15-D 12")	

HDR Engineering, Inc.

Project Title: CITY OF MOUNT VERNON
SEWER SERVICE STUDY FOR URBAN GROWTH AREA

Sheet Title: URBAN GROWTH AREA (UGA)
NORTH SERVICE AREA
PROPOSED SEWER PLAN

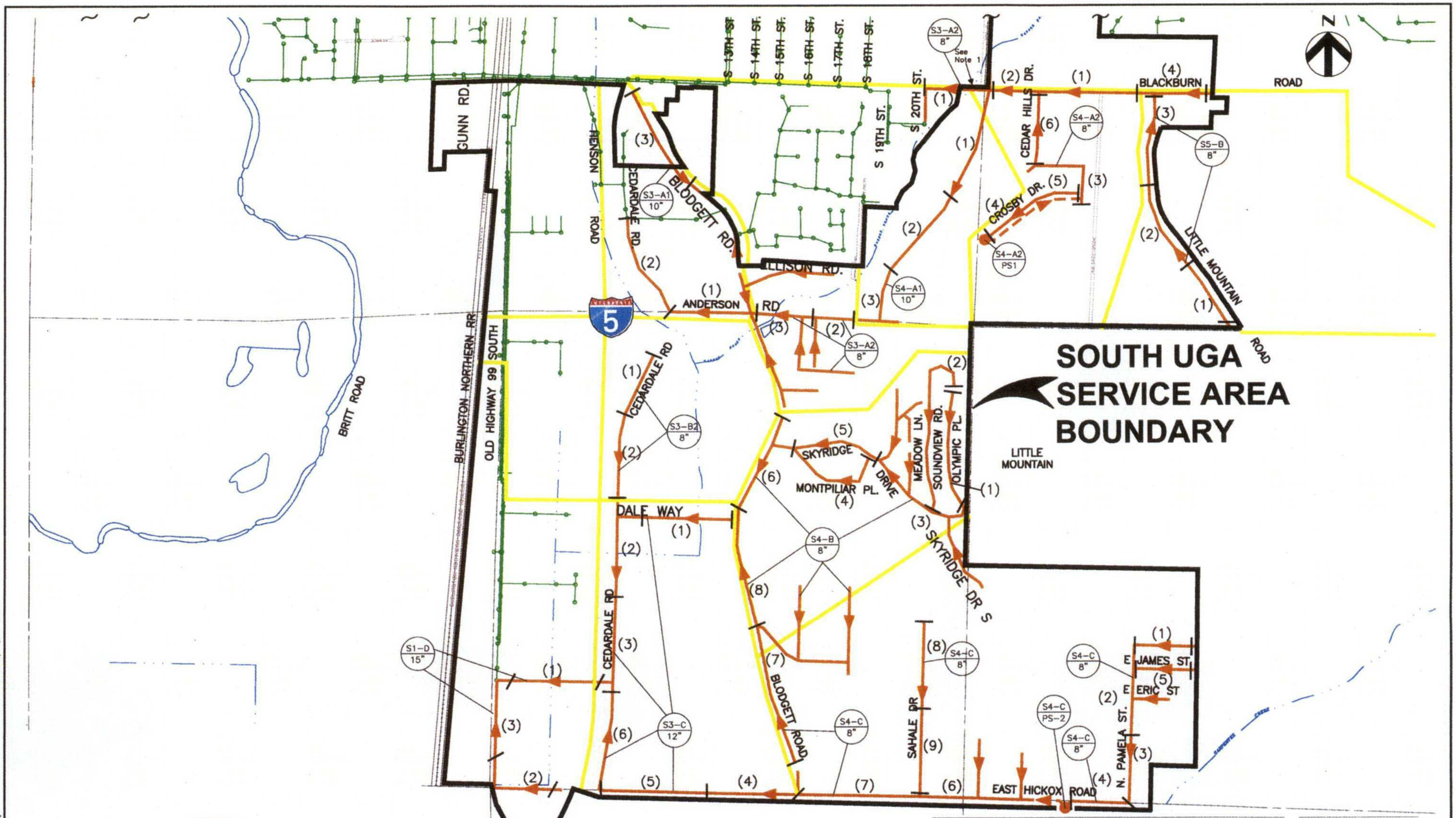
Figure No. 6

Date: AUGUST 2003

Scale: 1" = 1000'

MV-UGA-NORTH-FIG6.dwg 09/08/03 GUNDY

FILENAME: MV-UGA-SOUTH-FIG7.dwg DATE: 09/12/03 GUNDY



LEGEND

- DRAINAGE BASIN BOUNDARY
- EXISTING SEWER
- PROPOSED SEWER
- PROPOSED SEWER FORCEMAIN
- DRAINAGE BASIN ID / PIPE SIZE B/W TICKS OR PUMP STA #
- PUMP STATION
- DIRECTION OF FLOW

NOTES:

1. Sewer service to S4-A2 and S5-B may initially be provided via pipe segment S3-A2(1); however, as flows increase in the future, they will need to be diverted to S4-A1 (1), (2), and (3) to prevent overloading. The City should monitor flows to determine when pipe segments S4-A1 (1), (2), and (3) are required.

HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA
Sheet Title	URBAN GROWTH AREA (UGA) SOUTH SERVICE AREA PROPOSED SEWER PLAN
Figure No.	7
Date	SEPTEMBER 2003
Scale	1" = 1000'

LIST OF APPENDICES

APPENDIX A

Hydraulic Analysis Output of the City of Mount Vernon's Urban Growth Area Wastewater Collection System

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
North UGA																		
Thillberg Trunk																		
N15-A (1)	155.0	153.9	147.0	143.0	9.5	1000	8	0.004	101	0.00	0.00	0.111	0.101	3.20	0.43	0.49	87.59	
N15-A (2)	153.9	112.0	143.0	104.0	9.5	1000	8	0.039		0.11	0.10	0.000	0.000	3.20	0.43	1.54	28.05	
N15-A (3)	112.0	85.0	104.0	77.0	8.0	1000	8	0.027		0.11	0.10	0.000	0.000	3.20	0.43	1.28	33.71	
N15-A (4)	85.0	58.0	77.0	50.0	8.0	1300	8	0.0208		0.11	0.10	0.000	0.000	3.20	0.43	1.13	38.44	
N15-C (1)	58.0	57.3	50.0	46.0	9.7	700	10	0.0057	64	0.11	0.10	0.070	0.064	3.07	0.69	1.07	64.15	
N15-C (2)	57.3	56.4	46.0	42.0	12.9	1000	10	0.004		0.18	0.16	0.000	0.000	3.07	0.69	0.90	76.67	
N15-C (3)	56.4	55.8	42.0	40.0	15.1	600	10	0.0033		0.18	0.16	0.000	0.000	3.07	0.69	0.82	83.99	
Swan Road Trunk																		
N15-B (1)	134.1	122.2	126.1	112	9.1	1100	8	0.0128	130	0.00	0.00	0.143	0.130	3.13	0.55	0.88	62.21	
N15-B (2)	122.2	117.5	112	102	12.9	1100	8	0.0091		0.14	0.13	0.000	0.000	3.13	0.55	0.74	73.87	
N15-B (3)	117.5	90.0	102.0	82.0	11.8	1100	8	0.0182		0.14	0.13	0.000	0.000	3.13	0.55	1.05	52.24	
N15-B (4)	90.0	67.6	82.0	59.6	8.0	1000	8	0.0224		0.14	0.13	0.000	0.000	3.13	0.55	1.17	47.06	
N15-B (5)	67.6	57.2	59.6	49.2	8.0	1000	8	0.0104		0.14	0.13	0.000	0.000	3.13	0.55	0.80	69.07	
N15-B (6)	158.7	122.2	150.7	114.2	8.0	800	8	0.0456	2	0.00	0.00	0.002	0.002	4.22	0.01	1.67	0.64	
N15-D (1)	134.1	122.9	126.1	114.9	8.0	1000	10	0.0112	57	0.14	0.13	0.063	0.057	3.04	0.77	1.50	51.62	
N15-D (2)	122.9	44.0	114.9	36.0	8.0	1250	10	0.0631		0.21	0.19	0.000	0.000	3.04	0.77	3.56	21.74	
N15-D (3)	56.0	43.0	40.0	30.0	14.5	1000	10	0.01		0.21	0.19	0.000	0.000	3.04	0.77	1.42	54.63	
N15-D (4)	43.0	42.0	30.0	26.0	14.5	800	12	0.005		0.21	0.19	0.000	0.000	3.04	0.77	1.63	47.51	
N15-D (5)	130.0	105.0	122.0	97.0	8.0	1000	8	0.025	2	0.00	0.00	0.002	0.002	4.22	0.01	1.23	0.86	
N16 (1)	134.7	118.0	126.7	110.0	8.0	1000	8	0.0167	47	0.00	0.00	0.052	0.047	3.40	0.21	1.01	20.89	
N16 (2)	118.0	70.0	110.0	62.0	8.0	800	8	0.06		0.05	0.05	0.000	0.000	3.40	0.21	1.91	11.02	
N9-F (1)	152.0	150.0	144.0	142.0	8.0	600	8	0.0033	25	0.00	0.00	0.028	0.025	3.56	0.31	0.45	68.75	
N9-F (2)	151.0	130.0	143.0	122.0	8.0	1100	8	0.0191		0.08	0.07	0.000	0.000	3.29	0.32	1.08	29.22	
West UGA																		
Dunbar/Sunset Trunk																		
W2-A (1)	23.7	22.3	15.7	14.3	8.0	1000	8	0.0014	47	0.00	0.00	0.052	0.047	3.40	0.21	0.29	72.14	1/2 of W2-A basin
W2-A (2)	22.3	20.9	14.3	12.9	8.0	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	72.32	
W2-A (3)	20.9	19.5	12.9	11.0	8.3	1000	8	0.0019		0.05	0.05	0.000	0.000	3.40	0.21	0.34	62.08	
W2-A (4)	19.5	19.1	11.0	9.1	9.3	1000	8	0.0019		0.05	0.05	0.000	0.000	3.40	0.21	0.34	62.14	1/2 of W2-A basin
W2-A (5)	19.1	18.7	9.1	7.7	10.5	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	73.54	
W2-A (6)	18.7	18.4	7.7	6.4	11.5	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	73.54	
W2-A (7)	20.7	19.9	12.7	11.4	8.3	1100	8	0.0012	2	0.00	0.00	0.002	0.002	4.22	0.01	0.27	3.96	
Cottonwood/Mc Lean Trunk																		

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
W2-B (1)	20.6	17.4	12.6	9.4	8.0	800	8	0.004	36	0.00	0.00	0.040	0.036	3.47	0.16	0.49	33.28	1/2 of W2-B basin
W2-B (2)	17.4	20.2	9.4	8.2	10.0	800	8	0.0015		0.04	0.04	0.000	0.000	3.47	0.16	0.30	54.34	
W2-B (3)	20.2	21.0	8.2	7.0	13.0	800	8	0.0015		0.04	0.04	0.000	0.000	3.47	0.16	0.30	54.34	
W2-B (4)	21.0	23.4	7.0	5.1	16.2	800	8	0.0024		0.04	0.04	0.000	0.000	3.47	0.16	0.38	43.19	
W2-B (5)	23.4	22.6	5.1	4.6	18.2	800	8	0.0006		0.04	0.04	0.000	0.000	3.47	0.16	0.20	84.19	1/2 of W2-B basin
W2-B (6)	22.6	18.3	4.6	3.3	16.5	500	8	0.0026		0.04	0.04	0.000	0.000	3.47	0.16	0.40	41.28	
W2-B (7)	19.0	23.4	11.0	5.4	13.0	500	8	0.0112	2	0.00	0.00	0.002	0.002	4.22	0.01	0.83	1.29	
South UGA																		
Little Mountain/Blackburn Trunk																		
S5-B (1)	372.9	363.0	364.9	355.0	8.0	1000	10	0.0099	123	0.00	0.00	0.135	0.123	3.15	0.52	1.41	37.07	1/3 of S5-B basin
S5-B (2)	363.0	322.5	355.0	314.5	8.0	1000	10	0.0405		0.14	0.12	0.000	0.000	3.15	0.52	2.85	18.33	2/3 of S5-B basin
S5-B (3)	322.5	260.0	314.5	252.0	8.0	990	10	0.0631		0.14	0.12	0.000	0.000	3.15	0.52	3.56	14.68	
S5-B (4)	310.0	260.0	302.0	252.0	8.0	820	10	0.061		0.14	0.12	0.000	0.000	3.15	0.52	3.50	14.94	
S4-A2 (1)	260.0	194.9	252.0	186.9	8.0	1000	10	0.0651	91	0.14	0.12	0.100	0.091	3.00	1.15	3.61	31.83	
S4-A2 (2)	194.9	175.0	186.9	167.0	8.0	600	10	0.0332		0.24	0.21	0.000	0.000	3.00	0.88	2.58	34.04	
S3-A2 (1)	175.0	146.0	167.0	138.0	8.0	1100	10	0.0264	167	0.24	0.21	0.184	0.167	2.85	1.51	2.30	65.51	exist. SS present
Cedar Hills Dr. Trunk																		
S4-A2 (5)	294.0	265.0	286.0	257.0	8.0	550	8	0.0527	4	0.00	0.00	0.004	0.004	4.04	0.02	1.79	1.15	
S4-A2 (4)	265.0	243.0	257.0	235.0	8.0	600	8	0.0367		0.00	0.00	0.000	0.000	4.04	0.02	1.50	1.37	
S4-A2 (3)	294.0	197.0	286.0	189.0	8.0	950	8	0.1021	4	0.00	0.00	0.004	0.004	4.04	0.02	2.50	0.82	
S4-A2 (6)	197.0	194.9	190.0	186.9	7.5	800	8	0.0039		0.00	0.00	0.000	0.000	4.04	0.02	0.49	4.23	
S4-A1 (1)	155.0	150.0	147.0	137.0	10.5	1000	10	0.01	66	0.24	0.21	0.073	0.066	2.93	1.13	1.42	79.75	
S4-A1 (2)	150.0	125.0	137.0	117.0	10.5	1000	10	0.02		0.31	0.28	0.000	0.000	2.93	1.13	2.00	56.39	
S4-A1 (3)	125.0	113.5	117.0	105.5	8.0	1000	10	0.0115		0.31	0.28	0.000	0.000	2.93	1.13	1.52	74.36	
S3-A2 (2)	113.5	80.0	105.5	72.0	8.0	500	8	0.067	167	0.31	0.28	0.184	0.167	2.81	1.75	2.02	86.47	exist. SS present
S3-A2 (3)	80.0	37.6	72.0	29.6	8.0	650	8	0.0652		0.49	0.45	0.000	0.000	2.81	1.75	1.99	87.63	
Blodgett/Anderson Trunk																		
S3-A1 (1)	37.6	20.0	29.6	12.0	8.0	1200	10	0.0147	67	0.31	0.28	0.074	0.067	2.88	1.38	1.71	80.47	
S3-A1 (2)	20.0	18.0	12.0	-1.0	13.5	1000	10	0.013		0.38	0.35	0.000	0.000	2.88	1.38	1.61	85.47	
S3-A1 (3)	65.3	30.0	57.3	22.0	8.0	1700	10	0.0208	2	0.00	0.00	0.002	0.002	4.22	0.01	2.04	0.52	
Cedardale Rd Trunk																		
S3-B2 (1)	21.0	18.0	13.0	10.0	8.0	800	8	0.0038	84	0.00	0.00	0.092	0.084	3.25	0.36	0.48	75.89	
S3-B2 (2)	18.0	16.0	10.0	7.0	8.5	900	8	0.0033		0.09	0.08	0.000	0.000	3.25	0.36	0.45	80.50	
Montpilar/Skyridge Trunk																		
S4-B (1)	340.0	300.0	332.0	292.0	8.0	1400	8	0.0286	124	0.00	0.00	0.136	0.124	3.14	0.52	1.32	39.73	
S4-B (3)	300.0	200.0	292.0	192.0	8.0	1000	8	0.1		0.14	0.12	0.000	0.000	3.14	0.52	2.47	21.24	
S4-B (4)	173.0	96.0	165.0	88.0	8.0	1200	8	0.0642		0.14	0.12	0.000	0.000	3.14	0.52	1.98	26.51	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
S4-B (5)	173.0	96.0	165.0	88.0	8.0	1100	8	0.07		0.14	0.12	0.000	0.000	3.14	0.52	2.07	25.38	
S4-B (6)	82.0	38.0	74.0	30.0	8.0	1200	8	0.0367		0.14	0.12	0.000	0.000	3.14	0.52	1.50	35.07	
S4-B (7)	50.0	38.3	42.0	30.3	8.0	1500	8	0.0078		0.14	0.12	0.000	0.000	3.14	0.52	0.69	76.04	
S4-B (8)	38.3	38.0	30.3	22.0	12.0	1300	8	0.0064		0.14	0.12	0.000	0.000	3.14	0.52	0.62	84.05	
S4-B (2)	290.0	245.0	282.0	237.0	8.0	1800	8	0.025	2	0.00	0.00	0.002	0.002	4.22	0.01	1.23	0.86	
East Hickox Road/PamelaTrunk																		
S4-C (1)	275.0	225.0	267.0	217.0	8.0	700	8	0.0714	136	0.00	0.00	0.150	0.136	3.12	0.57	2.09	27.49	1/2 of S4-C basin
S4-C (2)	225.0	115.0	217.0	107.0	8.0	1000	8	0.11		0.15	0.14	0.000	0.000	3.12	0.57	2.59	22.16	
S4-C (3)	115.0	65.0	107.0	57.0	8.0	1000	8	0.05		0.15	0.14	0.000	0.000	3.12	0.57	1.75	32.86	
S4-C (4)	65.0	58.0	57.0	50.0	8.0	550	8	0.0127		0.15	0.14	0.000	0.000	3.12	0.57	0.88	65.13	
S4-C (5)	220.0	176.0	212.0	168.0	8.0	700	8	0.0629	1	0.00	0.00	0.001	0.001	4.40	0.01	1.96	0.28	
S4-C (6)	58.0	65.0	50.0	41.0	16.0	1250	8	0.0072	137	0.00	0.00	0.151	0.137	3.12	0.58	0.66	87.20	1/2 of S4-C basin
S4-C (7)	70.0	30.0	41.0	22.0	18.5	1350	8	0.0141		0.15	0.14	0.000	0.000	3.12	0.57	0.93	61.94	
Sahale Drive																		
S4-C (8)	190.0	150.0	182.0	142.0	8.0	950	8	0.0421	2	0.00	0.00	0.002	0.002	4.22	0.01	1.60	0.66	
S4-C (9)	150.0	70.0	142.0	62.0	8.0	950	8	0.0842		0.00	0.00	0.000	0.000	4.22	0.01	2.27	0.47	
Cedardale/Dale Way Trunk																		
S3-C (1)	38.0	16.0	22.0	8.0	12.0	1300	12	0.0108	93	0.23	0.21	0.102	0.093	2.91	1.20	2.39	50.35	2/3 of S3-C basin
S3-C (2)	16.0	14.7	8.0	0.7	11.0	1000	12	0.0073		0.33	0.30	0.000	0.000	2.91	1.20	1.97	61.15	
S3-C (3)	14.7	12.0	0.7	-6.0	16.0	900	12	0.0074		0.33	0.30	0.000	0.000	2.91	1.20	1.99	60.56	
S3-C (4)	30.0	17.0	22.0	9.0	8.0	1000	10	0.013	93	0.15	0.14	0.102	0.093	2.98	0.94	1.61	57.93	1/3 of S3-C basin
S3-C (5)	17.0	13.5	9.0	3.5	9.0	1200	12	0.0046		0.25	0.23	0.000	0.000	2.98	0.94	1.56	59.99	
S3-C (6)	13.5	12.0	3.9	-6.0	13.8	1100	12	0.009		0.25	0.23	0.000	0.000	2.98	0.94	2.18	42.81	
S1-D (1)	12.0		4.0	-8.0	8.0	1100	15	0.005	141	0.48	0.44	0.155	0.141	2.74	2.22	2.95	75.05	no contour data
S1-D (2)					8.0	800	10	0.005	141	0.00	0.00	0.155	0.141	3.11	0.59	1.00	59.29	no contour data
S1-D (3)					8.0	1150	10	0.005		0.16	0.14	0.000	0.000	3.11	0.59	1.00	59.29	no contour data
East UGA																		
E-13	500.0	494.0	492.0	484.0	9.0	4500	8	0.0018	65	0.00	0.00	0.071	0.065	3.31	0.28	0.33	86.46	
Andal Road Trunk																		
E-11 (1)	496.0	476.0	484.0	458.0	15.0	3000	8	0.0087	90	0.07	0.06	0.099	0.090	3.09	0.65	0.73	88.96	
E-11 (2)	541.0	484.0	533.0	476.0	8.0	2300	8	0.0248		0.10	0.09	0.000	0.000	3.23	0.39	1.23	31.68	
E-15	484.0	350.0	476.0	342.0	8.0	2500	8	0.0536	40	0.17	0.15	0.044	0.040	3.03	0.80	1.81	44.39	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
E-12	484.0	400.0	476.0	392.0	8.0	3000	8	0.028	104	0.00	0.00	0.114	0.104	3.19	0.45	1.31	34.14	
Mountain View Road Trunk																		
E-14(1)	483.0	231.0	475.0	223.0	8.0	2000	8	0.126	86	0.00	0.00	0.095	0.086	3.24	0.37	2.77	13.46	
E-14(2)	231.0	100.0	223.0	92.0	8.0	2200	8	0.0595		0.21	0.19	0.000	0.000	3.03	0.79	1.91	41.20	
State Highway 9 Trunk																		
E-8 (2)	337.0	112.0	329.0	104.0	8.0	1900	8	0.1184	176	0.21	0.19	0.194	0.176	2.86	1.47	2.69	54.57	
E-8 (3)	112.0	100.0	104.0	92.0	8.0	4800	15	0.0025		0.41	0.37	0.000	0.000	2.86	1.47	2.09	70.26	
E-8 (1)	145.0	112.0	137.0	104.0	8.0	2300	10	0.0143	2	0	0.00	0.002	0.002	4.22	0.22	1.70	13.24	
E-8 (4)	163.9	158.0	155.9	140.0	13.0	2000	15	0.008		0.62	0.56	0.000	0.000	2.86	2.22	3.72	59.61	
Burlingame Road / Big Lake Road Trunk																		
E-3 (1)	391.0	393.0	383.0	381.0	10.0	1200	8	0.0017	42	0.00	0.00	0.046	0.042	3.43	0.19	0.32	59.62	
E-3 (2)	393.0	395.0	385.0	383.0	10.0	1200	8	0.0017		0.05	0.04	0.000	0.000	3.43	0.19	0.32	59.62	
E-1 (1)	395.0	317.7	383.0	307.0	11.3	1000	8	0.076	209	0.05	0.04	0.230	0.209	2.96	1.02	2.15	47.33	
E-1 (2)	317.7	240.3	307.0	231.0	10.0	1000	8	0.076		0.28	0.25	0.000	0.000	2.96	1.02	2.15	47.33	
E-1 (3)	240.3	163.0	231.0	155.0	8.7	1000	8	0.076		0.28	0.25	0.000	0.000	2.96	1.02	2.15	47.33	
E-6	391.0	355.0	383.0	347.0	8.0	1100	8	0.0327	28	0.00	0.00	0.031	0.028	3.53	0.13	1.41	9.18	
Kato Lane/Mountainview Road Trunk																		
E-9 (1)	522.0	500.0	514.0	492.0	8.0	1000	8	0.022	140	0.00	0.00	0.154	0.140	3.11	0.59	1.16	50.91	
E-9 (2)	500.0	340.0	492.0	332.0	8.0	1250	8	0.128		0.15	0.14	0.000	0.000	3.11	0.59	2.79	21.10	
E-9 (3)	340.0	230.0	332.0	222.0	8.0	1250	8	0.088		0.15	0.14	0.000	0.000	3.11	0.59	2.32	25.45	
E-7	235.0	207.0	227.0	199.0	8.0	800	8	0.035	63	0.15	0.14	0.069	0.063	3.02	0.84	1.46	57.18	
E-4 (1)	305.0	207.0	297.0	199.0	8.0	1200	8	0.0817	30	0.00	0.00	0.033	0.030	3.51	0.14	2.23	6.20	1/3 of E-4 basin
E-4 (2)	207.0	195.0	199.0	172.5	15.3	1100	8	0.0241	60	0.22	0.20	0.066	0.060	2.95	1.06	1.21	87.82	2/3 of E-4 basin
E-4 (3)	195.0	150.0	172.5	142.0	15.3	1000	8	0.0305		0.29	0.26	0.000	0.000	2.95	1.06	1.36	78.05	
E-4 (4)	150.0	158.0	142.0	139.0	13.5	1100	12	0.0027		0.29	0.26	0.000	0.000	2.95	1.06	1.20	88.53	
State Highway 9 Trunk, cont'd																		
E-1 (4)	163.0	117.0	146.0	109.0	12.5	2300	15	0.0161		0.89	0.56	0.000	0.000	2.75	2.43	5.30	45.97	
E-1 (5)	117.0	100.0	109.0	85.0	11.5	3600	15	0.0067		0.89	0.56	0.000	0.000	2.75	2.43	3.41	71.42	
N10-C (1)	100.0	43.0	85.0	22.0	18.0	4000	15	0.0158	37	1.19	1.08	0.041	0.037	2.57	4.11	5.24	78.43	
E-2	382.0	379.0	374.0	371.0	8.0	1500	8	0.002	35	0.00	0.00	0.039	0.035	3.47	0.16	0.35	45.83	
N10-H	379.0	360.0	371.0	352.0	8.0	1750	8	0.0109	55	0.04	0.04	0.061	0.055	3.23	0.39	0.81	47.86	
N10-E	360.0	300.0	352.0	292.0	8.0	1000	8	0.06	44	0.099	0.090	0.048	0.044	3.12	0.57	1.91	29.58	
N10-C (2)	300.0	100.0	292.0	92.0	8.0	1400	8	0.1429	37	0.14	0.04	0.041	0.037	3.29	0.41	2.95	14.05	
E-5 (1)	394.0	391.3	386.0	383.3	8.0	1000	8	0.0027	57	0.00	0.00	0.063	0.057	3.35	0.25	0.41	62.45	
E-5 (2)	391.3	388.6	383.3	380.6	8.0	1000	8	0.0027		0.06	0.06	0.000	0.000	3.35	0.25	0.41	62.45	
E-5 (3)	388.6	385.9	380.6	377.9	8.0	1000	8	0.0027		0.06	0.06	0.000	0.000	3.35	0.25	0.41	62.45	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
E-10		2.7							78	0.00	0.00	0.086	0.078					no individual collector pipe

APPENDIX B

Example of TABULA Cost Output and Additional Information

Cost Calculations for Pipe: **8" - 8' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 8 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	9.88 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,330	CY	10.00	13,300
Backfill	943	CY	5.00	4,720
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	19,750	SF	0.50	9,880
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	143,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	177,000

Total: $177,000

Cost Calculations for Pipe: **8" - 10' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 10 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	11.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,600	CY	10.00	16,000
Backfill	1,213	CY	5.00	6,060
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	23,750	SF	0.50	11,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	149,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	185,000

Total: $185,000

Cost Calculations for Pipe: **8" - 12' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 12 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	13.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,869	CY	10.00	18,700
Backfill	1,482	CY	5.00	7,410
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	27,750	SF	0.50	13,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	155,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	192,000

Total: $192,000

Cost Calculations for Pipe: **8" - 15' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 15 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	16.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	2,273	CY	10.00	22,700
Backfill	1,886	CY	5.00	9,430
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	33,750	SF	0.50	16,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,750.00	7,500
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	166,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	205,000

Total: $205,000

Appendix B – Example of TABULA Cost Output and Additional Information

The preceding examples are for 8-inch sewer pipe at different depths.

For additional information or to download the TABULA software, go to http://www.bugbytes.com/tabula/.

APPENDIX C

UGA Cost Estimates

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost [1]	Taxes (8.8%)	Contingency [2] (40%)	Engineering and Administration Costs [3] (25%)	Project Cost [4]
North UGA										
N15-A (1)	9.5	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	**$ 360,000**
N15-A (2)	9.5	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	**$ 360,000**
N15-A (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N15-A (4)	8.0	1300	8	LF	$ 177	$ 230,100	$ 20,249	$ 100,140	$ 87,622	**$ 440,000**
N15-C (1)	9.7	700	10	LF	$ 195	$ 136,500	$ 12,012	$ 59,405	$ 51,979	**$ 260,000**
N15-C (2)	12.9	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
N15-C (3)	15.1	600	10	LF	$ 216	$ 129,600	$ 11,405	$ 56,402	$ 49,352	**$ 250,000**
N15-B (1)	9.1	1100	8	LF	$ 185	$ 203,500	$ 17,908	$ 88,563	$ 77,493	**$ 390,000**
N15-B (2)	12.9	1100	8	LF	$ 192	$ 211,200	$ 18,586	$ 91,914	$ 80,425	**$ 410,000**
N15-B (3)	11.8	1100	8	LF	$ 192	$ 211,200	$ 18,586	$ 91,914	$ 80,425	**$ 410,000**
N15-B (4)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N15-B (5)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N15-B (6)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
N15-D (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
N15-D (2)	8.0	1250	10	LF	$ 187	$ 233,750	$ 20,570	$ 101,728	$ 89,012	**$ 450,000**
N15-D (3)	14.5	1000	10	LF	$ 216	$ 216,000	$ 19,008	$ 94,003	$ 82,253	**$ 420,000**
N15-D (4)	14.5	800	12	LF	$ 238	$ 190,400	$ 16,755	$ 82,862	$ 72,504	**$ 370,000**
N15-D (5)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N16 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
N16 (2)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
N9-F (1)	8.0	600	8	LF	$ 177	$ 106,200	$ 9,346	$ 46,218	$ 40,441	**$ 210,000**
N9-F (2)	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	**$ 380,000**
PS 1/N15-B & 3,400 lf FM		390		GPM	$ 2,100	$ 819,000	$ 72,072	$ 356,429	$ 311,875	**$ 1,560,000**
PS 2/N16 & 1,600 lf FM		150		GPM	$ 4,000	$ 600,000	$ 52,800	$ 261,120	$ 228,480	**$ 1,150,000**
PS 3/N15-D & 600 lf FM		875		GPM	$ 700	$ 612,500	$ 53,900	$ 266,560	$ 233,240	**$ 1,170,000**
						$ 6,030,000				**$ 11,580,000**

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
South UGA										
S5-B (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S5-B (2)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S5-B (3)	8.0	990	10	LF	$ 187	$ 185,130	$ 16,291	$ 80,569	$ 70,498	**$ 360,000**
S5-B (4)	8.0	820	10	LF	$ 187	$ 153,340	$ 13,494	$ 66,734	$ 58,392	**$ 300,000**
S4-A2 (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S4-A2 (2)	8.0	600	10	LF	$ 187	$ 112,200	$ 9,874	$ 48,829	$ 42,726	**$ 220,000**
S4-A2 (3)	7.5	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
S4-A2 (4)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S4-A2 (5)	8.0	550	8	LF	$ 177	$ 97,350	$ 8,567	$ 42,367	$ 37,071	**$ 190,000**
S4-A2 (6)	8.0	600	8	LF	$ 177	$ 106,200	$ 9,346	$ 46,218	$ 40,441	**$ 210,000**
S3-A2 (1)	8.0	1100	10	LF	$ 187	$ 205,700	$ 18,102	$ 89,521	$ 78,331	**$ 400,000**
S4-A1 (1)	10.5	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S4-A1 (2)	10.5	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S4-A1 (3)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S3-A2 (2)	8.0	500	8	LF	$ 177	$ 88,500	$ 7,788	$ 38,515	$ 33,701	**$ 170,000**
S3-A2 (3)	8.0	650	8	LF	$ 177	$ 115,050	$ 10,124	$ 50,070	$ 43,811	**$ 220,000**
S3-A1 (1)	8.0	1200	10	LF	$ 187	$ 224,400	$ 19,747	$ 97,659	$ 85,452	**$ 430,000**
S3-A1 (2)	13.5	1000	10	LF	$ 216	$ 216,000	$ 19,008	$ 94,003	$ 82,253	**$ 420,000**
S3-A1 (3)	8.0	1700	10	LF	$ 187	$ 317,900	$ 27,975	$ 138,350	$ 121,056	**$ 610,000**
S3-B2 (1)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
S3-B2 (2)	8.5	900	8	LF	$ 185	$ 166,500	$ 14,652	$ 72,461	$ 63,403	**$ 320,000**
S4-B (1)	8.0	1400	8	LF	$ 177	$ 247,800	$ 21,806	$ 107,843	$ 94,362	**$ 480,000**
S4-B (2)	8.0	1800	8	LF	$ 177	$ 318,600	$ 28,037	$ 138,655	$ 121,323	**$ 610,000**
S4-B (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-B (4)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	**$ 410,000**
S4-B (5)	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	**$ 380,000**
S4-B (6)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	**$ 410,000**

City of Mount Vernon

Urban Growth Area Sewer Service Study

October 2003

Prepared by:

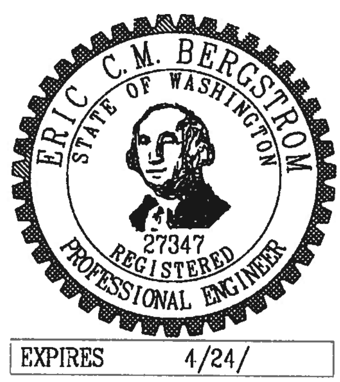
HDR

CERTIFICATION PAGE

FOR

City of Mount Vernon
Urban Growth Area Sewer Service Study
Project No. 000 000 000 005237 002

The engineering material and data contained in this Report were prepared under the supervision and direction of the undersigned, whole seal as registered professional engineer is affixed below.



Eric C.M. Bergstrom
Supervising Engineer

City of Mount Vernon

Urban Growth Area Sewer Service Study
Technical Memorandum

Date: October 15, 2003

To: Walt Enquist, Fred Buckenmeyer

From: Eric Bergstrom

Subject: Urban Growth Area Sewer Service Study

INTRODUCTION AND OBJECTIVE

The City is required to establish a plan to provide sewer service to properties within the Urban Growth Area (UGA). This study identifies at a planning level the facilities that would be required to provide sewer service to four major areas within the UGA. These UGA areas are situated to the north, south, east and west of City limits and as illustrated in Figure 1. The areas vary in size from 175 to 1,400 acres.

DRAINAGE BASIN DELINEATION

Each of the UGA service areas shown in Figure 1 was divided into a number of drainage basins. The drainage basins were delineated based on contour and mapping data provided by City of Mt. Vernon geographical information system (GIS) as well as some field reconnaissance. Figures 2, 3, 4, and 5 show the approximate drainage basin boundaries within north, south, east and west UGAs, respectively. Each drainage basin is designated an ID such as E-12, which serves to clarify new sewer locations. The first letter of basin ID refers to a specific UGA, i.e. S for south etc. The basin ID's follow a format set forth in the *City of Mount Vernon Comprehensive Sewer Plan Update*, February 2003.

DESIGN FLOWS

Design flows from each of the drainage basins were estimated based on an assumed population density of 2.5 persons per house and a house density of 4 houses per acre. Average daily flow per capita was assumed to be 100 gallons. Consistent with Comprehensive Sewer Plan, a peaking factor was applied to predict peak daily sanitary flow. The peaking factor for the sanitary flows at any point in the system is based on the following equation:

$$PF = -0.6 \log Q + 2.6$$

where,
PF peaking factor
Q average sanitary flow in million gallons per day (mgd)

Inflow and infiltration (I&I), is independent of sanitary flow and is assumed to be 1,100 gallons per acre per day (gpda). The sanitary sewer peaking factor is not applied to the allowance for I&I.

Table 1 summarizes the drainage basins and calculated average and peak flow for each basin.

Table 1
Drainage Basins Flows

Drainage Basin ID[(1)]	Basin Area (acres)	Estimated Population[(2)]	Average Sanitary Flow (gpm)	Peaking Factor	Inflow and Infiltration (gpm)	Peak Design Flow (gpm)
North UGA						
N11-T	26	260	18	3.6	20	84
N15-A	101	1007	70	3.2	77	300
N15-B	132	1320	92	3.1	101	388
N15-C	64	640	44	3.3	49	196
N15-D	59	590	41	3.3	45	182
N16	47	469	33	3.4	36	146
N9-F	25	249	17	3.6	19	80
South UGA						
S1-D	141	1407	98	3.1	107	411
S3-A1	69	689	48	3.3	53	211
S3-A2	167	1672	116	3.1	128	484
S3-B2	84	835	58	3.2	64	252
S3-C	139	1389	96	3.1	106	407
S4-A1	66	661	46	3.3	50	202
S4-A2	99	988	69	3.2	75	295
S4-B	124	1236	86	3.1	94	364
S4-C	274	2737	190	2.9	209	767
S5-B	185	1854	129	3.0	142	533
East UGA						
E-1	209	2088	145	3.0	160	596
E-10	172	1718	119	3.1	131	496
E-11	90	896	62	3.2	68	269
E-12	104	1044	73	3.2	80	311
E-13	129	1286	89	3.1	98	378
E-14	86	861	60	3.2	66	259
E-15	40	400	28	3.4	31	126
E-2	35	347	24	3.5	27	110
E-3	42	416	29	3.4	32	131
E-4	90	903	63	3.2	69	271
E-5	57	575	40	3.3	44	177
E-6	28	285	20	3.5	22	92
E-7	63	633	44	3.3	48	194
E-8	178	1782	124	3.0	136	513
E-9	140	1400	97	3.1	107	410
N10-C	37	375	26	3.5	29	119
N10-E	44	439	30	3.4	34	138
N10-H	55	548	38	3.4	42	169
West UGA						
W1	178	1781	124	3.0	136	513
W2-A	98	977	68	3.2	75	292
W2-B	75	751	52	3.3	57	228

(1) See Figures 2 through 5 for drainage basin designations in each UGA.
(2) Saturated development.

SEWER LAYOUT AND SIZING

Figures 6, 7, 8, and 9 illustrate proposed sewer locations within the UGAs. Where possible, proposed sewers were located in existing right-of-ways. In several locations proposed sewers are shown outside of right-of-way boundaries where these routes provide a more cost effective alignment. Some sewers are shown outside the boundary of the East UGA in order maximize the natural drainage of the area. For this study it was assumed that the sewers outside the UGA boundaries are strictly for conveyance and there are no service connections along the alignment. The piping shown on the figures only includes trunk sewers and interceptors. Small collector sewers that would serve individual properties generally have not been identified.

After proposed alignment of interceptors and major trunk lines was established, grade elevations at approximately 1,000-foot intervals were established based on City's contour mapping. For the purposes of this study it was assumed that the minimum pipe depth to the invert would be 8 feet below grade. In some cases, in order to provide greater slope to improve the flow, greater depths of pipe were assumed. The hydraulic analysis of proposed sewers was completed based on fully developed UGAs for each individual drainage basin. In the model the flows from the drainage basin or portions of the drainage basin are routed into the upstream end of pipe segments.

PROPOSED IMPROVEMENTS

Based on the UGA evaluation proposed sewer improvements were identified. Table 2 summarizes the improvements proposed for each UGA. For detailed list of improvements refer to Appendix A. Figures 6 through 9 illustrate the location of the sewers, forcemains and pump stations and show sewer sizing within each basin.

Table 2
Summary of Proposed Improvements for all UGAs

UGA	Sewer (linear feet)	Pump Stations (ea)	Force Main (linear feet)
North	22,000	3	5,000
South	45,000	2	2,000
East	53,000	1	5,000
West	12,000	1	800

Improvement S3-A2 (1) extends sewer service to intercept flows from basin S4-A2. Initially, sewer service in this basin can be served through SE-A2 (1). Ultimately, as the basin development proceeds, sewer flows will need to be routed down the proposed interceptor on the south side of Maddox Creek and includes sewer segments S4-A1 (1), (2), and (3) so that the sewers on South 19th Street do not become overloaded. The City should monitor flows in the sewer to determine when sewer segments S4-A1 (1), (2), and (3) are required.

Pump station S4-A2 PS1 has been identified at the end of Crosby Drive because the grade to the west may be excessive for a gravity sewer. It may be feasible to extend a gravity sewer to the west and connect to proposed sewer segments S4-A1 (1), (2), and (3) and the City should evaluate the potential for extending gravity service to Crosby Drive as development proceeds.

COST ESTIMATES

Construction Costs

Construction costs for the facilities required to provide sewer service to the Urban Growth Areas were based on cost established in the Comprehensive Sewer Plan Update as well as King County's cost estimating software TABULA. TABULA is a free software developed to estimate costs for sewer projects in the King County area. Use of TABULA allows for cost analysis that is always consistent. The costs can be adjusted to present day values using the ENR cost indexes and/or escalated to future years by using an annual projected inflation multiplier. The inflation multiplier can be defined in the program as any chosen percentage, however, 3 percent is commonly used. An effective 1.13 multiplier was used in the analysis to account for increase in construction cost from 1999 to the end of 2003.

For an example of TABULA's assumptions and item cost breakdown see Appendix B. Note that all assumptions can be defined within the program to better suit a specific project. Table 3 lists costs of pipe, at varying depths, based on TABULA. See Appendix C, column 7, for construction costs for major items associated with each UGA. Costs listed in Table 5 are also construction costs.

The construction costs include excavation and native backfill based on depth and pipe size, standard trench safety, backfill and pipe zone fill, manholes at average spacing of 500 feet, protecting/relocating average complexity utilities, minimal dewatering, traffic control for light traffic conditions, complete pavement restoration for width of trench, and mobilization/demobilization (10 percent of total). These particular costs do not include land acquisition or easements as these elements are difficult to define at the planning stages of design.

Table 3
Construction Cost Estimate Summary Table

Sewer Depth (ft)	Construction Cost per Liner Foot of Sewer								
	8-inch	10-inch	12-inch	15-inch	18-inch	24-inch	27-inch	30-inch	36-inch
8	$177	$187	$207	$237	$258	$316	$341	$385	$452
10	$185	$195	$215	$246	$267	$327	$351	$396	$465
12	$192	$203	$223	$255	$276	$337	$362	$408	$477
15	$205	$216	$238	$270	$292	$355	$381	$429	$500

Notes:
1) Costs are for year 2003.
2) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting/relocating existing utilities, dewatering, and traffic control.

The costs listed in Table 3 do not include taxes, construction contingency, or engineering and administration costs, which are briefly described below.

Contingency

The construction contingency is an allowance for additional costs not identified in the planning phase. Generally, these costs are not identified because they are unknown at the planning stages of the project. The contingency costs may include complex utility crossings, unique soil conditions, traffic control for heavy traffic conditions, land acquisition, easements, and other unidentified costs. See Appendix C, column 9, for contingency costs on construction costs for major items associated with each UGA.

Engineering and Administration

Engineering and administration costs include engineering and design, permitting process and fees, and City construction management costs. See Appendix C, column 10, for engineering and administration costs on construction costs for major items associated with each UGA.

Project Cost

Project costs include construction costs with an escalation for the following items:

- Sales Tax – 8.8 percent
- Contingency – 40 percent
- Engineering and Administration – 25 percent.

The major construction items and respective costs associated with each UGA are presented in Appendix C. See column 11 of Appendix C, for project costs on construction costs for major items associated with each UGA. Note that Figures 6 through 9 identify individual pipe segments, which are listed in Appendix C. The approximate construction and project costs estimated for each of the UGAs are summarized in Table 4. They include gravity and forcemain piping costs as well as pump station costs.

Table 4
Approximate UGA Construction and Project Costs

Urban Growth Area	Construction Cost (1) (2003)	Project Cost (2) (2003)
North	$6,030,000	$11,580,000
South	$10,510,000	$20,230,000
East	$15,720,000	$30,110,000
East (+ 1,200 ac) (3)	$8,540,000	$16,270,000
East (+ 5,600 ac) (3)	$12,840,000	$24,450,000
West	$2,820,000	$5,440,000

Notes:
(1) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting & relocating existing utilities, dewatering, and traffic control.
(2) Project costs include sales tax, contingency (unidentified item, such as complex utilities, soil conditions, traffic control, land acquisition, easements, etc.), and engineering and administration costs (engineering and design, permitting, management, etc.).
(3) The expended East service area is described in the proceeding section. Costs for additional 1,200 and 5,600 acres assumes PS1-E, E-8 (4), E-1(4), E-1(5), and N10-C(1) improvements only.

EXPANDED EAST SERVICE AREA

There is potential that sewer service may be provided east of the UGA. The impacts of this service on the sewer sizing within the City was evaluated for different size drainage areas to the east. Table 5 summarizes the impact on the existing sewers within the City along with the sizing of new facilities identified within this study.

Table 5
Expanded Service Area Impacts on Sewer Sizing

Improvement	Sewer Length (linear feet)	Assumed Slope (ft/ft)	Urban Growth Area Service			1,200 Additional Acres			5,600 Additional Acres		
			Design Flows (mgd)	Pipe Size (in)	Construction Cost [4] (million dollars)	Design Flows (mgd)	Pipe Size (in)	Construction Cost (million dollars)	Design Flows (mgd)	Pipe Size (in)	Construction Cost (million dollars)
PS1 - E	--	--	2.5	--	$2.74 [1]	6.6	--	$4.50 [1]	20.1	--	$7.01 [1]
Forcemain	4,300	--	2.5	12	--	6.6	24[5]	--	20.1	36[5]	--
E-8 (4)	2,000	0.008	2.5	15	$0.51	6.6	24	$0.67	20.1	36	$0.95
E-1 (4)	2,300	0.016	2.7	15	$0.59	7.3	24	$0.78	20.9	36	$1.10
E-1 (5)	3,600	0.007	2.7	15	$0.92	7.3	24	$1.21	20.9	36	$1.72
N10-C (1)	4,000	0.016	4.7	15	$1.08	8.3	24	$1.38	21.8	36	$2.06
East College Way Pump Station	--	--	9.6	--		13.3	--		24.4	--	
East College Way Pump Station Forcemain	6,300	--	9.6 [2]	24		13.3	30		24.4	36	
Kulshan Interceptor	6,860	0.006	18.9 [2]	24 & 30 [3]	--	22.5	30		35.1	36	

Notes:
(1) Cost Includes FM.
(2) Existing flows plus East UGA flows.
(3) Existing piping at capacity is approximately 18 mgd.
(4) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting/relocating existing utilities, dewatering, and traffic control.
(5) Multiple forcemains could be constructed with this effective pipe size diameter.

Note that costs listed Table 5 are construction costs only. See Appendix B for cost escalations to arrive at project costs.

LIST OF APPENDICES

Appendix A – Hydraulic Analysis Output of the City of Mount Vernon's Urban Growth Area Wastewater Collection System

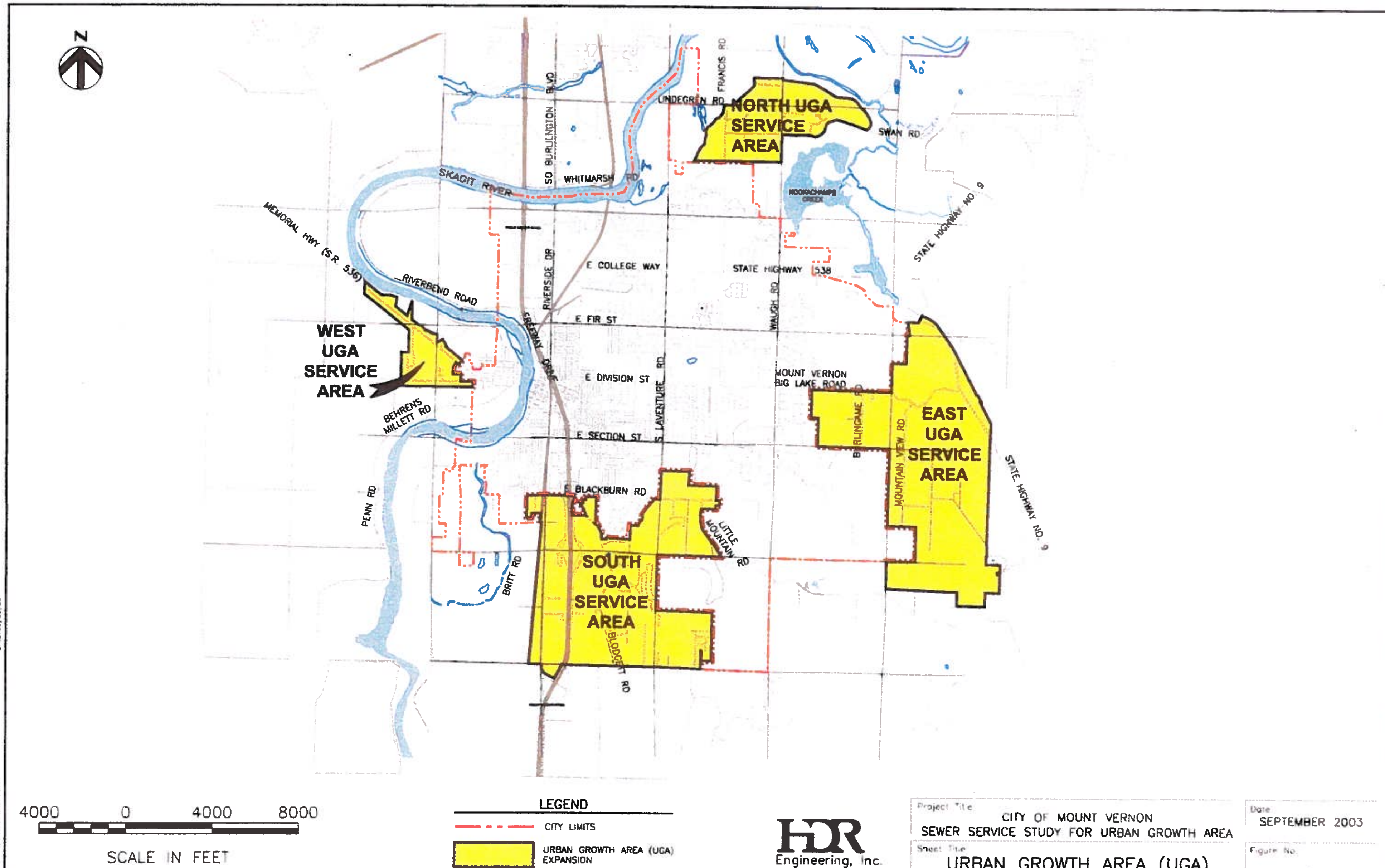
Appendix B – Example of TABULA Cost Output and Additional Information

Appendix C – UGA Cost Estimates

Appendix D – Related Documents

APPENDIX A

Hydraulic Analysis Output of the City of Mount Vernon's Urban Growth Area Wastewater Collection System



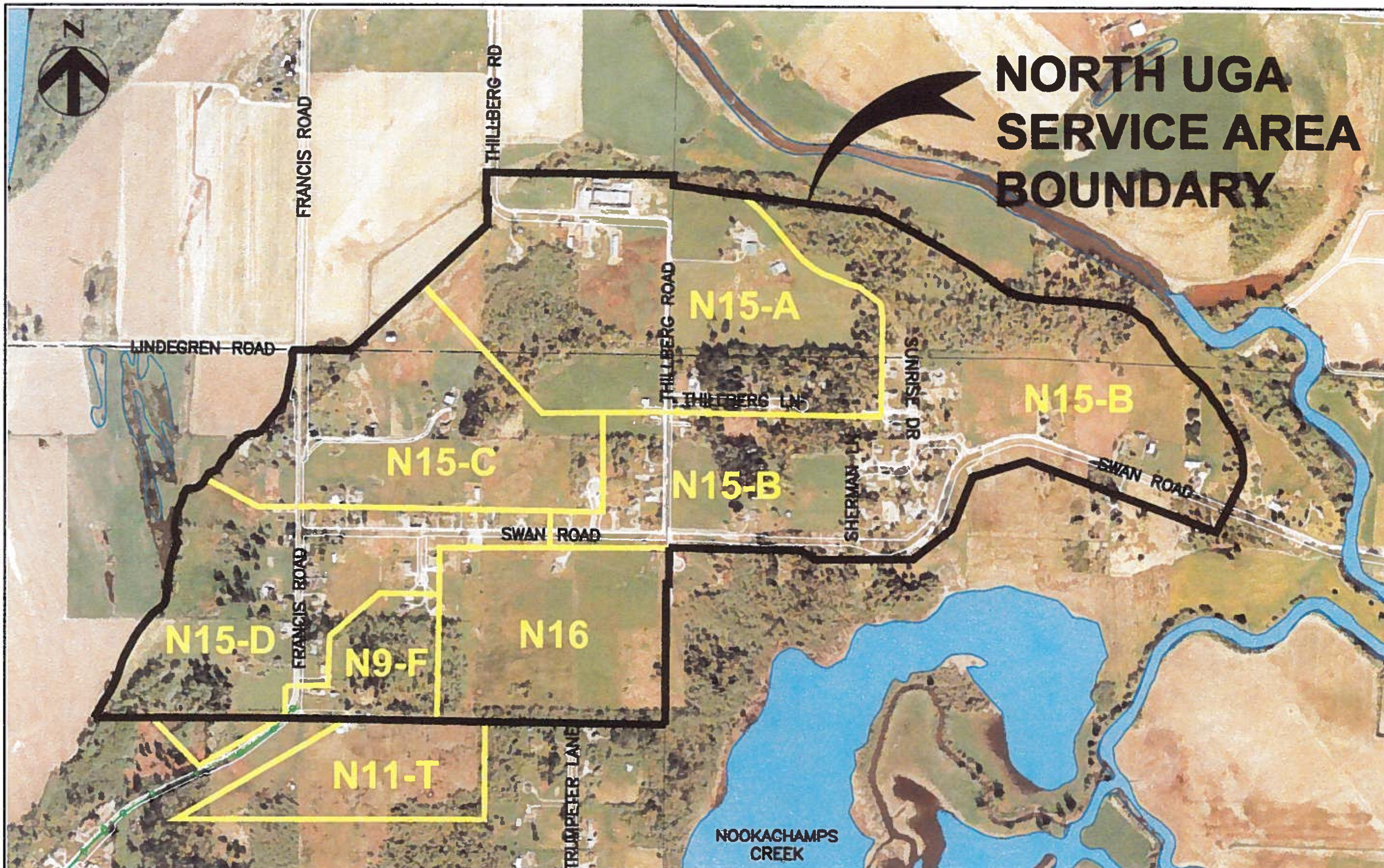
HDR Engineering, Inc.

Project Title: CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA

Sheet Title: URBAN GROWTH AREA (UGA) EXPANSION

Date: SEPTEMBER 2003

Figure No. 1



LEGEND

DRAINAGE BASIN BOUNDARY

EXISTING SEWER

HDR Engineering, Inc.

Project Title: CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA

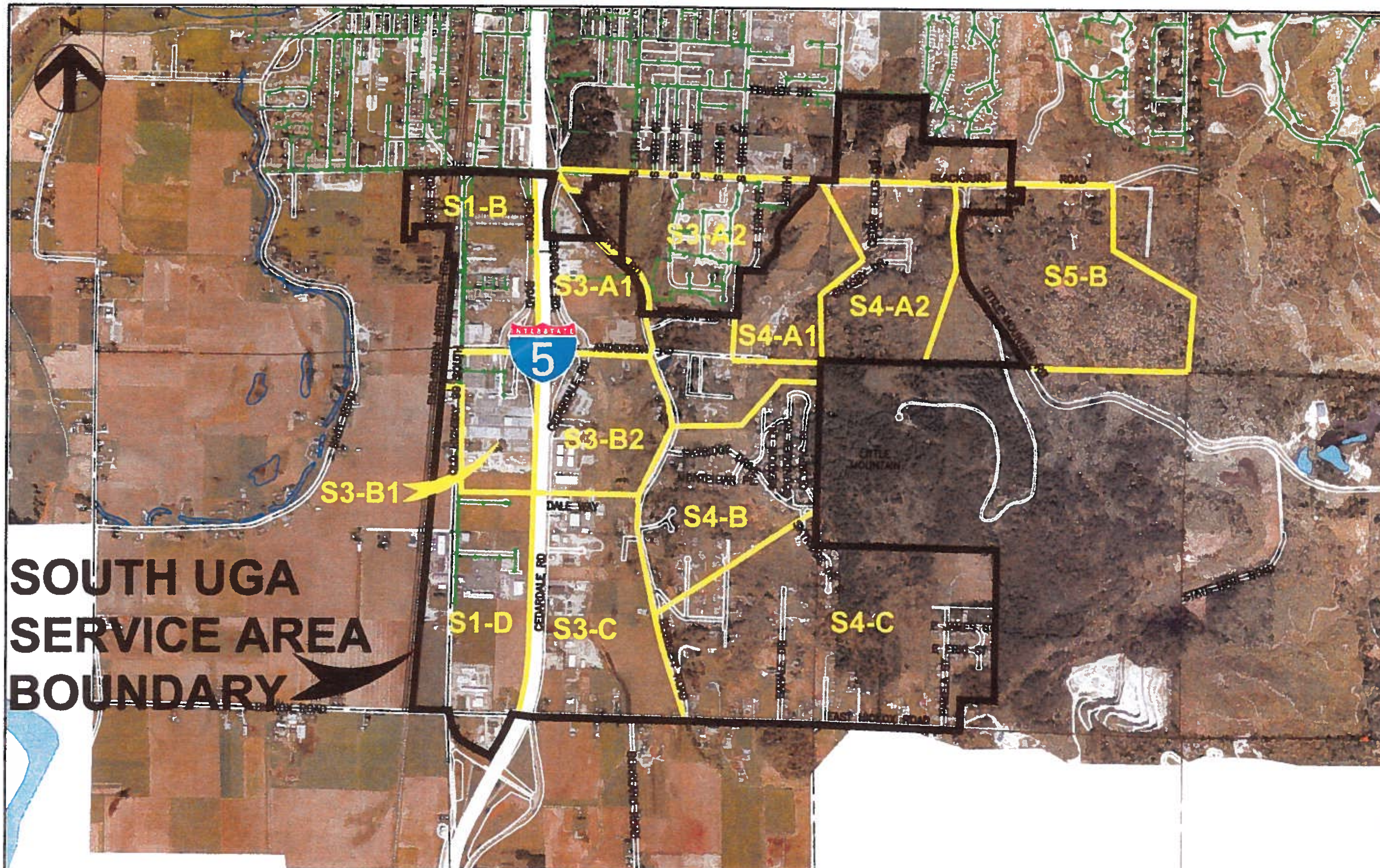
Sheet Title: URBAN GROWTH AREA (UGA) NORTH SERVICE AREA DRAINAGE BASINS

Figure No. 2

Date: AUGUST 2003

Scale: 1" = 1000'

MV-UGA-NORTH-FIG2A.dwg 06/20/03 BLUMENFELD



LEGEND

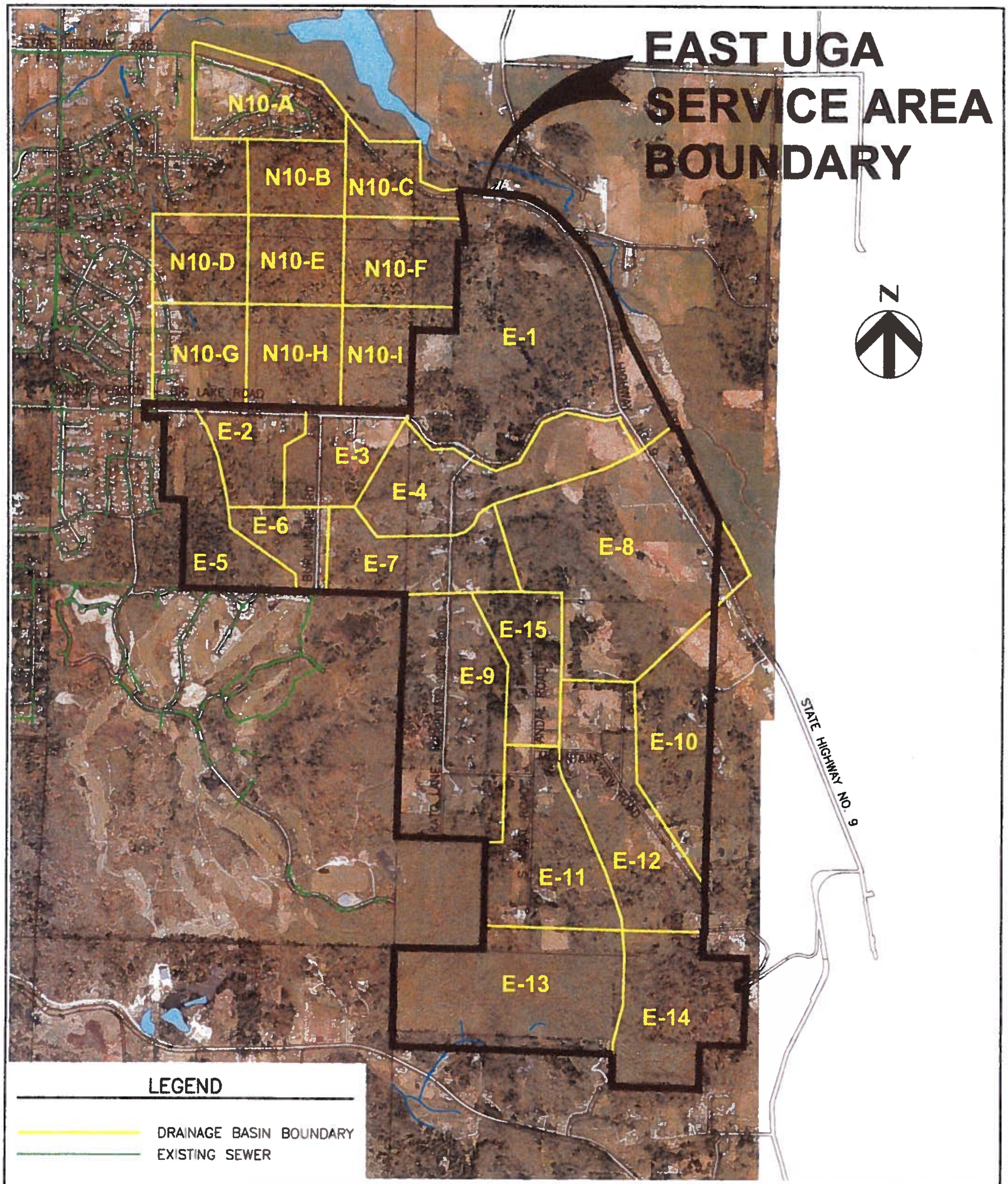
DRAINAGE BASIN BOUNDARY
EXISTING SEWER

HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA
Sheet Title	URBAN GROWTH AREA (UGA) SOUTH SERVICE AREA DRAINAGE BASINS
Figure No.	3
Date	SEPTEMBER 2003
Scale	1" = 2000'

MV-UGA-SOUTH-FIG3.dwg 09/12/03 GUNDY

14



Project Title: CITY OF MOUNT VERNON
SEWER SERVICE STUDY FOR URBAN GROWTH AREA

Sheet Title: URBAN GROWTH AREA (UGA)
DRAINAGE BASINS
EAST SERVICE AREA

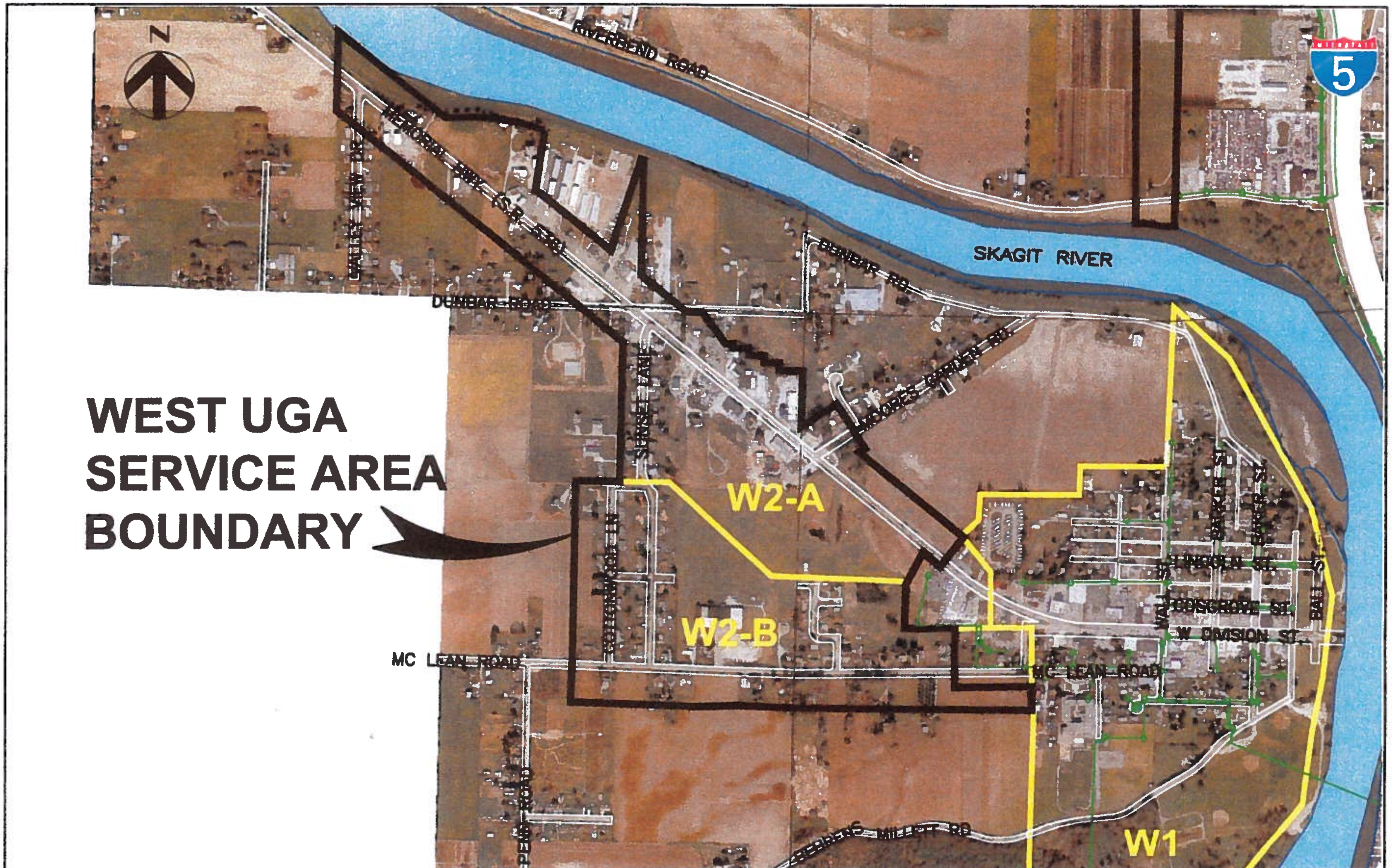
Figure No: 4

Date: AUGUST 2003

Scale: 1" = 2000'

HDR Engineering, Inc.

MV-UGA-EAST-FIG5A.dwg 08/20/03 BLUMENFELD



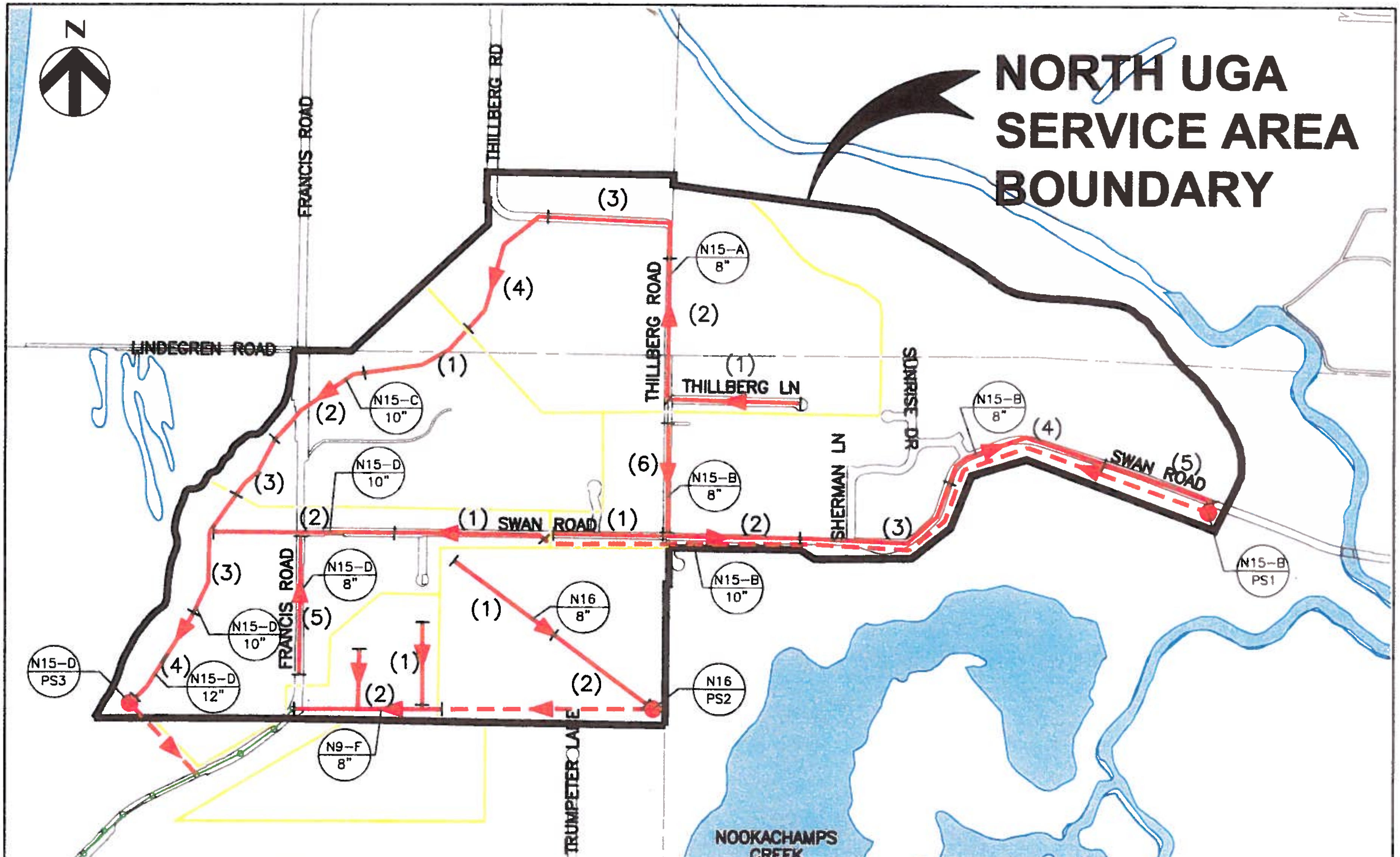
LEGEND

(yellow line)	DRAINAGE BASIN BOUNDARY
(green line)	EXISTING SEWER

HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA	Figure No. 5
Sheet Title	URBAN GROWTH AREA (UGA) WEST SERVICE AREA DRAINAGE BASINS	Date AUGUST 2003 Scale 1" = 1000'

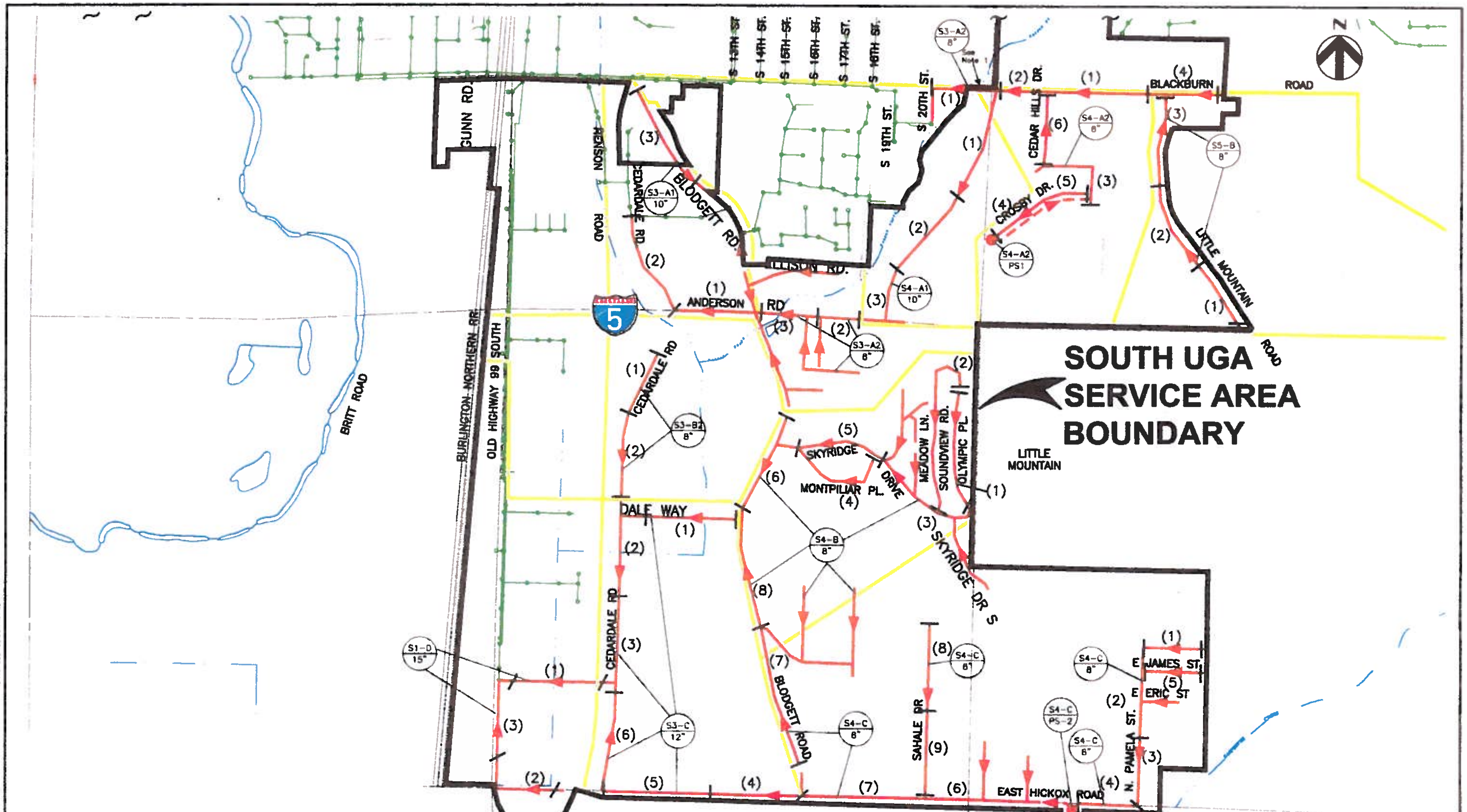
MV-UGA-WEST-FIG5.dwg 08/20/03 BLUMENFELD



HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA
Sheet Title	URBAN GROWTH AREA (UGA) NORTH SERVICE AREA PROPOSED SEWER PLAN
Figure No.	6
Date	AUGUST 2003
Scale	1" = 1000'

MV-UGA-NORTH-FIG6.dwg 09/08/03 GUNDY



LEGEND

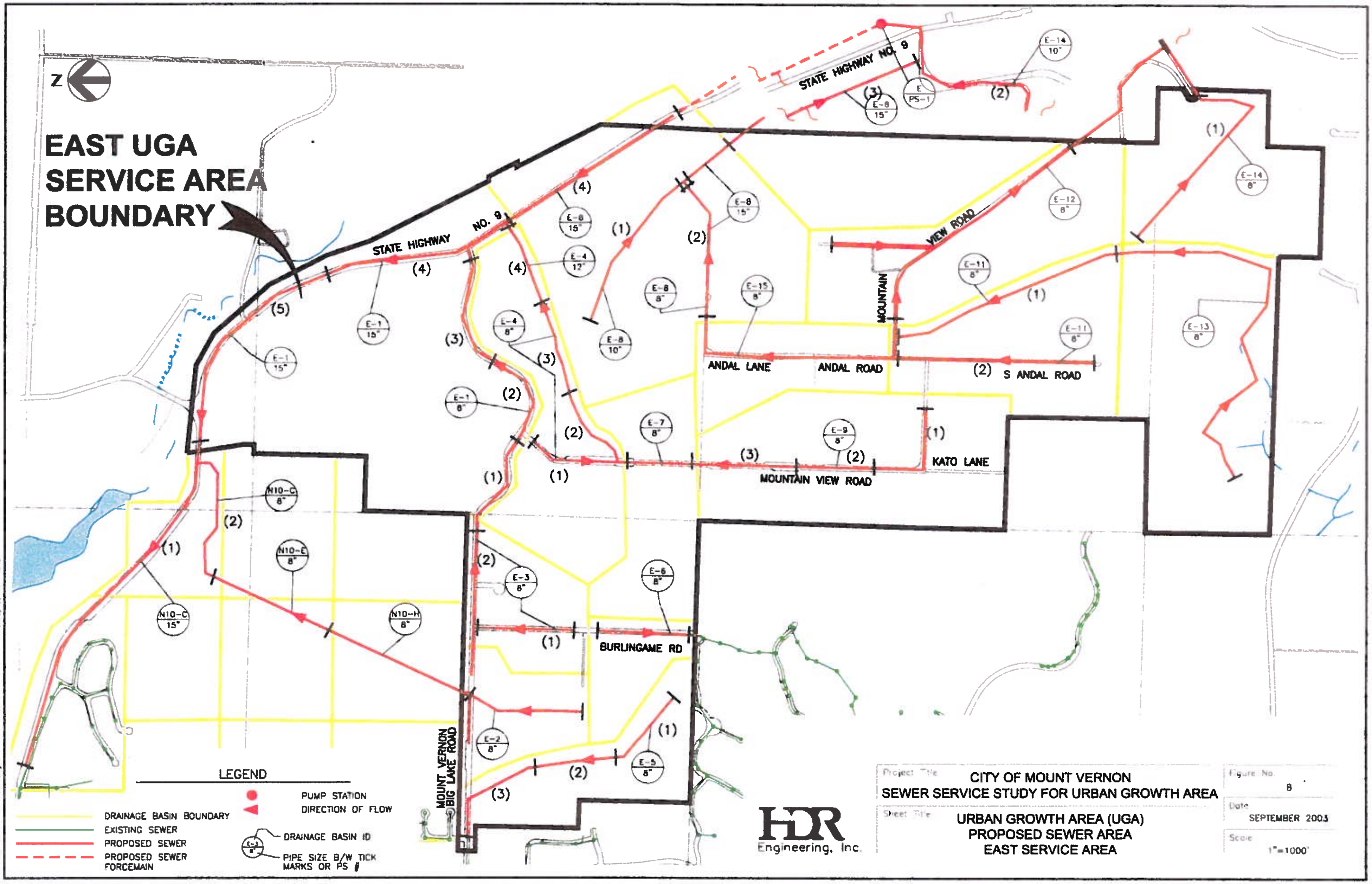
- DRAINAGE BASIN BOUNDARY
- EXISTING SEWER
- PROPOSED SEWER
- PROPOSED SEWER FORCEMAIN
- DRAINAGE BASIN ID PIPE SIZE B/W TICKS OR PUMP STA #
- PUMP STATION
- DIRECTION OF FLOW

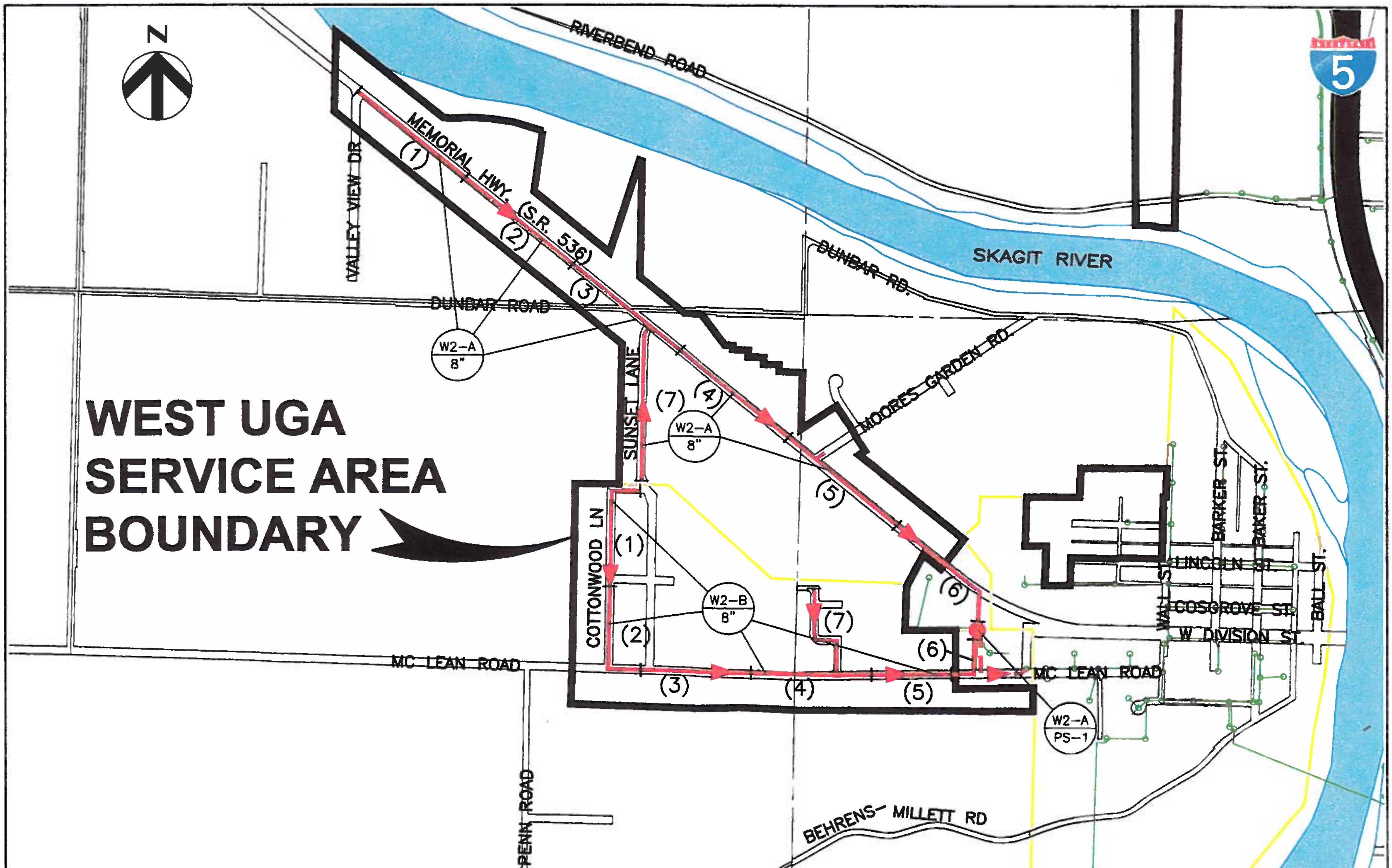
NOTES:

1. Sewer service to S4-A2 and S5-B may initially be provided via pipe segment S3-A2(1); however, as flows increase in the future, they will need to be diverted to S4-A1 (1), (2), and (3) to prevent overloading. The City should monitor flows to determine when pipe segments S4-A1 (1), (2), and (3) are required.

HDR Engineering, Inc.

Project Title	CITY OF MOUNT VERNON SEWER SERVICE STUDY FOR URBAN GROWTH AREA
Sheet Title	URBAN GROWTH AREA (UGA) SOUTH SERVICE AREA PROPOSED SEWER PLAN
Figure No.	7
Date	SEPTEMBER 2003
Scale	1" = 1000'


EAST UGA
SERVICE AREA
BOUNDARY
N
STATE HIGHWAY NO. 9
MOUNT VERNON BIG LAKE ROAD
BURLINGAME RD
MOUNTAIN VIEW ROAD
KATO LANE
ANDAL LANE
ANDAL ROAD
S ANDAL ROAD
MOUNTAIN
VIEW ROAD
LEGEND
DRAINAGE BASIN BOUNDARY
EXISTING SEWER
PROPOSED SEWER
PROPOSED SEWER FORCEMAIN
PUMP STATION
DIRECTION OF FLOW
DRAINAGE BASIN ID
PIPE SIZE B/W TICK MARKS OR PS #
HDR Engineering, Inc.
Project Title
CITY OF MOUNT VERNON
SEWER SERVICE STUDY FOR URBAN GROWTH AREA
Sheet Title
URBAN GROWTH AREA (UGA)
PROPOSED SEWER AREA
EAST SERVICE AREA
Figure No.
8
Date
SEPTEMBER 2003
Scale
1"=1000'



Project Title
CITY OF MOUNT VERNON
SEWER SERVICE STUDY FOR URBAN GROWTH AREA

Sheet Title
URBAN GROWTH AREA (UGA)
WEST SERVICE AREA
PROPOSED SEWER PLAN

Figure No. 9

Date SEPTEMBER 2003

Scale 1" = 1000'

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
North UGA																		
Thillberg Trunk																		
N15-A (1)	155.0	153.9	147.0	143.0	9.5	1000	8	0.004	101	0.00	0.00	0.111	0.101	3.20	0.43	0.49	87.59	
N15-A (2)	153.9	112.0	143.0	104.0	9.5	1000	8	0.039		0.11	0.10	0.000	0.000	3.20	0.43	1.54	28.05	
N15-A (3)	112.0	85.0	104.0	77.0	8.0	1000	8	0.027		0.11	0.10	0.000	0.000	3.20	0.43	1.28	33.71	
N15-A (4)	85.0	58.0	77.0	50.0	8.0	1300	8	0.0208		0.11	0.10	0.000	0.000	3.20	0.43	1.13	38.44	
N15-C (1)	58.0	57.3	50.0	46.0	9.7	700	10	0.0057	64	0.11	0.10	0.070	0.064	3.07	0.69	1.07	64.15	
N15-C (2)	57.3	56.4	46.0	42.0	12.9	1000	10	0.004		0.18	0.16	0.000	0.000	3.07	0.69	0.90	76.67	
N15-C (3)	56.4	55.8	42.0	40.0	15.1	600	10	0.0033		0.18	0.16	0.000	0.000	3.07	0.69	0.82	83.99	
Swan Road Trunk																		
N15-B (1)	134.1	122.2	126.1	112	9.1	1100	8	0.0128	130	0.00	0.00	0.143	0.130	3.13	0.55	0.88	62.21	
N15-B (2)	122.2	117.5	112	102	12.9	1100	8	0.0091		0.14	0.13	0.000	0.000	3.13	0.55	0.74	73.87	
N15-B (3)	117.5	90.0	102.0	82.0	11.8	1100	8	0.0182		0.14	0.13	0.000	0.000	3.13	0.55	1.05	52.24	
N15-B (4)	90.0	67.6	82.0	59.6	8.0	1000	8	0.0224		0.14	0.13	0.000	0.000	3.13	0.55	1.17	47.06	
N15-B (5)	67.6	57.2	59.6	49.2	8.0	1000	8	0.0104		0.14	0.13	0.000	0.000	3.13	0.55	0.80	69.07	
N15-B (6)	158.7	122.2	150.7	114.2	8.0	800	8	0.0456	2	0.00	0.00	0.002	0.002	4.22	0.01	1.67	0.64	
N15-D (1)	134.1	122.9	126.1	114.9	8.0	1000	10	0.0112	57	0.14	0.13	0.063	0.057	3.04	0.77	1.50	51.62	
N15-D (2)	122.9	44.0	114.9	36.0	8.0	1250	10	0.0631		0.21	0.19	0.000	0.000	3.04	0.77	3.56	21.74	
N15-D (3)	56.0	43.0	40.0	30.0	14.5	1000	10	0.01		0.21	0.19	0.000	0.000	3.04	0.77	1.42	54.63	
N15-D (4)	43.0	42.0	30.0	26.0	14.5	800	12	0.005		0.21	0.19	0.000	0.000	3.04	0.77	1.63	47.51	
N15-D (5)	130.0	105.0	122.0	97.0	8.0	1000	8	0.025	2	0.00	0.00	0.002	0.002	4.22	0.01	1.23	0.86	
N16 (1)	134.7	118.0	126.7	110.0	8.0	1000	8	0.0167	47	0.00	0.00	0.052	0.047	3.40	0.21	1.01	20.89	
N16 (2)	118.0	70.0	110.0	62.0	8.0	800	8	0.06		0.05	0.05	0.000	0.000	3.40	0.21	1.91	11.02	
N9-F (1)	152.0	150.0	144.0	142.0	8.0	600	8	0.0033	25	0.00	0.00	0.028	0.025	3.56	0.31	0.45	68.75	
N9-F (2)	151.0	130.0	143.0	122.0	8.0	1100	8	0.0191		0.08	0.07	0.000	0.000	3.29	0.32	1.08	29.22	
West UGA																		
Dunbar/Sunset Trunk																		
W2-A (1)	23.7	22.3	15.7	14.3	8.0	1000	8	0.0014	47	0.00	0.00	0.052	0.047	3.40	0.21	0.29	72.14	1/2 of W2-A basin
W2-A (2)	22.3	20.9	14.3	12.9	8.0	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	72.32	
W2-A (3)	20.9	19.5	12.9	11.0	8.3	1000	8	0.0019		0.05	0.05	0.000	0.000	3.40	0.21	0.34	62.08	
W2-A (4)	19.5	19.1	11.0	9.1	9.3	1000	8	0.0019		0.05	0.05	0.000	0.000	3.40	0.21	0.34	62.14	1/2 of W2-A basin
W2-A (5)	19.1	18.7	9.1	7.7	10.5	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	73.54	
W2-A (6)	18.7	18.4	7.7	6.4	11.5	1000	8	0.0014		0.05	0.05	0.000	0.000	3.40	0.21	0.29	73.54	
W2-A (7)	20.7	19.9	12.7	11.4	8.3	1100	8	0.0012	2	0.00	0.00	0.002	0.002	4.22	0.01	0.27	3.96	
Cottonwood/Mc Lean Trunk																		

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
W2-B (1)	20.6	17.4	12.6	9.4	8.0	800	8	0.004	36	0.00	0.00	0.040	0.036	3.47	0.16	0.49	33.28	1/2 of W2-B basin
W2-B (2)	17.4	20.2	9.4	8.2	10.0	800	8	0.0015		0.04	0.04	0.000	0.000	3.47	0.16	0.30	54.34	
W2-B (3)	20.2	21.0	8.2	7.0	13.0	800	8	0.0015		0.04	0.04	0.000	0.000	3.47	0.16	0.30	54.34	
W2-B (4)	21.0	23.4	7.0	5.1	16.2	800	8	0.0024		0.04	0.04	0.000	0.000	3.47	0.16	0.38	43.19	
W2-B (5)	23.4	22.6	5.1	4.6	18.2	800	8	0.0006		0.04	0.04	0.000	0.000	3.47	0.16	0.20	84.19	1/2 of W2-B basin
W2-B (6)	22.6	18.3	4.6	3.3	16.5	500	8	0.0026		0.04	0.04	0.000	0.000	3.47	0.16	0.40	41.28	
W2-B (7)	19.0	23.4	11.0	5.4	13.0	500	8	0.0112	2	0.00	0.00	0.002	0.002	4.22	0.01	0.83	1.29	
South UGA																		
Little Mountain/Blackburn Trunk																		
S5-B (1)	372.9	363.0	364.9	355.0	8.0	1000	10	0.0099	123	0.00	0.00	0.135	0.123	3.15	0.52	1.41	37.07	1/3 of S5-B basin
S5-B (2)	363.0	322.5	355.0	314.5	8.0	1000	10	0.0405		0.14	0.12	0.000	0.000	3.15	0.52	2.85	18.33	2/3 of S5-B basin
S5-B (3)	322.5	260.0	314.5	252.0	8.0	990	10	0.0631		0.14	0.12	0.000	0.000	3.15	0.52	3.56	14.68	
S5-B (4)	310.0	260.0	302.0	252.0	8.0	820	10	0.061		0.14	0.12	0.000	0.000	3.15	0.52	3.50	14.94	
S4-A2 (1)	260.0	194.9	252.0	186.9	8.0	1000	10	0.0651	91	0.14	0.12	0.100	0.091	3.00	1.15	3.61	31.83	
S4-A2 (2)	194.9	175.0	186.9	167.0	8.0	600	10	0.0332		0.24	0.21	0.000	0.000	3.00	0.88	2.58	34.04	
S3-A2 (1)	175.0	146.0	167.0	138.0	8.0	1100	10	0.0264	167	0.24	0.21	0.184	0.167	2.85	1.51	2.30	65.51	exist. SS present
Cedar Hills Dr. Trunk																		
S4-A2 (5)	294.0	265.0	286.0	257.0	8.0	550	8	0.0527	4	0.00	0.00	0.004	0.004	4.04	0.02	1.79	1.15	
S4-A2 (4)	265.0	243.0	257.0	235.0	8.0	600	8	0.0367		0.00	0.00	0.000	0.000	4.04	0.02	1.50	1.37	
S4-A2 (3)	294.0	197.0	286.0	189.0	8.0	950	8	0.1021	4	0.00	0.00	0.004	0.004	4.04	0.02	2.50	0.82	
S4-A2 (6)	197.0	194.9	190.0	186.9	7.5	800	8	0.0039		0.00	0.00	0.000	0.000	4.04	0.02	0.49	4.23	
S4-A1 (1)	155.0	150.0	147.0	137.0	10.5	1000	10	0.01	66	0.24	0.21	0.073	0.066	2.93	1.13	1.42	79.75	
S4-A1 (2)	150.0	125.0	137.0	117.0	10.5	1000	10	0.02		0.31	0.28	0.000	0.000	2.93	1.13	2.00	56.39	
S4-A1 (3)	125.0	113.5	117.0	105.5	8.0	1000	10	0.0115		0.31	0.28	0.000	0.000	2.93	1.13	1.52	74.36	
S3-A2 (2)	113.5	80.0	105.5	72.0	8.0	500	8	0.067	167	0.31	0.28	0.184	0.167	2.81	1.75	2.02	86.47	exist. SS present
S3-A2 (3)	80.0	37.6	72.0	29.6	8.0	650	8	0.0652		0.49	0.45	0.000	0.000	2.81	1.75	1.99	87.63	
Blodgett/Anderson Trunk																		
S3-A1 (1)	37.6	20.0	29.6	12.0	8.0	1200	10	0.0147	67	0.31	0.28	0.074	0.067	2.88	1.38	1.71	80.47	
S3-A1 (2)	20.0	18.0	12.0	-1.0	13.5	1000	10	0.013		0.38	0.35	0.000	0.000	2.88	1.38	1.61	85.47	
S3-A1 (3)	65.3	30.0	57.3	22.0	8.0	1700	10	0.0208	2	0.00	0.00	0.002	0.002	4.22	0.01	2.04	0.52	
Cedardale Rd Trunk																		
S3-B2 (1)	21.0	18.0	13.0	10.0	8.0	800	8	0.0038	84	0.00	0.00	0.092	0.084	3.25	0.36	0.48	75.89	
S3-B2 (2)	18.0	16.0	10.0	7.0	8.5	900	8	0.0033		0.09	0.08	0.000	0.000	3.25	0.36	0.45	80.50	
Montpilar/Skyridge Trunk																		
S4-B (1)	340.0	300.0	332.0	292.0	8.0	1400	8	0.0286	124	0.00	0.00	0.136	0.124	3.14	0.52	1.32	39.73	
S4-B (3)	300.0	200.0	292.0	192.0	8.0	1000	8	0.1		0.14	0.12	0.000	0.000	3.14	0.52	2.47	21.24	
S4-B (4)	173.0	96.0	165.0	88.0	8.0	1200	8	0.0642		0.14	0.12	0.000	0.000	3.14	0.52	1.98	26.51	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
S4-B (5)	173.0	96.0	165.0	88.0	8.0	1100	8	0.07		0.14	0.12	0.000	0.000	3.14	0.52	2.07	25.38	
S4-B (6)	82.0	38.0	74.0	30.0	8.0	1200	8	0.0367		0.14	0.12	0.000	0.000	3.14	0.52	1.50	35.07	
S4-B (7)	50.0	38.3	42.0	30.3	8.0	1500	8	0.0078		0.14	0.12	0.000	0.000	3.14	0.52	0.69	76.04	
S4-B (8)	38.3	38.0	30.3	22.0	12.0	1300	8	0.0064		0.14	0.12	0.000	0.000	3.14	0.52	0.62	84.05	
S4-B (2)	290.0	245.0	282.0	237.0	8.0	1800	8	0.025	2	0.00	0.00	0.002	0.002	4.22	0.01	1.23	0.86	
East Hickox Road/PamelaTrunk																		
S4-C (1)	275.0	225.0	267.0	217.0	8.0	700	8	0.0714	136	0.00	0.00	0.150	0.136	3.12	0.57	2.09	27.49	1/2 of S4-C basin
S4-C (2)	225.0	115.0	217.0	107.0	8.0	1000	8	0.11		0.15	0.14	0.000	0.000	3.12	0.57	2.59	22.16	
S4-C (3)	115.0	65.0	107.0	57.0	8.0	1000	8	0.05		0.15	0.14	0.000	0.000	3.12	0.57	1.75	32.86	
S4-C (4)	65.0	58.0	57.0	50.0	8.0	550	8	0.0127		0.15	0.14	0.000	0.000	3.12	0.57	0.88	65.13	
S4-C (5)	220.0	176.0	212.0	168.0	8.0	700	8	0.0629	1	0.00	0.00	0.001	0.001	4.40	0.01	1.96	0.28	
S4-C (6)	58.0	65.0	50.0	41.0	16.0	1250	8	0.0072	137	0.00	0.00	0.151	0.137	3.12	0.58	0.66	87.20	1/2 of S4-C basin
S4-C (7)	70.0	30.0	41.0	22.0	18.5	1350	8	0.0141		0.15	0.14	0.000	0.000	3.12	0.57	0.93	61.94	
Sahale Drive																		
S4-C (8)	190.0	150.0	182.0	142.0	8.0	950	8	0.0421	2	0.00	0.00	0.002	0.002	4.22	0.01	1.60	0.66	
S4-C (9)	150.0	70.0	142.0	62.0	8.0	950	8	0.0842		0.00	0.00	0.000	0.000	4.22	0.01	2.27	0.47	
Cedardale/Dale Way Trunk																		
S3-C (1)	38.0	16.0	22.0	8.0	12.0	1300	12	0.0108	93	0.23	0.21	0.102	0.093	2.91	1.20	2.39	50.35	2/3 of S3-C basin
S3-C (2)	16.0	14.7	8.0	0.7	11.0	1000	12	0.0073		0.33	0.30	0.000	0.000	2.91	1.20	1.97	61.15	
S3-C (3)	14.7	12.0	0.7	-6.0	16.0	900	12	0.0074		0.33	0.30	0.000	0.000	2.91	1.20	1.99	60.56	
S3-C (4)	30.0	17.0	22.0	9.0	8.0	1000	10	0.013	93	0.15	0.14	0.102	0.093	2.98	0.94	1.61	57.93	1/3 of S3-C basin
S3-C (5)	17.0	13.5	9.0	3.5	9.0	1200	12	0.0046		0.25	0.23	0.000	0.000	2.98	0.94	1.56	59.99	
S3-C (6)	13.5	12.0	3.9	-6.0	13.8	1100	12	0.009		0.25	0.23	0.000	0.000	2.98	0.94	2.18	42.81	
S1-D (1)	12.0		4.0	-8.0	8.0	1100	15	0.005	141	0.48	0.44	0.155	0.141	2.74	2.22	2.95	75.05	no contour data
S1-D (2)					8.0	800	10	0.005	141	0.00	0.00	0.155	0.141	3.11	0.59	1.00	59.29	no contour data
S1-D (3)					8.0	1150	10	0.005		0.16	0.14	0.000	0.000	3.11	0.59	1.00	59.29	no contour data
East UGA																		
E-13	500.0	494.0	492.0	484.0	9.0	4500	8	0.0018	65	0.00	0.00	0.071	0.065	3.31	0.28	0.33	86.46	
Andal Road Trunk																		
E-11 (1)	496.0	476.0	484.0	458.0	15.0	3000	8	0.0087	90	0.07	0.06	0.099	0.090	3.09	0.65	0.73	88.96	
E-11 (2)	541.0	484.0	533.0	476.0	8.0	2300	8	0.0248		0.10	0.09	0.000	0.000	3.23	0.39	1.23	31.68	
E-15	484.0	350.0	476.0	342.0	8.0	2500	8	0.0536	40	0.17	0.15	0.044	0.040	3.03	0.80	1.81	44.39	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
E-12	484.0	400.0	476.0	392.0	8.0	3000	8	0.028	104	0.00	0.00	0.114	0.104	3.19	0.45	1.31	34.14	
Mountain View Road Trunk																		
E-14(1)	483.0	231.0	475.0	223.0	8.0	2000	8	0.126	86	0.00	0.00	0.095	0.086	3.24	0.37	2.77	13.46	
E-14(2)	231.0	100.0	223.0	92.0	8.0	2200	8	0.0595		0.21	0.19	0.000	0.000	3.03	0.79	1.91	41.20	
State Highway 9 Trunk																		
E-8 (2)	337.0	112.0	329.0	104.0	8.0	1900	8	0.1184	176	0.21	0.19	0.194	0.176	2.86	1.47	2.69	54.57	
E-8 (3)	112.0	100.0	104.0	92.0	8.0	4800	15	0.0025		0.41	0.37	0.000	0.000	2.86	1.47	2.09	70.26	
E-8 (1)	145.0	112.0	137.0	104.0	8.0	2300	10	0.0143	2	0	0.00	0.002	0.002	4.22	0.22	1.70	13.24	
E-8 (4)	163.9	158.0	155.9	140.0	13.0	2000	15	0.008		0.62	0.56	0.000	0.000	2.86	2.22	3.72	59.61	
Burlingame Road / Big Lake Road Trunk																		
E-3 (1)	391.0	393.0	383.0	381.0	10.0	1200	8	0.0017	42	0.00	0.00	0.046	0.042	3.43	0.19	0.32	59.62	
E-3 (2)	393.0	395.0	385.0	383.0	10.0	1200	8	0.0017		0.05	0.04	0.000	0.000	3.43	0.19	0.32	59.62	
E-1 (1)	395.0	317.7	383.0	307.0	11.3	1000	8	0.076	209	0.05	0.04	0.230	0.209	2.96	1.02	2.15	47.33	
E-1 (2)	317.7	240.3	307.0	231.0	10.0	1000	8	0.076		0.28	0.25	0.000	0.000	2.96	1.02	2.15	47.33	
E-1 (3)	240.3	163.0	231.0	155.0	8.7	1000	8	0.076		0.28	0.25	0.000	0.000	2.96	1.02	2.15	47.33	
E-6	391.0	355.0	383.0	347.0	8.0	1100	8	0.0327	28	0.00	0.00	0.031	0.028	3.53	0.13	1.41	9.18	
Kato Lane/Mountainview Road Trunk																		
E-9 (1)	522.0	500.0	514.0	492.0	8.0	1000	8	0.022	140	0.00	0.00	0.154	0.140	3.11	0.59	1.16	50.91	
E-9 (2)	500.0	340.0	492.0	332.0	8.0	1250	8	0.128		0.15	0.14	0.000	0.000	3.11	0.59	2.79	21.10	
E-9 (3)	340.0	230.0	332.0	222.0	8.0	1250	8	0.088		0.15	0.14	0.000	0.000	3.11	0.59	2.32	25.45	
E-7	235.0	207.0	227.0	199.0	8.0	800	8	0.035	63	0.15	0.14	0.069	0.063	3.02	0.84	1.46	57.18	
E-4 (1)	305.0	207.0	297.0	199.0	8.0	1200	8	0.0817	30	0.00	0.00	0.033	0.030	3.51	0.14	2.23	6.20	1/3 of E-4 basin
E-4 (2)	207.0	195.0	199.0	172.5	15.3	1100	8	0.0241	60	0.22	0.20	0.066	0.060	2.95	1.06	1.21	87.82	2/3 of E-4 basin
E-4 (3)	195.0	150.0	172.5	142.0	15.3	1000	8	0.0305		0.29	0.26	0.000	0.000	2.95	1.06	1.36	78.05	
E-4 (4)	150.0	158.0	142.0	139.0	13.5	1100	12	0.0027		0.29	0.26	0.000	0.000	2.95	1.06	1.20	88.53	
State Highway 9 Trunk, cont'd																		
E-1 (4)	163.0	117.0	146.0	109.0	12.5	2300	15	0.0161		0.89	0.56	0.000	0.000	2.75	2.43	5.30	45.97	
E-1 (5)	117.0	100.0	109.0	85.0	11.5	3600	15	0.0067		0.89	0.56	0.000	0.000	2.75	2.43	3.41	71.42	
N10-C (1)	100.0	43.0	85.0	22.0	18.0	4000	15	0.0158	37	1.19	1.08	0.041	0.037	2.57	4.11	5.24	78.43	
E-2	382.0	379.0	374.0	371.0	8.0	1500	8	0.002	35	0.00	0.00	0.039	0.035	3.47	0.16	0.35	45.83	
N10-H	379.0	360.0	371.0	352.0	8.0	1750	8	0.0109	55	0.04	0.04	0.061	0.055	3.23	0.39	0.81	47.86	
N10-E	360.0	300.0	352.0	292.0	8.0	1000	8	0.06	44	0.099	0.090	0.048	0.044	3.12	0.57	1.91	29.58	
N10-C (2)	300.0	100.0	292.0	92.0	8.0	1400	8	0.1429	37	0.14	0.04	0.041	0.037	3.29	0.41	2.95	14.05	
E-5 (1)	394.0	391.3	386.0	383.3	8.0	1000	8	0.0027	57	0.00	0.00	0.063	0.057	3.35	0.25	0.41	62.45	
E-5 (2)	391.3	388.6	383.3	380.6	8.0	1000	8	0.0027		0.06	0.06	0.000	0.000	3.35	0.25	0.41	62.45	
E-5 (3)	388.6	385.9	380.6	377.9	8.0	1000	8	0.0027		0.06	0.06	0.000	0.000	3.35	0.25	0.41	62.45	

Drainage Segment ID	1 Upstream MH at Grade Elevation	2 Down-stream MH at Grade Elevation	3 Up-stream MH Invert Elevation	4 Down-stream MH Invert Elevation	5 Average Sewer Depth (ft)	6 Length (ft)	7 Dia-meter (in)	8 Slope	9 Service Area (ac)	10 Upstream Infilt (mgd)	11 Upstream Avg San (mgd)	12 Infilt (mgd)	13 Avg San Flow (mgd)	14 Peak Factor	15 Peak Flow (mgd)	16 Avail Capacity (mgd)	17 Percent Utilized (%)	Notes
E-10		2.7							78	0.00	0.00	0.086	0.078					no individual collector pipe

APPENDIX B

Example of TABULA Cost Output and Additional Information

Appendix B – Example of TABULA Cost Output and Additional Information

The preceding examples are for 8-inch sewer pipe at different depths.

For additional information or to download the TABULA software, go to http://www.bugbytes.com/tabula/.

Cost Calculations for Pipe: **8" - 8' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 8 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	9.88 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,330	CY	10.00	13,300
Backfill	943	CY	5.00	4,720
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	19,750	SF	0.50	9,880
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	143,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	177,000

Total: $177,000

Cost Calculations for Pipe: **8" - 10' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 10 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	11.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs **(Basis 1999)**

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,600	CY	10.00	16,000
Backfill	1,213	CY	5.00	6,060
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	23,750	SF	0.50	11,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	149,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	185,000

Total: $185,000

Cost Calculations for Pipe: 8" - 12' depth

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 12 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	13.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	1,869	CY	10.00	18,700
Backfill	1,482	CY	5.00	7,410
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	27,750	SF	0.50	13,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,000.00	6,000
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	155,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	192,000

Total: $192,000

Cost Calculations for Pipe: **8" - 15' depth**

Project year: 2003

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.).

Assumptions

Construction Year: 2003
Length: 1000 ft
Conduit Type: Gravity Sewer
Depth of Cover: 15 ft
Trench Backfill Type: Native
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Trench Width
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 8 in.

Geometry

Outer Diameter	0.875 ft
Trench Width	3.64 ft
Excavation Depth	16.9 ft
Complete Surface Rest. Width	5.64 ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	2,273	CY	10.00	22,700
Backfill	1,886	CY	5.00	9,430
Complete Pavement Restoration	626	SY	50.00	31,300
Trench Safety	33,750	SF	0.50	16,900
Spoil Load and Haul	387	CY	10.00	3,870
Pipe Unit Material Cost	1,000	lf	10.00	10,000
Pipe Installation	1,000	lf	10.00	10,000
Place Pipe Zone Fill	365	CY	25.00	9,130
Manholes	2	MH	3,750.00	7,500
Existing Utilities	1,000	lf	20.00	20,000
Dewatering	1,000	lf	20.00	20,000
Traffic Control	1,000	lf	5.00	5,000

Year 1999 subtotal	166,000
Mobilization/Demobilization at 10%	1.10
1999 to 2003	1.13
Effective Multiplier	1.24
Subtotal	205,000

Total: $205,000

APPENDIX C

UGA Cost Estimates

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost [1]	Taxes (8.8%)	Contingency [2] (40%)	Engineering and Administration Costs [3] (25%)	Project Cost [4]
North UGA										
N15-A (1)	9.5	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	$ **360,000**
N15-A (2)	9.5	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	$ **360,000**
N15-A (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ **340,000**
N15-A (4)	8.0	1300	8	LF	$ 177	$ 230,100	$ 20,249	$ 100,140	$ 87,622	$ **440,000**
N15-C (1)	9.7	700	10	LF	$ 195	$ 136,500	$ 12,012	$ 59,405	$ 51,979	$ **260,000**
N15-C (2)	12.9	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	$ **390,000**
N15-C (3)	15.1	600	10	LF	$ 216	$ 129,600	$ 11,405	$ 56,402	$ 49,352	$ **250,000**
N15-B (1)	9.1	1100	8	LF	$ 185	$ 203,500	$ 17,908	$ 88,563	$ 77,493	$ **390,000**
N15-B (2)	12.9	1100	8	LF	$ 192	$ 211,200	$ 18,586	$ 91,914	$ 80,425	$ **410,000**
N15-B (3)	11.8	1100	8	LF	$ 192	$ 211,200	$ 18,586	$ 91,914	$ 80,425	$ **410,000**
N15-B (4)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ **340,000**
N15-B (5)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ **340,000**
N15-B (6)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	$ **270,000**
N15-D (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	$ **360,000**
N15-D (2)	8.0	1250	10	LF	$ 187	$ 233,750	$ 20,570	$ 101,728	$ 89,012	$ **450,000**
N15-D (3)	14.5	1000	10	LF	$ 216	$ 216,000	$ 19,008	$ 94,003	$ 82,253	$ **420,000**
N15-D (4)	14.5	800	12	LF	$ 238	$ 190,400	$ 16,755	$ 82,862	$ 72,504	$ **370,000**
N15-D (5)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ **340,000**
N16 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ **340,000**
N16 (2)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	$ **270,000**
N9-F (1)	8.0	600	8	LF	$ 177	$ 106,200	$ 9,346	$ 46,218	$ 40,441	$ **210,000**
N9-F (2)	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	$ **380,000**
PS 1/N15-B & 3,400 lf FM		390		GPM	$ 2,100	$ 819,000	$ 72,072	$ 356,429	$ 311,875	$ **1,560,000**
PS 2/N16 & 1,600 lf FM		150		GPM	$ 4,000	$ 600,000	$ 52,800	$ 261,120	$ 228,480	$ **1,150,000**
PS 3/N15-D & 600 lf FM		875		GPM	$ 700	$ 612,500	$ 53,900	$ 266,560	$ 233,240	$ **1,170,000**
						$ 6,030,000				$ **11,580,000**

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Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost [1]	Taxes (8.8%)	Contingency [2] (40%)	Engineering and Administration Costs [3] (25%)	Project Cost [4]
South UGA										
S5-B (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S5-B (2)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S5-B (3)	8.0	990	10	LF	$ 187	$ 185,130	$ 16,291	$ 80,569	$ 70,498	**$ 360,000**
S5-B (4)	8.0	820	10	LF	$ 187	$ 153,340	$ 13,494	$ 66,734	$ 58,392	**$ 300,000**
S4-A2 (1)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S4-A2 (2)	8.0	600	10	LF	$ 187	$ 112,200	$ 9,874	$ 48,829	$ 42,726	**$ 220,000**
S4-A2 (3)	7.5	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
S4-A2 (4)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S4-A2 (5)	8.0	550	8	LF	$ 177	$ 97,350	$ 8,567	$ 42,367	$ 37,071	**$ 190,000**
S4-A2 (6)	8.0	600	8	LF	$ 177	$ 106,200	$ 9,346	$ 46,218	$ 40,441	**$ 210,000**
S3-A2 (1)	8.0	1100	10	LF	$ 187	$ 205,700	$ 18,102	$ 89,521	$ 78,331	**$ 400,000**
S4-A1 (1)	10.5	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S4-A1 (2)	10.5	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S4-A1 (3)	8.0	1000	10	LF	$ 187	$ 187,000	$ 16,456	$ 81,382	$ 71,210	**$ 360,000**
S3-A2 (2)	8.0	500	8	LF	$ 177	$ 88,500	$ 7,788	$ 38,515	$ 33,701	**$ 170,000**
S3-A2 (3)	8.0	650	8	LF	$ 177	$ 115,050	$ 10,124	$ 50,070	$ 43,811	**$ 220,000**
S3-A1 (1)	8.0	1200	10	LF	$ 187	$ 224,400	$ 19,747	$ 97,659	$ 85,452	**$ 430,000**
S3-A1 (2)	13.5	1000	10	LF	$ 216	$ 216,000	$ 19,008	$ 94,003	$ 82,253	**$ 420,000**
S3-A1 (3)	8.0	1700	10	LF	$ 187	$ 317,900	$ 27,975	$ 138,350	$ 121,056	**$ 610,000**
S3-B2 (1)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	**$ 270,000**
S3-B2 (2)	8.5	900	8	LF	$ 185	$ 166,500	$ 14,652	$ 72,461	$ 63,403	**$ 320,000**
S4-B (1)	8.0	1400	8	LF	$ 177	$ 247,800	$ 21,806	$ 107,843	$ 94,362	**$ 480,000**
S4-B (2)	8.0	1800	8	LF	$ 177	$ 318,600	$ 28,037	$ 138,655	$ 121,323	**$ 610,000**
S4-B (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-B (4)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	**$ 410,000**
S4-B (5)	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	**$ 380,000**
S4-B (6)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	**$ 410,000**

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Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
S4-B (7)	8.0	1500	8	LF	$ 177	$ 265,500	$ 23,364	$ 115,546	$ 101,102	**$ 510,000**
S4-B (8)	12.0	1300	8	LF	$ 192	$ 249,600	$ 21,965	$ 108,626	$ 95,048	**$ 480,000**
S4-C (1)	8.0	700	8	LF	$ 177	$ 123,900	$ 10,903	$ 53,921	$ 47,181	**$ 240,000**
S4-C (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-C (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
S4-C (5)	8.0	700	8	LF	$ 177	$ 123,900	$ 10,903	$ 53,921	$ 47,181	**$ 240,000**
S4-C (4)	8.0	550	8	LF	$ 177	$ 97,350	$ 8,567	$ 42,367	$ 37,071	**$ 190,000**
S4-C (6)	16.0	1250	8	LF	$ 205	$ 256,250	$ 22,550	$ 111,520	$ 97,580	**$ 490,000**
S4-C (7)	18.5	1350	8	LF	$ 177	$ 238,950	$ 21,028	$ 103,991	$ 90,992	**$ 460,000**
S4-C (8)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S4-C (9)	8.0	950	8	LF	$ 177	$ 168,150	$ 14,797	$ 73,179	$ 64,032	**$ 330,000**
S3-C (1)	12.0	1300	12	LF	$ 223	$ 289,900	$ 25,511	$ 126,164	$ 110,394	**$ 560,000**
S3-C (2)	11.0	1000	12	LF	$ 223	$ 223,000	$ 19,624	$ 97,050	$ 84,918	**$ 430,000**
S3-C (3)	16.0	900	12	LF	$ 223	$ 200,700	$ 17,662	$ 87,345	$ 76,427	**$ 390,000**
S3-C (4)	8.0	1000	10	LF	$ 203	$ 203,000	$ 17,864	$ 88,346	$ 77,302	**$ 390,000**
S3-C (5)	9.0	1200	12	LF	$ 223	$ 267,600	$ 23,549	$ 116,460	$ 101,902	**$ 510,000**
S3-C (6)	13.8	1100	12	LF	$ 223	$ 245,300	$ 21,586	$ 106,755	$ 93,410	**$ 470,000**
S1-D (1)	8.0	1100	15	LF	$ 270	$ 297,000	$ 26,136	$ 129,254	$ 113,098	**$ 570,000**
S1-D (2)	8.0	800	10	LF	$ 216	$ 172,800	$ 15,206	$ 75,203	$ 65,802	**$ 330,000**
S1-D (3)	8.0	1150	10	LF	$ 216	$ 248,400	$ 21,859	$ 108,104	$ 94,591	**$ 480,000**
PS 1/S4-C & 300 lf FM		770		GPM	$ 780	$ 600,600	$ 52,853	$ 261,381	$ 228,708	**$ 1,150,000**
PS 2/S4-A2 & 1,300 lf FM		150		GPM	$ 5,000	$ 750,000	$ 66,000	$ 326,400	$ 285,600	**$ 1,430,000**
						$ 10,510,000				**$ 20,230,000**
West UGA							$ -	$ -	$ -	
W2-A (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
W2-A (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**
W2-A (3)	8.3	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	**$ 340,000**

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Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)
W2-A (4)	9.3	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	$ 360,000
W2-A (5)	10.5	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	$ 370,000
W2-A (6)	11.5	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	$ 370,000
W2-A (7)	8.3	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	$ 380,000
W2-B (1)	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	$ 270,000
W2-B (2)	10.0	800	8	LF	$ 185	$ 148,000	$ 13,024	$ 64,410	$ 56,358	$ 290,000
W2-B (3)	13.0	800	8	LF	$ 192	$ 153,600	$ 13,517	$ 66,847	$ 58,491	$ 300,000
W2-B (4)	16.2	800	8	LF	$ 205	$ 164,000	$ 14,432	$ 71,373	$ 62,451	$ 320,000
W2-B (5)	18.2	800	8	LF	$ 205	$ 164,000	$ 14,432	$ 71,373	$ 62,451	$ 320,000
W2-B (6)	16.5	500	8	LF	$ 205	$ 102,500	$ 9,020	$ 44,608	$ 39,032	$ 200,000
W2-B (7)	13.0	500	8	LF	$ 192	$ 96,000	$ 8,448	$ 41,779	$ 36,557	$ 190,000
PS 1/W2-A & 600 lf FM		550		GPM	$ 1,000	$ 550,000	$ 48,400	$ 239,360	$ 209,440	$ 1,050,000
						$ 2,820,000				$ 5,440,000
East UGA										
E-13	9.0	4500	8	LF	$ 185	$ 832,500	$ 73,260	$ 362,304	$ 317,016	$ 1,590,000
E-11 (1)	15.0	3000	8	LF	$ 205	$ 615,000	$ 54,120	$ 267,648	$ 234,192	$ 1,180,000
E-11 (2)	8.0	2300	8	LF	$ 177	$ 407,100	$ 35,825	$ 177,170	$ 155,024	$ 780,000
E-15	8.0	2500	8	LF	$ 177	$ 442,500	$ 38,940	$ 192,576	$ 168,504	$ 850,000
E-14(1)	8.0	2000	8	LF	$ 177	$ 354,000	$ 31,152	$ 154,061	$ 134,803	$ 680,000
E-12	8.0	3000	8	LF	$ 177	$ 531,000	$ 46,728	$ 231,091	$ 202,205	$ 1,020,000
E-14(2)	8.0	2200	8	LF	$ 177	$ 389,400	$ 34,267	$ 169,467	$ 148,284	$ 750,000
E-8 (2)	8.0	1900	8	LF	$ 177	$ 336,300	$ 29,594	$ 146,358	$ 128,063	$ 650,000
E-8 (1)	8.0	2300	10	LF	$ 187	$ 430,100	$ 37,849	$ 187,180	$ 163,782	$ 820,000
E-8 (3)	8.0	4800	15	LF	$ 237	$ 1,137,600	$ 100,109	$ 495,084	$ 433,198	$ 2,170,000
E-8 (4)	13.0	2000	15	LF	$ 255	$ 510,000	$ 44,880	$ 221,952	$ 194,208	$ 980,000
E-3 (1)	10.0	1200	8	LF	$ 185	$ 222,000	$ 19,536	$ 96,614	$ 84,538	$ 430,000
E-3 (2)	10.0	1200	8	LF	$ 185	$ 222,000	$ 19,536	$ 96,614	$ 84,538	$ 430,000

Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost [1]	Taxes (8.8%)	Contingency [2] (40%)	Engineering and Administration Costs [3] (25%)	Project Cost [4]
E-1 (1)	11.3	1000	8	LF	$ 192	$ 192,000	$ 16,896	$ 83,558	$ 73,114	$ 370,000
E-1 (2)	10.0	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	$ 360,000
E-1 (3)	8.7	1000	8	LF	$ 185	$ 185,000	$ 16,280	$ 80,512	$ 70,448	$ 360,000
E-6	8.0	1100	8	LF	$ 177	$ 194,700	$ 17,134	$ 84,733	$ 74,142	$ 380,000
E-9 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ 340,000
E-9 (2)	8.0	1250	8	LF	$ 177	$ 221,250	$ 19,470	$ 96,288	$ 84,252	$ 430,000
E-9 (3)	8.0	1250	8	LF	$ 177	$ 221,250	$ 19,470	$ 96,288	$ 84,252	$ 430,000
E-7	8.0	800	8	LF	$ 177	$ 141,600	$ 12,461	$ 61,624	$ 53,921	$ 270,000
E-4 (1)	8.0	1200	8	LF	$ 177	$ 212,400	$ 18,691	$ 92,436	$ 80,882	$ 410,000
E-4 (2)	15.3	1100	8	LF	$ 205	$ 225,500	$ 19,844	$ 98,138	$ 85,870	$ 430,000
E-4 (3)	15.3	1000	8	LF	$ 205	$ 205,000	$ 18,040	$ 89,216	$ 78,064	$ 400,000
E-4 (4)	13.5	1100	12	LF	$ 238	$ 261,800	$ 23,038	$ 113,935	$ 99,693	$ 500,000
E-1 (4)	12.5	2300	15	LF	$ 255	$ 586,500	$ 51,612	$ 255,245	$ 223,339	$ 1,120,000
E-1 (5)	11.5	3600	15	LF	$ 255	$ 918,000	$ 80,784	$ 399,514	$ 349,574	$ 1,750,000
N10-C (1)	18.0	4000	15	LF	$ 270	$ 1,080,000	$ 95,040	$ 470,016	$ 411,264	$ 2,060,000
E-2	8.0	1500	8	LF	$ 177	$ 265,500	$ 23,364	$ 115,546	$ 101,102	$ 510,000
N10-H	8.0	1750	8	LF	$ 177	$ 309,750	$ 27,258	$ 134,803	$ 117,953	$ 590,000
N10-E	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ 340,000
N10-C (2)	8.0	1400	8	LF	$ 177	$ 247,800	$ 21,806	$ 107,843	$ 94,362	$ 480,000
E-5 (1)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ 340,000
E-5 (2)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ 340,000
E-5 (3)	8.0	1000	8	LF	$ 177	$ 177,000	$ 15,576	$ 77,030	$ 67,402	$ 340,000
E-10				LF	$ -	$ -	$ -	$ -	$ -	$ -
PS 1/East UGA &4,300 lf FM		1770		GPM	$ 1,550	$ 2,743,500	$ 241,428	$ 1,193,971	$ 1,044,725	$ 5,230,000
						$ 15,720,000				$ 30,110,000

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Cost Estimate by Basin/Segment

1	2	3	4	5	6	7	8	9	10	11
Description	Average Sewer Depth (ft)	Sewer Length/ Quantity (ft)	Diameter (in)	Unit	Unit Cost	Construction Cost (1)	Taxes (8.8%)	Contingency (2) (40%)	Engineering and Administration Costs (3) (25%)	Project Cost (4)

Notes:
(1) Construction costs include mobilization, excavation, backfill and pipe zone fill, pavement restoration, trench safety, pipe material and installation, manholes, protecting & relocating existing utilities, dewatering, and traffic control.
(2) The construction contingency is an allowance for additional costs not identified in the planning phase and may include utility crossings or unique soil conditions.
(3) Engineering and Administration costs include engineering and design, permitting fees, and City management costs.
(4) Project Costs include taxes (8.8%), contingency (40%), and engineering and administration costs (25%).

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APPENDIX D

Related Documents

City of Mount Vernon

Development Services

910 Cleveland Avenue
Post Office Box 809
Mount Vernon, WA 98273

Phone (360) 336-6214
FAX (360) 336-6283
E-Mail DS@ci.mount-vernon.wa.us
www.ci.mount-vernon.wa.us

August 22, 2003

Chris Parsons
Community, Trade and Economic Development
Growth Management Division
P.O. Box 48300
Olympia, Washington 98504-8300

Dear Chris:

I have enclosed for your information an update to **Mount Vernon's Comprehensive Sewer Plan** adding some additional specificity regarding service to the Urban Growth area. We will be taking this to the Planning Commission and City Council for public hearing later in October.

If you have any questions, please give me a call.

Sincerely,

Elizabeth Sjostrom

Elizabeth Sjostrom
Economic Development Planner

Encl.

City of Mount Vernon

Wastewater Division

1401 Britt Road
Mount Vernon, WA 98273-6511

Phone (360) 336-6219
FAX (360) 424-8749
E-Mail mvwwtp@ci.mount-vernon.wa.us
www.ci.mount-vernon.wa.us

August 25, 2003

Bernard Jones
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

Subject: Notification of sewer line extensions, including pump stations.

Dear Mr. Jones:

In accordance with WAC 173-240-030(5), the City of Mount Vernon is providing notice of planning for sewer pipe extensions, including pump stations in the urban growth area. The sewer expansion areas are shown in Figure 1 attached. The extension plan is in conformance with the Comprehensive Sewer Plan approved by Ecology on March 4, 2003.

If you have any questions on this matter please contact Walt Enquist at (360) 336-6219.

Sincerely,

Walt Enquist
Wastewater Utility Supervisor

Attachments

cc: John Buckley, Pubic Works Director
Elizabeth Sjostrom, Economic Development P
NPDES File

F:\Winword\WALT\COMP-PLA\UGA Amendment 2003\DOE Notifica

U.S. Postal Service
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MOUNT VERNON WA 98273 AUG 25 2003 USPS Postmark Here Clerk: KGV4KM 08/25/03

Sent To: Bernard Jones
Department of Ecology
Street, Apt. No.; or PO Box No.: Northwest Regional Office
3190 160th Avenue SE
City, State, ZIP+4: Bellevue, WA 98008-5452

PS Form 3800, April 2002 — See Reverse for Instructions

City of MOUNT VERNON
PUBLIC WORKS DEPARTMENT

TECHNICAL MEMO

DATE: July 20, 2016

FROM: Esco Bell, P.E., Public Works Director

SUBJECT: 2016 COMPREHENSIVE PLAN UPDATE AND SANITARY SEWER/WWTP PLANNING

INTRODUCTION:
This memo has been prepared to document that the City is planning for 20-years of growth with its sanitary sewer conveyance systems and Waste Water Treatment Plan through its Capital Facilities Element.

BACKGROUND:
The Growth Management Act (GMA) requires that comprehensive plans include a Capital Facilities Element that addresses the capital facilities needs to adequately support anticipated growth.

The GMA requires that a capital facilities element contain: 1) an inventory of existing capital facilities owned by public entities; 2) a forecast of future needs for such facilities; 3) the proposed locations and capacities of expanded or new facilities; 4) at least a six-year plan that will finance these facilities; and 5) a plan to reassess the land use element if projected funding falls short of meeting existing and expected needs.

The following technical documents are being readopted as part of the City's 2016 update to the Capital Facilities Element of the Comprehensive Plan:

1. Comprehensive Sewer Plan Update dated February 2003 prepared by HDR Engineering
2. Comprehensive Sewer Plan Amendment dated April 2004 prepared by HDR Engineering.
3. Urban Growth Area Sewer Service Study dated October 2003 prepared by HDR Engineering.

OLDER DOCUMENTS STILL VALID:
The above-listed Plans/Studies remain valid planning documents due to the population projections that were used when these documents were originally prepared. Each of these sewer plans used population projections that meet or exceed the projections used to update the City's 2016 Comprehensive Plan.

City of MOUNT VERNON

Appendix B

COMPREHENSIVE SURFACE WATER MANAGEMENT PLAN,
R.W. BECK (NOVEMBER, 1995)
COMPREHENSIVE STORMWATER MANAGEMENT PLAN,
CH2M HILL (NOVEMBER 2004 AND 2009 UPDATE)

COMPREHENSIVE SURFACE WATER MANAGEMENT PLAN

FINAL PLAN

City of Mount Vernon

CITY OF MOUNT VERNON

NOVEMBER 1995

R·W·BECK

November 20, 1995

R·W·BECK

Mr. John Wiseman
City Engineer
City of Mount Vernon
P. O. Box 800
Mount Vernon, Washington 98273

Dear Mr. Wiseman:

Subject: **City of Mount Vernon**
Final Comprehensive Surface Water Management Plan

We are pleased to submit this final Comprehensive Surface Water Management Plan for the City of Mount Vernon. The plan contains recommendations for a combination of policies, ordinances, regulations, public education, increased maintenance activities, and capital improvements to solve current and future flooding, water quality, and environmental resource protection problems.

The plan also contains a maintenance and operations and a financial plan to guide the City's long-term implementation of this plan.

We have enjoyed working with the City of Mount Vernon on the preparation of this plan, and appreciate the valuable assistance that the staff members have given to us.Sincerely,

R. W. BECK

Steve Swenson
Project Manager

SS:ec

Attachments

File: 12-00029-10101-0109
X1279120.987

2101 Fourth Avenue, Suite 600 Seattle, WA 98121-2375 Phone (206) 441-7500 Fax (206) 441-4962

COMPREHENSIVE SURFACE WATER MANAGEMENT PLAN

CITY OF MOUNT VERNON

Project funded with assistance from:

Washington State Department of Ecology
Centennial Clean Water Fund

Prepared for

City of Mount Vernon
Engineering Department

R·W·BECK

November 1995

ACKNOWLEDGEMENTS

R. W. BECK

November 1995

City of Mount Vernon
Engineering Department

John Wiseman, City Engineer

Consulting Staff

Steve Swenson, R. W. Beck	Project Manager
Mary Weber, R. W. Beck	Project Engineer
Hal Mullis, R. W. Beck	Hydrologist
Kim Levesque, R. W. Beck	Fish Habitat
Bill Roseboom, Northwest Hydraulic Consultants	Hydrology/Hydraulics
Malcolm Leytham, Northwest Hydraulic Consultants	Hydrology/Hydraulics
Andy Castelle, Adolfson Associates, Inc.	Wetlands
Rob Zisette, Herrerra Environmental Consultants	Watery Quality Monitoring
Mark Eubank, Herrerra Environmental Consultants	Watery Quality Monitoring
Mark Steranka, Matrix Management Group	Financing/Operation and Maintenance
Shaun Pigott, Shaun Pigott Associates	Financing

CERTIFICATE OF ENGINEER

CITY OF MOUNT VERNON

COMPREHENSIVE SURFACE WATER MANAGEMENT PLAN

The technical material and data contained in this report were prepared under the supervision and direction of the undersigned, whose seal as registered professional engineer licensed to practice as such in the State of Washington is affixed below.

Steven J. Swenson
Project Manager
R. W. Beck

MOUNT VERNON SURFACE WATER MANAGEMENT PLAN

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SECTION I
EXECUTIVE SUMMARY

R·W·BECK

SECTION I

EXECUTIVE SUMMARY

The City of Mount Vernon Surface Water Management Plan was developed with funding from the City of Mount Vernon and the Washington State Department of Ecology under the Centennial Clean Water Fund (CCWF). This plan consists of a comprehensive examination of the existing surface water management system with primary focus on water quantity and quality control as well as the preservation and enhancement of valuable environmental resources such as wetlands, riparian corridors, and fish habitat.

Through the use of field observations, results of past studies, hydrologic/hydraulic computer modeling, public input, and City input, the plan identifies existing problems and potential future problems that may result from continued development within the study area. A combination of policies, ordinances, regulations, public education, increased maintenance activities and capital improvements are recommended to solve these problems. The major plan elements include the following:

- Establishment of a Citizen Advisory Committee (CAC) and a series of several meetings in which public input was collected.
- Development of an environmental resources inventory.
- Continuous hydrologic and hydraulic computer modeling analysis of the major streams within Mount Vernon to simulate existing flows, project future flows and evaluate system requirements.
- Development of public education programs to increase the understanding and awareness of citizens and business owners about flood control and how their actions can affect water quality and environmental resources.
- Development of a Capital Improvement Program.
- Development of a Maintenance and Operations Plan.
- Development of a financial strategy and funding mechanism to support the recommended surface water management program.
- Review of local, state and federal policies, regulations, and programs relevant to surface water management and development of recommended changes to City regulations to be consistent with current and pending state and federal programs.

The City of Mount Vernon is an area that typifies the problems associated with protecting natural resources while accommodating development. Much of the study area has developed to urban and suburban densities and displays many of the unintended surface water problems associated with rapid growth. These problems include flooding, erosion, sedimentation, destruction of fish habitat, and degraded water quality.

The plan recommends a comprehensive surface water management program that relies on a combination of education, regulations, operation and maintenance, and capital projects to protect surface water resources. The recommendations, if implemented, will aid in preventing future flooding, improving the existing water quality, and protecting and enhancing valuable environmental resources.

The purpose of a Maintenance and Operations Program is to ensure system reliability, achieve the lowest life-cycle cost for facility replacement, and to use maintenance methods and standards that promote water quality. The recommended stormwater maintenance and operations program will require an annual budget of approximately $195,300 in 1995 dollars, which includes the equivalent of approximately three full-time staff persons. This represents an increase of the current budget and the addition of two maintenance workers. Specific maintenance and operation recommendations include increasing the frequency of catch basin cleaning an average of once every eight months, more maintenance of pipes and small culverts, and modified maintenance of roadside ditches.

The implementation of the 10-year capital improvement program was estimated to cost $7,129,500 in 1995 dollars. A summary of these costs is provided on Table X-1. The estimated total annual costs, minus maintenance, for ongoing programs is $278,200. The City has established a utility service charge to finance the program shown on Table I-1. The rate is set at $3.95 per month for each single family residence or duplex and each commercial Equivalent Service Unit (ESU).

TABLE I-1

Recommended Plan Summary

Brief Description	Annual Cost	Estimated Project Cost
Annual Maintenance Program	$195,300	
Surface Water Manager-Engineering and Regulatory Support	$ 88,200	
Operations	$ 41,000	
Public Education	$ 16,000	
Finance/Billing/Accounting/Payroll	$ 21,000	
Utility Taxes	$ 72,000	
Engineering[1]	$40,000	
Capital Improvements Program		
Years 1–10		$7,129,500
Years 11–20	———	$2,582,000
	$473,500	$9,711,500

[1] Costs to be incurred through the year 2000.

SECTION II
INTRODUCTION

R·W·BECK

SECTION II

INTRODUCTION

A. Purpose

A large percentage of the City of Mount Vernon has been developed into residential, commercial, and industrial land uses. As the City continues to grow and development continues, this conversion of natural pervious land areas to impervious areas will result in increased volumes of runoff entering the surface water drainage system. With existing development, the City experiences localized flooding, ponding, channel erosion, water quality, and sensitive resource problems. The flooding, water quality, and sensitive resource problems are the result of uncontrolled runoff from developed areas, inadequate capacity in existing storm drainage systems, and the loss of the natural flood-reducing capacity of wetlands, closed depressions and stream channel corridors. With future development, these problems will become worse unless proper surface water management strategies are implemented.

The purposes of this study are to:

- Analyze the existing drainage system with respect to flooding, water quality, and sensitive resources;
- Predict future flooding and storm water runoff patterns;
- Recommend revisions to existing policies and regulations to reduce future flooding, reduce water quality problems, and protect environmental resources;
- Recommend improvements to the existing surface water system to reduce future flooding and water quality problems, and to protect and enhance existing sensitive resources;
- Recommend a long-term maintenance and operation program that ensures system reliability and incorporates maintenance methods and standards that promote water quality and sensitive resource preservation; and
- Recommend a financing plan capable of funding recommended capital improvements, long-term education and monitoring programs, and maintenance and operations program.

B. Authority and Cooperation

Preparation of this Surface Water Management Plan was authorized by the City of Mount Vernon by an engineering agreement with R. W. Beck and Associates dated September 23, 1991.

The study area includes the entire Urban Service Area, as currently proposed and discussed in Section III. The study area is shown on Figure III-1.

The Washington State Department of Ecology (Ecology) provided funding assistance on this project through the Centennial Clean Water Fund (CCWF). Ecology will also provide a detailed review of this draft document prior to final approval of this plan.

C. Scope of Work

The scope of work was developed through discussions between City staff, Ecology staff, and R. W. Beck and Associates. Ecology staff and the City initially negotiated a scope of work for the project as part of the CCWF grant agreement. The City then negotiated a scope of work with R. W. Beck and Associates as part of the consultant contract that includes the scope of work items contained in the CCWF grant agreement. In accordance with the grant requirements, the plan will create a coordinated long-term management approach to issues affecting flood hazards, water quality, and protection of natural resources.

D. Public Involvement

To date, the public involvement program has included a series of eight Citizen Advisory Committee (CAC) meetings, one public meeting and two presentations to City Council. It is anticipated that several more CAC meetings and City Council presentations will be required before final completion of the final plan.

Public participation is an important part of the preparation of this plan. The public's opinions and concerns were expressed during meetings held throughout the duration of the project. Issues covered at the CAC and public meetings held to date were as follows:

1. <u>Citizen's Advisory Committee</u>

CAC Meeting 1 .... October 20, 1992

- Surface water needs and problems
- Planning process
- Role of CAC
- Goals and objectives of CAC

CAC Meeting 2 .... November 17, 1992

- Goals and objectives of the Surface Water Management Plan
- New City ordinance specifying surface water system standards for new development

CAC Meeting 3 .... December 15, 1992

- Goals and objectives of the Surface Water Management Plan
- New City ordinance specifying surface water system standards for new development

- Wetlands and Ecology regulations
- Financing the Surface Water Management Plan Recommendations

CAC Meeting 4 .... **January 19, 1993**

- Financing the Surface Water Management Plan Recommendations
- New City ordinance specifying surface water system standards for new development

CAC Meeting 5 .... **February 16, 1993**

- Funding direction
- Utility financial policies
- Preliminary budget for plan recommendations
- Sample rates and revenue projections
- Surface water utility ordinance framework
- New City ordinance specifying surface water system standards for new development

CAC Meeting 6 .... **March 16, 1993**

- Surface water utility service charge
- New City ordinance specifying surface water system standards for new development

CAC Meeting 7 .... **May 18, 1993**

- Results of April public meeting
- Surface water utility charge
- Surface water management plan status
- New City ordinance specifying surface water system standards for new development

CAC Meeting 8 .... **September 21, 1993**

- Management Plan Capital Improvements Program
- Preliminary Service Charge Rate Calculation

CAC Meeting 9 .... **October 19, 1993**

- Surface Water Management Plan Draft Document
- Utility Service Charge Revised Rate Analysis
- Utility Rate Ordinance
- Draft Drainage Ordinance

CAC Meeting 10 . . . . **November 20, 1993**

- Draft Drainage Ordinance

CAC Meeting 11 . . . . **January 18, 1994**

- Draft Drainage Ordinance

CAC Meeting 12 . . . . **February 8, 1994**

- Draft Drainage Ordinance

CAC Meeting 13 . . . . **March 8, 1994**

- Draft Drainage Ordinance

2. Public Meetings

Public Meeting 1 . . . . **April 27, 1993**

- Project introduction
- Problem identification
- Storm water management planning process
- Financing alternatives
- Questions and answers

These public meetings resulted in considerable discussions and input from local residents.

3. Council Presentation

Council Presentation 1 . . . . **March 24, 1993**

- Surface water issues
- What the Surface Water Management plan will provide
- Recommendations
- Surface water requirements
- Funding
- Next steps

Council Presentation 2 . . . . **July 14, 1993**

- Utility Formation Ordinance Public Hearing

Council Presentation 3 . . . . **November 3, 1993**

- Surface Water Management Plan - Draft Document
- Citizen's Committee
- Surface Water Program Financing
- Surface Water Utility Rate Ordinance

Council Presentation 4 . . . . **November 10, 1993**

- Surface Water Utility Rate Ordinance Public Hearing

Council Presentation 5 . . . . **July 12, 1995**

- Drainage Ordinance Public Hearing

Council Presentation 6 . . . . **November 29, 1995**

- Surface Water Management Plan—Final Document

Appendix D contains additional information about the public involvement process. Information includes:

1. Meeting agenda for each meeting.

2. Meeting graphics, which provided a partial summary of what was discussed at each meeting.

3. Meeting minutes for each meeting.

E. Goals and Objectives

Goals and objectives for the City of Mount Vernon's surface water management program were developed through input from City staff and the CAC. These goals, and the objectives to be met so as to accomplish each goal, are as follows.

Goal #1 - Prevent property damage from flooding

a. **OBJECTIVE:** Require adequate peak flow controls for new development.

The plan recommends and the City has adopted a new drainage ordinance consistent with the minimum requirements contained in Ecology's Stormwater Management Manual for the Puget Sound Basin. This ordinance includes requirements for peak flow controls. The adopted ordinance is contained in Appendix H.

b. **OBJECTIVE:** Perform the necessary analysis and recommend solutions for existing flooding problems.

As discussed in Section VII, the existing drainage system was analyzed to determine existing conveyance problems, and problems that might occur under future development conditions as well. Solutions to these problems are presented in the recommended plan under both the regional and local system solutions.

c. **OBJECTIVE:** Employ management strategies in flood prone areas to ensure that new development is not exposed to significant flood risk.

The recommended plan includes a number of management strategies to minimize flood risk. These include a recommendation for a new drainage ordinance with strict detention standards and requirements for an offsite analysis to determine any adverse impacts downstream. The plan also includes management strategies for streamside corridors and wetlands that will also minimize flood risk for new development.

<u>Goal #2</u> - Maintain good water quality

a. **OBJECTIVE:** Attempt to meet state Class A Water Quality Standards in area streams.

A number of recommendations for are proposed for improving water quality such as a public education program, source controls, erosion control, maintenance, spill response, prevention of illicit dumping, wetland protection, new ordinances, and residential, commercial, and agricultural water quality BMPs. A sampling program has also been recommended to monitor water quality parameters and progress towards achieving water quality goals.

b. **OBJECTIVE:** Require adequate erosion and sedimentation controls from new construction sites.

The plan recommends that the City enforce its new drainage ordinance consistent with the minimum requirements contained in Ecology's <u>Stormwater Management Manual for the Puget Sound Basin</u>. This ordinance includes requirements for erosion and sediment controls. The ordinance is contained in Appendix I.

c. **OBJECTIVE:** Require adequate water quality controls for new development.

The plan recommends that the City enforce its new drainage ordinance consistent with the minimum requirements contained in Ecology's <u>Stormwater Management Manual for the Puget Sound Basin</u>. This ordinance includes requirements for water quality BMPs. The ordinance is contained in Appendix I.

d. **OBJECTIVE:** Implement public education programs to reduce the source of pollutants entering surface waters.

The plan recommends that a public education program be implemented to improve stormwater quality. This education program includes components to inform citizens about surface water quality source controls, erosion control, spill response, prevention of illicit dumping, maintenance of private drainage systems, and residential, commercial, and agricultural water quality BMPs.

<u>Goal #3</u> - Preserve sensitive resources and maintain varied use

a. **OBJECTIVE:** Preserve fish and wildlife habitat.

The plan includes a number of preservation and enhancement projects for fish habitat. The plan includes an inventory of City streams by category, and the City's Critical Areas Ordinance provides adequate protection for stream corridors by specifying minimum setback requirements according to the stream category.

b. **OBJECTIVE:** Preserve wetlands and implement a wetlands management strategy.

The plan includes a recommendation that the City review the wetlands management section of the City's Critical Areas Ordinance to determine the need for a wetland classification system and associated buffers. The report also suggests several alternative wetlands management strategies with the recommendation that these be reviewed and that a policy decision be made as to which alternative should be implemented.

c. **OBJECTIVE:** Provide public access and recreation opportunities.

The plan does not include specific recommendations on public access and recreation opportunities. A number of opportunities exist within areas along the City's streams for trails and passive recreation. If these recreational opportunities are pursued, additional buffer requirements may be necessary so that human recreation does not interfere with fish and wildlife habitat needs.

d. **OBJECTIVE:** Preserve open space.

The plan does not include specific recommendations on preserving open space, but recommendations on preservation of wetlands and fish habitat will preserve open space associated with surface water resources.

e. **OBJECTIVE:** Review the City's Sensitive Areas Ordinance to ensure consistency with the surface water management program goals.

As mentioned previously, the plan includes a recommendation to that the City review the wetlands management section of the City's Critical Areas Ordinance to determine the need for a wetland classification system and associated buffers.

Goal #4 - Develop a continuous and comprehensive program for managing surface water.

a. **OBJECTIVE:** Ensure a dedicated funding source for program implementation.

The plan recommends and the City has implemented primary and secondary funding sources. The City implemented a surface water utility as the primary funding source for implementing the plan.

b. **OBJECTIVE:** Coordinate the City program with the Skagit County program.

Several recommendation have been included to coordinate the City of Mount Vernon's program with programs in Skagit County and adjacent drainage districts. These include coordination with Drainage District 17 and Skagit County on future preparation of a watershed plan for Madox Creek. The plan also lists the recommendations as they relate to Mount Vernon, from the Nookachamps Creek Watershed Plan prepared by Skagit County.

F. Agency Coordination

In the preparation and review of this plan, various agencies and jurisdictions were contacted to obtain input:

- Puget Sound Water Quality Authority: Regarding regulations for storm water management plans. Presenting information to the public and City Council.
- Department of Ecology: CCWF grant administration, attendance at CAC meetings, and information on wetlands management.
- Department of Fisheries: Participation of regional habitat manager on CAC and habitat inventory field trip.
- Department of Wildlife: Telephone contract, deferred to Department of Fisheries.

G. Previous Studies

The primary investigations previously conducted in the study area that were consulted in preparation of this report are as follows:

1. Storm Drainage Study (Riverside Drive/ Freeway Drive Basins)

The Storm Drain Study (Bell-Walker Engineers, Inc., 1987) analyzed the area within the City of Mount Vernon that presently drains to the Kulshan Creek Pump Station and Skagit River outfall system located west of Freeway Drive and south of Riverbend Road. The purpose of the study was to determine the probable runoff from the study area, and to establish a recommended network of storm drainage trunk lines, open conveyance systems, and detention facilities needed to transport and dispose of the stormwater runoff.

2. Comprehensive Sewer and Combined Sewer Overflow Reduction Plans for the City of Mount Vernon.

The Comprehensive Sewer and Combined Sewer Overflow Reduction Plans (R. W. Beck and Associates, 1991) addresses alternatives for reducing combined sewer overflows (CSOs) in order to help protect the health and safety of the public, the environment, and property while maintaining the economic capability of the City.

3. Wetlands Mitigation Banking

The guidance document Wetlands Mitigation Banking (Castelle et al, 1992), recently published by Ecology, discusses many mitigation banking issues from agency, developer, and environmental view point. The report addresses planning considerations and general guidelines for potential mitigation bank implementation.

4. Nookachamps Watershed Nonpoint Action Plan

The Nookachamps Watershed Nonpoint Action Plan (Skagit County, May 1995) evaluated a number of source control strategies such as programs to repair or eliminate failing septic systems, improve forest and agriculture Best Management Practices, control stormwater runoff, and implement a public education program.

SECTION III
CHARACTERISTICS OF THE STUDY AREA

R·W·BECK

SECTION III

CHARACTERISTICS OF THE STUDY AREA

A. Study Area

The study area is shown on Figure III-1. When this project began in 1991, this study area was designated as the proposed GMA Urban Growth Boundary (UGB). Between 1991 and 1995, the Urban Growth Boundary, as shown in the City's 1995 Comprehensive Plan, changed. The 1995 UGB is slightly larger than the 1991 UGB. It was decided that the 1991 UGB would still be adequate in this plan for addressing the majority of surface water issues for the City. The major differences between the study area for this plan and the UGB in the 1995 Comprehensive Plan is the addition of a small area to the north along the Skagit River and over to Nookachamps Creek, the addition of an area on the east that is east of Sections 15, 22, 27, and 34, and a reduction of the area along Hickox Road to the south. The study area includes all the existing city incorporated areâ, plus some portions of Skagit County. Although the UGB changed, portions of Skagit County were included in the study area as a result of the growth management planning process which in 1991 identified areas that the City will likely annex in the future. These areas were included so that the Plan would represent the ultimate system the City may have to manage. There are seven drainage basins that make up the study area. The basins in the study area are as follows: Kulshan Creek, Madox Creek, Carpenter Creek, the area tributary to Nookachamps Creek, Trumpeter Creek, Britt Slough, and West Mount Vernon.

B. Climate

The average annual precipitation and temperature are approximately 30 inches and 50 degrees Fahrenheit, respectively. Precipitation data from the NOAA station in Burlington, Washington as well as data collected at the City's waste water treatment plant and the Washington State University Research Station were used in this study. How the different precipitation data sets were used is discussed in Section IV.

C. Topography and Soils

The study area slopes in all directions with all the surface water eventually draining into the Skagit River or Nookachamps Creek. The study area is situated above the surrounding area so all surface water runoff exits the area, and no runoff is contributed from outside areas. The highest elevation is approximately 910 feet above mean sea level. Slopes range from zero in the lower areas to 96 percent around Little Mountain. The upper reaches of Madox Creek, Flower Creek, and Carpenter Creek are situated in Ravines with sideslopes of 35 to 45 percent.

Information on area soils was obtained from the "Soil Survey of Skagit County Area, Washington," Soil Conservation Service, U. S. Department of Agriculture, 1979. Approximately 35 different soil types exit within the study area. For the purposes of this study these soil types were combined into four basic categories based on their hydrologic properties. The four categories are glacial till, glacial outwash, flood plain, and wetland soils.

The flood plain soils, which are found in the lower areas within the flood plain of the Skagit River, cover approximately 30 percent of the study area. Till soils cover approximately 65 percent. The wetland and outwash soils cover the remaining area. The areas covered by the different soil categories are shown in Figure III-2.

D. Vegetation

The Puget Sound region is part of the Coastal Coniferous Fir Zone, the largest vegetation zone in Western Washington. The zone, also known as the Cedar-Hemlock zone, reaches from British Columbia to Oregon. Two dominant types of vegetation characterize the region: Fir-Cedar-Hemlock and Alder-Maple-Cottonwood.

Coniferous trees of the Fir-Cedar-Hemlock association include Western Red Cedar, White and Douglas Fir, Sitka Spruce, and Western Hemlock.

Deciduous or native broadleaf species of the Alder-Maple-Cottonwood association include Black Cottonwood, Pacific Madrona, Oregon Ash, Red Alder, Broadleaf Maple, Vine Maple, Sitka Willow, Coast Willow, Brown Dogwood, Pacific Dogwood, and Bunchberry Dogwood.

Salal, Oregon Grape, Bracken and Sword Fern, Red Elderberry, Salmonberry, Creambush and Grand Oceanspray, Shinyleaf Spirea and various currants are the most common varieties of understory vegetation.

Typical urban area vegetation is found throughout the study area, including lawns, ornamental plants, and landscaped areas. While most of the natural vegetation that remains is concentrated on steep slopes, in riparian areas, and on the undeveloped parcels, there are a few developed areas in which mature natural vegetation remains.

E. Land Use

The land use in the study area are single family residential, multi-family residential, commercial, schools and churches, parks and open spaces and agricultural. Figures III-3 and III-4 show the areas of the various land use for existing conditions and future buildout conditions respectively. Aerial photos taken in 1987 and 1991 along with field observations were used to evaluate the existing land use conditions. Future land uses were evaluated based on information presented in the City's Comprehensive Plan assuming full buildout. For the purposes of the hydrologic analysis, the land uses were categorized in a slightly different manner as described in Section IV.

F. Existing Surface Water System

1. Major Streams and Associated Drainage Basins

The study area is comprised of seven separate drainage basins: Kulshan Creek, Madox Creek, Carpenter Creek, Nookachamps Creek, Trumpeter (College Way) Creek, Britt Slough, and West Mount Vernon. Each of these drainage basins were further divided into several smaller subbasins. The surface water conveyance system in the study area consists of open channels, ditches, and pipes. Figure III-5 shows the drainage basins and subbasins within the study area. The existing surface water system is shown on Figure B-1 through B-14 in both Appendix B and Appendix C.

The Kulshan Creek drainage basin is 1,404 acres and is made up of subbasins 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14. It is located in the northwest corner of the study area. The creek begins just east of LaVenture and flows west between College Way and Fir Street to the Kulshan Creek Pump Station. When Skagit River water levels are low, the flow from Kulshan Creek flows by gravity into the Skagit River. At high Skagit River water levels, the pump station can pump up to 20 cfs of the flow in Kulshan Creek into the river.

The Madox Creek drainage basin is 1,984 acres and is made up of subbasins 22, 19, 34, 37, and 51. It is located in the south central portion of the study area. Madox Creek originates in the Eaglemont Golf Course Residential Development and flows southwest into Drainage District 17. After it exits the study area, Madox Creek flows south for several miles before discharging through tide gates into Skagit Bay south of Conway. Flowers Creek is a tributary to Madox Creek that begins at Blackburn Road near South 16th Street. Flowers Creek flows southwest and crosses Blodgett Road and eventually joins Madox Creek east of the freeway near Anderson Road.

The Carpenter Creek drainage basin within the Urban Service Area is 3,753 acres and is comprised of subbasins 35, 36 and 38. It is located in the southeast corner of the study area. Carpenter Creek flows out of the study area as it crosses Hickox Road, and then continues to flow southwest along the base of the hill until it joins the Skagit River south of Conway.

The three basins that drain directly to the Nookachamps Creek, subbasins 2, 38 and 39 are 254, 303 and 90 acres respectively. They are located on either side of Trumpeter Creek in the northeast portion of the study area. Neither basin has a well established conveyance system.

The Trumpeter (College Way) Creek drainage basin is 2,013 acres and is made up of subbasins 4, 15, 16, 17, and 18. It is located in the in the east central portion of the study area. The main stem of Trumpeter Creek originates just north of Fir Street. Two tributaries (southwest fork and southeast fork) east of the main stem join together at College Way and then join the main stem about 900 feet north east of College Way. Trumpeter Creek flows east from its confluence and eventually joins Nookachamps Creek.

The Britt Slough drainage basin is 73 acres and is represented by subbasin 30. It is located in the southwest portion of the study area. The slough flow southwest and enters the Skagit River just upstream of where the Skagit splits around Fir Island.

The West Mount Vernon drainage basin is 450 acres and is comprised of subbasins 24, 25, and 26. It is a portion of the study area located west of the Skagit River. The main drainage system in the basin flows east along Memorial Highway (SR 536) and then heads south along Wall Street. After Wall Street ends, the storm drain crosses undeveloped property south to a small pump station. The pump station pumps the stormwater runoff from the basin through the dike into the Skagit River.

The major streams were analyzed to determine if they have the capacity to carry the 100-year storm flow. This analysis and a discussion of stream segments, pipes, or culverts that do not have the capacity to pass the 100-year peak flow is contained in Section VI.

Subbasin 23 is 462 acres and is a combined sewered area. All of the surface runoff in that area flows to the sanitary sewer and is treated at the waste water treatment plant. Previous work on the combined sewer system concluded that it was not cost effective to separate the storm and sanitary flows. Therefore, it is not likely that the City will ever have to manage a separate storm drain system in this area.

2. Major Storm Drainage Pipe and Ditch Systems

The major storm drain systems that feed the major streams include the pipe system along Riverside Drive, the pipe system along Stanford Drive between Division and Fir Streets, the pipe system under I-5 south of Blackburn Road, the culverts along the southwest fork of Trumpeter Creek near Fir Street, the culvert and ditch system between Britt Slough and Blackburn Road near Walter Street, the pipe system along Memorial Highway and Wall Street, and the pipe system along Fox Hill Street. Pertinent information about theses systems was gathered from surveys or as-builts, and the information was entered into the computer program Flow Master (Haestad, 1991) to determine the capacity of each system. The major storm drain systems were analyzed to determine if they have capacity to handle the 10-year storm flow. A discussion of the systems that did not have the capacity to pass the peak flow from the 10-year storm event is contained in Section VI.

G. Existing Resources

1. Fish Habitat

The existing fish habitat was assessed based on field observations and agency consultations. A complete discussion and maps describing the fish habitat assessment are presented in Appendix B. According to the Washington Department of Fisheries, all five streams (Kulshan Creek, Madox Creek, Trumpeter Creek, Carpenter Creek, and Flowers Creek) in the study area are used to some extent by salmonids for rearing and spawning. Species include coho, chum and chinook salmon, and steelhead and cutthroat trout. The field survey indicated that all the streams had available fish habitat and met the criteria of Mount Vernon's Critical Areas Ordinance Category II streams (streams that are used by a substantial number of anadromous or resident game fish for spawning, rearing, or migrating) in at least some portion of the study area. The field survey also indicated that each of the drainages displayed varying effects from past and present development. Portions of some drainages have been channelized or ditched and riparian vegetation has been removed. This has resulted in a loss of pools and riffles, a loss of cover for fish, increased erosion, and loss of shade which results in increased summertime stream temperatures. Culverts have been installed for road crossings of streams which often result in fish migration barriers during certain stream flow conditions.

2. Wildlife

A reconnaissance level evaluation of wildlife habitat was conducted to determine the general availability of wildlife habitat within the study area. A complete discussion and maps describing the wildlife habitat assessment are presented in Appendix B.

Riparian corridors, forested areas, and wetlands existing within the study area provide habitat for a variety of wildlife. Mammals that are likely to occur in these habitats include raccoons, coyotes, opossums, various rodents, cottontail rabbit, and blacktailed deer. In addition, a variety of songbirds, waterfowl, reptiles, and amphibians are expected to use these habitats.

Three important sensitive species have been identified by the Washington State Department of Wildlife (DOW) as inhabiting the study area. The bald eagle is on the DOW's priority species list and is federally designated as a threatened species. The osprey is listed as a state monitor species on the DOW's priority species list. The DOW manages monitor species, as needed, to prevent them from becoming endangered, threatened, or "sensitive". Trumpeter swans are protected under the Migratory Bird Treaty Act and the Skagit County lowlands provide important winter feeding habitat for the birds.

In addition, other priority wildlife species not specifically identified in the study area by DOW, but whose distribution range and habitat characteristics suggest that they may be within the study area, are blue grouse, Columbian black-tailed deer, great blue heron, pileated woodpecker, and several species of waterfowl.

3. Wetlands

As part of the Surface Water Management Plan, a wetland reconnaissance level inventory was conducted. The inventory included the following three tasks:

1) a wetlands paper inventory with limited on-site and roadside surveys,
2) a discussion of wetlands resources problem areas, and
3) a discussion of wetlands resources protection measures.

The inventory study area included the city's Urban Service Area, but concentrated on the area located within the city's Urban Growth Boundary. The characterization of wetlands according to the U.S. Fish and Wildlife Service classification system (Cowardin et al., 1979) and further classification of these wetlands based upon their qualitative functional values. The location and type of each wetland is indicated in Appendix A. A complete wetland inventory report is also contained in Appendix A. No formal wetland delineations were conducted as part of this project.

The inventory was limited to a reconnaissance-level survey. Performing a detailed survey would require extensive fieldwork and was beyond the scope of this planning effort.

a. <u>Wetland Definition and Regulations</u>.

Wetlands are formally defined as "... those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." (Federal Register, 1980, 1982).

Numerous federal, state, and local regulations govern development and other activities in or near wetlands; at each level, there are typically several agencies charged with such powers (Appendix A). Mount Vernon has adopted a Critical Areas Ordinance (CAO) (Ordinance No. 2482) in compliance with the Washington State Growth Management Act. A summary of some of the regulatory implications of the city's ordinance is also included in Appendix A.

b. <u>Methods</u>.

Two levels of investigation were conducted for the analysis of wetlands located within the study area: a review of existing information and an on-site reconnaissance survey.

A review of existing literature, maps, and other materials was conducted to identify wetlands or site characteristics indicative of wetlands in the study area. Note that these sources can only indicate the likelihood of the presence of wetlands; actual wetland determinations must be based upon data obtained from field investigations.

Several documents were available for this review:

- U.S. Geological Survey 7.5-Minute Topographic Map, Mount Vernon Quadrangle (1981)
- Soil Survey of Skagit County Area, Washington (Klungland and McArthur, 1989)
- *National Wetland Inventory*, Mount Vernon Quadrangle (1989)
- *Hydric Soils of the State of Washington* (SCS, 1985)
- Aerial photograph, 1"=800'
- Mount Vernon wetlands paper inventory (Jones and Stokes, 1991)
- Previous wetland delineation reports

Given that there were no rights-of-entry granted for this survey, in most instances site reconnaissance was limited to roadside surveys. However, several landowners and tenants encountered during the survey invited somewhat closer observations of a few parcels. Wetland hydrology (such as standing water) and dominant vegetation types were the features most readily identified from the roadways. In some instances, soil saturation at the surface could be observed in places where water was not ponded. Binoculars were used to facilitate these assessments. Additional soils information was limited to published documents and readily apparent features; no soil cores were taken.

c. Wetland Characteristics.

Wetland Functions and Values. Wetlands play important roles that provide valuable benefits to the environment and society. Detailed scientific knowledge of wetland functions is limited, so that evaluations of the functions of individual wetlands are often necessarily qualitative and dependent upon professional judgement.

Several wetland functional evaluation methods have been developed. The most common methods applicable in the Pacific Northwest were developed by the Army Corps of Engineers (Reppert et al., 1979; Adamus, 1983; Adamus et al., 1987). These methods were modified for use for wetland evaluations of the following wetland functions: (1) water quality improvement; (2) storm and flood flow attenuation and storage; (3) hydrologic support; and (4) natural biological support.

Water quality improvements functions of wetlands include the ability of wetlands to remove sediments from surface waters passing through the wetlands. This helps prevent the siltation of fish spawning gravels, particularly for economically-important salmonid species. Because many pollutants are associated with particulates, sediment removal results in better water chemistry in receiving waters. Further, many wetland plants and microbial communities associated with plants have the ability to directly remove pollutants or to transform them into less harmful chemical compounds.

Storm and flood flow attenuation and storage results in smoother (less "flashy") hydrographs for streams and other surface waters. The helps prevent flooding conditions on private and public lands, reduces streambank erosion, and maintains the hydrology necessary to support wetland plants.

Because stormwater is detained in wetlands, water is released to surface and occasionally to groundwater receiving waters at a slower rate. Such hydrologic support helps maintain proper flow rates in streams and may help recharge aquifers. The hydrologic support function of some wetlands may also assist in providing readily available irrigation water for agricultural uses.

Natural biological support functions of wetlands includes providing the necessary hydrologic regime for aquatic organisms and providing the habitat resources (for example, food, cover, and nesting materials) for wildlife. Wetlands may be particularly important for biological support because many organisms are partially or completely dependent on wetlands for their survival. In Washington for example, the number of sensitive, threatened, and endangered species which are associated with wetlands is disproportionately high relative to the extent of wetlands in the landscape.

d. Findings.

The National Wetlands Inventory (Mount Vernon quadrangle, 1989) was used as a rough indicator of wetland presence; this inventory identified only four wetlands within the study boundary. A preliminary wetlands inventory limited to the Urban Growth Boundary area was prepared in 1991 (Jones and Stokes and Associates, 1991). That document identified 31 wetlands and proved to be a valuable resource. However, many wetlands identified in the earlier inventory were found to differ in size from this current inventory due to both development activity and because this inventory included field studies. For example, one of the wetlands identified in the earlier work was determined to be completely upland, and one new wetland was identified. Several other areas identified as discrete wetlands in the earlier inventory were determined to be contiguous wetlands through site reconnaissance. As a result, the locations of 28 wetlands were verified within this portion of the study area. Note that a few wetland sites inventoried in the fall of 1991 were under development only a few months later.

Differences in wetland classification using the 1987 Corps Manual versus the 1989 Federal Manual are largely due to vegetation ratings. Many of the pastures in Mount Vernon were dominated in part by facultative species such as colonial bentgrass (Agrostis tenuis) with additional dominant species having facultative upland or upland ratings. As a result, many of these pastures failed to meet the hydrophytic vegetative criteria under the 1987 Manual. A discussion of these manuals is included in Appendix A.

The most common type of wetlands within the study site are fresh water, non-tidal ("palustrine"), emergent wetlands. The majority of these are used as grazing areas for livestock, but others are fallow fields and open pastures. Large tracts of relatively undisturbed forested wetlands are also somewhat common. Scrub/shrub wetlands are primarily restricted to small streamside corridors and successional areas. Open water areas are limited to a few small farm ponds and the seasonal flooding of Barney Lake. Note that while it is likely that additional wetlands would be identified with more intensive field surveys (for example, those resulting in formal wetlands delineations), it appears unlikely that additional wetland types would be identified. The following summaries describe the types of wetlands located within the study area.

- Palustrine Open Water (POW) Wetlands. Few open water wetlands are found within the study site boundary. These are essentially farm ponds likely used to water livestock, and with the exception of Barney Lake, are typically inclusions in emergent wetland areas. Characteristic vegetation includes common cattail (Typha latifolia), reed canarygrass (Phalaris arundinaceae), and soft rush (Juncus effusus). Due to their small size - typically less than one acre - and low vegetative diversity, they do not merit a high rating for habitat. However, Barney Lake provides relatively high wetland functions.

- Palustrine Emergent (PEM) Wetlands. The typical fresh water emergent wetland in the study area ranges from five to 30 acres in size, with saturated soils and fewer than 10 plant species. Often these sites are active pastures or have other agricultural use. Common vegetation includes soft rush, creeping buttercup (Ranunculus repens), hardhack (Spiraea douglasii), and reed canarygrass. Depending on size, overall diversity, and adjacent land uses, these wetlands have low to moderate wetland functional value.

- Palustrine Scrub/ Shrub (PSS) Wetlands. Scrub/shrub wetlands are commonly found along stream corridors and at the edge of emergent sites. These areas often have low plant species diversity; those observed include hardhack, red alder, reed canarygrass, red osier dogwood (Cornus stolonifera), and blackberries (Rubus spp.). Their role in providing streamside habitat and water quality protection generally gives them a moderate functional rating.

- Palustrine Forested (PFO) Wetlands. Forested sites are the second most common wetland in the study area. These wetlands are included as portions of other wetland areas, or in strictly forested tracts of up to 100 acres. Western red cedar and red alder are the typical dominant species. Forested wetlands are considered a more unusual wetland type in western Washington, and therefore merit higher functional value ratings.

e. Summary.

The following is a summary of the functional levels of the wetland types found in the study area.

Generally, larger, more diverse wetlands provide the highest wetland functions and small, less diverse, and disturbed wetlands provide the lowest degree of wetland function. Water quality improvements are best realized in larger wetlands, simply because they can "treat" relatively large volumes of water, and by wetlands located either near pollutant sources or near receiving waters. In Mount Vernon, these wetlands include the larger of the emergent wetlands, Barney Lake, much of the forested wetland, and most of the riparian scrub/shrub wetlands located near the creeks and the skagit River. The small, isolated emergent wetlands, particularly those located in active pastures, function at a low level for water quality improvements.

Storm and flood flow attenuation and storage are best realized in the same types of wetlands which provide the most water quality improvement. This is because the longer water is held in a wetland (that is, the greater the storage capacity), the more water quality improvement is possible. In this regard, Barney Lake appears to be the most valuable wetland in the study area with respect to water storage functions.

Hydrologic support, particularly of surface waters, is best provided by wetlands located near streams and other surface water bodies. These wetlands, even if moderately-sized, release water over time to help maintain important base flows in the city's streams. In this regard, Barney Lake may be viewed both as receiving water for many of the wetlands and small tributaries of the Nookachamps Creek system, and as a wetland which itself helps hydrologically support the Skagit River. The smaller, isolated wetlands provide low hydrologic support.

Biological support is primarily a function of size and habitat diversity. Accordingly, the larger, undisturbed wetlands, particularly Barney Lake and the city's forested wetlands, provide high biological support. Additionally, the scrub/shrub wetlands located in riparian areas provide food and cover for fish and other aquatic organisms. This is particularly important since salmonids are known to utilize many reaches of the streams located in the city. Further, suitable habitat for salmonids is known to exist through the study; however, downstream obstructions are preventing the full utilization of these streams by salmonids. Maintenance of the riparian wetlands are an important element of maintaining viable habitat so that as the obstructions are removed, salmonids may reclaim greater portions of the creeks. The small, isolated emergent wetlands provide habitat for some songbirds, and during the dry season may help support small mammals. While their individual contributions to wildlife support are quite low, in conjunction with surrounding upland areas they provide food resources for larger wildlife such as raptors and coyotes.

H. Existing Water Quality

A water quality assessment was prepared as part of the surface water management plan. Its purpose was to characterize the quality of the surface waters and to identify potential sources of pollution in the Mount Vernon study area. A complete discussion of the water quality assessment is presented in Appendix G. Pollutant loading for existing and future land uses is presented in Appendix H. Historical information (Skagit River basin study, Entranco 1991; Nookachamps management plan, Cook 1980; A catalog of Washington streams and salmon utilization, WDF 1975; Baseline monitoring at proposed Sea-Van Development Site, Sea-Van fisheries resources, W&H Pacific 1992; Predicted water quality impacts from the proposed Sea-Van golf course and residential site, Harding Lawson Associates), was used to characterize the Skagit River, Nookachamps Creek and streams in the study area. A water quality monitoring program and a stormwater pollutant loading study were used to characterize the streams in the study area. The monitoring program was used to identify specific pollutant problems in the study area, while the pollutant loading study, which estimates loadings based on land use activity, was used to indicate the relative pollutant problem in each of the study area major drainage basins and also the relative increase in pollutants in each basin due to future urbanization.

1. Monitoring Program

The monitoring program was implemented to identify the water and sediment quality of the streams in the study area. The monitoring program was conducted according to the water quality monitoring and quality assurance plan prepared for the surface water management plan. Five monitoring stations were used and they are located as listed below:

- Station 1 is located at the mouth of Kulshan Creek, which flows west into the Skagit River

- Station 2 is located on main stem of Trumpeter (College Way) Creek at Waugh Road, which flows east into Nookachamps Creek

- Station 3 is located on Madox Creek near Anderson Road, which flows southwest into the Skagit River

- Station 4 is located on Carpenter Creek at Hickox Road, which also flows southwest into the Skagit River

- Station 5 is located on a tributary to Madox Creek along freeway north of Anderson Road that flows south into Madox Creek below Station 3.

Water samples were collected as grab samples three times at each station between January and July 1992. Sampling occurred twice during storm flow conditions and once during base flow conditions. At each station, five sediment subsamples were collected to a depth of 2 cm in sediment deposition areas, then combined into a single sample for each station. All of the deposition areas were located less than 60 feet downstream of the water sampling stations, except for Station 1 on Kulshan Creek where the nearest deposition area is located 2,400 feet upstream of the mouth, upstream of a long piped section of the stream.

The results of the monitoring program and the review of historical information indicates that all four study area streams have pollutant parameter concentrations greater than those in the Skagit River upstream of Mount Vernon. Kulshan Creek is the most urbanized and has the highest pollutant parameter concentrations of the four streams, while Carpenter Creek is the least urbanized and has the lowest pollutant parameter concentrations.

From this preliminary assessment of the water quality in the study area, moderate contamination by metals and petroleum hydrocarbons was observed in streams located in developed basins. Kulshan Creek had the highest levels of these pollutants, as a result of runoff from paved areas and perhaps from commercial activity. Contamination by fecal coliform bacteria and nutrients was observed in each stream, probably from a combination of poor agricultural (livestock) practices, failing septic systems, and improper sewer line connections. These pollutants were most elevated in the Kulshan Creek basin, probably as a result of sewage contamination. Further discussion of water quality problems is contained in Section VI.

2. Stormwater Pollutant Loading Study

A stormwater pollutant loading study was performed to estimate the relative stormwater pollutant loading for each basin based on land use activities. Basins that had the highest relative estimates, and thus contribute the greatest amount of pollution, were identified and targeted as having the greatest need for water quality protection. This information is contained in Appendix H.

The national urban runoff model, developed by the U.S. Environmental Protection Agency (USEPA,1983), was used to determine annual pollutant loadings from five major basins draining from the Mount Vernon Urban Service Area. Each of the drainage basins were divided into one of four land use categories based on current land use and future zoning. The four land use categories are: commercial, residential, forest, and pasture. Five target pollutants were selected due to their association with stormwater. The pollutants are total suspended solids, nitrate + nitrite nitrogen, total phosphorus, lead, and fecal coliform bacteria. The concentration of stormwater pollutants used to estimate loadings for each land use type were obtained from the City of Portland's Clean Rivers Program (Wooward-Clyde 1993).

The results of the pollutant loading study indicates that the Kulshan Creek drainage basin is the most significant contributor of stormwater-related pollution from the urban service area for the existing conditions, followed by Trumpeter Creek, then the Madox Creek drainage basins. Despite its large area, Carpenter Creek contributes relatively lower loadings of pollutants. Existing pollutant washoff estimates for the area draining to Nookachamps Creek were the lowest of all basins due to the high percentage of rural area within this basin. This pollutant loading analysis was used primarily to describe problems associated with relative increases in pollutant loads with future development. These problem descriptions are discussed in Section VI.

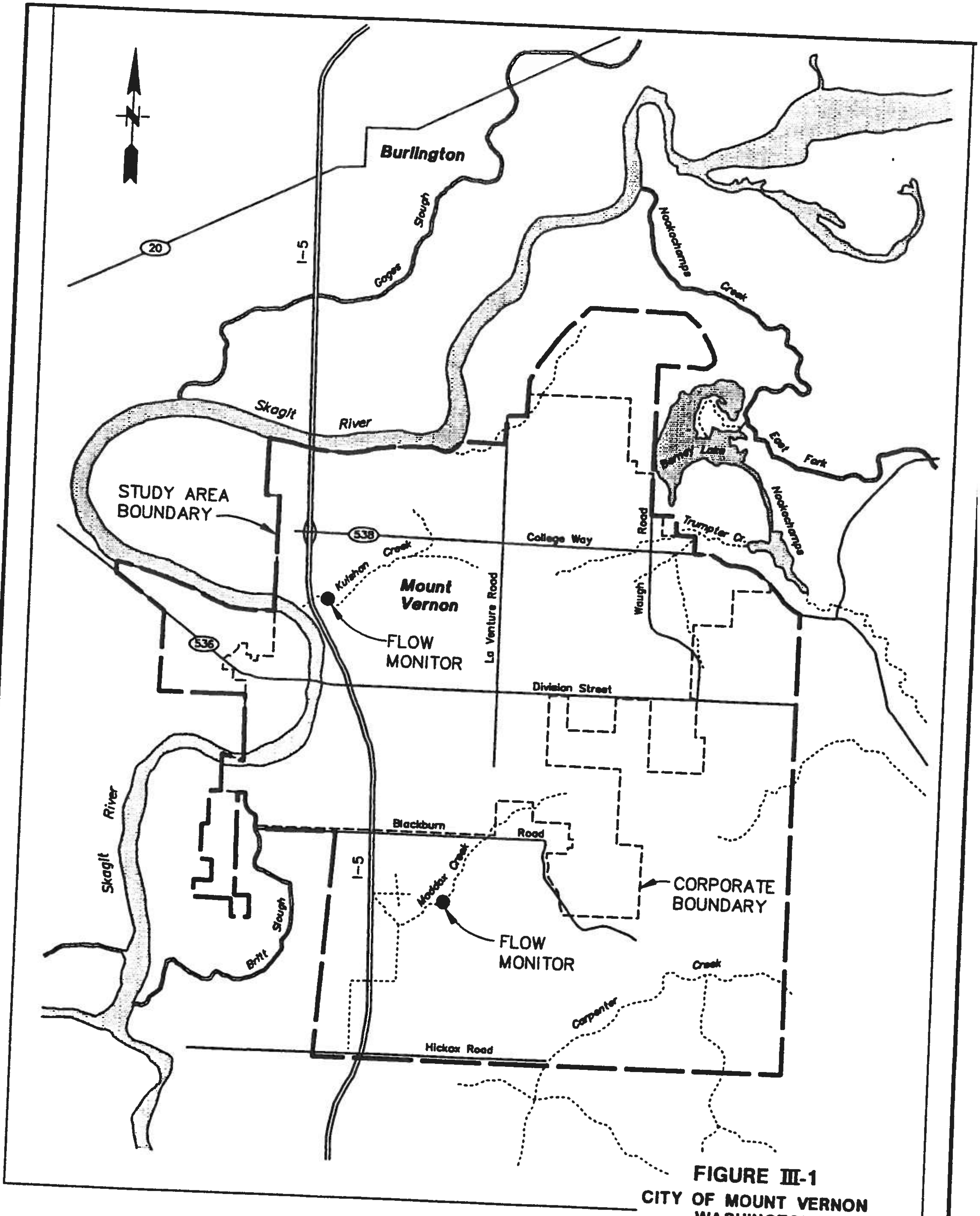

FIGURE III-1

CITY OF MOUNT VERNON WASHINGTON

SURFACE WATER MANAGEMENT PLAN STUDY AREA

R·W·BECK

T.M.G. K:\WAA04\WAA0-033 8-13-93 @ 15:48

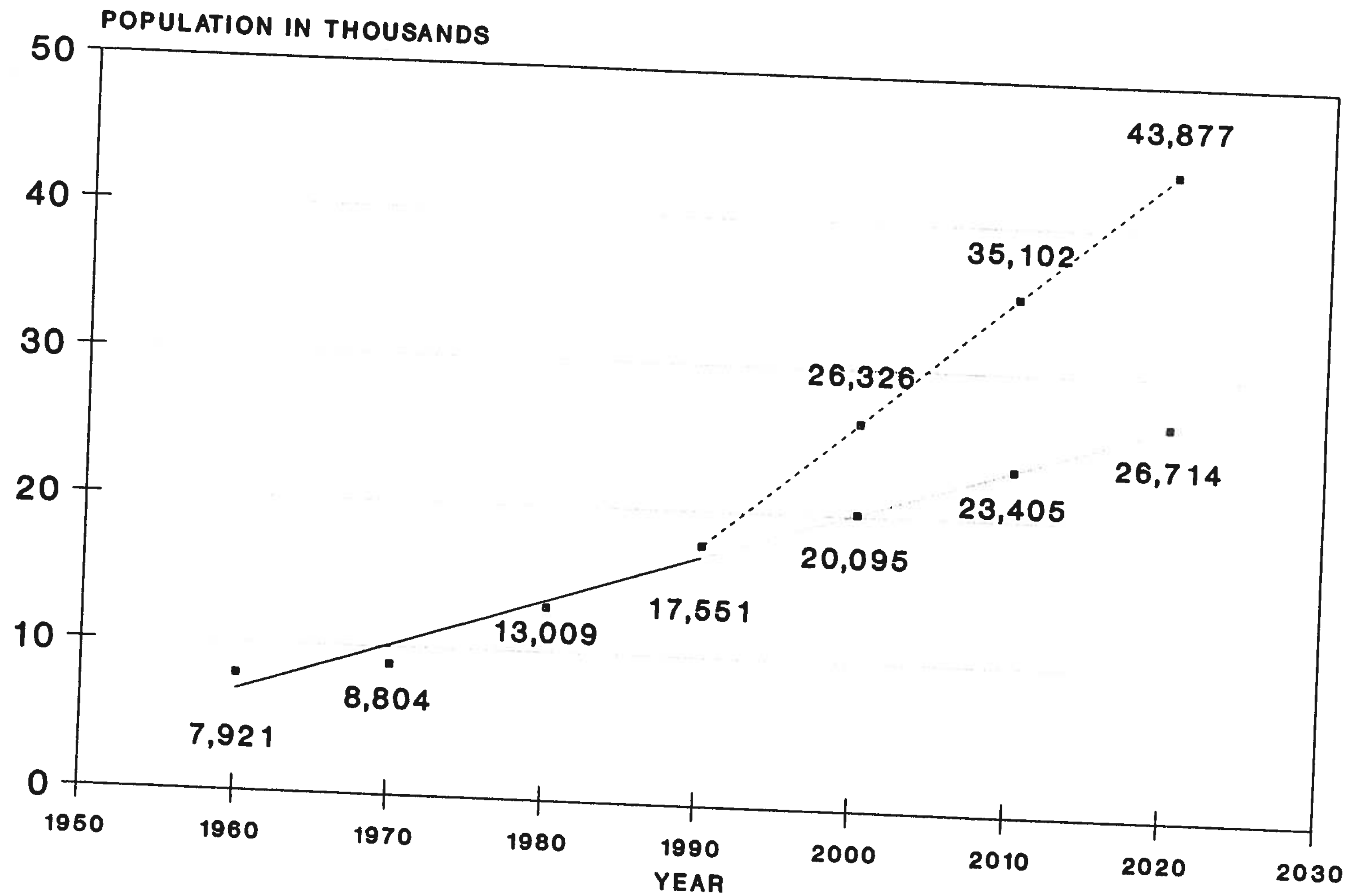

FIGURE II-2
HISTORICAL POPULATION AND
PROJECTED POPULATION GROWTH

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

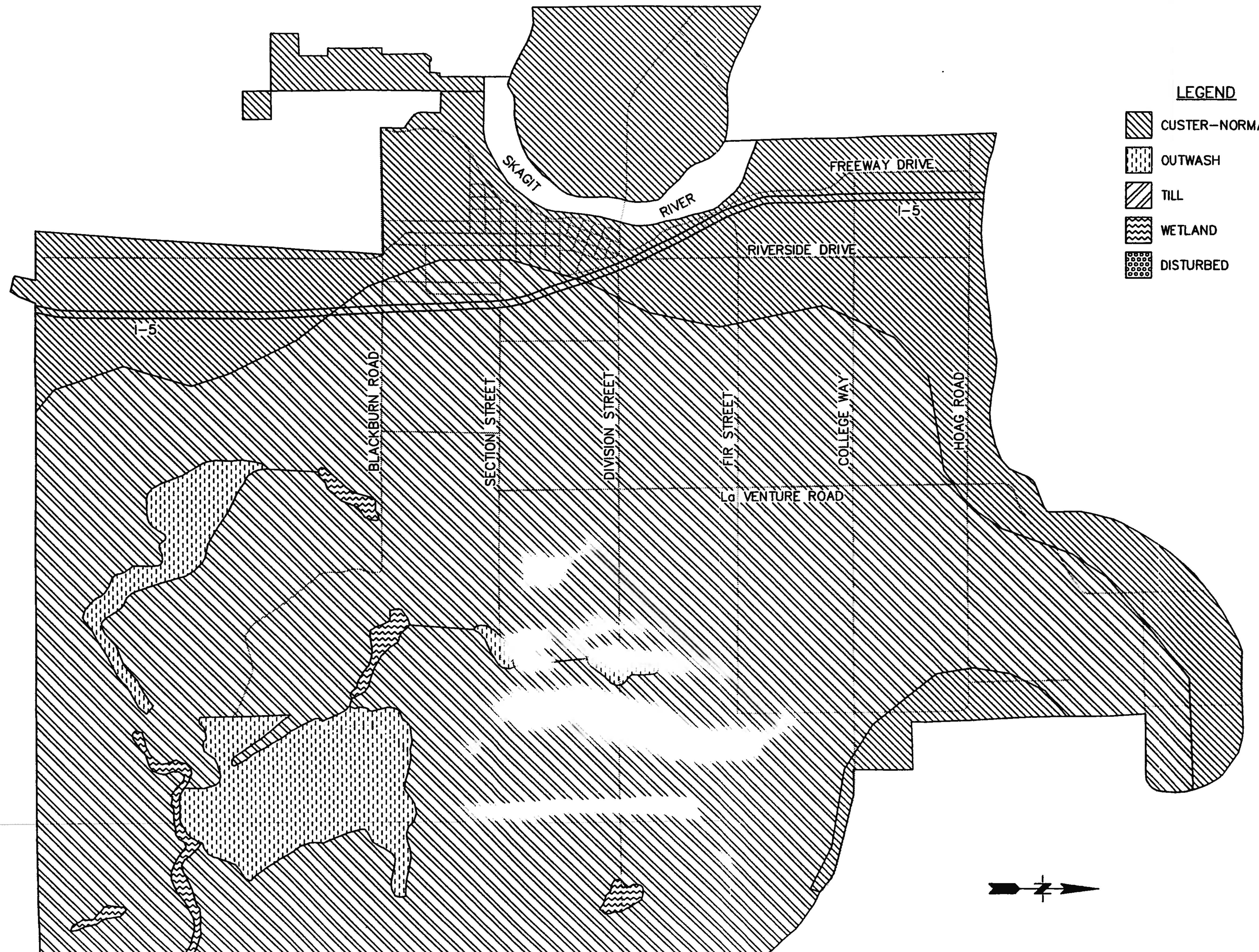

FIGURE III-2
CITY OF MOUNT VERNON
SURFACE WATER
MANGEMENT PLAN

SOIL TYPES

R·W·BECK

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S. K:\MAA04\MAA04002 9-03-93 @ 09:24

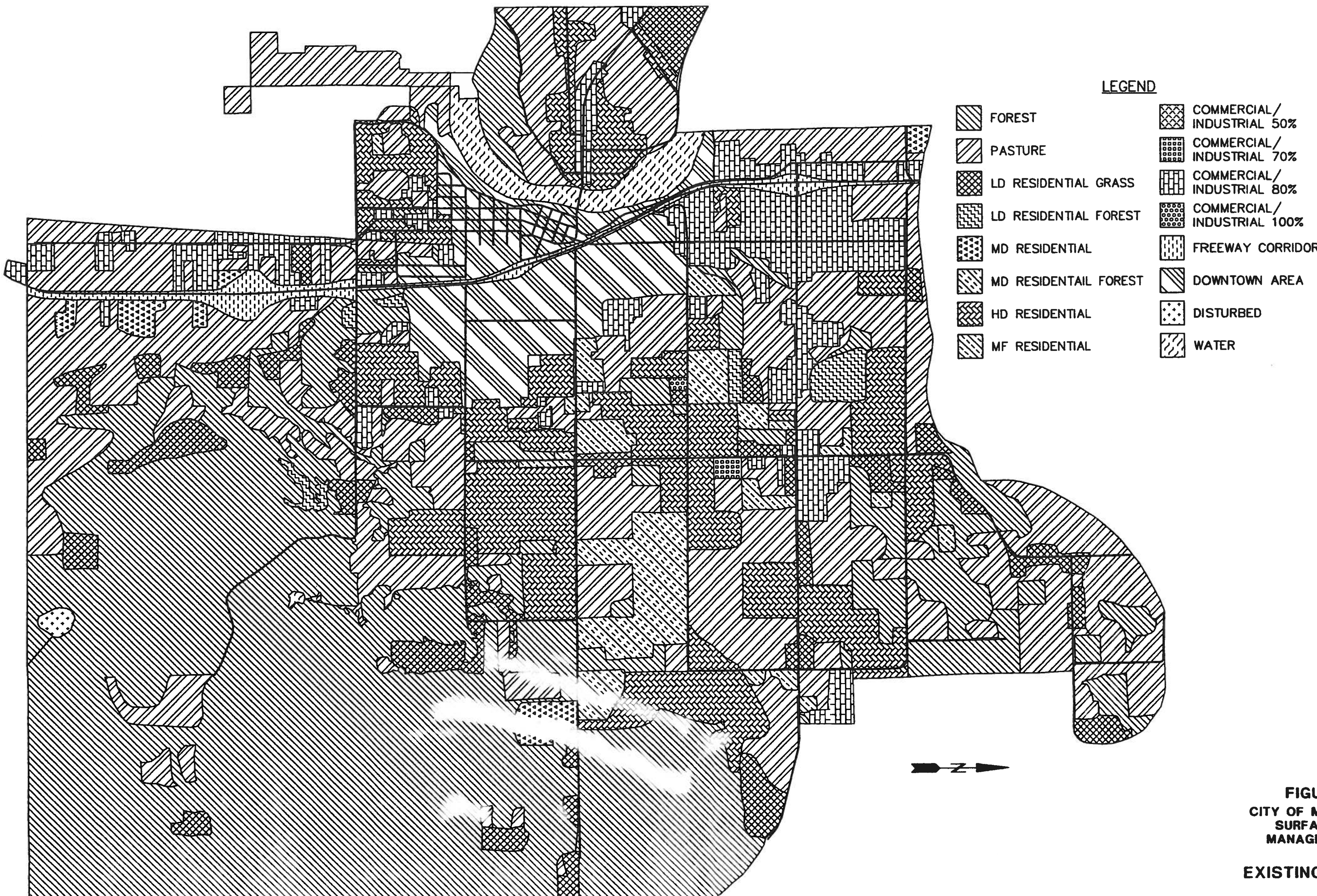


FIGURE III-3
CITY OF MOUNT VERNON SURFACE WATER MANAGEMENT PLAN

EXISTING LAND USE

R·W·BECK

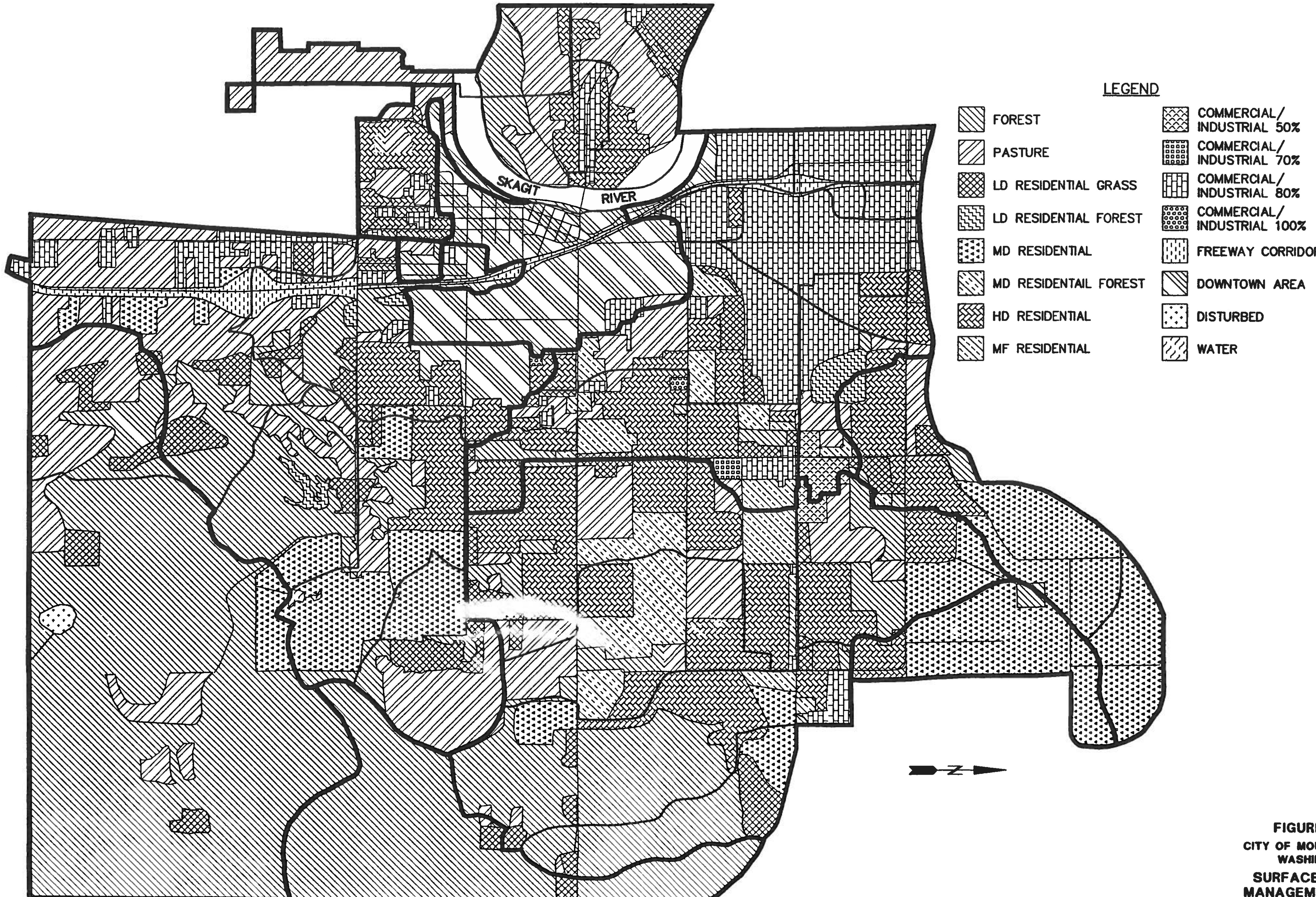


FIGURE III-4
CITY OF MOUNT VERNON
WASHINGTON
SURFACE WATER
MANAGEMENT PLAN
FUTURE LAND USE

R.W. BECK

JM K:\MAA12\MAA12019 11-16-95 @ 12:47

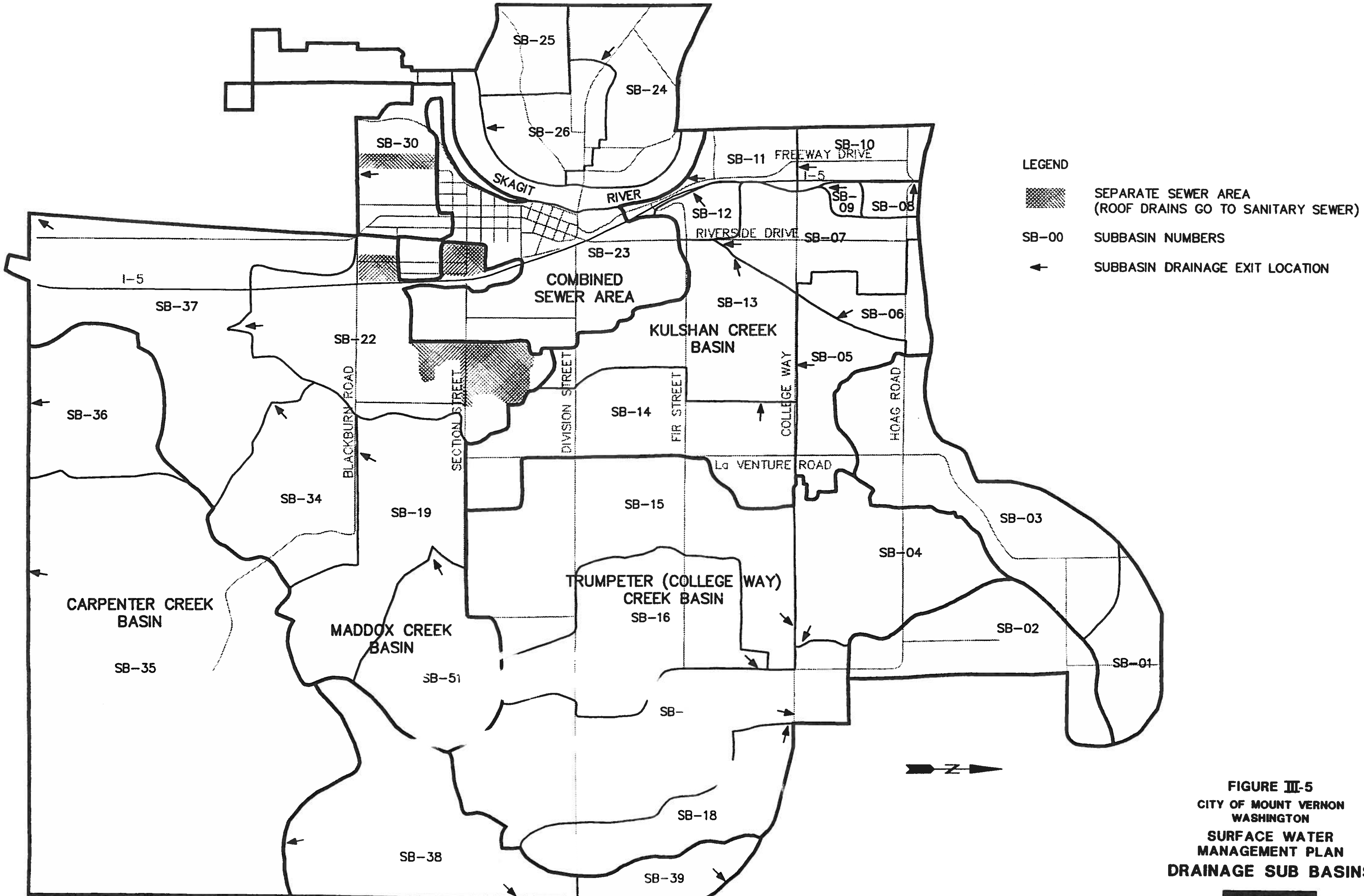


FIGURE III-5

CITY OF MOUNT VERNON
WASHINGTON

SURFACE WATER MANAGEMENT PLAN

DRAINAGE SUB BASINS

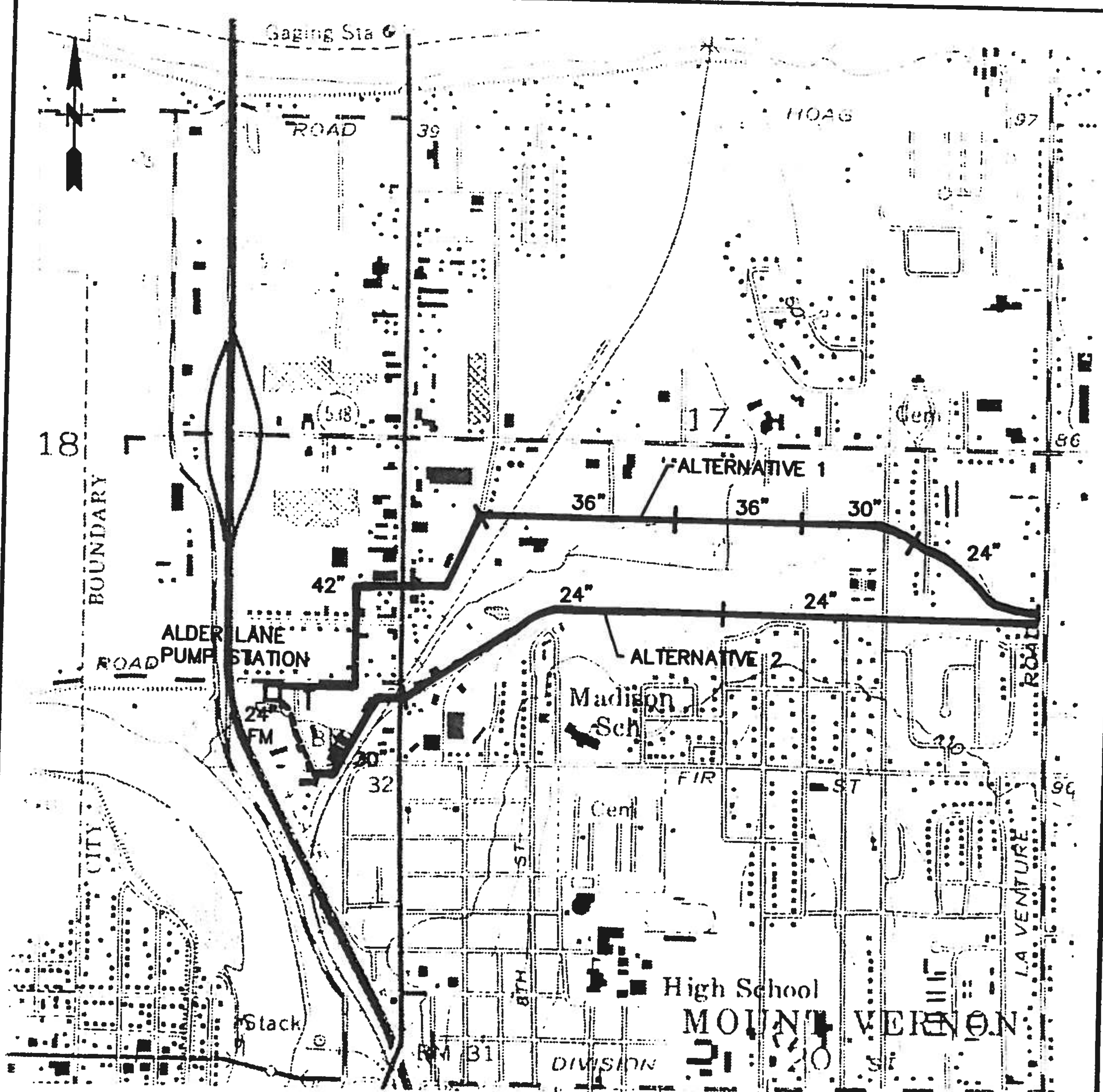


FIGURE III-3

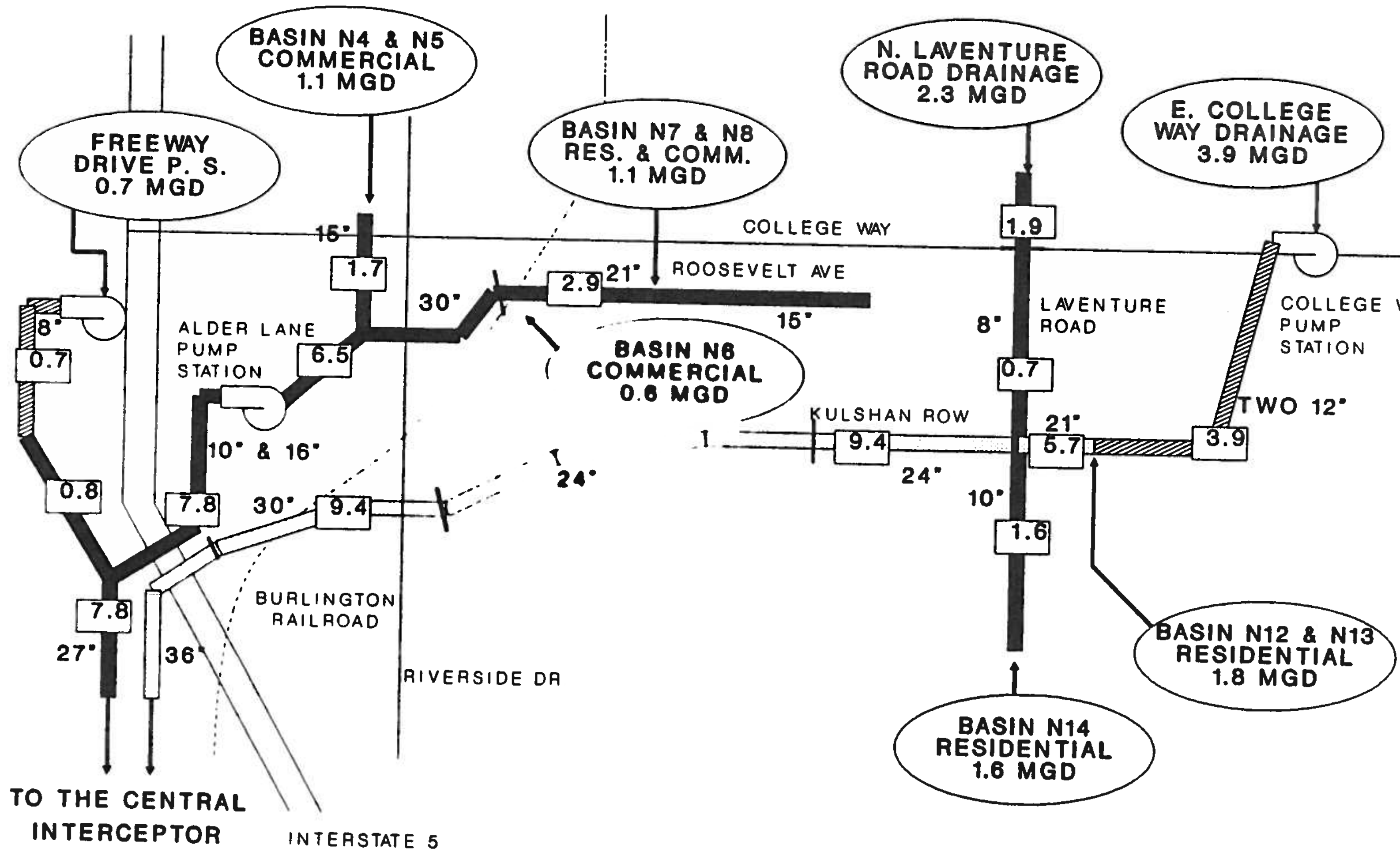
CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER PLAN

KULSHAN INTERCEPTOR ALTERNATIVES

R·W·BECK

EJM C:\TEMP\85X1 ...94 @ 14:29



LEGEND

NEW FORCE MAIN
NEW KULSHAN INTERCEPTOR
EXISTING INTERCEPTOR
RAILROAD TRACKS
3.9 INTERCEPTOR OR FORCE MAIN CAPACITY, MGD

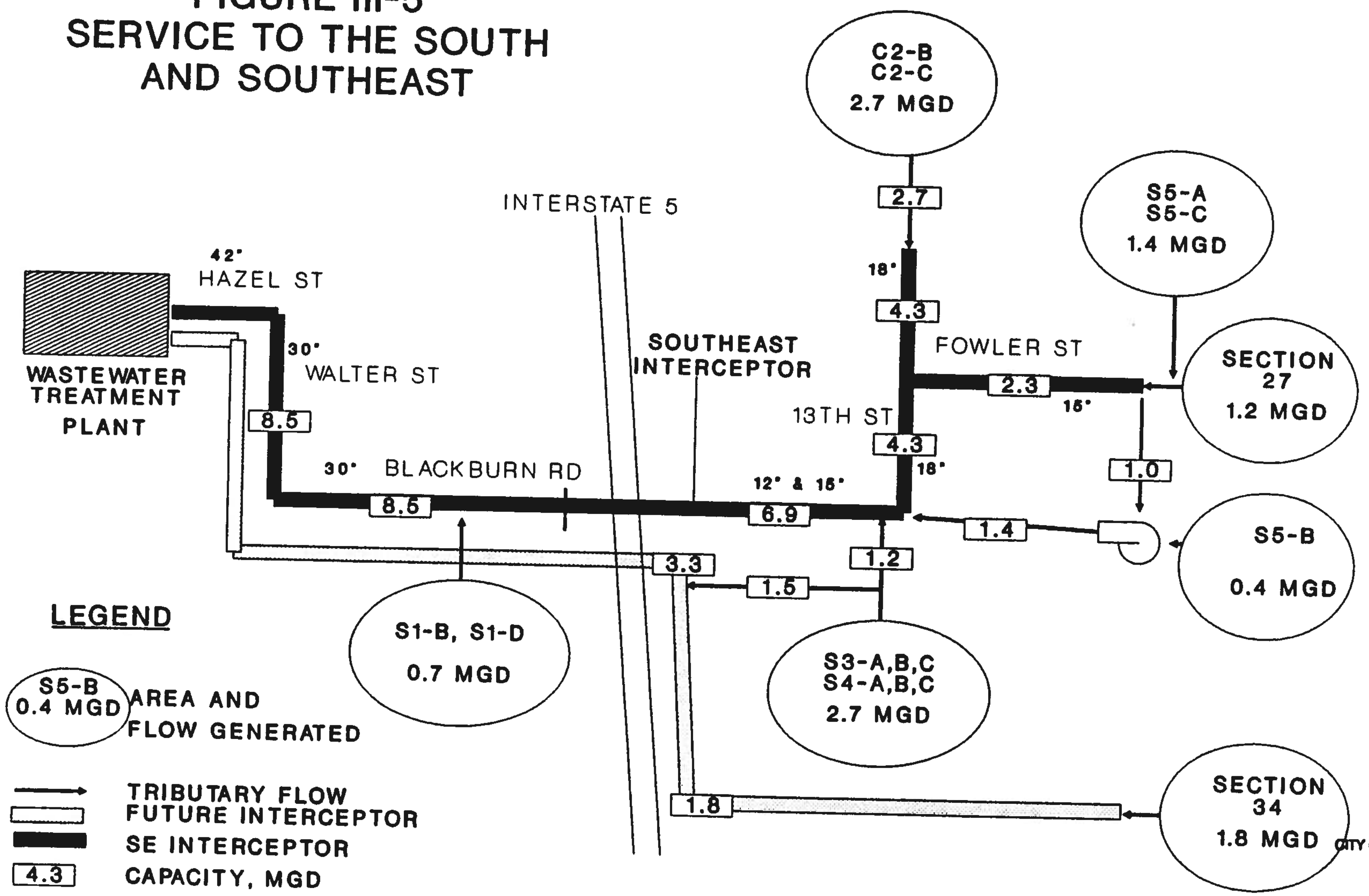
FIGURE III-4
NORTH SERVICE AREA SCHEMATIC

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINEI SEWER OVERFLOW REDUCTION PLANS

R·W·BECK

FIGURE III-5
SERVICE TO THE SOUTH AND SOUTHEAST

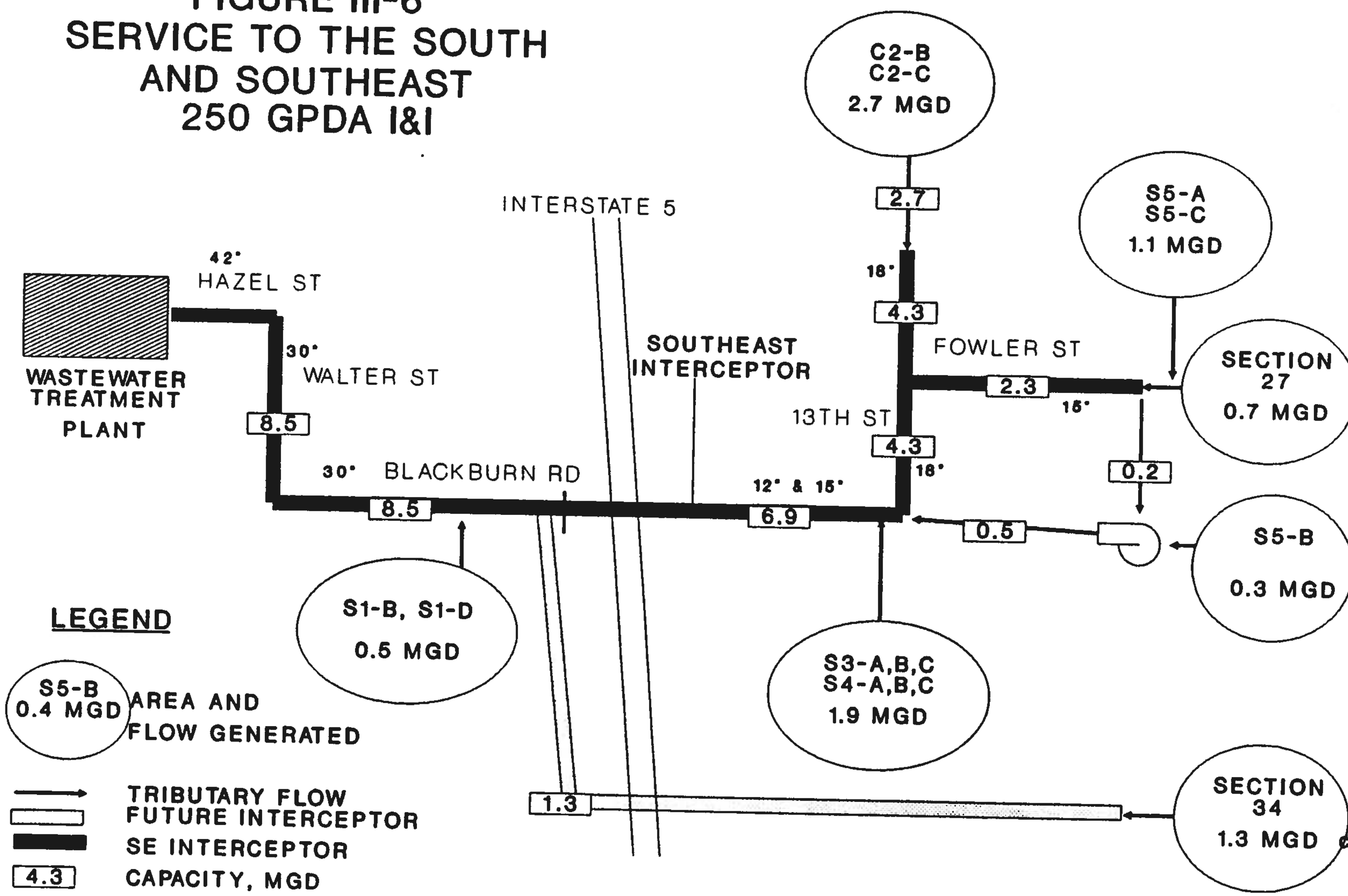


CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINE SEWER OVERFLOW REDUCTION PLANS

R·W·BECK

FIGURE III-6
SERVICE TO THE SOUTH AND SOUTHEAST 250 GPDA I&I

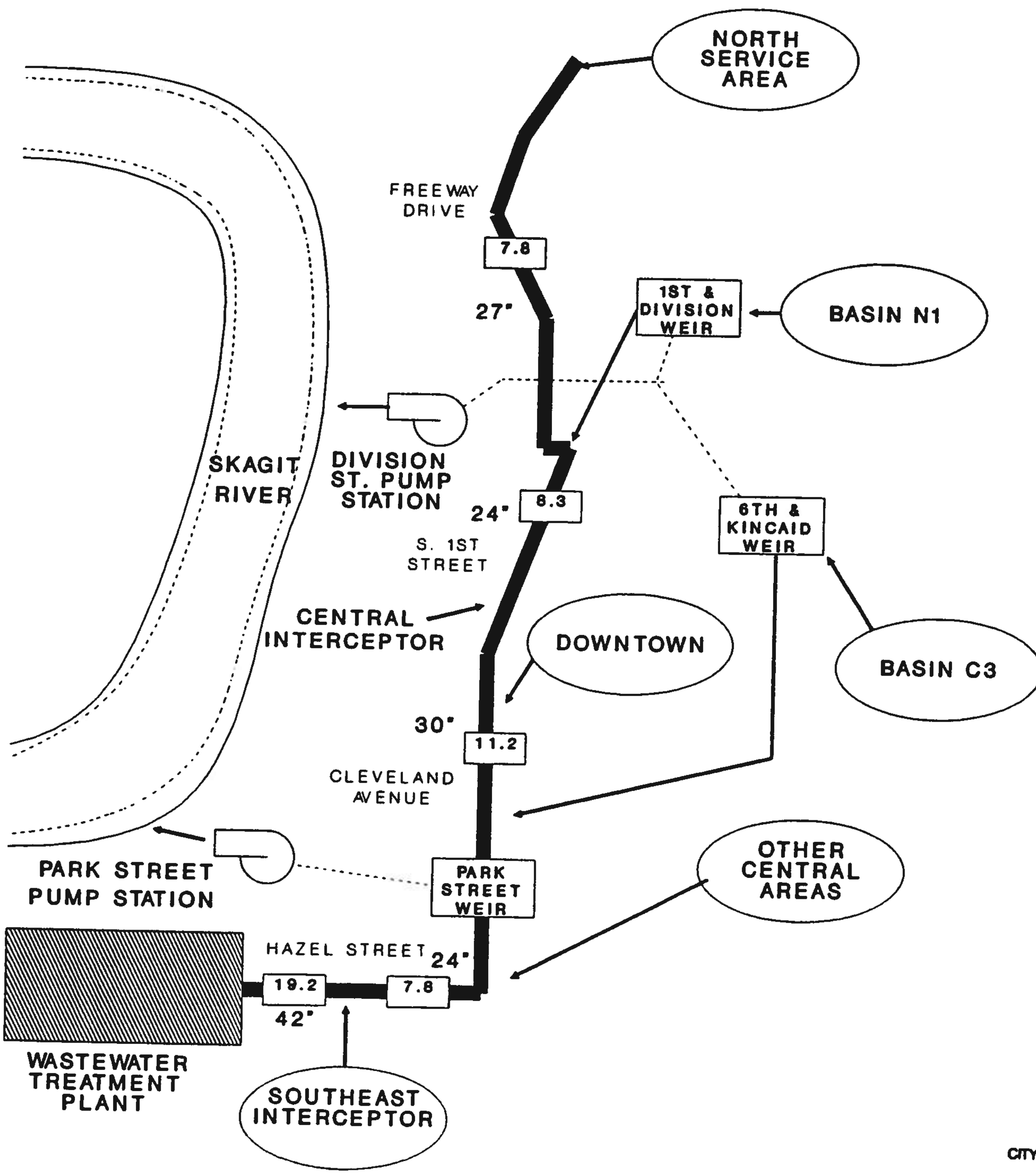


CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINED SEWER OVERFLOW REDUCTION PLANS

R·W·BECK

FIGURE III-7
EXISTING CENTRAL AREA DRAINAGE

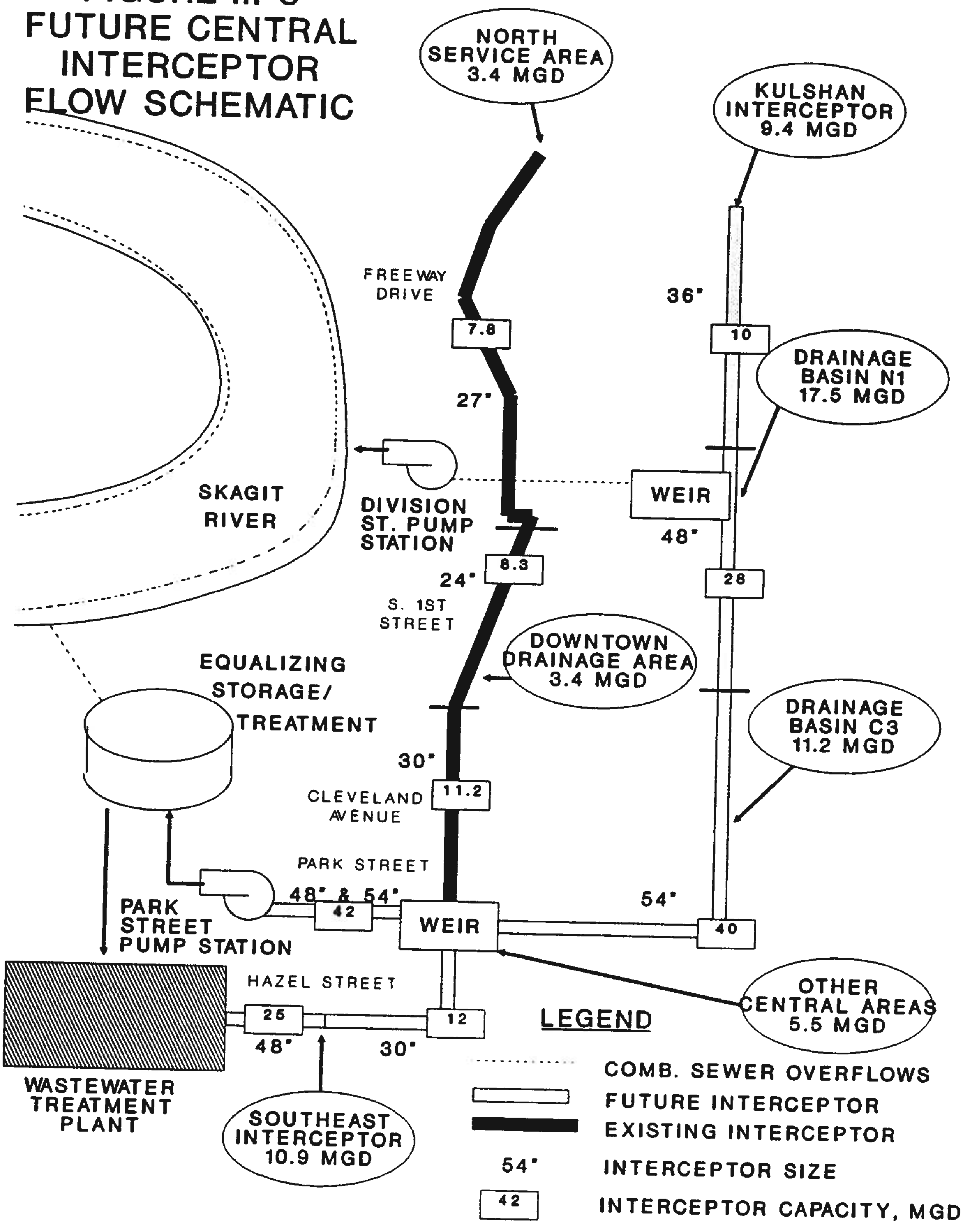


CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

FIGURE III-8
FUTURE CENTRAL INTERCEPTOR FLOW SCHEMATIC



SECTION IV

HSPF HYDROLOGIC COMPUTER ANALYSIS

SECTION IV

HSPF HYDROLOGIC COMPUTER ANALYSIS

A. General

A sophisticated hydrologic analysis was performed for each of the major drainage basins within the study area. This analysis was used to predict runoff volumes and peak flows for storm events with a specified return frequency. This information is necessary to establish design criteria for conveyance, water quality controls, and fish habitat preservation.

B. Hydrologic Modeling

Hydrologic modeling was performed using EPA's HSPF model. HSPF is a sophisticated computer modeling program that simulates land surface and instream hydrologic processes on a continuous basis. The model is used to transform a long time-series of observed rainfall and evaporation data into a time-series of runoff using continuous accounting of soil moisture levels.

The HSPF model provides a distinct advantage over more traditional event-based models. Event-based models simulate streamflow for individual synthetic storms, and their accuracy depends on the user's ability to accurately portray watershed conditions (primarily soil moisture levels) existing before the storm being modeled.

Hydrologic modeling involved four basic steps:

- definition of drainage basin and subbasin characteristics;
- calibration with recorded flow data;
- simulation of runoff for current and future land use conditions; and
- frequency analysis of simulated runoff data to provide design inflow hydrographs to the storm drainage system.

To provide the necessary hydrologic design data for this project, HSPF was used to simulate an extended period of runoff data that was then subject to a frequency analysis.

As noted earlier, HSPF operates by transforming a long sequence of rainfall data into a sequence of runoff data. The exact nature of this transformation is controlled by a number of model parameters. Application of HSPF involves appropriate configuration of the model by characterizing each of the study area basins, selection of model parameters to represent the rainfall/runoff transformation by calibrating the model to continuous flow monitoring devices, performing long-term simulations by applying a time-series of rainfall data representative of local meteorological conditions, and frequency analysis to estimate 2-, 10-, and 100-year runoff values.

1. Basin Characterization

The study area is comprised of seven separate drainage basins: Kulshan Creek, Madox Creek, Carpenter Creek, Nookachamps Creek, Trumpeter Creek, Britt Slough, and West Mount Vernon. Each of those subbasins were further divided into several smaller subbasins. The land use for each subbasin were divided into seven different land use categories: forest, grassland, low-density residential, medium-density residential, high-density residential, multi-family residential, and commercial/industrial. Presented in Tables IV-1 and IV-2 are the existing and future land uses for the study area by basin. Figure III-5 shows the drainage basins and subbasins within the study area. The Flowers Creek basin (subbasin 22) was further divided to perform a hydrologic analysis and evaluate the surface water impacts of the proposed Blackburn Ridge development on the south side of Blackburn Road. The results of that analysis are presented in Appendix M.

HSPF differentiates between impervious and pervious surfaces. The effective impervious area is that portion of the impervious area contributing runoff directly to the drainage system. In low-density residential, medium-density residential, high-density residential, multi-family residential, and commercial/industrial, this was estimated to be 4, 10, 18, 50, and 85 percent, respectively, of the total area in each land use. The commercial/industrial areas were further divided into 50 percent impervious, 70 percent impervious, and 100 percent impervious. Non-effective impervious areas in residential and commercial districts were assumed to have the same hydrologic characteristics as grass or as open pasture overlying the appropriate soil type.

The areas identified in Figure III-5 with shading are unique in terms of the surface runoff they generate. Because these are formerly combined sewered areas, the homes in the areas have roof drains that are connected to the City's sanitary sewer. Therefore, it is assumed that only the runoff generated from the streets and driveways enters the storm drainage system. Subbasin 23 is a combined sewered area and was excluded from the hydrologic and hydraulic analysis. All of the surface runoff in that area flows to the sanitary sewer and is treated at the waste water treatment plant.

The pervious areas within each of the subbasins were further divided into 11 categories based on soil type. Each pervious area category was assumed to have homogeneous hydrologic characteristics. The nine categories of pervious area used were:

(1) Forested outwash soils
(2) Pastured outwash soils
(3) Grassed outwash soils
(4) Forested till soils
(5) Pastured till soils
(6) Grassed till soils
(7) Forested flood plain soils
(8) Grassed flood plain soils
(9) Wetland soils

2. Model Calibration

The hydrologic response of the various pervious and impervious areas is controlled in HSPF by a number of model parameters. The parameter values were adjusted to reflect actual streamflow measurements so that the model will accurately simulate the hydrologic response of a drainage basin. This process of parameter values adjustment is known as model calibration. Model calibration was performed for both the Madox Creek and Kulshan Creek drainage basins where flow monitoring equipment was installed at the beginning of this planning effort. The two drainage basins are very different in terms of existing land use conditions.

Madox Creek is mostly undeveloped with only a small amount of effective impervious surface in that basin. A continuous flow recording device was installed in a 200-foot-long 84-inch-diameter corrugated metal pipe approximately 1200 feet upstream from Anderson Road. The device was used to monitor depth of flow in the pipe. The recorded depths were then converted to flow in CFS using Manning's equation, which was verified by comparison with selected flows measured by a flume at this same location. The total basin area tributary to the monitoring location is approximately 900 acres.

The Kulshan Creek Basin is mostly developed and has a high percentage of effective impervious area. A continuous flow recorder was installed in the 48-inch concrete pipe section of the creek where it parallels the Burlington Northern railroad track on the east side of and approximately 200 feet downstream of Riverside Drive. The total basin area tributary to the monitoring location is approximately 1125 acres.

Calibrating both of the drainage basins using recorded flow data verified that the selected parameter values produced reasonable results for both Madox Creek and Kulshan Creek. Once the parameter values were adjusted for the Madox and Kulshan Creek basins, these same values were used to produce predicted flowrates for the other five drainage basins within the study area.

The period used to calibrate the model was from December 1991 through February 1993. Flow data were collected on both Kulshan Creek and Madox Creek during that period at the locations identified in Figure III-5 and previously described. Precipitation data were collected at the Mount Vernon Waste Water Treatment Plant during the same period. Both the flow and precipitation data were collected with equipment that provided this information on a fifteen minute time increment.

The calibration process involved adjustment of certain model parameter values to produce simulated flow volumes for the calibration period which were similar to the recorded flow volumes. Once the volumes were accurately simulated, other parameter values were modified to produce simulated hydrographs for individual precipitation events which were similar to the recorded hydrographs.

The calibration period was extended from the original plan to monitor only the 91-92 wet weather season because of the lack of data for a large storm. By including the 92-93 wet season, there was a greater chance that data from a large storm could be collected.

which would improve the accuracy of the model simulation for larger storm events. In spite of this extended calibration period, the largest precipitation event that occurred during the calibration period was in January of 1992. The flow and precipitation data from that storm event were used to fine tune the calibration of the HSPF model. Based on the frequency analysis performed for the long term simulation as described in the subsequent subsection the return period for the January 1992 event is approximately a three-year event.

The calibration process produced a set of parameter values that could be used to represent both Kulshan Creek and Madox Creek drainage basins. One parameter was assigned different values for the Madox Creek and Kulshan Creek calibration. The value for "DEEPFR" used for the Kulshan Creek calibration was 0.85. This means that 85 percent of the portion of the rainfall that enters the groundwater system never reenters the creek and continues down gradient until it reaches the Skagit River. This assumption is based on the fact the topography is flat. Also, the creek in the lower portion of the basin is contained in a 48-inch concrete conduit, which precludes subsurface groundwater flows from entering the system. Because of the length of time it takes for groundwater flows to reach surface waters downgradient, the peak flows in the area streams are not affected by the groundwater flows in the system. However, because some portion of the groundwater flows do eventually reach surface waters, the volumes of surface water runoff are affected by the groundwater contribution. For that reason, in areas where the HSPF model was used to simulate alternative solutions involving detention storage, careful consideration was given to the amount of groundwater that could reasonably be expected to enter the surface water system. The value of the "DEEPFR" parameter was set to 0.0 for the other basins.

There are some indications that the peak flow estimates generated by the HSPF model may be too high and could lead to overly conservative designs. One indication is the flow period used to calibrate the model. Although the flow monitoring was extended to include the 92-93 wet season in addition to the 91-92 wet season, unfortunately this period coincided with two of the driest winters in recent years. As noted above, only one moderately large storm event occurred during this period (January 1992) and it was only approximately a three-year event. The calibration is therefore based on minimal amount of high flow data.

Further uncertainty about the peak flows estimates arises when comparing flows predicted by HSPF with reported occurrences of flooding on Kulshan Creek. The HSPF model for current land use conditions predicts peak flows on Kulshan Creek below Riverside Drive of 110 cfs with a return period of about 2.5 years. Hydraulic analysis of the current pipeline capacity below Riverside Drive indicates that flows of this magnitude with free outflow to the Skagit River would produce water levels at about elevation 27 feet. Since serious flooding would occur if the water level in the area exceeded elevation 26, this would indicate that serious flooding should occur about once in every two years on average. Although serious flooding occurred in November 1990 as a result of inadequate pump station capacity, there is no evidence to suggest that flooding occurs as frequently as once every two years as the result of limitations in the pipeline capacity under gravity flow conditions. This observation therefore suggests that the current estimates of peak flows under current and future land use conditions are too high. It follows that design based on these peak flows might be overly conservative.

The graphs in Figures IV-1 and IV-2 show the results of the calibration for the January 1992 event for Madox Creek and Kulshan Creek respectively. Each graph shows two lines. One line represents actual flow measurements, and the other line represents the HSPF computer simulation of flow at the same location.

3. Long Term Runoff Simulation

The calibrated HSPF model was then used by inputting 36 years of hourly rainfall data from the NOAA Weather Station in Burlington, Washington to simulate 36 years of runoff for each subbasin for each pervious land use category and for impervious areas. For pervious areas, HSPF splits runoff into a surface, interflow and groundwater component. For each subbasin, careful consideration was given as to which of these three components of runoff could reasonably be assumed to enter the pipe or channel system. In general, it was assumed that the surface runoff component generated within a subbasin would leave the subbasin as a surface water discharge at its defined outlet point in either a stream channel or a major storm drain. Interflow (shallow groundwater flow) generated within a subbasin was assumed to either leave the subbasin by reaching a surface water system at its defined outlet point or the interflow would continue to accumulate as subsurface flow moving downslope in a dispersed manner to the next downslope subbasin. Interflow was assumed to enter the surface water system only if shallow subsurface movement of water could reasonably be expected to be intercepted by roadside ditches. Otherwise, the model assumed it continues to flow downhill until intercepted by a perennial stream channel. The groundwater component of runoff was generally assumed not to enter pipe systems in the basin. Remaining groundwater was assumed to flow downslope until it reached a defined stream channel.

HSPF was used to combine runoff data from the effective impervious and pervious areas for the surface, interflow, and groundwater runoff components. This process gave a 36-year time-series of outflows at selected points for each subbasin.

Runoff was simulated for both the existing land use and the future buildout condition.

4. Frequency Analysis

Peak annual discharges were determined for each of the 36 years of simulated flows and subjected to frequency analysis. Frequency analyses were used to estimate the peak 2-, 10-, and 100-year runoff values at selected locations for both existing and future land use conditions. The results of the frequency analyses are presented in Tables IV-3 and IV-4 for future and existing land use conditions, respectively. The future runoff condition assumes that no onsite or regional controls are effective in reducing peak flows. As part of the work performed for Section VII, frequency analyses were also used to evaluate the effectiveness of alternative structural solutions. The HSPF model was modified as part of that work to simulate the effects of alternatives involving detention. As discussed in Section VII, comparisons of peak runoff were made for the alternatives to evaluate their effectiveness.

C. Use of Hydrology for Evaluating New Development Projects

The hydrologic data contained in Table IV-4 can be used to determine peak flows from smaller areas within individual subbasins. This may be useful for establishing design criteria for new conveyance improvements. This table shows the total acreage, and return period flows for each subbasin in the study area under future land use conditions. The return period flows listed are for the 2, 10, and 100 year return frequencies.

To provide flow information for design, the drainage area tributary to any proposed conveyance improvements should be calculated. This smaller tributary area should be divided by the total subbasin area in which it is contained to determine the fraction of the subbasin area tributary to the proposed conveyance improvements. This fraction is multiplied by the flows for the subbasin presented in Table IV-4 to determine the appropriate flow for the smaller tributary area for the various return periods.

Some care should be taken when applying this methodology. This methodology assumes that the future land use within the entire larger subbasin is somewhat uniform. If a significant portion of the future land use within a subbasin is undeveloped, the undeveloped area should be subtracted from the total subbasin area before the subbasin area is used in any of the calculations described above. To assist in determining whether the future land use within any individual subbasin is uniform, the subbasin boundaries are shown together with the future land use on Figure III-4.

Table IV-1
City of Mount Vernon

Existing Land Use in Acres

LAND USE	Drainage Subbasin				
	Kulshan Cr.	Trumpeter Cr. (College Way Cr.)	Madox Cr.	Carpenter Cr.	Area to Nookachamps
Commercial					
100% Impermeable	3.10	0.00	1.50	0.00	0.00
80% Impermeable	388.80	22.60	212.60	0.00	0.00
50% Impermeable	31.00	15.40	0.00	0.00	0.00
Total Commercial	422.90	38.00	214.10	0.00	0.00
Residential					
Multifamily	89.00	25.70	0.00	0.00	0.00
High Density	242.10	442.60	156.80	0.00	30.40
Medium Density	50.50	208.60	35.80	0.00	0.00
Low Density (forested)	36.50	6.00	20.80	35.70	0.00
Low Density (grassland)	40.50	106.10	146.40	18.80	16.30
Separate Sewer Area	0.00	0.00	103.00	0.00	0.00
Total Residential	458.60	789.00	462.80	54.50	46.70
Forest	87.70	700.60	730.20	3,319.60	340.30
	435.10	485.20	577.00	378.60	100.50
Total Land Use Area	1,404.00	2,013.00	1,984.00	3,753.00	488.00

Table IV-2
City of Mount Vernon

Future Land Use in Acres

LAND USE	Drainage Subbasin				
	Kulshan Cr.	Trumpeter Cr. (College Way Cr.)	Madox Cr.	Carpenter Cr.	Area to Nookachamps
Commercial					
100% Impermeable	3.10	0.00	1.50	0.00	0.00
80% Impermeable	682.02	27.10	212.60	0.00	0.00
50% Impermeable	30.99	15.36	0.00	0.00	0.00
Total Commercial	716.11	42.46	214.10	0.00	0.00
Residential					
Multifamily	97.12	70.55	0.00	0.00	0.00
High Density	319.47	619.40	200.73	0.00	30.40
Medium Density	31.97	328.39	320.00	118.01	448.90
Low Density (forested)	26.18	6.00	20.77	0.00	0.00
Low Density (grassland)	58.58	127.42	142.71	54.41	0.00
Separate Sewer Area	0.00	0.00	103.00	0.00	0.00
Total Residential	533.32	1,151.76	787.21	172.42	479.30
Forest	37.13	560.10	431.03	3,129.77	8.17
Pasture	117.30	258.71	551.24	450.18	0.00
Total Land Use Area	1,404.00	2,013.00	1,984.00	3,753.00	488.00

Table IV-3
City of Mount Vernon

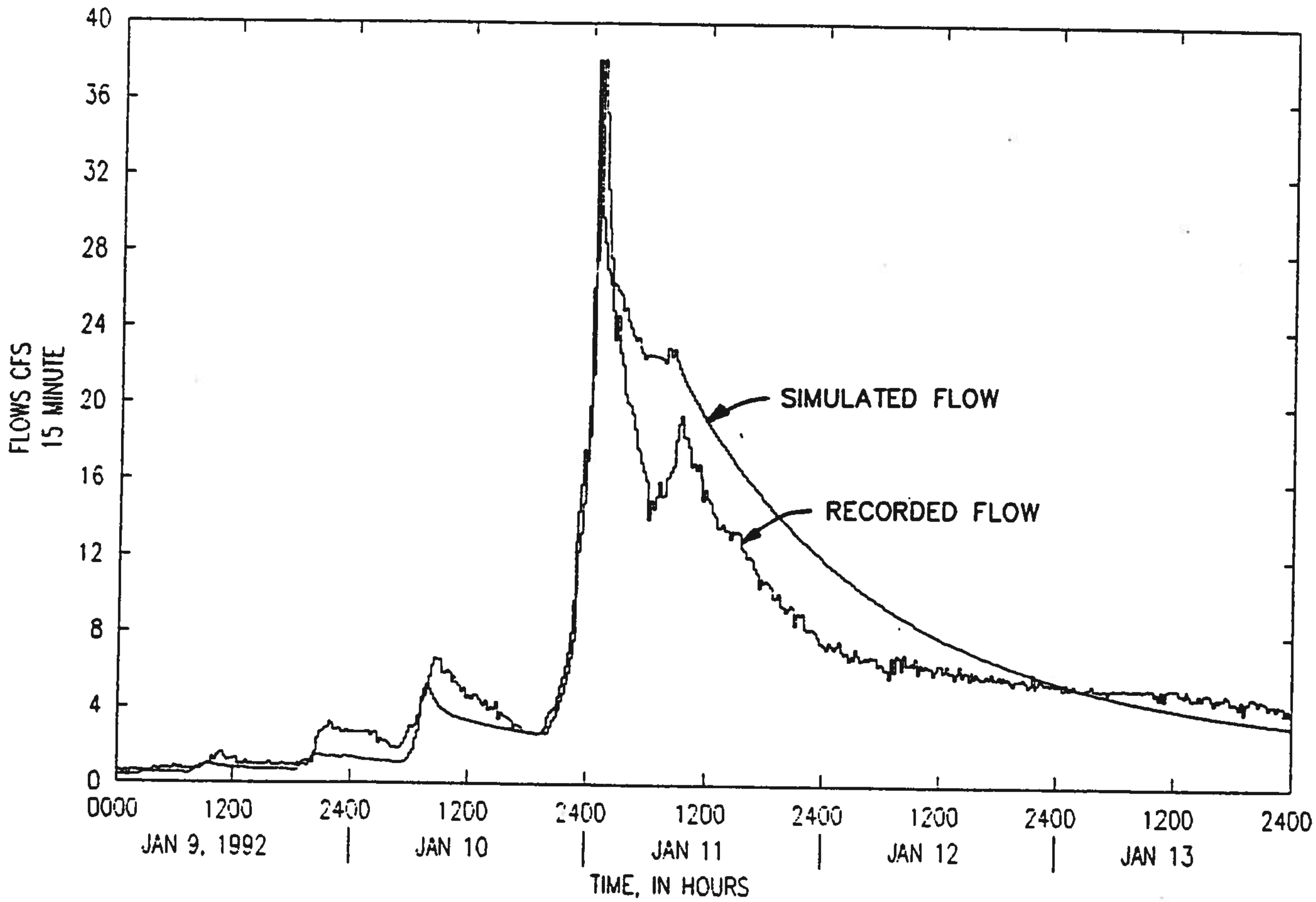
Existing Land Use and Existing Drainage System
Peak Flows (cfs)

Drainage Basin	Drainage Subbasin	Return Period (years)		
		2	10	100
Skagit River Tributary	SB-01	4.6	7.4	10.8
	SB-03	19.7	32.4	51.8
Riverbend Road	SB-08	2.0	3.1	5.0
	SB-09	1.2	1.8	2.8
	SB-10	8.3	12.7	20.2
	SB-11	10.3	15.6	23.9
West Mount Vernon	SB-24	10.8	17.2	27.9
	SB-25	3.9	6.0	8.2
	SB-26	10.2	15.2	23.1
Kulshan Creek	SB-05	13.1	20.1	30.8
	SB-14	37.2	58.2	91.5
	SB-13	57.3	74.0	90.9
	SB-06	11.7	18.0	27.1
	SB-07	25.2	38.5	57.9
Entire Kulshan Creek Basin at Pump Station	SB-05, 14, 13, 06, 07, 12	96.9	132.0	173.0
Trumpeter Creek	SB-04	18.3	31.9	54.7
	SB-15	42.2	74.5	134.0
	SB-04, 15	59.3	103.0	183.0
	SB-16	21.9	40.4	82.0
	SB-17	30.9	53.5	100.0
	SB-16, 17	51.8	91.2	160.0
	SB-18	8.7	15.0	22.5
Nookachamps Creek	SB-02	11.6	19.5	30.6
Madox Creek	SB-51	12.0	20.0	32.0
	SB-51, 19	17.0	25.0	40.0
	SB-51, 19, 34	28.0	45.0	70.0
	SB-22	40.1	64.6	107.0
	SB-37	40.3	61.6	93.6
Entire Madox Creek Basin	SB-51, 19, 34, 22, 37	95.0	170.0	280.0
Carpenter Creek	SB-35	99.2	174.0	267.0
	SB-36	10.9	19.1	29.8
Britt Slough	SB-30	14.6	22.4	35.7

Table IV-4
City of Mount Vernon

Future Land Use and Existing Drainage System
Peak Flows (cfs)

Drainage Basin	Drainage Subbasin	Area (Acres)	Return Period (years)		
			2	10	100
Skagit River Tributary	SB-01	125	4.8	8.32	13.2
	SB-03	395	25.1	41.9	73.4
Riverbend Road	SB-08	27	5.9	8.9	71.4
	SB-09	15	3.4	5.1	7.4
	SB-10	99	21.6	32.5	47.1
	SB-11	91	19.9	29.9	43.4
West Mount Vernon	SB-24	208	10.8	17.2	27.9
	SB-25	101	3.9	6.0	8.2
	SB-26	140	10.2	15.2	23.1
Kulshan Creek	SB-05	146	15.8	24.2	37.0
	SB-14	384	41.4	64.3	99.7
	SB-13 (includes SB-05 and 14)	843	66.6	84.7	106.0
	SB-06	89	16.1	24.4	36.0
	SB-07	190	34.5	52.3	77.0
Entire Kulshan Creek Basin at Pump Station	SB-05, 14, 13, 06, 07, 12	1172	121.0	163.0	210.0
Trumpeter Creek	SB-04	327	23.3	41.5	77.2
	SB-15	561	52.1	88.1	154.0
	SB-04, 15	888	74.1	127.0	226.0
	SB-16	365	26.8	30.0	100.0
	SB-17	543	33.3	57.1	105.0
	SB-16, 17	908	58.6	103.0	190.0
	SB-18	216	9.4	16.0	24.2
Nookachamps Creek	SB-02	253	19.1	34.9	65.2
Madox Creek	SB-51	283	18.0	31.0	70.0
	SB-51, 19	615	35.0	70.0	120.0
	SB-51, 19, 34	901	50.0	90.0	170.0
	SB-22	469	40.7	65.9	109.0
	SB-37	616	40.3	61.6	93.6
Entire Madox Creek Basin	SB-51, 19, 34, 22, 37	1989	110.0	205.0	350.0
Carpenter Creek	SB-35	2622	100.0	177.0	230.0
	SB-36	261	11.3	19.7	31.2
Britt Slough	SB-30	169	14.5	22.4	35.6



MADDOX CREEK
CALIBRATION
JAN 9 1992 THRU JAN 13 1992

FIGURE IV-1
CITY OF MOUNT VERNON
SURFACE WATER MANAGEMENT PLAN
HSPF RESULTS FOR JANUARY 1992 EVENT ON MADDOX CREEK

R·W·BECK

JAW C:\TEMP\MARY\ 9 @ 11:06

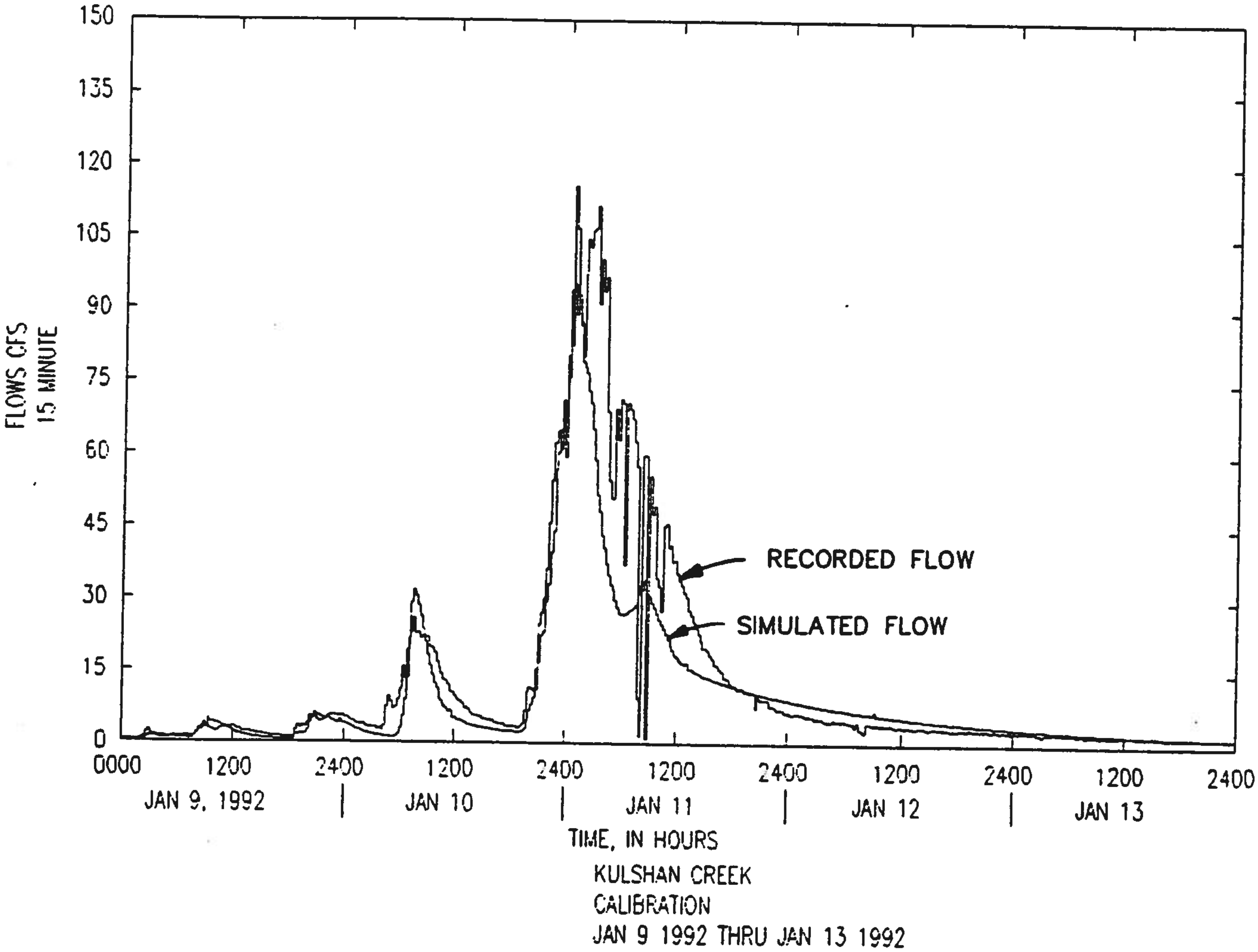


FIGURE IV-2

CITY OF MOUNT VERNON

SURFACE WATER MANAGEMENT PLAN

HSPF RESULTS FOR JANUARY 1992 EVENT ON KULSHAN CREEK

R·W·BECK

SECTION V
EXISTING POLICIES, ORDINANCES AND REGULATIONS

R·W·BECK

SECTION V

EXISTING POLICIES, ORDINANCES AND REGULATIONS

A. Introduction

This section includes a review of the existing City, state, and federal policies, regulations, and ordinances relevant to surface water management.

B. Relevant City Policies, Ordinances and Regulations

This section provides an overview of the City's relevant policies, ordinances, and regulations to surface water management.

1. City of Mount Vernon Municipal Code

   a. Chapter 2673 Drainage Ordinance. The City has recently adopted a new drainage ordinance that fulfills the minimum requirements for development standards as required by the *Puget Sound Water Quality Management Plan*. These minimum requirements for stormwater facilities and Best Management Practices (BMPs) are described in Ecology's *Stormwater Management Manual for the Puget Sound Basin*.

   b. Chapter 16.32 Short Plats and Sub-Divisions. This chapter includes requirements for specific design standards for short plats and subdivisions served by private roads.

      These include requirements that storm drainage runoff from the easement road be directed away from other properties and preferably into the public storm-sewer or drainage system and that all sewer, drainage and roadway improvements be designed by a professional civil engineer registered in the state of Washington.

   c. Chapter 15.36 Floodplain Management Standards. This chapter outlines regulations and conditions for floodplain development. City development regulations are identical to State of Washington floodplain development regulations. State regulations are, in turn, consistent with National Flood Insurance Program regulations promulgated by FEMA, with the single exception of residential development within a designated floodway.

      City regulations require the submittal of a development permit application for properties within an "area of special flood hazard" so that the City Building Official may review flood hazard area status and proposed flood control/floodproofing measures in consideration of the permit.

Significant features of City floodplain management standards include the following:

(1) City-designated "areas of special flood hazard" are identified by FEMA in its Flood Insurance Study and associated Flood Insurance Rate Maps (FIRM) prepared in 1985. These include the extent of the 100-year base flood, based on topography and the base (100-year) flood elevation profile.

(2) Residential and nonresidential development within the areas of special flood hazard is permitted under specific fixed floor elevation and floodproofing conditions for new construction or substantial improvements of existing structures. New residential construction or substantial improvements are required to elevate lowest floors one foot above the base flood elevation. Nonresidential construction or substantial improvements are required either to elevate lowest floor one foot above the base flood elevation or provide watertight floodproofing to one foot above the base flood elevation.

(3) Construction of residential structures in the floodway (designated as Zone AI on the FIRM maps) is prohibited except for repairs to an existing structure that do not exceed 50 percent of its market value.

(4) New construction within the AO zones must be elevated one foot above the elevation specified on the FIRM.

(5) Regulations specify conditions for structure anchoring and pressure equilibration, floodproofing materials, piling, and development utility provisions.

(6) Provisions for noncompliance penalties, appeals, and variances are provided. Variances involving floodway development will not be considered if an increase in base flood elevation will result.

2. Critical Areas Ordinance #2482

This ordinance was adopted February 26, 1992 to comply with the requirements of the Growth Management Act (GMA) which was passed by the Washington State Legislature in 1990. A brief summary is also provided here.

The GMA requires the fastest growing counties (including Skagit County and the Cities within Skagit County) to comply with the act. The act requires these cities and counties to develop local comprehensive land use plans and development regulations. It also requires that cities and counties classify, designate and develop regulations to protect certain critical areas prior to the completion of comprehensive land use plans. The critical areas include:

- Wetlands;
- Streams;

- Fish and wildlife habitat conservation area;
- Areas of potential geologic instability or hazard; and
- Hillside developments.

The first three critical areas have a direct impact on surface water and are discussed in detail later in this section.

The intent of the critical area designation is to require cities and counties to provide regulatory protection of these critical areas prior to the development and adoption of comprehensive land use plans. Mount Vernon's critical areas ordinance requires that permits be obtained from the City for any activity which alters or disturbs an environmentally sensitive area as defined by the Critical Areas Inventory Maps or by separate studies. Further, no development permits shall be granted for any lot which contains or is adjacent to an environmentally sensitive area until approvals as required by this ordinance have been granted by the City.

The following paragraphs provide a summary of the recommendations pertaining to critical area designations and interim policies for each critical area.

a. Wetlands. Wetlands and associated buffers may be altered provided that:

- The city approves a mitigation plan, construction techniques and appropriate permits before any site work occurs.

- The plans and proposals comply with all applicable state and federal laws and regulations.

A wetland buffer zone is defined as the area up to 25 feet from a wetland edge as marked in the field. Regulating activity in the 25-foot buffer is presumed to provide necessary and sufficient protection to the wetland, but may be increased pursuant to the following paragraph.

The City may require increased buffer widths as necessary to protect wetland functions and values, based on local conditions. The areas where an increased buffer may be required include areas where adjacent land is susceptible to severe erosion, areas where a larger buffer is necessary to maintain viable populations of existing species or to prevent degradation or alteration of existing hydro-regime.

Building setback of ten feet is required from the edge of any wetland buffer. Minor structural intrusions into the area may be allowed if the City determines that such intrusions will not negatively impact the wetland.

b. Streams. The standard buffer width for streams depends upon the stream's classification according to WAC 222-16-030, Forest Practice Regulations.

- Category I. Category I streams are those streams inventoried as "Shoreline of the State" under Chapter 90.58 RCW. Within the City of Mount Vernon, those portions of the Skagit River which lie within the City's jurisdiction are classified as Category I. The buffer required for this category shall be determined by the City's Shoreline Management Plan.

- Category II. Category II streams are those streams that are classified as Type 2 and Type 3 waters by WAC 222-16-030. The characteristic Category II stream is, in part, one used by a substantial number of anadromous or resident game fish for spawning, rearing, or migration. According to this ordinance, the buffer for this category shall be 100 feet total width centered on the stream.

- Category III. Category III streams concern, in part, protection of the downstream water quality and includes streams that are naturally intermittent or ephemeral during years of normal rainfall and are not used by anadromous or resident game fish. According to this ordinance, the buffer for this category shall be 50 feet total width centered on the stream.

The City may require increased buffer widths to protect streams when they are particularly sensitive to disturbance or the development poses unusual impacts. Such circumstances may include:

- Stream reaches affected by the development proposal serves a critical fish habitat for spawning or rearing.

- The stream or adjacent riparian corridor is used by endangered, threatened, rare, sensitive, or monitored species, or provides critical or outstanding actual habitat for such species.

- The riparian corridor is underlain by highly infiltrative soils that provide ground water which nourishes the stream or by till soils that produce high runoff if cleared of vegetation.

- The riparian corridor provides a significant source of water, provides shading of stream waters, or contributes organic material important to stream habitat areas.

- A drainage improvement or water quality feature such as a grass lined swale is proposed within the buffer.

A building setback of ten feet from the edge of all stream buffers is required to prevent any encroachment into the buffer area during and after construction.

c. Fish and Wildlife Habitat. If a development is proposed within or adjacent to a priority habitat area, a wildlife assessment shall be prepared by a qualified professional. The assessment shall include recommendations for protection of the habitat and species of concern.

3. Shoreline Master Program

The Skagit County Shoreline Master Program was originally developed in 1976 in accordance with the State Shorelines Management Act, and was adopted by the City of Mount Vernon. The program provides for orderly management and regulation of uses along significant stream, lake, and marine shorelines of the City. The program seeks to accommodate water-dependent uses in a balanced manner that will achieve shoreline planning objectives of public access, economic development, historical/cultural amenities, circulation, recreation, and conservation.

The program authorizes the Planning Department to administer a shorelines permit program for development within or adjacent to regulated shorelines. The process includes submittal of a permit application to the City Planning Department for consideration, public notification of development intent, and a public hearing if warranted. The process culminates in a recommendation from the Shoreline Planning Commission to grant or deny the permit, and transmittal of its decision to Ecology and the State Attorney General's Office for review. Provisions are outlined for conditional use, variance, and appeals procedures.

Within the study area, only the Skagit River is considered to be waters of the state and thereby under the program. Because all of the streams within the study area have a mean annual flow of less than 20 cubic feet per second, they are not regulated under this program. The scope of this plan includes only surface waters that are tributary to receiving waters such as the Skagit River and none of these streams are regulated by this program. Therefore, this program does not include any areas regulated by this program.

4. City of Mount Vernon Comprehensive Plan

To comply with the Washington State Growth Management Act, the City adopted its Comprehensive Plan in January 1995. This plan contains policies and recommendations to direct public and private decisions affecting future growth and development. It contains elements relating to land use, housing, transportation, utilities, public facilities and services, and parks and open space. The Comprehensive Plan includes a brief summary of the City of Mount Vernon Draft Surface Water Management Plan, October 1993. This summary describes the surface water plan goals and objectives, the study area and drainage area subbasins, problem and solution identification, and the plan capital improvements program.

C. Relevant State and Federal Regulations and Programs

1. Stormwater Management Standards/Guidelines

There are a number of recently promulgated programs relevant to stormwater management planning in the study area. These are discussed below.

a. Puget Sound Water Quality Management Plan. The Puget Sound Water Quality Management Plan (PSWQMP) establishes a comprehensive plan to protect and improve water quality and aquatic resources in Puget Sound. The Puget Sound Water Quality Authority (PSWQA) was directed to identify water quality problems and corresponding pollution sources affecting marine life and human health, and to develop effective pollution control and management programs that could be implemented in a comprehensive multijurisdictional manner throughout the Puget Sound basin.

The 1994 plan incorporates and builds on the Authority's 1991, 1989, and 1987 management plans. The 1994 plan is also the draft Puget Sound Comprehensive Conservation and Management Plan (CCMP) under the Puget Sound Estuary Program, as authorized by the federal Clean Water Act.

A continuing planning process was established through 1994, with a revised management plan to be produced every two years. The revised plans evaluated progress toward Plan goals and addressed new concerns. Plan revisions were produced in 1987, 1989, and 1991.

In addition to plan development, the Authority carries out responsibilities in the areas of planning, coordination, analysis, education, contract and grant administration, studies and research relating to Puget Sound water quality, and the implementation of programs to implement Chapter 90.70 RCW.

A number of programs regarding stormwater management have been included in the 1994 plan. State authority to require jurisdictions to implement the provisions contained within the PSWQMP is inherent with the 1994 plan adoption. These programs are as follows:

(1) Development Standards and Operations and Maintenance Programs for All Cities and Counties.

The provisions within the 1994 PSWQMP for achieving the program's goal of controlling pollution from stormwater is to implement best management practices (BMPs), assess their effectiveness, and, as necessary, require further water quality controls that may include treatment. This includes a requirement for jurisdictions to adopt minimum standards for new development and redevelopment.

These ordinances shall address, at a minimum: (1) the control of off-site water quality and quantity impacts; (2) the use of source control best management practices and treatment best management practices; (3) the effective treatment, using best management practices, of the 6-month design storm for proposed development; (4) the use of infiltration, with appropriate precautions, as the first consideration in stormwater management; (5) the protection of stream channels and wetlands; (6) erosion and sedimentation control for new construction and redevelopment projects; (7) local enforcement of these stormwater controls.

In addition, each county and city shall also develop and enforce operation and maintenance programs and ordinances for new and existing public and private stormwater systems. Each county and city shall maintain records of new public and private storm drainage systems and appurtenances.

The 1994 plan also requires that in conjunction with the runoff control ordinances for new development and redevelopment, each jurisdiction shall adopt a stormwater management manual containing state-approved BMPs. A local government may adopt the manual prepared by WSDOE or prepare its own manual as long as it has equivalent technical standards to those prepared by WSDOE. The City staff is currently working with the study's Citizen Advisory Committee on developing this manual.

Education programs to inform citizens about stormwater and its effects on water quality, flooding, and fish-wildlife habitat, and to discourage dumping of waste material or pollutants into storm drains, are also included in the Education and Public Involvement Program and the Household Hazardous Waste Program sections of the 1994 plan.

Each city or county that adopts a comprehensive land use plan and development regulations under the provisions of Chapter 36-70A RCW (the Growth Management Act), shall incorporate the goals of the local stormwater program into the goals of the comprehensive plan and shall incorporate the ordinances required by this element into the development regulations.

Consistent with the Growth Management Act, each local jurisdiction in the Puget Sound Basin is expected to cooperate with neighboring jurisdictions in growth management stormwater planning and stormwater basin planning.

WSDOE will monitor compliance with these requirements, reviewing the status of city and county operation and maintenance and runoff control programs every two years to ensure consistent and adequate implementation and report to the Authority. WSDOE's oversight role shall pertain only to compliance with the objectives of the plan's stormwater program and appropriate rules and statutes and technical suggestions to improvement implementation. This should ensure maximum flexibility and creativity for local governments to resolve site-specific stormwater problems in accordance with their land use and other local policies.

(2) Comprehensive Urban Stormwater Programs: Stormwater Management Programs for Urbanized Areas. Starting with the five larger jurisdictions in the Puget Sound basin named in the EPA stormwater NPDES regulation and eventually expanding to cover all urbanized areas, each city must develop

and implement a stormwater management program consistent with the requirements in appropriate subsections of the stormwater NPDES regulations.

- The purposes of the comprehensive urban stormwater management program will be:

  - To control erosion and manage the quantity and the quality of stormwater runoff from public and private activities

  - To protect and enhance water quality, and achieve water quality and sediment quality standards

  - To reduce the discharge of pollutants to the maximum extent practicable within the constraints of federal and state laws

  - To protect beneficial uses, as described in Chapter 173-201 WAC

  - To achieve the four items above in a manner that makes efficient use of limited resources to address the most critical problems first

  Each urban stormwater program shall seek to control the quality and quantity of runoff from public facilities and industrial, commercial, and residential areas, including streets and roads. Each program shall cover both new and existing development. Early action by urbanized areas that are prepared to implement stormwater control programs shall be allowed. Emphasis shall be placed on controlling stormwater through source controls and BMPs. Where local programs are not effectively solving stormwater problems, Ecology shall ensure compliance through its oversight role or through issuance and enforcement of individual or watershed-based NPDES permits. Each city or urban area shall have the flexibility to design its own program, but the content, priorities, and deadlines for compliance shall be subject to review by Ecology for consistency with the Puget Sound Plan and NPDES regulations.

  In some cases, significant stormwater problems may be originating in urbanized areas outside of a local jurisdiction. In those situations, the sequencing of areas for urban stormwater programs may be modified to address problems in shared watersheds. The neighboring jurisdictions will develop local coordination mechanisms to cooperatively resolve the identified problems. Where joint programs are not developed, WSDOE shall ensure consistency in programs through its oversight role.

At a minimum, each urban stormwater program shall include:

- Identification and ranking of significant pollutant sources and their relationship to the drainage system and water bodies through an ongoing assessment program.

- Investigations and corrective actions of problem storm drains, including sampling.

- Programs for operation and maintenance of storm drains, detention systems, ditches, and culverts.

- A water quality response program, to investigate sources of pollutants, and respond to citizen complaints or emergencies such as spills, fish kills, illegal hookups, dumping, and other water quality problems. These investigations should be used to support compliance/ enforcement efforts.

- Assurance of adequate local funding for the storm water program through surface water utilities, sewer charges, fees, or other revenue-generating sources.

- Local coordination arrangements such as interlocal agreements, joint programs, consistent standards, or regional boards or committees.

- Ordinances requiring implementation of stormwater controls for new development and redevelopment.

- A stormwater public education program aimed at residents, businesses, and industries in the urban area.

- Inspection, compliance, and enforcement measures.

- An implementation schedule.

- If, after implementation of the control measures listed in the points above, there are still discharges that cause significant environmental problems, retrofitting of existing development and/or treatment of discharges from new and existing development may be required.

Stormwater quality in public stormwater systems in commercial and industrial areas shall have a high priority in the city programs. WSDOE shall determine, in compliance with EPA regulations, and in consultation with local governments, the appropriate approach to controlling stormwater discharges from industrial and commercial

facilities that are not currently required to have stormwater NPDES or point source discharge permits. Stormwater controls are included in NPDES permits for discharges of stormwater from commercial and industrial point source facilities, which are addressed in the Municipal and Industrial Discharges Program.
WSDOE shall have oversight responsibilities for the urban stormwater programs. WSDOE shall review each urban stormwater program every two years to ensure consistent and adequate implementation and report to the Authority.
This Surface Water Management Plan fulfills many of these requirements.

(3) Technical Manuals and Assistance on Stormwater and Erosion Controls.

Technical Manuals. WSDOE has produced a technical manual for use by local jurisdictions in stormwater planning. The technical manual provides technical guidance for implementing local programs.

Vactor Waste. In the 1994 plan, Ecology has committed to develop a program for a vactor waste disposal program.

Monitoring Guidance. In the 1994 plan, Ecology has also committed to develop guidance on how to monitor stormwater runoff compliance and the effectiveness of BMPs.

(4) Local Government Stormwater Assistance Service.

The intent of the 1994 PSWQMP is to provide technical assistance to local governments through people who have hands-on experience with (1) the design and implementation of stormwater programs at the local level, (2) current Best Management Practices for stormwater, and (3) local basin characteristics. WSDOE shall work with the City with current stormwater expertise to establish a technical assistance service.

This service will support the exchange of technical information and assistance on stormwater among local governments, will train WSDOE and local government staff in current practices and real world application and problems in stormwater technology, and will operate as an integral part of the state technical assistance program. The service will have the goal of acting as an in-the-field branch of WSDOE's technical assistance program.This service will support the exchange of technical information and assistance on stormwater among local governments, will train WSDOE and local government staff in current practices and real world application and problems in stormwater technology, and will operate as an integral part of the state technical assistance program. The service will have the goal of acting as an in-the-field branch of WSDOE's technical assistance program.

NPDES Coordination. In the 1994 plan, Ecology has been designated to provide technical assistance to local governments that are required to obtain NPDES permits.

(5) Guidance and Model Ordinances.

WSDOE will prepare and update guidance and model ordinances for stormwater programs for all cities and for comprehensive urban stormwater programs. All cities will adopt stormwater programs that include minimum requirements for new development and redevelopment set by the plan and in guidance developed by WSDOE.

The guidance shall include:

- Procedures for development local programs, including procedures for review and approval of programs.

- Minimum requirements for runoff controls and system maintenance required in local ordinances.

- Minimum requirements for control of private sector maintenance of private drainage systems.

- Minimum requirements for the operation and maintenance programs, including recordkeeping requirements for new drainage systems and facilities.

- Methods for assuring practical and appropriate disposal procedures for decant water, solid, and other substances from drainage system clean out and maintenance. Methods shall address catch basins, oil/water separators, pipelines, swales, detention/retention basins, and other appropriate drainage elements.

Additionally, the guidance for the comprehensive urban stormwater programs will include:

- Procedures for identification and ranking of significant pollutant sources and their relationship to the drainage system and water bodies

- Procedures for source tracing investigations, including sampling of problem storm drains

- Procedures for investigations, implementation of spill control measures, enforcement, and remedial actions

- Methods for assuring adequate local funding for the urban stormwater program

- Provisions for agreements with neighboring jurisdictions when stormwater and watersheds do not follow jurisdictional boundaries

- Requirements for public education programs

- Requirements for retrofitting and/or treatment measures, if necessary

- Procedures for inspection, compliance, and enforcement measures

- Requirements for implementation schedules

- Methods to coordinate stormwater management with other watershed habitat protection and growth management activities

The guidance will lay out acceptable approaches to control stormwater from new development and redevelopment, such as water quality policies for use in SEPA, NPDES, and other permit decisions; density controls to limit development in sensitive areas; development standards to limit the amount of impervious surfaces; regional detention ponds; oil separators or other treatment facilities; grading and drainage ordinances; erosion control programs; buffers next to waterways; preservation of wetlands; and other appropriate elements.

a. Federal Requirements - National Pollutant Discharge Elimination System. The Environmental Protection Agency (EPA) has determined that stormwater discharges will be regulated under the National Pollutant Discharge Elimination System (NPDES) process. As a result, some stormwater dischargers will be required to submit permit applications.

On October 31, 1990, the EPA administrator signed into law final regulations requiring NPDES permits for three categories of stormwater discharges: (1) medium cities with population between 100,000 and 250,000; (2) large cities with population greater than 250,000; and (3) discharges associated with industrial activity.

The non-point source permits will differ from standard NPDES permits in that the industrial discharge permits can be issued to a class or group of dischargers, and the municipal stormwater permit can be issued on a jurisdiction-wide basis. EPA stated that the ideal permit basis would be the watershed. In other words, individual permits for each outfall would not be required.

The municipal stormwater permit programs will include a combination of required ordinances, mapping, discharge characterization, source identification, and public education. Stormwater associated with industrial activities would also be regulated. Some industrial activities within the City may be regulated depending on their Standard Industrial Code (SIC). The City of Mount Vernon may also conduct certain activities that would require NPDES permits for stormwater. This includes operation of the City's waste water treatment plant.

The City of Mount Vernon is not required by federal law to apply for a municipal permit because it's population is less than 100,000. The State of Washington has been given the authority to administer the federal NPDES program.

2. Growth Management Act

A general discussion of the Growth Management Act is provided in this section because it contains land use planning requirements for designating and protecting critical environmental areas such as wetlands and fish habitat areas.

a. Purpose. The Growth Management Act became effective July 1, 1990. The Act's goal is to manage growth in Washington State's fastest growing counties through the adoption of local comprehensive land use plans and development regulations. The City of Mount Vernon adopted its Comprehensive Plan in conformance with the Growth Management Act in January 1995.

b. Who Must Develop Comprehensive Plans. The Act requires the following jurisdictions to adopt comprehensive land use plans:

- Counties with population of 50,000 or greater and an increase in population of more than 10 percent in the last 10 years and any cities in such a county.

- Counties that have a population increase of more than 20 percent in the last 10 years and any cities in such a county.

- Counties that elect to conform with the Act.

Eleven counties in Washington, including Skagit County must adopt comprehensive plans under the Act. Mount Vernon, as a city in Skagit County, must comply with this Act. Those required to adopt comprehensive land use plans must do so on or before July 1, 1994.

c. Comprehensive Plans - Advisory Goals. The standard for all plans are thirteen advisory goals aimed solely at guiding the development of local comprehensive plans. These advisory goals include encouraging urban growth where reasonable, reducing urban sprawl, encouraging efficient transportation systems based on regional priorities, encouraging the availability and variety of affordable housing, encouraging the retention of open space and recreational opportunities, and protecting the environment.

d. Comprehensive Plans - Requirements

(1) Comprehensive plans must contain design elements for the following:

- land use
- housing
- capital facilities
- utilities
- rural areas (counties only)
- transportation

(2) Where applicable, the land use element must:

- provide for protection of the quality and quantity of groundwater used for public water supplies;

- shall review drainage, flooding, and stormwater runoff in the area and nearby jurisdictions; and

- provide guidance for corrective actions to mitigate or cleanse those discharges that pollute waters of the state, including Puget Sound, or waters entering Puget Sound.

(3) Comprehensive plans must be consistent with plans of neighboring jurisdictions.

e. Development Regulations - Natural Resource Lands and Critical Areas. Cities and counties subject to the act must:

(1) Inventory and designate natural resource lands and critical areas on or before September 1, 1991. This has been completed by the City with the adoption of Ordinance #2482.

(2) Adopt development regulations on or before September 1, 1991 to ensure the conservation of agricultural, forest, and mineral resource lands. This has been completed by the City with the adoption of Ordinance #2482.

(3) Adopt development regulations on or before September 1, 1991, precluding land uses or development that is incompatible with designated "critical areas," which include the following areas and ecosystems:

- Wetlands
- Areas with a critical recharging effect on aquifers used for potable water
- Fish and wildlife habitat conservation
- Frequently flooded areas
- Geologically hazardous areas

This has been completed by the City with the adoption of Ordinance #2482.

f. Implementation. Within one year of the adoption of its comprehensive plan, counties and cities must enact development regulations, such as zoning ordinances, official controls, and planned unit development ordinances, that are consistent with and implement the comprehensive plan.

Each county and city that adopts a comprehensive plan under the Act is required to report to the Department of Community Development annually for a period of five years, beginning on January 1, 1991, and each five years thereafter, on the progress made by that county or city in implementing the requirements of the Growth Management Act.

3. Wetlands - Relevant Federal and State Regulations

Wetlands are identified and delineated within the City of Mount Vernon using the *Corps of Engineers Wetlands Delineation Manual* (1987 Manual) (Environmental Laboratory, 1987). The 1987 Manual is required for review of wetlands within the City as well as required by the U.S. Army Corps of Engineers for federal review of wetland impact. As of September 1995, the State of Washington also follows the 1987 Manual in determining the presence and extent of jurisdictional wetlands. The methodology outlined in this manual is based upon three characteristics of wetlands: 1) hydrophytic vegetation, 2) hydric soils, and 3) wetland hydrology. All three of these characteristics must be present in order to make a positive wetland determination using the 1987 Manual (unless disturbed areas are encountered).

a. Federal Regulations. The primary federal laws that regulate activities in or near wetlands are Sections 401 and 404 of the Clean Water Act (CWA), Section 10 of the River and Harbor Act of 1899, and the "Swampbuster" provision of the Food Security Act (FSA) of 1985. All federal actions are also subject to the 1969 National Environmental Policy Act (NEPA) and many to the Coastal Zone Management Act of 1972.

Section 401 of the CWA mandates that federally permitted activities in wetlands comply with the CWA and state water quality standards. Under Section 404 of the CWA, the U.S. Army Corps of Engineers (Corps) has been given the responsibility and authority to regulate the discharge of dredged or fill materials into waters and adjacent wetlands of the United States (Federal Register, 1986). Under the River and Harbor Act, the Corps also issues permits for construction in or along navigable waters, including any wetlands within those waters. The "Swampbuster" provision of the FSA denies eligibility for all U.S. Department of Agriculture farm programs to farmers who convert wetlands to croplands.

Of the above regulations, Section 404 permitting is the most commonly applicable to freshwater wetlands. Two kinds of permits are issued by the Corps: General and Individual. General Permits (also known as Nationwide Permits, or NWPs) cover proposals that would have minimal adverse impacts on the environment. The most commonly used NWP for wetland alterations is NWP 26; this NWP specifically addresses wetlands which are (1) above the headwaters of a river or stream (that point in the watercourse at which the mean annual discharge is less than five cubic feet per second) or (2) hydrologically isolated. Such permits apply to fills and other impacts of less than one acre, although impacts of up to two acres may be covered by a General Permit. However, proposed impacts from one to two acres require a Water Quality Certification under Section 401 of the CWA from the Department of Ecology (as discussed under Washington State regulations, below). Other NWPs allow impacts to wetlands for specific purposes. For example, a NWP 12 is used for wetland impacts due to utility installation and maintenance. Unless they may be covered by one of the NWPs, projects with wetlands impacts of more than two acres require Individual Permits. The Corps evaluates Individual Permits based upon the probable impacts of a project on environmental quality and on a determination of whether or not the project is in the public interest. Actions seeking Individual Permits must comply with the Section 404(b)(1) guidelines which require that an applicant prove that there are no other practicable alternatives to the proposed project and that the project has avoided and/or minimized impacts to wetlands to the maximum extent practicable.

b. Washington State Regulations. The principal Washington State regulations that govern activities in or near wetlands are the Shoreline Management Act (SMA) of 1971 (Chapter 90.58 RCW), the 1949 State Hydraulic Code (RCW 75.20.100-140), State 401 (Water Quality) Certification, Coastal Zone Management (CZM) determinations, and the Floodplain Management Program. All actions are also subject to the State Environmental Policy Act (SEPA) of 1971 (with new implementation rules adopted in 1984, Chapter 197-11 WAC) and, in Western Washington, to the Puget Sound Water Quality Act (Chapter 90.70 RCW). Some actions may also be subject to the Forest Practices Act (Chapter 76.09 RCW). The Shoreline Master Program, Hydraulic Project Approval, and the Floodplain Management Program were discussed previously.

4. Wetlands Standards/Guidelines

The preservation/enhancement of wetlands has recently become a prominent issue in the Pacific Northwest, spurred in large part by the Growth Management Act. Two relevant wetland protection programs which provide guidelines and standards for wetlands protection are the Washington Department of Ecology's (Ecology) Model Wetlands Protection Ordinance (September 1990) and element W-2 of the Puget Sound Water Quality Management Plan (May 1994).

a. Model Wetlands Protection Ordinance, Department of Ecology. The purpose of Ecology's model wetlands ordinance is to provide guidance to cities and counties in developing standards and regulations governing wetlands. It is written as a template which cities and counties may adopt and modify according to their needs and provides minimum guidelines for wetlands protection. The model ordinance establishes a definition of wetlands, recognizes their value and the negative impacts which may result from construction, and provides guidelines for the following:

(1) Lands to which the ordinance applies. This section provides standards for regulated activities which are subject to approval if they are conducted in wetlands or their buffers; standards for wetland delineation; and suggestions for adopting either the Washington State rating system or the Puget Sound Region wetlands rating system in order to categorize wetlands. The newly adopted Washington State Wetlands Rating System for Eastern and Western Washington (October 1991) provides guidelines for categorizing wetlands. The wetlands rating system is a process that differentiates wetlands according to specific characteristics or functional attributes. The rating system includes four categories of wetland that are used to determine the size of buffer zones and the ratio for replacing wetlands. A Category I wetland has exceptional resource value and contains rare plant or animal species; a category IV wetland has ordinary resource value, with generally one type of vegetation, and is isolated from other aquatic systems. Categories II and III are intermediate in terms of species diversity and resource value. The Model Ordinance requires a 200- to 300-foot buffer (depending upon surrounding land use) for a category I wetland, a 100- to 200-foot buffer for Category II, a 50- to 100-foot buffer for Category III, and a 25- to 50-foot buffer for a Category IV wetland. Permit decisions can then be considered in light of the wetland rating and the potential development impact. The Puget Sound Region wetlands rating system provides slightly more specific criteria for classification of wetlands than the Washington State system.

(2) Regulated and allowed activities. This section lists the types of activities which will be regulated and allowed in wetlands under the ordinance. Examples of regulated activities include the removal, excavation, grading, or dredging of soil, sand, gravel, minerals, organic matter, or material of any kind; and the destruction or alteration of wetlands vegetation through clearing, harvesting, shading, intentional burning, or planting of vegetation that would alter the character of the wetland. Examples of allowable activities include conservation of soil, water, vegetation, fish, shellfish, and other wildlife; and existing or ongoing agricultural activities.

(3) Procedures for wetland permits. This section provides guidelines on information required and procedures for obtaining, complying with, and processing wetlands permits.

(4) Standards for wetland permit decisions. This section establishes standards and conditions for wetlands permits, including: establishing wetland buffers according to classification category; permitted uses within buffers; procedures for minimizing and/or avoiding impacts to wetlands; density transfers; special use conditions for sensitive areas; and compensatory mitigation requirements for wetlands impacts.

b. 1994 Puget Sound Water Quality Management Plan - Section W-2 Puget Sound Local Government Wetland Protection Programs. The Puget Sound Water Quality Authority (PSWQA) has adopted minimum standard guidelines for local governments to use in protecting wetlands in the Puget Sound area under the Growth Management Act. Local governments are encouraged to use these guidelines for reviewing actions that impact wetlands.

The goal of the standards is to protect wetlands by achieving no net loss of wetlands in the short-term and a long-term wetlands gain. The proposed standards call for all local governments in the Puget Sound planning area to develop and carry out a wetlands protection program. The PSWQA standards present a framework for wetlands protection, allowing local governments to decide specifics in implementing the program, such as permitting requirements, penalties, etc.

Under the standards, local governments would use permits or other mechanisms to avoid impacts on wetlands or to minimize and compensate for unavoidable and necessary impacts. Permits would be required for dredging, dumping, draining, construction or clearing in wetlands.

The PSWQA standards include a minimum definition of regulated wetlands and compensatory mitigation for wetlands impacts. The standards also specify regulated activities, methods to avoid wetland impacts, and general permits to allow some activities.

The PSWQA standards require that damage or destruction of a wetland is allowable only if there is no reasonable alternative. If the destruction is unavoidable and necessary, compensation is required to replace it by creating or restoring wetlands at an increased ratio. The proposed replacement ratio for category IV is 1.25 to one, e.g., for every one acre of wetland destroyed, it must be replaced with 1.25 acre of wetland.

5. Floodplain Regulations

a. State Floodplain Regulations. Chapter 86.16 RCW establishes statewide authority through regulations promulgated by WSDOE for coordinating the floodplain management regulation elements of the National Flood Insurance Program. Under Chapter 173-158 WAC, WSDOE requires local governments to adopt and administer regulatory programs compliant with the minimum standards of the NFIP. WSDOE provides technical assistance to local governments for both identifying the location of the 100-year (base) floodplain and in administering their floodplain management ordinances.

WSDOE also establishes land management criteria in the base floodplain area by adopting the federal standards and definitions contained in 44 CFR, Parts 59 and 60, as minimum state standards. In addition to adopting the federal standards, the state regulations provide for additional regulation of residential development in the floodplain. Federal regulations allow residential and nonresidential development in the floodplain if the proponent can demonstrate there is no resultant increase in base flood elevations within the floodway. State regulations allow only for repair or reconstruction of existing residential structures within the floodway that do not increase the building footprint and that cost less than 50 percent of the value of the existing structure.

b. <u>Federal Floodplain Regulations</u>. The Federal Emergency Management Agency, (FEMA), implements provisions of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This legislation and companion administrative regulations support the availability of flood insurance for development in flood-prone areas and ensures that the availability of insurance is conditional on the development of a floodplain management plan that will limit flood damages.

A detailed outline of the National Flood Insurance Program (NFIP) and its companion regulations is presented in 44 CFR. Selected elements of FEMA regulations with special significance to Mount Vernon are as follows:

(1) The technical basis for the NFIP is the development of a flood boundary map and the corresponding Flood Insurance Rate Map (FIRM). The flood boundary map is the product of a hydrologic/hydraulic analysis that designates base flood elevations and corresponding lateral boundaries of flood hazard. This map serves as the technical basis for an approved floodplain management plan. The FIRM identifies appropriate insurance premium rates for zones of varying risk within the floodplain.

Flood Insurance Studies were performed in the City in 1979 and 1980. The studies included the preparation of Flood Insurance Rate Maps, which show the 100-year flood boundary and were adopted by the City. The flood zones are shown in Figure V-1.

The flood hazard zones each have a specific flood potential or hazard as is indicated by one of the following flood insurance zone designations:

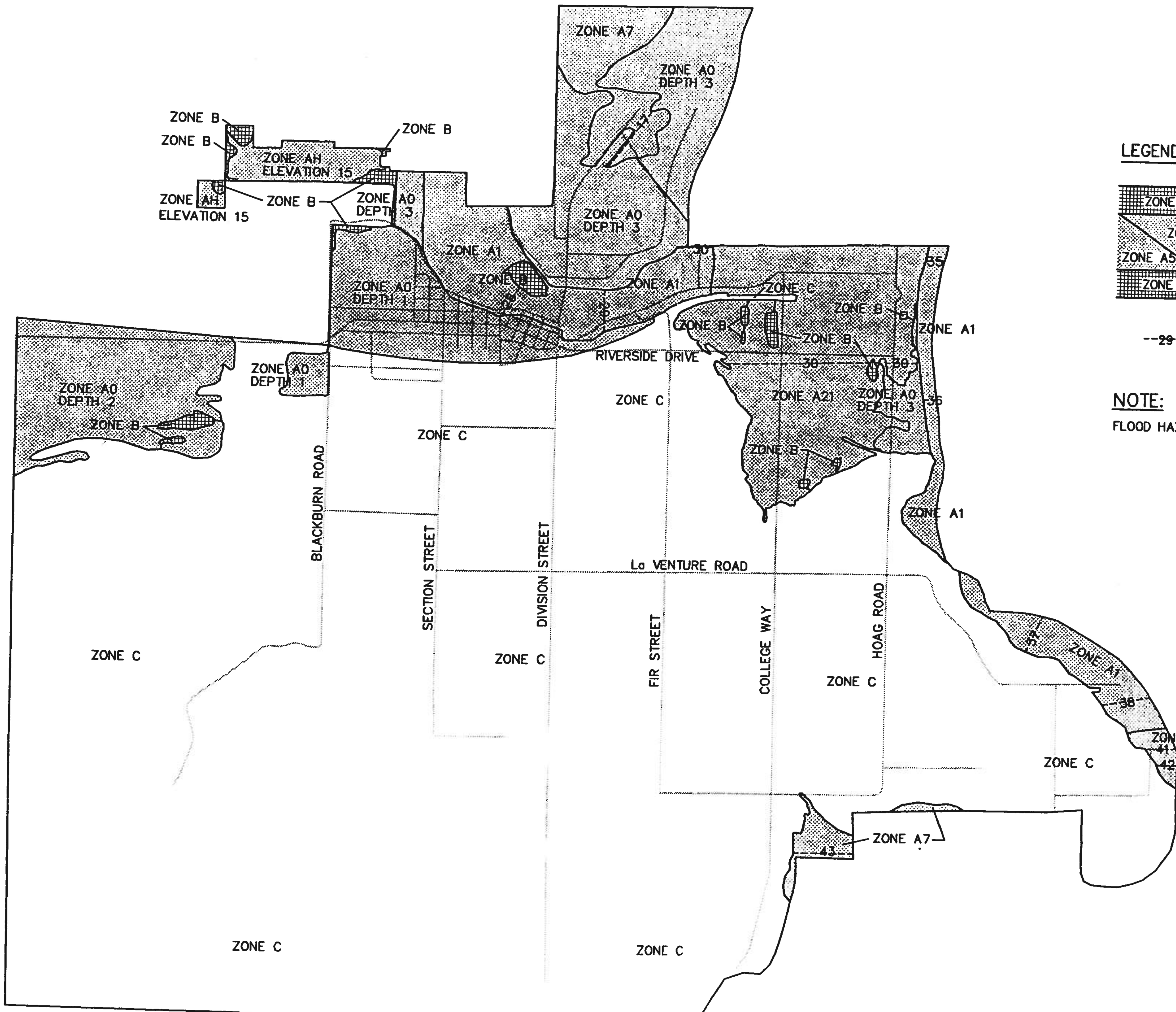
Zone A: Special flood hazard areas inundated by the 100-year flood, determined by approximate methods.

Zone AO: Special flood hazard areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown on the FEMA maps.

Zone AH: Special flood hazard areas inundated by types of 100-year shallow flooding where the depths are between 1.0 and 3.0 feet; base flood elevations are shown on the FEMA maps.

Zones A1, A7 and A21:	Special flood hazard areas inundated by the 100-year flood, determined by detailed methods; base flood elevations and zones subdivided according to flood hazard factors are shown on the FEMA maps.
Zone B:	Areas between the special flood hazard areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where the depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile.
Zone C:	Areas of minimal flooding.

(2) Specific floodplain management criteria for development are presented in 44 CFR Section 60.3. These measures, and more restrictive measures, have been adopted by the State of Washington and the City of Mount Vernon under Chapter 15.36 of the Mount Vernon Municipal Code.



LEGEND

ZONE B — 500 YEAR FLOOD BOUNDARY

ZONE A1 — 100 YEAR FLOOD BOUNDARY

ZONE A5

ZONE B — 100 YEAR FLOOD BOUNDARY — 500 YEAR FLOOD BOUNDARY

--29-- BASE FLOOD LEVEL ELEVATION LINE WITH ELEVATION IN FEET (NATIONAL GEODETIC VERTICAL DATUM OF 1929)

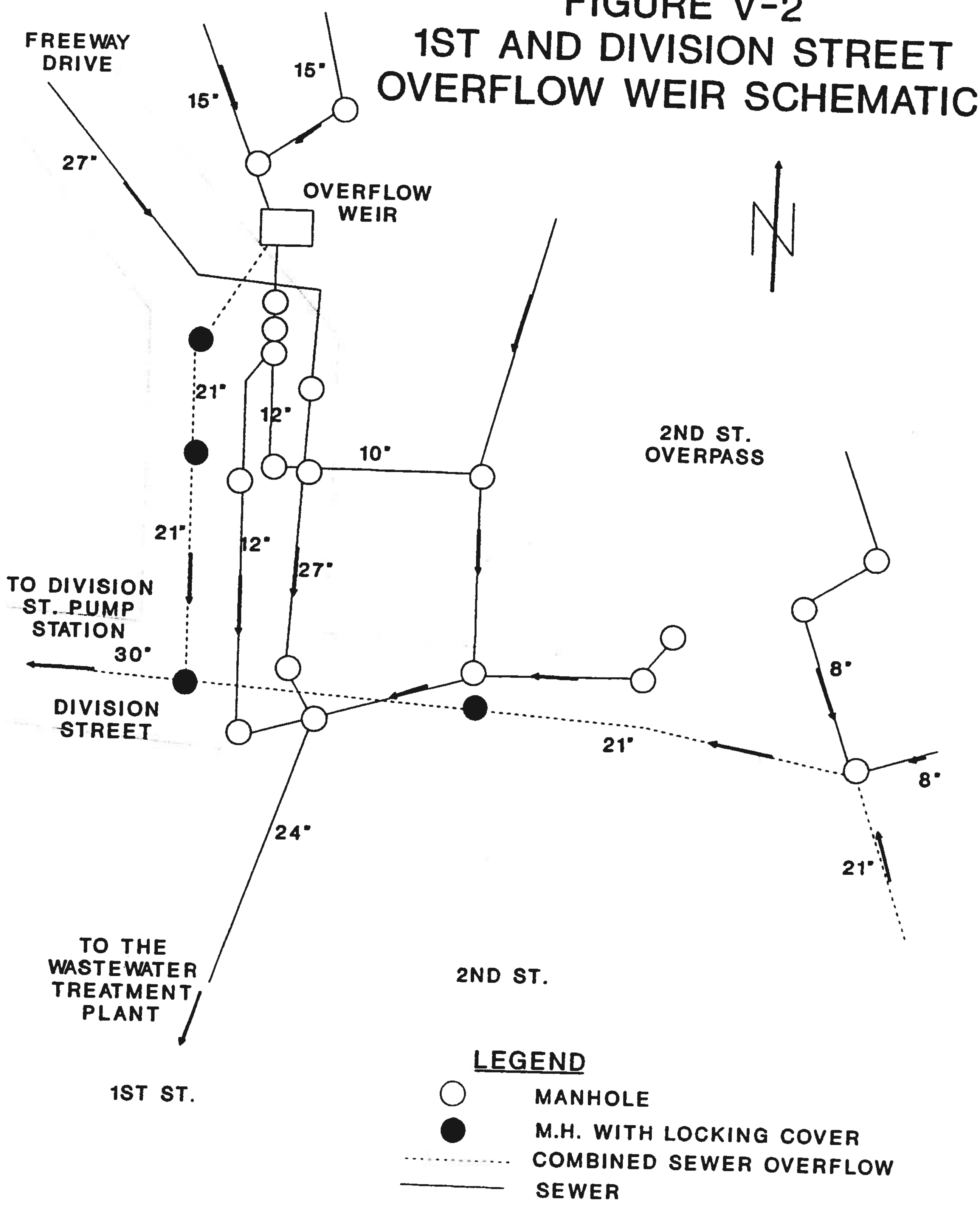
NOTE:

FLOOD HAZARD ZONE DESIGNATION ARE DEFINED IN THE TEXT.

FIGURE V-1
CITY OF MOUNT VERNON
SURFACE WATER
MANAGEMENT PLAN

FLOOD ZONES

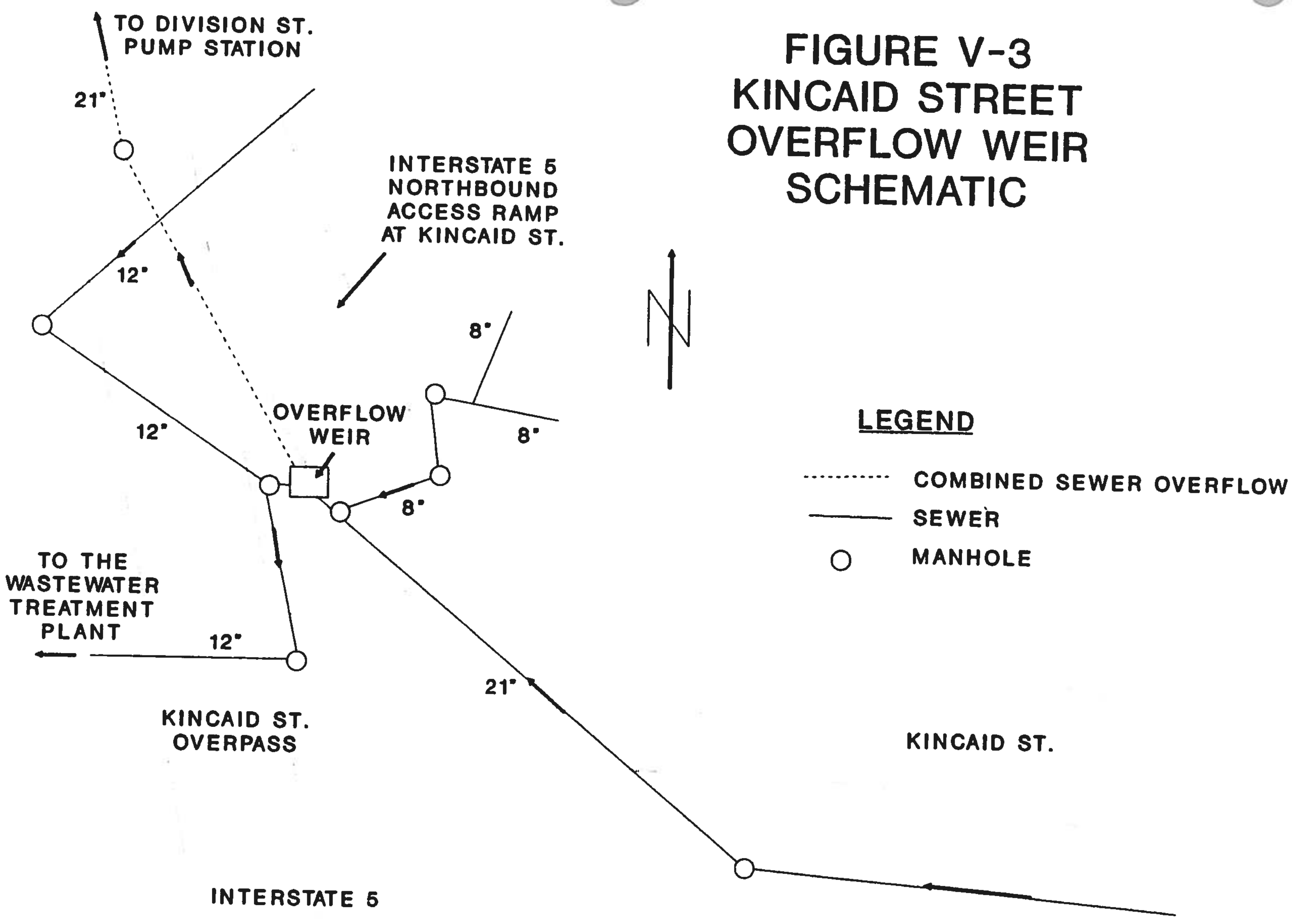
FIGURE V-2
1ST AND DIVISION STREET OVERFLOW WEIR SCHEMATIC



CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW

FIGURE V-3
KINCAID STREET OVERFLOW WEIR SCHEMATIC



CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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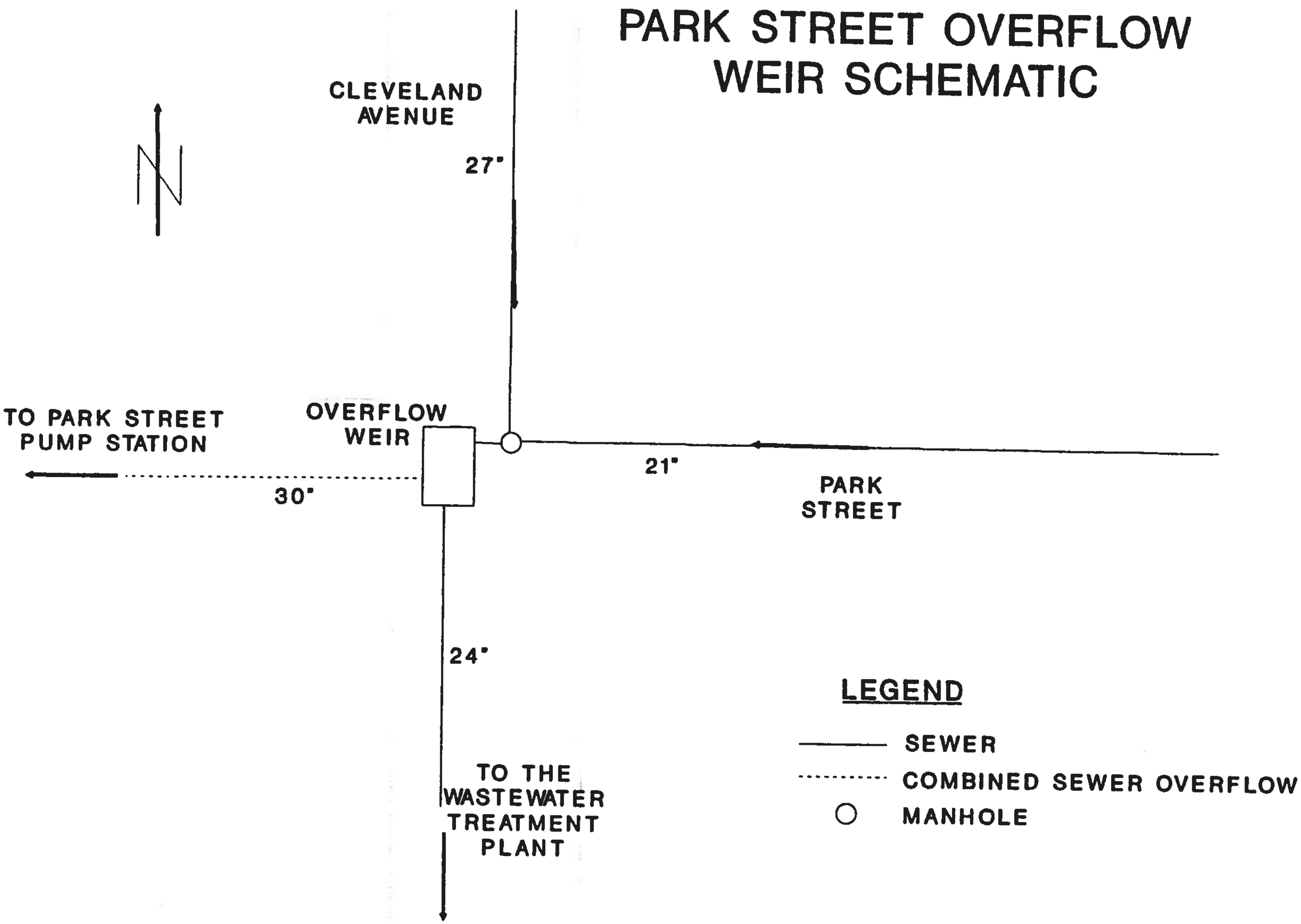
FIGURE V-4
PARK STREET OVERFLOW WEIR SCHEMATIC



CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINE
SEWER OVERFLOW
REDUCTION PLANS

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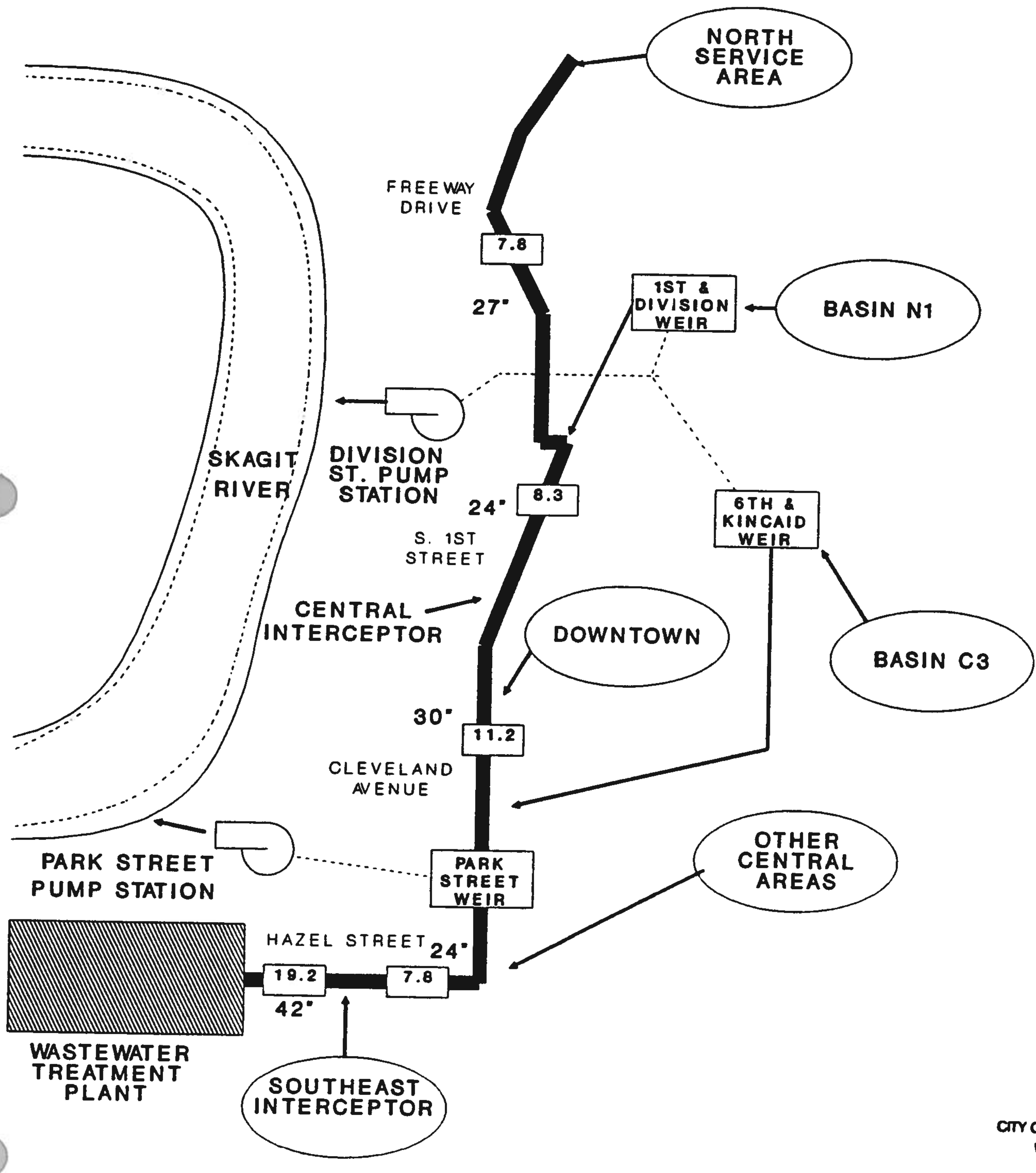
FIGURE V-5
EXISTING CENTRAL AREA DRAINAGE



CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINED SEWER OVERFLOW REDUCTION PLANS

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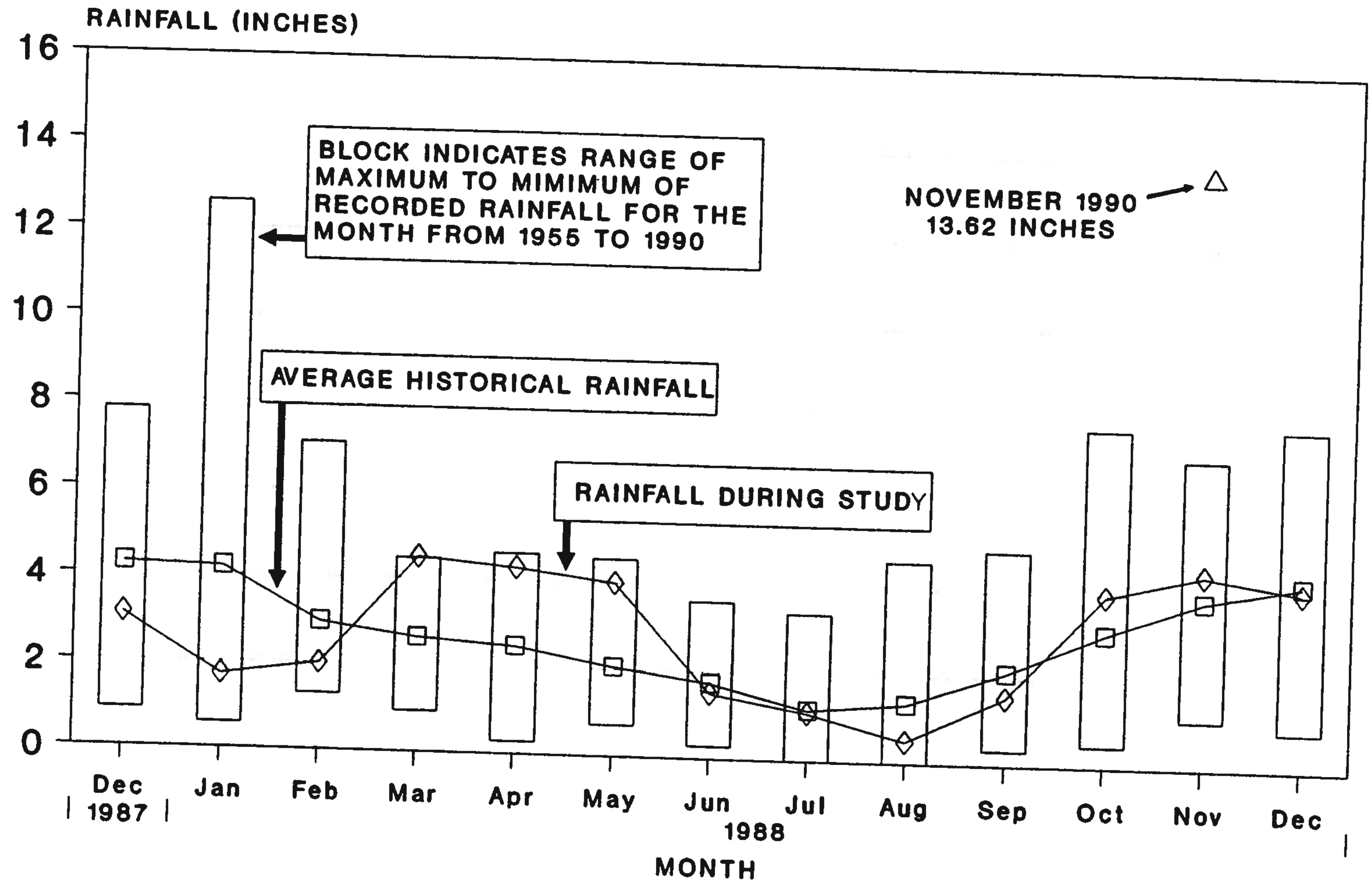

FIGURE V-6
RAINFALL DURING THE STUDY AND HISTORICAL RAINFALL PATTERNS FOR WSU RESEARCH STA.

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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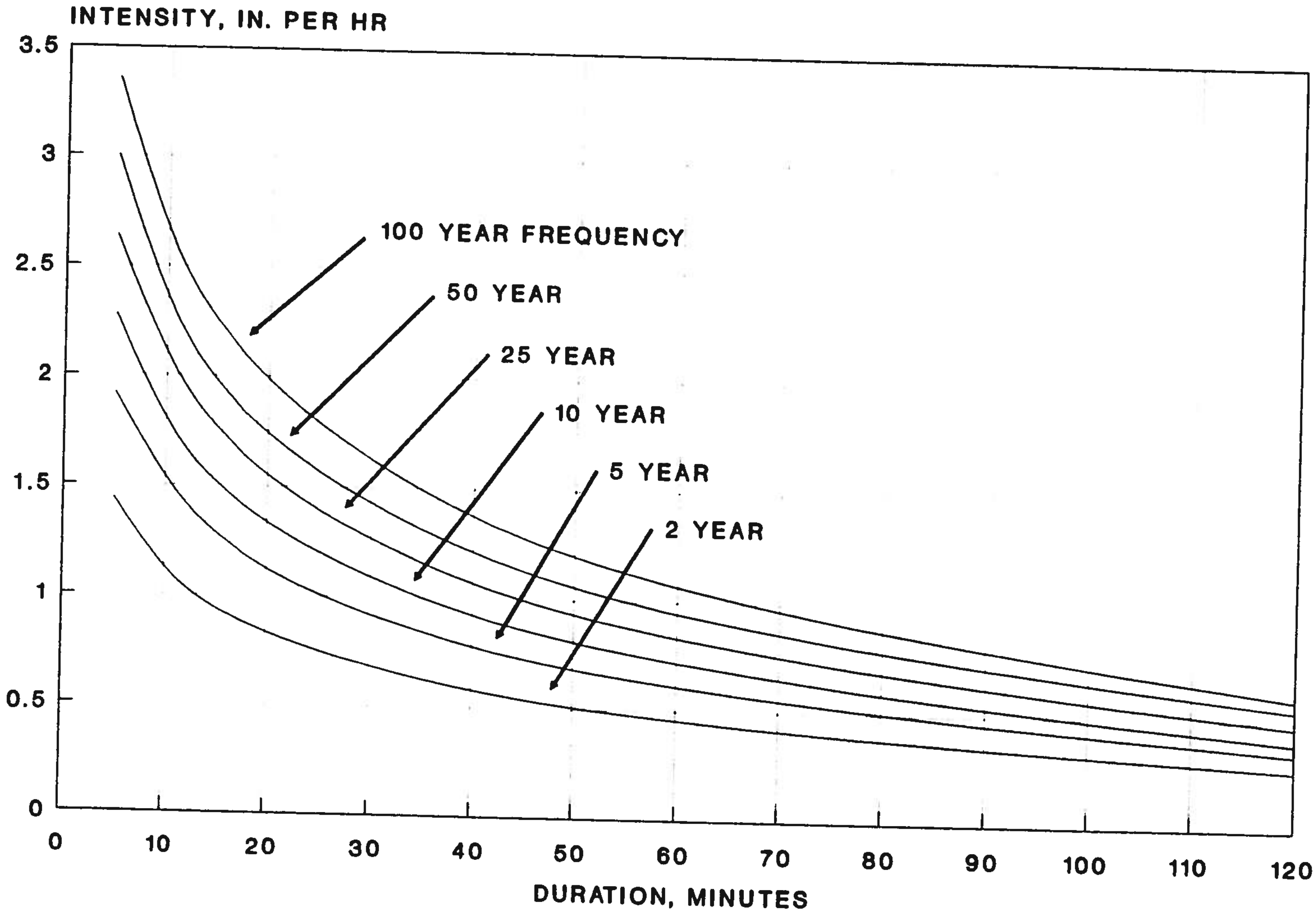

FIGURE V-7
RAINFALL - INTENSITY - DURATION

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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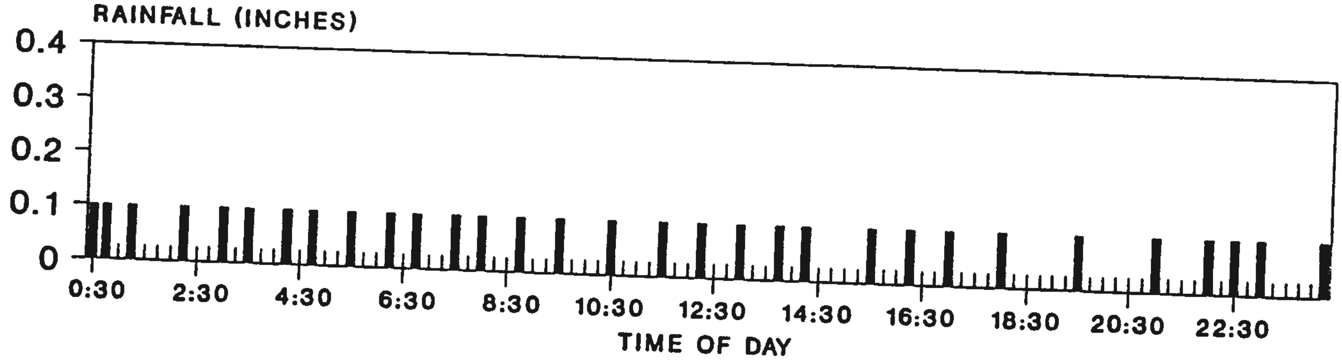
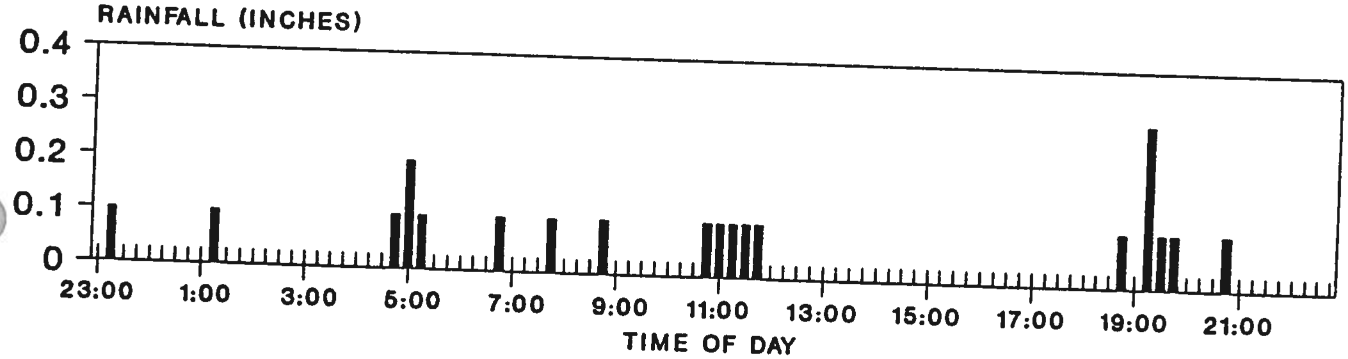
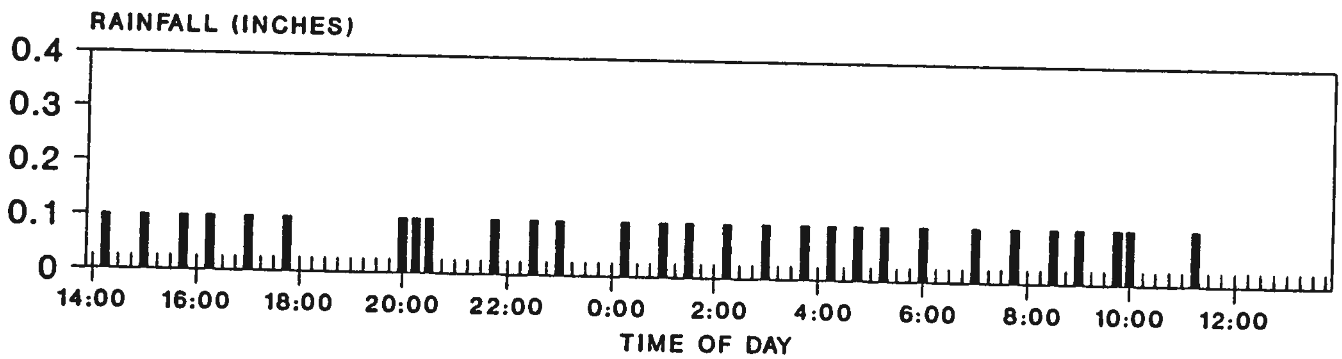
FIGURE V-8
STORMS OF NOVEMBER 1990



NOVEMBER 9, 1990
3.1 INCHES OF RAINFALL IN 24 HOURS
25 YEAR -24 HOUR STORM



NOVEMBER 12 - 13, 1990
2.1 INCHES OF RAINFALL IN 24 HOURS
2 TO 5 YEAR - 24 HOUR STORM



NOVEMBER 23 - 24, 1990
3.0 INCHES OF RAINFALL IN 24 HOURS
ALMOST A 25 YEAR - 24 HOUR STORM

CITY OF MOUNT VERNON
WASHINGTON

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SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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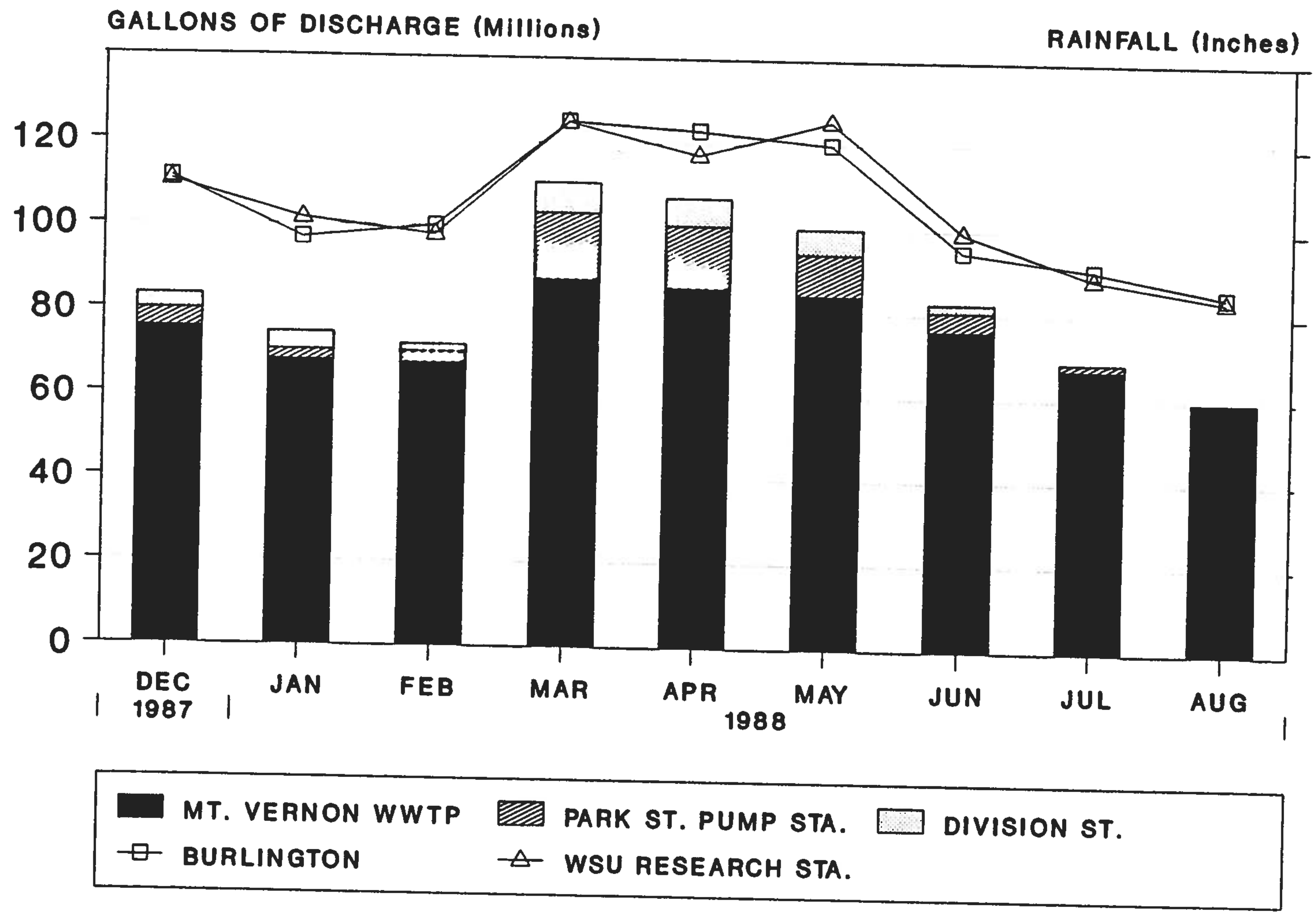

FIGURE V-9
MONTHLY RAINFALL AND DISCHARGES TO THE SKAGIT RIVER DURING THE STUDY

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINED SEWER OVERFLOW REDUCTION PLANS

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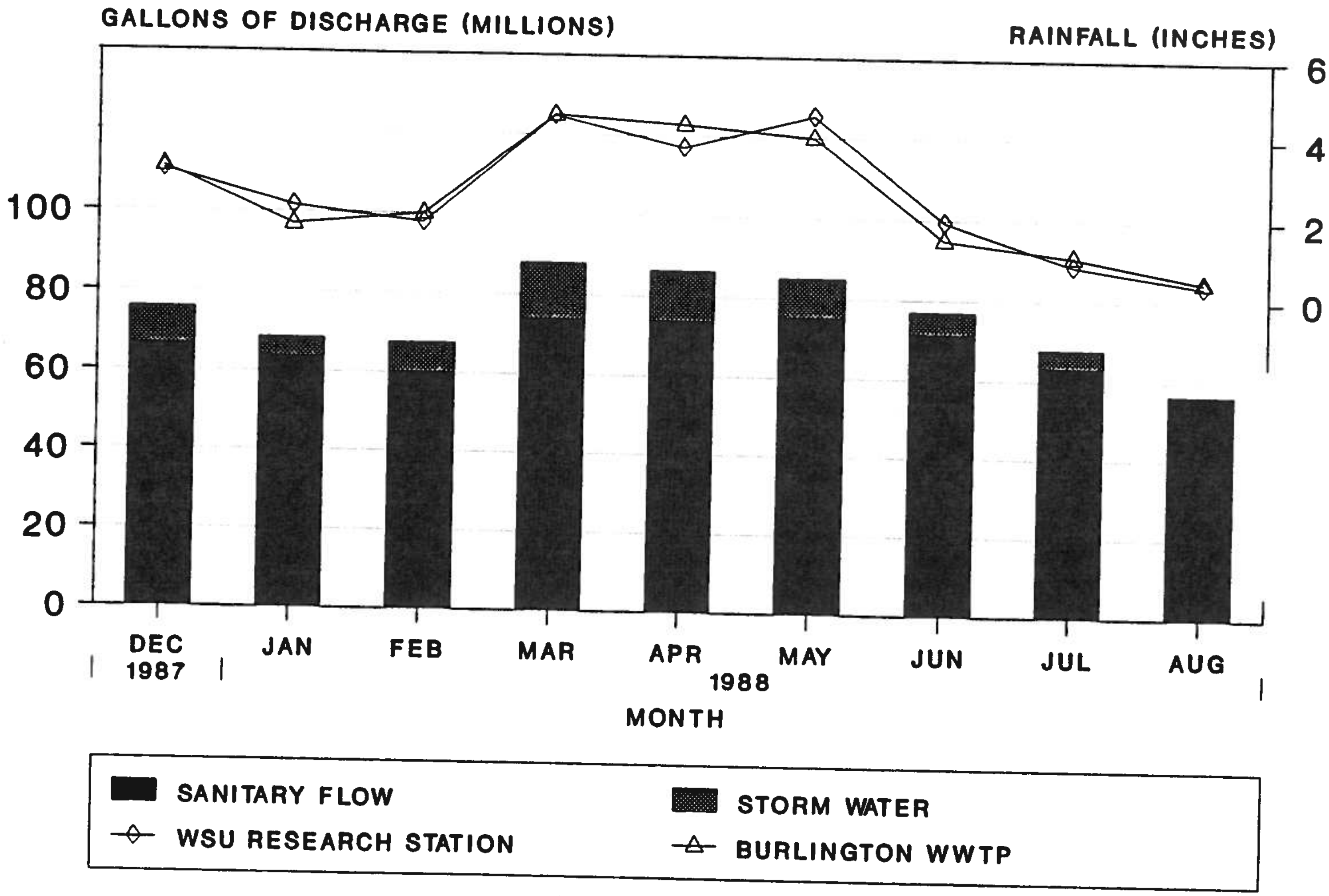

FIGURE V-10
TOTAL FLOWS TREATED AT THE MT. VERNON WWTP - SANITARY FLOW AND STORM WATER

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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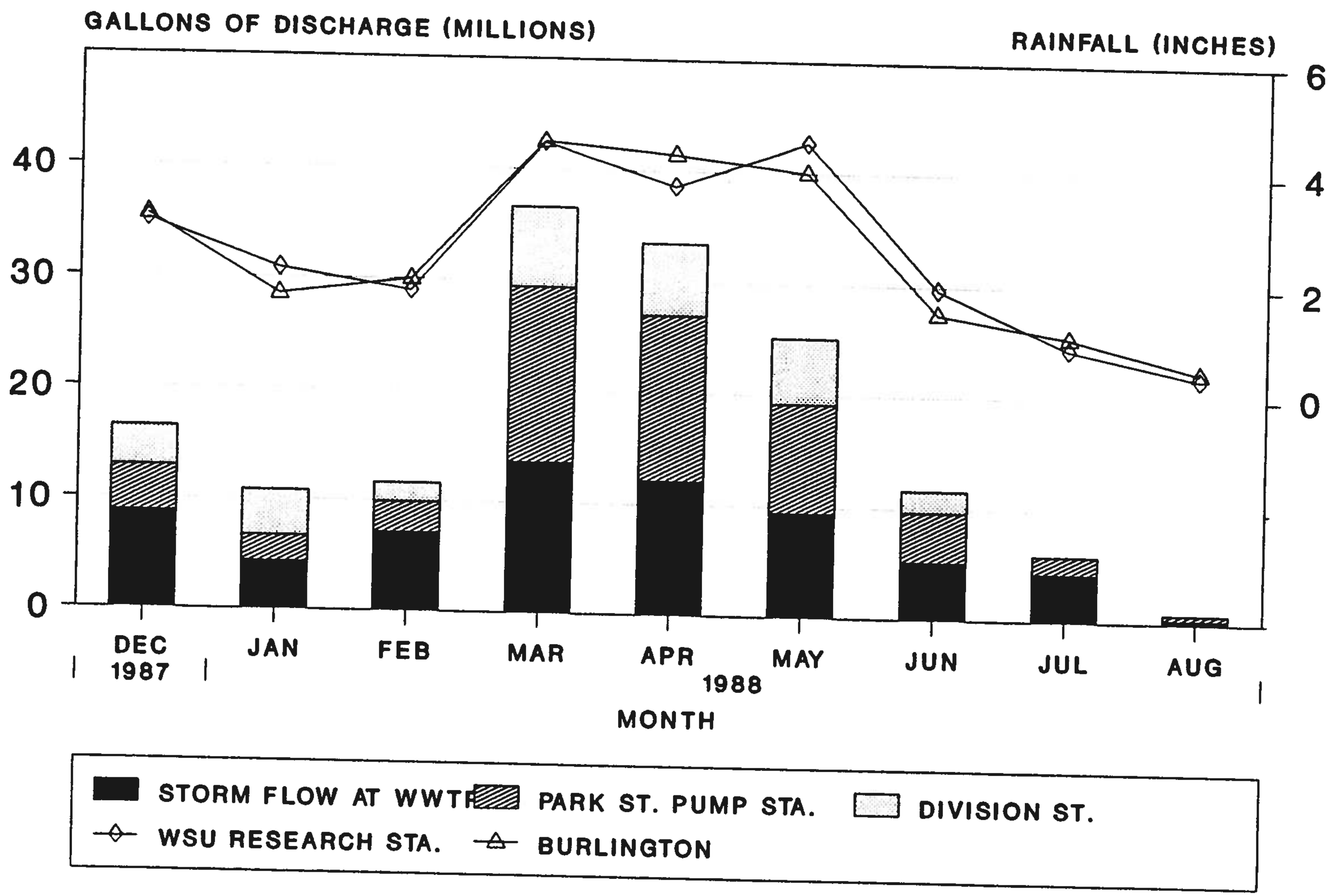

FIGURE V-11
MONTHLY STORMWATER FLOW AND
RAINFALL DURNING THE STUDY

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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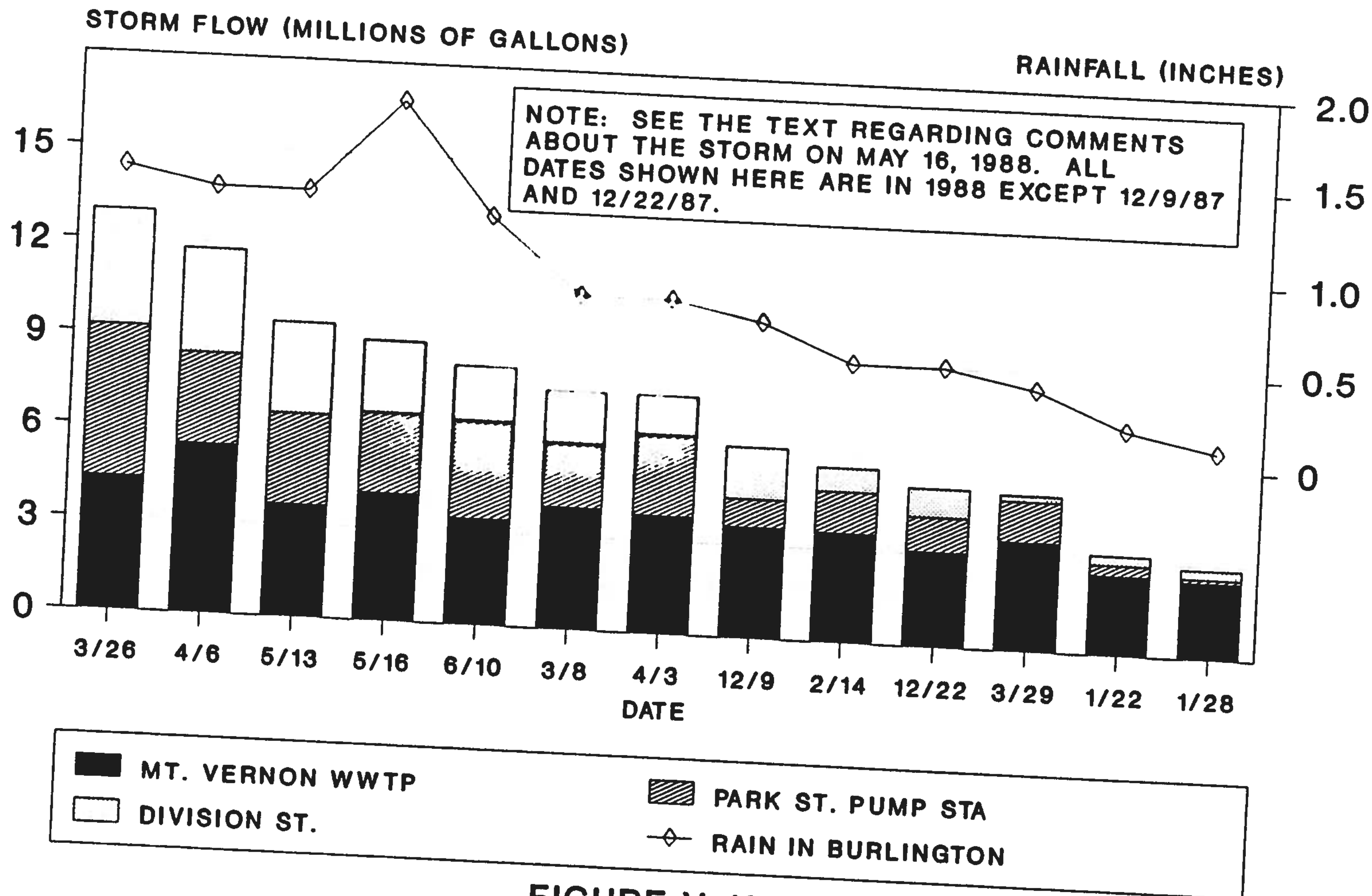

FIGURE V-12
DISCHARGES TO THE SKAGIT RIVER AND RAINFALL FOR SIGNIFICANT STORM EVENTS

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINED SEWER OVERFLOW REDUCTION PLANS

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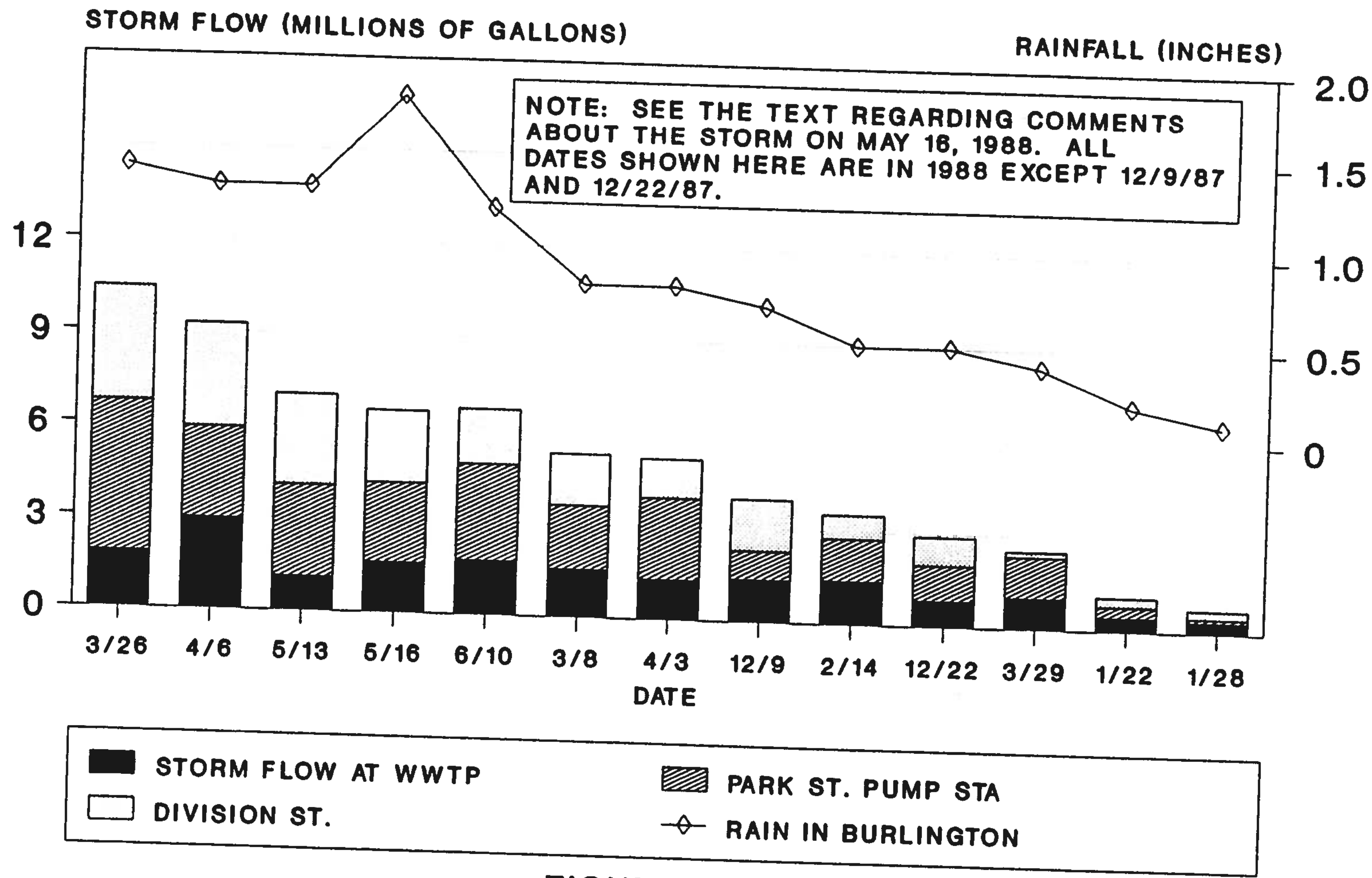

FIGURE V-13
STORM FLOW AND RAINFALL FOR SIGNIFICANT STORM EVENTS

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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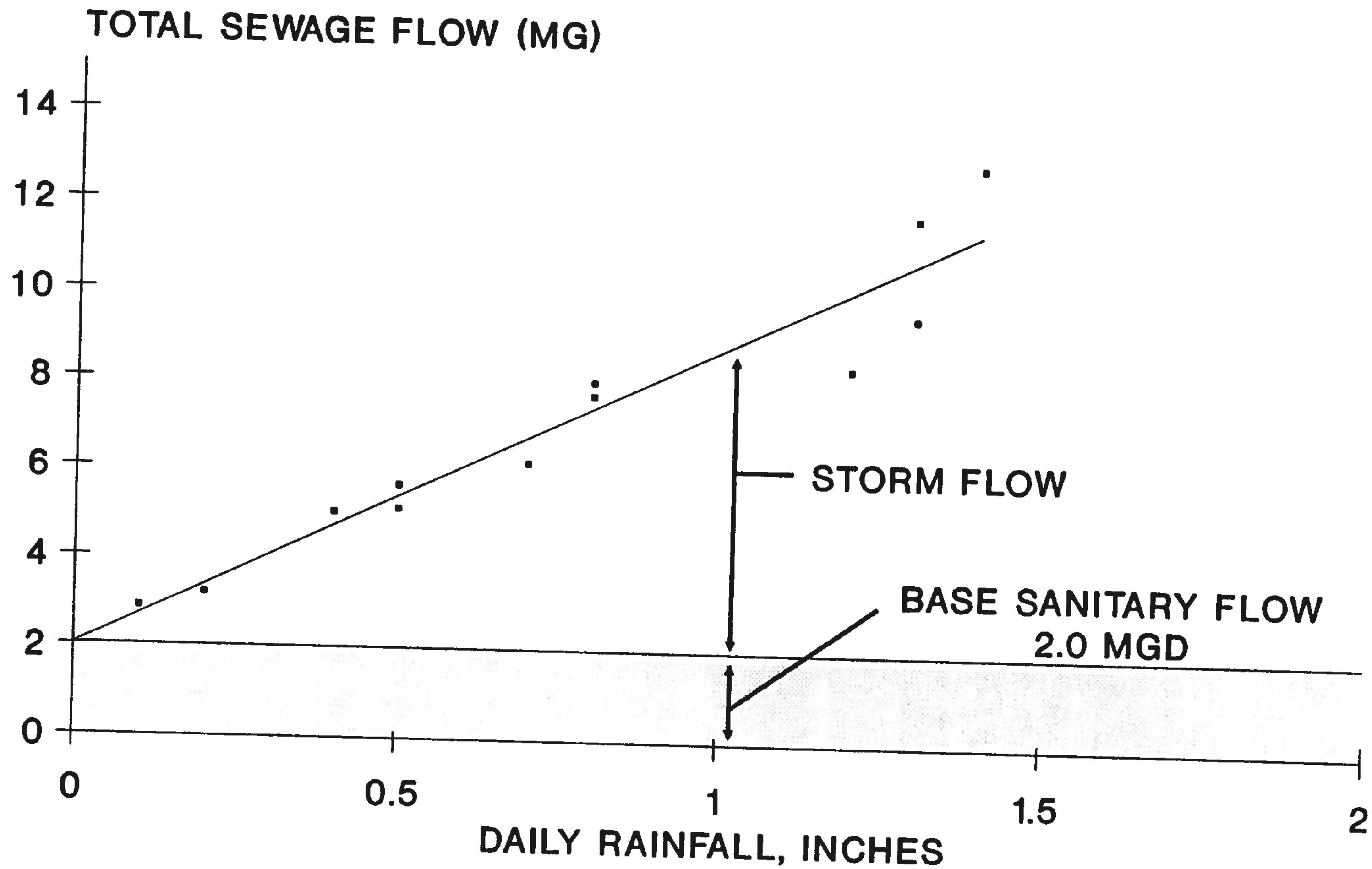

FIGURE V-14
TOTAL SEWAGE FLOW FROM STORM EVENTS VS. RAINFALL

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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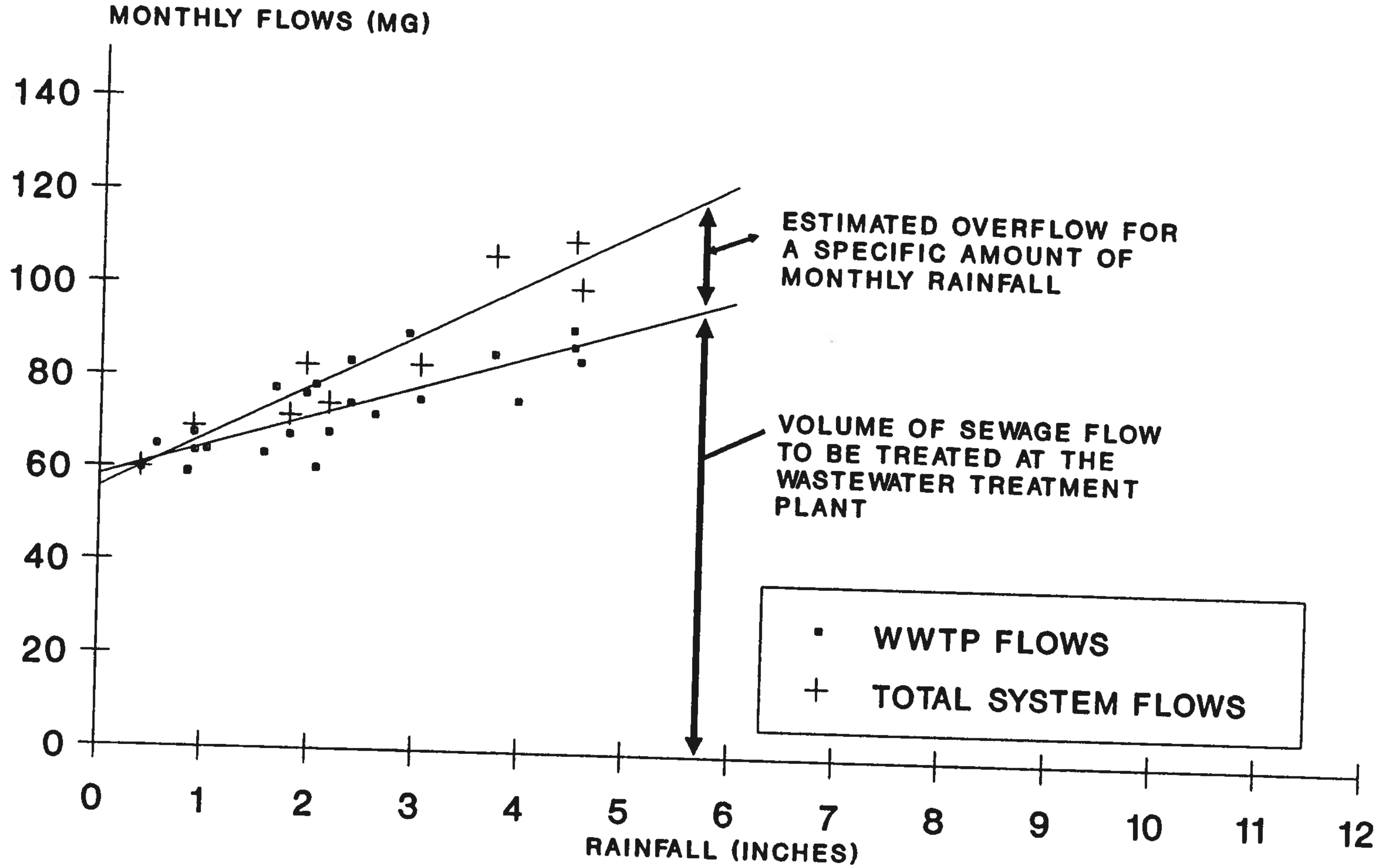

FIGURE V-15
MONTHLY WWTP FLOWS AND TOTAL SEWER SYSTEM FLOWS VS. RAINFALL

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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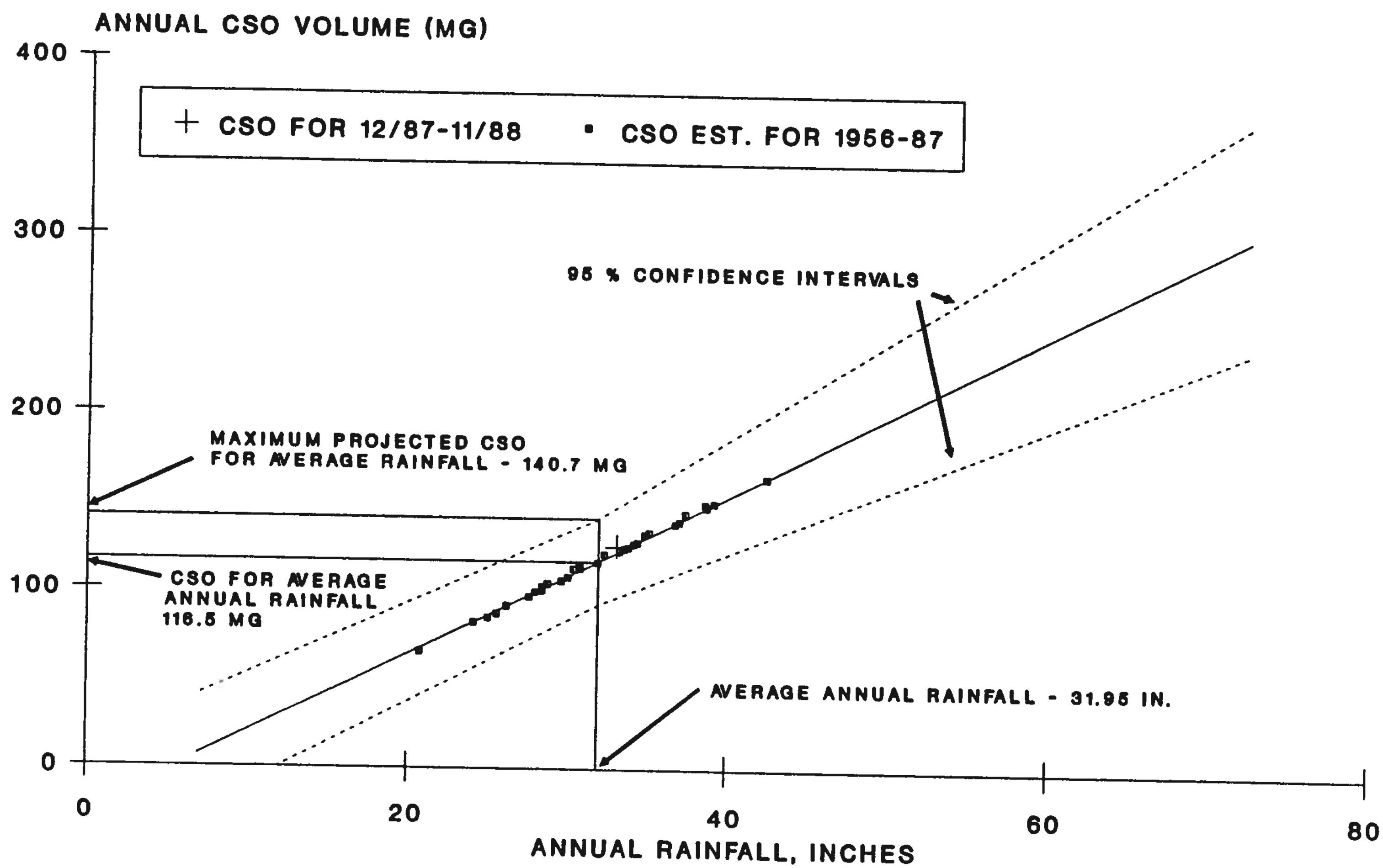

FIGURE V-16
CSO BASELINE FOR THE MOUNT VERNON SEWER SYSTEM: ESTIMATED CSO VS ANNUAL RAINFALL

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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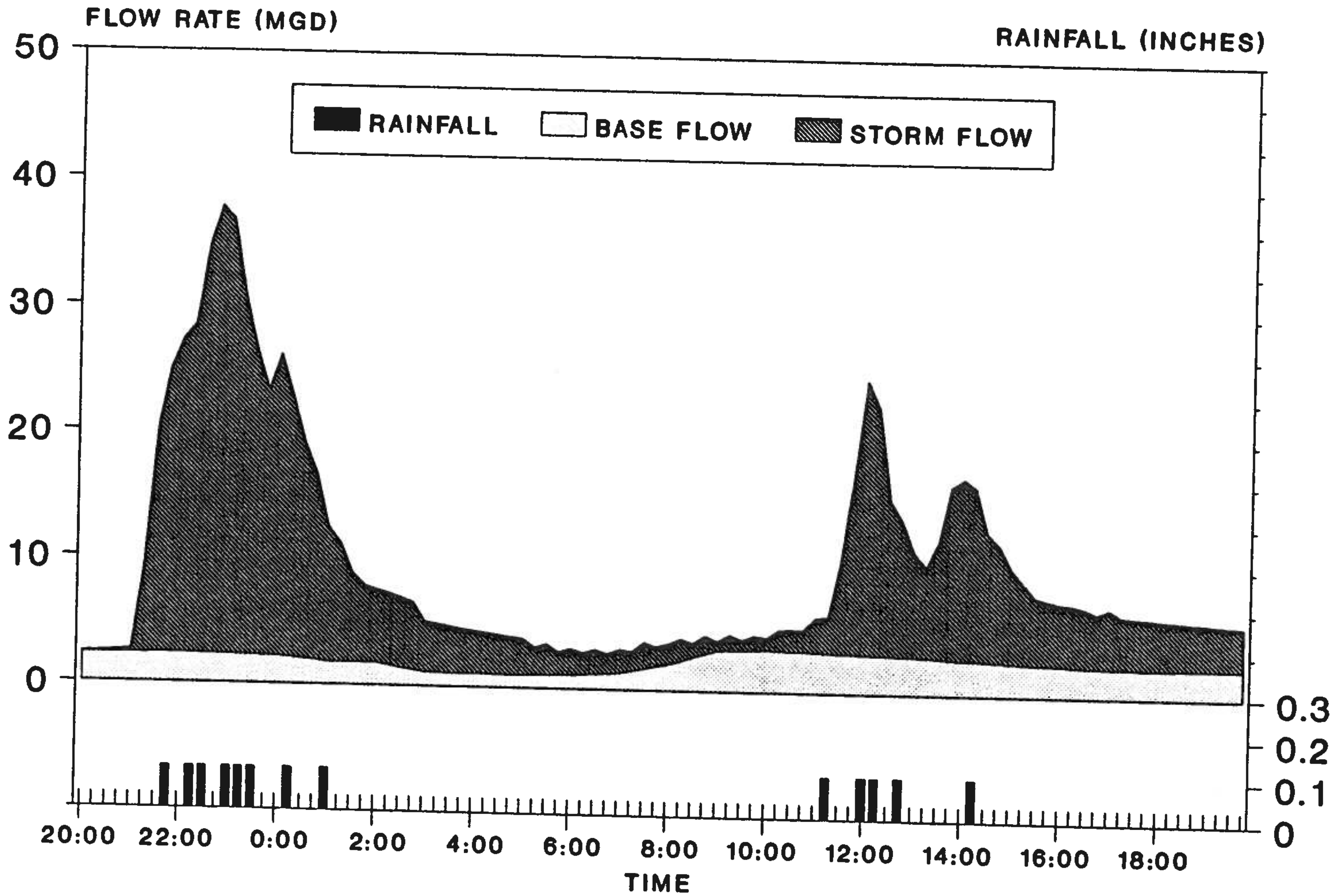

FIGURE V-17
SANITARY AND STORMWATER FLOWS
MAY 12 - 13, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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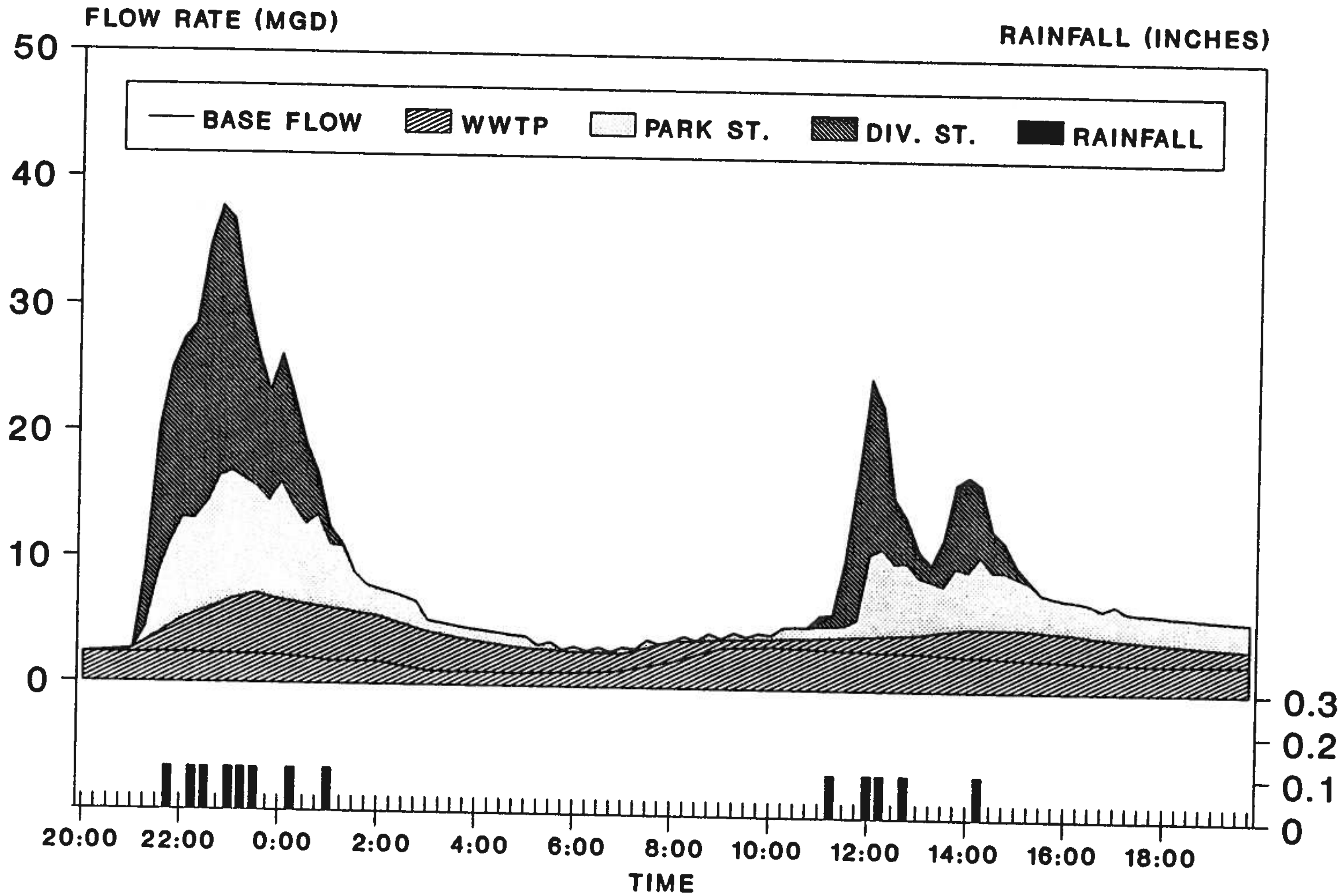

FIGURE V-18
COMBINED SEWER FLOWS
MAY 12 - 13, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

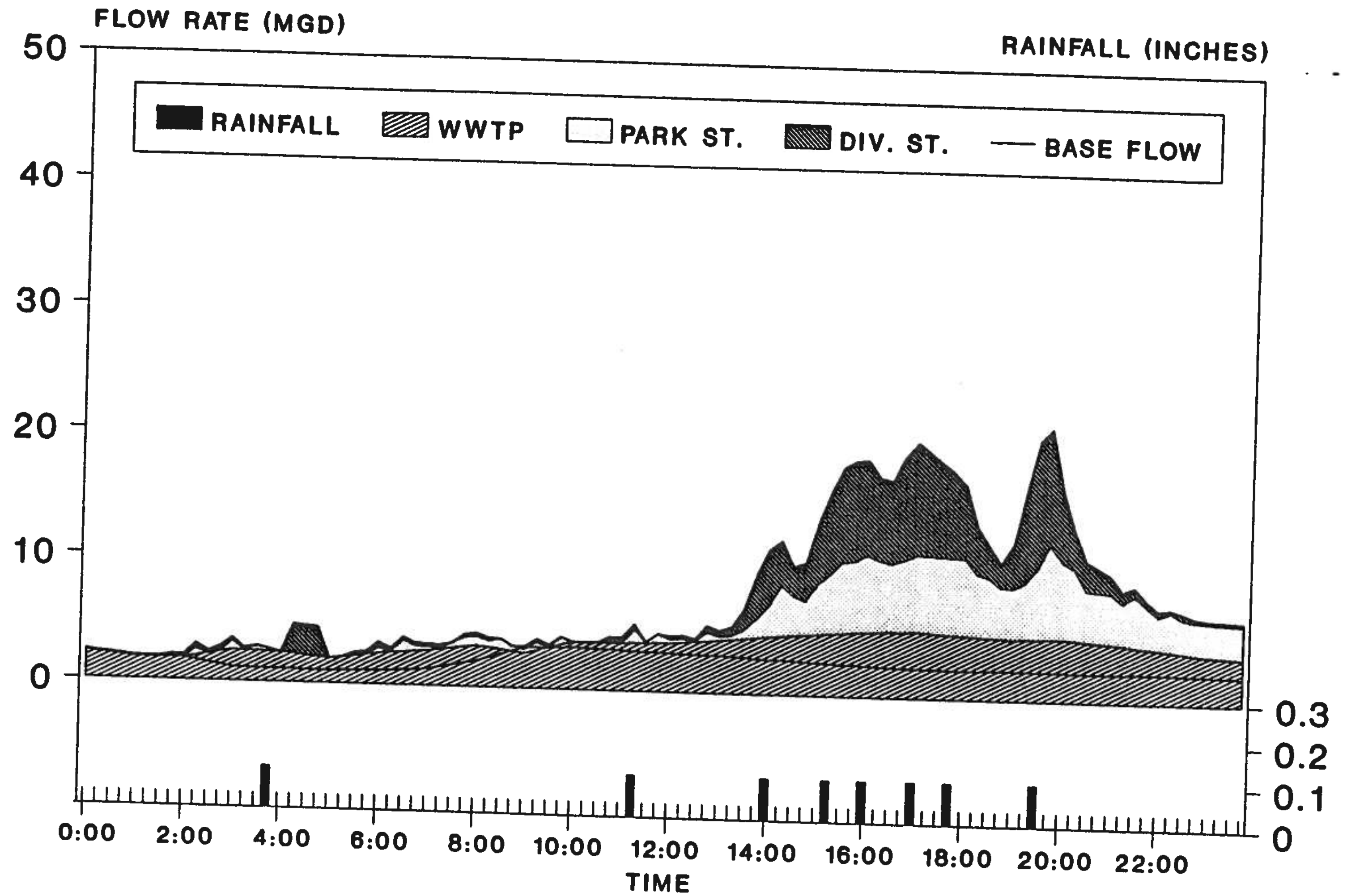

FIGURE V-19
COMBINED SEWER FLOWS
MARCH 8, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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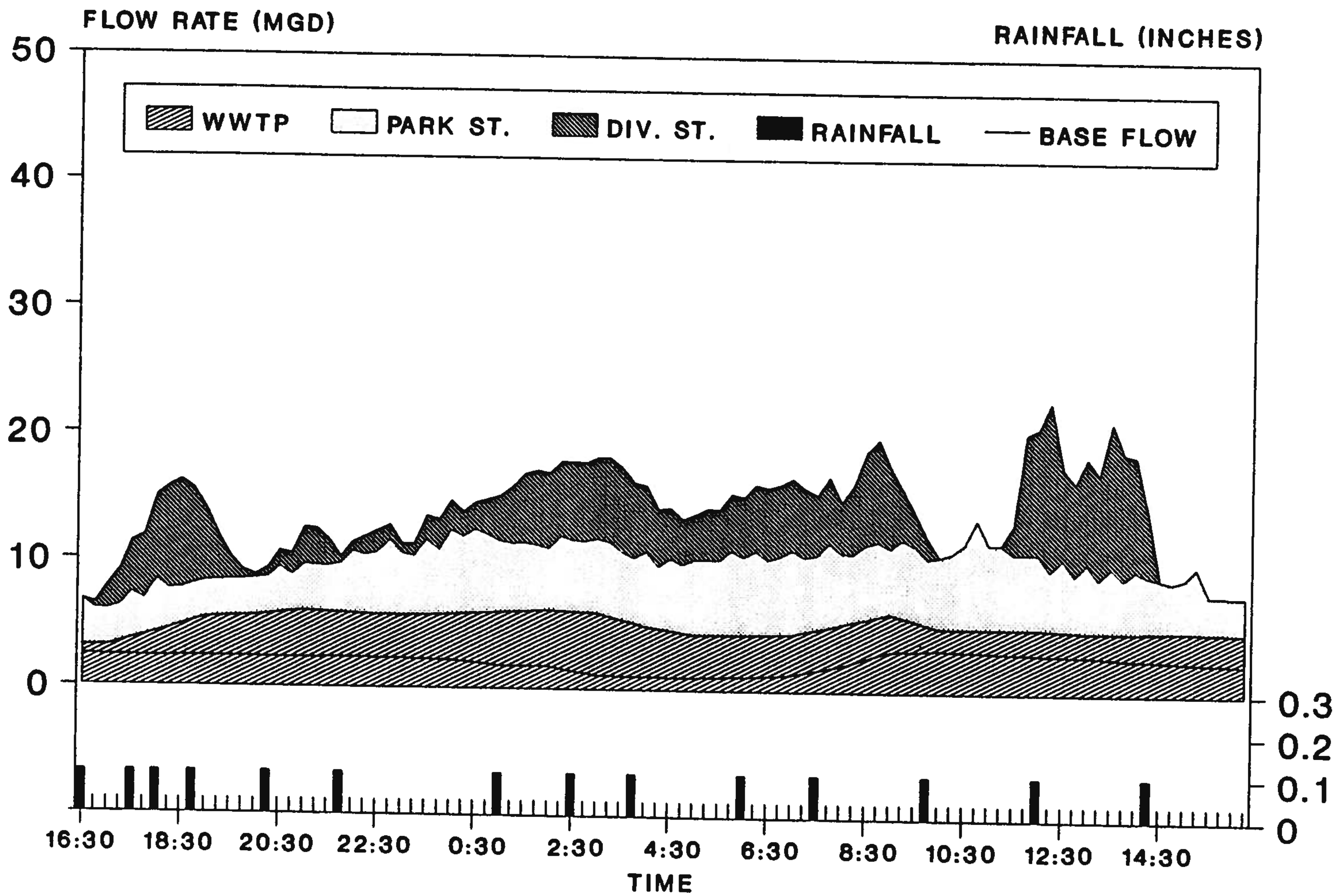

FIGURE V-20
COMBINED SEWER FLOWS
MARCH 25-26, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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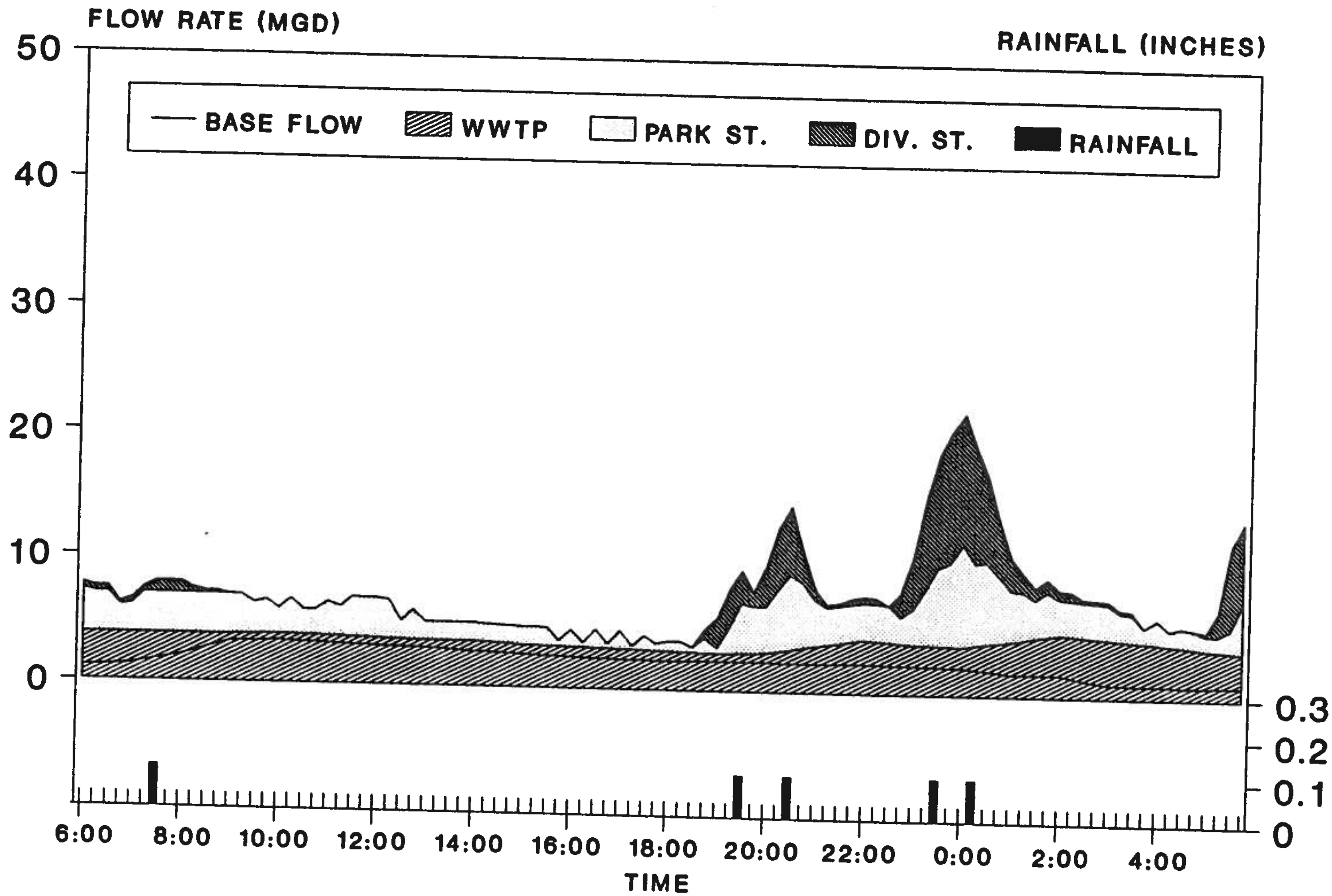


FIGURE V-21
COMBINED SEWER FLOWS
APRIL 3 - 4, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

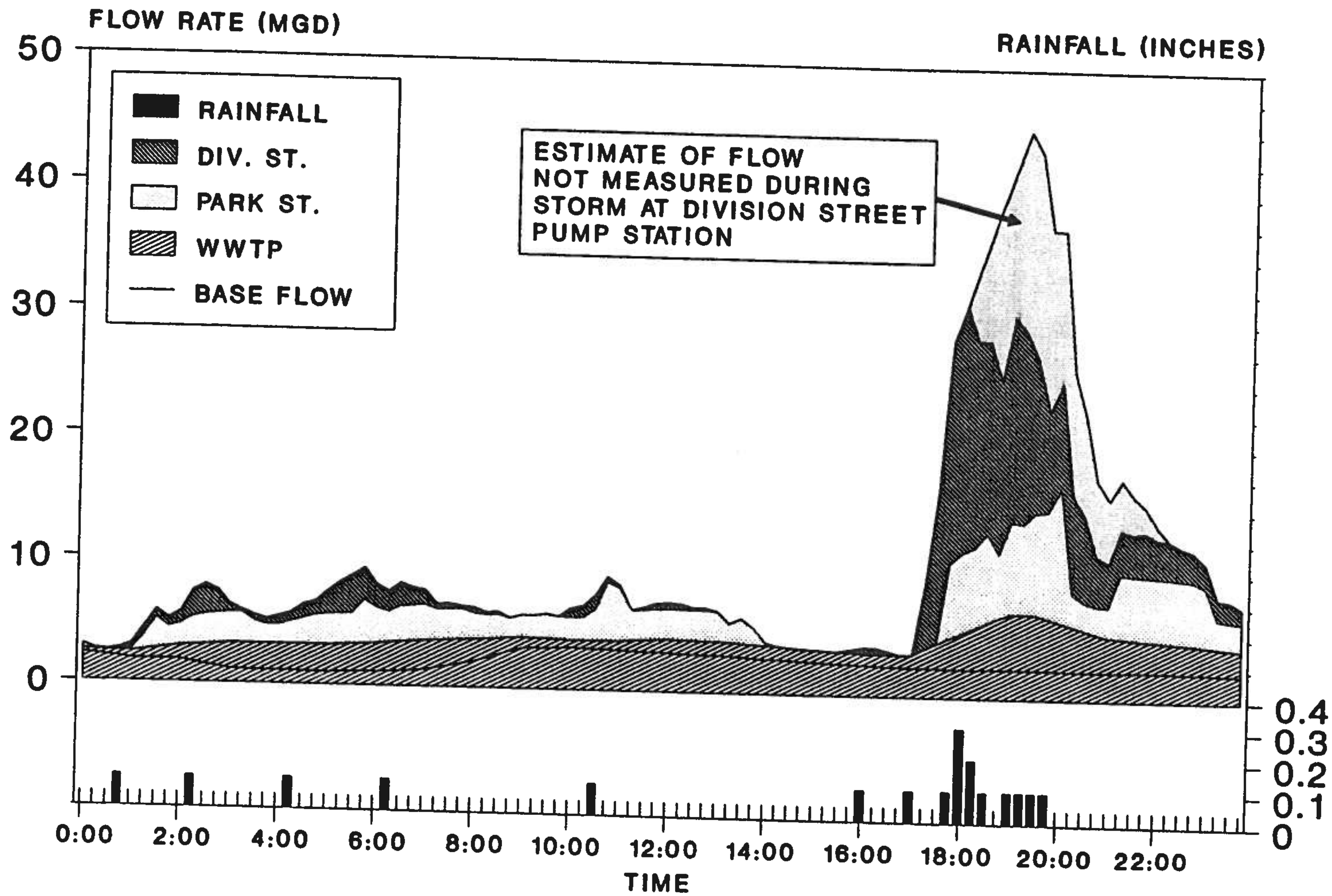


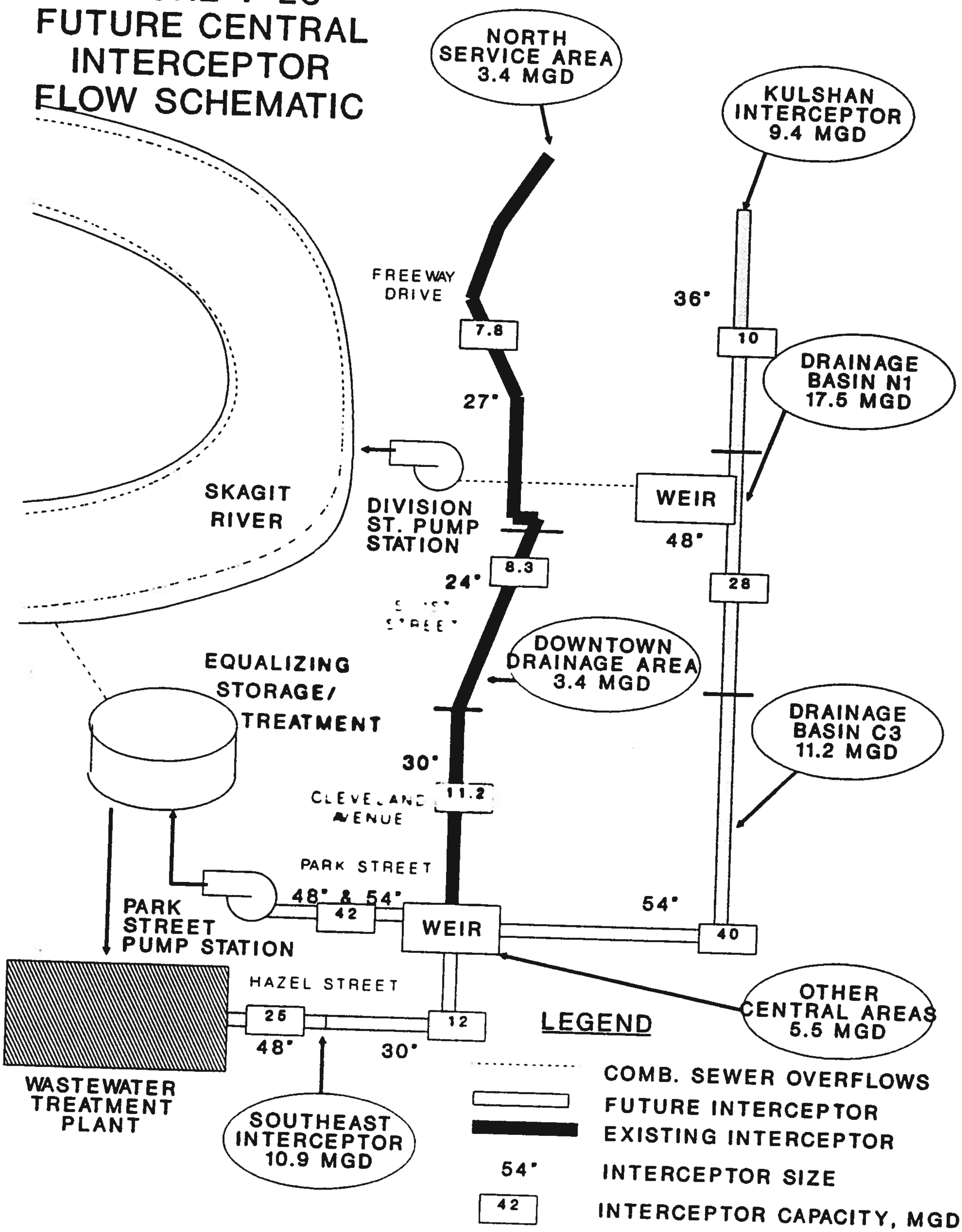
FIGURE V-22
COMBINED SEWER FLOWS
MAY 16, 1988

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

FIGURE V-23
FUTURE CENTRAL INTERCEPTOR FLOW SCHEMATIC



CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE SEWER AND COMBINED SEWER OVERFLOW REDUCTION PLANS

R·W·BECK

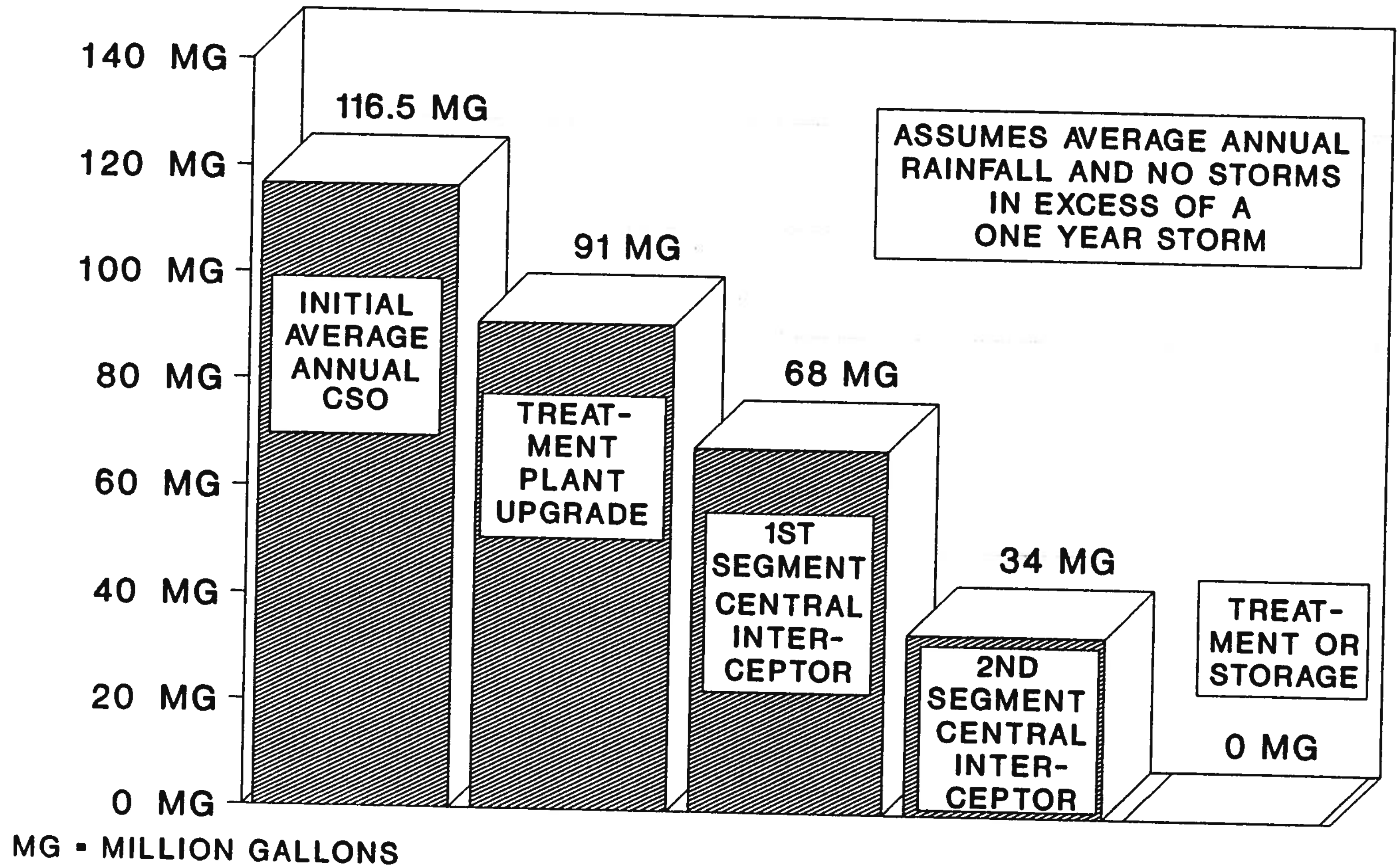


FIGURE V-24
ESTIMATED ANNUAL OVERLFOWS
WITH CSO REDUCTION FACILITIES

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

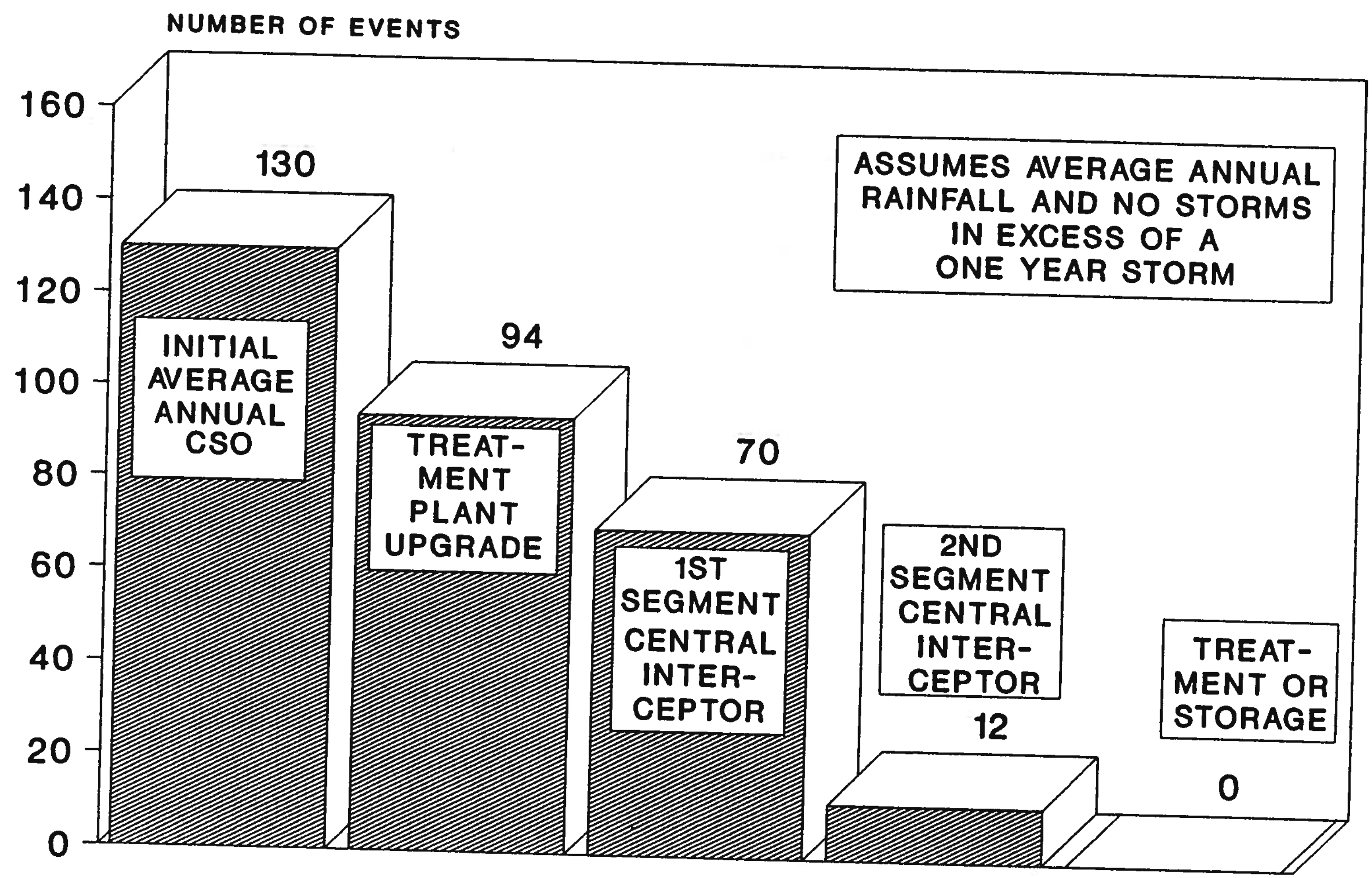


FIGURE V-25
ESTIMATED FREQUENCY OF OVERFLOWS
PER YEAR WITH CSO REDUCTION FACILITIES

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

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SECTION VI
PROBLEM IDENTIFICATION

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SECTION VI

PROBLEM IDENTIFICATION

A. General

This section describes surface water problems in the study area and the methodology used to identify them. Problems are categorized into one of the following type:

- System problems, such as flooding, channel erosion, and damaged or old-substandard storm drainage systems
- Water quality problems
- Environmental resource problems, such as fish habitat and wetlands preservation problems

The development of solutions to address these problems is discussed in Section VII.

B. Problem Identification Methodology

Developing a comprehensive summary of stormwater problems in the study area involved a combination of conducting interviews, field observations, and performing specific technical investigations. Detailed descriptions of the information sources used and technical investigations performed are described in the following paragraphs.

1. Public Input

Input from the public regarding drainage problems was solicited through a notice that was sent out in a citywide mailing. The notice described the comprehensive surface water management plan and requested individuals to attend a public meeting to help identify existing drainage problems.

2. City Staff

Both the City engineering staff and the maintenance personnel provided input on problems. Several of the staff have personal knowledge of historical flooding problems.

3. Interviews with Agencies/Jurisdictions

Agencies and jurisdictions were contacted, informed about the planning effort, and solicited for information regarding problems occurring in the study area. Agencies and jurisdictions contacted as a part of this planning effort were listed in Section II.

4. Citizen's Advisory Committee

A Citizen's Advisory Committee (CAC) was formed by the City to assist in formulating the history of problems and facilities in the drainage basins, make recommendations to the final goals and objectives, and assist in developing the surface water management plan.

5. Hydrologic/Hydraulic Computer Analysis

Hydrologic and hydraulic computer models were developed to simulate the response of the drainage basins to storm events. The computer models were used to help assess the magnitude and frequency of flooding problems in the basins, and also to identify flooding problems not already identified by City staff or the public.

a. Hydrology. Hydrologic modelling of the study area was performed using EPA's HSPF computer model. The hydrologic computer model was developed to simulate the runoff hydrographs from the study area during storm events. The hydrologic computer analysis was described in Section IV.

b. Hydraulics.

(1) Regional System Problems, as defined in Part C. of this section, were analyzed using the future and existing flows at various points in the study area based on the results from the HSPF hydrologic computer simulation. HEC-2, Water Surface Profiles computer program (US Army Corps of Engineers, 1990) was used to assess the impacts of these flows in Kulshan Creek upstream of Riverside Drive. The computer program HY8, Culvert Analysis (Federal Highway Administration, 1987) was used to estimate the performance of culverts on channels other than Kulshan Creek.

(2) Local System Problems

Local system problems, as defined in Part C. of this section, were analyzed by comparing the peak flows from the runoff hydrographs generated by the HSPF computer model, with the capacity of existing drainage systems determined using Flowmaster computer program (Haestad, 1991). The capacity of these systems were compared with the peak flows for the 10-year 24-hour storm event to estimate the magnitude and frequency of flooding problems. The results are tabulated in Table VII-1.

6. Water Quality Investigations

A water quality assessment was prepared as part of the surface water management plan. Its purpose was to characterize the quality of the surface waters and to identify potential sources of pollution in the Mount Vernon study area. A complete discussion of the water quality assessment is presented in Appendix G. Historical information (Skagit River basin study, Entranco 1991; Nookachamps management plan, Cook 1980; A catalog of Washington streams and salmon utilization, WDF 1975; Baseline monitoring at proposed Sea-Van

Development Site, Sea-Van fisheries resources, W&H Pacific 1992; Predicted water quality impacts from the proposed Sea-Van golf course and residential site, Harding Lawson Associates), was used to characterize the Skagit River, Nookachamps Creek and streams in the study area. A water quality monitoring program and a stormwater pollutant loading study was used to characterize the streams in the study area. The monitoring program was used to identify specific pollutant problems in the study area, while the pollutant loading study, which estimates loadings based on land use activity, was used to indicate the relative pollutant problem in each of the study area major drainage basins and also the relative increase in pollutants in each basin due to future urbanization.

7. Fish Habitat Inventory and Investigation

A field inventory of the fish habitat and riparian corridors was conducted for Kulshan Creek, Trumpeter (College Way) Creek, Maddox Creek, Flowers Creek, and Carpenter Creek. The inventory describes fish habitat and associated riparian areas of importance to both fish and wildlife. As part of this inventory, fish habitat problems were identified and are discussed in Section VII.

C. System Problems

System problems such as flooding and channel erosion are a result of uncontrolled runoff from developed areas, inadequate capacities or material failures in existing storm drainage systems, and the loss of flood reducing storage capacity in natural depressions and riparian areas. Some of the problems are considered local system problems if they are located in areas tributary to major streams or drainage systems. Other problems are considered regional system problems if they are associated with a major stream or drainage system. The following problems have been identified by City staff, modelling efforts based on existing and future land use, and the public. The locations of these problems are shown in Figure VI-1.

1. Regional System (RS) Problems

a. Problem RS1 The drainage system along Freeway Drive north of College Way, including the detention pond constructed with the Eagle Hardware development and the existing 2.67 cfs pump station, does not have enough capacity to adequately convey flows with proposed future development in the area. There is also no drainage system along Freeway Drive south of College Way.

b. Problem RS2 The two 36-inch-diameter culverts under Parker Way along Kulshan Creek have insufficient capacity to prevent overtopping of the road.

c. Problem RS3 The existing culvert for a tributary to Kulshan Creek across College Way east of Continental Place has insufficient capacity to pass the 10-year storm event. This problem may be aggravated by routing flows from areas west of the Burlington Northern Railroad tracks into this system.

d. Problem RS4 Kulshan Creek is conveyed to the Skagit River via a pipe system from Riverside Drive to an existing pump station west of Freeway Drive. When the water levels in the Skagit River are normal and low enough for gravity flow, the existing pipe conveyance system to the Kulshan Creek Pump Station has a capacity of 100 cfs with an upstream water surface elevation of about 25 feet at Riverside Drive. When the water level on the Skagit River is high, the water from Kulshan Creek must be pumped into the Skagit River. The combined capacity of the existing two pumps at the pump station is about 20 cfs at 20 feet total dynamic head. Therefore, if the flow from Kulshan Creek is more than 20 cfs when the Skagit water level is high or if the flow from Kulshan Creek is more than 100 cfs during normal Skagit River levels, extensive flooding is possible along Kulshan Creek upstream of the pump station. This is one of the most severe flooding problems in the City, which resulted in extensive property damage during flood events in November 1990.

e. Problem RS5 According to the hydrologic analysis, future development in the Trumpeter Creek basin could cause peak flows to increase by up to 30 percent in some areas over existing conditions if no additional detention were provided. This would cause an increase in local flooding and erosion problems, as well as water quality and fish habitat problems.

f. Problem RS6 Large amounts of undeveloped property remain in the Madox Creek basin and, without adequate controls, development to current zoning would result in significant increases in peak flows at all points along the main stem of Madox Creek. Some of the areas of the basin could experience an increase in peak flows that would be triple the peak flow under existing conditions. Such a significant increase in peak flows would undoubtedly create local flooding problems and aggravate the existing erosion problems along Madox Creek.

g. Problem RS7 Erosion problems on the main stem of Madox create have been noted just below Blackburn Road. At this point, Madox Creek enters a well defined steep-sided ravine with a bed slope of approximately 0.05 foot/foot. Erosion of the channel bed and banks has resulted in downcutting of the channel bed up to three feet in places and a number of side slope failures over a distance of several hundred yards downstream from Blackburn Road. The channel bed has been eroded down to an underlying layer of relatively hard glacial till, which will likely impede further down cutting. Similar erosion problems on a tributary to Madox Creek, Flowers Creek, have also occurred downstream from Blackburn Road. Continued erosion of the stream banks and further side slope failures are likely in the future and the problems will likely become more severe in the absence of adequate stormwater controls. In addition, the material eroded from Madox Creek and Flowers Creek will be carried downstream and deposited in the low gradient reaches downstream of Blodgett Road. Deposition of eroded material will reduce the capacity of the downstream reaches of Madox Creek and may result in increased incidence of flooding.

h. Problem RS8 Madox Creek exits the City of Mount Vernon into Drainage District 17 south of the City. Concerns have been raised by the district as to the overall responsibility of the City to contribute to maintenance and operations of the Madox

Creek system within the district. The primary concern is related to costs associated with maintaining and operating a stormwater pump station near Conway, and removal of sediment near Blodgett Road. This problem relates to determining how much the City contributes to problems in the district, and to what degree the City should be responsible for maintaining and operating the pump station at Conway.

2. Local System (LS) Problems

a. Problem LS1 During periods of high water levels in the Skagit River, flooding occurs in the area west of LaVenture Road and north of Hoag Road. One house on the corner of Hoag Road and Horizons Street has sustained flood damage.

b. Problem LS2 Flooding occurs northwest of the intersection of Hoag Road and the Burlington Northern Railroad. There is no drainage system in this area so once runoff collects in this area it has no means of escape.

c. Problem LS3 Flooding has occurred at the residence located west of where La Venture Road turns east several blocks north of Hoag Road. It was reported that drainage from La Venture Road was running off into the property. It appears that the problem may have already been resolved. During a field visit, it was noted that a concrete berm had been placed along the outside of the curve to prevent runoff from entering the property.

d. Problem LS4 Ponding occurs on a commercial site northeast of the College Way - Urban Avenue intersection. The loading bays were graded much lower than the rest of the site and therefore collect site runoff.

e. Problem LS5 Runoff from the south side of Fir Street flows north across the roadway just west of North 14th Street because of an inadequate drainage system in that area. This problem was recently solved with system improvements that were installed as part of the Fir Street reconstruction.

f. Problem LS6 Erosion is occurring in a small stream channel tributary to Kulshan Creek north of Cedar Lane. The channel has incised down to a glacial till soil layer.

g. Problem LS7 Erosion is occurring in an open channel tributary to Kulshan Creek north of Viewmont Drive and downstream from an 18-inch pipe outlet. The erosion problem originated where the channel descends a steep grade immediately south of Kulshan Creek. Over time, the channel erosion has progressed south towards the 18-inch pipe outfall.

h. Problem LS8 There is an undersized culvert along the west side of North 16th Street just south of the railroad grade which is causing flooding in the area.

i. Problem LS9 There are two problems in trailer parks adjacent to Trumpeter Creek. One flooding problem occurs in a trailer park east of North 30th Street and 1,300 feet south of College Way as runoff overtops a ditch and flows overland to

Trumpeter Creek. There are several areas where flows overtop the ditch which is adjacent to the south property line of the trailer park. Another problem occurs in the Park Village trailer court north of First Street and east of LaVenture Road. This problem occurs on the main stem of Trumpeter Creek along the east property line of the development. It is our understanding that this flooding problem is limited to landscaped areas and has not caused property damage to adjacent structures.

j. Problem LS10 There are stream channel erosion and deposition problems along the southeast fork of Trumpeter Creek where it crosses Kiowa Drive west of Seneca Drive and east of Waugh Road.

k. Problem LS11 A storm drain runs through an easement along the east property line of the second house east of Nez Perce Drive on the south side of Kiowa Drive. Sediment and debris plug a pipe inlet behind the house which is flooded as a result.

l. Problem LS12 There is localized flooding along Memorial Highway (SR 536) in West Mount Vernon due to insufficient capacity of the storm drain system. The storm drain system which collects drainage for most of West Mount Vernon is only 12 inches in diameter.

m. Problem LS13 Flooding occurs near the intersection of Garfield Street and Wall Street in West Mount Vernon. When the Skagit River is high, the groundwater table rises above the ground surface in the low spots in this area causing flooding of several residences.

n. Problem LS14 Ponding occurs at the intersection of Cosgrove Street and Wall Street in West Mount Vernon.

o. Problem LS15 Flooding occurs at the intersection of Division Street and South 20th Street as a result of an undersized conveyance system north of Division Street. Several homes are affected.

p. Problem LS16 Erosion is occurring along a portion of the southwest fork of Trumpeter Creek between Mohawk Drive and Apache Drive east of Comanche Drive.

q. Problem LS17 Uncontrolled runoff from an undeveloped parcel south of Commanche Drive flows north into a ditch on the south side of Commanche Drive. The ditch capacity is insufficient and high flows spill out of the ditch, causing flooding of two homes on the north side of Commanche Drive just east of 30th Street.

r. Problem LS18 There is a 12-inch-diameter culvert under Shoshone Drive just east of Sioux Drive that is overtopped during high flows.

s. Problem LS19 The two detention ponds north of Division Street and west of Waugh Road do not have emergency overflow spillways. Lack of well armored spillways for emergency use may lead to failure of the pond in an extreme flood event. Also, residents have encroached with landscaping into the easements around these ponds which may inhibit access for maintenance.

t. Problem LS20 Several homes are flooded on the west side of South 6th Street north of Blackburn Road. There is no drainage system in the area.

u. Problem LS21 Flooding occurs on the west side of Riverside Drive in the vicinity of Willow Lane and Alder Lane.

v. Problem LS22 Flooding occurs northwest of the Riverside Drive - Fir Street intersection in the area south east of the Burlington Northern Railroad. There is no drainage system to convey runoff from the area. Three businesses in the area are affected by the flooding.

w. Problem LS23 Flooding occurs along the east side of Interstate 5 where Fir Street curves into Cameron Way. Several businesses are affected by the flooding. There is no drainage system to convey runoff from this area.

x. Problem LS24 Flooding occurs in a large commercial area on the west side of Interstate 5 south of College Way. Because of the flat topography and lack of any conveyance system, the runoff that is generated remains on site.

y. Problem LS25 It was determined from the hydraulic analysis that portions of the pipe and ditch system between Blackburn Road and Britt Slough appear to be under capacity and may cause water to back up in the system and cause flooding during a 10-year storm event.

z. Problem LS26 It was determined from the hydraulic analysis that portions of the storm drain system containing the North Fork of Trumpeter Creek along Fox Hill Street have insufficient capacity to pass the 10-year storm event. This may cause flow to back up and flood the streets and homes in the area. In addition, safety problems associated with a deep ditch west of 32nd need to be resolved.

aa. Problem LS27 It was determined from the hydraulic analysis that the culvert under Interstate 5 on the system tributary to Madox Creek between Blackburn Road and Anderson Road appears to have insufficient capacity. In fact, the pipe section on the east side of Interstate 5 is set at a reverse grade. Therefore, in order for flow to pass through this pipe, water must pond upstream of the pipe and create enough pressure to force the flow through.

D. Water Quality Problems

1. Introduction

For purposes of discussion, water quality problems in the study area are separated into water quality problems attributable to urban development and water quality problems attributable to rural development. Stormwater runoff from these distinct land uses typically contains different types of pollutants and are discussed below. In addition to these two types of general water quality problems, several specific water quality problems identified in the water quality monitoring program are also discussed. Problems associated with pollutant loading increases from future development are also discussed based on the pollutant loading analysis.

2. Water Quality Problems Resulting From Urban Development

The problem of contaminated urban runoff is not unique to the Mount Vernon urban service area. This pollution problem is prevalent everywhere urban development occurs, and nationwide efforts to clean up surface waters reflect the increasing concern with this form of water pollution. Urban development results in increased contamination of runoff as a variety of commercial and residential activities introduce chemicals, petroleum products, solid wastes, and other pollutants onto the land surface, and stormwater runoff subsequently carries those pollutants into receiving waters. Urban development also causes an increase in the volume and peak rate of stormwater runoff. As more buildings, paved areas, and other impervious surfaces are constructed in an area, a greater proportion of the precipitation over the area becomes surface runoff rather than infiltrating into the ground. Greater areas of impervious surfaces also lead to increased peak runoff rates because roof drains, streets, gutters, storm sewers, and other stormwater drainage facilities quickly convey runoff to receiving waters. With the increased volume and peak rate of surface runoff, there is greater potential for pollutants to be washed off the land surface and carried into surface waters.

The general causes of water quality problems related to urban development in the study area can be classified into several broad categories, including illicit wastewater discharges to the storm drainage system; erosion, transport, and deposition of sediments; contamination of runoff by diffuse sources of pollutants on the land; spills of solid and liquid materials; and illegal dumping of materials into the storm drainage system. These general urban water quality problems within the study area are discussed individually below. Specific water quality problem sources within the study area are discussed in a later section of this report.

a. Problem WQ-1—Illicit Connections of Wastewater Discharges to the Storm Drainage System. A common problem that occurs in urbanized areas is illicit wastewater discharges into a designated storm drainage system. Examples are plumbing connections for sanitary sewer pipes, process wastewater discharges, sump overflows, and internal shop floor drains that enable wastewater to enter storm sewers and drainage ditches, and ultimately to receiving waters. These discharges should be directed to sanitary sewers, combined sewers, septic systems, onsite process water treatment systems, or isolated sumps so that the wastewater is treated (or collected for treatment) before entering the surface water environment.

In many instances these connections are unknown to the business or home owner, and may not even show up on building drawings. The pollution problems these discharges cause can be severe, and they may persist because detection of the illicit wastewater discharge locations may never occur. Cross-connections of sanitary sewer pipes to the storm drainage system were discovered at the Heritage

Apartments on 19th Street, and have since been rerouted to the sanitary sewer system (Enquist 1993 personal communication). It is likely that other illicit wastewater discharges exist in the study area.

b. Problem WQ-2—Erosion, Transport, and Deposition of Sediments. Erosion within the study area results in increased sediment loading to surface waters. Sedimentation degrades receiving water quality and impacts aquatic habitat. Sediment can be the result of several phenomena. The major causes of sediment deposition include:

- Erosion of stream channels and ditches
- Erosion of cleared or disturbed land
- Particulates, such as wintertime traction sand, which settle on surfaces such as roadways, are washed off and carried to the drainage system.

Pollutants often found in stormwater, including metals, nutrients, bacteria, and petroleum products, can accumulate in sediments deposited near the outfalls from storm drainage systems. Significant sediment deposition was observed in the lower reaches of Madox Creek and Flowers Creek.

Urbanization within the study area has resulted in increased soil erosion from developed land, subsequent deposition of sediments in receiving waters, and scouring of sediments in streams receiving elevated rates of stormwater runoff. Construction sites typically create conditions where soils are vulnerable to erosion by wind or rain. Soils that are stripped bare during site preparation can easily erode. Heavy equipment operating on a construction site can track sediments off the site onto adjacent roads, where the sediments are picked up by wind or stormwater runoff and carried into receiving waters. The steeper the ground slope, the greater the potential for construction-related erosion problems. Erosion can also occur in residential and commercial areas where lawns, landscaped planters, and gardens typically have reduced amounts of ground cover compared to predevelopment conditions.

Sediments that are picked up by wind or stormwater runoff can be carried into receiving waters, where they eventually settle to the bottom. Sediments that are suspended in water can cause problems for the normal functioning of fish and other aquatic organisms. When sediments deposit in the bottom of lakes, wetlands, and streams, they can destroy the habitat for fish and a variety of aquatic organisms.

Erosion and sedimentation problems are aggravated by existing maintenance practices for grass-lined ditches which, in some instances, resulted in removing all the vegetation in the ditch. This practice results in exposing ditch soils to increased erosion, and eliminates the biofiltration capacity of the grass-lined ditch. It also increases runoff velocity through the ditch, which in turn results in increased erosion.

c. <u>Problem WQ-3—Contamination of Runoff by Diffuse Sources of Pollutants on the Land</u>. Urbanization leads to a variety of diffuse sources of pollution. These pollution sources are called nonpoint sources because they cannot be traced to a single location. Rather, they occur in a widespread and uneven manner over the developed land surface. Examples of nonpoint pollution sources in the study area, and urban areas in general, are oil and grease that drip from the undercarriages of automobiles in parking lots, roadways, and driveways; pesticide and fertilizer residues that wash off lawns and other landscaped areas; animal wastes that wash off residential yards; and automobile emissions and other airborne particulates that fall from the air. The collective adverse impact of these nonpoint sources of pollution on the quality of receiving waters can be great. This unseen and previously ignored type of pollution is increasingly being targeted nationwide as a major cause of environmental degradation. Nonpoint pollution sources within the Mount Vernon study area are a major threat to the continuing health of surface and ground water resources.

Results of water quality monitoring conducted as part of this study indicate the existence of several water quality problems that are caused by nonpoint pollution of urban runoff. The general trend of the monitoring results shows that streams in the more urbanized drainage basins have lower dissolved oxygen levels; higher turbidities; higher nutrient concentrations; higher metals concentrations; higher fecal coliform bacteria concentrations; and higher concentrations of oil, grease, and metals in the sediments (Herrera 1993).

Based on the stormwater pollutant loading study, urban runoff water quality problems will become exacerbated with new growth. Concentrated growth will occur in the Mount Vernon area, and existing stormwater regulations to protect water quality from new development may not be adequate.

Nonpoint sources such as sediment and associated pollutants that are carried into storm drain systems can be trapped in catch basins and then removed and disposed of. A potential cause of water quality problems in the study area is infrequent cleaning of catch basins or other urban storm drainage facilities. Nearly all of the urbanized portions of the study area drain into a constructed conveyance system. The stormwater conveyance system includes numerous catch basins. These devices are located where two or more drainpipes join together as well as beneath many surface drains. Catch basins usually have sumps in the bottom that provide storage spaces to collect floating materials, street grit, and other particulates in runoff. If the materials that collect in catch basin sumps are frequently removed and properly disposed of, the sumps do not contribute to pipe clogging problems and can continue to effectively prevent many pollutants from traveling downstream into receiving waters. However, if catch basin sumps are not frequently cleaned out, the collected materials can build up to a point where turbulent inflows easily dislodge the mucky contents, including pollutants, and move them downstream. When this happens, the catch basins may actually contribute to downstream pollution problems because concentrated amounts of polluted material are conveyed into receiving waters within a short period of time.

d. <u>Problem WQ-4—Spills of Solid and Liquid Materials</u>. An obvious source of pollution in urban areas is spills of solid and liquid materials. Countless types of chemicals, petroleum products, manufactured parts, packaging materials, and other synthetic materials are handled every day within the study area. Many of these materials are toxic in the receiving water environment, even in minimal concentrations or quantities. Spills, drips, and inadvertent littering of many of these materials occur frequently in urbanized areas. If spills go unreported and uncontrolled, they can reach a storm drain or surface water directly. Spilled, dripped, and littered materials that are not cleaned up can be carried into the receiving water environment with stormwater runoff and can cause subsequent water quality problems.

The potential for transportation-related and storage-related spills of hazardous materials is a concern for protection of groundwater and surface water resources. If a hazardous materials spill is not adequately cleaned up, residual contamination will contaminate the soil and groundwater and acts as a long-term pollutant source.

The major highways are generally of greatest concern from transportation-related spills because they have high traffic volumes and tend to have a high number of traffic accidents. Traffic accidents associated with automobiles can lead to spillage of crankcase oil, transmission fluid, and gasoline. Accidents associated with truck traffic can lead to more intense spills of oil and gas and spills of hazardous materials such as chemicals being transported. Water quality impacts from transportation related spills can occur either through infiltration of contaminants into groundwater, or by discharge directly into surface waters.

The City of Mount Vernon has no formal spill prevention regulations or written requirements for storage or handling of hazardous materials applicable to businesses. The city fire department relies on the Skagit County Department of Emergency Management for hazardous material spill response and cleanup resources. Thus, individual businesses that handle solid and liquid materials are not required by the city to develop spill control, response, or cleanup plans to prevent pollution problems from occurring (Lindall 1993 personal communication).

e. <u>Problem WQ-5—Illegal Dumping into the Storm Drainage System</u>. Another source of surface water pollution is illegal dumping of solid and liquid materials into street drains, roadside ditches, and other features of the storm drainage system. This often includes litter, lawn clippings, construction waste, landscaping refuse, used crankcase oil, and household hazardous wastes. It is common in many urbanized areas for a variety of materials to be dumped illegally (often by people who do not know it is illegal), including such substances as used motor oil, excess paints and solvents, and assorted refuse. Illegal dumping can introduce high concentrations of contaminants into the storm drainage system, causing severe water quality problems downstream.

3. Water Quality Problems Resulting From Rural Development

Rural development within the study area has led to water quality problems stemming from failure of septic systems, erosion of pasture land, and loading of animal wastes into surface waters. Each of these problems is discussed individually below.

a. Problem WQ-6—Failure of Septic Systems. Although the portion of the study area within the City of Mount Vernon is serviced by sanitary sewers, there are still active septic systems outside the City, but within the Urban Service Area. Septic system failures are a known problem within parts of this area (Herrera 1993). Malfunctioning septic systems have the potential to allow untreated sewage to reach receiving waters. Septic system failures have various causes: If a septic tank is ruptured or otherwise leaking, untreated sewage can seep into the surrounding soil and migrate toward ground water. If sandy and gravelly soils are present in a septic drain field, wastewater will quickly pass through the soil, potentially surfacing downslope or migrating toward ground water. If a drain field is underlain by a hard layer of clay or other impermeable material, percolating wastewater can travel laterally along the hard layer and move quickly away from the drain field without being fully treated. Infrequent maintenance of septic systems may also lead to drainfield failures. Finally, tree roots and other obstructions may cause drainpipes to rupture or collapse, resulting in partial failure of the system.

b. Problem WQ-7—Erosion of Pasture Land. Land that is converted into pasture can be a source of surface water pollutants if it is not managed properly. Overgrazing can strip the ground bare, leaving the soil vulnerable to erosion. If animals are allowed to graze near unprotected stream banks, they may trample the banks and eliminate streamside vegetation. This trampling and loss of vegetation can lead to sloughing of large amounts of soil and sediment into streams and can also cause longer-term erosion problems as gullies develop in the stream banks.

c. Problem WQ-8—Loading of Animal Wastes in Runoff and Directly to Surface Waters. Heavy grazing in certain spots can lead to concentrated areas of animal wastes. Rain that falls on these areas can carry high concentrations of fecal coliform bacteria and nutrients with runoff, degrading downstream surface waters. Similarly, if livestock are allowed to roam in streams or wetlands, they may introduce these pollutants directly to those waters in even greater concentrations than would occur in overland runoff.

4. Specific Water Quality Problems in the Study Area

Based on a review of previous studies, interviews with city staff members, analysis of records of registered businesses in the study area, and field reconnaissance, limited information on specific water quality problems has been identified within the study area. The few specific problems that were discovered are discussed below.

a. Problem WQ-9—Sewage Overflows in the Kulshan Creek Basin. Recent water quality monitoring in Kulshan Creek indicates numerous water quality problems.

One of the primary water quality problems in this 1,404-acre drainage basin is caused by discharges of untreated sewage into the creek (Herrera 1993). A sanitary sewer line adjacent to Kulshan Creek overflows during storm events, causing untreated sewage to spill into Kulshan Creek. This problem has been studied recently, and a bypass sewer line will be constructed next year to eliminate this raw sewage discharge (Bergstrom 1993 personal communication).

b. Problem WQ-10—Contaminated Sediments in Kulshan Creek. Water quality monitoring conducted for this plan indicates that sediments in Kulshan Creek have total petroleum hydrocarbon (TPH) contamination as high as 3,200 milligrams per kilogram (mg/kg) dry weight, a level that far exceeds the state Model Toxics Control Act cleanup level for soil of 200 mg/kg dry weight. This high sediment TPH contamination may be due to concentrations of TPH in runoff from streets and parking lots in the drainage basin, but it appears to be indicative of other sources in addition to urban runoff.

The sediment monitoring station was located approximately 2,400 feet upstream of the mouth of Kulshan Creek near the inlet to the pipe system. Field reconnaissance in the basin did not indicate any obvious sources of TPH contamination in the vicinity of the monitoring station. A former fuel oil storage and distribution business located on the south side of College Way to the west of the railroad crossing is under consideration as a state toxic waste site (Buckenmeyer 1993 personal communication). This site may be a significant contributor to TPH contamination in Kulshan Creek via contamination of stormwater runoff. Another source of TPH may be untreated stormwater runoff from numerous parking lots in the basin that discharges into Kulshan Creek. Several large parking lots are located near the sediment sampling station.

The city now requires new developments and redevelopments to comply with the Washington Department of Ecology (Ecology) stormwater management regulations, which require oil/water separators in some instances. However, existing developments are not required to be retrofitted to provide stormwater treatment (Buckenmeyer 1993 personal communication). Thus, most of the parking lots in the Kulshan Creek basin do not treat runoff using oil/water separators or other stormwater treatment devices. Other sources of oil in runoff, such as unprotected waste oil drums, may also be contributing to the problem.

5. Future Water Quality Problems in the Study Area

a. Problem WQ-11—Future Water Quality Problems. Increasing development within the study area will lead to a greater potential for contamination of stormwater runoff, which in turn will lead to increased surface water quality problems. Table 2 in Appendix H shows projected future land uses within the study area. Pollutant loading changes associated with the land use changes in the study area are shown in Table 4 of Appendix H. As Table 2 shows, most of the projected development is for residential uses, with a lower level of commercial development expected. While the new development will be required to incorporate stormwater treatment measures to satisfy Ecology standards, there remains a likelihood of degraded water quality in study area streams because stormwater treatment methods are not capable of removing all of the runoff pollutants that result from development.

Of particular concern is the impact that construction activities may have on water quality. Erosion and sedimentation controls on construction sites are often ineffective, even when they are designed and implemented according to established pollution control standards. Thus, increased sediment loading in study area streams is anticipated. In addition, the expansion of residential development in many parts of the study area will present a variety of potential stormwater quality problems. Pesticides, animal wastes, yard wastes, and automobile-related pollutants are typical sources of water quality problems that are difficult to control in residential areas.

Future water quality problems will also persist due to existing developments unless they are targeted for retrofitting of stormwater treatment facilities. This may be an even greater concern than stormwater contamination caused by new developments.

E. Environmental Resource Problems

1. Wetlands

This subsection identifies and describes wetlands management problems facing the City of Mount Vernon. Wetlands management problems have been divided into two groups: (1) "at-risk" wetlands, and (2) balancing wetlands protection with economic growth.

The City of Mount Vernon recognizes the presence and importance of wetlands within the city, and realizes that many of the wetlands are threatened by the encroachment of urbanization, agriculture, and other land uses. Several types of wetlands are particularly subject to degradation for a variety of reasons. This subsection first identifies and describes these threatened wetland areas, summarizing the nature of the problem affecting the wetland, and identifying the potential or known causes of the degradation. The second portion of this subsection describes potential difficulties the city may encounter in balancing wetlands protection while encouraging sound economic growth.

a. "At-Risk" Wetlands. Due to rapid growth in the City of Mount Vernon, wetland areas, particularly those located within the most urbanizing portions of the City, are threatened by the encroachment of development. These threatened wetland areas fall into five broad categories:

- Disturbed Areas
- Prior Converted Cropland and Farmed Wetlands
- High Value Wetlands Adjacent to Potentially Damaging Land Uses
- Unbuffered Wetlands
- Wetlands Historically Subjected to Filling

The following sections describe each of these categories.

Problem WT1—Disturbed Areas. Wetlands which have been disturbed are often difficult for the layperson to recognize as wetland. Many such wetlands lack one or more of the three wetland criteria (hydrophytic vegetation, hydric soils, and wetland hydrology). For example, areas without vegetation or those planted in tree plantations are considered disturbed areas. These areas are often disturbed by human activity such as ditching, diking, clearing, and filling. A disturbance may also be due to natural events such as landslides, beaver dams, or flooding. Should these man-made or natural disturbances occur in a wetland, the land would still be considered, and therefore regulated, as wetland, although the area may not be readily recognized as wetland. Further, although wetlands are still present after the disturbance, their ability to provide valuable wetland functions is often diminished by the disturbance.

The 1987 Manual describes most disturbed areas under the heading of "atypical situations." These are defined as those situations where one or more indicator is missing due to unauthorized activity (filling or dredging) or natural events. The 1987 Manual definition of atypical situations also includes wetlands dominated by facultative plant species (those plants equally likely to be found in wetlands and in uplands). A red cedar swamp is an example of an area described by this definition of an atypical situation.

Problem WT2—Prior Converted Cropland and Farmed Wetlands. Land that was historically wetland presently under agricultural use may fall under two different designations: prior converted cropland and farmed wetland. The following defines prior converted cropland; a summary of farmed wetlands follows.

The Soil Conservation Service has defined "Prior Converted Cropland" in the August 1988 National Food Security Act Manual as:

> Wetlands which were both manipulated (drained or otherwise physically altered to remove excess water from the land) and cropped before 23 December 1985, to the extent that they no longer exhibit wetland values. Specifically, prior converted cropland is inundated for no more than 14 consecutive days during the growing season.

This designation includes many areas that have been ditched or filled for use as pasture or cropland. The Soil Conservation Service is the only agency empowered to determine if agricultural land is indeed prior converted cropland. There are potentially many examples of prior converted cropland in Mount Vernon, as this area has been extensively used for agriculture.

These areas are exempt from regulation by the federal government. However, Washington State does not exempt prior converted cropland associated with Waters of the State from the Washington State Shorelines Management Act, and state and local agencies may consider prior converted croplands to be wetlands subject to regulation.

Another type of agricultural wetlands is known as "farmed wetlands." According to the 1988 National Food Security Act Manual, the Soil Conservation Service has defined "farmed wetland" as farmland where the soil and hydrology remain unchanged, and therefore still exhibit wetland characteristics. Ditched or filled farmland that is inundated for 15 or more days during the growing season is considered farmed wetland. In other words, hydric soil and wetland hydrology exist on the farmed land, and hydrophytic vegetation would return with the cessation of farming practices. There are many examples of farmed wetland within the city; most of these farmed wetlands are being used primarily for pasture. Farmed wetlands are still subject to wetlands regulation at all levels of government. However, no permitting is necessary to continue to use farmed wetlands for agricultural purposes.

The difference between prior converted cropland and farmed wetlands is important for several reasons. As mentioned above, prior converted croplands are exempt from federal regulation while farmed wetlands are regulated at all levels. Unfortunately, it is often difficult to distinguish one type of agricultural wetland from another. This makes it difficult for individual property owners and public planners alike to anticipate the regulatory constraints which may confront a given project without a detailed investigation. Additionally, often neither type of agricultural area appears to be wetlands to those lacking substantial training and expertise.

Problem WT3—High Value Wetlands Adjacent to Potentially Damaging Land Uses. High quality wetlands are those which perform valuable functions in the natural ecosystem and in the human environment. In general, wetlands are considered to be of high value if they (1) are large, (2) contain thick or diverse vegetative cover, (3) are close to a perennial stream or river, (4) are able to detain runoff and retain sediments and other pollutants, and (5) are located directly upstream from urban and developable areas. A number of wetlands located within the study area fulfill these criteria, and provide valuable storm and flood water control, water quality improvement, and biological support.

Residential development and small commercial development is the primary land use within the study area. These uses increase the stormwater runoff in the watersheds and degrade water quality by the non-point introduction of metals and excess nutrients.

Agricultural use can pose a threat to water quality in wetlands. One large dairy is located in close proximity to, and upslope from a valuable wetland in the northeast portion of the study area. The excess nutrients generated by the dairy are potentially damaging to the large wetland below.

Commercial operations such as the large nursery located off East College Way east of Waugh Road, may be a source of non-point pollutants such as fertilizers and herbicides. This operation is adjacent to a perennial stream and associated wetlands.

Problem WT4—Unbuffered Wetlands. Buffers are strips of land utilized to protect one type of land use from the effects of another. Buffers have been found to be effective at mitigating the effects of surrounding development on wetlands (Castelle et al. 1992a).

Buffers protect wetlands by providing the following functions:

- Stabilizing Soil and Preventing Erosion
- Filtering Suspended Solids, Nutrients, and Harmful or Toxic Substances
- Moderating Impacts of Stormwater Runoff
- Moderating System Microclimate
- Protecting Wetland Habitat from Adverse Impacts
- Maintaining and Enhancing Habitat Diversity and Integrity
- Supporting and Protecting Wetland Species and Providing Wildlife Corridors for Wetland and Upland Species
- Discouraging Adverse Human Impacts to Wetlands

Scientific studies have demonstrated that buffer effectiveness varies with buffer size. Buffer widths of between 25 and 600 feet are necessary to protect wetlands, depending upon site-specific conditions.

Numerous wetlands in the study area are surrounded by little or no upland buffer. They are bordered by roads, agricultural areas, and residential and commercial development.

Problem WT5—Wetlands Historically Subjected to Filling. Wetlands in urban and rural areas are often vulnerable to dumping of yard waste, construction debris, and refuse. The debris impacts wetland functions such as water quality, wildlife habitat, and aesthetic values.

Evidence of dumping of small amounts of yard waste, soil, and household refuse was observed during the field survey but was not widespread.

b. Wetlands Protection and Economic Growth.

Problem WT6: One of the main problems facing wetlands protection is the public's lack of recognition of (1) what wetlands are, and (2) what values wetlands may contribute to society. This lack of recognition of what many wetlands are and what benefits they may provide has resulted in the innocent loss of a significant amount of wetlands.

While most people would recognize an open water pond, ringed with cattails and full of turtles and waterfowl, as a wetland, this type of wetland is uncommon in Mount Vernon (see Chapter One). For example, one of the most common types of wetlands in the city, particularly within the Urban Growth Boundary, is wet meadows. Few individuals may realize that an area which has been used for pasturing livestock for generations could be considered a valuable natural resource. As a result, they are not likely to realize that the conversion of wet meadows to developed land uses results in a loss of wetlands.

Even those who may realize that a pasture may be a wetland may not appreciate the functional values provided by the wet meadows. For example, it has been a common mitigative practice to "compensate" for the loss of wet meadows by constructing open water wetlands. Most feel that since ponds have a more wetland-like appearance, then a meadow-for-pond trade-off actually results in a net gain for the environment. While this may be true in some instances, many ponds cannot provide the water quality improvement functions provided by wetland pasture grasses. Further, water fowl which utilize ponds may contribute significant excess nutrient and bacterial loading to streams and other natural water bodies. Additionally, many wildlife species which utilize wet meadows cannot survive in an open water setting. For example, most small mammals, which are important prey for sustaining raptors such as eagles and hawks, cannot survive if the soil is permanently inundated.

Problem WT7: Another problem may be contained within the city's CAO. This ordinance does not distinguish between higher- and lower-valued wetlands. As a result, no greater measure of protection is afforded the city's most valuable wetlands than is given to the least valuable wetlands. Because all wetlands are treated equally, there is no mechanism to plan for long-term protection of the most important wetlands. In some instances, for example, a developer may have a choice of impacting either a low-value or high-value wetland. Without a means of distinguishing one from the other, or without a regulatory disincentive to avoid the high-value wetland, the developer might spare the low-value wetland while destroying the high-value wetland. Note that both state and federal agencies (for example, the Washington Department of Ecology and the U.S. Army Corps of Engineers) do recognize that not all wetlands are of equal value. Differences between wetland functions and values are often reflected in permitting and mitigation requirements established by these agencies. However, projects which impact less than one acre of many wetlands are often not subject to state regulation, and may not receive the scrutiny from federal agencies which projects with larger impacts would. As a result, some higher-value wetlands may be impacted even though they appear to be protected by state and federal regulation.

Even the most restrictive wetlands management ordinances allow for the opportunity to impact some wetlands provided some form of compensatory mitigation is performed. The Mount Vernon CAO is an exception: there are no specific provisions for compensatory mitigation. As a result, each project proponent is left to develop a wetlands mitigation plan independently of any other wetlands management programs or projects. Without a means of coordinating wetlands protection and mitigation measures, the diversity and distribution of wetlands may be significantly altered. As in the example given above, it is common for open water wetlands to be created as compensation for the loss of wet meadows; open water wetland creation has also been used to compensate for the loss of scrub/shrub, forested, and other wetland types. If this were to occur in Mount Vernon, the city could see an increase in the number of small ponds, but a decrease in all other types of wetlands. Such a decrease in wetlands diversity may result in the degradation of the water quality of the city's streams, a reduction of the number of wildlife species, flood water storage capacity, and the diminution of other important wetland functions.

Problem WT8: Another problem regarding wetlands protection is that there are currently few incentives to protect wetlands, nor are there any mechanisms to fund or otherwise complete wetlands restoration and enhancement projects unless they are the result of some compensatory mitigation. In the absence of incentives, many people who own wetlands may view them as nothing but an economic liability; that is, as areas which have no or low recognizable intrinsic value to the land owners, but which cannot be fully developed. Further, despite development constraints placed on wetlands, many times the land is assessed as though it were non-wetland and may be fully developed.

Problem WT9: There are wetlands located within the study area of this report which have been degraded through past land use practices. Other wetlands have been eliminated or significantly reduced in size in locations where they may be particularly important. Currently, there are no programs which are aimed at enhancing or restoring these wetlands to a highly functioning condition. Further, as an ever-increasing amount of the city becomes developed, the opportunities for pro-active wetlands protection and enhancement are diminished.

2. Fish Habitat

Fish habitat problems identified within the study area generally fall into one of two categories: fish passage barriers and habitat limitations. Passage problems inhibit or prevent fish migration upstream or downstream. Fish habitat limitations generally include spawning and rearing habitat variables that limit the natural production of fish. Spawning habitat limitations deal with the quantity or quality of spawning gravels. Rearing habitat limitations include instream cover, food supply, temperature, and other water quality parameters.

a. Problem E1 A pump station on the piped section of Kulshan Creek at the outlet to the Skagit River presents a nearly total barrier to fish passage. Passage is only obtainable when conditions are such that the flap gate on the pipe outlet is propped open from flow and the Skagit River is high enough to create a take-off pool below the flap gate but not high enough to force the gate shut.

b. Problem E2 An existing manhole section in Kulshan Creek located east of the railroad collects debris and creates a partial fish passage barrier.

c. Problem E3 A culvert for Cedar Lane in an unnamed tributary to Kulshan Creek creates a partial fish passage barrier due to a 1-foot drop at the outlet.

d. Problem E4 The portion of Kulshan Creek upstream of Riverside Drive to about North 18th Street lacks riparian vegetation as well as pools and riffles that provide good instream habitat.

e. Problem E5 There is a lack of riparian vegetation as well as pools and riffles to provide good stream habitat along Trumpeter Creek from the confluence with Nookachamps Creek to 2,700 feet upstream and in portions of the mainstem from College Way to Fir Street.

f. Problem E6 The culvert along the Southeast Fork of Trumpeter Creek at Seneca Drive plugs with debris which causes fish passage problems.

g. Problem E7 The culvert along the Southeast Fork of Trumpeter Creek at Kiowa Drive presents a partial barrier to fish migration due to a 1-foot drop at the culvert outlet.

h. Problem E8 The culvert along the Southeast Fork of Trumpeter Creek at Lupine Street is blocked with debris and presents a barrier to fish passage.

i. Problem E9 A 42-inch-diameter culvert at Fir Street on the east side of Bakerview Park presents a partial fish passage barrier on the Southwest Fork of Trumpeter Creek due to a 1-foot drop at the culvert outlet.

j. Problem E10 A 210-foot-long 60-inch-diameter culvert on Maddox Creek 1,200 feet upstream from Anderson Road creates a fish barrier. The culvert is too long for fish to be able to maintain the energy to swim against the current in the culvert, and the fish would not be able to enter the culvert due to the 2-foot drop at the culvert's outlet.

k. Problem E11 The culvert on Maddox Creek at Blackburn Road is nearly a total fish passage barrier due to a 2-foot drop at the culvert's outlet.

l. Problem E12 The outfall pipe at the lower detention pond on Maddox Creek south of Section Street and east of Little Mountain Estates is plugged and creates a total fish passage barrier.

m. Problem E13 The section of Flowers Creek between its confluence with Maddox Creek and Blodgett Road lacks riparian vegetation.

n. Problem E14 The culvert for Flowers Creek at Blodgett Road presents a partial barrier for fish at low flows due to a 1-foot drop in elevation between the culvert outlet and the streambed.

o. Problem E15 The lower portion of Carpenter Creek along Bacon Road lacks pools and riffles as well as riparian vegetation that provide instream habitat.

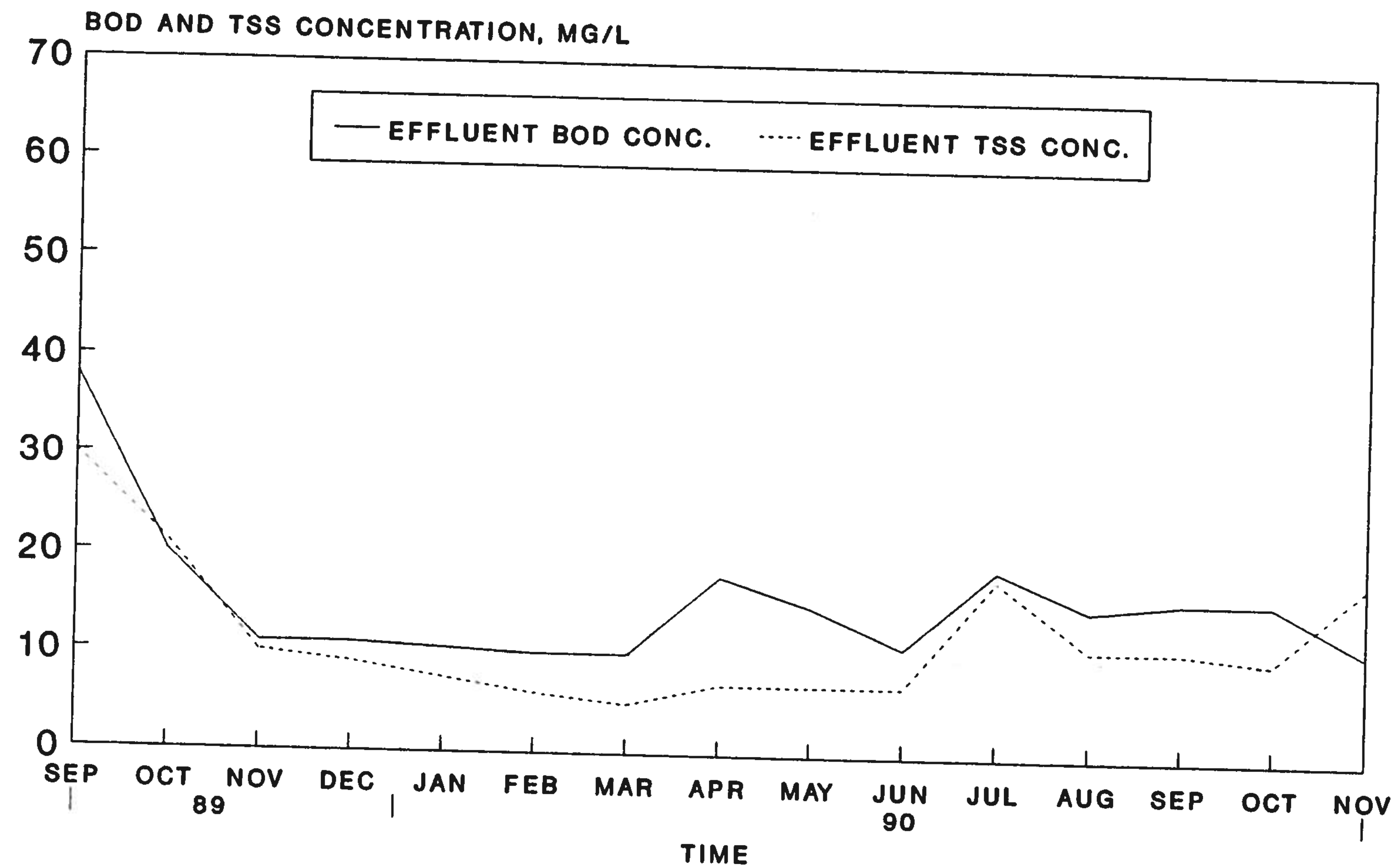


FIGURE VI-1
AVERAGE MONTHLY EFFLUENT BOD AND TSS CONCENTRATION SINCE PLANT STARTUP

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

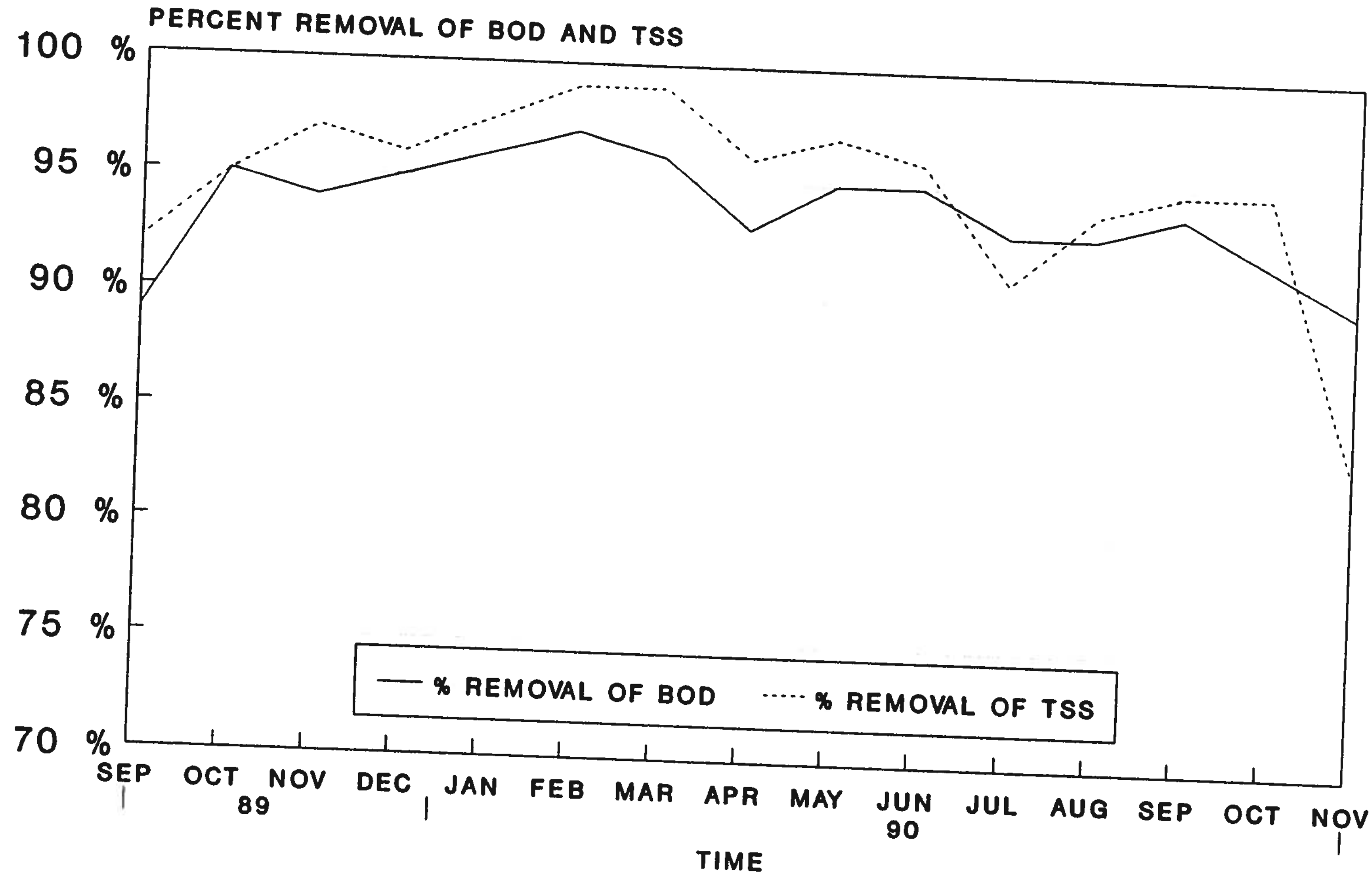


FIGURE VI-2
MONTHLY PERCENT REMOVAL OF BOD AND TSS SINCE PLANT STARTUP

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

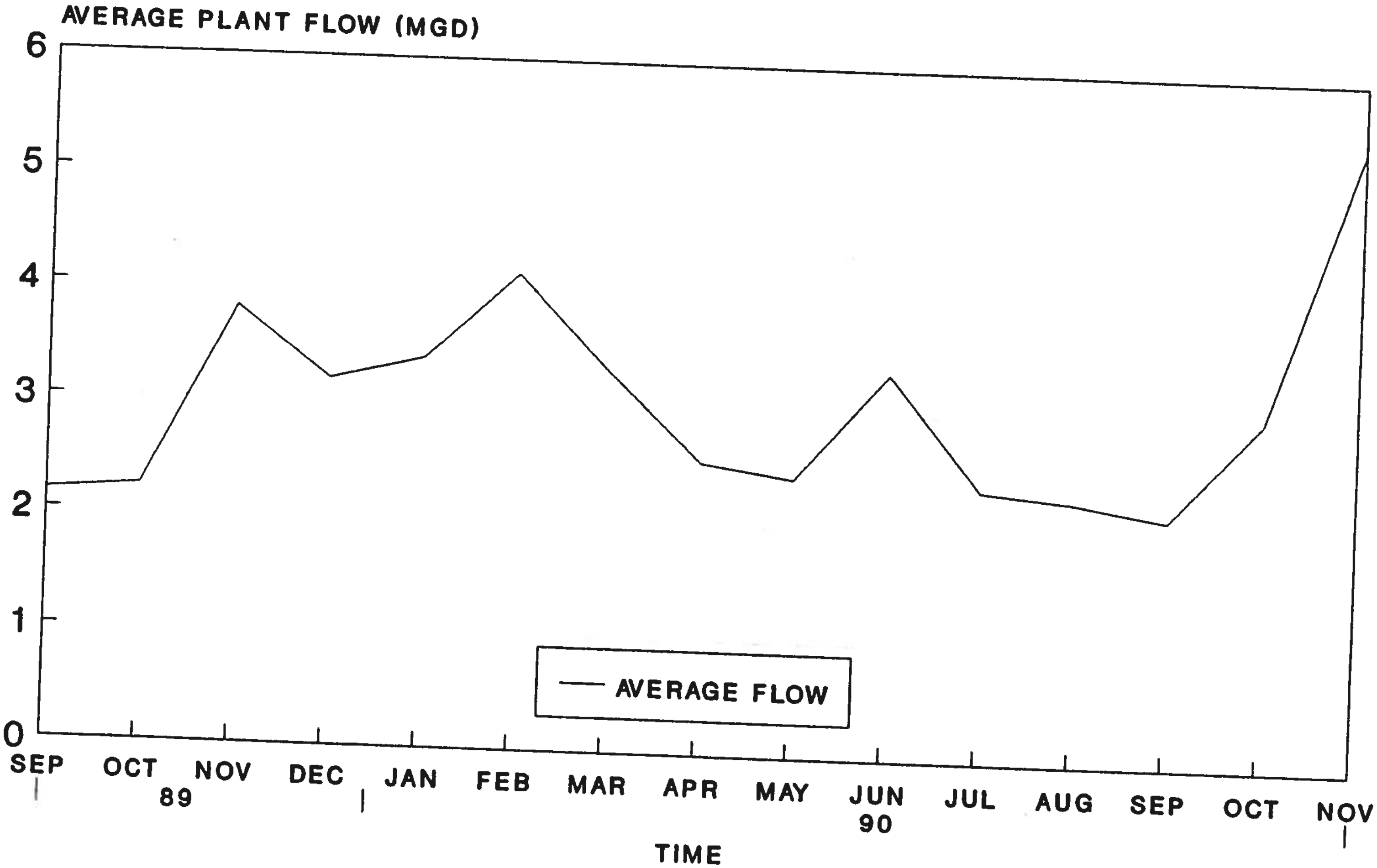


FIGURE VI-3
AVERAGE DAILY PLANT FLOWS
SINCE PLANT STARTUP

CITY OF MOUNT VERNON
WASHINGTON

COMPREHENSIVE
SEWER AND COMBINED
SEWER OVERFLOW
REDUCTION PLANS

R·W·BECK

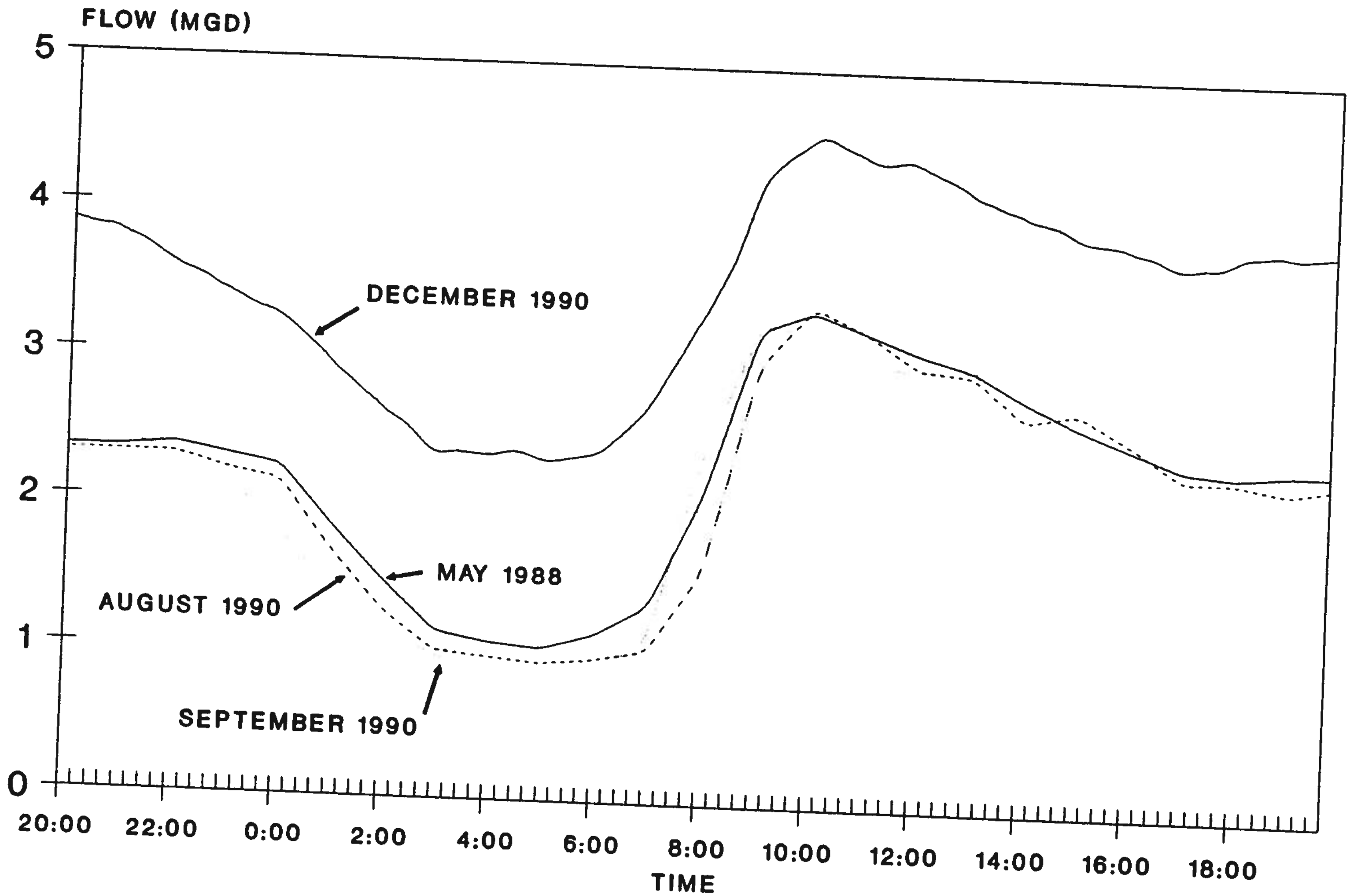
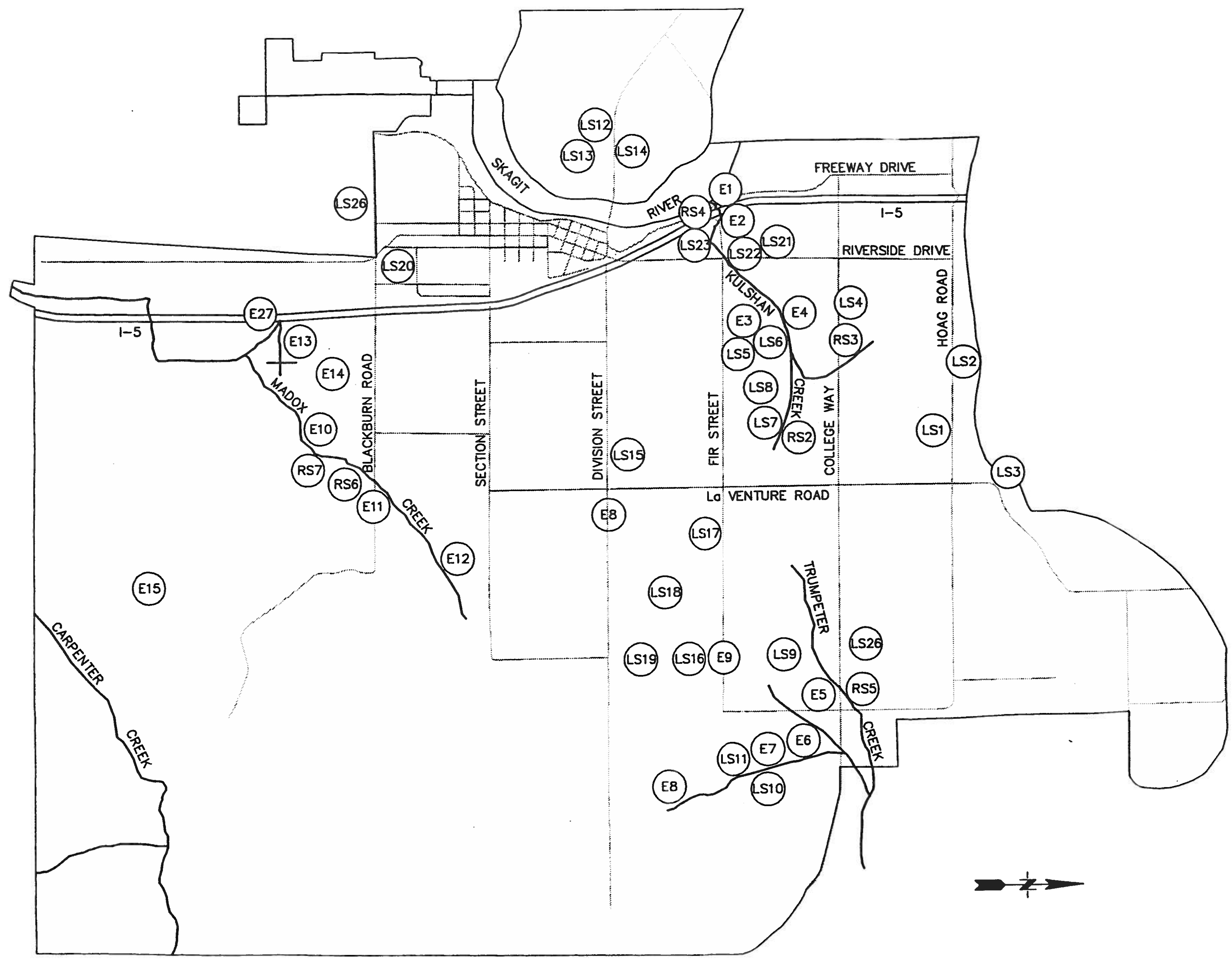


FIGURE VI-4
DIURNAL CURVE FOR FLOWS ENTERING THE WASTEWATER TREATMENT PLANT



LEGEND

RS4 REGIONAL SYSTEM PROBLEMS

LS9 LOCAL SYSTEM PROBLEMS

E6 FISH HABITAT PROBLEMS

FIGURE VI-1
CITY OF MOUNT VERNON SURFACE WATER MANGEMENT PLAN

PROBLEM LOCATION MAP

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SECTION VII
EVALUATION OF PROBLEM SOLUTIONS AND RECOMMENDATIONS

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SECTION VII

EVALUATION OF PROBLEM SOLUTIONS AND RECOMMENDATIONS

A. General

The following paragraphs describe the alternative solutions to the problems identified in the preceding section. For each problem, appropriate structural measures and/or non-structural measures are evaluated and recommendations are presented. Tables VII-1 and VII-2 show typical structural and nonstructural solutions to stormwater problems. Structural measures are capital improvements such as pipe replacement, a pump station, channel widening, or construction of detention facilities. Non-structural solutions include policies, ordinances, regulations, public education, and increased maintenance activities. The alternative solutions were evaluated and a recommendation is given to solve the problem. The alternative analysis for each problem is based upon criteria such as effectiveness; cost; environmental impacts; consistency with the long and short term goals; consistency with existing or proposed local, State, or Federal requirements for managing storm water; and public acceptance. Sketches of selected alternative solutions are also shown.

Two basic types of structural solutions to flooding and erosion problems are recommended due to the regional or local nature of the water quantity problems. Construction or modification of regional facilities may be required to solve problems that provide benefits throughout the stream system. Local improvements to the conveyance system may be all that is required to solve local water quantity problems.

For the regional system problems, flooding and erosion can be solved by sizing detention facilities to reduce peak outflows so that they can be accommodated by the existing conveyance system. The advantage of this type of structural solution is that it results in a reduction in downstream peak flow rates. The disadvantage is that in order to get the required peak flow reductions to prevent flooding, substantial storage volumes may be required, and the detention facilities needed may require large areas of land. Where land is not available, or where appropriate, increasing the capacity of the conveyance system is also used to solve regional problems.

For the large regional problems, alternative solutions are described. As part of this plan, the recommended alternatives were subject to environmental review, including a planning level SEPA checklist.

Local flooding or erosion problems can be solved at any specific location usually by increasing the capacity of the conveyance system. The advantage of this type of structural solution is that it does not require large areas of land. In some instances, undersized drainage system components result in flooding, but also create a significant amount of water storage. A disadvantage to increasing the system capacity is that in cases where eliminating flooding also eliminates significant storage volumes, downstream peak flow rates are increased, which can impact aquatic resources and increase flooding further downstream. The conveyance system improvements recommended here generally do not involve loss of flood storage of any significance and do not result in appreciable increases in downstream peak flows.

Cost estimates for several problems have been updated as part of several design projects and review of developer proposals. These estimates are shown in Appendix E. Estimates for the remaining problems have been taken from the 1993 draft plan and escalated at 4.5 percent per year for two years. The 1993 estimates for the remaining problems prior to escalation to 1995 costs are also shown in Appendix E. The 1993 estimates include an allowance of 10 percent for mobilization; 30 percent for construction contingency; 8 percent for sales tax; 2 percent for administration; and 30 percent for surveying, permitting, and engineering. Pipe replacement costs are based on using corrugated HDPE for pipes 24-inches in diameter or less, and concrete for pipes with diameters greater than 24 inches.

B. System Solutions

1. Regional System Problems

As described in Section VI - Problem Identification, regional system problems are those associated with flooding or erosion of major streams or drainage systems. These problems generally affect a larger geographic area and represent the most serious surface water problems within the City. Much of the work performed to identify the regional problems was performed as part of a separate task report contained in Appendix F. The problem solutions contained in that task report, with a few exceptions, are summarized under the following Regional System Problem solutions. It should be noted that the design criteria for solving regional system problems is to provide flood protection for a 100-year event. All the proposed solutions also assume runoff under future build-out land use conditions.

a. Problem RS1 — Riverbend Road (Freeway Drive) Drainage Problem.

RS1 Problem Description: The drainage system along Freeway Drive does not have enough capacity to convey flows from future development, nor does it provide service to the area south of College Way.

RS1 Structural Solutions: Two alternative structural solutions involving increased pumping capacity are proposed to provide drainage for the drainage basin around Freeway Drive. The first alternative solution would increase the capacity of the existing pump station. This solution would provide additional pumping and conveyance system capacity to service full development of the basin area around Freeway Drive north of College Way without construction of additional detention storage. It was found through model simulations that the pump capacity would need to be increased from 2.67 cfs to about 10 cfs to keep the frequency of pond overtopping to about once in 50 to 100 years. The 10-cfs pump station would be accompanied by 2,600 feet of 24-inch force main to carry the increased flow. This system would not provide drainage along Freeway Drive south of College Way.

Construction Cost = $983,000
Approximate Annual Energy Cost = $600–$1,200

The second alternative structural solution would provide gravity flow and pumping capacity to service all of the Freeway Drive drainage basin, both north and south of College Way, without construction of additional detention storage. This would require the construction of 2,600 feet of 48-inch gravity main and a 50-cfs pump station. The 48-inch gravity flow pipe would begin at the Eagle Hardware detention pond and run south along the western city boundary to a new pump station located near the Skagit River along Riverbend Road. The pump station would only operate under high water conditions in the Skagit River. This solution would limit the Eagle Hardware detention pond overtopping to about once in 100 years.

Construction Cost = $1,750,000
Design Cost = $242,000
Approximate Annual Energy Cost = $50–$100

RS1 Nonstructural Solutions: Because all of the existing commercial development along Freeway Drive is served by an existing pump station that is greatly undersized, serving this area under full build-out conditions, will require additional conveyance. Construction of additional on-site detention systems would not preclude the need for construction of additional conveyance capacity. Detention times in the existing Eagle Hardware pond are already becoming excessive, and this extra time that the pond is full causes a risk of additional flooding in back-to-back storms. For this reason, this problem is better solved by structural solutions.

RS1 Recommendations: To provide adequate flood protection for the full development of the basin, both north and south of College Way, the second alternative solution is recommended. The first alternative has a higher annual energy cost because all the flow is pumped. The second alternative has a lower annual energy cost because flow will only need to be pumped when the river levels are high.

b. Problem RS2 — Kulshan Creek Culverts.

RS2 Problem Description: The two 36-inch-diameter culverts under Parker Way have insufficient capacity to prevent overtopping of the road.

RS2 Structural Solutions: To prevent Kulshan Creek from overtopping Parker Way and possible local flooding upstream, two additional 36-inch diameter culverts are needed to supplement the capacity of the existing two 36-inch-diameter culverts.

Construction Cost = $13,100

RS2 Nonstructural Solutions: Since most of this basin is already developed, this problem is best solved by structural solutions. Nonstructural solutions such as new development standards will not solve this problem.

c. Problem RS3 — College Way Culvert.

RS3 Problem Description: The culverts for a tributary to Kulshan Creek across College Way and Continental Place have insufficient capacity to pass the 100-year storm event.

RS3 Structural Solution: To prevent local flooding upstream of the pipe system across College Way and Continental Place along a tributary to Kulshan Creek, both culverts should be replaced in accordance with the NHC report included in Appendix N. This report recommends installing a parallel 54-inch concrete or 6.42 x 4.33 CMP pipe arch at College Way, and adding a second 36-inch CMP culvert at Continental Place. It also recommends keeping this channel clear. In discussions with City Staff, an additional 24-inch pipe crossing of College Way is located a short distance to the east of the existing culvert for the Kulshan Creek Tributary. This crossing will provide some additional capacity, but will not preclude the need for constructing a new crossing for the Kulshan Creek Tributary.

Cost = $109,000

RS3 Nonstructural Solutions: The existing system is undersized for meeting design criteria for a major creek culvert crossing so that the solution to this problem is better accomplished by structural methods.

d. Problem RS4 — Kulshan Creek Pump Station.

RS4 Problem Description: The existing gravity pipe system and pump station discharge for Kulshan Creek is undersized and results in severe flooding of this area.

RS4 Structural Solutions: Several alternative structural solutions involving conveyance and pump station improvements were investigated to improve the drainage along Kulshan Creek. The alternatives describe several conveyance options, but they involve the same basic pump station design to provide capacity to serve a 100-year flow of 210 cfs. The basic design includes four vertical shaft centrifugal pumps in a concrete sump. Other alternatives to reduce the pump station capacity requirements through the use of upstream flood storage are described later in this problem solution section. The pump motors, controls and other associated equipment would be located in a frame structure above the sump. A below-grade reinforced concrete horizontal and vertical expansion structure would provide the room for a hydraulic transition between the supply pipe(s) and pump sump. The exact configuration of the expansion structure and sump will need to be determined during final design so that an economical structure can be devised that will not result in vortexes and pump cavitation. It may be cost effective to test the operation of a minimally sized expansion structure during design with the aid of a physical scale model. The alternatives discussed here primarily involve the location of the pump station and conveyance system.

The first alternative solution would be with a pump station sited at the same location as the existing pump station (see Appendix F, Figure 3.2). This location would require removing the existing pump station, and installing 1,600 feet of 60-inch-diameter supply pipe to supplement the existing 48-inch supply pipe. About 150 feet of the new 60-inch-diameter supply pipe would need to be installed under Interstate 5 either by jacking or some other trenchless method that would not require highway closure. The existing 10-inch-diameter force main from the Freeway Drive area basin would discharge directly into the sump. A concrete outlet structure would be adjacent to the downstream wall of the pump sump and would include a flap-gate to prevent back flooding from the Skagit River. Both the gravity drain and the pumps would discharge into the outlet structure then through the existing water course to the river. The outlet structure would be integral with the pump station structure.

The second alternative solution would be with a pump station sited on a portion of City of Mount Vernon property presently used for equipment storage and maintenance located on the east side of Interstate 5, opposite the existing pump station (see Appendix F, Figure 3.3). This alternative would allow gravity flow from the Kulshan Creek basin. The proposed location for this alternative would require supplementing 1,400 feet of existing 48-inch-diameter supply pipe with an additional 72-inch-diameter supply pipe, and will ultimately require the use of two force main pipelines under Interstate 5. Installation of a 72-inch pipe will allow for future service at the design flow with the existing 48-inch supply pipe out of service. One of the two force mains could be created by slip-lining the existing 48-inch-diameter gravity flow pipe; the second force main would require that an additional 48-inch pipe be installed either by jacking or some other trenchless method that will not require highway closure. Installing higher head pumps can defer construction of the second 48-inch force main under the freeway to beyond the 20-year planning period.

The third alternative solution would be sited with a pump station immediately southwest of existing manhole K-3 (see Appendix F, Figure 3.4). The existing pump station and outlet structure would remain in place and accommodate flow from the existing 10-inch-diameter force main from the Freeway Drive area basin as well as gravity flow from the Kulshan Creek basin. The existing 48-inch-diameter supply pipe between manholes K-5 and K-3, about 500 feet, would be supplemented by a new 60-inch-diameter pipe. Manhole K-3 would be modified to permit up to 20 cfs to flow to the existing pump station gravity outlet. Discharges in excess of 20 cfs and the entire discharge when gravity drainage is not possible, would flow into the new pump station sump and then be pumped through a new 1,200-foot-long 60-inch-diameter force main located along the railroad right-of-way. The force main would go under the Interstate 5 overpass to a new outlet structure that would be located on the left bank of the Skagit River at the north end of Riverside Park.

The fourth alternative solution is similar to the third alternative except that the pump station would be located on a portion of the City of Mount Vernon equipment maintenance and storage property (see Appendix F, Figure 3.5). This location will require 500 feet of new 72-inch-diameter supply line from the pump station to Manhole K-3, and supplementing about 500 feet of the existing 48-inch-diameter pipe between Manholes K-3 and K-5 with a new 60-inch-diameter pipe. Manhole K-3 would be modified the same as described for the third alternative solution. The force main from the pumps to the Skagit River would be the same as the third alternative solution, except the main would follow Cameron Way to the interstate highway overpass and then on the same route to the river as the third alternative solution.

Each of the pump station alternatives and modifications to the existing conveyance system would provide the required pumping capacity to prevent flooding in Kulshan Creek Basin; however, each alternative presents its own construction and operation considerations. The following presents a discussion of some of the more significant of these considerations.

- **Phased Construction.** To minimize initial construction costs, but still provide an appreciable reduction in flood risk for the initial investment, the overall layout of the pump station, related structures and piping should allow for phased construction. Items to be considered would include deferring construction of additional pipelines and using the existing 48-inch-diameter pipe to supply to a new pump station which would have the mechanical and electrical equipment to match the capacity of the existing pipe. The first and second alternative solutions allow phased construction that incorporates these items. The other alternatives do not.

- **Pumping Costs.** Pumping costs should be considered in the selection of the preferred alternative. Long force mains will require pumps with a larger total dynamic head, consequently larger horsepower motors and larger operating costs. Both the third and fourth alternative solutions will have the greatest operating costs due to the long force mains associated with these alternatives. The second alternative solution will also have some increase in operating costs when compared to the first alternative solution, which does not have any force mains.

- **Sited on City-owned Property.** Siting of the pump station on the identified city-owned property will reduce costs of acquiring real estate, will provide an added measure of security and reduced liability, could reduce problems in obtaining construction permits, and allow for construction out of the designated floodway. The second and fourth alternative solutions are sited on the city-owned property.

- **Construction Under Interstate Highway 5.** In order to convey Kulshan Creek floodwater to the Skagit River, a pipe must be passed under the interstate highway without interrupting the flow of traffic during construction. This means that the pipe must be tunneled or jacked under the roadway, or it must utilize an existing interstate overpass. The third and fourth alternative solutions utilize the overpass via long force mains. The first and second alternative solutions will ultimately require tunneling or jacking of at least one pipe under the interstate road bed. The existing 48-inch-diameter line under Interstate 5 could be slip-lined to provide a force main with an approximate 90 cfs capacity which would eventually be supplemented with another new 48-inch force main for the second alternative solution.

- **Access During Construction and for Operation.** Ease of access and ample room for construction will result in lower construction costs. Ease of access for operation and maintenance, especially during flood conditions, will result in lower operation costs and greater pumping reliability. Alternatives 2, 3, and 4 appear to allow reasonably good access. Alternative 1 has inadequate room for construction and would be the least accessible during flood conditions.

Considering the above factors, the preferred alternative appears to be Alternative 2 sited at the City of Mt. Vernon storage and maintenance yard on the east side of I-5 opposite the existing pump station. It is on city-owned property on the outside of the Skagit River floodway, there is ample room for construction and maintenance, construction can be phased to use the existing supply pipe, and future pump operating costs will be lower than other alternatives (3 and 4) with longer force mains.

In addition to evaluating alternatives for locating the pump station and conveyance system, opportunities for regional detention facilities were considered as a means to reduce peak flows and downsize the necessary pumping and conveyance system requirements. This would save on construction costs.

Preliminary costing for pump station improvements showed that using detention storage to reduce the required pump capacity is cost effective if it results in reducing peak flows from about 210 cfs to 100 cfs, which is the gravity-flow capacity of the existing system. If the required system capacity is reduced to the capacity of the existing system, then construction of new pipelines will not be required, resulting in significant cost savings. If peak flows exceed 100 cfs, major pipe system improvements would be required between Riverside Drive and the Skagit River. Pipe system improvements are a major part of the estimated $1.6 million cost difference for a 210 cfs versus 100 cfs capacity system for Kulshan Creek, assuming the recommended Alternative 2 pump station configuration.

Because of the previously mentioned cost difference and flow capacities, regional detention facilities would be cost-effective relative to downstream conveyance improvements only if 100-year peak flows at the downstream end of the Kulshan Creek basin could be limited by detention facilities to 100 cfs for a cost less than roughly $1.60 million dollars. 100-year peak flows at the downstream end of the Kulshan Creek basin under full development with on-site storage are estimated to be about 210 cfs. Of this amount, about 100 cfs originates east of the BNR railway tracks (sub-basins 5, 13, and 14). Another 90 cfs originates north and west of the railway tracks (sub-basins 6 and 7), and the remaining flow originates in the area west of Riverside Drive and south of Willow Lane (sub-basin 12). For regional detention to limit 100-year peak flows to 100 cfs, facilities would be required both east and west of the railway tracks or else sufficient hydraulic conveyance would need to be constructed under the tracks to equalize storage in both areas.

Two alternatives were evaluated to estimate the required storage volume to reduce the 100-year peak flow to 100 cfs. Under the first alternative, a hypothetical detention facility was modeled at the location which makes the most efficient use of the available storage. This ideal location is immediately downstream of the Kulshan Creek railway track crossing. It was found that about 30 acre-feet of storage between elevations 21.0 feet and 24.5 feet would keep 100-year peak flows to under 100 cfs. Unfortunately, 30 acre-feet of storage is not available at this location and land acquisition costs alone for this hypothetical facility, assuming 8 acres at $130,000 per acre, would exceed $1.0 million dollars. This alternative would not be acceptable relative to the larger pump station alternative because land acquisition is not possible given that this area is already developed. Given that this storage cannot realistically be provided at this preferred downstream location where the full basin flow could be intercepted, more than 30 acre-feet of storage would be required for alternative detention sites further upstream in the basin.

The locations of potential detention pond sites where land is available are shown on Figure 3.1. The site immediately west of the railroad marked as "vacant land" on Figure 3.1 in Appendix F is presently undeveloped, except for about five large power poles for a 55,000 Volt 3-phase transmission line (Puget Sound Power & Light Co. Easement No. 176764), and a sewer line (Easement No. 567033) as some of its easements. The property is about 1.5 acres in size.

The other potential detention site is on about 10 acres of land already owned by the City adjacent to Kulshan Creek as shown by Figure 3.1 in Appendix F. However, the land at this site has been tentatively classified as wetlands, which would make it very difficult to obtain the necessary permits to develop this area as a detention facility. The cost of a wetland development permit application would be in the order of $125,000. If approved, and there is no assurance of approval, there would likely be additional wetland mitigation costs of more than $0.50 per square foot of impacted wetland. Wetland mitigation costs for 10 acres would likely exceed $200,000. In addition to the wetland permitting and mitigation costs, additional costs would be required to provide fish passage since this would be an in-stream facility.

The maximum amount of detention storage which could realistically be developed at the two identified sites is about 7 acre-feet at the vacant land site west of the railway, and about 50 acre-feet at the city-owned site east of the railway along Kulshan Creek. Initial HSPF simulations found that if these sites were both fully developed for detention storage, and the drainage system in sub-basin 13 (see Figure III-5) were modified to directed all flows from this sub-basin to or above the 50 acre-foot pond, the frequency of downstream flood peaks exceeding 100 cfs would be reduced to about once every 50 to 100 years.

RS4 Nonstructural Solutions: The Kulshan Creek Basin is nearly built out so that implementation of nonstructural solutions such as strict onsite peak flow controls will not solve the existing flooding problems. The existing pump station is grossly undersized and the conveyance system must also be increased if this system is to provide 100-year protection. For these reasons, structural solutions will be necessary to solve this problem.

RS4 Recommendations

Nonstructural Recommendations: Developers should be required to provide on-site detention following accepted standards and guidelines to minimize further increases in flows in this basin.

Structural Recommendations: As discussed in the following paragraphs, the City should construct a 210-cfs pump station in the City-maintenance yard east of Interstate 5. Increase conveyance with the addition of a 72-inch-diameter gravity flow pipe from Riverside Drive to the new pump station, and a second 48-inch-diameter force main from the pump station to the outlet structure west of I-5. This work can be accomplished in two phases as discussed previously, and the City has obtained $724,500 in grant funds to offset the cost of constructing phase 1. Phase 2 would include the second 48-inch force main under I-5 and one 50-cfs pump. Phase 2 can be deferred beyond the 20-year planning period.

Phase 1 Cost	City Funds	=	$3,339,000
	Hazard Mitigation Grant	=	$ 724,500
	Total Phase I Design and Construction Cost	=	$4,063,500
Total Phase 2 Construction Cost (deferred past 20 years)		=	$ 672,000

The cost of constructing a 7-acre-foot detention facility west of the railway would be approximately $220,000. Land acquisition would be as much as $200,000 for a total cost of about $420,000. Construction costs are however uncertain because of lack of information on requirements to accommodate the existing utilities crossing the site.

The cost of constructing a 50-acre-foot detention facility in the city-owned property east of the railway would be in the order of $1,400,000, for a total cost including $325,000 for permitting and wetland mitigation of about $1,725,000. Fisheries mitigation costs could increase the cost of this facility.

The total cost of providing regional detention facilities to limit peak flows in Kulshan Creek at Riverside Drive to 100 cfs for return periods of 50- to 100-years would therefore be at least $2.145 million, which is greater than the cost of increasing pump station system capacity from 100 to 210 cfs. Also, provision of regional detention is subject to considerably greater risk because of uncertainty about the ability to obtain necessary wetland permits.

e. Problem RS5 — Problems in Trumpeter Creek Basin from Increased Flows.

RS5 Problem Description: Increases in peak flows in the Trumpeter Creek basin due to future development will occur and will result in aggravating existing flooding, water quality, and fish habitat problems downstream.

RS5 Structural Solutions: Structural solutions for this problem consist of two opportunities for improved or new regional detention facilities in the Trumpeter Creek basin as described below.

(1) The existing detention pond in the northeast corner of Bakerview Park was assessed to maximize the performance of this facility. The existing pond has a capacity of about 2.4 acre feet. Water backs up into the pond via a 24-inch plastic pipe from a ditch which runs along the north side of the pond. Discharge from the pond is by the same 24-inch pipe. Backup of water into the pond is caused by an 18-inch berm in the bed of the ditch downstream from the 24-inch pipe through which passes a 12-inch plastic pipe with its invert at the ditch invert. Apparently there was no detailed design for the pond or its control structure. It is unlikely that the current design makes effective use of the available storage since much of the storage is filled at relatively low flows. Improved performance could be achieved by eliminating the pond intake from the ditch on the north side of the pond and replacing it with an intake from the channel flowing along the pond's east edge. This inlet would consist of a side channel weir to divert high flows into the pond. The outlet structure should be modified as well. This project was constructed as a part of the Park Meadows project.

Cost = $0

(2) Preliminary analyses were done for a new detention pond south of the new school on Martin Road along the north fork of Trumpeter Creek to determine the storage requirements to keep future flows to current levels at the confluence of the north fork and mainstem of Trumpeter Creek. There is potential for considerable new development in the area draining to the north fork of Trumpeter Creek. This system at present consists of a number of small drainage ditches which enter a 30-inch-diameter pipe system near North 32nd and Fox Hill St. The pipe system has a current capacity of

between 6 and 21 cfs with the lowest capacity corresponding to the most upstream section of line which has the flattest grade. A new 7.5-acre-foot detention pond would control peak flows, reducing the 100-year peak to 15 cfs. This solution would require that the most upstream section pipe in the drainage system be replaced so that the entire system has a capacity of 15 cfs or greater. The City currently owns a parcel of property along the north fork of Trumpeter Creek that was intended to be developed as a regional detention pond. Because this parcel was determined to be a wetland, the City was not able to receive the necessary permits to construct a detention pond. Developing a pond on the north fork would require that the City purchase additional property.

Cost = $500,000

RS5 Nonstructural Solution: Because of the high cost of property along the north fork of Trumpeter Creek, it would be better for the City to enforce the new detention standards as described in Appendix I.

RS5 Recommended Solutions: The Bakerview Pond improvements were constructed.

Enforce new development peak flow control detention standards in accordance with the ordinance contained in Appendix I. As discussed previously, these standards should be applied in the Kulshan Creek Basin as well.

f. Problem RS6 — Problems in Madox Creek Basin from Increased Flows.

RS6 Problem Description: A large portion of the Madox Creek Basin remains undeveloped. Based on the HSPF hydrologic modeling, 100-year peak flows in Madox Creek at Blackburn Road are expected to triple with future buildout in the basin and assuming no peak flow control facilities. In addition, Madox Creek downstream from Blackburn Road has experienced severe erosion problems that would be aggravated by any increase in peak flows from new development.

RS6 Structural Solutions: In order to control the increase in peak flows due to future development in the Madox Creek basin, peak flow controls must be constructed. A structural solution would be to increase regional detention. One of the largest (11.1 acre-feet) existing detention facilities was built as part of the Little Mountain Estates subdivision. Analysis of this detention facility shows that a relatively large amount of available storage is not being used effectively due to improperly sized inlet and outlet structures. Analysis shows that the current inlet structure is too small to divert more that a small percentage of the peak stream flows into the diversion structure. Similarly, the orifices in the outlet structure are too large to maximize use of the available storage. Considerable improvements in the effectiveness of this pond could be gained by reconstructing the intake structure and adjusting the orifice sizes in the outlet structure. Design details on modifications to this regional detention facility are given in

Appendix F. The effectiveness of these modifications on peak flows is shown on Table 5.1 in Appendix F. These improvements are scheduled to be constructed by a developer as a condition for our upstream project.

Cost = $0

RS6 Nonstructural Solutions: Given the relatively steep topography in the Madox Creek basin, it is difficult to site regional detention facilities which alone could prevent future peak flow increases to the eroding reach of Madox Creek below Blackburn Drive. If peak flows are to be controlled, an alternative would be to impose stringent on-site detention standards for new developments in those areas of the basin which discharge to Madox Creek below the Little Mountain Estates pond.

For the Madox Creek basin, we suggest that on-site detention be designed either using an HSPF approach or by the SCS-based hydrograph procedures as required by the draft drainage ordinance in Appendix I, and as described in the King County Surface Water Design Manual (revised November 1992). If the SCS procedures are used, the following particular requirements are suggested for the design of on-site detention facilities in the Madox Basin:

- Time of concentration calculations for existing land use conditions must include travel time for the longest realistic distance of sheet flow, computed by the formula presented on page 3.5.2-6 of the KCSWDM as Manning's kinematic solution.

- All Madox Creek basin soils in SCS group "D" should be treated as SCS group "C" soils for purposes of selecting SCS runoff curve numbers.

- The SCS runoff curve number (CN) for current conditions land use should be the lowest number which could reasonably be selected for the existing land use (see table on page 3.5.2-3 of the KCSWDM).

- On-site pond volumes and orifices should be initially sized to meet the detention standards stated in the draft drainage ordinance in Appendix H, and then pond volumes at each depth should be increased by 30 percent for a factor of safety. This factor of safety is necessary because calibrated continuous hydrologic modeling has shown that SCS procedures used to size detention facilities to the standards in Appendix H do not reduce post-developed peak flows to predeveloped flows.

RS6 Recommended Solutions: Construct modifications to Little Mountain Estates Pond. Also, strict onsite stormwater control detention standards should be implemented for the Madox Creek Basin as described previously.

g. Problem RS7 — Erosion of Madox Creek Downstream of Blackburn Road.

RS7 Problem Description: The erosion on Madox Creek and Flowers Creek below Blackburn Road will likely continue in the future causing bank failures and increased sediment accumulation downstream reducing the channel capacity.

Madox Creek

RS7 Structural Solutions: Further erosion of the steep section of Madox Creek could be minimized by construction of a pipeline to divert peak flows around the steep reach of the channel (see Appendix F, Figure 5.1). Approximately 4,500 feet of pipe would be required to transport water from an intake constructed just above Blackburn Road to an outlet returning flow to the main channel below Blodgett Road. Assuming that improvements are made as recommended to the Little Mountain Estates pond, the diversion system should be sized for a 100-year flow of about 56 cfs, this being the difference between the current 100-year peak flow at Blackburn Road and the projected 100-year peak flow after future development. The first 1,400 feet of pipe would be at a flat grade and would need to be about 60-inch-diameter (CMP) to minimize head losses. The remaining pipe would mostly be on a steep grade with a slope of 0.019 or more and would need to be about 42-inch-diameter (CMP) to avoid pressure buildups by keeping the pipe friction slope less than the ground slope. However, the high-flow bypass pipeline will serve only to limit erosion through the steep reach of Madox Creek; the effect of increased peak flows below Blodgett Road have not been assessed. The cost estimate of this alternative, includes inlet and outlet structures and five road crossings.

Cost = $688,000

Another structural alternative to solving the erosion problem in Madox Creek is to construct bio-engineered stream channel protection that will prevent further erosion. Bio-engineered channel protection uses a combination of vegetation, log structures, and rock to reinforce the existing banks and stream but still provide opportunities for fish habitat. Prior to constructing any channel protection, a detailed examination of the erosion potential and further geotechnical and geomorphic investigations should be performed to determine the likelihood and risk of continued erosion, and to recommend what type of remedial actions should be taken. The estimated cost of any instream channel protection depends on the results of additional investigations. For budget purposes, it is anticipated that a moderate combination of bed control weirs and bank protection will be required for approximately 400 feet of channel.

Cost = $44,000 for additional geotechnical and geomorphic investigations
Cost = $349,000 for construction of channel restoration improvements

Flowers Creek

A structural solution to the erosion problem along Flowers Creek can be solved by installing a high flow bypass. How this can be constructed in conjunction with a nearby development project is described in Appendix M.

Cost = $0, to be constructed by the developer

RS7 Nonstructural Solutions: Nonstructural solutions to help solve erosion problems in Madox Creek are the same nonstructural solutions proposed for Problem RS6. These are strict onsite detention for new development.

RS7 Recommended Solutions: Because of the higher cost of constructing a bypass pipeline for Madox Creek, additional geotechnical and geomorphic investigations should be performed and recommended channel stabilization projects should be constructed. For Flowers Creek, a bypass pipeline could be constructed as part of an adjacent development project. Also, enforce strict onsite detention requirements for new development that are described under Problem RS6.

h. Problem RS8 — Madox Creek and Drainage District 17 Maintenance Responsibility.

RS8 Problem Description: It is uncertain as to what portion of the sediment removal work at Blodgett Road and the maintenance and operation of the Conway Pump Station is the responsibility of the City of Mount Vernon. This work and this facility is located in Drainage District 17, but Mount Vernon contributes flow to this system.

RS8 Recommended Solution: The Madox Creek system within Drainage District 17 is very complex. It extends south of Conway for several miles prior to discharging to Skagit Bay via tide gates. Backwater from the tide gates could affect water surface elevations in the wide channel all the way upstream to the pump station at Conway. Runoff from the entire basin could cause water levels to rise and thus trigger operation of the Conway Pump Station. Determining how much of the pump station maintenance and operation is necessary because of the area in Mount Vernon contributing to the system is not readily apparent. Additional hydraulic analysis of the Madox Creek system is necessary to answer this question. Mount Vernon's share in the cost of this analysis has been included in the surface water program budget.

The cost to remove sediment at Blodgett Road is not significant, and the City and the District have agreed to share this cost.

Cost of Mount Vernon's Share in Analysis Work = $44,000

2. Local System Problems

Local system problems are those flooding and erosion problems that are tributary to major streams or drainage systems. These problems generally affect only a small, localized area and represent mostly citizen complaints or staff-identified problems. These types of existing problems cannot be solved by nonstructural solutions such as new development standards or other regulations. For this reason, only structural solutions are presented for these more localized problems.

a. Problem LS1 One alternative to prevent the floodwater from the Skagit River from backing up over Hoag Road west of La Venture Road would be to build approximately 700 feet of berm along the north side of Hoag Road to an elevation of 385 feet.

Cost = $224,000

A less expensive alternative is recommended. This would involve warning potentially affected residences during a flood, and sandbagging their homes.

b. Problem LS2 This area northwest of the intersection of Hoag Road and the Burlington Northern Railroad is lower than the surrounding areas that have been filled for the road to the south, the railroad to the east and the Skagit River levee to the north. Any new development in the area would likely be built at least as high as the roadway and therefore it would be difficult for any new drainage system to include a connection to drain this area. The property owner could install a small pump station to discharge into the storm drain system being constructed for the new development on the south side of Hoag Road at this location. This should be the individual property owners' responsibility.

c. Problem LS3 Flooding has occurred at the residence located west of La Venture Road where it turns east several blocks north of Hoag Road. This problem appears to have been solved. A concrete curb has been placed on the west side of La Venture Road above the affected property.

d. Problem LS4 Ponding occurs on a commercial site northeast of the College Way - Urban Avenue intersection. The loading bays on this site have been graded much lower than the surrounding grounds and they collect water. The surrounding undeveloped area is heavily grassed and appears to be slightly lower in elevation than the commercial site, and therefore could not contribute any appreciable runoff to the site. Any water collected on the site would be from runoff generated on the site itself. Therefore, any water collected is the result of site grading and drainage problems that are the responsibility of the private property owner.

e. Problem LS5 This problem was resolved as part of a City project that improved portions of Fir Street.

f. Problem LS6 The Kulshan Creek tributary north of Cedar Lane has eroded the stream channel down to a firm till layer. Since the till layer is hard and resistant to erosion, the stream bed is not expected to erode any further. However, the channel banks are steep and not yet completely stabilized. The steep banks will most likely slough to the angle of repose where they will then be stable. Since this is a short section of stream, only 100- to 150-feet-long, it is recommended that the banks be allowed to come to the angle of repose naturally. This will be less disruptive to the environment than manually regrading the bank slopes. It is also recommended that a small log structure be placed across the creek downstream from the culvert outlet. The weir structure would help to stabilize the stream bed at the pipe outlet and prevent undermining of the culvert and therefore, would protect the stability of the roadway embankment. The weir would also provide better fish access to the culvert.

Cost = $11,000

g. Problem LS7 Flow from an 18-inch pipe north of Viewmont Drive is causing erosion where it descends a fairly steep grade down to Kulshan Creek. It is recommended that the pipe be extended to Kulshan Creek. A manhole drop structure near Kulshan Creek should be installed to dissipate energy and to allow the pipe to enter Kulshan Creek at the same elevation as the stream bottom.

Cost = $48,000

h. Problem LS8 The flooding problem along the west side and north end of North 16th Street north of Florence Street is caused by an undersized culvert. The culvert should be replaced with approximately 200 feet of 24-inch-diameter pipe.

Cost = $29,000

i. Problem LS9 Flooding occurs in a trailer park east of North 30th Street and south of College Way as runoff overtops a ditch 1300 feet south of College Way and flows overland to Trumpeter Creek. The ditch was analyzed based on current survey information and appears to have adequate capacity to carry the 10-year storm event. However, the ditch is not large enough to provide any freeboard for the 10-year peak flow. It is recommended that when the sewer interceptor is constructed along the north side of the ditch that an additional 6 to 12 inches be added to the top of the berm to provide additional room for freeboard.

Flooding also occurs at the Park Village Trailer Park north of First Street. To solve this flooding problem, a two-stage low flow and high flow channel is recommended. The low flow channel would handle flows up to the two-year peak and the high flow channel would be excavated to the east to accommodate the 100-year flow event. To obtain a Hydraulic Project Approval from the Department of Fish and Wildlife, fish habitat improvements would be required such as in stream elements like boulders and logs and out-of-stream elements such as trees for shade.

Cost = $53,000

j. Problem LS10 The southeast fork of Trumpeter Creek east of Waugh Road and south of College Way has problems with erosion and deposition. Channel erosion and mass wasting upstream of the culverts crossing Seneca Drive and Kiowa Drive has caused large amounts of material to move downstream and plug the culverts. Downstream of the culverts the stream bed is being eroded. This has created a large drop between the culvert outlets and the stream bottom causing fish passage problems.

One alternative solution would be a combination of stream bed control weirs and an enhanced maintenance program. A series of stream bed control log weir structures downstream of the culverts would accomplish two objectives. First, the weirs would dissipate some of the energy in the stream and would eliminate any channel incision downstream of the culverts. Second, they would create a series of pools that would facilitate fish access to the culverts. Regular mining of sediment deposited upstream of the culverts by maintenance staff during periods when fish are not migrating could prevent the culverts from filling up with sediment.

Cost = $22,000

Another alternative solution is to replace the existing culverts under Seneca and Kiowa drives with large concrete box culverts. The culverts would be large enough so that there is enough open area to pass both the 10-year peak flow and also allow most of the material moving downstream to pass through rather than plugging the culverts. This would also minimize the scour that is occurring downstream from the culverts.

Cost = $131,000

Because of the lower construction cost, the construction of bed control weirs is recommended.

k. Problem LS11 A trashrack should be installed behind the house that is east of Nez Perce on the south side of Kiowa Drive. Upstream from the inlet behind this house there is a driveway culvert. A trashrack should be installed upstream from the driveway culvert to prevent sediment and debris from plugging the downstream inlet. The driveway culvert with the trashrack and the inlet behind the house to the north should be included in a maintenance program and checked and cleaned regularly.

Cost = $500

l. Problem LS12 The solution to localized flooding problems in West Mount Vernon could be resolved by replacing the 12-inch-diameter storm drain system along Memorial Highway with a 30-inch-diameter system. The current 12-inch-diameter system is the main storm drainage for West Mount Vernon and is greatly undersized. This will increase the system's capacity and allow more flow to reach the pump station south of Wall Street and be pumped out into the Skagit River.

Cost = $557,000

m. Problem LS13 During periods of high water levels in the Skagit River, the ground water table in this portion of Mount Vernon is also high and reaches the ground surface in a low spot near the intersection of Wall Street and Garfield Street. Several homes are flooded as a result. To ensure that the water can drain once the Skagit recedes, catch basins should be placed in the low spots. Also, a notification system should be implemented. The residents in the areas should be notified when the Skagit River rises so they can move their belongings to higher levels. The only other alternative solution would be to demolish the affected houses and regrade the site to a higher elevation.

Cost = $14,000

n. Problem LS14 The flooding of the intersection of Cosgrove Street and Wall Street in West Mount Vernon is due to a lack of a drainage system at a low spot. The solution to this problem is to install a new inlet at the low spot and connect it to the storm drain on Wall Street north of Memorial Highway with a 12-inch-diameter pipeline.

Cost = $40,000

o. Problem LS15 Portions of the storm drain system north of Division Street along Stanford Drive, Streeter Place, North 21st Street and Fir Street west of LaVenture should be replaced due to insufficient capacity to carry a 10-year storm flow. Refer to Figure VII-1 and Table VII-3 for details of this solution.

Cost = $371,000

p. Problem LS16 There are two alternative solutions to control the channel incision between Mohawk Drive and Apache Drive east of Comanche Drive.

The first alternative is to install a rock lining in the stream between Mohawk Drive and Apache drive to protect the channel bed from further erosion.

Cost = $9,000

The second alternative solution is to install log structures across the channel to act as bed control weirs downstream of the culvert under Mohawk Drive. This would not only reduce the erosion in the stream bed, but would also facilitate upstream fish migration by creating a "ladder" with resting pools and access to the culvert under Mohawk Drive.

Cost = $11,000

It is recommended that the second alternative solution, the log weir structures, be implemented. Since the alternative solutions are fairly close in price, the second solution was chosen because constructing the log weir structures would provide better fish passage and habitat than lining the channel with rock.

q. Problem LS17 The flooding of the two homes on the north side of Comanche Drive east of 30th Street could be prevented by the implementation of one of two following alternative solutions.

The first alternative solution would be to construct a ditch on the north side of Comanche Drive (see Figure VII-2) and construct a 24-inch-diameter culvert across Comanche Drive from the ditch on the south side to the new ditch on the north side of the road. The upstream invert of the new culvert would be placed higher than the elevation of the bottom of the south ditch. This would allow the low flows to travel down the south ditch, as it currently does. But, during higher flows, some of the flow would spill into the new 24-inch pipe and then travel down the north ditch. The additional capacity provided by the north ditch would help contain high flows and transport them to the ditch system that is parallel to and 200 feet east of North 30th Street.

Cost = $14,000

The second alternative solution would be to install a 24-inch-diameter storm drain on the south side of Comanche Drive (see Figure VII-2 for details). The storm drain would begin upstream of the curve in Comanche Drive east of North 30th Street. The storm drain would follow Comanche Drive and then connect to the existing storm drain on North 30th Street. Sections of the storm drain on North 30th Street will also need to be upgraded to accommodate the additional flow from Comanche Drive.

Cost = $153,000

The first alternative solution is the recommended solution to this problem. Since either solution would solve the flooding problem adequately, the least cost solution is recommended.

r. Problem LS18 The 12-inch-diameter culvert under Shoshone Drive east of Sioux Drive should be replaced with 100 feet of 36-inch-diameter culvert.

Cost = $24,000

s. Problem LS19 Armored emergency overflow spillways should be constructed for the two detention ponds west of Waugh Road and north of Division Street. The armored spillways help ensure the stability of the embankment in case the control structure plugs or during an extreme event. The armoring may consist of gabions, heavy riprap or concrete lining. The spillways would channelize overflow and allow it to reach the downstream system without jeopardizing the embankment. Also, encroachments into the detention pond easements by the local residents should not be allowed so that proper maintenance of the ponds is ensured.

Cost = $59,000

t. Problem LS20 There is a low area behind several homes on the west side of South 6th Street north of Blackburn Road that collects water. During certain storm events, runoff drains to this low spot and can accumulate to where it floods several homes. It is recommended that two catch basins be placed in the low spot and a new storm drain system be constructed north on Railroad Avenue to Lind Street and east to the fork of Madox Creek that runs along the west side of Interstate 5. This would allow the area to drain and help prevent any further flooding in the area.

Cost = $155,000

u. Problem LS21 The flooding on the west side of Riverside Drive in the vicinity of Willow Lane and Alder Lane should be somewhat alleviated by the storm drain that was recently installed along the east side of Interstate 5 in this area. Also, the Kulshan Creek pump station as described in the solution to Problem RS 4 should significantly reduce the chance of flooding in this area from Kulshan Creek.

v. Problem LS22 The flooding in the low-lying area northwest of the Riverside Drive-Fir Street intersection is due to the lack of a drainage system to convey runoff. A catch basin should be installed in the low spot and it should be connected to the storm drain system west of the railroad tracks from this intersection. The cost for installing this system is high because it involves tunneling or jacking a new pipe under the railroad track.

Cost = $100,000

w. Problem LS23 Flooding occurs along the east side of I-5 where Fir Street curves into Cameron Way. Several businesses are affected by the flooding. This flooding problem could be solved by installing a storm drain system along the east side of I-5 that connects a new system along Cameron Way to the existing storm drain system to the north that contains Kulshan Creek.

Cost = $73,000

x. Problem LS24 With construction of the recommended solution to regional system problem RS1, drainage will be provided to the area south of College Way west of Interstate 5.

y. Problem LS25 From the hydraulic analysis, portions of the pipe and ditch system between Blackburn Road and Britt Slough are under capacity and may cause water to back up in the system and cause flooding during a 10-year storm event. The possibility of flooding could be reduced by replacing three of the pipes as indicated in Table VII-3 and Figure VII-3 with 30- to 36-inch-diameter concrete pipe.

Cost = $284,000

z. Problem LS26 From the hydraulic analysis, it was determined that portions of the storm drain system containing the North Fork of Trumpeter Creek along Fox Hill Street have insufficient capacity to pass the 10-year storm event. This may cause flow to back up flooding the streets and homes in the area. Since the recommended solution to regional solution RS5 was not to construct a regional detention facility, one of the two following alternatives for conveyance improvements can solve this problem.

The first alternative solution would be to replace the inadequate portions of the existing storm drain system. This would require that five sections of the storm drain system be replaced. See Figure VII-4 and Table VII-3 for the details of this solution.

Cost = $235,000

To solve the safety problem associated with the deep ditch west of 32nd will require placement of approximately 400 feet of 36-inch storm drain.

Cost = $66,000

The second alternative solution is to reroute flows from the portion of the subbasin north of Hoag Road. These flows would be directed into a new stormdrain system built as part of the extension of 30th Street from Hoag Road to College Way. The rerouted flows would travel south along the future 30th Street system to the existing system on College Way. The existing system on College Way flows east to where it discharges into Trumpeter Creek approximately 500 feet west of Waugh Road. By directing a portion or all of these flows away from the Fox Hill Street system, replacement of the portions of the system described under the first alternative might not be necessary. A hydraulic analysis was performed on the existing College Way system to determine if there is sufficient capacity to carry the additional flows rerouted down a future 30th Street stormdrain. The existing system on College Way is a 30-inch concrete stormdrain from west of 30th Street to east of 33rd Street. From this point east of 33rd Street, the College Way system is a 36-inch concrete stormdrain to where it discharges into Trumpeter Creek approximately 500 feet west of Waugh Road. Our hydraulic analysis indicates that the 30-inch portion of the College Way system has a capacity of approximately 40 cfs. The 36-inch portion has a capacity of 46 cfs. The 100-year return flow from the part of Subbasin 4 south of Hoag Road and west of 30th Street is 28 cfs. This means that 12 cfs can be directed to the College Way system from the area of the subbasin north of Hoag Road and still not exceed the 40 cfs capacity of the College Way System.

The existing system on Fox Hill Street and the existing system on College Way can provide a 10-year level of protection if 12 cfs is diverted from the area north of Hoag Road into the new system on 30th Street. The 10-year return flow for the area north of Hoag Road is 14 cfs. The 10-year flow for the area south of Hoag Road, but east of 30th Street, is 13 cfs. This means that during a 10-year event, 27 cfs will be routed through the Fox Hill Street system. The capacity of all but one segment of the Fox Hill system is 16 cfs. If 12 cfs out of the 27 cfs is diverted into the new 30th Street system, the Fox Hill Street system can carry the remaining 15 cfs in a 10-year event. With the 12-cfs diversion, the College Way system can still provide a 100-year level of protection. If the City wishes to provide a 100-year level of protection for the Fox Hill Street system, we recommend that, in addition to diverting 12 cfs of flow from north of Hoag Road through the new system on 30th Street, the pipe replacements described in Figure VII-4 and Table VII-3 should also be constructed. It is assumed that since pipe Number 7 shown on Figure VII-4 only has a capacity of 6 cfs, this segment will need to be replaced to provide even a 10-year level of protection.

aa. <u>Problem LS27</u> From the hydraulic analysis, part of the storm drain system that crosses under Interstate 5 at Anderson Road is determined to have insufficient capacity to pass a 100-year flow. Two pipe sections of this storm drain system were determined to have insufficient capacity. These include the pipe section on the east side of Interstate 5 parallel to the frontage road that is set at a reverse grade and the pipe section that crosses the frontage road. In order to correct this problem, the two inadequate sections of this system must be replaced and set at a positive grade. Details of this solution are presented in Figure VII-5 and Table VII-3.

Cost = $50,000

C. Water Quality Solutions

1. <u>Introduction</u>

The combination of the effects of urban and rural development on the quality of stormwater runoff and receiving waters results in a complex stormwater pollution prevention problem. For new development, water quality control facilities should be required because it is difficult to control the quality, volume, and rate of runoff once the areas are developed. Once pollutants are entrained in runoff, it is difficult to remove them before they reach receiving water bodies. Thus, the most effective approach to controlling water pollution attributable to existing developments is to implement source control best management practices (BMPs) for prevention of stormwater contamination. Source control BMPs are a variety of managerial, behavioral, and physical measures designed to prevent the release of pollutants and their entrainment into stormwater runoff. The following discussion of water quality problem solutions relies heavily on source control BMPs, although some water quality problems necessarily require more elaborate structural solutions.

2. Urban Water Quality Problems

a. Problem WQ1 — Illicit Connections of Wastewater Discharges to the Storm Drainage System.

WQ1 Problem Description: There may be cross-connections between the sewer and storm drain systems. Such cross-connections are usually caused by direct pipe connections between the sanitary sewer and the publicly maintained storm drain.

WQ1 Structural Solutions: Generally, the solution to this problem is more appropriately addressed by nonstructural solutions to identify cross-connections. However, when cross-connections are located, structural measures to eliminate the illicit connection would be required.

WQ1 Nonstructural Solutions: The first step in controlling pollution problems due to illicit connections is identifying locations where illicit connections to the storm drainage system exist (for example, where shop floors, appliances, or wastewater flows discharge to the storm drainage system rather than the sanitary sewer system). These plumbing connections are often unknown to the property owner. The list of registered businesses attached to the task report in Appendix G should be used to develop an initial prioritized list of the businesses that could adversely impact receiving water quality if they have illicit connections to the storm drainage system.

A program of water quality monitoring, smoke testing, dye testing, and pipe video inspections of storm sewers should be used to identify potential entry points for cross-connections as well as other water quality problems. The City's pipe video system will be very helpful in this effort. The video system can be used to identify pipe connections, leaks, damaged pipe, and the source of inflows during dry conditions.

The recommended approach for this water quality and illicit connection program is as follows:

Step (1) Water Quality Monitoring: A monitoring program should be initiated to confirm cross-connections or any other water quality problems.

Water quality monitoring should be conducted at strategic locations in the storm drainage system to assist in determining subareas of the city that have abnormally high pollutant concentrations in runoff. The monitoring program should include three wet weather and three dry weather sampling events. Samples collected during each event should be tested for several pollutant parameters, including fecal coliform bacteria and surfactants. The surfactants test is recommended because it will confirm that the source of contamination is a sanitary sewer cross-connection rather than some other fecal coliform contamination source (e.g., pet waste). Soaps and detergents, which are associated with sanitary sewage, will be indicated by a positive surfactants test.

Step (2) Smoke Testing, Die Testing and Pipe Video Inspections: After obtaining water quality data for specific systems that might indicate a problem, these tests are used to pinpoint cross-connection locations.

Step (3) Correct Cross-Connections: Cross-connections found that are part of the City maintained storm drainage system (in the right-of-way) can be corrected by City maintenance crews. Cross-connections that are part of private facilities are the responsibility of the private property owner, and the City will need to enforce corrective action.

Step (4) Additional Monitoring: Once it is believed that all cross-connections have been corrected for each of the systems determined to have a problem in Step 1, the City should conduct a follow-up monitoring program (similar to Step 1) for each system. This information can be used to evaluate whether all cross-connections have been corrected.

In addition, while the City is conducting this monitoring program, additional testing of outfall samples for other pollutant parameters is recommended.

WQ1 Recommendations: The City should conduct a monitoring and investigative program such as that described above (steps 1–4) for water quality parameters. The same protocol of six sampling events should be used. All major stream systems and outfalls should be sampled during each sampling effort. These pollutants include:

- Total petroleum hydrocarbons
- Suspended solids
- Nitrate plus Nitrite Nitrogen
- Total phosphorus
- pH
- Ammonia Nitrogen
- Temperature
- Lead
- Copper
- Zinc
- Dissolved oxygen
- Hardness

Sampling for these pollutants would provide additional information about the quality of water entering receiving waters and could be evaluated to determine the existence of other water quality problems in the City. This data could also be used as baseline information to evaluate the effectiveness of source control programs. It is recommended that the City conduct the monitoring program initially as a high priority and then a second time, a few years later, to determine the effectiveness of source control programs. In addition, this sampling program should include some sediment sampling in the Kulshan Creek Basin as discussed under problem WQ9.

Cost Estimate:	$19,500 baseline monitoring (staff time and sample costs)
	$19,500 follow-up monitoring
TOTAL	$39,000

b. Problem WQ2 — Erosion, Transport, and Deposition of Sediments.

WQ2 Problem Description: Erosion within the study area results in increased sediment loading to surface waters. Sedimentation of these systems degrade receiving water quality and impact aquatic habitat. Two types of erosion commonly occur: stream channel erosion and erosion associated with land disturbance activities.

Structural solutions are appropriate for solving existing stream channel erosion problems, whereas nonstructural solutions such as regulations requiring BMPs for erosion and sedimentation control are appropriate for erosion associated with existing and future land clearing. Nonstructural solutions are also effective in areas where measures to prevent future flooding and stream channel erosion are appropriate.

WQ2 Structural Solutions: Structural solutions for stream channel erosion problems consist of channel armoring or controlling peak runoff rates and reducing velocities through the use of detention facilities, diversions, check dams, and infiltration. Properly sized sedimentation facilities, either alone or combined with a detention facility, can effectively remove sediment load from surface waters.

WQ2 Nonstructural Solutions: Nonstructural solutions for erosion due to land clearing include ordinances and regulations that require new development to provide onsite erosion control devices. The City has adopted erosion and sedimentation control standards that meet the minimum requirements in Ecology's *Stormwater Management Manual for the Puget Sound Basin.*

Prompt revegetation requirements for cleared areas are required by the new standards and will reduce sediment loads to the stream system. BMPs, including minimizing the amount of clearing conducted, avoiding exposing denuded areas to runoff by stabilizing these areas, and prompt revegetation or replacement with sod, plastic covering, or mulch would help reduce land related erosion.

Retaining or promoting development of vegetated buffers between developed areas and surface water systems is an important mechanism in preventing sediment laden water from reaching the stream. Sheet flow runoff that must travel through a vegetated area is filtered and sediments are removed.

Catch basin cleaning at regular intervals has been shown to be an effective sediment removal technique. By increasing the frequency of cleaning private catch basin systems, sediment loads to surface water are significantly decreased. Increased maintenance is discussed further under problem WQ3.

WQ2 Recommendations: Recommendations for structural solutions for specific erosion problems are presented under specific system problems and environmental resource problems. Recommendations for nonstructural solutions for erosion problems include:

(1) The City has adopted a new ordinance that meets the PSWQA minimum requirements contained in Ecology's *Stormwater Management Manual.* The City must accompany the new standards with a public education and enforcement program to achieve the objectives of the erosion control ordinance. The City should develop a program to inform and educate area contractors about the new erosion control requirements. It is suggested that the City develop this program jointly with Skagit County. A joint City and County effort would likely be more successful in attracting area contractors.

    This education program can be one component of an overall public education program. The recommended overall education program is discussed later in this section.

(2) Increase the stream buffer requirements from the City's current standard described in Section 5. This is described in greater detail under the environmental resource problem solutions.

(3) Increase the frequency of catch basin cleaning from once a year to once every eight months. Increasing the frequency of catch basin cleaning is part of the recommended maintenance and operation plan, discussed in Section VIII. In addition, identify areas of potential high pollutant loading, such as streets that receive runoff from shopping center parking lots. Develop more frequent cleaning schedules for these areas, such as once every three months during the rainy season, or at least once every six months. The cost associated with catch basin cleaning is included in the annual maintenance and operation program costs.

c. Problem WQ3 — Contamination of Runoff by Diffuse Sources of Pollutants on the Land.

WQ3 Problem Description: Urban runoff from the City of Mount Vernon and surrounding area contributes to nonpoint source pollution in area streams and the Skagit River.

Existing problems associated with urban runoff will be addressed with both structural and nonstructural solutions as appropriate. Solutions for future urban runoff problems caused by anticipated future development will be addressed by nonstructural solutions.

WQ3 Structural Solutions: Structural solutions used for improving runoff water quality from existing development often requires the use of subsurface structures such as oil/water separators and oversized catch basins. Site constraints can cause difficulty in locating above ground facilities in existing development areas. Catch basins in the existing storm drainage system should be outfitted with inverted elbow outflow restrictors that enable trapping of floatable materials and some oil/water separation. These devices can significantly reduce the suspended solids loading to receiving waters and can trap larger-sized oil droplets in runoff. Currently, few of the city's catch basins have the capability to trap floating material (Haehn 1993 personal communication). Key locations such as large parking lots, maintenance facilities, and gas stations should be targeted for installation of inverted elbow outflow restrictors in catch basins. Maintenance personnel generally agree that oil/water separators are effective if frequently maintained. Depending upon the rate of accumulation (which is greatest during the rainy season), oil/water separators may require cleaning as frequently as every three months.

Installing oversized catch basins will provide greater sediment trapping than a standard catch basin, thereby reducing pollutant loading to the receiving water.

In some areas with existing development, it might be possible to install above ground stormwater quality control facilities. These types of facilities include biofiltration swales, extended detention ponds, and wet ponds. These facilities are described further under the nonstructural solutions required for new development.

WQ3 Nonstructural Solutions: Nonstructural solutions can help solve urban runoff water quality problems for both existing and future development. The nonstructural solutions for water quality improvement include methods for source control, regulatory strategies, and maintenance practices.

(1) Source Controls

(a) Reduce and Properly Dispose of Household Hazardous Waste

Conscientious use of household cleaning products, water disposal, and do-it-yourself automobile change practices by residents, will reduce the risk of stormwater contamination. Vehicles and other equipment should be washed either under covered areas where the drain is connected to the sanitary sewer, on a lawn where wash water can infiltrate, or at a commercial washing establishment. Liquid chemicals, waste oils, solvents, paints, and other household hazardous materials should be stored indoors and disposed of as hazardous waste. If these types of materials must be stored outside, a lean-to roof or other protective cover should be provided to keep them out of the rain. Care should be taken when changing automotive oil, and used oil should be brought to a gas station or proper disposal area. Skagit County Department of Public Works has begun a new program for collection of household hazardous waste materials. The County has opened a new Moderate Risk Waste Collection Center at the County's Resource Recovery Facility at 1200 Ovenell Road, Mount Vernon, Washington 98273. Information can be obtained by calling the facility at 424-7807.

(b) Eliminate Illegal Dumping of Waste

Residents should emphasize proper disposal of oil and liquid waste products as well as yard waste. Also, dumping of pet waste into roadside ditches should be avoided. Pet waste can contribute to bacteriological contamination of water resources.

(c) Minimize Exposure of Pollutants to Stormwater

Prevention measures undertaken by business owners that reduce the amount of waste materials that can come in contact with stormwater are the most effective ways of reducing stormwater pollution. It is much easier to keep pollutants out of stormwater than it is to remove them from contaminated stormwater ("an ounce of prevention is worth a pound of cure"). Measures include the proper storage of waste materials or other potential pollutants as an effective method of reducing stormwater pollution. Replacing aging, leaking, and otherwise ineffective outdoor waste containers (such as dumpsters and garbage cans) and ensuring that all containers have tight-fitting lids is also an effective method of controlling source pollution.

Reduction of impervious surfaces within the study area that are exposed to pollutants will reduce pollutant loading and improve stormwater quality. Viable impervious area limitation measures have been identified as: (1) development clustering; (2) porous pavement applications; (3) development conditions limiting impervious area; (4) subsurface parking or covered parking areas; and (5) downzoning to lower development density or intensity.

(d) Safely Use Pesticides and Herbicides

When businesses, groundskeepers, and residents emphasize conservative and correct use of herbicides and pesticides on gardens and lawns within urban areas, the potential for stormwater contamination by these products is reduced. Taking steps to limit over-application (and application preceding storm events) of fertilizers and/or pesticides used in landscaping activities can also reduce risks associated with these products and improve water quality. Information on the use of integrated pest management (IPM) should be made available to these groups to reduce dependence on chemical fertilizers and pesticides.

(e) Implement Public Education Programs

Several different types of public education programs regarding stormwater pollution prevention have been undertaken by other jurisdictions to educate targeted groups such as businesses, the public, contractors, and special industries. Table VII-4 provides examples of public education programs initiated in the Puget Sound area. Information can be communicated to the public in the form of workshops, flyers, pamphlets, and public meetings. A wealth of information on implementing stormwater management public education programs is contained in Ecology's *Stormwater Program Guidance Manual for the Puget Sound Basin*.

Implementation of a public education program for specific groups such as business owners, residents, and contractors regarding the need to help control stormwater pollution is an important first step in stormwater pollution source control. Public assistance with simple pollution control measures can be implemented to help improve stormwater quality. Educate contractors regarding the importance of stormwater source control related to erosion and sedimentation control procedures. Prepare a plastic coated pocket sized pamphlet that presents information on erosion control measures and distribute it to the contractors. Public works maintenance and inspection staff should also be educated in these areas. Many of these types of educational materials have already been developed by other local governments or state and federal agencies. These materials could be obtained from them and used in Mount Vernon as well.

Abatement of this large-scale water quality problem depends upon many applicable BMPs that collectively can reduce the pollution of receiving waters. A public education program should be developed to inform businesses and residences about various BMPs they should implement. Educational efforts should distinguish between residential activities of concern and commercial/industrial activities of concern. The list of registered businesses at the end of the task report in Appendix G can be of assistance in tailoring the educational program for businesses to focus on prevalent business types and related activities.

Many BMPs, including stormwater treatment measures that can be used if source controls are not feasible, are potentially applicable to businesses and residences. King County has developed a comprehensive BMP manual that outlines many of these additional measures. Additionally, Ecology's *Stormwater Management Manual for the Puget Sound Basin* contains BMP requirements for businesses in specific standard industrial codes (SIC). These manuals can serve as reference documents for further steps that can be taken to clean up nonpoint source discharges to streams in the study area.

Development of an outreach and education program on the importance of catch basin cleaning of private systems on a regular basis, and specific methods for cleaning the systems, would improve the success of implementing maintenance practices for private systems. These efforts should target commercial and industrial uses. Information could be distributed in the form of flyers, town meetings, newspaper articles, and workshops. Providing businesses with information and guidance on the importance of maintaining private catch basins would improve sedimentation problems within these systems. The City should also implement a new ordinance requiring maintenance of private systems. A model ordinance prepared by Ecology for this purpose is included in Appendix I.

The City could issue window stickers designating businesses as "environmentally friendly" (or something similar) if they actively implement and maintain pollution prevention BMPs. Other incentives to accomplish voluntary pollution prevention should be explored.

(2) Regulations and Ordinances

(a) Enforce New Development Standards Meeting PSWQA Minimum Requirements

In accordance with the *PSWQMP*, the City has adopted minimum requirements for water quality controls for new development. These standards will include erosion and sediment control requirements and runoff treatment BMPs.

(b) Adopt Regulations for Maintenance of Privately Owned Stormwater Control Facilities

As mentioned previously, maintenance of stormwater control facilities is important for improving water quality. Maintenance of privately owned facilities should be performed and encouraged by the City through public education. If education efforts fail, the City should have an ordinance that requires maintenance to be performed. A model ordinance developed by Ecology for this purpose is included in Appendix I.

(3) Maintenance

(a) Increase Frequency of Catch Basin Cleaning

Increased frequency of catch basin cleaning is needed along with the establishment of a list of priority catch basins. Catch basins should be prioritized for cleaning according to both the rate at which sediment accumulates in the trap and the degree to which land use in the upstream drainage area may contribute pollutants. The high priority catch basins to be cleaned most frequently should be those that accumulate the greatest sediment load and those that show signs of poor water quality. These catch basins may be located adjacent to areas used for automotive work, roadways following winter application of traction grit, and areas subject to new land clearing and development. Regular maintenance of catch basins is an effective means of reducing stormwater pollution because it reduces the amount of contaminants flushed into the storm drainage system. In areas known to generate high quantities of pollutants, catch basins may require increased maintenance especially during the rainy season.

A catch basin cleaning program should be developed that includes a schedule giving cleaning priority to those catch basins that are most frequently clogged with sediment and areas with the highest levels of stormwater pollutants. The schedule should provide for cleaning of the high priority sites as frequently as is necessary and the cleaning of the remaining catch basins a minimum of once every eight months.

(b) Improve Ditch Cleaning and Biofiltration Swale Maintenance Practices

The method and frequency of ditch maintenance should be conducted to improve water quality. Increased erosion and reduced filtration efficiency in drainage ditches due to maintenance practices can lead to increased stormwater pollution. Ditch maintenance should preserve vegetation lining to prevent erosion and to capture pollutants. Vegetation should only be disturbed when it is necessary to remove sediments in order to regain hydraulic capacity. When this type of ditch maintenance is required, it is best done so that some vegetative material remains to regenerate the vegetation lining. Reseeding or sodding of ditches should be performed as required to help prevent erosion.

(c) Maintain Detention Pond Vaults

Regular maintenance of detention ponds and vaults such as removal of sediment build-up will improve water quality and maintain the quantity control functions of the facility.

WQ3 Recommendations

Structural Recommendations

Two alternative structural measures were described above. They include the installation of oil/water separators at appropriate locations to reduce oils from entering area streams or the Skagit River, and the installation of enlarged catch basins/manholes where necessary to increase the volume of sediment and associated pollutants removed from the system. As part of the decision-making process over where it would be beneficial to install such facilities, it is recommended that the City perform monitoring investigations which would identify the severity of pollution from oil associated pollutants in these systems. A water quality monitoring program is recommended as a part of the solution to water quality problem WQ1 (sewer cross-connections). It is recommended that the City include tests for total petroleum hydrocarbons (to determine extent of contamination from oils) at each of the City major streams and outfalls when conducting the monitoring program as outlined under WQ1. If it is determined that a particular drainage area has a problem, the City should consider further investigations similar to the steps described under WQ1 solutions. These investigations may determine that installation of oil/water separators is appropriate at certain locations. For the purpose of cost estimates, it is assumed that 5 oil/water separators will be installed each year. Cost for the monitoring for this problem is included in WQ1.

Construction Cost = $16,350 per year

Installation of enlarged catch basins costs approximately $6,000 for a 72-inch manhole and $9,000 for a 96-inch manhole. Because of these high construction costs and because the increased frequency of catch basin cleaning can also reduce sediment entering the system at a lower cost, it is recommended that installation of enlarged catch basins be considered only if the increased frequency of catch basin cleaning does not adequately solve the problem. Under the catch basin cleaning program described above, the City will identify priority catch basins that need to be cleaned out more frequently than the standard eight months (e.g. every two months during the winter). If the more frequent cleaning does not solve the problem, source control measures should be pursued in the areas tributary to these catch basins. If these specific catch basins continue to be filled with sediment, it is recommended that these specific catch basins be replaced with oversized catch basins. In addition, water quality monitoring for suspended solids could be included in the monitoring program discussed under the solution for WQ1. This information would help identify sediment loads throughout the system and the associated need for source control measures, increased maintenance, and possibly enlarged catch basins. For the purpose of estimating costs, it is assumed that the increased frequency of catch basin cleaning and source control measures will solve the problem and that oversized catch basins will not be required. The cost associated with monitoring for suspended solids is included under water quality problem WQ1.

Nonstructural Recommendations

(1) Source Controls: Develop a public education program that encourages source control of stormwater pollution and includes the following objectives:

   (a) Residents should reduce the use of household products that are harmful to the environment. When these products are used, they should be disposed of as hazardous waste at the County's new Moderate Risk Waste Collection Center.

   (b) Eliminate illegal dumping of oils, liquid waste products, lawn clippings, pet waste and other pollution sources by the public and area businesses.

   (c) Reduce stormwater exposure whenever and wherever possible through the use of recommended BMPs.

   (d) Use pesticides and herbicides wisely and always follow application instructions. Also, whenever possible implement an Integrated Pest Management Plan (IPMP) rather than use chemical treatment.

   (e) Implement public education programs such as those indicated in Table VII-4 and in Ecology's *Stormwater Program Guidance Manual for the Puget Sound Basin*, Volume 2. Develop an educational program that educates commercial and industrial business owners of proper catch basin cleaning. Information could be distributed in the form of flyers, town meetings, newspaper articles and workshops. This education program can be a component of an overall public education program. The recommended overall commitment to an effective education program will require at least 25 percent to 30 percent of the City's new stormwater manager's time.

(2) Regulations and Ordinances:

   (a) Enforce new development standards meeting PSWQA minimum requirements.

   (b) Adopt a new ordinance requiring maintenance of privately owned stormwater control facilities.

(3) Maintenance:

   (a) Develop a catch basin cleaning program that (1) includes cleaning catch basins at a minimum frequency of once every eight months, and (2) develops a list of priority catch basins for more frequent cleaning.

(b) Educate City maintenance crews as to how to maintain ditches to leave a vegetative lining. It is recommended that the staff person responsible for this activity conduct interviews with other jurisdictions which have successfully implemented such practices. The Cities of Bellevue and Mountlake Terrace have historically focused on water quality and could provide valuable information.

(c) The recommended changes to current maintenance practices and associated costs are discussed in Section VIII — Maintenance and Operations.

d. Problem WQ4 — Spills of Solid and Liquid Materials.

WQ4 Problem Description: The potential for transportation-related and storage-related spills of hazardous materials causes concern for protection of groundwater and surface water resources. In addition, in cases where spilled material is not adequately cleaned up, pollution can act as long-term environmental contamination.

WQ4 Structural Solutions: Nonstructural and structural solutions are appropriate for addressing transportation-related spills whereas nonstructural solutions are more appropriate for storage-related spills. State highways and roadways are of greatest concern for transportation-related spills. Because of the risk of direct surface water contamination from spills of hazardous or toxic materials, implementation of roadway spill containment facilities at key intersections and other roadway areas of concern should be used to protect water resources. Generally, spill containment facilities consist of detention basins, oil/water separators, oil holding tanks, and high flow diversion systems. Other options for spill containment include oversized catch basins with overflow provisions designed for containing spills and an overflow device capable of separating floating material. All spill containment facilities should be constructed according to design standards adopted by the Federal Highway Administration (FHWA).

The City should perform a preliminary study to determine the need for spill containment facilities. The study should identify the areas of greatest concern, whether there is a problem, and whether corrective action is needed. The study should include the following:

(1) Traffic counts and historical accident counts on State Highways. The Department of Transportation will provide this information for a small fee.

(2) A summary of historical spills from City records, fire department records, Department of Transportation records, and Department of Ecology may also have records. Locations of these spills and proximity to resources should be noted.

(3) The ability of the Fire department to respond to a spill.

(4) An assessment as to the environmental damage that could result from a potential spill.

(5) The City should coordinate the study with the Department of Transportation.

WQ4 Nonstructural Solutions: Nonstructural solutions for handling transportation-related and storage-related spills include District Fire Department training and public education programs.

Spills of solid and liquid materials at businesses can be prevented or controlled in several ways. For certain types of businesses the state already has spill control requirements, for others an education program should be used to encourage spill control planning. Presently only businesses that work with chemicals listed as "extremely hazardous" by the EPA are required to prepare an emergency response plan (Bumgarner 1993 personal communication). There are many other chemicals and petroleum products of concern that are not on the EPA list.

State regulations require generators of "dangerous wastes" to obtain a Department of Ecology identification number if they generate more than 220 pounds of dangerous waste per month, or if they generate more than 2.2 pounds per month of wastes classified as "extremely hazardous." Ecology has several requirements related to waste storage, spill containment, and spill response for businesses that generate this much dangerous or extremely hazardous waste. Based on the list of registered businesses in the study area provided at the end of the task report in Appendix G, there should not be many businesses in Mount Vernon that fit the above category of dangerous waste generators. Ecology should already be communicating with these businesses.

Businesses that always generate less than 220 pounds of dangerous wastes or 2.2 pounds of extremely hazardous wastes per month, and that always dispose of the waste before it accumulates to these levels, are considered "small quantity generators" by state regulations. Small quantity generators (SQGs) are prevalent in all urbanized areas, and many of them are unaware of the state's regulations. Based on the types of registered businesses listed at the end of the task report in Appendix G and the limited ability of Ecology to identify and regulate SQGs, it is likely that several SQGs in the Mount Vernon urban service area are not following the state requirements. These requirements include characterizing wastes to determine if they are hazardous, properly packaging and labeling dangerous wastes, and disposing or recycling of dangerous wastes appropriately. As part of an overall education program for the Surface Water Management Plan, the city should inform potential businesses that might be SQGs of the state's dangerous waste regulations and work with Ecology to distribute appropriate educational materials that Ecology should already have available. Skagit County Department of Public Works has recently begun operation of a Moderate Risk Waste Collection Center. This collection center is currently collecting household hazardous waste as well as hazardous waste from SQGs.

It is likely that businesses that properly label, store, and dispose of dangerous wastes will be better prepared to prevent and control spills. Educational efforts for businesses of all types should encourage business owners and managers to implement spill control plans; educate employees about spill prevention, control, and reporting; and stock spill cleanup materials. Businesses in the automotive, printing, and manufacturing industries should especially be targeted for educational material on spill prevention and control because they have a greater likelihood of working with hazardous materials.

Similar educational efforts should be made for non-waste materials of concern, such as pesticides, paints, petroleum products, and a variety of solid and liquid chemicals. The Uniform Fire Code contains provisions for storing and working with reactive, ignitable, and flammable materials; the Mount Vernon Fire Department can enforce these provisions. As part of an overall pollution prevention education program for businesses, the City of Mount Vernon Engineering Department along with the Mount Vernon Fire Department, and the Skagit County Department of Emergency Management should work together to develop and distribute information on appropriate (and required) material handling storage, and spill control practices.

Fire Department Staff should be trained to address a hazardous or toxic spill within the City in a way that protects both human health and the environment. Clean up should include the use of methods that completely remove the material from the area, including contaminated soil. In addition, the fire department staff should be trained about the drainage system layout, including major storm drain system locations and discharges into the various creeks and the Skagit River. A copy of the drainage system maps should be available at the Fire Department. The Fire Department should also have emergency procedures for contacting affected agencies including the Department of Ecology, Department of Fisheries, and Department of Transportation.

A public education program that provides residents and business owners with information regarding who to contact in the event of a spill is an effective method of improving clean up time and protecting human health and the environment.

Nonstructural solutions for storage-related spills include a spill response program, training of the district Fire Department, and an inventory of industrial activities within the study area.

The development of a spill response program for large, but particularly for small, industrial and commercial business is a good first start in storage-related spill containment and control. Businesses to be targeted include gas stations, laundromats, Car washes, and automotive shops. The response program should provide information to the business owner or operator regarding who to contact in the event of spill and other important first steps to take immediately following the spill. All spill containment systems put into place will require effective response in the event of a spill.

The fire department should be trained to handle storage-related spills of hazardous or toxic materials. Training should include knowledge of the location and operation of spill containment facilities and other clean up procedures depending on the type of spill.

An inventory of all industrial activities within the study area has been conducted, and is included at the end of the task report in Appendix G. These facilities have been classified according to their standard industrial classification (SIC) code. Those facilities with SIC codes of concern that are in close proximity to water resources should be made a priority for spill prevention and containment facilities and programs. In addition, information on these sites should be available to the fire department and routine monitoring and inspection of these facilities should be performed.

WQ4 Recommendations:

(1) The City should conduct a study to identify the need for spill containment facilities to prevent spills from entering area streams and the Skagit River. The contents of the study were described above under structural solutions. This work should be accomplished by the new City stormwater manager who will be hired to administer the City's stormwater program.

(2) A City staff person should be assigned to develop information on how to handle transportation and storage related spills. It is suggest that this staff person interview the City of Renton Maintenance Department regarding the program Renton has developed for emergency spill response. The City of Renton has one of the most extensive emergency spill response programs in Washington. This staff person should then educate the fire department on appropriate methods and procedures. The staff person should also provide the fire department with all the necessary information on the City's storm drain system layout and the major outfalls to area streams and the Skagit River. This work should be accomplished by the new City stormwater manager who will be hired to administer the City's stormwater program.

(3) Develop a public education program to inform individuals of what to do in the event of a spill such as to report spills immediately using the 911 telephone number. This could be one component of the City's overall public education program that is budgeted for under a separate task.

(4) The City should develop a comprehensive information network to facilitate communication between the public, city staff, agencies and fire department spill clean up personnel in the event of a spill. Also, the City should develop a spill response program for the study area. The City should interview cities with successful programs such as the City of Renton to

develop the contents of the plan. This work will be accomplished by the City's new stormwater manager as well.

(5) Conduct an inventory of industrial facilities that store hazardous materials and keep their drainage system maps on file at the City and Fire Department. Those facilities with SIC codes of concern that are in close proximity to water resource should be made a priority for spill prevention and containment facilities and programs. In addition, information on these sites should be available to the fire department and routine monitoring and inspection of these facilities should be performed. Again, these types of nonstructural solutions will be coordinated by the City's stormwater manager.

e. Problem WQ5 — Illegal Dumping into the Storm Drainage System.

WQ5 Problem Description: Illegal dumping of material such as oil, antifreeze, vegetation and pet waste into the storm drain system has resulted in increased pollution of stormwater within the study area. Such dumping is often done due to ignorance of the harmful effects to water quality and the environment.

WQ5 Structural Solutions: This problem is best addressed by non-structural measures (e.g. public education).

WQ5 Nonstructural Solutions: An education program on the impacts of improper disposal of waste material on storm and surface water quality would provide guidance to the public regarding practices to improve water quality. Information could be provided in the form of public notices, outreach to targeted business by City staff, public events, flyers, and newspaper articles. Also, development of an area where individuals can safely, easily, and legally dispose of waste material such as motor oil, yard waste, and household chemicals would reduce the probability of these materials being dumped illegally. Information on Skagit County's household hazardous waste program was described under the solutions for Problem WQ3. Increased enforcement and the establishment of fines is also an effective deterrent for illicit dumping. A section of the new drainage ordinance in Appendix I defines illicit discharges to the storm drain system and establishes this as an illegal activity and describes penalties. Local citizens should be encouraged to report any illicit dumping actions. Increased patrolling of areas typically used for dumping will also help to reduce these actions.

Storm drains should have warning signs stenciled or posted near them with wording such as "dump no waste; drains to stream." Some storm drains in the city currently are stenciled in this manner, but many more are not. This simple measure can prevent much of the illegal dumping that occurs due to ignorance of the downstream effects. Other municipalities have had success stenciling warning signs near a large number of storm drains by means of educational or volunteer projects involving school students, Boy Scouts, church groups, etc. Mount Vernon should impose fines on individuals who illegally dispose of materials in drainage ditches, street drains, and other drainage system features. Citizens should be educated about the problems illegal dumping can cause and the associated penalties.

WQ5 Recommendations:

(1) Educational programs should be developed to inform the public of the impact to stormwater quality associated with illicit dumping of waste. This public education component and associated cost shall an element of the recommended overall public education program.

(2) The City should adopt the drainage ordinance and strictly enforce it to deter illegal dumping. Along with a public education element, this will reduce the potential for stormwater contamination associated with illegal waste disposal. Local citizens should be encouraged to report any illicit dumping to further help prevent these actions.

3. Rural Water Quality Problems

a. Problem WQ6 — Failure of Septic Systems. Since nearly all the existing septic systems in the study area are between the existing City corporate boundary and the urban growth boundary, the City should establish a policy of requiring sewer construction for new areas to be annexed to the City.

b. Problem WQ7 — Erosion of Pasture Land, and WQ8 — Loading Animal Wastes Directly to Surface Waters.

WQ7 and WQ8 Problem Description: Livestock farms are contributing to fecal coliform bacteria contamination and erosion and sedimentation within the study area. Another common problem associated with agricultural activities includes overgrazing by livestock which leads to land erosion within the study area.

WQ7 and WQ8 Structural Solutions: These problems are best addressed by nonstructural measures such as regulations and public education.

WQ7 and WQ8 Nonstructural Solutions:

Maintaining vegetation, and ground cover on grazed lands, croplands, and stream banks in the watershed will further protect the stream bank and preserve water quality. Vegetation helps to stabilize soil thereby decreasing soil erosion potential.

Maintaining vegetation on stream banks plays an important role in filtering pollutants from farm runoff. Maintenance of vegetated ground cover slows the velocity of runoff enabling more biofiltration to occur which reduces the potential for contamination by runoff that reaches the Creek. Vegetation filters out pollutants in runoff and reduces the amount of soil particles that become suspended in runoff thus diminishing the erosion process.

Several steps can be taken to limit erosion of farm lands used for livestock grazing, including limiting livestock density in grazing areas, rotating grazing pastures with the help of temporary fencing to maintain grass cover, and fencing off steep slopes to prevent livestock access to these erosion-prone areas.

The city should work with the Skagit Conservation District, the Washington State University/Skagit County Cooperative Extension, and the U.S. Department of Agriculture Cooperative Extension to develop an educational program and a set of BMPs for pastures within the study area. Commercial farms are likely to be getting information on pasture management BMPs from the above agencies. Therefore, educational efforts should target hobby farms. Examples of erosion control BMPs for pastures include the following:

- Preventing animal grazing access to steep slopes
- Reducing the density of animals on a given pasture size
- Rotating grazing areas with temporary fencing or other means to prevent overgrazing in any one area of the pasture
- Maintaining vegetated buffers between pastures and drainage paths
- Preventing animal access to stream banks and drainage ditches to prevent trampling of the banks.

Providing education to farmers regarding BMPs for farming practices may help to reduce fecal coliform bacteria contamination and bank erosion throughout the study area. BMPs should focus on those discussed below.

Restricting animal access to area creeks will reduce stream contamination and bank erosion. Installing sturdy fences along the banks of area creeks where livestock are kept will restrict direct access to the creek. In addition, fencing off drainage ditches and other significant tributary drainage paths that feed into the Creek is another effective measure for controlling source pollution. Fences can help in two ways; 1) animals are not able to defecate in the stream, thereby reducing the potential for fecal coliform bacteria contamination, and 2) trampling of the stream banks can be avoided thereby reducing the potential for bank erosion. Provision of a watering trough or pond away from the creek can also help to keep a particular farm's livestock out of the creek and off of its banks.

Other important BMPs limit contamination of farm runoff by manure and fertilizers. These include covering manure piles to protect them from precipitation, spreading manure in grazing pastures to avoid concentrated pollution source areas, applying fertilizers after a period of light rain (such that the soil is not saturated) and dry weather is expected, avoiding over-application of fertilizers and ensuring that fertilizers are worked into the soil when applied rather than simply dumped on the soil surface.

Erosion and runoff pollution can be further prevented by implementing source controls that limit contact between potential pollutants and stormwater. This will reduce the quantity of contaminated water that drains off of farms in the watershed. If possible, gutters and downspouts should be provided for all buildings and the runoff from these buildings should be routed away from animal confinement areas and/or manure piles.

The city should work with the Skagit Conservation District, the Washington State University/Skagit County Cooperative Extension, and the U.S. Department of Agriculture Cooperative Extension to develop an educational program and a set of BMPs aimed at limiting the amount of livestock waste that reaches receiving waters. Again, larger farms are probably getting this information already. Therefore, smaller commercial farms and hobby farms should be targeted for the educational outreach.

The simplest preventive measure is to fence off stream banks and drainage ditches so that livestock do not have direct access to them. Other BMPs that can reduce the problem of high fecal coliform concentrations in runoff include rotating grazing areas so that accumulations of manure do not develop, and maintaining vegetated buffers between grazing areas and drainage paths.

<u>WQ7 and WQ8 Recommendations</u>:

(1) The City should improve water quality by requiring the use of fences to keep farm animals out of area streams. The effort to install fences within the City should include a public education program for farm owners, development of an ordinance requiring the use of fences, and the possible development of assistance programs such as low interest loans for farmers to lessen the cost of fence installation. Methods of waste and pasture management should be established to reduce erosion and fecal coliform bacteria contamination from farms within the study area. Again, these efforts will be coordinated by the City's surface water manager.

2) The City should coordinate with area farmers to maintain riparian vegetation that will improve filtration of pollutants and reduce erosion thereby improving water quality. The City should prepare a public education program to inform farmers of the importance of riparian vegetation for water quality protection. As before, these efforts will be coordinated by the City's surface water manager.

4. Specific Water Quality Problems

a. Problem WQ9 — Sewage Overflows in Kulshan Creek Basin. A new sewer interceptor will be constructed in the spring and summer of 1996, which will eliminate future sanitary sewer overflows within the Kulshan Creek basin.

b. Problem WQ10 — Contaminated Sediments in Kulshan Creek. The problem of total petroleum hydrocarbon (TPH) contaminated sediments in Kulshan Creek may result from one or more specific sources that have yet to be identified, or from urban development in the basin in general. The city should collect additional sediment samples as part of the sampling program discussed under Problem WQ1 at various points in Kulshan Creek to determine if the TPH contamination problem can be traced to a localized area. More information should also be collected on the extent of soil contamination at the former fuel oil storage and distribution site on College Way near the railroad crossing. Leaching of contaminants from the soils on this site may be a major cause of the sediment contamination problem in Kulshan Creek. If the primary problem appears to be urban development in general, then educational efforts should be stepped up to convince businesses and residences within the drainage basin to implement many of the BMPs described in this report. In addition, if general urban runoff is found to be the problem, coalescing plate oil/water separators should be considered for installation in the larger parking lots of the basin as discussed under the solutions to Problem WQ3.

5. Future Water Quality Problems

a. Problem WQ11 — Future Water Quality Problems.

The first step the City should take to implement stormwater pollution control measures is to enforce the new drainage ordinance that meets the minimum requirements set forth in Ecology's *Stormwater Management Manual for the Puget Sound Basin*. The City should also educate residents and businesses in the study area about simple source control BMPs that can be used to reduce or prevent stormwater contamination. The City should encourage local schools to incorporate stormwater pollution prevention issues into environmental education programs.

Streams in the study area should also be monitored periodically, as discussed under Problem WQ1, to determine whether water quality improvements are being made. Where persistent problems are found, educational and enforcement efforts can be targeted at the sources.

D. Environmental Resource Solutions

1. Wetlands

a. Problems WT1, WT2, WT3, WT4, and WT5 — At-risk Wetlands.

To preserve "at risk" wetland areas described in Section VI that are threatened by encroachment of development, the following solutions have been developed. Since preservation of wetland areas is primarily a regulatory issue, these solutions are nonstructural by nature.

Public Information. As part of the City's overall public information/education program, land owners, and others may be assisted in understanding which types of land may be wetlands, and in recognizing the important functions and values which the wetlands provide to society and the environment.

A public information/education program should be combined with other public education program elements for water quality. For example, information regarding wetlands recognition, value, and regulation may be disseminated via mailing brochures, at demonstrations and question-and-answer sessions at public meetings, on posters displayed at public buildings, and through educational programs incorporated into primary, secondary, and post-secondary curricula.

Numerous pamphlets and brochures, many written for the non-scientific public, which describe wetlands and discuss their unique value, are available from public agencies such as the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the Washington Department of Ecology. Some organizations have prepared videos which present such information. Of course, the wetlands inventory maps compiled in support of the City of Mount Vernon Surface Water Management Plan should be included in the list of available information. Wetlands experts, such as those from public agencies, private consulting firms, and conservation organizations, are often available to speak at public information meetings. Further, several organizations have or are developing wetlands educational materials which may be incorporated into formal education at nearly any level.

Critical Areas Ordinance Revision. Other solutions may be accomplished by revising the CAO. For example, a revised CAO might contain a wetlands rating system based on wetland functional value. There are several wetlands ratings paradigms, but the most common models used in Washington are either a three- or four-tiered rating system. The three-tiered system was perhaps pioneered by King County and was adopted by many of the local governments which drafted wetlands management ordinances prior to being forced to do so by the state Growth Management Act (GMA). The primary criteria for establishing a wetlands' rating under this system are wetland size, the number of wetland habitats available within the wetland, and the presence or absence of sensitive or rare plant or animal species. Assigning a rating to a wetland under this system is a relatively easy task since few criteria must be quantified. Since the GMA, many jurisdictions have adopted wetlands ordinances which are based on the Model Wetlands Protection Ordinance prepared by the Washington Department of Ecology. These ordinances rely on a four-tiered system. Instead of relying on a few easily quantified criteria, this model uses a four-page rating form which requires that numerous questions be answered. Points are awarded for a wetlands' having certain physical attributes. In many cases, wetlands ratings are then determined by the number of points assigned to a wetland as a result of completing the data form.

Under both systems, wetlands protection varies as a function of wetland rating. For example, higher value wetlands are often protected by larger buffers. Further, the compensatory mitigation requirements for higher value wetlands are typically greater than for lower value wetlands. This in turn provides some disincentive for developers to impact high-value wetlands. For example, if a developer has a choice of impacting a low-and high-value wetland, and he knows that mitigation for impacts to the higher value wetland will cost more money, will require additional permit review time, or will necessitate setting aside a larger amount of land for compensatory purposes, then in most instances the developer will choose to avoid impacts to these wetlands.

b. <u>Problems WT6, WT7, WT8, and WT9 — Wetlands Protection and Economic Growth</u>.

All of the above solutions address case-by-case wetlands protection problems. This subsection presents two programmatic solutions which address a coordinated approach towards achieving both wetlands protection and economic growth goals. The first of these programs is known as "wetlands mitigation banking," and the second is known as a "Special Areas Management Plan," or "SAMP."

<u>Wetlands Mitigation Banking</u>. Wetlands mitigation banks involve the off-site creation, restoration, and/or enhancement of wetlands to compensate for unavoidable adverse impacts associated with development activities. The concept of mitigation banking was developed in the early 1980's as a mechanism to compensate for unavoidable habitat losses primarily associated with the federal Section 10 (Rivers and Harbors Act) and Section 404 (Clean Water Act) permit programs for wetland development projects (Short, 1988). The Washington Department of Ecology recently published a guidance document, Wetlands Mitigation Banking (Castelle et al., 1992b) which discusses many mitigation banking issues from agency, developer, and environmental viewpoints. A copy of this document is included in the task report in Appendix A.

Mitigation banking differs from most compensatory mitigation projects in that mitigation banking is a program created by agencies or other organizations to provide a relatively large compensatory mitigation site (or sites) to be used to collectively compensate for many, usually unrelated, development projects. This contrasts with more traditional compensatory mitigation measures which typically involve individual projects implemented by developers (Castelle et al., 1992b). In addition, most wetlands mitigation banking programs are established so that the compensation is accomplished prior to the wetlands impacts. This is one means of assuring that the compensatory measures will be successful and that there will be no net loss of wetlands.

An advantage of mitigation banking is that this type of program may reduce the cost of mitigation, thus allowing large, otherwise cost-prohibitive, mitigation projects to be completed (Borsch, 1987). Another advantage may be that large mitigation projects like those typical of mitigation banks are more useful than several small project in various locations. Arguably, larger mitigation projects provide more habitat, are easier to create, and prevent cumulative impacts (for example, habitat fragmentation) associated with many small, scattered mitigation projects (Castelle et al., 1992b).

However, mitigation banking programs also have several potential disadvantages. For example, there are relatively large up-front costs for establishing a mitigation bank. While these costs are sometimes borne by private groups, on other occasions public agencies must provide the "up-front" money. Further, these costs may never be recovered if the bank does not become fully utilized or utilized in a timely fashion. There are also ecological concerns about mitigation banking. For example, the same problems which have contributed to low success rates for individual compensation projects in many locations will also exist for mitigation bank sites. Lastly, widespread use of mitigation banks may be perceived, especially by conservation groups, to be a "wetlands give-away," wherein the normal mitigation process of first attempting to avoid and minimize wetlands impacts will be by-passed.

In Mount Vernon, mitigation bank sites might be established in one or several of the many large meadows which cover a significant portion of the city within the Urban Growth Boundary. In particular, meadows which fail to meet the mandatory criteria for wetlands identification only because they lack wetland plants may be useful. In these fields, wetland hydrology and wetland soil conditions are often present or can be established at low cost and with a high probability of success. Unfortunately, many of the areas which are best suited for banking sites are also well suited for development. However, with proper coordination, the city could achieve no net loss of wetlands while providing both large, high-value wetlands and sustained economic growth potential.

Lastly, consideration of a mitigation banking program for the city should include regulatory implications. For example, although the city may choose to promote, and perhaps to fund, the use of mitigation banking, all other pertinent wetlands permits must be obtained by each project proponent on a case-by-case basis. Despite the availability of using mitigation banks, any of the other agencies which may have permitting authority of wetlands impacts may decide against the use of the mitigation banking program. Unfortunately, project proponents may not be able to determine if their projects may be included in the banking program until after substantial resources are expended.

A recent strategy developed to help avoid the permitting uncertainties of a typical mitigation banking program is a SAMP; the following section summarizes this potential programmatic solution.

Special Areas Management Plans. Special Areas Management Plans, or SAMPs, like mitigation banking, represent a more global approach to managing wetlands resources and balancing natural resources protection with economic growth than a case-by-case approach. Unlike wetlands mitigation banking, however, SAMPs are designed to provide wetlands permitting on a "one-stop shopping" basis.

This is accomplished by generating an agreement, signed by all affected regulatory and resource agencies, as well as affected tribes and, in some instances, conservation groups. As a result of a SAMP, a local public agency, in this instance the Mount Vernon city government, would receive a "regional" permit. This permit transfers all permitting responsibilities from agencies such as the U.S. Army Corps of Engineers and the Washington Department of Ecology to the local agency. From that point forward, project proponents need only to secure a permit from the city, instead of having to approach each agency in turn.

The potential ecological advantages and disadvantages of SAMPs are essentially identical to those for mitigation banking. While larger, better planned wetlands may be created or restored, many conservation groups are concerned that the full mitigation process may be short-circuited.

Another advantage of a SAMP is the significant time savings for project proponents. Further, most SAMPs identify both the wetlands which may be impacted as part of the program and appropriate mitigation sites. The SAMP might also identify certain wetlands which are not included in the plan; those wetlands, typically the most highly valued wetlands, would still be subject to the standard permitting process. Therefore, a significant amount of both ecologically and economically sound planning is completed prior to the first wetland impact. Some SAMPs have incorporated a mitigation banking strategy.

Another disadvantage of SAMPs, however, is the relatively long time required for all agencies and other affected parties to reach an agreement. For example, a SAMP is being developed in the Auburn-Kent area of King County. Like Mount Vernon, these cities have large areas marked by low- to moderate-value wetlands, primarily wet meadows. The SAMP development process in that area has already taken in excess of four years, and only now the process seems as if an agreement may be reached. Until the Auburn-Kent SAMP is completed, it may be difficult to estimate the resources necessary to complete a SAMP in Mount Vernon.

c. Wetlands Recommendations.

Public information programs concerning the value of wetlands should be incorporated into the overall public education program and any costs will be incurred by that program.

The City could review its Critical Areas Ordinance in the future and evaluate its effectiveness, and consider the need to develop a rating system accompanied by associated buffer sizes.

Whether the City should sponsor a programmatic solution such as mitigation banking or a SAMP for managing wetlands, is a policy decision that should be made by City staff and elected officials.

2. Fish Habitat

A number of fish habitat problems were identified in Section VI that involve either fish passage problems or fish habitat problems. These problem solutions require physical changes to the existing environment and, therefore, are best handled through the use of structural solutions. Implementing nonstructural solutions such as new development standards will help preserve fish habitat in areas to be developed in the future. Nonstructural solutions to regulate new development were described in the water quality solutions section.

a. Problem E1 A pump station on Kulshan Creek above the outlet to the Skagit River presents a nearly total barrier to fish passage. Passage is only obtainable when flow from Kulshan Creek is sufficient to open a flap gate, and the Skagit River is high enough to create a take-off pool below the gate, but not high enough to force the gate shut. The problem with the flap gate can be solved by construction of the new pump station described under the solution to regional system problem RS4 which would eliminate the flap gate and replace it with a mechanically operated gate that will only close during high river levels. Allowing for fish access to the system will be solved by installing a vertical fishway. The cost of the fishway is included under RS4.

Cost= $0, included under solution for RS4

b. Problem E2 An existing manhole in the section of Kulshan Creek located east of the railroad collects debris and creates a partial fish passage barrier. There are two solutions to this problem. The first alternative is to increase the frequency of maintenance at the manhole. The second alternative is to remove the manhole. Removal of the manhole is recommended since there is no purpose for the structure in the middle of Kulshan Creek.

Cost = $2,000

c. Problem E3 A culvert in an unnamed tributary to Kulshan Creek north of Cedar Lane creates a partial fish passage barrier due to a one-foot drop at the outlet. One alternative solution to this problem is to replace the existing 24-inch-diameter culvert with a 36-inch diameter culvert.

Cost = $17,000

Another alternative solution is to install a series of two log weir structures at the outlet of the culvert that would create take-off pools downstream that would facilitate fish passage into the culvert.

Cost = $11,000

Installation of the log weir structure is the recommended solution because it is less expensive.

d. Problem E4 Approximately 2,200 feet of Kulshan Creek upstream of Riverside Drive to about North 18th Street lacks riparian vegetation as well as pools and riffles that would provide good stream habitat. Instream logs, root wads or other strategically placed devices should be added to this section of Kulshan Creek to create pools and riffles within the channel. Also, native riparian vegetation should be planted such as willow, red osier dogwood, and salmonberry. Utilizing volunteers and/or local schools will reduce costs. Constructing these habitat restoration projects can be phased, with only certain sections of the creek being restored in any given year.

Total Cost = $104,000 or $10,400 every other year over a 20-year period

e. Problem E5 There is a lack of riparian vegetation as well as pools and riffles to provide good stream habitat along Trumpeter Creek from its confluence with the Nookachamps Creek to 2,700 feet upstream, and in portions of the mainstem from College Way to Fir Street. All of this amounts to approximately 7,000 feet of stream channel. The solution to this problem would be the same as in Problem E4. Instream logs, root wads or other strategically placed devices should be added to these sections of stream to create pools and riffles within the channel. Also, native riparian vegetation should be planted such as willow, red osier dogwood, and salmonberry. Utilizing volunteers and/or local schools will reduce costs. Constructing these habitat restoration projects can be phased, with only certain sections of the creek being restored in any given year.

Total Cost = $327,000 or $32,700 every other year for 20 years

f. Problem E6 The culvert along the South Fork of Trumpeter Creek at Seneca Drive plugs up with debris which causes fish passage problems. Downstream there is a large drop between the culvert outlet and the stream channel. To correct the debris problem, the frequency of normal maintenance of this culvert should be increased. Maintenance costs are included in the cost of the stormwater maintenance program discussed in Section VIII. To correct the fish passage problem the log weirs proposed under the solution to local system problem LS10 provide the solution.

g. Problem E7 The culvert along the Southeast Fork of Trumpeter Creek at Kiowa Drive presents a partial barrier to fish migration due to the one-foot drop at the culvert outlet. This problem would also be solved by implementing the recommended solution to Problem LS10.

h. Problem E8 The culvert along the Southeast Fork of Trumpeter Creek at Lupine Street is blocked and presents a barrier to fish passage. This problem could be resolved by increasing the frequency of maintenance at the culvert.

i. Problem E9 A culvert at Fir Street on the east side of Bakerview Park presents a partial fish passage barrier on the Southwest Fork of Trumpeter Creek due to a one-foot drop at the culvert outlet. No action is recommended for this problem. Providing fish passage at this location would be unproductive because the creek immediately upstream of this pipe is completely enclosed in a pipe system and would not be suitable fish habitat.

j. Problem E10 The 210-foot-long culvert on Madox Creek 1,200 feet above Anderson Road is too long to allow fish passage. This culvert should be removed and the stream channel restored.

Cost = $40,000

k. Problem E11 The culvert on Madox Creek at Blackburn Road is a nearly total fish passage barrier due to a two-foot drop at the culvert outlet. Two alternative solutions could solve this problem. The first solution is to replace the culvert.

Cost = $33,000

The second solution is to install a series of log weir structures to create a series of pools downstream of the culvert that would raise the water surface level at the culvert outlet minimizing the distance fish would have to jump to enter the culvert.

Cost = $11,000

Installation of the log weir structures is the recommended solution because it would be less expensive.

l. Problem E12 The outfall pipe at the lower detention pond on Madox Creek south of Section Street and east of Little Mountain Estates is plugged and creates a total fish passage barrier. Two alternative solutions could solve this problem. The first solution is to replace the plugged culvert.

Cost = $19,000

The second solution is to clean out and maintain the existing culvert. This maintenance is included in the normal maintenance program. The second alternative solution is recommended.

m. Problem E13 The section of Flowers Creek between its confluence with Maddox Creek and Blodgett Road lacks riparian vegetation. Plant streamside vegetation of native species such as willow, red osier dogwood, and salmonberry. Cost is based on planting 1,500 feet of stream.

Cost = $38,000

n. Problem E14 The culvert along Flowers Creek at Blodgett Road presents a partial fish barrier at low flows due to a one-foot drop in elevation between the culvert outlet and the streambed. Again, two alternative solutions could solve this problem. The first solution would be to replace the culvert.

Cost = $19,000

The second solution is to install a series of log weir structures to create a series of pools downstream of the culvert that would raise the water surface level at the culvert outlet minimizing the distance fish would have to jump to enter the culvert.

Cost = $11,000

Installation of the log weir structures is the recommended solution because it would be less expensive.

o. Problem E15 The lower portion of Carpenter Creek along Bacon Road lacks pools and riffles that provide instream habitat as well as riparian vegetation on one bank. Instream logs, root wads or other strategically placed devices should be added to this section of stream to create pools and riffles within the channel. Also, native riparian vegetation should be planted such as willow, red osier dogwood, and salmonberry. Utilizing volunteers and/or local schools will reduce costs.

Cost = $21,000

TABLE VII-1

STRUCTURAL STORMWATER CONTROL SOLUTIONS

Typical Structural Solutions	Reduce Flooding	Reduce Channel Erosion	Improve Water Quality
Detention Facilities			
Ponds with Vegetation	✓	✓	✓
Closed Systems	✓	✓	
Detention/Sedimentation	✓	✓	✓
Infiltration	✓	✓	✓
Pipe Systems/Structures	✓		
Grass Swales		✓	✓
Stormwater Diversions	✓	✓	
Oil/Water Separators			✓
Check Dams		✓	✓
Channel Stabilization		✓	

TABLE VII-2

NONSTRUCTURAL STORMWATER SOLUTIONS

Typical Structural Solutions	Reduce Flooding	Reduce Channel Erosion	Improve Water Quality
Public Education	✓		✓
Improved Drainage Facility Maintenance	✓	✓	✓
Maintain Stream Vegetation and Natural Wetlands	✓	✓	
Regulation Enforcement		✓	✓
Ordinances (Clearing, Grading, Site Drainage Plan Requirements, and Maintenance)	✓	✓	✓
Revegetation		✓	✓
Coordination with Adjacent Jurisdictions	✓	✓	✓

TABLE VII-3

RESULTS OF HYDRAULIC ANALYSIS FOR VARIOUS PIPE SYSTEMS CITY OF MOUNT VERNON

Pipe System along Stanford between Division and Fir Streets LS15				
Pipe No.	**Capacity (cfs)**	**10-Year Flow (cfs)**	**Existing Diameter**	**Required Diameter**
1	2.13	32.15	18 CMP	36 CP
2	2.79	32.15	18 CMP	36 CP
3	6.92	32.15	18 CMP	36 CP
4	9.99	32.15	18 CMP	24 HDPE
5	5.57	32.15	15 CMP	24 HDPE
6	5.00	32.15	15 CMP	24 HDPE
7	5.93	32.15	15 CMP	24 HDPE
8	5.76	32.15	15 CMP	24 HDPE
9	5.80	32.15	15 CMP	24 HDPE
10	5.58	32.15	15 CMP	24 HDPE
11	22.66	42.90	24 CMP	24 HDPE[1]
12	19.37	42.90	24 CMP	24 HDPE[1]
13	12.38	42.90	24 CMP	30 HDPE
14	32.41	42.90	24 CMP/CP	24 HDPE[1]
15	45.72	42.90	24 CP	OK
16	20.35	42.90	21 CP	30 CP
17	16.72	42.90	18 CP	30 CP
Culvert and Ditch System between Britt Slough and Blackburn Road near Walter Street LS25				
Pipe No.	**Capacity (cfs)**	**10-Year Flow (cfs)**	**Existing Diameter**	**Required Diameter**
1	16.16	22.40	36 CMP	36 CP
2	5.71	22.40	21 CP	36 CP
3	129.75	22.40	Ditch	OK
4	19.79	22.40	36 CMP	30 CP
5	20.44	22.40	36 CMP	30 CP
Pipe System along Fox Hill Street LS26				
Pipe No.	**Capacity (cfs)**	**10-Year Flow (cfs)**	**Existing Diameter**	**Required Diameter**
1	59.2	41.50	42 CMP	OK
2	111.13	41.50	48 CMP	OK
3	16.63	41.50	30 CMP	36 CP
4	15.39	41.50	30 CMP	36 CP
5	16.63	41.50	30 CMP	36 CP
6	21.08	41.50	30 CMP	36 CP
7	6.07	41.50	30 CMP	36 CP
Pipe System under I-5 South of Blackburn LS27				
Pipe No.	**Capacity (cfs)**	**10-Year Flow (cfs)**	**Existing Diameter**	**Required Diameter**
1	11.11	11.00	30 CMP	OK
2	0.00[2]	13.18	30 CMP	24 HDPE[1]
3	7.37	13.18	30 CMP	30 CP[1]

NOTES: CP — Concrete Pipe
CMP — Corrugated Metal Pipe
HDPE — Smooth-lined Corrugated HDPE Pipe

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[1] Smoother pipe material will accommodate additional flow.

[2] Existing pipe set at reverse grade.

PUBLIC EDUCATION PROGRAMS

General

Clean Water Community (Steilacoom)
Purpose: Educate community in water quality issues
Methods:
1) Development of a "Puget Sound Promoter" theme with various activities to encourage participation
2) Water quality presentations in schools
3) Student monitoring of local waters
4) County declaration of Puget Sound Promoter Week
5) Distribution and collection of pledge cards endorsing water quality

Clean Water Action Committee (North Mason Community)
Purpose: Build community support for the addition of the water quality element to the Mason County Comprehensive Plan
Methods:
1) Brochures to increase awareness
2) Developing water quality element of comprehensive plan based upon community recommendations
3) Increase general awareness about water quality using information gathering technique called "sondeo"

Water in Whatcom County
Purpose: Broaden community involvement in watershed issues
Methods:
1) Developing educational materials
2) Establishing network for disseminating information
3) Promoting watershed related events

Opportunities for Public Involvement
Purpose: Increase public awareness of importance of watershed in involving citizens in developing watershed plans
Methods:
1) Public awareness meetings
2) Training for citizen advisory committees
3) Involvement of boy scouts in cleaning up stormwater detention ponds
4) Establishment of an Adopt-a-Wetlands program

Puget Sound Project
Purpose: Give educators a program focusing on the science an social issues that will determine the future of Puget Sound and to use that program as a basis for public outreach
Methods:
1) Developing curricula on Puget Sound for elementary, middle, junior, and senior high students

Public Service Announcements for Radio
Purpose: Increase public awareness of water quality issues and positive steps listeners may follow to improve water quality
Methods:
1) Development of 18 - 30 second public service announcements

Rainy Days Festival: The Problem of Stormwater Runoff (Federal Way)
Purpose: Inform residents of the damaging effect of stormwater runoff on Puget Sound and about remedies to correct the problem
Method:
1) Junior high school science students developing a video tape and fact sheet

School Stormwater Education Project (Roosevelt)
Purpose: Increase household and small business awareness about how their activities affect stormwater runoff and what they can do to reduce pollution
Method:
1) A year long curriculum for students including classroom, field, and community activities

Household Hazardous Waste

Household Hazardous Waste Collection
Purpose: To give households a safe way to dispose of hazardous waste
Method:
1) Collection events (e.g., 3 per year)
2) Public notice (advertising) events, flyers, newspaper, etc.

C.A.R. (change and Recycle) Oil Committee
Purpose: Encourage proper disposal of oil for the do-it-yourself oil changer
Methods:
1) Establishment of Committee consisting of representatives of auto supply stores and related businesses
2) Video to help train staff at these stores to encourage oil recycling when they sell oil
3) Brochure explaining consequences of improper disposal and identifying locations for proper disposal

Hazard Free Community
Purpose: Decrease household use of hazardous materials and increase knowledge of alternative materials
Methods:
1) Get households and businesses to sign Hazard Free Community Pledges
2) Recruit and train 50 community volunteers to be actively involved in the project
3) Distribute information to all students in area

Oil Recycling Project
Purpose: Increase proper disposal of oil by do-it-yourself auto oil changers
Methods:
1) Bring together high school students enrolled in science, vocational marketing, and graphics to market a product (the Gott Drain Tainer) which makes it easy for car owners to properly dispose of oil

Wetlands

Wetlands Awareness (for Mercer Slough)
Purpose: Involve community in protecting wetlands (Mercer Slough)
Methods:
1) Development of interpretive trail and canoe tour
2) Wetland clean-up day
3) Stream and wildlife enhancement projects
4) Training of park naturalist in water quality issues
5) Environmental studies by Bellevue Community College students

Wetlands Public Education Program (San Juan Islands)
Purpose: To demonstrate the value of wetlands
Methods:
1) Coordination with planning department
2) Contacting wetland owners to inform them of protective measures
3) Booth at fair emphasizing value of wetlands

Water Resources Poster
Purpose: Increase a community's awareness of its largest wetland and other resources
Method:
1) Inventory of Wetland and Creeks
2) Design of poster (map, text, and photos)
3) Evaluation survey
4) Distribution of survey and poster

Small Businesses

Waste Information Network
Purpose: To reduce amount of hazardous waste produced and/or improperly disposed of by small businesses
Method: 1) Gain support/assistance from trade associations
2) Staging a waste information network trade fair
3) Informational brochures on waste disposal

Waste Management for Auto Shops
Purpose: To show people in auto shops what to do with hazardous waste
Method: 1) Workshops/trade fair on waste disposal
2) Hazardous waste turn-in day at local treatment facility
3) Poster campaign aimed a auto shop employees

Team Consultations for Small Businesses
Purpose: Increase pollution prevention from small businesses
Methods: 1) Formation and training of industry/agency consultation teams to address pollution control faced by small businesses
2) Team Consultations conducted for small business requesting consultation
3) Development of a resource guide containing compliance expectations, pollution prevention suggestions, and listing resource contacts.

Hazardous Waste Management Assistance
Purpose: Inform area dry cleaners of proper pollution control
Methods: 1) One on one consultations with dry cleaner operators informing them of costs associated with improper disposal and of the benefits of proper disposal

Painting Contractor Education
Purpose: Inform paint contractors of proper disposal and waste reduction
Methods: 1) Brochure, posture, and live telephone information shall be used to communicate information
2) Information shall be disseminated through local paint suppliers

Water Quality Monitoring

Water Quality Monitoring Project
Purpose: Train students to perform scientific investigation of water quality in Green River that will be used by regulatory bodies
Methods: 1) Selecting teachers to devote class time to technical training
2) Using college science students to teach testing techniques

Volunteer Monitoring Program (Stilliguamish River)
Purpose: Involve diverse groups of citizens in collecting baseline data on water quality
Methods: 1) Designating 13 sites for sampling over 7 month period
2) Recruiting, training, and coordinating students, trout fisherman, tribal members, and environmentalist in water quality monitoring techniques and related issues

Construction/Erosion Practices

Water Quality and Construction Practices
Purpose: Encourage contractors to understand construction related impacts to water quality
Method: 1) Bring together contractors and discuss problems/solutions (seminars)
2) Distributing information to contractors
3) Compile regulations which apply to contractors

Streams

Stream Enhancement Newsletter
Purpose: To communicate the details of successful stream enhancement projects
Methods: 1) Publication of a quarterly newsletter

Stream Team Program (City of Bellevue)
Purpose: Involve people in caring for their neighborhood stream and to provide data on those streams to regulatory agencies
Methods: 1) Creating stream teams for specific areas
2) Workshops training volunteers to observe, gather data, and enhance streams
3) Public information campaign, city mailings, local media, and presentations to community groups

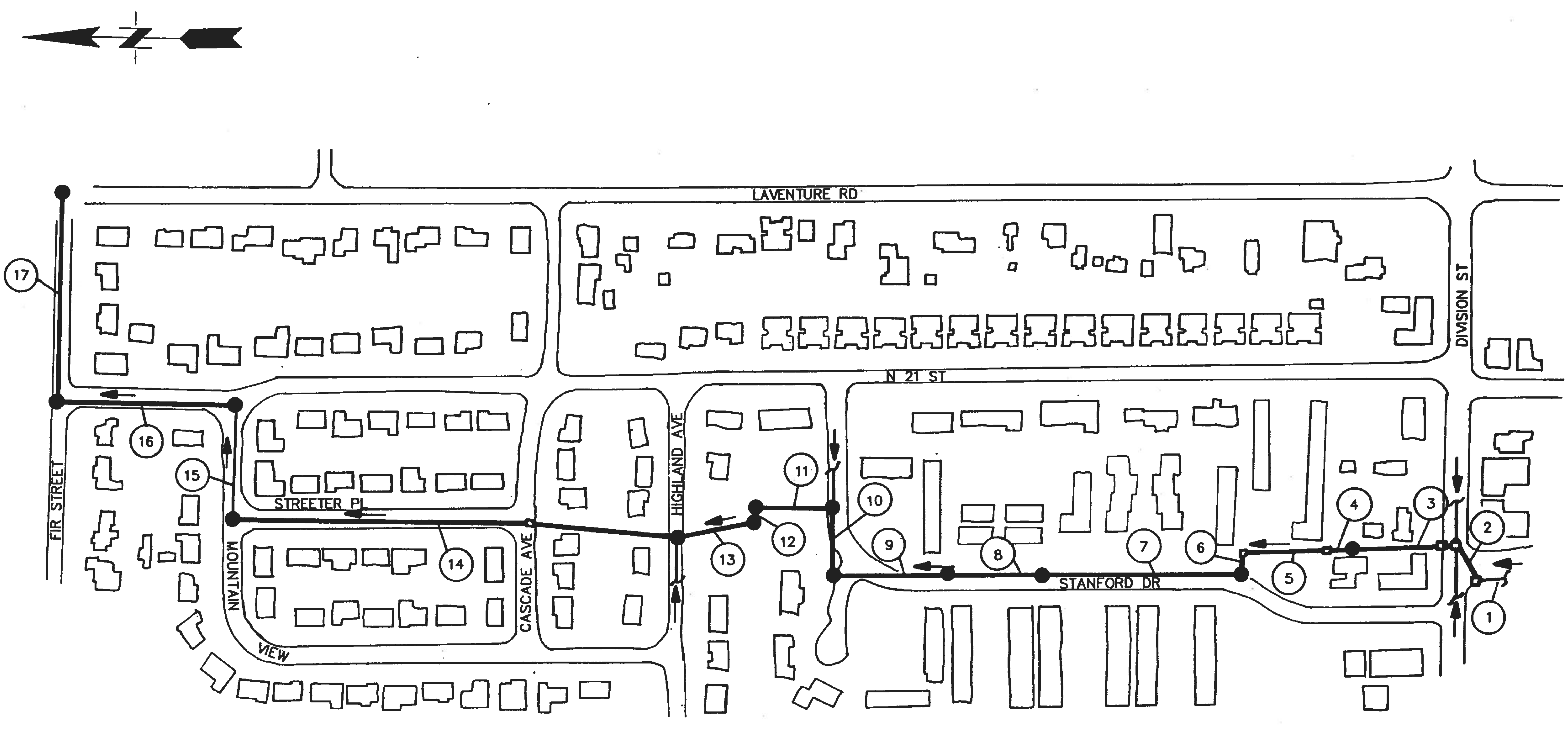
Blackjack Creek Brochure
Purpose: Increase awareness of the value of Blackjack Creek which was one of the few remaining salmon spawning stream in the City of Port Orchard
Methods: 1) Development/distribution of information brochure
2) Boy scouts stencilling storm drains to discourage dumping of oil

Miscellaneous

Horse Waste and Land Management Education
Purpose: Teach horse owners methods of waste and pasture management
Method: 1) Producing/distributing information about environmentally responsible methods for keeping horses

SOUND Gardening, SOUND Farming
Purpose: Educate gardeners and small farmers about the effects of their activities on water quality
Methods: 1) Developing instructional materials to be used in the ongoing Master Gardener and Seattle Food Gardener programs
2) Training and sending volunteers to educate proper gardening practices
3) Conference on better farming practices
4) Newsletter on water quality tips for farmers

J.M. K:\MAA07\MAA07001 9-27-93 @ 08:52



KEY

- PIPE TO BE REPLACED
- EXISTING PIPE TO REMAIN
- DITCH / STREAM
- MANHOLES
- CATCH BASINS
- (3) PIPE REPLACEMENT REFERENCE NUMBER, SEE TABLE VII-1

FIGURE VII-1

CITY OF MOUNT VERNON

SURFACE WATER MANAGEMENT PLAN

PROBLEM LS15 SOLUTION

R·W·BECK

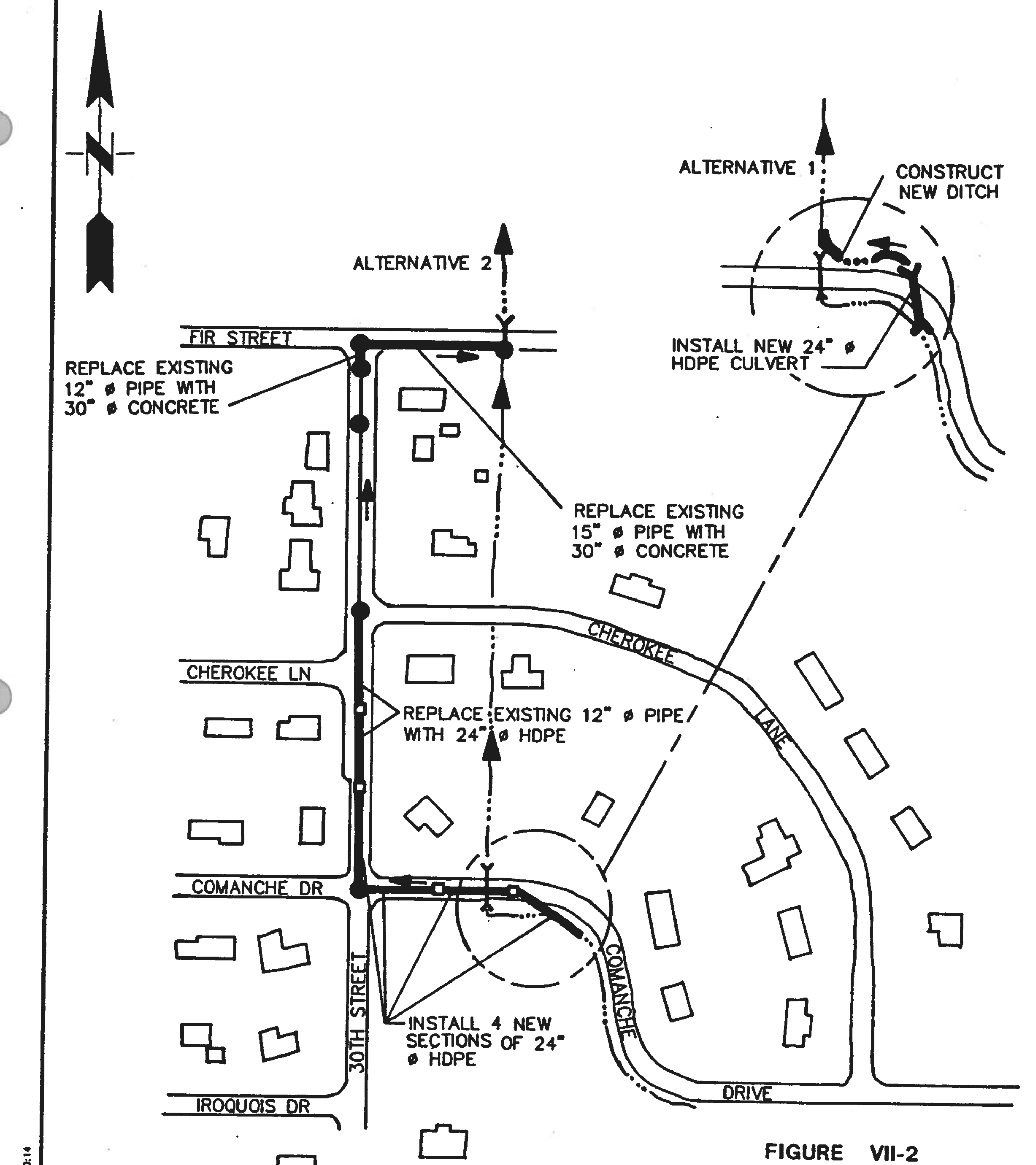


FIGURE VII-2

CITY OF MOUNT VERNON

SURFACE WATER MANAGEMENT PLAN

PROBLEM LS17 SOLUTION

R·W·BECK

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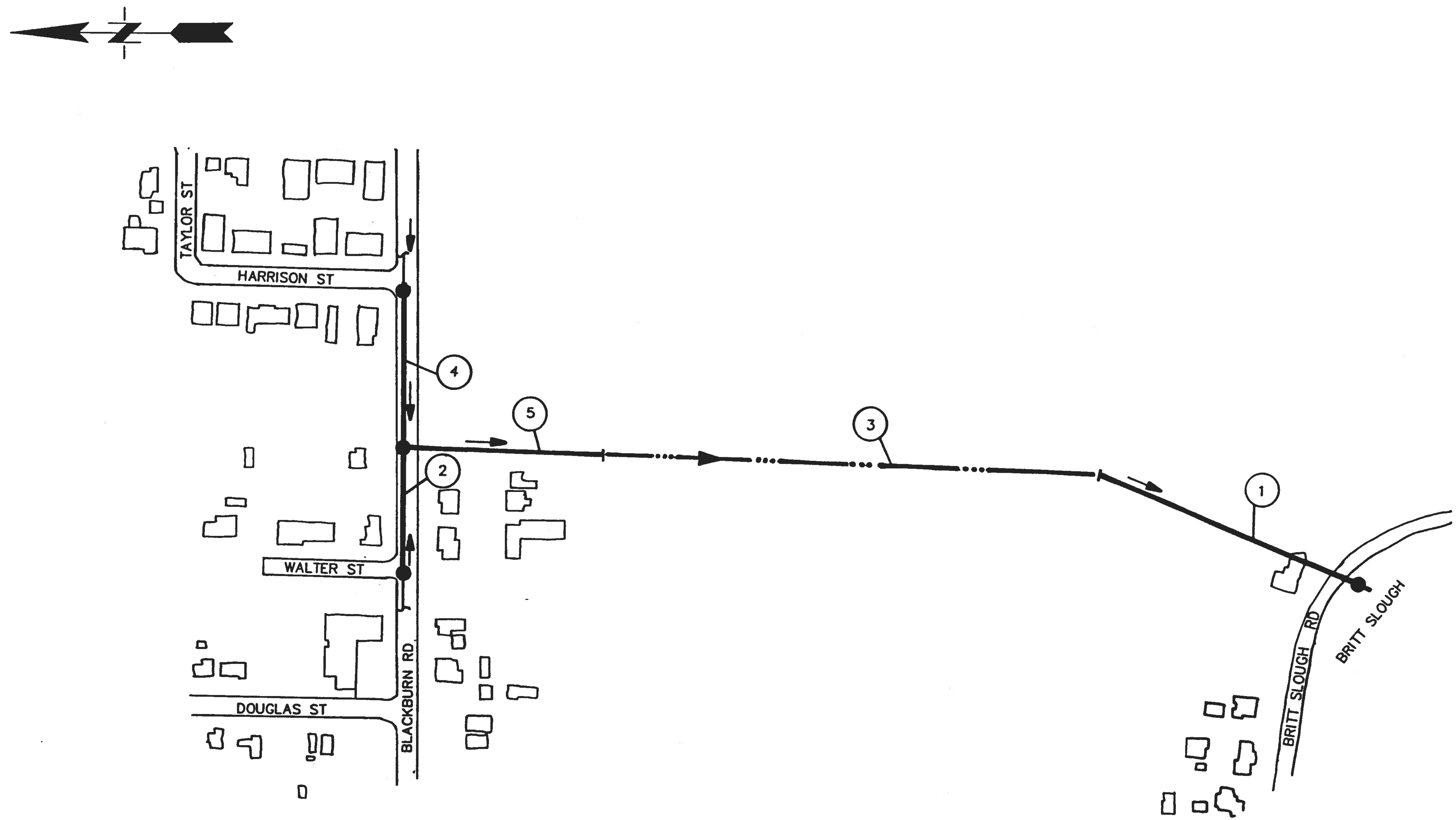


KEY

- PIPE TO BE REPLACED
- EXISTING PIPE TO REMAIN
- DITCH / STREAM
- MANHOLES
- CATCH BASINS
- (3) PIPE REPLACEMENT REFERENCE NUMBER, SEE TABLE VII-1

FIGURE VII-3
CITY OF
MOUNT VERNON
SURFACE WATER
MANAGEMENT PLAN
PROBLEM LS25
SOLUTION

R·W·BECK

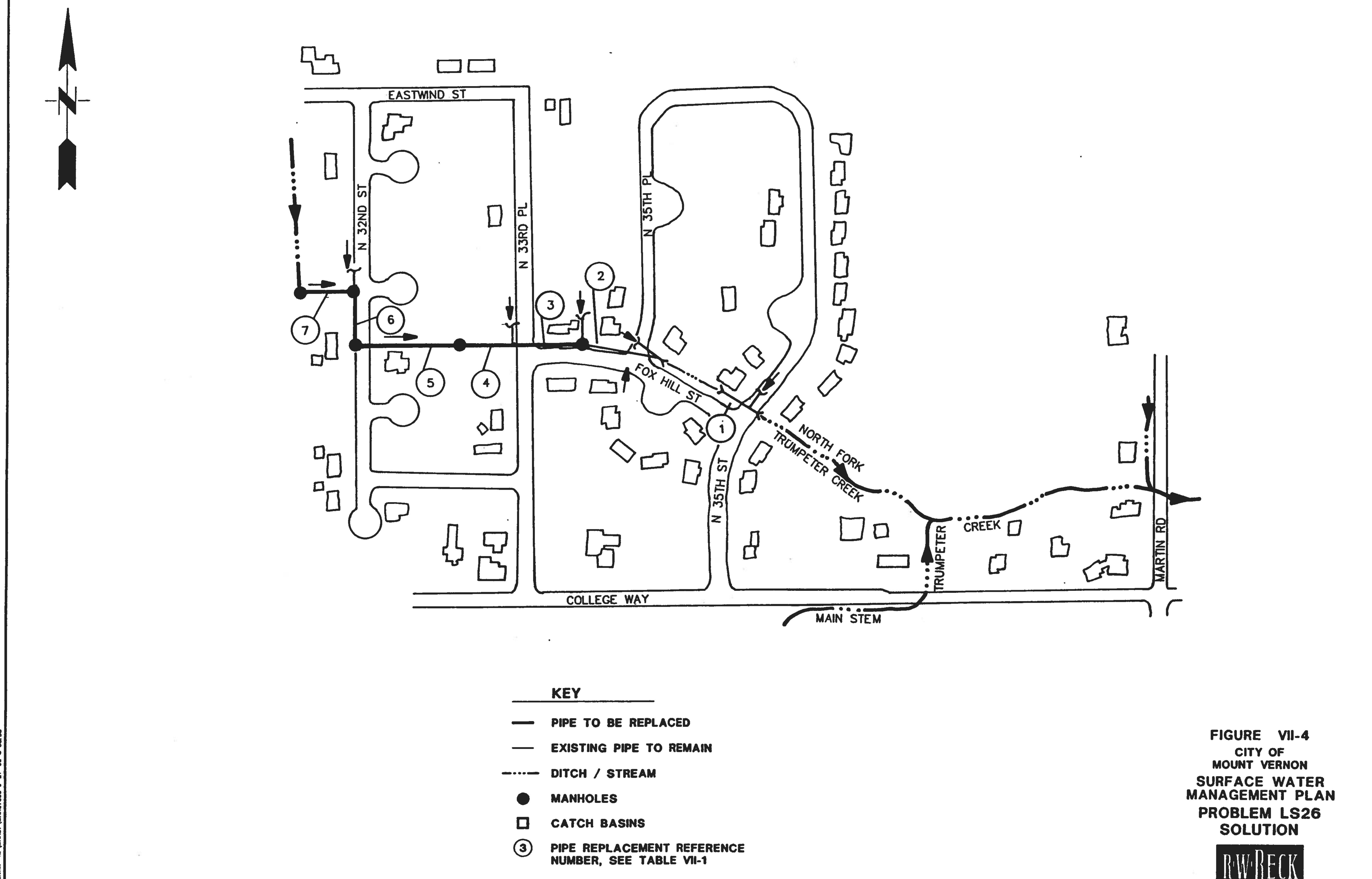
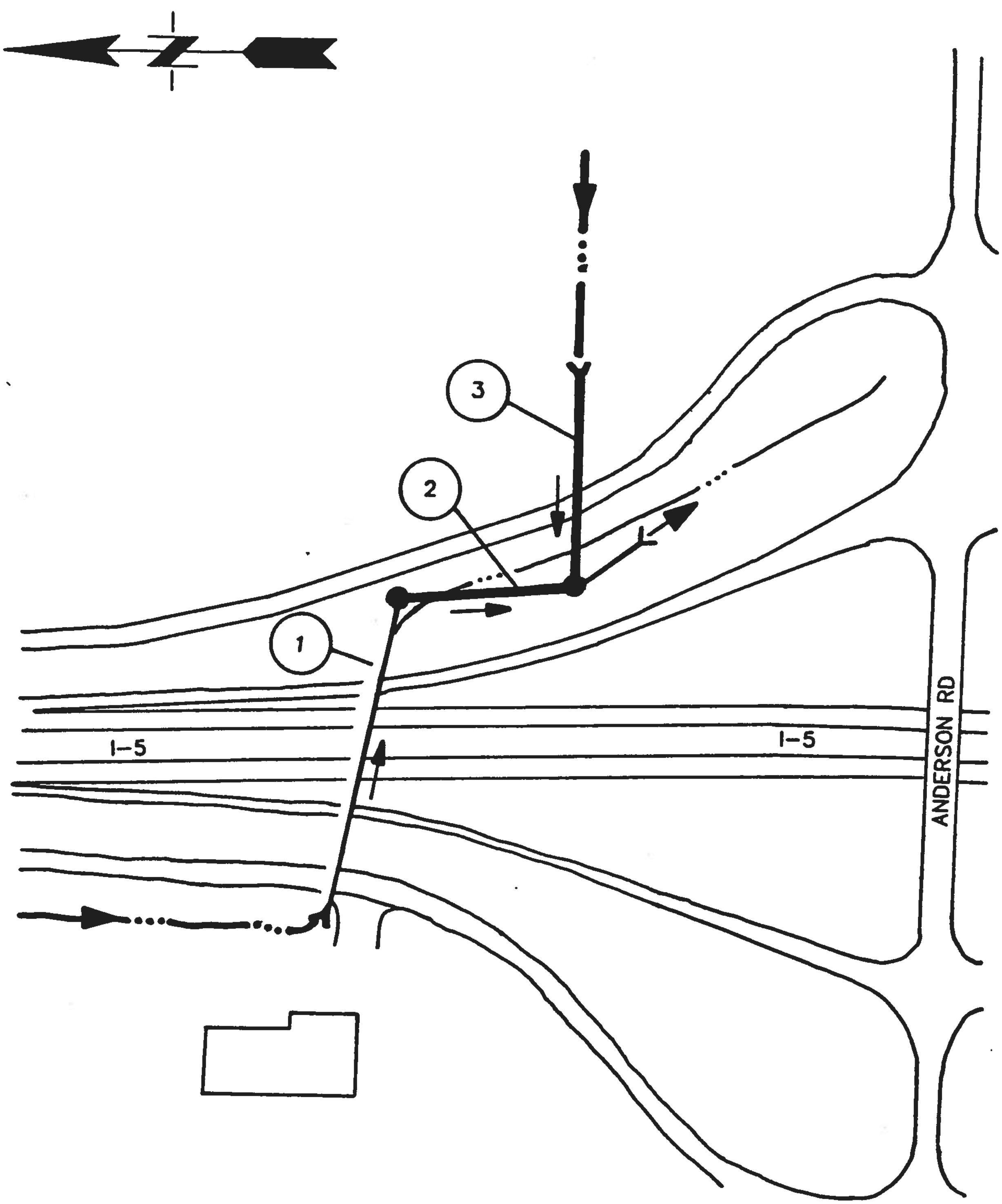


FIGURE VII-4
CITY OF
MOUNT VERNON
SURFACE WATER
MANAGEMENT PLAN
PROBLEM LS26
SOLUTION

R·W·BECK



KEY

- PIPE TO BE REPLACED
- EXISTING PIPE TO REMAIN
- DITCH / STREAM
- MANHOLES
- CATCH BASINS
- (3) PIPE REPLACEMENT REFERENCE NUMBER, SEE TABLE VII-1

FIGURE VII-5

CITY OF MOUNT VERNON

SURFACE WATER MANAGEMENT PLAN

PROBLEM LS27 SOLUTION

R·W·BECK

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SECTION VIII
MAINTENANCE AND OPERATIONS

R·W·BECK

SECTION VIII

Maintenance and Operations

A. General

The objective of a surface water maintenance and operations program is to assure the reliability and dependability of the surface water infrastructure including, but not limited to, catch basins, pipe networks, detention basins, and open ditches. Such a program is designed to minimize life-cycle costs, protect the lives and property of the residents living in the affected watershed, and enhance water quality.

Too often, a "fix it when it's broken" philosophy prevails. In the long term, this approach will cost far more than ongoing maintenance. Maintenance management programs include analysis of the frequencies and levels of maintenance required to ensure reliability and achieve the lowest life-cycle cost.

Findings are presented in Part B of this section and recommendations are provided in Part C. A typical maintenance management program is described in Part D. Recommended elements of a surface water maintenance management program for the City of Mount Vernon are identified in Part E. This subsection includes an inventory of facilities, maintenance frequencies, optimal crew configurations, equipment requirements, and performance standards. Staffing and equipment budget estimates are presented in Part F. Section G contains a brief discussion regarding maintenance management software.

The surface water program described in this section of the report uses generally accepted maintenance practices and planning standards. All data are based on best available estimates.

B. Findings

The City of Mount Vernon is making commendable efforts to maintain its surface water infrastructure, especially given that the City does not have a dedicated surface water maintenance crew. For instance, the City has implemented a comprehensive street cleaning program. All downtown streets and most arterials are cleaned daily, curb residential streets are cleaned every three weeks, and non-curb residential streets are cleaned every two months. Another example is the City's curb inlet cleaning program. Twice a year three two-person crews clean all curb inlets over a three day period.

However, the City has experienced water quality and quantity problems, which are especially apparent during heavy rain storms. A comprehensive maintenance program will help to alleviate some of the problems.

C. Recommendations

Four primary changes to the current surface water maintenance program are recommended. First, increase the maintenance frequencies for cleaning catch basins and manholes from once a year to once every eight months. This is an effective way to improve both water quality and water quantity carrying capacity. By cleaning these surface water collection facilities more frequently, sediments and accompanying contaminants will be removed from the surface water system. This will reduce both the level of contaminants in the water and the amount of sediments inhibiting the flow of water.

Second, decrease the maintenance frequency of downtown streets and arterials from once every day to once every week. Although it is commendable that the City is cleaning all downtown streets and arterials every day, once a week is more consistent with what is performed by other jurisdictions and will result in more efficient use of human resources.

Third, in accordance with recommendations in other sections of this plan to convert dirt ditches to grass swales, focus maintenance activities for these facilities on vegetation control and trash removal and away from sediment removal, especially removal that involves a backhoe. Backhoe operation can be extremely intrusive to a swale. Operation of a backhoe in a swale should be limited to removing pockets of sedimentation, such as those that form near culvert openings. Extensive reshaping of swales should be performed with a ditchmaster.

Fourth, incorporate inspections into maintenance activities. For example, prior to sending out a vactor crew to clean catch basins in an area of the City, conduct an inspection of the catch basins in the area to determine which need cleaning and which do not. This will ultimately save time since catch basin cleaning can be much more efficiently accomplished if catch basins that require cleaning have been identified in advance. This approach can be applied to the maintenance of all surface water facilities. It will also facilitate development of a condition and maintenance history of the facilities if the inspections are used to indicate condition and date of maintenance activity.

As part of an inspection program, utilize indicators to determine when maintenance is necessary. The following conditions indicate the need for maintenance:

- Pipes — accumulated sediment exceeds 20 percent of the pipe diameter.
- Catch basins — accumulated sediment exceeds 35 percent of basin capacity.
- Detention basins — accumulated sediment exceeds 10 percent of the design forebay/basin depth and unmowed grass/ground cover exceeds 18 inches.
- Detention pipes — accumulated sediment exceeds 10 percent of pipe diameter for 1/2 length of the pipe or exceeds 15 percent of pipe diameter at any point.
- Biofiltration swale — accumulated sediment inhibits healthy grass cover.

In order for the City's surface water system to function properly, the Recommended Surface Water Maintenance Program presented in Part E of this section, which reflects the above recommendations, should be followed. Implementation of this program, along with the recommended capital improvements will improve the performance of the surface water infrastructure. The maintenance program described in Table VIII-6 will require an estimated annual budget of $195,300 and approximately three full-time persons, along with a one-time purchase of additional equipment needed to support new maintenance activities at a cost of approximately $20,000. Table VIII-1, Annual Maintenance Costs, illustrates the distribution of maintenance costs for the major components of the surface water system, based on the recommended program described in Part E.

Current surface water maintenance activities are performed by street maintenance crews. Approximately one full-time equivalent of surface water maintenance service is realized by the combined efforts of several street crews. Achieving the workload required by the recommended surface water maintenance program will necessitate two additional surface water maintenance workers, which will bring surface water maintenance resources to three full-time equivalents.

The recommended surface water maintenance program places significant additional demands on the City's vactor, which is shared by the Sewer and Street departments. This piece of equipment is currently used primarily by the Sewer Department. The Sewer and Street departments will need to continue to work closely to coordinate the shared use of the vactor, given the increased demands on this vital piece of equipment. Over the next two years, when additional surface water maintenance personnel have been acquired and increased levels of service begin, the City should conduct an overall Sewer and Street department utilization assessment to determine if additional equipment is necessary. If the vactor cannot be shared to the extent that it is needed, a reduced level of service over what is proposed may be necessary until an additional vactor is obtained.

Table VIII-1
Annual Maintenance Costs

Structure	Maintenance Cost	Percent of Total Cost
Pipes	$ 37,500	19%
Catch Basins	$ 37,400	19%
Streets	$ 46,400	24%
Roadside Ditches	$ 22,100	11%
Manholes	$ 15,600	8%
Detention Basins	$ 19,700	10%
Pump Stations	$ 9,400	5%
Curb Inlets	$ 7,200	4%
Total	$195,300	100%

D. Typical Maintenance Management Program

A maintenance management program is a set of policies, procedures, and management tools for planning, organizing, directing, and controlling maintenance activities. Maintenance management is not a "speed up the work," highly controlled, punitive approach to work, but rather a system of "working smarter."

A typical maintenance management program, shown in schematic form in Figure VIII-1, Maintenance Management Program Development Process, consists of six basic modules: (1) inventory of facilities, (2) needs assessment, (3) optimal crew configurations, (4) planning factors, (5) schedule and resource allocation, and (6) reporting and control. These modules are described in more detail below.

1. Inventory of Facilities

An inventory is a complete record of all physical facilities that are maintained. This inventory should document the number, condition, and locations of each facility. A procedure for keeping the inventory current is critical.

2. Needs Assessment

Assessing needs (i.e., determining which facilities need how much maintenance, of what type, and why) is the initial step in a comprehensive maintenance management program. This module consists of several components, each of which assist in answering those questions. These components include:

a. Condition Assessment. Closely connected to the facilities inventory is the condition assessment. Some form of rating scale must be established for describing the condition of each type of facility that is maintained. A procedure is needed to describe the methods for evaluating and recording the condition of each facility. Like the inventory, the condition needs to be updated regularly.

b. Level of Service. Level of service goals or standards identify the conditions that necessitate maintenance (e.g., sedimentation exceeding 20 percent of pipe diameter or 35–50 percent of catch basin capacity as measured by depth).

c. Frequencies. Frequencies identify how often maintenance activities must be performed if the program is to achieve the desired level of service.

3. Optimal Crew Configurations

Optimal crew configurations are based on the accepted fact that for every activity, there is a combination of resources that results in the most efficient performance of work. Thus, optimal crew configurations are the compilation of the number and skills of people, the types of equipment, and the kinds and amounts of materials required to perform a task most efficiently.

4. Planning Factors

Inventorying needs, converting those needs to long- and short-term work plans, scheduling, and assigning individual work projects are all ingredients of the single most important aspect of effective maintenance management, which is planning. To engage in these planning activities, to "work smarter", it is necessary to establish planning tools.

Planning factors are those identifiers, measurement units, and standards that are necessary for planning and budgeting maintenance activities and reporting actual versus planned costs and performance. Planning factors include a list of all tasks and activities performed by the municipality and charts of accounts, output measures, and performance standards for each task or activity.

a. Chart of Accounts. A chart of accounts is a list by task code of all tasks or activities for which the municipality needs to plan and collect costs. As a general rule, a separate task code should be established for each activity.

b. Output Measures. Output measures are the appropriate units of measure for documenting production for each of the work tasks or activities contained within the chart of accounts. Examples of output measures include lineal feet, number of catch basins, and lane-miles.

c. Planning/Performance Standards. These standards are used to determine resource requirements as measures of efficiency. They are expressed in number of output units (e.g., numbers of catch basins cleaned) per unit of time (e.g., days).

5. Scheduling and Resource Allocation

In order to perform needed work activities at the appropriate time, a program for prioritizing work needs to be established. Given established priorities, a long-term work plan and budget can be developed to make the most efficient use of available resources. Once a long-term plan is completed, short-term scheduling facilitates the actual performance of maintenance activities.

a. Priorities. Priorities represent the relative importance of maintaining each type of facility and, therefore, conducting each type of maintenance activity. Priorities are used in preparing both long- and short-term work plans and schedules.

b. Annual Work Plans and Budgets. Annual work plans and budgets identify the types and locations of maintenance work to be performed during the coming year. The work plan is derived by scheduling work to be performed during the year over quarterly, monthly, or seasonal periods, in order of priority. Attention is given to 1) spreading the workload throughout the time period (i.e., resource leveling), and 2) preparing the work program in light of resource constraints (e.g., budget limitations).

The work that needs to be performed is determined by applying the desired level of service or frequencies to the inventory of physical facilities. In developing the work plan, consideration must also be given to emerging or unexpected needs, complaint response, non-project loss factors such as vacations, holidays, and sick leave, as well as requirements for replacements and improvements.

Cost estimates for work included in the proposed annual work plan are computed by applying optimal crew configurations and planning standards to the quantity of work to be performed to determine the crew-hours, various skill types, and equipment required. The cost of the necessary resources can then be computed by applying wage rates and equipment rental rates. Material costs for budgeting purposes also need to be determined, using estimated or historical data.

c. Short-term Work Plans and Schedules. Short-term work plans and schedules are the means by which the work activities identified in the annual program are translated into actual work assignments in the field. The process of work planning and scheduling determines who will do the work, where it will be done, when it will be done, and how much will be done.

6. Reporting and Control

a. Reports. Work reporting is the critical feedback mechanism that enables the comparison of actual versus planned costs, production, and efficiency. Work reporting is necessary to provide deserved recognition for a job well done, develop a database that can be used for improved planning and maintenance management in future years, and monitor group performance in order to take corrective action as needed to bring actual and planned performance into conformance.

Work reporting should provide a timely and accurate flow of information with a minimum of paperwork. Variables include time, equipment hours, materials used, and units of production. Reporting encompasses a hierarchy of reports that provide the appropriate level of detail to each level of management.

b. Control. Control includes establishing clear accountability for specific results and for the resolution of problems or variances from plans. Consequently, it is necessary to establish thresholds which, when exceeded, will trigger corrective action on the part of the appropriate manager. Thresholds will vary in sensitivity depending on the level of detail contained in the report and level of management that is receiving the report. Exception reporting is useful for highlighting only those instances where thresholds have been exceeded.

Finally, control includes determining the cause of the variance, assigning the appropriate resources to take corrective action, and describing the nature of the corrective action. Corrective actions may include changing work practices or amending the original work plan.

E. Proposed Maintenance Management Program

1. Inventory of Facilities

With the assistance of the municipal staff, the consultant team identified the number of each type of facility included within the City of Mount Vernon's present surface water system that requires maintenance. This information is summarized in Table VIII-2, Existing Inventory Summary.

Table VIII-2
Existing Inventory Summary

Maintenance Item	Quantity	Measurement Unit
Catch Basins	1,500	Each
Manholes	250	Each
Curb Inlets	800	Each
Roadside Ditches	105,600	Feet
Pipes	264,000	Feet
Regional Detention Basins	5	Each
Streets	80	Miles
Detention Pipes	25	Each
On-site Detention Basins	30	Each

2. Needs Assessment

a. Condition assessment. If the maintenance frequencies recommended in this report are adhered to, it will not be necessary to conduct separate periodic condition assessments of the surface water facilities. The condition of facilities, such as catch basins, manholes, and pipes, should be recorded at the time maintenance is performed. A condition assessment scheme, or a common rating system, is recommended below. Four levels of criticality are suggested to prioritize maintenance needs for each type of surface water facility.

(1) Maintenance Needed Immediately — Failure to perform maintenance will threaten public health or safety or will result in imminent damage to other publicly-owned facilities or private property.

(2) Maintenance Needed Sooner Than Scheduled — Maintenance can be scheduled on a short-term basis but will be required before the following year's annual work plan is developed or before the regularly scheduled preventive maintenance for a particular facility or piece of equipment.

(3) Regularly Scheduled Maintenance Program — The regularly scheduled preventive maintenance activities will be sufficient.

(4) Maintenance Done Only When Unused Resources Are Available — Maintenance should be performed only after the above three categories of maintenance requirements have been accomplished.

b. Level of Service. Desired levels of service have been established with staff and are expressed in terms of maintenance frequencies.

c. Frequencies. As stated above, the levels of service for surface water facilities have been established in terms of maintenance frequencies. These frequencies are the time intervals for performing recurring maintenance in order to realize the desired level of service. Average annual frequencies appear in Table VIII-3, Maintenance Frequencies.

Table VIII-3
Maintenance Frequencies

	Activity	Recommended Frequency
1	Clean Catch Basins	1.50 times/year
2	Clean Manholes	1.50 times/year
3	Clean Curb Inlets	2.00 times/year
4	Roadside Ditches (Remove sediments)	0.20 times/year
5	Roadside Ditches (Vegetation control)	2.00 times/year
6	Clean Pipes	0.33 times/year
7	Detention Basins (Vegetation Control)	1.00 times/year
8	Detention Basins (Remove Sediments)	0.33 times/year
9	Clean Streets	See Table VIII-6
10	Clean Detention Pipes	1.00 times/year
11	Pump Station Maintenance	See Table VIII-6

3. Optimal Crew Configurations

As a part of the maintenance management program development effort, optimal crew configurations were established for the City of Mount Vernon. These optimal configurations, assumed to be the most efficient complement of labor and equipment to perform each of the tasks, appear in Table VIII-4, Optimal Crew Configurations.

Table VIII-4
Optimal Crew Configurations

	Activity	Recommended Crew Configurations
1	Clean Catch Basins	2 Maintenance Workers 1 Vactor
2	Clean Manholes	2 Maintenance Workers 1 Vactor
3	Clean Inlets	6 Maintenance Workers 3 1 Ton Trucks
4	Roadside Ditches (Clean, reshape, remove sediments)	3 Maintenance Workers 1 Backhoe, 2 Dumptrucks
5	Roadside Ditches (Vegetation control)	1 Maintenance Worker 1 Mower
6	Detention Basins (Vegetation Control)	1 Maintenance Worker 1 Mower
7	Detention Basins (Remove Sediments)	2 Maintenance Workers 1 Backhoe, 1 Dumptruck
8	Clean Streets	1 Maintenance Worker 1 Street Sweeper
9	Clean Detention Pipes	2 Maintenance Workers 1 Vactor
10	Pump Station Maintenance	Work to continue to be performed by Sewer Department

4. Planning Factors

a. Chart of accounts. The surface water maintenance program should include the 10 surface water activities identified in Table VIII-4.

b. Output Measures. As a part of the development of this surface water maintenance program, measurement units were identified for each of the activities. These output measures, which appear in Table VIII-2, are used to document the amount of activity or production. They also allow for the identification of unit costs, which are the costs of labor, equipment, and materials associated with one unit of production. This information is used for planning, budgeting, scheduling, and reporting actual accomplishment.

c. Planning/Performance Standards. Planning/performance standards are expressed in terms of an average or reasonable amount of daily crew accomplishment. Standards recommended for the City of Mount Vernon are provided in Table VIII-5, Planning/Performance Standards.

Table VIII-5
Planning/Performance Standards

	Activity	Recommended Standard
1	Clean Catch Basins	30 per day
2	Clean Manholes	12 per day
3	Clean Inlets	266 per day
4	Roadside Ditches (Remove sediments)	750 lf/day
5	Roadside Ditches (Vegetation Control)	2500 lf/day
6	Clean Pipes	See Table VIII-6
7	Regional Detention Basins (Veg. Control)	1 per day
8	Regional Detention Basins (Remove Sed.)	1 per day
9	Clean Streets	See Table VIII-6
10	Clean Detention Pipes	2 per day
11	On-site Detention Basins (Veg. Control)	2 per day
12	On-site Detention Basins (Remove Sed.)	2 per day

The above performance standards are consistent with those standards used by other comparable municipalities. In the consultant's opinion, these represent a reasonable starting point. These standards should be reviewed at least annually, and refined as historical daily production data become available.

5. Scheduling and Resource Allocation

a. Priorities. While a maintenance management program is designed to ensure that all facilities will receive the appropriate level of maintenance, the reality is that this may not always be possible, due to emergencies, weather, inadequate resources, etc. Consequently, there is a need to establish relative priorities for various types of facilities and associated deficiencies. Under Needs Assessment, a general prioritization scheme was suggested. This scheme should be used to prioritize the need for certain types of maintenance activities on specific facilities.

b. Annual Work Plans and Budget. An annual work plan displays the amount and type of work, when it should be performed, and anticipated costs. It is used to compare actual versus planned performance of the maintenance program. The annual work program is also used to develop short-term schedules.

To develop annual resource requirements and budget estimates for a surface water maintenance program, recommended annual maintenance requirements and the associated resources were documented. The proposed program appears in Table VIII-6, Recommended Surface Water Maintenance Program.

c. Short-term Work Plans and Schedules. Short-term (e.g., weekly or bi-weekly) schedules should be prepared by the maintenance supervisor. Schedules should be based on planned preventive maintenance activities, improvements or small works projects, and outstanding work orders generated from complaints, system failures, and emergency needs. Schedules should be approved by the appropriate supervisor and posted for the crew's information.

Weekly scheduling permits the flexibility to respond to:

- Unscheduled breakdowns and failures
- Weather
- Reduced resource availability due to vacation and sick leave
- Construction projects planned by private utilities and other City crews

Most importantly, the weekly schedule permits the supervisor to coordinate and plan in detail the resources, labor, and equipment needed to accomplish the proposed monthly work plan.

6. Reporting and Control

a. Reports. A cost and performance report by activity should be produced monthly, which provides both monthly and year-to-date data. By tracking labor hours, equipment hours, and production data, comparisons can be made of planned versus actual costs and performance. This will enable supervisors and management to identify and reconcile performance problems in a timely manner. The records of actual production and cost will also be valuable for developing an historical database that can be used to refine planning, scheduling, and budgeting.

b. Control. Management control is based on the establishment of clear accountability for specific results. Reporting provides the critical feedback mechanism that enables supervisors and managers to track accomplishment or results as compared with the approved plan. Through this exercise, performance problems and deviations from the plan can be identified early on. This allows supervisors and managers to complete the control cycle by identifying causes for unacceptable production and taking action to either solve the problem or revise the plan.

Table VIII-6

City of Mount Vernon
Recommended Surface Water Maintenance Program

Item No.	Maintenance Activity	Units to be Maint.	Prod. Unit	Freq. (times/year)	Daily Prod.	Crew Size	Equipment	Annual Crew Days	Full-time Equip. Equiv.	Annual Person Days	Full-time Labor Equiv.	Annual Labor Cost	Annual Equipment Cost	Total Cost	Percent of Program
1	Clean Catch Basins	1,500	EA	1.50	30.00	2	1 Vactor	75.00	0.34	150.00	0.68	$28,462.91	$8,947.88	$37,410.78	19.15
2	Clean Manholes	250	EA	1.50	12.00	2	1 Vactor	31.25	0.14	62.50	0.28	$11,859.55	$3,728.28	$15,587.83	7.98
3	Clean Curb Inlets	800	EA	2.00	266.00	6	3 Trucks	6.02	0.03	36.09	0.16	$6,848.22	$321.92	$7,170.14	3.67
4	Roadside Ditches Remove Sediments	70,400	LF	0.20	750.00	3	1 Backhoe 2 Dumptrucks	18.77	0.09	56.32	0.26	$10,686.87	$4,538.12	$15,224.99	7.79
5	Roadside Ditches Vegetation Control	35,200	LF	2.00	2,500.00	1	1 Mower	28.16	0.13	28.16	0.13	$5,343.44	$1,664.12	$7,007.55	3.59
6	Clean Pipes (18" dia. or less)	132,000	LF	0.33	1,500.00	2	1 Vactor 1 Truck	29.04	0.13	58.08	0.26	$11,020.84	$3,982.69	$15,003.53	7.68
7	Clean Pipes (over 18" dia.)	132,000	LF	0.33	1,000.00	2	1 Vactor 1 Truck	43.56	0.20	87.12	0.40	$16,531.26	$5,974.04	$22,505.29	11.52
8	Regional Detention Basins Veg. Control	5	EA	2.00	1.00	1	1 Mower	10.00	0.05	10.00	0.05	$1,897.53	$590.95	$2,488.48	1.27
9	Regional Detention Basins Remove Sed.	5	EA	0.33	1.00	2	1 Backhoe 1 Dumptruck	1.65	0.01	3.30	0.02	$626.18	$243.58	$869.77	0.45
10	Clean Streets Downtown/Arterials	16	MI	50.00	12.00	1	1 Street Sweeper	66.67	0.30	66.67	0.30	$12,650.18	$16,130.33	$28,780.52	14.73
11	Clean Streets Curb Residential	24	MI	15.00	14.00	1	1 Street Sweeper	25.71	0.12	25.71	0.12	$4,879.36	$6,221.70	$11,101.06	5.68
12	Clean Streets Non-Curb Residential	40	MI	6.00	16.00	1	1 Street Sweeper	15.00	0.07	15.00	0.07	$2,846.29	$3,629.33	$6,475.62	3.32
13	Clean Detention Pipes	25	RT	1.00	2.00	2	1 Vactor	12.50	0.06	25.00	0.11	$4,743.82	$1,491.31	$6,235.13	3.19
14	On-site Detention Basin Veg. Control	30	EA	2.00	2.00	1	1 Mower	30.00	0.14	30.00	0.14	$5,692.58	$1,772.85	$7,465.43	3.82
15	On-site Detention Basins Remove Sed.	30	EA	0.33	2.00	2	1 Backhoe 1 Dumptruck	4.95	0.02	9.90	0.05	$1,878.55	$730.75	$2,609.30	1.34
16	Pump Station Maintenance	5	EA	*	*	*	*	*	*	*	*	*	*	$9,400.00	4.81
17	Catch Basins Repair/Replace	1,500	EA	0.02	1.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**

City of Mount Vernon
Recommended Surface Water Maintenance Program

Item No.	Maintenance Activity	Units to be Maint.	Prod. Unit	Freq. (times/year)	Daily Prod.	Crew Size	Equipment	Annual Crew Days	Full-time Equip. Equiv.	Annual Person Days	Full-time Labor Equiv.	Annual Labor Cost	Annual Equipment Cost	Total Cost	Percent of Program
18	Manholes Repair/Replace	250	EA	0.02	3.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
19	Curb Inlets Repair/Replace	800	EA	0.02	3.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
20	Pipes Repair/Replace	264,000	LF	0.02	50.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
								398.28	1.81	663.85	3.02	$125,967.57	$59,967.84	$195,335.41	100.00

Assumptions			
Labor Costs (Maintenance Worker)		Equipment Costs	
Average cost per hour	$20.07	Vactor	$119.31/day
Regular Workday (hrs.)	8 hours	10 Yard Dump	$94.11/day
		Mower	$59.10/day
		Street Sweeper	$241.96/day
		1 Ton Truck	$17.84/day
		Backhoe	$53.52/day

* Pump stations are maintained by the Sewer Department.
** These costs are typically covered in street replacement programs.

F. Budget, Staffing, and Equipment Requirements

Proper maintenance of the surface water facilities requires adequate budget, staff, and equipment to support the desired level of service. Annual resource requirements and direct costs necessary to accomplish the recommended maintenance program for the City of Mount Vernon appear in Table VIII-7, Annual Budget, Staffing, and Equipment Requirements.

Table VIII-7
Annual Budget, Staffing and Equipment Requirements

	Person Days	Crew Days	Budget Estimate
Direct Labor	663.85		$126,000
Pump Station Maintenance			$ 9,400
Equipment			
Vactor		191.35	$ 22,800
10 Yard Dumptruck		44.14	$ 4,100
1 Ton Truck		90.66	$ 1,600
Backhoe		25.37	$ 1,400
Mower		68.16	$ 4,000
Street Sweeper		107.38	$ 26,000
Equipment Subtotal			$ 69,300
TOTAL			$195,300

If actual time is assumed to be 220 days per year or about 85 percent of available time, then 3.03 full-time equivalents are required to perform surface water maintenance activities. This is determined by dividing 663.85 person-days by 220 annual work days.

In order to facilitate the performance of some new maintenance activities such as cleaning manholes and mowing detention basins, the City will need additional equipment. Equipment acquisitions should include safety equipment for cleaning manholes and a mower and trailer for vegetation control of regional detention basins. Approximately $20,000 should be budgted for purchase of this equipment.

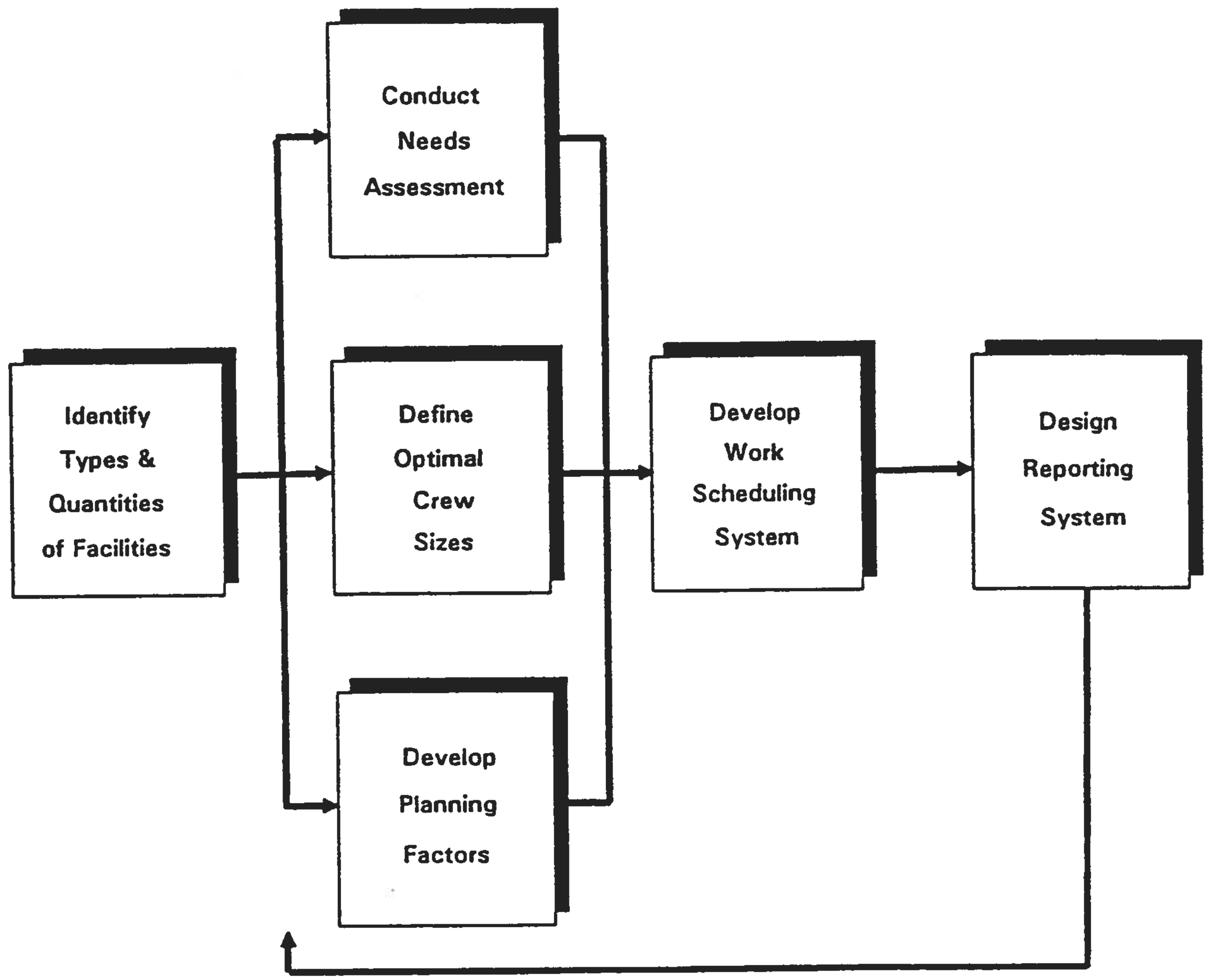
G. Maintenance Management Software

The ideal next step in establishing a Surface Water Maintenance Management Program is to automate the program. An automated program will support scheduling, tracking, reporting, and accomplishment of maintenance activities. Ideally, an automated maintenance program should be linked with other databases, such as a Geographic Information System. The reporting component of the program should be integrated with cost-accounting and financial reporting systems, so that performance and associated cost data is easily available in a useful format. Once maintenance standards are adopted, and planning, scheduling, and reporting procedures are in place, software can either be acquired or developed to meet data management requirements.

Software can be developed in-house or purchased through a vendor. Developing programs in-house using common database management software (e.g., DBASE, RBASE, and Paradox) is not recommended based upon the amount of time, effort, and knowledge necessary to develop an effective maintenance management program.

Vendor-supplied software can be acquired in two ways. First, software can be acquired by issuing a Request for Proposals (RFP) to develop a "custom" program. Second, software can be obtained by acquiring "off-the-shelf" packages. Custom developed programs can be time consuming and costly. Commercially available maintenance management software packages represent the most cost effective product.

Figure VIII-1
Maintenance Management Program Development Process



SECTION IX
FUNDING

SECTION IX

FUNDING

A. Background

1. Authority and Council Mandates

The financial portion of Mount Vernon's Surface Water Master Plan was considered critical in moving the engineering recommendations, water quality requirements and fish habitat recommendation from concept to reality. The City established a Citizen's Advisory Committee (CAC) to provide recommendations on the development of the Surface Water Management Plan, with specific emphasis on the funding program necessary to support implementation of the Plan. The stated goal for the Committee was to "ensure that the Surface Water Management Program, including financing alternatives, reflects the needs, priorities, and concerns of Mount Vernon's citizens and impacted organizations." The CAC members, meeting agendas, and meeting minutes are contained in Appendix D.

2. Process

Development of this financial program required the commitment of personnel from the City's Engineering Department, Street Department, Finance, and Building Inspection. Beyond these project team members were the persons who dedicated their time to participation on the Surface Water Citizen's Advisory Committee. These persons reviewed the analyses prepared by the Project Team and made recommendations to the Council. However, it was the Citizen's Committee who provided ongoing guidance to the Project Team in the design and implementation of the surface water financial program and ultimately the utility approach.

B. Surface Water Needs

Like many jurisdictions in the Northwest and throughout the country, surface water management in Mount Vernon has historically been considered a funding priority only after a major storm event. The 1990 floods and the management planning conducted as part of this project reemphasized the fact that surface water required an elevation of status supported by a dedicated and predictable funding source. This recognition is critical as Mount Vernon addresses not only surface water flooding issues and fish habitat, but also the water quality regulations from the Puget Sound Water Quality Authority and possible future federal requirements under the National Pollutant Discharge Elimination System (NPDES).

When evaluating Mount Vernon's management approach toward surface water, three functional areas have been addressed through this Plan. These focus on the technical, institutional and financial areas. A major milestone was passed when the City passed its Surface Water Utility Formation Ordinance in August in 1993 and the Surface Water Utility Rate Ordinance in November 1993. These ordinances will provide the financing to allow the City to undertake the institutional and technical issues necessary to implement a comprehensive surface water management program.

In order to implement the program, an assessment was made of Mount Vernon's current ability to support compliance with water quality nonpoint source regulations; maintain, repair and improve the City's overall surface water management system; and preserve, and possibly enhance, sensitive environmental resources. The Citizen's Committee reviewed the funding options available and concluded that the service charge represented a reasonable and equitable approach. Most surface water activities in Mount Vernon have been funded through piecemeal allocations from the City's General Fund, Street Fund or Sewer Fund. The Citizen's Committee agreed that given the magnitude of surface water flooding, water quality, and sensitive resource issues facing Mount Vernon, a dedicated funding source to surface water management needed to be given strong consideration. The idea of a utility approach toward funding surface water was considered to be the best option as the primary revenue source. Many if not most of the cities and counties in the Puget Sound area have implemented or are in the process of implementing a similar funding approach. The legal framework underlying development of this funding mechanism has long been established through Revised Code of Washington (RCW) 35.67 and has been upheld by the Washington Courts in Teter v. Clark County/City of Vancouver.

1. Management Plan Priorities

Comprehensive basin planning is the fundamental building block for long term surface water management in Mount Vernon. The water quality, flooding, and sensitive environmental resource needs identified through the planning effort provide the basis for prioritizing the capital needs and operations requirements. These needs are then translated to costs and construction schedules. Many of these needs are, or will be, mandated by new state and federal requirements. This includes the state's Puget Sound Water Quality Authority, which has issued its own rules pertaining to the quality and quantity of surface water discharges to the Sound. As discussed in the regulatory section of this Plan, legal mandates require specific actions of the City in terms of design standards, enforcement and maintenance. While the state does make some funds available for loans and grants, the on-going commitment required to meet these regulations mandates a financial approach far exceeding available grant funding.

C. Utility Design and Implementation

1. Introduction

The stated objective for financing the City's surface water program has been development of a consistent and dedicated surface water funding mechanism. This issue is also listed in the state PSWQA surface water requirements for Comprehensive Urban Stormwater Programs. Although Mount Vernon is not included in the urbanized areas that are required to implement the Comprehensive Urban Stormwater Program elements of the Puget Sound Plan, recent and future growth may soon trigger these requirements.

Specifically, the kind of commitment required by the Comprehensive Urban Stormwater Program is an assurance that there be adequate local funding for the stormwater program. This requires that a financial analysis be performed that includes:

- What funding options are available
- How these options compare in terms of accessibility and process for implementation
- What the cost estimates are for the principal nonpoint source controls being proposed
- What level of revenue can be anticipated and whether it meets the program's needs

The process of constructing Mount Vernon's funding program addressed each of these funding elements and identified a reasonable and implementable strategy for financing the program's surface water management program.

2. Funding Approaches—Citizen's Committee Evaluation Process

The Citizen's Committee reviewed the full spectrum of surface water funding options over the nine month evaluation process. The criteria used to evaluate funding options included:

- **Timing/Ease of Implementation**—How long will it take to implement the option(s) and is it flexible enough for use in the City's operating and political environment?
- **Responsiveness**—Will the option(s) be responsive/accountable to customers within the service area?
- **Start-up Costs**—Can the funding option be merged into existing data bases and accounting systems or will it require a separate process?
- **Equity**—Does the option produce an equitable allocation of surface water service costs?
- **Legal Framework**—Is the funding option consistent with local and state laws?
- **Revenue Capacity**—Can the option(s) produce the revenue necessary to meet the program needs/priorities identified in the Master Plan?

As a further guide toward developing a financial strategy for surface water management, the Citizen's Committee was focused on establishing a funding mechanism that equitably allocates program costs and ensures that the cost of program elements is commensurate with their benefits. Within this evaluation framework, the Citizens

Committee received staff reports and recommendations on each of the funding mechanisms being considered. It was also emphasized that no single source of funding would satisfy the overall surface water quality and quantity program requirements. Although the funding options discussed were presented individually, none of them were considered to be mutually exclusive. The Committee emphasized the need to recognize the difference between getting the existing surface water system working properly versus those future system requirements resulting from new development. Given this direction, the following options for funding the surface water program were reviewed by the Committee.

3. Funding Mechanisms—Surface Water Management

The Citizen's Committee review of the following options was geared toward the immediate objective of developing the funding required to meet the needs identified in the Surface Water Management Plan. However, these funding mechanisms were also evaluated in light of their flexibility to adjust as more data was developed regarding specific application of water quality charges to individual system users. A short discussion of funding options follows:

a. State/Federal Grants and Loans. Historically, local governments have experienced significant infrastructure funding support from state and federal government agencies in the form of block grants, direct grants in aid, interagency loans, and general revenue sharing. Federal deficit reduction pressures and virtual elimination of federal revenue sharing dollars are clear indicators that cities such as Mount Vernon will be left to their own devices regarding infrastructure finance in general and surface water funding in particular. Presently, the primary sources of assistance in the areas of surface water are the federally funded grants provided by the Housing and Urban Development's Community Development Block Grant (CDBG) Program. However, access to this funding mechanism becomes much more difficult in relation to surface water facilities. Numerous applicants compete for a very limited resource pool making this a questionable funding source and one that cannot be credibly relied upon as a consistent element of this program's on-going revenue base. Experience indicates that even when jurisdictions secure grants for their programs, the revenue rarely provides for a fully funded capital improvement program. The typical scenario is to apply these grant monies to a master planning process which often does not address the long term funding issues necessary to sustain the program.

   State funding, primarily through the Department of Ecology, presents opportunities for support of specific surface water related projects. These include the Centennial Clean Water Fund, DOE's Water Quality Financial Assistance Program; State Revolving Fund, Public Works Trust Fund, and the Flood Control Account Assistance Program (FCAAP). It is expected that the City will continue to aggressively pursue these sources of funds.

b. Debt Financing. General Obligation Bonds - Washington statute enables municipal issuance of bonds for the purposes of paying the cost of acquisition or construction of service facilities. General Obligation (G.O.) Bonds are debt instruments backed by the full faith and credit of the issuing jurisdiction. The bonds are secured by an unconditional pledge of the City to levy the necessary assessments, charges or ad valorem taxes necessary to retire the bonds. G.O. bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, grants/loans, or special assessment charges to form a dual security through the City's revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for stormwater management purposes will be a function of Mount Vernon's overall debt capacity. G.O. bond financing requires voter approval.

c. Revenue Bonds. This form of debt financing would also be available to Mount Vernon if and when a surface water utility revenue stream was established. Unlike G.O. bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the operating revenues of the City's surface water utility. Revenue bonds present a greater risk to the investor than do G.O. bonds, since repayment of debt depends on an adequate revenue structure and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally command a higher interest rate than G.O. bonds. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders. Typically, voter approval is not required when issuing revenue bonds.

d. System Development Charges. Mount Vernon does not presently employ impact or connection fees for surface water. However, some members of the Citizen's Committee did express an interest in keeping this option open as the surface water program gets further into its capital improvement programming. These charges are designed to provide a mechanism by which owners of properties to be developed in the future will share in the current cost of constructing surface water improvements. Surface water and flood control improvements are characteristically designed to last twenty years or more into the future. This charge offsets the inequity which results when owners of developed properties bear the entire cost of the surface water improvements while owners of property developing in the future enjoy the benefits of these improvements at no incremental cost.

The use of system development charges will provide important flexibility in terms of equitably allocating the cost of new development on the surface water quality or quantity infrastructure. Questions regarding who should pay for required upsizing of the surface water system due to new development, or how historical payers into the system can recover their costs in oversizing facilities that enable future growth, are exactly the types of equity issues that system development charges can be designed to accommodate. This method is also being considered for nonpoint source water quality controls by providing incentives for new development in order to maximize the mitigation of surface water quality impacts at the development site.

e. Fee-in-lieu-of Onsite Detention. In-lieu-of fees can either be a regulatory requirement or a development option that enables the City to offer developers the opportunity to construct on-site detention facilities in accordance with the established design criteria, or pay a fee into a fund dedicated to the construction of an off-site (regional) detention facility serving multiple properties.

This approach can be effective within the context of promoting the siting and construction of more regional versus on-site detention/retention facilities. This objective is consistent with the intent of fee-in-lieu-of ordinances which have proven practical as a vehicle to guide development patterns within a watershed and as a tool to encourage comprehensive surface water planning.

The shortcomings associated with fee-in-lieu-of construction revolve around cash flow and construction timing. The customary fee for a single property or development is rarely large enough to fund the construction of a regional facility. Therefore, either multiple developments must occur simultaneously in a given area to generate enough revenue to fund the construction of a regional facility, or more realistically, the project must be initially funded from Mount Vernon's utility rate reserves. Many surface water programs are finding it necessary to provide seed monies in order to successfully establish fee-in-lieu-of structures. It is also important to note that monies collected for fee-in-lieu-of purposes be "earmarked" for use in constructing the specific facility identified. Courts have generally held that commingling these funds and allocating them to unrelated surface water projects is illegal.

f. Improvement Districts and Special Assessments. The use of special drainage districts for funding surface water programs has decreased significantly due, in part, to the difficulty in quantifying the benefit to individual properties. In water, street, or sewer special assessments the benefit is normally determined as a function of the total area benefitted. The situation in surface water differs in that upstream or hillside properties that are major runoff contributors may not be specific recipients of project/maintenance benefits. Because the level of benefit could not be quantified, these properties would not be required to participate in the assessment base. In addition, the concept of local improvement or special assessment districts creating facilities or systems to mitigate surface water problems within narrowly defined areas can be counter-productive to a comprehensive approach to surface water management.

g. Plan Review and Inspection Fees. These fees are intended to recoup the expense of examining development plans to ensure consistency with comprehensive or master plans, and to insure that construction standards and regulations are met in the field. These fees are not designed to be primary revenue generating sources. Specific tasks are usually limited to engineering review and field inspection/certifications. In theory, a detailed cost accounting system can determine the actual costs of providing these services to developers. However, in practice most surface water authorities monitor the accumulated cost of providing this service so that the resulting fee is based on an average of the total cost.

One of the major concerns regarding current surface water development review operations is the lack of regulatory enforcement in the field. Plan review and inspection fees are designed to allocate direct costs back to those receiving service. These services are typified by the code enforcement work done by field inspection personnel. By implementing a plan review/inspection charge based on the true cost of providing an adequate level of service, the surface water program could enhance the development/construction review process (timeliness and predictability) and avoid passing the costs of these direct services back to the general rate or tax payers.

h. General, Street, Sewer Fund Support. These funding sources have historically been accessed by local governments to pay for minor drainage improvements and complaint/emergency response. Mount Vernon has allocated a portion of its general operating revenues to road related drainage maintenance in order to protect the integrity of the roadway network and for surface water emergency response activities. Overall, this characterizes the traditional approach toward funding surface water emergency response or protection of the transportation system. In most cases, the number of public services becoming reliant on general fund support is increasing. Therefore, services with potential customer bases, such as surface water, are being required to become self sufficient to the greatest extent possible. This self sufficiency is particularly true in terms of nonpoint source compliance.

i. Surface Water Service Charges. As conventional funding sources for surface water management become more difficult to access and as the costs of meeting surface water quality requirements are gaining focus, the utility or service charge approach toward surface water funding is becoming broadly applied and generally accepted by local government. There are numerous combinations and variations for surface water service charges. The generally accepted characteristics of a surface water service charge or rate are described below:

- **Amount of Impervious Surface**—Rates under this approach are set in direct proportion to the measured, estimated, or assumed extent of impervious area for each parcel of land. Impervious surface is that land occupied by building footprints, pavement or other non-permeable surfaces.

- **Density of Development**—Under this approach rates are determined by a runoff coefficient which is deemed to be appropriate for the type of land and the nature of the improvements on each parcel.

- **Flat Fee**—This mechanism utilizes a constant or uniform fee for each property within pre-existing classes or can be applied on a community-wide basis.

A service charge for surface water management reflects a rationale that those who contribute runoff to the surface water system should pay in relation to the amount of runoff conveyed by the systems and facilities operated by the surface water management entity. This approach is consistent with current rate structures for wastewater in Mount Vernon. As in the other rate structure, surface water service charges are based on an equivalent service/residential unit. Typically, the equivalent residential unit represents the average amount of impervious surface on a single family residential lot. Courts have consistently held that this type of approach toward a surface water service charge is reasonable and logical. The key test is whether the rate methodology relates the service charge with a measurable factor causing runoff. Impervious surface or other density of development factors are typically used as the basis for the rate structure. Jurisdictions including Anacortes, Everett, Snohomish County, Lynnwood, Mountlake Terrace, Seattle, King County, Tacoma, Auburn, Puyallup, Sumner, Steilacoom, Olympia, Thurston County, etc. have operating utilities. Nationally, it is estimated that 250 larger municipalities have implemented a surface water service charge.

j. Property Taxes. The property tax approach, while administratively straightforward, is flawed in relation to surface water because use or contribution of runoff to the system is not closely correlated with the value of the property. It is the increased emphasis on equity in allocating surface water costs to those contributors of runoff to the system that is the basis for moving away from taxes as the primary revenue source. A property tax approach toward funding surface water management in Mount Vernon would exempt the numerous developed properties owned by churches, schools and other owners enjoying tax exempt status. A key observation made by the Citizen's Committee in comparing the taxation versus service charge approach was that program costs are not affected by tax exempt status and if properties drop out of the revenue base due to tax status, program costs are shifted to the remaining properties. The bottom line is that all developed properties in Mount Vernon would be served by the utility, but only taxable properties would pay for these surface water services. This was considered inequitable by the Citizen's Committee.

4. Utility Approach and Financial Flexibility

While it is important that Mount Vernon's program develop a funding mix to support operations, it is also true that the elements of this mix will be designed and implemented over time. While financing techniques such as developer charges, plan review fees and grants/loans can serve to offset new facility or direct service costs, they cannot provide the revenue stream necessary to support a full-time, comprehensive surface water management program.

The following information summarizes the specific advantages correlated with the service charge approach in terms of Mount Vernon's specific situation:

a. Flexibility and Ability to Generate Required Revenue. As the surface water program develops, the need to adjust the funding plan to meet identified needs will be critical. The service charge can be adjusted to meet these requirements and the rate structure altered to most equitably allocate cost. As an example, some programs have involved surface water rate structures that consider the unique maintenance and capital requirements for each basin.

b. Process to Implement Database. Given the fact that Mount Vernon has a billing system in place for solid waste and sewer, economies of scale can be gained if a surface water service charge were to be added. However, there will be a one time cost in preparing the data base for surface water customer accounts.

c. Equity. The optimal approach for funding any infrastructure program is to allocate the cost of service/facilities based on levels of use. The stronger the correlation between use of the system and individual level of payment, the greater the equity of the cost allocation methodology. Jurisdictions employing surface water service charges (based on a measure of impervious surface for an individual property) have done so because, as a public utility, there must be a relationship between surface water rates and use of the surface water system.

Given the chief criteria of equity, flexibility and overall revenue capacity, the surface water service charge was endorsed by the Citizen's Committee as the optimal primary revenue source. The Committee also determined that secondary funding sources should be evaluated to further refine the equity of the revenue base.

5. Funding Recommendation and Citizen's Committee Evaluation

The Citizen's Committee's evaluation of the primary revenue sources available to support the overall surface water program resulted in the following direction to staff:

> A (surface water utility) service charge should be implemented based on a property's contribution of runoff to the surface water system with single family residences treated as one residential/dwelling service unit and other properties charged based on their estimated total runoff as primarily determined by the amount of impervious surface.

Based on the financial directions established through the Committee, the dedicated, predictable and consistent element for nonpoint management is the surface water service charge. At the same time, the flexibility to implement essential secondary funding options is preserved as the overall funding mix for addressing surface water quality and quantity needs is determined.

6. Program Directions and Costs

The services to be provided through the surface water management program emphasize activities that will enable the program to meet water quality requirements and, from an overall surface water management perspective, "not let current problems get worse." The program responds to the need for Mount Vernon to begin thinking of surface water quality and quantity management as an on-going and critical component of the public infrastructure. In order to begin this process, the initial program establishes a capital improvement schedule and a commitment to maintenance; implements a nonpoint source management plan; promotes regulatory and design criteria consistency; and actively involves the public with surface water management issues.

Revenue requirements for the surface water program have been prepared for the following budget categories (FY 95-96):

- Maintenance
- Engineering, Regulation, Erosion Control
- Operations
- Public Education
- Administration/Billing
- Utility Taxes
- Sewer Fund Repayment
- Capital Improvement

The functional service areas for the initial surface water program are summarized below.

a. Maintenance. There will be an increased emphasis on field maintenance operations throughout the City. Preservation of natural conditions while maintaining the hydrologic characteristics of these drainages is a delicate balance which often results in more labor intensive procedures for maintenance of these systems. This emphasis, in addition to the increased frequencies and enhanced maintenance procedures necessary to realize water quality nonpoint source reductions, will require a commensurate commitment of resources to this program element.

1995 Budget $195,300

b. Engineering, Regulation, and Erosion Control.

(1) Water Quality Management—Implementation of a water quality nonpoint source pollution control program will require additional expenditures for monitoring, enforcement and problem mitigation. Therefore, compliance monitoring will be an on-going and expanding cost to the City.

It should be emphasized that activities related to compliance with state, and possible federal, surface water regulations are contained in virtually all the budget categories. The costs contained in water quality management are specific to a response to the regulatory requirements issued by the PSWQA and EPA.

(2) Engineering Services—This function involves implementation of the projects identified in the management plan in a manner that is consistent with water quality flood control, and sensitive resource preservation policies and programs. With the management plan, overall guidance can be provided for directing the program toward more than meeting nonpoint source load allocations, but developing a full range of surface water services to the City. This document also provides the necessary data for estimating program costs and establishing legally defensible system development charges.

This program element will also be the lead in water quality nonpoint source management and will work with all program areas in assuring that: (a) a nonpoint source identification/monitoring program is implemented (b) control strategies are implemented, and (c) pollutant load reductions are achieved and measured. This process will include the necessary monitoring to measure the impacts of various nonpoint source mitigation measures in the field. This program area will also play a key role in water quality related regulations and conduct special analyses as required to evaluate the effectiveness of nonpoint source technologies.

The Engineering element will provide lead technical support for all surface water program areas and be a direct service provider in the area of plan review, design, field inspection and enforcement, including erosion and sedimentation control. While project management will be an increasingly important function, emphasis will also be placed on non-structural program planning. Initial program priorities will include preparing consistent design criteria and standards, developing an accurate surface water system inventory and implementing a hazard mitigation program. An overall physical feature (structures, floodplain, streams, problem areas, hazard locations) and problems assessment of the surface water system within the service area has not been prepared but will be an important element within this program heading.

The non-structural regulatory functions include enforcement and overseeing of surface water policies within the service area. It is through enforcement of the regulatory provisions that the overall surface water management program will be applied on a consistent basis and maximize nonpoint load reductions from all tributaries in the service area. Also, this mechanism provides the means to monitor the consistent application of standards and criteria to provide a uniform level of water quality, flood, and sensitive resource protection to the public.

1995 Budget $88,200

c. Operations. This function involves costs related to operational factors such as supplies, energy and equipment services.

1995 Budget $41,000

d. Public Education. Includes expenditures for public awareness brochures/flyers regarding surface water program needs, costs and rates. Billing stuffers and newsletters will also be developed as part of the short term utility implementation information effort and longer term program of public involvement regarding site quantity/quality controls.

1995 Budget $16,000

e. Finance/Billing/Accounting/Payroll. Are the utility support functions related to surface water data processing, invoicing, remittance handling and accounting? The surface water program's *pro rata* share of revenue generated in relation to the City's other utility programs is estimated based on projected staffing impacts and allocations based on the total number of additional accounts generated as a result of the program.

1995 Budget $21,000

f. Utility Taxes. For the upcoming year, includes state utility taxes and other costs which are allocated to Mount Vernon's surface water utility for city manager, city attorney and human resources time. This category also includes the utilities allocation for general government support.

1995 Budget $72,000

g. Sewer Fund Repayment. A loan from the Sewer Fund to support development of the Surface Water Master Plan is being paid back in equal installments through the year 2000.

1995 Budget $40,000

h. Capital Improvement Program. The Master Plan has identified numerous important projects to be scheduled over a 20-year planning period. A key element of the financial analysis is determining whether these projects will be funded on a "pay as you go" basis versus the debt service options discussed previously. In reviewing the financing strategies within the context of the projects, the Committee expressed its desire to minimize debt service costs while implementing a ramping of rates. As these options are further evaluated with the Committee, annual capital costs will be determined. Additional analysis on the funding of capital projects has been performed and is included in Appendix L, *Engineering Report Debt-Funded Stormwater Capital Projects*, April 1995, and this analysis was updated as described below. The Capital Improvements Program is listed on Table X-1 in the following section.

7. Historical and Forecasted Cash Flows

Historical and Forecasted Cash Flows for the Mount Vernon Surface Water Utility are shown in Section 4 of the *Engineering Report Debt-Funded Stormwater Capital Projects* contained in Appendix L. This cash flow analysis has been updated to:

- Reflect escalation of 1993 cost estimates to 1995 prices
- Update design costs for the Riverbend Road Pump Station
- Solve the flooding problem at the Park Village Trailer Court
- Update costs to provide adequate conveyance capacity in a tributary to Kulshan Creek across Continental Place and College Way.

This updated cash flow analysis is shown on Table IX-1.

D. Billing/Service Charge Implementation

The Citizen's Committee reviewed and voted on staff recommendations contained in a series of "issue papers." These papers, designed as decision tools for development of the surface water utility rate structure, became the building blocks of the rate structure.

This recommendation and the supporting issue papers were presented to Council with the following recommendations:

1. Three specific policies should be reflected in the surface water service charge:
   - Undeveloped properties, defined as those properties left in a natural state, would not be included in the service charge.
   - All publicly owned property should be included in the surface water service charge, except publicly owned streets which operate as part of the City's storm water conveyance system.
   - No exemptions be allowed from the rate based on property use (other than undeveloped) or tax exempt status.
2. The surface water service charge should be set at a level that recovers total surface water program costs while recognizing the cumulative impact of rates for water, sewer and solid waste.

3. Implementation of the surface water rate be accomplished in a manner that allows adequate time to inform the public about the program, regulatory mandates, costs and rate approach.

Based on these rate provisions, project staff and the City Attorney were directed to prepare a utility formation ordinance and a second ordinance establishing a system and structure for rates. These ordinances are contained in Appendix K.

The Project Team began the process of developing a customer inventory and surface water service charge system for all properties within Mount Vernon. This process involved not only Project Team members but also included utility billing personnel from the City's Finance Department and EDEN Systems (the City's Utility Billing software/programming consultant) in constructing an accurate data base on impervious area and downloading this data into a utility billing system.

City of Mount Vernon
Surface Water Program
Cash Flow Analysis

Table IX-1
CASH FLOW ANALYSIS

Term (yrs.) of Interfund Loan:	6
Kulshan Creek Alternative:	5
RS1 Year of Construction:	1996
Year Staff Added:	1995

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assumed Monthly Rate:	$3.95	$3.95	$5.35	$5.35	$6.05	$6.05	$6.05	$6.05	$6.05
Assumed Growth:	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Assumed # of ESUs:	15,190	15,494	15,804	16,120	16,442	16,771	17,106	17,448	17,797
Assumed Bond Issue: (1)	$0	$2,084,875	$0	$0	$0	$0	$0	$0	$0
Assumed PWTF Loan (2)	$0	$3,100,000	$0	$0	$0	$0	$0	$0	$0

	Estimated Cash Flow								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beginning Balance	$477,962	$584,960	$293,268	$67,062	$57,798	$178,734	$320,442	$228,608	$354,042
Revenues									
Rate Revenue	$720,000	$734,400	$1,014,588	$1,034,879	$1,193,690	$1,217,564	$1,241,915	$1,266,753	$1,292,088
Fund Earnings	$22,703	$27,786	$13,930	$3,185	$2,745	$8,490	$15,221	$10,859	$16,817
Rev. Bond Proceeds	$0	$1,825,531	$0	$0	$0	$0	$0	$0	$0
PWTF Loan Proceeds	$0	$3,100,000	$0	$0	$0	$0	$0	$0	$0
Total Available Funds	$1,220,666	$6,272,676	$1,321,786	$1,105,126	$1,254,233	$1,404,787	$1,577,578	$1,506,220	$1,662,947
Expenditures									
Operating Expenses	$473,500	$455,175	$477,934	$501,830	$526,922	$553,268	$580,931	$609,978	$640,477
Capital Spending	$123,184	$5,325,320	$284,813	$58,415	$66,390	$53,784	$334,661	$113,719	$117,995
Interfund Loan Repayment	$39,022	$39,022	$39,022	$39,022	$39,022	$39,022	$0	$0	$0
Rev. Bond Debt Service	$0	$145,941	$196,797	$196,797	$196,797	$196,797	$196,797	$196,797	$196,797
PWTF Debt Service	$0	$13,950	$256,158	$251,263	$246,368	$241,474	$236,579	$231,684	$226,789
Total Expenditures	$635,706	$5,979,408	$1,254,724	$1,047,328	$1,075,500	$1,084,345	$1,348,969	$1,152,179	$1,182,058
Ending Balance	$584,960	$293,268	$67,062	$57,798	$178,734	$320,442	$228,608	$354,042	$480,888
Coverage Attained	0.00	2.10	2.80	2.72	3.40	3.42	3.44	3.39	3.40
Target Balance (3)	$38,918	$37,412	$39,282	$41,246	$43,309	$45,474	$47,748	$50,135	$52,642

NOTES
1 Assumes bond reserve funded with proceeds.
2 Assumed match: 10% ; Interest rate: 3.00% ; 1st yr draw: 15% .
3 Target balance = 30 days of cash operating expenses.

Shaun Pigott Associates / FCS Group
Last Edited: 03-Nov-95

SECTION X
RECOMMENDED PLAN

SECTION X

RECOMMENDED PLAN

A. General

The recommended plan consists of five major components and includes non-structural (regulatory) recommendations, structural solutions (capital improvements), operations and maintenance program, financing plan, and interjurisdictional coordination. Collectively, these components will help solve current and future water quality and flooding problems, preserve and enhance valuable environmental resources, and establish a comprehensive and long-term approach to surface water management.

In general, non-structural solutions were emphasized to solve these problems because they do not require major capital expenditures. Non-structural solutions include public education, policies, ordinances and regulations, maintenance, monitoring and investigative studies. Where non-structural solutions could not, by themselves, solve these problems, structural solutions were recommended to supplement non-structural solutions. Recommended non-structural and structural solutions were developed in Section VII. The recommended operations and maintenance program was developed in Section VIII. The recommended financing plan was developed in Section IX.

This section also lists the goals and objectives that were developed in Section II and provides an explanation of how these goals and objectives can be achieved by implementing the recommended solutions.

Table X-1 lists the capital improvements plan. All costs are in 1995 dollars. This table also identifies relative priorities for implementation. These priorities were generally arrived at by considering, in order of importance, safety and human health, potential for property damage, correcting environmental problems, and enhancing environmental resources. The 1995 costs were escalated at 4.5 percent per year to show the future project cost in the year it is scheduled for implementation.

B. Cost Estimates

Cost estimates were developed for the recommended structural solutions. Cost estimates for several problems have been updated as part of several design projects and review of developer proposals. These estimates are shown in Appendix E. Estimates for the remaining problems have been taken from the 1993 draft plan and escalated at 4.5 percent per year for two years. The 1993 estimates for the problem solutions prior to escalation to 1995 costs are also shown in Appendix E. The 1993 cost estimates include an allowance for mobilization of 10 percent; construction contingency of 30 percent; state sales tax of 8 percent; administration of 2 percent; and surveying, permitting and engineering of 30 percent. All cost estimates are based on 1993 costs with an ENR construction cost index of 5,600.

C. Recommended Plan

1. Recommended Non-Structural Solutions

a. Public Education. The benefits of a strong public education program have been demonstrated by other communities and is recommended as a high priority for the City of Mount Vernon. The public education program should include elements to protect and improve water quality, protect against flooding, and preserve environmental resources. The purpose of public education is to increase the understanding of citizens and business owners about flood control and how their actions can affect water quality and environmental resources. The program should foster public ownership of and responsibility for stormwater quality and quantity.

Public education was identified as a solution, or as one component of a solution for several drainage system, water quality and environmental resource problems described in Section VII. A summary of the recommended public education elements is provided below; more specific detail about each of the program elements is contained in Section VII.

(1) Maintenance of Private Systems: Develop an educational program that educates commercial and industrial business owners of the benefits of proper catch basin cleaning and maintenance of detention systems. Information could be distributed in the form of flyers, town meetings, newspaper articles, outreach by City staff, and workshops. In addition, the City should adopt an ordinance requiring maintenance of private facilities similar to the model ordinance in Appendix J.

(2) Proper Erosion Control: Develop a program to inform and educate area contractors about the new erosion control requirements that the City has implemented as part of the new drainage ordinance that complies with the Puget Sound Water Quality Management Plan. It is suggested that the City develop this program jointly with Skagit County. A coordinated joint program would likely be more effective in attracting area contractors.

(3) Source Controls: Develop a public education program that encourages source control of stormwater pollution and includes the following objectives:

(a) Residents should reduce the use of household products that are harmful to the environment. When these products are used, they should be disposed of as hazardous waste at the County's new Moderate Risk Waste Collection Center.

(b) Eliminate illegal dumping of oils, liquid waste products, lawn clippings, pet waste and other pollution sources by the public and area businesses.

(c) Reduce stormwater exposure whenever and wherever possible through the use of recommended BMPs.

(d) Use pesticides and herbicides wisely and always follow application instructions. Also, whenever possible implement an Integrated Pest Management Plan (IPMP) rather than use chemical treatment.

(e) Implement public education programs such as those indicated in Table VII-4 and in Ecology's *Stormwater Program Guidance Manual for the Puget Sound Basin*, Volume 2. Develop an educational program that educates commercial and industrial business owners of proper catch basin cleaning. Information could be distributed in the form of flyers, town meetings, newspaper articles and workshops. This education program can be a component of an overall public education program. The recommended overall commitment to an effective education program will require at least 25% to 30% of the City's new stormwater manager's time.

(4) Spill Response: Develop a public education program to inform individuals of what to do in the event of a spill such as to report spills immediately using the 911 telephone number.

(5) Illicit Dumping: Develop a public educational program to inform the public of the impact to stormwater quality associated with illicit dumping of waste.

(6) Riparian Corridors: Develop an education program to increase community awareness of stream resources. The City could establish a volunteer program with school children or interested citizens, to assist in a planting program. The planting program would include planting additional native plant species to improve the quality of stream corridors by increasing cover, shade, visual buffer and filtration functions. The City should coordinate this effort with the Department of Fisheries to define the corridors most needing improvement. Several capital projects to help restore and enhance fish habitat could use volunteer labor for some portions of the work.

(7) Wetlands: Public information programs concerning the value of wetlands should be incorporated into the public education program.

(8) Agriculture BMPs: The City should coordinate with area farmers to maintain riparian vegetation that will improve filtration of pollutants and reduce erosion thereby improving water quality. The City should prepare a public education program to inform farmers of the importance of riparian vegetation for water quality protection. Example BMPs include:

- use fences to keep farm animals out of the area creeks.

- cover manure piles with plastic or spreading manure piles to avoid a concentrated pollution source, and

- maintain riparian vegetation along streams to improve filtration of pollutants and reduce erosion thereby improving water quality

To be effective, the above public education programs should be ongoing. It is therefore recommended that the City's new surface water manager be responsible for implementing and maintaining these education programs. It is estimated that these programs would require approximately a one-quarter to one-third full time staff equivalent.

b. Recommended Changes to Policies, Ordinance, and Regulations.

(1) Enforce the new drainage ordinance consistent with the minimum requirements of Ecology's *Stormwater Management Manual for the Puget Sound Basin.* The ordinance is contained in Appendix I.

The City should implement the new standards with a public education program designed to inform and educate affected parties about the new regulations. These public education programs were described earlier in this section. The City should attempt to use education as the primary mechanism to successfully implement the new regulations, and then enforcement as a last resort for those who fail to comply.

(2) Adopt a new ordinance requiring maintenance of privately owned stormwater control facilities. A draft model ordinance is contained in Appendix J.

(3) Enforce the new drainage ordinance provisions to deter illegal dumping. The drainage ordinance in Appendix I includes provisions to deter illegal dumping of material into or near the drainage system. Increased enforcement and prosecution of illicit dumpers will help to reduce the problem. Local citizens should be encouraged to report any illicit dumping to further help prevent these actions.

(4) Review existing wetland protection standards and wetlands management strategy. The City should review its Critical Areas Ordinance and evaluate the need to develop a rating system accompanied by associated buffer size. Whether the City should sponsor a programmatic solution such as mitigation banking or a SAMP for managing wetlands, is a policy decision that should be made by City staff and elected officials.

(5) Require fences to keep animals out of area streams. The City should improve water quality by adopting an ordinance requiring the use of fences

to keep farm animals out of area streams. The effort to install fences within the City should include a public education program for farm owners, development of an ordinance requiring the use of fences, and the possible development of assistance programs such as low interest loans for farmers to lessen the cost of fence installation.

(6) Require sewer construction for new construction. The City should establish a policy of requiring sewer construction for new construction in areas to be annexed to the City.

c. Monitoring/Investigative Studies.

(1) Investigating/Monitoring Program. The City should conduct a monitoring and investigative program for water quality parameters. Six sampling events should be used. All major stream systems and outfalls should be sampled during each sampling effort. These pollutants include:

- Total petroleum hydrocarbons
- Suspended solids
- Nitrate plus Nitrite Nitrogen
- Total phosphorus
- pH
- Ammonia Nitrogen
- Temperature
- Lead
- Copper
- Zinc
- Dissolved oxygen
- Hardness

Sampling for these pollutants would provide additional information about the quality of water entering receiving waters and could be evaluated to determine the existence of other water quality problems in the City. This data could also be used as baseline information to evaluate the effectiveness of source control programs. It is recommended that the City conduct the monitoring program initially as a high priority and then a second time, a few years later, to determine the effectiveness of source control programs. In addition, this sampling program should include some sediment sampling in the Kulshan Creek Basin.

(2) Spill Containment Needs Assessment. The City should conduct a study to identify the need for spill containment facilities to prevent transportation related spills from entering area streams and the Skagit River. This work would be accomplished by the City's new stormwater manager.

(3) Emergency Spill Response Program. The City should implement a emergency spill response program. A City staff person should be assigned to develop information on how to handle transportation and storage related spills. This staff person should then educate the fire department on appropriate methods and procedures. The staff person should also provide the fire department with all the necessary information on the City's storm drain system layout and the major outfalls to area streams and the Skagit River. The City should develop a comprehensive information network to

facilitate communication between the public, city staff, agencies and fire department spill clean up personnel in the event of a spill. The City should conduct an inventory of industrial facilities that store hazardous materials and keep their drainage system maps on file at the City and Fire Department. Those facilities with SIC codes of concern that are in close proximity to water resource should be made a priority for spill prevention and containment facilities and programs. In addition, information on these sites should be available to the fire department and routine monitoring and inspection of these facilities should be performed. This work should be coordinated by the City's stormwater manager.

d. Maintenance.

(1) Increase the Frequency of Catch Basin Cleaning. The City should increase the frequency of catch basin cleaning from once a year to once every eight months. Increasing the frequency of catch basin cleaning is part of the recommended maintenance and operation plan, discussed in Section VII. In addition, the City should identify areas of potential high pollutant loading, such as streets that receive runoff from shopping center parking lots and develop more frequent cleaning schedules for these areas, such as once every three months during the rainy season, or at least once every six months.

(2) Maintain Ditches to Preserve Vegetative Lining. Ditch maintenance should preserve vegetation lining to prevent erosion and to capture pollutants. Vegetation should only be disturbed when it is necessary to remove sediments in order to regain hydraulic capacity. When this type of ditch maintenance is required, it is best done so that some vegetative material remains to regenerate the vegetation lining. Reseeding or sodding of ditches should be performed as required to help prevent erosion.

2. Recommended Structural Solutions

a. General. Table X-1 lists the recommended structural solutions that were developed in Section VII. Structural solutions were developed to solve both regional and local system problems, water quality problems, and sensitive environmental resource problems.

b. Regional System Structural Recommendations.

- To provide adequate flood protection for the full development of the Freeway Drive basin, a 2,600-foot, 48-inch gravity main and a 25-cfs pump station should be constructed. The 48-inch gravity flow pipe would begin at the Eagle Hardware detention pond and run south along the western city boundary to a new pump station located near the Skagit River along Riverbend Road. The pump station would only operate under high water conditions in the Skagit River. This solution would limit the Eagle Hardware detention pond overtopping to about once in 100 years.

- To prevent Kulshan Creek from overtopping Parker Way and possible local flooding upstream, two additional 36-inch diameter culverts are needed to supplement the capacity of the existing two 36-inch-diameter culverts.

- To prevent local flooding upstream of the pipe systems across College Way and Continental Place along a tributary to Kulshan Creek, a parallel 54-inch concrete or 6.42 x 4.33 CMP pipe arch should be constructed. An additional 36-inch CMP culvert should also be constructed across Continental Place.

- As discussed in Section VII, the City should construct a 210-cfs pump station for Kulshan Creek in the City-maintenance yard east of Interstate 5. Increase conveyance with the addition of a 72-inch-diameter gravity flow pipe from Riverside Drive to the new pump station, and a second 48-inch-diameter force main from the pump station to the outlet structure west of I-5. This project can be phased as discussed previously.

- Construct modifications along Madox Creek to the Little Mountain Estates Pond.

- Construct bio-engineered stream channel protection that will prevent further erosion along Madox Creek. Prior to constructing any channel protection, a detailed examination of the erosion potential and further geotechnical and geomorphic investigations should be performed to determine the likelihood and risk of continued erosion, and to recommend what type of remedial actions should be taken.

- Work with the developer to construct a high flow bypass on Flowers Creek.

c. Local System Structural Recommendations. Local - system structural recommendations are shown on Table X-1 and described in Section VII.

d. Water Quality Structural Recommendations. As shown on Table X-1 and described in Section VII, water quality structural recommendations consist of a water quality sampling program, and a program to install oil/water separators where sampling results indicate problems with oil and grease.

e. Sensitive Environmental Resource Structural Recommendations. Sensitive environmental resource structural recommendations are shown on Table X-1 and described in Section VII.

3. Recommended Maintenance and Operations Plan

The purpose of a Maintenance and Operations Program is to ensure system reliability, achieve the lowest life-cycle cost for facility replacement, and to use maintenance methods and standards that promote water quality. The recommended stormwater maintenance and operations program will require an annual budget of approximately $195,300, including the equivalent of approximately three full-time staff persons. This represents a slight increase of the current budget and the addition of two maintenance workers. Specific maintenance and operation recommendations include increasing the frequency of catch basin cleaning an average of once every eight months; more maintenance of pipes and small culverts; maintenance of stormwater pump stations; modified maintenance of roadside ditches; purchasing equipment; and, purchasing and implementing a maintenance management software package to support the reporting, scheduling, and completion of maintenance activities.

4. Recommended Financial Plan

The purpose of the financial plan is to develop a financial strategy that will support the recommended surface water management program on a long-term basis. Now that the surface water utility is in place, the overall financial plan is described in more detail in the document *Engineering Report Debt-Funded Stormwater Capital Projects*, April 1995, in Appendix L, as well as updated cash flow projections in Section IX.

Available state and federal grant programs should also be utilized whenever possible, particularly to implement the recommended capital improvement program. Grant funds, as well as other secondary funding sources, can serve to reduce the need for anticipated rate increases.

5. Interjurisdictional Coordination

Many of the recommendations included in this plan will require interjurisdictional coordination. Opportunities may also exist for joint funding of projects. Some of the major coordination efforts are listed in the following paragraphs.

a. Coordination with the Washington State Department of Transportation regarding recommended drainage improvements along state highways.

b. Coordination with Skagit County regarding possible joint public education efforts, and a consistent approach to stormwater management regulations.

c. Coordination with Drainage District 17 and Skagit County on future preparation of a watershed plan for Madox Creek.

d. Coordination of the City's plan with the watershed plan recently completed by Skagit County for Nookachamps Creek. The Nookachamps Creek Plan did not evaluate specific non-point problems related to stormwater runoff, because it suggested these issues are already being addressed by Mount Vernon and Skagit

County in their respective plans. The Nookachamps Plan does recommend that Mount Vernon adopt clearing and grading ordinances that meet the intent of Ecology's minimum requirements (this ordinance was adopted by the City in July 1995). The Nookachamps Plan also recommends that a memorandum of agreement be developed between Mount Vernon and Skagit County to define a process for project review when a development proposal in either jurisdiction can have an impact on surface water resources in the other jurisdiction. The Nookachamps Plan also recommends that the City of Mount Vernon fund pollution control equipment on drainage systems that are part of the Nookachamps basin. The Nookachamps Plan also recommends that the City of Mount Vernon allocate a specific percentage of time for an inspector to inspect drainage projects in the City that are also in the Nookachamps Watershed. The Nookachamps Plan also recommends that the City of Mount Vernon should implement a storm drain stenciling program. The Nookachamps Plan also recommends cross training Skagit County and Mount Vernon staff involved in permitting and inspection to identify code violations that might impact water quality. The Nookachamps Plan also recommends education forums for Skagit County Commissioners and the Mount Vernon City Council on stream protection and recycling programs.

e. Coordination with the Washington State Department of Fisheries regarding habitat management and improvements to the area streams.

D. Plan Goals

Implementation of the recommended solutions will enable the City to achieve the goals and objectives that were defined in Section II. The following paragraphs provide an explanation of how these goals and objectives can be achieved by implementing the recommended solutions.

Goal #1 - Prevent property damage from flooding

a. **OBJECTIVE:** Require adequate peak flow controls for new development.

This objective has been accomplished because the City has adopted a new drainage ordinance consistent with the minimum requirements contained in Ecology's *Stormwater Management Manual for the Puget Sound Basin*. This ordinance includes requirements for peak flow controls. The ordinance is contained in Appendix I.

b. **OBJECTIVE:** Perform the necessary analysis and recommend solutions for existing flooding problems.

As discussed in Section VII, the existing drainage system was analyzed to determine existing conveyance problems, and problems that might occur under future development conditions as well. Solutions to these problems are presented in the recommended plan under both the regional and local system solutions.

c. **OBJECTIVE:** Employ management strategies in flood prone areas to ensure that new development is not exposed to significant flood risk.

The recommended plan includes a number of management strategies to minimize flood risk. These include enforcement of the new drainage ordinance with strict detention standards, and requirements for an offsite analysis to determine any adverse impacts downstream. The plan also includes management strategies for streamside corridors and wetlands that will also minimize flood risk for new development.

<u>Goal #2</u> - Maintain good water quality

a. **OBJECTIVE:** Attempt to meet state Class A Water Quality Standards in area streams.

A number of recommendations for are proposed for improving water quality such as a public education program, source controls, erosion control, maintenance, spill response, prevention of illicit dumping, wetland protection, new ordinances, and residential, commercial, and agricultural water quality BMPs. A sampling program has also been recommended to monitor water quality parameters and progress towards achieving water quality goals.

b. **OBJECTIVE:** Require adequate erosion and sedimentation controls from new construction sites.

This objective has been accomplished because the City adopted a new drainage ordinance consistent with the minimum requirements contained in Ecology's *Stormwater Management Manual for the Puget Sound Basin*. This ordinance includes requirements for erosion and sediment controls. The ordinance is contained in Appendix I.

c. **OBJECTIVE:** Require adequate water quality controls for new development.

This objective has been accomplished because the City adopted a new drainage ordinance consistent with the minimum requirements contained in Ecology's *Stormwater Management Manual for the Puget Sound Basin*. This ordinance includes requirements for water quality BMPs. The ordinance is contained in Appendix I.

d. **OBJECTIVE:** Implement public education programs to reduce the source of pollutants entering surface waters.

The plan recommends that a public education program be implemented to improve stormwater quality. This education program includes components to inform citizens about surface water quality source controls, erosion control, spill response, prevention of illicit dumping, maintenance of private drainage systems, and residential, commercial, and agricultural water quality BMPs.

Goal #3 - Preserve sensitive resources and maintain varied use

a. **OBJECTIVE:** Preserve fish and wildlife habitat.

The plan includes a number of preservation and enhancement projects for fish habitat. The plan includes an inventory of City streams by category, and the City's Critical Areas Ordinance provides adequate protection for stream corridors by specifying minimum setback requirements according to the stream category.

b. **OBJECTIVE:** Preserve wetlands and implement a wetlands management strategy.

The plan includes a recommendation that the City review the wetlands management section of the City's Critical Areas Ordinance to determine the need for a wetland classification system and associated buffers. The report also suggests several alternative wetlands management strategies with the recommendation that these be reviewed and that a policy decision be made as to which alternative should be implemented.

c. **OBJECTIVE:** Provide public access and recreation opportunities.

The plan does not include specific recommendations on public access and recreation opportunities. A number of opportunities exist within areas along the City's streams for trails and passive recreation. If these recreational opportunities are pursued, additional buffer requirements may be necessary so that human recreation does not interfere with fish and wildlife habitat needs.

d. **OBJECTIVE:** Preserve open space.

The plan does not include specific recommendations on preserving open space, but recommendations on preservation of wetlands and fish habitat will preserve open space associated with surface water resources.

e. **OBJECTIVE:** Review the City's Sensitive Areas Ordinance to ensure consistency with the surface water management program goals.

As mentioned previously, the plan includes a recommendation to that the City review the wetlands management section of the City's Critical Areas Ordinance to determine the need for a wetland classification system and associated buffers.

Goal #4 - Develop a continuous and comprehensive program for managing surface water.

a. **OBJECTIVE:** Ensure a dedicated funding source for program implementation.

The City has implemented a surface water utility as the primary funding source for implementing the plan.

b. **OBJECTIVE:** Coordinate the City program with the Skagit County program.

Several recommendation have been included to coordinate the City of Mount Vernon's program with programs in Skagit County and adjacent drainage districts. These include coordination with Drainage District 17 and Skagit County on future preparation of a watershed plan for Madox Creek. The plan also lists the recommendations as they relate to Mount Vernon from the Nookachamps Creek Watershed Plan prepared by Skagit County.

11/15/95

Table X-1
CITY OF MOUNT VERNON CAPITAL IMPROVEMENT PLAN

REGIONAL SYSTEM PROBLEMS

Problem No	Location	1995 Costs	Escalated Costs 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
RS1	Construct new Riverbend Road (Freeway Drive) System	1750000		1750																	
RS1	Design new Riverbend Road (Freeway Drive) System	242000	121	121																	
RS2	Install two additional 36" culverts at Parker Way	13000									19										
RS3	Culvert replacement at College Way update price	109000							142												
RS4a	Kulshan Creek Pump Station Phase I (1)	3339000		3489																	
RS4b	Kulshan Creek Pump Station Phase II - Beyond 20 Years	672000																			
RS6	Little Mountain Estates Detention Pond modifications	Developer Build																			
RS7	Erosion control on Madox Creek	393000										584									
RS8	Madox Creek-Drainage District 17 Study	44000			48																

LOCAL SYSTEM PROBLEMS

Problem No	Location	Cost	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LS6	Install log bed control weir to control erosion north of Cedar Lane	11000			12																
LS7	MH drop structure and pipe extension on Kulshan tributary near Viewmount	48000			52																
LS8	Culvert replacement along N 16th north of Florence	29000											46								
LS9	Park Village Mobile Home Park	53000							69												
LS10	Culvert Replacement at Kiowa and Seneca	22000			24																
LS11	Install trashrack at storm drain inlet near Kiowa and Nez Percé	500			1																
LS12	Replace storm drain system in W. Mount Vernon along Memorial Highway	557000														987					
LS13	Install additional catchbasins at Wall Street and Garfield Street	14000			16																
LS14	Install a new catchbasin and storm drain connection at Wall Street north of Memorial Hwy	40000								55											
LS15	Replace 16 of the storm drains between Division and Fir just west of LaVenture	371000																		785	
LS16	Install log bed control weir in stream between Mohawk and Apache.	11000								15											
LS17	Install culvert and ditch at Comanche Drive	14000									20										
LS18	Culvert replacement at Shoshone east of Sioux	24000							31												
LS19	Install armoured spillway in two detention ponds near Waugh and Division	59000											92								
LS20	Install storm drain west of S 6th upto Lind and connect to Madox tributary	155000										230									
LS22	Install catchbasin and storm drain connection for the NW corner of Riverside and Fir	100000													170						
LS23	Install storm drain connection along I-5 between Cameron and Kulshan Pump Station	73000															135				
LS25	Replace 3 pipes between Britt Slough and Blackburn Road	284000																	574		
LS26a	Upgrade drainage system on Fox Hill Street - Replace Pipes in Street	235000										349									
LS26b	Upgrade drainage system on Fox Hill Street - Install Pipe in Deep Ditch	66000			72																
LS27	Replace 2 pipes along I-5 between Blackburn and Anderson Road	50000															93				

WATER QUALITY PROBLEMS

Problem No	Location	Cost	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
WQ1	Water Quality Monitoring Program	39000			21							29									
WQ3	Oil/water separators	328000			21	22	23	24	25	26	27	29	30	31	33	34	36	37	39	41	43

ENVIRONMENTAL RESOURCE PROBLEMS

Problem No	Location	Cost	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
E1	Kulshan Creek Pump Station - Fish ladder	Included in RS4																			
E2	Manhole barrier in Kulshan east of Railroad	2000	2																		
E3	Log weir fish structure - Kulshan Creek north of Cedar Lane	11000						14													
E4	Restore channel on Kulshan from Riverside to N 18th (2,200 feet)	104000				15		16		18		19		21		23		25		27	
E5	Restore channel on mainstem of Trumpeter (7,000 feet)	328000			40		43		47		52		57		62		67		74		80
E10	Remove Culvert and restore stream channel on Madox near Anderson	40000																		B5	
E11	Log weir fish passage structure d/s of culvert on Madox Creek at Blackburn Road	11000																			24
E13	Add riparian vegetation on Flowers Creek between Madox and Blodgett (1,500 feet)	38000				44															
E14	Log weir fish passage structure on Flowers Creek at Blodgett Road	11000																			24
E15	Restore channel on Carpenter Creek along Bacon Road (1,600 feet - one side)	21000																			46

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	$9,711,500	123	5360	306	80	66	54	315	114	118	1241	224	52	265	1044	332	62	687	938	217
Total 1995-2004	$7,129,500																			
Total -After 2005	$2,582,000																			

(1) Project cost adjusted to reflect $724,500 grant.

SECTION XI
BIBLIOGRAPHY

SECTION XI

BIBLIOGRAPHY

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FINAL

City of Mount Vernon Comprehensive Stormwater Management Plan Update

Prepared for

City of Mount Vernon, Washington

Mount Vernon

November 2004

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SECTION 1: INTRODUCTION

City of Mount Vernon Comprehensive Stormwater Management Plan Update

1. Introduction

1.1 Background

The purpose of the Comprehensive Stormwater Management Plan Update (Stormwater Plan Update) is to provide an update to the strategic framework for the management of stormwater within Mount Vernon. The Stormwater Plan Update is intended to be a flexible document that may be readily revised should the priorities and focus of the City change. It is also intended to act as a reference for other City departments whose activities may impact storm and surface water and could be affected by drainage.

Because this is an Update to an existing plan, the 1995 Comprehensive Surface Water Management Plan (1995 Surface Water Plan) will be referenced frequently and should be considered a companion document. As a general practice, only new material, findings, and recommendations will be included in this update. Occasionally material from the existing plan will be re-iterated in the interest of clearly communicating a point.

The role of surface water management in Mount Vernon is to:

1. Respect and preserve the City's watercourses
2. Minimize water quality degradation and control sedimentation of creeks, streams, ponds, lakes, and other water bodies
3. Protect the life, health, and property of the general public
4. Preserve and enhance the suitability of waters for contact recreation and fish habitat
5. Preserve and enhance the aesthetic quality of the waters
6. Maintain and protect valuable ground water quantities, locations, and flow patterns
7. Insure the safety of City roads and rights-of-way
8. Decrease drainage-related damages to public and private property

The City uses the following tools and regulations to manage stormwater:

- Mount Vernon Comprehensive Surface Water Management Plan, (R.W. Beck and Associates, November 1995) (1995 Surface Water Plan)
- Mount Vernon Comprehensive Plan (January 1995)
- Mount Vernon Municipal Code (Specifically, Chapter 2673, Chapter 16.32, and Chapter 15.36)

- Mount Vernon Development Code (Title 13, Sewers; Title 14, Land Use and Development; and Title 15, Buildings and Construction)
- Comprehensive Sewer and Combined Sewer Overflow Reduction Plans for the City of Mount Vernon (R.W. Beck and Associates, 1991)
- Critical Areas Ordinance #2482 (February, 1992)
- Section 4(d) of the Endangered Species Act (National Marine Fisheries Service)
- Shoreline Management Act (RCW Chapter 90.58, 1971) and the Skagit County Shoreline Master Program (developed in 1976 in accordance with the State Shorelines Management Act)
- State Hydraulic Code (RCW Chapter 75.20.100-140, 1949)
- State 402 (Water Quality) Certification
- Coastal Zone Management Determinations
- Floodplain Management Program
- State Environmental Policy Act (1971, with new implementation rules adopted in 1984, WAC Chapter 197-11)
- Puget Sound Water Quality Management Plan (Puget Sound Water Quality Authority, 1994)
- NPDES Phase II Minimum Control Measures (EPA, October 1990)
- Sections 401 and 404 of the Clean Water Act
- Section 10 of the River and Harbor Act of (1899)
- National Environmental Policy Act (1969)
- Coastal Zone Management Act of (1972)
- Forest Practices Act (RCW Chapter 76.09)
- State Floodplain Regulations (Chapter 86.16 RCW)
- National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 (FEMA)
- Model Wetlands Protection Ordinance (Ecology, September 1990)
- DRAFT Capital Improvements Plan for Surface Water for the Years 2005 – 2010 (Developed June 2004, Pending Council Approval)
- City Design Standards - MVMC Title 12 Streets, Sidewalks and Public Works, Title 13 Sewers, Title 14 Land Use and Development, Title 15 Buildings and Construction, Title 16 Subdivisions, Title 17 Zoning, and various ordinances.

The City of Mount Vernon Comprehensive Plan (Comp Plan) provides guidance to direct public and private decisions affecting future growth and development. The Surface Water

Plan gives the Public Works Department a guide to implement the policy impacting surface water set in the Comprehensive Plan and is intended to assist the City in meeting its surface-water-related legislated responsibilities as well as recommend improvements to operations and maintenance activities and the CIP. The Capital Improvements Plan (CIP) identifies and discusses program elements, project and funding. Brief descriptions of the other tools and regulations in this list can be found in the 1995 Surface Water Plan or in the Regulations and Policies portion (Section 4) of this Update.

This document is the first update since the first Surface Water Management Plan was prepared in 1995. It addresses changes that have taken place since 1995, including new federal regulations and changing surface water management techniques and strategies. The City has implemented many of the recommendations contained in the initial Surface Water Plan and has addressed its most pressing basic issues related to property damage from flooding. As the City moves through its hierarchy of needs, it is expected that the focus will shift from addressing these basic quantifiable needs to goals that relate more to the character of the City and the vision of its citizens and leaders.

1.2 Goals and Objectives

The objective of the Surface Water Plan is to provide a surface water management framework that will protect the public's safety, health and property, conserve and enhance natural systems within the City, and comply with local, state, and federal regulations. This update was developed using the following principles:

- The Surface Water Plan should be a "living" document that encompasses alternative solutions such as Low Impact Development and can be adapted to conditions and priorities.
- The recommendations should meet the current and anticipated requirements of federal regulations, particularly the Endangered Species Act (ESA) and Phase II of the National Pollution Discharge Elimination System (NPDES).

Specific goals and objectives for the City of Mount Vernon's Surface Water Management Program are articulated in Section II of the 1995 Surface Water Management Plan.

1.3 Report Organization

The body of this plan summarizes the general surface water conditions in the City. Technical conclusions are detailed in appendices. The Plan comprises the following:

- **Section 1:** Introduction to the City of Mount Vernon Comprehensive Surface Water Management Plan Update
- **Section 2:** Summary of the physical surface water, drainage, and drainage-related characteristics of the City
- **Section 3:** Description of the surface water storage and conveyance system analyses performed for this update. Discussion of results and potential solutions to surface water issues.

- **Section 4:** Review of the regulatory framework to assure the City's surface water management policies are in compliance with federal, state, and local regulations. Discussion of "Street Edge Alternatives" and criteria for potential candidate sites in Mount Vernon is included in Appendix B.
- **Section 5:** Identification of CIP recommendations and potential program funding sources.
- **Section 6:** Documentation of the existing O&M programs and recommendations to increase the efficiency and effectiveness of that program.
- **Section 7:** Stormwater rate analysis.
- **Section 8:** Recommendations.
- **Appendixes:** Provide surface water modeling analysis, regulations and policies, storm drainage capital improvement plan projects, and operations and maintenance.

SECTION 2: DRAINAGE BASIN CHARACTERISTICS

2. Drainage Basin Characteristics

Topography, land use, climate, soils, and other physical characteristics affect surface water runoff quantity and quality in the City. These characteristics, along with other watershed resources such as fish habitat, wildlife and wetlands are described in the 1995 Surface Water Plan. Because this is an Update to that plan, it will be referenced frequently and should be considered a companion document. Updated information about the characteristics of the drainage basins that was performed for this Update will be the focus of this chapter. Occasionally, material from the existing plan will be repeated in this chapter to provide clarity.

2.1 General Description

The study area includes the City of Mount Vernon's urban growth boundary, as shown in Figure 2-1. This area is similar to the study area described in the 1995 Surface Water Plan, with the exception that the corporate City Limits have expanded since that plan was prepared. The urban growth boundary has not changed.

The climate is typical of areas west of the Cascade Mountains and is strongly influenced by the Pacific Ocean. Winters are generally wet and mild with temperatures varying from 30°F to 50°F. Summers are usually relatively dry and cool with temperatures rarely exceeding 80°F. The average annual temperatures and precipitation are approximately 50 degrees Fahrenheit and 30 inches, respectively. Precipitation data used in the updated hydrologic modeling analyses performed for this Update were obtained from the National Oceanic and Atmospheric Administration (NOAA) station at Burlington (10/1/56 – 11/30/93) and from the Washington State University Cooperative Extension Public Agricultural Weather System (PAWS) station at Mount Vernon for the period of 12/2/1993 through 11/23/2002.

The topography is highly variable within the study area, comprising relatively steep slopes of the hillsides of the eastern portion of the City and flat floodplains of the Skagit River and Nookachamps Creek in the western and northern portions of the City, respectively. The study area slopes in all directions, with all the surface water eventually draining into the Skagit River and Nookachamps Creek. The highest elevation is approximately 910 feet above mean sea level. Slopes range from zero in the floodplain area to 96 percent around Little Mountain.

Soils categories in the study area are comprised of four types: glacial till, glacial outwash, flood plain, and wetland soils. A more detailed description of the soil types can be found in the 1995 Surface Water Plan.

2.2 Drainage Basins

The study area is comprised of seven separate drainage basins: Kulshan Creek (including the Freeway Drive subbasin system), Maddox Creek, Carpenter Creek, Nookachamps Creek, Trumpeter Creek (College Way), Britt Slough, and West Mount Vernon. There is an additional drainage basin not associated with a stream which includes the downtown Mount Vernon combined sewer system area. These basins were delineated as part of the 1995 Surface Water Plan. The basins were further divided into several smaller subbasins. The authors of the original plan used topographic maps and drainage system inventories to

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map the basins and subbasins. The original basin delineations are shown on maps and figures in the 1995 Surface Water Plan.

As part of this plan Update, one of the tasks was to develop GIS layers and prepare drainage maps of the City's storm drainage data inventory and associated drainage features. Drainage basins were then redelineated using detailed topography of the GIS, storm drainage network, and basin delineation features associated with the GIS software. Drainage basin delineations were field checked for two specific detailed modeling areas: Freeway Drive and Upper Maddox Creek (Little Mountain Estates area). All the original basins and subbasins are included in the Update, and no new basins were added to the system with one exception: one subbasin was added to the Kulshan Creek basin for modeling purposes (subbasin 8A). Figure 2-1 shows the revised drainage basins and subbasins, as well as the drainage inventory.

The following sections describe the updated basin delineations and available resources used to complete the task. For a complete description of each of the major streams and associated drainage basins, refer to the 1995 Surface Water Plan, Section III.

2.2.1 Available Resources

Several resources were used to prepare the drainage basemaps in accordance with the Scope of Work. These included existing GIS shapefiles, City storm drainage inventory, and AutoCAD basemap files. The City initially provided some of the GIS shapefiles from their existing data inventory, and the remaining shapefiles were prepared as a part of this Update. The City provided the following data sets: streets, parcels, City boundaries, water bodies, streams, wetlands, and stormwater management facilities (i.e., ponds). A subconsultant to the City had recently inventoried the wetlands, streams, fish habitat, and stormwater facilities. This information was incorporated into the City's GIS.

Several resources came from information that resided in the City's AutoCAD files. This included the 2-foot topographical contours within the City limits, and the drainage basin delineations from the 1995 Surface Water Plan. The AutoCAD files were converted to GIS format and then adjusted to align with the City's datum.

The storm drainage inventory (storm sewers and catch basins) came from the City's inventory. The City had been inventorying their storm sewer system for several years. Most of this information was collected by City staff on handwritten log books and field maps. Information such as pipe size, depth of the pipes, and pipe and catch basin type and material was collected by the staff. As part of the plan Update, CH2M HILL assisted the City staff with setting up the GIS storm drainage shape files and inputting the inventory into the database. Personnel from the City's GIS group digitized the locations of catch basins in GIS format and connected the catch basins with storm pipes. Pipe and catch basin information from the field books was added to the data set. CH2M HILL did not verify or field check the data inventory. As of the date of this plan Update, the City is still in the process of completing the data inventory. The GIS figure included in this section reflects the most up-to-date inventory of storm drains and catch basin at the time of writing of this report.

The original drainage basin delineations were hand-drawn on AutoCAD maps, and these were also used to refine the basins. These maps are included in Appendix C of the 1995 Surface Water Plan.

2.2.2 Updated Basin Delineations

As described in the previous subsection, the City provided the AutoCAD-converted drainage basin delineations from the 1995 Surface Water Plan. City staff digitized the shapefiles into GIS, using the hardcopy basemaps. Many of the basins required adjustment to reflect the detailed, topographic information (2-foot contours) that was recently incorporated into the City's GIS, and the drainage system inventory. An automatic delineation routine within the GIS program that uses digital elevation data was used to help refine the basin boundaries. Boundaries were checked against the drainage inventory (pipe flow directions) as well as the original AutoCAD drainage maps from the 1995 Surface Water Plan.

For several of the basins that are partially located within the study area, some of the basin outer boundaries were extended to reflect the new City Limits, thereby increasing the basin sizes. Also, some of the original basin boundaries were "cut off" at the study limits (i.e., the entire basin was not mapped), and these basins have been extended to accurately reflect the basin drainage area, even though some of these areas are outside the City Limits. The majority of the other basins that are contained within the City Limits were unchanged with respect to total drainage area.

Table 2-1 lists the basins and subbasins, drainage areas, and original drainage areas from the 1995 Surface Water Plan. The updated basins are shown in Figure 2-1.

TABLE 2-1
Drainage Basin Areas

Basin Name	Subbasin	Subbasin Area (acres)	Basin Area (acres)	Original Basin[1] Area (acres)
Britt Slough	SB-30	386	386	73
Carpenter Creek Basin		-	1760	3753
	SB-35	1519	-	-
	SB-36	241	-	-
Combined Sewer Area	SB-23	438	438	462
Kulshan Creek Basin		-	1396	1404
	SB-14	394	-	-
	SB-05	147	-	-
	SB-06	89	-	-
	SB-11	80	-	-
	SB-12	55	-	-
	SB-09	9	-	-
	SB-10	122	-	-

TABLE 2-1
Drainage Basin Areas

Basin Name	Subbasin	Subbasin Area (acres)	Basin Area (acres)	Original Basin[1] Area (acres)
	SB-08	21	-	-
	SB-13	303	-	-
	SB-08A	5	-	-
	SB-07	171	-	-
Maddox Creek Basin		-	2058	1984
	SB-22	477	-	-
	SB-37	633	-	-
	SB-19	177	-	-
	SB-51	383	-	-
	SB-34	388	-	-
Nookachamps Creek		-	1073	347
	SB-02	431	-	-
	SB-39	77	-	-
	SB-38	565	-	-
Skagit River Tributary		-	842	
	SB-01	191	-	-
	SB-03	651	-	-
Trumpeter Creek Basin		-	2046	2013
	SB-04	339	-	-
	SB-18	205	-	-
	SB-17	553	-	-
	SB-15	564	-	-
	SB-16	384	-	-
West Mount Vernon		-	350	450
	SB-26	114	-	-
	SB-25	80	-	-
	SB-24	156	-	-

[1]Basin areas were calculated and delineated as part of the 1995 Surface Water Plan. Subbasin areas were not included in the plan.

2.2.3 Freeway Drive Subbasin

The Freeway Drive subbasin is part of the Kulshan Creek basin. As part of the Stormwater Plan Update, CH2M HILL and its subconsultant Northwest Hydraulic Consultants (NHC) performed a detailed hydrologic and hydraulic modeling exercise to simulate existing and future conditions of this area. The area is flat with developing commercial properties, and the storm drainage is pumped via a pump station and force main to the Skagit River. The City requested that an analysis be performed to determine the existing capacity of the system and the current level of system performance, and to identify the system pump station improvements which would be needed for future build-out of the basin.

The detailed modeling task required a review of drainage basin areas for the Freeway Drive stormwater system so that the hydrologic model could be updated. The City provided information about the existing storm drainage system and the operation of the detention ponds in the area. As-built drawings, 2-foot topographical contours, and drainage inventory provided information about drainage basins. Field investigations were also performed to help in the delineation process.

The subbasins tributary to the Freeway Drive pump station were updated using the information described above. Three changes were made to the basin delineations that are different than the original plan. First, a new subbasin 8A was added to the system. This subbasin was originally part of the north section of subbasins 7 and 6 (See Figure III-5, 1995 Surface Water Plan). Subbasins 6 and 7 drain south to the Kulshan Creek pump station. It was determined through conversations with City Staff that a portion of those subbasins drain to the west and then to the Freeway Drive system. Therefore, subbasin 8A was delineated and included in the Freeway Drive system.

The second change to the system involved removing the tributary area of subbasin 9. During a meeting, City staff indicated drainage from subbasin 9 (previously assumed to be tributary to the Freeway Drive pump station) likely flows instead to the separate College Way system (Kulshan Creek).

The third change is an addition to the Freeway Drive system within the non-tributary subbasin 11. Part of subbasin 11 south of College Way (the area bounded by the centerlines of Interstate 5 to the east and Freeway Drive to the west) was determined to drain to the Freeway Drive pump station. The drainage corridor follows the alignment of the force main for the Freeway Drive pump station.

2.2.4 Upper Maddox Creek

The analysis of upper Maddox Creek and the Little Mountain Estates area was a detailed hydrologic and hydraulic modeling study to determine the performance of the Little Mountain Estates Regional detention facility and determine if there is unused capacity in the detention storage systems. As part of the analysis, a redelineation of the areas tributary to the facility was performed to more accurately reflect the conditions at the facility. A review of the subbasin delineation for the Little Mountain Estates detention facility showed this subbasin (51) to be nearly twice as large as previously estimated for the 1995 Surface Water Plan. For this reason, the tributary basin was redelineated based on the GIS 2-foot contour interval topographic mapping, recent drainage inventory, drainage reports, and visual field observations. This Little Mountain Estates subbasin was further subdivided into

5 separate subbasins to account for the routing effects of two upstream detention ponds tributary to Maddox Creek.

SECTION 3: SURFACE WATER MODELING AND ANALYSIS

3. Surface Water Modeling and Analysis

This section describes the surface water analyses performed for the surface water comprehensive plan update. The purpose of the analysis presented in this section is to provide updated surface water models to more accurately reflect land use and floodplain storage in the Maddox Creek basin. The information presented in this analysis will also be used to develop Capital Improvement Program (CIP) projects and may be used to support future stormwater planning efforts.

3.1 Maddox Creek HSPF Model Update

The hydrologic analysis of the Maddox Creek basin was performed using the Hydrologic Simulation Program – Fortran (HSPF) model. This model was selected because it uses historical rainfall records to generate a long-term series of surface water flows. This long-term flow record gives a more accurate estimate of flood-frequency at a given point than provided by single-event design storm analysis. A long-term flow record also allows analysis of flow duration, which is useful when studying the flow effects on channel erosion.

An HSPF model for the Maddox Creek basin was originally developed in 1993 to support the 1995 Surface Water Plan. For this plan update, the model was updated and recalibrated to include a longer meteorological record, changed land use, and a more accurate representation of storage volumes in the lower portion of the basin. The updated HSPF analysis is fully documented in Technical Memorandum No. 1 found in Appendix A.

The updated Maddox Creek HSPF model will be used for future analysis. The updated meteorological and calibrated input parameters developed for this model form the basis for HSPF models developed for detailed study areas described in Section 3.2.

3.1.1 Model Set-up

The Maddox Creek HSPF model continuously simulated streamflows for existing land use conditions at a one-four time step. The simulation was performed using a 46-year meteorological record extending from October 1956 to December 2002. This model was based on the original HSPF model developed to support the 1995 Surface Water Plan. Revisions to the model included:

- Extending the meteorological data set to include recent precipitation data
- Updating land-use to reflect current (2002) land use conditions
- Refining instream storage volume estimates

Meteorological Inputs

Meteorological inputs included 1-hour precipitation data from the NOAA precipitation station at Burlington and WSU Public Agricultural Weather Station (PAWS) precipitation station at Mount Vernon. Data from the Mount Vernon precipitation station were adjusted to represent the slightly higher rainfall amounts at the Burlington precipitation station. Daily pan evaporation data were obtained from the WSU PAWS Puyallup pan evaporation station.

Subbasin and Land Use

The 1995 Surface Water Plan divided the Maddox Creek basin into 5 separate subbasins. This analysis used the subbasin delineation developed for the 1995 Surface Water Plan (see Figure III-5 in the 1995 Plan).

Land segment parameter values were defined to represent the conditions that allow rainfall to infiltrate into the soil, cause rainfall to pond and evaporate, and produce runoff in the drainage systems and streams. These values are based on a combination of land use, surface vegetation, and soils.

A review of the 1992 and 2001 aerial photography of the basin showed that land development in the Maddox Creek basin is about midway between full buildout and the level of development that existed when the original HSPF model was created. Therefore, existing conditions land use (year 2002) was approximated as an average of the current (1991) and future build-out estimated in the 1995 Surface Water Plan. Future land use conditions were based on a recently completed land use analysis.

Land use is converted to HSPF land segment parameter values representing the amount of surface effective impervious areas (EIA), vegetation, and soils. Effective impervious area is the area that is directly connected to the conveyance system and does not infiltrate into the ground. Surface vegetation was classified into three general categories (forest, pasture, and grass) which affect how much rainfall is intercepted before reaching the ground. Finally, soils have a major impact on how much and how fast the rainfall can infiltrate into the ground before it begins to generate stormwater runoff. Four general soils categories were used: till, outwash, Custer-Norma, and saturated. Table 3-1 describes the HSPF land use parameters used in the analysis.

TABLE 3-1
2002 Existing Conditions HSPF Land Use Parameters (area in acres)

	SB 51	SB 19	SB 34	SB 22	SB 37	TOTAL
Till Forest	100.1	95.7	200.1	82.3	82.2	560.4
Till Pasture	102.1	77.2	51.1	57.5	62.3	350.1
Till Grass	53.8	123.1	20.1	146.9	15.9	359.8
Outwash Forest	--	--	--	--	23.7	
Outwash Pasture	6	12.1	--	--	13.7	31.8
Custer Norma Grass	--	--	--	27.5	301.9	329.4
Saturated	2	14.3	11.8	--	--	28.1
Impervious (EIA)	6.8	21.5	2.7	133.1	116.4	280.4
TOTAL	270.6	343.8	285.7	447.3	616.1	1963.6

Detention and Instream Storage

The original Maddox Creek models did not account for the significant amount of channel floodplain storage in the relatively flat lower basin areas. As a result, the original estimates of peak flows at Hickox Road were overestimated. Additional analysis showed that approximately 120 acre-feet of floodplain storage exists at this location during peak flow conditions.

Existing detention facilities were generally not included in the model. These facilities likely provide little flow attenuation because they are small in size and were designed using ineffective flow control standards. The exception is the large regional detention facility at Little Mountain Estates.

The regional detention pond at Little Mountain Estates is an 8.7-acre-foot facility that provides critical control of peak flows from the upstream basin area. A side-flow weir located adjacent to Maddox Creek controls inflow to the facility. This weir, as originally designed, was intended to divert high streamflows into the detention facility while allowing relatively low flows to remain in the channel. However, this weir failed after a short period of service, causing a large portion of creek flow to be directed into the pond. Sandbags have been placed as a temporary measure to keep at least some flow in the main channel, but these are expected to be ineffective under high flow conditions. For this reason, the revised HSPF model was configured so that the Little Mountain Estates pond receives all streamflow from the upper basin flows to reflect the failed condition of the side-flow weir. The flow routing table for this facility was also updated to reflect a more accurate estimate of the outlet structure discharge rating. Additional analysis of the Little Mountain Estates regional detention facility and side-flow weir is presented in Section 3.2.2.

Calibration

This calibration effort focused on streamflow data collected at Hickox Road during the period December 2001 through February 2002. The largest peak flow event during this period occurred on December 13, 2001. The magnitude of this event was estimated to be equivalent to a 2-year recurrence interval peak flow event. The original Maddox Creek HSPF models were calibrated to streamflow data collected during the 1991-92 and 1992-93 wet weather seasons at a culvert located 1,200 feet upstream from Anderson Road. The largest flow during the original calibration period had a return period estimated as approximately a three-year event, resulting from a storm on January 11, 1992.

The revised model was unable to match measured streamflow during the initial calibration effort. Calibration was improved when two revisions were made to the original model. First, the original land segment parameter values were replaced with regional parameters develop by the USGS for basins in Western King and Snohomish Counties (Dinacola, 1990). The second revision routed groundwater from the upper basin directly to the lower basin, bypassing the stream channels in the upper basin.

3.1.2 Flood Frequency Analysis

Peak flood frequency is the probability that a given peak flood event will occur in any year. Flood frequency is commonly expressed as a return-period, which is the inverse of the probability, and represents the average interval between the occurrences of a specific magnitude flood. Peak flood-frequency was determined from the 46 peak annual discharge values computed with the updated HSPF model.

Tables 3-2 lists the peak flows for existing land use conditions determined with the updated Maddox Creek hydrologic model for the 2-, 10-, and 100-year recurrence intervals. Table 3-3 shows this information from the 1995 CSWMP.

TABLE 3-2
Existing Conditions Peak Flood Frequency Computed With Updated Maddox Creek HSPF Model

Subbasin	2-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
SB 51 - Maddox Creek Below Little Mountain Estates Pond	4	11	14
SB 19 - Maddox Creek at Blackburn Road	19	34	67
SB 34 - Maddox Creek above Anderson Road	28	61	105
SB 22 - Flowers Creek & I-5 Highway Corridor	46	77	100
SB 37 - Maddox Creek at Hickox Road	46	75	95

Note: Flow values reported in the table include contributions from upstream tributary subbasins.

TABLE 3-3
Existing Conditions Peak Flood Frequency Computed With 1993 CSWMP Maddox Creek HSPF Model

Source: City of Mount Vernon Comprehensive Surface Water Management Plan (R.W. Beck, 1995)

Subbasin	2-Year Peak Flow (cfs)	10-Year Peak Flow (cfs)	100-Year Peak Flow (cfs)
SB 51 - Maddox Creek Below Little Mountain Estates Pond	12	20	32
SB 19 - Maddox Creek at Blackburn Road	17	25	40
SB 34 - Maddox Creek above Anderson Road	28	45	70
SB 22 - Flowers Creek & I-5 Highway Corridor	40	65	107
SB 37 - Maddox Creek at Hickox Road	95	170	280

Note: Flow values reported in the table include contributions from upstream tributary subbasins.

The updated land use and revised HSPF parameter set used in the updated Maddox Creek HSPF model resulted in higher predicted peak flows for most upland subbasins in the Maddox Creek basin. Subbasin SB 51 is the exception where peak flows decreased due to the revised stage-discharge relationship used for Little Mountain Estates pond. However, the increase in peak flows from the upland subbasins (SB-19, SB-22, and SB-34) was offset by the floodplain storage added in lower Maddox Creek (SB 37). Including the floodplain storage in the lower reach of Maddox Creek (SB 37) resulted in a significant reduction in peak flow at this location and more closely represents the actual flood condition observed in this reach.

3.2 Detailed Study Area Investigation

Detailed technical analysis was performed for four separate study areas in the City of Mount Vernon. Three of these studies investigated stormwater flooding issues using detailed numerical analysis and information developed with the updated Maddox Creek HSPF model. The fourth study was more qualitative and investigated the use of Low Impact Development (LID) techniques to reduce stormwater impacts.

3.2.1 Maddox Creek Floodplain Encroachment

The current Mount Vernon Critical Areas Ordinance (CAO) requires 25- to 50-foot buffer widths for Maddox Creek. Because these buffer widths are substantially lower than recommended by current scientific research, the City is considering updating the CAO to require larger buffer widths. The Lower Maddox Creek floodplain area is under considerable development pressure to fill and otherwise encroach upon the floodplain. Because much of the floodplain area lies outside the stream buffer, current regulations would allow this area to be filled.

Output from the updated HSPF model described in Section 3.1 was used to analyze the hydrologic impacts of two encroachment scenarios. The two scenarios are:

- Scenario 1 - Allow the floodplain to be encroached upon up to the existing 25-foot buffer width (50-foot-wide corridor) for natural and constructed channels.
- Scenario 2 - Limit floodplain encroachment to the proposed 100-foot buffer width (200-foot-wide corridor) for natural channels and 25-foot buffer width (50-foot-wide corridor) for constructed channels.

A peak flow event occurring in November 1990 was selected as the design event for this analysis. The recurrence interval for this event is estimated to be roughly equivalent to a 100-year peak flow event. This hydrograph was routed through an unsteady flow hydraulic model to accurately compute the peak water surface elevation and peak flow impacts.

Table 3-4 shows the results of the floodplain encroachment analysis. This table shows that potential loss of floodplain storage in the lower basin could result in a 50 percent increase in the 100-year peak flow in Maddox Creek at the City's urban growth boundary (Hickox Road) for the existing buffer width requirement (Scenario 1). The floodplain analysis also showed that Maddox Creek flood water levels within the city limits could increase by up to 1.6 feet at some locations.

TABLE 3-4
Peak Flow Increase at Hickox Road for Floodplain Encroachment Scenarios

	Peak Flow (cfs)	Percent Increase[1]
Scenario 1 – 25-foot buffer	200	52
Scenario 2 – 100-foot buffer	182	38

Note:
[1] 100-year peak flow is 132 cfs under future land use conditions.

The HSPF analysis for floodplain encroachment is fully documented in Technical Memorandum No. 1 found in Appendix A.

The floodplain encroachment analysis documented in this section demonstrates the effectiveness of floodplain storage in attenuating peak flows during large storm events. When fill is placed in the floodplain, the attenuating affects of storage are lost. This loss of attenuation usually results in higher peak flood stages and/or downstream increased peak flow rates. More flooding leads to the need for flood control projects that ultimately result in transferring stormwater management costs to the public.

3.2.2 Little Mountain Estates Regional Detention Facility Evaluation

The Little Mountain Estates detention facility is located in the southeastern part of the City (SB-51) of the Maddox Creek basin (see Technical Memorandum No. 3 in Appendix A). This pond was built in the 1990s to provide 8.7 acre-feet of stormwater detention for the Little Mountain Estates subdivision and to serve as a regional facility to attenuate peak streamflow rates caused by future development in the upper Maddox Creek basin. A concrete side-flow weir was constructed at the southeast corner of the pond to divert high streamflow in Maddox Creek into the facility. The weir has failed in recent years allowing a greater volume of streamflow into the pond.

Two detention ponds were constructed upstream of the Little Mountain Estates facility to provide stormwater control for all phases of the Maddox Creek Planned Urban Development (PUD). There may be unused storage capacity in these ponds because not all phases of the PUD were constructed as planned.

The hydrologic analysis of the Little Mountain Estates regional detention facility was performed using the HSPF model. This analysis used the land use parameters and meteorological inputs developed for the regional Maddox Creek HSPF model described in Section 3.1. This model was used to investigate:

- The potential to mitigate peak flow increases due to future land development,
- The availability of unused detention storage in the Maddox Creek PUD detention ponds, and
- Alternative diversion weir/outlet structure configurations for Little Mountain Estates Regional Detention Facility.

The HSPF analysis was performed for five scenarios assuming three land use conditions in combination with three routing scenarios. Table 3-5 describes the five scenarios.

TABLE 3-5
HSPF Modeling Scenarios

Scenario	Land Use Condition	Routing Scenario
1	Pre-Developed (forested)	No Ponds
2	Existing Condition	Damaged diversion weir and existing control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2

TABLE 3-5
HSPF Modeling Scenarios

Scenario	Land Use Condition	Routing Scenario
3	Existing Condition	Modified Diversion and control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2
4	Future Condition	Damaged diversion weir and existing control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2
5	Future Condition	Modified Diversion and control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2

A review of the subbasin delineation for the Little Mountain Estates detention facility (SB-51) showed this subbasin to be nearly twice as large as previously estimated for the 1995 CSWMP. For this reason, the tributary basin was redelineated based on new, 2-foot contour interval topographic mapping, recent drainage inventory, drainage reports, and visual observation. This Little Mountain Estates subbasin was further subdivided into 5 separate subbasins to account for the routing effects of two detention ponds serving the Maddox Creek PUD.

Predeveloped conditions were assumed to be forested except for wetland areas. Existing and future land use conditions were recomputed for this analysis to account for the larger tributary area. More precise techniques were used to determine land use because this analysis required a higher level of accuracy than was needed for the regional HSPF model. Existing conditions land use was updated to reflect current (2004) development conditions. The current development conditions were based on aerial photography, drainage reports for existing developments, and visual observations. Future conditions land use was updated based on current land use zoning with a few exceptions. Existing undeveloped, and low-density residential areas were assumed to be redeveloped to higher-density land use unless in a critical or protected area.

The existing and modified channel bypass and weir diversion configuration were explicitly modeled in this analysis. The characteristics of the existing weir were approximated based on actual site conditions observed in February 2004. The characteristics of the modified diversion weir were based on recommendations provided in the draft letter report on *Hydraulic Structure Modifications for Little Mountain Estates Detention Facility* (R.W. Beck, 1995).

Table 3-6 shows the peak flood frequency for Little Mountain Estates Regional Detention Facility. This table shows that for the existing land use condition, the Little Mountain Estates Regional Detention Facility with the current diversion weir and control structure configuration (Scenario 2) attenuates peak flows to predeveloped conditions peak flows for events less than or equal to the 10-year event. If the diversion weir and control structure are modified as proposed in the R.W. Beck report, peak flow rates will increase for events below the 2-year return frequency but decrease for less frequent return periods.

Table 3-6 shows that flows are predicted to significantly increase under future land use conditions (Scenario 4). The peak flow increase ranges from a doubling for the 2-year event to about a 60 percent increase for events with a return period equal to or higher than the 100-year event. The diversion weir and control structure modifications (Scenario 5) mitigate the peak flows, but the increase will still be greater than peak flows under existing land use conditions.

TABLE 3-6
Peak Flood Frequency at Little Mountain Estates Regional Detention Facility

Scenario	Land Use Condition	Diversion and Control Structure Configuration	2-Year Peak Flow Rate (cfs)	10-Year Peak Flow Rate (cfs)	100-Year Peak Flow Rate (cfs)
1	Predeveloped (forested)	None	10.0	18.7	20.3
2	Existing	Existing	8.9	18.0	24.4
3	Existing	Modified	10.5	15.5	19.9
4	Future	Existing	20.0	32.5	39.1
5	Future	Modified	16.5	24.4	34.5

Table 3-7 shows the peak annual stage for the Little Mountain Estates Regional Detention Facility. This table shows that approximately 0.5 feet of unused storage depth (0.8 acre-feet) is available in the pond for Scenario 2. The storage volume will be fully utilized for Scenario 3 and Scenario 4. The storage volume will be 0.7 feet higher than the maximum allowable high water elevation for Scenario 5 (0.9 acre-feet over-utilized).

TABLE 3-7
Peak Stage Frequency at Little Mountain Estates Regional Detention Facility

Scenario	Land Use Condition	Diversion and Control Structure Configuration	2-Year Peak Elevation (feet)	10-Year Peak Elevation (feet)	100-Year Peak Elevation (feet)	Comparison to Maximum Pond Elevation (assuming 1-foot freeboard)
2	Existing	Existing	215.6	217.0	217.3	0.5 feet remain
3	Existing	Modified	216.6	216.1	217.8	Fully utilized
4	Future	Existing	217.0	217.5	217.8	Fully utilized
5	Future	Modified	215.8	218.3	218.5	Over-utilized

Note: Overflow elevation = 218.8 feet. Maximum pond elevation = 217.8 assuming 1 foot freeboard.

Flow duration analysis was performed for the reach downstream of Little Mountain Estates Regional Detention Facility. This reach was assumed to include the predicted outflow from the Little Mountain Estates pond with the predicted discharge in the bypass reach. Flow duration is the amount of time (generally expressed as a percent of total) in which a given flow is equaled or exceeded. Table 3-8 shows the results of this analysis. This table shows that the flow duration under Scenario 2 is slightly higher than the predeveloped condition

(Scenario 1) flow duration. This table also shows that flow duration will increase under future land use conditions.

TABLE 3-8
Flow Duration at Little Mountain Estates Regional Detention Facility

	Flow Duration (cfs)				
Percent Time Exceeded	**Scenario 1 – Predeveloped Land Use, No Pond**	**Scenario 2 – Ex. Land Use, Ex. Structure Configuration**	**Scenario 3 – Ex. Land Use, Mod. Structure Configuration**	**Scenario 4 – Fu. Land Use, Ex. Structure Configuration**	**Scenario 5 – Fu. Land Use, Mod. Structure Configuration**
0.01	14.3	16.6	14.9	26.3	21.9
0.05	10.1	11.6	11.2	18.4	16.4
0.1	8.4	9.2	10.0	14.9	14.3
0.2	6.9	7.5	8.9	11.4	12.1
0.5	4.9	5.6	7.0	7.7	9.5
1	3.4	4.3	5.2	6.0	8.0
5	1.2	2.2	2.0	3.2	3.5
10	0.6	1.4	1.2	2.2	1.8
30	0.1	0.3	0.3	0.4	0.4
90	0.01	0.02	0.02	0.02	0.02

The HSPF analysis showed that the Maddox Creek PUD ponds are fully utilized and have no excess capacity.

The Little Mountain Estates Regional Detention Facility in its current configuration is able to match predeveloped peak flow for the current land use condition. However, this facility is not large enough to mitigate the increase in peak flow rates predicted for future land use conditions.

3.2.3 Freeway Drive

The Freeway Drive subbasin is an internally drained, 46-acre basin located west of Interstate 5 within a meander loop of the Skagit River. Stormwater from this basin flows to a regional detention facility located west of Freeway Drive and is then pumped to the Skagit River. The current pond/pump configuration is adequately sized to convey stormwater for existing development but does not have the capacity to convey stormwater from future development.

The hydrologic analysis of the Freeway Drive basin was performed using an updated HSPF model. This analysis used the land use parameters and meteorological inputs developed for the regional Maddox Creek HSPF model described in Section 3.1.

The tributary subbasin area was revised to better reflect actual drainage conditions. More precise techniques were used to determine land use because this analysis required a higher level of accuracy than was needed for the regional HSPF model. Predeveloped conditions were assumed to be forested. Existing land use conditions were revised to reflect the current (2004) development conditions based on aerial photography, drainage reports for existing developments, and visual observations. Future land use conditions were based on the assumption that undeveloped parcels would develop as commercial property.

The routing elements of the model were updated to better include:

- Additional volume in the Freeway Drive Regional Stormwater Facility. The previous estimate of storage volume was based on the live storage level shown in the design plans. As-built drawings showed the live storage level to be 2 feet lower than assumed.
- Pump station improvements. Recent pump station improvements more than doubled the conveyance capacity of the system from 557 gpm to 1325 gpm.
- Storage in large ditch adjacent to Freeway. The previous analysis assumed this ditch would be replaced with a large diameter pipeline. According to City staff, this project is unlikely to occur.
- Additional detention storage due to construction of new facilities. The updated model includes a new facility constructed for the Riverside Bridge project and a composite detention pond that incorporates the cumulative storage routing characteristics for all detention facilities constructed since the time of the original analysis.

The performance standard used for this analysis assumed that the volume of overflow from the Freeway Drive facility should not be greater than the runoff volume that occurred under predevelopment conditions. This subbasin is a closed depression, so controlling peak flows is not necessary because there are no streams to protect. Because this subbasin is a closed depression, controlling the duration of inundation (or volume) is critical. For this analysis, the performance standard was to limit the volume of overflow from the Freeway Drive regional detention facility to 8 acre-feet. This value corresponds to the amount of runoff volume estimated to occur under predevelopment conditions.

Figure 3-1 shows the performance of the current Freeway Drive pump/pond configuration. This figure shows that the Freeway Drive pond has enough capacity to mitigate about 28 of the available 56 acres of new commercial development in the subbasin. This corresponds to 50 percent of the current development potential in the subbasin.

The HSPF analysis for the Freeway Drive Pump Station analysis is fully documented in Technical Memorandum No. 2 found in Appendix A.

To accommodate full buildout of the Freeway Drive basin north of College Way, the existing 10-inch force main should be replaced with an 18-inch diameter pipe. An 18-inch-diameter pipe will allow the existing pump to operate at a higher capacity. The recommended improvement will control buildout condition overflows from the regional stormwater pond to a runoff volume less than what occurred under predeveloped (forested basin) conditions. Construction of this improvement should be timed to occur before the development of the next 28 acres.

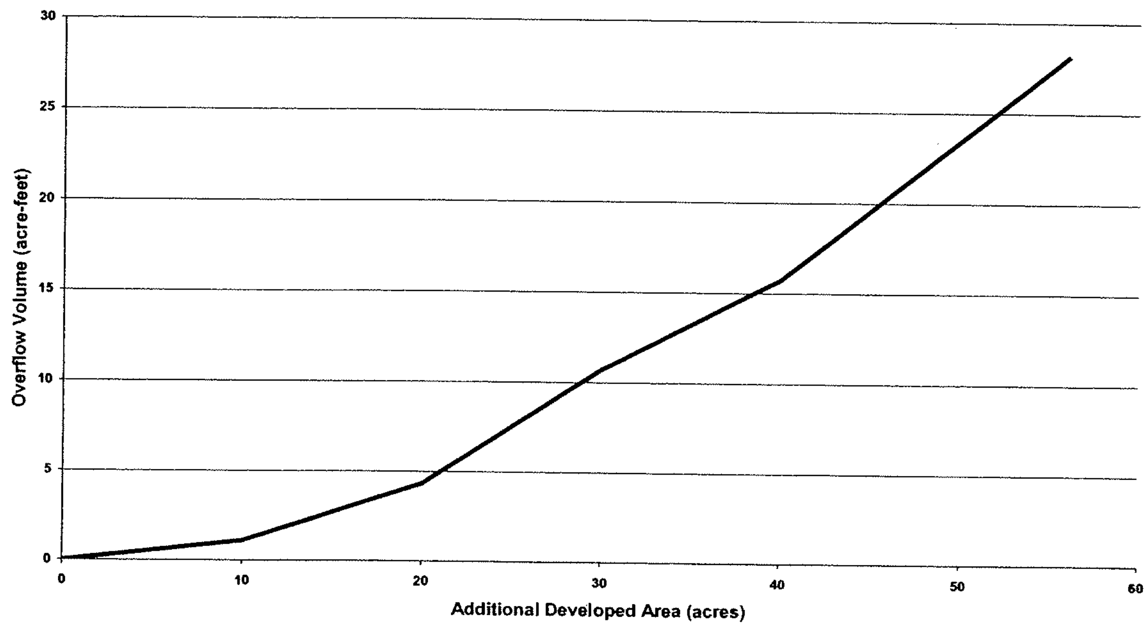

FIGURE 3-1
Development Potential in Freeway Drive Subbasin

Figure 3-2 shows the effect of pump capacity on overflow volume. This figure shows that a pump with a capacity of 2400 gpm (or greater) will limit overflow volume to less than 8 acre-feet.

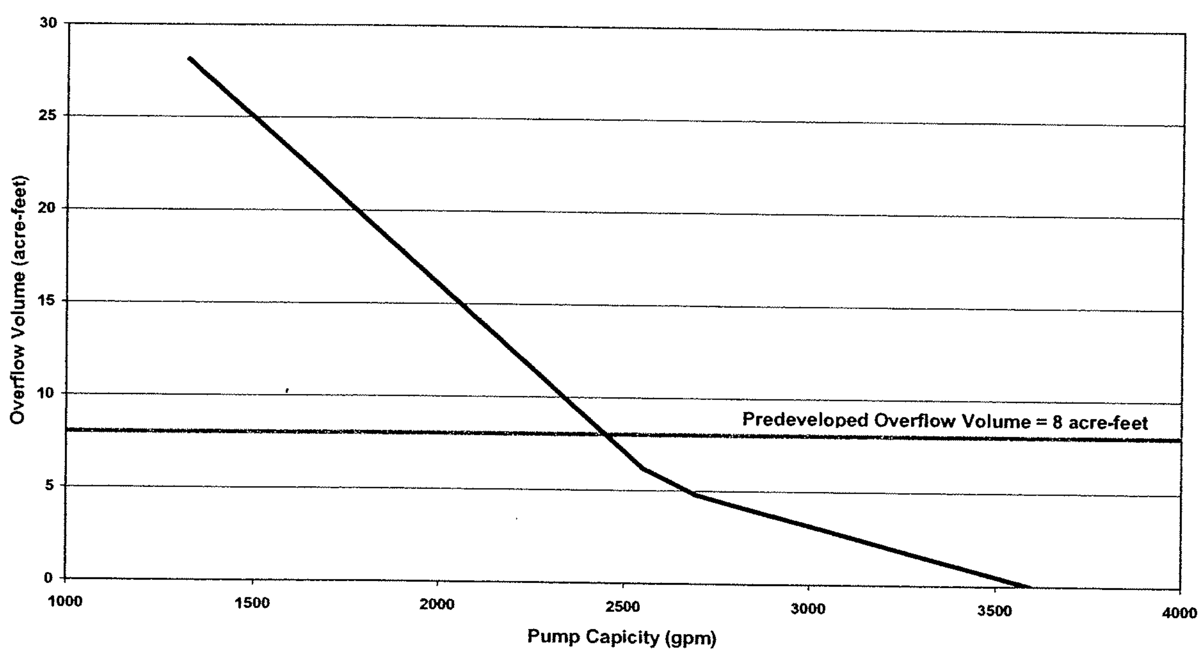

FIGURE 3-2
Effect of Pump Capacity on Overflow Volume

3.2.4 Stormwater Management at Cascade Christian Center Using Low Impact Development Techniques

Low Impact Development (LID) strategies are being introduced to the Western Washington area as a means of reducing impacts to aquatic systems by identifying development measures which promote natural hydrologic functions such as evaporation and infiltration and reduce or eliminate water quality impacts. The premise is that the natural hydrologic function cannot be achieved with conventional development and large end-of-the-pipe facilities. Rather, a new approach to site development is needed that creates less runoff and preserves more of the functions of the native forest. LID strategies allow natural infiltration to occur as close as possible to the original area. By engineering the terrain, vegetation, and soil features to perform this function, costly conveyance, treatment and detention systems can be avoided, and the landscape can retain more of its natural hydrological function.

The Cascade Christian Center of Skagit County development project was selected as the LID demonstration project. Alternative site designs were developed showing various LID techniques that can be included in the project.

Phase I of the Cascade Christian Center includes the construction of a new church building and parking lot and eight residential lots on an 8 acre site. This development will include about 5 acres of impervious area directly connected to the storm drain system. The impervious area consists of rooftops, parking areas, streets and sidewalks. The remaining area is landscaped or grass. Runoff control will be provided in a 2.1 acre-foot detention facility.

An alternative design was prepared that includes LID techniques such as biorentention cells, permeable pavers, forest retention and rainfall dispersion from impervious areas. The overall design promotes a decrease in impervious area and a more engineered landscape to facilitate storage and infiltration of stormwater runoff. This will decrease the required detention storage by 1.1 acre-feet. The result of the LID design was an overall reduction of total impervious area (primarily parking areas) of approximately 1.5 acres.

The LID approach reduced the effective impervious areas from 65 percent to 44 percent. In the process, the total volume of total stormwater runoff decreased from approximately 35% to approximately 3% with more effective water quality treatment.

The LID approach is fully documented in Technical Memorandum No. 4 found in Appendix A.

SECTION 4: REGULATIONS AND POLICIES

4. Regulations and Policies

4.1 Regulatory Compliance Gap Analysis Summary

4.1.1 Introduction

A variety of state and federal regulations affect City storm and surface water programs. These regulations include the Clean Water Act (CWA), National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Program, the Endangered Species Act (ESA), and the Puget Sound Water Quality Management Plan (PSWQMP). Additionally, there are related guidance documents that recommend actions that are likely necessary to achieve compliance with the regulations. As an initial step in developing a comprehensive stormwater management plan update, Mount Vernon's existing regulatory compliance was evaluated to identify where potential "gaps" may lie between the City's existing policies, plans, codes, and practices and the regional and federal laws and guidance documents. Because they are enforceable federal laws, this analysis focuses on the CWA and ESA listings of salmon. The Washington State PSWQMP also specifies stormwater programs that jurisdictions must implement. This manual has not been enforced consistently, but the PSWQMP and the NOAA Fisheries Model ESA recommendation will be used by regulatory agencies to assess compliance. This section of the Surface Water Plan Update summarizes the major areas, where the City of Mount Vernon may not meet the requirements set forth by the above-mentioned programs, and identifies actions that are underway and future actions needed to fill existing gaps.

A detailed analysis of findings was prepared and a report was submitted previously to the City of Mount Vernon. The full report can be found in Appendix B of this Surface Water Plan Update. The discussion herein is a summary and update of that earlier report. The City has already initiated a number of actions to address potential gaps in regulatory compliance.

4.1.2 Methods

To identify potential "gaps" in Mount Vernon's regulations, policies, and practices, the following were reviewed:

- Mount Vernon Municipal Code
- Mount Vernon Comprehensive Plan
- Mount Vernon Comprehensive Surface Water Management Plan
- NPDES Phase II Minimum Control Measures
- NMFS 4(d) Municipal, Residential, Commercial, and Industrial (MRCI) Development Standards
- Tri-County Model 4(d) Proposal
- Puget Sound Water Quality Management Plan

A series of interviews related to regulatory compliance were also conducted with Mount Vernon Staff. These interviews contributed to the identification of potential "gaps." It was necessary to interview City staff from a variety of departments to understand the current level of enforcement and implementation of existing regulations and policies. In addition, staff members were able to identify particular areas of concern and desired outcomes associated with the Surface Water Plan Update.

4.1.3 Findings

4.1.3.1 NPDES Phase II Permit Requirements

EPA's Stormwater Phase II Final Rule requires Municipal Separate Storm Sewer Systems (MS4s) serving cities whose population is less than 100,000 to obtain an NPDES Phase II Municipal Stormwater Permit. Stormwater discharges are considered "point sources" of pollution, and the Clean Water Act requires all point source discharges to be covered by federally enforceable NPDES permits.

Mount Vernon complied with the regulatory requirements by submitting an application for coverage under a permit by the deadline of March 10, 2003. Ecology has not yet developed or issued a final permit for Phase II jurisdictions. Thus, the actual permit conditions are not yet known, and jurisdictions have no current mechanism to obtain a permit or permit coverage. In the interim, EPA has identified 6 minimum requirements that are discussed below. Ecology is likely to require more than the EPA 6 minimum requirements to provide consistency with the PSWQMP and the more stringent requirements of Phase I municipal stormwater permit jurisdictions. Mount Vernon does not yet meet the minimum requirements of 3 of the 6 EPA elements and only partially meets the minimum requirements of 1 of the 6 elements (Table 4-1):

TABLE 4-1
Mount Vernon and the NPDES Minimum Control Measure Requirements

Minimum Control Measure	Minimum Requirements Met
1. Public Education and Outreach on Stormwater Impacts	Yes[1]
2. Public Involvement/Participation	No
3. Illicit Discharge Detection and Elimination	No
4. Construction Site Stormwater Runoff Control	Yes[1]
5. Post-Construction Stormwater Management in New Development and Redevelopment	Partial[2]
6. Pollution Prevention/Good Housekeeping for Municipal Operations	No

[1]While the minimum requirements are currently met, the city will still need to set measurable goals to be in full compliance.
[2]Partial means that some of the minimum requirements have been implemented, but further additions are needed for compliance.

To meet the conditions of the NPDES permit, Mount Vernon will need to meet the minimum requirements of the 6 above listed measures. While some of the requirements include a substantial number of actions to implement them, others do not require a tremendous effort to achieve full compliance. Table 4-1 summarizes the 6 minimum control measures. The complete list of NPDES Phase II Requirements and NMFS Municipal, Commercial, Residential and Industrial Development Standards for a "Take" Exemption are provided in Appendix B.

For example, Minimum Control Measure (MCM) 2, "Public Involvement/Participation," only requires a jurisdiction to comply with applicable state, tribal, and local public notice requirements. On the other hand, MCM 3 requires an operator of a regulated small MS4 to develop, implement, and enforce an illicit discharge detection and elimination program. The permit requires that the program include a number of components including completing a storm sewer system map, which shows the location of all outfalls, and the names and location of all waters of the United States that receive discharge from those outfalls. The measure also requires the City to develop a program to detect non-stormwater discharges and illegal dumping. Since a complete inventory of the storm sewer system in Mount Vernon still needs to be completed, and because there is not a program for the detection of illicit discharges to storm sewers, the minimum requirements set forth in MCM #3 have not been met.

Additionally, the City will be required to keep records related to permit compliance and make them available for review for at least 3 years and prepare an annual report in years 2 and 4 of the permit.

4.1.3.2 Endangered Species Act 4(d) Rules for Incidental "take" Allowances

The ESA provides for the protection of endangered and threatened species. Two sections of the ESA directly affect local jurisdictions:

Section 4(d) relates to the listing of species as threatened or endangered. It allows the listing agency to publish rules that define conditions under which "incidental" take is permissible. The National Marine Fisheries Service (NMFS) issued the final 4(d) rules governing the conservation of steelhead and salmonids in the Northwest. To qualify for incidental take protection, municipalities must demonstrate compliance with the 4(d) rule. NMFS 4(d) rule allowing incidental take requires municipalities to conduct program actions and create and issue regulations which will provide for the conservation of threatened species.

Section 9 defines specific actions that are prohibited, which may result in a "take" of endangered species. A "take" could involve harming, harassing, pursuing, hunting, or killing a listed or endangered species. Destruction or changes to habitat (supporting listed and threatened species) is defined as a "harm" under the ESA, and Mount Vernon could be liable. However, the 4(d) rule for Northwest salmonids has an exemption for certain governmental activities if they meet the municipal, commercial, residential, and industrial (MRCI) development standards outlined in the final rules released in July 2000.

Recently NOAA Fisheries prepared a document that provides guidance for their staff when reviewing projects or evaluating municipal programs for ESA compliance. The guidance is based on the best science and commercial data available. The document lists best management practices (BMPs) to avoid and minimize the effects of stormwater on listed salmonids using natural watershed features. Furthermore, the document includes model terms and conditions that may be applied to programs that predict effects of hydrology and water quality as a result of stormwater runoff. It mentions that these terms and conditions can also be used to minimize impacts of programs being evaluated in the Section 4(d) process. Two "Reasonable and Prudent Measures" define the basis for the terms and conditions that are presented in the document:

<u>The (Federal action agency) shall:</u>

1. Minimize incidental take from development or land conversions by avoiding or minimizing adverse effects to watershed processes, or riparian or aquatic systems through the protection of subwatershed or reach water quality and natural hydrology.
2. Complete a monitoring and reporting program to ensure the objective of this Opinion is met, to minimize the likelihood of take from activities that result in stormwater runoff with the potential to affect water quality and hydrology in streams with listed salmonids.

Table 4-2 below presents NOAA Fisheries Model Terms and Conditions to minimize "take" and to support the survival and recovery of listed salmonids, and how Mount Vernon plans to accomplish each of them.

TABLE 4-2
NOAA Fisheries Model Terms and Conditions[1] to Minimize "take" and to Support the Survival and Recovery of Listed Salmonids

To Implement Reasonable and Prudent Measure #1, Mount Vernon Shall:	Will Be Accomplished By:
1A. Use a subwatershed or landscape approach to look for opportunities to restore natural hydrology.	Critical Areas Ordinance Update in progress
1B. Develop and implement a Stormwater Management Plan.	Comprehensive Surface Water Management Plan Update in progress
2. During construction, prevent pollutants from entering stormwater runoff.	Staff working to clarify responsibilities and improve inter-departmental communication
3. Minimize alteration of natural soils and vegetation.	Critical Areas Ordinance Update in progress
4. If designated (i.e., engineered) facilities are needed to minimize or avoid effects to hydrology and water quality; continuous rainfall/runoff models must be used to calculate the design facility.	Adoption of New (August 2001) Ecology Manual
To Implement Reasonable and Prudent Measure #2, Mount Vernon Shall:	**Area to Be Addressed:**
1. <u>Implementation monitoring.</u> Ensure that a monitoring report is submitted within 120 days of program implementation describing the success of implementing and meeting permit conditions. This shall include review of the Stormwater Management Plan.	Underway, will be refined in Comprehensive Surface Water Management Plan Update
2. <u>Effectiveness monitoring.</u> Gather any other data or analyses deemed necessary or helpful to complete an assessment of habitat trends in hydrology and water quality as a result of the permitted actions. Monitoring must demonstrate that the facility is operating as designed.	To be defined in Comprehensive Surface Water Management Plan Update

[1]These are generalized terms and conditions, and, therefore, should not be applied *pro forma*.

Low impact development (LID) techniques can be effective BMPs to minimize stormwater impacts on listed species. A document titled "Identifying Sites for 'Street Edge Alternatives'" is included in Appendix B as one example of BMPs that may be applicable to the City of Mount Vernon.

4.1.3.3 Puget Sound Water Quality Management Plan

The Puget Sound Water Quality Management Plan lists the elements of a comprehensive stormwater program that are required for local jurisdictions. The elements are similar to EPA's 6 minimum measures, but include the following additional requirements:

- "Assurance of adequate funding for the stormwater program through surface water utilities, sewer charges, fees, or other revenue-generating sources."
- "Local coordination arrangements such as interlocal agreements, joint programs, consistent standards, or regional boards or committees."

The PSWQMP also requires jurisdictions to include a stormwater element in their land use plans.

4.1.3.4 Growth Management Act

The growth management act requires land use plans to address stormwater as described in the PSWQMP and to provide concurrency of stormwater facilities with growth.

The GMA also directs growth in cities, creating a challenge for cities to accommodate growth and protect water quality and aquatic resources.

SECTION 5: STORM DRAINAGE CAPITAL IMPROVEMENT PLAN PROJECTS

5. Storm Drainage Capital Improvement Plan Projects

5.1 Purpose

The Capital Improvement Program (CIP) is a list of priority projects showing the estimated costs and available funding for each capital project over a 20-year period (2005 – 2024). The CIP implements and is consistent with the policies contained in the *Capital Improvements Plan (2004-2009)*, a regularly updated component of the *City of Mount Vernon Comprehensive Plan (1995)*.

5.2 Identification of Proposed Projects and Prioritization

The 1995 Surface Water Plan identifies a number of CIP and non-CIP problems in Section VI "Problem Identification." Table X-1 in Section X of the 1995 Plan summarizes the suggested Surface Water CIPs and shows a proposed schedule for improvements. This table has been reproduced in Appendix C to show the recommended projects and their disposition. The 1995 Plan's methodology of developing a comprehensive summary of stormwater problems involved public input, interviews with City Staff, interviews with agencies and jurisdictions, field observations and the performance of hydrologic and hydraulic modeling for specific areas.

This Stormwater Plan Update includes the pending projects identified by City staff as a result of the 1995 Surface Water Plan's CIP. It also includes CIP recommendations from the Shannon and Wilson, Inc. report "Inventory and Evaluation of the Kulshan and Trumpeter Stream Systems, Mount Vernon, Washington" (March 2001). In addition, several specific problems were identified by City staff and included in modeling analyses for this Plan Update. Of these, one will be included in the CIP.

The Surface Water section of the City's latest overall CIP (2004 – 2009), and a more current, Draft Surface Water CIP (for 2005 – 2010), received from the City were also referenced in the development of this CIP Update. The Draft CIP will need to obtain Planning Commission and Council Approval before it becomes official; however, it is an important planning tool for the development of this CIP.

The City's overall CIP for the years 2003 - 2008 (prepared by the Finance Department) lists the following priorities for the City's projects:

1) A safe and livable community
2) Infrastructure that assists in economic development
3) Completing unfinished projects

The approach to developing the CIP list shown herein focuses on clearly identifiable local improvements, with emphasis later in the planning period on projects requiring considerable analysis, design, and/or larger amounts of funding.

The entire list of recommended Surface Water CIP Projects for the City of Mount Vernon is shown in Table 5-1. This table identifies the CIP projects for a 20-year planning period, beginning in 2005, and lists estimated project costs. Costs developed for the 1995 Surface Water Plan have been escalated to 2005 levels using a 1.422 multiplier (based on ENR indices between 1995 and 2005). Detailed CIP sheets have been developed for 8 projects from the larger list. Table 5-2 lists these projects and Figure 5-1 shows their locations. The detailed CIP sheets are located in Appendix C.

TABLE 5-1
Surface Water Capital Improvement Projects – DRAFT, August 2004: Pending Council Approval

Project ID	Project Title	Project Cost in 2005 Dollars	Comments
D-01-01	Blackburn Road Culvert Replacement	~~$85,000~~ 194k	
D-01-02	Maddox Creek Restoration and Pond Retrofit	$50,000	
D-01-05	Park Street Pump Station	$30,000	Shared funding for this $60k total project: $30k Sewer Capital Reserve and $30k Surface Water Utility
D-05-01	Downtown Floodwall – Semi-Permanent	$180,000	Shared funding for this $250k total project: $70,000 Dike District, $180,000 Surface Water Utility
D-05-02	UGA Drainage Analysis	$80,000	
D-05-03	West MV Storm Force Main Upgrade	$35,000	
D-94-11	Erosion Problem Repairs	$12,000	
D-94-14	Log Weir Fish Structure	$12,500	
D-98-01	Downtown Floodwall – Permanent	$1,367,400	
D-06-01	Freeway Drive Force Main Replacement[1]	$765,000	
Regional System Problems[3]			
RS4b	Kulshan Creek Pump Station Phase II – Beyond 20 Years	$956,000	Not completed
RS6	Little Mountain Estates Detention Pond Modifications	Developer Build	Not completed. Included as analysis and recommendation element in the 2004 Surface Water Plan Update.
RS7	Erosion Control on Maddox Creek	$559,000	In progress (culvert removal). Project may incorporate with road improvements and become a County project. Centennial Grant obtained for stream enhancement, and Eaglemont development will fund culvert replacement.
Y	Maddox Creek Floodplain Encroachment – Future Channel Restoration[2]		

SEA31005345192.DOC/042310012

Local System Problems			
LS1	700-Foot-Long Berm along Hoag Road	$319,000	Not completed. City working with Wildlands, Inc.
LS6	Log Bed Control Weir Installation to Control Erosion North of Cedar Lane	$16,000	Not completed
LS7	MH Drop Structure and Pipe Extension on Kulshan Tributary Near Viewmount	$68,000	Not completed
LS11	Trashrack Installation at Storm Drain Inlet Near Kiowa and Nez Perce	$700	Not completed
LS12	Replacement of Storm Drain System in W. Mount Vernon along Memorial Highway	$792,000	Not completed
LS13	Additional Catchbasins Installation at Wall Street and Garfield Street	$20,000	Not completed
LS14	New Catchbasin Installation and Storm Drain Connection at Wall Street North of Memorial Hwy	$57,000	Not completed
LS15	Replacement of 16 Storm Drains Between E. Division and E. Fir Just West of N. LaVenture	$528,000	Not completed
LS16	Log Bed Control Weir Installation in Stream Between Mohawk and Apache	$16,000	Not completed
LS17	Culvert and Ditch Installation at Comanche Drive	$20,000	Not completed
LS18	Culvert Replacement at Shoshone East of Sioux	$34,000	Not completed
LS19	Armoured Spillway Installation in Two Detention Ponds Near Waugh and Division	$84,000	Not completed
LS20	Storm Drain Installation West of S 6th up to Lind and Connect to Maddox Tributary	$220,000	Not completed
LS24	*Drainage Improvement in Commercial Area on West Side of I-5 South of College Way.*	*Fix anticipated in conjunction w/RS1*	*Not completed*
LS25	Replacement of 3 Pipes Between Britt Slough and Blackburn Road	$404,000	In progress. Interlocal agreement with school district.
LS27	Replacement of 2 Pipes Along I-5 Between Blackburn and Anderson Road	$71,000	In progress

	Available Funds for Drainage Complaint Solutions	$600,000	$30,000 per year for 20-year planning period
Water Quality Problems			
WQ3	Installation of Oil/water separators	$466,000	Not completed
Environmental Resource Problems			
E2	Manhole Barrier Removal in Kulshan East of Railroad	$2,800	Not completed
E3	Log Weir Fish Structure Installation – Kulshan Creek North of Cedar Lane	$16,000	Not completed
E4	Restoration of Channel on Kulshan from Riverside to N 18th (2,200 feet)	$148,000	Not completed
E5	Restoration of Channel on Mainstem of Trumpeter (7,000 feet)	$466,000	Not completed
E11	Log Weir Fish Passage Structure Installation d/s of Culvert on Maddox Creek at Blackburn Road	$16,000	Not completed
	Conservation of Prime Headwater Habitats (Land Acquisition)[4]		
	Protection of Wetland Connections (Land Acquisition)[4]		
	Removal of Fish Passage Barriers in Trumpeter Creek System[4]		
	Protection of Remaining Riparian Conditions (Study/Policy Development)[4]		
	Restoration of In-Stream and Riparian Habitats[4]		
	Restoration of Wetland Connections[4]		

Total Project Costs $ 8,496,400

Footnotes:

[1] Upgrades will involve an optimization study; however, WSDOT has performed a regional study that may allow for a simplified look at Mount Vernon's specific issue. Results of the WSDOT study should be available in June 2004.

[2] There should be no filling of the original channel. While floodplain encroachment is a policy issue; ultimately, there is an opportunity for future restoration of the channel.

[3] See R.W. Beck Comprehensive Surface Water Management Plan, November 1995.

[4] See Shannon & Wilson Inventory and Evaluation of the Kulshan and Trumpeter Stream Systems, March 2001, for detailed list of projects under this category. Reference Appendix J "Review and Comment Letter from WDFW, Dated 9/25/02" for direction on completion of projects.

TABLE 5-2
Surface Water Capital Improvement Plan Project Funding by Source – DRAFT, June 2004: Pending Council Approval

Project ID	Project Title	Project Cost in 2005 Dollars
D-01-02	Maddox Creek Restoration and Pond Retrofit	$50,000
D-05-03	West Mount Vernon Storm Force Main Upgrade	$35,000
D-94-11	Erosion Problem Repairs	$12,000
D-94-14	Log Weir Fish Structure	$12,500
X	Freeway Drive Force Main Replacement	$765,000
LS1	700-Foot-Long Berm Along Hoag Road	$319,000
LS12	Replacement of Storm Drain System in W. Mount Vernon Along Memorial Highway	$792,000
LS15	Replacement of 16 Storm Drains Between E. Division and E. Fir, West of N. LaVenture	$528,000
	Total Cost	**$2,513,500**

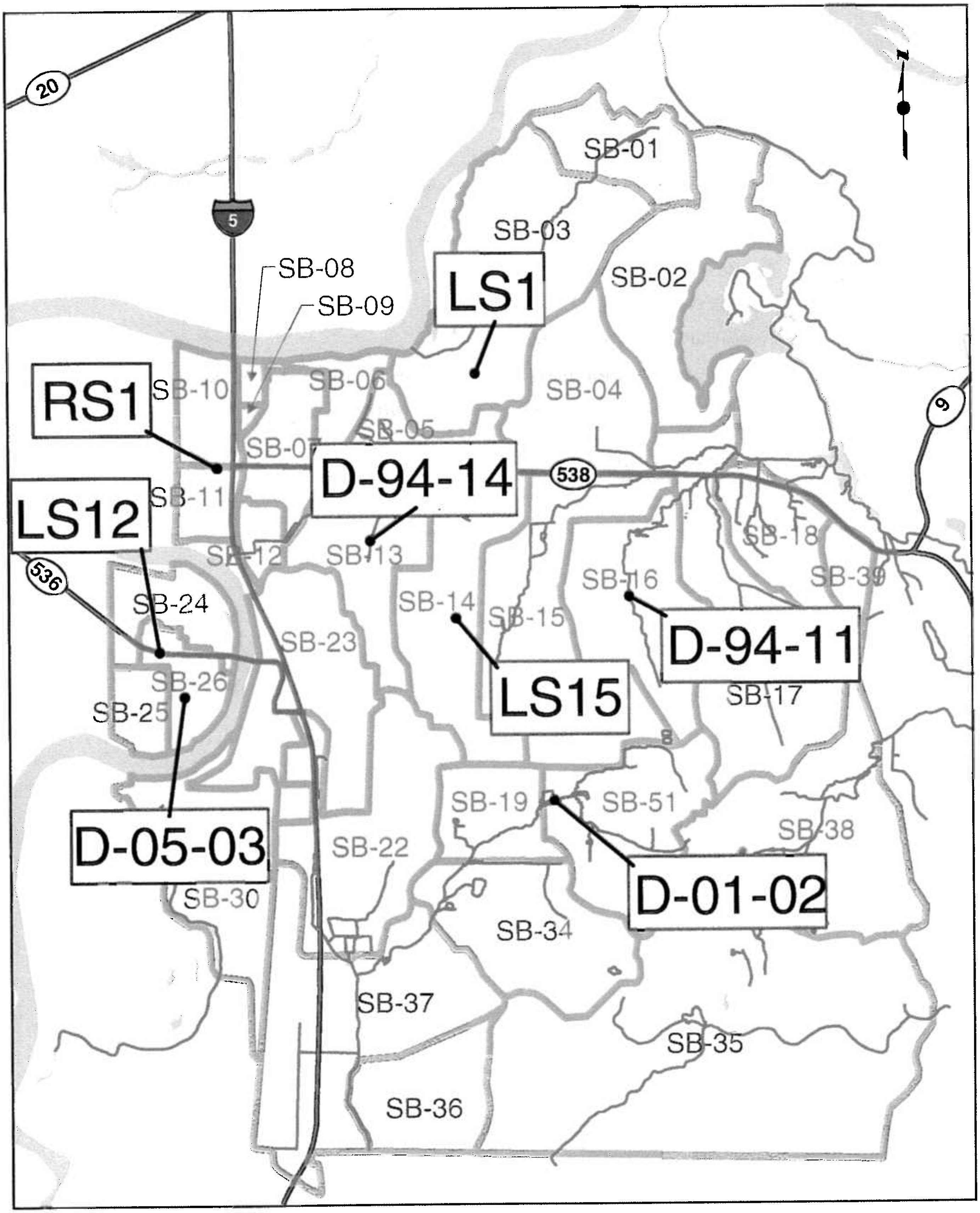

Figure 5-1
Detailed CIP Sheet
Location Map
See Sheets in Appendix C

SECTION 6: OPERATIONS AND MAINTENANCE

6. Operations and Maintenance

6.1 Purpose

The Washington State Growth Management Act requires the City of Mount Vernon to implement a stormwater facilities (public and private) maintenance program. This section provides an update to the 1995 Comprehensive Surface Water Management Plan's maintenance and operations section.

6.2 Current Level of Maintenance

6.2.1 Facilities Description/Inventory

Stormwater facilities include the storm sewer conveyance system (i.e., stormwater pipe, ditches, catch basins, and other structures) and retention/detention facilities. The City is currently working on a field update to their catch basin and stormwater conveyance inventory, with data being entered into the City's GIS Database. In the September 13, 2002, Pentec Environmental Report titled *Mount Vernon Stormwater Pond Inventory*, an inventory of the City's ____ retention/detention facilities is detailed. These facilities have been included in Figure 2-1, along with the City's most up-to-date GIS inventory of catch basins and stormwater conveyance facilities. Appendix D contains individual inventory sheets for the City's retention/detention facilities, as prepared by Pentec.

The City's stormwater facilities consist of the following system elements:*

___________ feet of stormwater conveyance pipe

___________ catch basins

___________ feet of open ditches

___________ residential retention/detention stormwater facilities

___________ commercial retention/detention stormwater facilities

___________ oil/water separators

___________ regional facilities (channels, pipes, enclosed drains)

* *This information to be filled in with the final GIS inventory data (currently being compiled by the City of Mount Vernon).*

6.2.2 Existing Stormwater Facilities Maintenance Program

As detailed in the 1995 Surface Water Plan, the City of Mount Vernon has an effective operations and maintenance program for certain elements of its stormwater system; however, some systemic issues, such as water quality and quantity problems, are apparent during heavy storms. The 1995 Surface Water Plan (Section VIII, Maintenance and Operations) suggested improvements to the existing plan to ensure that a comprehensive maintenance program would be employed. Refer to "C. Recommendations" in the 1995 Plan for a complete list of these suggested improvements.

6.3 Recommended Level of Maintenance

6.3.1 Proposed Maintenance Type/Frequency

Refer to the recommendations in the 1995 Surface Water Plan. No updates are proposed at this time. Tables 6-1 and 6-2, provided herein, are updated versions of the Annual Maintenance Costs and the Recommended Surface Water Maintenance Program tables from the 1995 Plan, respectively. The costs associated with maintenance activities have been updated from 1995 dollars to 2005 dollars using a standard index multiplier of 1.422, based on *Engineering News Record*'s cost indices.

TABLE 6-1
Annual Maintenance Costs

Structure	Maintenance Cost[a]	Percent of Total Cost
Pipes	$53,300	19%
Catch Basins	$53,200	19%
Streets	$66,000	24%
Roadside Ditches	$31,400	11%
Manholes	$22,200	8%
Detention Basins	$28,000	10%
Pump Stations	$13,400	5%
Curb Inlets	$10,300	4%
Total	$277,700	**100%**

[a]A conversion factor of 1.422 was used to turn 1995 dollars into 2005 estimate.
Final inventory quantities may affect the total maintenance costs.

TABLE 6-2
City of Mount Vernon Recommended Surface Water Maintenance Program

Note that the "units to be maintained" column will need to be updated when the City completes its system inventory.

Item No.	Maintenance Activity	Units to be Maint.	Prod. Unit	Freq. (times/ year)	Daily Prod.	Crew Size	Equipment	Annual Crew Days	Full-time Equip. Equiv.	Annual Person Days	Full-time Labor Equiv.	Annual Labor Cost[a]	Annual Equipment Cost[a]	Total Cost[a]	Percent of Program
1	Clean Catch Basins	1,500	EA	1.50	30.00	2	1 Vactor	75.00	0.34	150.00	0.68	$40,474.26	$12,723.89	$53,198.15	19.15
2	Clean Manholes	250	EA	1.50	12.00	2	1 Vactor	31.25	0.14	62.50	0.28	$16864.28	$5,301.61	$22,165.89	7.98
3	Clean Curb Inlets	800	EA	2.00	266.00	6	3 Trucks	6.02	0.03	36.09	0.16	$9,738.17	$457.77	$10,195.94	3.67
4	Roadside Ditches Remove Sediments	70,400	LF	0.20	750.00	3	1 Backhoe 2 Dumptrucks	18.77	0.09	56.32	0.26	$15,196.73	$6,453.21	$21,649.94	7.79
5	Roadside Ditches Vegetation Control	35,200	LF	2.00	2,500.00	1	1 Mower	28.16	0.13	28.16	0.13	$7,598.37	$2,366.38	$9,964.75	3.59
6	Clean Pipes (18" dia. or less)	132,000	LF	.33	1,500.00	2	1 Vactor 1 Truck	29.04	0.13	58.08	0.26	$15,671.63	$5,663.39	$21,335.02	7.68
7	Clean Pipes (over 18" dia.)	132,000	LF	0.33	1,000.00	2	1 Vactor 1 Truck	43.56	0.20	87.12	0.40	$23,507.45	$8495.08	$32,002.53	11.52
8	Regional Detention Basins Veg. Control	5	EA	2.00	1.00	1	1 Mower	10.00	0.05	10.00	0.05	$2698.29	$840.33	$3,538.62	1.27
9	Regional Detention Basins Remove Sed.	5	EA	0.33	1.00	2	1 Backhoe 1 Dumptruck	1.65	0.01	3.30	0.02	$890.43	$346.37	$1,236.80	0.45

TABLE 6-2
City of Mount Vernon Recommended Surface Water Maintenance Program

Note that the "units to be maintained" column will need to be updated when the City completes its system inventory.

Item No.	Maintenance Activity	Units to be Maint.	Prod. Unit	Freq. (times/ year)	Daily Prod.	Crew Size	Equipment	Annual Crew Days	Full-time Equip. Equiv.	Annual Person Days	Full-time Labor Equiv.	Annual Labor Cost[a]	Annual Equipment Cost[a]	Total Cost[a]	Percent of Program
10	Clean Streets Downtown/ Arterials	16	MI	50.00	12.00	1	1 Street Sweeper	66.67	0.30	66.67	0.30	$17,988.56	$22,937.33	$40,925.89	14.73
11	Clean Streets Curb Residential	24	MI	15.00	14.00	1	1 Street Sweeper	25.71	0.12	25.71	0.12	$6,938.45	$8,847.26	$15,785.71	5.68
12	Clean Streets Non-Curb Residential	40	MI	6.00	16.00	1	1 Street Sweeper	15.00	0.07	15.00	0.07	$4,047.42	$5,160.91	$9,208.33	3.32
13	Clean Detention Pipes	25	RT	1.00	2.00	2	1 Vactor	12.50	0.06	25.00	0.11	$6,745.71	$2,120.64	$8,866.35	3.19
14	On-site Detention Basin Veg. Control	30	EA	2.00	2.00	1	1 Mower	30.00	0.14	30.00	0.14	$8,094.85	$2,520.99	$10,615.84	3.82
15	On-site Detention Basins Remove Sed.	30	EA	0.33	2.00	2	1 Backhoe 1 Dumptruck	4.95	0.02	9.90	0.05	$2,671.30	$1,039.13	$3,710.43	1.34
16	Pump Station Maintenance	5	EA	*	*	*	*	*	*	*	*	*	*	$13,366.80	4.81
17	Catch Basins Repair/Replace	1,500	EA	0.02	1.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
18	Manholes Repair/Replace	250	EA	0.02	3.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
19	Curb Inlets Repair/Replace	800	EA	0.02	3.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**

TABLE 6-2
City of Mount Vernon Recommended Surface Water Maintenance Program

Note that the "units to be maintained" column will need to be updated when the City completes its system inventory.

Item No.	Maintenance Activity	Units to be Maint.	Prod. Unit	Freq. (times/ year)	Daily Prod.	Crew Size	Equipment	Annual Crew Days	Full-time Equip. Equiv.	Annual Person Days	Full-time Labor Equiv.	Annual Labor Cost[a]	Annual Equipment Cost[a]	Total Cost[a]	Percent of Program
20	Pipes Repair/ Replace	264,000	LF	0.02	50.00	3	1 Dumptruck 1 Backhoe	0.00	0.00	0.00	0.00	$0.00	$0.00	$0.00	**
								398.28	1.81	663.85	3.02	$179,125.90	$85,273.99	$277,766.99	100.00

[a]A conversion factor of 1.422 has been used to convert 1995 dollars into 2005 dollars.

*Pump stations are maintained by the Sewer Department

**These costs are typically covered in street replacement programs.

Assumptions			
Labor Costs (Maintenance Worker)		**Equipment Costs**	
Average cost per hour	$29.44	Vactor	$169.66/day
Regular Workday (hrs.)	8 hours	10 Yard Dump	$133.82/day
		Mower	$84.04/day
		Street Sweeper	$34.07/day
		1 Ton Truck	$25.37/day
		Backhoe	$76.11/day

SECTION 7: STORMWATER RATE ANALYSIS

7. Stormwater Rate Analysis

This section describes the results of a surface water utility rate study based on the proposed stormwater programs and capital projects. The rate study entailed projecting utility revenue needs, projecting revenue under current rates, and projecting revenue if rates are (a) reduced for commercial properties with on-site detention facilities, and (b) reduced temporarily for newly annexed areas. The expectation is that rates will meet the utility's objectives for revenue generation, equity among customers, rate defensibility, and administrative ease.

This report discusses the following:

- Surface water utility customer base and growth projections
- Existing surface water rates and revenue projections based on this rate structure
- Annual surface water system capital and operating cost projections, and 5-year revenue requirements (calendar year 2005-2009)
- Discussion of costs/savings associated with on-site detention facilities, policy issues, and implications for revenue generation of a rate reduction for these properties
- Discussion of costs/savings associated with the South Mount Vernon annexation area, policy issues, and implications for revenue generation of reducing rates for 5 years
- Pro forma projections of revenues, operating and maintenance expenses, with presentation of rates for three alternatives:
    1. A uniform rate per equivalent service unit (ESU), at the current rate level
    2. Same as #1, but with a reduced rate for property with on-site detention facilities
    3. Same as #2, but with a 5-year reduction in rates for the South Mount Vernon annexation area, under two rate reduction scenarios

Key findings include:

- The current rates are adequate to support the existing services and a small portion of the proposed CIP.
- Additional funding will be needed to fund the bulk of planned capital projects or to expand services.
- Discounts in rate for on-site detention facilities are defensible and would have a modest financial impact on the utility, but should be established only if these do not interfere with the utility's ability to fully fund operational and capital needs.
- Temporary rate reductions for newly annexed areas are defensible from an equity and financial perspective; the level of service could be proportional to revenue generated from rates in these areas.

7.1 Customer Base

Table 7-1 presents the customer base as of March 31, 2004. The table shows the number of accounts and ESUs for the different land uses in the system. An ESU, as defined in the Mount Vernon Municipal Code, is:

> ...a configuration of development, or impervious surfaces on a parcel, estimated to contribute an amount of runoff to the city's surface water management system which is approximately equal to that created by the average developed single-family residential parcel within Mount Vernon. One ESU is equal to 2,657 square feet of impervious surface area [Section 13.35.101 D].

The Code continues with a definition of "impervious surface" as:

> ... that hard surface that either prevents or retards the entry of water in the soil mantle and/or causes water to run off the surface in greater quantities or at an increased rate of flow from that present under natural conditions. Impervious surfaces may include, but are not limited to, rooftops, concrete or asphalt paving, walkways, patios, driveways, parking lots or storage areas, trafficked gravel, and oiled, macadam or other surfaces which similarly impede the natural infiltration or runoff of surface water [Section 13.35.101 E].

TABLE 7-1
Account Data (as of March 31, 2004)

Account Type	# Accounts	# ESUs
Single Family Residential	5,518	5,995
SFR Seniors*	335	335
Duplex	228	229
Restaurant	51	393
Commercial	517	5,791
Apartment	239	1,734
Government	126	2,897
Multiple Family Residential	4	23
Industrial	1	52
Total	**7,019**	**17,449**
Of Total – with Detention**	187	3,612
Detention as % if total	3%	21%
Seniors as % of total	5%	2%

* Assumes all senior accounts are single-family residential (SFR)

** On-site detention as of June 25, 2004

As Table 7-1 shows, in March 2004 there were a total of 7,019 accounts and 17,449 ESUs in the system. Industrial, government, and commercial accounts have the largest number of ESUs per account. While one ESU is equal to an average single-family account, it is assumed that there are more ESUs than single-family accounts due to some misclassification of customers into the single-family residential category. The table also notes that 187 accounts (excluding single-family residential, as discussed below) have on-site detention facilities, which contain 3,612 ESUs (21 percent of the system's total ESUs).

Table 7-2 presents the projected ESUs in the system through 2009, based on the existing service area, along with the projected surface water fee revenues, based on the utility's current rates (discussed below). It is assumed that the number of accounts and ESUs in the system will grow at a rate of 2 percent per year for all property types (based on information provided by the City). The table shows the number of ESUs in each year as of March 31 (the date of the base data provided by the City), the new/growth ESUs, and the mid-year/average ESUs for the year (as of July 31). The mid-year/average ESUs are used to project revenue.

7.2 Existing Rate Structure and Associated Revenue Projections

The existing surface water rates are designed to fund administration, planning, design, construction, water quality programming, operation, maintenance and repair of surface water system facilities, conveyance and program needs. The charges, which are per ESU, were established in 1994, to meet the needs identified in the Comprehensive Surface Water Management Plan.

The charges, per ESU, were set at $3.95 per month in 1994 through 1996, $5.35 per month in 1997 and 1998, and $6.05 per month in 1999 through 2003, and have not changed since. The charge for single-family residential customers is equal to one ESU per month; for duplexes it is equal to two ESUs per month; undeveloped parcels are not charged; all other parcels are charged based on the total amount of impervious surface area divided by the impervious area of one ESU (2,657 square feet), rounded to the nearest whole number, and multiplied by the rate per ESU. Low-income elderly persons are charged 75 percent of the otherwise applicable rate (currently $4.54 per ESU). The amount charged is included in the City's monthly utilities bill as a surface water line item.

Table 7-2 shows revenue projections through 2009, applying the current rate structure and the customer growth projections discussed above. It should be noted that the 2004 projection is approximately 3.7 percent below that projected by the City. The City's projection is based on cash inflows without receivables, and the prior year's revenue. Table 7-2 bases the projection on actual and projected new accounts/ESU data and the utility's current rates, which are used as the basis for projecting revenue under different rate structure scenarios. It is assumed that this modest discrepancy results from the timing of cash inflows and account growth (which is not evenly paced through the year). It should be noted that the revenue projection assumes that there are no unpaid accounts as, according to the City, unpaid accounts do not have an appreciable bearing on revenue generation.

TABLE 7-2
Projected ESUs and Surface Water Utility Revenues (2004 – 2009)

	March 31					
	2004	**2005**	**2006**	**2007**	**2008**	**2009**
Number of ESUs						
Single Family Residential	5,995	6,115	6,237	6,362	6,489	6,619
SFR Seniors	335	342	349	356	363	370
Duplex	229	234	238	243	248	253
Restaurant	393	401	409	417	425	434
Commercial	5,791	5,907	6,025	6,145	6,268	6,394
Apartment	1,734	1,769	1,804	1,840	1,877	1,914
Government	2,897	2,955	3,014	3,074	3,136	3,199
Multiple Family Residential	23	23	24	24	25	25
Industrial	52	53	54	55	56	57
Total	17,449	17,798	18,154	18,517	18,887	19,265
Growth Rate	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
New ESUs During Year						
Single Family Residential	118	120	122	125	127	130
SFR Seniors	7	7	7	7	7	7
Duplex	4	5	5	5	5	5
Restaurant	8	8	8	8	8	9
Commercial	114	116	118	120	123	125
Apartment	34	35	35	36	37	38
Government	57	58	59	60	61	63
Multiple Family Residential	0	0	0	0	0	0
Industrial	1	1	1	1	1	1
Total	342	349	356	363	370	378
ESUs at end of July (mid-year average)	17,535	17,885	18,243	18,608	18,980	19,360
Charge per ESU	$6.05	$6.05	$6.05	$6.05	$6.05	$6.05
Discounted Senior Charge	$4.54	$4.54	$4.54	$4.54	$4.54	$4.54
Projected Fee Revenues	$1,267,000	$1,292,000	$1,318,000	$1,344,000	$1,371,000	$1,399,000

7.3 Revenue Requirements

This section presents costs that the surface water system is projected to incur over the 5-year period 2005 through 2009. These costs must be recovered through surface water utility rates and other sources. The system revenue requirements for this calculation are based on the system's cash needs, and thus exclude non-cash expenses such as depreciation. The following categories of expenditure make up the revenue requirements: operation and maintenance expenses, CIP, and debt service requirements. No transfers out are anticipated.

7.3.1 Operation and Maintenance Expenses

The City's operation and maintenance (O&M) expenses include administration (primarily personnel and administrative overhead), maintenance, capital projects (non-CIP renewal and replacement), professional services, public education outreach, taxes, and miscellaneous expenses. The historical and projected operation and maintenance expenses of the surface water system are summarized in Table 7-3.

As Table 7-3 shows, operating expenses grew from 2001 to 2003, when they spiked upward; expenses are expected to decline precipitously in 2004, and then to increase gradually through 2009. The sharp increase in O&M costs in 2003 was due to one-time professional services and flood control costs. The projected 2004 O&M costs are based on the 2002 actual costs, adjusted by a 2 percent annual escalation factor for inflation. O&M costs are projected to continue to escalate at 2 percent per year from 2005 through 2009. Taxes are also projected to increase by 2 percent per year from 2005 through 2009. ("Taxes" refer to the business and occupation tax that the utility collects from its customers; it passes 85 percent of this revenue to the City's general fund and 15 percent to the state.) It is assumed that there will be no non-CIP capital costs included in operating expenses from 2005 through 2009.

TABLE 7-3
Actual and Projected Expenditures – 2001 through 2009

	Actual	Actual	Actual	*Estimated*	Projected				
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Operations/ Maintenance	$796,927	$794,216	$1,230,240	$826,302	$842,828	$859,685	$876,879	$894,416	$912,305
Taxes	$99,248	$209,049	$102,310	$102,162	$104,205	$106,289	$108,415	$110,583	$112,795
Capital Expenses (non-CIP)	$454,108	$211,100	$192,858	$75,840	$0	$0	$0	$0	$0
Total Operating Expenses	$1,350,283	$1,214,365	$1,525,408	$1,004,304	$947,034	$965,974	$985,294	$1,005,000	$1,025,100

Source: City of Mount Vernon, Strategic Outlook, 2004 – modified with assumption that 2004 O&M is based on 2002 actual, adjusted by a 2% annual escalation factor for inflation (based on discussion with the City's Director of Finance).

7.3.2 Capital Improvement Program and Debt Service

The surface water system's 6-year CIP is presented in Section 5. The total known capital needs are $8,500,000. Of this total, $600,000 is expected to be funded by rates in 2005 through 2007. The remaining $7,900,000, which is 93 percent of the total, is currently unfunded. The City does not plan on issuing new debt during the forecast period to cover these CIP costs.

The utility obtained a Public Works Trust Fund loan of $3.1 million in 1997 to cover system capital improvement costs. This loan, which has a 3 percent interest rate, has a term of 20-years and thus is scheduled to be paid off in 2016. Debt service payments, comprised of principal and interest, are close to $230,000 in 2004. They will decline to approximately $200,000 in 2009, and to $170,000 in 2016, following which the loan will be retired. The loan covenants require the City to set aside funds each month to meet the July debt service payments.

Additional revenues will be needed to fund capital projects after the next three years.

7.3.3 Transfers Out

In the 4 years between 1998 and 2001, the utility transferred more than $1.0 million to other City departments. The utility has not transferred out funds since 2001, and no transfers are projected during the study period.

7.3.4 Potential Additional Revenues

Additional revenues would be needed to fund the recommended expansions in services and capital projects. There are several potential sources for additional revenue. The most common include:

- Increased SWM fee
- Grants
- Debt
- Capital facility fees
- Existing Taxes

A mixture of these sources should be considered. The most straight forward source is an increase in the SWM fee. However, this is unlikely to receive public support without an extensive public process to build understanding among the public and develop support for specific program elements and specific capital projects.

Grants are available from a variety of sources but are very competitive and largely focused on habitat or water quality projects. An exception is the Flood Control Assistance Account Program (FCAAP) created by Washington state. This program funds projects related to flooding but also gives priority to projects that provide a benefit to fish or water quality. The City has been successful in competing for and winning grants and should continue pursuit of grants for appropriate projects.

There are also a variety of sources for debt including some that provide low interest rates. Debt is not recommended at this time because the City already has a substantial debt payment and there is not adequate revenue to repay additional debt.

Capital facility fees are a potential source of funding for capital projects related to growth. Such fees are charged against new development to support necessary public drainage facilities or improvements. The analyses and the list of capital projects in this plan may provide an adequate basis to support a capital facility fee.

Existing tax revenues are fully allocated for other issues and there is far more demand than supply. This is a major reason that the Storm and Surface Water Utility was created. Thus, the use of existing tax revenues for surface water projects is unlikely.

Table 7-4 below illustrates a potential combination of funding sources for capital projects. The complete list of individual capital projects is found in Section 5.

TABLE 7-4
Illustration of Capital Project Funding Needs and Potential Revenue Needs

Total Identified Capital Project Needs	$8,496,400
Potential CIP Projects with Existing Revenues	$(584,500)
Potential FCAAP funding for flood wall @50% ($250,000 plus $1,367,000 for semi-permanent and permanent wall)	$(808,500)
Assume SRFB or other grants for habitat related projects	$(300,000)
Six Year Revenue Shortfall	$6,803,400
Annual Revenue Shortfall	$1,133,900
Annual Revenue Generated by $3.00 Rate Increase*	$648,000

* Based on approximately 18,000 ESUs

Revenue sources and the need for the projects should be evaluated during the annual budget processes.

7.4 Pro Forma Projections and Rate Adjustments

This section presents a 5-year pro forma projection of the surface water system's financial performance based on projected system growth and costs discussed above. The proposed adjustments in the City's monthly surface water rates are calculated to meet the system's policy goals, primarily associated with equity, along with financial commitments, including debt service coverage requirements.

Table 7-5 presents a pro forma projection of system revenues and expenses for 2005 through 2009. The top portion of the table shows the calculation of the system revenue requirements. Revenues from sources other than rates are then deducted to determine the amount of revenue that needs to be generated through surface water rates to cover the system costs in each year. These rate revenue requirements are then compared with projected revenues under existing rates – and, in addition, with a potential on-site detention discount, which is discussed below. Any revenue surplus or shortfall is then calculated, which is added to or deducted from the cash balance.

7.5 System Revenue Requirements From Rates and Projected Revenue Under Existing Rates

As Table 7-5 shows, the total system revenue requirements amount to about $1.4 million in 2005, and decline to about $1.2 million in 2009. Revenue requirements are projected to decline during the 5-year period as rate-funded improvements decline from $255,000 in 2005 to zero in 2008 and 2009.

Nonrate revenues, in the case of the City, consist of interest income. Interest income is projected to be 3 percent per year of the beginning cash balance (under the existing rates scenario). As the table shows, interest income would fluctuate over the 5-year period from a low of approximately $13,000 in 2007, to a high of $21,000 in 2009. Given the small contribution of nonrate revenue to cover the system's costs, the amount of revenue that is needed to be generated through surface water fees is close to the total system revenue requirements.

As Table 7-5 shows, under the current rate structure, the system would experience a deficit and dip into reserves in 2005 and 2006, when rate-funded CIP improvements are highest, but would experience an operating surplus for the last 3 years of the period, which would enable the utility to fully replenish its reserves. Rate revenue, under the current rate structure, would be adequate to meet the system's anticipated needs for the 5-year period.

7.5.1 Surface Water Rate Modifications and Projected Revenue

Two alternatives for stormwater rate reductions are under consideration by the City:

- Reduced rate for properties with on-site detention facilities
- Temporarily reduced rate for properties in newly annexed areas.

Apart from these two changes, the City would like to maintain the current rate structure and fee levels.

The following paragraphs identify and evaluate the implications of the two potential changes to the rate structure. The analysis explored how rate reductions would impact the utility's objectives for revenue generation, equity among customers, rate defensibility, and ease in rate administration.

Before delving into the specifics of the two potential rate reductions, it should be noted that if a class of properties has a reduced need for surface water services, a rate reduction is defensible. Other jurisdictions offer surface water rate reductions or credits for properties with inspected and approved on-site detention facilities and it is not uncommon for jurisdictions to provide a reduced rate for a particular sub-zone of the service area, where this can be justified. From a legal perspective, a nexus must exist between the rate and the demand for service.

TABLE 7-5
Surface Water Fee Revenue Requirement Calculations, 2005-2009

Revenue Requirements	2005	2006	2007	2008	2009
Operating Expenditures	$947,034	$965,974	$985,294	$1,005,000	$1,025,100
Debt Service	$224,505	$219,553	$214,601	$209,648	$204,696
Rate Funded Improvements	$255,000	$252,500	$77,000	$0	$0
Transfers Out	$0	$0	$0	$0	$0
Total Revenue Requirements	$1,426,539	$1,438,027	$1,276,895	$1,214,648	$1,229,796
Non-Rate Revenues					
Interest Income	$19,749	$16,305	$13,193	$15,602	$20,761
Other Non-Rate Revenues	$0	$0	$0	$0	$0
Total Non-Rate Revenues	$19,749	$16,305	$13,193	$15,602	$20,761
Surface Water Fee Revenue Requirements	$1,406,790	$1,421,722	$1,263,701	$1,199,045	$1,209,035
Projected Surface Water Fee Revenues					
1. Under Current Rate Structure	$1,292,000	$1,318,000	$1,344,000	$1,371,000	$1,399,000
Operating Surplus/(Deficit)	($114,790)	($103,722)	$80,299	$171,955	$189,965
Cash Carried Forward (beginning balance)	$658,292	$543,502	$439,780	$520,078	$692,033
2. With On-Site Detention Discount	$1,238,505	$1,263,435	$1,288,344	$1,314,231	$1,341,095
Operating Surplus/(Deficit)	($168,285)	($158,287)	$24,642	$115,185	$132,060
Cash Carried Forward (beginning balance)	$658,292	$490,007	$331,719	$356,362	$471,547

7.5.2 Rate Reduction for Properties with On-Site Detention Facilities

The question of whether properties with on-site detention and water quality treatment facilities should be given a credit against the surface water rate has public policy dimensions as well as revenue generation implications. A discussion of these issues follows.

7.5.2.1 Policy Considerations – On-Site Detention Discount

The concept of a rate reduction for properties with on-site detention and water quality treatment facilities is based on the premise that these properties do not create the same impacts and therefore do not require the same level of service as properties without such facilities. This assumes that the facilities were adequately designed and constructed, are adequately maintained and perform as intended. Where this is the case, these properties result in reduced need for public capital projects and related maintenance.

As on-site detention facilities only partially mitigate impacts to natural systems, there is still a need for publicly-funded capital projects to mitigate drainage impacts. In addition, these properties would not reduce the need for general storm/surface water services, such as planning, inspection, monitoring, administration and education.

The City's current surface water budget has a portion dedicated to maintenance of facilities on single-family developments, but no budget for maintenance of facilities on all other privately-owned or public properties. It is proposed that a rate reduction be extended only to non-single-family residential properties, in proportion to the ongoing cost savings to the City associated with facility maintenance. This savings represents 20 percent of the cost to provide service to these properties. Thus, a credit of 20 percent is proposed.

7.5.2.2 Revenue Projections – On-Site Detention Discount

As of June 25, 2004, 187 accounts (excluding single-family residential) in the existing service area, with a total of 3,612 ESUs, benefit from private on-site detention facilities. While this is only 3 percent of accounts, it represents 21 percent of the system's ESUs. It is assumed that the number of such accounts and ESUs will grow at a rate of 2 percent per year, which is the growth rate for the service area. Table 7-6 shows the financial implications of establishing a 20 percent discount for these customers. As the table indicates, a 20 percent discount would result in a 4 percent reduction in revenue (i.e., 20 percent of 21 percent of the ESUs). Over the 5-year period, this represents $278,391 in lost revenue.

TABLE 7-6
On-Site Detention Discount - Projected Revenues, 2005-2009

	2005	2006	2007	2008	2009	Total
Detention Discount per ESU	$4.84	$4.84	$4.84	$4.84	$4.84	
Number of ESUs with Detention	3,684	3,758	3,833	3,910	3,988	
Lost Revenue Due to Discount	$53,495	$54,565	$55,656	$56,769	$57,905	$278,391
Lost Revenue as % of Fee Revenue	4%	4%	4%	4%	4%	4%

Table 7-5 shows the total projected surface water fee revenues during the 5-year period, with an on-site detention discount. As the table shows, while the discount would detract from net revenue, its impact would not be large enough to create a deficit in 2007, 2008 or 2009. While the utility would meet its financial obligations during the period, reserves would decline by approximately $187,000 (from the beginning balance of 2005 to the beginning balance of 2009), due primarily to the on-site detention discount.

7.5.3 Temporary Rate Reduction for Properties in Newly Annexed Areas

Discussions are underway concerning the annexation of South Mount Vernon into the service area. It is anticipated that other areas may be annexed in the future. Policy considerations along with associated revenue projections follow.

7.5.3.1 Policy Considerations – Newly Annexed Areas

It is expected that, in the long run, the cost of providing surface water utility service to the South Mount Vernon annexation area – and any other annexation areas – will be comparable, per ESU, to the cost of providing service within the current service area. In the long-run, therefore, the monthly surface water fee, per ESU, should be uniform throughout the service area. However, a reduced monthly fee is suggested during a 5-year transition period, for the following reasons:

- Customers in the annexation area currently pay an annual fee to the Skagit County Surface Water Utility for services, at a level that is about one-third or less than that of the City's fee; the City's monthly fee of $6.05 per ESU would be a significant increase for these customers, many of whom would not have a chance to budget accordingly.
- Customers in the annexation area have contributed fees to the South Mount Vernon sub-flood control zone (SFCZ), although these fees were last assessed in 1987. Unspent resources associated with these fees amount to approximately $58,700, which should be earmarked for annexation area projects or services – offsetting, as appropriate, City fees in the short-term.
- The utility has not budgeted for or scheduled work for the annexation area, and would be unlikely to provide full service to this area immediately.
- The utility does not have available resources to initiate service to the annexation area (and that area has not yet paid for such service).
- The utility does not have a thorough understanding of the surface water system in the annexation area – its condition, maintenance needs and capital needs – and currently lacks resources to meet those needs.
- The annexation area is more rural than the existing service area, and surface water service costs may be lower in this area per ESU; within 5 to 6 years, the annexation area is expected to be significantly more built out and its surface water service costs then are expected to be comparable with those in the rest of the service area.
- Reduced rates were instituted for a 5-year transitional period, between 1994 and 1998, when the City introduced its surface water rate, as discussed above; a similar approach should be taken with newly annexed areas.
- Service in the annexation area could be scaled to equal revenue generated, during a transitional period.

The City considered rate alternatives that would transition annexation area customers from their existing County surface water rates to those charged by the City. Two transitional rate alternatives were considered – a 50 percent transitional rate, and a stepped increase. For both alternatives, a 5-year transitional period is proposed, as it is expected that in year 6 the service level and associated costs in the annexation area will be comparable with those in the existing service area. It should be noted that these alternatives are illustrative of many transitional rate schedules that the City might consider.

7.5.3.2 Existing Skagit County Surface Water Rate

Customers in the annexation area are currently subject to the surface water rates shown in Table 7-7. As the table indicates, the County charges an annual fee per parcel for residential properties excluding apartments, and a fee per impervious area for apartments, commercial and industrial properties. It also charges $.30 per acre for all parcels – developed and undeveloped. The City's fee is only applied to properties with impervious area (i.e., developed properties). The County also charges the surface water fee for County roads ($0.007 per impervious square foot) and State roads ($0.0021 per impervious square foot), which the City does not do.

TABLE 7-7
Annual Surface Water Rates, City of Mount Vernon and Skagit County

	Single Family Residential	Duplex	Multiple Family (assume fourplex)	Apts, Commercial, Industrial
City Rate per ESU	$72.60	$72.60	$72.60	$72.60
County Rate				
per Parcel	$25.80	$31.79	$31.79	
per Impervious Sq. Ft.				$0.007
per Acre	$0.30	$0.30	$0.30	$0.30
Total (w/o acreage fee)	$25.80	$15.90	$7.95	$18.60
	per dwelling	per dwelling	per dwelling	per City ESU
County as % of City	36%	22%	varies	26%

The majority of South Mount Vernon annexation area is nonresidential property. These customers' current rates are approximately 26 percent of what they would be under the City's existing rates, per ESU, excluding the County's acreage fee. (This is calculated by multiplying $0.007 per square feet x 2,657 square feet per ESU = $18.60 per ESU, which is 26 percent of $72.60.) The fee per acre is modest ($0.30) and results in limited revenue, as there are only 518 total acres in the annexation area (121 acres of state and county roads and 397 parcel-related acres); this fee component is therefore excluded from the analysis.

7.5.3.3 Stepped Transitional Rate

Customers in the annexation area would not be subject to the Skagit County Surface Water Utility fee when they join the Mount Vernon service area. It is therefore suggested that, following annexation, these customers continue to pay a "typical" County fee for their first year of service with the Mount Vernon Surface Water Utility. That fee would be $0.007 per impervious square foot, which is $18.60 per year per ESU (2,657 square feet), or $1.55 per month per ESU. This fee would cover the cost of maintaining the level of service performed by the County, for 1 additional year. The fee would then increase each year in equal steps of $10.80 per ESU, to arrive at $72.60 per year per ESU in year 6; on a monthly basis, the fee would increase $0.90 per year, to arrive at $6.05 per month in year 6. The gradual, step-wise rate increase would be commensurate with the step-wise expansion of service and increase in associated costs. This gradual approach would ease customers into the new/increased rates.

7.5.3.4 Fifty Percent Transitional Rate

This alternative would set the transitional rate at the mid-point between the typical customer's Skagit County rate ($18.60 per year per City ESU) and the City's existing rate ($72.60 per year per ESU) for 5 years, representing an increase of $27.00 per ESU and a 145 percent increase from the County's rates. On a monthly basis, the fee would be $3.80 per ESU. After the 5-year period, the annexation area rate would increase to match the City's rate of $6.05 per ESU. The higher rate in year 1, relative to the stepped alternative, recognizes initial/start-up costs associated with the annexation – such as developing an inventory of the annexed surface water system, a work-plan and budget – while maintaining service on par with that provided by the County. By providing more resources up-front, this averaged approach would give the utility slightly more flexibility in terms of timing projects in the annexation area during the initial 5-year period. From the customer's perspective, this approach would represent a larger initial jump than the stepped alternative, but the fee would then remain constant for 5 years, before it would jump again.

7.5.4 Revenue Projections – Newly Annexed Areas

Table 7-8 shows revenue projections for the South Mount Vernon annexation area under three scenarios, over the 5-year period:

- Full rates
- Fifty percent transitional rates
- Stepped transitional rates

The following parameters were used and assumptions made regarding the South Mount Vernon annexation area, for the revenue projections:

- There were an estimated 2,905 ESUs in the annexation area, based on aerial photography in May 2003, and it is assumed (per the City) that there have been minimal changes to date.
- There are 914 ESUs (per the City) that have benefited from on-site detention facilities and would be eligible for an on-site detention discount, which is about 31 percent of ESUs.
- There is almost no residential development in the annexation area, and therefore no accounts (or an unappreciable amount) would be eligible for a senior discount.
- Following annexation, a spurt in growth would occur at a rate of approximately 5 percent per year for 5 years; following that growth, the area's development would resemble that of the rest of Mount Vernon, and future growth would be at a relatively slower pace.

Table 7-8 shows the potential revenue generated under the three scenarios, with and without a discount for on-site detention. As the table indicates, if the discount is granted for on-site detention facilities, this would reduce annual revenue by 6 percent under all three scenarios (which is the 20 percent discount on 31 percent of ESUs). Assuming this discount is granted, revenue at full rates would be approximately $207,000 in 2005 and would increase to approximately $252,000 in 2009, with total revenue of $1.1 million over the 5-year period. Under the 50 percent transitional rate scenario, revenue would increase from approximately $130,000 in 2005 to approximately $158,000 in 2009, with total revenue of $720,000 over the 5-year period. Under the stepped transitional rate scenario, revenue would increase from approximately $53,000 in 2005 to approximately $215,000 in 2009, with total revenue of $651,000 over the 5-year period. Over the 5-year period (assuming there is a discount for on-site detention facilities), revenue under the 50 percent transitional rate scenario would be $426,000 less than or 63 percent of that of the full fee, while revenue for the stepped transitional rate scenario would be $495,000 less than or 57 percent of that of the full fee.

TABLE 7-8
South Mount Vernon Annexation Area - Projected Revenues of Transitional Rate Scenarios, 2005-2009

	2005	2006	2007	2008	2009	
South Mt. Vernon ESUs	3,050	3,202	3,362	3,531	3,707	
Number of ESUs with Detention	960	1,008	1,058	1,111	1,167	
1. Revenue - Fee at 100%						
Monthly Fee per ESU	$6.05	$6.05	$6.05	$6.05	$6.05	
Potential Revenue	$221,417	$232,488	$244,113	$256,318	$269,134	
Lost revenue if Detention Discount	($13,935)	($14,632)	($15,363)	($16,131)	($16,938)	
2. Revenue - 50% (midpoint) Transitional Rate						
Monthly Fee per ESU	$3.80	$3.80	$3.80	$3.80	$3.80	
Potential Revenue	$139,070	$146,024	$153,325	$160,991	$169,041	
Lost revenue if Detention Discount	($8,752)	($9,190)	($9,649)	($10,132)	($10,639)	
3. Revenue - Stepped Transitional Rate						
Fee Steps (% of $6.05)	26%	40%	55%	70%	85%	
Monthly Fee per ESU	$1.55	$2.45	$3.35	$4.25	$5.15	
Potential Revenue	$56,724	$94,146	$135,168	$180,057	$229,097	
Lost Revenue if Detention Discount	($3,570)	($5,925)	($8,507)	($11,332)	($14,418)	
Total Revenue with Detention Discount						**Total**
1. Revenue - Fee at 100%	$207,482	$217,857	$228,749	$240,187	$252,196	$1,146,471
2. Revenue - 50% Transitional	$130,318	$136,834	$143,676	$150,860	$158,402	$720,090
3. Revenue - Stepped Transitional	$53,154	$88,221	$126,661	$168,725	$214,679	$651,439

7.5.5 Rate Reduction for Properties with On-Site Detention Facilities

CH2M HILL recognizes that a rate reduction for properties with on-site detention facilities is defensible from an equity and legal standpoint, and would be reasonably easy to implement from an administrative perspective. However, implementing this rate reduction would, over the course of the coming 5-year period, cost the utility approximately $280,000, depleting reserves that could be used for needed capital improvements.

CH2M HILL recommends that the City establish a rate reduction for properties with on-site detention facilities only if this does not interfere with the ability to fully fund Surface Water Utility expenditure needs. Rates, coupled with other projected sources of revenue, should fully fund operational and capital needs. The policy decision should rest on carefully considered O&M projections. If the City is confident that O&M costs will reflect Table 7-5 projections (or be lower), and that other revenue sources will be identified to fund capital needs, the City should proceed with the rate reduction. If O&M costs are expected to be higher than those projected in Table 7-5, and/or if other revenue sources cannot be identified to fund capital needs, CH2M HILL recommends that the City consider coupling the rate reduction for properties with on-site detention facilities with an overall rate increase. This would serve both the City's equity objectives and revenue generation needs.

7.5.6 Temporary Rate Reduction for Properties in Newly Annexed Areas

CH2M HILL recommends that the City establish a temporary rate reduction for properties in newly annexed areas, with a 5-year timeframe. This timeframe would enable the City to inventory, budget and plan projects in the newly annexed area, and to scale up the level of service as resources become increasingly available. Of the two alternatives discussed, CH2M HILL recommends the transitional-stepped rate increase, as this approach would enable customers to budget for and get accustomed to higher rates, as their level of service increases in proportion to the rates they pay. The City might consider other transitional rate schedules, as the needs of the annexation area and associated costs become more apparent.

CH2M HILL recommends that if the City increases or otherwise modifies its surface water rates for existing service area customers during the 5-year transitional period, the rates of annexation area customers should be increased/modified proportionately, so that in year 6 the rates in the annexation area are the same as those in the City's larger service area.

If the City implements a rate reduction for on-site facilities in the existing service area, CH2M HILL recommends the same policy should apply to properties in newly annexed areas.

CH2M HILL also recommends that the unspent revenue that customers in the annexed areas have contributed to the South Mount Vernon sub-flood control zone ($58,700), should be transferred to the City's utility. If these funds were earmarked for capital projects – or if there are pressing capital needs in the annexed area – the funds should be spent on capital projects. If there are no pressing capital needs in the annexation area, these funds should offset annexation area surface water rates and be used for general operating expenses.

It is suggested that the customers in the annexation area be billed on a monthly basis, once they are integrated into the City's utilities billing system.

SECTION 8: RECOMMENDATIONS

8. Recommendations

The following recommendations have been synthesized from the information and analyses in the previous sections of this plan.

8.1 Regulations and Policies: Adopt Ecology "Stormwater Management Manual for Western Washington, August 2001"

The City should adopt the Ecology "Stormwater Management Manual for Western Washington" (as required by state law). The manual requires the use of a continuous simulation hydrologic model to evaluate impacts and determine the size of detention facilities. It will require the definition of pre-development conditions as forested for the purpose of hydrologic modeling. These two factors (continuous simulation and forested conditions) will result in larger detention ponds for most new developments which will provide better protection of stream resources and reduce future flooding and erosion in streams.

8.2 Enhance Education

The City should continue to contract with Skagit River non-profit groups to provide education related to stormwater. Additionally, the City should develop targeted educational information for commercial and industrial property owners regarding illicit discharges. Examples of printed information are available from other jurisdictions.

8.3 Implement Detection of Illicit Connections and Discharges

The City should develop a regular program for detection of illicit connections and illicit discharges to reduce pollutants within the City's stormwater conveyance system and the potential discharge of those pollutants to receiving waters. This is an action that is required by NPDES municipal stormwater permits. This is a relatively inexpensive activity that can be very effective. Stormwater systems in commercial and industrial areas should be visually inspected during the dry portions of the year. If there are flows, they are likely illicit discharges, particularly if they are not consistent flows (consistent flows could be groundwater).

Field screening of storm drain connections begins with a visual inspection, and consists of the following actions if the visual inspection indicates the potential for an illicit connection:

- Observe the physical conditions of the catch basin and the contributing pipes
- Photograph the catch basin rim and bottom (and incoming pipes if possible)
- Perform onsite water quality analysis of flows into the catch basin
- Estimate flow rate into the catch basin
- Repeat these water quality and flow analyses between 4 and 24 hours after completion of the first sample set at each site.

Storm drains should be inspected no sooner than 72 hours after the last measurable precipitation event to determine if there is flow in any of the incoming drainage pipes, or if an incoming drainage pipe is aligned directly with a business or industry. If there is flow, the water coming from the pipe in question (or the catch basin itself when the pipe flow cannot be isolated) should be analyzed as described below. In cases where water quality sampling is performed, it is necessary to resample the site 4 to 24 hours after the completion of the first analysis.

It is recommended that City staff use a commercial storm drain kit to perform on-site evaluations of storm drains exhibiting flow after a 72-hour dry period. The parameters that should be monitored and their analysis methods are listed in Table 8-1.

TABLE 8-1
Illicit Storm Drain Connection Monitoring Parameters and Analysis Methods

Parameter	Analysis Method	Parameter	Analysis Method
Odor	Observation	Flow rate	Volume and time estimation
Color	Observation	PH	Field meter
Clarity	Observation	Phenol	Colorimetric test kit
Floatables	Observation	Total chlorine	Colorimetric test kit
Deposits/stains	Observation	Copper	Colorimetric test kit
Vegetation	Observation	Detergents	Colorimetric test kit
Structural condition	Observation	Turbidity	Colorimetric test kit
Biological growth	Observation	Color	Colorimetric test kit

In the event that a suspected illicit storm drain connection is confirmed by the results of field monitoring, the City's building official should be contacted for enforcement of building and drainage regulations. Enforcement may consist of physically disconnecting sources, educating site owners regarding proper disposal of pollutants, or making referrals to Ecology of other water quality agencies.

8.4 Improve and Document Enforcement Actions

Additional resources should be provided and inspections of new development should be increased. Native growth protection easements and aquatic resource setbacks should be field marked and inspected prior to construction . Regular inspection should document that these areas remain marked and are not violated during construction. Erosion control facilities should also be installed prior to construction, regularly inspected throughout construction, and removed and stabilized following construction. Drainage facilities such as swales, ditches, pipes, catch basins, and detention ponds should be inspected to assure that they are constructed in accordance with the design and are properly functioning at the completion of construction.

The responsibility among City departments for inspection should be clarified for each type and stage of permit review and construction. This will require an evaluation of the specific needs for inspection, training, staffing and assignments.

Additional training should be provided for all staff involved in permit review or inspection. Training should include the value of aquatic resources, potential impacts and methods to avoid, minimize, and compensate for impacts. Specific training is needed for marking and maintaining aquatic resource setbacks, and for erosion and sediment control.

8.5 Complete Inventories and GIS

The City is currently preparing inventories of the drainage system, streams, and wetlands. These inventory activities should be completed and periodically updated as appropriate. The information should be placed in the Geographical Information System for display on maps. The maps should be available at the City permit counters for use by property owners and developers.

8.6 Complete Capital Improvement Projects

Capital projects should be completed within available annual funding limits. Priorities for capital projects are listed in Section 5 of this plan. At the present funding levels and with the required annual debt payment for prior capital projects, new capital projects will be minimal. The capital improvement plan should be incorporated annually into the overall City capital improvement plan (normally completed as part of the budget process).

8.7 Evaluate the Need of Additional Funding to Complete Capital Improvement Projects

The demand for capital projects exceeds the available revenues for the stormwater utility. While this may not be unusual, there may be compelling reasons for some of the capital projects that warrant consideration of additional revenue (for example, a rate increase). The proposed capital improvement program should be reviewed by the Planning Commission or other public group to evaluate the demand for surface water capital projects and balance the demand against the desire to reduce or at least avoid increases in stormwater rates. The Planning Commission recommendations should be forwarded to the City Council for consideration.

There is no allowance in the budget for long-term replacement of the drainage infrastructure. Since much of the City is relatively new, this may not be critical at this time. But, it would be advantageous to start setting aside funding for eventual replacement before the issue becomes critical.

There are a number of grant programs available for capital projects that should be pursued aggressively. Most grants are for innovative projects, water quality, or habitat protection. There are very limited grant opportunities for typical stormwater projects to address local drainage problems as these are expected to be locally funded.

8.8 Rate Reductions

Rate reductions for on-site detention facilities and for newly annexed areas should be considered as discussed in Section 7 of this plan.

8.9 Update Plan in Five Years

Mount Vernon is growing rapidly, resulting in additional impervious surfaces and reduction in forests and open spaces and encroachment in riparian corridors. Changes will degrade streams and wetlands and increase flooding and erosion. This plan should be updated in 5 years to reflect changing regulatory requirements, growth, and changing public interests.

8.10 Maintenance

Continue maintenance activities as currently practiced. Develop documentation of tasks performed, the level of effort required, and known "hot spots," such as frequent drainage, erosion, or water quality problems. Use the documented level of effort to develop unit costs for each activity. This will allow appropriate budgets and billing for stormwater maintenance. Complete and regularly update the inventory of drainage facilities. Incorporate the inventory findings in the GIS system.

Develop and maintain a spill response program. Provide training for maintenance crews in containment and cleanup of spills.

8.11 Stormwater Pollution Prevention

Inspect existing facilities owned or operated by the Public Works and Parks Departments for stormwater pollution prevention. Identify and eliminate exposed sources of potential stormwater pollutants. Assure secondary containment of liquids that could become contaminants if spilled or leaked. Assure vehicle maintenance is performed in appropriate areas (either covered or in an areas that drains to the sanitary sewer or a separate treatment facility). Storage and transfer of potential pollutants should be under cover.

Review Integrated Pest Management Plans for the Department of Public Works and the Department of Parks. Update as appropriate.

8.12 LID

Continue to encourage and promote the use of Low Impact Development techniques. Suggest approaches to developers. Explore the potential to offer incentives to developers, such as reduced detention requirements or increased density. Allow flexibility in design standards to accommodate LID techniques. Amend design standards to specify pervious pavement for walkways and parking areas and allow narrow streets in residential areas if Low Impact Development features are implemented.

Review each City capital project for opportunities to incorporate LID techniques. Develop and adopt a City policy that directs inclusion of appropriate LID techniques. These projects can become examples for the development community to increase understanding and confidence in the approach.

Select a street upgrade project and fully incorporate LID techniques as a demonstration. Incorporate LID techniques in all road improvement projects as feasible.

8.13 Flood Protection

The original stormwater utility did not include actions to address flooding from the Skagit River since these actions are funded by various dike, drainage, and flood control districts. There are certain capital projects that would provide additional flood protection for the City that are not likely to be provided by the existing flood control districts. It would be beneficial if the City had a designated funding source for these activities. The potential to expand the use of the Storm and Surface Water Utility funds for this purpose should be evaluated by the City. This use of the funds would reduce funding available for other on-going stormwater actions. Thus, additional revenues may be necessary if river flood response actions are added.

8.14 Advocate

At the present time, there is no individual position that is dedicated or entirely available to manage the stormwater program. Therefore, there is no clear voice or advocate for surface water in the City.

Stormwater and related regulations are changing rapidly. As a relatively new field, the technology is also rapidly changing. With the amount of change, it is difficult to stay up to date. It would be helpful to have at least one staff dedicated (subject to budget constraints) to stormwater with primary responsibility in the City for monitoring changing regulatory conditions and technology.

Mount Vernon is blessed with an abundance of surrounding open space and productive aquatic resources. With the anticipated growth, this may change. If it does, citizens may become more outspoken about the need to protect or restore the City's aquatic resources. Having an advocate in the City now may prevent some of the loss of existing aquatic resources.

City staff should evaluate the departmental organizations and clarify responsibilities regarding surface water management. A position should be identified as the primary contact and representative for surface water issues.

APPENDICES

Appendix A
Surface Water Modeling and Analysis

- Technical Memorandum No. 1
- Technical Memorandum No. 2
- Technical Memorandum No. 3
- Technical Memorandum No. 4

TECHNICAL MEMORANDUM #1

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Prepared For: CH2M HILL

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Subject: City of Mount Vernon Comprehensive Surface Water Management Plan Update; Maddox Creek HSPF Model and Lower Basin Channel Encroachment.

Date: June 30, 2004

Introduction

Hydrologic Simulation Program – Fortran (HSPF) hydrologic models for the Maddox Creek basin were originally developed in 1993 during preparation of the 1995 City of Mount Vernon Comprehensive Surface Water Management Plan (CSWMP). In the current work, the models were updated with meteorological data through December 2002 and modified to provide a more realistic representation of storage volumes in the lower portion of the basin. Model accuracy was reviewed by comparing the results of the updated HSPF simulations with Maddox Creek recorded streamflow data at Hickox Road for the period of May 2001 through September 2002. Finally, an assessment was made of potential lower-basin channel encroachments and loss of floodplain storage, and the effects of such encroachments on flood levels and peak discharges.

The Maddox Creek basin above the original calibration point, located 1,200 feet upstream from Anderson Road, is relatively steep-sloped and well-drained. The original Maddox Creek models did not include any channel storage in the relatively-flat lower basin areas below the calibration point. Because significant storage in the lower basin areas was neglected, model estimates of Maddox Creek peak flows at Hickox Road (the City's urban growth boundary and the downstream end of the HSPF model) were overestimated.

Model Update

Revisions to the Maddox Creek models included: 1) extending the meteorological data sets through mid-December 2002; 2) developing approximate land use data reflecting current (2002) land use conditions; 3) simulating the current (2002) performance of the regional detention pond at Little Mountain Estates; and 4) using a FEQ hydraulic model of the lower basin to estimate realistic lower-basin storage characteristics for HSPF simulations. Each of these updates is discussed below. The update work made use of available HSPF model sequences previously prepared by R.W. Beck and therefore relied upon the original soils mapping, the original land use mapping, and the original sub-basin delineations presented in the 1995 CSWMP. Sub-basin delineations from the 1995 CSWMP are reproduced in Figure 1, with annotations to highlight locations of interest to the current work.

Meteorological Data Update

Precipitation data used in the updated hydrologic modeling were obtained from the National Oceanic and Atmospheric Administration (NOAA) station at Burlington for the period of October 1, 1956 through November 30, 1993, and from the Washington State University (WSU) Cooperative Extension Public Agricultural Weather System (PAWS) Mt. Vernon station for the period of December 1, 1993 through December 23, 2002. Data from the PAWS station were increased by 11% to represent the generally-higher rainfall amounts at Burlington and in the Maddox Creek basin. The NOAA Station at Burlington is located about 3 miles north of downtown Mount Vernon and has a reported station elevation of 30 feet. The Mount Vernon PAWS station is located about 3 miles west of downtown Mount Vernon, and has a reported station elevation of 10 feet. A comparison of monthly data for these two stations for 83 concurrent months between years 1991 and 1999 found that rainfall amounts at the NOAA (Burlington) gage are, on average, about 11% greater than at the PAWS gage. This variation is consistent with isopluvial mapping, which shows an eastward increase in rainfall amounts across the area.

Although the Burlington gage was assumed to best represent precipitation characteristics in the Maddox Creek basin based on isopluvial mapping, there are significant gaps in the records for that gage, and no concurrent rainfall records are available for either of the two documented high streamflow events in June 2001 and December 2001. Because of its relatively-complete record, the post-1993 rainfall data set was based exclusively on the PAWS data times a 1.11 multiplier. It should be noted that, on a monthly basis, total rainfall amounts at Burlington typically range from being about 10% lower to 20% higher than at the PAWS station. Similar monthly variability, and greater storm-specific variability, is expected between the PAWS rain gage and the Maddox Creek basin. Because of uncertainty over the actual rainfall in the Maddox Creek basin, HSPF validation results for individual storm events should be interpreted with caution.

Daily pan evaporation data were obtained from the Puyallup pan evaporation station, with winter months filled using the Jensen-Haise equation. The Puyallup station operated from water year 1960-1995. Daily values prior to 1960 (by others) and for 1996 and 1997 were assumed to have been copied from existing years. Evaporation values for water year 1998 and subsequent years were based on long term monthly averages. The latter assumption may not be appropriate for evaluating summer low flows but will have negligible impact on modeled storm flows.

Land Use Update for Current (Year 2002) Conditions

Land use characteristics representing current (year 2002) conditions were approximated as an average of estimates from the 1995 CSWMP of then-current (1991) and future buildout conditions for each sub-basin. This approach was based on a cursory visual inspection of basin aerial photographs showing the basin conditions in years 1992 and 2001. This was considered to be a reasonable and cost-effective approach.

Previous estimates of sub-basin land-use conditions were not tabulated in the 1995 CSWMP and had to be recovered from a combination of sources. Data sources included: 1) HSPF input sequences from 1993 of existing and future conditions, prior to the addition of sub-basin 51 above the Little Mountain Estates Pond; 2) a land-use breakdown (estimated in 1993) for sub-basin 51; and 3) an HSPF input sequence of future buildout land use conditions, based on a reanalysis of land-use by RW Beck in 2000. Table 1 summarizes the land-use conditions used for the current work, developed from the above sources.

Three irregularities were noted during the review of the previously-developed land-use data. First, the year 1993 and year 2000 estimates of the areas of sub-basins 19 and 52 differed by 24 acres or 4% of the combined total area of 614 acres. The reason for the difference is unclear, but may be due to use of different map products for the two analyses. The difference is small in relation to the total basin area and is felt to be inconsequential to model results. Second, in sub-basin 22 (which includes the Flowers Creek basin and about 1.3 miles of I-5 highway corridor) the year 2000 estimate of future impervious surface was 78 acres greater than the year 1993 estimate, even though both estimates were reportedly based on the same RW Beck land use mapping. The discrepancy was reduced, but not eliminated, by excluding 20 acres representing rooftop drainage in an area served by a combined sanitary-storm sewer. The third irregularity is in sub-basin 37 which includes lower Maddox Creek from Hickox Road to the confluence with Flowers Creek. The previous land use analysis for sub-basin 37 did not show any change in land use between the current (1991) and future buildout conditions. The "future" land use data based on the past work and recreated here is therefore believed to reflect outdated 1991 conditions rather than a future buildout scenario.

Note that the future land use data presented in Table 1 were used in the current study as a means to estimate the current land use, but were not used to develop a new future-conditions HSPF hydrologic model of the basin. The focus of the current study was to calibrate the HSPF model to flows recorded near the city urban growth boundary and, using an FEQ hydraulic model with previously-estimated future conditions flows, to assess the impacts of lower basin channel encroachment.

Table 1
Maddox Creek Soil and Land Use Data for HSPF Modeling
Land Use In Acres

	1991 Existing Conditions (estimated in 1993)					
	SB 51	SB 19	SB 34	SB 22	SB 37	TOTAL
Till Forest	174.0	146.5	218.0	82.2	76.4	697.1
Till Pasture	80.0	114.3	54.6	78.2	84.4	411.6
Till Grass	15.0	23.8	0.1	155.0	-	193.9
Outwash Forest	-	-	-	-	24.1	24.1
Outwash Pasture	5.0	24.2	-	-	13.4	42.6
Custer Norma Grass	-	-	-	28.5	303.0	331.5
Saturated	4.0	13.2	11.8	-	-	29.0
Impervious (EIA)	5.0	9.7	0.9	102.9	115.2	233.6
TOTAL	283.0	331.7	285.5	446.8	616.4	1963.3

	2002 Existing Conditions (estimated in 2003)					
	SB 51	SB 19	SB 34	SB 22	SB 37	TOTAL
Till Forest	100.1	95.7	200.1	82.3	82.2	560.4
Till Pasture	102.1	77.2	51.1	57.5	62.3	350.1
Till Grass	53.8	123.1	20.1	146.9	15.9	359.8
Outwash Forest	-	-	-	-	23.7	23.7
Outwash Pasture	6.0	12.1	-	-	13.7	31.8
Custer Norma Grass	-	-	-	27.5	301.9	329.4
Saturated	2.0	14.3	11.8	-	-	28.1
Impervious (EIA)	6.8	21.5	2.7	133.1	116.4	280.4
TOTAL	270.6	343.8	285.7	447.3	616.1	1963.6

	Future Conditions (estimated in 2000, adjusted in 2003)					
	SB 51	SB 19	SB 34	SB 22	SB 37	TOTAL
Till Forest	26.1	44.9	182.2	82.3	88.1	423.6
Till Pasture	124.1	40.0	47.6	36.8	40.1	288.6
Till Grass	92.5	222.4	40.0	138.9	31.9	525.7
Outwash Forest	-	-	-	-	23.3	23.3
Outwash Pasture	6.9	-	-	-	14.0	20.9
Custer Norma Grass	-	-	-	26.5	300.9	327.4
Saturated	-	15.3	11.7	-	-	27.1
Impervious (EIA)	8.6	33.2	4.4	163.3	117.6	327.2
TOTAL	258.2	355.8	286.0	447.9	615.9	1963.8

NOTE: Future conditions adjustment in 2003 was to reduce the SB 22 impervious area by 19.6 acres, which is the amount by which the total SB 22 area (estimated in 2000) exceeded the original SB 22 area (estimated in 1993). The increased total and impervious area in the year 2000 estimate is thought to have resulted from not deducting areas of roofs in SB 22, which drain to the sanitary sewer. Figure III-5 of the 1995 CSWMP shows that such areas exist.

Existing Detention Pond Update

The effects of existing detention ponds in the Maddox Creek basin were ignored in the existing conditions (2002) model, except for a large regional detention pond at Little Mountain Estates. This approach is the same as was adopted for the 1995 CSWMP. The rationale for ignoring other existing ponds is uncertainty over the historical ineffective design standards that regulated the design of these facilities, coupled with the expense of researching and modeling multiple discrete facilities which likely provide little peak flow control during major storm events. Consideration was given to modeling a new large detention pond in the Flowers Creek basin (part of model sub-basin 22), but this was not done in favor of putting more effort towards developing realistic channel storage characteristics for modeling the lower basin.

The regional detention pond at Little Mountain Estates is a significant facility which provides peak flow control for the entire basin (model sub-basin 51) upstream of the pond. As originally designed, a side weir on the main Maddox Creek channel was intended to split high streamflows into the detention facility while allowing relatively low flows to remain in the channel. However, the side weir failed after a short period of service, causing the entire creek flow to be directed into the pond. Sandbags have been placed as a temporary measure to keep at least some flow in the main channel, but these are expected to be ineffective under high flow conditions. Work is underway by the City to address the failed side weir.

For assessing current (year 2001-02) basin conditions, the HSPF model was configured to have the Little Mountain Estates pond receive 100% of the upper basin flows, reflecting the failed condition of the side weir during the validation period. Prior estimates of pond stage, area, and volume characteristics were retrieved from working files for the 1995 CSWMP. The outlet structure stage-discharge relationship was re-computed to accurately represent the hydraulic controls described in facility as-built drawings. Table 2 summarizes the hydraulic characteristics of the pond in its as-built configuration, assuming unobstructed orifices and no backwater effects from the outlet channel.

Table 2
Little Mountain Estates Detention Pond
As-Built Hydraulic Characteristics**

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow (cfs)
0.0	0.1	0.0	0.0
0.5	1.5	0.0	1.2
5.0	1.5	5.1	3.9
5.5	1.5	5.8	4.1
6.0	1.5	6.6	5.7
6.5	1.5	7.2	9.4
7.0	1.5	8.1	17.2
7.5	1.5	8.7	28.3
8.0	1.5	9.6	42.5
8.5	1.5	10.6	65.2
9.0	1.5	11.2	111.5

** The flows in Table 2 above reflect the discharges computed through four orifices at pond depths of 0.0 through 6.4 feet and a control structure overflow riser at a depth of 7.6 feet. The crest (overflow) elevation of the pond emergency spillway is at a pond depth of 8.4 feet.

Lower Basin Storage Update

Previous HSPF modeling of the Maddox Creek basin did not incorporate any channel storage below the original calibration point located about 1,200 feet upstream from Anderson Road. For the current work, lower basin channel storage was estimated by modifying an FEQ (Full Equations) hydraulic model developed for a separate project along lower Maddox Creek. This model[1] includes the lower reach of Maddox Creek from Hickox Road to the inlet side of a long culvert crossing I-5, and simulates hydraulic conditions for the month of November 1990 with inflows based on basin future conditions as estimated by RW Beck. November 1990 produced the highest peak flows in the hydrologic simulation period of January 1956 through February 1993. The original FEQ model was set up to route flows from the entire month of November 1990 because the large amount of flood storage along lower Maddox Creek would cause peak water levels to be the result of a prolonged large-volume event rather than a 24-hour peak flow event.

For the present work, the upstream limit of the original FEQ model for November 1990 was extended upstream about 1,600 feet to the confluence of Maddox Creek and Flowers Creek. Model output was processed at 12-hour increments to identify flows at Hickox Road and the

[1] The source (original) FEQ model is described in the July 2002 report "Maddox Creek Hydraulic and Hydrologic Analysis -Final," prepared by RW Beck for the City of Mount Vernon

corresponding total channel and floodplain storage between Hickox Road and the confluence with Flowers Creek. Figure 2 provides a sketch of the lower reach covered by this analysis and also a plot of the resulting volume-discharge data used in the HSPF model.

Analysis of the FEQ model results determined that nearly 120 acre-feet of water could be stored in the lower Maddox Creek channel and floodplain areas during a major flood such as occurred in November 1990. To put this in some context, the regional detention pond at Little Mountain Estates has a total storage volume of only about 11 acre-feet before overflow.

The HSPF model update work did not attempt to develop (and does not include) an accurate estimate of additional storage in model sub-basin 22, upstream of the confluence with Flowers Creek. This area consists of the Flowers Creek channel and roadway ditches along approximately 1.3 miles of I-5 highway corridor. From a cursory review, storage in this area is expected to be small relative to the lower basin storage shown in Figure 2.

Comparison of Maddox Creek Simulated and Recorded Flows at Hickox Road

Continuous water level and velocity data for Maddox Creek at Hickox Road have been collected since May 9, 2001 at a site known as the Carpenter School gage. Preliminary streamflow data from that gage through September 23, 2002, were provided to **nhc** for purposes of comparison with the simulation results from the updated HSPF model for current (year 2002) conditions.

A review of the preliminary streamflow data sets and comparison with available stream gaging measurements determined that reliable continuous streamflow data were available only for the months of December 2001 through February 2002. This period of reliable streamflow record includes an event on December 13, 2001 with a peak flow having about a 2-year recurrence interval, based on subsequent analysis.

Figure 3 presents HSPF simulation results, using USGS generalized parameters, for Maddox Creek at Hickox Road for water years 2001 and 2002 (October 2000 through September 2002). Figures 4, 5, and 6 compare the simulation results from the updated HSPF model with recorded flows at Hickox Road for the months of December 2001 through February 2002, for which the recorded streamflow data are reliable. Two versions of updated HSPF model results are presented to provide an assessment of the runoff parameters used in the HSPF modeling. The first set of HSPF simulation results uses the 1993 calibration parameters developed during preparation of the 1995 CSWMP. The second set of HSPF simulation results uses generalized parameters published by the USGS for basins in Western King and Snohomish Counties (Dinicola, 1990). It can be seen from Figures 4 through 6 that, of the two HSPF simulations, the flows produced with the USGS generalized parameters provide the best fit to the recorded data and a reasonably good reproduction of the recorded peak flows and volumes for these months. Subsequent HSPF simulations for the Maddox Creek basin are based exclusively on the USGS generalized parameters.

Comparison of Maddox Creek Simulated and Recorded Flows at Former Calibration Point above Anderson Road

The original Maddox Creek HSPF model was calibrated to streamflow data collected during the 1991-92 and 1992-93 wet weather seasons at a culvert located 1,200 feet upstream from Anderson Road, using concurrent 15-minute rainfall data collected at the Mount Vernon Waste Water Treatment Plant. The largest flow during the original calibration period had a return period estimated as approximately a three-year event, resulting from a storm on January 11, 1992.

The basin tributary to that original calibration point is relatively steep-sloped and well-drained. As a check on the revised parameter selection, an HSPF model input sequence was developed using the USGS generalized parameters and the 1991 land cover data from Table 1. The model was run to evaluate whether the use of USGS generalized parameters, in place of the calibration parameters developed for the 1995 CSWMP, would adversely affect model ability to simulate flows in the upper basin.

In the updated model for 1991 conditions, groundwater from the upper basin was assumed to bypass the original calibration gage site, emerging instead in the flat lands of the lower basin. This groundwater routing assumption is different from that in the earlier work; the change was made to improve model calibration while using the generalized parameters. The original model for the 1995 CSWMP assumed that upper basin groundwater would be measurable as streamflow at the original calibration gage site, and the model parameters had been adjusted to suppress groundwater flow.

Available results of the original calibration are limited to a single figure in the 1995 CSWMP showing simulated and recorded flows for a flood event in the period January 9-13, 1992. Figure 7 superimposes a plot of the updated simulation results onto an image of that figure. It can be seen from Figure 7 that the use of the USGS generalized parameters, together with updated groundwater routing assumptions, produces simulated flows which are in reasonable agreement with the recorded flows for the upper basin gage site and are at least as good as the original calibration results. This finding supports the use of the USGS generalized parameters for subsequent HSPF simulations in the Maddox Creek basin.

Maddox Creek Updated Flood Frequency Curves for Existing Conditions

Flood frequency curves for Maddox Creek were developed from the updated HSPF simulation results. Figure 8 plots the current-condition (year 2002) flood frequency curves for all five sub-basins represented in the updated Maddox Creek HSPF model.

Table 3 provides a summary of the flood quantiles for the basin, based on a visual evaluation of the frequency curve plots. Note that these curves reflect the current (failed) condition of the side weir at the Little Mountain Estates regional detention pond, and that land use in the lower basin (model sub-basin 37) reflects 1991 rather than 2002 conditions.

Table 3
Maddox Creek Peak Flows, Existing (2002) Conditions

Location (Cumulative flows to sub-basin outlet)	Flows (cfs) by Recurrence Interval 2-year	10-year	50-year	100-year
SB 51 - Maddox Creek Below Little Mountain Estates Pond	4	11	13	14
SB 19 - Maddox Creek at Blackburn Road	19	34	55	67
SB 34 - Maddox Creek 1200 ft above Anderson Road	28	61	90	105
SB 22 - Flowers Creek & I-5 Highway Corridor	46	77	95	100
SB 37 - Maddox Creek at Hickox Road	46	75	90	95

Lower Basin Channel Encroachment Assessment

The FEQ hydraulic model was used to assess the hydraulic impacts of possible channel encroachment in the lower basin. The FEQ model used for this purpose was the same model which was used to develop the stage-storage relationship presented in Figure 2 for the lower basin area.

Flood-prone areas in the lower Maddox Creek basin were identified from output of the FEQ model. As stated previously, this model computes flows and water levels for the month of November 1990 assuming future basin conditions as simulated by RW Beck. The peak flows and water levels determined from the model results reflect a major flood with a recurrence interval likely in the range 50 to 100 years.

Approximate inundation limits corresponding to the FEQ estimates of flood event peak water levels were estimated using City digital topographic mapping with two-foot contour intervals. Figure 9 presents the Maddox Creek inundation limits on a standard USGS base map. Included on Figure 9 are peak water levels and flows for the base condition of current channel conditions as well as for alternative encroachment scenarios discussed below.

Two encroachment scenarios were assessed. The first and most severe scenario assumed a 25-foot wide buffer from the centerline of channel, providing a total stream corridor width of 50 feet for both natural and ditched sections of channel. In the second scenario, the 25-foot buffer was retained for ditched sections of channel, and a 100-foot buffer (providing a 200-foot wide stream corridor) was assumed for the natural channel reaches. Figure 9 shows the locations of the ditched and natural sections of channel. The natural channel is located to the east of Interstate 5; the ditched reach of channel is located west of Interstate 5 and is connected to the natural channel by culverts beneath the highway. The modeling of these encroachment scenarios assumes that fill (eliminating floodplain storage) will be placed to the encroachment limits and that flow will be confined to the protected stream corridor.

Assessment results are summarized in Figure 9. The results show that both encroachment scenarios will result in noticeably higher peak water levels within the city as well as higher peak flows where Maddox Creek flows cross the city urban growth boundary at Hickox Road. The greatest water level increase of up to 1.6 feet will occur at the upper end of the ditched reach of channel, causing upstream backwater impacts of up to 1.3 feet in the natural channel. Very similar water level impacts will occur with both scenarios, presumably because the greatest impacts are associated with encroachment along the ditched section of channel where a constant 25-foot buffer (50-foot corridor) was assumed for both scenarios.

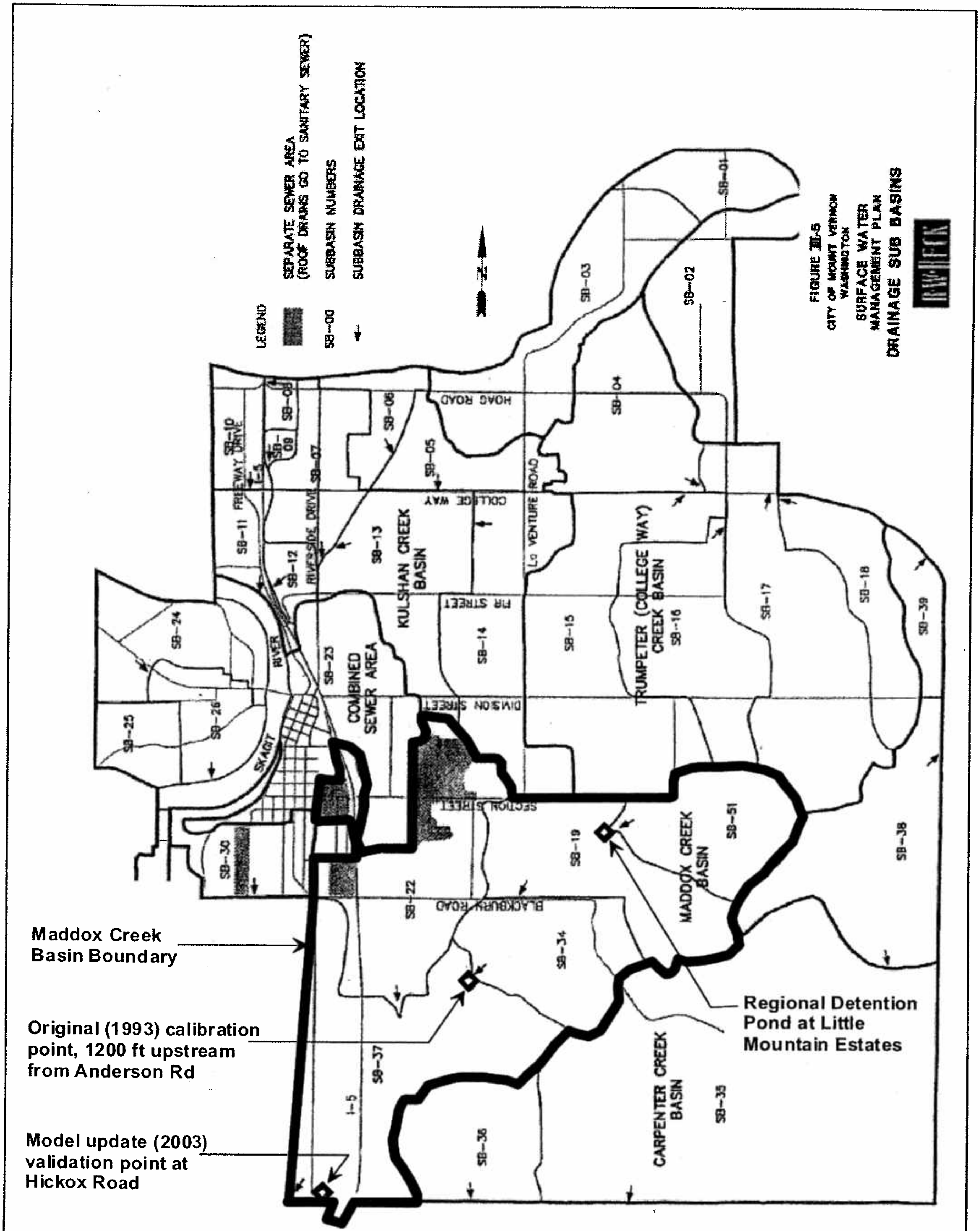
The combined peak flows at the ditch and channel crossings of Hickox Road (flow points 4 and 2 on Figure 9) would increase by up to 50%, from a base condition of 132 cfs to 200 cfs under the first encroachment scenario and 182 cfs under the second encroachment scenario. It should be noted that all of the modeled scenarios assume future buildout of the basin without effective onsite flow control and result in conservatively high estimates of peak flow. However, because the identical hydrology is assumed in each of the modeled scenarios, the estimated changes to peak flows and water levels provide a reasonable measure for comparison of the alternatives.

Summary

The HSPF model for Maddox Creek was updated with meteorological data through December 2002, realistic storage data for the flat lower basin, and land use data reflecting current (year 2002) conditions. Simulation results from two versions of the updated model—one version using calibrated parameters from the 1995 CSWMP and a revised version using USGS generalized parameters and alternative groundwater routing assumptions—were compared to available observed streamflow data for Maddox Creek at Hickox Road. Results from the revised model using USGS generalized parameters produced the best match to the observed flows. Simulation results using USGS generalized parameters and 1991 land use data were then compared to calibration results presented in the 1995 CSWMP for a site located upstream from Anderson Road. The results of the revised model are at least as good as those of the earlier work in matching observed streamflows at the original calibration site.

The updated HSPF model for Maddox Creek produces credible results based on comparisons of simulated and observed flows in the upper basin above Anderson Road and in the lower basin at Hickox Road. Conditions represented in the current-conditions (year 2002) model include the failed side weir at the Little Mountain Estates regional detention pond, and considerable channel and floodplain storage in the lower basin below the confluence of Flowers and Maddox Creeks. Application of the models, particularly for future land-use conditions, should be done with caution. The potential loss of storage, resulting from fill placement at flood-prone properties that would likely occur during development of the lower basin, could have a significant effect on peak flows at the City's urban growth boundary.

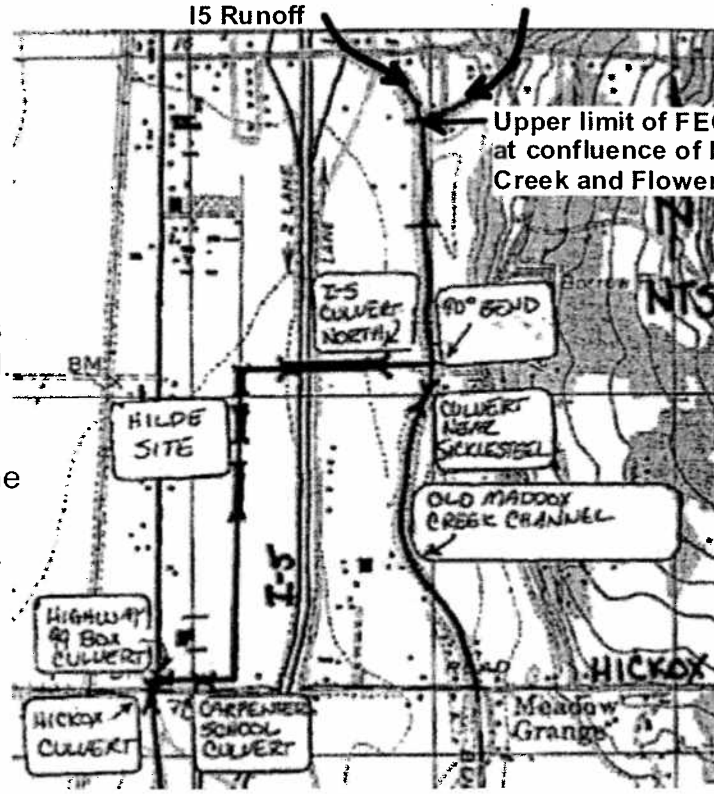
Potential loss of floodplain storage in the lower basin could result in Maddox Creek the future condition 100-year peak flows at the City's urban growth boundary (Hickox Road) being increased by as much as 50% above conditions without floodplain fill. Maddox Creek flood water levels within the city limits could be locally increased by up to 1.6 feet.



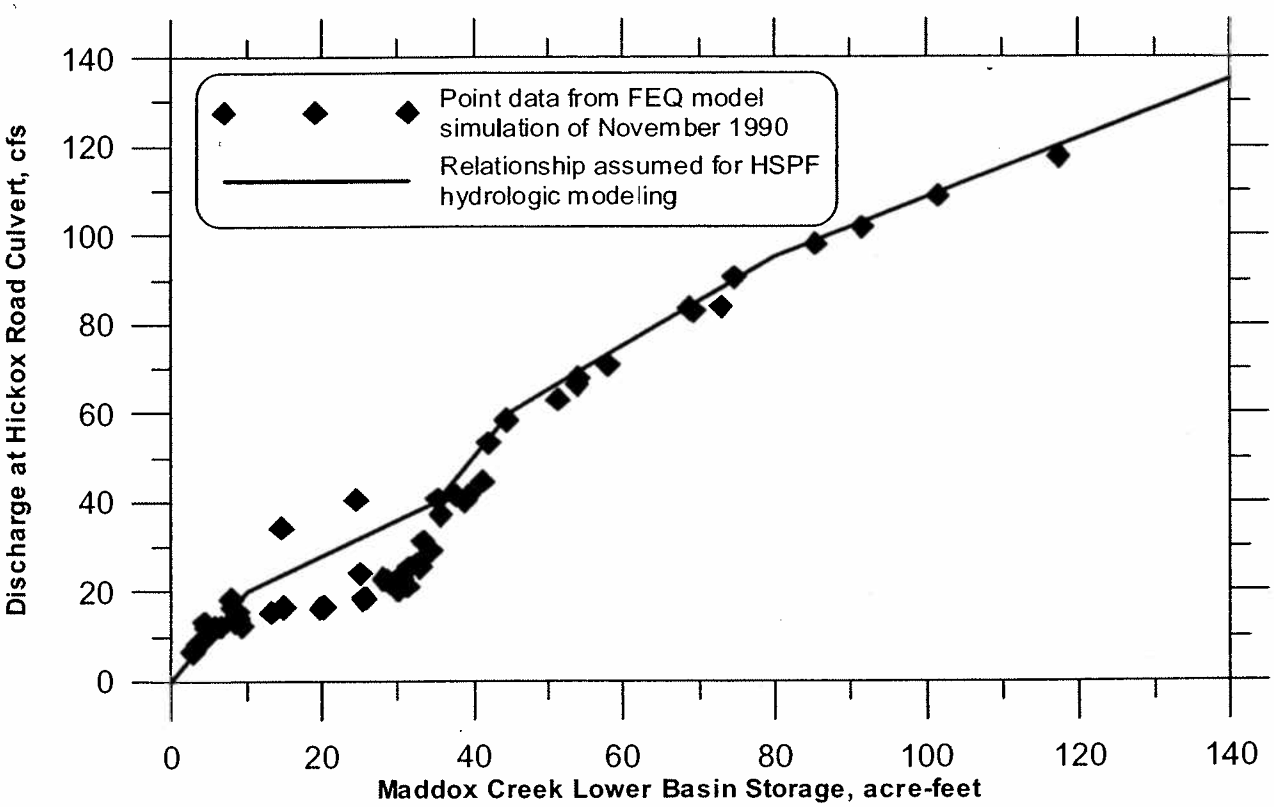
City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update northwest hydraulic consultants, June 2004	FIGURE 1 Sub-Basin Boundaries from 1995 CSWMP

Stage-storage points for the lower Maddox Creek basin determined by an FEQ hydraulic model of the reaches shown, beginning at the confluence of Maddox and Flowers Creeks and ending at Hickox Road.

The old Maddox Creek channel above Hickox road is included in the storage calculations, in addition to storage in the active ditched reach. Storage amounts are paired with FEQ-modeled discharges at "Hickox Culvert."

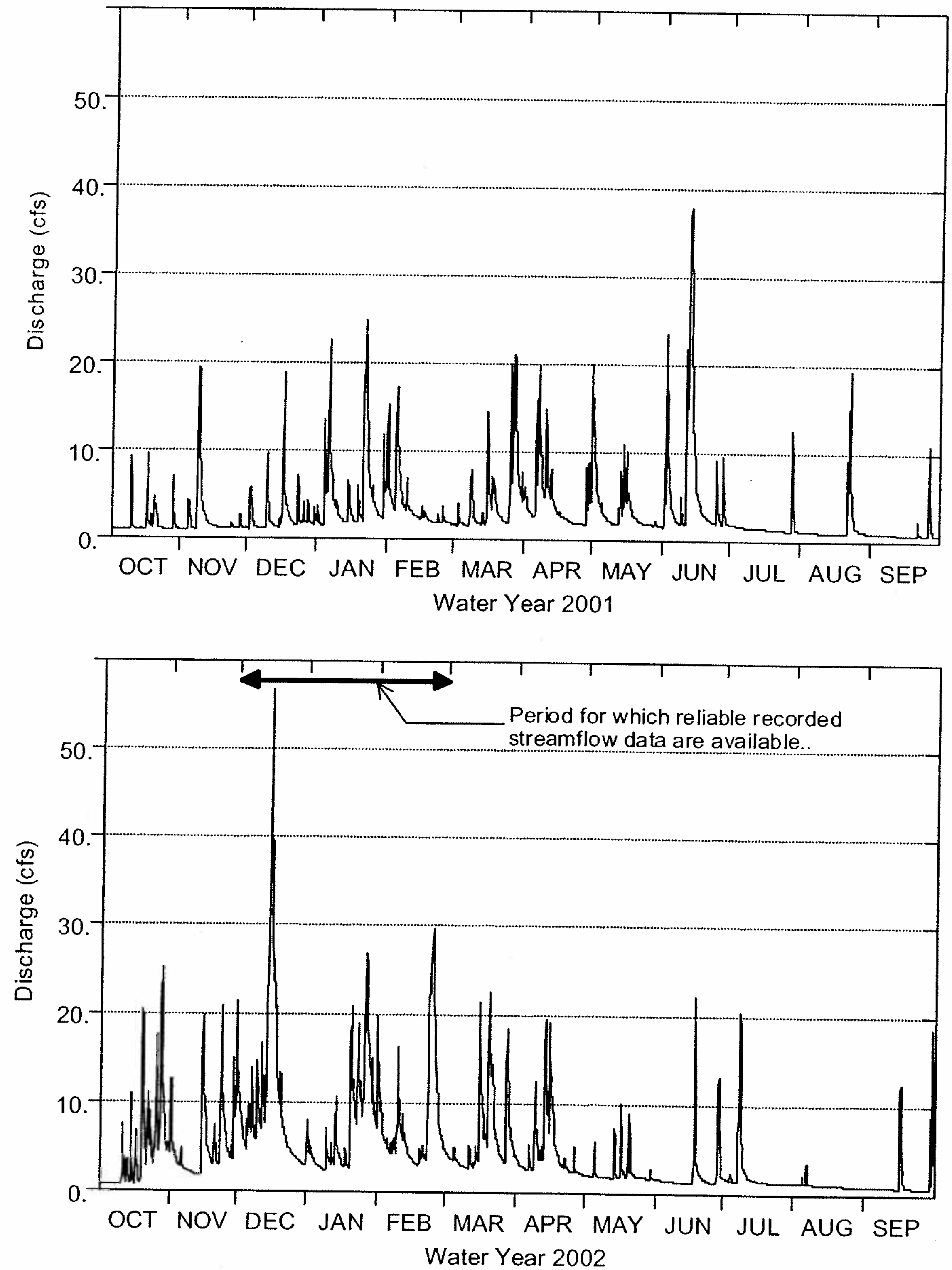


Base Map of FEQ model components from RW Beck Report dated July 2002

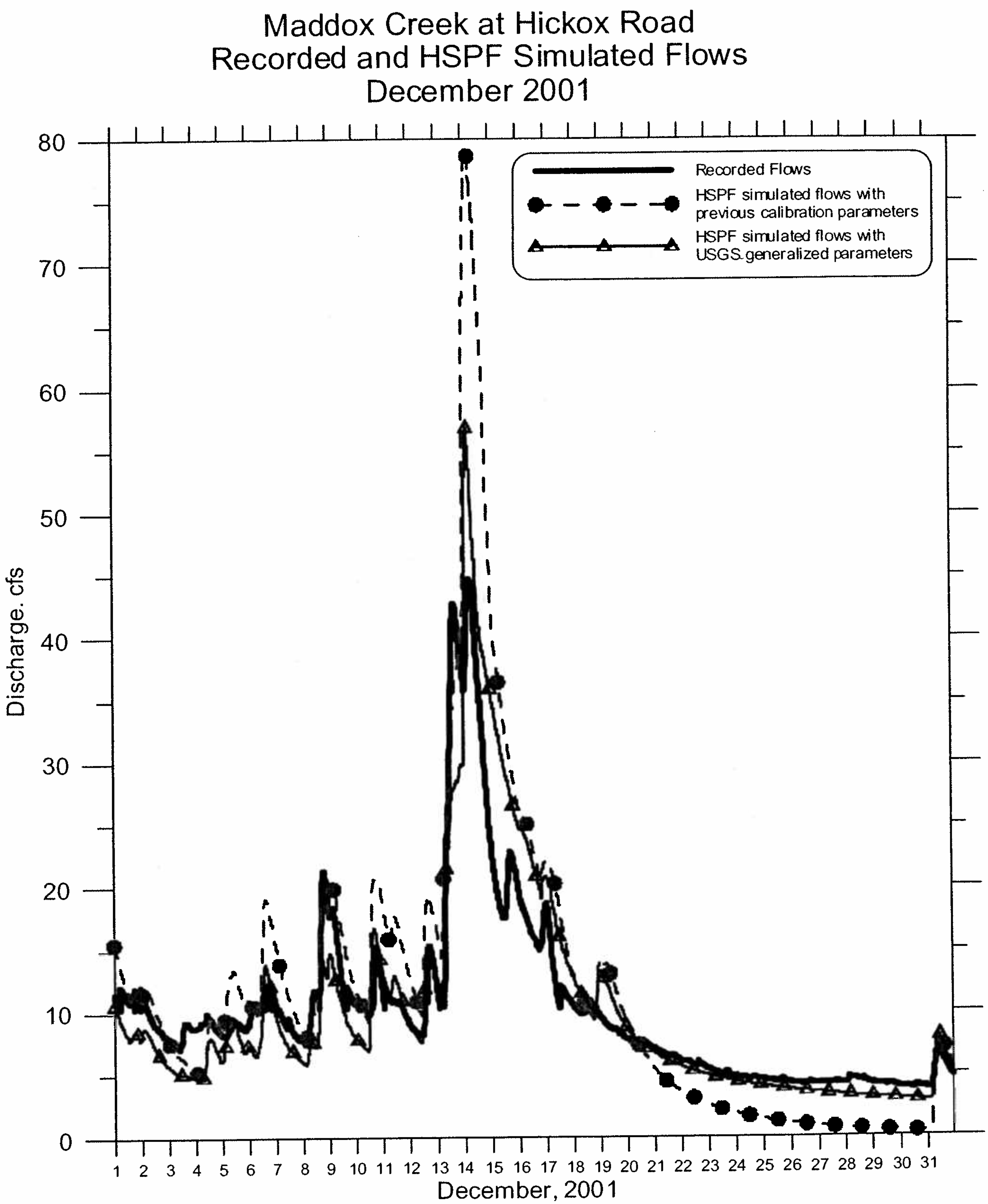


City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update northwest hydraulic consultants, June 2004	FIGURE 2 Maddox Creek Lower Basin Storage

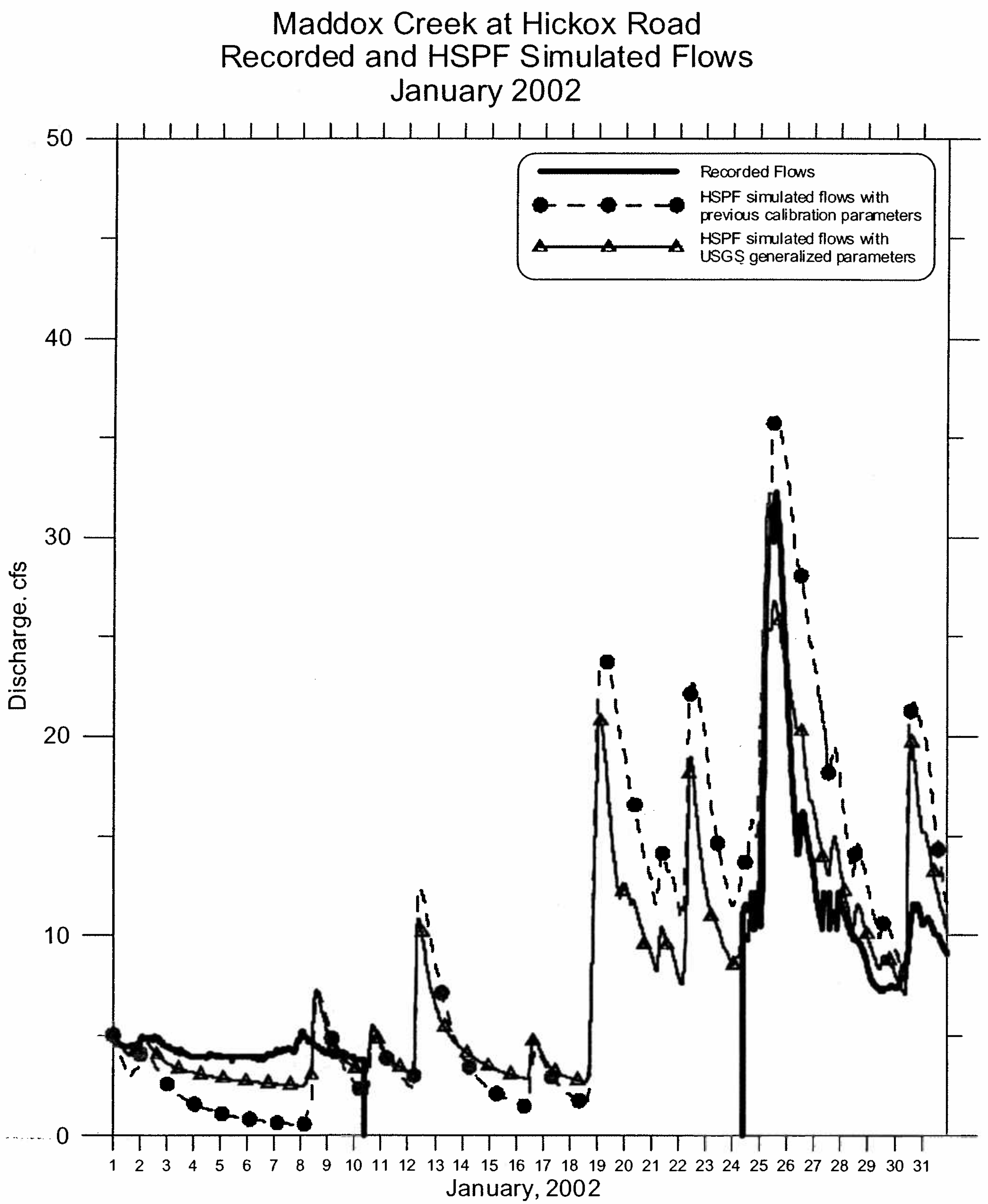
Maddox Creek at Hickox Road
HSPF Simulated Flows With USGS Generalized Parameters



City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update northwest hydraulic consultants, June 2004	FIGURE 3 Simulated Flows at Gage Site, 2001-02

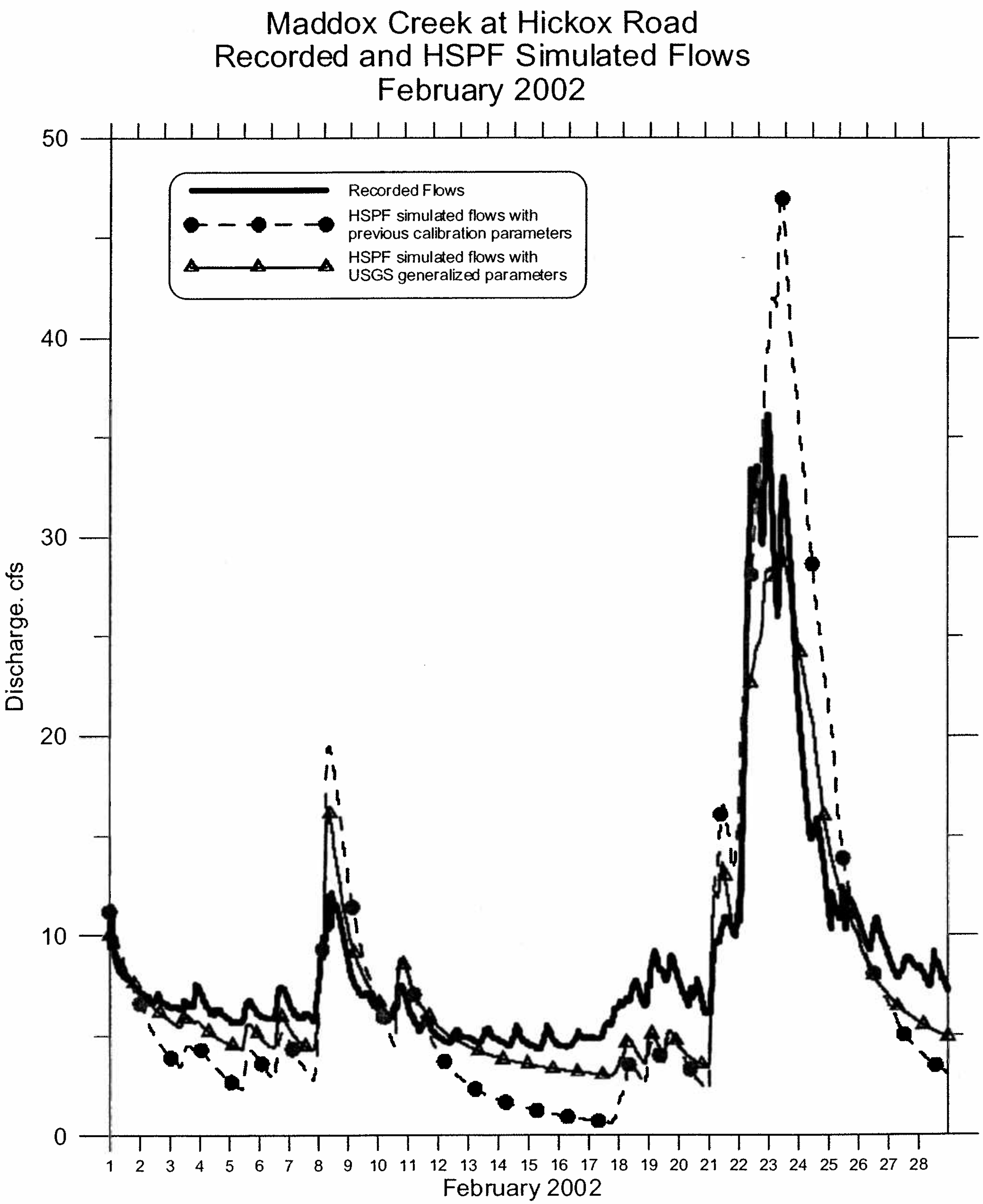


City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update northwest hydraulic consultants, June 2004	FIGURE 4 Flow Comparison for December 2001



City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update
northwest hydraulic consultants, June 2004

FIGURE 5
Flow Comparison for January 2002



City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update
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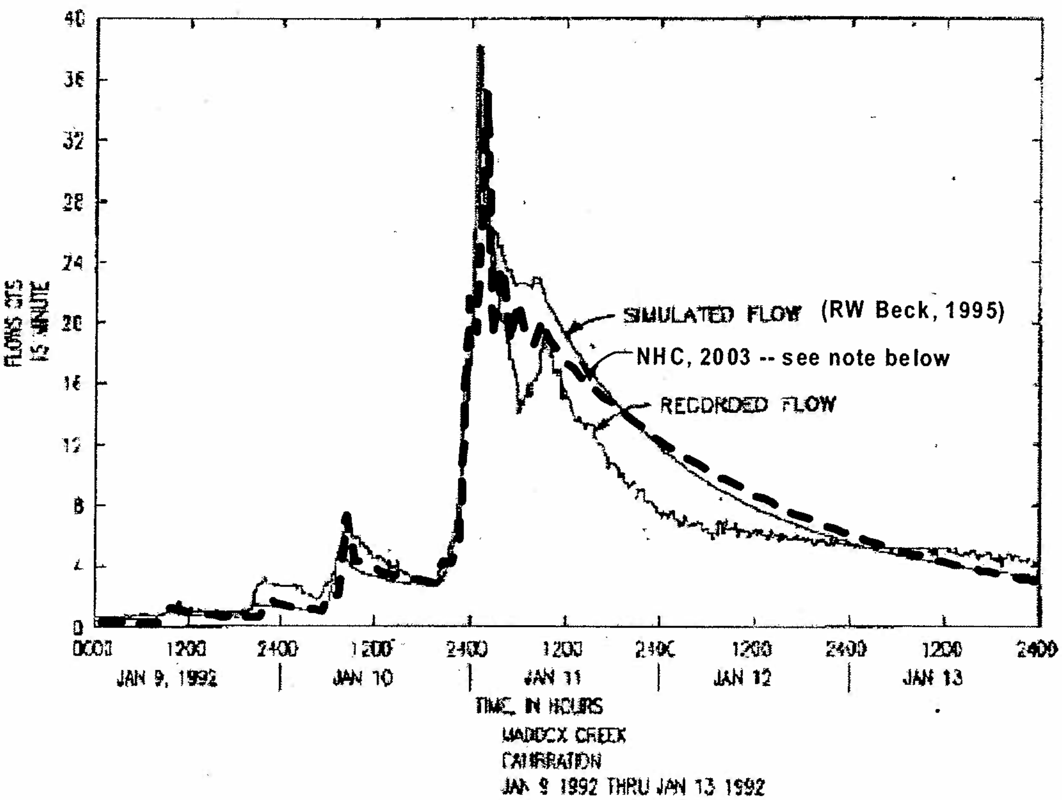
FIGURE 6
Flow Comparison for February 2002

Maddox Creek above Anderson Road
Recorded and HSPF Simulated Flows
January 1992 Event



Heavy dashed line shows HSPF hourly simulation results by NHC in 2003 using 1990 land use data, USGS generalized HSPF parameters for King and Snohomish Counties, and hourly rainfall data from the NOAA Burlington gage.

In the NHC simulations with USGS generalized parameters, groundwater in the upper basin is assumed to surface in the the lower basin, and does not contribute to streamflows at the calibration location represented in the above plot.

FIGURE IV-1
CITY OF MOUNT VERNON
SURFACE WATER MANAGEMENT PLAN
HSPF RESULTS FOR JANUARY 1992 EVENT ON MADDOX CREEK

R.W. BECK AND ASSOCIATES

FIGURE 7
Flow Comparison for January 1992 Event

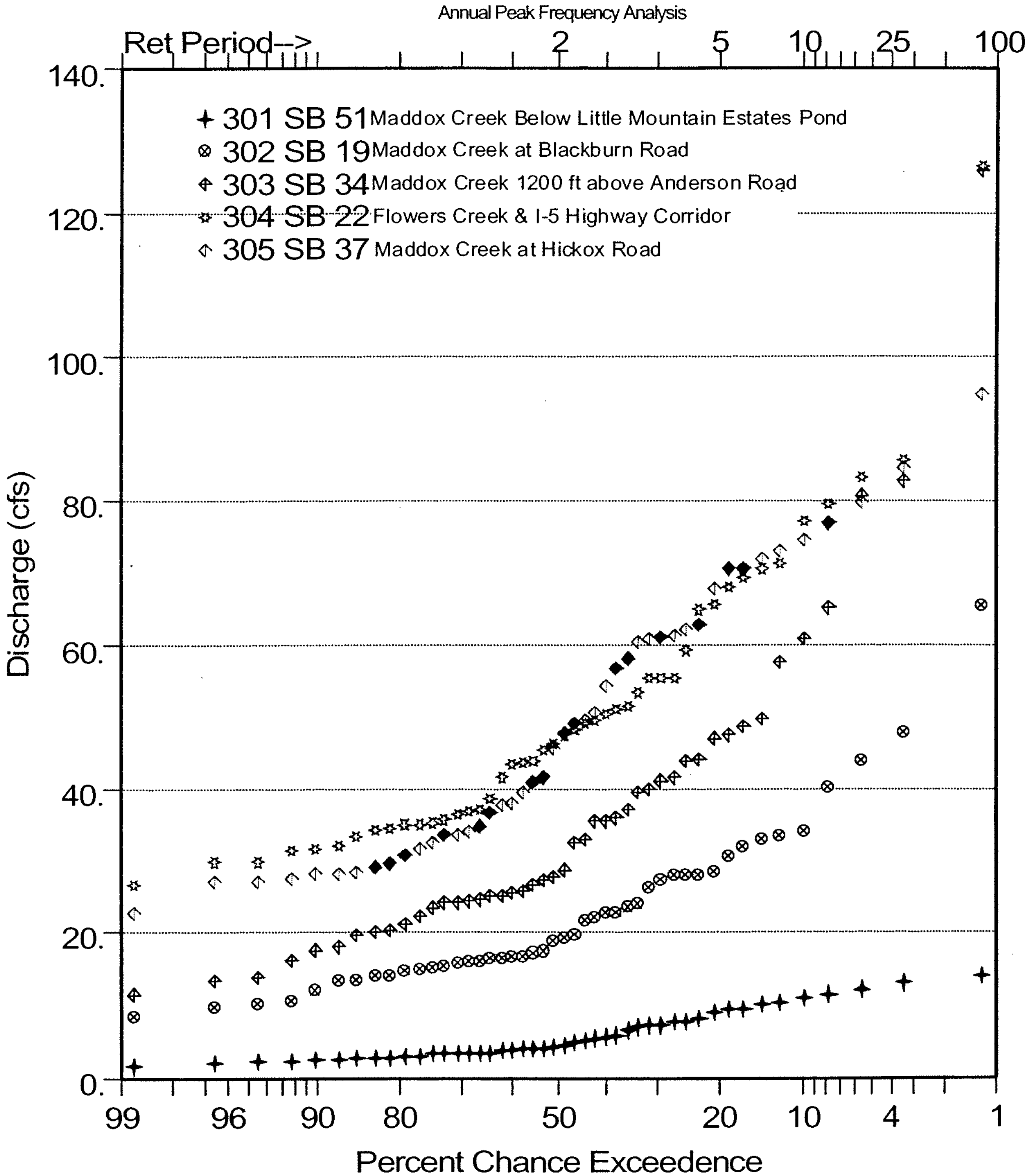


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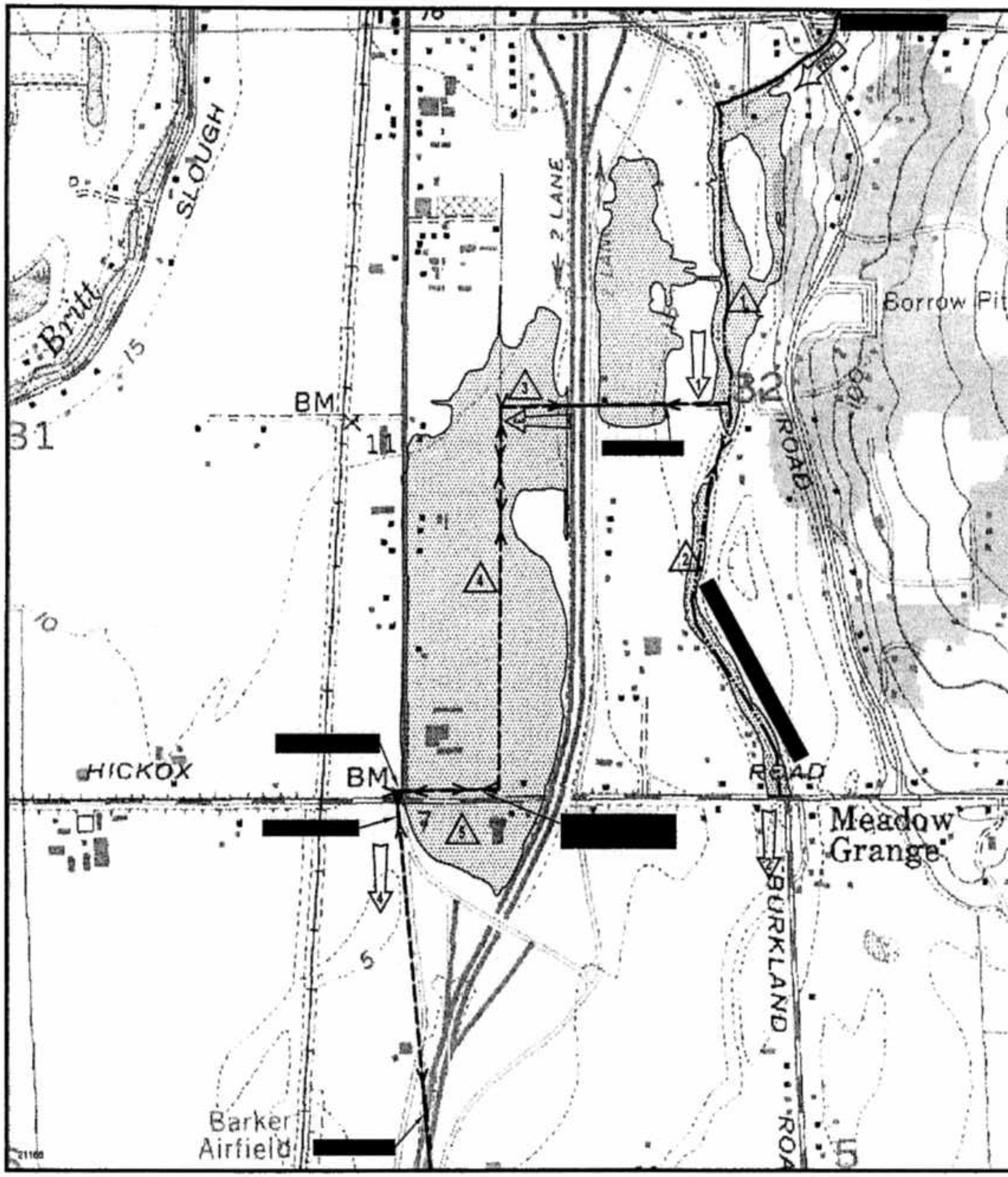
FIGURE 8
Peak Flows, Existing (Year 2002) Conditions



Legend

- Natural Channel
- Ditched Channel
- Base Condition Flood Innundation Limits
- Peak Water Levels Along Channel Reach
- Peak Flows

Base Condition Scenario:

Peak flows, peak water levels, and innundation limits derived from an FEQ model of Maddox Creek for the flood event of November 1990, developed by RW Beck for the City of Mount Vernon (July 2002). Hydrology for the base condition and all scenarios reflects future build-out of the tributary basin.

Alternative 1 Encroachment Scenario:

Establish a buffer (no fill) width of 25 feet from centerline of channel. This provides a stream corridor 50 feet wide for both natural and ditched sections of channel.

Alternative 2 Encroachment Scenario:

Establish a buffer (no fill) width of 25 feet from centerline of ditched reaches of channel, and of 100 feet from centerline of natural reaches of channel. This provides a stream corridor 200 feet wide for natural sections, including the now-abandoned segment of natural channel upstream from Hickox Road.

	Peak Water Levels:	Peak Flows:
1	Base: 15.3' Alt 1: 16.6' Alt 2: 16.5'	Base: 111cfs Alt 1: 186 cfs Alt 2: 162 cfs
2	Base: 12.0' Alt 1: 12.1' - 12.3' Alt 2: 12.1' - 12.2'	Base: 15 cfs Alt 1: 57 cfs Alt 2: 50 cfs
3	Base: 9.3' - 9.4' Alt 1: 10.9' Alt 2: 10.7'	Base: 123 cfs Alt 1: 151 cfs Alt 2: 136 cfs
4	Base: 9.2 - 9.3', Alt 1: 9.5 - 10.9' Alt 2: 9.4' - 10.7'	Base: 117 cfs Alt 1: 143 cfs Alt 2: 132 cfs
5	Base: 9.2' Alt 1: 9.3' - 9.4' Alt 2: 9.3'	

800 0 800 1600 feet

Lower Maddox Creek Flood Assessment

November 1990 Event
Peak Flows
& Water Levels

northwest hydraulic consultants inc.

Date: June 2004 | Figure 9

TECHNICAL MEMORANDUM #2

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Prepared For: CH2M HILL

Prepared By: Bill Rozeboom, P.E.

Subject: City of Mount Vernon Comprehensive Surface Water Management Plan Update; Freeway Drive Basin Update.

Date: June 30, 2004

Introduction

The Freeway Drive basin is a poorly drained area along the Freeway Drive commercial district in the northwest corner of the city of Mount Vernon. Basin boundaries are shown by Figure 1. The basin is confined by diked reaches of the Skagit River to the north and to the south, and by the city limits to the west. The eastern boundary to the basin generally follows the I-5 highway corridor and includes some additional area along the northern city limit adjacent to the Skagit River east of I-5. The natural drainage from the basin is by a combination of infiltration and unconcentrated surface flow to the agricultural lands west of the city. The area west of the city is contained within a meander loop of the Skagit River and includes Ledger Lake as a closed depression drainage feature and a surface expression of the local groundwater table.

College Way divides the Freeway Drive basin approximately in half. The area to the south of College Way, sub-basin 11 on Figure 1, presently lacks a defined drainage outlet, and most runoff from this area either infiltrates to groundwater or flows westward to Ledger Lake. The area to the north of College Way, including sub-basins 8, 8A, and 10, is served by a regional drainage system including a large stormwater detention pond adjacent to Lowe's Hardware and a stormwater pump station located near the intersection of College Way and Freeway Drive. The basin stormwater system does not have a gravity outlet; runoff either infiltrates as seepage from the stormwater system or is pumped to the Skagit River.

Hydrologic analysis was performed to investigate the performance of the Freeway Drive pump station for current and future conditions. The Hydrologic Simulation Program – Fortran (HSPF) was used for this analysis.

HSPF hydrologic models for the Freeway Drive basin were originally developed in 1993 during preparation of the 1995 City of Mount Vernon Comprehensive Surface Water Management Plan (CSWMP). In the current work, the models for current and future conditions were updated with meteorological data through December 2002, and modified to reflect updated estimates of pump station capacity, stormwater storage, and land use. The updated models were used to determine the current level of system performance and to identify the system pump station improvements which would be needed for future build-out of the basin.

Model Update

The revisions to the Freeway Drive Basin models involved extending the simulation period through mid-December 2002 using meteorological data sets developed during the update of the HSPF models for Maddox Creek, and developing models for past, current, and future conditions as summarized below.

- Past-Conditions (Validation) Model. A past-conditions validation model was developed to represent the historical condition of the Freeway Drive stormwater system and pump station during the period of 1994 through 2001. The modeled tributary basin area was 46 acres, and the modeled pump capacity was 1.24 cfs, consistent with past conditions.

- Current Conditions Model. A current conditions model was developed to represent the condition of the Freeway Drive stormwater system as of early 2004. The modeled tributary basin area was 82.4 acres and the modeled pump capacity was 2.95 cfs, consistent with current conditions.

- Future Conditions Models. A series of future conditions models was developed to represent buildout of the Freeway Drive basin north of College Way. The modeled tributary basin area incrementally increased by up to 56 additional acres for a total tributary basin area of 138.4 acres, and various pump station capacities were evaluated. The analysis did not include potential development in the Freeway Drive basin south of College Way.

<u>Past-Conditions (Validation) Model</u>

The HSPF models previously developed for the Freeway Drive basin reflected a conservative assumption of a constantly-high groundwater table which limits the amount of live storage in the regional stormwater detention pond. Conservatism was warranted because of anecdotal reports of a high groundwater table, combined with uncertain rates of seepage inflow from the Skagit River during periods of high river flow. Because the original HSPF analysis (1993) preceded the pond construction (1994), there was no opportunity for model validation at the time of the earlier work. For this update, the original existing-conditions model was reconfigured to more accurately reflect conditions since the pond was constructed and model simulation results for 1994-2001 were compared with available information on actual system performance.

Previous land use analysis of existing conditions in 1994 determined that the Freeway Drive Pump Station and the Lowe's (formerly Eagle) Hardware Regional Stormwater Pond would receive runoff from 46 acres of effective impervious surface, including the surface area of the regional pond. All pervious area in the basin, at both developed and undeveloped sites, was assumed to not have access to the storm drain system and to not contribute any flow to the pump station. The model conservatively assumed that a constantly high groundwater table would fill the regional pond to an elevation of 19 feet and that live storage would occur only above that elevation.

A review of basin areas for the Freeway Drive stormwater system found that two offsetting adjustments to the previously-mapped basin areas are indicated. The areas involved in these adjustments are identified on Figure 1. From a December 2003 meeting with City of Mount Vernon staff, it was determined that drainage from developed areas of sub-basin 9 (previously assumed to be tributary to the Freeway Drive pump station) likely drains instead to the separate College Way system. In the prior analysis, that sub-basin had been assumed to contribute runoff from 8.6 acres of impervious surface to the pump station, representing 22% of the inflow volume in 1995. The deduction is largely offset by an additional area south of College Way which had previously been included as part of (non-tributary) sub-basin 11. The offsetting area south of College Way consists of a north-sloping corridor bounded by the centerlines of Interstate 5 to the east and Freeway Drive. For the current work it is assumed that the year 1994 tributary area to the stormwater system and pump station is 46 acres of impervious surface, as described in the earlier analysis.

The modeled basin storage in the Freeway Drive stormwater system was adjusted to better reflect actual storage conditions in the regional facilities. Significant storage volumes exist at two locations: the regional stormwater pond behind Lowe's Hardware and in a large open ditch along the west side of Freeway Drive. In the updated analysis, pumped-outflow live storage in the regional pond begins at outlet elevation 17.4 feet, which corresponds to the top of existing stoplogs at the outlet structure as confirmed by a field inspection in late 2003. Low-rate seepage flow of 0.03 inches per hour is modeled as occurring from the dead storage pool and to draw the pond down to its bottom, elevation 15.2 feet. In the previous analysis, live storage was assumed to be available only above elevation 19 feet, which is the top of stoplogs as shown on the pond engineering plans. Higher stoplogs are believed to have been initially proposed due to concerns of a high groundwater table at the pond location.

The regional stormwater pond behind Lowe's Hardware is an unlined excavation in an area mapped as having Custer Norma soils. Actual infiltration rates from this pond are expected to be highly variable due to groundwater table effects and the amount of organics and silts found at the surface. The Custer Norma soil series has a limiting infiltration capacity in the upper soil layers in the range of 0.2 to 0.6 inches per hour. If the surface layers are removed (e.g., by pond excavation), the infiltration capacity at depth can be as great as 20 inches per hour. However, the pond will tend to seal over time as sediments are deposited from the stormwater runoff, and no infiltration will occur during periods of high river level and high groundwater of concern. As a simplifying assumption, the infiltration from the dead storage pool was modeled at a conservatively low rate of 0.03 inches per hour, which is representative of relatively fine-grained Alderwood soils. That rate corresponds to 0.044 cfs over the 1.5-acre area of the pond bottom. Modeled infiltration was furthermore set to zero during relatively wet periods, when the water level in the Freeway Drive Regional Pond is in the live storage range and when the system pump station is in operation. Subsequent evaluation of model results determined that the modeled infiltration rate produced significant drawdowns (to below elevation 17 feet) only during the summer months.

Storage in the large ditch along Freeway Drive was ignored in the previous analysis with the conservative assumption that the ditch would be replaced by a pipe system in the future. However, the ditch exists under current conditions and is now considered likely to remain in the future. In discussions with city staff in November 2003, it was concluded that future development of the Freeway Drive basin would preserve the ditch and the stormwater storage that it provides.

For the model update, regional pond stage-storage data were computed from the pond as-built engineering plans[1]. Stage-storage data for the Freeway Drive ditch were computed from a representative measured ditch section having a bottom width of 6 feet at elevation 17 feet, side slopes of 1:1, and a length of 1800 feet. The resulting storage characteristics in the Freeway Drive basin are summarized in Table 1 below. Relative to the previous analysis, the storage below the spillway crest is increased by 6.5 acre-feet in the active storage (pumped-outflow) range from elevation 17.4 to 22.5 feet and by 3.7 acre-feet in the limited-use storage (seepage outflow) range below 17.4 feet.

Table 1
Freeway Drive Basin Regional System Stormwater Storage

Regional Pond Reference Point	**Elevation** Feet	**Storage Volume, Acre-feet** Pond	Ditch	Combined
Bottom of pond	15.2	0.00	0.00	0.00
	15.3	0.15	0.00	0.15
Invert of outlet pipe	17.0	2.94	0.00	2.94
	17.1	3.13	0.03	3.15
Top of stoplog (actual)	17.4	3.68	0.11	3.79
	17.5	3.87	0.13	4.01
Top of stoplog (plans)	19.0	6.95	0.66	7.61
	20.0	9.25	1.12	10.36
Crest of spillway	22.5	15.91	2.61	18.52
	23.0	(17.40)*	(2.98)*	(20.38)*
Top of perimeter berm	23.5	(18.95)*	(3.36)*	(22.31)*

(*Values in parentheses are for an overflow condition which exceeds pond full supply level)

The other revision to the validation-period model was to reduce the pump capacity. The original report had estimated the capacity of the pump station to be 2.67 cfs, but subsequent pump tests by the city determined that the actual capacity was only 1.24 cfs. The lesser capacity corresponds to the then-existing10 hp pumps and 10" diameter PVC forcemain.

[1] Final dimensions shown as annotations on approved engineering plans for storm drainage system and detention pond for City of Mount Vernon, Eagle Hardware & Garden. Plans dated 04/30/93 by Bell Walker Engineers, Inc and approved 05/18/93 by the city of Mount Vernon..

Larger 25 hp motors were installed in 2002, which has increased the current pump capacity to 2.95 cfs (1325 gpm). For the purpose of model validation to conditions in 1994-2001, simulations were run with the original 1.24 cfs capacity.

Historical records of monthly total operating hours and estimated pumped volumes at the Freeway Drive Stormwater Pump Station are the only data available to describe system performance over the validation period, years 1994 through 2001. No records, photographs, or other anecdotal reports could be located by the city to describe maximum levels or water level fluctuations in the regional pond, and the city was unable to comment on the reasonableness of simulated pond stage hydrographs.

Model Validation

Evaluation of the validation model results focused on the period of November 1995 through January 1996 and which included a prolonged period of wet weather and high river levels. This period was also used by nhc to calibrate a previous water level model for the City of Mount Vernon of the Ledger Lake area immediately west of the Freeway Drive basin. The results of the previous Ledger Lake study showed that the maximum groundwater level (and Ledger Lake level) was 20.0 feet and occurred in November 1995. This groundwater level was the second-highest in the 40-year simulation period with an estimated recurrence interval between 25 and 50 years. The only higher groundwater level in the Ledger Lake study simulation period was 20.2 feet, occurring in November 1990.

The best available estimates of local groundwater levels over the validation event are from the prior Ledger Lake analysis, which considered the lake to be a surface expression of groundwater levels. Figure 2 presents the results of that earlier study for the period of the validation event. This figure shows that the local groundwater table at Ledger Lake immediately west of the Freeway Drive basin may have been in the live storage range for the regional stormwater pond (higher than 17.4 feet) for most of December 1995 and well below the live storage range for most of November as well as for all of January.

Table 2 compares the predicted basin outflow with the pump station records for the November 1995 to January 1996 validation event. Pump station inflow volumes were computed by multiplying monthly rainfall by the impervious tributary area of 46 acres. Predicted pump station outflow volumes were computed by adjusting the inflow volumes for the simulated changes in pond storage over each month, with an additional manual adjustment for refill of approximately 4 acre-feet of limited use storage below pond elevation 17 feet at the start of the period. The manual adjustment was made to correct for the discrepancy between actual conditions and the simulations results at the start of the validation event. The HSPF simulation results produced a water level of 17.1 feet on November 1, 1995; whereas, the estimated actual groundwater level on that date, based on the Ledger Lake analysis, was about 10 feet, indicating a dry pond. Values presented in Table 2 as actual pumped outflow volumes are based on data obtained from the City's Station Time Records for the Freeway Drive Storm Station. The station time records report total pumped volumes for each month as determined from pump operating hours and an assumed pump rate of 1.24 cfs.

Table 2
Validation Event Predicted and Pumped Outflow Volumes

Month	Rain (inches)	Pumped Outflow Volume (acre-feet)		
		Predicted	Actual	Difference
Nov 1995	11.1	30.5	6.6	+23.9 (362%)
Dec 1995	3.5	20.8	23.5	-2.7 (-11%)
Jan 1996	5.6	21.4	15.4	+6.0 (+39%)

Variations in seepage losses over the validation period are presumably responsible for the inconsistent match of predicted and actual outflows. The Freeway Drive stormwater system is mostly an open system, and seepage losses from the system can occur from the unlined ditches as well as from the bottom area (1.5 acres) of the unlined regional detention facility. During periods of low groundwater, infiltration losses from the pond bottom will occur at rates significantly greater than simulated in the model.

The validation period results show that the model greatly over-estimates pumped-outflow volumes during the high-rainfall month of November 1995, when groundwater levels were initially low. However, model predictions for the high-groundwater, low-rainfall condition in December 1995 are reasonably consistent with the actual pumped volumes. These results suggest that modeled pumped volumes are reasonable under conditions of a high groundwater table, such as occurred in December 1995 but will overestimate pumped outflows in other periods. The HSPF analysis assumed that high groundwater persists throughout all winter months.

A second finding from the validation exercise is that external (Skagit River) horizontal seepage inflows to the storm drain system appear to be minor relative to the existing pump capacity. As stated above, elevated groundwater conditions are thought to have been present for most of December 1995, with groundwater levels above elevation 17 feet for most of the month and a peak water level of nearly 20 feet. Seepage inputs to the stormwater system, if significant, should have shown up in the pump records for December 1995. Instead, the pump station records show pump operation for only 230 hours (or 31 % of the available hours in the month), and the pumped volumes are within 11% of the estimated stormwater runoff from the basin. For December 1995, the excess pumped volume of 2.7 acre feet is equivalent to an average seepage inflow 0.04 cfs over the month or 0.09 cfs if the seepage inflows occurred over the two week-period with the highest estimated local groundwater levels above 19 feet elevation.. While the estimated rates of seepage inflow are approximate, the point to be made is that the limited excess pumping during a prolonged period of high groundwater conditions suggests that seepage inputs from groundwater are small relative to the pump capacity and are not significant to the performance of the Freeway Drive stormwater system.

Updated Current Conditions Model (Year 2004)

The HSPF model of the Freeway Drive basin was configured to current conditions by setting the pump capacity to the upgraded station capacity of 2.95 cfs (1325 gpm) and by adjusting the tributary basin to reflect conditions as of early 2004. Tributary basin adjustments were made to reflect areas of new commercial development within the basin service area north of College Way, and to include additional basin areas identified as sub-basin 8A on Figure 1 which will result from stormwater routing for the Riverside Bridge Replacement Project. New areas of commercial development over the period 1994-2003 were identified by comparing the basin land use mapping from the 1995 CSWMP with a current aerial image from the City GIS system. The basin areas to drain by gravity and pumped flows to a new detention pond for the Riverside Bridge Replacement Project[2] and thence to the Freeway Drive stormwater system, were confirmed by correspondence with the project drainage engineers, Leonard, Boudinot & Skodje, Inc.

Commercial properties which had been developed as of 1994 are assumed to have 80% effective impervious coverage, with only the impervious portion, totaling 46 acres, being directly tributary to the Freeway Drive storm drain system. That assumption is consistent with the prior analysis conducted in 1993 and also the current model validation run. New properties developed from 1994 to 2004 are assumed to have runoff from both impervious and pervious surfaces routed through an on-site stormwater detention facility, meeting the city's current stormwater standards, prior to discharge to the regional Freeway Drive system. Ponds constructed over this period have been at an elevation range which avoids backwater effects, with the consequence that local detention storage is independent of (rather than a part of) the live storage pool of the Freeway Drive regional pond and ditch system. The total acreage of new commercial development from 1994 to 2004, excluding the Riverside Bridge Replacement Project, is estimated to be 16.5 acres at 80% effective impervious cover. The bridge project, which first drains to its own on-site stormwater detention facility, adds an additional basin area of 19.9 acres at 55% effective impervious cover.

The HSPF model of current (year 2004) conditions includes three stormwater ponds. These are: 1) the Freeway Drive regional pond, described above, with pumped outflow at 2.95 cfs; 2) the Riverside Bridge Project stormwater detention pond with stage-storage-outflow characteristics as presented in the design report for that project; and 3) a composite detention pond reflecting the cumulative performance of on-site stormwater detention facilities assumed to have been constructed since 1994. Inflow to the Freeway Drive Regional Pond consists of the outflow from the other two ponds, plus direct runoff from the 46 acres of original tributary basin.

Hydraulic characteristics for the Riverside Bridge Project stormwater detention pond were determined from the project design report and are summarized in Table 3. Hydraulic characteristics for the Composite Detention Pond were determined by scaling the pond hydraulic data presented in the design report[3] by Semrau Engineering for a detention pond recently constructed for an 80% impervious, 4-acre site on Freeway Drive, about 1000 feet north of College Way. Pond hydraulic data of storage and discharge values were scaled to

[2] "Riverside Bridge Replacement Project Stormwater Drainage Analysis; City of Mount Vernon, Washington, City of Burlington, Washington" dated February 7, 2002 by Leonard, Boudinot & Skodje, Inc. for Harding Lawson Associates.

[3] "Drainage Report for W.L. and Kathleen M. Massey Fill and Grade Application; Section 18, T.34N, R.4E., W.M. City of Mount Vernon, Job NO. 91-045A" dated April 29, 1999 by Semrau Engineering & Surveying for W.L. and Kathleen M. Massey.

unit area values, representing a one-acre commercial site, by dividing the design report values by the basin area. For the composite pond, Table 4 presents stage-storage discharge data in both unit-area amounts as well as the composite values used in the model of current conditions.

Table 3
Detention Pond Hydraulic Characteristics
Riverside Bridge Replacement Project
19.9-Acre Basin at 55% Effective Impervious Area

Stage Ft	Depth ft	Storage ac-ft	Discharge Cfs
30.0	0.0	0	0
30.5	0.5	0.13	0.31
31.0	1.0	0.28	0.43
31.5	1.5	0.44	0.92
32.0	2.0	0.61	1.19
32.5	2.5	0.80	1.41
33.0	3.0	1.01	2.04
33.5	3.5	1.23	3.24
34.0	4.0	1.47	4.38

Table 4
Detention Pond Hydraulic Characteristics
Composite On-Site Stormwater Detention Pond
Developments at 80% Effective Impervious Area

		Unit Area Values 1-Acre-Increment		Composite Pond 16.5-Acres of Development	
Stage ft	Depth Ft	Storage ac-ft	Discharge cfs	Storage ac-ft	Discharge cfs
23.0	0.0	0.0000	0.0000	0.00	0.00
23.5	0.5	0.0057	0.0192	0.09	0.32
24.0	1.0	0.0140	0.0271	0.23	0.45
24.5	1.5	0.0252	0.0332	0.42	0.55
25.0	2.0	0.0393	0.0384	0.65	0.63
25.5	2.5	0.0566	0.0429	0.93	0.71
26.0	3.0	0.0772	0.1178	1.27	1.94
26.5	3.5	0.1014	0.4751	1.67	7.84
27.0	4.0	0.1293	1.5824	2.13	26.11

Key elements of the HSPF model of current (Year 2004) conditions are a total tributary basin area of 82.4 acres, two on-site detention ponds with a combined live storage of about 2.7 acre feet before overflow, a total of 14.7 acre-feet of pumped-outflow live storage in the regional detention pond and ditch system, and a regional system pump capacity of 2.95 cfs (1325 gpm). The HSPF simulation results for this condition showed that the level of protection against uncontrolled overflows from the regional pond is presently greater than once in 100 years.

Future Development Scenarios

The future development scenarios considered here address buildout of the Freeway Drive basin areas north of College Way, which have drainage access to the Freeway Drive regional detention pond and pump station. The assessment does not address existing or future development in those Freeway Drive basin areas located south of College Way (and west of Freeway Drive), which at present drain by percolation into the ground and by westward overland flow at the city limits. The 1995 CSWMP had explored scenarios which included a relocated pump station to serve the presently non-draining area. However, for the current work it was decided, in consultation with City of Mount Vernon staff, to evaluate scenarios which could be accomplished without relocation of the existing pump station. Evaluation of the non-draining area would be deferred for future study.

The remaining developable area in the tributary basin to the Freeway Drive regional storm drain system was determined from a recent aerial image from the City's GIS system. Four properties within the city limits, totaling approximately 56 acres, remain to be developed as follows: 1) a 40-acre property immediately north of Lowe's Hardware and the regional stormwater pond; 2) a 4.2-acre property adjacent to the Skagit River at the northwest corner of the city limits; 3) a 2.9-acre property adjacent to the Skagit River east of Interstate 5; and 4) an 8.9-acre property about 1,000 feet south of the river and east of Interstate 5. The land use assumption used in the model for the future build-out condition of these commercial-zoned properties is to have effective impervious coverage at 80% with runoff from both pervious and impervious surfaces being conveyed to the Freeway Drive regional storm drain system.

An initial simulation of basin buildout with the existing pump station determined that frequent overflows would occur from the emergency spillway of the regional (Lowe's Hardware) pond. Model results, which reflect the conservative assumption of a constantly high groundwater table and minimal seepage losses from the storm drain system, showed spillway overflow in nearly one half of the 46 years of the simulation. Table 5 presents the dates of the largest nine overflow events, ranked by both pond peak level and total overflow volume. Included in Table 5 are the estimated groundwater conditions for each event, based on the previously-identified water level model of the Ledger Lake area.

Table 5
Major Stormwater Events and Coincident Groundwater Conditions
Based on Preliminary Basin Buildout Modeling of Freeway Drive Stormwater System
(events ranked by total modeled volume of overflow at emergency spillway)

Overflow Volume (rank)	Event Period		Monthly Rainfall (inches)	Pond Peak Level (HSPF Model)		Est'd Actual GW Elev. (ft)	
	Month	Year		Date	(rank)	On Date of Pond Peak	Max in Next 7 days
1	Nov	1990	14.8	24-Nov-90	4	**19.0**	**20.2**
2	Nov	1989	10.7	10-Nov-79	2	13.6	16.4
3	Nov	1995	11.1	28-Nov-95	8	**18.1**	**20.0**
4	Jan	1971	12.3	26-Jan-71	5	14.0	15.9
5	Jan	1982	8.7	23-Jan-82	6	11.0	12.7
6	Dec	1979	8.6	14-Dec-79	1	12.8	17.2
7	Dec	1967	7.3	25-Dec-67	3	12.5	14.8
8	Jan	1974	7.6	24-Jan-74	9	15.0	15.8
9	Jan	1984	8.3	24-Jan-84	7	11.8	13.9

The information in Table 5 was compiled to assess the reliability of the simulation results given the findings of the model validation exercise. Table 5 shows that only two of the nine largest runoff (pond overflow) events in the simulation period had high coincident groundwater conditions as estimated by the prior analysis of the Ledger Lake area. It is likely that the modeled overflows in other events are overestimated because of the conservative assumption of high groundwater through the winter months, with infiltration at a correspondingly low rate. As discussed earlier, the findings of the validation exercise were that modeled pond outflows appeared to be reasonably accurate for periods of high groundwater conditions but could significantly overestimate pond outflow in other periods. The model is particularly likely to overestimate peak pond levels and outflow volumes for events in which the actual groundwater level is below the bottom of the regional pond at 15.2 feet.

Model results summarized below for future development scenarios include the peak rates and total volumes of overflow for the November 1990 event. The simulation results for the November 1990 event, during a period of high groundwater, are felt to be the most accurate and useful for quantifying system performance under design storm conditions. The modeled pond overflows for the other major events previously identified in Table 5 are not included in the future scenario results because the model is believed to significantly overestimate overflows for all but the November 1990 and November 1995 events. The November 1990 event is adopted here as a design storm because it is the most severe storm in the period of record. It has the highest simulated overflow volumes in the 46-year HSPF simulation period from 1957 to 2002 and also the highest estimated groundwater level in the 40-year Leger Lake analysis period from 1957 to 1996.

Table 6 summarizes the results of future scenario model runs to assess system performance with incremental levels of additional basin development, with increased pump station capacity, and with optional on-site detention storage. Basin development is increased in regular increments up to the buildout condition of 56 acres more than existing conditions. Simulated pump capacities of 2.95 cfs and 5.68 cfs, respectively, represent the existing capacity of the Freeway Drive Stormwater Pump Station and the capacity which, per a concurrent CH2M Hill analysis, would be achieved by replacing the existing 10" diameter forcemain with a larger 18" diameter pipe. Other simulated pump capacities are arbitrary. Most of the simulations assume that new development will not be required to follow the city's current detention standards for stream bank erosion control, with the belief that those standards may be inappropriate in the context of the pumped-outflow Freeway Drive system, and that existing standards are likely to be relaxed. The issue of alternative detention standards in the Freeway Drive basin was deferred for future study. In those scenarios where additional detention is modeled, the composite on-site stormwater facility for recent development under the current city regulations (Table 4) was scaled up to reflect the additional development.

Table 6
Future Conditions Scenario Analysis
Freeway Drive Regional Stormwater System

Additional Development (acres)	Pump Capacity (cfs)	Additional on-site detention?	Stormwater Pond Overflows	
			Overflow in Nov 1990 design event	
			volume (ac-ft)	peak Q (cfs)
+ 0 ac	2.95	No	0	0
+ 10 ac	2.95	No	1.1	1.4
+ 20 ac	2.95	No	4.3	3.1
+ 30 ac	2.95	No	10.7	6.9
+ 40 ac	2.95	No	15.7	11.5
+ 56 ac	2.95	No	28.1	16.5
+ 56 ac	2.95	Yes	24.8	12.8
+ 30 ac	5.68	No	0	0
+ 40 ac	5.68	No	0.7	1.3
+ 56 ac	5.68	No	6.2	6.2
+ 56 ac	5.68	Yes	1.7	2
+ 56 ac	6.0	No	4.8	5.5
+ 56 ac	8.0	No	0	0

Table 6 quantifies how the volume and peak rate of overflow for the design event increase with increasing basin development and are diminished by increasing pump size. The presence of additional on-site stormwater ponds per the city's existing regulations does not appreciably affect buildout development impacts on overflow volumes unless the pump station capacity is also increased.

A well-defined performance standard does not exist for the Freeway Drive regional stormwater system. The issue is discussed here because some definition of "acceptable" performance is essential to designing stormwater facilities and interpreting performance results. Guidelines adopted by the Department of Ecology and other jurisdictions would suggest that a suitable performance standard would generally be to preserve discharges to the natural location (e.g. maintain the flow pathways which exist prior to basin development), without adversely increasing the rates or volumes of flow at the point of discharge. Determination of a reasonable performance standard for the Freeway Drive system therefore requires consideration of the natural discharges which would occur without development, the condition of the downstream flow path, and the potential damage which could result from development-related increases to flow rates and flow volumes.

One reasonable performance standard for the Freeway Drive regional stormwater system would be to limit the design event outflow volume to an amount which does not exceed the estimated runoff volume to the overflow point under natural conditions. Peak flows are not felt to be an issue because any overflow from the stormwater facility would discharge to a shallow closed depression.

The Freeway Drive regional stormwater pond is located in a very broad swale which discharges to a closed depression located west of the city limits. At an elevation of 20 feet, representing the level of flooding which occurred during the November 1990 event, the closed depression has a surface area of about 60 acres and is separated from the adjacent Ledger Lake area by a low ridge. The depressional area was described in the prior Ledger Lake analysis as "the eastern fields." The natural-conditions tributary basin from city lands to the eastern fields includes approximately 80 acres north of College Way and west of Interstate 5. Under buildout development conditions, those areas will drain to the Freeway Drive storm drain system and will normally be pumped to the Skagit River rather than discharging to their natural location. During major storm events, water in excess of the system capacity will spill to the eastern fields, which is the natural discharge point. The area of the eastern fields closed depression is used for agricultural production.

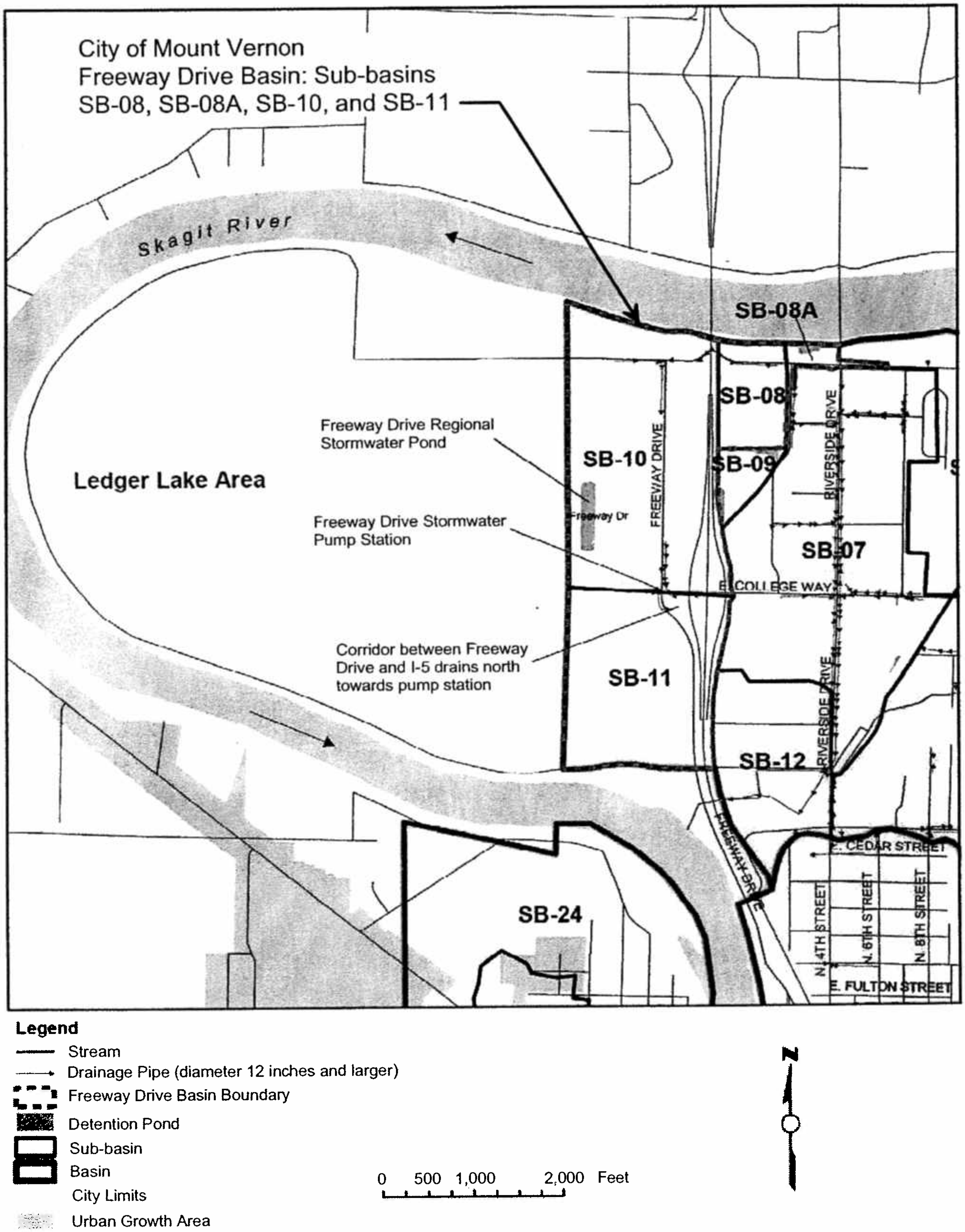
A simple HSPF model was developed to estimate the volume of runoff which, under natural conditions, would have flowed to the eastern fields closed depression during the month of November 1990. The model assumed a basin condition of 80 acres of forested land on Custer Norma soils as shown on soils mapping for the area. Generalized parameters developed by the USGS were used to characterize the basin runoff response for this combination of soil and land cover. Runoff volumes were determined by summing the modeled surface flows plus interflow runoff (SURO plus IFWO); modeled groundwater flows (AGWO) were not counted in the runoff total. The model results showed that under natural forested conditions, the tributary basin within the city limits would have contributed approximately 8 acre-feet of runoff to the eastern fields in the month of November 1990. An additional 6 acre-feet of runoff would have flowed into the eastern fields the following month. The peak discharge was approximately 0.5 cfs, occurring on November 24, 1990.

The proposed performance standard for the stormwater system is to limit the modeled overflow volume for November 1990 to no more than 8 acre feet, which is the same as the monthly runoff volume under the pre-development (forested) basin condition.

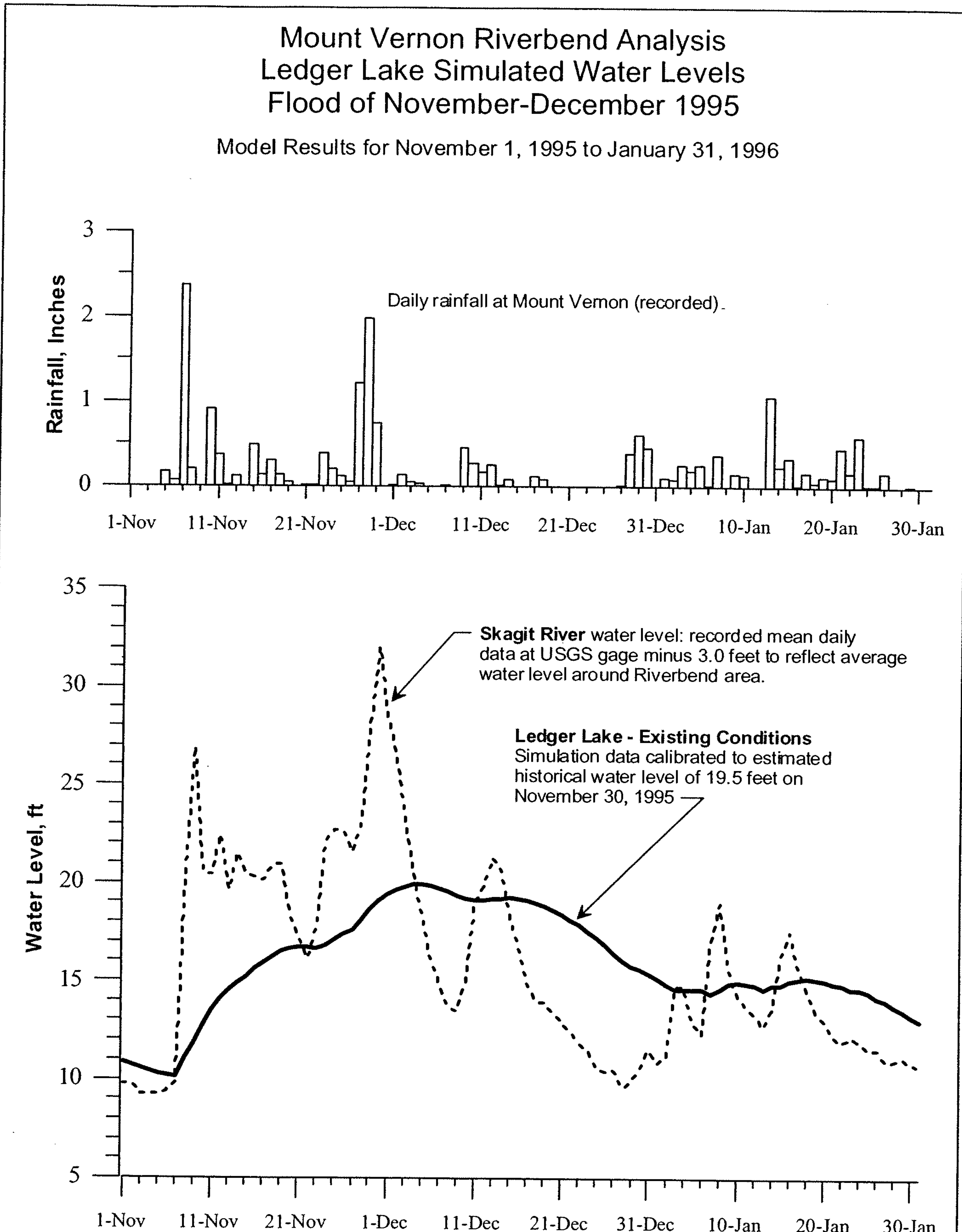
Recommendation

It our recommendation that, to accommodate full buildout of the Freeway Drive basin north of College Way, the capacity of the existing Freeway Drive stormwater pump station should be increased from 2.95 cfs to 5.68 cfs. According to a concurrent analysis by CH2M Hill, this increased capa city can be achieved by replacing the existing 10″ forcemain with an 18″ diameter pipe. The recommended pump station improvements will control buildout condition overflows from the regional stormwater pond to amounts less than runoff from pre-development (forested basin) city lands to the same discharge point.

The natural discharge point for the Freeway Drive basin under both predevelopment and developed conditions is a closed depression in an agricultural area west of the city. The regional stormwater pond behind Lowe's Hardware is expected to overflow to the natural discharge point during major events which occur coincident with high groundwater conditions such as those that occurred in November 1990 and November 1995. The pond overflow volume during the most severe event on record, November 1990, is equivalent to less than 2″ of water over an already-flooded depressional area and is less than the runoff volume to the area which would have occurred with the city basins in a forested condition.



City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update northwest hydraulic consultants, June 2004	FIGURE 1 Freeway Drive Basin Location Map



City of Mount Vernon, Comprehensive Surface Water Management Plan (CSWMP) Update
northwest hydraulic consultants, June 2004

FIGURE 2
Ledger Lake Regional Groundwater, Nov 1995

Hydrologic Analysis of Little Mountain Estates Regional Detention Facility

PREPARED FOR: City of Mount Vernon, Washington

PREPARED BY: Jerry Scheller/CH2M HILL

COPIES: Bill Derry/CH2M HILL

DATE: March 31, 2004

1.0 Introduction

This technical memorandum documents the hydrologic analysis performed to evaluate the effectiveness of the Little Mountain Estates regional detention facility located in the upper reach of the Maddox Creek basin.

The purpose of this study was to:

1. Analyze the performance of the Little Mountain Estates detention facility to facilitate development of a project.
2. Analyze the performance alternative structure modification developed in previous study efforts.
3. Determine if there is unused capacity in the Maddox Creek PUD Ponds 1 and 2.

2.0 Description of the Study Area

The Little Mountain Estates detention facility is located in the southeast part of the City in the Maddox Creek basin. This pond was built in the 1990's to provide 8.7 acre-feet of stormwater detention for the Little Mountain Estates subdivision and to also serve as a regional facility to attenuate peak streamflow rates in Maddox Creek. A concrete side-flow weir was constructed at the southeast corner of the pond to divert high streamflow in Maddox Creek into the facility. The weir has failed in recent years allowing a greater volume of streamflow into the pond.

The area tributary to the Little Mountain Estates pond is about 380 acres. The topography of the basin is flat to moderately sloped in the vicinity of the pond but relatively steep in the upland areas. Existing land use in the northern half of the basin is characterized as primarily medium density residential development with pockets of low- and high-density mixed in. Land use in the southern half of the basin is primarily low-density residential with some undeveloped pasture and forested areas. A large wetland area exists immediately to the east of the Little Mountain Estates subdivision (between S 36th Street and Maddox Creek Road). There are two additional stormwater detention ponds, PUD Ponds 1 and 2, upstream of the

Maddox Creek Pond, that collect and store runoff from some of the residential development in the upper part of the basin.

3.0 Hydrologic Model Development

The hydrologic analysis of the Little Mountain Estates pond was performed using the Hydrologic Simulation Program – Fortran (HSPF) model. This model was selected because it uses historical rainfall records to generate a long-term series of surface water flows. This long-term flow record gives a more accurate estimate of flood-frequency at a given point than provided by single-event design storm analysis. A long term flow record also allows analysis of flow duration which is useful when studying the flow effects on channel erosion.

This analysis builds on previous analyses in support of the 1993 City of Mt. Vernon Comprehensive Surface Water Management Plan (CSWMP), (RW Beck, 1993). This analysis also uses information recently developed by Northwest Hydraulic Consultants (nhc) for the update to the Maddox Creek HSPF model.

The HSPF analysis was performed for five scenarios assuming three land use conditions in combination with three routing scenarios. Table 1 describes the five scenarios.

TABLE 1
HSPF Modeling Scenarios

Scenario	Land Use Condition	Routing Scenario
1	Pre-Developed (forested)	No Ponds
2	Existing Condition	Damaged diversion weir and existing control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2
3	Existing Condition	Modified Diversion and control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2
4	Future Condition	Damaged diversion weir and existing control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2
5	Future Condition	Modified Diversion and control structure at Little Mountain Estates Detention Facility, Maddox Creek PUD Ponds 1 and 2

3.1 Meteorological Data Inputs

This analysis used the updated precipitation data set developed by nhc for the Maddox Creek HSPF model. This data set was developed by combining rainfall data from the National Oceanic and Atmospheric Administration (NOAA) station at Burlington, Washington, with rainfall data collected at Washington State University Cooperative Extension station at Mt. Vernon.

Daily pan evaporation data were obtained from the Washington State University Cooperative Extension station at Puyallup, Washington.

The rainfall and evaporation data sets include the period from October 1956 through December 2002. The development of these data sets are fully documented in the nhc Maddox Creek Model Update report.

3.2 Subbasin Delineation

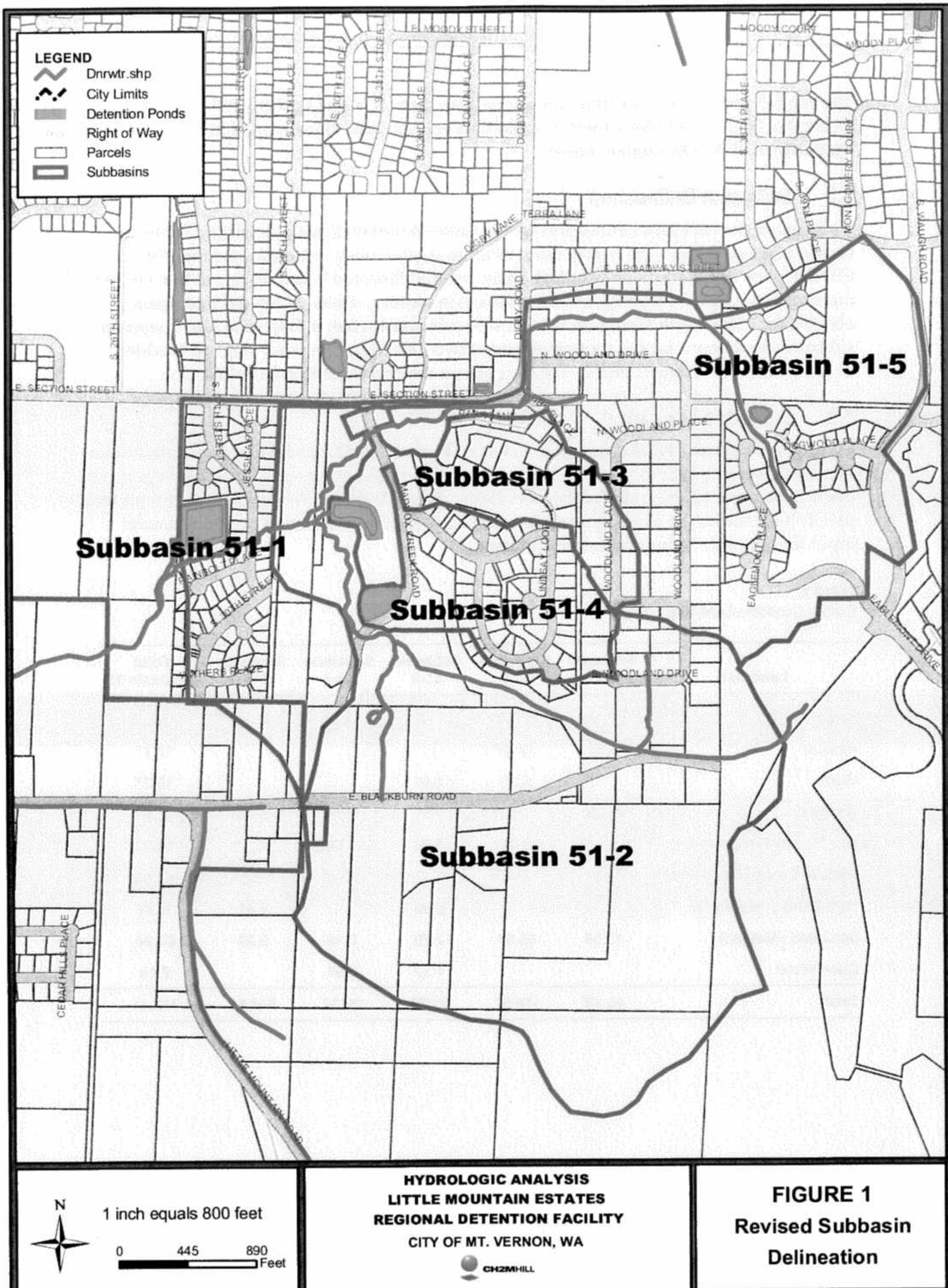
A review of the subbasin delineation for the Little Mountain Estates detention facility showed this subbasin to be nearly twice as large as previously estimated for the 1993 CSWMP. For this reason, the tributary basin was redelineated based on new 2-foot contour interval topographic mapping, recent drainage inventory, drainage reports and visual observation. This Little Mountain Estates subbasin was further subdivided into 5 separate subbasins to account for the routing effects of two detention ponds serving the Maddox Creek PUD (PUD Ponds 1 and 2). Figure 1 shows the revised subbasin delineation.

3.3 Land Use Scenarios

Existing conditions land use was updated to reflect current (2004) development conditions. The current development conditions was based on aerial photography, drainage reports for existing developments, and visual observations. Figure 2 shows the existing conditions land use. Table 2 shows the existing conditions land use and Table 3 shows the HSPF model input for the Little Mountain Estate subbasin.

TABLE 2
Existing Conditions Land-Use

Land Use	Subbasin 51-1	Subbasin 51-2	Subbasin 51-3	Subbasin 51-4	Subbasin 51-5	Total Subbasin 51
Forest		113.80	7.09	3.38	34.98	159.26
Pasture	1.63	12.07				13.71
Grass		5.26	5.01			10.27
Roadway	0.85			1.64	6.38	8.87
Low Density Residential		9.64	5.63	2.84	36.11	54.23
Medium Density Residential	24.11	2.23		19.40	19.35	65.09
High Density Residential			6.55		2.44	8.99
Saturated (Wetland)	13.54	35.57	2.29	0.16	9.29	60.84
Open Water			1.22	0.94		2.16
Total	40.13	178.57	27.79	28.37	108.55	383.41



HYDROLOGIC ANALYSIS
LITTLE MOUNTAIN ESTATES
REGIONAL DETENTION FACILITY
CITY OF MT. VERNON, WA

CH2MHILL

FIGURE 1
Revised Subbasin Delineation

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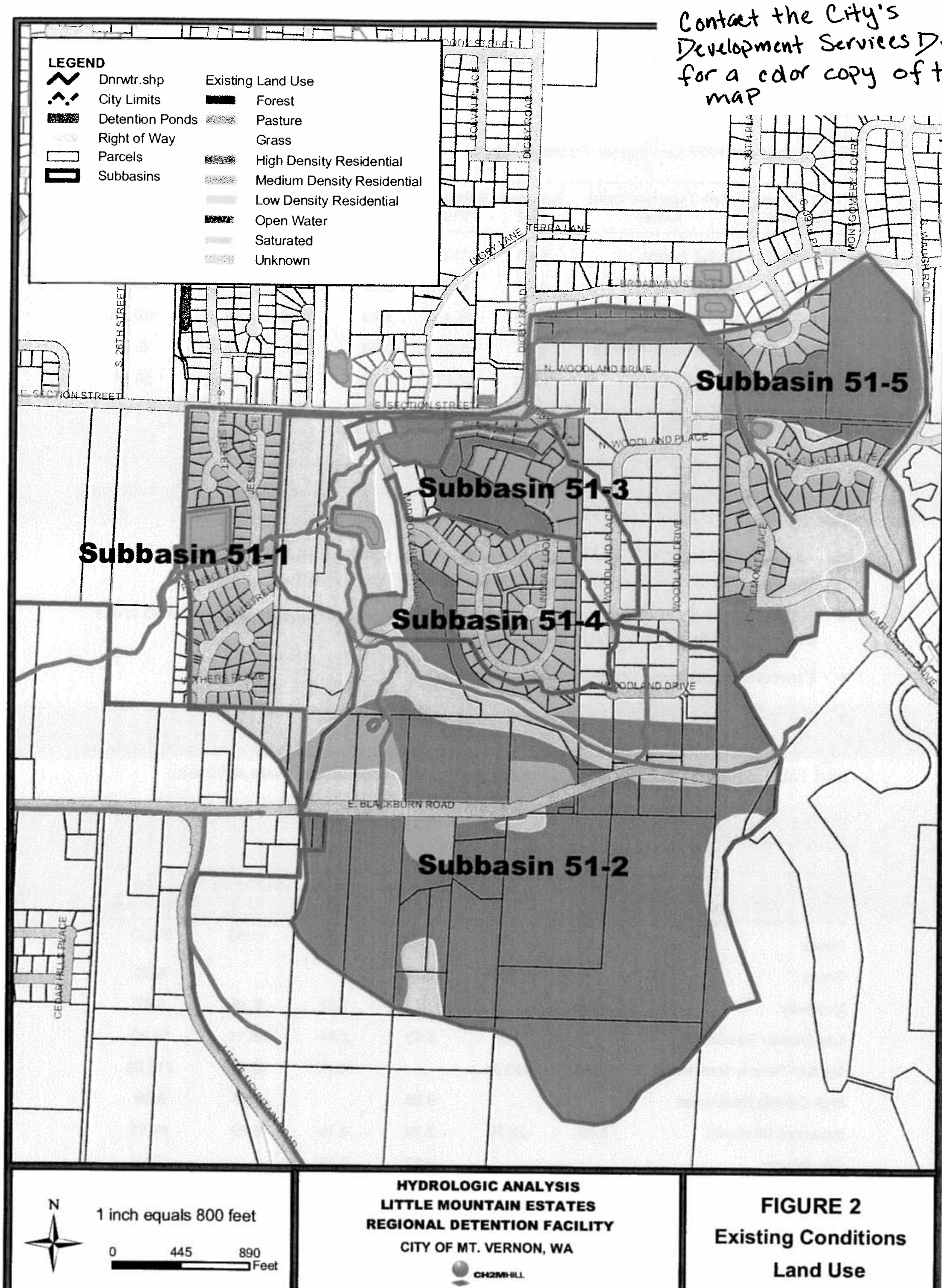
Contact the City's Development Services Dept. for a color copy of this map



HYDROLOGIC ANALYSIS
LITTLE MOUNTAIN ESTATES
REGIONAL DETENTION FACILITY
CITY OF MT. VERNON, WA

CH2MHILL

FIGURE 2
Existing Conditions
Land Use

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TABLE 3
Existing Conditions HSPF Land Segment Parameter Values

HSPF Land Segment	Soil Type and Land Cover	Subbasin 51-1	Subbasin 51-2	Subbasin 51-3	Subbasin 51-4	Subbasin 51-5	Total Subbasin 51
PERLND 15	Till Soil, Forest	0.00	113.80	7.09	3.38	34.98	159.26
PERLND 17	Till Soil, Pasture	1.63	6.07	0.00	0.00	0.00	7.71
PERLND 25	Till Soil, Grass	14.46	15.41	8.69	15.69	48.28	102.53
PERLND 27	Outwash Soil, Pasture	0.00	6.00	0.00	0.00	0.00	6.00
PERLND 51	Wetland	13.54	35.57	2.29	0.16	9.29	60.84
IMPLND 11	Impervious	10.49	1.72	9.72	9.13	16.01	47.07
Total		40.13	178.57	27.79	28.37	108.55	383.41

Future conditions land use was updated based on current land use zoning and the following assumptions:

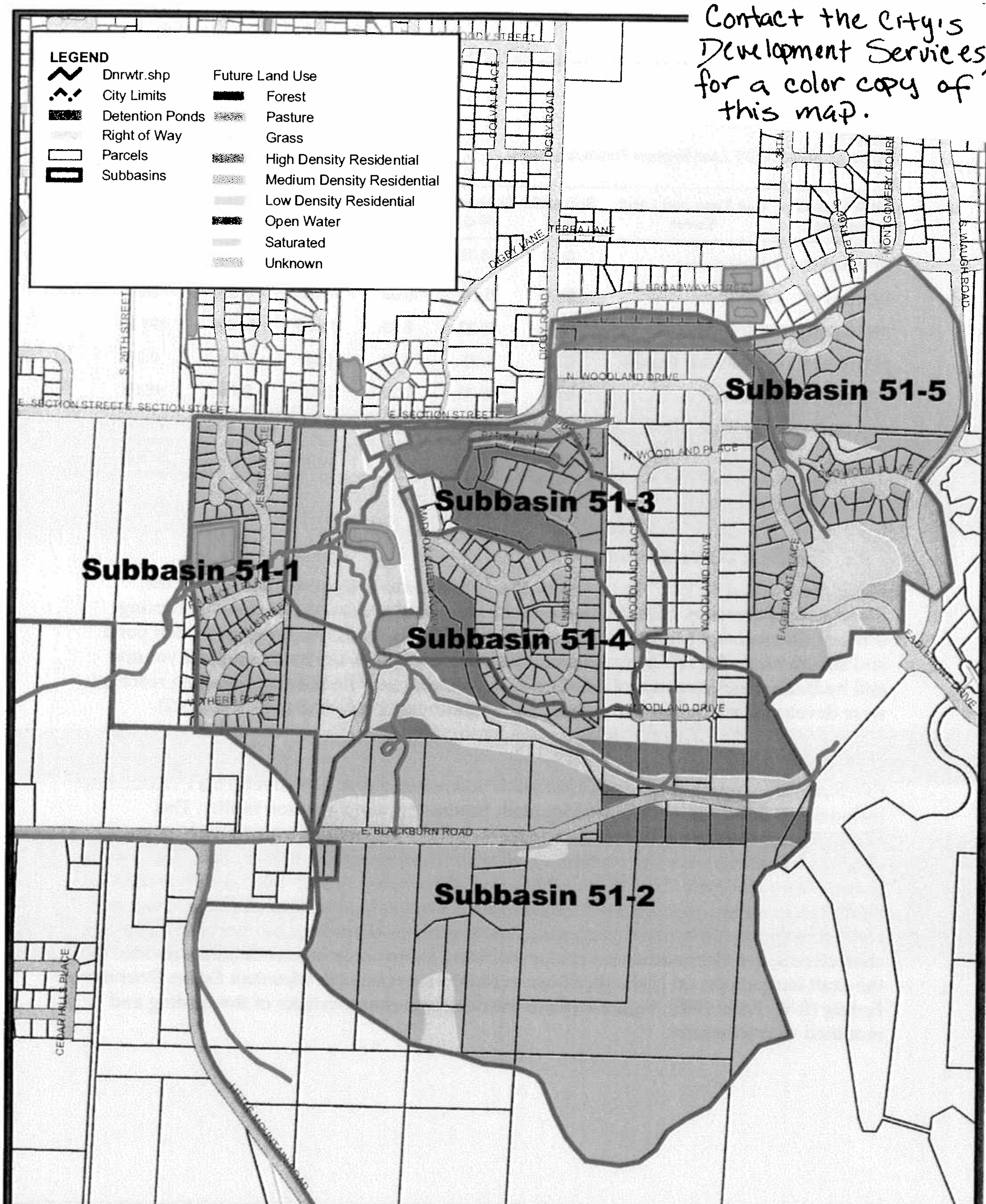
- Existing undeveloped, and low-density residential areas are assumed to redeveloped to higher density land use unless in a critical areas as noted below.
- No development will occur in critical areas. Critical areas are defined as wetland areas and areas with slopes greater than 40 percent.
- Protected areas were not assumed to develop.
- No redevelopment to a lower density will occur.

Figure 3 shows the future conditions land use. Table 4 shows the future conditions land use and Table 5 shows the HSPF model input for the Little Mountain Estate subbasin.

TABLE 4
Future Conditions Land-Use

Land Use	Subbasin 51-1	Subbasin 51-2	Subbasin 51-3	Subbasin 51-4	Subbasin 51-5	Total Subbasin 51
Forest		16.26	7.09	3.38	11.60	38.33
Grass		0.63	5.01			5.65
Roadway	0.85			1.64	6.38	8.87
Low Density Residential		9.64	5.63	2.84	36.11	54.23
Medium Density Residential	33.18	123.34		19.40	42.73	218.66
High Density Residential			6.55		2.44	8.99
Saturated (Wetland)	6.09	28.70	2.29	0.16	9.29	46.53
Open Water			1.22	0.94		2.16
Total	40.13	178.57	27.79	28.37	108.55	383.41

Contact the City's Development Services Dept. for a color copy of this map.



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1 inch equals 800 feet

0 445 890 Feet

HYDROLOGIC ANALYSIS
LITTLE MOUNTAIN ESTATES
REGIONAL DETENTION FACILITY
CITY OF MT. VERNON, WA

CH2MHILL

FIGURE 3
Future Conditions
Land Use

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TABLE 5
Future Conditions HSPF Land Segment Parameter Values

HSPF Land Segment	Soil Type and Land Cover	Subbasin 51-1	Subbasin 51-2	Subbasin 51-3	Subbasin 51-4	Subbasin 51-5	Total Subbasin 51
PERLND 15	Till Soil, Forest	0.00	16.26	7.09	3.38	11.60	38.33
PERLND 17	Till Soil, Pasture	0.00	0.00	0.00	0.00	0.00	0.00
PERLND 25	Till Soil, Grass	19.91	83.32	8.69	15.69	64.02	191.63
PERLND 27	Outwash Soil, Pasture	0.00	0.00	0.00	0.00	0.00	0.00
PERLND 51	Wetland	6.09	28.70	2.29	0.16	9.29	46.53
IMPLND 11	Impervious	14.12	50.30	9.72	9.13	23.65	106.93
Total		40.13	178.57	27.79	28.37	108.55	383.41

3.4 FTABLE Development

FTABLEs are used by HSPF to represent stage-storage-discharge relationships for the Maddox Creek reaches. FTABLEs are used by the model to simulate stormwater routing through the system. FTABLEs generated for this analysis are of two types: detention pond and stream reach. FTABLEs representing detention facilities were based on pond volume and hydraulic characteristics of the flow control structures. FTABLEs representing reaches were developed using the open channel hydraulic model HEC-RAS (US COE, 2002).

FTABLE 510

FTABLE 510 represents Maddox Creek reach downstream of S. 27th Street. This FTABLE also includes the diversion to the Little Mountain Estates regional detention facility. This FTABLE for this reach was developed using the HEC-RAS model. Cross sections were obtained from the draft letter report on *Hydraulic Structure Modifications for Little Mountain Estates Detention Facility* (R.W. Beck, 1995). The lateral weir option in HEC-RAS was used to model the existing and modified diversion weir. The physical characteristics of the existing weir were approximated based on actual site conditions observed in February 2004. The characteristics of the modified diversion weir were based on recommendations provided in the draft letter report on *Hydraulic Structure Modifications for Little Mountain Estates Detention Facility* (R.W. Beck, 1995). Figure 4 shows the discharge characteristics of the existing and modified weir structure.

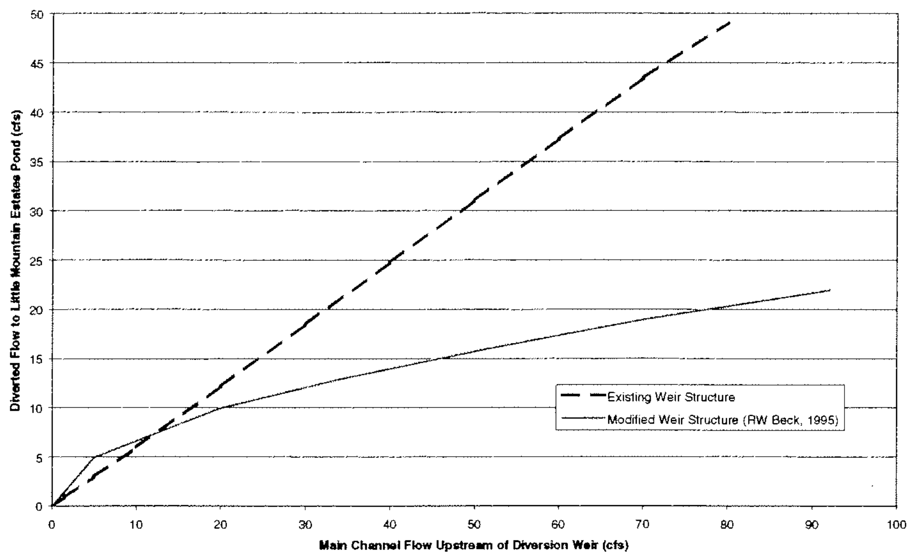

FIGURE 4
Diversion Weir Discharge Rating

FTABLE 511

FTABLE 511 represents the Little Mountain Estates regional detention facility. Stage-storage discharge characteristics for the existing pond and control structure were obtained from the draft Maddox Creek HSPF Model Update (nhc, 2003). Control structure modifications were based on recommendations provided in the draft letter report on *Hydraulic Structure Modifications for Little Mountain Estates Detention Facility* (R.W. Beck, 1995). Figure 5 shows the storage volume and Figure 6 shows the control structure stage discharge rating for the Little Mountain Estates regional detention facility.

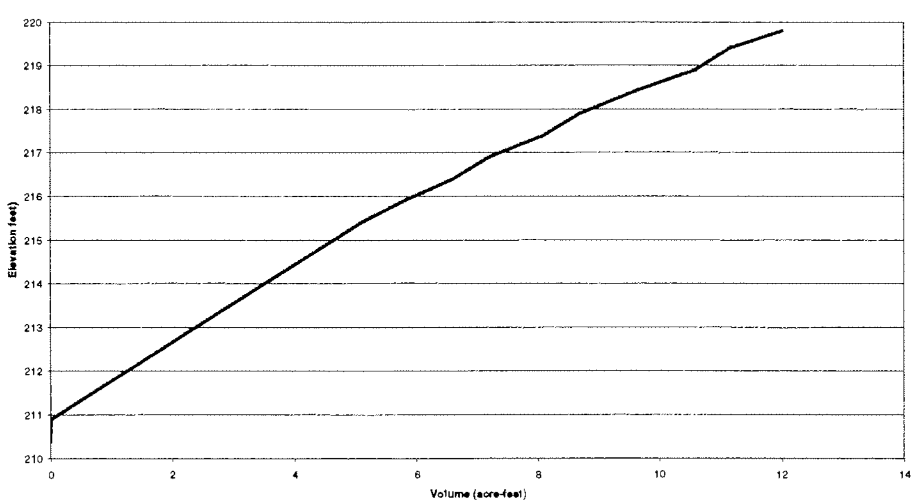

FIGURE 5
Storage Volume in Little Mountain Estates Regional Detention Facility

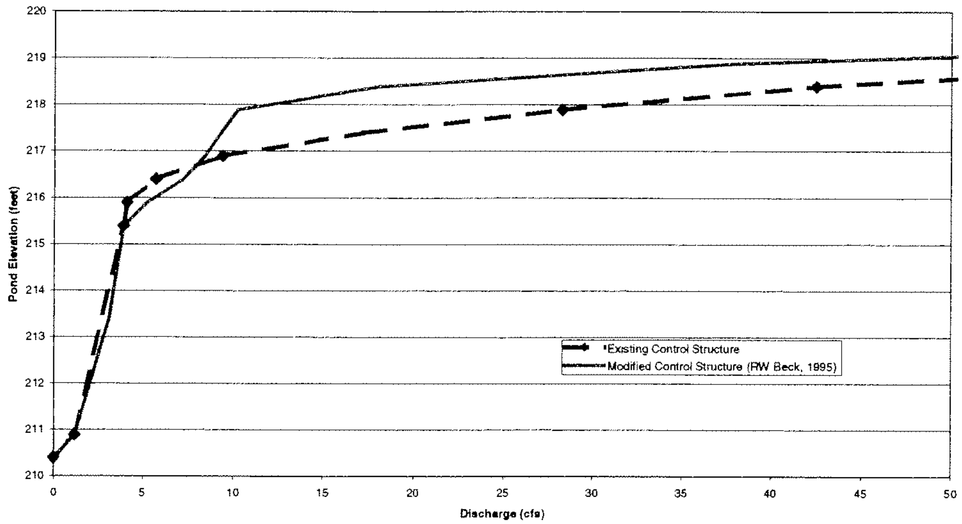

FIGURE 6
Discharge Rating for Little Mountain Estates Regional Detention Facility

FTABLE 512

FTABLE 512 represents the 1,200 foot reach between S. 27th Street and Maddox Creek Road. This FTABLE also includes a 2,400 foot reach of a tributary ditch extending from E. Blackburn Road to the confluence with Maddox Creek. HEC-RAS was used to develop the FTABLE for this reach. HEC-RAS cross sections were based on existing 2-foot topographic mapping.

FTABLE 513

FTABLE 513 represents the Maddox Creek PUD detention facility POND 1. Stage-storage discharge characteristics were obtained from existing drainage reports (Semrau and Lisser, 1995 and 1999). Figure 7 shows the storage volume for this detention pond.

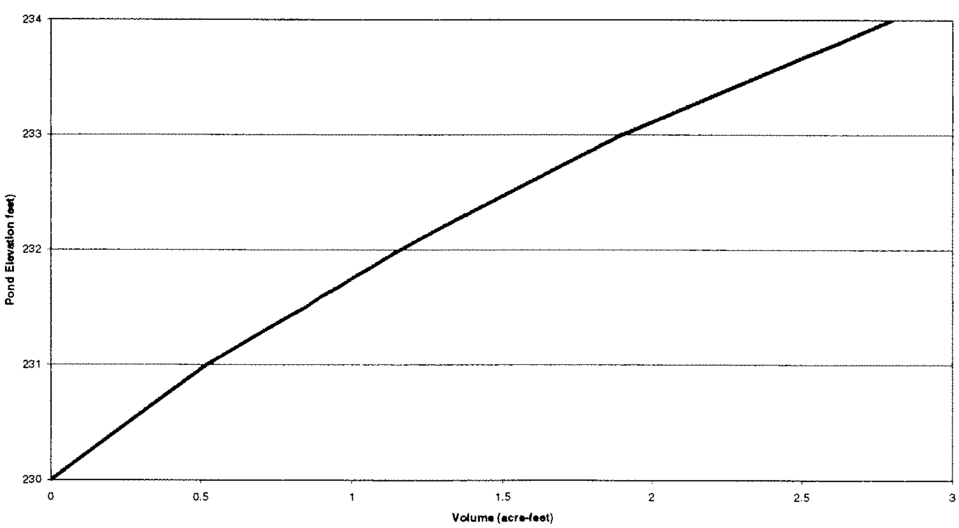

FIGURE 7
Storage Volume in Maddox Creek PUD Pond 1

FTABLE 514

FTABLE 514 represents the Maddox Creek PUD detention facility POND 2. Stage-storage discharge characteristics were obtained from existing drainage reports (Semrau and Lisser, 1995 and 1999). Figure 8 shows the storage volume for this detention pond.

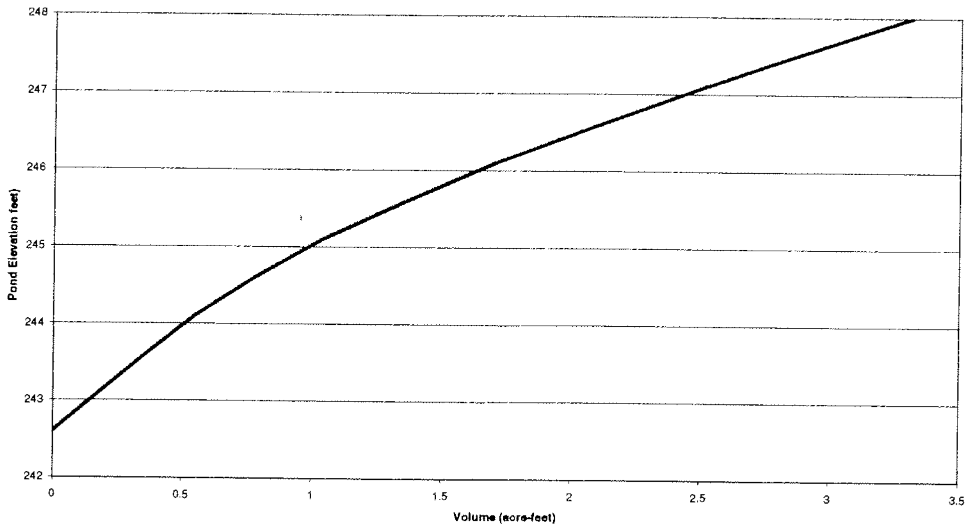

FIGURE 8
Storage Volume in Maddox Creek PUD Pond 2

FTABLE 515

FTABLE 515 represents the 4,200 foot reach upstream of Maddox Creek Road adjacent to E. Section Street. HEC-RAS was used to develop the FTABLE for this reach. HEC-RAS cross section were based on existing 2-foot topographic mapping.

3.5 HSPF Model Schematic

Figure 9 shows the HSPF model schematic used in this analysis.

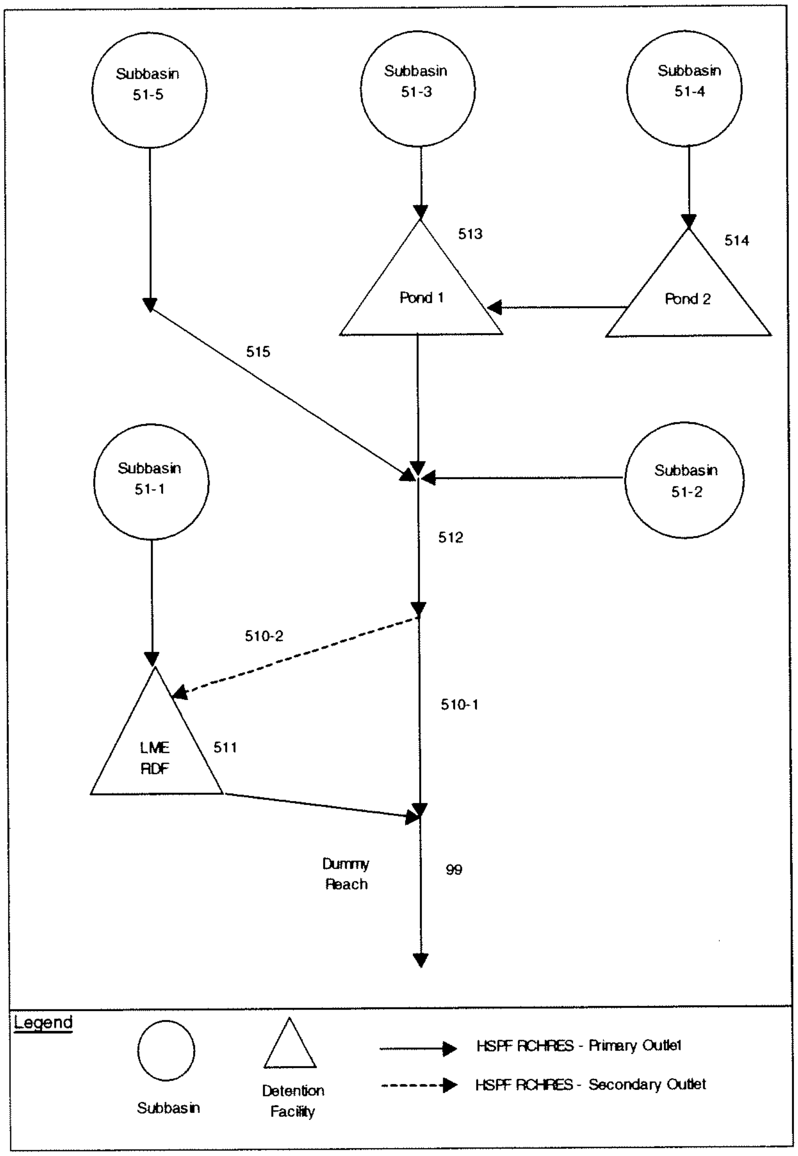

FIGURE 9
HSPF Model Schematic

4.0 Results of the Analysis

4.1 Peak Flood and Stage Frequency

Peak flood frequency is the probability that a given peak flood event will occur in any year. Flood frequency is commonly expressed as a return-period which is the inverse of the probability, and represents the average interval between the occurrence of a specific magnitude flood. For instance, a peak flood with a 50 percent probability of occurring in any given year is equivalent to a 2-year return period (1/0.5 = 2).

Table 3 shows the results of the HSPF analysis. Flood frequency was computed using the standard Log-Person Type III distribution (USGS, 1982).

TABLE 6
Flood Frequency for HSPF Analysis – Peak Flow in cfs

RCHRES	Location	2-year	10-year	25-year	100-year
Scenario 1 - Pre-Developed Condition (Forested)					
511[1]	Little Mountain Estates Pond Outlet	10.0	18.7	19.6	20.3
512	S. 24th Street	8.9	16.3	17.3	18.1
515	Maddox Creek Road	2.4	4.5	4.9	5.0
Scenario 2 - Existing Land Use Condition, Existing Diversion and Control Structure Configuration					
99[1]	Little Mountain Estates Pond Outlet	8.9	18.0	23.3	24.4
512	S. 24th Street	13.8	24.7	28.9	35.6
513	Maddox Creek PUD Pond 1	2.6	4.4	5.1	6.1
514	Maddox Creek PUD Pond 2	1.0	2.2	2.7	3.4
515	Maddox Creek Road	6.9	11.8	14.9	20.3
Scenario 3 - Existing Land Use Condition, Modified Diversion and Control Structure Configuration					
99	Little Mountain Estates Pond Outlet	10.5	15.5	18.6	19.9
512	S. 24th Street	13.8	24.7	28.9	35.6
513	Maddox Creek PUD Pond 1	2.6	4.4	5.1	6.1
514	Maddox Creek PUD Pond 2	1.0	2.2	2.7	3.4
515	Maddox Creek Road	6.9	11.8	14.9	20.3
Scenario 4 - Future Land Use Condition, Existing Diversion and Control Structure Configuration					
99	Little Mountain Estates Pond Outlet	20.0	32.5	37.9	39.1
512	S. 24th Street	29.8	50.0	62.3	83.5
513	Maddox Creek PUD Pond 1	2.6	4.4	5.1	6.1
514	Maddox Creek PUD Pond 2	1.0	2.2	2.7	3.4
515	Maddox Creek Road	9.3	15.6	19.4	26.0
Scenario 5 - Future Land Use Condition, Modified Diversion and Control Structure Configuration					
99	Little Mountain Estates Pond Outlet	16.5	24.4	28.4	34.5
512	S. 24th Street	29.5	49.6	60.7	78.5
513	Maddox Creek PUD Pond 1	2.6	4.4	5.1	6.1
514	Maddox Creek PUD Pond 2	1.0	2.2	2.7	3.4
515	Maddox Creek Road	9.3	15.6	19.4	26.0

1. Flood-frequency estimated from a graphical fit of the data plotted using the Gringorton plotting position

Figure 10 shows the peak flood frequency for Little Mountain Estates pond. This figure shows that for the existing land use condition, the Little Mountain Estates regional detention facility with the current diversions weir and controls structure configuration (Scenario 2) attenuates peak flows to predeveloped conditions (Scenario 1) peak flows for events less than or equal to the 10-year event. If the diversion weir and control structure are modified as proposed in the RW Beck report, peak flow rates will increase for events below the 2-year return frequency but decrease for less frequent return periods.

Figure 10 shows that flows are predicted to significantly increase under future land use conditions (Scenario 4). The peak flow increase ranges from a doubling for the 2-year event to about a 65 percent increase for events with a return period higher than the 25-year. The diversion weir and control structure modifications (Scenario 5) mitigate the peak flow increase will still be greater than peak flows under existing land use conditions.

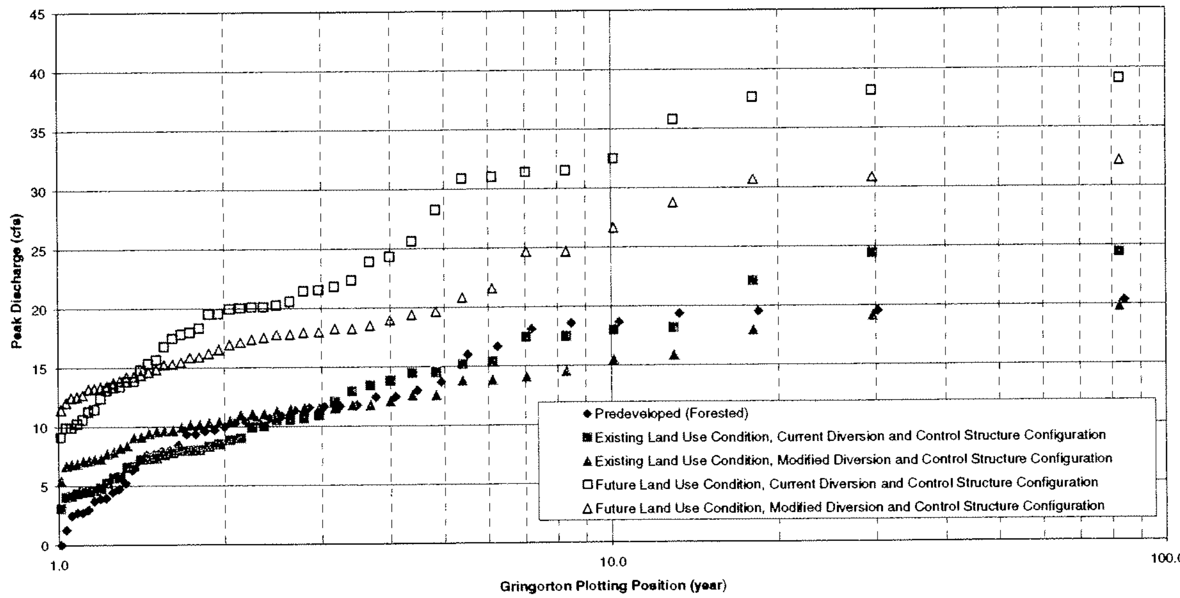

FIGURE 10
Peak Flood Frequency at Little Mountain Estates Pond
Plot shows creek flow for predeveloped condition and combined bypass and pond outflow for existing and future land use condition

Figure 11 shows the peak annual stage for Little Mountain Estates pond. This figure shows that:

- Approximately 0.8 acre-feet of unused storage volume is available in the pond for the existing land use condition and the current diversion weir and control structure configuration (Scenario 2).
- The storage volume will be fully utilized for the existing land use condition and the modified diversion weir and control structure configuration (Scenario 3) and future land use conditions the current diversion weir and control structure configuration (Scenario 4).

- The storage volume will be over utilized by 0.9 acre-feet for the future land use conditions and modified current diversion weir and control structure configuration (Scenario 5).

These conclusions are based on the assumption that there is 8.7 acre-feet of useable storage volume in the facility at the maximum allowable high water level of 217.8 feet (overflow elevation – 1 foot freeboard).

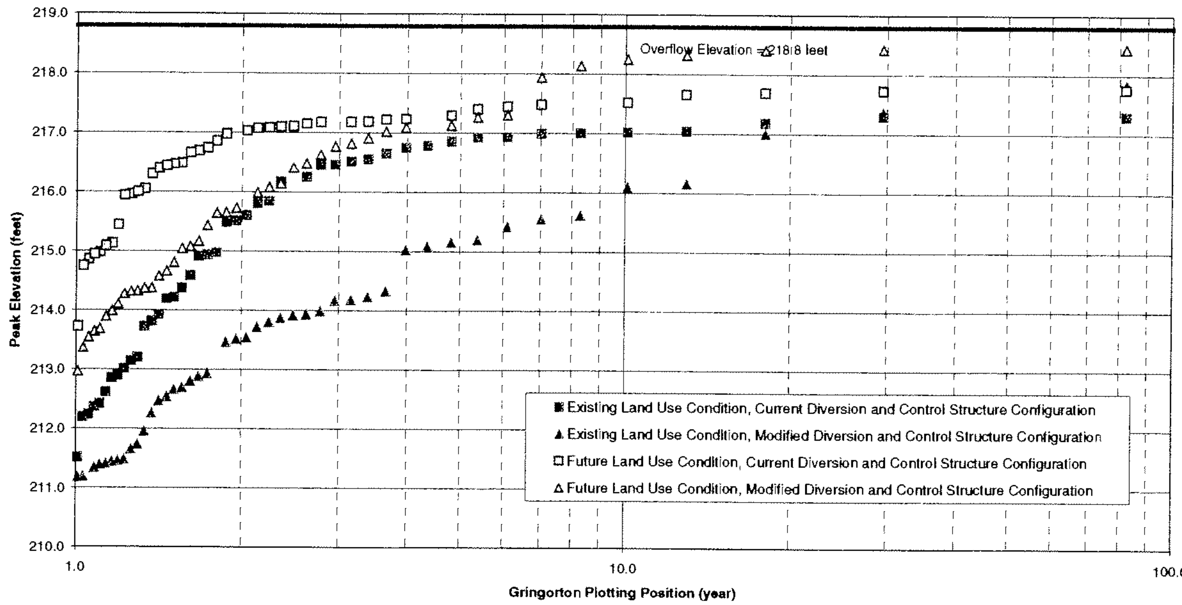

FIGURE 11
Ranked Peak Annual Stage at Little Mountain Estates Pond

Figures 12 and 13 show the peak annual flow for the Maddox Creek PUD Ponds 1 and 2 respectively. These figures show that the detention volume in these ponds is fully utilized (based on the 1 foot freeboard assumption).

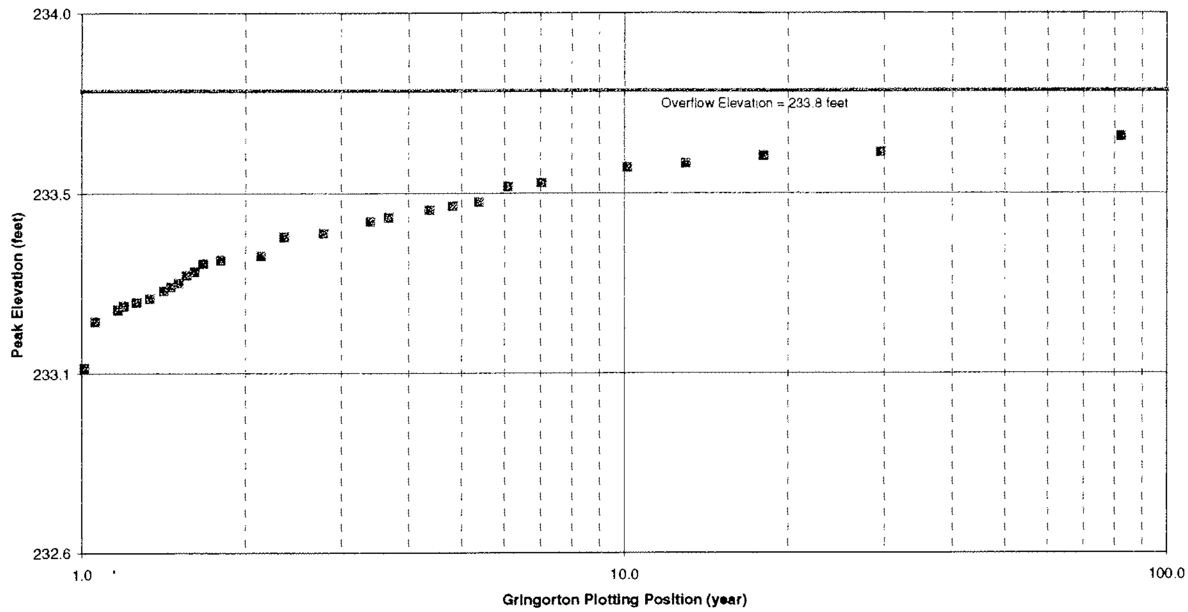

FIGURE 12
Ranked Peak Annual Stage at Maddox Creek PUD Pond 1

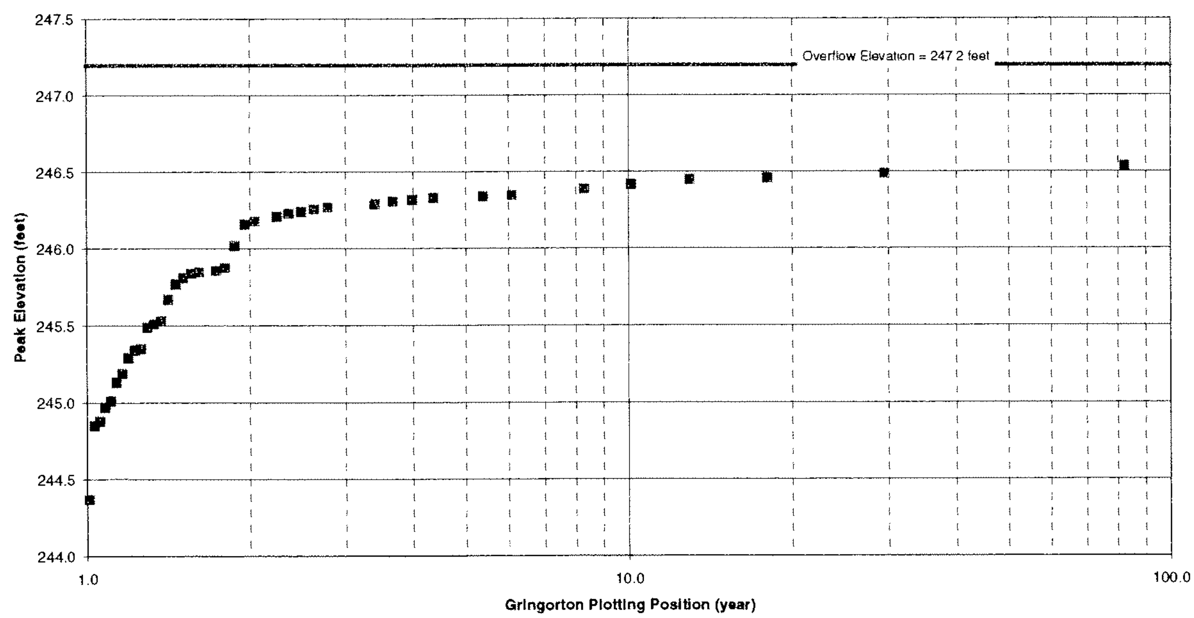

FIGURE 13
Ranked Peak Annual Stage at Maddox Creek PUD Pond 2

4.2 Duration Analysis

Flow duration analysis was performed for reach downstream of Little Mountain Estates pond. This reach was assumed to include the predicted outflow from the Little Mountain Estates pond with the predicted discharge in the bypass reach. Flow duration is the amount of time (generally expressed as a percent of total) in which a given flow, is equaled or exceeded. Figure 14 shows the results of this analysis. This figure shows that the flow duration under the existing land use condition and the current diversion weir and control structure configuration (Scenario 2) is slightly higher than the predeveloped condition (Scenario 1) flow duration. This figure also shows that flow duration will increase under future land use conditions.

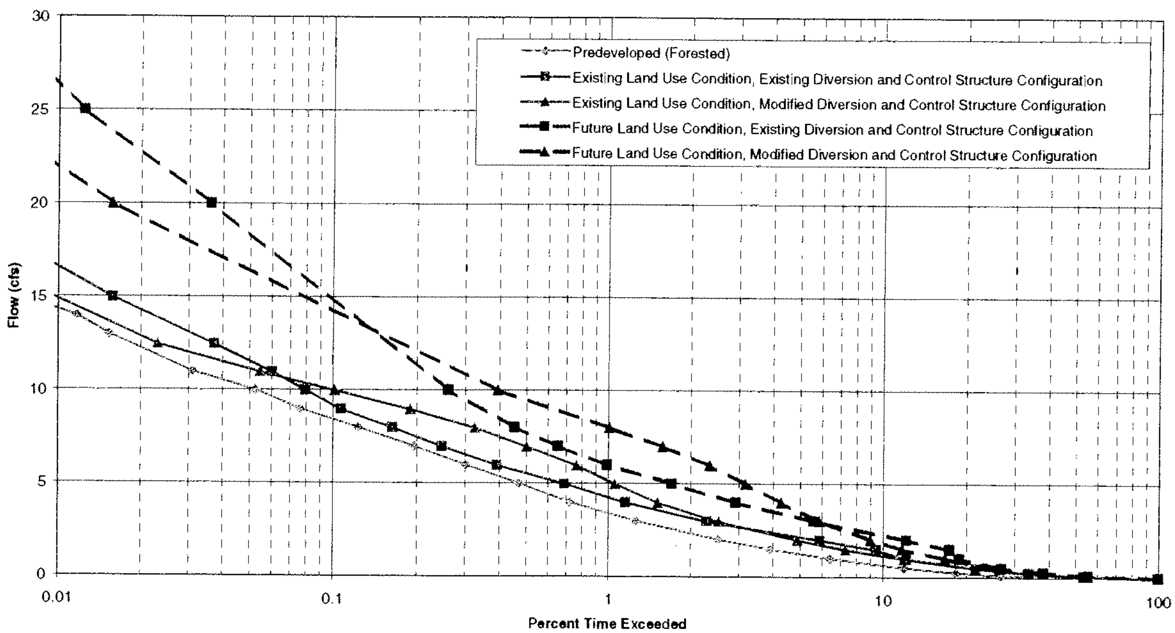

FIGURE 14
Flow Duration at Little Mountain Estates Pond
Plot shows creek flow for predeveloped condition and combined bypass and pond outflow for existing and future land use condition

5.0 References

R.W. Beck, 1993 City of Mt. Vernon Comprehensive Surface Water Management Plan, Seattle, Washington.

R.W. Beck, 1995. Hydraulic Structure Modifications for Little Mountain Detention Facility, Draft Letter Report, Seattle, Washington.

NHC, 2003. Maddox Creek HSPF Model Update, Draft Report, Tukwila, Washington.

Semrau and Lisser, 1995. Drainage Report for Maddox Creek P.U.D., Phase 1, 2, and 4, Mount Vernon, Washington.

Semrau and Lisser, 1999. Drainage Report for Maddox Creek P.U.D., Phase 3 and Post Construction Analysis of Detention Ponds, Mount Vernon, Washington.

United States Army Corp of Engineers, Hydrologic Engineering Center, 2002. HEC-RAS, River Analysis System, Davis, California.

United States Geological Survey, 1982. Guideline for Determining Flood Flow Frequency, Reston, Virginia.

United States Geological Survey, 2002. Hydrologic Simulation Program – FORTRAN, Reston, Virginia.

Appendix B
Regulations and Policies

- Regulatory Compliance Gap Analysis - Full Report
- NPDES Phase II Requirements
- NMFS Municipal, Commercial, Residential, and Industrial Development Standards for a "Take" Exemption
- Tri-County Proposal - Model Planning Policies
- Identifying Sites for "Street Edge Alternatives"

1.0 Introduction

1.1 Purpose

A variety of state and federal regulations affect City storm and surface water programs. These regulations include the Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Program, the Endangered Species Act (ESA), and the Puget Sound Water Quality Management Plan (PSWQMP). Additionally, there are related guidance documents that recommend actions that are likely necessary to achieve compliance with the regulations. As an initial step in developing a comprehensive stormwater management plan (CSMP) update, Mount Vernon asked CH2M HILL to identify where potential "gaps" may exist between the City's existing policies, plans, codes, and practices and the regional and federal laws and guidance documents. Because they are enforceable Federal laws, this analysis focuses on the CWA and ESA listings of salmon. The Washington State PSWQMP also specifies stormwater programs that jurisdictions most implement. This manual has not been enforced consistently, but the PSWQMP and the Tri-County ESA recommendation will be used by regulatory agencies to assess compliance. While this paper emphasizes the Federal laws and guidance, it also identifies areas where there are substantial differences between the Federal guidance and State or regional guidance documents.

1.2 Methods

To identify potential "gaps" in Mount Vernon's regulations, policies, and practices, the following were reviewed:

- Mount Vernon Municipal Code
- Mount Vernon Comprehensive Plan
- Mount Vernon Comprehensive Surface Water Management Plan
- Mount Vernon Staff Interviews
- NPDES Phase II Minimum Control Measures
- NMFS 4(d) Municipal, Residential, Commercial, and Industrial (MRCI) Development Standards
- Tri-County Model 4(d) Proposal
- Puget Sound Water Quality Management Plan

It was necessary to interview city staff from a variety of departments to understand the current level of enforcement and implementation of existing regulations and policies. In addition, staff members were able to identify particular areas of concern and desired outcomes associated with the surface water plan update. The following City staff members were interviewed:

- Skye Richendrfer, Mayor
- Jennifer Aylor, Manager, Surface Water Utility
- Dan Eises, Capital Projects Manager
- Walt Enquist, Supervisor, Wastewater Utility
- Andrew Denham, Sewer, Drainage Maintenance Foreman

- Fred Buckenmeyer, Engineering Director
- Roxanne Michael, Planning Director
- Gloria Rivera, Senior Planner.

A list of the pre-prepared questions for each is attached in Attachment A. A detailed list of responses was previously provided.

This analysis will be used to identify the need for new or expanded City regulations and policies, program modifications, and/or management activities, which may be required for compliance with relevant state and federal regulations.

2.0 Tri-County Proposal

2.1 Tri-County Proposal Response Background

Although Mount Vernon was not part of the Tri-County ESA response effort, the Tri-County proposal provides the best guidance available regarding what is needed to qualify for a 4(d) take limitation. The current 4(d) rule (see ESA discussion below) allows local jurisdictions to receive an exemption for certain governmental activities like park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater maintenance. Rather than each jurisdiction having to get approval, NMFS encouraged regional responses to the rule.

The Tri-County Proposal is an attempt to create a set of regulations that will meet the MRCI standards set forth by NMFS, in order to qualify for the 4(d) take limitation. While no elements of the Tri-County Proposal have been approved yet by NMFS and the USFWS, if is important to see if Mount Vernon's existing policies and code are consistent with the model regulations set forth in the Tri-County Proposal.

2.2 The Tri-County Model Response Proposal

The Tri-County Model 4(d) Rule Response Proposal consists of three regulatory and programmatic components:

- Regional Road Maintenance
- Stormwater
- Land Management

For the purposes of this report, the main focus of this analysis will look at the stormwater and land management components of the Tri-County Proposal. Since Mount Vernon is not located within the boundaries of the Tri-County proposal area, it is not required to adopt or comply with the Tri-County Model Response Proposal. However, if Mount Vernon wants to be sure it's going to be eligible for "take" protection, the City must have adequate policies and regulations in place to protect habitat functions.

2.2.1 Stormwater

The Tri-County Proposal includes a Stormwater Management Checklist that lists mandatory program elements, which can then be applied to Mount Vernon's existing programs, to identify areas lacking regulatory components. The following six areas of stormwater regulations were reviewed:

- Technical Standards

- Erosion Control
- Inspection and Enforcement
- Maintenance
- Source Control
- Discharge Reduction

Each of the requirements set forth in the Stormwater Management Checklist corresponds to a particular MRCI Standard and/or NPDES Phase II Minimum Control Measure. To prevent repetition, only the Tri-County Standards that were not previously addressed/considered have been included in Sections 4.0 and 5.0 under the headings "Minimum Requirements" or "Regulatory Guidance" respectively. Due to time and budget constraints, Mount Vernon's Programs, Policies, and Regulations were not analyzed in regard to the Tri-County proposed standards/checklist.

2.2.2 Land Management

The land management component consists of two parts:

Model Planning Policies (MPPs)
MPPs provide the policy basis to conserve salmonids listed under the ESA. These could include countywide planning policies or policies adopted through individual comprehensive plans. These model land management goals and policies act as the foundation for development regulations. The Tri-County Model suggests MPPs that adequately address issues related to salmonids; these have been included in Section 5.4 of this report.

Development Regulations
Model development regulations that apply to activities in the aquatic and adjacent near-shore areas that either provide salmonid habitat or are connected to waters that supply salmonid habitat. The Tri-County program provides three options for local governments, who can choose one or any combination of the following:

- Fixed Regulations – development proposals must comply with a standard set of prescribed development regulations without deviation. Regulations include inner and outer Management Zones (MZ) with specific provisions for each zone, designed to protect habitat functions from adverse project impacts.
- Site-Specific Habitat Evaluations – proposals for development are required to complete a Habitat Evaluation (HE), which will look at the habitat functions that are likely to be impacted as a result of the project. The HE requires the applicant provide conservation measures that are consistent with the program's habitat goals and objectives, in addition to mitigating for impacts to key habitat functions.
- Programmatic Regulations – conduct a HE on a specific geographic area or specific type or category of development activity. Based on the results of the HE, the jurisdiction will identify allowable activities and appropriate protection and mitigation measures that are consistent with the habitat goals and objectives of the Tri-County Program.

Of the three options, the Fixed Regulations option is the only option that sets default-buffer widths for streams and wetlands. Mount Vernon currently has fixed regulations regarding buffer widths. Therefore, the Tri-County development regulation standards for the Fixed Regulations option looked at in the following sections:

5.4 *MRCI #1 – Ensure that Development Avoids Critical Areas*

5.6 *MRCI #3 - Protect Riparian Areas*

3.0 Puget Sound Water Quality Management Plan

The Puget Sound Water Quality Management Plan (PSWQMP) is Washington's long-term strategy for protecting and restoring Puget Sound. The management plan takes a proactive approach towards pollution prevention, and recognizes that it will cost us far more to clean up pollution later than to prevent it now.

The recently adopted 2000 PSWQMP consists of 21 programs that address major concerns about Puget Sound and its resources. These programs aim to coordinate the roles and responsibilities of federal, state, tribal, and local governments. While almost all of the programs will ultimately have some effect on Mount Vernon, the following programs require direct action on the part of local governments:

- Marine and Freshwater Habitat Protection
- Municipal and Industrial Discharges
- Non-point Source Pollution
- Agricultural Practices
- Forest Practices
- Local Watershed Action
- On-Site Sewage Systems
- Stormwater and Combined Sewer Overflows
- Education and Public Involvement

Each of these programs includes various requirements and recommendations for local governments that will most likely require revisions and additions to comprehensive plans, municipal code sections, and city programs.

4.0 NPDES Phase II Stormwater Program

4.1 Background

Published in the Federal Register (64 FR 68722) in December, 1999, EPAs Stormwater Phase II Final Rule requires Municipal Separate Storm Sewer Systems (MS4s) serving cities whose population is less than 100,000, to obtain an NPDES Phase II Municipal Stormwater Permit. Stormwater discharges are considered "point sources" of pollution, and the Clean Water Act requires all point source discharges to be covered by federally enforceable NPDES permits. The NPDES Phase II Rule states the regulated jurisdiction must:

- Specify best management practices (BMPs) for six Minimum Control Measures (MCMs)
- Identify measurable goals
- Show an implementation schedule, and
- Define the entity responsible for implementation.

EPA provides very specific regulatory guidance (40 CFR 122.34(b)), for stormwater management BMPs, in regard to each of the six MCM requirements. This guidance is what Mount Vernon's existing regulations and practices were evaluated against, and therefore it has been included in Attachment B. BMPs, when implemented together, are expected reduce pollutants discharged into receiving water bodies to the Maximum Extent Practicable (MEP).

4.2 Organization and Level of Analysis

The following sections analyze each of the six MCMs and their minimum BMP requirements in relation to what was learned through staff interviews and from the review of Mount Vernon's existing regulations and policies. In order to identify potential gaps, the following had to be looked at and evaluated for each MCM:

- Minimum control measure requirements set forth in the Code of Federal Regulations
- Regulatory guidance and potential BMPs suggested by the EPA
- Applicable Mount Vernon Municipal Code (MVMC) sections
- Applicable goals, policies, and objectives of the Mount Vernon Comprehensive Plan
- Information from staff interviews

Table 1 provides an overview of the NPDES Phase II minimum control measure requirements in regard to Mount Vernon's existing programs, policies, and practices.

Table 2 provides an in-depth look at the specific requirements of each MCM in regard to Mount Vernon's programs, policies, and regulations. Gaps were identified, where they existed, and potential actions were recommended to fill those gaps.

Table 1
Mount Vernon's Regulations and Policies and the NPDES Minimum Control Measure Requirements*

Minimum Control Measure	Minimum Requirements Met	Current Implementation	Extent of Enforcement	Comprehensive Plan Coverage	Municial Code Coverage
1) Public Education & Outreach on Stormwater Impacts	Yes	Yes	Adequate	Adequate	Inadequate
2) Public Involvement/Participation	No	Partial	Inadequate	Inadequate	Inadequate
3) Illicit Discharge Detection & Elimination	No	No	Inadequate	Inadequate	Inadequate
4) Construction Site Stormwater Runoff Control	Yes	Partial	Partial	N/A	Adequate
5) Post-Construction Stormwater Management in New Development & Redevelopment	Partial	Partial	Partial	Partial	Adequate
6) Pollution Prevention/Good Housekeeping for Municipal Operations	No	No	Inadequate	N/A	Inadequate

*Preliminary draft

Notes:

Partial = Means that some of the minimum requirements have been implemented, but further additions are needed for compliance.
Adequate = Means that the provisions set forth within the MCM are adequately being enforced and or covered within the City's code or comprehensive plan.
Inadequate = Means that the provisions set forth within the MCM are not adequately being enforced and or covered within the City's code or comprehensive plan.

Table 2 (11x17) NPDES Phase II Requirements and Mount Vernon's Policies and Regulations (5 Pages)

4.3 MCM #1 - Public Education and Outreach on Stormwater Impacts

4.3.1 Minimum Requirements

"Implement a public education program to distribute materials to the community or conduct equivalent outreach activities about the impacts of stormwater discharges on water bodies and the steps that the public can take to reduce pollutants in stormwater runoff."

4.3.2 Regulatory Guidance

The public education program should inform individuals and households about different ways to reduce stormwater pollution, such as:

- Proper septic system maintenance
- Proper use and disposal of landscape and garden chemicals including fertilizers and pesticides
- Protecting and restoring riparian vegetation
- Properly disposing of used motor oil and household hazardous wastes

In addition, the program should be tailored, using a mix of strategies, to target specific audiences and communities. Examples of strategies include:

- Distribute brochures or fact sheets
- Sponsoring speaking engagements before community groups
- Providing public service announcements
- Implementing educational programs targeted at school age children
- Conducting community-based projects such as storm drain stenciling and watershed cleanups

EPA recommends that some of the materials be directed towards targeted groups of commercial, industrial, and institutional entities likely to have significant stormwater impacts.

4.3.3 Mount Vernon Municipal Code

This section is not applicable to MCM Standard #1.

4.3.4 Mount Vernon Comprehensive Plan

The plan recommends a comprehensive, surface water management program that relies on a combination of education, regulations, operation and maintenance, and capital projects to protect surface water resources.

A major comprehensive plan element, within Chapter 6, *Utilities,* supports the requirements of MCM #1. The element includes, "Development of public education programs to increase the understanding and awareness of citizens and business owners about flood control and how their actions can affect water quality and environmental resources".

In addition, Chapter 6 identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality.

Objective "d" of this goal reads, "Implement public education programs to reduce the source of pollutants entering surface waters".

4.3.5 City Staff Interviews

The following are highlights of the information and opinions obtained during individual staff interviews.

- The general public doesn't understand how their utility bill is divided, and what their money pays for or whom it benefits. One bill is sent out for wastewater, water, SWM, and solid waste, and the bills don't show a breakdown of costs.
- There is concern about how the public would perceive another rate increase on the utility bill because Mount Vernon already has one of the highest property tax rates in the County because of the low commercial tax base.
- The average resident is quite conservative and not open to the idea of paying extra money to restore habitat while potentially loosing property rights due to buffer increases. The City should improve communication regarding the benefits to salmon protection.
- The City should complete a couple projects such as walking and bike paths so the public can see the results and enjoy the restoration they pay for (ex. watching salmon spawn, interpretive trails, school field trips, etc.).
- More money could be spent on the implementation side rather than the regulatory side to ensure that results can clearly be seen.
- Explore more volunteer programs to aid in policy implementation and help save money.

4.3.6 Positive Aspects of the City's Current Programs

The City teams up with the Skagit Fisheries Enhancement Group (SFEG) to engage communities in habitat restoration and watershed stewardship. This program, called the Stormwater Education Program, has been implemented as a result of the Mount Vernon Comprehensive Stormwater Management Plan developed in 1994. The education program is aimed at teaching residents how to prevent stormwater pollution. Recently, 4th through 12th grade students participated in a storm drain stenciling program while being educated about the problem of pollution in local creeks, streams and rivers. Also, a television channel, Mount Vernon Television (MVTV), occasionally features segments regarding stormwater education. The City has a brochure showing "Home Tips for Healthy Streams" which has a variety of good ways to reduce pollution to stormwater and limit runoff.

4.3.7 Gaps or Deficiencies Identified

The City meets the minimum requirements of MCM #1 because the City has a contract with SFEG to develop and implement a stormwater education program. However, it should also target adults, homeowners, and businesses. The City should:

- Develop a program to educate business owners, especially those thought to have significant stormwater impacts (developers, etc.).

- Sponsor speaking engagements and slide shows before community groups and homeowners living along streams and rivers.
- Hold demonstrations showing the things people can do to reduce runoff and stormwater pollution, such as planting native vegetation.
- Create a series of fact sheets that expand on each of the tips suggested in the existing brochure.

4.4 MCM #2 - Public Involvement/Participation

4.4.1 Minimum Requirements

The public must be involved in developing the SWM program, complying with state, tribal, and local public notice requirements when implementing a public involvement/participation program.

4.4.2 Regulatory Guidance

The public shall be included in creating, implementing, and updating the storm/surface water management program. Municipalities should make efforts to reach out and engage all economic and ethnic groups. Opportunities for public involvement include:

- Serving as citizen representatives on a local stormwater management panel
- Attending public hearings
- Serving as citizen volunteers to educate other individuals about the program
- Assisting in program coordination with other pre-existing programs
- Participating in volunteer monitoring efforts

4.4.3 Mount Vernon Municipal Code

No sections within the Mount Vernon Municipal Code (MVMC) currently address MCM #2.

4.4.4 Mount Vernon Comprehensive Plan

A major comprehensive plan element, within Chapter 6, *Utilities,* supports the requirements of MCM #2. The element includes, "Establishment of a Citizen Advisory Committee (CAC) and a series of several meetings in which public input was collected".

4.4.5 City Staff Interviews

The City currently has a Citizens Advisory Committee, which comprises elected members. However, a collaboration needs to be developed between the CAC and the general public to make them feel as though they were part of the process. A coalition may reduce the number of complaints received if utility rates are increased. It may help to get the public focused on the issues and not on the government. The CAC should report to the Mayor not the City Council. There should be diversity in public involvement, not just interest groups. Utilize MVTV and the stormwater education program to target all income levels and ethnicity's.

4.4.6 Positive Aspects of the City's Current Programs

The City currently has a CAC. The City currently has a TV channel that can help engage the community and notify them about upcoming public hearings or workshops. The City used a CAC to develop the initial CSMP.

4.4.7 Gaps or Deficiencies Identified

Additional effort is needed to engage the public and create a local stormwater CAC. The general public should be engaged in the process of updating the stormwater plan. Page 6-6 of the Comprehensive Plan mentions a comprehensive, surface water management program that relies on a combination of education, regulations, operation and maintenance, and capitol projects to protect surface water resources. It appears that the City is lacking involvement between the public and the CAC. Since the CAC comprises elected citizens, it is important to encourage the general public to work with the CAC, so they can convey information directly to the mayor.

4.5 MCM #3 - Illicit Discharge Detection and Elimination

4.5.1 Minimum Requirements

Develop, implement, and enforce a program to detect and eliminate illicit discharges into the city's MS4. This includes:

- complete a storm sewer system map, showing the location of all outfalls and the names and location of all waters of the United States that receive discharge from those outfalls,
- effectively prohibit, through ordinance, or appropriate enforcement procedures and actions, non-stormwater discharges into your system, including illegal dumping to your system,
- inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

Tri-County standards for source control requires local jurisdictions to:

- compile a list of existing commercial, multifamily, industrial, and government sites to assist in a monitoring and inspection program.
- fund site inspections and enforcement of source control BMP's,
- establish source control program policies and procedures and provide appropriate staff training to implement a six-year inspection schedule/plan.

In addition to source control requirements, the Tri-County Propôsal sets standards for the reduction of illicit discharges. The proposed standards require jurisdictions to adopt ordinances, to make it illegal to dump or spill contaminants into the storm drainage system, or have connections to the storm drainage system that discharge contaminants. Jurisdictions must allocate funding for investigation, referral, and enforcement as needed for illicit discharges identified from complaints, inspections, or other monitoring information. Investigation or referral to an appropriate agency of complaints/reports (indicating a potential illicit discharge) shall occur within 7 days on average.

4.5.2 Regulatory Guidance

Illicit discharge detection programs should include the following four components:

- Procedures for locating priority areas likely to have illicit discharges
- Procedures for tracing the source of an illicit discharge
- Procedures for removing the discharge
- Procedures for program evaluation and assessment.

EPA recommends that the program also promotes, publicizes, and facilitates public reporting of illicit connections or discharges and distributes outreach materials.

4.5.3 Mount Vernon Municipal Code

MVMC 13.33.050 (parts B and C) address part (ii) B of MCM requirement #3 as the section prohibits illicit discharges to public drainage control systems, in addition to defining "illicit discharges" and providing a list of common substances considered to be "illicit".

Chapter 13.33.050 (part F) partially addresses part (ii) C of MCM #3, mentioning that an engineer can hire someone to sample and analyze a discharge thought to be illicit. The code however only allows for sampling when an engineer has reason to believe a discharge is illicit.

4.5.4 Mount Vernon Comprehensive Plan

A major comprehensive plan element, within Chapter 6, *Utilities,* supports the requirements of MCM #3. The element includes, "Development of public education programs to increase the understanding and awareness of citizens and business owners about flood control and how their actions can affect water quality and environmental resources".

In addition, Chapter 6 identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality. Objective "d" of this goal reads, "Implement public education programs to reduce the source of pollutants entering surface waters".

4.5.5 City Staff Interviews

Currently, surfacewater staff do not monitor water quality/pollution levels, and have expressed that they don't want to. Ecology has sampled Kulshan Creek in the past for dissolved oxygen and fecal coliform. Mount Vernon currently monitors for illicit discharges to sanitary systems, but not stormwater systems.

4.5.6 Positive Aspects of the City's Current Programs

The City already has its own television station named MVTV, which can be utilized to inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste. The program could display a phone number that people could call if they happened to know of violators or locations where illegal dumping occurs. The City has already signed a contract with SFEG to develop and implement a stormwater education program. SFEG could work with volunteers to detect illicit discharges.

4.5.7 Gaps or Deficiencies Identified

The minimum requirements include completing a storm sewer system map which shows the location of all outfalls and the names and location of all waters of the United States that receive discharge from those outfalls. Since a complete inventory of the storm sewer system in Mount Vernon, still needs to be completed, and because there is not a program for the detection of illicit discharges to storm sewers, the minimum requirements set forth in MCM #3 have not been met.

The code does not currently include provisions for illicit discharge detection and elimination program to be created. The comprehensive plan does not mention the hazards associated with illicit discharges and illegal dumping.

4.5.8 Recommendations for Compliance

To comply with the minimum requirements, Mount Vernon must develop a program to detect non-stormwater discharges and illegal dumping, unless these are not significant contributors of pollutants to their MS4. It is also recommended that the City create and distribute a pamphlet to inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper waste disposal and provide a telephone number they can call to report violators. Chapter six of the Comprehensive Plan should have another Objective added to Goal #2 – Maintain Good Water Quality. The Objective should read, "Implement an illicit discharge detection and elimination program to keep harmful substances from entering surface waters."

4.6 MCM #4 - Construction Site Runoff Control

4.6.1 Minimum Requirements

Develop, implement, and enforce a program to reduce pollutants in any stormwater runoff to the MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. At a minimum your program must include:

(A) An ordinance or other regulatory mechanism to require erosion and sediment controls (ESC), as well as sanctions to ensure compliance to the extent allowable under State, Tribal, or local law.

(B) Requirements for construction site operators to implement appropriate ESC BMPs

(C) Requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality.

(D) Procedures for site plan review which incorporate consideration of potential water impacts

(E) Procedures for receipt and consideration of information submitted by the public

(F) Procedures for site inspection and enforcement of control measures

Tri-County standards prevent the transport of sediment from development sites during and after construction. The standards also require the application of various erosion and sedimentation control BMP's. In addition, projects that add or replace 2,000 square feet or more of impervious surface or clear more than 7,000 square feet must prepare a Construction SWPPP (Stormwater Pollution Prevention Plan).

4.6.2 Regulatory Guidance

EPA encourages municipalities to provide appropriate education and training measures to ensure that construction site operators implement ESC measures correctly. Procedures for site plan review should include the review of individual pre-construction site plans to ensure consistency with local ESC requirements. Procedures for site inspections and enforcement could include steps to identify priority sites based on the nature of the construction activity, topography, characteristics of soils, and receiving water quality. Examples of sanctions to ensure compliance include non-monetary penalties, fines, bonding requirements, and/or permit denials for non-compliance.

4.6.3 Mount Vernon Municipal Code

MVMC13.33.090, lists eleven Large Parcel Minimum Requirements (LPRs) aimed at controlling erosion and sediment movement to protect water quality during construction. LPRs apply to new development that includes the creation or addition of 5,000 square feet, or greater, of new impervious area or any land-disturbing activity of one acre or greater. The language within this section directly relates to MCM #4, part (A).

<u>LPR #1 – Erosion and Sediment Control Plan.</u> Requires developers to create a large parcel stormwater plan showing how a variety of BMPs will be accomplished. This requirement addresses MCM #4, part (B).

<u>LPR #3 – Source Control of Pollution.</u> Requires source control BMPs to be applied to all projects to the maximum extent possible. This requirement addresses MCM #4, part (C).

MVMC 13.33.120, provides the enforcement to make sure ESC measures get implemented properly, by requiring site inspections at various stages of work. It is necessary that the city develops a prioritization plan and supplies sufficient staff to carry out this provision, especially as development increases. This directly relates to MCM #4, part (F).

4.6.4 Mount Vernon Comprehensive Plan

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality, Objective b of this goal reads, "Require adequate erosion and sedimentation controls from new construction sites". Objective "c" reads, "Require adequate water controls for new development. Both objectives support, and are consistent with MCM #4.

4.6.5 City Staff Interviews

Regulations are not adequate to protect aquatic resources because the existing regulations are not properly enforced. The responsibility for, who is supposed to do enforcement, is not clear. Staff is limited, which also makes enforcement and site inspections hard. Mount Vernon has adopted both the DOE and King County manuals for its current drainage coded and ECS code. The ESC code includes provisions for turbidity monitoring, and if it's too high, a letter of non-compliance will be issued. If turbidity levels don't drop, then a stop-work order will be issued. Two stop-work orders were issued in 2002. A few developers cause the majority of Mount Vernon's erosion issues associated with development. It is unclear to the Planning Department how to enforce provisions set forth within the critical areas code which require buffers along streams and wetlands. They expect engineers to do this when in theory, they need to have trained people visiting large parcel construction sites on a regular basis to ensure code compliance.

4.6.6 Positive Aspects of the City's Current Programs

The City's regulations show consistency with the requirements set forth in MCM #4. These regulations act as the cornerstone for Mount Vernon's ability to comply with state and federal regulations. Implementation and enforcement of the code could enhance compliance.

4.6.7 Gaps or Deficiencies Identified

Interviews with City staff reveal that there is a deficiency in the amount of staff available to inspect large parcel sites for adequate ESC measures during construction. In addition, existing regulations are not being enforced because the responsibility for enforcement is not clear, as previously mentioned, staff is limited. There is a lack of good resource inventory maps and materials available to planners to ensure development is not occurring within a critical area. No training for site inspections and monitoring has been provided for the Planning Department. For more information, see MRCI #1 in Section 5.4 of this report.

Language supporting the following minimum requirement of MCM #4 could not be found within the MVMC or Mount Vernon Comprehensive Plan:

(E) Procedures for receipt and consideration of information submitted by the public.

4.6.8 Recommendations for Compliance

For the most part, the language of the code does not need revision, as it supports the requirements set forth in MCM #4. What is needed is the addition of staff members, who can read, understand, and adequately implement and enforce the existing code. If budget is limited, it is recommended that a site inspection prioritization plan be developed, based on the nature of the construction activity, topography, characteristics of soils, and receiving water quality . This would give priority to construction activities thought to pose the greatest risk to water quality, etc.

4.7 MCM #5 - Post-Construction Stormwater Management in New Development and Redevelopment

4.7.1 Minimum Requirements

Develop, implement, and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger plan of development. The program must ensure that controls are in place that would prevent or minimize water quality impacts. At a minimum, the program must:

(A) Develop and implement strategies which include a combination of structural and non-structural BMPs best suited for the community.

(B) Use an ordinance or regulatory mechanism to address post-construction runoff.

(C) Ensure adequate long-term operation and maintenance of BMPs.

Tri-County technical stormwater standards require water quality treatment facilities/BMPs that treat 90% of the annual runoff from new and redeveloped pollution-generating surfaces using the following thresholds:

<u>Threshold 1</u> – All projects that add 5,000 square feet or more of new impervious surface or create 35,000 square feet or more of new cleared area.

<u>Threshold 2</u> – All transportation redevelopment projects, in which new impervious surface is 5,000 square feet or more and equal to 50% or more of the existing impervious surface within the project limits.

<u>Threshold 3</u> – All non-transportation redevelopment projects, in which the total of new plus replaced impervious surface is 5,000 square feet or more, and for which the

valuation of proposed improvements exceeds 50% of the assessed value of the existing site improvements.

Proposed Tri-County inspection/enforcement standards require an inspection schedule/plan for all private flow control and water quality facilities that ensures the inspection of each facility at least once in the first six years after the start date. Furthermore, inspection of all new flow control and water quality treatment facilities in subdivisions is required every six months during the period of heaviest house construction (1-2 years after approval).

4.7.2 Regulatory Guidance

The guidance provided within 40 CFR 122.34(b)(5)iii recommends that the City take a proactive approach towards reducing water quality impacts associated with new development and redevelopment. A good mixture of structural BMPs and non-structural BMPs will lead to the most successful stormwater management program. Non-Structural BMPs are preventative actions that involve management and source controls such as:

- Policies and ordinances that provide requirements and standards to direct growth to identified areas
- Protect sensitive areas such as wetlands and riparian areas
- Maintain and/or increase open space (dedicate a funding source just for acquisition)
- Provide buffers along sensitive water bodies
- Minimization of percent impervious area after development
- Minimize disturbance of soils and vegetation
- Encourage infill development in higher density urban areas with policies or ordinances
- Provide education programs for developers and the public about designs that minimize water quality impacts

For more guidance from the EPA and a list of structural BMPs, see Attachment A.

4.7.3 Mount Vernon Municipal Code

MVMC 17.69, establishes a Planned Unit Development (PUD) district which provides for innovative land use management techniques aimed at proactively dealing with storm water impacts. This non-structural BMP can help to encourage infill while rewarding developers who choose to avoid critical areas. This chapter of the MVMC follows the regulatory guidance provided under MCM #5, and meets the minimum requirement (A).

MVMC 17.119, establishes a Transfer or Purchase of Development Rights (TDRs) program. This is another example of a non-structural BMP that deals with stormwater impacts proactively. This chapter of the MVMC follows the regulatory guidance provided under MCM #5, and meets the minimum requirement (A).

MVMC 13.33.090, requires a permanent stormwater quality control plan (PSQCP) to be completed as part of the submittal requirements set forth in LPR #11. This regulation addresses the minimum requirements set forth in MCM #5, part (B).

MVMC 13.33.090, requires an operation and maintenance schedule for all proposed stormwater facilities and BMPs as part of LPR #10, including identifying the party or parties responsible for maintenance and operation. This regulation meets the minimum requirements set forth under MCM #5, part (C).

4.7.4 Mount Vernon Comprehensive Plan

Chapter 1, *Background Analysis*, discusses various "implications for the plan", which are like goals and objectives, but they are not numbered. One of the implications says, "Development regulations should support retention of natural areas and include design criteria to achieve subdivision and site layouts which will be sensitive to the environmental constraints and optimize open space and views." This is consistent with the regulatory guidance provided under MCM #5, and meets the minimum requirement (A).

Chapter 6, *Utilities,* identifies various objectives to be met in order to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality, Objective "c" reads, "Require adequate water controls for new development". The objective supports, and is consistent with MCM #4.

4.7.5 City Staff Interviews

Ordinances, which support non-structural BMPs, such as the ones mentioned above provide a proactive way to reduce stormwater impacts. According to the interviews, there is a significant lack of knowledge among staff, regarding how to implement the provisions currently set forth in the code. Developers have been allowed to construct projects, in which they negatively impact sensitive areas, such as cutting down trees which are located within a streamside buffer. Developers have not mitigated for adverse impacts to water quality in the past. In an extreme example, Stonebridge developers ended up violating federal regulations and federal and state agencies jumped in to stop the development. This sends a bad message to agencies about Mount Vernon's ability to comply with state and federal regulations. In addition, it has drawn the attention of the agencies to keep a closer watch on the City.

4.7.6 Positive Aspects of the City's Current Programs

The City currently has a variety of good non-structural BMP programs in place, which encourage preservation of critical areas and infill in already developed areas with existing infrastructure. Unfortunately, there is inadequate enforcement to support the regulations.

4.7.7 Gaps or Deficiencies Identified

There is a lack of understanding among staff, regarding how to identify critical areas, and how to review development proposals for compliance with the municipal code. Furthermore, responsibility and a plan for enforcement of BMPs and mitigation measures is unclear between departments, most noticeably planning and engineering. It appears that from interviews, certain staff are unfamiliar with enforcement procedures and requirements set forth in the development code.

While the City's code currently addresses the minimum requirements set forth under MCM #5, the comprehensive plan could include more objectives, goals, and policies directed towards proactive thinking and land use management. The use of non-structural BMPs (mentioned above) should be encouraged and included as a goal of the comprehensive plan.

4.8 MCM #6 - Pollution Prevention/Good Housekeeping for Municipal Operations

4.8.1 Minimum Requirements

Develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. The program must include employee training to prevent and reduce stormwater pollution from activities such as:

- Park and open space maintenance
- Fleet and building maintenance
- New construction and land disturbances
- Stormwater maintenance

Tri-County maintenance standards/programs require local jurisdictions to "Adopt the regulatory authority necessary to enforce adopted maintenance standards and allocate funding for inspection and maintenance of stormwater facilities. The following inspection requirements apply to public/municipal facilities:

- Inspection of all public flow control and water quality facilities annually except where a lesser or greater frequency is appropriate to ensure compliance with standards.
- Inspection of all public flow control and water quality facilities after major storm events.
- Require inspection of all public culverts that have a history of maintenance-related fish passage problems once in spring and once in summer.
- Take appropriate maintenance actions based on the findings of the inspections.

4.8.2 Regulatory Guidance

At a minimum, EPA recommends the following is considered when developing an operation and maintenance program for municipal operations:

- Maintenance activities, schedules, and long-term inspection procedures for structural and nonstructural stormwater controls to reduce floatables and other pollutants discharged from the MS4.
- Controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, maintenance and storage yards, and waste transfer stations.
- Procedures for properly disposing of waste removed from the separate storm sewers and areas listed above (such as dredge spoil, accumulated sediments, floatables, and other debris).

Operation and maintenance programs can reduce the risk of water quality problems when they are developed and implemented properly. This measure is intended to improve the efficiency of these programs, which should be an integral component of all stormwater management programs

4.8.3 Mount Vernon Municipal Code

No language regarding an operation and maintenance program for municipal activities was found within Chapter 13.33, *Drainage Utility* or Chapter 13.34, *Surface Water Utility*.

4.8.4 Mount Vernon Comprehensive Plan

A major comprehensive plan element, within Chapter 6, *Utilities,* is consistent with the requirements of MCM #6. The element includes, "Development of a Maintenance and Operations Plan".

The comprehensive plan goes on to mention that the purpose of a Maintenance and Operations Program is to ensure system reliability, achieve the lowest life-cycle cost for facility replacement, and to use maintenance methods and standards that promote water quality.

4.8.5 City Staff Interviews

An inventory of the drainage system is needed to establish a maintenance schedule so crews can react and update/revise the inventory and data regarding routine maintenance schedules. Jennifer Aylor is waiting for an intern to help out with doing the inventory and to transfer existing data into digital format. The following facilities have not yet been inventoried: pipes, catch basins, roadside ditches, manholes, and curb inlets. Detention ponds and pump stations have already been inventoried. There is a need to identify methods to prevent fish from accessing the closed conduit system. Salmon have been "vactored" up in the past by maintenance staff. Need to identify stormwater discharge locations that currently have no source control or treatment prior to discharge. Present treatment options to meet water quality standards.

4.8.6 Positive Aspects of the City's Current Programs

Existing wastewater utility staff are already aware of improvements that are needed to the operations and maintenance program. In addition, the wastewater utility staff understands what updates need to occur to comply with NPDES Phase II requirements. The City has dramatically reduced the number of annual overflow events by completing an interceptor project and by making improvements to its WWTP. The utility has met Ecology's requirements ahead of schedule.

4.8.7 Gaps or Deficiencies Identified

There is no benchmark/frequency for all maintenance activities. Inventory and mapping of the existing storm sewer system is not complete. Software and survey crews are needed to complete the inventory, to begin tracking service requests, maintenance, and street sweeping schedules.

There is no language within the *Drainage Utility* or *Surface Water Utility* Chapters of the code that mentions an operations and maintenance plan for municipal activities. The Goals at the end of Chapter 6 of the comprehensive plan, could include a statement that a good maintenance and operations program is an objective of Goal #2 – Maintain Good Water Quality.

5.0 Section 4(d) of the Endangered Species Act

5.1 Background

The ESA provides for the protection of endangered and threatened species. Two sections of the ESA directly affect local jurisdictions:

Section 4(d) relates to the listing of species as threatened or endangered. It allows the listing agency to publish rules that define conditions under which "incidental" take is permissible. The National Marine Fisheries Service (NMFS) issued the final 4(d) rules governing the conservation of steelhead and salmonids in the Northwest. To qualify for incidental take protection, municipalities must demonstrate compliance with the 4(d) rule. NMFS 4(d) rule allowing incidental take requires municipalities to conduct program actions and create and issue regulations which will provide for the conservation of threatened species.

Section 9 defines specific actions that are prohibited, which may result in a "take" of endangered species. A "take" could involve harming, harassing, pursuing, hunting, or killing a listed or endangered species. Destruction or changes to habitat (supporting listed and threatened species) is defined as a "harm" under the ESA, and Mount Vernon could be liable. However, the 4(d) rule for Northwest salmonids, has an exemption, for certain governmental activities, if they meet the municipal, commercial, residential, and industrial (MRCI) development standards outlined in the final rules, released in July 2000.

5.2 MRCI Standards /Evaluation Considerations

There are a total of twelve evaluation considerations when NMFS reviews a local jurisdiction's comprehensive plan and development regulations when determining a city's ability to conserve listed species, by protecting and restoring their habitat. These MRCI Standards have been taken directly from the 4(d) rule, and are provided in Attachment B. If NMFS approves Mount Vernon's policies and regulations, the city will be granted an exemption under the MRCI standards to a "take". Mount Vernon would be protected from action from NMFS and would have their support in the event of any third party lawsuits against the jurisdiction for action under the MRCI standards.

Some of the MRCI standards are very similar to the NPDES Phase II Minimum Control Measure Requirements. Therefore, in order to reduce repetition, the analysis will not go into detail regarding the following MRCI Standards:

- MRCI #2 – *Avoid Stormwater Discharge Impacts*, is covered under MCM #5 - Post-Construction Stormwater Management in New Development and Redevelopment
- MRCI #9 - *Prevent Erosion and Sediment Run-off During Construction,* is covered under MCM #4 - Construction Site Runoff Control.

5.3 Organization and Level of Analysis

The following sections analyze each of the twelve evaluation considerations in relation to what was learned through staff interviews and review of Mount Vernon's existing regulations and policies. In order to identify potential gaps, the following had to be looked at and evaluated for each MRCI:

- Regulatory guidance and suggested actions by NMFS
- Sections of the Mount Vernon Municipal Code, relating to the MRCI requirements
- Applicable goals, policies, and objectives of the Mount Vernon Comprehensive Plan
- Information from staff interviews

Table 3 provides an overview of the MRCI standards and the extent of Mount Vernon's existing programs, policies, and practices.

Table 3
Mount Vernon's Regulations and Policies and the NMFS 4(d) MRCI Standards*

MRCI Standard	Current Implementation	Extent of Enforcement	Comprehensive Plan Coverage	Municial Code Coverage
#1) Ensure that Development Avoids Critical Areas	No	Inadequate	Inadequate	Inadequate
#2) Avoid Stormwater Discharge Impacts	Partial	Partial	Partial	Adequate
#3) Protect Riparian Areas	Partial	Inadequate	Inadequate	Inadequate
#4) Avoid Stream Crossings	No	N/A	N/A	Inadequate
#5) Protect Channel Migration Zones	Partial	N/A	N/A	Inadequate
#6) Protect Wetlands and Wetland Functions	No	Inadequate	Inadequate	Inadequate
#7) Preserve Hydrologic Capacities of Streams	Partial	N/A	N/A	Adequate
#8) Include Provisions for Native Vegetation	No	N/A	Inadequate	Inadequate
#9) Prevent Erosion and Sediment Run-off During Construction	Partial	Partial	N/A	Adequate
#10) Ensure Water Supply Diversions Don't Harm Salmon	No	Inadequate	N/A	Inadequate
#11) Enforcement, Funding, and Implementation Mechanisms	Yes	N/A	Adequate	Adequate
#12) Compliance w/ State and Federal Laws/Permits	Partial	Inadequate	Adequate	Adequate

*Preliminary draft

<u>Notes</u>:

Partial = Means that some of the standards have been met, but further actions are needed for compliance.
Adequate = Means that the provisions set forth within the MRCI Development Standards are adequately being enforced and or covered within the City's code or comprehensive plan.
Inadequate = Means that the provisions set forth within the MRCI Development Standards are not adequately being enforced and or covered within the City's code or comprehensive plan.

5.4 MRCI #1 - Ensure that Development Avoids Critical Areas

5.4.1 Regulatory Guidance

Ensuring that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites. Activities such as development, timber harvest, or other soil disturbance should be sited in appropriate areas--avoiding unstable slopes, wetlands, areas already in a proper functioning condition, areas that are more functional than neighboring sites, and areas with the potential to be fully restored.

The Tri-County Proposal fixed regulations option requires the creation of Inner and Outer "Management Zones" along with a separate set of regulations for each. Management Zones (MZs) are just like buffers in the sense that they restrict development on property, which lies immediately adjacent to a defined water body that either provides salmonid habitat or contributes to the proper functioning of salmonid habitat. Tri-County requirements for MZ widths for streams are provided in Section 5.6, which discusses the protection of riparian areas.

5.4.2 Mount Vernon Municipal Code

MVMC Chapter 15.40, *Additional SEPA Guidelines*, consists of a variety of regulations aimed at protecting critical areas such as wetlands, streams, fish and wildlife habitat, and steep hillsides. This chapter would be reviewed when evaluating MCRI Standard #1.

5.4.3 Mount Vernon Comprehensive Plan

Chapter 1, *Background Analysis,* page 1-19 of the comprehensive plan does not identify threatened and endangered species within the City of Mount Vernon.

Chapter 1, *Background Analysis*, also discuses various "implications for the plan", which are like goals and objectives, but they are not numbered. One of the implications says, "Development regulations should support retention of natural areas and include design criteria to achieve subdivision and site layouts which will be sensitive to the environmental constraints and optimize open space and views." This is consistent with the regulatory guidance provided under MRCI #1

Another implication for the plan states that, "Wildlife habitat should be created or enhanced along riparian areas as part of wildlife protection and enhancement". This is consistent and supports MRCI #1.

The following Tri-County MPPs are good examples of comprehensive plan policies that Mount Vernon could adopt, to acknowledge and comply with the listing of Puget Sound Chinook under the ESA. Additional guidance regarding the implementation of each MPP is provided in Attachment C. The following policies address MRCI Standard #1 by providing framework for the creation, implementation, and enforcement of development regulations:

<u>Model Policy No. 2</u>: The city should preserve, protect, and where possible, restore natural habitat critical for the conservation of salmonid species listed under the federal ESA, through the adoption of comprehensive plan policies that seek to protect, maintain

or restore aquatic ecosystems, associated habitats and aquifers through the use of management zones, development regulations, incentives for voluntary efforts of private landowners and developers, land use classifications or designations, habitat acquisition programs or habitat restoration projects.

Model Policy No. 4: All jurisdictions shall work together to identify and protect natural habitat networks that cross jurisdictional boundaries.

Model Policy No. 6: All jurisdictions shall cooperatively work together to create and adopt modifications to their Critical Areas Regulations that include the best available science for the protection of existing habitat, wetlands, estuaries, riparian areas by avoiding negative impacts.

Model Policy No. 7: Upon adoption of a state classification system, the cities and the county shall work together to establish a single system for stream typing.

Model Policy No. 9: All jurisdictions shall establish a monitoring and evaluation method, which is designed to determine the effectiveness of restoration, enhancement, and recovery strategies for listed species.

Model Policy No. 10: All jurisdictions shall recognize that the best available science, to address listed species recovery issues, is evolving. Each jurisdiction shall apply an adaptive management strategy to determine how well the objectives of listed species recovery and critical habitat preservation/restoration are being achieved.

5.4.4 City Staff Interviews

As previously mentioned, a critical areas code exists, but it is hard to locate because it is titled, "Additional SEPA Guidelines". Wetland buffers set forth within the code are inadequate. Wetlands types are not classified or considered when impacts are mitigated. Enforcement through site visits is lacking.

5.4.5 Positive Aspects of the City's Current Programs

The City has a stream and wetlands inventory that shows the presence or absence of fish in streams. The "Shannon and Wilson" report is a reconnaissance level report, which includes maps of streams and wetlands in Mount Vernon.

5.4.6 Gaps or Deficiencies Identified

There may be a lack of understanding regarding how to identify critical areas, and how to review development proposals for compliance with the critical areas code. Furthermore, responsibility and a plan for enforcement appears unclear between departments. There were two "stop work" orders issued to developers in 2002, who failed to comply with the MVMC, resulting in state and federal agency involvement.

The current code, "Additional SEPA Guidelines" should be renamed "Critical Areas Ordinances" so it will be easier to find/stand out.

The City doesn't have geologic hazards (steep hillsides) critical areas mapped out as critical areas to avoid.

The Planning Department should revise the way they average buffer widths.

The City currently has a wetland setback/buffer that is a standard 25 feet. There are no increases in wetland buffer width depending on the rating or overall function of a wetland. Furthermore there are no compensatory requirements or replacement ratios provided for impacts to or filling of wetlands.

The comprehensive plan does not have an "environmental" chapter/element with specific goals and policies for salmon protection. It is recommended that the City adopt comprehensive policies and goals similar to the Tri-County MPPs mentioned above.

5.5 MRCI #2 - Avoid Stormwater Discharge Impacts

5.5.1 Regulatory Guidance

Adequately preventing stormwater discharge impacts on water quality and quantity and stream flow patterns in the watershed--including peak and base flows in perennial streams. Stormwater management programs must require development activities to avoid impairing water quality and quantity.

This evaluation consideration is identical to the NPDES Phase II minimum control measure #5, which requires the development, implementation, and enforcement of a stormwater runoff program. See page 10 for a complete analysis.

5.6 MRCI #3 - Protect Riparian Areas

5.6.1 Regulatory Guidance

Protecting riparian areas well enough to attain or maintain Properly Functioning Conditions (PFC) around all rivers, estuaries, streams, lakes, deepwater habitats, and intermittent streams. Compensatory mitigation shall be provided, where necessary to offset unavoidable damage to PFC in riparian management areas. Activities should be quite limited in areas adjacent to all perennial and intermittent streams and waters supporting listed salmon and steelhead in order to avoid soil disturbance and maintain vegetated riparian corridors.

As previously mentioned the Tri-County Proposal Fixed Regulations Option requires the creation of Inner and Outer "Management Zones", along with a set of restrictions for each zone. Management Zones (MZs) are basically stream buffers, which aim to protect salmonid habitat, or areas that contribute to the proper functioning of salmonid habitat. The minimum prescribed widths of MZs are determined by water types, as established by the Washington *Forest and Fish Report*. This method of classification is "habitat-driven" instead of designating streams according to geomorphic parameters. The following MZ widths are recommended for the adequate protection of threatened salmonids:

Water Type S: 200 feet

Water Type F: 200 feet

Water Type F – Steep Ravine: 100 feet or 25 feet from the top of the bank

Water Type N – Within a ¼ mile upstream of a Type S or F stream: 115 feet

Water Type N – More than ¼ mile upstream of a Type S or F stream: 65 feet

5.6.2 Mount Vernon Municipal Code

MVMC 15.40.010, *Purpose,* includes goals which are applicable/address MRCI Standard #3:

C. Preserve and protect environmentally sensitive areas by regulating development within and adjacent to them.

E. Prevent adverse cumulative impacts to the water quality, wetlands, streams, stream corridors, and fish and wildlife habitat.

MVMC 15.40.080, *Buffers and Setbacks,* mentions that a 10-foot building setback from the edge of all critical area buffers may be required to prevent encroachment into the buffer.

The section of the code should be revised to say that a 10-foot setback is required.

In addition, this section needs to refer back to MVMC 15.40.050, *Regulated and Allowed Activities*, because that section mentions what activities are allowed and what activities are prohibited in buffers.

MVMC 15.40.050.C, *Wetland and Buffer Alteration*, starts off by mentioning that, "Wetlands and associated buffers may be altered provided that..."

This language could be changed to say, "Alterations to wetlands and buffers is

MVMC 15.40.120, *Stream Buffer Requirements,* provides stream ratings, which place streams into three different categories pursuant to WAC 222-16-030, Forest Practice Regulations.

MVMC 15.40.120 provides stream buffer requirements for minimum buffer widths:

Category I – Determined by the Skagit County Shoreline Master Program

Category II – 100 total width centered on the stream (i.e., 50 feet on each side of the centerline of the stream)

Category III – 50 total width centered on the stream (i.e., 25 feet on each side of the centerline of the stream)

MVMC 15.40.130, *Stream Preservation/Alternatives and Mitigation*, addresses stream mitigation, but fails to mention mitigation requirements for Category II and III streams. It mentions that "All Category I streams shall be preserved in accordance with the Shoreline Management Master Program". The previous sentence should mention the actual name of the shoreline program (i.e. Skagit County Shoreline Master Plan).

MVMC 15.40.140, *Fish and Wildlife Habitat Conservation Areas,* mentions that certain areas within the City shall be named Priority Habitat. In order for an area to be classified as priority habitat, it must meet one of the following:

1. Presence of a species federally or state listed or proposed for listing as threatened, endangered, sensitive, or as priority species, or outstanding potential habitat for those species.
2. Areas contiguous with large blocks of habitat extending outside the city limits and providing a travel corridor to a significant resource.
3. Areas adjacent to or contiguous with wetlands and streams which enhance the value of those areas for fish and wildlife.

If a development is proposed within or adjacent to a priority habitat area, the applicant shall provide a wildlife habitat assessment prepared by a professional.

The existing code only mentions that the habitat assessment shall include recommendations for protection of the identified habitat areas and species of concern. It is recommended that the code include more stipulations for the assessment.

The Tri-County Proposal provides a habitat evaluation outline, which requires the developer to look at habitat goals and objectives, inherent site potential, and conservation measures to mitigate for impacts.

5.6.3 Mount Vernon Comprehensive Plan

Chapter 1, *Background Analysis,* page 1-11 of the comprehensive plan mentions that the City of Mount Vernon's current development and future growth are controlled largely by it's existing physical features:

"The Skagit River defines the edge of the City to the north and west, except adjacent to downtown. A number of streams, some salmon bearing, provide natural corridors which should be protected from development by adequate buffers".

This is consistent with MRCI Standard #3, protect riparian areas.

Chapter 1, *Background Analysis*, page 1-22, also discuses various "implications for the plan", which are like goals and objectives, but they are not numbered. One of the implications says, "Wildlife habitat should be created or enhanced along riparian areas as part of wildlife protection and enhancement". This goal or policy is consistent with MRCI #3.

Page 1-18 of the plan, *Riparian Habitat,* also mentions that riparian habitat along streams usually supports diverse and productive wildlife communities.

5.6.4 City Staff Interviews

It is currently unclear who is responsible for enforcing the City's Critical Area Ordinances each time a project comes up for review. The City has a Problem Enforcement Team (PET) that comprises policy, fire, public works and planning staff. The Kulshan Ridge development was approved, and then a "stop work" order had to be issued because the developer did not obey stream buffer ordinances. Construction staging inspections and buffer inspections are lacking due to staffing issues. The way that the planning department averages buffers should be clarified and strengthened.

5.6.5 Positive Aspects of the City's Current Programs

The current comprehensive plan supports the protection and enhancement of riparian areas. The city already has a transfer of development rights program and other density credit programs in place to protect sensitive areas such as riparian corridors.

5.6.6 Gaps or Deficiencies Identified

The EPA mentions that streamside activities, carried out within a distance equal to the height of the tallest tree that can grow on that site (site potential tree height), can significantly affect essential habitat functions. This science-based method allows stream buffers to vary, depending on the type of habitat the stream supports.

Based on a comparison the existing Mount Vernon requirements for riparian/stream buffer widths and the requirements set forth within the Tri-County Proposal, it appears that the required widths of stream buffers may not be wide enough for Category II and III streams.

Staff lacks knowledge of how to apply the current "Shannon and Wilson Report" or utilize it when reviewing a project proposal. The planning department does not do many site visits/inspections to make sure trees are not getting cut down or that riparian areas/buffers are being preserved. Mount Vernons' Municipal Code should have more strict enforcement; it should be clarified who is responsible for enforcing which provisions.

Induce more penalties for developers who have deliberately and repeatedly broken sensitive area ordinances.

5.7 MRCI #4 - Avoid Stream Crossings

5.7.1 Regulatory Guidance

Avoiding stream crossings--whether by roads, utilities, or other linear development--wherever possible and, where crossings must be provided, minimize impacts. One method of minimizing stream crossings and their associated disturbances is to optimize transit opportunities to and within newly developing urban areas.

Where a crossing is unavoidable, the plan or ordinance should minimize its affect by preferring bridges over culverts; sizing bridges to a minimum width; designing bridges and culverts to pass at least the 100-year flood (and associated debris).

5.7.2 Mount Vernon Municipal Code

MVMC 15.40.130.B.2 address road stream crossings and states, "Culverting within a stream shall only be permitted to provide access to a lot when no other feasible means of access exists. Use of common access points shall be required for abutting lots which have no other feasible means of access. Culverting shall be limited to the minimum number of stream crossing required to permit reasonable access.

This section should mention that where crossings are unavoidable, bridges are preferred over culverts, and widths should be minimized. It should apply to City streets in addition to private roads or driveways.

MVMC 13.33.90.D.1, part i, *Underground Utility Construction,* includes guidance for developers regarding the construction of underground utilities. A section (4) should be added which urges the avoidance of stream crossing wherever possible, and if a utility must cross a stream, than underground boring is preferred over open trench construction.

5.7.3 Mount Vernon Comprehensive Plan

Polices, goals, and objectives within comprehensive plans are generally to broad to apply to MRCI Standard #4, Avoiding Stream Crossings.

5.7.4 Gaps or Deficiencies Identified

It is clear in the municipal code that new stream crossings are not recommended and should be avoided. Development standards should be more specific, and mention that stream crossings, if absolutely necessary, should be bridges, not culverts, and widths should be minimized. Also, the code should mention that installing cable underground should avoid stream crossings if at all possible. The code should encourage utilization of existing utility crossing corridors where streams or riparian buffers are present, and must be crossed.

5.8 MRCI #5 - Protect Channel Migration Zones

5.8.1 Regulatory Guidance

Adequately protecting historic stream meander patterns and channel migration zones (CMZs) and avoiding hardening of stream banks and shorelines. Any MRCI development should be designed to allow streams to meander in historic patterns of channel migration. Activities on the landscape must protect conditions that allow gradual bank erosion, flooding, and channel meandering in the zone within which it would naturally occur. This natural channel migration promotes gravel recruitment, geomorphic diversity, and habitat development.

If unusual circumstances require bank erosion to be controlled, it should be accomplished through vegetation or carefully bioengineered solutions. Rip-rap blankets or similar hardening techniques would not be allowed, unless particular site constraints made bioengineered solutions impossible.

"Management Zones", as prescribed within the Tri-County Proposal Fixed Regulations Option, seek to protect meander patterns and historic flow patterns of streams by encompassing CMZs and their associated wetlands. The Tri-County Proposal requires jurisdictions to conduct a jurisdiction-wide study, to set initial CMZ boundaries for all stream reaches where stream power, soil conditions, and valley-floor widths are sufficient enough to cause channel migration.

5.8.2 Mount Vernon Municipal Code

MVMC Chapter 15.36, *Floodplain Management Standards*, is the most applicable section of the code in regard to MRCI #5.

MVMC 15.36.020, *Methods of Reducing Flood Losses,* includes methods and provisions for reducing flood losses:

C. Controlling the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters.

"Channel Migration Zones" should be added to this provision.

MVMC Chapter 15.36 should have a special section that discuses the protection of historic stream meander patterns and channel migration zones. A section adequately addressing the regulatory guidance set forth in MRCI #5 could not be found.

MVMC 15.36.030, *Definitions.* A definition for "Channel Migration Zones" should be added.

MVMC 15.40.010, includes one goals which is applicable and addresses MRCI Standard #5:

F. Protect the public and public resources and facilities from injury, loss of life, property damage, or financial losses due to flooding, erosion, land uses, soil subsidence or steep slopes failure.

MVMC 15.40.130, *Stream Preservation/Alternations and Mitigation,* should include a section that provides for the protection of historic stream meander patterns and channel migration zones. It should require that development, near streams, must allow for gradual bank erosion, flooding, and channel meandering in the zone where it would normally occur.

5.8.3 Mount Vernon Comprehensive Plan

The comprehensive plan mentions that a surface water management program will aid in preventing future flooding as a result of new development. It doesn't mention any specifics regarding the protection of channel migration zones and meander patterns. This is too specific for a comprehensive plan.

5.8.4 Gaps or Deficiencies Identified

The code does not discuss and define "channel migration zones". The planning department may not review maps showing channel migration areas and historic stream flow patterns when signing off on a development proposal.

5.9 MRCI #6 - Protect Wetlands and Wetland Functions

5.9.1 Regulatory Guidance

Adequately protecting wetlands, wetland buffers, and wetland function--including isolated wetlands. Activities on the landscape must protect wetlands and the vegetation surrounding them to avoid disturbing soils, vegetation, and local hydrology. Such conditions on the landscape contribute to the natural succession of wetlands and protect wetland functions needed to meet salmonid habitat requirements such as food chain support, shoreline protection, water purification, storm and flood water storage, and groundwater recharge. These conditions are also needed to protect the freshwater, marine, and estuarine wetland systems that provide vital habitat for rearing and migrating salmon and steelhead.

5.9.2 Mount Vernon Municipal Code

MVMC 15.40.010, includes goals which are applicable/address MRCI Standard #6:

C. Preserve and protect environmentally sensitive areas by regulating development within and adjacent to them.

E. Prevent adverse cumulative impacts to the water quality, wetlands, streams, stream corridors, and fish and wildlife habitat.

MVMC 15.40.050 discusses activities that are regulated and allowed (with a permit) within environmentally sensitive areas, such as wetlands.

D. Compensatory Mitigation. As a condition of any permit allowing alteration of wetlands and associated buffers the applicant may propose to restore, create, or enhance wetlands and their associated buffers.

This provision is inadequate because it says developers "may" propose not "will". This section should include more guidance for developers such as off-site and out-of-kind opportunities such as a wetland mitigation-banking program or financial contributions to an established water quality program.

E. Mitigation Plan. The city shall approve a mitigation plan before issuing any permits for development activity on a lot upon which a wetland alteration, restoration, creation, or enhancement is proposed.

This provision is inadequate because it fails to include "wetland buffers" as areas that require a mitigation plan if they are impacted.

In addition, the mitigation section provides no ratios or standards for the amount of wetland creation/replacement that would need to occur when a developer fills wetlands.

MVMC 15.40.080, *Buffers and Setbacks*, includes a provision under section (C) Fencing and Signage, that requires, "a split rail fence to be installed along the boundaries of all critical area buffers and, in a prominent location, one wetland/stream sign shall be posted per lot, or every 150 feet of buffer." This provision supports MRCI #6.

MVMC 15.40.090, *Wetland Delineation*, mentions that "wetlands shall be identified and delineated in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual".

MVMC 15.40.100, *Wetland Buffers*, requires a buffer zone of 25 feet for all regulated activities adjacent to regulated wetlands. According to the Tri-County Proposal, this buffer width requirement is not adequate to protect wetland functions, and therefore does not address or meet MRCI Standard #6. The Tri-County standards require a minimum buffer of 100 feet around wetlands.

5.9.3 Mount Vernon Comprehensive Plan

Environmentally Sensitive Areas, Page 1-13 of the comprehensive plan addresses the need and objective of a wetland inventory:

"The objective of a wetland inventory is to assist the city with identifying the approximate location and extent of wetlands within the existing City limits and proposed urban growth area."

The section goes on to mention that the accuracy of the current wetland inventory is limited by a number of factors (i.e. age of photographs reviewed, limited time spent in the field verifying, etc.). In addition, it mentions that it is possible that additional wetlands are present, that were not located during the inventory.

Fish and Wildlife Priority Habitat and Species, Page 1-18 of the comprehensive plan briefly mentions that wetlands are an important type of wildlife habitat, but it does not make the link that wetlands act as filters and detention areas for run off, and that protecting wetlands will significantly improve water quality. There is no mention of threatened salmon, and how wetland protection will play a role in their recovery.

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality, but there is no objective that relates to the preservation of wetlands and their associated buffers.

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 3 is to preserve sensitive resources and maintain varied use. Objective "b" of this goal reads, "Preserve wetlands and implement a wetlands management strategy." This objective supports, and is consistent with MCM #6.

5.9.4 City Staff Interviews

Mount Vernon does have a stream and wetlands inventory that shows the presence or absence of fish in streams. Referred to as the, "Shannon and Wilson Report," this report is a reconnaissance level report, which includes maps of streams and wetlands in Mount Vernon. It appears that the planning department does not look at this report when reviewing a project proposal._A hot issue is the City's wetland setback buffer that is a standard 25 feet. Interviews with staff suggested that this was not adequate and that it is not based on the function of a wetland. Certain tribes tell the City that the setbacks are not adequate, and that they should be equal or greater to the setbacks required by Skagit County.

5.9.5 Gaps or Deficiencies Identified

The Mount Vernon Municipal Code has one standard buffer width for wetland protection, regardless of the type and/or function of the wetland. The standard buffer width of 25 feet is inadequate and does not comply with state and federal regulations and requirements. There is no wetland overlay/map layer to show the location of all the regulated wetlands within the City. Language within the code prohibiting impacts to wetlands is weak and is not adequate for the protection of wetlands and wetland buffers. The comprehensive plan should include more goals, policies, and objectives that address how important wetland protection is, especially when it comes to water quality and salmon recovery.

5.10 MRCI #7 - Preserve Hydrologic Capacities of Streams

5.10.1 Regulatory Guidance

Adequately preserving a permanent and intermittent streams' ability to pass peak flows. Activities that decrease a stream's hydrologic capacity by filling in its channel for road crossings or other development will increase water velocities, flood potential, and channel erosion, as well as degrade water quality, disturb soils and groundwater flows, and harm vegetation adjacent to the stream.

Minimum Tri-County flow control standards for new impervious surfaces/cleared areas include matching discharge durations ranging from 50% of the 2-year rate to 100% of the 50-year rate for the site condition that existed prior to any development in the region. For existing and incremental new impervious surfaces/ cleared areas require site-specific flow control facilities to mitigate for runoff from these surfaces in accordance with specific thresholds and design information specified within the Tri-County Proposal.

5.10.2 Mount Vernon Municipal Code

MVMC 13.33.90.D.2, *LPR #2 - Preservation of Natural Drainage Systems,* requires that natural drainage patterns shall be maintained in conformance with general design and construction standards. It goes on to mention that surface water entering the subject property shall be received at the naturally occurring locations and surface water exiting the subject property shall be discharged into the naturally occurring drainage basin.

MVMC 13.33.90.D.8, *LPR #8 - Off-Site Analysis and Mitigation,* requires all large parcel development projects to conduct a downstream analysis of water quality and quantity impacts resulting from the project. MRCI Standard #7 requires the following impacts to be evaluated and mitigated:

b. Stream bank and stream bed erosion

f. Inadequate storm water conveyance capacities

g. Excessive stormwater velocities

MVMC 13.33.190.A, also addresses MRCI #7, "Development which would increase the volume or rate of discharge due to any storm from the subject property shall not be permitted in areas designated by the engineer.

5.10.3 Mount Vernon Comprehensive Plan

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 1 is to prevent property damage from flooding. Objective b of this goal reads, "Require adequate peak flow controls for new development". This objective supports, and is consistent with MCM #7.

5.10.4 City Staff Interviews

The engineering director felt that infiltration would be a good thing to work into the development code. Water quality credits for developers who implement rain gardens, vegetated roofs, or place houses on pins to allow for greater infiltration may improve water quality and preserve hydrologic capabilities of streams. However, infiltration does not work well everywhere. The City could develop a map of potential sites where infiltration would work well, and then these would be the only areas where developers could receive water quality credits.

5.10.5 Gaps or Deficiencies Identified

Adequate regulations in the MVMC appear to be in place to comply with these requirements. The City should require continuous simulation modeling for sizing new facilities. Cumulative impacts and imperfect enforcement should be addressed and a method of compensation should be developed through the CSMP update process. A gap may exist when it comes to reviewing drainage plans for development proposals. Additional staff may be required to adequately enforce the existing municipal code, in regard to downstream drainage concerns and preservation of hydrologic stream capacities.

5.11 MRCI #8 - Include Provisions for Native Vegetation

5.11.1 Regulatory Guidance

Providing adequate provisions for landscaping with native vegetation to reduce the need to water and apply herbicides, pesticides, and fertilizer. Plans must describe the techniques that local govemments will use to encourage planting with native vegetation, reducing lawn area, and lowering water use. These provisions will maintain essential habitat processes by helping conserve water and reduce flow demands that compete with fish needs. They will also reduce the amount of chemicals contributing to water pollution.

One of the minimum technical standards that the Tri-County Proposal sets forth, requires rural single-family residential developments to use runoff dispersion techniques. Dispersion BMPs, wherever possible, shall minimize effective impervious surface to less than 10% of the development site or be used for "fully dispersing" runoff from impervious surfaces and cleared areas of development sites that protect at least 65% of the site in a forest or native condition. This is known as the "65/10 Standard".

5.11.2 Mount Vernon Municipal Code

MVMC 13.33.090, requires a permanent stormwater quality control plan (PSQCP) to be completed as part of the submittal requirements set forth in LPR #11. The PSQCP is required to show the existing and proposed vegetative cover, soil types including trees, shrubs, and grasses shall be depicted on a map of the site. Measures for controlling runoff after construction are required in accordance with the Ecology and King County Manuals, but there is no mention of required vegetation to be planted.

MVMC Title 16, *Subdivisions*, fails to include any sections relating to a vegetation management plan, or retention of significant trees. Chapter 16.16, *Design Standards*, mentions nothing about tree retention or minimum vegetation requirements.

MVMC 16.32.032, *Design of short plats – Standards,* mentions nothing in regard to native vegetation requirements or tree retention.

5.11.3 Mount Vernon Comprehensive Plan

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 2 is to maintain good water quality. Objective "d" of this goal reads, "Implement public education programs to reduce the source of pollutants entering surface waters." This objective supports the regulatory guidance provided above, and is therefore consistent with MCM #6.

5.11.4 City Staff Interviews

Interviews revealed that the average Mount Vernon resident is unaware of things they can do to reduce impacts to stormwater runoff. Residents tend to be conservative in nature, and may be unaware of the importance of planting native vegetation to help reduce runoff.

5.11.5 Gaps or Deficiencies Identified

The current development code for subdivision development has no regulations for a vegetation plan or minimum standards for tree retention. The municipal code is inadequate in regard to MRCI Standard #8.

Plans must describe the techniques that local governments will use to encourage planting with native vegetation, reducing lawn area, and lowering water use. It appears that this element is lacking from the current surface water program in Mount Vernon.

The stormwater education program should focus more on educating homeowners (living adjacent to critical streams/buffers) about specific alternatives to using harmful pesticides and fertilizers and changing the type of plants they have in their back yard. Interactive displays or workshops may be necessary to fully engage the public.

More programs should be developed that are aimed at teaching developers and businesses new ways of reducing runoff and ways to limit impacts to water quality.

5.12 MRCI #9 - Prevent Erosion and Sediment Run-off During Construction

5.12.1 Regulatory Guidance

Preventing erosion and sediment run-off during (and after) construction, which thus prevents sediment and pollutant discharge to streams, wetlands, and other water bodies that support listed salmonids. These provisions, at a minimum, should include detaining flows, stabilizing soils, protecting slopes, stabilizing channels and outlets, protecting drain inlets, maintaining Best Management Practices (BMPs), and controlling pollutants.

This evaluation consideration is identical to the NPDES Phase II minimum control measure #4, which requires jurisdictions to develop, implement, and enforce a program to reduce pollutants in any stormwater runoff to the MS4 from construction activities. See page 8 for a complete analysis.

5.13 MRCI #10 - Ensure Water Supply Diversions Don't Harm Salmon

The City of Mount Vernon currently contracts with the Skagit PUD to provide drinking water. MRCI Standard #10 applies to the PUD and not the Mount Vernon Surface Water Division. Therefore, an analysis of this standard is not included in the scope of this report.

5.13.1 Regulatory Guidance

Ensuring that water supply demands can be met without affecting–either directly or through groundwater withdrawals--the flows that threatened salmonids need. A plan must ensure that any new water diversions are positioned and screened in a way that prevents salmonid injury or death.

5.13.2 Mount Vernon Municipal Code

Not covered within the existing municipal code

5.13.3 Mount Vernon Comprehensive Plan

Not covered within the existing comprehensive plan.

5.13.4 City Staff Interviews

Not discussed during interviews.

5.13.5 Gaps or Deficiencies Identified

The existing municipal code is lacking regulations that protect threatened salmon from new water diversions and diversion facilities. The comprehensive plan fails to include a policy or objective that mentions the importance of water conservation and salmon protection.

5.14 MRCI #11 – Enforcement, Funding, and Implementation Mechanisms

5.14.1 Regulatory Guidance

Providing mechanisms for monitoring, enforcing, funding, reporting, and implementing a program. Formal plan evaluations should take place at least once every five years. The plan should make a commitment to (and assign responsibility for) regular monitoring and maintenance activities for any detention basins, erosion and sediment control measures, and other management tools over the long term.

Practices should be adapted, as needed, based on monitoring results. In addition, to ensure that development activities comply with the ordinance or plan and that PFC is attained or maintained, commitments must be made for regular funding, enforcement, reporting, implementation, and plan evaluations.

A proposed Tri-County standard, regarding inspection/enforcement, requires the establishment of policies and procedures along with staff training/certification, to ensure that the following activities are carried out:

- Review all stormwater design plans required to be submitted for proposed development activities.
- Inspect all development sites that are hydraulically near a sediment/erosion sensitive site prior to clearing and construction.
- Inspect all development sites during construction to ensure proper installation and maintenance of erosion and sediment controls.
- Inspect all development sites upon completion of construction and prior to final approval/occupancy to ensure proper installation of permanent erosion controls and stormwater facilities/BMP's.
- Investigate reported water quantity/quality problems and potential violations within 7 days on average.

5.14.2 Mount Vernon Municipal Code

The code includes many sections that provide language for enforcement of regulations:

MVMC

5.14.3 Mount Vernon Comprehensive Plan

The following comprehensive plan element, located on page 6-6 of the *Utilities* section, is consistent with MRCI #11:

"Development of a financial strategy and funding mechanism to support the recommended surface water management program"

The comprehensive plan recommends a comprehensive stromwater management program that relies on a combination of the following, to protect surface water resources:

- Education
- Regulations
- Operation and Maintenance
- Capitol Projects

For this to be consistent with the MRCI Standards, "Public Input" should be added to this list.

Chapter 6, *Utilities,* identifies various objectives to be met to accomplish the goals set forth in the water management program. Goal 4 is to develop a continuous and comprehensive program for managing surface water. Objective a of this goal reads, "Ensure a funding source for program implementation" This objective is directly consistent with MCM #11.

5.14.4 City Staff Interviews

As previously mentioned, interviews with staff members has revealed that certain regulations are unknown to some city staff. Without having a good knowledge of where regulations/ordinances exist and what they mean, enforcement will be difficult.

Implementation will require additional revenues. Unfortunately, residential property rates in Mount Vernon are currently high. City staff are worried about discouraging new residents and commercial development because property taxes are high. Enforcement of environmental regulations may further discourage new development. Burlington (which lies just to the north) has a large amount of commercial development because it has no salmon bearing streams and development regulations are less strict. Mount Vernon may continue to lose commercial businesses to Burlington. There is a perception among developers that Mount Vernon already has strict development regulations.

5.14.5 Gaps or Deficiencies Identified

Enforcement, enforcement, enforcement...Also, a financial plan for program implementation should be developed with as much public knowledge and input as possible. More training is needed for the staff to adequately implement provisions set forth with the MVMC.

5.15 MRCI #12 - Compliance with State and Federal Laws and Permits

5.15.1 Regulatory Guidance

Complying with all other state and Federal environmental and natural resource laws and permits.

This standard, unlike the others, is too broad to be applied to individual regulations, policies, and programs identified within the City code and Comprehensive Plan. However, this gap analysis report will help Mount Vernon significantly, to identify the areas where they are lacking policies or regulations, which are needed for them to comply with State and Federal regulations

ATTACHMENT A

NPDES Phase II Minimum Control Measure Requirements and Regulatory Guidance

(Source: 40 CFR 122.34(b))

(1) Public Education and Outreach on Stormwater Impacts

Minimum Requirements – *40 CFR 122.34(b)(1)(i)*
You must implement a public education program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water runoff.

Regulatory Guidance – *40 CFR 122.34(b)(1)(ii)*
You may use storm water educational materials provided by your State, Tribe, EPA, environmental, public interest or trade organizations, or other MS4s. The public education program should inform individuals and households about the steps they can take to reduce storm water pollution, such as ensuring proper septic system maintenance, ensuring the proper use and disposal of landscape and garden chemicals including fertilizers and pesticides, protecting and restoring riparian vegetation, and properly disposing of used motor oil or household hazardous wastes. EPA recommends that the program inform individuals and groups how to become involved in local stream and beach restoration activities as well as activities that are coordinated by youth service and conservation corps or other citizen groups. EPA recommends that the public education program be tailored, using a mix of locally appropriate strategies, to target specific audiences and communities. Examples of strategies include distributing brochures or fact sheets, sponsoring speaking engagements before community groups, providing public service announcements, implementing educational programs targeted at school age children, and conducting community-based projects such as storm drain stenciling, and watershed and beach cleanups. In addition, EPA recommends that some of the materials or outreach programs be directed toward targeted groups of commercial, industrial, and institutional entities likely to have significant storm water impacts. For example, providing information to restaurants on the impact of grease clogging storm drains and to garages on the impact of oil discharges. You are encouraged to tailor your outreach program to address the viewpoints and concerns of all communities, particularly minority and disadvantaged communities, as well as any special concerns relating to children.

(2) Public Involvement/Participation

Minimum Requirements – *40 CFR 122.34(b)(2)(i)*
You must, at a minimum, comply with State, Tribal and local public notice requirements when implementing a public involvement/ participation program.

Regulatory Guidance – *40 CFR 122.34(b)(2)(ii)*

EPA recommends that the public be included in developing, implementing, and reviewing your storm water management program and that the public participation process should make efforts to reach out and engage all economic and ethnic groups. Opportunities for members of the public to participate in program development and implementation include serving as citizen representatives on a local storm water management panel, attending public hearings, working as citizen volunteers to educate other individuals about the program, assisting in program coordination with other pre-existing programs, or participating in volunteer monitoring efforts. (Citizens should obtain approval where necessary for lawful access to monitoring sites.)

(3) Illicit Discharge Detection and Elimination

Minimum Requirements – *40 CFR 122.34(b)(3)(i-iii)*
(i) You must develop, implement and enforce a program to detect and eliminate illicit discharges (as defined at § 122.26(b)(2)) into your small MS4.

(ii) You must:

> (A) Develop, if not already completed, a storm sewer system map, showing the location of all outfalls and the names and location of all waters of the United States that receive discharges from those outfalls;
> (B) To the extent allowable under State, Tribal or local law, effectively prohibit, through ordinance, or other regulatory mechanism, non-storm water discharges into your storm sewer system and implement appropriate enforcement procedures and actions;
> (C) Develop and implement a plan to detect and address non-storm water discharges, including illegal dumping, to your system; and
> (D) Inform public employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste.

(iii) You need address the following categories of non-storm water discharges or flows (i.e., illicit discharges) only if you identify them as significant contributors of pollutants to your small MS4: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)), uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water (discharges or flows from fire fighting activities are excluded from the effective prohibition against non-storm water and need only be addressed where they are identified as significant sources of pollutants to waters of the United States).

Regulatory Guidance – *40 CFR 122.34(b)(3)(iv)*
EPA recommends that the plan to detect and address illicit discharges include the following four components: procedures for locating priority areas likely to have illicit discharges; procedures for tracing the source of an illicit discharge; procedures for removing the source of the discharge; and procedures for program evaluation and assessment. EPA recommends visually screening outfalls during dry weather and

conducting field tests of selected pollutants as part of the procedures for locating priority areas. Illicit discharge education actions may include storm drain stenciling, a program to promote, publicize, and facilitate public reporting of illicit connections or discharges, and distribution of outreach materials.

(4) Construction Site Stormwater Runoff Control

Minimum Requirements – *40 CFR 122.34(b)(4)(i)*
You must develop, implement, and enforce a program to reduce pollutants in any storm water runoff to your small MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. Reduction of storm water discharges from construction activity disturbing less than one acre must be included in your program if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more. If the NPDES permitting authority waives requirements for storm water discharges associated with small construction activity in accordance with § 122.26(b)(15)(i), you are not required to develop, implement, and/or enforce a program to reduce pollutant discharges from such sites.

(ii) Your program must include the development and implementation of, at a minimum:

(A) An ordinance or other regulatory mechanism to require erosion and sediment controls, as well as sanctions to ensure compliance, to the extent allowable under State, Tribal, or local law;
(B) Requirements for construction site operators to implement appropriate erosion and sediment control best management practices;
(C) Requirements for construction site operators to control waste such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality;
(D) Procedures for site plan review which incorporate consideration of potential water quality impacts;
(E) Procedures for receipt and consideration of information submitted by the public, and
(F) Procedures for site inspection and enforcement of control measures.

Regulatory Guidance – *40 CFR 122.34(b)(4)(iii)*
Examples of sanctions to ensure compliance include non-monetary penalties, fines, bonding requirements and/or permit denials for non-compliance. EPA recommends that procedures for site plan review include the review of individual pre-construction site plans to ensure consistency with local sediment and erosion control requirements. Procedures for site inspections and enforcement of control measures could include steps to identify priority sites for inspection and enforcement based on the nature of the construction activity, topography, and the characteristics of soils and receiving water quality. You are encouraged to provide appropriate educational and training measures for construction site operators. You may wish to require a storm water pollution prevention plan for construction sites within your jurisdiction that discharge into your system. See § 122.44(s) (NPDES permitting authorities' option to incorporate qualifying State, Tribal and local erosion and sediment control programs into NPDES permits for storm water

discharges from construction sites). Also see § 122.35(b) (The NPDES permitting authority may recognize that another government entity, including the permitting authority, may be responsible for implementing one or more of the minimum measures on your behalf.)

(5) Post-Construction Stormwater Management in New Development and Redevelopment

Minimum Requirements – *40 CFR 122.34(b)(5)(i)*
You must develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into your small MS4. Your program must ensure that controls are in place that would prevent or minimize water quality impacts.

(ii) You must:

(A) Develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs) appropriate for your community;
(B) Use an ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects to the extent allowable under State, Tribal or local law; and
(C) Ensure adequate long-term operation and maintenance of BMPs.

Regulatory Guidance – *40 CFR 122.34(b)(5)(iii)*
If water quality impacts are considered from the beginning stages of a project, new development and potentially redevelopment provide more opportunities for water quality protection. EPA recommends that the BMPs chosen: be appropriate for the local community; minimize water quality impacts; and attempt to maintain pre-development runoff conditions. In choosing appropriate BMPs, EPA encourages you to participate in locally-based watershed planning efforts which attempt to involve a diverse group of stakeholders including interested citizens. When developing a program that is consistent with this measure's intent, EPA recommends that you adopt a planning process that identifies the municipality's program goals (*e.g.*, minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (e.g., adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing your program, you should consider assessing existing ordinances, policies, programs and studies that address storm water runoff quality. In addition to assessing these existing documents and programs, you should provide opportunities to the public to participate in the development of the program. Non-structural BMPs are preventative actions that involve management and source controls such as: policies and ordinances that provide requirements and standards to direct growth to identified areas, protect sensitive areas such as wetlands and riparian areas, maintain and/or increase open space (including a dedicated funding source for open space acquisition), provide buffers along sensitive water bodies, minimize impervious surfaces, and minimize disturbance of soils and vegetation; policies or ordinances that encourage infill development in higher density urban areas, and areas with existing infrastructure; education programs for developers

and the public about project designs that minimize water quality impacts; and measures such as minimization of percent impervious area after development and minimization of directly connected impervious areas. Structural BMPs include: storage practices such as wet ponds and extended-detention outlet structures; filtration practices such as grassed swales, sand filters and filter strips; and infiltration practices such as infiltration basins and infiltration trenches. EPA recommends that you ensure the appropriate implementation of the structural BMPs by considering some or all of the following: pre-construction review of BMP designs; inspections during construction to verify BMPs are built as designed; post-construction inspection and maintenance of BMPs; and penalty provisions for the noncompliance with design, construction or operation and maintenance. Storm water technologies are constantly being improved, and EPA recommends that your requirements be responsive to these changes, developments or improvements in control technologies.

(6) Pollution Prevention/Good Housekeeping for Municipal Operations

Minimum Requirements – *40 CFR 122.34(b)(6)(i)*
You must develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. Using training materials that are available from EPA, your State, Tribe, or other organizations, your program must include employee training to prevent and reduce storm water pollution from activities such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and storm water system maintenance.

Regulatory Guidance – *40 CFR 122.34(b)(6)(ii)*
EPA recommends that, at a minimum, you consider the following in developing your program: maintenance activities, maintenance schedules, and long-term inspection procedures for structural and non-structural storm water controls to reduce floatables and other pollutants discharged from your separate storm sewers; controls for reducing or eliminating the discharge of pollutants from streets, roads, highways, municipal parking lots, maintenance and storage yards, fleet or maintenance shops with outdoor storage areas, salt/sand storage locations and snow disposal areas operated by you, and waste transfer stations; procedures for properly disposing of waste removed from the separate storm sewers and areas listed above (such as dredge spoil, accumulated sediments, floatables, and other debris); and ways to ensure that new flood management projects assess the impacts on water quality and examine existing projects for incorporating additional water quality protection devices or practices. Operation and maintenance should be an integral component of all storm water management programs. This measure is intended to improve the efficiency of these programs and require new programs where necessary. Properly developed and implemented operation and maintenance programs reduce the risk of water quality problems.

ATTACHMENT B

National Marine Fisheries Service Municipal, Commercial, Residential, and Industrial (MRCI) Development Standards for a "Take" Exemption

(Source: 50 CFR 223.203(b)(12))

"...The prohibitions of paragraph (a) of this section relating to threatened species of salmonids listed in Sec. 223.102 (a)(5) through (a)(10), and (a)(12) through (a)(19) do not apply to municipal, residential, commercial and industrial (MRCI) development (including redevelopment) activities provided that:

(i) Such development occurs pursuant to city, county, or regional government ordinances or plans that NMFS has determined are adequately protective of listed species; or within the jurisdiction of the Metro regional government in Oregon and pursuant to ordinances that Metro has found comply with its Urban Growth Management Functional Plan (Functional Plan) following a determination by NMFS that the Functional Plan is adequately protective. NMFS approval or determinations about any MRCI development ordinances or plans, including the Functional Plan, shall be a written approval by NMFS Northwest or Southwest Regional Administrator, whichever is appropriate. NMFS will apply the following 12 evaluation considerations when reviewing MRCI development ordinances or plans to assess whether they adequately conserve listed salmonids by maintaining and restoring properly functioning habitat conditions:

(A) MRCI development ordinance or plan ensures that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites.

(B) MRCI development ordinance or plan adequately avoids stormwater discharge impacts to water quality and quantity, or to the hydrograph of the watershed, including peak and base flows of perennial streams.

(C) MRCI development ordinance or plan provides adequately protective riparian area management requirements to attain or maintain PFC around all rivers, estuaries, streams, lakes, deepwater habitats, and intermittent streams. Compensatory mitigation is provided, where necessary, to offset unavoidable damage to PFC due to MRCI development impacts to riparian management areas.

(D) MRCI development ordinance or plan avoids stream crossings by roads, utilities, and other linear development wherever possible, and where crossings must be provided, minimize impacts through choice of mode, sizing, and placement.

(E) MRCI development ordinance or plan adequately protects historic stream meander patterns and channel migration zones and avoids hardening of stream banks and shorelines.

(F) MRCI development ordinance or plan adequately protects wetlands and wetland functions, including isolated wetlands.

(G) MRCI development ordinance or plan adequately preserves the hydrologic capacity of permanent and intermittent streams to pass peak flows.

(H) MRCI development ordinance or plan includes adequate provisions for landscaping with native vegetation to reduce need for watering and application of herbicides, pesticides and fertilizer.

(I) MRCI development ordinance or plan includes adequate provisions to prevent erosion and sediment run-off during construction.

(J) MRCI development ordinance or plan ensures that water supply demands can be met without impacting flows needed for threatened salmonids either directly or through groundwater withdrawals and that any new water diversions are positioned and screened in a way that prevents injury or death of salmonids.

(K) MRCI development ordinance or plan provides necessary enforcement, funding, reporting, and implementation mechanisms and formal plan evaluations at intervals that do not exceed five years.

(L) MRCI development ordinance and plan complies with all other state and Federal environmental and natural resource laws and permits.

(ii) The city, county or regional government provides NMFS with annual reports regarding implementation and effectiveness of the ordinances, including: any water quality monitoring information the jurisdiction has available; aerial photography (or some other graphic display) of each MRCI development or MRCI expansion area at sufficient detail to demonstrate the width and vegetation condition of riparian set-backs; information to demonstrate the success of stormwater management and other conservation measures; and a summary of any flood damage, maintenance problems, or other issues.

(iii) NMFS finds the MRCI development activity to be consistent with the conservation of listed salmonids' habitat when it contributes to the attainment and maintenance of PFC. NMFS defines PFC as the sustained presence of a watershed's habitat-forming processes that are necessary for the long-term survival of salmonids through the full range of environmental variation. Actions that affect salmonid habitat must not impair properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC. Periodically, NMFS will evaluate an approved program for its effectiveness in maintaining and achieving habitat function that provides for conservation of the listed salmonids. Whenever warranted, NMFS will identify to the jurisdiction ways in which the program needs to be altered or strengthened. Changes may be identified if the program is not protecting desired habitat functions, or where even with the habitat characteristics and functions originally targeted, habitat is not supporting population productivity levels needed to conserve the ESU. If any jurisdiction within the limit does not make changes to respond adequately to the new information in the shortest amount of time feasible, but not longer than one year, NMFS will publish notification in the Federal Register announcing its intention to withdraw the limit so that take prohibitions would then apply to the program as to all other activity not within a limit. Such an announcement will provide for a comment period of not less than 30 days, after which NMFS will make a final determination whether to subject the activities to the ESA section 9(a)(1) prohibitions.

(iv) Prior to approving any city, county, or regional government ordinances or plans as within this limit, or approving any substantive change in an ordinance or plan within this limit, NMFS will publish notification in the Federal Register announcing the availability of the ordinance or plan or the draft changes for public review and comment. Such an announcement will provide for a comment period of no less than 30 days."

Identifying Sites for "Street Edge Alternatives"

The City of Mount Vernon is interested in identifying sites for "street edge alternatives" to promote infiltration along city streets. Street edge alternatives incorporate strategic site planning with micro-management techniques to achieve environmental protection, while allowing for development or infrastructure rehabilitation to occur. There are budgetary and environmental limitations that affect where the types of street edge alternative facilities discussed in this report are most applicable. Therefore it is necessary first to identify areas where the approach is feasible and second, areas with highest priority for implementation. This section describes the criteria, methodology, results and conclusions from an analysis of feasible and high priority locations for application of street edge alternative facilities.

Street Edge Alternative Concept

Street Edge Alternatives are also referred to as low impact development (LID) and natural drainage systems (NDS). LID involves practices such as incorporating existing land contours, native vegetation, native soil, longer time of concentration, natural drainage systems, raingardens, less effective impervious area and clumping (to name a few) in the initial development of the land, that result in less stormwater runoff.

Level of Service

Prioritization of street edge alternatives projects will require information on the selected level of service associated with each potential project site. Levels of service generally include:

- Traditional drainage system (curb and gutter, pipe and detain)
- Natural drainage system without sidewalks or curved streets
- Natural drainage system with sidewalks and curved streets

The City of Seattle implemented several variations of street edge alternatives projects. The SEA Streets model includes full re-development of a residential street right-of-way, including vegetated swales, a curvilinear street, and a sidewalk on one side of the street. The 110th Cascade model includes a series of stair-stepped natural pools, with extensive tree and shrub cover on one side of the roadway and a sidewalk on the opposite side. The High Point re-development incorporates street edge alternatives into a 129-acre housing development. This project differs from other street edge alternatives projects in that it integrates natural drainage elements into a traditional curb, gutter, and sidewalk approach throughout a highly dense area.

The City of Mount Vernon will need to prioritize which of these street edge alternatives variations is most appropriate for each project selected. Implementation decisions will be based on site characteristics, cost/benefit analysis, and community input. The SEA Streets model can be very costly, if it includes full re-development of the street and sidewalk within the right-of-way. The Cascade model is most appropriate for steep residential streets. Incorporating sidewalks and curvilinear streets adds cost to street edge alternatives projects, but also provides safety and aesthetic benefits to the immediate neighborhood surrounding the project. The City of Mount Vernon must work with the neighborhood residents to determine the correct level of service (size and scale) for each individual street edge alternatives project.

Criteria for Candidate Project Sites

The following criteria were used to identify potential project sites for street edge alternative drainage implementation. These criteria include:

- Areas of the City not served by a combined sewer system
- Roadway grade from 1 percent to 4 percent
- Areas without clay soils
- Residential streets only (no arterials)
- Sites with existing flooding problems or known drainage problems

Methodology

Geographic information systems (GIS) technology was used to screen and map candidate street edge alternatives project sites. GIS allows one or more criteria to be applied to a specific geographic area to produce a map of potential street edge alternatives project sites.

The areas in the City of Mount Vernon that meet the basic criteria described above were identified using GIS. Areas were excluded that have roadway slopes greater than 8 percent, steep slopes and 300-foot buffers around those steep slopes, clay soils, arterial streets, or combined sewer systems. This analysis provided an initial sense of which areas are potentially suitable for a street edge alternatives, based on physical characteristics (slope, soils, and drainage system).

Once the areas with inadequate physical characteristics were excluded, an analysis of the existing flooding and drainage problems throughout the City were reviewed. These areas were identified by consulting with the City of Mount Vernon Public Works staff and the Comprehensive Surface Water Management Plan, 1995. The resulting sites were identified as high priority for street edge alternatives, based on their physical characteristics and the community issues surrounding them (see Figure 1).

The GIS analysis identified potential candidate sites for street edge alternatives implementation, based on an objective set of established screening criteria. The general topography in the City has slopes that range from zero in the lower areas to 96 percent around Little Mountain. The upper reaches of Maddox Creek, Flower Creek, and Carpenter Creek are situated in ravines with sideslopes of 35 to 45 percent.

The cumulative results of this screening process identify high-priority sites that meet all of the screening criteria. These sites have the appropriate roadway slopes and soil conditions, have existing drainage problems, are not on arterial roadways and are located in traditional ditch and culvert drainage areas for street edge alternatives implementation.

Site Visit

Additional analysis will be necessary to make final selections of sites. Field investigations may provide additional information regarding feasibility. Although the GIS results are useful for initial planning, selection of individual project sites requires a much more detailed process that includes site visits to verify physical characteristics and a detailed community involvement process conducted to gain buy-in from residents that would be affected by project implementation.

Community Involvement

A comprehensive community involvement strategy is required to select final candidate sites for street edge alternatives implementation. This strategy will include:

- A survey of neighborhood residents to determine their willingness to participate in a street edge alternatives project
- Community meetings to explain street edge alternatives concepts, costs/benefits, and risks, and to solicit feedback and design considerations from potential affected neighbors
- City-resident partnership agreements once final site locations are determined
- Ongoing communication with residents (e.g., newsletters, meetings) during site design and construction phases

Final street edge alternatives project sites should be selected with the approval of the affected neighbors. Residents should agree to the location and design of the project, as well as to any financial and/or maintenance agreements with the City related to the project.

Project Selection Policy Decisions

The City of Mount Vernon will need to address several challenging policy issues when prioritizing and selecting street edge alternatives project sites, including:

- How will project sites be distributed geographically throughout the City?
- How will environmental issues (flooding, water quality, habitat) be prioritized in the selection of project sites? Is protecting salmon in one watershed more important than preventing flooding in another watershed?
- How will the appropriate scale and level of service for individual projects be determined?
- What maintenance agreements with residents will be needed at project sites?
- Will residents be asked to contribute financially to street edge alternatives projects?

These policy issues are summarized in Figure 5-8.

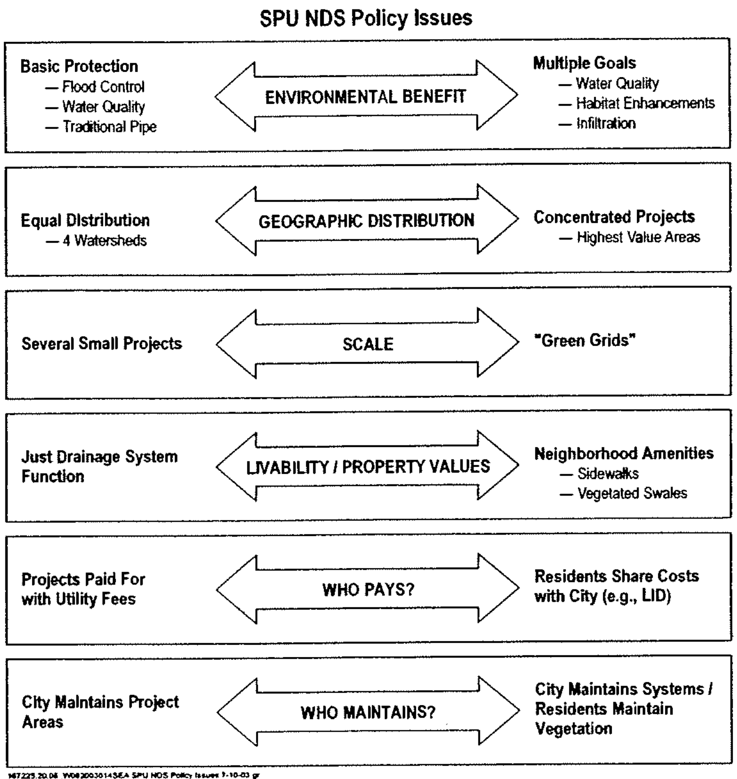

Figure 5-8

Maintenance Agreements

The City of Mount Vernon should make a policy decision regarding the maintenance practices required for various street edge alternatives projects. Residents might be expected to maintain the landscaping and vegetation associated with individual street edge alternative installations. This maintenance agreement should be described in all communications with neighbors in a potential project site area. Residents must agree to support the level of maintenance required for the selected street edge alternatives level of service.

Financial Assistance

The City of Mount Vernon could pursue an option for creating financial partnerships with neighborhood residents in areas that receive street edge alternative projects. This option could be included in community outreach surveys to potential candidate project site recipients. A financial partnership could include a Local Improvement District (LID) or some other form of short-term arrangement between the City and neighborhood residents for project development.

Considerations for the Future

In the future, it might be appropriate to revisit the issue of excluding areas with combined sewers. Applying street edge alternatives would reduce the amount of water entering the combined system, thus reducing the costs of conveyance and treatment of the combined sewage. Proper application of a street edge alternatives approach should eliminate the need for treatment of stormwater runoff.

Expanding the concept to private properties as they are rebuilt could provide further advantages in all areas, including areas with combined sewers. If homeowners collected rooftop runoff, which is relatively clean, and used it to flush toilets, wash clothes, or irrigate, there would be substantial benefits to the City's natural resources and infrastructure costs. In a residential area, approximately one-third of the impervious area is rooftops. If this source of runoff were eliminated, there would be a corresponding reduction of runoff entering either the stormwater system or the combined sewer system during peak flows.

Toilet flushing and clothes washing are responsible for nearly half the water consumption year round in residences. In the summer, peak demand for water is driven largely by landscape irrigation. If an alternate source, such as rooftop runoff could be used for these tasks, there could be a reduction of as much as half the demand for domestic water in residential areas. This would in turn reduce the public cost of infrastructure for the water system and would allow more water to be left in the rivers that supply the City's water. These rivers are productive salmon habitat, and reducing the water demand would benefit that habitat. In terms of abundance and diversity of fish, habitat improvements in these rivers would far outweigh improvements in urban streams.

ATTACHMENT C

Tri-County Proposal – Model Planning Policies

Overview:
It is the intent of the Tri-County proposal to use the process established under the Growth Management Act ("GMA") (Ch. 36.70A RCW), to have individual jurisdictions ensure their planning policies and thus their implementing regulations, adequately address issues related to salmonids. With the adoption of the GMA, the seemingly logical step of a direct link between policies and implementing regulations and programs became mandated. For the purpose of this Model program, local jurisdictions that don't already have the requisite policy basis to provide protection for listed species should adopt relevant and appropriate model planning policies, either through the regional process of adopting countywide planning policies and/or through the adoption of planning elements of individual comprehensive plans.

The following is a list of proposed Model Planning Policies (MPPs) which jurisdictions planning under GMA that need to adopt policies may consider in order to provide the policy basis to conserve salmonids listed under the Endangered Species Act. While the Tri-County Model suggests the use of the county-wide planning policy process, it also recognizes the same end can be achieved by local jurisdictions individually adopting comprehensive plan policies covering the same topics.

General:
Model Policy No. 1: The county and cities should protect and enhance the natural ecosystems through comprehensive plan policies and development regulations that reflect natural constraints and protect sensitive features.

Discussion:

Regulate land use and development in a manner which respects fish and wildlife habitat in conjunction with natural features and functions (water quality, hydrologic and hydraulic functions, vegetation retention, etc.).

Manage natural resources and the built environment to protect, improve and sustain environmental quality while minimizing public and private costs.

Adopt an ecological approach to improving in-stream habitat including the establishment of water quality and quantity parameters to address impacts to critical fish species.

Work towards reducing the total effective impervious surface area within individual development sites and also within watershed[1] basins or larger geographic boundaries.

[1] A "watershed" is a geographic area that drains toward or contributes flow to the stream or river of interest. The geographic limits of the watershed are defined by the points at which the topography breaks to drain surface water into the tributaries which feed the stream or river system.

Model Policy No. 2: The county and cities should preserve, protect and, where possible, restore natural habitat critical for the conservation of salmonid species listed under the federal Endangered Species Act, through the adoption of comprehensive plan policies that seek to protect, maintain or restore aquatic ecosystems, associated habitats and aquifers through the use of management zones, development regulations, incentives for voluntary efforts of private landowners and developers, land use classifications or designations, habitat acquisition programs or habitat restoration projects.

Discussion:

Designate fish and wildlife habitat conservation areas[2] *as a priority for acquisition programs such as Conservation Futures and Floodplain Buyout programs*

Utilize incentive programs to encourage the preservation and/or restoration of critical habitat areas.

- *Counties should adopt a Public Benefit Rating System under the Current Use Assessment Program (RCW 84.34) that includes a higher priority for fish and wildlife habitat conservation areas.*
- *All jurisdictions should provide other types of incentive programs such as Transfer of Development Rights (TDR) and Purchase of Development Rights programs.*

Consider fish and wildlife habitat conservation areas when designating land use designations and companion zoning regulations.

Amend existing critical area regulations, as necessary, to protect fish and wildlife habitat conservation areas from development impacts.

Coordination of Watershed Planning and Land Use Planning:

Model Policy No. 3: The county and cities should protect the natural habitat critical for the conservation of salmonid species listed under the federal Endangered Species Act, through the adoption of comprehensive plan policies which encourage the use of planning activities or study techniques that are capable of determining changes in stream hydrology and water quality under different land use scenarios at full build-out of designated land use classifications.

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[2] The term "fish and wildlife habitat conservation area" is defined in RCW 36.70A.030(5).

Inter-jurisdictional Cooperation:

Model Policy No. 4: All jurisdictions shall work together to identify and protect natural habitat networks that cross jurisdictional boundaries.

Discussion:

Networks shall link large protected or significant blocks of fish and wildlife habitats within and between jurisdictions to achieve a continuous countywide network.

Networks shall be mapped and displayed in comprehensive plans and may be incorporated into open space/greenbelt corridor maps.

Establish informational sharing workshops or present information at established coordinating committees.

Whenever possible, utilize watershed boundaries instead of jurisdictional boundaries for plans and studies.

Model Policy No. 5: All jurisdictions shall coordinate watershed/aquatic restoration planning and implementation activities within a watershed.

Discussion:

Consider the implications of planning and implementation activities not only within jurisdictional boundaries, but also the implications of decisions and activities on habitat for critical fish species that is located outside jurisdictional boundaries but within the shared watershed.

Model Policy No. 6: All jurisdictions shall cooperatively work together to create and adopt modifications to their Critical Areas Regulations that include the best available science for the protection of existing habitat, wetlands, estuaries, riparian areas by avoiding negative impacts.

Discussion:

Provide for the removal of invasive species and the replanting of natural vegetation.

Support local community groups in critical habitat restoration and enhancement efforts through reduced or waiver of permit fees and streamlined permitting procedures.

Provide incentives to encourage landowners to retain, enhance, or restore critical habitat.

Development Standards:
Model Policy No. 7: Upon adoption of a state classification system, the cities and the county shall work together to establish a single system for stream typing.

Model Policy No. 8: All jurisdictions shall maintain or enhance water quality through control of runoff and best management practices to maintain natural aquatic communities and beneficial uses.

Monitoring, Best Available Science and Adaptive Management:
Model Policy No. 9: All jurisdictions shall establish a monitoring and evaluation method, which is designed to determine the effectiveness of restoration, enhancement, and recovery strategies for listed species.

Discussion:

Monitoring and evaluation strategies should be linked to future policy choices and management actions.

Adoption of local plans, which include Conservation Plans or watershed basin plans, and regulations, should include monitoring and evaluation criteria and timelines for conducting such activities.

Fish and wildlife habitat preservation or restoration plans, prepared by applicants who are proposing developments within critical habitat areas designated under Critical Area Regulations adopted pursuant to GMA and/or identified under SEPA, should include monitoring and evaluation criteria and timelines for conducting such activities.

At a minimum, monitoring and evaluation techniques should address:

- *Pre-development conditions including data on species viability and habitat, and when appropriate, watershed quality.*
- *A discussion of the limiting factors related to the proposal and suggested methods to eliminate a potential "take" of the species as a result of the proposal.*
- *A commitment to change conservation approaches if monitoring data indicates a potential degradation of the listed species.*

Develop complementary, coordinated, integrated, and flexible approaches for the collection, analysis, and sharing of monitoring information (e.g., GIS data, hydrologic and hydraulic analysis, etc.).

Model Policy No. 10: All jurisdictions shall recognize that the best available science to address listed species recovery issues is evolving. Each jurisdiction shall apply an adaptive management strategy to determine how well the objectives of listed species recovery and critical habitat preservation/restoration are being achieved.

Discussion:

Incorporate the results of pilot developments into land use regulations, zoning, and technical standards.

Model Policy No. 11: The counties and the cities shall ensure that any proposal to consider moving the current[3] UGA boundary provide at least the same level of protection afforded salmonid species habitat pursuant to the area's previous rural or resource designation. If the UGA is expanded prior to the completion of WRIA conservation plans, rural or resource standards previously applied to the areas will be maintained UNLESS a biological assessment has been conducted and demonstrates that revised standards are justifiable.

Discussion:

Continue the use of the rural standards in areas later designated to be within the urban growth area unless a study has been done to identify other protective measures that will be equal to those previously in plac

[3] The "current" UGA boundary refers to the boundary adopted as of the date the jurisdiction receives a take limit from the NMFS or USFWS.

Appendix C
Storm Drainage Capital Improvement Plan Projects

- 1995 Plan Projects and Disposition
- Detailed CIP Sheets for Select Projects

TABLE X-1
City of Mount Vernon Capital Improvement Plan from 1995 RW Beck Comprehensive Surface Water Management Plan

Problem Number	Location	1995 Cost	Disposition
Regional System Problems			
RS1	Construct new Riverbend Road (Freeway Drive) System	$1,750,000	Not yet completed
RS1	Design new Riverbend Road (Freeway Drive) System	$242,000	Not yet completed
RS2	Install two additional 36-inch culverts at Parker Way	$13,000	Completed or not needed
RS3	Culvert replacement at College Way update price	$109,000	Completed or not needed
RS4a	Kulshan Creek Pump Station Phase I (1)	$3,339,000	Completed or not needed
RS4b	Kulshan Creek Pump Station Phase II – Beyond 20 Years	$672,000	Not yet completed
RS6	Little Mountain Estates Detention Pond modifications	Developer Build	Not yet completed
RS7	Erosion control on Maddox Creek	$393,000	In progress. Shared funding.
RS8	Maddox Creek-Drainage District 17 Study	$44,000	?
Local System Problems			
LS6	Install log bed control weir to control erosion north of Cedar Lane	$11,000	Not yet completed
LS7	MH drop structure and pipe extension on Kulshan tributary near Viewmount	$48,000	Not yet completed
LS8	Culvert replacement along N 16th north of Florence	$29,000	Completed or not needed
LS9	Park Village Mobile Home Park	$53,000	Completed or not needed
LS10	Culvert replacement at Kiowa and Seneca	$22,000	Completed or not needed
LS11	Install trashrack at storm drain inlet near Kiowa and Nez Perce	$500	Not yet completed
LS12	Replace storm drain system in W. Mount Vernon along Memorial Highway	$557,000	Not yet completed
LS13	Install additional catchbasins at Wall Street and Garfield Street	$14,000	?

TABLE X-1
City of Mount Vernon Capital Improvement Plan from 1995 RW Beck Comprehensive Surface Water Management Plan

Problem Number	Location	1995 Cost	Disposition
LS14	Install new catchbasin and storm drain connection at Wall Street north of Memorial Hwy	$40,000	Not yet completed
LS15	Replace 16 of the storm drains between Division and Fir just west of LaVenture	$371,000	Not yet completed
LS16	Install log bed control weir in stream between Mohawk and Apache	$11,000	Not yet completed
LS17	Install culvert and ditch at Comanche Drive	$14,000	Not yet completed
LS18	Culvert replacement at Shoshone east of Sioux	$24,000	Not yet completed
LS19	Install armoured spillway in two detention ponds near Waugh and Division	$59,000	Not yet completed
LS20	Install storm drain west of S 6th up to Lind and connect to Maddox tributary	$155,000	Not yet completed
LS22	Install catchbasin and storm drain connection for the NW corner of Riverside and Fir	$100,000	Completed or not needed
LS23	Install storm drain connection along I-5 between Cameron and Kulshan Pump Station	$73,000	Completed or not needed
LS25	Replace 3 pipes between Britt Slough and Blackburn Road	$284,000	Completed or not needed
LS26a	Upgrade drainage system on Fox Hill Street – Replace Pipes in Street	$235,000	Completed or not needed
LS26b	Upgrade drainage system on Fox Hill Street – Install Pipe in Deep Ditch	$66,000	Completed or not needed
LS27	Replace 2 pipes along I-5 between Blackburn and Anderson Road	$50,000	In progress
Water Quality Problems			
WQ1	Water Quality Monitoring Program	$39,000	Completed or not needed
WQ3	Oil/water separators	$328,000	Not yet completed

TABLE X-1
City of Mount Vernon Capital Improvement Plan from 1995 RW Beck Comprehensive Surface Water Management Plan

Problem Number	Location	1995 Cost	Disposition
Environmental Resource Problems			
E1	Kulshan Creek Pump Station – Fish ladder	Included in RS4	Completed or not needed
E2	Manhole barrier in Kulshan east of Railroad	$2,000	Not yet completed
E3	Log weir fish structure – Kulshan Creek north of Cedar Lane	$11,000	Not yet completed
E4	Restore channel on Kulshan from Riverside to N 18th (2,200 feet)	$104,000	Not yet completed
E5	Restore channel on mainstem of Trumpeter (7,000 feet)	$328,000	Not yet completed
E10	Remove Culvert and restore stream channel on Maddox near Anderson	$40,000	Completed or not needed (Centennial grant through Skagit County to be used??)
E11	Log weir fish passage structure d/s of culvert on Maddox Creek at Blackburn Road	$11,000	
E13	Add riparian vegetation on Flowers Creek between Maddox and Blodgett (1,500 feet)	$38,000	Not yet completed
E14	Log weir fish passage structure on Flowers Creek at Blodget Road	$11,000	Not yet completed
E15	Restore channel on Carpenter Creek along Bacon Road (1,600 feet – one side)	$21,000	Not yet completed

Mount Vernon

Comprehensive Stormwater Management Plan Update

CIP ITEM # D-01-02: Maddox Creek Restoration and Pond Retrofit

Location

Maddox Creek at S. 27th and
Section ______

Concerns

- Failed detention pond causing drainage and water quality treatment problems

Proposed Action

- Retrofit failed detention pond
- Re-channelize Maddox Creek
- Re-plant site

Benefits

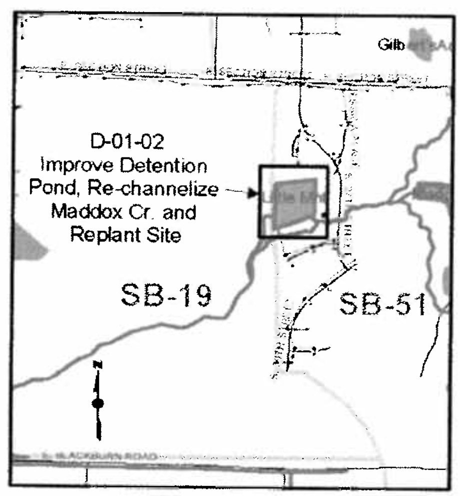
- Improved drainage and water quality treatment
- Separation of Maddox Creek from failed detention pond
- Elimination of jurisdictional wetlands from detention pond

Costs

Engineering:	$10,000
Construction:	$40,000
	$50,000

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project
D-99-05	Digby Road and Woodland Drive Stream Enhancement
T-00-04	Digby Road Improvements and Maddox Creek Relocation

- ☒ In Prior Plan and in Progress
- ☒ In Prior Plan and Appropriated
- ☐ In Prior Plan but not Appropriated
- ☐ New Project
- ☒ Consistent with Comprehensive Plan

CIP ITEM # D-05-03: West Mount Vernon Storm Surface Main Upgrade

Location

West Mount Vernon Storm Station

Concerns

- Storm sewer surcharges
- Localized flooding

Proposed Action

- Construct 75 feet of 18-inch ductile pipe from pump discharge through dike

Benefits

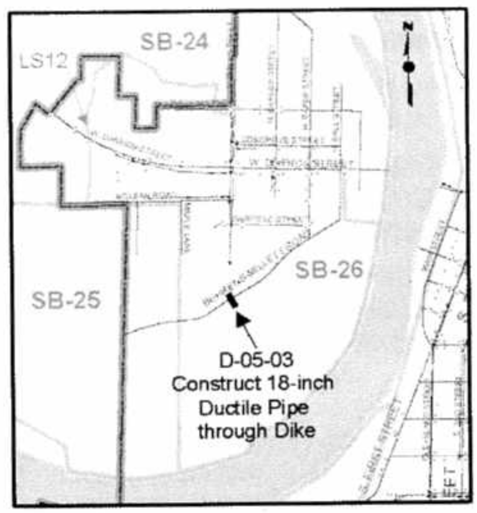
- Surcharging and flood reduction and consequent liability reduction for damages

Costs

Engineering:	$10,000
Construction:	$25,000
	$35,000

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project

☐ In Prior Plan and in Progress
☐ In Prior Plan and Appropriated
☐ In Prior Plan but not Appropriated
☒ New Project
☒ Consistent with Comprehensive Plan

Mount Vernon Comprehensive Stormwater Management Plan Update

CIP ITEM # D-94-11: Erosion Problem Repairs

Location

Trumpeter Creek between Mowhawk and Apache, east of Comanche

Concerns

- Erosion along portion of Southwest Fork of Trumpeter Creek
- Sedimentation

Proposed Action

- Install bed control weirs
- Restore stream channel between Mowhawk and Apache

Benefits

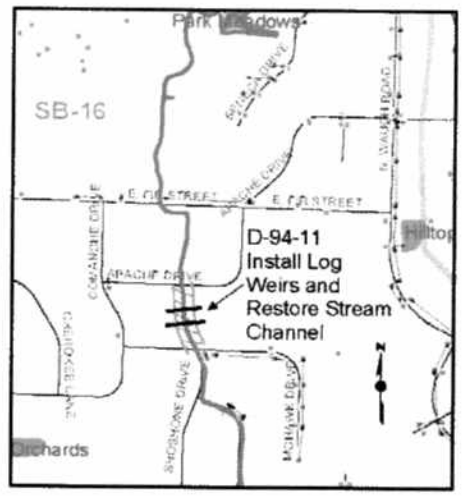
- Control and prevention of erosion and sedimentation

Costs

Engineering:	$2,100
Construction	$9,900
	$12,000

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project

- ☐ In Prior Plan and in Progress
- ☐ In Prior Plan and Appropriated
- ☒ In Prior Plan but not Appropriated
- ☐ New Project
- ☒ Consistent with Comprehensive Plan

CIP ITEM # D-94-14: Log Fish Weir Structure

Location

Tributary to Kulshan Creek near Cedar Lane

Concerns

- Partial fish barrier created by 1-foot drop in culvert outlet

Proposed Action

- Place log weirs at culvert outlet to facilitate fish passage

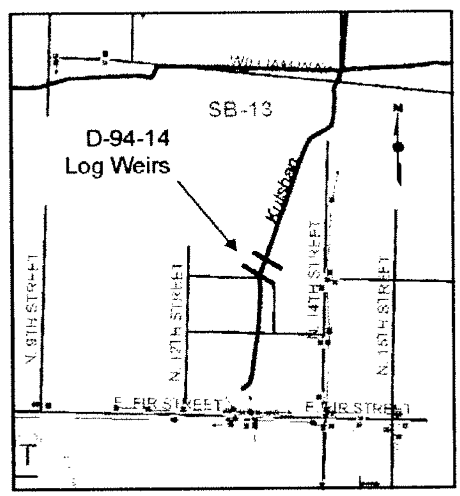
Benefits

- Improved fish habitat
- Increased fish population and survival rate

Costs

Engineering:	$2,100
Construction:	$10,400
	$12,500

Revenue Source



Linkage to Other Projects

CFP #	Project
D-94-07	Cedar Lane Erosion Control

- ☐ In Prior Plan and in Progress
- ☐ In Prior Plan and Appropriated
- ☒ In Prior Plan but not Appropriated
- ☐ New Project
- ☒ Consistent with Comprehensive Plan

CIP ITEM # LS1: 700-Foot Long Berm along Hoag Road

Location

Hoag Road west of LaVenture Road

Concerns

- Flooding during high water events in the Skagit River

Proposed Action

- Construct 700-foot-long berm along the north side of Hoag Road to an elevation of 385 feet

Benefits

- Flood reduction and consequent liability reduction for damages

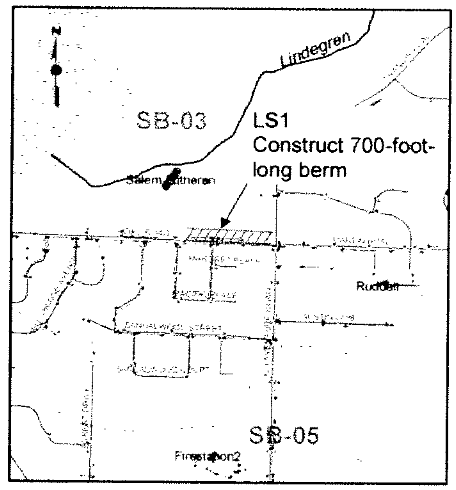
Costs

Engineering: $29,000
Construction: $290,000

$319,000

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project

- ☐ In Prior Plan and in Progress
- ☐ In Prior Plan and Appropriated
- ☒ In Prior Plan but not Appropriated
- ☐ New Project
- ☒ Consistent with Comprehensive Plan

Mount Vernon — Comprehensive Stormwater Management Plan Update

CIP ITEM # LS12: Replacement of Storm Drain System in W. Mount Vernon along Memorial Highway

Location

Memorial Highway west of S. Wall Street

Concerns

- Localized flooding along Memorial Highway (SR 536) due to insufficient capacity in storm drain system

Proposed Action

- Replace 1,700 feet of 12-inch storm drainage pipe with 30-inch pipe

Benefits

- Flood reduction and consequent liability reduction for damages

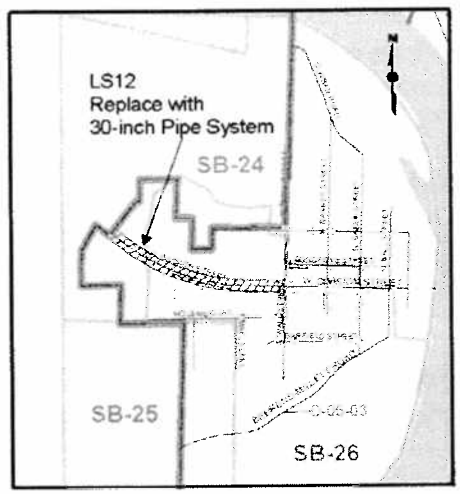
Costs

Engineering: $118,800
Construction: $673,200

<u>$792,000</u>

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project

- ☐ In Prior Plan and in Progress
- ☐ In Prior Plan and Appropriated
- ☒ In Prior Plan but not Appropriated
- ☐ New Project
- ☒ Consistent with Comprehensive Plan

Mount Vernon

Comprehensive Stormwater Management Plan Update

CIP ITEM # X: Freeway Drive Force Main Replacement

Location

Along Freeway Drive, north of College Way, detention pond and pump station near Lowe's Hardware

Concerns

- Inadequate conveyance capacity for predicted future development flows

Proposed Action

- Replace 2,600 linear feet of existing 12-inch stormwater conveyance pipe with 18-inch ductile iron pipe (DIP)

Benefits

- Capacity to convey stormwater flows from predicted future development

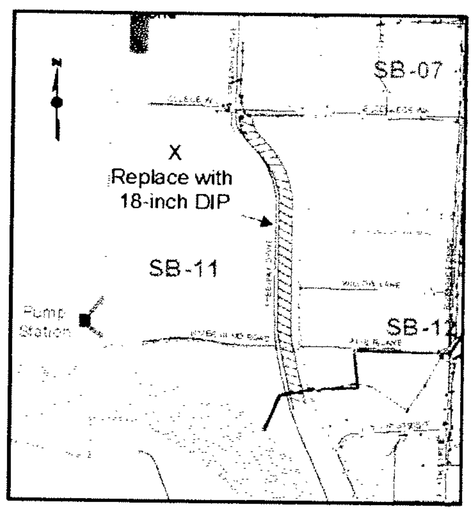
Costs

Engineering: $80,000
Construction: $685,000

<u>$765,000</u>

Revenue Source

City Surface Water Utility Fund



Linkage to Other Projects

CFP #	Project

☐ In Prior Plan and in Progress
☐ In Prior Plan and Appropriated
☒ In Prior Plan but not Appropriated
☐ New Project
☒ Consistent with Comprehensive Plan

CIP ITEM # LS15: Replacement of 16 Storm Drains between E. Division and E. Fir, West of N. LaVenture

Location

Between E. Division Street and E. Fir Street, West of N. LaVenture Road, including portions of Stanford Drive, Streeter Place, N. 21st Street and Fir Street

Concerns

- Localized flooding affecting several homes at the intersection of Division Street and South 20th Street
- Insufficient capacity in conveyance system north of Division Street for 10-year design flows

Proposed Action

- Replace 2,350 feet of undersized 15-inch to 24-inch CMP/CP storm drainage pipes with 24-inch to 36-inch CP and HDPE pipes along portions of streets identified in location description above

Benefits

- Flood reduction and consequent liability reduction for damages

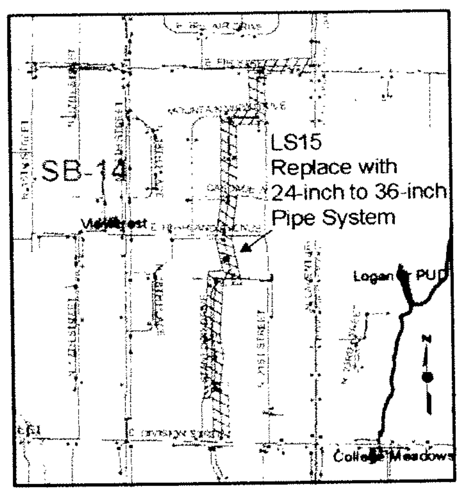
Costs

Engineering: $79,200
Construction: $448,800

$528,000

Revenue Source

City Surface Water Utility Fund



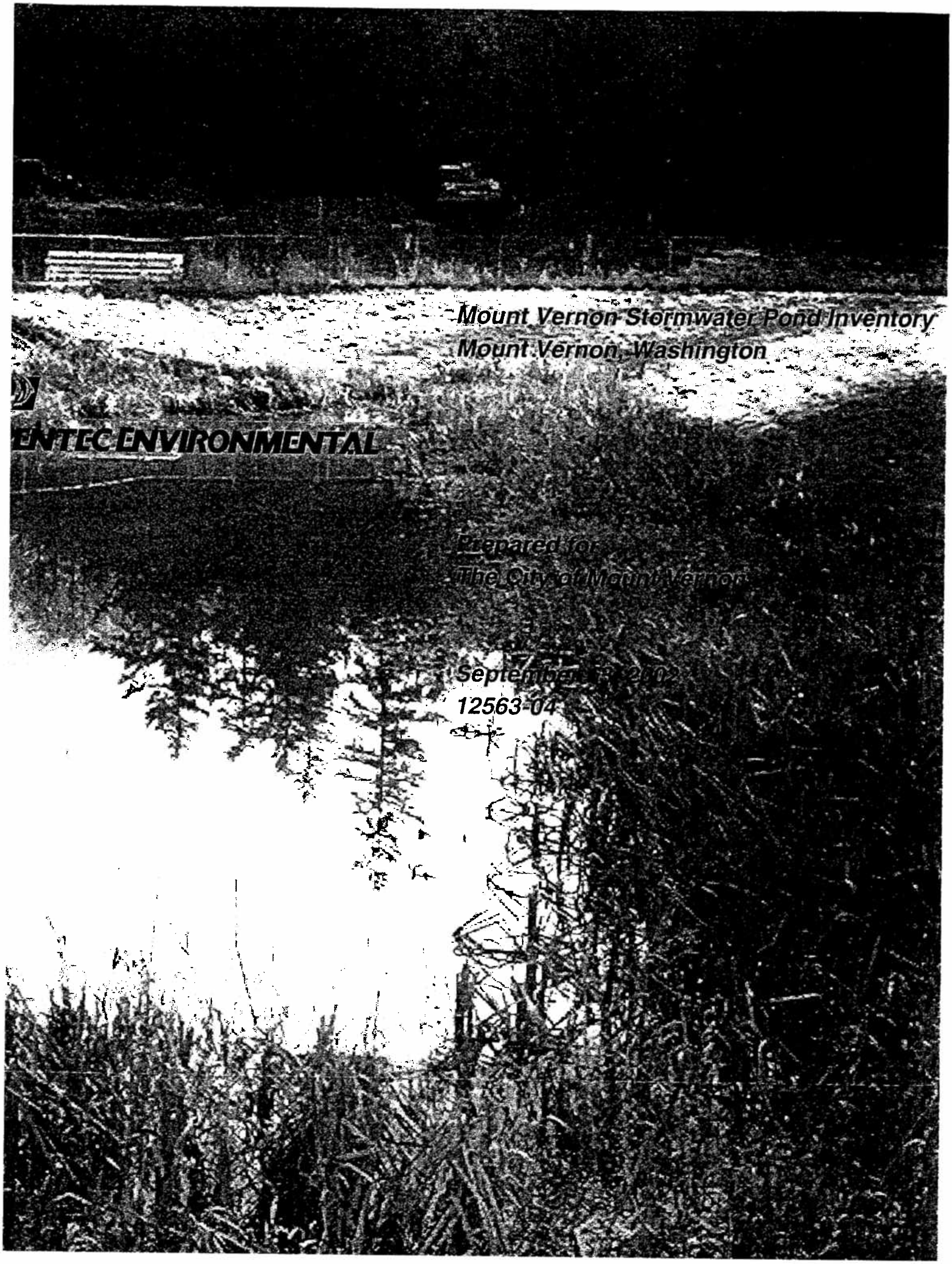
Linkage to Other Projects

CFP #	Project

☐ In Prior Plan and in Progress
☐ In Prior Plan and Appropriated
☒ In Prior Plan but not Appropriated
☐ New Project
☒ Consistent with Comprehensive Plan

Appendix D
Operations and Maintenance

- Pentec Environmental's Mount Vernon Stormwater Pond Inventory



Mount Vernon Stormwater Pond Inventory
Mount Vernon, Washington

ENTEC ENVIRONMENTAL

Prepared for
The City of Mount Vernon

September [illegible], 2002
12563-04

Mount Vernon Stormwater Pond Inventory
Mount Vernon, Washington

Prepared for
The City of Mount Vernon

September 13, 2002
12563-04

Prepared by
Pentec Environmental

Michael J. Muscari
Wetland Ecologist

Mary Lear
Water Resources Engineer

CONTENTS

MOUNT VERNON STORMWATER INVENTORY

INTRODUCTION

The City of Mount Vernon (City) contracted with Pentec Environmental (Pentec) to conduct an inventory of the City's stormwater detention facilities. This report documents the findings of the inventory of all stormwater ponds that are known by City staff to be the responsibility of the City. The report will be used by the City to form the basis of an ongoing maintenance program and cost estimates for the stormwater ponds for which the City is responsible.

This report includes information collected from the City's files, information collected during site visits to each pond, and detailed knowledge of the stormwater system conferred by City Wastewater Utility staff.

METHODS

The stormwater pond inventory was conducted by Michael Muscari and Mary Lear of Pentec, and John Dilley, lead operator for the City's Wastewater Utility. The field survey was completed between February 20 and April 11, 2002.

At each pond a Trimble Pathfinder Pro XRS global positioning system (GPS) was used to map the boundaries of the pond. The Trimble GPS has a horizontal precision to less than 1 meter (m), and at most ponds the precision was to less than 0.5 m. A level scope mounted on a tripod and staff gage were used to take relative elevation measurements. At a minimum, relative elevations were taken at the invert of the outlet, at the top of berm, and at the emergency overflow. The area of each pond, derived from the GPS data, and the relative elevations were used to calculate an approximate live storage volume for each of the ponds that have a flow control structure (FCS). The few ponds and swales without flow control structures were assumed to have little if any detention and so were not included in the calculations. These volume estimates are approximations only. An accurate measurement of volume would require a detailed topographic survey because of the varying slopes at most of the ponds. A detailed topographic study was not within the scope of this project.

Digital photographs were taken of each pond. Rough sketches were made at each site to document features such as inlet pipes, outlet pipes, FCS, spillways, etc. Sketches and photographs of each pond are included on the summary sheets. The lids were removed at every FCS to inspect the design and condition of standpipes and other flow restricting devices. It was not in the scope of this project to enter the subterranean FCS vaults, so only information readily seen or measured from outside the hole was collected. A staff gage was used at each FCS to take approximate measurements of sediments in the vaults.

The information collected on the condition and function of the ponds was used to assign a maintenance priority rating. The purpose of the priority rating is to provide the City with a decision-making tool for scheduling improvements, repairs, and maintenance. Rating scores of High, Medium, and Low were given based on the conditions seen on the day of the site visit. Ponds were given a rating score based on the following scale.

- **High**—In need of immediate maintenance or repairs (sediment clogging FCS, berm erosion, sediment in pond or swale restricting flow, etc.);

- **Medium**—Repairs or maintenance needed but not urgent to function of detention pond (sediment in FCS but not clogging orifice, access road needs improvements or maintenance, remove small amount of vegetation from outlet); or

- **Low**—No repairs needed, maintain on regular schedule (mow to prevent invasive plant growth, check FCS for sediment, check outlet and inlet).

In consultation with City staff a cost estimate was made for recommended repairs and maintenance at each pond. The cost estimates are provided in Table 2.

DEFINITIONS AND ACRONYMS

Wet pond—Ponds constructed with the invert of the outlet pipe at a higher elevation than the bottom of the pond, resulting in permanent standing water at least 1 foot deep, but generally greater than 2 feet deep.

Dry pond—Ponds constructed with the invert of the outlet pipe at the same, or at only a slightly higher, elevation than the bottom of the pond. Dry ponds typically do not retain water more than a few days following a storm, but can have standing water up to 1 foot deep during the winter and into early spring.

Wetland Pond—Ponds with permanent standing water greater than 2 feet deep that do not have a flow control structure and usually do not provide a significant amount of live storage.

Swale—Linear shaped basins that are constructed to slow and treat road runoff, but do not have a flow control structure and therefore do not detain a significant amount of stormwater.

Detention Swale—Linear-shaped basins that have a flow control structure and are constructed to slow, treat, and detain stormwater. These swales do not receive a significant amount of water and likely detain stormwater only during the peak of large storm events.

Siltation Pond—Shallow ponds constructed to slow water flow and settle out suspended solids. There is no regulated flow control structure therefore there is no significant amount of stormwater detention.

FCS—Flow control structure.

CB—Catch basin.

PVC pipe—Polyvinyl chloride pipe.

CMP—Corrugated metal pipe.

HDPE pipe—High-density polyethylene pipe.

RESULTS

The results of the compilation of background information and the field survey are summarized for all of the ponds in the sections below. Detailed results for each of the ponds are provided on the attached data sheets. Figure 1 shows the approximate location of each pond on a map of the City.

General Conditions

A total of 69 stormwater treatment facilities were surveyed for this inventory. Four of the facilities were later determined to be private ponds, and so are not included in the following summaries or maintenance recommendations, but are included in a list of known private ponds in Appendix A. The 11 ponds (Eaglemont-56 to Eaglemont-66) on Eaglemont golf course will be discussed in a separate section from the ponds in the rest of the City, but six are maintained by the city and are included in the summary sheets. Of the 54 facilities within the city limits, there are 31 dry detention ponds, 14 wet detention ponds, 5 swales, 1 detention swale, 2 wetland ponds, and 1 siltation pond.

Seven ponds received a high maintenance rating, 23 ponds received a medium rating, and 26 ponds received a low rating (Table 1 and Data Sheets).

Of the 69 ponds included in the inventory 35 are owned by the City of Mount Vernon, and were mostly acquired through dedication. Four files are silent on ownership (older ponds), but are assumed to be the City's. The ownership of one pond is still to be determined. The remaining 29 ponds are privately owned and are typically part of a lot. Responsibility for maintenance of the ponds generally follows the guideline that if the pond filters city street water, then maintenance is assumed to be the City's responsibility. Forty-nine of the ponds are wholly the responsibility of the City. The City maintains an additional four ponds, although the older files do not address ongoing maintenance. Maintenance is shared for six of the ponds, the City being responsible for structural maintenance and homeowners' associations being responsible for aesthetic maintenance. Maintenance responsibility is still to be determined for one pond. Nine of the ponds are wholly private. Ownership and maintenance are reported for each pond on the data sheets.

Maintenance Recommendations

Maintenance recommendations vary for each pond and are discussed on each of the data sheets. Routine maintenance includes mowing of berm slopes, inspection of FCS, cleanout (vactor) of FCS, and cleanout of vegetation from around inlet and outlet pipes.

Mowing of berm slopes is recommended for most of the ponds in order to prevent the spread of invasive woody plant species such as Himalayan blackberry (*Rubus discolor*) and Scot's broom (*Cytisus scoparius*). Some of the berms have been planted with native trees and shrubs. Mowing is not recommended at these ponds. Weeding around the planted trees and shrubs is often necessary to promote healthy growth. Most of these plantings are assumed to have been done by local residents and homeowners associations and appear to be weeded and maintained by them. Generally, mowing once in the early summer and once in the late summer should be sufficient. Some of the dry ponds (Loveless-23) are used as parks and are mowed frequently to maintain a lawn.

Although in the early stages of growth woody plants (e.g., willows, alder, cottonwood, dogwood, etc.) provide additional functions at the detention ponds, removal of woody vegetation is recommended for a few of the ponds. Dense woody vegetation can slow the flow of water through the ponds and aid in removal of sediments, and provide wildlife habitat. Growth of non-woody plants (specifically cattail) can also aid in sediment removal and is also known to remove toxins from the water. Cattail should be retained when not interfering with the inlet or outlet pipes. At some point the growth of trees within the detention area could begin to remove a significant amount of storage capacity from the pond. It is recommended that large trees be removed from the detention ponds before they become so large that the trunks start to take up detention volume, and before they are so large that removing the trees becomes difficult and requires heavy equipment. Most of the trees and shrubs that grow in the detention ponds will regenerate from the remaining roots within the next growing season, and so water quality and wildlife habitat functions will only be temporarily affected. It is recommended that trees be cut and removed from detention ponds when they have a diameter at breast height (dbh) of greater than 6 inches.

Dredging of detention ponds and drainage ditches is recommended at some of the sites. It is difficult to assign a schedule for dredging of ponds because of the variety of factors influencing the input and deposition of sediments to the ponds. In general it is recommended that each facility be inspected annually to assess the sediment deposition in the ponds and in the inlet and outlet pipes.

It is also difficult to assign a schedule for removal of sediments from the FCS because of the varied and changing factors affecting input of sediments to the system. Annual inspection of all FCS is recommended to avoid problems with clogging of the orifices in the FCS. Sediment build-up greater than 4 inches deep should be removed.

Improvement and Repair Recommendations

Improvements recommended are minor and include installing trash racks on outlet pipes, flap gates on inlet pipes, safety bars on large pipe openings, and woody plants on erosion-prone slopes. Specific improvement recommendations are included on the summary sheets.

Repairs are specified on the summary sheets and include repair of an erosion-damaged berm, reattachment of standpipe to vault wall, and replacement of a vandalized emergency overflow pipe.

Although not in the scope of this inventory, sites were evaluated for their potential for wildlife habitat enhancement. Native shrub and tree plantings can add wildlife habitat functions to many of the ponds without interfering with the detention function. Trees and shrubs planted along the slopes of the berms, outside of access ramps and paths, can provide habitat for birds, amphibians, and small mammals while providing shade for the pond. Shade on the pond can help reduce water temperature, which could be beneficial for fish downstream of the pond. Because funding for wildlife habitat enhancement can be tight, plantings should be directed at sites where the most benefit would be received and where the highest probability of success can be assured. To control costs, tree and shrub plantings can often be accomplished with the help of volunteers and civic groups. Relatively small planting effort at some of these ponds could result in relatively large increases in wildlife habitat.

At one pond (Thunderbird-07), enhancement of wildlife habitat could be accomplished with little or no cost. There is a double-celled pond at this location with a low area between the two cells. This low area is connected to a wetland to the east and is likely partially wetland itself. The low area appears to be mowed on a regular basis along with the berm slopes. Ceasing mowing in the low area would not affect the detention functions of the ponds. If mowing were to continue along the berm slopes, but were discontinued in the low area between the pond cells, it is assumed that native shrubs would grow. Many native shrub stumps were seen in this area that are regularly mowed, but appear to be alive. Additional plantings of native trees in this area would speed the establishment of native vegetation.

Cost Estimates

Cost estimates for improvements, repairs, and maintenance are in Table 2. Cost estimates are based on information provided by the City on material and labor costs for tasks related to maintenance and repairs. Site-specific maintenance and repair cost estimates were made by giving consideration to the specific repairs or maintenance needed as well as the site conditions and access. These estimates provide an approximate cost only and are therefore most useful for relative comparison between different maintenance and repair needs.

The following rates were provided by the City and were used in the estimates of repair and maintenance costs.

- Vactor—$195 per hour including two operators.
- Dump Truck—$70 per hour including operator.
- Back hoe—$65 per hour including operator.
- Tractor mower—$65 per hour including operator.
- Operator—$25 per hour.

Routine maintenance of detention ponds includes periodic inspection of FCS and outlet/inlet pipes for sediment and debris accumulation, minor shovel work to clear plants and debris from inlet and outlet pipes, vactor sediment from FCS, and mowing of berm slopes and access roads. It is assumed that mowing at most of the detention ponds can be accomplished by one operator with tractor mower in under 2 hours. It is assumed that inspection of FCS and minor shovel work to clear debris from inlet and outlet pipes can be accomplished by one staff member in under two hours. It is assumed that at most ponds removing small amounts of sediment from FCS can be accomplished by two staff members is less than 2 hours.

Eaglemont Golf Course Ponds

Based on the detention pond index map (November 24, 1999) provided by the City, it is estimated that there are 31 detention ponds on the Eaglemont Golf Course property. There are four types of ponds described on the map and in the stormwater operation manual (June, 1994): 1 residential detention pond, 4 wet/detention ponds, 11 golf course detention ponds with underdrains, and 15 wetland/weir wall detention ponds.

Eleven ponds were inventoried on the Eaglemont property. Six of these ponds were determined to be maintained by the City. The remaining five ponds do not receive runoff from City streets, and are included in the list of private ponds in Appendix A.

Some of the golf course detention ponds and one of the wet/detention ponds could not be located. The detention pond index map shows a different configuration of fairways and greens than was constructed, and it appears that the location and number of ponds constructed is also different than shown on the map.

Rating of the 11 ponds for maintenance and repair needs resulted in 3 high, 6 medium, and 2 low scores. Ratings for each pond are shown on 11 data sheets titled Eaglemont 56 to Eaglemont 66 (6 data sheets in Sheets; 5 data sheets in Appendix A). Problems requiring maintenance or repairs include large amounts of sediment in FCS, clogged underdrains, nonfunctional charcoal filter units, insufficient berm height, erosion damage to berms, trees and shrubs growing on emergency overflow spillway, and trees and shrubs blocking access road to FCS. Although not included in the inventory, it was observed that several of the wetland/weir detention ponds had clogged outlets and remained filled to capacity more than 48 hours after the most recent storm.

LIMITATIONS

Work for this project was performed, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the City of Mount Vernon for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

Any questions regarding our work and this report, the presentation of the information, and the interpretation of the data are welcome and should be referred to the authors of this document.

We trust that this report meets your needs.

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UPDATE

City of Mount Vernon Comprehensive Stormwater Management Plan

August 2009

City of Mount Vernon
Public Works Department
1024 Cleveland Avenue
Mount Vernon, Washington 98273

City of Mount Vernon Comprehensive Stormwater Management Plan

2009 Update

1. Introduction

1.1 Background

The policies of the Mount Vernon Comprehensive Plan provide guidance for making decisions that may affect the quality of life in Mount Vernon, the environment in the City and surrounding area, and the City's future growth and development. Components of this plan, two companion documents, the 1995 Mount Vernon Comprehensive Surface Water Management Plan and its 2004 update, the Comprehensive Stormwater Management Plan Update, provide policies specifically intended to guide decisions that impact surface water. The role of surface water management in Mount Vernon is to:

- Protect the life, health, and property of the general public
- Ensure the safety of City roads and rights-of-way
- Respect and preserve the City's watercourses
- Minimize water quality degradation and control sedimentation of creeks, streams, ponds, lakes, and other water bodies
- Preserve and enhance the suitability of waters for contact recreation and fish habitat
- Preserve and enhance the aesthetic quality of the waters
- Maintain and protect valuable ground water quantities, locations, and flow patterns
- Decrease drainage-related damages to public and private property

1.2 Goals and Objectives of the 1995 Comprehensive Surface Water Management Plan

Goals and objectives for the City of Mount Vernon's Comprehensive Surface Water Management Plan were developed through input from City staff and the Citizen Advisory Committee. These goals, and the objectives to be met so as to accomplish each goal, area as follows:

1.2.1 Goal #1: Prevent property damage from flooding

- Objective: Require adequate peak flow controls for new development.
- Objective: Perform the necessary analysis and recommend solutions for existing flooding problems.
- Employ management strategies in flood prone areas to ensure that new development is not exposed to significant flood risk.

1.2.2 Goal #2: Maintain good water quality

- Objective: Attempt to meet state Class A Water Quality Standards in area streams.
- Objective: Require adequate erosion and sedimentation controls from new construction sites.
- Require adequate water quality controls for new development.
- Implement public education programs to reduce the source of pollutants entering surface waters.

1.2.3 Goal #3: Preserve sensitive resources and maintain varied use.

- Objective: Preserve fish and wildlife habitat.
- Objective: Preserve wetlands and implement a wetlands management strategy.
- Objective: Provide public access and recreation opportunities.
- Objective: Preserve open space.
- Objective: Review the City's Sensitive Areas Ordinance to ensure consistency with the surface water management program goals.

1.2.4 Goal #4: Develop a continuous and comprehensive program for managing surface water.

- Objective: Ensure a dedicated funding source for program implementation.
- Objective: Coordinate the City program with the Skagit County program.

1.3 Objectives of the 2004 Comprehensive Stormwater Management Plan Update

The objectives of the Comprehensive Stormwater Management Plan, 2004 Update was to provide a surface water management framework that would protect the public's safety, health and property, conserve and enhance natural systems within the City, and comply with local, state, and federal regulations. The update was developed using the following principles:

1. The Surface Water Plan should be a “living” document that encompasses alternative solutions such as Low Impact Development and can be adapted to conditions and priorities.
2. The recommendations should meet the current and anticipated requirements of federal regulations, particularly the Clean Water Act (CWA), Endangered Species Act (ESA), and Phase II of the National Pollution Discharge Elimination System (NPDES).

2. 2009 Comprehensive Plan Amendment

2.1 Capital Facilities, Public Services, and Utilities Element of the Comprehensive Plan

The 2004 Comprehensive Stormwater Management Plan Update (update of the 1995 Comprehensive Surface Water Management Plan) is Appendix CF-5 of Chapter 7 of the Mount Vernon Comprehensive Plan, the Capital Facilities, Public Services, and Utilities Element

The purpose of periodic updates of the Stormwater Management Plan is to provide an update to the strategic framework for the management of stormwater within Mount Vernon. The Stormwater Management Plan is intended to be a flexible document that may be readily revised should the priorities and focus of the City change. It is also intended to act as a reference for other City departments whose activities may impact storm and surface water and could be affected by drainage.

2.2 The 2009 Stormwater Plan Update

The Stormwater Plan Update, an amendment to the Comprehensive Plan Amendment proposed by the Mount Vernon Public Works Department, would revise previous plans, by adopting the Washington State Department of Ecology 2005 Stormwater Management Manual for Western Washington.

The City of Mount Vernon is one of nearly 100 Washington municipalities covered by the Phase II Municipal State Stormwater Permit. The Permit was issued by the Washington State Department of Ecology in January 2007, under authority of the federal Clean Water Act. One of the key Permit requirements is that cities adopt, by August 2009, either the 2005 Stormwater Management Manual for Western Washington or another municipal stormwater management manual that Ecology has approved as “equivalent.” The City of Mount Vernon intends to adopt the 2005 Stormwater Management Manual.

One of the first steps required in order to adopt the Ecology Manual is to update the City’s Comprehensive Plan, specifically Chapter 7 of the Comprehensive Plan, the Capital Facilities, Public Services, and Utilities Element. Appendix CF-5 of Chapter 5 is the Comprehensive Stormwater Management Update, prepared by CH2MHill, dated November 2004. This Appendix needs to be updated to reflect the Permit requirements from Ecology with which the City is required to comply.

The principal change to the current Stormwater appendix will be to revise the existing language that states, “Adopt Ecology Stormwater Management Manual for Western Washington, August 2001,” so that it states the City will adopt the latest edition of the Ecology Stormwater Management Manual for Western Washington.

3. 2005 Stormwater Management Manual for Western Washington

3.1 Background

The Department of Ecology updated the previous manual, the 2001 Stormwater Management Manual for Western Washington, to correct errors, clarify statements, update design criteria and procedures, and apply recent research. Local governments use the manual to set stormwater requirements for new development projects, redevelopment projects, and to set operation and maintenance standards. Land developers and development engineers use the manual to help design site plans and determine stormwater infrastructure. Businesses use the manual to help design their stormwater pollution prevention plans. The manual is useful for anyone needing guidance on sediment and erosion control for construction sites.

Stormwater is the water that runs off surfaces such as rooftops, paved streets, highways, and parking lots. It can also come from hard grassy surfaces like lawns, play fields, and from graveled roads and parking lots.

Urban development causes significant changes in patterns of stormwater flow from land into receiving waters. Increased surface runoff flows cause stream channel changes that destroy habitat for fish. Water quality can be harmed when runoff carries pollutants such as eroded soil, oil, metals or pesticides into streams, wetlands, lakes, rivers, and marine waters or into ground water. Managing stormwater runoff helps to reduce these significant pollution problems that make waterways unhealthy for people and fish.

The stormwater management advocated in this manual involves: careful application of site design principles; construction techniques to prevent erosion and the discharge of sediments and other pollutants; source controls to keep pollutants out of stormwater; flow control facilities to reduce discharge flow rates; and treatment facilities to reduce pollutants.

3.2 2005 Stormwater Management Manual Objectives

The objective of the 2005 update of the Stormwater Management Manual for Western Washington is to provide guidance on the measures necessary to control the quantity and quality of stormwater produced by new development and redevelopment such that they comply with water quality standards and contribute to the protection of beneficial uses of the receiving waters.

The manual establishes minimum requirements for development and redevelopment projects and provides guidance concerning how to prepare and implement stormwater site plans. These requirements are, in turn, satisfied by the application of Best Management Practices (BMPs) from Volumes II through V. Projects that follow this approach will apply reasonable, technology-based BMPs and water quality-based BMPs to reduce the adverse impacts of stormwater. The manual is applicable to all types of land development – including residential, commercial, industrial, and roads.

City of MOUNT VERNON

Appendix C

CAPITAL IMPROVEMENT PLAN

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Appendix D

MOUNT VERNON SCHOOL DISTRICT'S CAPITAL IMPROVEMENT PLAN
SEDRO-WOOLLEY SCHOOL DISTRICT'S CAPITAL IMPROVEMENT PLAN