Comprehensive Sanitary Sewer Plan – 2008

City of Poulsbo

September 2008

Parametrix

Comprehensive Sanitary Sewer Plan – 2008

Prepared for

City of Poulsbo
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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

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APPENDICES

ACRONYMS

AAF	Average Annual Flow
ADF	Average Design Flow
ADWF	Average Dry Weather Flow
AWWF	Average Wet Weather Flow
CCI	Construction Cost Index
CEMP	Comprehensive Emergency Management Plan
CFP	Capital Facilities Plan
CIP	Capital Improvement Plan
CKWWTP	Central Kitsap Wastewater Treatment Plant
CPI	Consumer Price Index
CSP	Comprehensive Sanitary Sewer Plan
Ecology	Washington State Department of Ecology
GMA	Growth Management Act
GPCD	Gallons Per Capita Per Day
HDPE	High-Density Polyethylene
HYDRA	HydraGraphics Software Package, Version 4.85
I&I	Inflow and Infiltration
JRMS	Johnson Road Metering Station
KCDPW	Kitsap County Department of Public Works
KCPUD	Kitsap County Public Utility District
LSMS	Lift Station Monitoring System
MSC	Marine Science Center
MGD	Million Gallons Per Day
PDF	Peak Design Flow
PWD	Public Works Department
RCP	Reinforced Concrete Pipe
RCW	Revised Code of Washington
RTU's	Remote Telemetry Units
SCADA	Supervisory Control and Data Acquisition
SEPA	State Environmental Policy Act
TM	Technical Memorandum
UGA	Urban Growth Area
USEPA	United States Environmental Protection Agency
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

BACKGROUND

The City of Poulsbo's sanitary sewer system was largely constructed during the 1930s and 1940s. The system's age, general condition and the significant population growth over the last decade have combined to raise concerns regarding the system's adequacy for the future and the potential financial impacts for repairs and improvements. By the late 1980s, City leaders agreed that the first step would be the update of the Comprehensive Sewer Plan (CSP). A plan was commissioned and a draft completed in 1992. Updates to the plan were completed in 1998 and 2002.

A requirement for any city to upgrade or expand its sewage facilities is the preparation and adoption of a comprehensive plan under Revised Code of Washington (RCW) 35.67. An additional driving force is the land use planning process mandated under the Growth Management Act (GMA). Poulsbo adopted their Comprehensive Land Use Plan in 1994 and is in the process of preparing an update. One of the key elements of this land use plan as required by the GMA is a Capital Facilities Plan (CFP). The CFP is a six-year plan for capital improvements that support Poulsbo's current and future population and economy. An integral part of the CFP is sanitary sewer service.

PLANNING PROCESS

In 1996, the City retained the services of a consulting engineer, Parametrix, Inc., and authorized them to revise the 1992 Draft Plan and assist the City with preparation of a six-year capital improvement plan, rate analysis, and amendment of the City's existing sewer service agreement with Kitsap County.

A draft of this plan was completed in 1998 and was reviewed by the Washington State Department of Ecology (Ecology). This plan identified several alternatives for providing long-term service. However, further study of these long-term service alternatives was deemed necessary. These studies included preparation of an Environmental Impact Statement and the preparation of a Bond Road Pump Station and Force Main Study, both of which were completed in 2000. In 2002, a Draft CSP was completed that reflected the results of the studies conducted since 1998.

RELATIONSHIP TO OTHER PLANS

This document is an update to the 2002 Draft CSP. The following documents have been reviewed in the preparation of this document:

- 1994 Central Kitsap County Wastewater Facilities Plan
- 1994 City of Poulsbo Comprehensive Plan
- 1998 City of Poulsbo Draft Comprehensive Sewer Plan Update
- 2000 Final Supplemental Environmental Impact Statement to the Final Environmental Impact Statement for the Central Kitsap County Wastewater Facilities Plan
- 2002 Poulsbo Subarea Plan
- 2006 Kitsap County Comprehensive Plan
- 2007 City of Poulsbo Draft Comprehensive Water Plan

The planning and evaluation process associated with these reports has identified the need for sewer system improvements to meet the needs of the City and the Urban Growth Area for the next 20 years.

SERVICE AREA AND POPULATION

Study Area

Under the Growth Management Act, the City's sanitary sewer service area is defined as the Urban Growth Area boundary (UGA). The UGA as accepted by the City of Poulsbo and Kitsap County is shown in Figure ES-1.

Population

Population data for the study area is shown in Table ES-1. The City's 2005 population of 7,450 residents is expected to increase to 10,552 residents by 2025. Total UGA population is projected to increase to 14,808 in 2025 with an annual growth rate of 2.7 percent.

Table ES-1. Poulsbo Population Forecast

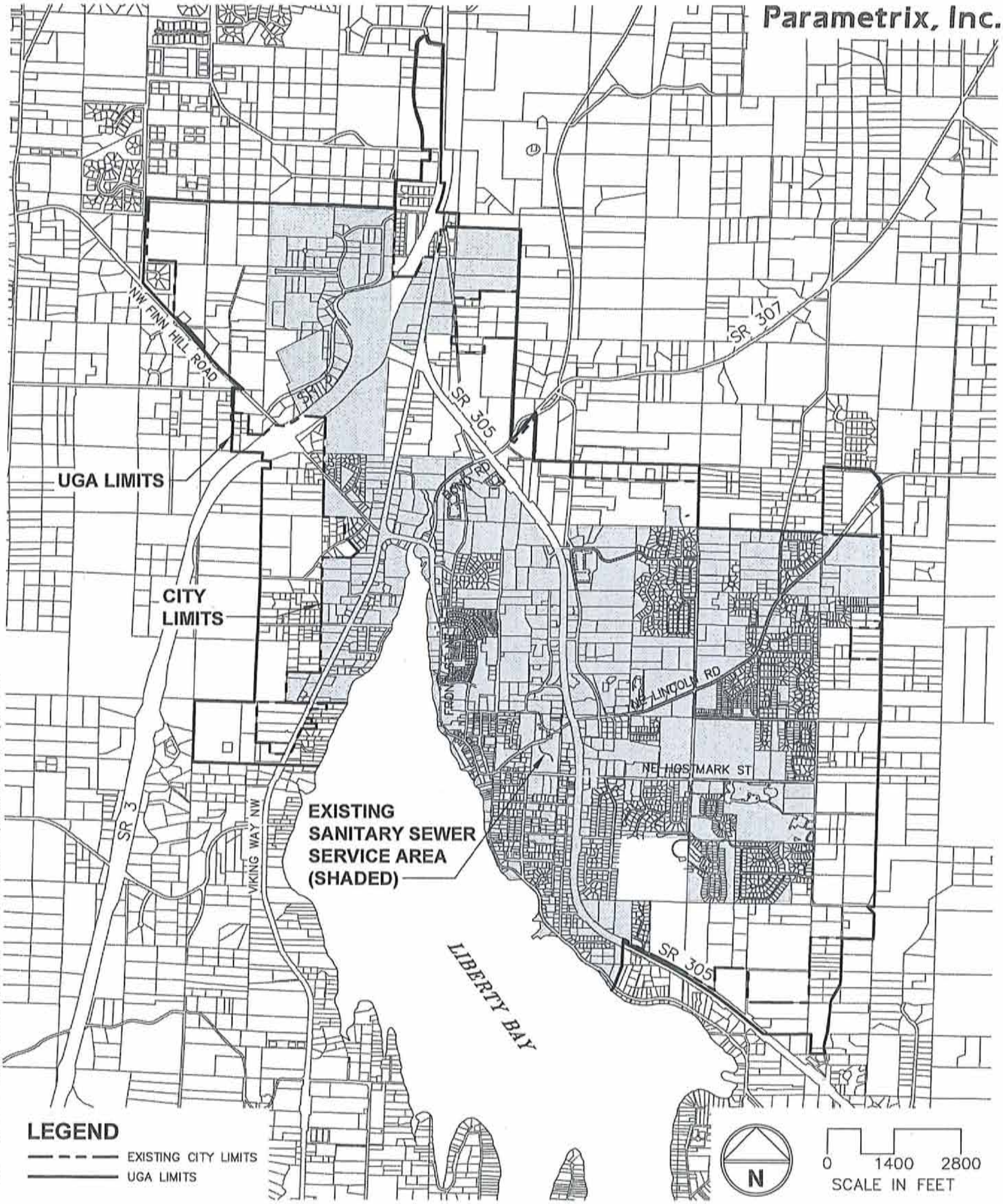
Population Distribution	Year			Annual Growth Rate
	2000	2005	2025	
City Limits	6,813	7,450	10,552	1.8%
UGA	901	1,230	4,256	6.4%
Total	**7,714**	**8,680**	**14,808**	2.7%

Source: Kitsap County Comprehensive Plan 10 Year Update 2006.

Existing and Projected Wastewater Flows

Corresponding to the anticipated growth in population for Poulsbo will be an increase in wastewater flows. Assuming a conservative annual growth rate of 2.7 percent over the 20-year planning period, Poulsbo's sewage flows (average daily flow) are expected to increase from 0.67 million gallons per day (mgd) to approximately 1.16 mgd. Peak hourly flows are estimated to increase from approximately 2.7 mgd in 2006, to approximately 4.2 mgd in 2025. Table ES-2 summarizes wastewater flow components for the planning period.

Table ES-2 presents a range of population growth for evaluating flow projections. The use of a range of growth rates reflects the uncertainty about how sewer service would be provided outside the City limits in the County portion of the UGA. At present, there are only 13 sewer connections outside the City limits. Therefore, the population growth projections for the City portion of the UGA (1.8 percent per year) are appropriate to use as the low-end estimate of growth in projected sewer flows. It is assumed that over the 20-year planning period a portion of the UGA outside of the City limits may become served by City sewer. The combined City and County UGA annual growth rate, 2.7 percent, is therefore used as the upper conservative end of the growth range. This upper range estimate is also used for capital project planning.



DATE: MARCH 2007

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Existing Sanitary Sewer Service Area

FIGURE ES-1

Table ES-2. Poulsbo Comprehensive Sewer Plan Flow Projections

		Actual		Projected			
Item	**Description**	**2005**	**2006**	**2010**	**2015**	**2025**	**2050**
1.	Sewered Population at a 2.7 % Annual Growth Rate[1]	7,450		8,512	9,724	12,693	24,707
2.	Sewered Population at a 1.8 % Annual Growth Rate	7,450		8,145	8,905	10,522	16,627
3.	Gallons per Capita per Day	87	88	91[2]	91	91	91
4.	Peaking Factor	3.71	4.02[3]	4.02/3.1[4]	4.02/3.1	4.02/3.1	4.02/3.1
5.	Annual Average Daily Flow, mgd	0.65	0.67				
	2.7 % Annual Growth Rate			0.77	0.88	1.16	2.25
	1.8 % Annual Growth Rate			0.74	0.81	0.97	1.51
6.	Peak Hourly Flow, mgd (gpcd)	2.40	2.70				
	2.7 % Annual Growth Rate			3.02	3.36	4.20	7.59
	1.8 % Annual Growth Rate			2.92	3.13	3.62	5.31

1 Sewered population is assumed same as City population, and does not include existing population within County portion of UGA where sewer service is not available.

2 Projected gallons per capita per day based on average gallons per capita per day from 2000-2005 period.

3 Peaking factor based on highest observed 2006 hourly flow (2.7 mgd) compared to average daily flow in 2006 (0.67 mgd).

4 Peaking factor of 4.02 is applied to 2005 population. A peaking factor of 3.1 is applied to population that is added after 2005, and assumes lower I&I rate due to new construction.

Projections shown in Table ES-2 are based on current conditions and do not reflect future flow reductions that will result from the Central Poulsbo I&I reduction project that will occur in 2008-2009, and the annual inflow reduction program that will be implemented in 2008. The flow projections should therefore be considered conservative estimates of potential future conditions.

DESCRIPTION OF EXISTING SEWER SYSTEM

The City of Poulsbo sewer collection system was initially constructed during the 1930s and 1940s. In 1942, a primary wastewater treatment plant was constructed near the City's business district. The City-owned treatment plant discharged to Liberty Bay until the late 1970s. In 1978, the Central Interceptor was constructed along SR 305 to transport flows to facilities owned by Kitsap County. The County facilities transport wastewater from Lemolo to the Central Kitsap Wastewater Treatment Plant (CKWWTP) in Brownsville. The flow crosses Liberty Bay via two 12-inch gravity siphons and is routed south to the CKWWTP.

The collection system contains a variety of pipe materials including concrete, PVC, and ductile iron. Over time, sewers in the oldest part of the City have been replaced, which has reduced infiltration/inflow. Eight pump stations transport flow throughout the collection system. The existing system transports flow to the Kitsap County Metering Station at Johnson Road and Peterson Way. From that point, flow is directed to the CKWWTP through County conveyance facilities.

SYSTEM DEFICIENCIES

Evaluation of the existing system consisted of interviewing City engineering staff, field review of the City pump stations with maintenance staff, review of previous reports, and evaluation of flows and downstream conveyance capacity.

Primary deficiencies consist of high inflow and infiltration (I&I), and potential capacity constraints in the downstream conveyance system owned by Kitsap County. Previous I&I reduction projects in the 6th Avenue basin have been successful in reducing peak flow. Flow data indicates the 6th Avenue project may have resulted in an overall 15 percent reduction in average flow from the City, and a 35 percent reduction in peak flow in the 6th Avenue basin.

Capital improvement projects have been identified to address deficiencies, including the Central Poulsbo I&I Reduction project, a new inflow reduction program, and increasing the capacity of the Lemolo pipeline that conveys flow under Liberty Bay to the CKWWTP. Without recommended improvements, and based on projected flows, capacity of the downstream conveyance system may be exceeded by approximately 2013. With recommended improvements, downstream capacity appears sufficient to support growth that would occur over the next 20 years.

SYSTEM EXPANSION

System upgrades are anticipated to accommodate growth. The Olhava and Finn Hill developments in the north and the Noll Road development to the east are the principle areas of growth. Recommended system upgrades to accommodate this growth include:

- Lindvig to Bond Road force main to replace deteriorated beach force main
- Finn Hill collection system
- Noll Road collection system

Other smaller system expansion projects are proposed for other basins in the City. The CSP evaluates the capital improvement needs of the sewer system. The cost of each project has been scheduled over a six-year period to reflect priorities and to balance annual capital costs. Projects identified in the 6-year Capital Improvement Plan (CIP) are listed in Table ES-3. The sewer upgrade project costs are often shared between the City and the developer as both parties benefit from the completed infrastructure. Developer and City funding for CIP projects is shown in Table ES-3.

FINANCIAL PLAN

A preliminary sewer utility financial analysis for the 20-year study period is shown in Table ES-4. The summary includes capital improvement costs, treatment plant capital allocation, funding sources, ending fund balances, and revenue and expenses.

Based on Table ES-4, it appears a rate adjustment will likely be necessary in 2009 and beyond in order to maintain adequate fund balances, and meet projected capital expenditures, operation and maintenance, and contract services to Kitsap County for treatment of wastewater. It should be noted that the City and County will need to renegotiate the conveyance and treatment contract in 2008 or later, after Kitsap County completes its update to the County Comprehensive Sewer Plan.

Table ES-3. Capital Improvement Plan

Project	2008	2009	2010	2011	2012	2013	2014	Not Scheduled
Sewer Utility Funded Projects								
Replace Johnson Road Metering Station	$25,000							
Portable Trash Pumps – Bond Rd, Lindvig, MSC	$167,000							
Bond Rd Force Main	$849,000							
Central Poulsbo I&I Reduction	$535,000	$536,000						
9th Avenue Pump Station Upgrade		$241,000						
6th Ave Pump Station Upgrade		$138,000						
Village Pump Station Upgrade			$81,000					
Replace 6th to 9th Force Main			$380,000					
Marine Science Center Pump Station Repair			$54,000					
Replace Force Main Between MSC & Harrison Street					$328,000			
Replace 175 ft 18-in RCP with 24 in PVC – Johnson Rd				$58,000				
I&I Effectiveness and Downstream Capacity Engineering Study				$110,000				
Lemolo Pipeline Improvements					$50,000			
Slipline Beach Force Main						$180,000	1,120,000	
Olhava Pipe Run 18 Capacity Increase								$40,000 [3]
SR305 to Bond Rd Pump Station Capacity Increase								$30,000 [3]
Pump Station 16 Capacity Increase								$250,000 [4]
Non-Construction Sewer Utility Funded Projects								
Annual In-Flow Reduction Program	$20,000	$40,000	$21,000	$22,000	$23,000	$24,000	$25,000	
Kitsap County Contract Renewal Technical & Legal Services			$50,000					
Rate Study	$25,000							
Comprehensive Plan Update						$50,000	$50,000	
Total Sewer Utility Funded Projects	**$1,621,000**	**$955,000**	**$586,000**	**$190,000**	**$401,000**	**$254,000**	**$1,195,000**	**$320,000**

(Table Continues)

Table ES-3. Capital Improvement Plan (Continued)

Project	2008	2009	2010	2011	2012	2013	2014	Not Scheduled
Developer or LID Funded Projects[1]								
Noll Road North Collection System		$1,445,000						
Finn Hill Collection System		$1,756,000						
Liberty Bay Pump Station Upgrades		$250,000						
Central Viking Way Collection System			$677,000					
South Viking Way Collection System								$1,106,000
Noll Road South Collection System								$1,306,000
Total Developer/LID Funded Projects		**$3,451,000**	**$677,000**					**$2,412,000**
TOTAL ALL PROJECTS[2]	**$1,621,000**	**$4,406,000**	**$1,263,000**	**$190,000**	**$401,000**	**$254,000**	**$1,195,000**	**$2,732,000**

1 Schedule & costs for Developer/LID funded projects are estimated.
2 Costs are escalated 5% from 2007 to the year of construction.
3 Schedule is dependant upon build out within the basin.
4 Cost is estimated. Project assumed to be needed by 2020.
5 Estimated to be needed by 2030.

Table ES-4. City of Poulsbo Sewer Fund Financial Summary

Sewer Fund Element	Actual				Budgeted	Projected						
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Capital												
Capital Projects [1]	$ 165,913	$ 149,941	$ 15,602	$ 38,367	$ 1,055,000 [8]	$ 1,621,000	$ 955,000	$ 586,000	$ 190,000	$ 401,000	$ 254,000	$ 1,195,000
Equipment Replacement	$ -	$ -	$ -	$ 56,368	$ 110,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
New Public Works Complex [2]	$ -	$ -	$ -	$ -	$ -	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000
Total Capital Costs	**$ 165,913**	**$ 149,941**	**$ 15,602**	**$ 94,734**	**$ 1,165,000**	**$ 1,785,000**	**$ 1,119,000**	**$ 750,000**	**$ 354,000**	**$ 565,000**	**$ 418,000**	**$ 1,359,000**
Fund Balances												
Operating Fund	$ 865,332	$ 1,225,013	$ 1,634,380	$ 1,978,097	$ 2,145,966 [9]	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966
Sewer Capital Reserve [3]	$ 392,894	$ 180,753	$ 661,576	$ 870,738	$ 1,255,116	$ 2,255,116	$ 1,136,116	$ 386,116	$ 32,116	$ (532,884)	$ (950,884)	$ (2,309,884)
Debt Service Fund	$ 477,302	$ 669,344	$ 454,233	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686
Total Fund Balance	**$ 1,735,528**	**$ 2,075,110**	**$ 2,750,189**	**$ 3,316,521**	**$ 3,868,768**	**$ 3,868,768**	**$ 2,749,768**	**$ 1,999,768**	**$ 1,645,768**	**$ 1,080,768**	**$ 662,768**	**$ (696,232)**
Revenues												
Service Charges [4]	$ 1,852,713	$ 1,756,729	$ 1,794,011	$ 1,846,416	$ 1,751,000	$ 1,821,740	$ 1,895,339	$ 1,971,910	$ 2,051,576	$ 2,134,459	$ 2,220,691	$ 2,310,407
Restricted Revenues	$ 144,351	$ 11,506	$ 14,020	$ 112,287	$ 42,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Connection Charges	$ 143,782	$ 182,206	$ 267,732	$ 225,805	$ 100,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
City Share of SR350 FM and Bond Rd PS [5]	$ -	$ -	$ -	$ -	$ -	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)
Revenue Bond Proceeds	$ -	$ -	$ 2,444,520	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 2,140,846**	**$ 1,950,441**	**$ 4,520,283**	**$ 2,184,508**	**$ 1,893,000**	**$ 1,657,075**	**$ 1,730,674**	**$ 1,807,245**	**$ 1,886,911**	**$ 1,969,794**	**$ 2,056,026**	**$ 2,145,742**
Expenses												
Operation & Maintenance [6]	$ 671,381	$ 688,280	$ 729,224	$ 787,389	$ 891,889	$ 909,727	$ 927,921	$ 946,480	$ 965,409	$ 984,718	$ 1,004,412	$ 1,024,500
Contracted Services *(Sewage Treatment)*	$ 464,292	$ 473,641	$ 492,956	$ 505,001	$ 500,000	$ 510,000	$ 520,200	$ 530,604	$ 541,216	$ 552,040	$ 563,081	$ 574,343
Regional Sewage Treatment Capital System [7]	$ 156,521	$ 216,896	$ -	$ -	$ 220,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000
Debt Service	$ 484,546	$ 481,357	$ 2,795,646	$ 483,986	$ 398,343	$ 372,011	$ 373,412	$ 380,912	$ 384,188	$ 387,194	$ 393,842	$ 393,842
Total Expenses	**$ 1,776,740**	**$ 1,860,174**	**$ 4,017,826**	**$ 1,776,376**	**$ 2,010,232**	**$ 2,191,738**	**$ 2,221,533**	**$ 2,257,996**	**$ 2,290,813**	**$ 2,323,952**	**$ 2,361,335**	**$ 2,392,685**
TOTAL SEWER UTILITY BALANCE	**$ 1,933,721**	**$ 2,015,436**	**$ 3,237,044**	**$ 3,629,919**	**$ 2,586,536**	**$ 1,549,106**	**$ 1,139,909**	**$ 799,018**	**$ 887,865**	**$ 161,611**	**$ (60,540)**	**$ (2,302,174)**

Notes:
1. Refer to Table 7.1 for breakdown of CIP costs and schedule. CIP costs escalated at 5% per year per historical Construction Cost Index (CCI).
2. Estimated sewer utility share of debt service for new Public Works complex (25 percent of total).
3. Sewer capital reserves for 2007 through 2014 period calculated as prior years reserve less current years capital costs.
4. Service charges for period 2008 through 2013 based on average 2.0% growth per year, and 2.0% CPI adjustment per year.
5. City share (42%) of total cost of SR305 force main and Bond Road pump station projects ($6,000,000 total). Assumes average of 135 ERUs per year from Olhava for period 2007 through 2013. Total City obligation of approximately $2,520,000.
6. Operation and maintenance costs estimated to increase 2 percent per year.
7. Estimated cost for Poulsbo share of capacity improvements at CKWWTP. Actual costs to be developed by Kitsap County in 2007-2008 after completion of the County's Draft CSP update.
8. Actual approved 2007 City budget is $1,055,000.
9. Transfer $1,000,000 from Operating Fund to Capital Fund in 2008.

Table ES-5 summarizes sewer rates for wastewater service providers in Kitsap County. Higher monthly rates are due to Poulsbo's generally smaller population compared to other local utilities and the associated requirement to spread costs to a smaller rate payer base. The long conveyance system from the City to the CKWWTP, and the high I&I from the old City sewer system also contribute to higher rates compared to other local utilities. However, facility charges in Poulsbo are lower than many other nearby communities.

Table ES-5. Summary of Residential Monthly Sewer Rate in Kitsap County

	Monthly Rate			
Jurisdiction	Fixed	Commodity (per 600 cf)	Total	Facility Charge
Poulsbo	$29.61	$3.89	$52.95	$5,319
Bainbridge Island	$28.13	$4.80	$56.93	$5,123
Shelton	$20.80	$4.16	$45.76	$7,240
Port Orchard	$36.00	$ -	$36.00	$7,240
Kitsap County				
Central Kitsap	$48.33	$ -	$48.33	$2,840
Kingston	$48.33	$ -	$48.33	$7,182
Suquamish	$48.33	$ -	$48.33	$4,506
Bremerton	$22.08	$3.68	$44.16	$3,586

The financial analysis indicates sewer rates may need to be increased within the next several years to cover costs associated with system upgrades and normal O&M. A rate analysis to determine the extent of a potential rate increase is outside the scope of this CSP update. It is therefore recommended that the City initiate a rate study in 2008 to evaluate financial needs in greater detail. Based on the proposed CIP, sewer rates may need to be increased in 2009 and beyond in order to generate sufficient revenue to fund identified improvements.

As part of the recommended rate study, the City should evaluate the adequacy of the sewer connection (facility) charge. Costs for future conveyance and capacity improvements needed to accommodate growth should be reflected in connection charges to ensure that new customers are paying their fair share of capital facilities. Increasing the connection charge for new customers, if warranted, may reduce the magnitude of the rate increase that may need to be borne by all system users.

1. INTRODUCTION

1.1 BACKGROUND AND AUTHORIZATION

The City of Poulsbo owns, operates, and maintains a wastewater collection and conveyance system that serves approximately 2.5 square miles within the City of Poulsbo and the associated UGA. The sewer system consists primarily of gravity collection lines, which feed two interceptor sewers that convey wastewater from the west and north sides of Liberty Bay to the Kitsap County conveyance system at Lemolo. The County conveyance facilities transport the wastewater south under Liberty Bay to the CKWWTP located in Brownsville. The effluent is treated at the CKWWTP, which is owned and operated by Kitsap County Department of Public Works (KCDPW).

The City of Poulsbo's sanitary sewer system can be generally divided based on age and type of construction. The downtown and older parts of the City were largely constructed during the 1940s using clay and concrete tile pipe. The newer developments since 1960 are generally at higher elevations away from Liberty Bay and have good serviceable infrastructure. The age of the system, general condition, and the significant population growth in the 1980-2000 period combined to raise questions about the system's adequacy for the future and the financial impacts for necessary repairs and improvements. The City therefore commissioned an update to the CSP and a plan was completed in 1992, with draft updates in 1998 and 2002. However, due to changing conditions and policies, the 2002 draft plan was not adopted.

Parametrix, Inc. was authorized by the City of Poulsbo in October 2006 to prepare this Comprehensive Sewer Plan Update. The sewer plan has been prepared in accordance with Washington Administrative Code (WAC) 173-240, which provides guidelines for the preparation of General Sewer Plans. This plan will be adopted by the City under the provisions of the RCW 35.67. This document updates the City of Poulsbo CSP of April 2002, which in turn was an update of a Draft CSP dated May 1998.

1.2 PURPOSE AND SCOPE

The purpose of the CSP is to evaluate the City sewer system and determine if the sewer utility is adequately serving the current and future needs of the community, as well as meeting applicable regulatory requirements. Specific goals of this CSP update include:

- Evaluate existing wastewater collection and treatment requirements and project future wastewater system demands.
- Analyze the existing wastewater system to determine if it meets minimum requirements mandated by the Department of Ecology.
- Identify wastewater system improvements necessary to resolve existing system deficiencies and accommodate future needs of the system for 20 years into the future.
- Prepare a CIP and implementation schedule of improvements that meet the goals of the City's community service needs.

1.3 NEED FOR THE PLAN

A requirement for any city to upgrade or expand its sewage facilities is the preparation and adoption of a comprehensive plan under RCW 35.67. An additional driving force is the land use planning process mandated under the Growth Management Act (GMA). Poulsbo adopted their Comprehensive Land Use Plan in 1994 and is preparing an update that will be adopted in 2008. One of the key elements of this land use plan, as required by GMA, is a Capital Facilities Plan (CFP). This CFP is a six-year plan for capital improvements that support Poulsbo's current and future population and economy. An integral part of the CFP is the element addressing sanitary sewer service.

In December 2001, the City of Poulsbo and Kitsap County agreed upon the boundaries for the Poulsbo UGA. An update to the CSP was therefore completed in 2002 but not formally submitted to Ecology by the City due to uncertainties regarding population growth allocation within the City and the UGA. A draft copy was informally reviewed by the Department of Ecology, and verbal comment received. In January 2006, Kitsap County completed their Comprehensive Plan Update, which confirmed population forecasts within the Poulsbo UGA. This Comprehensive Sewer Plan therefore reflects final UGA boundaries and population projections. This CSP also meets the CFP requirements for sewer systems under the GMA.

The following documents have been reviewed in the preparation of this document:

- Poulsbo Comprehensive Sanitary Sewer Plan by R. W. Beck, Draft August 1992
- Central Kitsap County Wastewater Facilities Plan by Brown and Caldwell, May 1994
- Comprehensive Sewer Plan-1998 and 2002 Update by Parametrix, Inc.
- 2000 Final Supplemental Environmental Impact Statement to the Final Environmental Input Statement for the Central Kitsap County Wastewater Facilities Plan
- Bond Road Pump Station and Pipeline Predesign Technical Memorandum by Parametrix, Inc., December 18, 2000
- Poulsbo Subarea Plan Draft by Kitsap County Department of Community Development, 2001
- 2006 Kitsap County Comprehensive Plan
- City of Poulsbo Water System Plan (Draft) by Gray & Osborne, Inc. dated January 2007

2. SERVICE AREA, POPULATION, AND FLOW PROJECTIONS

This chapter presents the planning data and flow assessment needed to assess existing and future system needs including service area, population and conveyance capacity.

The City of Poulsbo Comprehensive Plan was adopted on June 13, 1994. The Plan was developed to meet the requirements of the Washington State GMA. The GMA requires, among other things, consistency between land use and utility plans and their implementation. This chapter demonstrates the compatibility of the Comprehensive Sewer System Plan with other plans, identifies the designated land uses within the existing and future service area, and identifies population projections within the Poulsbo planning area.

2.1 SERVICE AREA DESCRIPTION

2.1.1 Sewer System Service Area

The City of Poulsbo is located adjacent to Liberty Bay, which is a portion of Puget Sound in central Kitsap County. Figure 2-1 shows the City limits and the UGA approved by Kitsap County and Poulsbo. The Poulsbo sanitary sewer utility serves essentially the entire City and currently there are few extensions outside the city limits. The service area is limited to the UGA. The City and County, through the comprehensive planning process completed by Kitsap County in 2006, have designated the Poulsbo UGA as shown in Figure 2-1.

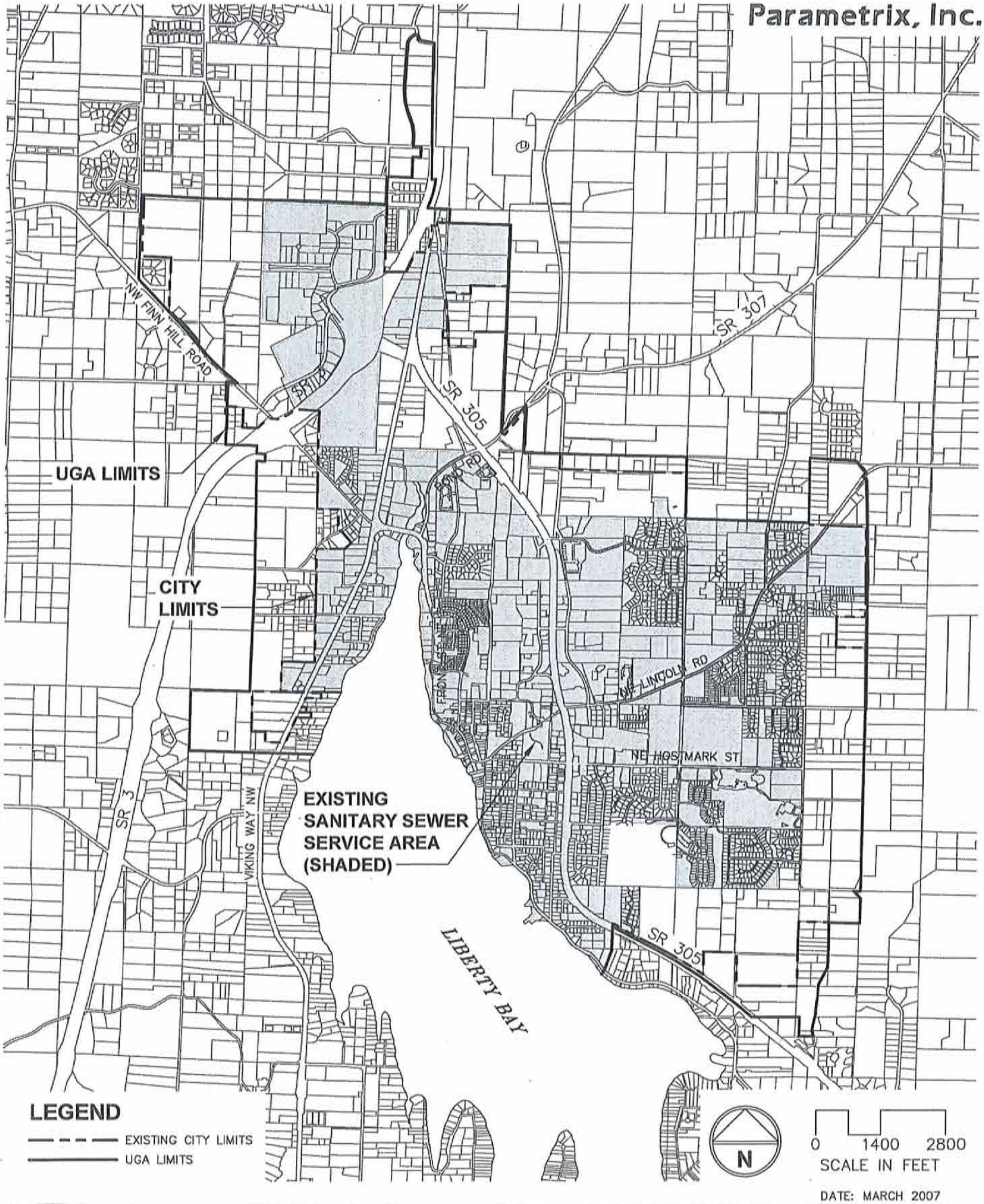
Most of the land area within the City limits and UGA is designated for residential use. Approximately 65 percent of the land area within the City limits and approximately 93 percent of the land area within the UGA is designated for residential use. Commercial use accounts for approximately 22 percent of the land area within the City limits and less than 2 percent of the land area within the UGA. The remaining land area is designated for business park, light industrial, open space, parks, conservation (environmentally sensitive areas), and public schools uses. There are no significant industrial or manufacturing uses in the Poulsbo area. Zoning and land use is shown in Figure 2-2.

2.1.2 Climate

The average annual precipitation for Poulsbo is about 37 inches and the average annual temperature is approximately 60°F. The climate is heavily influenced by Poulsbo's proximity to the Pacific Ocean. Maritime air has a moderating influence on landward temperature in both winter and summer. The prevailing wind is from the south or southwest in fall and winter, gradually shifting to west or northwest in late spring and summer. There is a well-defined dry season in summer and a rainy season in winter characterized by prolonged periods of moderate rainfall and cloudiness.

2.1.3 Topography, Geology, and Critical Environmental Areas

Poulsbo is typical of Kitsap County, with numerous hills and valleys, streams, and Puget Sound waterfront (Figure 2-3). Elevations range from sea level to 440 feet, with moderate to steep slopes prevalent. Two ridges run along each side of Liberty Bay and gradually rise in elevation to the north, accentuating the general topographical trend within Poulsbo.



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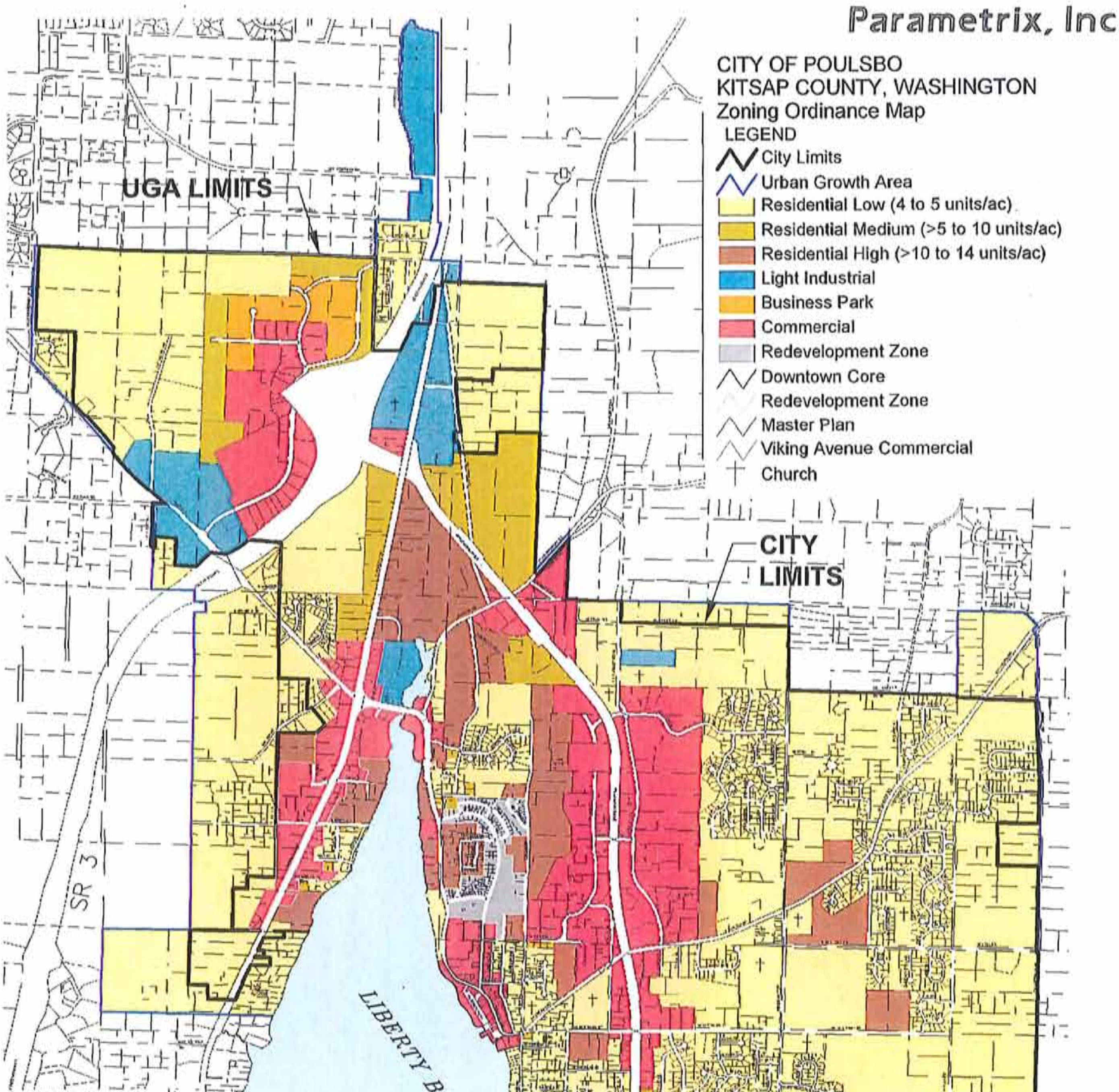
CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Existing Sanitary Sewer Service Area

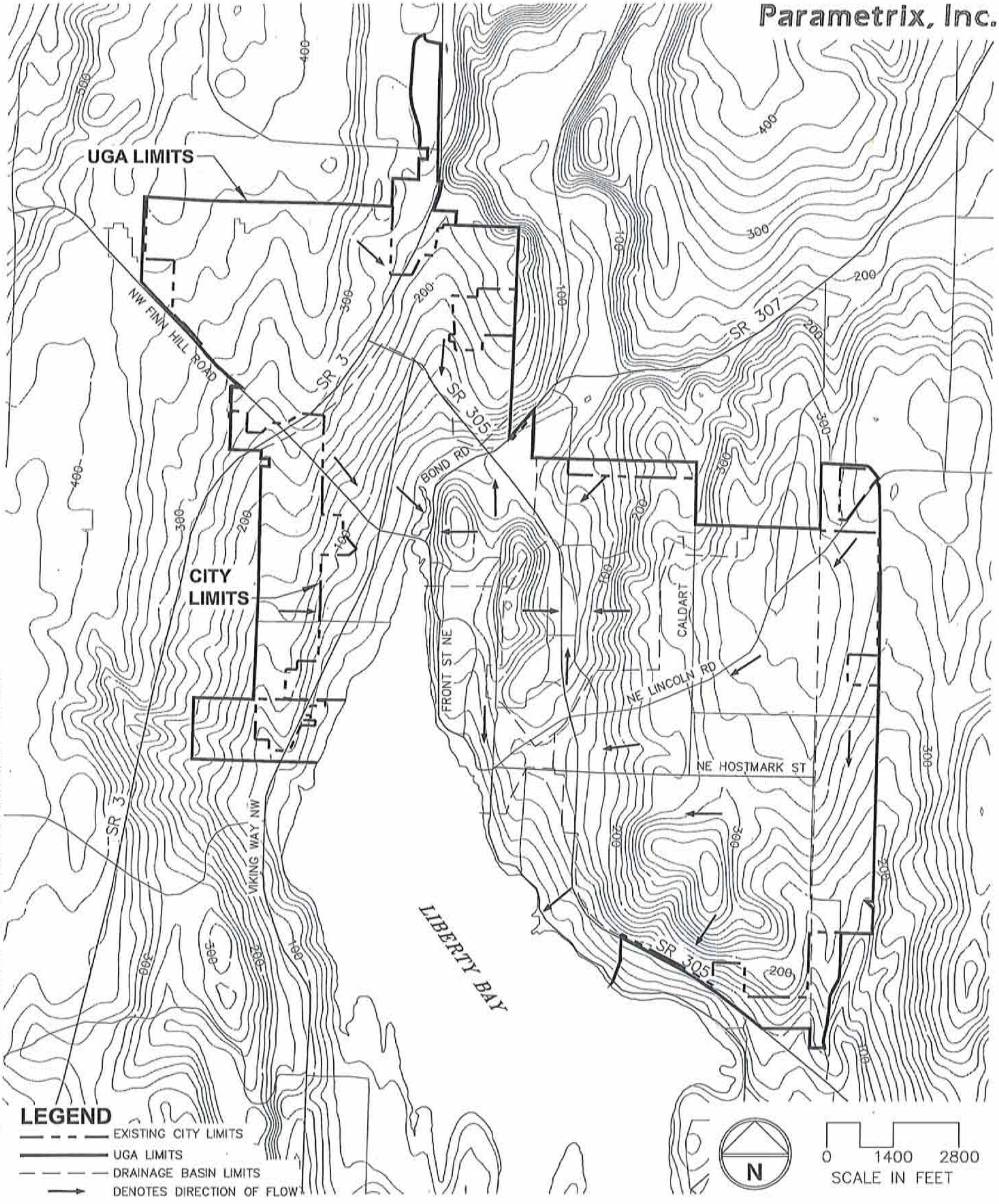
FIGURE 2-1



CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Land Use Map

FIGURE 2-2



CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Poulsbo Area Topography and Drainage Basins

FIGURE 2-3

Surface soils in the Poulsbo area consist of Vashon Till (hardpan) with a depth ranging from 20 to 40 inches. The majority of soil within the UGA is composed of the Poulsbo-Ragnar unit, which is composed of a gravelly sandy loam. The soil profile is nearly level to moderately steep, moderately deep, and moderately well drained on broad uplands.

Geologically critical areas are places highly susceptible to erosion, landslides, earthquakes, or other geologic events. In Poulsbo, the most hazardous of these areas is typically found along the marine shoreline and stream ravines. In many cases, these areas may be extremely desirable for development because of their scenic views or water and beach access, but their development may endanger people, property, and surface water resources.

Environmental critical areas within the study area include the Liberty Bay marine shoreline; Dogfish Creek, which drains into Liberty Bay at the northern end of the bay; the wetlands along the South Fork of Dogfish Creek, which follows SR 305 from Bond Road south, and steep slopes adjacent to Liberty Bay.

The GMA requires that critical areas be designated and protected. Critical areas include aquifer recharge areas, wetlands, and steep slopes. Appendix A contains the State Environmental Policy Act (SEPA) checklist that addresses critical areas and the CSP.

2.1.4 Frequently Flooded Areas

Areas designated as 100-year flood zones are located along the western and eastern sides of Liberty Bay and along Dogfish Creek, as shown on Figure 2-4. A 100-year storm event has a one percent chance of occurring each year, although this type of storm may occur more frequently. The areas portrayed in Figure 2-4 were identified by FEMA from aerial photos and topographic maps. Portions of the designated 100-year floodplain associated with Dogfish Creek lie within the service area.

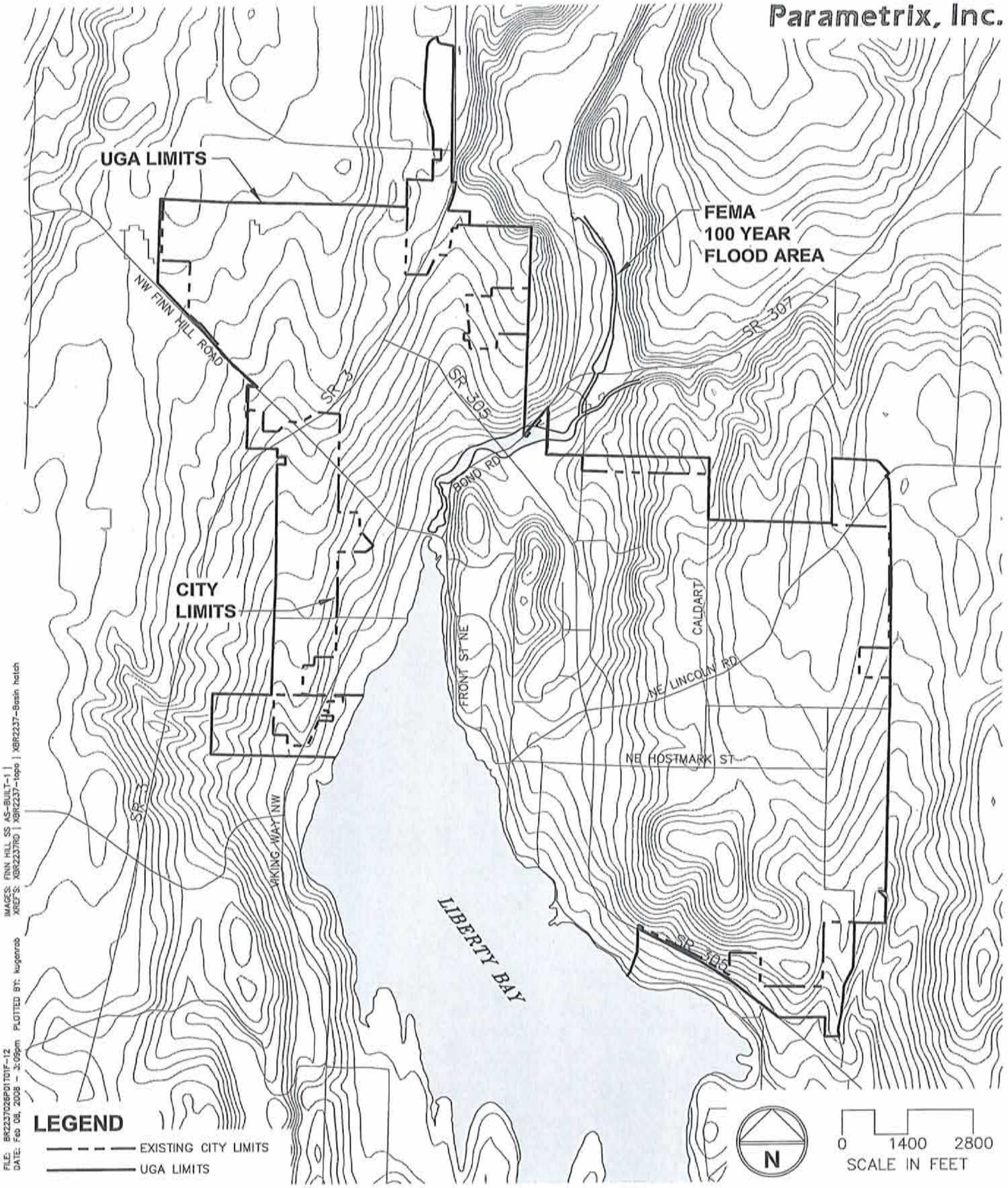
2.1.5 Water Utility

The City of Poulsbo owns and operates the water utility as well as the sewer utility. Water service is provided to essentially the same customer base and area as wastewater service. Figure 2-5 shows the water system. Poulsbo has an intertie at Finn Hill Road to the Kitsap County Public Utility District (KCPUD) No. 1 System. The City has five deep wells, and all are chlorinated and fluoridated. Table 2-1 summarizes the five wells.

Table 2-1. Poulsbo Water Supply Wells

Well	Average Production (gpd) for 2005
Big Valley Well No. 1	148,200
Big Valley Well No. 2	357,600
Pugh Well	216,300
Lincoln Well	171,300
Westside Well	On Line in 2006. No data available

Source: Draft City of Poulsbo Water Plan (2007)

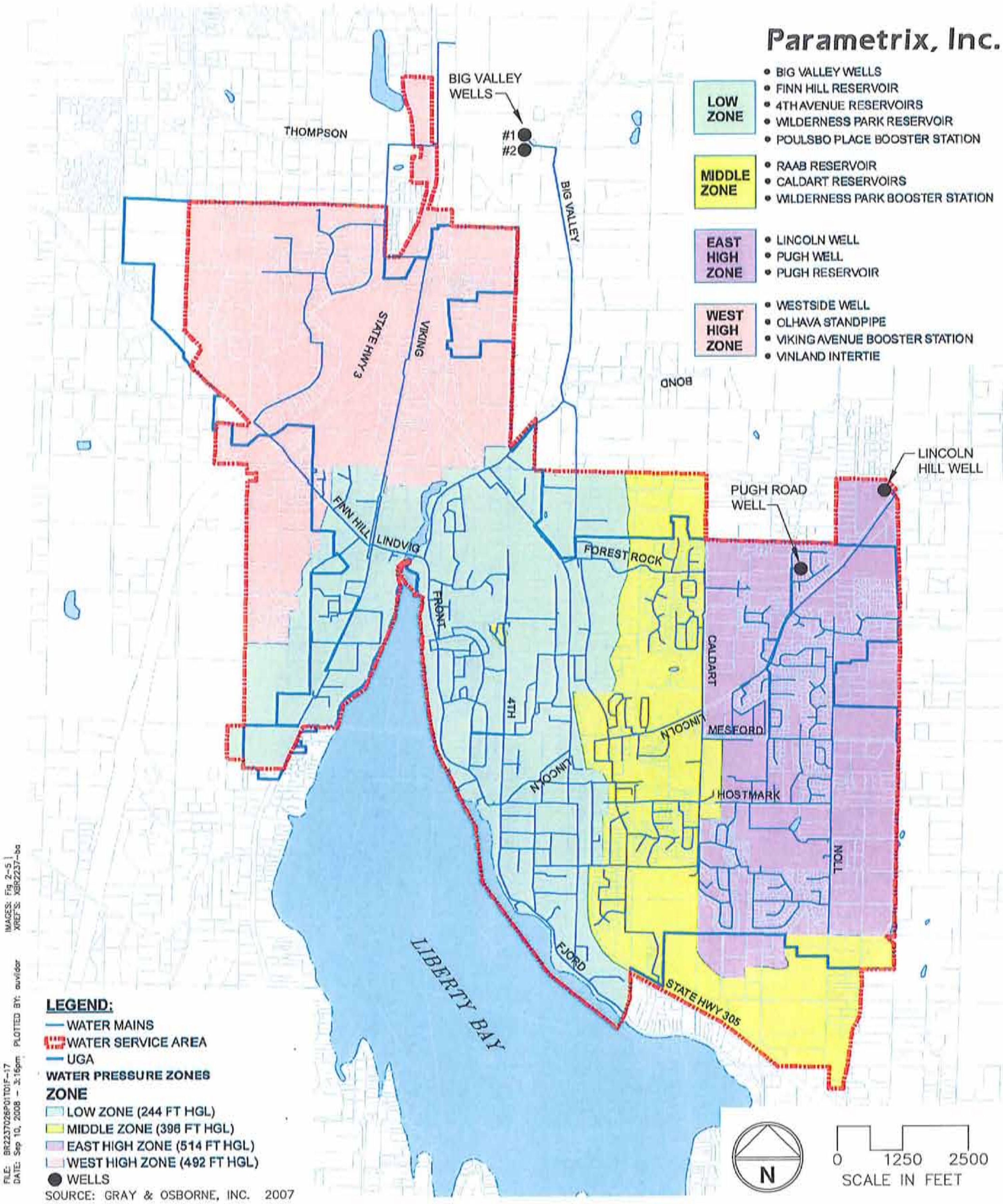


CITY of POULSBO

COMPREHENSIVE SEWER PLAN

Fema 100 Year Flood Area

FIGURE 2-4



CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Existing Water System

FIGURE 2-5

2.2 SEWER SYSTEM ORGANIZATION

2.2.1 Sewer System Ownership and Management

The City provides service to approximately 2,585 customers within a service area of about 2.5 square miles. The City contracts with Kitsap County to treat the wastewater. The Poulsbo collection system transports the wastewater to a Kitsap County metering structure from which the County accepts responsibility for transport across Liberty Bay to the CKWWTP at Brownsville under an agreement dated October 4, 1995, and amended July 1996 and 1998 (Appendix B).

The system functions under the direction of the Public Works Director. The Assistant Public Works Director – O&M, supervises daily operations of the Utilities Division. Tasks performed by the operations and maintenance staff include general and TV inspection, testing, installation, cleaning and repair of system facilities, routine operation and preventive maintenance, record keeping, data collection, administrative tasks, and corrective or breakdown maintenance required in response to emergencies.

2.2.2 Wastewater Treatment History

Poulsbo's sewer collection system was initially constructed during the 1930s and 1940s. In 1942, a primary wastewater treatment plant was constructed near the City's business district. The City-owned treatment plant discharged effluent to Liberty Bay until the late 1970s. The City then entered into a contract with Kitsap County for the treatment of Poulsbo's wastewater. In 1978, the Central Interceptor was constructed parallel with SR 305, connecting the City of Poulsbo to the metering facility at Johnson Road. The County transports wastewater from the Central Interceptor at the metering station via two 12-inch gravity siphons and Kitsap County Pump Stations Nos. 16 and 24 to the CKWWTP in Brownsville.

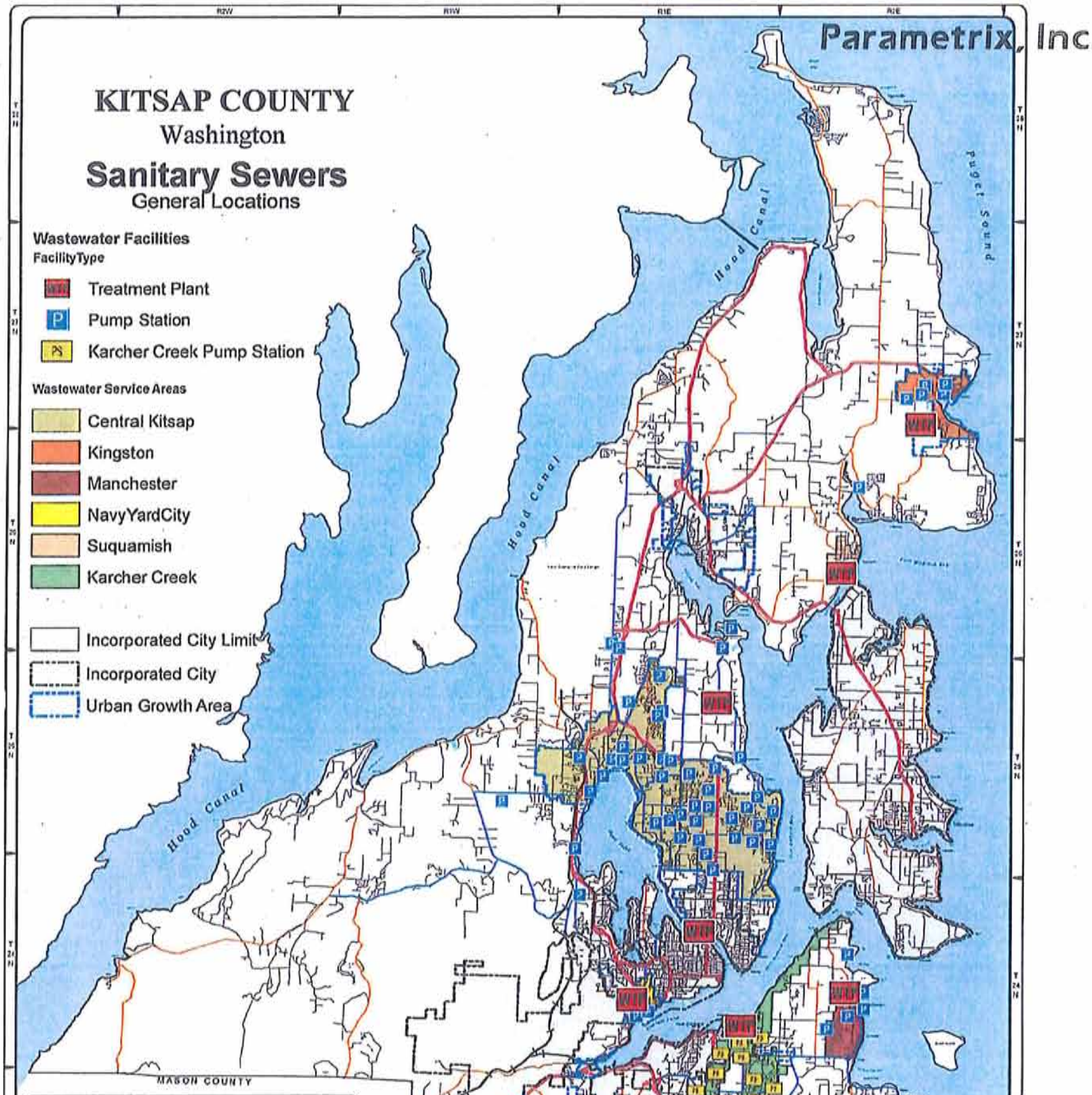
Approximately 11 single-family residences are connected to the County system between Johnson Road and Pump Station 16 in Keyport. The community of Keyport and the US Navy Undersea Warfare Station connects to the County system between Pump Station 16 and Pump Station 24.

Kitsap County operates three Wastewater Treatment Plants in the area (Kingston, Suquamish, and Brownsville). Figure 2-6 shows regional wastewater treatment facilities. Figure 2-7 shows the principle collector sewers and force mains in Poulsbo and the route of wastewater flow from the City to the CKWWTP. The flow crosses Liberty Bay at Lemolo.

2.2.3 Kitsap County Wastewater Treatment and Disposal Agreement

The City discharges wastewater to Kitsap County for treatment and disposal. Under the terms of the Agreement, the average flow from the City was not to exceed 0.95 mgd. The City was charged a fixed fee for up to 0.95 mgd. The fixed fee is recalculated when the flow exceeds 0.95 mgd for any given month and the higher rate remains in effect for the rest of the plan year. The Agreement also provides for the City to participate in the cost of CKWWTP improvements. Amendment No. 2 to the Agreement was developed in 1998 and it establishes the shared costs and method of payment for County conveyance improvements. The Contract

Agreement, including Amendments No. 1 and 2, is included in Appendix B. Anticipated costs as determined by Kitsap County for 2006-2007 are also provided in Appendix B.



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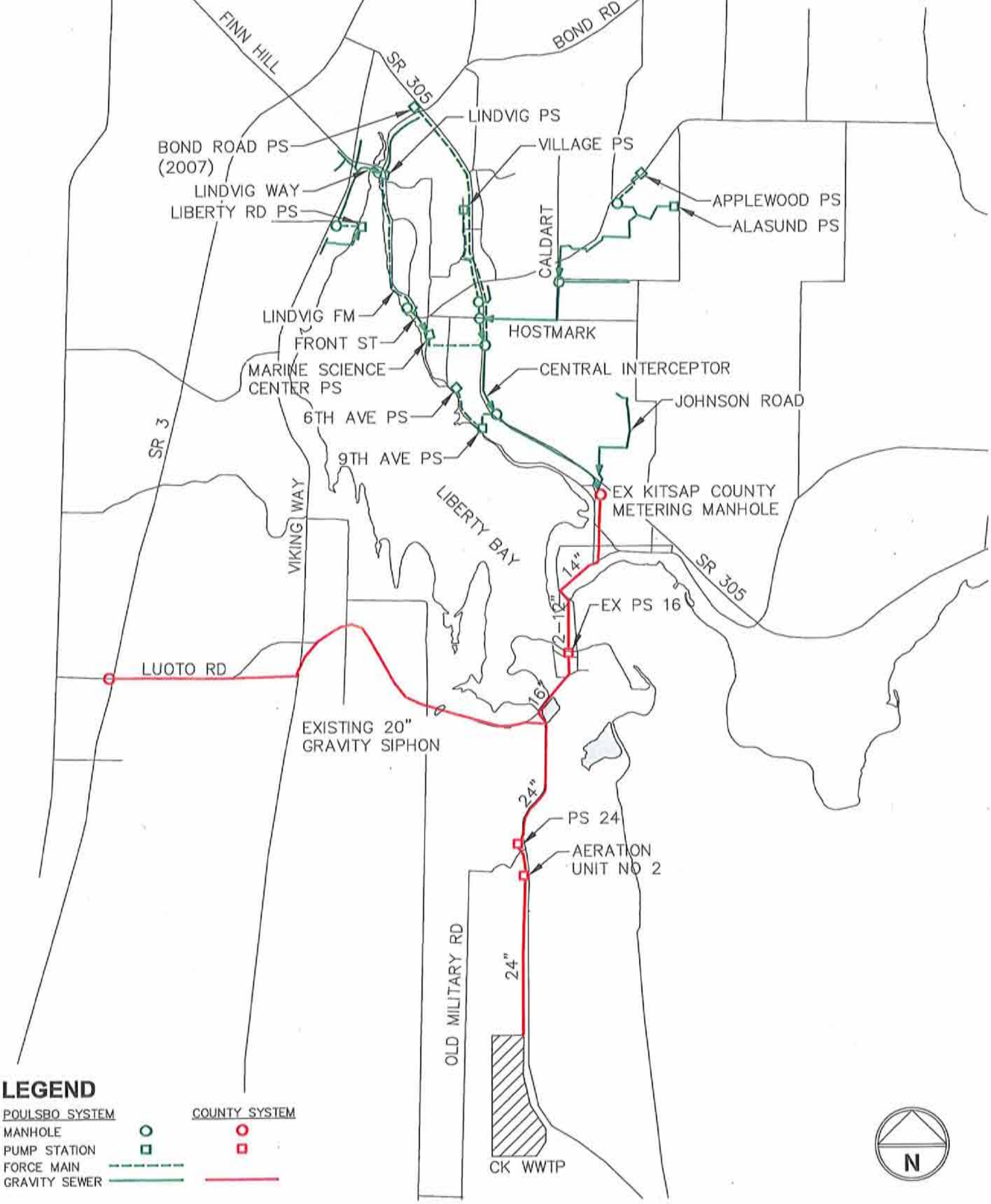
CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Regional Wastewater Treatment Facilities

FIGURE 2-6

Parametrix, Inc.



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CITY of POULSBO VIKING CITY

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

City & County Collection Systems

FIGURE 2-7

2.3 POPULATION

2.3.1 Historical Population

The City's population growth rate over the last ten years is presented in Table 2-2. Over the last ten years, approximately 1,685 new residents have become part of the City. Population growth during this period averaged 2.6 percent.

Table 2-2. City of Poulsbo Historical Population 1995 to 2005

Year	City Population	Annual Growth Rate
1995	5,765	6.5%
1996	6,070	5.3%
1997	6,140	1.2%
1998	6,590	7.3%
1999	6,445	-2.2%
2000	6,813	5.7%
2001	6,965	2.2%
2002	7,005	0.6%
2003	7,010	0.1%
2004	7,200	2.7%
2005	7,450	3.5%

2.3.2 Household Trends

The 2000 Census reported 2,845 total households. The average household size in Poulsbo was 2.3 persons per household. The average household size in all of Kitsap County was 2.6 persons per household in 1990. The City Planning Department currently estimates the smaller average household size in Poulsbo reflects the retirement base of the Poulsbo community.

2.3.3 Future Population

City of Poulsbo population projections are based on population projections provided in the final Kitsap County Comprehensive Plan (2006). Table 2-3 summarizes the population forecast for the planning period as established by the 2006 Kitsap County Comprehensive Plan.

Table 2-3. Poulsbo UGA Population Forecast

Population Distribution	Year 2000	Year 2005	Year 2025	Annual Growth Rate
City Limits	6,813	7,450	10,552	1.8%
UGA	901	1,230	4,256	6.4%
Total	**7,714**	**8,680**	**14,808**	2.7%

Kitsap County projects the City's UGA population to increase to 14,808 by 2025, or 2.7% per year. Sewer system flow increases associated with this growth are described in the following section.

Table 2-3 presents a range of population growth for evaluating flow projections. The use of a range of growth rates reflects the uncertainty about how or if sewer service would be provided outside the City limits in the County portion of the UGA. At present, there are only 13 sewer connections outside the City limits. Therefore, the population growth projections for the City portion of the UGA (1.8 percent per year) are appropriate to use as the low-end estimate of growth in projected sewer flows. It is assumed that over the 20-year planning period, a portion of the UGA outside of the City limits may become served by City sewer. The combined City and County UGA annual growth rate, 2.7 percent, is therefore used as the upper conservative end of the growth range. This upper range estimate is also used for capital project planning.

2.4 WASTEWATER FLOWS

Wastewater flow analysis is an important tool in the evaluation and planning of the sewer system. Table 2-4 defines typical wastewater flow parameters utilized in this section. The rate of wastewater flow varies throughout the day, the month, and the year.

Table 2-4. Typical Wastewater Flow Parameters

Parameter	Definition
Average Annual Flow (AAF)	The average flow computed from yearlong flow records.
Average Dry Weather Flow (ADWF)	Average flow occurring in dry-weather seasons.
Average Wet Weather Flow (AWWF)	Average flow occurring in wet-weather seasons.
Average Design Flow (ADF)	Peak month flow rate.
Peak Design Flow (PDF)	The peak 60 minute flow rate occurring during wet weather.
Infiltration	When groundwater enters the system through cracks in the pipe, joints or defects in the manhole walls.
Inflow	When surface runoff enters the system during storm events from storm drains, roof drains, curtain drains, and other stormwater connections.
Steady Flow	Water entering the system through constant sources of discharge including leaking faucets, leaking toilets, or cooling water.

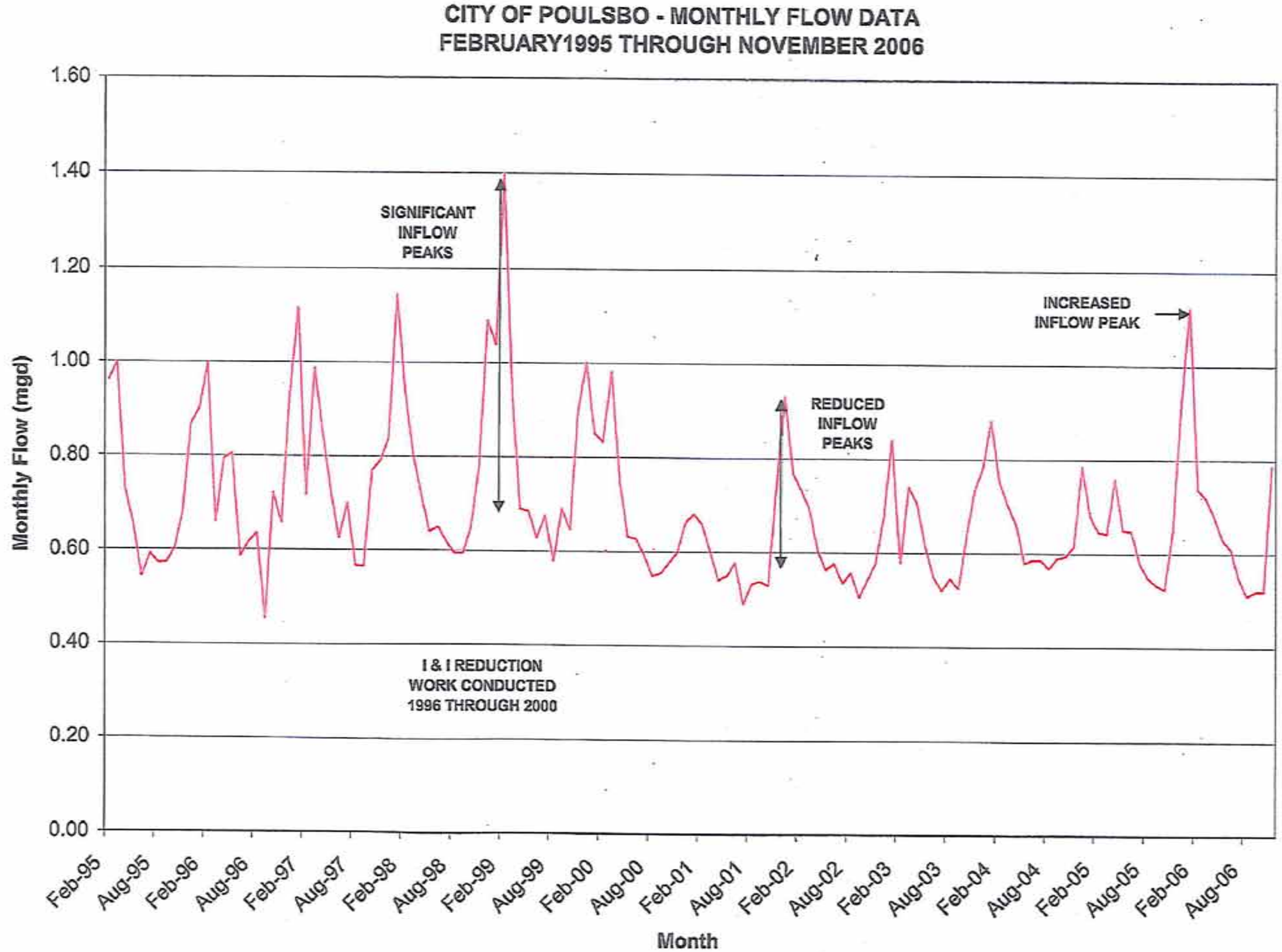
2.4.1 Historical Wastewater Flows

A summary of average monthly flows for 1995 through 2006 is shown below in Table 2-5 and in Figure 2-8.

A significant reduction in flow can be seen in Figure 2-8 after 2000, with large peaks between the dry weather and wet weather season showing a significant decrease in inflow. This reduction is likely due in large part to system rehabilitation that occurred in 2000 (6th Street Basin I&I), however, 2000 was also a low rainfall year. Inflow appears to increase in February 2006. The wet weather season for 2005 through 2006 is further discussed in section 2.4.

Monthly flows average approximately 0.76 mgd during the 1995 through 1999 period. In 2000, the City constructed the 6th Street I&I reduction project. Between 2000 and 2006, average monthly flows dropped to 0.65 mgd. This drop in average monthly flows equates to an approximated 15 percent reduction in flow. During the 2000 to 2006 period, the City population increased by 637 residents. The reduction in flow during a period of growth attests to the effectiveness of the 6th Street I&I reduction project.

Parametrix, Inc.



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CITY of POULSBO
COMPREHENSIVE SEWER PLAN

City of Poulsbo
Monthly Flow Data
February 1995 through
November 2006

FIGURE
2-8

Table 2-5. Average Monthly Flows for the City of Poulsbo 1995– 2006 (mgd)

	Monthly Flow												
Year	Jan	Feb	Mar	Apr	May	May	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
1995	0.94	0.96	1.00	0.73	0.65	0.65	0.59	0.57	0.57	0.60	0.68	0.86	0.72
1996	0.90	1.03	0.66	0.80	0.78	0.78	0.62	0.63	0.45	0.72	0.66	0.93	0.73
1997	1.19	0.67	0.99	0.85	0.72	0.72	0.70	0.57	0.57	0.77	0.82	0.84	0.78
1998	1.15	0.94	0.80	0.72	0.64	0.64	0.62	0.59	0.59	0.65	0.78	0.77	0.74
1999	1.04	1.40	0.93	0.69	0.72	0.72	0.67	0.58	0.69	0.64	0.90	0.90	0.82
2000	0.90	0.83	0.98	0.75	0.63	0.63	0.59	0.55	0.52	0.61	0.60	0.68	0.69
2001	0.64	0.63	0.62	0.52	0.55	0.55	0.49	0.53	0.54	0.51	0.73	0.93	0.61
2002	0.77	0.73	0.69	0.60	0.56	0.56	0.53	0.56	0.50	0.54	0.58	0.68	0.61
2003	0.84	0.58	0.74	0.71	0.61	0.61	0.52	0.55	0.52	0.63	0.73	0.78	0.65
2004	0.88	0.75	0.70	0.66	0.58	0.58	0.59	0.57	0.59	0.59	0.61	0.78	0.66
2005	0.68	0.64	0.64	0.76	0.65	0.65	0.58	0.55	0.53	0.53	0.65	0.91	0.65
2006	1.10	0.74	0.80	0.68	0.63	0.63	0.55	0.51	0.52	0.52	0.79	ND	0.67

2.4.2 Infiltration and Inflow (I&I) Analysis

The 1992 CSP identified significant I&I in the older sections of the City. The City spent the next ten years repairing and replacing many of the original sewers. The 2002 CSP identified a significant reduction of infiltration, steady flow, and inflow into the Poulsbo wastewater collection system compared to the 1992 study. Between 1996 and 2000, a total of about 30,000 lineal feet of gravity sewer main in Jensen Way, Front Street, Caldart Avenue, and streets in the 6th Avenue Basin area were repaired or replaced by both open trench and pipe bursting methods. Inflow during storm events before 1999 had often exceeded the capacity of the Kitsap County conveyance system, causing the Central Interceptor to surcharge, lifting off manhole covers, and causing the 6th Avenue pump station to run continuously for days.

The United States Environmental Protection Agency (USEPA) requires analysis of I&I if the domestic wastewater flow plus infiltration exceeds 120 gallons per capita per day (gpcd) during periods of high groundwater level (7-14 day average) or 275 gpcd during a storm event as a prerequisite to treatment plant expansion projects. Averages that exceed these amounts are considered "excessive" by the I&I Analysis and Projection Certification, Ecology Publication No. 97-03.

2.4.2.1 2005 & 2006 Flow Records

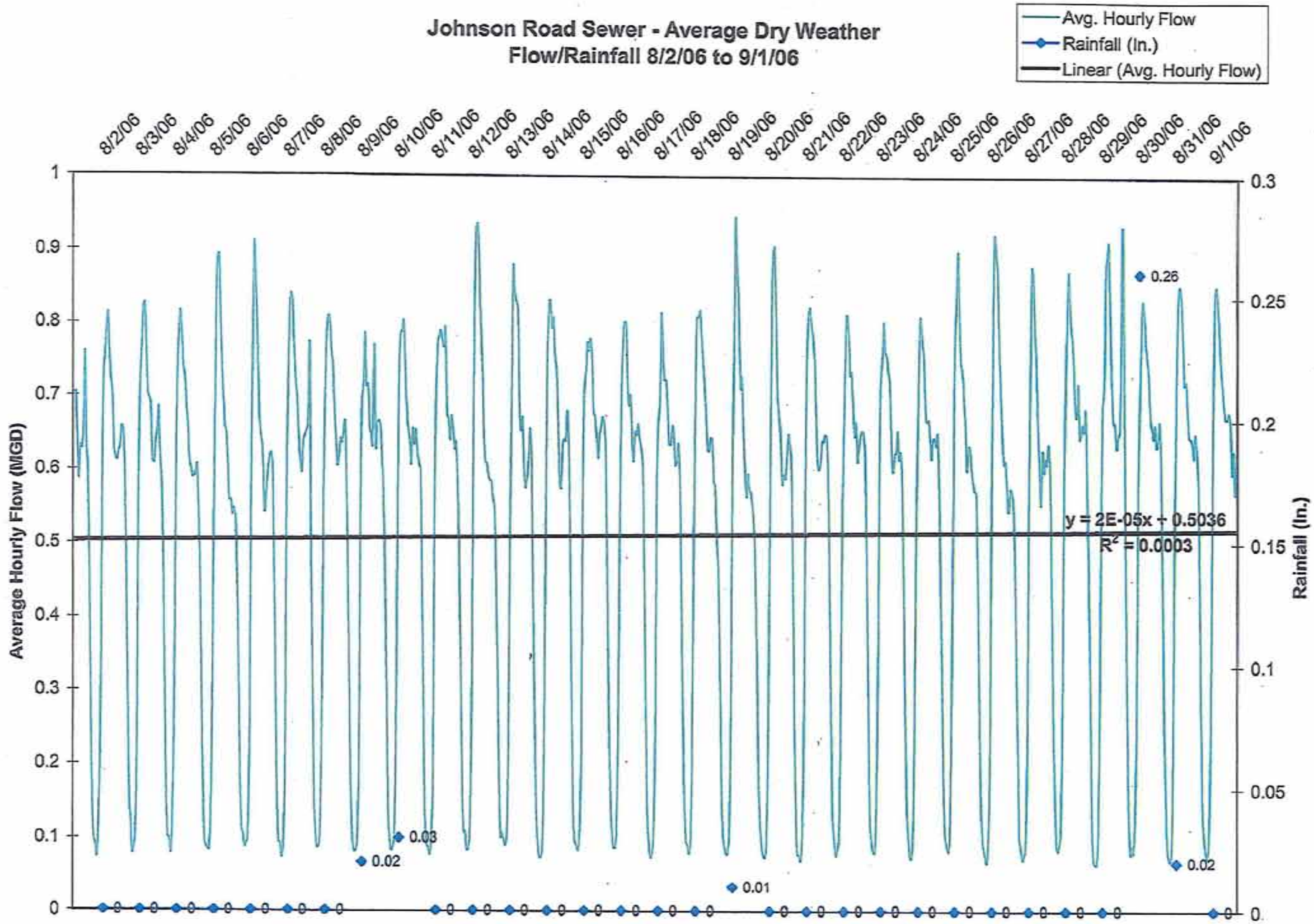
Year 2005 and 2006 flow records show a dry weather (August 2006) average flow of 0.509 mgd, and a wet weather (December 7, 2005 through February 27, 2006) average daily flow of 0.947. Flows from this same period are depicted in Figures 2-9 and 2-10.

According to EPA guidelines, inflow is considered to be non-excessive if the average daily flow during periods of heavy rainfall or spring thaw (i.e. any event that creates surface ponding and surface runoff) does not exceed 275 gallons per capita per day (gpcd). In order for the amount of infiltration to be considered non-excessive, the average daily flow must be less than 120 gpcd (i.e. a 7-to-14 day average measured during periods of seasonal high ground water). Average flows during periods of heavy rainfall and during seasonal high water were calculated to compare with EPA criteria as shown in Tables 2-6 and 2-7. Based on this data, the City does not exceed EPA criteria for excessive inflow or infiltration. Inflow during periods of heavy rain was calculated at 170 gallons per capita per day (gpcd), compared to EPA "excessive inflow" criteria of 275 gpcd. Infiltration during the seasonal high water table period of January, February and March 2005 and 2006 was calculated at 108 gpcd, compared to EPA "excessive infiltration" criteria of 120 gpcd.

Table 2-6. Average Daily Flow Per Capita During Heavy Rainfall Conditions, 2005 - 2006

Date	24 Hr Rainfall (in)	Total Daily Flow (MGD)	Population	Gal/Capita/Day
12/20/2005	0.92	0.992	7450	133
12/13/2005	1.59	1.141	7450	153
12/15/2005	1.13	1.140	7450	153
1/1/2006	1.51	1.608	7584	212
1/4/2006	1.12	1.367	7584	180
1/21/2006	2.97	1.673	7584	221
1/28/2006	1.13	1.048	7584	138
Averages	**1.48**	**1.281**	**7527**	**170**
EPA Threshold for "excessive" inflow				*275*

Parametrix, Inc.



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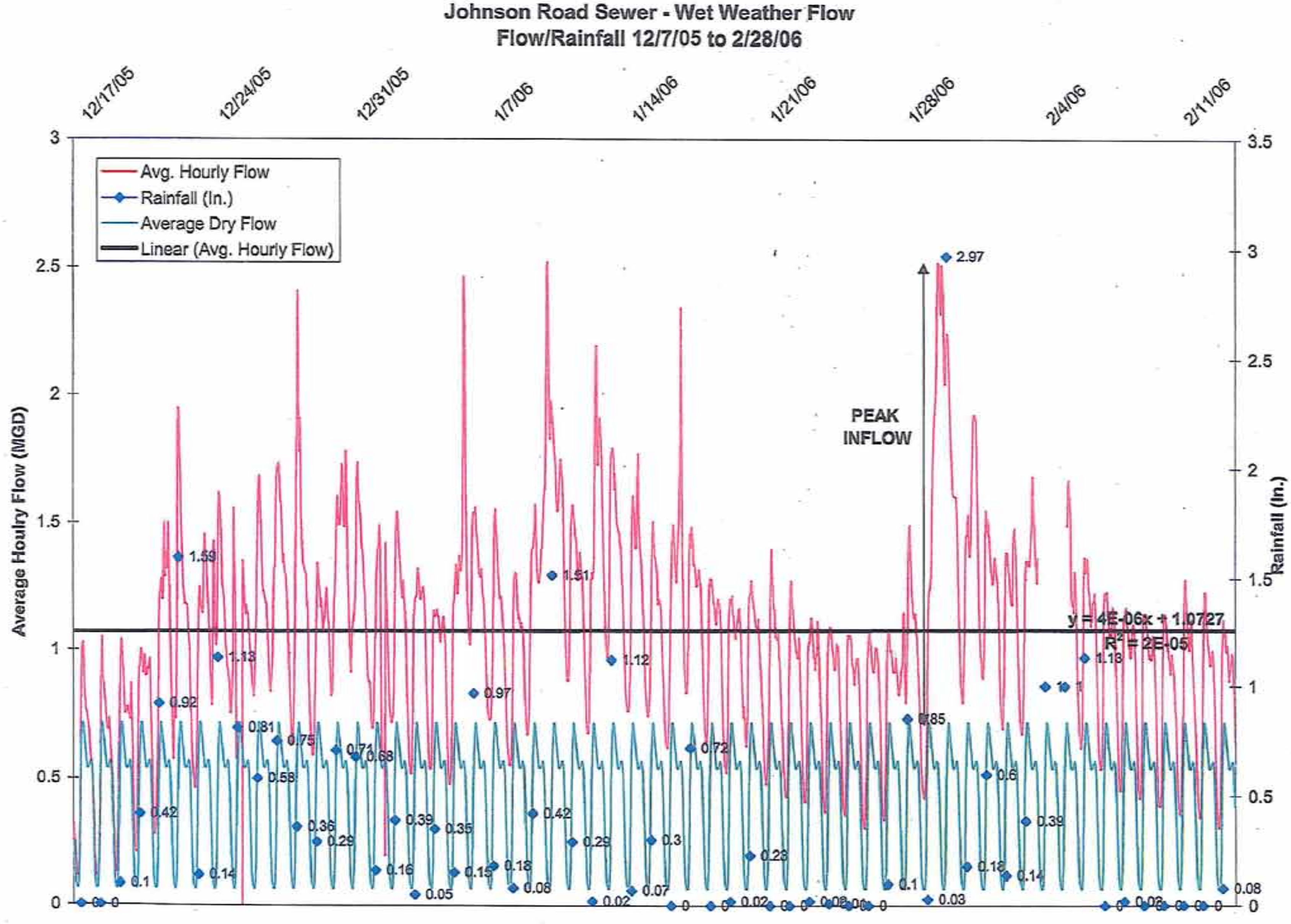
CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Johnson Road Sewer
Average Dry Weather
Flow/Rainfall 8/2/06 to 9/1/06

FIGURE 2-9



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CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Johnson Road Sewer
Wet Weather Flow
Flow/Rainfall 12/7/05 to 2/28/06

FIGURE 2-10

Table 2-7. Average Daily Flow Per Capita During High Infiltration (Seasonal High Water Table) Conditions, 2005 - 2006

Date [1]	24 Hr Rainfall (in)	Total Daily Flow (MGD)	Population	Gal/Capita/Day
1/18/2006	0	1.040	7584	137
1/25/2006	0	0.802	7584	106
2/7/2006	0	0.967	7584	128
2/10/2006	0	0.835	7584	110
2/15/2006	0	0.692	7584	91
3/3/2006	0	0.707	7584	93
3/13/2008	0	0.709	7584	93
Average	**0.00**	**0.822**	**7584**	**108**
	EPA Threshold for "excessive" infiltration			*120*

2.4.2.2 Pump Records Analysis

An I&I analysis was performed to evaluate stormwater inflow and infiltration in the largest of the City's basins, and to assess apparent effectiveness of the 6th Avenue basin I&I project completed in 2001. Of the five basins evaluated (6th Avenue, 9th Avenue, Liberty Bay, Lindvig and Marine Science Center) the quantity of stormwater infiltration per lineal feet of pipe and per acre of basin drained was highest in the 6th and 9th Avenue basins.

On the basis of total inflow, the Marine Science Center (MSC) pump station basin contributed the greatest volume of stormwater, followed by the 6th Avenue basin and the Lindvig pump station basin. It should also be noted that the majority of I&I in the MSC PS basin is generated in the older downtown area where the City's next I&I reduction project will be implemented. The pump station flow analysis is provided in Appendix C.

2.4.2.3 Effect of 6th Avenue Basin I&I Reduction Project

A contract for pipe bursting and side sewer replacement in the 6th Avenue Basin was completed in early 2001. The work included replacement of the majority of collection sewers and a portion of side services to individual residences. Prior to the project, major rainfalls caused the 6th Avenue pump station to run continuously for several days. During these events, the Central Interceptor would surcharge causing back pressure on the force main and reducing the pumping rate.

Analysis of pump records indicate that the project reduced pump run time by over 35 percent. The limited number of data points does not provide sufficient information for a strong conclusion. However, it does indicate that the project is likely to have reduced flow in the basin by approximately 35 percent.

2.4.2.4 I&I Conclusions

Flow analysis and the I&I evaluation shows that there continues to be a significant I&I problem, especially in the older portions of the City, and that further evaluation is necessary to determine specific sources of inflow and infiltration. I&I reduction efforts including pipe rehabilitation and implementation of on-going inflow reduction program are therefore included in the CIP. Refer to Chapter 7 for a more detailed description of proposed I&I reduction elements.

2.5 PROJECTED WASTEWATER FLOWS

Future wastewater flows for the City of Poulsbo were estimated utilizing the design criteria established from actual flow data from June 3, 2005 through November 21, 2006. This flow data is presented graphically in Figure 2-11. It should be noted that nearly a week of data is missing in July of both 2005 and 2006. These time frames fall within the dry season, and were excluded from use in calculations. Due to apparent malfunctions with the flume and/or meter flow, data is not available for flows over 2.52 mgd. There were three instances when this occurred, two on January 29, 2006 and one on January 10, 2006.

The peaking factor recommended in the Criteria for Sewage Works Design by the Department of Ecology for the system, results in a theoretical peaking factor ranging from 3.08 in 2005, to 2.56 in 2050. Based on actual flow data, it appears that this theoretical peaking factor does not accurately reflect the actual peaks found in the system. Therefore, the 5-year storm event on January 29, 2006, was used to establish the peaking factor. Figure 2-12 depicts the average hourly flows for January 28, 2006 through January 30, 2006. The average dry weather flow is added for reference purposes only. Malfunctions with the flume and flow meter require a projection for the peak flow from this rain event, which is derived from Figure 2-12. This actual peak flow and the annual average of 0.67 mgd results in a peaking factor of 4.02, significantly higher than the theoretical 3.08 calculation that is based on population alone. This high peaking factor is a clear indication of high I&I to the system.

Table 2-8 presents flow projections through 2050. Two population growth rates are used; a 2.7 percent growth rate that reflects average growth within the UGA, and 1.8 percent growth which reflects the growth rate within the City limits. These two rates are provided due to the uncertainty regarding the future extent of sewer service in the UGA outside of City limits. Currently sewer service limits are the same as the City limits. Two peaking factors are also used in estimating future flows. A peaking factor of 4.02 is used for the population existing in 2005, and a peaking factor of 3.1 is used for population added after 2005. This lower peaking factor reflects that new construction has lower I&I, and is consistent with Ecology's peaking factor criteria for populations that range from 7,000 to 10,000.

The average gallons per capita per day value is based on historical flow data and is derived from the average of the 2000 through 2006 gpcd, which ranges from 105 to 87 gpcd. A value of 91 gpcd is used for the projections in Table 2-8.

Peak hour flow projections are shown graphically in Figure 2-13. If these peak rates continue, the analysis shows that beyond the year 2013, peak hourly flow may exceed the existing 3.2 mgd capacity of the Lemolo siphon. With proposed improvements, it appears the downstream conveyance system has adequate capacity to accommodate flows through the 20-year planning period. Refer to Chapters 5 and 7 for additional discussion of downstream capacity and recommended improvements.

Projections shown in Table 2-8 are based on current conditions and do not reflect I&I reductions that will result from the Central Poulsbo I&I reduction program that will occur in 2008, and the annual inflow reduction program that will be implemented in 2008. The flow projections should therefore be considered conservative estimates of potential future conditions.

Table 2-8. Poulsbo Comprehensive Sewer Plan Flow Projections

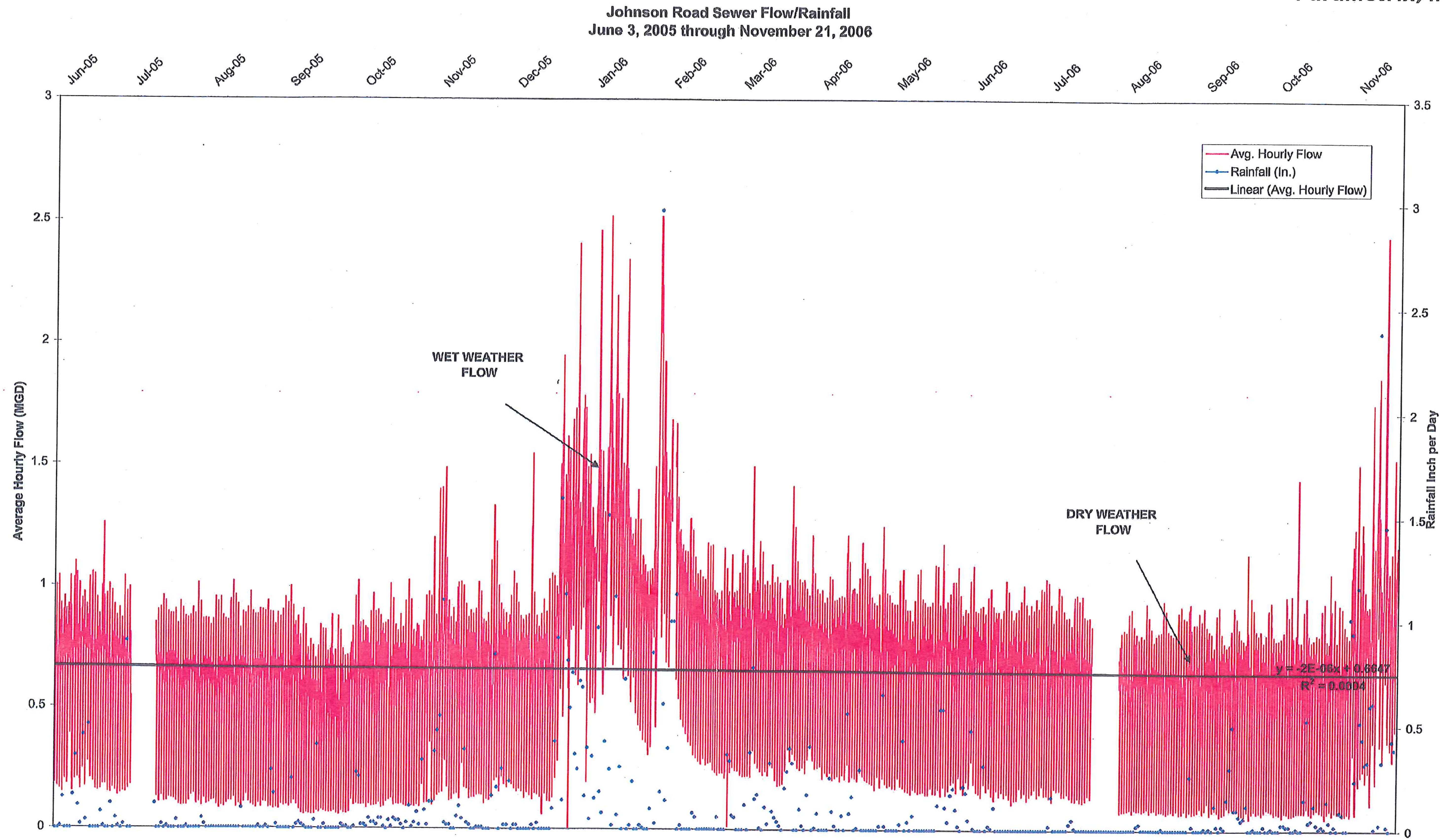
		Actual		Projected			
Item No.	**Description**	**2005**	**2006**	**2010**	**2015**	**2025**	**2050**
1.	Sewered Population at a 2.7 % Annual Growth Rate[1]	7,450		8,512	9,724	12,693	24,707
2.	Sewered Population at a 1.8 % Annual Growth Rate	7,450		8,145	8,905	10,522	16,627
3.	Gallons per Capita per Day	87	88	91[2]	91	91	91
4.	Peaking Factor	3.71	4.02[3]	4.02/3.1[4]	4.02/3.1	4.02/3.1	4.02/3.1
5.	Annual Average Daily Flow, mgd	0.65	0.67				
	2.7 % Annual Growth Rate			0.77	0.88	1.16	2.25
	1.8 % Annual Growth Rate			0.74	0.81	0.97	1.51
6.	Peak Hourly Flow, mgd (gpcd)	2.40	2.70				
	2.7 % Annual Growth Rate			3.02	3.36	4.20	7.59
	1.8 % Annual Growth Rate			2.92	3.13	3.62	5.31

1 Sewered population is assumed same as City population, and does not include existing population within County portion of UGA where sewer service is not available.

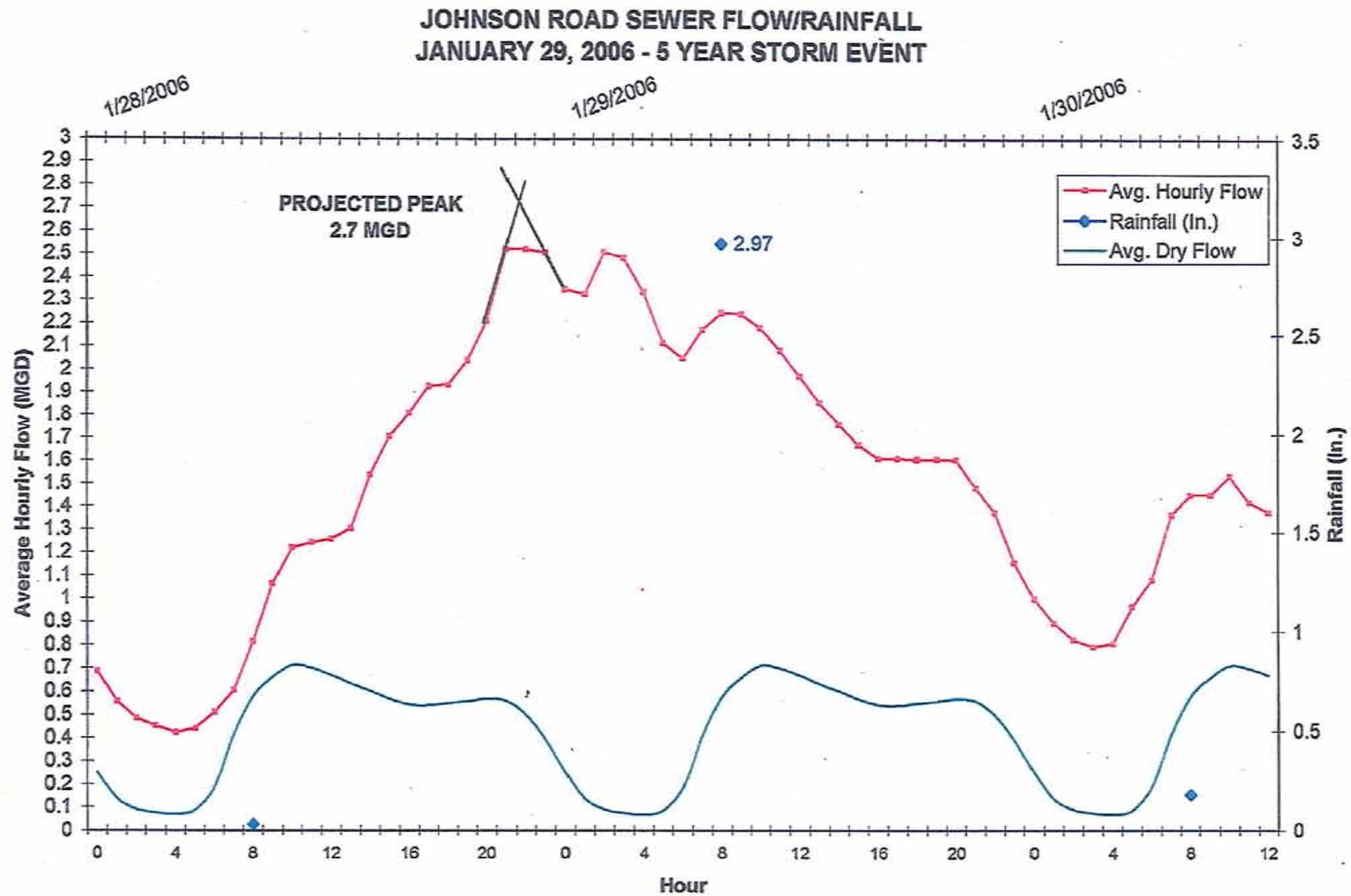
2 Projected gallons per capita per day based on average gallons per capita per day from 2000-2005 period.

3 Peaking factor based on highest observed 2006 hourly flow (2.7 mgd) compared to average daily flow in 2006 (0.67 mgd).

4 Peaking factor of 4.02 is applied to 2005 population. A peaking factor of 3.1 is applied to population that is added after 2005, and assumes lower I&I rate due to new construction.



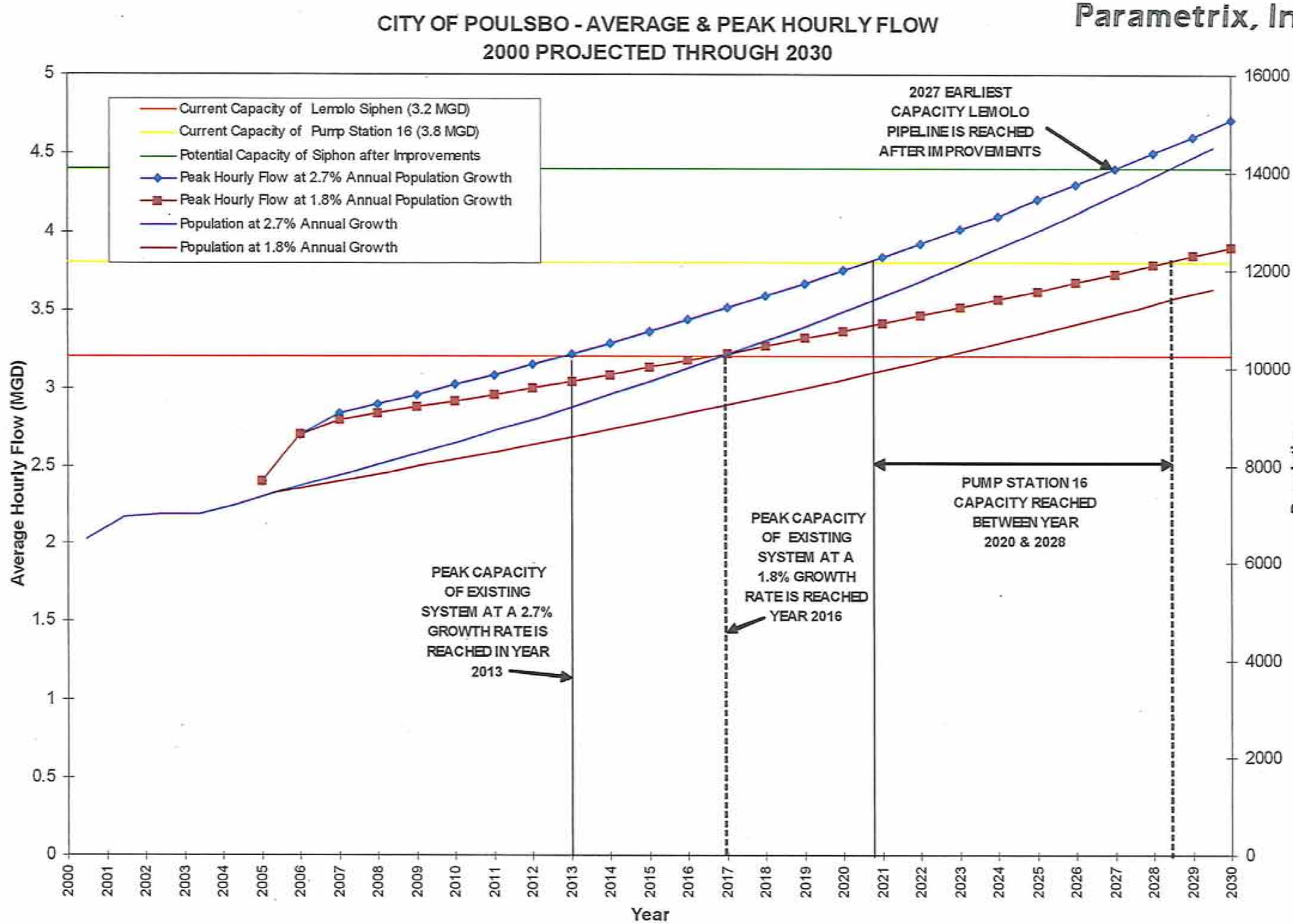
FILE: BR2237026P01T01F-24 PLOTTED BY: kugenrob IMAGES: Flow-Rainfall June 2005 to Nov 2006
DATE: Feb 08, 2008 - 3:28pm XREF'S:



Johnson Road Sewer
Projected Peak Flow
January 29 2006
5 Year Storm Event

FIGURE
2-12

Parametrix, Inc.



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DATE: Feb 11, 2008 - 3:56pm PLOTTED BY: fronkset XREF'S:

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Johnson Road Sewer
Average & Peak Hourly Flow
2000 Projected through 2030

FIGURE 2-13

3. SEWER SYSTEM DESCRIPTION

The City's sewer system consists of a combination of gravity collection lines, pump stations, and force mains. No wastewater treatment is performed by Poulsbo; rather, the City contracts with Kitsap County for treatment at the CKWWTP at Brownsville.

The original portions of the sewer system were constructed in the 1930s and 1940s. The post-war system contains a variety of pipe materials including concrete and vitrified clay. The majority of the system constructed since the 1960s consists of 8-, 10-, 12-, 15-inch ductile iron, and 18-inch PVC pipe. The majority of the existing sewers are 8-inch diameter. Recent pipe replacements have used high-density polyethylene (HDPE).

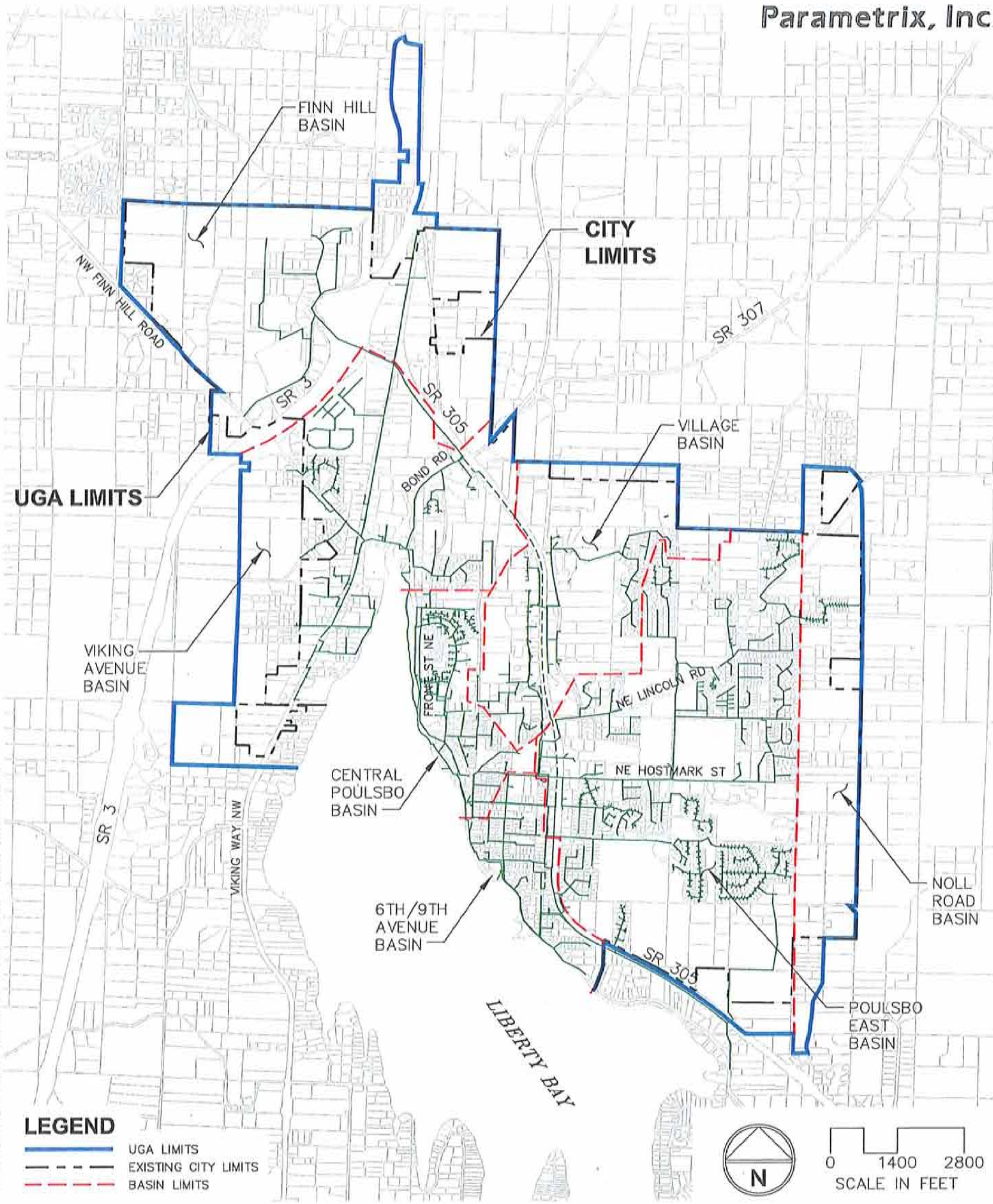
The system is considered a separated sewer system, meaning that it is designed to carry only sanitary wastewater. Storm and surface water are accommodated in other systems. The oldest sanitary sewers typically experience a high rate of I&I, which is groundwater that leaks into the pipes (infiltration), and rainwater that flows directly into the sewer (in-flow).

In 1942, a primary wastewater treatment plant was constructed near the City business district and operated until 1978. In 1978, an interceptor was constructed along SR 305 connecting the City system to the Kitsap County conveyance system south of Poulsbo at Lemolo, where the wastewater is discharged to facilities owned by Kitsap County. The interceptor constructed in 1978 is referred to as the Central Interceptor. The County transports the wastewater to the CKWWTP near Brownsville via a series of pumping stations, force mains and gravity interceptors.

A new force main was installed in 2006 to carry wastewater from the Olhava development to the Central Interceptor gravity main located in SR 305 at NE Tollefson Street, which carries the sewage to the Lemolo siphon. In 2007 a new pump station was constructed at the Bond Road/SR 305 intersection.

3.1 COLLECTION AND CONVEYANCE SYSTEM

The sewer system consists of approximately 28 miles of collection system main, nine wastewater pump stations, and a gravity interceptor connecting the City's system with Kitsap County's conveyance system. Table 3-1 summarizes collection and conveyance piping. Figure 3-1 shows the Poulsbo sewer collection system.



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CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Sewer Collection System Map

FIGURE 3-1

Table 3-1. Sizes and Lengths of Gravity and Pressurized Pipe

	Length of Pipe (Feet)	
Diameter of Pipe	**Gravity Sewer**	**Force Main**
4-inch		2,300
6-inch	1,200	1,200
8-inch	142,000	3,700
10-inch	9,100	4,700
12-inch	800	14,500
15-inch	970	0
18-inch	8,700	0

The City's collection system is divided into seven drainage basins (Figure 3-2). Basin boundaries are determined primarily by the contours of the land. Five of the basins flow to a pump station at the low point in the basin. The Poulsbo East Basin, however, flows by gravity to the Central Interceptor. Figure 3-3 is a schematic of the sewer collection system.

The following sections provide a general description of each basin. Information on sewer system condition and recommended improvements, basin maps and proposed upgrades, is provided in Chapter 4.

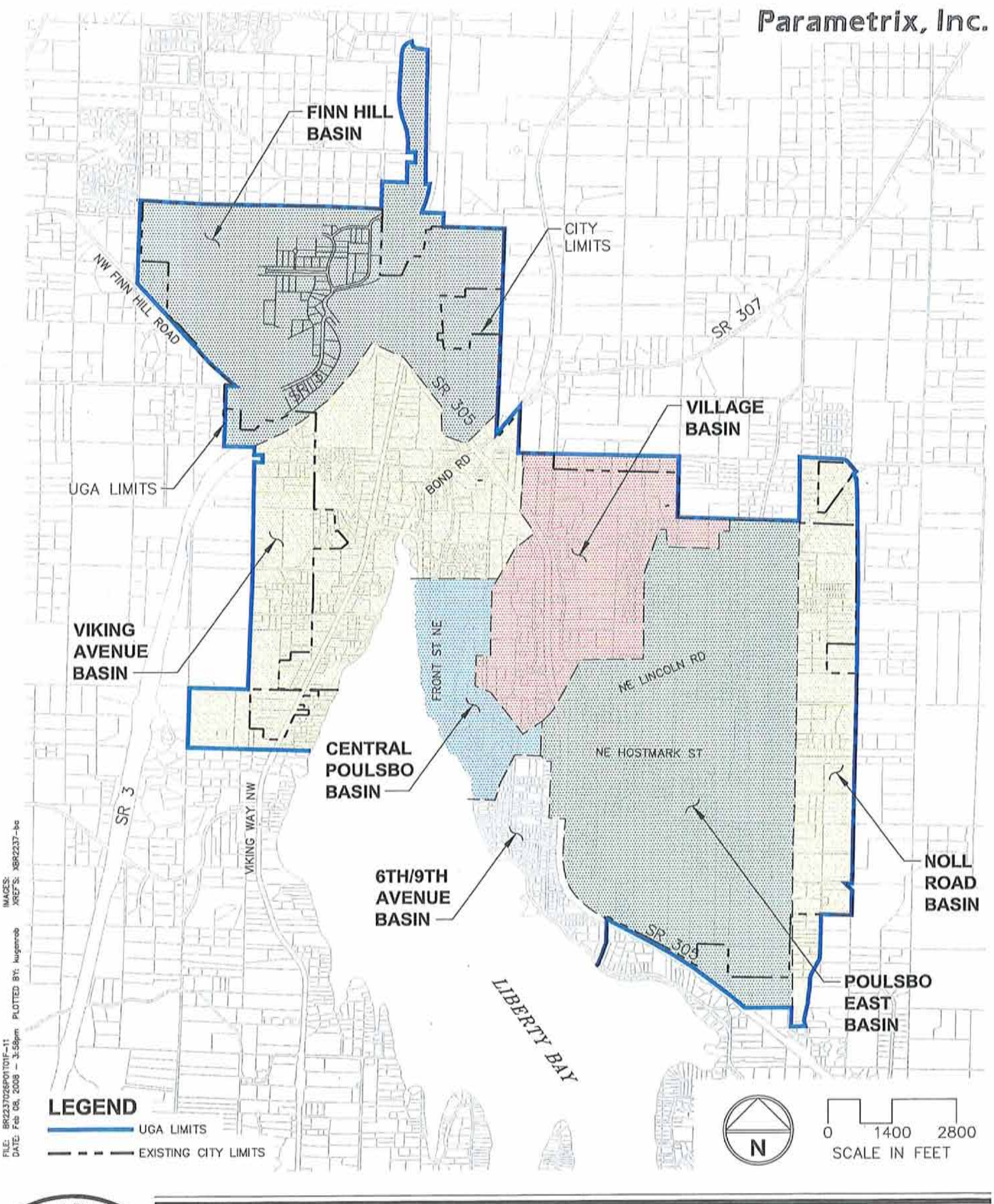
3.1.1 Viking Avenue Basin

This basin serves all of Poulsbo west of Liberty Bay, including the commercial district along Viking Avenue. It also serves the Olhava development and Finn Hill Road located south of SR 3. This basin is a major growth area for Poulsbo. Wastewater flows by gravity to both the Lindvig pump station and the new Bond Road pump station. The Lindvig pump station was rebuilt and expanded in 1999. Wastewater is pumped from the Lindvig pump station into the Central Poulsbo drainage basin via an 8-inch force main and a 15- and 18-inch diameter PVC gravity main located along Front Street.

A small pump station (Liberty Road pump station) collects wastewater adjacent to Liberty Bay and lifts it to the gravity main in Viking Avenue.

3.1.2 Finn Hill Basin

Recent construction in this basin includes the Olhava Shopping Center and the Olympic College Annex. A gravity collection system was constructed as part of this development. It currently flows to the Lindvig pump station, but will be redirected to the Bond Road pump station when it becomes operational in late 2007. Future residential and commercial development in the northwest section of the basin will require new collection systems. Portions of this area could gravity flow through Olhava to the Bond Road pump station. Other portions must flow to the low point in the basin near Finn Hill and "A" street, and then be pumped to the Olhava system. A new gravity main in Viking Avenue north of SR 305 will serve housing being constructed at Vetter Road. Refer to Chapter 4 for additional details.

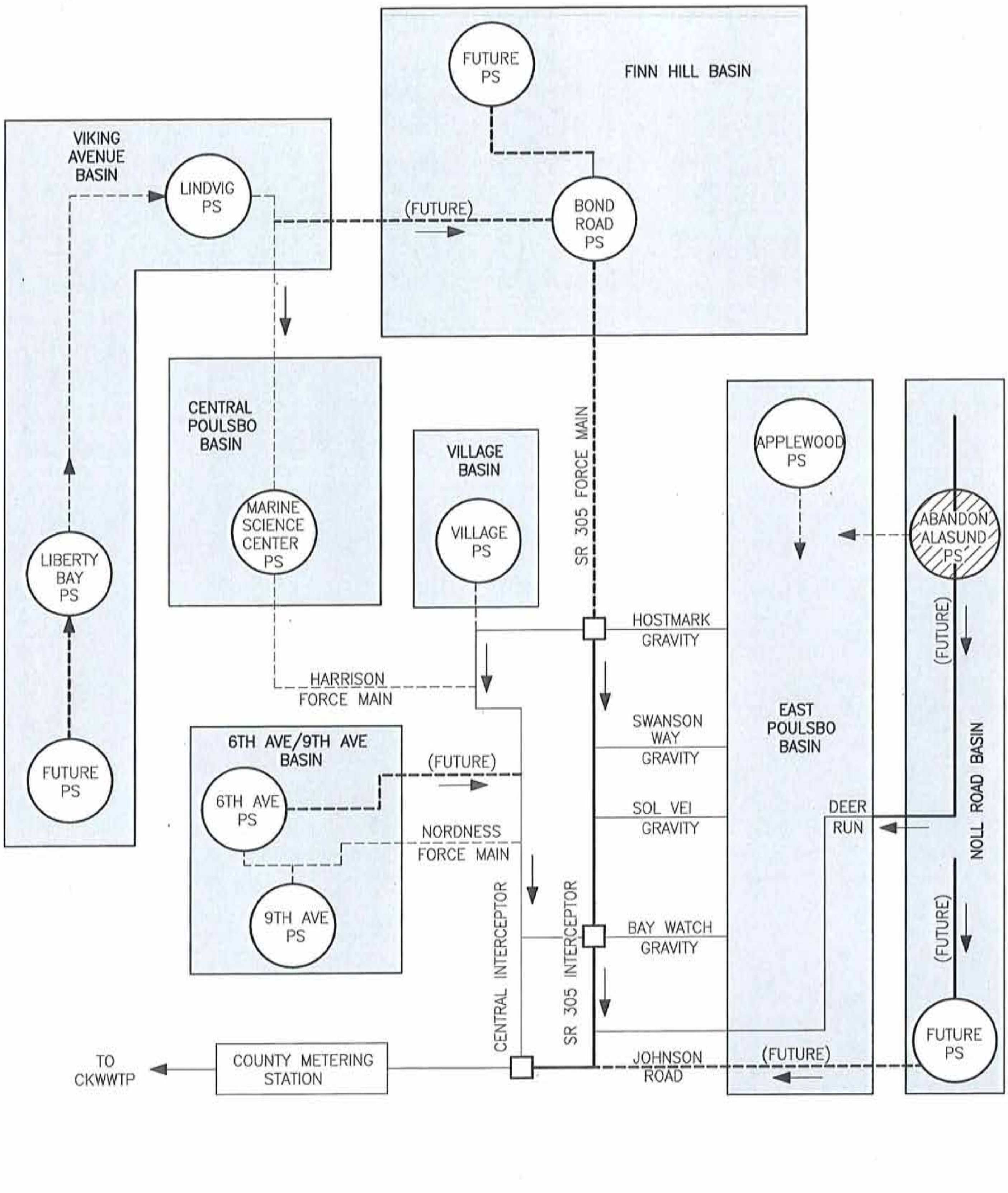


CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Sub-Basins Map

FIGURE 3-2

Parametrix, Inc.



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CITY of POULSBO VIKING CITY

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

LEGEND

EXISTING		PROPOSED
□	INTERCEPTOR CROSS CONNECTION POINTS	□
- - - - -	FORCE MAIN	- - - - -
———	GRAVITY MAIN	———

Poulsbo Sewer System Schematic

FIGURE 3-3

3.1.3 Central Poulsbo and Marine Science Center Basin

The Marine Science Center pump station provides service to the central area of Poulsbo, including the downtown business area. The Marine Science Center pump station is located off Front Street, immediately adjacent to the Marine Science Center. This station pumps flow from the Central Poulsbo drainage basin and the Lindvig pump station to the Central Interceptor through a 12-inch force main. System rehabilitation and I&I reduction through pipe bursting in this basin is scheduled for 2008. Growth in this area will be in-fill.

3.1.4 Village Basin

This drainage basin, also referred to as the Little Valley basin, collects commercial wastewater from the shopping and business centers along 7th Avenue. It also collects wastewater from the residential neighborhoods located on the hillside to the east of SR 305. Wastewater is pumped from the Village pump station via a 4-inch force main south along 7th Avenue into the Central Interceptor between Lincoln Road and Hostmark Street. Little growth is expected in this basin as much of the area consists of wetlands and steep hillsides.

3.1.5 6th Avenue/9th Avenue Basin

Prior to 2001, this older established area south of the central business district had been an area of significant infiltration. Most of the older mains and side sewers in this basin were replaced in 2000-2001. Growth in this area is primarily in-fill. Two pump stations collect and convey wastewater from 6th and 9th Avenues south of Hostmark Street via a 6-inch force main along 9th Avenue and Nordness Street to the Central Interceptor located on SR 305.

3.1.6 Poulsbo East Basin

This large drainage basin located east of SR 305 has potential for significant growth. The entire area drains by gravity to the Central Interceptor at five locations. The only exception is the Applewood area, which has a small lift station that discharges into the gravity sewers in this basin.

3.1.7 Noll Road Basin

Most of this drainage basin is currently undeveloped. Except for one small housing development served by a pump station directing sewage to the Poulsbo East Basin, none of the basin is currently served by sewer. This basin has the potential for significant future growth. A future gravity main in Noll Road will carry wastewater south to connect into the existing gravity system serving the Deer Park development that drains to the Johnson Road Metering Station (JRMS).

3.2 PUMP STATIONS

The City of Poulsbo currently operates and maintains nine pump stations (including the future Bond Road pump station) located throughout the existing service area. They vary in size from approximately 0.1 to 1.4 mgd and are summarized in Table 3-2. The most current pump test data on file in the City are also shown in Table 3-2.

Table 3-2. Existing Pump Stations

Location	Design Flow (mgd)	Pump Data	Standby Power	Flow Metering
Liberty Bay PS	0.14	2 Pumps 7.5 HP 100 gpm @ 56 head (each)	Portable Generator Connection	No
Lindvig PS[a]	0.8	2 pumps 60 HP Pump 1: 515 gpm Pump 2: 500 gpm	On-site Generator	Yes
Marine Science Center PS[b]	1.4	3 pumps Pump 1: 50 HP, 705 gpm Pump 2: 50 HP,725 gpm Pump 3: 30 HP, 383 gpm	On-site Generator	No
Bond Road PS[c]	1.0	2 Pumps 150 HP 700 gpm	On-Site Generator	Yes
Village PS	0.5	2 Pumps 20 HP 350 gpm @ 92' Head (each)	On-site Generator	No
Applewood PS	0.2	2 Pumps 10 HP 135 gpm @ 60' Head (each)	On-site Generator (located at Water Well)	No
Alasund Meadows PS	0.18	2 Pumps 15 HP 125 gpm @ 90' Head (each)	Portable Generator Connection	No
9th Avenue PS	0.14	2 Pumps 10 HP 100 gpm @ 80' Head (each)	Portable Generator	No
6th Avenue PS	0.2	2 Pumps 15 HP 142 gpm @ 83' Head (each)	Portable Generator	No

a Pump station rebuilt in 1999.
b Pumps replaced in 2000.
c Constructed in 2007.

The City's policy is to identify and implement the ultimate design of a collection and conveyance system and to eliminate proliferation of interim facilities and pump stations. In the future, all pump stations shall be designed according to Ecology and City standards and shall include flow meters, telemetry, generators, trash pump connections, and odor control.

3.3 CENTRAL INTERCEPTOR

The Central Interceptor located in SR 305 consists of a 12-inch force main from Bond Road to Harrison, a new 18-inch gravity main to Tollefson, and an older 18-inch gravity main to the Kitsap County manhole at Johnson Way. The Central Interceptor accepts gravity flow from the East Poulsbo Basin and pumped flow from the following pump stations:

Pump Station	Inflow Location
Village PS	South of Lincoln Street
Marine Science Center PS	At Harrison Street
Sixth and Ninth Avenue PS	At Nordness Street
Bond Road PS	At Bond Road

The Central Interceptor conveys all the wastewater flows from the City of Poulsbo to Kitsap County's metering station located on SR 305 at Johnson Way.

3.4 COUNTY CONVEYANCE SYSTEM

The City of Poulsbo's Central Interceptor connects to the Kitsap County conveyance system at the intersection of SR 305 and Johnson Road, the location of Kitsap County's metering station. At this point, the Central Interceptor connects to a 24-inch gravity/force main. The force main continues south to the two 12-inch siphons at Lemolo, where it crosses under Liberty Bay to Keyport. At Keyport, it continues south through Pump Station 16 and southwest through a 16-inch force main to Pump Station 24. From Pump Station 24, it discharges through a 24-inch force main past and is discharged into the CKWWTP.

3.5 WASTEWATER TREATMENT

The City of Poulsbo has a contract with Kitsap County to allow for the treatment of the City's sewage at the CKWWTP. Details of the Agreement and Amendments No. 1 and No. 2 are discussed in Section 2.2.3 of this Plan.

4. SEWER SYSTEM EVALUATION

4.1 SYSTEM EVALUATION

Evaluation of the existing system consisted of a review of previous work and documents, a conveyance system capacity assessment, and review of the City pump stations with maintenance staff.

4.2 CONVEYANCE SYSTEM CAPACITY ASSESSMENT

4.2.1 1998 HYDRAULIC MODEL

The purpose of the 1998 hydraulic model was to identify capacity problems within the system. The Poulsbo sanitary sewer system was evaluated in 1998 using the HydraGraphics Software Package, Version 4.85 (HYDRA). The HYDRA model generates the sanitary flow using diurnal curves, which represent the daily flow pattern of the service area. These diurnal curves are combined with the daily flow for a residence to create a sanitary hydrograph. This method reflects the actual configuration of the system by having the ability to input the diurnal curves for individual service areas to reflect the service area characteristics, the system geometry, and the changing contributions the area encounters in the future. The model additionally accounts for time delays associated with moving the flows through the system. It then combines these hydrographs using the time delays to create the outfall hydrograph for the system. The output identifies peak hourly flow rates and percent capacity for the piping network.

The model was based upon the 1991 HYDRA model prepared by R. W. Beck. The data from the previous model was transferred into the updated version of HYDRA. This information was supplemented with additional piping data provided by the City of Poulsbo Engineering Department and updated population data from the Planning Department.

From the 1998 analysis, it was determined that the majority of the sewer mains within the system are adequately sized for existing flows from tributary areas. The principle capacity problems identified by the 1998 analysis were the ability of the Central Interceptor, as well as the Marine Science Center and Lindvig Pump Stations, to accommodate the Peak Design Flow (PDF). The deficiencies are listed in Table 4-1, along with action the City has taken since 1998.

4.3 2007 CAPACITY EVALUATION

The purpose of the 2007 capacity assessment was to evaluate selected conveyance pipes that have been identified by the City as having potential capacity concerns due to recent or future growth. Conveyance pipes in the following areas were evaluated:

- Finn Hill and Olhava area, particularly the sewer mains in the Olhava shopping district that are proposed to convey sewage from the Finn Hill housing areas located west of Olhava

- Sewer trunk line from Olhava to the Bond Road pump station
- Viking Avenue, both north and south of SR 305
- Caldart Avenue from a location approximately 200 feet north of Lincoln Street to Hostmark Avenue, and then down Hostmark to Highway 305
- 8th and 9th Avenue mains between the Village pump station and the point where the main feeds into the new main recently installed in Highway 305 at Harrison Avenue
- Noll Road, including an evaluation of providing a new sewer to serve the eastern boundary of the service area and an evaluation of the sewer main between Deer Run and the Johnson Road Chlorination Station

Table 4-1. 1998 System Capacity Deficiencies and City Action

Location	Problem	Action
Central Interceptor	7,160 lineal feet of sewer main potential to surcharge during peak flow.	Parallel interceptor has been constructed in SR 305. I&I has been reduced.
Marine Science Center Pump Station	Peak flow exceeds maximum pump station discharge rate.	Pumps upgraded in 2000 and 2007.
Lindvig Pump Station	Excessive pump cycling. Pumps undersized and wet well under sized.	Pump station rebuilt in 1999.
Inflow and Infiltration	Excessive I&I in basins tributary to the Marine Science Center, 9th Avenue, and 6th Avenue pump stations.	Extensive pipe bursting and replacement has been completed. Second I&I project has been designed.

Appendix D provides additional detail on the capacity analysis including location of sewer mains. Based on the analysis, it is likely that pipe segments in several areas of the City are potentially deficient within the next 5 to 10 years. The highest priority areas are within the Olhava basin, followed by the Noll Road basin. A single pipe segment in the Caldart basin marginally exceeds full build out flows. Capacity in the Viking basin is adequate with the exception of the Liberty Bay pump station, which needs to be expanded.

Conveyance pipes in the Olhava basin that have long-term capacity concerns are currently flowing at about 20 percent of total capacity. Capacity issues in the Olhava basin will generally not occur until approximately 300 gpm (400+ ERUs) are added to the system. The proposed plat of Cook Addition and other residential development in the Finn Hill basin that is outside Olhava are estimated to add approximately 300 gpm so it may be appropriate for the future residential development outside of Olhava to fund conveyance capacity increases in this basin.

Based on the results of the capacity assessment, the following projects have been added to the 6-year CIP:

- Finn Hill basin near Wal-Mart, Pipe Run 18. Increase 246-ft of 8-in diameter pipe to 10 or 12-in diameter. The preliminary cost estimate for this project is $40,000.
- Finn Hill basin on Bond Road, Pipe Run 94. Increase 70-ft of 8-in diameter pipe to 10 or 12-in diameter. The preliminary cost estimate for this project is $25,000.

- Viking basin. Liberty Bay pump station. Increase capacity from 100 gpm to 400 gpm. The preliminary cost estimate for this project assumes a complete rebuild of the pump station at a cost of $250,000.

4.4 PUMP STATION EVALUATION

The City of Poulsbo currently owns and operates nine sanitary sewage pump stations (the Bond Road pump station is under construction). Site visits and interviews with maintenance staff provided information on the condition of each pump station, as well as recent repair and maintenance records. Recommendations for additional improvements have been derived from this field work. The results of the site visit are summarized in the following paragraphs.

4.4.1 Liberty Bay Pump Station

4.4.1.1 Description

The Liberty Bay pump station serves a portion of the Viking Avenue Basin. It collects wastewater from the south Viking Avenue area and pumps it to the Lindvig pump station. This small 0.14 mgd pump station has two 7.5 hp pumps mounted at grade above a 56-inch diameter wet well.

4.4.1.2 General Comments

The south end of the basin is expected to experience significant development (low and high density residential). Expansion of the pump station will be required to increase capacity from its current limit of 100 gpm, to 400 gpm (0.58 mgd). The preliminary cost estimate for this assumes a complete rebuild of the pump station at a cost of $250,000.

4.4.1.3 Recommendations

Capacity increases will be driven by future development. The City should therefore require that pump station improvements be paid for by the developer.

4.4.2 Lindvig Pump Station

4.4.2.1 Description

This pump station serves much of Poulsbo west of Liberty Bay, including the commercial district along Viking Avenue and the Olhava housing along Viking Ave. It accepts wastewater from the Liberty Road pump station. Prior to the construction of the Bond Road pump station, it received flow from the Olhava commercial property west of SR 3. When the Bond pressure main is completed, this pump station will send wastewater to the Bond Road pump station. This 0.8 mgd pump station was reconstructed in 1999 and has two 60 HP submersible pumps, with space for a third pump, in a 9-foot diameter wet well. Wastewater is currently pumped to the Marine Science pump station via a force main located on the beach of Liberty Bay, but will be redirected to the Bond Road pump station in the future.

4.4.2.2 General Comments

The 1999 rebuild provided excess pumping capacity, room for expansion, flow metering, variable speed pumping, and emergency power generation.

The force main from the pump station goes south along Front Street, crossing an unstable hillside, and discharges into the Central Poulsbo Drainage Basin. There is concern for the stability of the pipe in case of a landslide. The flow is pumped at the Marine Science Center pump station to the Central Interceptor.

4.4.2.3 Recommendations

A new force main will be constructed in 2007 along Bond Road to the new Bond Road pump station. The force main will avoid the unstable hillside and pipeline along the beach, reduce flow to the Marine Science Center pump station, and provide system flexibility. The force main would be 8 inches in diameter and approximately 2,400 feet long. The existing force main would be retained, repaired, and used as an emergency backup system to the Bond Road pump station.

4.4.3 Marine Science Center Pump Station

4.4.3.1 Description

This 1.4-mgd pump station serves the Central Poulsbo Basin, as well as the flow from the Lindvig and Liberty Road pump stations. The station has three (two 50 hp and one 30 hp) pumps located in a below-grade dry well adjacent to an 8 foot diameter wet well. This station pumps wastewater via a 12-inch force main to the Central Interceptor.

4.4.3.2 General Comments

The station is in fair condition. In 2000, the pumps were replaced and in 2007 check valves were replaced. Since the Lindvig pump station will be redirected to the Bond Road pump station, no increase in pumping capacity is required. In fact, the 50 HP pumps currently only have a total run time of about 1 hour per day, since they are able to pump down the wet well in several minutes. Check valves have been recently replaced, but the gate valves are in very poor condition and require replacement.

4.4.3.3 Recommendation

The recommended improvements to the pump station are:

- Add flow metering to the central alarm location
- Replace the old emergency generator
- Replace gate valves
- Relocate and improve the receiving manhole at the end of the force main

Cost of the recommended work is estimated at $54,000. Refer to Chapter 7 for additional cost detail.

4.4.4 Village Pump Station

4.4.4.1 Description

This pump station serves the businesses along 7th Avenue and the residential developments along the hillside east of SR 305. This 0.5 mgd pump station has two 20 hp dry pit pumps serving an extremely deep (38 feet) wet well. This station pumps wastewater via a 5-inch force main to the Central Interceptor at SR 305 near Lincoln Road.

4.4.4.2 General Comments

The pump station is extremely deep because it collects the flow from the gravity sewer on Forrest Rock Drive, which goes underneath SR 305. At present, the pump station can service the area without major capital improvements, although general repair and maintenance, as well as flow meters, are recommended.

4.4.4.3 Recommendations

Station improvements to add flow metering, and improvements to the electrical and control system are recommended. The control panel is located at the bottom of the station, and should be relocated to the top for easier servicing. Gate valves are old and very difficult to operate and should be replaced. Only minor repair and maintenance is required.

4.4.5 6th Avenue Pump Station

4.4.5.1 Description

This pump station serves the residential area south of the Central Business district. This 0.2-mgd pump station has two 15 hp self-priming pumps located above grade in a small building located in a playground. Wastewater is pumped via a 6 inch force main to the Central Interceptor. The 9th Avenue pump station also pumps into the same force main.

4.4.5.2 General Comments

Worn pumps are not performing to factory specifications. Back pressure on the force main from the 9th Avenue pump station can reduce capacity. This will be corrected by proposed rerouting the force main up Matson Street.

The pumps should be replaced because of age. Operation outside the recommended operating range has worn the impellers. The impeller was recently replaced, but the pumps continually lose prime. Replacement should consider use of submersible units that would remove the pumps from the overcrowded electrical building.

Other station deficiencies include lack of ventilation, maintenance pump-out connection, and emergency power generator, as well as electrical wiring that needs replacement.

4.4.5.3 Recommendation

Pump station upgrades should be considered a high priority. Improvements to include:

- Replace pumps with submersible pumps
- Add wet well ventilation and odor control
- Replace electrical system
- Add a flow meter
- Add an emergency generator
- Add building ventilation

Cost for the recommended work is $138,000. Refer to Chapter 7 for additional cost detail.

4.4.6 9th Avenue Pump Station

4.4.6.1 Description

This pump station serves a residential area at the south end of Poulsbo. This small 0.14-mgd pump station has two 10 hp pumps located below grade in a "can" pump station. Wastewater is pumped to the Central Interceptor via the same 6 inch force main as the 6th Avenue pump station.

4.4.6.2 General Comments

The vertical configuration of the station is a safety concern because electrical gear is in a confined space directly above the wet well. The electrical panel and wiring should be replaced and relocated aboveground and the wet well sealed and vented aboveground. The junction boxes from the floats in the wet well need to be replaced with intrinsically safe switches or be isolated from the space above the wet well. The pumps are old and should be replaced. A portable generator provides emergency power.

The 6 inch force main discharges to a manhole at the Central Interceptor near SR 305. This manhole and gravity main cannot handle the quantity of wastewater under peak pumping conditions. Turbulence in the manhole may be the cause of odor complaints in that area.

If the 6th Avenue pump station is not redirected via Matson Avenue, then modifications to the force main where the 6th and 9th Avenue pump stations combine is required. Specifically, a sweeping "Y" and a new check valve should be installed at the junction.

4.4.6.3 Recommendation

This pump station upgrade includes:

- Replace the pumps
- Seal the wet well from the valve chamber, provide ventilation and odor control in the wet well
- Relocate the electrical system
- Add a flow meter
- Add an emergency generator

Prior to pump station upgrades, an engineering analysis should be performed to assess the feasibility of eliminating the pump station and installing a gravity line between the 6th Avenue pump station and the 9th Avenue pump station.

4.4.7 Applewood Pump Station

4.4.7.1 Description

This small 0.08 mgd pump station serves a small housing development in the Poulsbo East Basin. Two small pumps located above a small wet well pump wastewater via a 4 inch force main to a manhole that connects to a gravity main in Caldart Avenue, which ultimately leads to the Central Interceptor in SR 305.

4.4.7.2 General Comments

This station serves very few homes and runs for only a couple of hours a day. Emergency power is provided from a generator at a nearby water system facility. Future development east of the Applewood subdivision may allow gravity flow to the southeast and the station could then be abandoned.

4.4.7.3 Recommendation

An access ladder is recommended. This is a low cost item and is not included in the CIP.

4.4.8 Alasund Meadows Pump Station

4.4.8.1 Description

This small 0.18-mgd pump station serves several housing areas located east of Noll Road. Two 15 HP pumps delivers wastewater via a 4 inch force main to a gravity main in Noll Road that flows east to the Poulsbo East Basin.

4.4.8.2 General Comments

This pump station uses a power converter to transform locally available power to 230 volts, making the system somewhat unreliable. However, this pump station will be abandoned once the new Noll Road gravity main is installed.

4.4.8.3 Recommendation

There are no recommendations, other than to construct the new Noll Road gravity trunk main, for this pump station. The pump station will be abandoned upon completion of the gravity main. However, if the Noll Road gravity main is not installed, then a new 230 volt power service should be installed in order to eliminate the power converter.

4.4.9 Bond Road Pump Station

4.4.9.1 Description

This new pump station serves the Finn Hill Basin, which includes Olhava and the Olympic College annex.

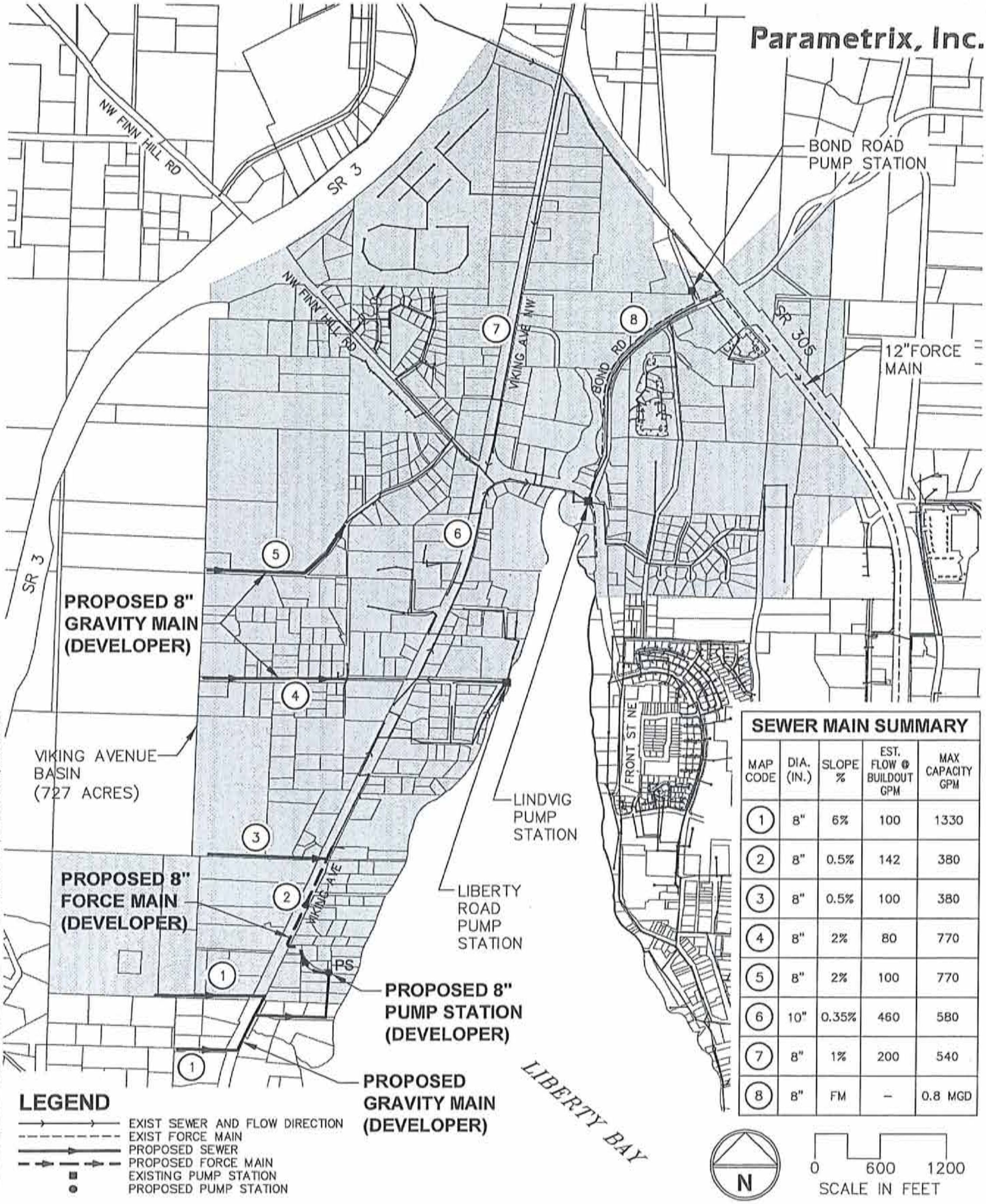
4.4.9.2 General Comments

This pump station is under construction and will be in excellent condition and therefor not require any improvements or expansion. It also will serve the Viking Avenue Basin after the new force main from the Lindvig pump station is installed.

4.5 BASIN BY BASIN SUMMARY

The following summary sheets (Tables 4-2 through 4-8) and map figures (Figures 4-1 through 4-7) summarize the improvements recommended to the existing system and present future methods for providing service to areas currently undeveloped and unsewered.

The term "Proposed" is used to refer to capital improvement projects that are in design and intended to be completed within two to four years. The term "Future" is used for sewer system extensions that are presented here only as a concept of how developers may service an area currently undeveloped and unsewered. No "Future" projects are considered as capital improvements.



SEWER MAIN SUMMARY

MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	6%	100	1330
2	8"	0.5%	142	380
3	8"	0.5%	100	380
4	8"	2%	80	770
5	8"	2%	100	770
6	10"	0.35%	460	580
7	8"	1%	200	540
8	8"	FM	–	0.8 MGD

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Viking Avenue Basin

FIGURE 4-1

Table 4-2. Viking Avenue Basin – Descriptive Information

Size: 727 acres

Percent Developed: 50 Percent

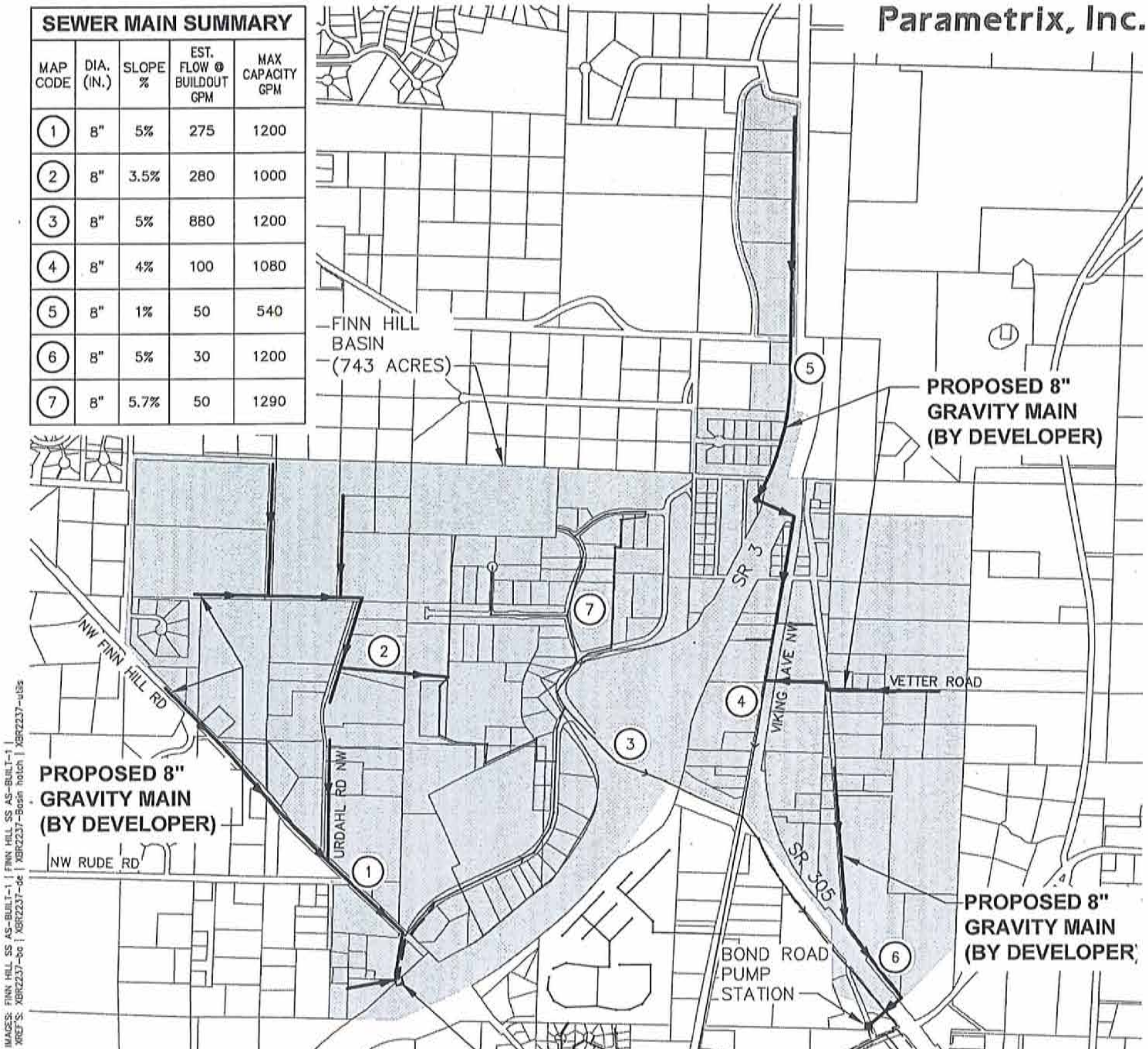
Zoning:
- Low Density Residential (45 Percent)
- Commercial (15 Percent)
- Parks (15 Percent)
- Business Park (20 Percent)
- Light Industrial (5 Percent)

This basin serves all of Poulsbo west of Liberty Bay, including the commercial district along Viking Avenue. It also serves the portion of Olhava and Finn Hill Road located south of SR 3. Most of the wastewater flows by gravity to the Lindvig Pump Station. A small pump station (Liberty Road Pump Station) collects wastewater adjacent to the bay and lifts it up to the gravity main in Viking Avenue. The Finn Hill basin wastewater now flows through this basin down Viking Way to the Lindvig pump station. Following completion of the Bond Road Pump Station, it will flow directly down SR 305 to the new pump station.

Facilities	Comments and Recommended Improvements
1. **Lindvig Pump Station:** This 1.4-mgd variable speed submersible pump station was reconstructed in 1999. It has two submersible pumps in a 9-foot-diameter wet well. Space for a future third pump exists.	1. No new work needed.
2. **Force Main:** Wastewater is pumped from the Lindvig Pump Station to the Marine Science Center Pump Station via an 8-inch force main and a 15- and 18-inch PVC gravity main. A portion of the force main is located on the beach of Liberty Bay beneath an unstable hillside slope.	2. Build a new 8-inch force main from Lindvig to the proposed Bond Road Pump Station. Slip line the beach force main to provide an emergency sewer reroute.
3. **Liberty Road Pump Station:** This small 0.2-mgd pump station has two 7.6-hp Smith and Loveless vertical nonclog pumps mounted at grade above a 56-inch-diameter wet well.	3. Future growth requires increase in capacity from 100 gpm to 400 gpm. Pump station improvements to be funded by developers.
4. **Collection System:** Wastewater is pumped to Viking Way then flows by gravity to the Lindvig PS.	4. I&I investigation with smoke test and TV inspection of the collection system.
5. **Future Extension:** The undeveloped areas of this basin can generally be served with gravity sewer extensions and one small pump station.	5. A new small pump station at Anderson Lane will be required to lift sewage up to the gravity line in Viking Avenue.

Parametrix, Inc.

SEWER MAIN SUMMARY				
MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	5%	275	1200
2	8"	3.5%	280	1000
3	8"	5%	880	1200
4	8"	4%	100	1080
5	8"	1%	50	540
6	8"	5%	30	1200
7	8"	5.7%	50	1290



CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Finn Hill Basin

FIGURE 4-2

Table 4-3. Finn Hill Basin – Descriptive Information

Size: 743 acres

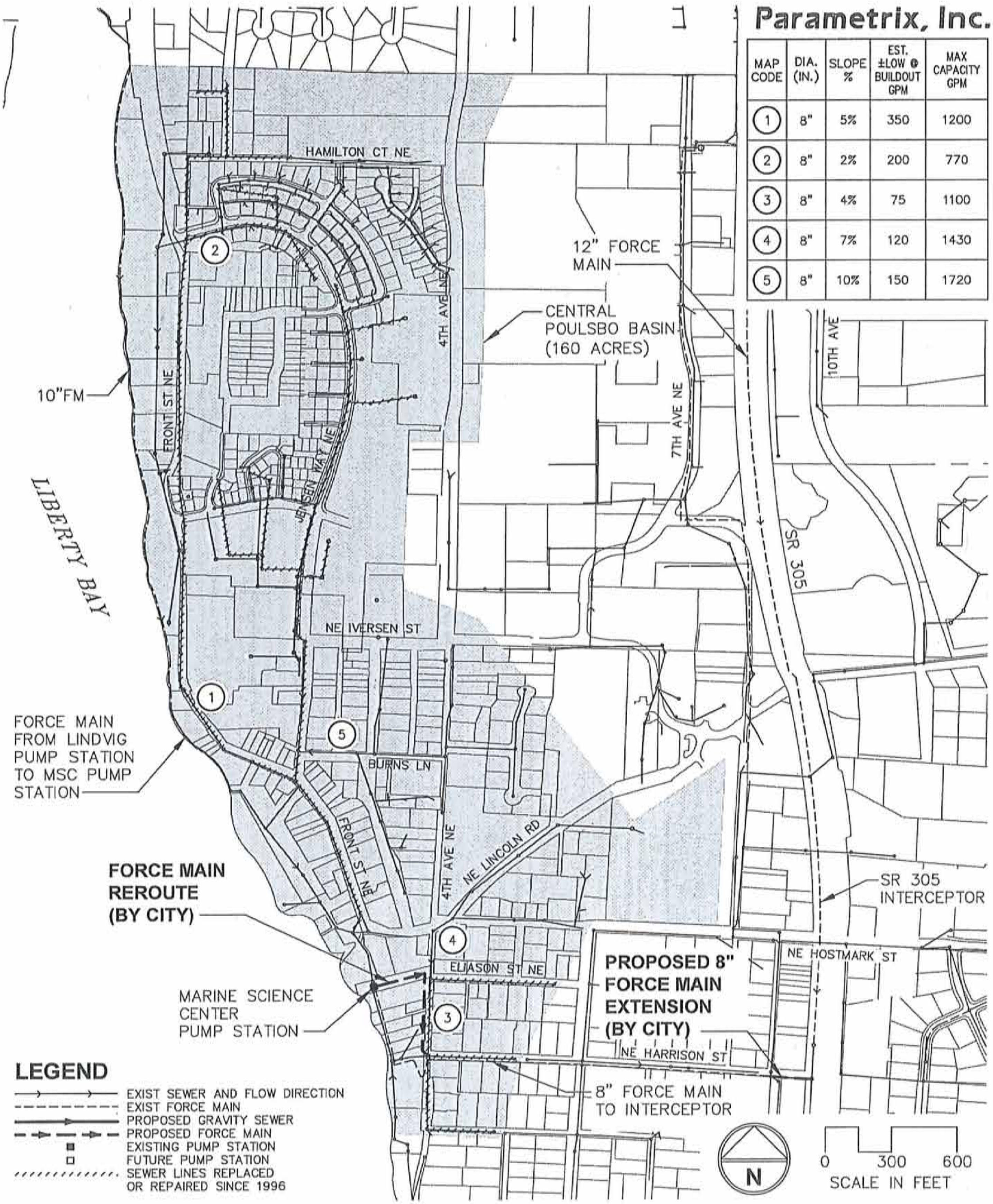
Percent Developed: 60 Percent

Zoning:

- Low Density Residential (50 Percent)
- High Density Residential (15 Percent)
- Schools (10 Percent)
- Commercial (25 Percent)

A large portion of this basin is occupied by the Olhava project. Land west of Olhava, on either side of Finn Hill Road, can be served either by this basin or by the Lindvig Basin. To prevent overloading the distribution system to the Lindvig Basin, flow will generally be directed through this basin to the new Bond Road Pump Station. The Bond Road Pump Station directs flow to the Central Interceptor via a new force main in SR 305.

Facilities	Comments and Recommended Improvements
1. **Bond Road Pump Station:** This pump station was constructed in 2007.	1. No improvements or upgrades are planned.
2. **Force Main:** A new 12-inch HDPE force main was constructed in SR 305 from Bond Road Pump Station to Hostmark Street.	2. No improvements or upgrades planned.
3. **SR 305 Interceptor:** Tollefson Street to Kitsap County metering station accepts flow from Bond Road Pump Station and most of the East Poulsbo Basin.	3. No improvements or upgrades planned.
4. **Existing Gravity Sewers:** Existing gravity sewers near Wal Mart and the Bond Road Pump Station have inadequate capacity to support full build out in the basin.	4. Increase capacity in identified segments. Funding to be provided by Developers.
5. **Future Gravity Sewers:** The entire basin will be served by gravity sewers to the new Bond Road Pump Station.	5. Gravity sewers and any small pump stations will be provided by Developers.
6. **Future Pump Station:** Construct a new pump station at the low end of Finn Hill and a new force main from this pump station to the gravity sewer in A Street in front of Wal-Mart.	6. No improvements or upgrades planned.



MAP CODE	DIA. (IN.)	SLOPE %	EST. ±LOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	5%	350	1200
2	8"	2%	200	770
3	8"	4%	75	1100
4	8"	7%	120	1430
5	8"	10%	150	1720

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Central Poulsbo Basin

FIGURE 4-3

Table 4-4. Central Poulsbo Basin – Descriptive Information

Size: 160 acres

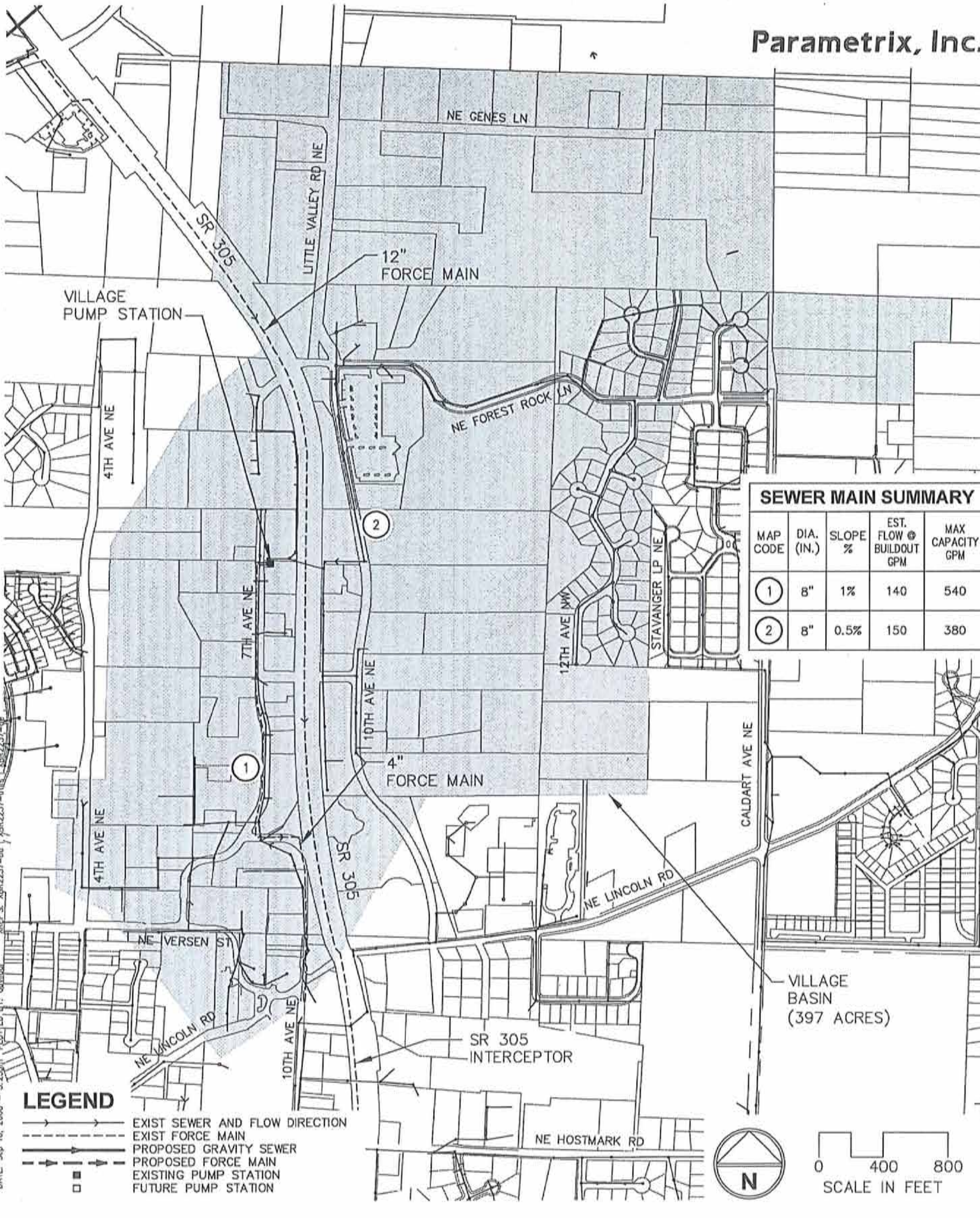
Percent Developed: 90 Percent

Zoning:

- Commercial (80 Percent)
- Low Density Residential (10 Percent)
- Parks (10 Percent)

The Marine Science Center Pump Station provides service to the central area of Poulsbo, including the downtown business area. The Marine Science Center Pump Station is located just off Front Street, immediately adjacent to the Marine Science Center. This station pumps the flows from the drainage basin and the Lindvig Pump Station to the Central Interceptor through a 12-inch force main.

Facilities	Comments and Recommended Improvements
1. **Marine Science Pump Station:** This pump station has three vertical nonclog pumps in a below-grade dry well adjacent to an 8-foot-diameter wet well. An on-site generator is located in the enclosure above the pumps. In 2000, the City replaced the pumps with larger 50-hp pumps and one 30-hp pump. Limitations to the wiring prevent installing three 50-hp pumps.	1. The new 50-hp pumps operate at a much higher head and flow than the 30-hp pump. Therefore, the combination of a 50-hp and a 30-hp pump produces only slightly more flow than the 50-hp pump alone. The combined two 50-hp pumps may produce 1,200 gpm. However, the firm pumping rate of the pump station is determined with the largest unit out of service. Therefore, to consider 1,200 gpm as firm pumping, the 30-hp pump must be replaced with another 50-hp pump and the wiring upgraded.
2. **Pump Station Discharge Main:** The 12-inch discharge force main runs along the beach and then up Harrison Street to the Interceptor.	2. Reroute the force main along Fjord Dr to Harrison Street to minimize breaks and discharge along the beach.
3. **Force Main:** The 8-inch Beach force main from Lindvig to Marine Science PS is subject to frequent failures, primarily from leaks caused by pipe corrosion.	3. Slip line the 8-inch force main with a new 6-inch HDPE line. This will provide emergency backup to the new 8-inch force main leading to the Bond Road PS.
4. **Gravity Collection Sewers:** The sewers in this basin are the oldest in the system. Many of the lines had failed and have been replaced using pipe bursting techniques or total sewer replacement. Some additional sewer replacements are still required.	4. Most collection sewers and side sewers have been replaced. Lincoln Avenue is perhaps the notable exception which remains to be replaced. Previous reports set the I&I rate at over 12,000 gpm. The I&I has been almost eliminated.



SEWER MAIN SUMMARY

MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	1%	140	540
2	8"	0.5%	150	380

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Village Basin

FIGURE 4-4

Table 4-5. Village Basin – Descriptive Information

Size: 397 acres

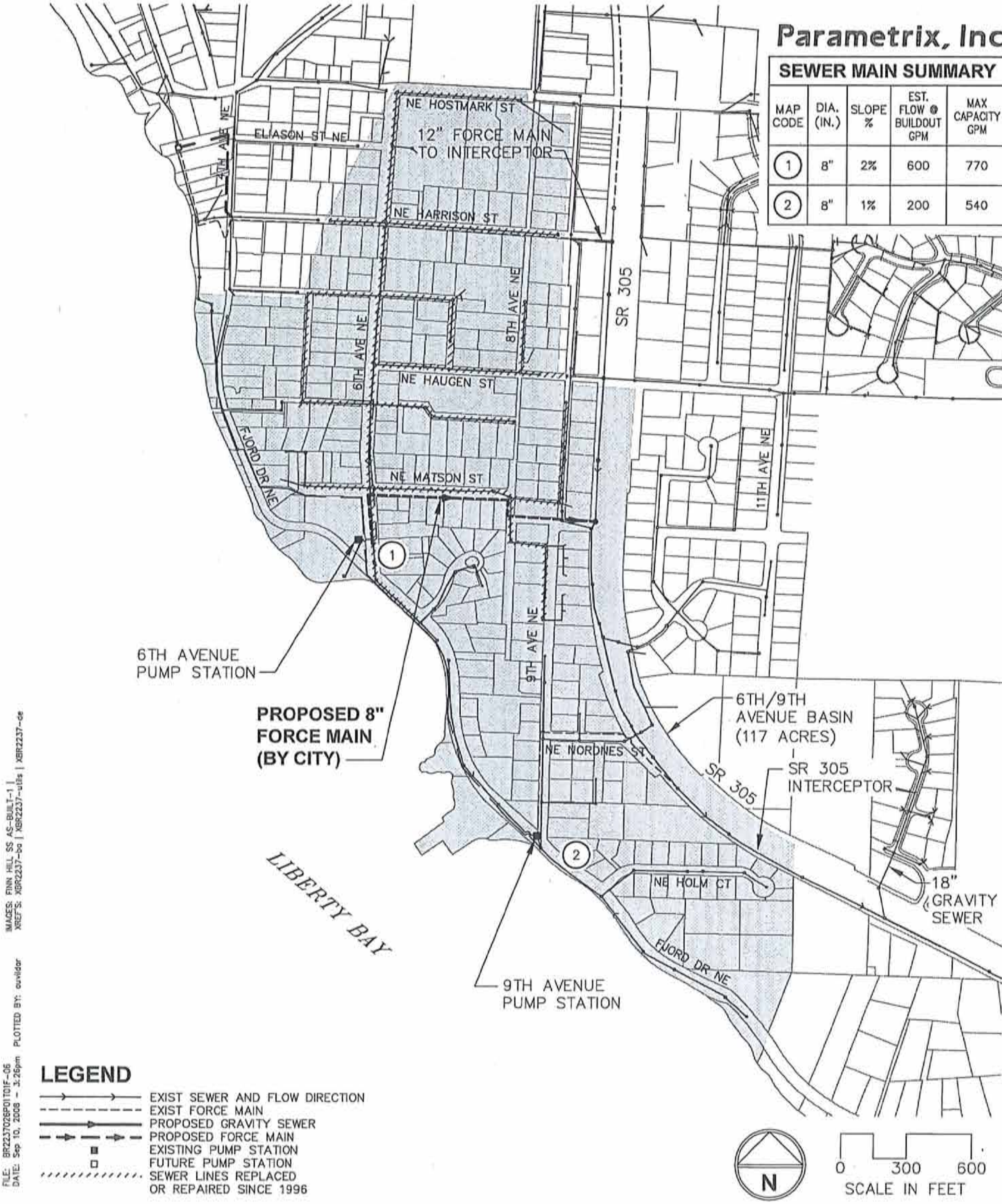
Percent Developed: 80 Percent

Zoning:

- Commercial (60 Percent)
- Low Density Residential (25 Percent)
- Parks (15 Percent)

This drainage basin, sometimes referred to as the Little Valley Basin, collects commercial wastewater from the shopping and business centers along Seventh Avenue and SR 305. It also collects wastewater from the residential neighborhoods located on the hillside to the east of SR 305. Wastewater is pumped from the Village Pump Station via a 4-inch force main south along Seventh Avenue into the Central Interceptor between Lincoln Road and Hostmark Street.

Facilities	Comments and Recommended Improvements
1. **Village Pump Station:** This 0.5-mgd pump station contains two 20-hp vertical dry pit pumps below grade. The wet well is extremely deep. The electrical panel has been located above grade. There is an on-site generator.	1. Provide general pump station rehabilitation.
2. **Force Main:** 8-inch force main going south on Seventh Avenue to the beginning of the Central Interceptor.	2. No recommendations.
3. **Gravity Collection Sewers:** Most sewers in this basin are well-constructed PVC pipes. Infiltration is within normal guidelines. Any development in this basin will be infill.	3. Smoke test and TV inspect basin for I&I identification.
4. Future pump station relocation could eliminate extreme depth.	4. Pump station relocation will depend on the future extension of 7th Avenue.



SEWER MAIN SUMMARY				
MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	2%	600	770
2	8"	1%	200	540

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

6th/9th Avenue Basin

FIGURE 4-5

Table 4-6. Sixth Avenue/Ninth Avenue Basin – Descriptive Information

Size: 117 acres

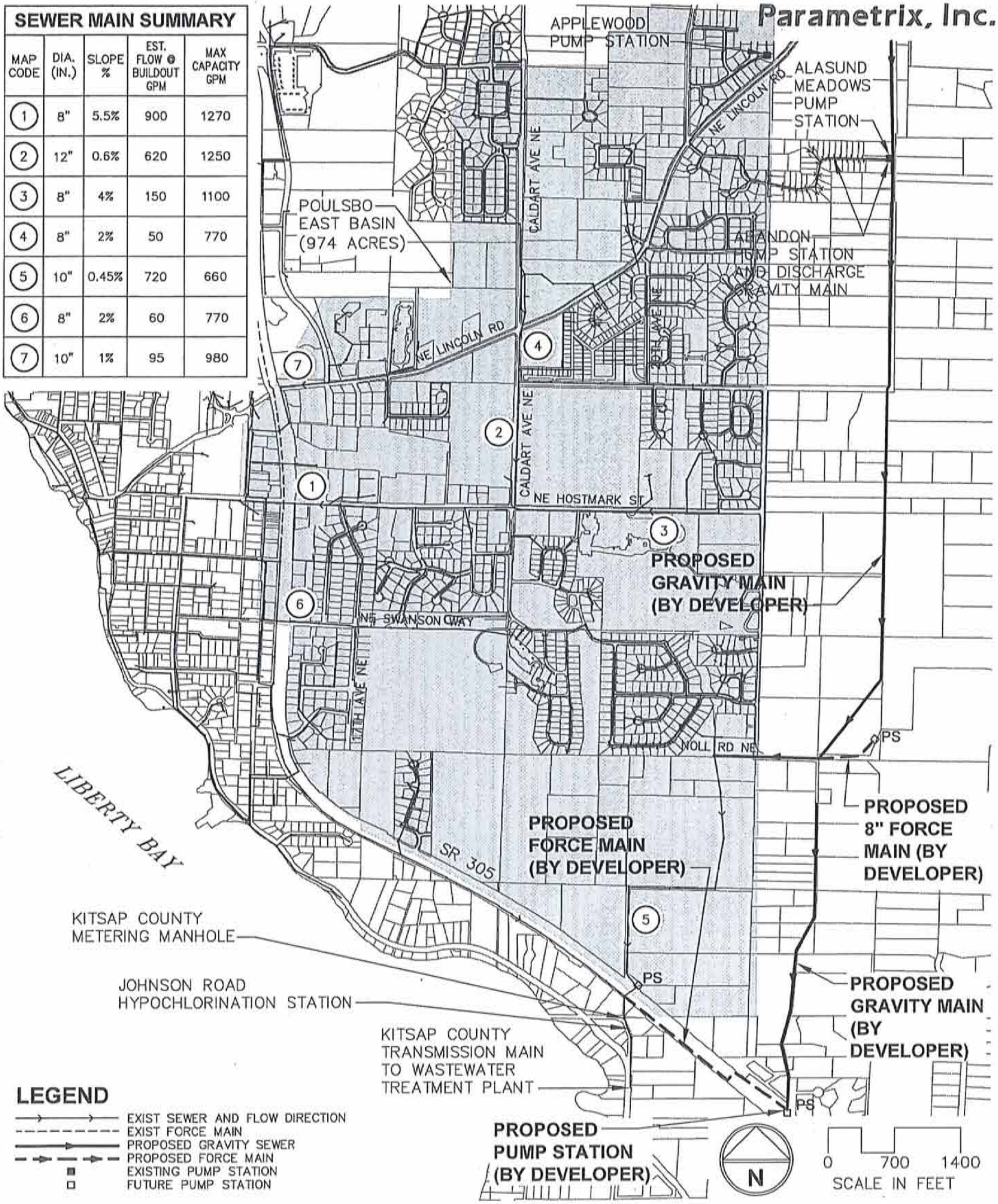
Percent Developed: 100 Percent

Zoning:
- Low Density Residential (90 Percent)
- Parks (10 Percent)

Two pump stations collect and convey wastewater from Sixth and Ninth Avenues south of Hostmark Street via a 6-inch force main along Ninth Avenue and Nordness Street to the Central Interceptor located on SR 305. Almost all of the mains and side sewers in the Sixth Avenue Basin were replaced by pipe bursting in 2000.

Facilities	Comments and Recommended Improvements
1. **Sixth Avenue Pump Station:** Pump station has two 15-hp self-priming pumps mounted in an aboveground building adjacent to the wet well. There is a connection for a portable generator. Rated capacity is 229 gpm. There is a 4-foot by 6-foot cast-in-place concrete wet well that has access from outside the building. Pump run time indicates limited discharge when running simultaneously with Ninth Avenue Pump Station or when the Central Interceptor is backed up.	1. High priority pump station improvements include: • Flow meter and Telemetry data recording. • Replace pumps with submersible units. • Power and control wiring replaced. • Emergency generator. Improve ventilation and odor control.
2. **Ninth Avenue Pump Station:** Vertical "can" pump station with two 10-hp submersible pumps. Check valves and control panel directly above 4-foot-diameter wet well. Pump capacity is 135 gpm. Connection for portable generator. Evaluate possibility of abandoning pump station and flowing wastewater by gravity to the 6th Ave pump station.	2. High priority pump station improvements include: • Replace pumps. • Relocate float switches outside of wet well enclosure. • Ventilation fan required and seal wet well from dry well above it. • Odor control. • Flow meter and telemetry data recording.
3. **Sixth Avenue Force Main:** Force main combines with force main from Ninth Avenue Station. Pumping rate is lowered if both stations run at the same time. There is an optional force main that can be used to flow wastewater to the Marine Science Center Pump Station.	3. Provide force main on NE Matson Street directly to new SR 305. Alternative is to replace the beach force main with a new main located in Fjord Drive.
4. **Sixth Avenue Gravity Collection Sewers:** Original pipes failed and have been replaced using pipe bursting methods on main and side sewers.	4. No additional work.
5. **Ninth Avenue Gravity Sewers:** Normal infiltration.	5. Smoke test and TV inspect sewers to determine the amount of I&I. Replace sewers and side services.

SEWER MAIN SUMMARY				
MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	5.5%	900	1270
2	12"	0.6%	620	1250
3	8"	4%	150	1100
4	8"	2%	50	770
5	10"	0.45%	720	660
6	8"	2%	60	770
7	10"	1%	95	980



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XREF'S: XBR2237-bo | XBR2237-utils | XBR2237-de

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Poulsbo East Basin

FIGURE 4-6

Table 4-7. Poulsbo East Basin – Descriptive Information

Size: 974 acres

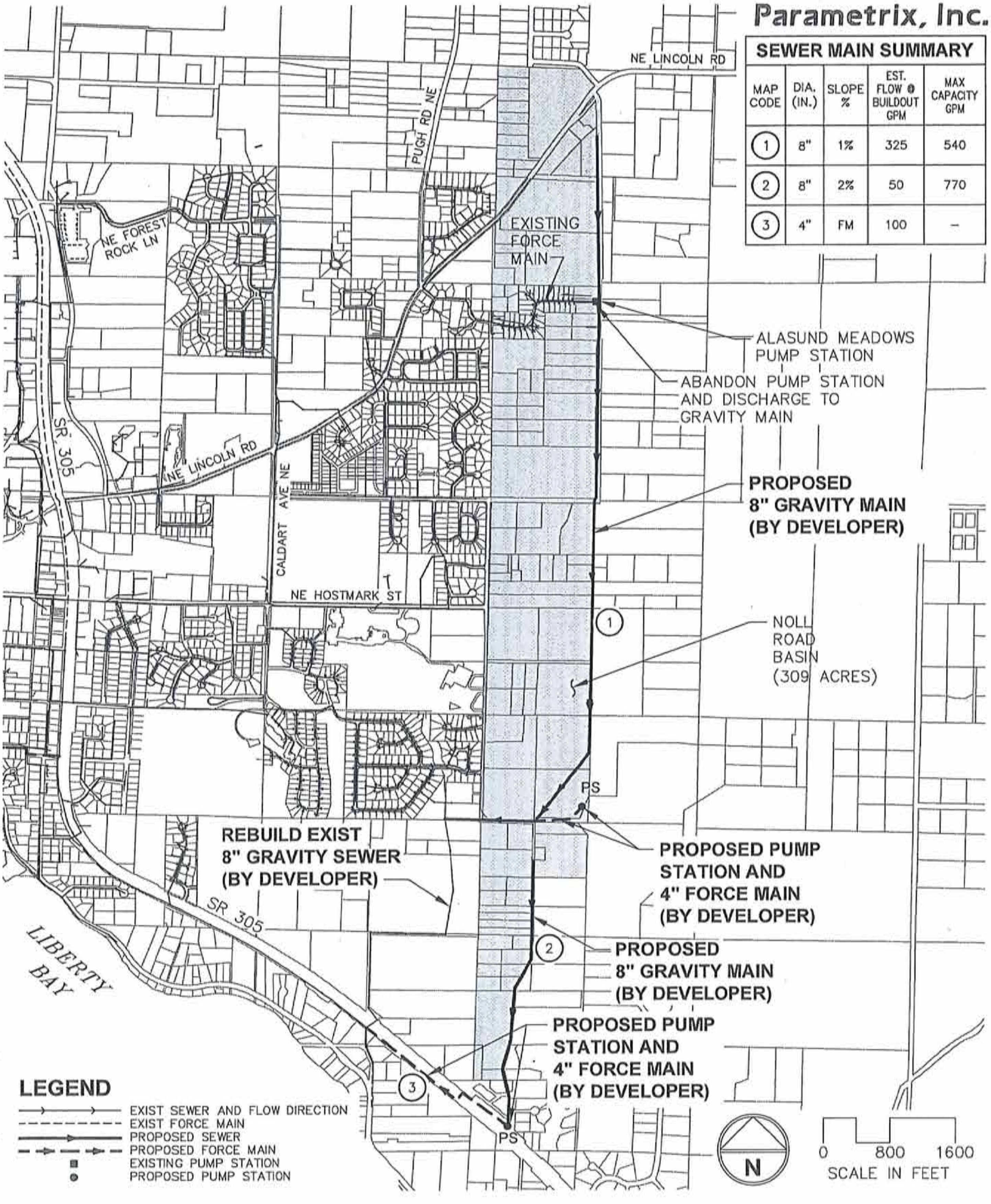
Percent Developed: 50 Percent

Zoning:

- Low Density Residential (70 Percent)
- Schools (15 Percent)
- Parks (10 Percent)
- Commercial (5 Percent)

This large drainage basin has the potential for significant growth. The basin is located on the hill to the east of SR 305. The entire area drains by gravity to the Central Interceptor at five locations. The only exception is the Applewood area.

Facilities	Comments and Recommended Improvements
1. **Applewood Pump Station:** This small 0.08-mgd pump station serves a small housing development. It has two pumps with a total design capacity of 90 gpm. A water utility generator is used for emergency power. A small three-sided enclosure protects the electrical panels.	1. Access ladder recommended. Future growth to the east and south could eliminate need for this lift station.
2. **Alasund Meadows Pump Station:** This small pump station will be abandoned after the Noll Road gravity main is installed.	2. Electrical system is deficient. Existing power feed requires a converter. Run new PSE service to pump station. Do not accomplish if Noll Road gravity main is imminent. Abandon after Noll Road gravity main is installed.
3. **Force Main:** 4-inch force main to the Lincoln Ave gravity sewer.	3. None
4. **Sewers enter the Central Interceptor at:** • Lincoln Avenue • Hostmark Avenue • Haugen Avenue • Sol Vei Way • Johnson Way	4. Establish program of I&I investigation with smoke testing and TV inspection.
5. **Caldart/Hostmark Mains:** Flows from the Applewood Pump Station discharge to the Caldart Avenue gravity main, which was replaced in 2001 with a 12-inch HDPE gravity main. This new 12-inch main flows into the 8-inch PVC line running down Hostmark to the Central Interceptor line in SR 305.	5. Replacement of the Caldart Avenue sewer in 2001 has eliminated maintenance problems in that line. Divert Hostmark Street Sewer at SR 305 to the proposed SR 305 Interceptor.



SEWER MAIN SUMMARY

MAP CODE	DIA. (IN.)	SLOPE %	EST. FLOW @ BUILDOUT GPM	MAX CAPACITY GPM
1	8"	1%	325	540
2	8"	2%	50	770
3	4"	FM	100	–

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Noll Road Basin

FIGURE 4-7

Table 4-8. Noll Road Basin – Descriptive Information

Size: 309 acres

Percent Developed: 10 Percent

Zoning:
- Low Density Residential (100 Percent)

Most of this drainage basin is undeveloped. Except for one small housing area with a small pump station, none of the basin is currently served by sewer. This basin has the potential for significant growth, although some property will probably remain as small farms for some time. A future gravity main on Noll Road, which is situated in a natural swale, will carry wastewater south to a tie into the existing gravity system serving the Deer Park Development. From here, the wastewater flows to the Johnson Road Metering Station.

Facilities	Comments and Recommended Improvements
1. **Noll Road Gravity Main:** None currently exists	1. Construct new gravity main along east edge of basin that ties into the Deer Park Collection system. This will serve the northern three fourths of the basin. Construct new gravity main in Noll Road leading to SR 305 to serve southern quarter of the basin.
2. **Force Main:** None currently exists	2. Construct new pump station at Noll Road and SR 350 intersection. Provide new force main to Johnson Way chlorination manhole.
3. **Alasund Meadows Pump Station**	3. Abandon and remove pump station after gravity main is installed.

5. DOWNSTREAM CONVEYANCE AND TREATMENT SYSTEM

The objective of the downstream conveyance and treatment evaluation is to ensure that adequate capacity is available within the Kitsap County conveyance and treatment system to meet the growth needs of the City.

5.1 DESCRIPTION OF DOWNSTREAM CONVEYANCE AND TREATMENT SYSTEM

The City's sewer system currently discharges to the County's system at the metering manhole located at Johnson Road in Lemolo. At this point, the City's Central Interceptor connects to a 24-inch gravity/force main which continues south to the two, 12-inch diameter siphons at Lemolo where it crosses under Liberty Bay to Keyport. At Keyport, it continues south to Pump Station 16, then southwest through a 16-inch force main to Pump Station 24. From Pump Station 24, flows discharge through a 24-inch force main to the CKWWTP.

The City has a contract with Kitsap County for treatment of up to 0.95 mgd wastewater at the CKWWTP. Based on the original 1996 contract, the County bills the City on a yearly basis for their share of the fixed operation, maintenance, and replacement costs of that portion of the system used to transport sewage generated by Poulsbo to the treatment plant based upon the ratio of Poulsbo's flow compared to the total flow for those facilities.

The 1998 contract amendment established a 3-tier system for sharing in the cost of capital improvements whereby County system connection charges were collected by the City and passed through to the County. The agreement provided that the City contributed capital for its proportional share of the North Central Conveyance improvements, and Poulsbo paid their fair share of the required plant improvements on a system-wide basis.

The County billed the City a total of $530,268 in 2005 with fixed costs accounting for $405,768 and variable costs $124,500. Fixed costs consist of operation and maintenance of the CKWWTP, Pump Station 16 and 24, and the Johnson Road chlorination and meter station. Variable costs are calculated based on amount of wastewater treated at $498.00 per million gallons treated.

The 1998 contract amendment has expired and is expected to be updated in 2007-2008 after Kitsap County completes the update to the CKWWTP Facility Plan.

5.2 DOWNSTREAM TREATMENT CAPACITY

The CKWWTP has an existing treatment capacity of 10.8 mgd, which is adequate to accommodate City flows. Future capacity at the CKWWTP will be evaluated as part of the Facility Plan update currently being prepared by the County, and the City will participate on a pro-rata basis for capital improvements needed at the CKWWTP. An allocation of $400,000 per year is reflected in the financial assessment.

5.3 DOWNSTREAM CONVEYANCE CAPACITY

Capacity of the County conveyance system is currently limited by the Lemolo siphon and Pump Station 16. Based on correspondence with Kitsap County (Appendix C), the existing capacity of the Lemolo siphon is 3.2 mgd, and the capacity of Pump Station 16 in Keyport is 3.8 mgd with two of the three pumps operating (firm capacity as required by Ecology). The capacity of the existing system is therefore limited by the siphon to 3.2 mgd.

Flow projections provided in Chapter 2 show that the existing conveyance system has capacity for peak flows until approximately 2013. At that time, peak hourly flows may meet or exceed existing capacity.

5.3.1 Future Potential Capacity Upgrades to Existing Conveyance System

There are several actions that have potential to increase the capacity of the County's conveyance system, subject to additional engineering analysis and concurrence by Ecology. These improvements are described in the following sections.

5.3.1.1 Lemolo Pipeline Improvements

Prior to 2013, improvements will be necessary to increase capacity of the siphon system. Reports prepared by Kitsap County (CH2M Hill, 2001) concluded that with the installation of three air and vacuum valves and sealing of three manholes between Johnson Road and the siphon, the capacity of the siphon system would increase to between 4.4 to 5.1 mgd, depending on the condition of the interior walls of the pipe. For the purposes of this CSP, the more conservative 4.4 mgd capacity is assumed.

Pressure tests conducted in 2006 by Kitsap County show that the future pressure within the siphon after installation of the air vacuum valves and sealing of manholes meets Department of Ecology requirements. Test results and Ecology approvals are provided in Appendix E. Costs for installation of relatively inexpensive, air/vacuum release valves and sealing of manholes is estimated at $50,000. Following these improvements, the siphon will have a capacity of at least 4.4 mgd, sufficient to meet future flows until approximately 2030.

Additional study and confirmation from Ecology would also be needed before this additional capacity can be verified. An engineering study is therefore proposed in 2011 to verify that capacity improvements can be attained. Construction of improvements would occur in 2012.

5.3.1.2 Pipe Replacement at Johnson Road

The conveyance pipe from Johnson Road and State Route 305 leaves the JRMS in an 18-inch diameter reinforced concrete pipe (RCP). One hundred and seventy-five feet away the conveyance turns into a 14-inch diameter ductile iron pipe force main. This pipe connects into the two 12-inch diameter siphons under Liberty Bay. The capacity of the conveyance is estimated to be about 3.2 mgd based on the limitations of the 18-inch diameter RCP leaving the JRMS. If the 175-foot long 18-inch diameter pipe leaving the JRMS was replaced with a 24-inch diameter PVC pipe, the capacity of this portion of the conveyance could potentially be increased to at least 4.4 mgd.

The pipe replacement would need to be conducted prior to or concurrent with the Lemolo pipeline improvements described in 5.3.1.1 above. The estimated cost for labor, materials and engineering to replace the 175-feet of 18-inch RCP with 24-inch PVC is $58,000. Improvements resulting from this action are based on preliminary analysis. A more comprehensive hydraulic and preliminary engineering analysis would need to be conducted of the siphon and conveyance system to evaluate and confirm the effects of this alteration. This engineering analysis would be conducted as part of the engineering study described in section 5.3.1.1.

5.3.1.3 Pump Station 16 Improvements

Pump Station 16 has three similar pumps rated at 950 gpm at 114 feet of head. These pumps were each tested by Kitsap County. Calculations based on all three pumps operating simultaneously were made based on several scenarios (factory pump data, actual pump test data, and downstream inflow from Bangor). Capacity with all three pumps operating ranged from a low of 5.0 mgd to a high of 6.2 mgd. However, firm pumping capacity must be calculated based on the assumption that one pump is out of service for repair. With two pumps operating, the firm PS 16 capacity ranges from a low of 3.8 mgd to a high of 4.6 mgd.

The current Pump Station 16 capacity is therefore 3.8 mgd. By adding a fourth 950 gpm pump, the firm capacity can be increased to 5.0 mgd (per the evaluation cited above). This additional pump, and wet well expansion, would need to occur by 2020, at an estimated cost of $250,000.

5.3.2 West Side Conveyance Alternative

Constructing a new or supplemental conveyance system around the west side of Liberty Bay has been previously identified as a potential alternative to the continued use of the Lemolo siphon (Kitsap County 2000). These alternatives would eliminate or supplement the two Lemolo siphons by reversing the wastewater flow from Poulsbo to flow around the north end of Liberty Bay and then south along the west side of Liberty Bay to the CKWWTP located near Brownsville.

The total estimated project cost to reroute all wastewater along the west side of Liberty Bay is estimated to be about $49 million. The alternative would require construction of a major new regional conveyance system, as well as reconfiguration of substantial portions of the City's existing collection and conveyance system. Refer to Appendix F for details on the west side conveyance alternative and costs.

Recent pressure tests of the siphons conducted by Kitsap County have shown that the siphons are functioning satisfactorily and have adequate capacity for City flows up to an estimated 4.4 mgd. At that time, expansion of the siphon system or construction of a supplemental conveyance system on the west side of Liberty bay may need to be considered. Costs for a supplemental west side conveyance system are estimated at approximately $33 million and assume that the siphon system will continue to operate up to its capacity, and only flow in excess of the siphon capacity is routed through the west side system. The Technical Memorandum (TM) shown in Appendix F provides more detailed description of the west side alternative and potential costs and benefits.

Flow projections show that the current siphon system, with improvements, will have capacity until approximately 2030, assuming a growth rate consistent with current City of Poulsbo Comprehensive Plan. Since capacity is available through the 20-year planning horizon associated with this plan, the west side conveyance alternative is not included as part of facility planning. However, long range planning and future updates to the CSP should continue to consider the west side option since wastewater flows are likely to someday exceed capacity of the siphon system.

5.4 PLANNING FOR LONG TERM CONVEYANCE CAPACITY

Based on the planned improvements described above, there will be sufficient capacity within the existing system to convey projected flows through the 20-year planning period. The City will coordinate with Kitsap County on potential long term alternatives for ensuring adequate downstream conveyance capacity for peak flows is available. This will include continued refinement of the flow monitoring system, engineering analysis of the siphon and Pump Station 16 to confirm whether additional capacity can be gained, and implementation of additional I&I projects. The schedule and cost for these projects, including engineering analyses of downstream conveyance components, are identified in the CIP presented in Chapter 7.

6. OPERATION AND MAINTENANCE PROGRAM

This chapter provides a description and evaluation of the City's operation and maintenance program and its ability to adequately manage and maintain sewer facilities.

6.1 GENERAL ORGANIZATION

The Public Works Department (PWD) is managed by the Public Works Director and is comprised of two primary divisions: Operations/Maintenance and Engineering. Each division is managed by an Assistant Public Works Director. In addition to the sewer utility, the PWD also includes water, stormwater, and solid waste utilities as well as managing the parks, streets, and public buildings. Public Works staff generally split their time between various duties, although a few operations and maintenance staff are fully dedicated to the sewer utility.

6.2 SYSTEM OPERATION AND CONTROL

The City has a Supervisory Control and Data Acquisition (SCADA) system with a master control located at the Public Works maintenance facility. The master polls all system Remote Telemetry Units (RTU's) by radio telemetry. The system uses a maximum transmission unit graphical interface on a series of screens that allow the operator to view a variety of parameters at all lift station facilities. The system includes an error handling alarm system with automated dialer.

The lift station telemetry provides only informational input data. It does not allow the operator to remotely control or operate any lift station equipment. Additionally, the system does not provide any flow indication at any of the pump station sites. Remote flow metering would provide the ability to quickly identify and respond to sewer pipe breaks, and the City is working on an automated monitoring system.

6.3 MONITORING PROCEDURES

The City maintains a Lift Station Monitoring System (LSMS) that provides a tool for the daily evaluation of the sanitary sewer system for leaks, line breaks, pump failures, or other abnormalities. The LSMS is a manual data entry spreadsheet operating in Microsoft Excel.

The spreadsheet consists of 19 tabs for data entry. There are two tabs for each of the nine pump stations, and one tab for recording the daily rainfall. The tabs are all interactive and worksheets are updated automatically.

As data is being entered, the spreadsheet checks it against an historical range trend. If the data falls out of the trend, an alarm in the spreadsheet is triggered and the operator must either re-enter the data or add an explanation for why it is out of the historical range.

Trends are updated routinely, generally every 45 days. Evaluation of the spreadsheet graphs and other data are also accomplished routinely.

Although the system requires manual inputting of data, and manual evaluation, it does provide a means for identifying system failures, or, in the case of repairs such as I&I projects, system improvements.

6.4 EMERGENCY PROCEDURES

The City completed a Comprehensive Emergency Management Plan (CEMP) in October 2004. The CEMP identifies the authorities and responsibilities of the City during an emergency. This is not specifically tailored to the emergency response of the sewer system, but does provide a framework for organizing and executing a successful response to an emergency.

6.4.1 Pump Station Emergency Procedures

The City has developed an emergency procedures manual for each of the pump stations. The first section of the manual is a brief description of potential failures and what immediate action to take to correct the problem. An example is a power failure. Other examples are stuck floats or pump failures.

Each manual provides a call list for notifying key personnel in the County and State, as well as local emergency coordinators.

The manuals also provide technical information for each pump station. Types of pumps, depths of wet wells, high and low float levels for pump start and stops, and other useful data are summarized in the manual. Copies of forms that can be used to notify agencies of spills are also included.

6.4.2 Customer Complaint Response

The City responds to all customer complaints. Administrative staff generally receives initial customer contact where the complaint is taken. The Utilities Foreman is notified of all complaints and decides how to resolve the situation. If a complaint cannot be resolved by phone, staff will visit the customer and take appropriate action.

6.5 PREVENTATIVE MAINTENANCE PROGRAM

Maintenance of the system is generally on an as-needed basis. Facility components are repaired or replaced as they are damaged, worn out, or expended. The City performs regular inspections of system components to remove accumulated debris and sediment, and minimize potential spills, leaks, and complaints.

6.6 I&I ASSESSMENT

The City has periodically performed smoke test and TV assessment to evaluate potential I&I problems. It is recommended that the City increase their routine I&I assessment and monitoring procedures as part of the on-going O&M program. This would include on-going systematic evaluation to identify and correct potential in-flow sources, and areas of significant infiltration. Refer to section 7.4.1.2 for additional information on the annual inflow reduction program.

6.7 DESIGN STANDARDS

The City has a Developer's Guide that provides construction standards and specifications for sanitary sewer collection systems. The Guide provides copies of various City Ordinances that incorporate this Guide as well as other nationally and professionally recognized design standards. Copies of the Developer Guide detail drawings are available in the City Engineer's office.

7. CAPITAL IMPROVEMENT PLAN

This chapter presents the CIP for the six-year period 2008 to 2014, including future improvements and estimated costs for each project. Previous chapters evaluated future sewage flow projections and various aspects of the existing collection and conveyance system, and identified where improvements to the existing facilities and expansions of the system are necessary to provide adequate service to existing and future users.

Projects are categorized as system upgrades and system rehabilitation and maintenance. System upgrade projects are generally associated with expanding the system to meet the future sewage flows resulting from population and business expansion, such as the Olhava Development. Rehabilitation and maintenance projects are generally associated with repairing existing older components of the system, such as projects to reduce infiltration in downtown Poulsbo and to replace components in the 9th Avenue pump station.

Table 7-1 summarizes recommended capital improvement projects, planning level cost estimates, and the schedule for construction. Appendix G provides backup detail for the estimates. The CIP schedule was developed with priority given to those projects needed to prevent or reduce risk of spill or leak, projects needed to repair existing facilities, and projects needed to serve future development. Consideration was also given for balancing the yearly project expenditures.

7.1 RECENTLY COMPLETED PROJECTS

The SR 305 force main was constructed in 2006, which consisted of a new 12-inch force main between Bond Road and Harrison Street and a new 18-inch gravity main from Harrison Street to Tollefson Street. Both mains are located in SR 305 and were installed in conjunction with the SR 305 highway widening project. This new force main carries wastewater from the Olhava development, and will be used to carry all wastewater from Finn Hill and Viking Avenue areas once the flow from the Lindvig pump station is redirected to this new main.

A new pump station (Bond Road pump station) was completed during 2007. This pump station delivers wastewater through the Central Interceptor main.

Total construction cost of the Central Interceptor project was $4,000,000, and the cost for the Bond Road pump station is $2,000,000. Both of these projects received 58 percent financial distribution from the Olhava developer.

7.2 SYSTEM REPAIR AND UPGRADES

Table 7-1 summarizes projects that provide repairs to pump stations, replace deteriorated piping systems, and install new infrastructure to allow for continued expansion of the service areas. These projects are described in more detail in Appendix G and in the paragraphs following Table 7-1. All projects are escalated at 5 percent per year to account for inflation and increase in construction costs. The 5 percent increase is consistent with the historic rate of growth of the Construction Cost Index (CCI).

Table 7-1. City of Poulsbo – Sewer Capital Improvements Six-Year Plan

Project	2008	2009	2010	2011	2012	2013	2014	Not Scheduled
Sewer Utility Funded Projects								
Replace Johnson Road Metering Station	$25,000							
Portable Trash Pumps – Bond Rd, Lindvig, MSC	$167,000							
Bond Rd Force Main	$849,000							
Central Poulsbo I&I Reduction	$535,000	$536,000						
9th Avenue Pump Station Upgrade		$241,000						
6th Ave Pump Station Upgrade		$138,000						
Village Pump Station Upgrade			$81,000					
Replace 6th to 9th Force Main			$380,000					
Marine Science Center Pump Station Repair			$54,000					
Replace Force Main Between MSC & Harrison Street					$328,000			
Replace 175 ft 18-in RCP with 24 in PVC – Johnson Rd				$58,000				
I&I Effectiveness and Downstream Capacity Engineering Study				$110,000				
Lemolo Pipeline Improvements					$50,000			
Slipline Beach Force Main						$180,000	1,120,000	
Olhava Pipe Run 18 Capacity Increase								$40,000 [3]
SR305 to Bond Rd Pump Station Capacity Increase								$30,000 [3]
Pump Station 16 Capacity Increase								$250,000 [4]
Non-Construction Sewer Utility Funded Projects								
Annual In-Flow Reduction Program	$20,000	$40,000	$21,000	$22,000	$23,000	$24,000	$25,000	
Kitsap County Contract Renewal Technical & Legal Services			$50,000					
Rate Study	$25,000							
Comprehensive Plan Update						$50,000	$50,000	
Total Sewer Utility Funded Projects	**$1,621,000**	**$955,000**	**$586,000**	**$190,000**	**$401,000**	**$254,000**	**$1,195,000**	**$320,000**

(Table Continues)

Table 7-1. City of Poulsbo – Sewer Capital Improvements Six-Year Plan (Continued)

Project	2008	2009	2010	2011	2012	2013	2014	Not Scheduled
Developer or LID Funded Projects[1]								
Noll Road North Collection System		$1,445,000						
Finn Hill Collection System		$1,756,000						
Liberty Bay Pump Station Upgrades		$250,000						
Central Viking Way Collection System			$677,000					
South Viking Way Collection System								$1,106,000
Noll Road South Collection System								$1,306,000
Total Developer/LID Funded Projects		**$3,451,000**	**$677,000**					**$2,412,000**
TOTAL ALL PROJECTS[2]	**$1,621,000**	**$4,406,000**	**$1,263,000**	**$190,000**	**$401,000**	**$254,000**	**$1,195,000**	**$2,732,000**

1 Schedule & costs for Developer/LID funded projects are estimated.
2 Costs are escalated 5% from 2007 to the year of construction.
3 Schedule is dependant upon build out within the basin.
4 Cost is estimated. Project assumed to be needed by 2020.
5 Estimated to be needed by 2030.

7.3 SYSTEM EXPANSION PROJECTS

System expansion projects provide for new facilities in the service area in order to support new housing and commercial development within the City as well as the UGA. These upgrades generally consist of new gravity collection mains that carry wastewater to one of the nine existing pump stations. In a few cases, at low elevations in the service area, a pump station will be required to lift the wastewater to a gravity main. Attempts to minimize new pump stations have been made in order to reduce future operation and maintenance costs and to be consistent with City policy. The following sections describe specific projects to expand the service area.

7.3.1 Finn Hill Basin Collection System

Based on the capacity assessment, the following projects in the Olhava basin have been added to the 6-year CIP.

- Olhava basin near Wal-Mart, Pipe Run 18. Increase 246-ft of 8-in diameter pipe to 10 or 12-in diameter. The preliminary cost estimate for this project is $40,000.
- Olhava basin on Bond Road, Pipe Run 94. Increase 70-ft of 8-in diameter pipe to 10 or 12-in diameter. The preliminary cost estimate for this project is $25,000.

Additional projects to increase capacity of the other segments in the Olhava basin that exceed capacity for 100 percent of full build out may be added to the CIP at a later date after development assumptions and as-built conditions are confirmed. These pipe segments appear to have adequate capacity in the near term to allow completion of a more detailed hydraulic model and back water analysis that would verify capacity conditions.

7.3.2 Noll Road (North) Collection System

This project will serve new residential development in the Noll Road corridor and consists of a new gravity main in or near Noll Road between Lincoln Avenue and Deer Run. The new pipe will connect to the 10-inch main carrying wastewater from the Deer Run development. Since the 10-inch Deer Run gravity main is on a very flat slope, the new development flows will result in existing capacity being exceeded. Therefore, the existing 10-inch main will either be increased to a 15-inch diameter main using pipe bursting methods, or a new 10-inch diameter main paralleling the existing main will be installed.

A new pump station and force main would be constructed to serve a small portion of this basin that is not able to connect to the main by gravity flow.

The new gravity sewer would allow the existing Alasund Meadows pump station and force main to be phased out.

This project will allow the development of new housing along Noll Road. Project cost is estimated at $1.445 million. Funding will be by LID, with repayment by developers under latecomer agreements.

7.3.3 Noll Road (South) Collection System

Property along Noll Road south of Deer Run is at a low elevation and therefor cannot drain into the existing Deer Run collection main. To serve this area, a new 10-inch main will be placed in or near Noll Road from Deer Run to SR 305. A pump station will be constructed at SR 305 and the wastewater pumped through a new force main in SR 305 to the chlorination manhole located at Johnson Road.

This project will allow wastewater collection from existing and future homes along Noll Road. Project cost is estimated at $1.306 million. No major developments are currently proposed, nor is it likely that any large development will be proposed that could fund the entire project. Funding may therefore need to be a combination of developer latecomer fees and City funding, if available.

7.3.4 South Viking Way Collection System

This project consists of constructing a new collection system to serve residential and commercial areas at the south end of Viking Way. A pump station at the lower end of Anderson Lane will be required to convey wastewater to the existing gravity main in Viking Way. Flow from both the east and west sides of Viking Way could discharge to this pump station.

This project will allow wastewater to be collected from a new development west of Viking Way. Existing homes located east of Viking Way, currently on septic systems, could connect to the system if the pump station is located in Anderson Lane. Total project cost is estimated at $1.106 million, including the new pump station. Funding by LID with latecomer fees is proposed.

7.3.4.1 Liberty Bay Pump Station Improvements

The south end of the Viking Way basin is expected to experience significant development. Expansion of the pump station will be required to increase capacity from the current 100 gpm, to 400 gpm (0.58 mgd). The preliminary cost estimate for this assumes a complete rebuild of the pump station at a cost of $250,000 with funding provided by the developer.

7.3.5 Central Viking Way Collection System

This project consists of constructing a new collection system to serve the area west of Viking Way that can flow either to the Liberty Road pump station or to the Lindvig pump station. No pump stations or force mains will be required. This project will allow wastewater to be collected from new developments west of Viking Way. Developer funding is proposed in the amount of $677,000.

7.3.6 Finn Hill Collection System

This project consists of constructing a new collection system to serve the Finn Hill and Urdahl Road areas located north of SR 3. Wastewater from these properties will all flow via the Olhava gravity system to the Bond Road pump station. A gravity main will be placed in Finn Hill Road and a portion of Urdahl Road leading to a new pump station at Finn Hill near SR 3. This pump station will lift the wastewater to the gravity system in "A" Street in front of Walmart, which will carry it to the Bond Road pump station. Portions of the north end of Urdahl can flow either by gravity to the Olhava sewer system, or to the new pump station at the lower end of Finn Hill Road.

The total estimated cost of this system is $1.756 million. It can be constructed incrementally, with several proposed housing developments constructing pump station and main down Finn Hill Road with developers of future projects adding on to the system.

7.4 SYSTEM REHABILITATION PROJECTS

7.4.1 Inflow and Infiltration Reduction

Flow monitoring data presented in Chapter 2 indicates the City's system has significant I&I. Additionally, downstream conveyance capacity is limited. Therefore, I&I reduction will be a high priority for the sewer utility CIP. The following I&I projects are proposed.

7.4.1.1 Central Poulsbo I&I Reduction

This is the second Infiltration and Inflow (I&I) project for the older, central portion of Poulsbo. The first project in the 6th Avenue basin was completed in 2002. This project will replace old deteriorated mains in the areas of 3rd Avenue, 5th Avenue, Moe Street, Lincoln and Hostmark Streets south of SR 305, and Swanson Way. Construction will likely be by pipe bursting techniques. New side sewers leading to homes will also be installed to eliminate inflow from roof downspouts. Design is complete, and construction is planned for 2008 and 2009 with an estimated cost of $1.071 million.

7.4.1.2 Annual Inflow Reduction Program

Flow monitoring data shows that the existing sewer system experiences high levels of in-flow during storm events. This inflow may be associated with leaking man-holes, storm drain connections or roof drain connections. Starting in 2007-2008, the City will implement an annual inflow reduction program consisting of identifying and repairing inflow sources.

An annual allocation of approximately $20,000 is established, with the exception of 2009 when $40,000 is allocated for development of an I&I control program that will include the following elements:

- Installation of inflow prevention devices (such as manhole inserts) in public right-of-way
- Development of an I&I monitoring program to identify areas of high I&I
- Smoke tests of suspected high I&I areas to identify specific inflow sources
- Development of public education activities and City policies that will encourage private property owners to disconnect roof drains and other sources of direct inflow to the sanitary sewer system

7.4.2 Pump Station Upgrades

The CIP identifies a total of four pump station upgrade projects. Each of these projects is described below.

7.4.2.1 6th Avenue Pump Station Upgrade

This project consists of replacement of the pumps and electrical system, providing metering, and installing an emergency generator. The work is required for pump station rehabilitation. The project cost is estimated at $138,000.

7.4.2.2 9th Avenue Pump Station Upgrade

This project provides a complete rebuild of the pump station. Safety is an issue because the electrical float control contacts are directly above the wet well. Gas from the sewers can accumulate in the can pump station and could explode with an electrical spark. The work would be a complete rehabilitation to include new pumps, valves, electrical control, flow metering, and telemetry at a cost of cost is approximately $241,000.

7.4.2.3 Village Pump Station Repair

This pump station is in generally good condition, but repair and maintenance will be required to ensure reliability and safety. The existing J-box for the floats located in the wet well can be difficult to access and can be submerged during power outages. The J-box should therefore be relocated. The cost for this repair maintenance work is estimated at $81,000.

7.4.2.4 Marine Science Pump Station Repair

This pump station is in generally good condition. However, the existing 30-hp pump station must be replaced with a 50-hp pump in order to ensure a firm pumping rate of 2,000 gpm for the pump station. The cost of the valve replacement and other minor work is about $54,000.

7.4.2.5 Purchase Portable Trash Pumps

This project consists of purchasing three portable trash pumps for emergency use at the City's pump stations, primarily at the Bond Road, Lindvig, and Marine Science Center pump stations. The total project cost is $167,000.

7.4.3 Downstream Conveyance Capacity Improvements

Downstream conveyance capacity projects are designed to increase capacity of County-owned facilities located between the Johnson Road Metering Stations, and the CKWWTP. Pursuant to the agreement between the City and the County, the City is responsible for 100 percent of the costs of these improvements because the City generates 100 percent of flow within this portion of the County's system.

7.4.3.1 Replace Metering Flume and Flow Measurement System

The JRMS measures wastewater flow from the City of Poulsbo into the Kitsap County conveyance system. The JRMS is not currently able to record flows above 2.5 mgd due to flooding of the sonic measuring device in the existing Parshall flume, which is set at 14 inches. The existing metering system reports flow as weekly summary only. Peak day and peak hourly flow data is not available.

Analysis of the JRMS identified several potential options to improve flow measurement. This analysis is included in Appendix H. The recommended improvement consists of installation of a new flow meter upstream of the JRMS. This would allow for accurate flow measurement for both the City and County, measurement of peak instantaneous and peak hourly flow, as well as reduce uncertainty regarding the affect of downstream hydraulics on the existing flow meter. This project would be implemented in 2008 at an estimated cost of $25,000.

There are several actions that have potential to increase the capacity of the County's conveyance system, subject to additional engineering analysis and concurrence by Ecology. These improvements are described in the following sections.

7.4.3.2 Lemolo Pipeline Improvements

Installation of three air and vacuum valves and sealing of three manholes between Johnson Road and the siphon will increase the capacity of the siphon system to 4.4 mgd. Costs for installation of relatively inexpensive, air/vacuum release valves and sealing of manholes is estimated at $50,000. Following these improvements, the siphon will have a capacity of at least 4.4 mgd, sufficient to meet future flows until approximately 2030.

Additional study and confirmation from Ecology would also be needed before this additional capacity can be verified as available. An engineering study is therefore proposed in 2011 to verify that capacity improvements can be attained (see section 7.4.3.5). Construction of improvements would occur in 2012.

7.4.3.3 Pipe Replacement at Johnson Road

The conveyance pipe from Johnson Road and State Route 305 leaves the JRMS in an 18-inch diameter RCP. The capacity of the conveyance is estimated to be about 3.2 mgd based on the limitations of the 18-inch diameter RCP leaving the JRMS. Replacing the 175-foot long 18-inch diameter pipe with a 24-inch diameter PVC pipe, the capacity of the conveyance could potentially be increased to at least 4.4 mgd.

The pipe replacement would need to be conducted prior to or concurrent with the Lemolo pipeline improvements described in 7.4.3.2 above. The estimated cost for labor, materials and engineering to replace the 175-feet of 18-inch RCP with 24-inch PVC is $58,000. A more comprehensive hydraulic and preliminary engineering analysis would need to be conducted of the siphon and conveyance system to evaluate and confirm the effects of this alteration. This engineering analysis would be conducted as part of the engineering study described in section 7.4.3.5.

7.4.3.4 Pump Station 16 Improvements

Pump Station 16 has firm pumping capacity with two pumps operating of between 3.8 mgd to a high of 4.6 mgd. The current Pump Station 16 capacity is therefore 3.8 mgd. By adding a fourth 950 gpm pump, the firm capacity can be increased to 5.0 mgd (per the evaluation cited above). This additional pump, and wet well expansion, would need to occur by 2020. The CIP includes an allocation of $250,000 for this project.

7.4.3.5 I&I Effectiveness and Downstream Conveyance Improvements Engineering Study

This project would consist of engineering analysis to document I&I reduction program effectiveness, and to design hydraulic improvements to the downstream conveyance system needed to increase conveyance capacity over 3.7 mgd. This engineering analysis would be conducted at an estimated cost of $110,000 in 2011 after implementation of the central Poulsbo I&I project, and several years of implementation of the I&I reduction program that will be established by the City in 2008.

7.4.4 Other Rehabilitation Projects

7.4.4.1 New Force Main between Lindvig and Bond Road Pump Stations

This project provides a new force main between the Lindvig and Bond Road pump stations. Currently, wastewater flows by gravity from Bond Road to Lindvig, where it is pumped along the waterfront to the Marine Science Center pump station. The force main along the beach experienced several leaks in 2006, and has deteriorated to the point that it must be either rehabilitated or abandoned. This new main will allow wastewater from Viking Way to enter the Central Interceptor and will allow the waterfront main to be repaired and used as an emergency backup if the Bond Road pump station ever fails. Project cost is estimated at $849,000.

7.4.4.2 Slipline Force Main between Lindvig and Marine Science Center Pump Stations

This project will be accomplished after the new force main to the Bond Road pump station is complete. The project will slip line the existing 10-inch force main with an 8-inch HDPE main. The cost is estimated to be approximately $1.3 million.

7.4.4.3 Replace Force Main between Marine Science Center Pump Station and Harrison Street

This project replaces the 12-inch force main from the Marine Science Center pump station that runs along the beach. The existing main is subject to damage or failure which would result in release of sewage to Liberty Bay. The force main will be rerouted along Fjord Drive and then tie into the existing Central Interceptor main in SR 305 at Harrison Street. Estimated cost is $328,000.

7.4.4.4 Replace 6th to 9th Pump Station Force Main

This project serves two purposes. First, it replaces a force main running adjacent to the beach. Secondly, it separates the flows between the two stations. Currently, if both pump stations are running at the same time, the rate of pumping of both stations is reduced because they share the same undersized pipe.

A new force main serving the 6th Avenue pump station will be constructed up Matson Street to the new Central Interceptor in SR 305. The existing force main to the 9th Avenue pump station will be either abandoned, or retained for use as emergency backup for the 6th Avenue pump station. Total project cost is estimated at $380,000.

8. FINANCIAL PLAN

8.1 INTRODUCTION

This chapter contains an analysis of the City's ability to meet future operating expenses and fund improvements outlined in the previous chapters. Potential funding sources, financial status of the utility, funding required for scheduled improvements, and the potential impacts of system improvements on rates are presented.

The City operates a combined water and wastewater utility, but the analysis presented in this chapter is specific to the sewer utility. All revenues and expenses known to be associated with the sewer system are included in the analysis. The fiscal planning period for this analysis is the six years from 2008 through 2014. The fiscal impacts that will occur after 2014 are not considered in this financial analysis.

The purpose of this financial analysis is to determine whether, based on reasonable assumptions made today, the City can implement the CIP recommended in Chapter 7 of this CSP while maintaining sewer user rates at reasonable levels. This financial plan is intended to satisfy the requirements of WAC 173.240.050, and RCW 36.704.070.

8.1.1 Financial Structure of a City Sewer Utility

Municipal utilities in Washington State are operated as enterprise funds and are required by state law to operate with a balanced budget. Therefore, the City must decide how it will finance its utility capital improvements as well as provide funds to operate the utility through some combination of user rates, debt, and contributions. It must then establish user rates at a level that is sufficient to operate and maintain its facilities, pay debt service on any debt issued, and maintain reasonable cash reserves.

Financial activity of the City sewer utility occurs in three funds; the operating or maintenance fund, the capital fund, and the bond redemption fund. Routine financial transactions can affect one or more of these funds.

8.2 REVENUE AND EXPENSES

Actual revenue and expenses over the previous 5 years, and projections for the 2008 through 2014 period are shown in Table 8-1.

8.2.1 Revenues

Revenues are derived from rates and connection charges. Current City sewer rates are shown in Table 8-2. Per Poulsbo Municipal Code, rates are adjusted every January based on the Consumer Price Index (CPI) for Urban Consumers, US City Average. Rate revenue projections assume 2.0% annual CPI adjustment, and 2.0% annual growth. These CPI assumptions are consistent with historical CPI levels.

Table 8-1. City of Poulsbo Sewer Fund Financial Summary

Sewer Fund Element	Actual				Budgeted	Projected						
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Capital												
Capital Projects [1]	$ 165,913	$ 149,941	$ 15,602	$ 38,367	$ 1,055,000 [8]	$ 1,621,000	$ 955,000	$ 586,000	$ 190,000	$ 401,000	$ 254,000	$ 1,195,000
Equipment Replacement	$ -	$ -	$ -	$ 56,368	$ 110,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
New Public Works Complex [2]	$ -	$ -	$ -	$ -	$ -	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000	$ 64,000
Total Capital Costs	**$ 165,913**	**$ 149,941**	**$ 15,602**	**$ 94,734**	**$ 1,165,000**	**$ 1,785,000**	**$ 1,119,000**	**$ 750,000**	**$ 354,000**	**$ 565,000**	**$ 418,000**	**$ 1,359,000**
Fund Balances												
Operating Fund	$ 865,332	$ 1,225,013	$ 1,634,380	$ 1,978,097	$ 2,145,966 [9]	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966	$ 1,145,966
Sewer Capital Reserve [3]	$ 392,894	$ 180,753	$ 661,576	$ 870,738	$ 1,255,116	$ 2,255,116	$ 1,136,116	$ 386,116	$ 32,116	$ (532,884)	$ (950,884)	$ (2,309,884)
Debt Service Fund	$ 477,302	$ 669,344	$ 454,233	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686	$ 467,686
Total Fund Balance	**$ 1,735,528**	**$ 2,075,110**	**$ 2,750,189**	**$ 3,316,521**	**$ 3,868,768**	**$ 3,868,768**	**$ 2,749,768**	**$ 1,999,768**	**$ 1,645,768**	**$ 1,080,768**	**$ 662,768**	**$ (696,232)**
Revenues												
Service Charges [4]	$ 1,852,713	$ 1,756,729	$ 1,794,011	$ 1,846,416	$ 1,751,000	$ 1,821,740	$ 1,895,339	$ 1,971,910	$ 2,051,576	$ 2,134,459	$ 2,220,691	$ 2,310,407
Restricted Revenues	$ 144,351	$ 11,506	$ 14,020	$ 112,287	$ 42,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Connection Charges	$ 143,782	$ 182,206	$ 267,732	$ 225,805	$ 100,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
City Share of SR350 FM and Bond Rd PS [5]	$ -	$ -	$ -	$ -	$ -	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)	$ (334,665)
Revenue Bond Proceeds	$ -	$ -	$ 2,444,520	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Revenues	**$ 2,140,846**	**$ 1,950,441**	**$ 4,520,283**	**$ 2,184,508**	**$ 1,893,000**	**$ 1,657,075**	**$ 1,730,674**	**$ 1,807,245**	**$ 1,886,911**	**$ 1,969,794**	**$ 2,056,026**	**$ 2,145,742**
Expenses												
Operation & Maintenance [6]	$ 671,381	$ 688,280	$ 729,224	$ 787,389	$ 891,889	$ 909,727	$ 927,921	$ 946,480	$ 965,409	$ 984,718	$ 1,004,412	$ 1,024,500
Contracted Services *(Sewage Treatment)*	$ 464,292	$ 473,641	$ 492,956	$ 505,001	$ 500,000	$ 510,000	$ 520,200	$ 530,604	$ 541,216	$ 552,040	$ 563,081	$ 574,343
Regional Sewage Treatment Capital System [7]	$ 156,521	$ 216,896	$ -	$ -	$ 220,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ 400,000
Debt Service	$ 484,546	$ 481,357	$ 2,795,646	$ 483,986	$ 398,343	$ 372,011	$ 373,412	$ 380,912	$ 384,188	$ 387,194	$ 393,842	$ 393,842
Total Expenses	**$ 1,776,740**	**$ 1,860,174**	**$ 4,017,826**	**$ 1,776,376**	**$ 2,010,232**	**$ 2,191,738**	**$ 2,221,533**	**$ 2,257,996**	**$ 2,290,813**	**$ 2,323,952**	**$ 2,361,335**	**$ 2,392,685**
TOTAL SEWER UTILITY BALANCE	**$ 1,933,721**	**$ 2,015,436**	**$ 3,237,044**	**$ 3,629,919**	**$ 2,586,536**	**$ 1,549,106**	**$ 1,139,909**	**$ 799,018**	**$ 887,865**	**$ 161,611**	**$ (60,540)**	**$ (2,302,174)**

Notes:
1. Refer to Table 7.1 for breakdown of CIP costs and schedule. CIP costs escalated at 5% per year per historical Construction Cost Index (CCI).
2. Estimated sewer utility share of debt service for new Public Works complex (25 percent of total).
3. Sewer capital reserves for 2007 through 2014 period calculated as prior years reserve less current years capital costs.
4. Service charges for period 2008 through 2013 based on average 2.0% growth per year, and 2.0% CPI adjustment per year.
5. City share (42%) of total cost of SR305 force main and Bond Road pump station projects ($6,000,000 total). Assumes average of 135 ERUs per year from Olhava for period 2007 through 2013. Total City obligation of approximately $2,520,000.
6. Operation and maintenance costs estimated to increase 2 percent per year.
7. Estimated cost for Poulsbo share of capacity improvements at CKWWTP. Actual costs to be developed by Kitsap County in 2007-2008 after completion of the County's Draft CSP update.
8. Actual approved 2007 City budget is $1,055,000.
9. Transfer $1,000,000 from Operating Fund to Capital Fund in 2008.

Table 8-2. Current Rate Structure

	Base Charge[1]	Commodity Charge[2]
Single Family Residence	$29.61	$3.89
Multi-Family	$31.34	$4.32
Commercial	$31.34	$4.32
Outside City Residential	$44.17	$5.28
Outside City Commercial	$47.03	$6.48
Low Income Seniors	$13.87	$3.83

[1] Fixed charges increase with Meter Size. Rates shown based on 3/4".

[2] Commodity charge based on per 100 cubic ft.

The City currently collects approximately $2,479 per new residential connection as a general facility charge. Connection charge revenues shown in Table 8-1 reflect a conservative projection of new general facility charge revenues compared to the previous 5 years. A connection charge "credit" to the Olhava developer is also provided pursuant to the Olhava Developer Agreement. This agreement provides that the City reimburse, through future connection charges, the Olhava Developer 42 percent of the cost of construction of the SR 305 force main and Bond Road pump station. The total estimated cost for these improvements was $6,000,000 so the City's total obligation under the agreement is approximately $2,520,000. The estimated connection charge credit shown in Table 8-1 is based on the estimated build out at Olhava over the next 6 years.

8.2.1.1 Developer Extensions

For new developments, the City requires the developer or landowner to agree to execute a utility extension agreement. Through this agreement, the City requires the developer or property owner to pay all costs associated with designing, engineering, and constructing the extension to City standards. This agreement does not, however, guarantee or reserve sewer capacity within the system. Capacity is only assured when a building permit is actually issued. The agreement also requires the developer/landowner to turn over and dedicate any capital facilities such as main lines, pump stations, and wells to the City at no cost. All agreements must be approved by the City Council. The City anticipates this process will be used more often to serve development occurring throughout the UGA.

8.2.2 Expenses

Expenses shown in Table 8-1 reflect an estimated annual cost increase of 2 percent for O&M, and 2 percent for treatment services contracted with Kitsap County. Estimated cost sharing for capital improvements at the CKWWTP is also included, with an allocation of $400,000 per year. The basis for calculating the City's cost share is described in the following section.

8.2.2.1 Cost Sharing of Kitsap County Capital Costs

During the development of the 1998 CSP, Kitsap County and Poulsbo negotiated an approach to sharing capital costs related to Poulsbo sewer services. This approach is documented in Amendment No. 2 (see Appendix B) to the Contract for Sanitary Sewerage Service executed by the City and County in December 1997. The amendment provides for three methods of cost sharing between Poulsbo and Kitsap County:

- Two-tiered connections charge – Poulsbo will collect both its own and Kitsap County's connection charge from new connections within the City. Poulsbo will pass on the County portion on a monthly basis directly to Kitsap County.
- Contributed capital costs – Poulsbo made direct capital contributions to Kitsap County of $3.34 million from 1997 through 2000. These costs were funded from user rates and debt as part of the regular Poulsbo sewer capital program. This cost has been paid by the City and is no longer a consideration of the current financial plan.
- Capital recovery charges – Poulsbo will pay a monthly charge to the County computed on an ERU basis as Poulsbo's share of County regional capital expenses.

A copy of the Kitsap County notice of anticipated costs for 2006-2007 is provided in Appendix B.

8.3 PROPOSED CAPITAL IMPROVEMENTS

The proposed capital improvements for the Poulsbo sewer system are discussed in Chapter 7 of this Plan. A total of $5,202,000 in City funded capital project need has been identified over the 2008-2014 period. It should be noted that the CIP will be revisited annually to verify that project costs and schedule meet the City's needs at that time.

8.4 SUMMARY AND CONCLUSIONS

Based on the preceding information and the data contained in Table 8-1, it appears that there is financial capacity to implement the CIP through approximately 2011. After that date, the sewer capital reserve fund balance will likely drop below acceptable levels.

The financial analysis indicates sewer rates may need to be increased within the next several years to cover costs associated with system upgrades and O&M. A rate analysis to determine the extent of a potential rate increase is outside the scope of this CSP update. It is therefore recommended that the City initiate a rate study in 2008 to evaluate financial needs in greater detail.

Based on the proposed CIP, sewer rates will likely need to be increased in order to generate sufficient revenue to fund identified capital improvements and the estimated WWTP capital allocation. As part of the recommended rate study, the City should also evaluate the sewer connection charge. Costs for future conveyance and capacity improvements to accommodate growth should be reflected in connection charges to ensure that new customers are paying their fair share of capital facilities. Increasing the connection charge for new customers, if warranted, may reduce the magnitude of the rate increase that is borne by all system users.

Table 8-3 summarizes sewer rates for several Kitsap County utilities. City sewer rates are above average when compared to similar sized utilities in Kitsap County. The City's facility charge (connection charge) is, however, lower than several utilities.

Higher monthly rates are due to Poulsbo's generally smaller population compared to other local utilities and the associated requirement to spread costs to a smaller rate payer base. The long conveyance system from the City to the CKWWTP, and the high I&I from the old City sewer system also contribute to higher rates compared to other local utilities.

Table 8-3. Summary of Monthly Residential Sewer Rates in Kitsap County

Jurisdiction	Monthly Rate			Facility Charge
	Fixed	Commodity (600f)	Total	
Poulsbo	$29.61	$3.89	$52.95	$5,319
Bainbridge Island	$25.76	$4.39	$52.10	$5,123
Shelton	$20.80	$4.16	$45.76	$7,240
Port Orchard	$36.00	$ -	$36.00	$7,240
Kitsap County				
Central Kitsap	$48.33	$ -	$48.33	$2,840
Kingston	$48.33	$ -	$48.33	$7,182
Suquamish	$48.33	$ -	$48.33	$4,506
Bremerton	$22.08	$3.68	$44.16	$3,586

9. REFERENCES

Brown and Caldwell, 1994. Central Kitsap County Wastewater Facility Plan. Prepared for Kitsap County Public Works.

CH2M Hill, 2001. Existing Lemolo Pipeline and Pump Station 16 Analysis. Technical memorandum prepared for Kitsap County. July 19.

City of Poulsbo and Kitsap County, 2001. Poulsbo Sub-Area Plan. olume I. December 17.

Gray and Osborne, Inc., 2007. City of Poulsbo Draft Water System Plan. G&O #06657. January.

Kitsap County, 2000. Final Supplemental Environmental Impact Statement for the Central Kitsap County Facilities Plan.

Kitsap County, 2006. Final 10-Year Comprehensive Plan Update. December.

Parametrix, 1998. City of Poulsbo Draft Comprehensive Sewer Plan Update. May.

Parametrix, 2002. City of Poulsbo Draft Comprehensive Sewer Plan Update – 2002 Update. April.

R.W. Beck, 1992. City of Poulsbo Comprehensive Sanitary Sewer Plan. August.

APPENDIX A

SEPA Checklist

City of Poulsbo

Planning Department

CITY OF POULSBO
DETERMINATION OF NONSIGNIFICANCE (DNS)
WAC 197-11-970

Description of proposal: The City of Poulsbo has prepared a draft update to the City's 2002 Draft Comprehensive Sanitary Sewer Plan. The draft update will be used to evaluate the City sewer system and determine if the sewer utility is adequately serving the current and future needs of the community, as well as meeting applicable regulatory requirements. The draft update will also support the revision to the Capital Facilities Element of the Comprehensive Plan, which is anticipated to occur in 2007.

File: 05-02-07-1

Proponent: City of Poulsbo, Public Works Department

Location of Proposal: The draft Sewer Plan is an administrative planning document that does not affect a specific site. Projects undertaken in accordance with the final plan will address sanitary sewer needs within the City's designated Urban Growth Area. All future projects will undergo separate permit review including review under SEPA.

Lead Agency: City of Poulsbo

The lead agency for this proposal has determined that it does not have a probable significant 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 after using the optional DNS process in WAC 197-11-355. There is no further comment period on the DNS.

Responsible official:	Barry Berezowsky
Position/Title:	Planning Director
Address:	City of Poulsbo P. O. Box 98 Poulsbo, WA 98370
Phone:	360-779-3006

Date: May 30, 2007 Signature: ____________

You may appeal this determination in writing to the responsible official listed above no later than 10 working days from the date of this notice. You should be prepared to make specific factual objections. Contact the responsible official to read or ask about the procedure for SEPA appeals.

Gene

SEPA - NOA - NOD distribution list (Circle one)

PROJECT NAME City Sewer Plan FILE NO: 05-02-07-1 DATE: 5/2/07

4c

- ~~17~~ Department of Ecology - SEPA-Environmental Review Section
- ~~18~~ Washington Department of Fish & Wildlife
- ~~31~~ Kitsap Transit
- ~~34~~ NK School District #400,
- ~~35~~ Kitsap County DCD
- ~~36~~ Poulsbo Library
- ~~38~~ The Suquamish Tribe
- ~~39~~ Tollman, Jeff - Muni Court
- Anya Funk - ***COND OF APP LONG***
- ~~42~~ Puget Sound Power & Light
- ~~43~~ Sprint Telephone Co.
- ~~47~~ Kitsap County Herald
- ~~52~~ Bremerton Sun
- ~~53~~ Kitsap Business Journal ***NOA***
- ~~55~~ ATT Broadband
- ~~60~~ Kit. Co. assessor ***NOD***

City of Poulsbo:
- Office of the Mayor
- City Council - 7 copies
- Planning Commission - 7 copies
- Park Commission - 7 copies
- Finance Department
- Fire Department
- Police Department
- Public Works Department
- Engineering Department
- Parks Department
- Hearing Examiner

ADMIN WALL DRAWER P.O.

****

Federal:
1 Environmental Protection Agency
2 Regional Director, Department of Commerce, Economic Dev. Admin.
3 Building Industry Association of Washington
4 Department of Housing & Urban Development
5 U. S. Fish & Wildlife Service
6 U. S. Army Corps of Engineers, Wetlands Division
7 National Marine Fisheries Service

State Agencies:
8 State of Washington - Office of the Governor
9 Washington State Office of Archaeology & Historic Preservation
10 Washington State Department of Transportation
11 Washington State DOT - Local Programs Office
12 Department of Community Trade & Economic Development (formerly DCD)
13 Department of Natural Resources - SEPA Center
14 Department of Social & Health Services
15 Department of Game - Environmental Affairs
16 Department of Ecology - Shoreline Permit Review

Regional:
19 Puget Sound Air Pollution Control Agency
20 Puget Sound Regional Council
21 Daily Journal of Commerce
22 Puget Sound Assn of Coop Tribes
23 Puget Sound Water Quality Authority

Other Recipients:
37 Port of Poulsbo
40 Poulsbo Chamber of Commerce
41 Poulsbo Yacht Club
44 League of Women Voters
45 Hood Canal Environmental Council
46 Marine Science Center
48 Poulsbo Senior Citizen Center
49 View Side Community Water System
50 Economic Development Council of Kitsap County
51 Washington Environmental Council
54 Olympic College
56 Fed. Aviation Admin
57 Fed. Comm.Com
58 HDPA
59 Kitsap PUD

County and Subcounty:
~~24~~ Kitsap County Health ~~Department~~ District
25 Kitsap County Commissioners
26 Kitsap County Association of Realtors
27 Kitsap County Homebuilders Associatior
28 Kitsap County Sheriff's Dept.
29 Kitsap County Comp Health Plan. Coun.
30 Kitsap County Plan. Comm.
~~32~~ Kitsap County Public Works
33 Kitsap County Cen Com

Other persons notified:
Andrzej
Crystal

CITY of POULSBO
VIKING CITY

AFFIDAVIT OF MAILING

STATE OF WASHINGTON)
) SS.
COUNTY OF KITSAP)

The undersigned, being first duly sworn, on oath states: That on May 3, 2007,

affiant caused to be deposited in the mails of the United States of America a properly stamped and addressed envelope directed to See attached containing a copy of the document to which this affidavit is attached.

Subscribed and sworn to before me this 3rd day of May, 2007.

CHERLYN J. HALEY
COMMISSION EXPIRES
NOTARY
PUBLIC
3-13-11
STATE OF WASHINGTON

NOTARY PUBLIC in and for the State of Washington, residing at Poulsbo

My Commission expires on 3-13-11

SEPA

ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable:

   City of Poulsbo Comprehensive Sanitary Sewer Plan (CSP)

   This plan includes a capital improvement plan, but does not directly include any construction activities.

2. Name of applicant:

   City of Poulsbo

3. Address and phone number of applicant and contact person:

   Andre Kasiniak
   City Engineer
   City of Poulsbo
   P.O. Box 2275
   Poulsbo, WA 98370

4. Date checklist prepared:

   February 2007

5. Agency requesting checklist:

   City of Poulsbo

6. Proposed timing or schedule (include phasing, if applicable):

   Comprehensive Plan approval by the City and Department of Ecology (Ecology) is expected in April – May 2007.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

   The City of Poulsbo's CSP will be updated approximately every 5 years.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

   None

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

None

10. List any government approvals or permits that will be needed for your proposal, if known.

The CSP must be approved by Ecology.

11. Give a brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The CSP is a non-project proposal addressing the comprehensive sewer system needs within the City of Poulsbo and its proposed Urban Growth Area (UGA). The plan includes projections of waste water generation through 2025, review of system facilities, recommendations for improvement and replacements to the system, and discussion of operation and maintenance of the system.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of an area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The plan addresses sanitary sewer needs within the city limits of the City of Poulsbo and the proposed Urban Growth Area (UGA) of the City of Poulsbo (see Figure 1). The plan area is within Township 26 N., Range 1 E., Sections 9, 10, 11, 13, 14, 15, 21, 22, 23, 24, and 25.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): flat, rolling, hilly, steep slopes, mountainous, $\boxed{\text{other}}$.

Variable – flat, rolling and hilly – elevations within the Plan area vary from approximately 23 feet to 141 feet above sea level.

b. What is the steepest slope on the site (approximately percent slope)?

The steepest slope where construction could take place is approximately 15%.

c. What general types of soils are found on the site (for example, clay, and, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

The Soil Survey of Kitsap County Area, Washington (Soil Conservation Service (SCS), 1980) has described the soils that exist in the area as Poulsbo-Ragnar series. The project area soils are largely split between upland fill areas, which are dominated by sandy construction fill, and the valley bottom, which is dominated by soils closely resembling the units mapped by SCS.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No unstable soils are located at utility locations, except for the force main located below Front Street on Liberty Bay at the base of an unstable slope. Following construction of the Bond Road force main in 2008, this force main will be used only in emergencies.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

N/A. Non-project proposal.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

N/A. Non-project proposal.

g. What percent of the site will be covered with impervious surfaces after project construction (for example, asphalt, or buildings)?

N/A. Non-project proposal.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

N/A. Non-project proposal.

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile odors, and industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

N/A. Non-project proposal.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

N/A. Non-project proposal.

c. Proposed measures to reduce or control emissions or other impacts to air, if any?

N/A/ Non-project proposal.

3. Water

a. Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, and wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Surface waters within the Plan area include the South Fork of the Dogfish Creek, Dogfish Creek and Liberty Bay. South Fork Dogfish Creek is a small, urbanized stream that drains into Dogfish Creek on the north side of Bond Road (SR 307). In addition, wetlands are present in the project vicinity.

2) Will the project require any work over, in or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

N/A. Non-project proposal.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site what would be affected. Indicate the source of fill material.

N/A/ Non-project proposal.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

N/A. Non-project proposal.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No part of the study area is within a 100-year floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

N/A. Non-project proposal.

b. Ground:

1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

N/A. Non-project proposal.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage: industrial, containing the following chemicals: agricultural, etc). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

N/A. Non-project proposal

c. Water Runoff (including storm water):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

N/A. Non-project proposal.

2) Could waste materials enter ground or surface waters? If so, generally describe.

N/A. Non-project proposal.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

N/A. Non-project proposal.

4. Plants

a. Check or circle types of vegetation found on the site:

- √ deciduous tree: alder, maple, aspen, other: Pacific willow
- √ evergreen tree: fir, cedar, pine, other: Western hemlock
- √ shrubs
- √ grass
- √ pasture
- crop or grain
- √ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other: Red Alder, Nootka rose, reed canarygrass, soft rush, black cottonwood
- water plants: water lily, eelgrass, milfoil, other
- √ other types of vegetation: salal, Oregon grape, vine maple, sword fern

b. What kind and amount of vegetation will be removed or altered:

N/A. Non-project proposal.

c. List threatened or endangered species known to be on or near the site.

The Washington Natural Heritage program (Washington Department of Natural Resources) has no record of rare or sensitive plants in the vicinity of the project area.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

N/A. Non-project proposal.

5. Animals

a. Circle any birds and animals that have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other: rufous-sided towhee, Stellar's jay, American crow
mammals: deer, bear, elk, beaver, other: raccoons, deer mice, voles, Virginia opossum, northern red-legged frog, Pacific chorus frog, rough-skinned newt, western red-backed salamander
fish: bass, salmon, trout, herring, shellfish, other:______________

b. List any threatened or endangered species known to be on or near the site.

Two species listed as threatened by federal agencies have been identified as potentially occupying areas within the plan area. A bald eagle *(Haliaeetus leucocephalus)* nest has been documented by Washington State Department of Fish and Wildlife two miles west of the project area near Liberty Bay; and a small number of Chinook salmon *(Oncorhynchus tshawytscha)* has been observed in reaches of Dogfish Creek and South Fork Dogfish Creek during Suquamish Tribe fish surveys. These are the product of nest boxes rather than natural production.

Six wildlife species listed as species of concern by federal agencies have been identified as being likely to occur within the plan area. These species include long-eared myotis *(Myotis evotis)*, long-legged myotis *(Myotis volans)*, olive-sided flycatcher *(Contopus cooperi)*, pacific lamprey *(Entosphenus tridentata)*, Pacific Townsend's big-eared bat *(Corynorhinus townsendii)*, and river lamprey *(Lampetra ayresi)*. Of these six species, two are listed as candidate species by state agencies: Pacific Townsend's big-eared bat and river lamprey.

c. Is the site part of a migration route? If so, explain.

N/A. Non-project proposal.

d. Proposed measures to preserve or enhance wildlife, if any:

N/A. Non-project proposal.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc?

N/A. Non-project proposal.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

N/A. Non-project proposal.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

N/A. Non-project proposal.

7. Environmental Health:

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

N/A. Non-project proposal.

1) Describe special emergency services that might be required.

N/A. Non-project proposal.

2) Proposed measures to reduce or control environmental health hazards, if any:

N/A. Non-project proposal.

b. Noise

1) What types of noise exist in the area which may affect your project: (for example: traffic, equipment, operation, other)?

N/A. Non-project proposal

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise could come from the site.

N/A. Non-project proposal.

3) Proposed measures to reduce or control noise impacts, if any:

N/A. Non-project proposal.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The current use of the plan area is residential and commercial.

b. Has the site been used for agriculture? If so, describe.

No area potentially affected by the proposed Plan has been used for agriculture.

c. Describe any structures on the site.

The plan area includes land within and around the City of Poulsbo. Structures within the plan area are many, including single- and multiple-family residences, commercial buildings, schools, churches, etc.

d. Will any structures be demolished? If so, what?

N/A. Non-project proposal.

e. What is the current zoning classification of the site?

Zoning in the plan area includes high-, medium-, and low-density residential, commercial, light industrial, business park, conservation, parks, and public school classification (see Figure 4).

f. What is the current comprehensive plan designation of the site?

The current comprehensive plan designation of the site is Urban Growth Area.

g. If applicable, what is the current shoreline master program designation of the site?

N/A

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

There are several wetlands and creeks within the project boundaries.

i. Approximately how many people would reside or work in the completed project?

No people will reside or work in the completed project.

j. Approximately how many people would the completed project displace?

N/A. Non-project proposal.

k. Proposed measures to avoid or reduce displacement impacts, if any:

N/A. Non-project proposal.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed CSP is consistent with the City of Poulsbo's Comprehensive Land Use Plan, the City's Critical Areas Ordinance, the City's 6-year Capital Improvement Plan, and the Central Kitsap County Wastewater Facilities Plan.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

N/A. Non-project proposal.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

N/A. Non-project proposal.

c. Proposed measures to reduce or control housing impacts, if any:

N/A. Non-project proposal.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas: what is the principal exterior building material(s) proposed?

N/A. Non-project proposal.

b. What views in the immediate vicinity would be altered or obstructed?

N/A. Non-project proposal.

c. Proposed measures to reduce or control aesthetic impacts, if any:

N/A. Non-project proposal.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

N/A. Non-project proposal.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

N/A. Non-project proposal.

c. What existing off-site sources of light or glare may affect your proposal?

N/A. Non-project proposal.

d. Proposed measures to reduce or control light and glare impacts, if any:

N/A. Non-project proposal.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

Several parks exist within the plan area.

b. Would the proposed project displace any existing recreational uses? If so, describe.

N/A. Non-project proposal.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to the provided by the project or applicant, if any:

N/A. Non-project proposal.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

No places or objects listed on, or proposed for, national, state, or local preservation registers are known to be within the plan area.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

There are no traditional cultural properties within the Plan area recorded at the Office of

Archaeology and Historic Preservation located in Lacey, Washington. Also, there are no previously recorded cultural resources within the plan area. There are no known sites eligible for the National Register of Historic Places.

c. Proposed measures to reduce or control impacts, if any:

N/A. Non-project proposal.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Figure 1 shows the public streets and highways serving the plan area from within the Kitsap Peninsula and the Greater Seattle area.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

Yes. There are numerous bus stops throughout the plan area.

c. How many parking spaces would the completed project have? How many would the project eliminate?

N/A. Non-project proposal.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

N/A. Non-project proposal.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

N/a. Non-project proposal.

f. How many vehicular trips per day would be generated by the completed project? (If known, indicate when peak volumes would occur.

N/A. Non-project proposal.

g. Proposed measures to reduce or control transportation impacts, if any:

N/A. Non-project proposal.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

N/A. Non-project proposal.

b. Proposed measures to reduce or control direct impacts on public services, if any:

N/A. Non-project proposal.

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

N/A. Non-project proposal.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

N/A. Non-project proposal.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: ______________________

Date Submitted: 4-27-06

APPENDIX B

Kitsap County Contract Agreement and Amendments 1 and 2

0060.175.012
JEH/bw
12/04/85
01/15/86

CONTRACT FOR SANITARY SEWAGE SERVICE

THIS AGREEMENT is entered into between Kitsap County (hereinafter referred to as "the County") and the City of Poulsbo (hereinafter referred to as "Poulsbo"), for the purposes hereinafter stated.

WHEREAS, RCW 36.94.190 and Chapter 39.34 RCW authorize Cities and Counties to contract with one another for the establishment, maintenance and operation of sewerage systems, and

WHEREAS, the County has constructed and currently operates sanitary sewer facilities capable of receiving, carrying, treating and disposing of sewage produced by Poulsbo, and

WHEREAS, the County and Poulsbo have contracted since 1977 for County treatment and disposal of Poulsbo sewage under that certain agreement entitled "Contract Regarding Sanitary Sewerage Service Between the City of Poulsbo and Kitsap County" and Poulsbo's sewerage system currently connects to the County's facilities in the vicinity of the intersection of Johnson Road and SR-305, and

WHEREAS, the parties desire to continue to contract for the provision of sanitary sewer service to Poulsbo by the County but have determined that a substantial revision of the method by which Poulsbo pays for such service is necessary in order to assure an equitable distribution of the operation and maintenance costs, now, therefore,

IN CONSIDERATION OF the mutual covenants contained herein, it is hereby agreed as follows:

<u>Section 1. Sewerage Facilities.</u>

a. The County shall plan, construct, reconstruct, operate and maintain a sanitary sewerage system which shall include treatment facilities, sewer lines and interceptors, pump stations, outfalls, and other necessary appurtenances. Such sewerage system shall be known as the Central Kitsap Wastewater Facililty (hereinafter Wastewater Facility). The Wastewater Facility shall be capable of receiving, carrying, treating, and disposing of the sanitary sewage produced by Poulsbo in the quantities specified in Section 4 and shall be constructed and maintained so as to allow connection by the City of Poulsbo at the delivery point specified in Section 3.

b. The County shall plan, construct, operate and maintain the Wastewater Facility in a manner that will constitute no unnecessary hazard to the public health, safety or welfare and in conformance with all applicable federal, state and local laws, rules and regulations as now or hereafter amended.

Section 2. Poulsbo's Collection Facilities.

a. Poulsbo shall construct, operate and maintain a sanitary sewage collection system to the point of delivery specified in Section 3. Such system shall be capable of collecting and delivering the sanitary sewage produced by Poulsbo to the said point of delivery.

b. Poulsbo shall construct, operate and maintain its sanitary sewage collection system in such a manner as will constitute no unnecessary hazard to the public health, safety or welfare and in conformance with all applicable federal, state and local laws, rules and regulations as now or hereafter amended.

c. The County shall not make any connection to Poulsbo's sanitary sewage collection system in order to provide sewage service to areas outside the city limits of Poulsbo without the prior written consent of Poulsbo.

Section 3. Delivery and Receipt of Sewage.

a. Poulsbo shall deliver to the County and the County shall receive from Poulsbo the sanitary sewage produced by Poulsbo. Such delivery and receipt shall occur at a metering manhole at a mutually agreed upon point in the immediate vicinity of the intersection of SR-305 and Johnson Road.

b. Poulsbo shall notify the County whenever Poulsbo intends to substantially increase the quantity of sewage delivered to the County in order that the County may anticipate and plan for this increase.

Section 4. Quantity of Sewage. The County shall reserve and make available to Poulsbo the capacity to receive, carry, treat and dispose of sanitary sewage in the amount of 0.75 million gallons per day (MGD), average daily flow. Average daily flow shall be computed by dividing by 30 the sewage delivered and received over a 30-day period which period shall commence on the first day of a calendar month.

Section 5. Ownership of Facilities. Notwithstanding any payment or capital contribution made by Poulsbo, the Wastewater Facility and all parts thereof constructed, operated and maintained by the County shall be and remain the property of the County. Notwithstanding any payment or capital contribution made by the County, all sewer service facilities constructed, operated and maintained by Poulsbo shall be and remain the property of Poulsbo.

Section 6. Maintenance, Operation and Replacement Charges.

a. Generally.

1) Maintenance, operation and replacement charges generally. Both parties recognize that the County will incur operation, maintenance and replacement costs in connection with the treatment plant and that portion of the Wastewater Facility that is used to transport raw sewage generated by Poulsbo to the treatment plant. Poulsbo agrees to pay the proportionate share of these costs allocable to Poulsbo based upon Poulsbo's flow through the system. The allocable proportion shall be made up of two components: (1) a fixed maintenance and operation component; and (2) a variable maintenance and operation component.

2) Capital contributions and bonds. Both Poulsbo and the County anticipate that each may issue bonds in order to make capital contributions for those portions of the Wastewater Facility that each will utilize. Debt service, coverage requirements, principal payments and related fees for bonds issued by Poulsbo shall be the sole responsibility of Poulsbo. Similarly, debt service, coverage requirements, principal payments and related fees for bonds issued by the County shall be the sole responsibility of the County. No amount for debt service, coverage requirements, principal payments, and/or related fees for County bonds shall be included within or as part of the maintenance and operation cost to be borne by Poulsbo.

b. Fixed Maintenance and Operation Component.

1) Treatment Plant Fixed Costs. Fixed maintenance and operation costs include all costs of maintaining and operating the Wastewater Facility except those costs

included within the variable maintenance and operation component. The fixed maintenance and operation component of treatment plant costs payable by Poulsbo is based upon the ratio which the treatment capacity of the treatment plant reserved for Poulsbo bears to the treatment capacity of the entire Wastewater Facility. Thus, the fixed maintenance, operation and replacement component for treatment plant costs payable by Poulsbo

equals ($\frac{.75}{4.8}$) (fixed maintenance, operation and replacement costs)

2) Fixed Costs for Transporting Sewage. Poulsbo's proportionate share of the fixed operation, maintenance and replacement costs of that portion of the Wastewater Facility used to transport raw sewage generaged by Poulsbo to the treatment plant shall be based upon the ratio which the average daily flow of sewage generated by Poulsbo and carried through said facilities bears to the average daily flow of all sewage carried through said facilities. Based upon these formulas, Poulsbo's 1985-1986 share of the fixed maintenance and operation costs for the Wastewater Facility are estimated to be as follows:

ITEM	POULSBO SHARE TOTAL ESTIMATED FIXED COST	% To Be Paid by Poulsbo
Treatment plant OM&R	$575,343	15.62
Johnson Road Chlorinator Station/Meter and valve box	6,235	100
Pump Station No. 16 OM&R	34,740	65.04
Pump Station NO. 15 AS2 OM&R	38,318	37.85
Pressure line cleaning Johnson Rd. to PS #16	5,480	100

Pressure line cleaning PS #16 to Tagholm Rd	2,540	65.04
Pressure line cleaning Tagholm Rd. to PS #15	3,380	37.85
TOTAL ESTIMATED YEARLY FIXED COST TO BE PAID BY POULSBO		$141,614
TOTAL ESTIMATED MONTHLY FIXED COST TO BE PAID BY POULSBO		$ 11,801

Both parties understand that these costs are estimated costs only. Overages and underages for 1985-1986 shall be determined as provided in Section 6(f) below. The fixed and variable costs for each succeeding year shall be computed as provided in Sections 6(e) and (f).

c. Treatment Plant Variable Maintenance, Operation and Replacement Component. Variable maintenance, operation and replacement costs consist of the following: (1) sledge processing and disposal; (2) chlorination; (3) dechlorination; and (4) electricity for the treatment plant. The variable maintenance and operation component payable by Poulsbo is based upon the amount of sewage actually delivered by Poulsbo. Poulsbo shall pay the proportion of the variable maintenance and operation costs of the treatment plant which is determined by dividing the entire amount of sewage received, treated and disposed of at the treatment plant into the amount of sewage delivered by Poulsbo and then multiplying that figure with the variable maintenance and operation costs for the treatment plant. For that portion of 1985 and for the year 1986, the variable maintenance and operation component for the treatment plant is declared to be $170 per million gallons of sewage.

d. Billings. The County shall bill Poulsbo for Poulsbo's share of maintenance and operation on a monthly basis. Poulsbo shall pay such bills within thirty (30) days of receipt thereof and any portion of any bill not so paid shall bear interest at the rate of eight percent (8%) per annum until paid, provided, however, that in the event Poulsbo disputes in good faith any portion of any bill, interest shall not be applicable to that portion of the bill, if any, which is ultimately found not to be properly chargeable to Poulsbo.

e. Rate Adjustment. On or before August 5, 1986 and each August 5 thereafter during the term of this Agreement, the

County shall estimate the anticipated fixed and variable maintenance and operation costs for the year commencing on the following October 1. The County will consider previous and anticipated maintenance and operation costs, anticipated inflation, and other relevant facts and information. On or before August 5, 1986 and each August 5 thereafter, the County shall submit the rate estimates to Poulsbo for review and comment. Thereafter the County shall evaluate Poulsbo's comments, if the same are received by September 5, and may, in its discretion, implement such comments into the rate estimates. The rate estimates shall become effective October 1, 1986 and each October 1 thereafter for the term of this Agreement.

f. Overage or Underage. The intent of this subsection is to require an annual accounting so that amounts paid by Poulsbo, which were based upon estimated or declared rates, may be adjusted so that Poulsbo pays no more or less than actual costs for maintenance and operation as such costs are subsequently determined. Should the rate or rate estimate declared in this section prove insufficient or in excess of actual costs for maintenance and operation, then, in the case of an insufficiency, Poulsbo shall pay a supplementary bill in the appropriate amount, or, in the case of an excess, the County shall allow Poulsbo a credit in the appropriate amount. The foregoing adjustment shall occur on or before December 31, 1986 and, thereafter, on or before December 31 of each year during the term of this Agreement.

g. Measurement of Service. The quantity of sewage collected by Poulsbo and received by the County shall be measured by metering equipment located at the point of delivery and receipt specified in Section 3. The metering equipment shall be of standard design and manufacture and shall be furnished, installed, maintained and read by the County. Initial caliberation of the meter shall be performed by manufacturer's representative and the County shall no less than weekly inspect the meter and shall test the metering device no less than annually. Poulsbo shall have access to the meter recording device to obtain data for the maintenance and operation of its sewage collection system and the County shall furnish Poulsbo with a copy of the weekly recorded flow chart. In the event that any meter fails to correctly measure the quantity of sewage delivered, the quantity of sewage delivered shall be estimated by the County and Poulsbo shall be so advised. An adjustment shall be made if the meter read registers more than plus or minus two percent (2%) of actual volume. If necessary, the County shall make an adjustment in previous billings to reflect the greater or lesser amount of sewage delivered.

<u>Section 7. Repeal of Sewage Agreement</u>. Poulsbo and the County hereby repeal, terminate and declare null and void that certain Agreement entitled "A contract Regarding Sewerage Service Between the City of Poulsbo and Kitsap County" executed by the parties on April 27, 1977.

<u>Section 8. Term of Agreement</u>. This Agreement shall be in full force and effect on October 1, 1985 and shall terminate on September 30, 1990.

<u>Section 9. Management of Wastewater Facility</u>. The County shall use reasonable and efficient business judgment in the management, operation, maintenance and control of the Wastewater Facility to the end that Poulsbo's costs for maintenance and operation will not be unnecessarily increased. Furthermore, the County shall comply with all applicable federal, state and local laws, rules and regulations in the management, operation, maintenance and control of the Wastewater Facility.

<u>Section 10. Books and Records</u>. The County shall maintain detailed and sufficient books and records pertaining to the planning, construction, maintenance and operation of the Wastewater Facility. Furthermore, the County shall develop and maintain detailed and sufficient books and records pertaining to the rates and rate adjustments mentioned in Section 6. Each party shall have full and complete access to the books and records of the other at any and all reasonable times.

<u>Section 11. Delivery of Legal Sewage</u>. Poulsbo agrees to deliver only legal and lawful sewage to the County as determined by applicable federal, state and local laws, rules and regulations as now or hereafter amended, including but not limited to, Kitsap County Ordinance No. 55, as now existing or as hereinafter amended or superseded. The County shall take all reasonable measures to insure that no person, firm, corporation, governmental entity or other entity discharges or delivers into the Wastewater Facility any unlawful or illegal sewage as such is defined by the preceding sentence.

<u>Section 12. Upgrading Facilities</u>. Subsequent to the effective date of this contract, should any federal or state law, rule or regulation increase acceptable water quality standards, mandate more costly methods of affluent treatment, restrict acceptable types or amounts of affluent discharge or otherwise make sewage carriage, treatment or discharge more costly, the parties shall make all reasonable efforts to agree upon a means of upgrading the

Wastewater Facility to meet such new standards, methods or needs; provided, that if either party determines that it is unwilling or unable to participate in or bear the additional costs or expenses which would permit its proportionate share to be upgraded, either party may terminate this contract upon one year's written notice to the other.

Section 13. Increasing Capacity. Subsequent to the effective date of this contract, should Poulsbo desire to increase the capacity reserved to it beyond that mentioned in Section 4, the County shall cooperate with Poulsbo in all reasonable ways to make increased capacity available. Such efforts shall include, but are not limited to, the use of unneeded reserve capacity legally available to the County, the use of the County rights of way and property for additional sewerage facilities, concurrence of the County and grant applications by Poulsbo and letting construction contracts for addition sewerage facilities. The parties understand that such efforts by the County will not necessarily be free of charge but the County and Poulsbo shall agree upon any additional charge for such efforts prior to such efforts being made.

Section 14. Grant Assistance. The County shall, at Poulsbo's request, assist Poulsbo in all reasonable ways to obtain grants and other funds from state or federal agencies or departments in order that Poulsbo may obtain financial assistance to make improvements to the sewerage system presently owned and operated by Poulsbo and in order that Poulsbo may obtain financial assistance to defray, in whole or in part, costs incurred as a result of this Agreement and/or costs incurred to construct or maintain any collection facilities deemed necessary by Poulsbo to comply with the terms of this Agreement.

Section 15. Advisory Council. There is hereby created the Central Kitsap Wastewater Facility Advisory Council (hereinafter "Council"). The Council shall be composed of the Mayor of Poulsbo and the three members of the County's Board of County Commissioners. Additionally, a representative of any other governmental entity which contracts with the County for at least .25 MGD treatment capacity at the Wastewater Facility shall be invited to and shall become a member of Council at the option of such entity. The members of Council shall elect a chairperson by majority vote.

Council shall meet from time to time to discuss any matters pertinent to the Central Kitsap Wastewater Facility and to provide a free flow of information regarding the Wastewater Facility between the parties. Council may make recommendations to the County concerning the operation and management of the Wastewater Facility, but decisions of the County on such matters shall be conclusive subject to reasonable and efficient business judgment as specified in Section 9.

Section 16. Indemnity. Each party shall indemnify, defend and hold harmless the other party, its officers, agents and employees, from and against any and all claims, losses or liability, or any portion thereof, including attorney's fees and costs, arising from injury or death to persons, including injuries, sickness, disease or death to each party's own employees, or damage to property arising out of or occasioned by such party's performance under this Agreement.

Section 17. Notices. All communications, notices, bills and other correspondence regarding this contract shall be addressed as follows:

POULSBO: City of Poulsbo
P. O. Box 98
Poulsbo, WA 98370

COUNTY: Kitsap County
614 Division St.
Port Orchard, WA 98366

Section 18. Entire Agreement. This Agreement constitutes the entire understanding between the parties and no other agreement, oral or otherwise, shall be deemed to exist with respect to the subject matter herein.

DATED this 12th day of February, 1986.

CITY OF POULSBO

Richard Mitchusson

RICHARD MITCHUSSON, MAYOR

ATTEST/AUTHENTICATED:

Jackie McNeese

CITY CLERK, JACKIE McNEESE

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY

BY James E. Haney

DATED this 24th day of February, 1986.

KITSAP COUNTY BOARD OF COUNTY COMMISSIONERS:

Ray Aardal
____

W. A. Mahan
____

John Horsley
____

ATTEST/AUTHENTICATED

Janet R. Bernard
~~COUNTY~~ CLERK of the Board

AMENDMENT NO. 1
CONTRACT FOR SANITARY SEWERAGE SERVICE

THIS AMENDMENT NO. 1 is entered into as of the 17th day of June, 1996, by and between the City of Poulsbo (hereinafter referred to as "Poulsbo") and Kitsap County (hereinafter referred to as the "County"), for the purposes hereinafter stated.

WHEREAS, Poulsbo and the County have previously entered a Contract for Sanitary Sewerage Service, dated October 4, 1995, and

WHEREAS, the County has embarked on a major capital improvement program to rehabilitate and expand the Central Kitsap Wastewater Facility which shall benefit customers of both the County and Poulsbo, and

WHEREAS, it is in the best interest of both parties to this Contract to define the capital contributions and method of payment for said capital improvement program;

NOW, THEREFORE, in consideration of the mutual promises herein contained and of the benefits derived to the parties, it is hereby agreed as follows:

1. Section 6a.2 - Capital Contributions and Bonds shall be amended in its entirety to read as follows:

6.a.2. Capital Contributions and Bonds - Phase I Improvements

The current County Capital Improvement Plan (1996-2001) proposes rehabilitation and improvements to the Central Kitsap Wastewater Facility in two Phases. Phase I provides for rehabilitation of the Facility a portion of which is used by Poulsbo and increases available capacity for Poulsbo from 0.75 MGD to 0.95 MGD. Estimated project costs are $9,800,000 with Poulsbo's share estimated at $1,584,000 based upon proportionate capacity.

Both Poulsbo and the County anticipate that each may issue bonds in order to make capital contributions for those portions of the Wastewater Facility that each will utilize. Debt service, coverage requirements, principal payments and related fees for bonds issued by Poulsbo shall be the sole responsibility of Poulsbo. Similarly, debt service, coverage requirements, principal payments and related fees for bonds issued by the County shall be the sole responsibility of the County. No amount for debt service, coverage requirements, principal payments and/or related fees for County bonds shall be included within or as part of the maintenance and operation costs to be borne by Poulsbo, unless specifically agreed upon in writing by both parties as an amendment to this agreement.

In accordance with the above Poulsbo agrees to make a lump sum capital contribution in the amount of $1,584,000 (estimated). Actual amount to be determined by audit of project costs upon completion of Phase I. Payment to be made to Kitsap County on or before March 31, 1997 or within 30 days of project audit, whichever is later.

2. New Section 6a.3 shall be added as follows:

6a.3. Capital Contributions - Phase II Improvements

The County and Poulsbo agree that certain improvements proposed under Phase II may not be required by Poulsbo based upon recent modifications to the Poulsbo Comprehensive Plan and the parties agree to convene a joint Value Engineering Team composed of Poulsbo and County staff and their designated consultants. The Value Engineering Team will evaluate the proposed Phase II improvements and develop recommendations for modification of the scope of the improvements, their schedule and/or alternative funding mechanisms.

The County and Poulsbo agree to stop all work and expenditures on Phase II from the date of this Amendment to allow completion of the Value Engineering Team study and consideration of recommendations. Once negotiations reconvene, both parties agree to expedite the process for completion on or before December 31, 1996. The County agrees that costs associated with these negotiations, including the Value Engineering effort, shall be considered as a part of the overall Phase II Improvement Program and shall be shared by both parties in accordance with their proportionate capacity in the overall Facility (i.e., Poulsbo - 15.62%; County - 84.38%).

The County and Poulsbo further agree to establish a procedure which allows Poulsbo to participate in the planning for capital improvements which Poulsbo will share the costs of. This intent of this procedure is to allow Poulsbo to have input into the sewer capital planning process and to have early visibility of upcoming capital costs. This will allow Poulsbo to develop its own sewer financial plan which will provide the County with certainty of funding for Poulsbo capital costs.

All other terms and conditions of the original Contract between Poulsbo and the County shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment No. 1 as of the day and year first written above.

CITY OF POULSBO

Richard Mitchusson

Richard Mitchusson, Mayor

ATTEST/AUTHENTICATED

Terry White for

City Clerk

APPROVED AS TO FORM
OFFICE OF CITY ATTORNEY
By SEE ATTACHED FAX

DATED this 13th Day of June 1996

KITSAP COUNTY BOARD
OF COUNTY COMMISSIONERS 6/17/96

Chairman

Commissioner

Commissioner

ATTEST AND AUTHENTICATE

Clerk of Board

2. New Section 6a.3 shall be added as follows:

6a.3. Capital Contributions - Phase II Improvements

The County and Poulsbo agree that certain improvements proposed under Phase II may not be required by Poulsbo based upon recent modifications to the Poulsbo Comprehensive Plan and the parties agree to convene a joint Value Engineering Team composed of Poulsbo and County staff and their designated consultants. The Value Engineering Team will evaluate the proposed Phase II improvements and develop recommendations for modification of the scope of the improvements, their schedule and/or alternative funding mechanisms.

The County and Poulsbo agree to stop all work and expenditures on Phase II from the date of this Amendment to allow completion of the Value Engineering Team study and consideration of recommendations. Once negotiations reconvene, both parties agree to expedite the process for completion on or before December 31, 1996. The County agrees that costs associated with these negotiations, including the Value Engineering effort, shall be considered as a part of the overall Phase II Improvement Program and shall be shared by both parties in accordance with their proportionate capacity in the overall Facility (i.e., Poulsbo - 15.62%; County - 84.38%).

The County and Poulsbo further agree to establish a procedure which allows Poulsbo to participate in the planning for capital improvements which Poulsbo will share the costs of. This intent of this procedure is to allow Poulsbo to have input into the sewer capital planning process and to have early visibility of upcoming capital costs. This will allow Poulsbo to develop its own sewer financial plan which will provide the County with certainty of funding for Poulsbo capital costs.

All other terms and conditions of the original Contract between Poulsbo and the County shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment No. 1 as of the day and year first written above.

CITY OF POULSBO

Richard Mitchusson, Mayor

ATTEST/AUTHENTICATED

City Clerk

APPROVED AS TO FORM
OFFICE OF CITY ATTORNEY
By

DATED this 13 Day of June 1996

KITSAP COUNTY BOARD
OF COUNTY COMMISSIONERS

Chairman

Commissioner

Commissioner

ATTEST AND AUTHENTICATE

Clerk of Board

CONTRACT FOR SANITARY SEWAGE SERVICE

THIS AGREEMENT is entered into between Kitsap County (hereinafter referred to as "the County") and the City of Poulsbo (hereinafter referred to as "Poulsbo'), for the purposes hereinafter stated.

WHEREAS, RCW 36.94.190 and Chapter 39.34 RCW authorize Cities and Counties to contract with one another for the establishment, maintenance and operation of sewerage systems, and

WHEREAS, the County has constructed and currently operates sanitary sewer facilities capable of receiving, carrying, treating and disposing of sewage produced by Poulsbo, and

WHEREAS, the County and Poulsbo have contracted since 1979 for County treatment and disposal of Poulsbo sewage under that certain agreement entitled "Contract For Sanitary Sewage Service" and Poulsbo's sewerage system currently connects to the County's facilities in the vicinity of the intersection of Johnson Road and SR-305, and

WHEREAS, the present contract terminates September 30,1995 and the parties desire to continue to contract for the provision of sanitary sewer service to Poulsbo by the County,

Now, Therefore: IN CONSIDERATION OF the mutual covenants contained herein, it is hereby agreed as follows:

Section 1. Sewerage Facilities

a. The County shall plan, construct, reconstruct, operate and maintain a sanitary sewerage system which shall include treatment facilities, sewer lines and interceptors, pump stations, outfalls, and other necessary appurtenances. Such sewerage system shall be known as the Central Kitsap Wastewater Facility (hereinafter Wastewater Facility). The Wastewater Facility shall be capable of receiving, carrying, treating, and disposing of the sanitary sewage produced by Poulsbo in the quantities specified in Section 4 and shall be constructed and maintained so as to allow connection by the City of Poulsbo at the delivery point specified in Section 3.

b. The County shall plan, construct, operate and maintain the Wastewater Facility in a manner that will constitute no unnecessary hazard to the public health, safety or welfare and in conformance with all applicable federal, state and local laws, rules and regulations as now or hereafter amended.

Section 2. Poulsbo's Collection Facilities

a. Poulsbo shall construct, operate and maintain a sanitary sewage collection system to the point of delivery specified in Section 3. Such system shall be capable of collecting and delivering the sanitary sewage produced by Poulsbo to the said point of delivery.

b. Poulsbo shall construct, operate and maintain its sanitary sewage collection system in such a manner as will constitute no unnecessary hazard to the public health, safety or welfare and in conformance with all applicable federal, state and local laws, rules and regulations as now or hereafter amended.

c. The County shall not make any connection to Poulsbo's sanitary sewage collection system in order to provide sewage service to areas outside the city limits of Poulsbo without the prior written consent of Poulsbo.

Section 3. Delivery and Receipt of Sewage

a. Poulsbo shall deliver to the County and the County shall receive from Poulsbo the sanitary sewage produced by Poulsbo. Such delivery and receipt shall occur at a metering manhole at a mutually agreed upon point in the immediate vicinity of the intersection of SR-305 and Johnson Road.

b. Poulsbo shall notify the County of changes in it's capital improvement plan that will result in substantial increases in the quantity of sewage delivered to the County in order that the County may anticipate and plan for this increase.

Section 4. Quantity of Sewage

The County shall reserve and make available to Poulsbo the capacity to transport sanitary sewage from the connection point specified in section 3 to the Central Kitsap Wastewater Treatment Plant a peak instantaneous flow of 2.5 million gallons per day..

The County shall reserve and make available to Poulsbo the capacity to receive, carry, treat and dispose of sanitary sewage in the amount of 0.75 million gallons per day (MGD), average daily flow for maximum month. Average daily flow shall be computed by dividing the total flow for each month by the number of days in that corresponding month. Average daily flow for maximum month shall be determined by comparing the average daily flow for each month and determining the month with the maximum average daily flow. The flows referred to in this section are those flows measured at the metering manhole near Johnson Road and SR 305.

Section 5. Ownership of Facilities

Notwithstanding any payment or capital contribution made by Poulsbo, the Wastewater Facility and all parts thereof constructed, operated and maintained by the County shall be and remain the property of the County. Notwithstanding any payment or capital contribution made by the County, all sewer service facilities constructed, operated and maintained by Poulsbo shall be and remain the property of Poulsbo.

Section 6. Maintenance, Operation and Replacement Charges

a. Generally

1. Maintenance, operation and replacement charges generally

Both parties recognize that the County will incur operation, maintenance and replacement costs in connection with the treatment plant and that portion of the Wastewater Facility that is used to transport raw sewage generated by Poulsbo to the treatment plant. Poulsbo agrees to pay the proportionate share of these costs allocable to Poulsbo based upon Poulsbo's flow through the system. The allocable proportion shall be made up of two components: (1) a fixed maintenance and operation component; and (2) a variable maintenance and operation component.

2. Capital contributions and bonds

Both Poulsbo and the County anticipate that each may issue bonds in order to make capital contributions for those portions of the Wastewater Facility that each will utilize. Debt service, coverage requirements, principal payments and related fees for bonds issued by Poulsbo shall be the sole responsibility of Poulsbo. Similarly, debt service, coverage requirements, principal payments and related fees for bonds issued by the County shall be the sole responsibility of the County. No amount for debt service, coverage requirements, principal payments, and/or related fees for County bonds shall be included within or as part of the maintenance and operation costs to be borne by Poulsbo, unless specifically agreed upon in writing by both parties as an amendment to this agreement.

b. Fixed Maintenance and Operation Component

1. Treatment Plant Fixed Costs

Fixed maintenance and operation costs include all costs of maintaining and operating the Wastewater Facility except those costs included within the variable maintenance and operation component. The fixed maintenance and operation component of treatment plant costs payable by Poulsbo is based upon the ratio which the treatment capacity of the treatment plant reserved for Poulsbo bears to the treatment capacity of the entire Wastewater Facility. Thus, the fixed maintenance, operation and replacement component for treatment plant costs payable by Poulsbo equals 15.62 percent.

2. Fixed Costs for Transporting Sewage

Poulsbo's proportionate share of the fixed operation, maintenance and replacement costs of that portion of the Wastewater Facility used to transport raw sewage generated by Poulsbo to the treatment plant shall be based upon the ratio which the total daily flow of sewage generated by Poulsbo and carried through said facilities bears to the total flow of all sewage carried through said facilities. Facilities used by Poulsbo for transporting sewage which will be used for determining costs are:

1. The Johnson Road Chlorination Station, meter, valve vault and pressure line to Pump Station 16,

2. Pump Station 16 and pressure line to Pump Station 15,

3. Pump Station 15, Aeration Station 2 and pressure line to treatment plant.

The fixed and variable costs for 1995-1996 year and each succeeding year shall be computed as provided in Sections 6 (e) and (f).

c. Treatment Plant Variable Maintenance, Operation and Replacement Component

Variable maintenance, operation and replacement costs consist of the following:

(1) Sludge and Grit processing and disposal (2) Chlorination (3) Dechlorination (4) Energy for Ultraviolet Disinfection (5) Utilities for the treatment plant

The variable maintenance and operation component payable by Poulsbo is based upon the amount of sewage actually delivered by Poulsbo. Poulsbo shall pay the proportion of the variable maintenance and operation costs of the treatment plant which is determined by dividing the entire amount of sewage received, treated and disposed of at the treatment plant into the amount of sewage delivered by Poulsbo and then multiplying that figure with the variable maintenance and operation costs for the treatment plant.

d. Peaking Factor Charges

Poulsbo shall pay a peaking factor charge for delivery of sanitary sewage in excess of the average maximum monthly flows specified in section 4. The excess charge shall be based on the fixed costs and will be assessed as if Poulsbo had reserved the excess capacity at the treatment facility for the entire contractural year. The calculation will be based on the meter readings taken at the measuring manhole at Johnson Road and SR 305. Poulsbo shall pay the fixed costs for the reserved 15.62 per cent of the treatment plant capacity as a minimum. Whenever the average monthly flow exceeds 0.75 mgd, the new average monthly flow will be used to calculate the new percentage of the total plant capacity that is being used by Poulsbo, and that percentage will be applied to the fixed costs for billing. That new percentage will be used for the succeeding months of the contractural year to calculate Poulsbo's fixed costs. At the end of that period, provided that the monthly average flow does not exceed the contract amount, the percentage will be reduced to the contract amount of 15.62 percent of the fixed costs. Any time that the flow that is used to establish a peaking factor charge percentage is exceeded, a new percentage will be calculated for the remaining months in the contractural year. The Contractural Year is defined as beginning on October first and ending on September thirty of the following year.

e. Billings

The County shall bill Poulsbo for Poulsbo's share of maintenance and operation on a monthly basis. Poulsbo shall pay such bills within thirty (30) days of receipt thereof and any portion of any bill not so paid shall bear interest at the rate of eight percent (8%) per annum until paid, provided, however, that in the event Poulsbo disputes in good faith any portion of any bill, interest shall not be applicable to that portion of the bill, if any, which is ultimately found not to be properly chargeable to Poulsbo.

e. Rate Adjustment

On or before August 5, 1995 and each August 5 thereafter during the term of this Agreement, the County shall estimate the anticipated fixed and variable maintenance and operation costs for the year commencing on the following October 1. The County will consider previous and anticipated maintenance and operation costs, anticipated inflation, and other relevant facts and information. On or before August 5, 1995 and each August 5 thereafter, the County shall submit the rate estimates to Poulsbo for review and comment. Thereafter the County shall evaluate Poulsbo's comments, if the same are received by September 5, and may, in its discretion, implement such comments into the rate estimates. The rate estimates shall become effective October 1, 1995 and each October 1 thereafter for the term of this Agreement.

f. Overage and Underage

The intent of this subsection is to require an annual accounting so that amounts paid by Poulsbo, which were based upon estimated or declared rates, may be adjusted so that Poulsbo pays no more or less than actual costs for maintenance and operation as such costs are subsequently determined. Should the rate or rate estimate declared in this section prove insufficient or in excess of actual costs for maintenance and operation, then, in the case of an insufficiency, Poulsbo shall pay a supplementary bill in the appropriate amount, or, in the case of an excess, the County shall allow Poulsbo a credit in the appropriate amount. The foregoing adjustment shall occur on or before December 31, 1995 and, thereafter, on or before December 31 of each year during the term of this Agreement. This subsection applies only to the usage of facilities within the agreed to average and peaking flow limits identified in Section 4 of this document. Peaking factor charges are not estimated and are in addition to the annual cost estimate. The peaking factor charges are not recoverable under this subsection.

g. Measurement of Service

The quantity of sewage collected by Poulsbo and received by the County shall be measured by metering equipment located at the point of delivery and receipt specified in Section 3. The metering equipment shall be of standard design and manufacture and shall be furnished, installed, maintained and read by the County. Initial calibration of the meter shall be performed by manufacturer's representative and the County shall no less than weekly inspect the meter and shall test the metering device no less than annually. Poulsbo shall have access to the meter recording device to obtain data for the maintenance and operation of its sewage collection system and the County operation of its sewage collection system and the County shall furnish Poulsbo with a copy of the weekly flow chart, if requested. In the event that any meter fails to correctly measure the quantity of sewage delivered, the quantity of sewage delivered shall be estimated by the County and Poulsbo shall be so advised. An adjustment shall be made if the meter read registers more than plus or minus two percent (2%) of actual volume. If necessary, the County shall make an adjustment in previous billings to reflect the greater or lesser amount of sewage delivered.

Section 7. Repeal of Sewage Agreement

Poulsbo and the County hereby repeal, terminate and declare null and void that certain Agreement entitled "Contract For Sanitary Sewage Service" executed by the parties on April 1, 1991.

Section 8. Term of Agreement

This Agreement shall be in full force and effect on October 1, 1995 and shall terminate on September 30, 2000.

Section 9. Management of Wastewater Facility

The County shall use reasonable and efficient business judgment in the management, operation, maintenance and control of the Wastewater Facility to the end that Poulsbo's costs for maintenance and operation will not be unnecessarily increased. Furthermore, the County shall comply with all applicable federal, state and local laws, rules and regulations in the management, operation, maintenance and control of the Wastewater Facility.

Section 10. Books and Records

The County shall maintain detailed and sufficient books and records pertaining to the planning, construction, maintenance and operation of the Wastewater Facility. Furthermore, the County shall develop and maintain detailed and sufficient books and records pertaining to the rates and rate adjustments mentioned in Section 6. Each party shall have full and complete access to the books and records of the other at any and all reasonable times.

Section 11. Delivery and Legal Sewage

Poulsbo agrees to deliver only legal and lawful sewage to the County as determined by applicable federal, state and local laws, rules and regulations as now or hereafter amended, including but not limited to, Kitsap County Ordinance No. 55, as now existing or as hereinafter amended or superseded. The county shall take all reasonable measures to insure that no person, firm, corporation, governmental entity or other entity discharges or delivers into the Wastewater Facility any unlawful or illegal sewage as such is defined by the preceding sentence.

Section 12. Upgrading Facilities

Subsequent to the effective date of this contract, should any federal or state law, rule or regulation increase acceptable water quality standards, mandate more costly methods of effluent or sludge treatment, restrict acceptable types or amounts of effluent discharge or sludge disposal, or otherwise make sewage or sludge carriage, treatment or discharge more costly, the parties shall make all reasonable efforts to agree upon a means of upgrading the Wastewater Facility to meet such new standards, methods or needs; provided, that if either party determines that it is unwilling or unable to participate in or bear the additional costs or expenses which would permit its proportionate share to be upgraded, either party may terminate this contract upon one year's written notice to the other.

Section 13. Increasing Capacity

Subsequent to the effective date of this contract, should Poulsbo desire to increase the capacity reserved to it beyond that mentioned in Section 4, the County shall cooperate with Poulsbo in all reasonable ways to make increased capacity available. Such efforts shall include, but are not limited to, the temporary use of capacity legally available to the County, the use of the County rights of way and property for additional sewerage facilities, concurrence of the County with grant applications by Poulsbo and letting construction contracts for additional sewerage facilities. The parties understand that such efforts by the County will not necessarily be free of charge by the County and Poulsbo shall agree upon any additional charge for such efforts prior to such efforts being made.

Section 14. Grant Assistance

The County shall, at Poulsbo's request, assist Poulsbo in all reasonable ways to obtain grants and other funds from state or federal agencies or departments in order that Poulsbo may obtain financial assistance to make improvements to the sewerage system presently owned and operated by Poulsbo and in order that Poulsbo may obtain financial assistance to defray, in whole or in part, cost incurred as a result of this Agreement and/or costs incurred to construct or maintain any collection facilities deemed necessary by Poulsbo to comply with the terms of this Agreement.

Section 15. Advisory Council

There is hereby created the Central Kitsap Wastewater Facility Advisory Council (hereinafter "Council"). The Council shall be composed of the Mayor of Poulsbo (or designee) and the three members of the County's Board of County Commissioners (or designee). Additionally, a representative of any governmental entity which contracts with the County for at least .25 MGD treatment capacity at the Wastewater Facility shall be invited to and shall become a member of Council at the option of such entity. The members of Council shall elect a chairperson by majority vote.

Council shall meet from time to time to discuss any matters pertinent to the Central Kitsap Wastewater Facility and to provide a free flow of information regarding the Wastewater Facility between the parties. Council may make recommendations to the County concerning the operation and management of the Wastewater Facility, but decisions of the County on such matters shall be conclusive subject to reasonable and efficient business judgment as specified in Section 9.

Section 16. Indemnity

The County shall protect, defend, save harmless and indemnify Poulsbo and its officers, agents and employees from and against all claims, suits and actions for all damage, sickness, death or injury the negligent and/or malicious acts or errors or omissions and any willful, wanton, malicious acts or intentional tortious conduct on the part of the County or its agents and/or employees arising from or in any way related to the operation and/or performance of this agreement. The County further agrees to fully indemnify Poulsbo from and against any and all costs including attorney's fees of defending any such claim or demand. Additionally, the County specifically waives it immunity under Title 51 of the Revised Code of Washington, the Industrial Insurance Act, for injuries to its employees and agrees that the obligation to indemnify Poulsbo extends to any claim, demand, or action brought by or on behalf of any employee of the County, and includes any judgment, award, and cost thereof including attorney's fees incurred. This paragraph shall not apply to damages and claim resulting from the sole negligence of Poulsbo.

Poulsbo shall protect, defend, save harmless and indemnify the County and its officers, agents and employees from and against all claims, suits and actions for all damage, sickness, death or injury arising from the negligent and/or malicious acts or errors or omissions and any willful, wanton, malicious or intentional tortious conduct on the part of Poulsbo or its agents and/or employees arising from or in any way related to the operation and/or performance of this agreement. Poulsbo further agrees to fully indemnify the County from and against any and all costs including attorney's fees of defending any such claim or demand. Additionally, Poulsbo specifically waives its immunity under Title 51 of the Revised Code of Washington, the Industrial Insurance Act, for injuries to its employees and agrees that the obligation to indemnify the County extends to any claim, demand, or action brought by or on behalf of any employee of Poulsbo, and includes any judgement, award, and cost thereof including attorney's fees incurred. This paragraph shall not apply to damages and claims resulting from the sole negligence of the County.

Section 17. Notices

All communications, notices, bills and other correspondence regarding this contract shall be addressed as follows:

Poulsbo:
City of Poulsbo
P O Box 98
Poulsbo, WA 98370

County:
Kitsap County Public Works
Department - Utilities Division
614 Division Street
Port Orchard, WA 98366

Section 18. Entire Agreement

This Agreement constitutes the entire understanding between theparties and no other agreement, oral or otherwise, shall be deemed to exist with respect to the subject matter herein.

Section 19. Modifications

Either party may request modifications to this contract. Proposed changes which are mutually agreed upon shall be incorporated by written amendment to this contract.

Section 20. Assignment and Subcontract

The County shall not assign or subcontract, to any person or entity, any of the services contemplated by this contract without Poulsbo's written consent.

Section 21. Applicable Law - Venue

This contract shall be governed and construed in accordance with the laws of the State of Washington and, in the event of a dispute, the venue of any action brought hereunder shall be in Kitsap County, Washington.

DATED this 4th day of October, 1995.

CITY OF POULSBO

Richard Mitchusson

RICHARD MITCHUSSON, MAYOR

ATTEST/AUTHENTICATED:

Karol Jones

CITY CLERK,

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY

BY

DATED this 16th day of Nov., 1995.

KITSAP COUNTY BOARD OF COUNTY COMMISSIONERS:

NOT PRESENT

CHAIRMAN

ACTING CHAIRMAN

COMMISSIONER

Phil Best

COMMISSIONER

ATTEST/AUTHENTICATED:

CLERK OF THE BOARD

Amendment to Contract for Sewage Service

This amendment to the basic agreement for sewage service between the City of Poulsbo and Kitsap County dated October 4 1995 and November 6, 1995 is made for the purpose of making more specific the language describing the Capital Contributions and Bonds of Section 6. 2.. The Clause is amended as follows:

2. Capital Contributions and Bonds

Both Poulsbo and the County anticipate that each may issue bonds in order to make capital contributions for those portions of the Wastewater Facility that each will utilize. Debt service, coverage requirements, principal payments and related fees for bonds issued by Poulsbo shall be the sole responsibility of Poulsbo. Similarly, debt service, coverage requirements, principal payments and related fees for bonds issued by the County shall be the sole responsibility of the County. No amount for debt service, coverage requirements, principal payments and/or related fees for County bonds shall be included within or as part of the maintenance and operation costs to be borne by Poulsbo, unless specifically agreed upon in writing by both parties as an amendment to this agreement.

The current Capital Improvement Plan that the County has developed for the Years 1996 through 2001 describes such capital improvements, the facility to serve Poulsbo and the facility to serve the County's needs. The first phase of expansion of the Central Kitsap County Wastewater Treatment Plant provides for rehabilitation of part of the facility used by Poulsbo and for provision of 0.2 mgd of new capacity for Poulsbo to bring the total reserve for Poulsbo to 0.95 mgd. Poulsbo agrees to pay to the County $1,584,000 in cash in the first quarter of 1997, for that rehabilitation and the new capacity. Further, The Council of the City of Poulsbo directs their staff and consultants to continue to negotiate and collaborate with the County staff and consultants to develop the most advantageous means of phasing and financing the remaining future program required to provide Poulsbo's share of the Capital Facilities.
All other clauses in the agreement remain in effect as previously agreed to by both parties.

DATED this day of June 1996

CITY OF POULSBO

____

Richard Mitchusson, Mayor

ATTEST/AUTHENTICATED

____

City Clerk

APPROVED AS TO FORM
OFFICE OF CITY ATTORNEY
By____________________________

DATED this ___ Day of June 1996

KITSAP COUNTY BOARD OF COUNTY COMMISSIONERS

____
Chairman

____
Commisioner

____
Commisioner

ATTEST AND AUTHENTICATE

____

IW-407 13-D

AMENDMENT NO. 2
CONTRACT FOR SANITARY SEWERAGE SERVICE

8 THIS AMENDMENT NO. 2 is entered into as of the 9th day of February, 1997, by and between the City of Poulsbo (hereinafter referred to as "Poulsbo") and Kitsap County (hereinafter referred to as the "County"), for the purposes hereinafter stated.

WHEREAS, Poulsbo and the County have previously entered a Contract for Sanitary Sewerage Service, dated October 4, 1995, and amended June 17, 1996; and

WHEREAS, the County plans to embark on a major capital improvement program to rehabilitate and expand the Central Kitsap Wastewater Facility and necessary conveyance upgrades which shall benefit customers of both the County and Poulsbo; and

WHEREAS, it is in the best interest of both parties to this Contract to redefine the distribution of capital contributions and method of payment for said capital improvement program; and

WHEREAS, the City of Poulsbo is embarking on capacity improvements and inflow and infiltration improvements within the City and it is in the best interest of both parties to this contract to redefine the method of billing for peak flow from Poulsbo.

NOW, THEREFORE, in consideration of the mutual promises herein contained and of the benefits derived to the parties, it is hereby agreed as follows:

Section 4. Quantity of Sewage shall be amended in its entirety to read as follows:

The County shall make available to Poulsbo capacity to receive , convey, treat and dispose of sanitary sewage from Poulsbo sewer customers in accordance with the Central Kitsap Wastewater Treatment Facilities Plan and the City of Poulsbo Sewer Comprehensive Plan Update, December 1997. Said plans are to be reviewed on a periodic schedule and updates are to be included in this agreement.

Section 6. Maintenance, Operation and Replacement Charges shall be amended and follows:

New Section 6a.4 Capital Improvement Contributions

The section establishes the procedure for the Poulsbo to share the cost of Wastewater Facility and Conveyance Capital Improvement projects to be constructed by the County.

Poulsbo's participation in the capital program will involve 3 techniques:

- Two tiered - System Development Charges
- Contributed Capital Costs
- Capital Recovery Charges

1. System Development Charges

   New customers in Poulsbo will be charged a two tiered system development charge (SDC). The SDC will include the City's portion plus a charge equal to the County's Central Kitsap Basin current rate. The County portion will be passed through to Kitsap County on a monthly basis.

2. Contributed Capital Costs

   The County will require approximately $1.80 million in contributed capital over the next 3 years. These contributions ($0.8 million - 1998; $0.36 million - 1999; $0.64 million - 2000) will be used to finance portions of the North Central Conveyance improvements. It is anticipated that proceeds from Poulsbo sewer revenue bonds would be used to fund these contributions. The annual amounts are due July 1st of 1998, 1999 and 2000 respectively.

3. Capital Recovery Charges

   Poulsbo's share of the remaining capital improvements would be financed through a capital recovery system which would charge Poulsbo a fair share of these improvements based on a system wide approach. This capital recovery charge would begin in 1998 and extend approximately 20 years or until the capital debt issued to finance the improvements in the current County Capital Improvement Plan, has been retired. The current County Capital Improvement Plan is incorporated as Exhibit A. The capital recovery charge will be established as follows:

Definitions

a. "Billing Year" shall mean the year in which the Capital Recovery Charge is effective.

b. "Calculation Year" shall mean the year prior to the Billing Year.

c. "Base Debt Service" shall mean the annual debt service payments on all County sewer revenue debt issued prior to the date of this agreement.

d. "New Debt Service" shall mean the annual debt service payments on all debt issued for the purpose of financing the County CIP attached hereto as Exhibit A. It is currently contemplated that the County will issue $15,000,000 of sewer revenue bonds in 1999 and another $10,000,000 in 2002 to finance its current CIP.

e. "Poulsbo ERUs" shall mean the sum of monthly single family residences and commercial equivalent billings for the twelve months ending June 30 of the Calculation Year. Commercial equivalent billings are calculated by dividing water consumption by 700 cubic feet per ERU per month.

f. "County ERUs" shall mean the sum of monthly single family residences and commercial equivalent billings for the twelve months ending June 30 of the Calculation Year. Commercial equivalent billings are calculated by dividing water consumption by 700 cubic feet per ERU per month.

g. "Annual Operating and Maintenance Expenses" shall mean estimated County operating expenses for the Billing Year as defined in the County's current sewer revenue bond resolution.

h. "Annual County Sewer Revenue Requirements" shall mean the total operating revenues required to operate the County sewer program in the Billing Year as estimated by its financial advisor.

i. "Capital Recovery Charges" shall mean the total amount Poulsbo is required to pay under this section in a Billing Year.

Calculation Defined

The County will calculate the Capital Recovery Charge as follows:

1. The percentage that New Debt Service is of the total of Base Debt Service, New Debt Service and Annual Operating and Maintenance Expenses is calculated. This becomes an estimate of what percentage of the total county system resources are used for new capital financing.

2. The percentage calculated in 1. above is then multiplied by the percent that Poulsbo ERUs are of the total of County ERUs and Poulsbo ERUs.

3. Finally, the annual Poulsbo Capital Recovery Charge is calculated by multiplying the percentage determined in the prior paragraph by the Annual County Sewer Revenue Requirements.

4. The following example shows how the Capital Recovery Charge has been calculated for 1998. The amounts are taken from the County Sewer Operating Projections dated 9/24/97.

   a. 1998 Base Debt Service = $2,033,000
   b. 1998 Total Debt Service = $2,606,000
   c. 1998 New Debt Service = $2,606,000 - $2,033,000 = $573,000
   d. 1998 Annual Operating Expenses = $6,581,000
   e. New Debt Service Percentage = $573,000 / ($2,606,000 + $6,581,000) = 6.24%
   f. Poulsbo ERUs = 3,066
   g. County ERUs = 21,234
   h. Percent Poulsbo ERUs = 3,066/21,234 = 14.44%
   i. Poulsbo Share of County Operating Revenues = 6.25% x 14.44% = .90%
   j. 1998 County Revenue Requirements = $10,471,000
   k. Poulsbo Capital Recovery Charge = .90%x$10,471,000 = $94,239

Implementation

1. The City and County agree that the Capital Recovery Charge for 1998 shall be $94,239.

2. On or before August 5, 1998 and each year thereafter the County shall calculate the capital recovery charge for the following year and submit such charges together with the detailed calculations to Poulsbo for review. Poulsbo may submit comments to the County regarding the proposed charges if done by September 5. The County shall consider such comments and calculate the final Capital Recovery Charge by October 1st. Such charges will be effective January 1st of Billing Year.

3. Poulsbo will remit one twelfth of the Capital Recovery Charge to the County by the 20th of each month of the Billing Year.

4. Poulsbo will pay Capital Recovery Charges in any year that "New Debt Service" from debt issued to finance the County's current capital program is outstanding. If the County refunds its sewer debt, both Base Debt Service and New Debt Service will be reduced proportionately by any debt service savings which result from the refunding but the period over which Poulsbo shall pay Capital Recovery Charges shall not be extended as a result of the refunding.

6.d. Peaking Factor Charges

Delete this section in it's entirety.

All other terms and conditions of the original Contract between Poulsbo and the County shall remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Amendment No. 2 as of the day and year first written above.

CITY OF POULSBO	KITSAP COUNTY BOARD OF COUNTY COMMISSIONERS 2/9/98
Richard Mitchusson, Mayor	Chairman
	Phil Best Commissioner
	Charlotte Garrido Commissioner
ATTEST/AUTHENTICATED	ATTEST/AUTHENTICATED
Karol Jones City Clerk	Clerk of Board

APPROVED AS TO FORM
OFFICE OF CITY ATTORNEY

By____________________

DATED this _____ day of ____________________, 19_____.

Ex[illegible] A

Capital Cash Flows - Kitsap County Revised Assumptions
Kitsap County Capital Improvement Plan

Projects Included In Plan			Total	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
100%	95-003	Central Kitsap WWTP Renovation & Repair	10,224	9,591	633	"	"	"	"	"	"	"	"	"	"	"
100%	90-004	Suquamish Wastewater Treatment Plant Renovation	5,787	1,749	4,038	"	"	"	"	"	"	"	"	"	"	"
100%	93-002-4	Infiltration/Inflow Repair Projects	312	349	165	"	"	"	"	"	"	"	"	"	"	"
100%	95-095	Collection System Channelization Equipment Renovation	956	"	888	"	"	"	"	"	"	"	"	"	"	"
100%	93-010	Manchester Wastewater Treatment Plant Renovation	6,285	600	4,050	1,625	"	"	"	"	"	"	"	"	"	—
100%	97-001	N. Cntl. Col. Sys. Impr. -a- Keyport PS 16 & Gra.	1,759	"	1,039	720	"	"	"	"	"	"	"	"	"	
100%	97-002	N. Cntl. Col. Sys. Impr. -b- PS 15 Modifications	2,087	"	"	"	731	1,356	"	"	"	"	"	"	"	"
100%	97-003	N. Cntl. Col. Sys. Impr. -c- Lemolo PS & Force	3,188	"	"	"	1,119	2,069	"	"	"	"	"	"	"	"
100%	96-004	Central Kitsap Phase II WWTP Expansion	36,350	"	"	4,250	10,000	5,100	"	"	"	"	1,000	6,000	9,000	"
100%	96-003	Kingston Wastewater Treatment & Collection System	12,041	276	"	"	"	"	1,007	4,393	4,393	2,032	"	"	"	"
0%	95-012	South Central Collection System Improvements	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0%	95-006	Waaga Way Collection System	22,000	"	"	"	"	"	"	"	"	"	"	"	8,000	14,000
		TOTAL	100,989	12,565	10,813	6,595	11,850	8,525	1,007	4,393	4,393	2,032	1,000	6,000	17,000	14,000

h:\project\poulsbo\plsbcsp\2237-09\excel\revexhibit-a.xls

December 1997
PMX #23-2237-09

Kitsap County Department of Public Works
614 Division Street (MS-27), Port Orchard, WA 98366-4699 *R.W. Casteel, P.E., Director*

November 1, 2006

Honorable Mayor Kathryn Quade
City of Poulsbo
P O Box 98
Poulsbo, WA 98370

Dear Mayor Quade:

Under the terms of the contract for sewer service between the City of Poulsbo and Kitsap County, the City of Poulsbo is to pay Kitsap County their share of the fixed and variable cost of the operations of the Central Kitsap Wastewater Treatment Facility. Section 6 of the contract requires Kitsap County to notify the City of Poulsbo of the rates for the upcoming year.

Anticipated operational costs for the coming year starting October 1, 2006 and ending September 30, 2007 are:

CITY OF POULSBO	**TOTAL**	**%**	**CITY SHARE**
FIXED COSTS			
Treatment Plant OM & R	$2,014,904	15.62	$314,728
Johnson Rd. Chlorination Station, Meter, Valve Vault & Pressure Line	$22,850	100	$22,850
Pump Station 16 & Pressure Line	$27,212	100	$27,212
Pump Station 24, Air	$78,682	52.08	$40,978
TOTAL ESTIMATED YEARLY FIXED COSTS			$405,768
TOTAL ESTIMATED YEARLY VARIABLE COSTS 250 mg @ $498			$124,500
TOTAL ESTIMATED YEARLY COSTS			**$530,268**

The estimated treatment plant variable costs are $498.00 per million gallons treated.

If you should have any questions, please call our office at (360) 337-5777.

Sincerely,

Barry Loveless, P.E.
Senior Program Manager

BL:nlb

APPENDIX C

Inflow and Infiltration Assessment

Parametrix

ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

4660 KITSAP WAY, SUITE A
BREMERTON, WA 98312-2357
T. 360.377.0014 F. 360.479.5961
www.parametrix.com

TECHNICAL MEMORANDUM

Date:	October 24, 2007
To:	Andre Kasiniak, P.E., City of Poulsbo
From:	Phil Struck, Ken Brown
Subject:	Pump Station Infiltration/Inflow Analysis
cc:	File
Project Number:	233-2237-026 (01/01)
Project Name:	Poulsbo Comprehensive Sanitary Sewer Plan

INTRODUCTION

The purpose of this Technical Memorandum (TM) is to perform a preliminary evaluation of stormwater inflow and infiltration for five Poulsbo wastewater pump stations. The following pump stations (PS) were selected for study:

- 6th Avenue
- 9th Avenue
- Liberty Bay
- Lindvig
- Marine Science Center

This TM also includes an overview of the apparent effectiveness of the 6th Avenue basin I&I project completed in 2001.

DATA SOURCES AND ANALYSIS CRITERIA

The following criteria form the basis of this study:

- The City has hour meters installed on each of the pumps in each of the pump stations. Data has been compiled daily since the summer of 2004. It shows the total number of hours each pump ran during the 24-hour period.
- The City has recorded the amount of rainfall during the 24-hour period since the summer of 2004.
- Each pump has a rated capacity in gallons per minute at a specified head (the pressure the pump is pumping against). The 6th Avenue PS has two 142 gpm pumps rated at an 83-foot head (36 psi). So, if one of the pumps operates for one hour (60 minutes), it would pump 8,520 gallons of wastewater. Several factors affect the head or pressure. If both pumps are simultaneously

pumping (unlikely since they usually each only pump several hours per day) into one small pipe, the pressure will increase and the rate will decrease. The rated capacity at the stipulated head may not be the same as in the actual installation because of elevation of the pump or depth of water in the wet well. For this preliminary study, these factors are not considered, and only the rated pump capacity has been used.

- A 78-day wet period of November 25, 2005 through February 10, 2006 was chosen to compare with a 78-day dry period of July 25, 2006 through October 10, 2006. A total of 25.8 inches of rain fell during the wet period, and 2.11 inches of rain fell during the dry period.
- A 7-day wet period of December 24, 2005 through December 30, 2005 was chosen to compare with a 7-day dry period of August 15, 2006 through August 21, 2006. A total of 4.63 inches of rain fell during the wet period and no rain fell during the dry period.

BASIN ANALYSIS

Refer to the spreadsheets in Attachment A for a summary of the flow analysis. The percent of stormwater in the total sewage flow being pumped is the best indication of the amount of inflow and infiltration at each pump station. Table 1 provides a summary for the 7-day period analyzed.

Table 1. Summary of Infiltration/Inflow Analysis

7-Day Analysis							
Pump Station	Total Gallons Pumped During Dry Weather	Percent of Total – Dry Weather Flow	Total Gallons Pumped During Wet Weather	Percent of Total – Wet Weather Flow	Percent Stormwater	Gallons Stormwater	Percent of Total Stormwater
6th Avenue PS	244,000	10%	678,000	16%	64.1%	435,000	22.5%
9th Avenue PS	78,600	3%	217,000	5%	63.7%	138,000	7%
Liberty Bay PS	157,800	7%	202,000	5%	21.7%	44,000	2%
Lindvig PS	1,022,900	43%	1,455,000	33%	29.7%	432,000	22.5%
Marine Science Center PS	873,000	37%	1,772,000	41%	50.7%	898,000	46%
Totals	2,376,300	100%	4,324,000	100%	-	1,947,000	100%

Because flow volume is calculated from pump records, the actual number of gallons pumped may not be accurate, but the relationship between wet weather and dry weather flow, which is the percentage computation, should be very reliable since it is based solely on pump run times.

Note that the MSC pump station shows a lower volume than the Lindvig pump station during dry weather flow, which is opposite than what is expected given that the Lindvig PS flows to the MSC PS.

Based on a very rough analysis of the quantity of stormwater infiltration per lineal feet of pipe and per acre of basin drained, the 6th and 9th Avenue basins appear to contribute the most I&I on a per linear foot basis. Preliminary calculations indicate a 7-day I&I contribution of 39 gal/lf and 26 gal/lf for the 6th Avenue and 9th Avenue basins, respectively. It should also be noted that the majority of I&I in the MSC PS basin is generated in the older downtown area where the City's next I&I reduction project will be implemented.

6TH AVENUE BASIN I&I PROJECT ANALYSIS

A contract for pipe bursting and side sewer replacement in the 6th Avenue Basin was completed in early 2001. The work included replacement of the majority of collection sewers and side services all the way to the house.

The major effect of the construction is likely to be inflow reduction during a major rainfall event. Prior to the project, major rainfalls caused the 6th Avenue pump station to run continuously for several days. During these events, the Central Interceptor would surcharge causing back pressure on the force main and reducing the pumping rate.

Attachment B provides a compilation of the pump run times for the 6th Avenue pump station for the period of March 1, 2006 through March 31, 2006. The pumps ran for 161.6 hours. There was a recorded 3.71 inches of rain during that time period. Dividing these two numbers results in a pump run time of 41.6 hours per inch of rain. Using the historical data for March 2000 from Table 2, and dividing the pump run time by the inches of rain, a comparable pump run time of 49.1 hours per inch of rain is obtained. This shows that prior to the I&I project, the pumps had to run 7.5 hours longer for each inch of rain than they do now. This is a reduction of 15.1%.

Table 2. 6th Avenue Basin Pump Station Flow, March 2000 and November 2000

Dates	Rainfall	Pump Run Times (Hours)	Estimated Pumped Flow (gpd)
March 1–March 30, 2000	3.19 inches	156.57	59,500
November 5–December 5, 2000	3.83 inches	104.7	39,800

Refer to Attachment B for a compilation of the pump run times for the 6th Avenue pump station for the period of November 5, 2006 through December 5, 2006. The pumps ran for 232.5 hours. There was a recorded 13.1 inches of rain during that time period. Dividing these two numbers results in a pump run time of 17.7 hours per inch of rain. Using the historical data for November 5, 2000 from the above table, and dividing the pump run time by the inches of rain, a comparable pump run time of 27.3 hours per inch of rain is obtained. This shows that prior to the I&I project, the pumps had to run 9.6 hours longer for each inch of rain than they do now. This is a reduction of 35.1%.

The limited number of data points does not provide sufficient information for a strong conclusion. However, it does indicate that there may have been a 20 to 30% reduction in sewage flow as a result of the project.

CONCLUSION

This evaluation concludes that there is still a significant I&I problem, especially in the older portions of the City, and that further evaluation is necessary to determine specific sources of inflow and infiltration. It is therefore recommended that further I&I studies (smoke testing and video camera evaluation) be conducted in the 6th and 9th Avenue basins to identify specific I&I sources.

ATTACHMENTS:

A Pump Station Flow Analyses
B 6th Avenue Pump Run Times

ATTACHMENT A

Pump Station Flow Analyses

ANALYSIS OF STORMWATER INFLOW AND INFILTRATION AT VARIOUS PUMP STATIONS

7 DAY ANALYSIS PERIOD

	DRY WEATHER (8/15/06 THRU 8/21/06)		WET WEATHER (12/24/05 THRU 12/30/05)		ANALYSIS					
Lift Station	Total Rainfall	Total gallons pumped	Total Rainfall	Total gallons pumped	Net Rainfall	Extra gallons pumped	Extra gal/inch	Assumed Dry Weather Flow	Total flow attributed to rain	Percent of flow attributed to rain
6th Ave	0	243,672	4.63	678,192	4.63	434,520	93,849	243,672	434,520	64.1%
9th Ave	0	78,600	4.63	216,600	4.63	138,000	29,806	78,600	138,000	63.7%
Liberty Bay	0	157,800	4.63	201,600	4.63	43,800	9,460	157,800	43,800	21.7%
Lindvig	0	1,022,940	4.63	1,455,330	4.63	432,390	93,389	1,022,940	432,390	29.7%
MSC	0	873,036	4.63	1,772,370	4.63	899,334	194,241	873,036	899,334	50.7%

Total Rainfall: Data obtained from City of Poulsbo daily pump station records. See pump station spreadsheets.
Total gallons pumped: See pump station spreadsheets. This is derived by multiplying the number of hours each pump ran in the 7 day period by the rated pumping capacity of the pump (eg., 100 gpm) and then by 60 minutes per hour.
Net Rainfall: The difference between the total wet weather rainfall and the total dry weather rainfall
Extra gallons pumped: The difference between the gallons pumped during wet weather and during dry weather
Extra gallons per inch: The number of extra gallons (actual stormwater) pumpeD per inch of rain
Assumed dry weather flow: For this spreadsheet, it is the same as the dry weather flow because no rain was recorded
Total flow attributed to rain: This is the actual stormwater that was pumped
Percent of flow attributed to rain: This is the percent of stormwater in the total wet weather flow (Total flow attributed to rain divided by total wet weather water pumped)

DISCUSSION AND CONCLUSION

The greatest possibility for error is in the assumed pumping rate for each pump. As the head increases, the rate (gpm) decreases. This would occur if both pumps are pumping at the same time into one pipe. Also, the diameter of the pipe being pumped to can increase the head and decrease the pumping rate.

The MSC pump station has three pumps. One of the pumps was not operational, and may have been replaced during this time period. There appears to be a discrepancy between the total gallons pumped at the MSC and the total pumped at Lindvig. All Lindvig sewage flows through MSC. The pump rating capacities may be slightly off, but the basic conclusions are still based primarily on pump run times at individual pump stations during wet and dry periods.

6th Ave Pump Station

		Date	Rainfall (inches)	Hour Meter Reading		Hours running in 24 hour period		Comments by City
				Pump 1	Pump 2	Hours Pump 1	Hours Pump 2	
1		11/25/2005	0.16	103.5	170	2.4	2.5	
2		11/26/2005	0.84	105.9	172.5	2.2	3.4	
3		11/27/2005	0.20	108.1	175.9	2.6	3.1	
4		11/28/2005	0.00	110.7	179	2.1	2.4	
5		11/29/2005	0.29	112.8	181.4	2	2.4	
6		11/30/2005	0.02	114.8	183.8	2.4	2.3	
7		12/1/2005	0.02	117.2	186.1	2.3	2.2	
8		12/2/2005	0.23	119.5	188.3	2.7	2.5	
9		12/3/2005	0.00	122.2	190.8	2.6	2.3	
10		12/4/2005	0.02	124.8	193.1	2.2	2.3	
11		12/5/2005	0.02	127	195.4	2.7	2.6	
12		12/6/2005	0.00	129.7	198	2.1	2.3	
13		12/7/2005	0.00	131.8	200.3	2.2	2.2	
14		12/8/2005	0.00	134	202.5	2	2.2	
15		12/9/2005	0.00	136	204.7	2.2	2.2	
16		12/10/2005	0.00	138.2	206.9	2.3	2.2	
17		12/11/2005	0.02	140.5	209.1	2.7	2.3	
18		12/12/2005	0.00	143.2	211.4	2.5	2.2	
19		12/13/2005	0.03	145.7	213.6	2.2	2.1	
20		12/14/2005	0.00	147.9	215.7	2.4	2.4	
21		12/15/2005	0.00	150.3	218.1	2.1	2.1	
22		12/16/2005	0.00	152.4	220.2	2	1.9	
23		12/17/2005	0.00	154.4	222.1	2.3	2.2	
24		12/18/2005	0.00	156.7	224.3	2.5	2.5	
25		12/19/2005	0.10	159.2	226.8	2.7	2.7	
26		12/20/2005	0.42	161.9	229.5	2.2	2.4	Lots of rain.
27		12/21/2005	0.92	164.1	231.9	3.3	3.6	Lots of rain.
28		12/22/2005	1.59	167.4	235.5	3.3	3.7	Lots of rain.
29		12/23/2005	0.14	170.7	239.2	4	4.6	Lots of rain.
30		12/24/2005	1.13	174.7	243.8	4.9	6.2	Lots of rain.
31		12/25/2005	0.81	179.6	250	4.3	5.5	Lots of rain.
32		12/26/2005	0.58	183.9	255.5	5.3	6.5	Lots of rain.
33		12/27/2005	0.75	189.2	262	5.2	6.4	Lots of rain.
34	WET WEATHER	12/28/2005	0.36	194.4	268.4	5.2	6.7	Lots of rain.
35		12/29/2005	0.29	199.6	275.1	4.5	5.4	Lots of rain.
36		12/30/2005	0.71	204.1	280.5	6.1	7.4	Lots of rain.
37		12/31/2005	0.68	210.2	287.9	5.5	6.6	Lots of rain.
38		1/1/2006	0.16	215.7	294.5	5.9	6.4	Lots of rain.
39		1/2/2006	0.39	221.6	300.9	5.2	5.8	Lots of rain.
40		1/3/2006	0.05	226.8	306.7	4.9	5.1	Lots of rain.
41		1/4/2006	0.35	231.7	311.8	4.4	4.5	Lots of rain.
42		1/5/2006	0.15	236.1	316.3	5.9	5.8	Lots of rain.
43		1/6/2006	0.97	242	322.1	5.6	5.5	Lots of rain.
44		1/7/2006	0.18	247.6	327.6	5	5.2	
45		1/8/2006	0.08	252.6	332.8	5.1	5.1	
46		1/9/2006	0.42	257.7	337.9	7.4	7.9	
47		1/10/2006	1.51	265.1	345.8	8.7	7.8	Heavy rain.
48		1/11/2006	0.29	273.8	353.6	6.7	6.3	
49		1/12/2006	0.02	280.5	359.9	7.5	7.3	
50		1/13/2006	1.12	288	367.2	7.1	6.9	
51		1/14/2006	0.07	295.1	374.1	6	6.4	Heavy rain.
52		1/15/2006	0.30	301.1	380.5	4.5	4.6	Heavy rain.
53		1/16/2006	0.00	305.6	385.1	6.1	6.3	Heavy rain.
54		1/17/2006	0.72	311.7	391.4	5.1	5.4	Heavy rain.
55		1/18/2006	0.00	316.8	396.8	4.7	4.8	
56		1/19/2006	0.02	321.5	401.6	4.2	4.1	
57		1/20/2006	0.23	325.7	405.7	3.7	3.7	
58		1/21/2006	0.00	329.4	409.4	3.8	3.7	
59		1/22/2006	0.00	333.2	413.1	4.1	4	
60		1/23/2006	0.02	337.3	417.1	3.3	3.4	
61		1/24/2006	0.01	340.6	420.5	2.9	3	
62		1/25/2006	0.00	343.5	423.5	3.2	3.4	
63		1/26/2006	0.00	346.7	426.9	2.9	2.9	
64		1/27/2006	0.10	349.6	429.8	3.5	3.5	
65		1/28/2006	0.85	353.1	433.3	3.7	3.6	Heavy rain.
66		1/29/2006	0.03	356.8	436.9	10.7	7.4	Heavy rain.
67		1/30/2006	2.97	367.5	444.3	8.6	9.1	Heavy rain.
68		1/31/2006	0.18	376.1	453.4	8.5	7.3	
69		2/1/2006	0.60	384.6	460.7	5.5	5.7	
70		2/2/2006	0.14	390.1	466.4	5.9	5.6	
71		2/3/2006	0.39	396	472	7.4	6	Heavy rain.
72		2/4/2006	1.00	403.4	478	7.4	6	
73		2/5/2006	1.00	410.8	484	7.4	6.1	
74		2/6/2006	1.13	418.2	490.1	5.4	4.5	
75		2/7/2006	0.00	423.6	494.6	5	4.4	
76		2/8/2006	0.02	428.6	499	4.5	4.6	
77		2/9/2006	0.00	433.1	503.6	3.7	4.3	
78		2/10/2006	0.00	436.8	507.9	3.2	2.4	
		Total	25.80			336.5	340.3	

Total operating hours of both pumps over 78 day monitoring period 676.8 hours
Total inches of rainfall over the 78 day monitoring period 25.80 inches

142 gpm per pump
5,766,336 gallons pumped in 78 days

6th Ave Pump Station

DRY WEATHER

	Date	Rainfall (inches)	Hour Meter Reading		Hours running in 24 hour period		Comments by City
			Pump 1	Pump 2	Hours Pump 1	Hours Pump 2	
1	7/25/2006	0.00	875	853.9	2.3	1.6	
2	7/26/2006	0.00	877.3	855.5	2.3	1.7	
3	7/27/2006	0.00	879.6	857.2	2.2	1.6	
4	7/28/2006	0.00	881.8	858.8	2.1	1.5	
5	7/29/2006	0.00	883.9	860.3	2.6	1.9	
6	7/30/2006	0.00	886.5	862.2	3.2	2.1	
7	7/31/2006	0.00	889.7	864.3	2.8	2	
8	8/1/2006	0.00	892.5	866.3	2.5	1.9	
9	8/2/2006	0.00	895	868.2	2.5	1.9	
10	8/3/2006	0.00	897.5	870.1	2.4	1.9	
11	8/4/2006	0.00	899.9	872	2.6	1.9	
12	8/5/2006	0.00	902.5	873.9	2.6	1.6	
13	8/6/2006	0.00	905.1	875.5	2.9	1.7	
14	8/7/2006	0.00	908	877.2	2.6	1.6	
15	8/8/2006	0.00	910.6	878.8	2.2	1.6	
16	8/9/2006	0.02	912.8	880.4	2.3	1.6	
17	8/10/2006	0.03	915.1	882	2.5	1.6	
18	8/11/2006	0.00	917.6	883.6	1.9	1.6	
19	8/12/2006	0.00	919.5	885.2	2.3	1.6	
20	8/13/2006	0.00	921.8	886.8	2.9	1.7	
21	8/14/2006	0.00	924.7	888.5	2.6	1.6	
22	8/15/2006	0.00	927.3	890.1	2.2	1.5	
23	8/16/2006	0.00	929.5	891.6	2.6	1.6	
24	8/17/2006	0.00	932.1	893.2	2.5	1.5	
25	8/18/2006	0.00	934.6	894.7	2.4	1.5	
26	8/19/2006	0.00	937	896.2	2.6	1.6	
27	8/20/2006	0.00	939.6	897.8	2.7	1.7	
28	8/21/2006	0.00	942.3	899.5	2.6	1.6	
29	8/22/2006	0.00	944.9	901.1	2.4	1.6	
30	8/23/2006	0.00	947.3	902.7	2.4	1.5	
31	8/24/2006	0.00	949.7	904.2	2.1	1.5	
32	8/25/2006	0.00	951.8	905.7	2.1	1.4	
33	8/26/2006	0.00	953.9	907.1	2.2	1.6	
34	8/27/2006	0.00	956.1	908.7	2.6	1.7	
35	8/28/2006	0.00	958.7	910.4	2.5	1.6	
36	8/29/2006	0.00	961.2	912	3	2	
37	8/30/2006	0.26	964.2	914	2.4	1.6	
38	8/31/2006	0.02	966.6	915.6	2.4	1.6	
39	9/1/2006	0.00	969	917.2	2.2	1.5	
40	9/2/2006	0.00	971.2	918.7	1.9	1.5	
41	9/3/2006	0.00	973.1	920.2	3.4	1.6	
42	9/4/2006	0.00	976.5	921.8	3.4	1.9	
43	9/5/2006	0.01	979.9	923.7	2.8	1.6	hi water test
44	9/6/2006	0.00	982.7	925.3	2.7	1.5	
45	9/7/2006	0.01	985.4	926.8	2.2	1.5	
46	9/8/2006	0.00	987.6	928.3	2.2	1.4	
47	9/9/2006	0.12	989.8	929.7	2.4	1.5	
48	9/10/2006	0.02	992.2	931.2	2.8	1.8	
49	9/11/2006	0.00	995	933	2.5	1.6	
50	9/12/2006	0.02	997.5	934.6	2.2	1.5	
51	9/13/2006	0.01	999.7	936.1	2.4	1.5	
52	9/14/2006	0.15	1002.1	937.6	2.3	1.6	
53	9/15/2006	0.30	1004.4	939.2	2.3	1.4	
54	9/16/2006	0.50	1006.7	940.6	2.4	1.5	
55	9/17/2006	0.10	1009.1	942.1	3.1	1.6	
56	9/18/2006	0.10	1012.2	943.7	2.5	1.5	
57	9/19/2006	0.07	1014.7	945.2	2.5	1.4	
58	9/20/2006	0.05	1017.2	946.6	2.5	1.6	
59	9/21/2006	0.06	1019.7	948.2	2.4	1.5	
60	9/22/2006	0.12	1022.1	949.7	2.4	1.8	
61	9/23/2006	0.00	1024.5	951.5	2.6	1.3	
62	9/24/2006	0.00	1027.1	952.8	3.4	2	
63	9/25/2006	0.01	1030.5	954.8	3.4	2.6	
64	9/26/2006	0.00	1033.9	957.4	2.4	1	
65	9/27/2006	0.00	1036.3	958.4	2.3	1.6	
66	9/28/2006	0.00	1038.6	960	2	1.3	
67	9/29/2006	0.02	1040.6	961.3	2.1	1.4	
68	9/30/2006	0.00	1042.7	962.7	2.5	1.6	
69	10/1/2006	0.00	1045.2	964.3	3	1.8	
70	10/2/2006	0.01	1048.2	966.1	2.3	1.5	
71	10/3/2006	0.00	1050.5	967.6	2.2	1.5	
72	10/4/2006	0.00	1052.7	969.1	2.1	1.4	
73	10/5/2006	0.00	1054.8	970.5	2.2	1.5	
74	10/6/2006	0.03	1057	972	2	1.4	
75	10/7/2006	0.03	1059	973.4	2.1	1.4	
76	10/8/2006	0.02	1061.1	974.8	2.2	1.6	
77	10/9/2006	0.02	1063.3	976.4	2.4	1.6	
78	10/10/2006	0.00	1065.7	978	2.3	1.6	
	Total	2.11			193	125.7	

Total operating hours of both pumps over 78 day monitoring period 318.7 hours
Total inches of rainfall over the 78 day monitoring period 2.11 inches

142 gpm per pump
2,715,324 gallons pumped in 78 days

3,051,012 gallons pumped for 23.69 inches

118,256 gallons of rainwater pumped per i

		Date	Rainfall (inches)	9th Ave Pump Station: Hour Meter Reading Pump 1	9th Ave Pump Station: Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2	Comments by City
1		11/25/2005	0.16	921.6	151.5	0.9	1.5	
2		11/26/2005	0.84	922.5	153	0.7	1.2	
3		11/27/2005	0.20	923.2	154.2	0.7	1.2	
4		11/28/2005	0.00	923.9	155.4	0.7	1.1	
5		11/29/2005	0.29	924.6	156.5	0.7	1.1	
6		11/30/2005	0.02	925.3	157.6	0.7	1.1	
7		12/1/2005	0.02	926	158.7	0.7	1.1	
8		12/2/2005	0.23	926.7	159.8	0.8	1.3	
9		12/3/2005	0.00	927.5	161.1	0.8	1.3	
10		12/4/2005	0.02	928.3	162.4	0.7	1.2	
11		12/5/2005	0.02	929	163.6	0.8	1.2	
12		12/6/2005	0.00	929.8	164.8	0.7	1.1	Ran Generator.
13		12/7/2005	0.00	930.5	165.9	0.7	1.1	
14		12/8/2005	0.00	931.2	167	0.7	1.1	
15		12/9/2005	0.00	931.9	168.1	0.7	1.1	
16		12/10/2005	0.00	932.6	169.2	0.6	1	
17		12/11/2005	0.02	933.2	170.2	0.8	1.3	
18		12/12/2005	0.00	934	171.5	0.7	1.1	
19		12/13/2005	0.03	934.7	172.6	0.7	1	
20		12/14/2005	0.00	935.4	173.6	0.7	1.1	
21		12/15/2005	0.00	936.1	174.7	0.6	0.9	
22		12/16/2005	0.00	936.7	175.6	0.7	1.1	
23		12/17/2005	0.00	937.4	176.7	0.7	1.1	Readings not taken on weekend. Averaged.
24		12/18/2005	0.00	938.1	177.8	0.8	1.2	Readings not taken on weekend. Averaged.
25		12/19/2005	0.10	938.9	179	0.8	1.4	
26		12/20/2005	0.42	939.7	180.4	0.9	1.4	Lots of rain.
27		12/21/2005	0.92	940.6	181.8	1.3	2.1	Lots of rain.
28		12/22/2005	1.59	941.9	183.9	1.5	2.3	Lots of rain.
29		12/23/2005	0.14	943.4	186.2	1.4	2.5	Lots of rain.
30		12/24/2005	1.13	944.8	188.7	1.7	3	Lots of rain.
31		12/25/2005	0.81	946.5	191.7	1.6	2.9	Lots of rain.
32		12/26/2005	0.58	948.1	194.6	1.8	3.3	Lots of rain.
33		12/27/2005	0.75	949.9	197.9	1.7	3.1	Lots of rain.
34	WET WEATHER	12/28/2005	0.36	951.6	201	1.9	3.2	Lots of rain.
35		12/29/2005	0.29	953.5	204.2	1.8	3.1	Lots of rain.
36		12/30/2005	0.71	955.3	207.3	2.2	4.8	Lots of rain.
37		12/31/2005	0.68	957.5	212.1	2.2	4.2	Lots of rain.
38		1/1/2006	0.16	959.7	216.3	2.4	4.2	Lots of rain.
39		1/2/2006	0.39	962.1	220.5	1.4	3.4	Lots of rain.
40		1/3/2006	0.05	963.5	223.9	2.2	3.1	Lots of rain.
41		1/4/2006	0.35	965.7	227	1.6	2.8	Lots of rain.
42		1/5/2006	0.15	967.3	229.8	1.8	3	Lots of rain.
43		1/6/2006	0.97	969.1	232.8	1.7	3.1	Lots of rain.
44		1/7/2006	0.18	970.8	235.9	1.8	2.8	
45		1/8/2006	0.08	972.6	238.7	1.7	2.7	
46		1/9/2006	0.42	974.3	241.4	2.1	3.8	
47		1/10/2006	1.51	976.4	245.2	2.1	4	Heavy rain.
48		1/11/2006	0.29	978.5	249.2	2	3.5	
49		1/12/2006	0.02	980.5	252.7	2	3.8	
50		1/13/2006	1.12	982.5	256.5	2.1	4	
51		1/14/2006	0.07	984.6	260.5	2	3.8	Heavy rain.
52		1/15/2006	0.30	986.6	264.3	1.7	2.7	Heavy rain.
53		1/16/2006	0.00	988.3	267	2	3.5	Heavy rain.
54		1/17/2006	0.72	990.3	270.5	1.8	3.1	Heavy rain.
55		1/18/2006	0.00	992.1	273.6	1.6	2.8	
56		1/19/2006	0.02	993.7	276.4	1.5	2.5	
57		1/20/2006	0.23	995.2	278.9	1.3	2.4	
58		1/21/2006	0.00	996.5	281.3	1.1	2.2	
59		1/22/2006	0.00	997.6	283.5	1.7	2.3	
60		1/23/2006	0.02	999.3	285.8	1.2	1.9	
61		1/24/2006	0.01	3000.5	287.7	1.5	2.6	
62		1/25/2006	0.00	3002	290.3	1.2	2	
63		1/26/2006	0.00	3003.2	292.3	1.1	1.6	
64		1/27/2006	0.10	3004.3	293.9	1.2	2	
65		1/28/2006	0.85	3005.5	295.9	1.5	2.6	Heavy rain.
66		1/29/2006	0.03	3007	298.5	2.4	4.7	Heavy rain.
67		1/30/2006	2.97	3009.4	303.2	2.2	4.2	Heavy rain.
68		1/31/2006	0.18	3011.6	307.4	2.3	4.5	
69		2/1/2006	0.60	3013.9	311.9	1.9	3.2	
70		2/2/2006	0.14	3015.8	315.1	1.3	3.5	
71		2/3/2006	0.39	3017.1	318.6	2.8	4.3	Heavy rain.
72		2/4/2006	1.00	3019.9	322.9	2.8	4.3	Readings not taken due to storm work. (Averaged)
73		2/5/2006	1.00	3022.7	327.2	2.9	4.4	Readings not taken due to storm work. (Averaged)
74		2/6/2006	1.13	3025.6	331.6	1.6	2.9	
75		2/7/2006	0.00	3027.2	334.5	1.5	2.6	
76		2/8/2006	0.02	3028.7	337.1	1.6	2.6	
77		2/9/2006	0.00	3030.3	339.7	1.2	2.1	
78		2/10/2006	0.00	3031.5	341.8	1.3	2.2	
		Total	25.80			111.2	192.5	

Total operating hours of both pumps over 78 day monitoring period — 303.7 hours

Total inches of rainfall over the 78 day monitoring period — 25.80 inches

100 gpm per pump

1,822,200 gallons pumped in 78 days

9th Ave Pump Station

DRY WEATHER

	Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2	Comments by City
1	7/25/2006	0.00	3190.2	1583	0.9	1.1	
2	7/26/2006	0.00	3199.1	1584.1	0.9	1.4	Gease held the float up kept float turned on
3	7/27/2006	0.00	3200	1585.5	0.7	1.1	cleaned wet well fished out grease
4	7/28/2006	0.00	3200.7	1586.6	0.6	0.9	
5	7/29/2006	0.00	3201.3	1587.5	0.8	1	
6	7/30/2006	0.00	3202.1	1588.5	0.9	1.3	
7	7/31/2006	0.00	3203	1589.8	0.9	1.2	
8	8/1/2006	0.00	3203.9	1591	0.9	1.1	
9	8/2/2006	0.00	3204.8	1592.1	0.6	1.2	
10	8/3/2006	0.00	3205.4	1593.3	0.7	1.1	
11	8/4/2006	0.00	3206.1	1594.4	0.8	1.2	
12	8/5/2006	0.00	3206.9	1595.6	1.2	1.2	
13	8/6/2006	0.00	3208.1	1596.8	0.8	1.2	
14	8/7/2006	0.00	3208.9	1598	0.8	1.2	
15	8/8/2006	0.00	3209.7	1599.2	0.8	1.1	
16	8/9/2006	0.02	3210.5	1600.3	0.7	1	
17	8/10/2006	0.03	3211.2	1601.3	0.8	1.1	
18	8/11/2006	0.00	3212	1602.4	0.7	1	
19	8/12/2006	0.00	3212.7	1603.4	0.7	1	
20	8/13/2006	0.00	3213.4	1604.4	0.9	1.2	
21	8/14/2006	0.00	3214.3	1605.6	0.8	1.2	
22	8/15/2006	0.00	3215.1	1606.8	0.9	1.2	
23	8/16/2006	0.00	3216	1608	0.7	1	
24	8/17/2006	0.00	3216.7	1609	0.8	1.1	
25	8/18/2006	0.00	3217.5	1610.1	0.8	1	
26	8/19/2006	0.00	3218.3	1611.1	0.7	1.1	
27	8/20/2006	0.00	3219	1612.2	0.8	1.1	
28	8/21/2006	0.00	3219.8	1613.3	0.9	1	
29	8/22/2006	0.00	3220.7	1614.3	0.7	1.1	
30	8/23/2006	0.00	3221.4	1615.4	0.8	1.1	
31	8/24/2006	0.00	3222.2	1616.5	0.7	1.1	
32	8/25/2006	0.00	3222.9	1617.6	0.7	0.9	
33	8/26/2006	0.00	3223.6	1618.5	0.7	1.1	
34	8/27/2006	0.00	3224.3	1619.6	0.9	1.2	
35	8/28/2006	0.00	3225.2	1620.8	0.7	1	
36	8/29/2006	0.00	3225.9	1621.8	1	1.2	
37	8/30/2006	0.26	3226.9	1623	0.8	1	
38	8/31/2006	0.02	3227.7	1624	0.7	1	
39	9/1/2006	0.00	3228.4	1625	0.6	0.9	
40	9/2/2006	0.00	3229	1625.9	0.7	1	
41	9/3/2006	0.00	3229.7	1626.9	0.7	1	
42	9/4/2006	0.00	3230.4	1627.9	0.9	1.2	
43	9/5/2006	0.01	3231.3	1629.1	0.7	1	hi water test
44	9/6/2006	0.00	3232	1630.1	0.7	1	
45	9/7/2006	0.01	3232.7	1631.1	0.7	1	
46	9/8/2006	0.00	3233.4	1632.1	0.6	0.9	
47	9/9/2006	0.12	3234	1633	0.8	1	
48	9/10/2006	0.02	3234.8	1634	0.8	1	
49	9/11/2006	0.00	3235.6	1635	0.8	1.1	
50	9/12/2006	0.02	3236.4	1636.1	0.6	1	
51	9/13/2006	0.01	3237	1637.1	0.8	0.9	
52	9/14/2006	0.15	3237.8	1638	0.7	1.2	
53	9/15/2006	0.30	3238.5	1639.2	0.8	1.1	
54	9/16/2006	0.50	3239.3	1640.3	0.7	1	
55	9/17/2006	0.10	3240	1641.3	0.8	1.2	
56	9/18/2006	0.10	3240.8	1642.5	0.9	1.2	
57	9/19/2006	0.07	3241.7	1643.7	0.7	1.1	
58	9/20/2006	0.05	3242.4	1644.8	0.7	1	
59	9/21/2006	0.06	3243.1	1645.8	0.8	1	
60	9/22/2006	0.12	3243.9	1646.8	0.7	1	
61	9/23/2006	0.00	3244.6	1647.8	0.7	1.1	
62	9/24/2006	0.00	3245.3	1648.9	0.9	1.1	
63	9/25/2006	0.01	3246.2	1650	0.8	1.2	
64	9/26/2006	0.00	3247	1651.2	0.8	1.1	
65	9/27/2006	0.00	3247.8	1652.3	0.7	1	
66	9/28/2006	0.00	3248.5	1653.3	0.7	0.9	
67	9/29/2006	0.02	3249.2	1654.2	0.6	0.9	
68	9/30/2006	0.00	3249.8	1655.1	0.7	1	
69	10/1/2006	0.00	3250.5	1656.1	1	1.2	
70	10/2/2006	0.01	3251.5	1657.3	0.8	1.1	
71	10/3/2006	0.00	3252.3	1658.4	0.6	0.9	
72	10/4/2006	0.00	3252.9	1659.3	0.7	1	
73	10/5/2006	0.00	3253.6	1660.3	0.7	0.9	
74	10/6/2006	0.03	3254.3	1661.2	0.6	0.8	
75	10/7/2006	0.03	3254.9	1662	0.7	1	
76	10/8/2006	0.02	3255.6	1663	0.7	1.1	
77	10/9/2006	0.02	3256.3	1664.1	0.8	1.1	
78	10/10/2006	0.00	3257.1	1665.2	0.7	1	
	Total	2.11			59.6	83.2	

Total operating hours of both pumps over 78 day monitoring period — 142.8 hours

Total inches of rainfall over the 78 day monitoring period — 2.11 inches

100 gpm per pump

856,800 gallons pumped in 78 days

965,400 gallons pumped for 23.69 inches of rain (25.80 inches -

37,419 gallons of rainwater pumped per inch of rainfall

WET WEATHER

	Date	Rainfall (inches)	Liberty Bay Pump Station: Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours Pump 2	Comments by City
1	11/25/2005	0.16	483.5	356.5	2.6	1.7	
2	11/26/2005	0.84	486.1	358.2	1.5	2.3	
3	11/27/2005	0.20	487.6	360.5	2.4	1.6	
4	11/28/2005	0.00	490	362.1	2.1	2.5	
5	11/29/2005	0.29	492.1	364.6	2.9	1.7	
6	11/30/2005	0.02	495	366.3	1.3	2.7	
7	12/1/2005	0.02	496.3	369	2.6	1.5	
8	12/2/2005	0.23	498.9	370.5	1.8	3.1	
9	12/3/2005	0.00	500.7	373.6	2.7	1.5	
10	12/4/2005	0.02	503.4	375.1	1.1	2.3	
11	12/5/2005	0.02	504.5	377.4	2.6	1.5	
12	12/6/2005	0.00	507.1	378.9	1.4	2.5	
13	12/7/2005	0.00	508.5	381.4	2.5	1.4	
14	12/8/2005	0.00	511	382.8	1.4	2.4	
15	12/9/2005	0.00	512.4	385.2	2.2	1.4	
16	12/10/2005	0.00	514.6	386.6	1.6	2.1	
17	12/11/2005	0.02	516.2	388.7	2.7	1.2	
18	12/12/2005	0.00	518.9	389.9	1.3	2.5	
19	12/13/2005	0.03	520.2	392.4	1.9	1.7	
20	12/14/2005	0.00	522.1	394.1	2.1	1.8	
21	12/15/2005	0.00	524.2	395.9	1.9	1.3	
22	12/16/2005	0.00	526.1	397.2	1.5	2.2	
23	12/17/2005	0.00	527.6	399.4	2.5	1.1	
24	12/18/2005	0.00	530.1	400.5	1.3	2.4	
25	12/19/2005	0.10	531.4	402.9	3	1.6	
26	12/20/2005	0.42	534.4	404.5	1.9	2.4	Lots of rain.
27	12/21/2005	0.92	536.3	406.9	3.1	2.5	Lots of rain.
28	12/22/2005	1.59	539.4	409.4	1.6	2.2	Lots of rain.
29	12/23/2005	0.14	541	411.6	3.5	1.6	Lots of rain.
30	12/24/2005	1.13	544.5	413.2	1.5	3	Lots of rain.
31	12/25/2005	0.81	546	416.2	3.2	1.3	Lots of rain.
32	12/26/2005	0.58	549.2	417.5	1.9	3.1	Lots of rain.
33	12/27/2005	0.75	551.1	420.6	3	1.5	Lots of rain.
34	12/28/2005	0.36	554.1	422.1	1.9	3.1	Lots of rain.
35	12/29/2005	0.29	556	425.2	3	1.8	Lots of rain.
36	12/30/2005	0.71	559	427	2.1	3.2	Lots of rain.
37	12/31/2005	0.68	561.1	430.2	3.1	1.5	Lots of rain.
38	1/1/2006	0.16	564.2	431.7	2	2.6	Lots of rain.
39	1/2/2006	0.39	566.2	434.3	2.8	1.6	Lots of rain.
40	1/3/2006	0.05	569	435.9	1.9	2.7	Lots of rain.
41	1/4/2006	0.35	570.9	438.6	2.4	1.9	Lots of rain.
42	1/5/2006	0.15	573.3	440.5	2.4	3.2	Lots of rain.
43	1/6/2006	0.97	575.7	443.7	3	2	Lots of rain.
44	1/7/2006	0.18	578.7	445.7	2.3	2.9	
45	1/8/2006	0.08	581	448.6	3.3	1.6	
46	1/9/2006	0.42	584.3	450.2	2	3.6	
47	1/10/2006	1.51	586.3	453.8	3.2	1.9	Heavy rain.
48	1/11/2006	0.29	589.5	455.7	1.8	2.8	
49	1/12/2006	0.02	591.3	458.5	3.4	1.9	
50	1/13/2006	1.12	594.7	460.4	1.8	3	
51	1/14/2006	0.07	596.5	463.4	3.2	2.2	Heavy rain.
52	1/15/2006	0.30	599.7	465.6	1.7	2.4	Heavy rain.
53	1/16/2006	0.00	601.4	468	3.3	2.4	Heavy rain.
54	1/17/2006	0.72	604.7	470.4	1.9	2.7	Heavy rain.
55	1/18/2006	0.00	606.6	473.1	2.8	1.6	
56	1/19/2006	0.02	609.4	474.7	1.8	3.1	
57	1/20/2006	0.23	611.2	477.8	3	1.5	
58	1/21/2006	0.00	614.2	479.3	1.6	2.6	
59	1/22/2006	0.00	615.8	481.9	3.2	1.4	
60	1/23/2006	0.02	619	483.3	1.6	2.5	
61	1/24/2006	0.01	620.6	485.8	2.5	1.7	
62	1/25/2006	0.00	623.1	487.5	1.9	2.2	
63	1/26/2006	0.00	625	489.7	2.4	1.7	
64	1/27/2006	0.10	627.4	491.4	1.7	2.8	
65	1/28/2006	0.85	629.1	494.2	3.2	1.6	Heavy rain.
66	1/29/2006	0.03	632.3	495.8	3.4	4.4	Heavy rain.
67	1/30/2006	2.97	635.7	500.2	3.9	1.8	Heavy rain.
68	1/31/2006	0.18	639.6	502	2.5	2.7	
69	2/1/2006	0.60	642.1	504.7	2.8	1.8	
70	2/2/2006	0.14	644.9	506.5	1.6	2.5	
71	2/3/2006	0.39	646.5	509	2.73	2.1	Heavy rain.
72	2/4/2006	1.00	649.23	511.1	2.73	2.1	
73	2/5/2006	1.00	651.96	513.2	2.74	2	
74	2/6/2006	1.13	654.7	515.2	1.6	2.4	
75	2/7/2006	0.00	656.3	517.6	2.9	1.6	
76	2/8/2006	0.02	659.2	519.2	1.9	2.4	
77	2/9/2006	0.00	661.1	521.6	2.8	1.2	
78	2/10/2006	0.00	663.9	522.8	2	2.5	
	Total	25.80			182.4	168.8	

Total operating hours of both pumps over 78 day monitoring period 351.2 hours
Total inches of rainfall over the 78 day monitoring period 25.80 inches

100 gpm per pump
2,107,200 gallons pumped in 78 days

Liberty Bay Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2	Comments by City
1		7/25/2006	0.00	976.8	806.9	2.4	1.3	
2		7/26/2006	0.00	979.2	808.2	1.8	2.5	
3		7/27/2006	0.00	981	810.7	2.5	1.8	
4		7/28/2006	0.00	983.5	812.5	1.6	2.5	
5		7/29/2006	0.00	985.1	815	2.7	1.4	
6		7/30/2006	0.00	987.8	816.4	1.2	2.4	
7		7/31/2006	0.00	989	818.8	2.4	1.4	
8		8/1/2006	0.00	991.4	820.2	1.6	2.2	
9		8/2/2006	0.00	993	822.4	2.6	1.5	
10		8/3/2006	0.00	995.6	823.9	1.4	2.3	
11		8/4/2006	0.00	997	826.2	2.1	1.4	
12		8/5/2006	0.00	999.1	827.6	1.4	1.9	
13		8/6/2006	0.00	1000.5	829.5	2.3	1.4	
14		8/7/2006	0.00	1002.8	830.9	1.6	2	
15		8/8/2006	0.00	1004.4	832.9	2.3	1.6	
16		8/9/2006	0.02	1006.7	834.5	1.3	2.2	
17		8/10/2006	0.03	1008	836.7	2.4	1.6	
18		8/11/2006	0.00	1010.4	838.3	1.5	1.8	
19		8/12/2006	0.00	1011.9	840.1	1.9	1.3	
20		8/13/2006	0.00	1013.8	841.4	1.3	2.1	
21		8/14/2006	0.00	1015.1	843.5	2.4	1.6	
22		8/15/2006	0.00	1017.5	845.1	1.4	2.1	
23		8/16/2006	0.00	1018.9	847.2	2.3	1.9	
24		8/17/2006	0.00	1021.2	849.1	1.6	2.2	
25		8/18/2006	0.00	1022.8	851.3	2.3	1.4	
26		8/19/2006	0.00	1025.1	852.7	1.4	2.3	
27		8/20/2006	0.00	1026.5	855	2.2	1.2	
28		8/21/2006	0.00	1028.7	856.2	1.6	2.4	
29		8/22/2006	0.00	1030.3	858.6	2.2	1.8	
30		8/23/2006	0.00	1032.5	860.4	1.6	2.2	
31		8/24/2006	0.00	1034.1	862.6	2.5	1.5	
32		8/25/2006	0.00	1036.6	864.1	1.5	2	
33	DRY WEATHER	8/26/2006	0.00	1038.1	866.1	2.2	1.4	
34		8/27/2006	0.00	1040.3	867.5	1.7	2.2	
35		8/28/2006	0.00	1042	869.7	2.1	1.7	
36		8/29/2006	0.00	1044.1	871.4	1.6	2.1	
37		8/30/2006	0.26	1045.7	873.5	2.4	1.3	
38		8/31/2006	0.02	1048.1	874.8	1.4	2.1	
39		9/1/2006	0.00	1049.5	876.9	2.1	1.2	
40		9/2/2006	0.00	1051.6	878.1	1.1	2	
41		9/3/2006	0.00	1052.7	880.1	1.9	1.2	
42		9/4/2006	0.00	1054.6	881.3	1.5	2	
43		9/5/2006	0.01	1056.1	883.3	1.7	1.6	hi water test
44		9/6/2006	0.00	1057.8	884.9	1.9	1.7	
45		9/7/2006	0.01	1059.7	886.6	1.8	2.4	
46		9/8/2006	0.00	1061.5	889	2.9	2	
47		9/9/2006	0.12	1064.4	891	1.4	2.4	
48		9/10/2006	0.02	1065.8	893.4	2	1.4	
49		9/11/2006	0.00	1067.8	894.8	1.6	2.3	
50		9/12/2006	0.02	1069.4	897.1	2	1.6	
51		9/13/2006	0.01	1071.4	898.7	1.5	2	
52		9/14/2006	0.15	1072.9	900.7	2.3	1.4	
53		9/15/2006	0.30	1075.2	902.1	2.1	2.6	
54		9/16/2006	0.50	1077.3	904.7	2.4	1.4	
55		9/17/2006	0.10	1079.7	906.1	1.6	2	
56		9/18/2006	0.10	1081.3	908.1	2.2	1.4	
57		9/19/2006	0.07	1083.5	909.5	1.8	2.2	
58		9/20/2006	0.05	1085.3	911.7	2.2	1.6	
59		9/21/2006	0.06	1087.5	913.3	1.7	2.3	
60		9/22/2006	0.12	1089.2	915.6	2.5	1.7	
61		9/23/2006	0.00	1091.7	917.3	1.4	2.3	
62		9/24/2006	0.00	1093.1	919.6	2.9	2	
63		9/25/2006	0.01	1096	921.6	1.6	2.3	
64		9/26/2006	0.00	1097.6	923.9	2.6	1.4	
65		9/27/2006	0.00	1100.2	925.3	1.6	2.3	
66		9/28/2006	0.00	1101.8	927.6	2	1.5	
67		9/29/2006	0.02	1103.8	929.1	1.6	2.2	
68		9/30/2006	0.00	1105.4	931.3	2.8	1.3	
69		10/1/2006	0.00	1108.2	932.6	1.4	2.1	
70		10/2/2006	0.01	1109.6	934.7	2.2	1.5	
71		10/3/2006	0.00	1111.8	936.2	1.5	2.4	
72		10/4/2006	0.00	1113.3	938.6	2.9	1.7	
73		10/5/2006	0.00	1116.2	940.3	1.5	2.1	
74		10/6/2006	0.03	1117.7	942.4	2.4	1.6	
75		10/7/2006	0.03	1120.1	944	1.4	2.2	
76		10/8/2006	0.02	1121.5	946.2	1.9	1.2	
77		10/9/2006	0.02	1123.4	947.4	1.5	2.2	
78		10/10/2006	0.00	1124.9	949.6	2.1	1.5	
		Total	2.11			150.2	144.2	

Total operating hours of both pumps over 78 day monitoring period — 294.4 hours
Total inches of rainfall over the 78 day monitoring period — 2.11 inches

100 gpm per pump
1,766,400 gallons pumped in 78 days

340,800 gallons pumped for 23.69 inches of rain (25.

13,209 gallons of rainwater pumped per inch of rainf

Lindvig Pump Station

WET WEATHER

	Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period Hours Pump 1	Hours running in 24 hour period Hours Pump 2	Comments by City
1	11/25/2005	0.16	691	788.8	2.5	2.5	
2	11/26/2005	0.84	693.5	791.3	2.1	2.1	
3	11/27/2005	0.20	695.6	793.4	2.1	2.1	
4	11/28/2005	0.00	697.7	795.5	2	2	
5	11/29/2005	0.29	699.7	797.5	2	2.1	
6	11/30/2005	0.02	701.7	799.6	1.9	1.9	
7	12/1/2005	0.02	703.6	801.5	1.9	1.9	
8	12/2/2005	0.23	705.5	803.4	2.1	2.2	
9	12/3/2005	0.00	707.6	805.6	1.9	1.9	
10	12/4/2005	0.02	709.5	807.5	1.8	1.8	
11	12/5/2005	0.02	711.3	809.3	2	2	
12	12/6/2005	0.00	713.3	811.3	1.9	1.9	
13	12/7/2005	0.00	715.2	813.2	1.9	1.9	
14	12/8/2005	0.00	717.1	815.1	2	2	
15	12/9/2005	0.00	719.1	817.1	1.6	1.7	
16	12/10/2005	0.00	720.7	818.8	1.8	1.7	
17	12/11/2005	0.02	722.5	820.5	2.1	2.2	
18	12/12/2005	0.00	724.6	822.7	1.9	1.9	
19	12/13/2005	0.03	726.5	824.6	2	1.9	
20	12/14/2005	0.00	728.5	826.5	1.9	2	
21	12/15/2005	0.00	730.4	828.5	1.8	1.8	
22	12/16/2005	0.00	732.2	830.3	1.8	1.8	
23	12/17/2005	0.00	734	832.1	1.8	1.8	
24	12/18/2005	0.00	735.8	833.9	1.9	1.9	
25	12/19/2005	0.10	737.7	835.8	2.4	2.4	
26	12/20/2005	0.42	740.1	838.2	2.2	2.3	Lots of rain.
27	12/21/2005	0.92	742.3	840.5	3	3	Lots of rain.
28	12/22/2005	1.59	745.3	843.5	2.6	2.6	Lots of rain.
29	12/23/2005	0.14	747.9	846.1	3	3	Lots of rain.
30	12/24/2005	1.13	750.9	849.1	2.8	2.8	Lots of rain.
31	12/25/2005	0.81	753.7	851.9	2.6	2.6	Lots of rain.
32	12/26/2005	0.58	756.3	854.5	3.1	3.2	Lots of rain.
33	12/27/2005	0.75	759.4	857.7	3.4	3.6	Lots of rain.
34	12/28/2005	0.36	762.8	861.3	3.9	3.9	Lots of rain.
35	12/29/2005	0.29	766.7	865.2	3.7	3.8	Lots of rain.
36	12/30/2005	0.71	770.4	869	4.2	4.2	Lots of rain.
37	12/31/2005	0.68	774.6	873.2	3.6	3.7	Lots of rain.
38	1/1/2006	0.16	778.2	876.9	3.6	3.8	Lots of rain.
39	1/2/2006	0.39	781.8	880.7	3.5	3.6	Lots of rain.
40	1/3/2006	0.05	785.3	884.3	3.7	3.8	Lots of rain.
41	1/4/2006	0.35	789	888.1	3.5	3.7	Lots of rain.
42	1/5/2006	0.15	792.5	891.8	4.5	4.7	Lots of rain.
43	1/6/2006	0.97	797	896.5	3.8	4.1	Lots of rain.
44	1/7/2006	0.18	800.8	900.6	3.8	4	
45	1/8/2006	0.08	804.6	904.6	4	4.2	
46	1/9/2006	0.42	808.6	908.8	5.1	5.3	
47	1/10/2006	1.51	813.7	914.1	4.6	4.9	Heavy rain.
48	1/11/2006	0.29	818.3	919	4.4	4.6	
49	1/12/2006	0.02	822.7	923.6	4.9	5.2	
50	1/13/2006	1.12	827.6	928.8	4.6	4.8	
51	1/14/2006	0.07	832.2	933.6	4.4	4.7	Heavy rain.
52	1/15/2006	0.30	836.6	938.3	3.5	3.8	Heavy rain.
53	1/16/2006	0.00	840.1	942.1	4.8	5.2	Heavy rain.
54	1/17/2006	0.72	844.9	947.3	4.1	4.2	Heavy rain.
55	1/18/2006	0.00	849	951.5	3.9	4.1	
56	1/19/2006	0.02	852.9	955.6	4	4.1	
57	1/20/2006	0.23	856.9	959.7	3.5	3.6	
58	1/21/2006	0.00	860.4	963.3	3.3	3.4	
59	1/22/2006	0.00	863.7	966.7	3.7	3.7	
60	1/23/2006	0.02	867.4	970.4	3.4	3.5	
61	1/24/2006	0.01	870.8	973.9	3.3	3.4	
62	1/25/2006	0.00	874.1	977.3	3.4	3.4	
63	1/26/2006	0.00	877.5	980.7	3	3.1	
64	1/27/2006	0.10	880.5	983.8	3.7	3.9	
65	1/28/2006	0.85	884.2	987.7	3.5	3.6	Heavy rain.
66	1/29/2006	0.03	887.7	991.3	5.9	6.2	Heavy rain.
67	1/30/2006	2.97	893.6	997.5	4.8	4.9	Heavy rain.
68	1/31/2006	0.18	898.4	1002.4	5	5.1	
69	2/1/2006	0.60	903.4	1007.5	4.2	4.3	
70	2/2/2006	0.14	907.6	1011.8	4.4	4.5	
71	2/3/2006	0.39	912	1016.3	4.6	4.7	Heavy rain.
72	2/4/2006	1.00	916.6	1021	4.6	4.7	
73	2/5/2006	1.00	921.2	1025.7	4.5	4.6	
74	2/6/2006	1.13	925.7	1030.3	3.8	4	
75	2/7/2006	0.00	929.5	1034.3	3.9	3.9	
76	2/8/2006	0.02	933.4	1038.2	4	4.1	
77	2/9/2006	0.00	937.4	1042.3	3.4	3.5	
78	2/10/2006	0.00	940.8	1045.8	3.5	3.6	
	Total	25.80			253.3	260.6	

515 gpm Pump #1
500 gpm Pump #2

Total operating hours of both pumps over 78 day monitoring period 513.9 hours
Total inches of rainfall over the 78 day monitoring period 25.80 inches

15,644,970 gallons pumped in 78 days

Lindvig Pump Station

DRY WEATHER

	Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period Hours Pump 1	Hours running in 24 hour period Hours Pump 2	Comments by City
1	7/25/2006	0.00	6384.9	6501.2	2.5	2.7	
2	7/26/2006	0.00	6387.4	6503.9	2.7	2.7	
3	7/27/2006	0.00	6390.1	6506.6	2.5	2.6	
4	7/28/2006	0.00	6392.6	6509.2	2.5	2.5	
5	7/29/2006	0.00	6395.1	6511.7	2.4	2.5	
6	7/30/2006	0.00	6397.5	6514.2	2.4	2.5	
7	7/31/2006	0.00	6399.9	6516.7	2.4	2.4	
8	8/1/2006	0.00	6402.3	6519.1	2.5	2.6	
9	8/2/2006	0.00	6404.8	6521.7	2.5	2.6	
10	8/3/2006	0.00	6407.3	6524.3	2.4	2.5	
11	8/4/2006	0.00	6409.7	6526.8	2.2	2.2	
12	8/5/2006	0.00	6411.9	6529	2.4	2.5	
13	8/6/2006	0.00	6414.3	6531.5	2.5	2.5	
14	8/7/2006	0.00	6416.8	6534	2.7	2.7	
15	8/8/2006	0.00	6419.5	6536.7	2.6	2.7	
16	8/9/2006	0.02	6422.1	6539.4	2.3	2.4	
17	8/10/2006	0.03	6424.4	6541.8	2.3	2.3	
18	8/11/2006	0.00	6426.7	6544.1	2.3	2.4	
19	8/12/2006	0.00	6429	6546.5	2.4	2.3	
20	8/13/2006	0.00	6431.4	6548.8	2.5	2.7	
21	8/14/2006	0.00	6433.9	6551.5	2.4	2.4	
22	8/15/2006	0.00	6436.3	6553.9	2.7	2.9	
23	8/16/2006	0.00	6439	6556.8	2.7	2.7	
24	8/17/2006	0.00	6441.7	6559.5	2.3	2.3	
25	8/18/2006	0.00	6444	6561.8	2.2	2.3	
26	8/19/2006	0.00	6446.2	6564.1	2.2	2.2	
27	8/20/2006	0.00	6448.4	6566.3	2.1	2.3	
28	8/21/2006	0.00	6450.5	6568.6	2.4	2.3	
29	8/22/2006	0.00	6452.9	6570.9	2.3	2.3	
30	8/23/2006	0.00	6455.2	6573.2	2.3	2.4	
31	8/24/2006	0.00	6457.5	6575.6	2.2	2.3	
32	8/25/2006	0.00	6459.7	6577.9	2.3	2.3	
33	8/26/2006	0.00	6462	6580.2	2.1	2.2	
34	8/27/2006	0.00	6464.1	6582.4	2.3	2.2	
35	8/28/2006	0.00	6466.4	6584.6	2.5	2.6	
36	8/29/2006	0.00	6468.9	6587.2	2.4	2.5	
37	8/30/2006	0.26	6471.3	6589.7	2.4	2.4	
38	8/31/2006	0.02	6473.7	6592.1	2.4	2.5	
39	9/1/2006	0.00	6476.1	6594.6	2.5	2.6	
40	9/2/2006	0.00	6478.6	6597.2	2.4	2.4	
41	9/3/2006	0.00	6481	6599.6	2.2	2.2	
42	9/4/2006	0.00	6483.2	6601.8	2.4	2.5	
43	9/5/2006	0.01	6485.6	6604.3	2.3	2.4	hi water test
44	9/6/2006	0.00	6487.9	6606.7	2.6	2.5	
45	9/7/2006	0.01	6490.5	6609.2	2.5	2.6	
46	9/8/2006	0.00	6493	6611.8	2.6	2.7	
47	9/9/2006	0.12	6495.6	6614.5	2.4	2.4	
48	9/10/2006	0.02	6498	6616.9	2.3	2.4	
49	9/11/2006	0.00	6500.3	6619.3	2.3	2.4	
50	9/12/2006	0.02	6502.6	6621.7	2.4	2.4	
51	9/13/2006	0.01	6505	6624.1	2.4	2.5	
52	9/14/2006	0.15	6507.4	6626.6	2.4	2.5	
53	9/15/2006	0.30	6509.8	6629.1	2.5	2.6	
54	9/16/2006	0.50	6512.3	6631.7	2.2	2.3	
55	9/17/2006	0.10	6514.5	6634	2.5	2.6	
56	9/18/2006	0.10	6517	6636.6	2.4	2.4	
57	9/19/2006	0.07	6519.4	6639	2.4	2.5	
58	9/20/2006	0.05	6521.8	6641.5	2.5	2.5	
59	9/21/2006	0.06	6524.3	6644	2.5	2.6	
60	9/22/2006	0.12	6526.8	6646.6	2.3	2.4	
61	9/23/2006	0.00	6529.1	6649	2.4	2.4	
62	9/24/2006	0.00	6531.5	6651.4	2.5	2.7	
63	9/25/2006	0.01	6534	6654.1	2.5	2.4	
64	9/26/2006	0.00	6536.5	6656.5	2.4	2.5	
65	9/27/2006	0.00	6538.9	6659	2.4	2.5	
66	9/28/2006	0.00	6541.3	6661.5	2.3	2.3	
67	9/29/2006	0.02	6543.6	6663.8	2.3	2.4	
68	9/30/2006	0.00	6545.9	6666.2	2.4	2.4	
69	10/1/2006	0.00	6548.3	6668.6	2.5	2.5	
70	10/2/2006	0.01	6550.8	6671.1	2.4	2.5	
71	10/3/2006	0.00	6553.2	6673.6	2.4	2.4	
72	10/4/2006	0.00	6555.6	6676	2.4	2.5	
73	10/5/2006	0.00	6558	6678.5	2.3	2.5	
74	10/6/2006	0.03	6560.3	6681	2.2	2.2	
75	10/7/2006	0.03	6562.5	6683.2	2.3	2.3	
76	10/8/2006	0.02	6564.8	6685.5	2.1	2.2	
77	10/9/2006	0.02	6566.9	6687.7	2.7	2.7	
78	10/10/2006	0.00	6569.6	6690.4	2.2	2.3	
	Total	2.11			186.9	191.5	

Total operating hours of both pumps over 78 day monitoring period 378.4 hours
Total inches of rainfall over the 78 day monitoring period 2.11 inches

515 gpm Pump #1
500 gpm Pump #2
11,520,210 gallons pumped in 78 days
0.15 MGD average

4,124,760 gallons pumped for 23.69 inches of rain (25.80 inches - 2.11 inches)

159,874 gallons of rainwater pumped per inch of rainfall

Marine Science Center Pump Station

WET WEATHER

	Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hour Meter Reading Pump 3	Hours running in 24 hour period Hours Pump 1	Hours Pump 2	Hours Pump 3		Comments by City Personnel
1	11/25/2005	0.16	961	966.5	426.4	1.3	1.2	3.4		
2	11/26/2005	0.84	962.3	967.7	429.8	1.1	1.1	2.6		
3	11/27/2005	0.20	963.4	968.8	432.4	1	1	2.3		
4	11/28/2005	0.00	964.4	969.8	434.7	0.9	1	2.3		
5	11/29/2005	0.29	965.3	970.8	437	1	1	2.4		
6	11/30/2005	0.02	966.3	971.8	439.4	1	1	2.3		
7	12/1/2005	0.02	967.3	972.8	441.7	0.9	1	2.2		
8	12/2/2005	0.23	968.2	973.8	443.9	1.1	1.1	2.5		
9	12/3/2005	0.00	969.3	974.9	446.4	0.9	0.9	2.3		
10	12/4/2005	0.02	970.2	975.8	448.7	0.9	0.9	2		
11	12/5/2005	0.02	971.1	976.7	450.7	0.9	1	2.3		
12	12/6/2005	0.00	972	977.7	453	0.9	0.8	2.1		
13	12/7/2005	0.00	972.9	978.5	455.1	1	1	2.3		
14	12/8/2005	0.00	973.9	979.5	457.4	0.9	0.9	2.2		
15	12/9/2005	0.00	974.8	980.4	459.6	0.8	0.9	1.8		
16	12/10/2005	0.00	975.6	981.3	461.4	3	1.3	3.9		
17	12/11/2005	0.02	978.6	982.6	465.3	1	1.1	2.3		
18	12/12/2005	0.00	979.6	983.7	467.6	0.9	0.9	2.3		
19	12/13/2005	0.03	980.5	984.6	469.9	1	0.9	2.2		
20	12/14/2005	0.00	981.5	985.5	472.1	1.1	7.4	1.9		
21	12/15/2005	0.00	982.6	992.9	474	1	0.9	2.1		
22	12/16/2005	0.00	983.6	993.8	476.1	0.8	0.7	2		
23	12/17/2005	0.00	984.4	994.5	478.1	1.1	1	2.1		
24	12/18/2005	0.00	985.5	995.5	480.2	0.7	0.9	2.2		
25	12/19/2005	0.10	986.2	996.4	482.4	1.2	1.2	3.1		
26	12/20/2005	0.42	987.4	997.6	485.5	1.4	1.3	3.4	Lots of rain.	
27	12/21/2005	0.92	988.8	998.9	488.9	1.8	1.6	6.2	Lots of rain.	
28	12/22/2005	1.59	990.6	1000.5	495.1	3.2	1.7	1.5	Lots of rain.	
29	12/23/2005	0.14	993.8	2.2	496.6	4	2.2	0	Lots of rain.	Lots of rain. Recalibrated pump 2.
30	12/24/2005	1.13	997.8	4.4	496.6	4	2	0	Lots of rain.	Lots of rain. Note pump 2 rolled over. Shut off pump 3 and jumpered to pump #1.
31	12/25/2005	0.81	2001.8	2006.4	496.6	3.4	1.7	0	Lots of rain.	Lots of rain - jumped #3 to #2
32	12/26/2005	0.58	2005.2	2008.1	496.6	4	2	0	Lots of rain.	Lots of rain - jumped #3 to #2
33	12/27/2005	0.75	2009.2	2010.1	496.6	3.9	2.1	0	Lots of rain.	Lots of rain - jumped #3 to #2
34	12/28/2005	0.36	2013.1	2012.2	496.6	4.2	2	0	Lots of rain.	Lots of rain - jumped #3 to #2
35	12/29/2005	0.29	2017.3	2014.2	496.6	3.4	1.8	0	Lots of rain.	#3 still off & jumped to #1.
36	12/30/2005	0.71	2020.7	2016	496.6	4.5	2.5	0	Lots of rain.	#3 still off & jumped to #1.
37	12/31/2005	0.68	2025.2	2018.5	496.6	4.3	3.8	0	Lots of rain.	#3 still off & jumped to #1.
38	1/1/2006	0.16	2029.5	2022.3	496.6	4.6	3.8	0	Lots of rain.	#2 lost prime/ cleaned shut off float
39	1/2/2006	0.39	2034.1	2026.1	496.6	3	1.6	0	Lots of rain.	#3 still off & jumped to #1.
40	1/3/2006	0.05	2037.1	2027.7	496.6	3	1.5	0	Lots of rain.	#3 still off & jumped to #1.
41	1/4/2006	0.35	2040.1	2029.2	496.6	2.9	1.5	0	Lots of rain.	#3 still off & jumped to #1.
42	1/5/2006	0.15	2043	2030.7	496.6	4.4	2.3	0	Lots of rain.	#3 still off & jumped to #1.
43	1/6/2006	0.97	2047.4	2033	496.6	3.4	1.7	0	Lots of rain.	Lots of rain.#3 still off & jumped to #1.
44	1/7/2006	0.18	2050.8	2034.7	496.6	3	1.6	0		#3 still off & jumped to #1.
45	1/8/2006	0.08	2053.8	2036.3	496.6	3.2	1.6	0		#3 still off & jumped to #1.
46	1/9/2006	0.42	2057	2037.9	496.6	5.7	2.9	0		#3 still off & jumped to #1.
47	1/10/2006	1.51	2062.7	2040.8	496.6	4.5	2.4	0	Heavy rain.	Heavy rain. #3 still off & jumped to #1.
48	1/11/2006	0.29	2067.2	2043.2	496.6	3.5	1.9	0		#3 still off & jumped to #1.
49	1/12/2006	0.02	2070.7	2045.1	496.6	4.9	2.5	0		#3 still off & jumped to #1.
50	1/13/2006	1.12	2075.6	2047.6	496.6	4.1	2.1	0		#3 still off & jumped to #1.
51	1/14/2006	0.07	2079.7	2049.7	496.6	3.8	1.9	0	Heavy rain.	Heavy rain. #3 still off & jumped to #1.
52	1/15/2006	0.30	2083.5	2051.6	496.6	2.9	1.4	0	Heavy rain.	Heavy rain. #3 still off & jumped to #1.
53	1/16/2006	0.00	2086.4	2053	496.6	4.2	2.2	0	Heavy rain.	Heavy rain. #3 still off & jumped to #1.
54	1/17/2006	0.72	2090.6	2055.2	496.6	3.2	1.7	0	Heavy rain.	Heavy rain. #3 still off & jumped to #1.
55	1/18/2006	0.00	2093.8	2056.9	496.6	3	1.5	0		Heavy rain. #3 still off & jumped to #1.
56	1/19/2006	0.02	2096.8	2058.4	496.6	3.2	1.6	0		Heavy rain. #3 still off & jumped to #1.
57	1/20/2006	0.23	2100	2060	496.6	2.7	1.4	0		#3 still off & jumped to #1.
58	1/21/2006	0.00	2102.7	2061.4	496.6	2.6	1.3	0		#3 still off & jumped to #1.
59	1/22/2006	0.00	2105.3	2062.7	496.6	2.8	1.4	0		#3 still off & jumped to #1.
60	1/23/2006	0.02	2108.1	2064.1	496.6	2.6	1.4	0		#3 still off & jumped to #1.
61	1/24/2006	0.01	2110.7	2065.5	496.6	2.5	1.2	0		#3 still off & jumped to #1.
62	1/25/2006	0.00	2113.2	2066.7	496.6	2.5	1.3	0		#3 still off & jumped to #1.
63	1/26/2006	0.00	2115.7	2068	496.6	1.2	1	2.5		#3 still off & jumped to #1.
64	1/27/2006	0.10	2116.9	2069	499.1	1.4	1.4	3.9		
65	1/28/2006	0.85	2118.3	2070.4	503	1.3	1.3	4	Heavy rain.	heavy rain
66	1/29/2006	0.03	2119.6	2071.7	507	3.8	2.1	11.4	Heavy rain.	heavy rain
67	1/30/2006	2.97	2123.4	2073.8	518.4	2.3	4.8	0	Heavy rain.	heavy rain #3 jumped to #2
68	1/31/2006	0.18	2125.7	2078.6	518.4	2.3	4.7	0		#3 off & jumped to #1.
69	2/1/2006	0.60	2128	2083.3	518.4	1.6	3.4	0		
70	2/2/2006	0.14	2129.6	2086.7	518.4	1.6	3.4	0		
71	2/3/2006	0.39	2131.2	2090.1	518.4	2	4	0	Heavy rain.	heavy rain #3 jumped to #2
72	2/4/2006	1.00	2133.2	2094.1	518.4	2	4	0		Readings not taken due to storm work. (Averaged)
73	2/5/2006	1.00	2135.2	2098.1	518.4	1.9	4	0		Readings not taken due to storm work. (Averaged)
74	2/6/2006	1.13	2137.1	2102.1	518.4	1.4	2.9	0		#3 off-jumpered to #2
75	2/7/2006	0.00	2138.5	2105	518.4	1.4	2.8	0		#3 off-jumpered to #2
76	2/8/2006	0.02	2139.9	2107.8	518.4	1.4	2.9	0		#3 off-jumpered to #2
77	2/9/2006	0.00	2141.3	2110.7	518.4	1.2	2.5	0		#3 off-jumpered to #2
78	2/10/2006	0.00	2142.5	2113.2	518.4	1.3	2.6	0		#3 off-jumpered to #2
	Total	25.80				182.8	149.3	92		

Pump 1 =	705 gpm	7,732,440 gallons pumped in 78 days
Pump 2 =	725 gpm	6,494,550 gallons pumped in 78 days
Pump 3 =	383 gpm	2,114,160 gallons pumped in 78 days
		16,341,150 gallons pumped in 78 days

Total operating hours of both pumps over 78 day monitoring period 424.1 hours

Total inches of rainfall over the 78 day monitoring period 25.80 inches

Marine Science Center Pump Station

DRY WEATHER

	Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 1	Hour Meter Reading Pump 3	Hours running in 24 hour period: Hours Pump 1	Hours Pump 2	Hours Pump 3	Comments by City Personnel
1	7/25/2006	0.00	2303.7	2280.6	916.2	0.9	0.9	2.2	
2	7/26/2006	0.00	2304.6	2281.5	918.4	0.9	1	2.4	
3	7/27/2006	0.00	2305.5	2282.5	920.8	0.8	0.9	2.4	
4	7/28/2006	0.00	2306.3	2283.4	923.2	0.9	0.9	2.3	
5	7/29/2006	0.00	2307.2	2284.3	925.5	0.8	0.8	2.2	
6	7/30/2006	0.00	2308	2285.1	927.7	0.9	0.9	2.2	
7	7/31/2006	0.00	2308.9	2286	929.9	0.8	0.9	2.2	
8	8/1/2006	0.00	2309.7	2286.9	932.1	0.9	0.8	2.3	
9	8/2/2006	0.00	2310.6	2287.7	934.4	1	0.9	2.2	
10	8/3/2006	0.00	2311.6	2288.6	936.6	0.9	1	2.2	
11	8/4/2006	0.00	2312.5	2289.6	938.8	0.9	0.8	2.2	
12	8/5/2006	0.00	2313.4	2290.4	941	0.8	1	2.1	
13	8/6/2006	0.00	2314.2	2291.4	943.1	0.9	0.9	2.2	
14	8/7/2006	0.00	2315.1	2292.3	945.3	0.9	1	2.3	
15	8/8/2006	0.00	2316	2293.3	947.6	0.9	0.9	2.3	
16	8/9/2006	0.02	2316.9	2294.2	949.9	0.9	0.9	2.2	
17	8/10/2006	0.03	2317.8	2295.1	952.1	0.8	0.9	2.1	
18	8/11/2006	0.00	2318.6	2296	954.2	0.9	0.9	2.1	
19	8/12/2006	0.00	2319.5	2296.9	956.3	0.9	0.9	2.1	
20	8/13/2006	0.00	2320.4	2297.8	958.4	0.9	1	2.1	
21	8/14/2006	0.00	2321.3	2298.8	960.5	0.8	0.9	2.2	
22	8/15/2006	0.00	2322.1	2299.7	962.7	0.8	1.1	2.1	
23	8/16/2006	0.00	2322.9	2300.8	964.8	0.6	1	1.8	
24	8/17/2006	0.00	2323.5	2301.8	966.6	0.9	0.9	2.1	
25	8/18/2006	0.00	2324.4	2302.7	968.7	0.9	0.8	2.3	
26	8/19/2006	0.00	2325.3	2303.5	971	0.9	0.9	2.3	
27	8/20/2006	0.00	2326.2	2304.4	973.3	0.9	0.8	2.2	
28	8/21/2006	0.00	2327.1	2305.2	975.5	0.8	0.9	2.4	
29	8/22/2006	0.00	2327.9	2306.1	977.9	0.9	0.9	2.4	
30	8/23/2006	0.00	2328.8	2307	980.3	0.9	0.9	2.2	
31	8/24/2006	0.00	2329.7	2307.9	982.5	0.9	0.9	2.3	
32	8/25/2006	0.00	2330.6	2308.8	984.8	0.9	0.9	2.4	
33	8/26/2006	0.00	2331.5	2309.7	987.2	0.9	0.8	2.2	
34	8/27/2006	0.00	2332.4	2310.5	989.4	0.9	1	2.2	
35	8/28/2006	0.00	2333.3	2311.5	991.6	0.9	0.8	2.5	
36	8/29/2006	0.00	2334.2	2312.3	994.1	1	0.9	2.4	
37	8/30/2006	0.26	2335.2	2313.2	996.5	0.9	0.9	2.4	
38	8/31/2006	0.02	2336.1	2314.1	998.9	0.9	0.9	2.4	
39	9/1/2006	0.00	2337	2315	1001.3	0.9	0.9	2.3	
40	9/2/2006	0.00	2337.9	2315.9	1003.6	0.9	1	2.4	
41	9/3/2006	0.00	2338.8	2316.9	1006	0.8	0.9	2.2	
42	9/4/2006	0.00	2339.6	2317.8	1008.2	0.9	1	2.5	
43	9/5/2006	0.01	2340.5	2318.8	1010.7	0.9	0.9	2.6	hi water test
44	9/6/2006	0.00	2341.4	2319.7	1013.3	0.9	1	2.3	
45	9/7/2006	0.01	2342.3	2320.7	1015.6	0.9	0.8	2.4	
46	9/8/2006	0.00	2343.2	2321.5	1018	0.8	0.9	2.4	
47	9/9/2006	0.12	2344	2322.4	1020.4	0.9	0.8	2.2	
48	9/10/2006	0.02	2344.9	2323.2	1022.6	0.9	0.8	2.2	
49	9/11/2006	0.00	2345.8	2324	1024.8	0.9	0.9	2.4	
50	9/12/2006	0.02	2346.7	2324.9	1027.2	0.9	0.8	2.1	
51	9/13/2006	0.01	2347.6	2325.7	1029.3	1	0.9	2.4	
52	9/14/2006	0.15	2348.6	2326.6	1031.7	0.9	0.9	2.4	
53	9/15/2006	0.30	2349.5	2327.5	1034.1	1.1	0.8	2.5	
54	9/16/2006	0.50	2350.6	2328.3	1036.6	0.9	0.8	2.5	
55	9/17/2006	0.10	2351.5	2329.1	1039.1	0.9	0.9	2.6	
56	9/18/2006	0.10	2352.4	2330	1041.7	1	0.8	2.4	
57	9/19/2006	0.07	2353.4	2330.8	1044.1	1	0.8	2.4	
58	9/20/2006	0.05	2354.4	2331.6	1046.5	1.1	0.8	2.3	
59	9/21/2006	0.06	2355.5	2332.4	1048.8	1.3	1	2.8	
60	9/22/2006	0.12	2356.8	2333.4	1051.6	0.9	0.7	2.3	
61	9/23/2006	0.00	2357.7	2334.1	1053.9	1	0.8	2.4	
62	9/24/2006	0.00	2358.7	2334.9	1056.3	1.1	0.7	2.2	
63	9/25/2006	0.01	2359.8	2335.6	1058.5	0.9	0.8	2	
64	9/26/2006	0.00	2360.7	2336.4	1060.5	1	0.7	2.6	
65	9/27/2006	0.00	2361.7	2337.1	1063.1	1	0.8	2.3	
66	9/28/2006	0.00	2362.7	2337.9	1065.4	0.9	0.8	2.3	
67	9/29/2006	0.02	2363.6	2338.7	1067.7	1	0.6	2.4	
68	9/30/2006	0.00	2364.6	2339.3	1070.1	1	0.8	2.4	
69	10/1/2006	0.00	2365.6	2340.1	1072.5	0.9	0.8	2.6	
70	10/2/2006	0.01	2366.5	2340.9	1075.1	1	0.8	2.3	
71	10/3/2006	0.00	2367.5	2341.7	1077.4	1	0.8	2.4	
72	10/4/2006	0.00	2368.5	2342.5	1079.8	1	0.7	2.3	
73	10/5/2006	0.00	2369.5	2343.2	1082.1	0.9	0.8	2.3	
74	10/6/2006	0.03	2370.4	2344	1084.4	0.9	0.8	2.3	
75	10/7/2006	0.03	2371.3	2344.8	1086.7	0.9	0.8	2.2	
76	10/8/2006	0.02	2372.2	2345.6	1088.9	0.9	0.7	2.2	
77	10/9/2006	0.02	2373.1	2346.3	1091.1	1.1	0.8	2.5	
78	10/10/2006	0.00	2374.2	2347.1	1093.6	1	0.9	2.2	
	Total	2.11				71.5	67.4	179.6	

Total operating hours of both pumps over 78 day monitoring period 318.5 hours
Total inches of rainfall over the 78 day monitoring period 2.11 inches

Pump 1 =	705 gpm	3,024,450 gallons pumped in 78 days
Pump 2 =	725 gpm	2,931,900 gallons pumped in 78 days
Pump 3 =	383 gpm	4,127,208 gallons pumped in 78 days
		10,083,558 gallons pumped in 78 days

6,257,592 gallons pumped for 23.69 inches (

242,542 gallons of rainwater pumped per i

ANALYSIS OF STORMWATER INFLOW AND INFILTRATION AT VARIOUS PUMP STATIONS
78 DAY ANALYSIS PERIOD

	DRY WEATHER (7/25/06 THRU 10/10/06)		WET WEATHER (11/25/05 THRU 2/10/06)		ANALYSIS					
Lift Station	Total Rainfall	Total gallons pumped	Total Rainfall	Total gallons pumped	Net Rainfall	Extra gallons pumped	Extra gal/inch	Assumed Dry Weather Flow	Total flow attributed to rain	Percent of flow attributed to rain
6th Ave	2.11	2,715,324	25.8	5,766,336	23.69	3,051,012	128,789	2,443,579	3,322,757	57.6%
9th Ave	2.11	856,800	25.8	1,822,200	23.69	965,400	40,751	770,815	1,051,385	57.7%
Liberty Bay	2.11	1,766,400	25.8	2,107,200	23.69	340,800	14,386	1,736,046	371,154	17.6%
Lindvig	2.11	11,520,210	25.8	15,644,970	23.69	4,124,760	174,114	11,152,830	4,492,140	28.7%
MSC	2.11	10,083,558	25.8	16,341,150	23.69	6,257,592	264,145	9,526,212	6,814,938	41.7%

Total Rainfall:	Data obtained from City of Poulsbo daily pump station records. See pump station spreadsheets.
Total gallons pumped:	See pump station spreadsheets. This is derived by multiplying the number of hours each pump ran in the 78 day period by the rated pumping capacity of the pump (eg., 100 gpm) and then by 60 minutes per hour.
Net Rainfall:	The difference between the total wet weather rainfall and the total dry weather rainfall
Extra gallons pumped:	The difference between the gallons pumped during wet weather and during dry weather
Extra gallons per inch:	The number of extra gallons (actual stormwater) pumpeD per inch of rain
Assumed dry weather flow:	This removes the stormwater pumped that resulted from the 2.11 inches of rain during the dry period
Total flow attributed to rain:	This is the actual stormwater that was pumped
Percent of flow attributed to rain:	This is the percent of stormwater in the total wet weather flow (Total flow attributed to rain divided by total wet weather water pumped)

DISCUSSION AND CONCLUSION

The greatest possibility for error is in the assumed pumping rate for each pump. As the head increases, the rate (gpm) decreases. This would occur if both pumps are pumping at the same time into one pipe. Also, the diameter of the pipe being pumped to can increase the head and decrease the pumping rate.

The MSC pump station has three pumps. One of the pumps was not operational, and may have been replaced during this time period. There appears to be a discrepancy between the total gallons pumped at the MSC and the total pumped at Lindvig. All Lindvig sewage flows through MSC. The pump rating capacities may be slightly off, but the basic conclusions are still based primarily on pump run times at individual pump stations during wet and dry periods.

6th Ave Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period Hours Pump 1	Hours running in 24 hour period Hours Pump 2
1	WET WEATHER	12/24/2005	1.13	174.7	243.8	4.9	6.2
2		12/25/2005	0.81	179.6	250	4.3	5.5
3		12/26/2005	0.58	183.9	255.5	5.3	6.5
4		12/27/2005	0.75	189.2	262	5.2	6.4
5		12/28/2005	0.36	194.4	268.4	5.2	6.7
6		12/29/2005	0.29	199.6	275.1	4.5	5.4
7		12/30/2005	0.71	204.1	280.5	6.1	7.4
		Total	4.63			35.5	44.1

Total operating hours of both pumps over 7 day monitoring period 79.6 hours
Total inches of rainfall over the 7 day monitoring period 4.63 inches

142 gpm per pump
678,192 gallons pumped in 7 days

6th Ave Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period Hours Pump 1	Hours running in 24 hour period Hours Pump 2
1	DRY WEATHER	8/15/2006	0.00	927.3	890.1	2.2	1.5
2		8/16/2006	0.00	929.5	891.6	2.6	1.6
3		8/17/2006	0.00	932.1	893.2	2.5	1.5
4		8/18/2006	0.00	934.6	894.7	2.4	1.5
5		8/19/2006	0.00	937	896.2	2.6	1.6
6		8/20/2006	0.00	939.6	897.8	2.7	1.7
7		8/21/2006	0.00	942.3	899.5	2.6	1.6
		Total	0.00			17.6	11

Total operating hours of both pumps over 7 day monitoring period 28.6 hours
Total inches of rainfall over the 7 day monitoring period 0.00 inches

142 gpm per pump
243,672 gallons pumped in 7 days

434,520 gallons pumped for 4.63 inches of rain

93,849 gallons of rainwater pumped per inch of rainfall

9th Ave Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
1	WET WEATHER	12/24/2005	1.13	944.8	188.7	1.7	3
2		12/25/2005	0.81	946.5	191.7	1.6	2.9
3		12/26/2005	0.58	948.1	194.6	1.8	3.3
4		12/27/2005	0.75	949.9	197.9	1.7	3.1
5		12/28/2005	0.36	951.6	201	1.9	3.2
6		12/29/2005	0.29	953.5	204.2	1.8	3.1
7		12/30/2005	0.71	955.3	207.3	2.2	4.8
		Total	4.63			12.7	23.4

Total operating hours of both pumps over 7 day monitoring period 36.1 hours

Total inches of rainfall over the 7 day monitoring period 4.63 inches

100 gpm per pump

216,600 gallons pumped in 7 days

9th Ave Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
1	DRY WEATHER	8/15/2006	0.00	3215.1	1606.8	0.9	1.2
2		8/16/2006	0.00	3216	1608	0.7	1
3		8/17/2006	0.00	3216.7	1609	0.8	1.1
4		8/18/2006	0.00	3217.5	1610.1	0.8	1
5		8/19/2006	0.00	3218.3	1611.1	0.7	1.1
6		8/20/2006	0.00	3219	1612.2	0.8	1.1
7		8/21/2006	0.00	3219.8	1613.3	0.9	1
		Total	0.00			5.6	7.5

Total operating hours of both pumps over 7 day monitoring period 13.1 hours

Total inches of rainfall over the 7 day monitoring period 0.00 inches

100 gpm per pump

78,600 gallons pumped in 7 days

138,000 gallons pumped for 4.63 inches of rain

29,806 gallons of rainwater pumped per inch of rainfall

Liberty Bay Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
1	WET WEATHER	12/24/2005	1.13	544.5	413.2	1.5	3
2		12/25/2005	0.81	546	416.2	3.2	1.3
3		12/26/2005	0.58	549.2	417.5	1.9	3.1
4		12/27/2005	0.75	551.1	420.6	3	1.5
5		12/28/2005	0.36	554.1	422.1	1.9	3.1
6		12/29/2005	0.29	556	425.2	3	1.8
7		12/30/2005	0.71	559	427	2.1	3.2
		Total	4.63			16.6	17

		100	gpm per pump
Total operating hours of both pumps over 7 day monitoring period	33.6 hours	201,600	gallons pumped in 7 days
Total inches of rainfall over the 7 day monitoring period	4.63 inches		

Liberty Bay Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
1	DRY WEATHER	8/15/2006	0.00	1017.5	845.1	1.4	2.1
2		8/16/2006	0.00	1018.9	847.2	2.3	1.9
3		8/17/2006	0.00	1021.2	849.1	1.6	2.2
4		8/18/2006	0.00	1022.8	851.3	2.3	1.4
5		8/19/2006	0.00	1025.1	852.7	1.4	2.3
6		8/20/2006	0.00	1026.5	855	2.2	1.2
7		8/21/2006	0.00	1028.7	856.2	1.6	2.4
		Total	0.00			12.8	13.5

		100	gpm per pump
Total operating hours of both pumps over 7 day monitoring period	26.3 hours	157,800	gallons pumped in 7 days
Total inches of rainfall over the 7 day monitoring period	0.00 inches		

43,800 gallons pumped for 4.63 inches of rain

9,460 gallons of rainwater pumped per inch of rainfall

Lindvig Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
30	WET WEATHER	12/24/2005	1.13	750.9	849.1	2.8	2.8
31		12/25/2005	0.81	753.7	851.9	2.6	2.6
32		12/26/2005	0.58	756.3	854.5	3.1	3.2
33		12/27/2005	0.75	759.4	857.7	3.4	3.6
34		12/28/2005	0.36	762.8	861.3	3.9	3.9
35		12/29/2005	0.29	766.7	865.2	3.7	3.8
36		12/30/2005	0.71	770.4	869	4.2	4.2
		Total	4.63			23.7	24.1

515 gpm Pump #1
500 gpm Pump #2

Total operating hours of both pumps over 7 day monitoring period 47.8 hours — 1,455,330 gallons pumped in 7 days
Total inches of rainfall over the 7 day monitoring period 4.63 inches

Lindvig Pump Station

		Date	Rainfall (inches)	Hour Meter Reading Pump 1	Hour Meter Reading Pump 2	Hours running in 24 hour period: Hours Pump 1	Hours running in 24 hour period: Hours Pump 2
22	DRY WEATHER	8/15/2006	0.00	6436.3	6553.9	2.7	2.9
23		8/16/2006	0.00	6439	6556.8	2.7	2.7
24		8/17/2006	0.00	6441.7	6559.5	2.3	2.3
25		8/18/2006	0.00	6444	6561.8	2.2	2.3
26		8/19/2006	0.00	6446.2	6564.1	2.2	2.2
27		8/20/2006	0.00	6448.4	6566.3	2.1	2.3
28		8/21/2006	0.00	6450.5	6568.6	2.4	2.3
		Total	0.00			16.6	17

515 gpm Pump #1
500 gpm Pump #2

Total operating hours of both pumps over 7 day monitoring period 33.6 hours — 1,022,940 gallons pumped in 7 days
Total inches of rainfall over the 7 day monitoring period 0.00 inches

432,390 gallons pumped for 4.63 in.of rain

93,389 gallons of rainwater pumped per in of rainfall

Marine Science Center Pump Station

			Rainfall	Hour Meter Reading			Hours running in 24 hour period		
		Date	(inches)	Pump 1	Pump 2	Pump 3	Hours Pump 1	Hours Pump 2	Hours Pump 3
30	WET WEATHER	12/24/2005	1.13	997.8	4.4	496.6	4	2	0
31		12/25/2005	0.81	2001.8	2006.4	496.6	3.4	1.7	0
32		12/26/2005	0.58	2005.2	2008.1	496.6	4	2	0
33		12/27/2005	0.75	2009.2	2010.1	496.6	3.9	2.1	0
34		12/28/2005	0.36	2013.1	2012.2	496.6	4.2	2	0
35		12/29/2005	0.29	2017.3	2014.2	496.6	3.4	1.8	0
36		12/30/2005	0.71	2020.7	2016	496.6	4.5	2.5	0
		Total	4.63				27.4	14.1	0

Total operating hours of both pumps over 7 day monitoring period 41.5 hours
Total inches of rainfall over the 7 day monitoring period 4.63 inches

Pump 1 =	705 gpm	1,159,020 gallons pumped in 7 days
Pump 2 =	725 gpm	613,350 gallons pumped in 7 days
Pump 3 =	383 gpm	0 gallons pumped in 7 days
		1,772,370 gallons pumped in 7 days

Marine Science Center Pump Station

			Rainfall	Hour Meter Reading			Hours running in 24 hour period		
		Date	(inches)	Pump 1	Pump 1	Pump 3	Hours Pump 1	Hours Pump 2	Hours Pump 3
22	DRY WEATHER	8/15/2006	0.00	2322.1	2299.7	962.7	0.8	1.1	2.1
23		8/16/2006	0.00	2322.9	2300.8	964.8	0.6	1	1.8
24		8/17/2006	0.00	2323.5	2301.8	966.6	0.9	0.9	2.1
25		8/18/2006	0.00	2324.4	2302.7	968.7	0.9	0.8	2.3
26		8/19/2006	0.00	2325.3	2303.5	971	0.9	0.9	2.3
27		8/20/2006	0.00	2326.2	2304.4	973.3	0.9	0.8	2.2
28		8/21/2006	0.00	2327.1	2305.2	975.5	0.8	0.9	2.4
		Total	0.00				5.8	6.4	15.2

Total operating hours of both pumps over 7 day monitoring period 27.4 hours
Total inches of rainfall over the 7 day monitoring period 0.00 inches

Pump 1 =	705 gpm	245,340 gallons pumped in 7 days
Pump 2 =	725 gpm	278,400 gallons pumped in 7 days
Pump 3 =	383 gpm	349,296 gallons pumped in 7 days
		873,036 gallons pumped in 7 days

899,334 gallons pumped for 4.63 inches of rain
194,241 gallons of rainwater pumped per inch of rainfall

ANALYSIS OF STORMWATER INFLOW AND INFILTRATION AT VARIOUS PUMP STATIONS

7 DAY ANALYSIS PERIOD

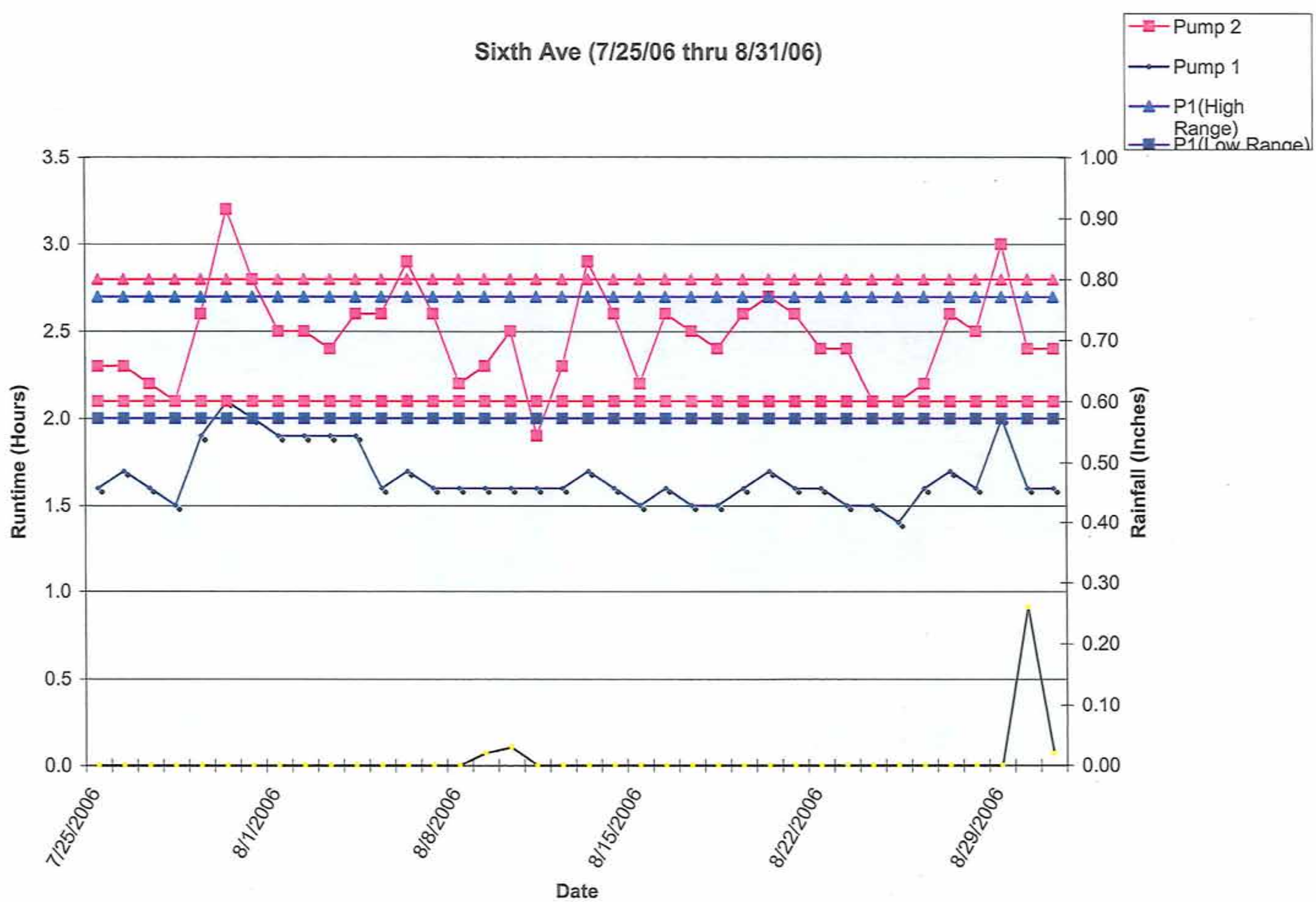
	DRY WEATHER (8/15/06 THRU 8/21/06)		WET WEATHER (12/24/05 THRU 12/30/05)		ANALYSIS					
Lift Station	Total Rainfall	Total gallons pumped	Total Rainfall	Total gallons pumped	Net Rainfall	Extra gallons pumped	Extra gal/inch	Assumed Dry Weather Flow	Total flow attributed to rain	Percent of flow attributed to rain
6th Ave	0	243,672	4.63	678,192	4.63	434,520	93,849	243,672	434,520	64.1%
9th Ave	0	78,600	4.63	216,600	4.63	138,000	29,806	78,600	138,000	63.7%
Liberty Bay	0	157,800	4.63	201,600	4.63	43,800	9,460	157,800	43,800	21.7%
Lindvig	0	1,022,940	4.63	1,455,330	4.63	432,390	93,389	1,022,940	432,390	29.7%
MSC	0	873,036	4.63	1,772,370	4.63	899,334	194,241	873,036	899,334	50.7%

Total Rainfall:	Data obtained from City of Poulsbo daily pump station records. See pump station spreadsheets.
Total gallons pumped:	See pump station spreadsheets. This is derived by multiplying the number of hours each pump ran in the 7 day period by the rated pumping capacity of the pump (eg., 100 gpm) and then by 60 minutes per hour.
Net Rainfall:	The difference between the total wet weather rainfall and the total dry weather rainfall
Extra gallons pumped:	The difference between the gallons pumped during wet weather and during dry weather
Extra gallons per inch:	The number of extra gallons (actual stormwater) pumpeD per inch of rain
Assumed dry weather flow:	For this spreadsheet, it is the same as the dry weather flow because no rain was recorded
Total flow attributed to rain:	This is the actual stormwater that was pumped
Percent of flow attributed to rain:	This is the percent of stormwater in the total wet weather flow (Total flow attributed to rain divided by total wet weather water pumped)

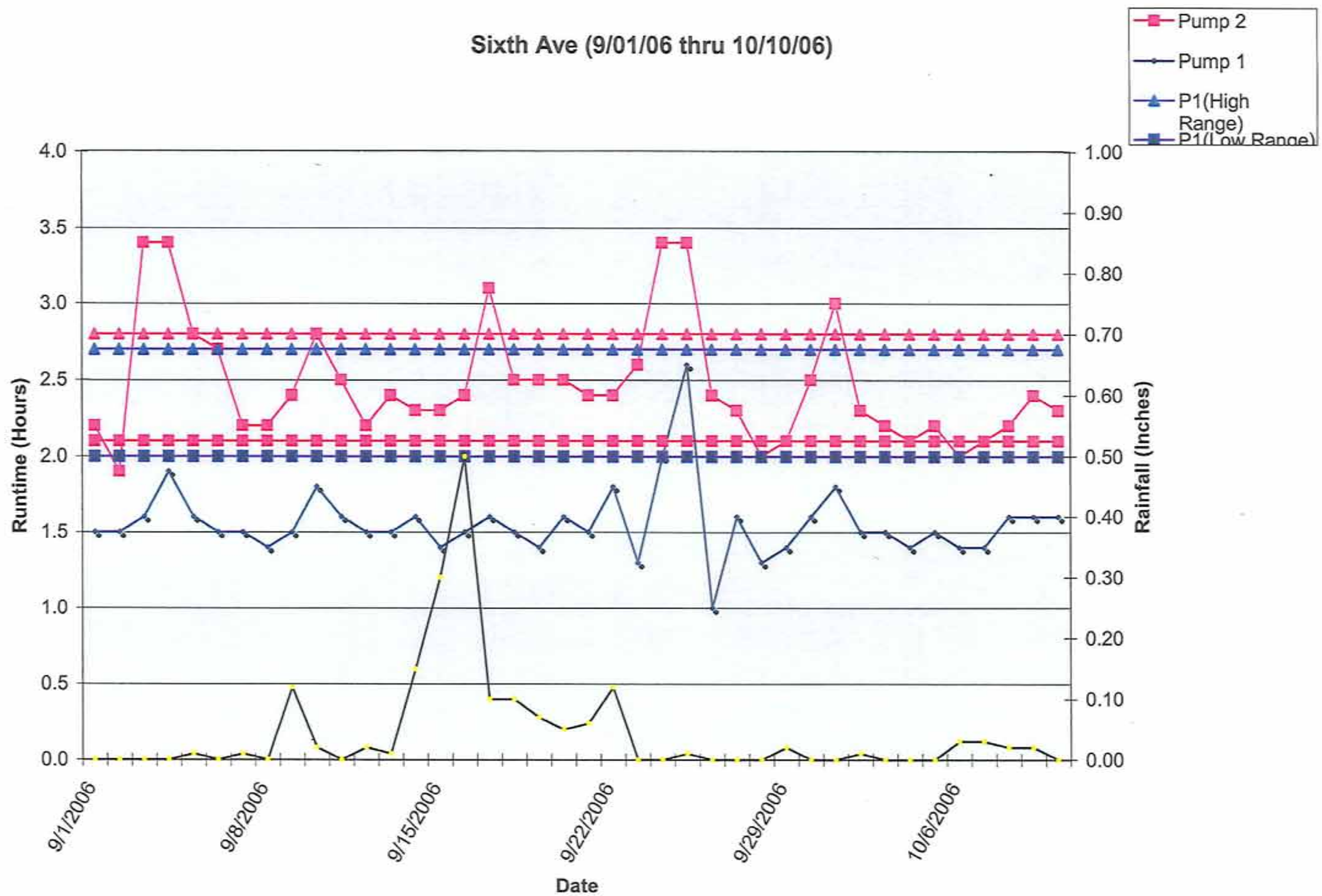
DISCUSSION AND CONCLUSION

The greatest possibility for error is in the assumed pumping rate for each pump. As the head increases, the rate (gpm) decreases. This would occur if both pumps are pumping at the same time into one pipe. Also, the diameter of the pipe being pumped to can increase the head and decrease the pumping rate.

The MSC pump station has three pumps. One of the pumps was not operational, and may have been replaced during this time period. There appears to be a discrepancy between the total gallons pumped at the MSC and the total pumped at Lindvig. All Lindvig sewage flows through MSC. The pump rating capacities may be slightly off, but the basic conclusions are still based primarily on pump run times at individual pump stations during wet and dry periods.

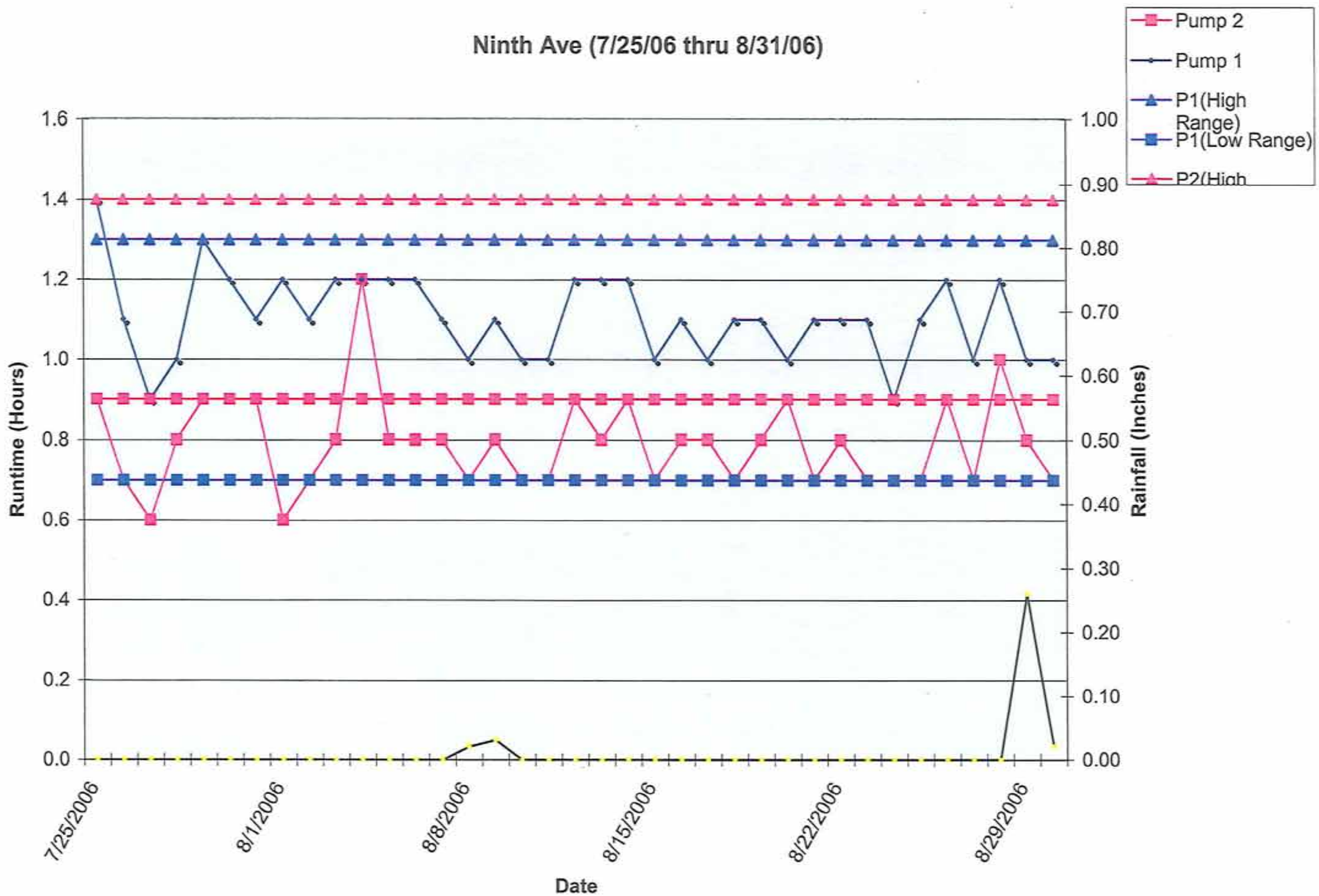


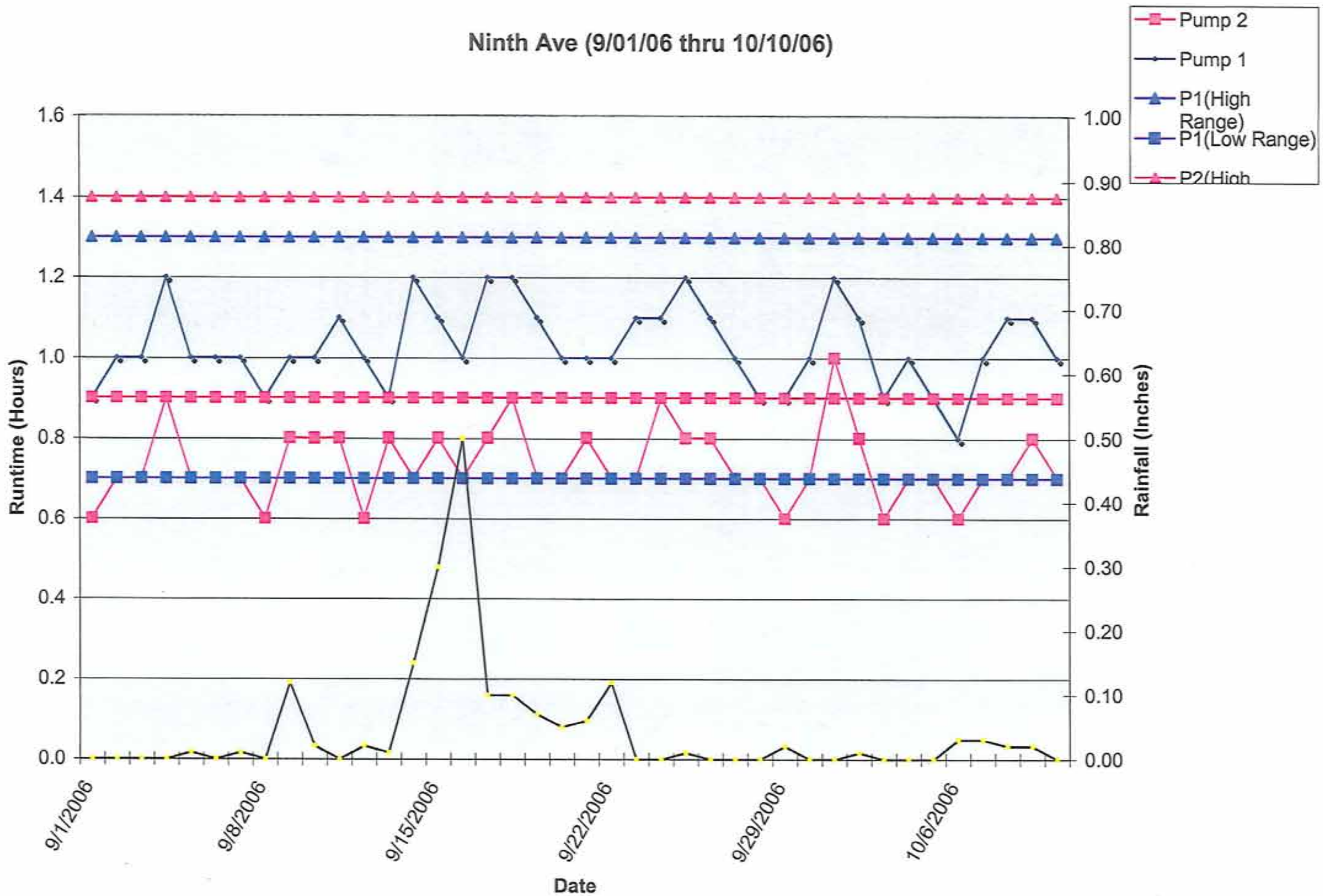
Sixth Ave (7/25/06 thru 8/31/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
Rainfall (Inches)
Date
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7/25/2006
8/1/2006
8/8/2006
8/15/2006
8/22/2006
8/29/2006



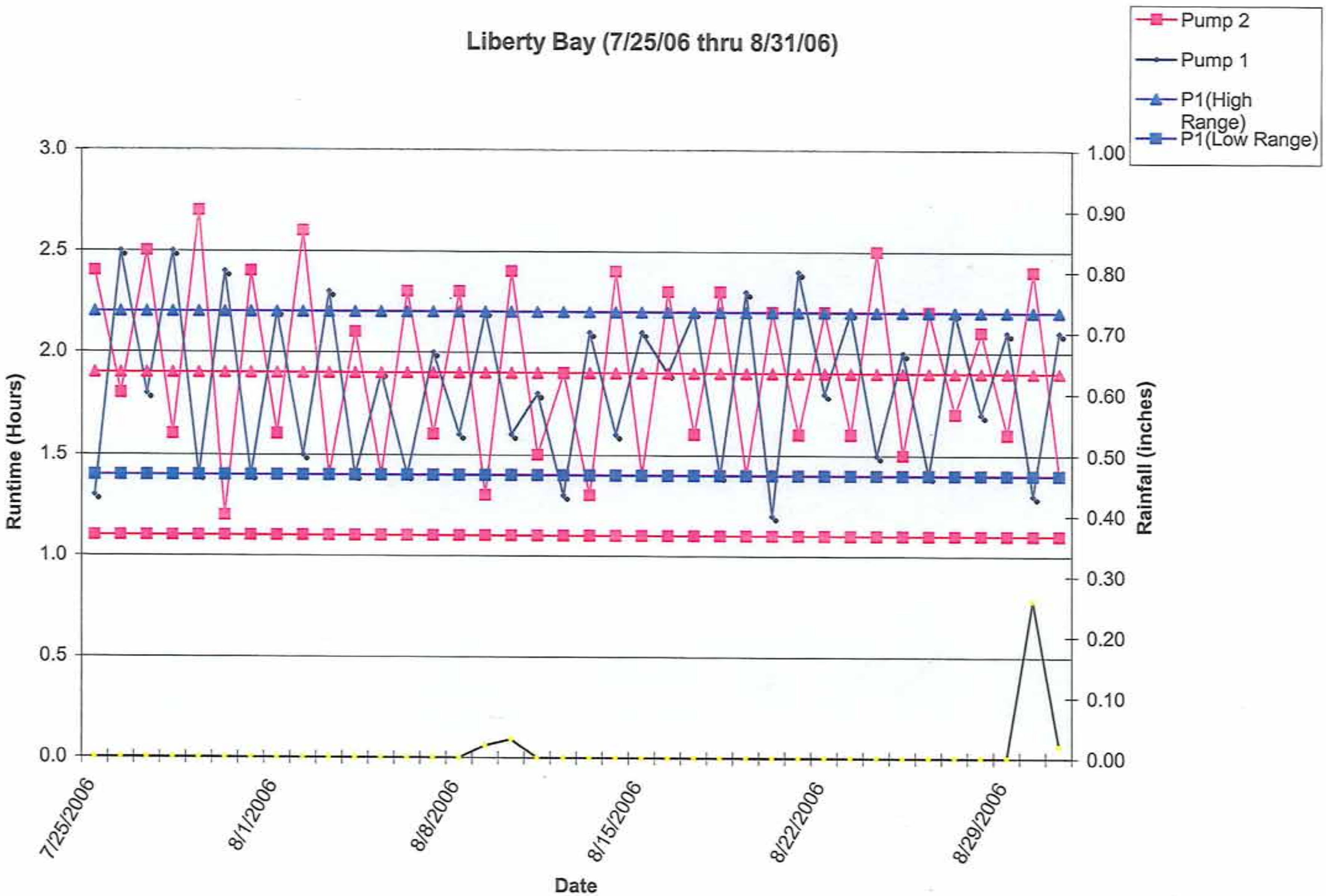
Sixth Ave (9/01/06 thru 10/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (Inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
9/1/2006
9/8/2006
9/15/2006
9/22/2006
9/29/2006
10/6/2006
Date

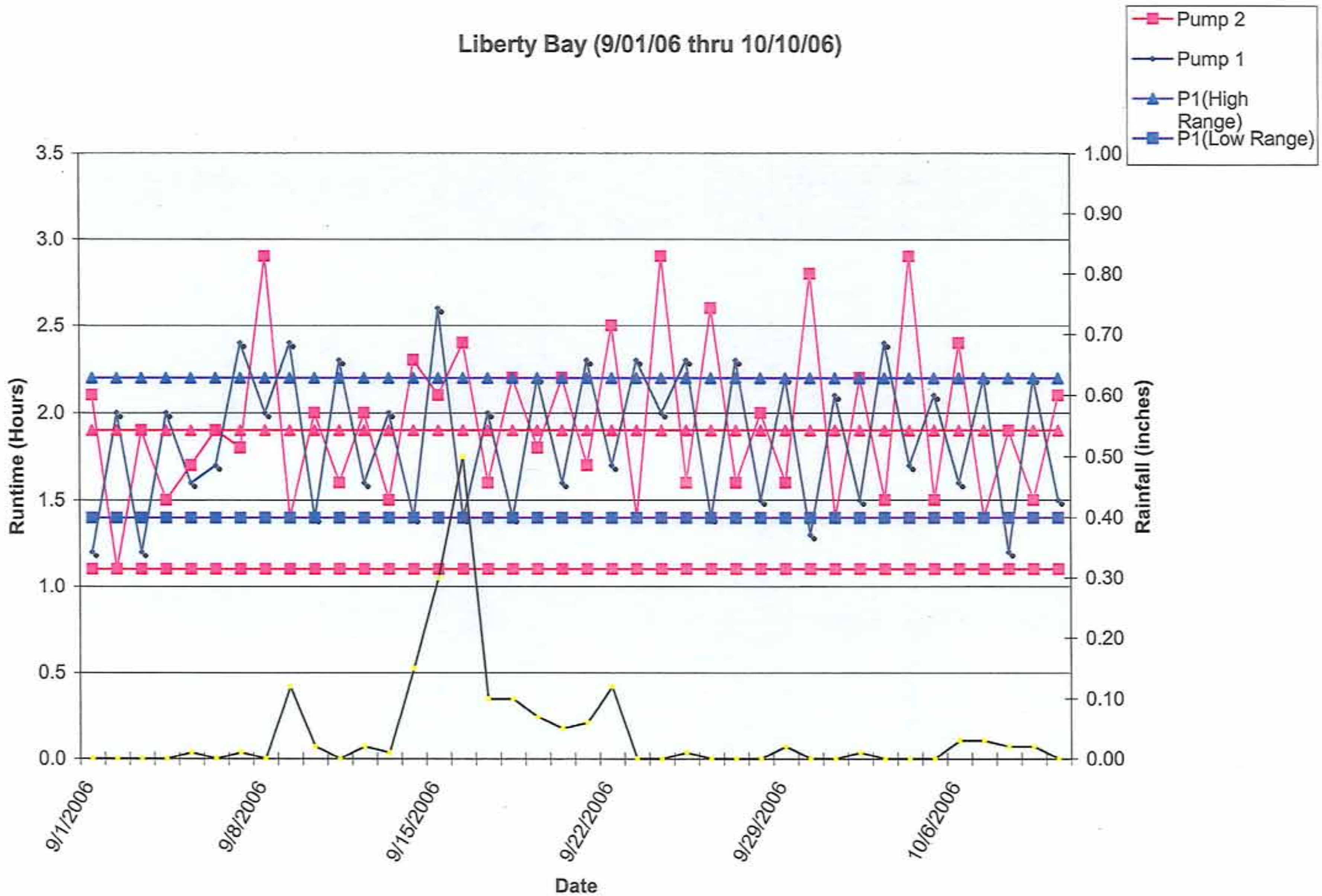
Ninth Ave (7/25/06 thru 8/31/06)

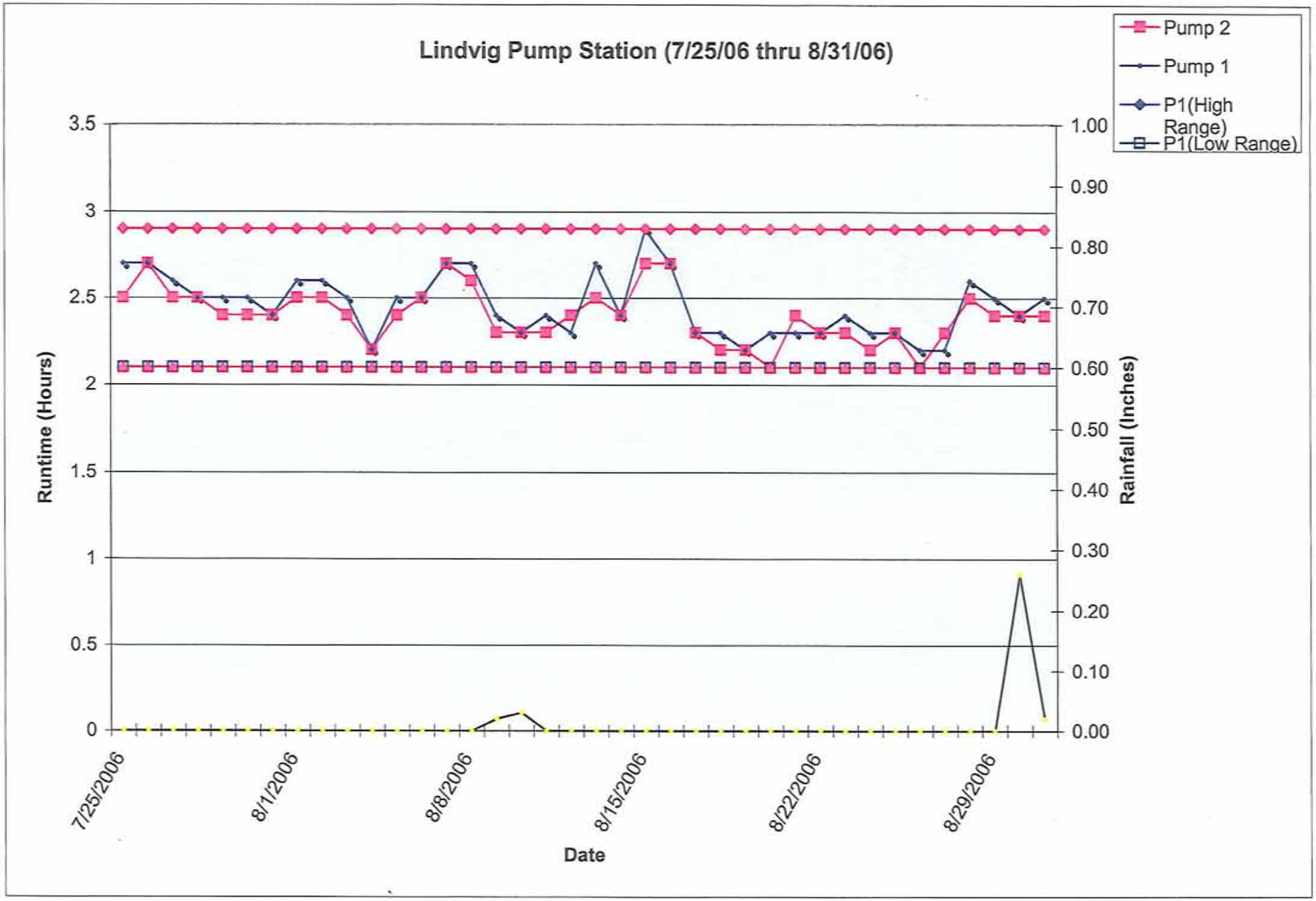


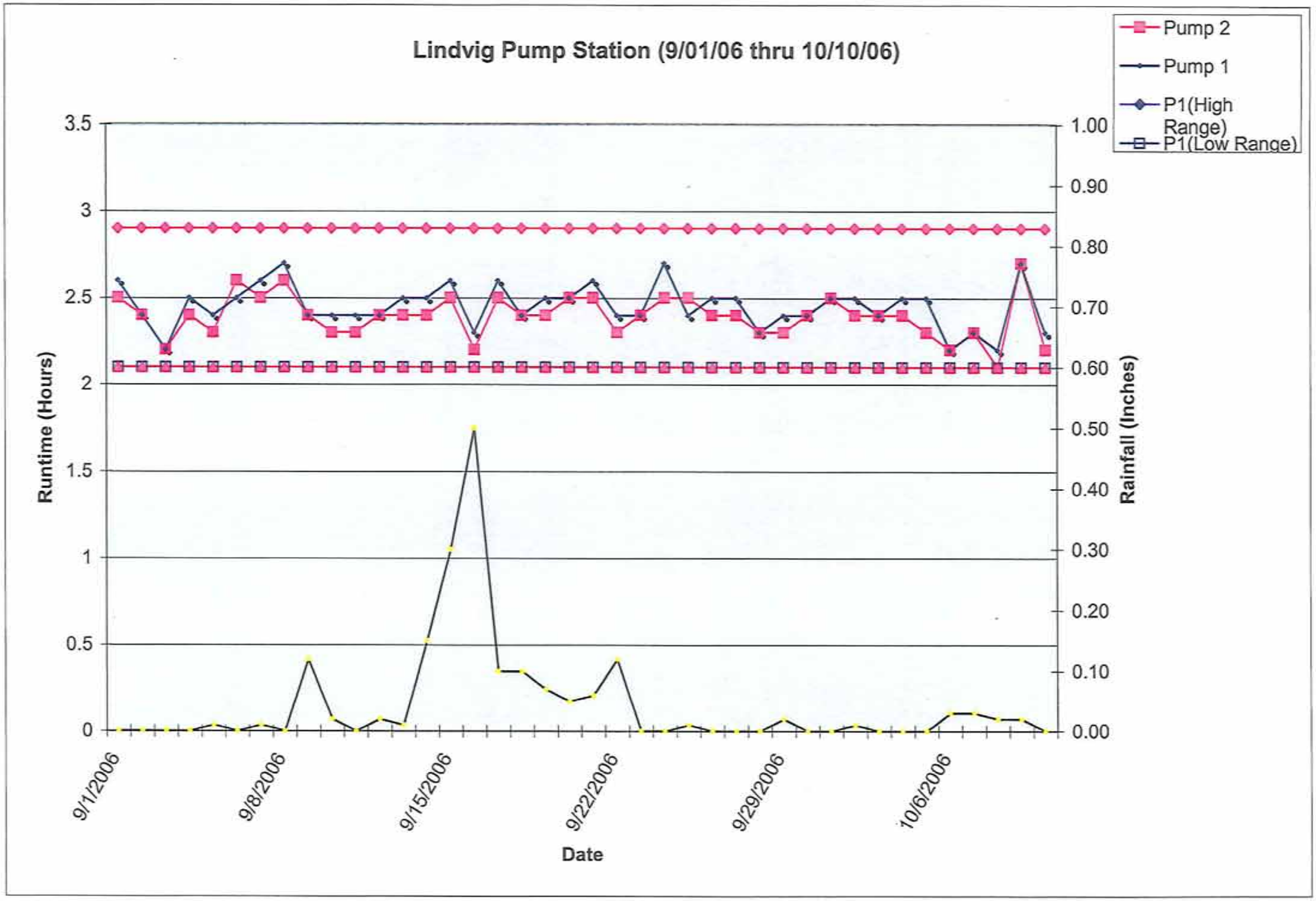

Ninth Ave (9/01/06 thru 10/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
P2(High
Runtime (Hours)
Rainfall (Inches)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
9/1/2006
9/8/2006
9/15/2006
9/22/2006
9/29/2006
10/6/2006
Date

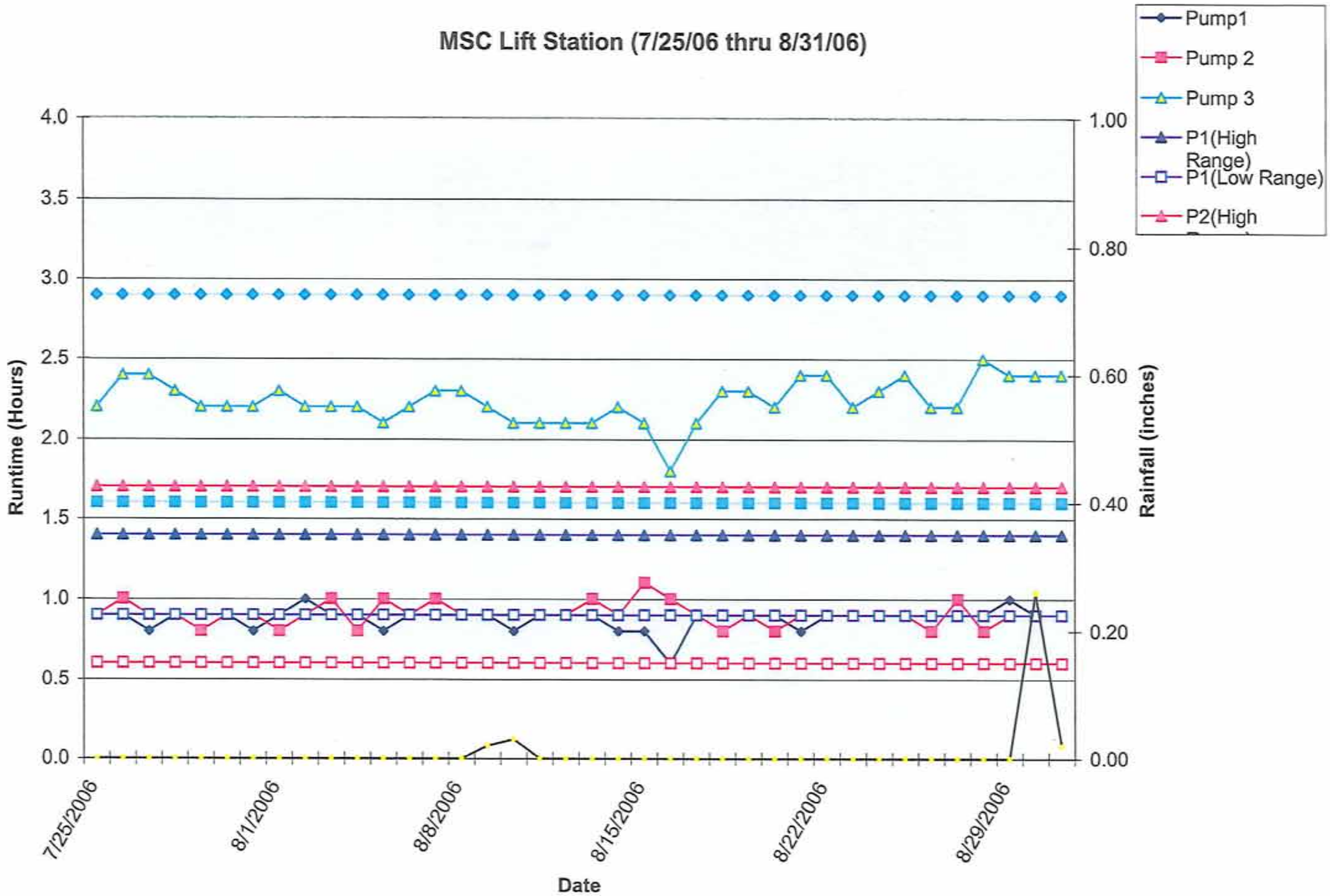
Liberty Bay (7/25/06 thru 8/31/06)



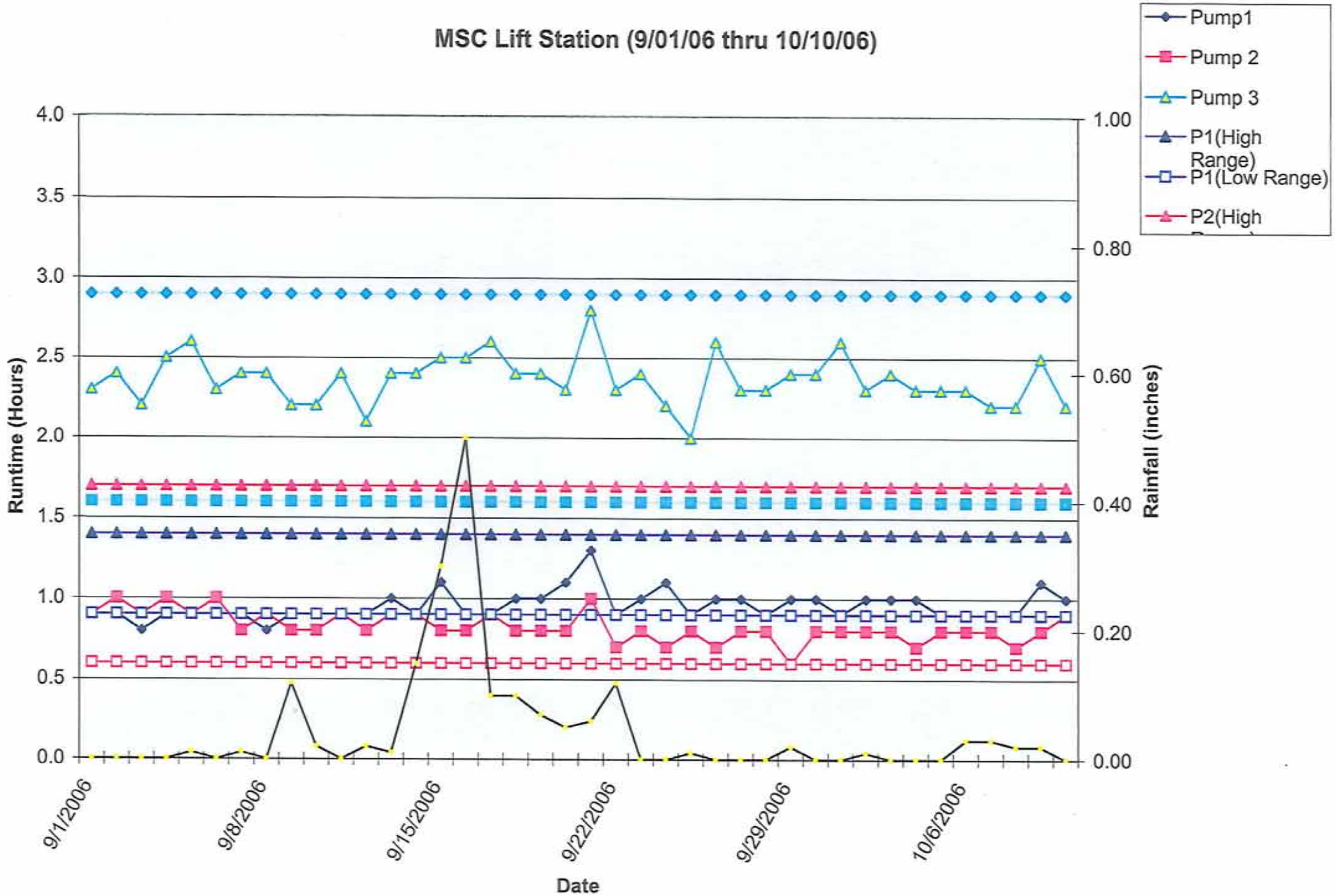

Liberty Bay (9/01/06 thru 10/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
9/1/2006
9/8/2006
9/15/2006
9/22/2006
9/29/2006
10/6/2006
Date


Lindvig Pump Station (7/25/06 thru 8/31/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
3.5
3
2.5
2
1.5
1
0.5
0
Rainfall (Inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7/25/2006
8/1/2006
8/8/2006
8/15/2006
8/22/2006
8/29/2006
Date

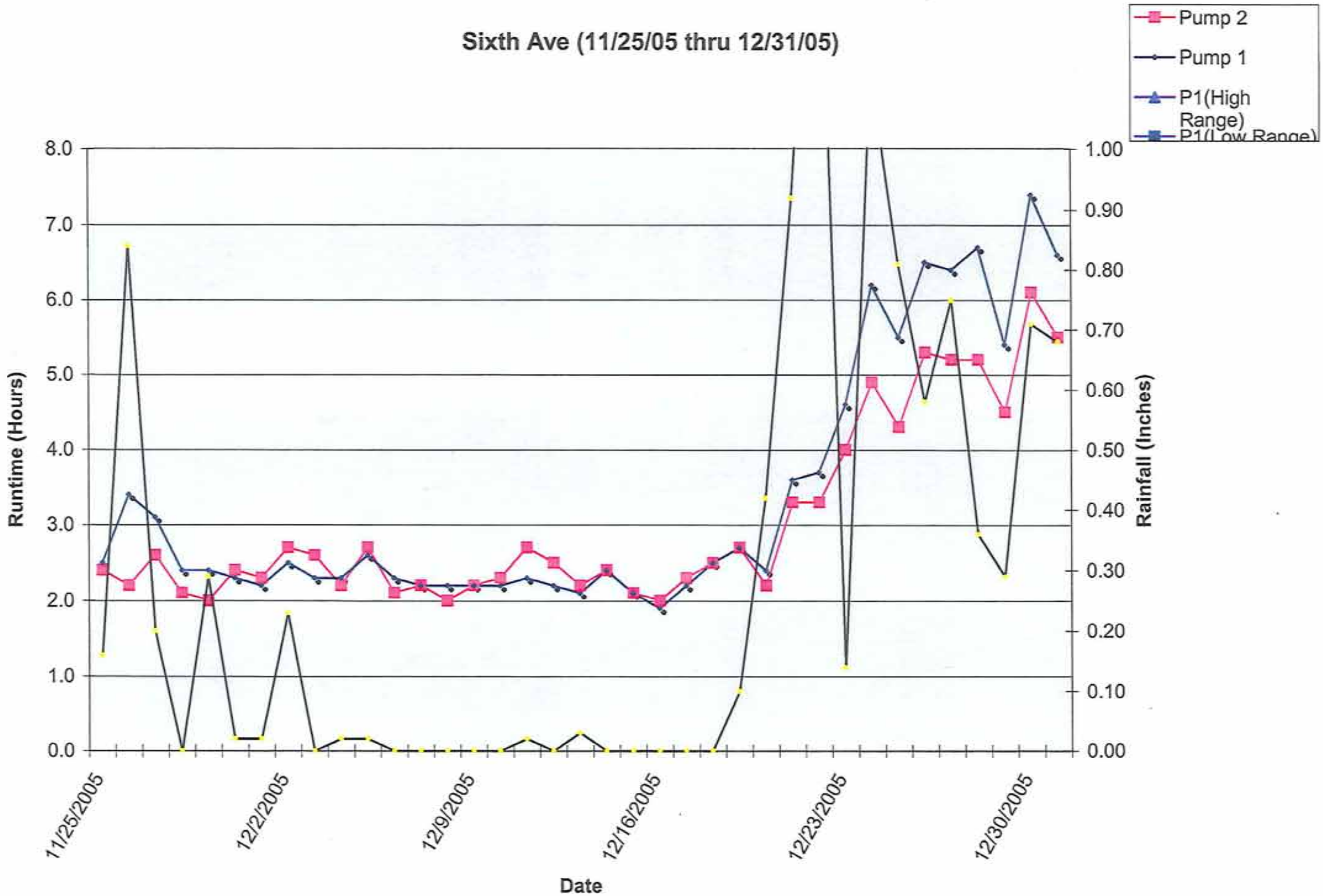

Lindvig Pump Station (9/01/06 thru 10/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
Rainfall (Inches)
Date
3.5
3
2.5
2
1.5
1
0.5
0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
9/1/2006
9/8/2006
9/15/2006
9/22/2006
9/29/2006
10/6/2006

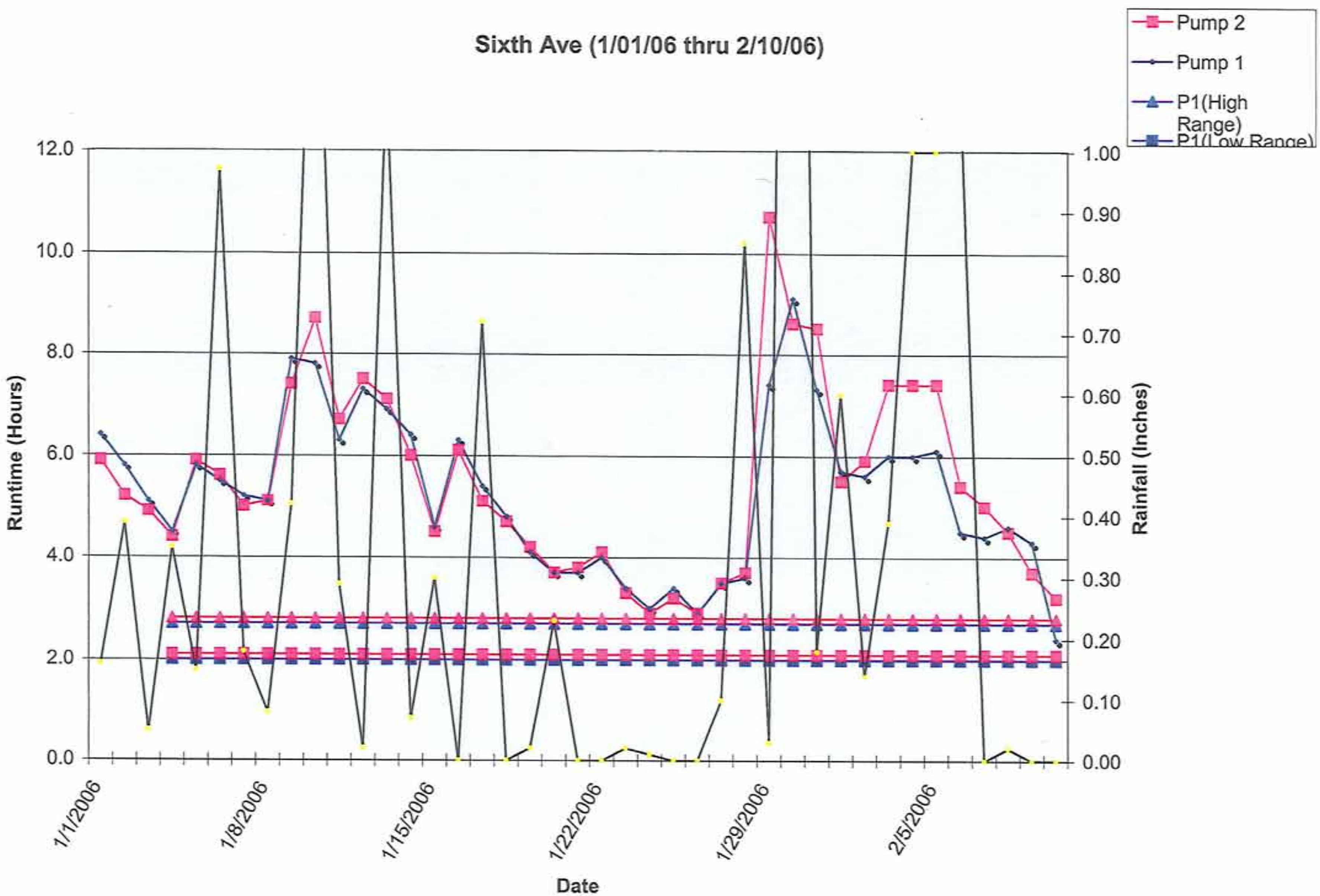


MSC Lift Station (7/25/06 thru 8/31/06)
Runtime (Hours)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.80
0.60
0.40
0.20
0.00
7/25/2006
8/1/2006
8/8/2006
8/15/2006
8/22/2006
8/29/2006
Date
Pump1
Pump 2
Pump 3
P1(High Range)
P1(Low Range)
P2(High

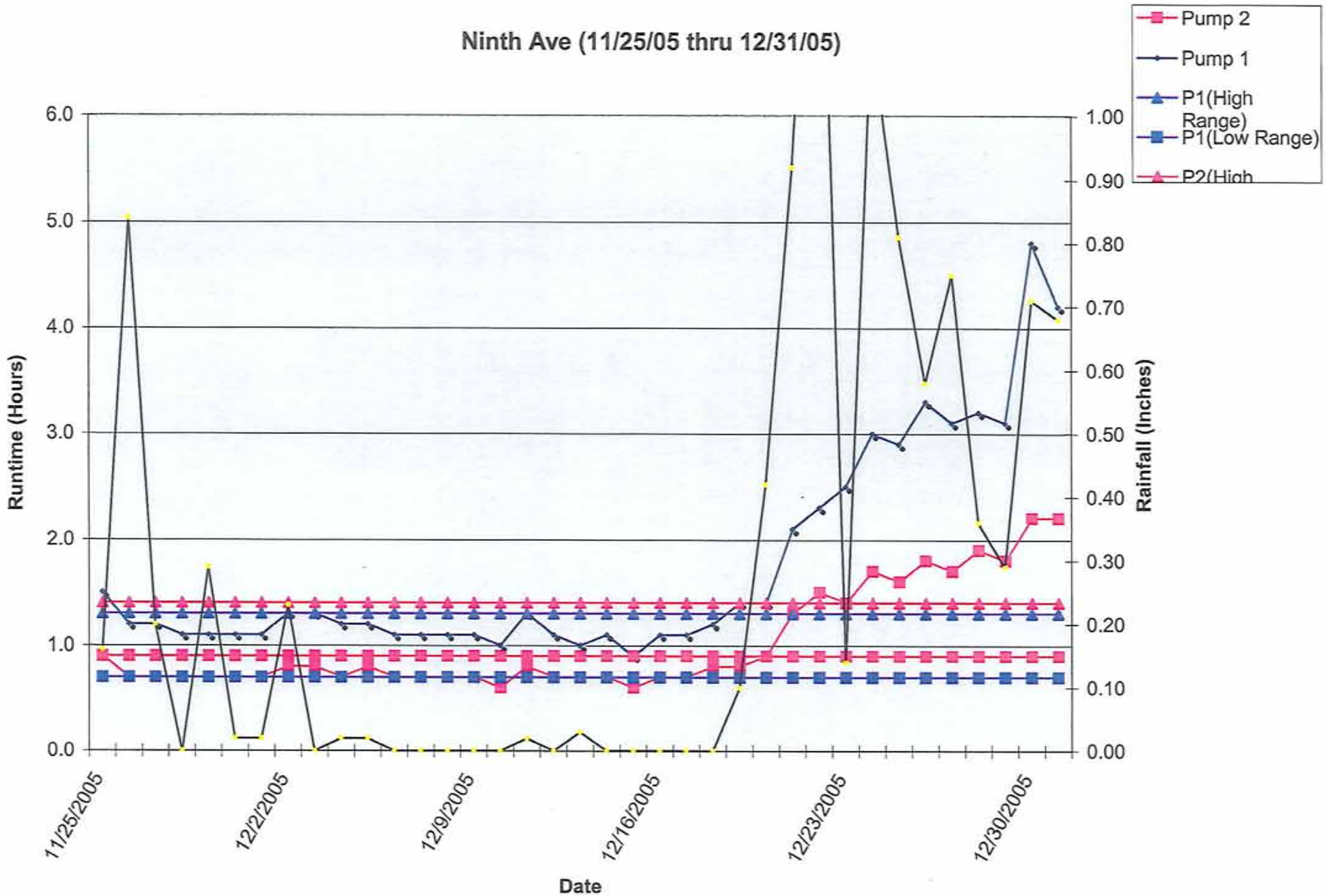

MSC Lift Station (9/01/06 thru 10/10/06)
Runtime (Hours)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.80
0.60
0.40
0.20
0.00
9/1/2006
9/8/2006
9/15/2006
9/22/2006
9/29/2006
10/6/2006
Date
Pump1
Pump 2
Pump 3
P1(High Range)
P1(Low Range)
P2(High

Sixth Ave (11/25/05 thru 12/31/05)

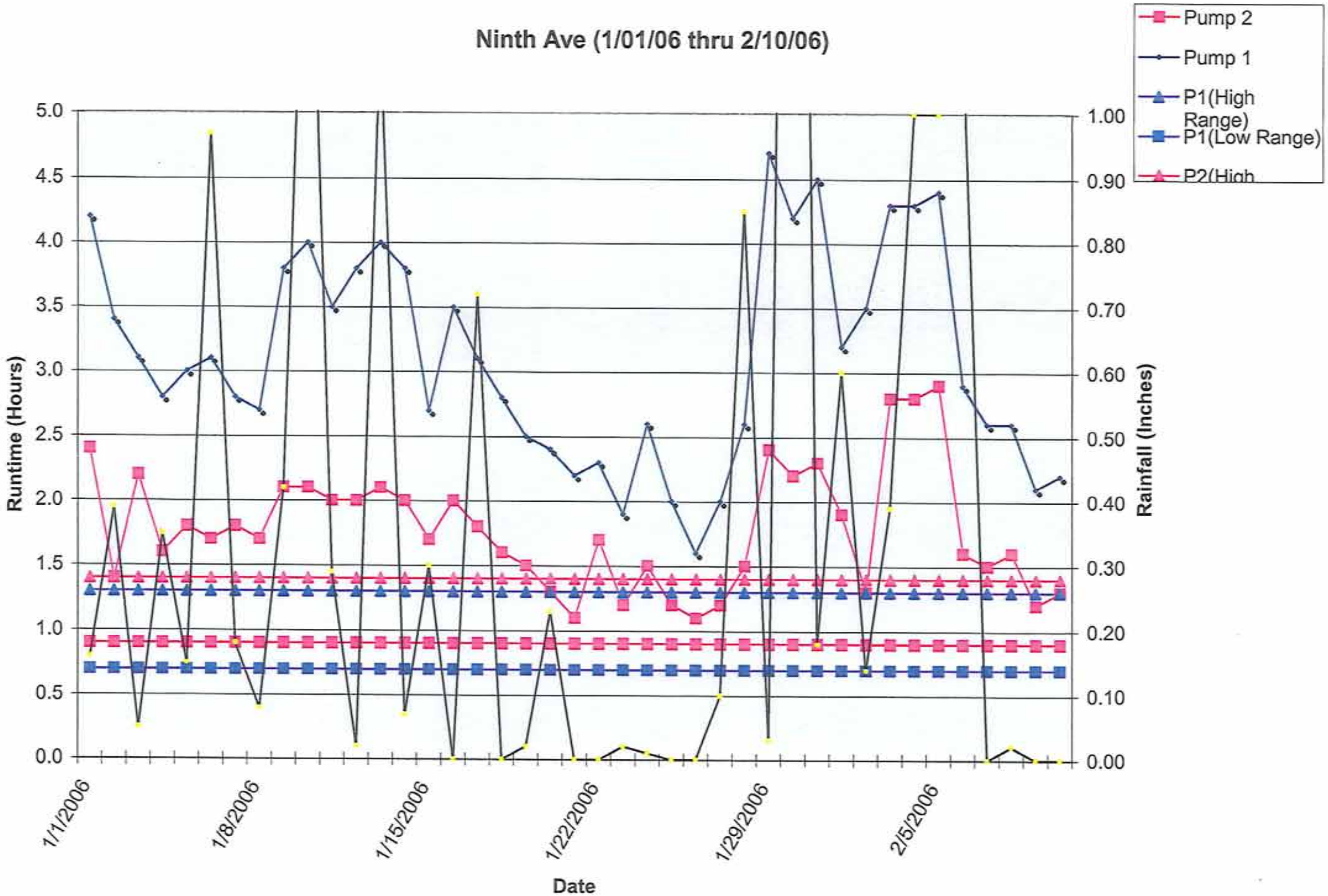


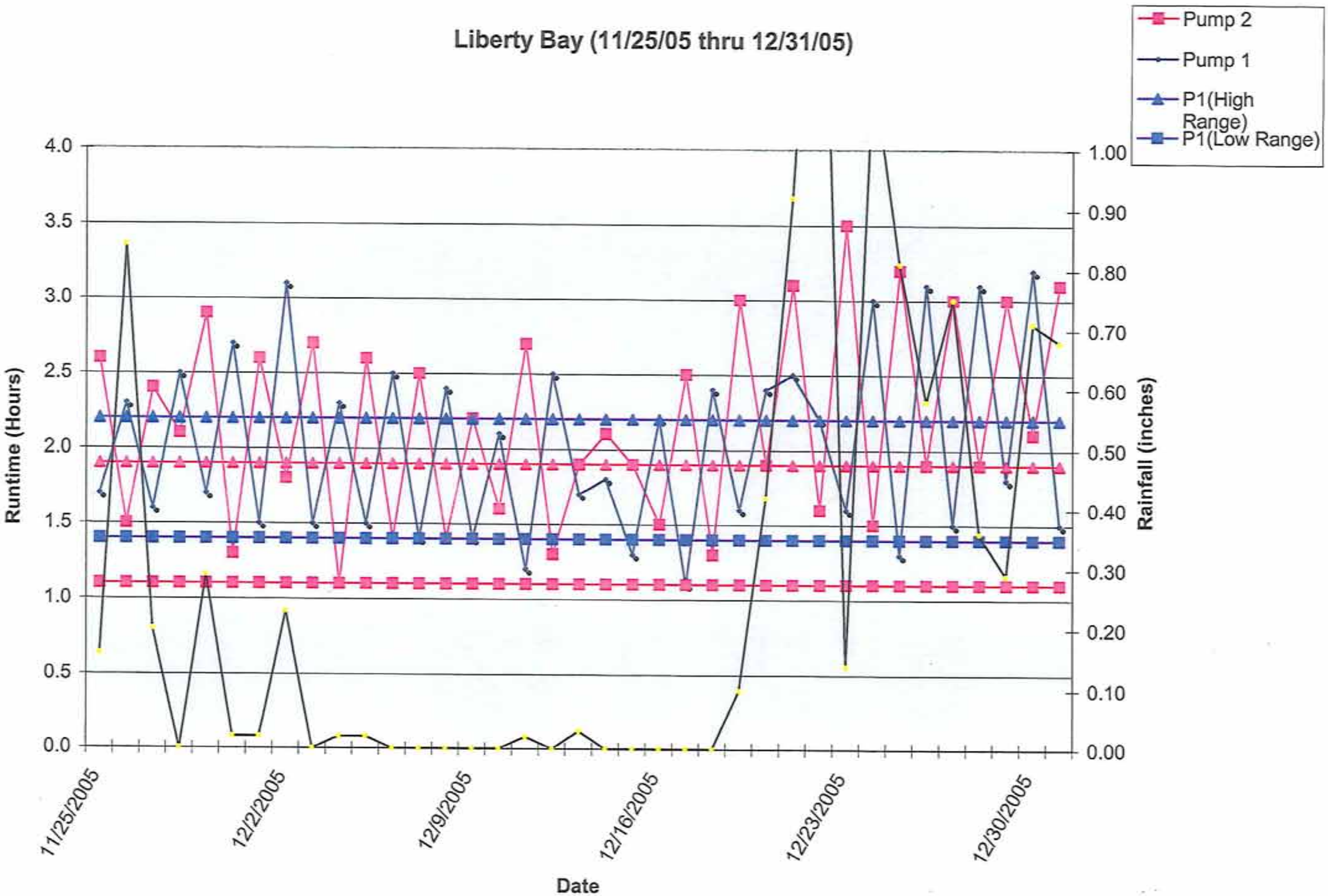


Sixth Ave (1/01/06 thru 2/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Runtime (Hours)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Rainfall (Inches)
1/1/2006
1/8/2006
1/15/2006
1/22/2006
1/29/2006
2/5/2006
Date

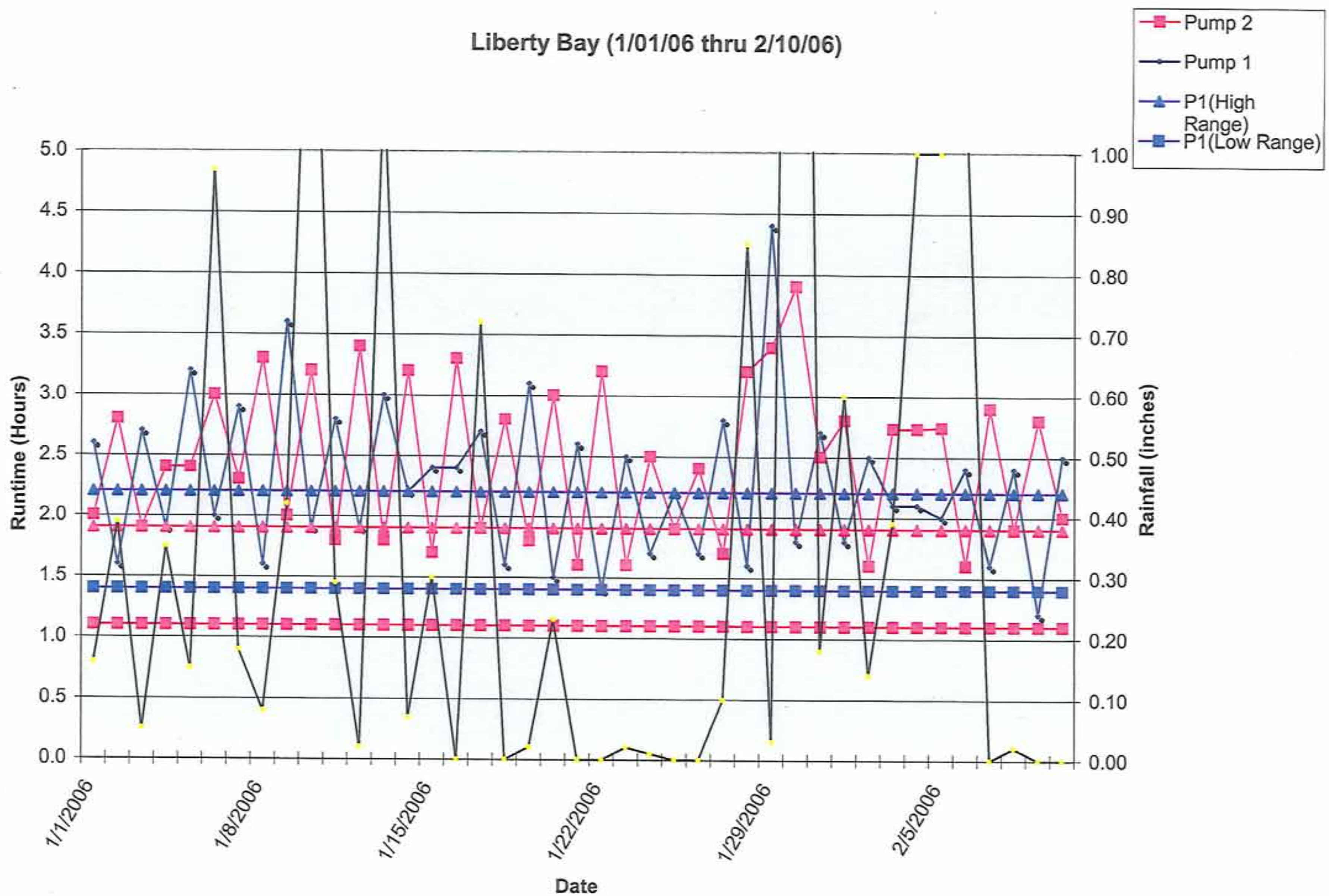


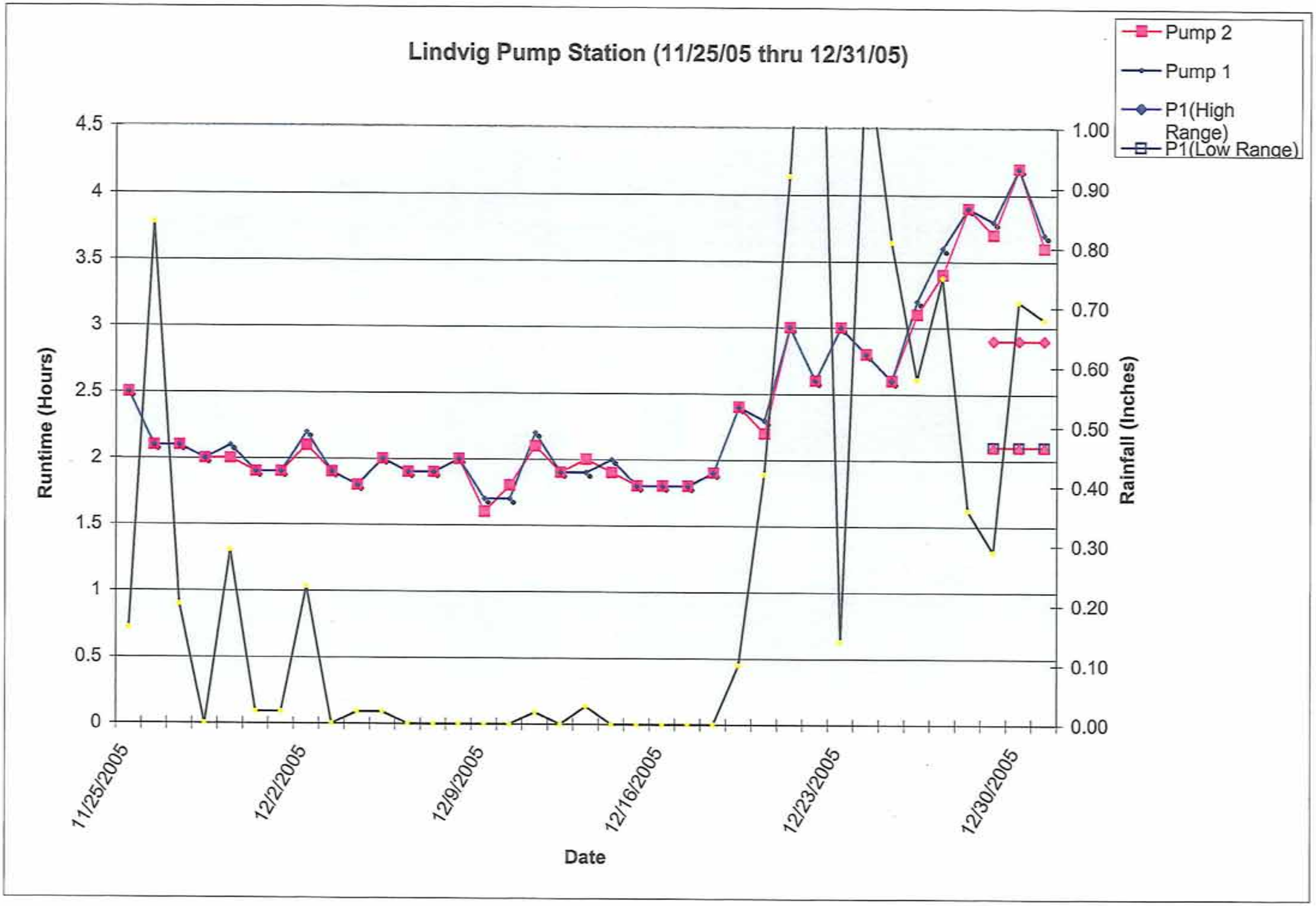
Ninth Ave (11/25/05 thru 12/31/05)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
P2(High
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Runtime (Hours)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Rainfall (Inches)
11/25/2005
12/2/2005
12/9/2005
12/16/2005
12/23/2005
12/30/2005
Date

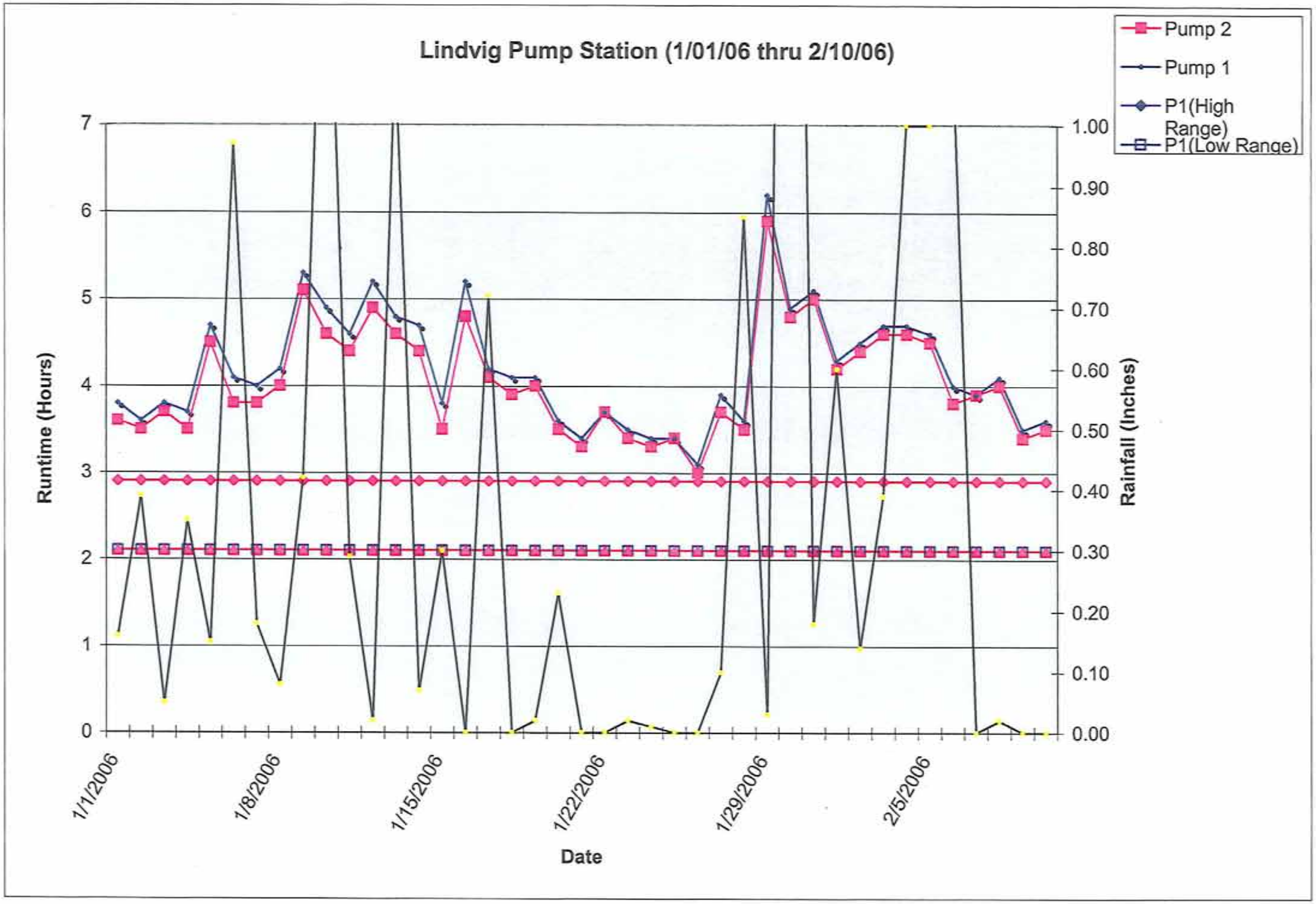

Ninth Ave (1/01/06 thru 2/10/06)
Runtime (Hours)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (Inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1/1/2006
1/8/2006
1/15/2006
1/22/2006
1/29/2006
2/5/2006
Date
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
P2(High

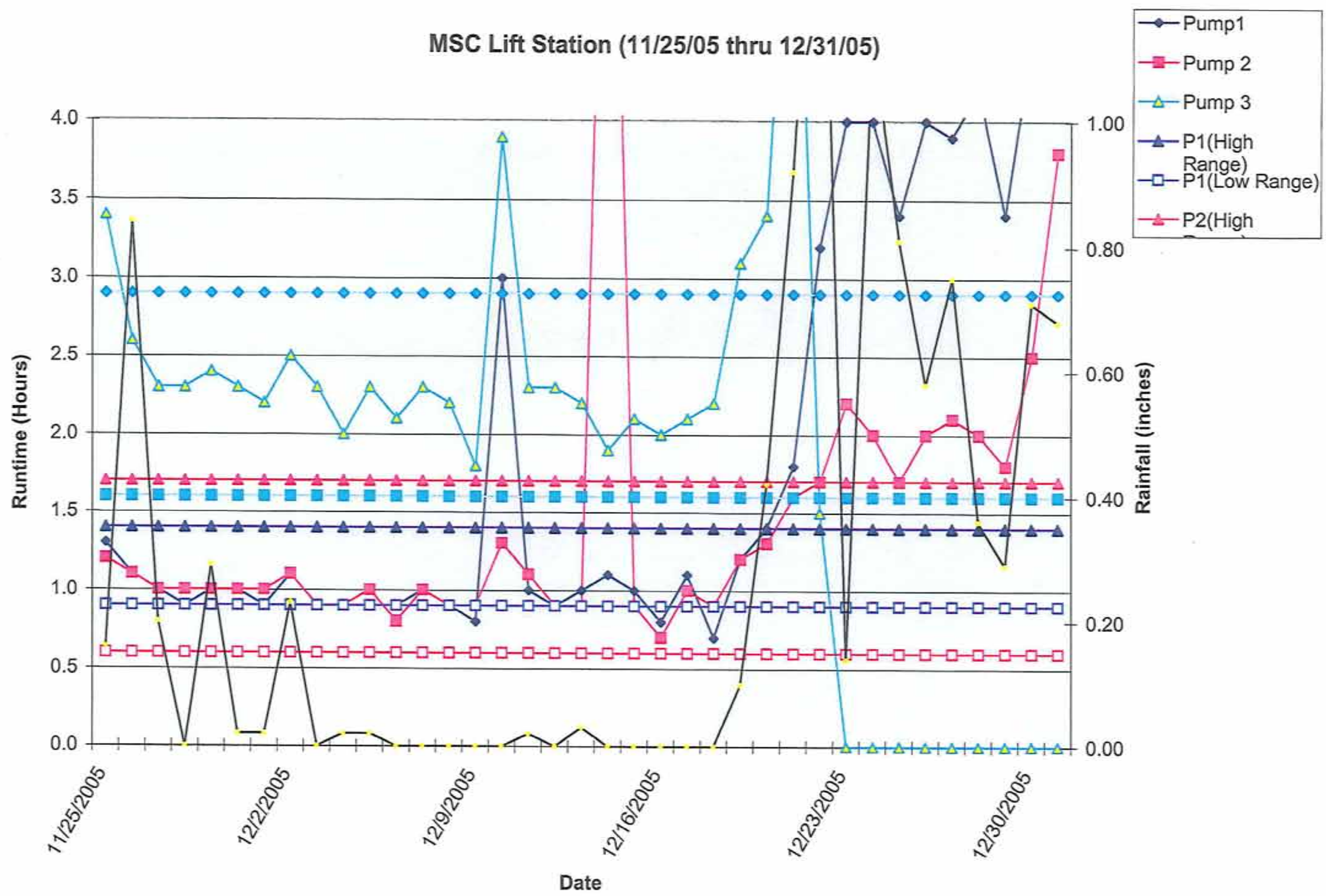


Liberty Bay (11/25/05 thru 12/31/05)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
11/25/2005
12/2/2005
12/9/2005
12/16/2005
12/23/2005
12/30/2005
Date

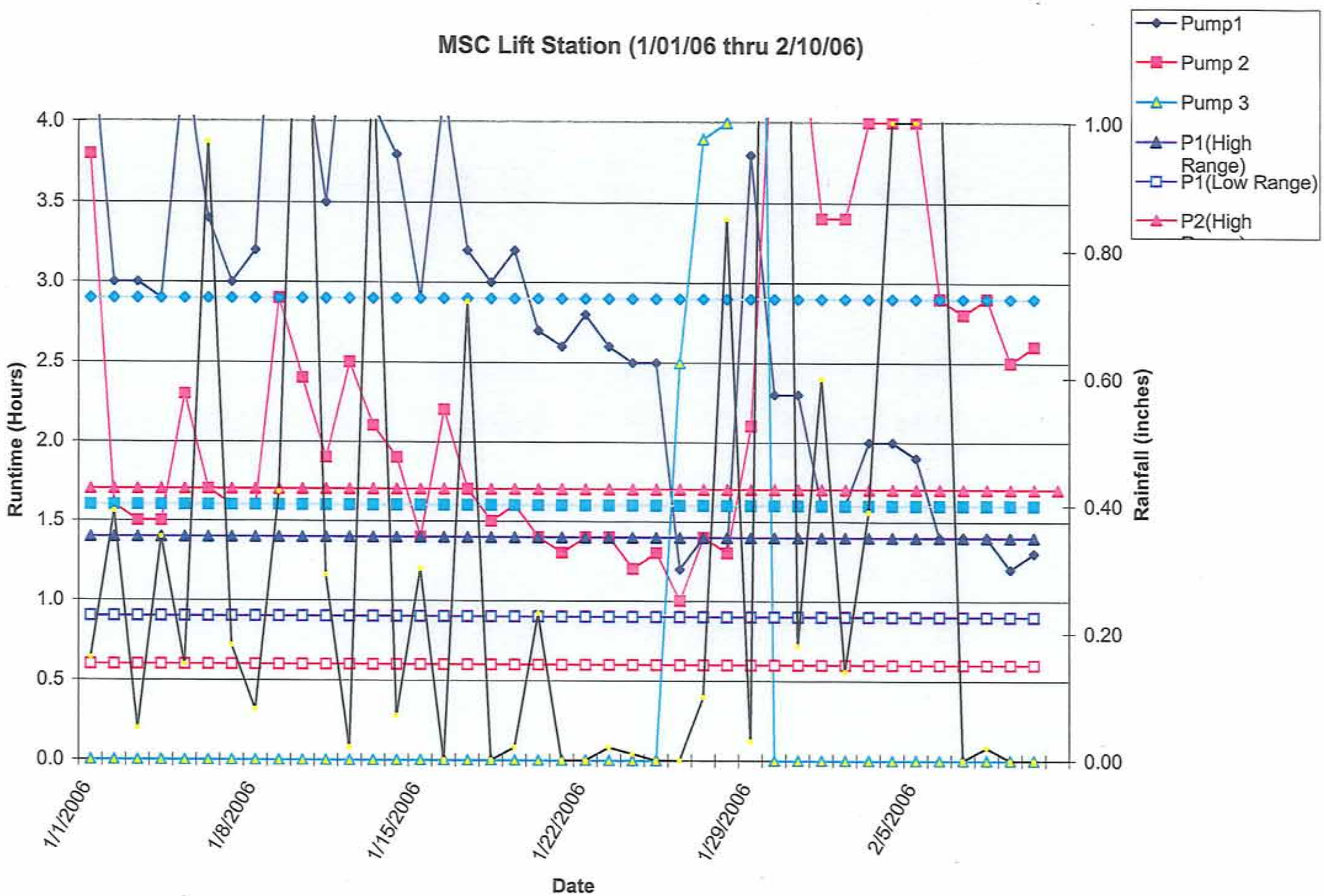

Liberty Bay (1/01/06 thru 2/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1/1/2006
1/8/2006
1/15/2006
1/22/2006
1/29/2006
2/5/2006
Date


Lindvig Pump Station (11/25/05 thru 12/31/05)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Rainfall (Inches)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
11/25/2005
12/2/2005
12/9/2005
12/16/2005
12/23/2005
12/30/2005
Date


Lindvig Pump Station (1/01/06 thru 2/10/06)
Pump 2
Pump 1
P1(High Range)
P1(Low Range)
Runtime (Hours)
Rainfall (Inches)
Date
0
1
2
3
4
5
6
7
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1/1/2006
1/8/2006
1/15/2006
1/22/2006
1/29/2006
2/5/2006


MSC Lift Station (11/25/05 thru 12/31/05)
Pump1
Pump 2
Pump 3
P1(High Range)
P1(Low Range)
P2(High
Runtime (Hours)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (inches)
1.00
0.80
0.60
0.40
0.20
0.00
11/25/2005
12/2/2005
12/9/2005
12/16/2005
12/23/2005
12/30/2005
Date

MSC Lift Station (1/01/06 thru 2/10/06)



ATTACHMENT B

6th Avenue Pump Run Times

TABLE 1

6th Avenue Pump Station
Comparison of Pump Run times for March 2000 and March 2006

Dates in March 2006	P1 hours		P2 hours	
1	2.8		2.5	
2	2.7		2.5	
3	2.4		2.1	
4	2.8		2.4	
5	2.9		2.7	
6	2.6		2.5	
7	2.2		2.4	
8	3.3		3.1	
9	2.6		2.5	
10	2.5		2.5	
11	2.7		2.8	
12	2.8		2.8	
13	2.8		2.6	
14	2.5		2.5	
15	2.6		2.6	
16	2.4		2.6	
17	2.8		2.8	
18	2.2		2.2	
19	3.3		3.4	
20	2.3		2.2	
21	2.5		2.4	
22	2.5		2.5	
23	2.5		2.6	
24	2.6		2.6	
25	2.7		2.8	
26	2.7		2.9	
27	2.6		2.7	
28	2.4		2.7	
29	2.6		2.7	
30	2.4		2.6	
31	2.3		2.4	
Total	81	hours	80.6	hours

Total for both pums 161.6 hours with total rainfall of 3.71 inches

Compare to 156.57 hours of total pump time from Mar 1 thru Mar 30, 2000 with a total rainfall of 3.19 inches

Conclusion:
March 2000 Data: 156.57 hours of pump time for 3.19 inches of rain
March 2006 Data: 156.9 hours of pump time for 3.71 inches of rain

March has 31 days. Assume the table from 2000 is for all of March
March 2000 Data: 156.57 hours of pump time for 3.19 inches of rain
March 2006 Data: 161.6 hours of pump time for 3.88 inches of rain

49.1 hours of pump run time per inch of rain in March 2000 based on 31 day assumption
41.6 hours of pump run time per inch of rain in March 2006 based on 31 day assumption

49.1 hours of pump run time per inch of rain in March 2000 based on 30 day assumption
42.3 hours of pump run time per inch of rain in March 2006 based on 30 day assumption

15.1% reduction based on 31 day assumption
13.8% reduction based on 30 day assumption

TABLE 2

6th Avenue Pump Station
Comparison of Pump Run times for Nov 5 to Dec 5 of 2000 and 2006

Dates in 2006	P1 hours		P2 hours	
5-Nov	2.9		2.1	
6-Nov	3.1		2.2	
7-Nov	2.7		2	
8-Nov	3.1		2.3	
9-Nov	2.5		1.8	
10-Nov	3.9		2.7	
11-Nov	2.9		2.4	
12-Nov	5.6		3.5	
13-Nov	4.2		2.9	
14-Nov	3.3		2.8	
15-Nov	6.5		4.3	
16-Nov	4.1		3.2	
17-Nov	3.4		2.5	
18-Nov	3.6		2.7	
19-Nov	4.8		3.3	
20-Nov	5.4		3.4	
21-Nov	8.6		5.1	
22-Nov	7.8		4.8	
23-Nov	6.3		4.3	
24-Nov	5.1		3.5	
25-Nov	4.3		3.1	
26-Nov	5.7		4.1	
27-Nov	5.2		3.5	
28-Nov	6.2		5.3	
29-Nov	4.8		2.9	
30-Nov	3.9		2.9	
1-Dec	3.2		2.5	
2-Dec	3.3		2.7	
3-Dec	3.9		2.7	
4-Dec	3		2.3	
5-Dec	3.2		2.2	
Total	136.5	hours	96	hours

Total for both pums 232.5 hours with total rainfall of 13.10 inches

Compare to 156.57 hours of total pump time from Mar 1 thru Mar 30, 2000 with a total rainfall of 3.19 inches

Conclusion:

Nov 5 - Dec 5, 2000 104.7 hours of pump run time for 3.83 inches of rain
Nov 5 - Dec 5, 2006 232.5 hours of pump run time for 13.1 inches of rain

27.3 hours of pump run time per inch of rain in November 2000
17.7 hours of pump run time per inch of rain in November 2006

35.1% reduction

APPENDIX D

Collection and Conveyance System Capacity Assessment

Parametrix ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

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TECHNICAL MEMORANDUM

Date:	September 25, 2007
To:	Andrzej Kasiniak, Jeff Bauman, City of Poulsbo
From:	Ken Brown, Phil Struck
Subject:	Poulsbo Sanitary Sewer Preliminary Capacity Analysis
cc:	file
Project Number:	237-2237-026 (01/04)
Project Name:	Comprehensive Sanitary Sewer Plan 2007 Update

SCOPE AND BACKGROUND

The purpose of this Technical Memorandum (TM) is to perform a preliminary evaluation of sanitary sewer pipes that have been identified by the City as having potential capacity concerns due to recent or future growth. Specifically, the City identified pipes in the following areas as needing capacity evaluation:

- Finn Hill and Olhava area, particularly the sewer mains in the Olhava shopping mall that are proposed to convey sewage from the Finn Hill housing areas located west of Olhava.
- Sewer trunk line from Olhava to the Bond Road pump station.
- Viking Avenue, both north and south of SR 305.
- Caldart Avenue from a location approximately 200 feet north of Lincoln Street to Hostmark Avenue, and then down Hostmark to Highway 305.
- 8th and 9th Avenue mains between the Village pump station and the point where the main feeds into the new main recently installed in Highway 305 at Harrison Avenue.
- Noll Road, including an evaluation of providing a new sewer to serve the eastern boundary of the service area and an evaluation of the sewer main between Deer Run and the Johnson Road Chlorination Station.

Figure 1 (attached) shows the general location of these sewer mains.

DATA SOURCES AND PLANNING ASSUMPTIONS

The City's Sewer Comprehensive Plan system map dated June 2005 provided the basic information for analysis of selected portions of the collection and conveyance system. This map does not generally show pipe slopes or invert elevations in manholes, however. Slopes are the primary factor influencing the sewer pipe capacity. Record drawings (construction and surveys) were used to determine slopes when available.

Pipe segments, where no as-built survey information was available, are identified in the calculations provided in Attachment A.

Projected sewer flows were developed based on the Washington State Department of Ecology Criteria for Sewage Works Design, December 1998 (Orange Book) criteria, the Poulsbo zoning code/map, and water use data (gallons per Equivalent Residential Unit [ERU]) provided by the City.

ASSUMPTIONS

The assumptions used to calculate estimated future sewage flows is the most significant variable factor in determining future sewer main adequacy. For this analysis, it was assumed that currently vacant land will be fully built out per the current land use zoning criteria. For established residential areas, the existing density is based on an approximate count of existing lots. For vacant land, 5 dwelling units per acre for Residential Low and 14 dwelling units for Residential High was assumed. This is considered conservative, because all property will probably not be built to the maximum density. However, the City Planned Residential Development code does allow bonus densities, so the lower base density was considered an appropriate criterion for this preliminary analysis.

Per Capita Flow

The Orange Book criteria for developing the sewage flow in pipes (Q_{gpm}) uses 2.5 persons per dwelling unit and 100 gallons per person per day (gpd). A peaking factor is multiplied to represent the maximum time for water usage, which generally occurs in the morning and evening hours. For small populations of less than 400 people, a peaking factor of 4.0 is used. For populations of 3,000 persons discharging to the pipe system, a peaking factor of 3.5 is used. For populations of 10,000 persons, a peaking factor of 3 is recommended. The following formula, which incorporates reasonable stormwater infiltration rates, can therefore be used to represent the flow in a pipe:

$$Q_{gpm} = \frac{\text{Dwelling Units X 2.5 persons X 100 gallons per day X 4.0 Peaking Factor}}{\text{1440 minutes per day}}$$

An alternative method of analysis is to base sewage flows on the actual metered use of water. City records show that water use in the average residential house in Poulsbo is 189 gallons per day. A portion of this water is used for irrigation and other purposes and does not enter the sewer. However, infiltration and inflow of stormwater does enter the system, and is assumed to offset water used for other purposes. The analysis presented in this TM therefore uses the actual 189 gallons per day water use measured in the City, instead of 250 gallons per day assumed in the Orange Book. This results in estimated peak flows of 76% of the Orange Book criteria. The formula is as follows:

$$Q_{gpm} = \frac{\text{Dwelling Units X 189 gallons per day X 4.0 Peaking Factor}}{\text{1440 minutes per day}}$$

Peaking Factor

A peaking factor is applied to the average daily sewage flow to account for early morning or evening periods when many households are simultaneously using water. For smaller population groups, the Orange Book recommends multiplying the average daily sewage flow by 4.0 (ie, a peaking factor of 4). For trunk lines well downstream from the primary home sources, a peaking factor of 3.5 can be used. A peaking factor of 3.5 would result in estimated peak flows of about 88% of those computed with a peaking factor of 4.0.

The Olhava Master Plan used a peaking factor of 2.5, which is considered low. The negotiated contract sewage flow rates, based on the Schedule B Parcel Development Plan, developed sewage flow rates more consistent with a higher peaking factor. This preliminary analysis treats Olhava similar to other Poulsbo areas by applying the Orange Book 4.0 peaking factor to commercial properties and the representative residential historical values to the homes.

Pipe Coefficient and Fullness

The "n" value is a representation of the pipe wall smoothness. The Orange Book recommends using 0.013. A more realistic value for new PVC pipe is 0.012. Over the years, as pipes deteriorate and become rougher, the 0.013 factor is more appropriate. To ensure a conservative analysis, the analysis presented in this TM uses the 0.013 value. If the 0.012 value was used, the capacity of individual pipes would increase by 0.013 / 0.012 = 1.083, or 8.3 percent.

This analysis computes the full flow Q based on the pipe running completely full, when actually, the maximum Q occurs when the pipe is 93.82% full. For an 8-inch pipe, this occurs when the pipe is running at a depth of 7.5 inches. At that depth the maximum Q is about 7% greater than what is shown on the tables. This factor has been ignored, resulting in an additional small factor of safety.

The City has indicated that given the above factors, a 100 percent maximum full flow is the acceptable upper limit for pipe capacity. It should be noted that this preliminary analysis is based on general computations and no backwater analysis was performed. A future more detailed analysis of specific problem sewer runs should therefore be accomplished to determine more precisely the maximum pipe capacity.

Slope

The primary factor for determining capacity of a pipe is the slope. The pipe slope is determined by surveying the manhole rims and then measuring down to the invert (or bottom) of the pipe. A small measurement error, especially in measuring down, could affect the slope. For example, a 100-foot pipe run that drops 6 inches has a slope of 0.5%. A measurement error of 1-inch would increase the drop to 7 inches, resulting in a slope of 0.58%. This would increase the pipe capacity by about 8%. Therefore, for relatively flat pipes that appear to be inadequate, it is recommended that the slope be reconfirmed by survey prior to planning for replacement.

ANALYTICAL METHODS

A spreadsheet was developed for each basin in order to individually analyze each pipe run. Pipe runs are keyed to a system map. The spreadsheet calculations (Attachment A) compute the theoretical full flow capacity based on the pipe diameter and pipe slope, and then compares the value to the projected flow. A percent of full flow capacity is then computed. An analysis of individual runs was made to determine how significant a near-capacity pipe run may be, based on the City's criteria of 100 percent maximum capacity. Specific pipe runs that should be considered as problem areas are highlighted with pipes that exceed 80 percent of capacity highlighted in orange, and pipes that exceed 100 percent of capacity are highlighted in red. Figures are provided in Attachment B showing segments that exceed 100 percent of capacity.

FINDINGS

A spreadsheet for each basin is provided in Attachment A. Each spreadsheet presents a summary of the system capacity by pipe segment. The following sections summarize the findings presented in the individual spreadsheets.

Finn Hill / Olhava Basin

The Olhava Master Plan estimated future flows of 294 gpm, based on a peaking factor of 2.5, which is considered low. The Finn Hill pump station design (N. L. Olsen & Assoc. 2007) computed future flows of 372 gpm for the service area based on a peaking factor of 4.0. Although Olson used a different method of analysis, his results are consistent with the analysis presented herein (365 gpm).

The Finn Hill pump station will serve about half of the Finn Hill Basin. The other half of the basin was computed to have a future flow of 375 gpm (which would enter Olhava next to Home Depot). These three flows add to 1041 gpm, which is the flow leaving Olhava and going down SR 305 towards the Bond Road pump station (increasing to 1161 gpm after the Viking Avenue flow enters the system).

Projected future peak flow would occur when the Olhava development is built-out, and residential portions of the basin outside of Olhava are also fully developed. The Olhava sewer system was originally designed to serve only the Olhava development. Pipes are all 8-inches in diameter, and at very flat slopes – less than 0.4 percent in several places.

The analysis indicates that up to 1,700 feet of pipe in Olhava may have insufficient capacity to convey flows at full build-out (see Attachment A and B for details). Using the Olhava system to convey flow from residential development outside the Olhava development is likely not feasible without increasing pipe diameter.

Key criteria for evaluating significance of the capacity issue in the Olhava Basin include the schedule for build-out, and build-out assumptions. Full build-out may not occur for 30 years or more, and may never build out to the full density of 5 dwelling units per acre. A build-out density of 4 dwelling units per acre would result in an estimated peak flow of 80 percent of that shown in the spreadsheet. This change in assumptions would likely eliminate capacity problems in many segments. It is therefore recommended that build-out assumptions be verified prior to decisions to increase capacity.

Pipes can be economically (about $50 per lineal foot, plus overhead, mobilization, and tax) increased in diameter by either pipe bursting, if located in a street, or by open trench replacement.

SR 305 and Bond Road Pipe Run

This 8-inch main carries all the flow from Olhava and the Finn Hill basin. It currently carries a very small 60 gpm; full build-out is projected to be 1041 gpm, increasing to 1161 gpm with the Viking Way inflow.

These flows will result in many of the pipe runs to be at about 85 percent of capacity. About 1,000 lineal feet of pipe between Viking Way and the Bond Road pump station will exceed 100 percent of capacity. Of particular concern is a flat segment (0.8 percent slope) on Bond Road just upstream of the branch into the Bond Road pump station. We estimate that this main is currently running at 31 percent of capacity and may exceed capacity in several years.

A possible alternative to increasing the pipe diameters downstream of Viking Avenue is to place a diversion structure in the SR 305/Viking Avenue intersection and route excess flow down the existing Viking Avenue sewer main to the Lindvig pump station.

Viking Basin

Both the north and south ends of the Viking Basin are expected to experience significant development (low and high density residential). No pipe segments were identified as exceeding capacity. The southern end of the Viking sewage distribution system is more significantly affected because of the flat terrain. Either a new pump station, or an expansion of the Liberty Bay Pump Station, will be required.

The northern distribution system slopes towards Lindvig, and therefore no capacity problems are anticipated.

Additional survey information is needed for several of the sewer mains prior to finalizing this analysis. Also, a more rigorous analysis of future growth at the south end of the basin should also be accomplished, including consideration or potential annexation areas.

Caldart Basin

The sewer main flowing south on Caldart Avenue likely has adequate capacity for the full build-out of the Caldart basin. However, there are two potential capacity concerns that should be investigated:

- Several of the mains located north of Lincoln are shown as 10-inch diameter on some references. We have assumed them to be 12-inch diameter, but this should be confirmed.
- Two sections of pipe in Caldart in front of the high school have computed slopes of 0.36% and 0.40%, marginally adequate to support future flows. Elevations and measure downs are based on Parametrix surveys in support of the Caldart Street construction. The rim elevations are most likely accurate. The measure downs should be reconfirmed and the slopes adjusted if necessary.

No slope information was available for the pipe run on Hostmark; however, since the street is steep in this area, there is likely low potential for capacity problems, nor any need to obtain slope information.

No as-built information was available for the pipe run across SR 305 to the point where it connects with the flow from the Village Pump Station. This segment could potentially be a concern if the slopes are flat. These mains, and especially the ones downstream of the combining of the Caldart and Village flows, should be surveyed to obtain accurate slopes.

8th and 9th Street Basin

No as-built or survey data showing pipe slopes was available. No capacity problems are expected in the pipes flowing north to the Village Pump Station because sewer flows are mostly from commercial areas, which typically generate low flows.

A potential capacity problem exists where the 4-inch force main from the Village pump station combines with the larger flow from Caldart and Hostmark. Although it flows into a 10-inch main, the flows could be near capacity if these pipes have a flat slope. It is recommended that these pipes (identified as pipe runs 50 through 53 and beyond to the new SR 305 interceptor) be surveyed to determine slope and to confirm capacity.

Noll Road Basin

To support development of property located east of Noll Road and beginning just south of Lincoln, a new 9,600 linear foot sewer trunk main must be installed. This new main will connect to the gravity main leaving the Deer Run housing area. This existing main flows to the Johnson Road Chlorination Station.

The new Noll Road sewer main is routed on terrain sloping gently to the south. The average slope of the main will be about 1.2%, sufficient to support an 8-inch main, and likely increasing to a 10-inch main near Deer Park.

This new main will connect to an existing 10-inch ductile iron sewer main just south of Deer Park. This 10-inch main flows at a relatively constant slope of 0.47 to 0.57 percent slope until dropping down a fairly steep slope leading to Johnson Road. This flat 10-inch main is currently operating at about 25% of full flow capacity. However, with the total build-out of the Noll Road basin, it will increase to 144% of capacity. At some time in the future, either a parallel main must be installed, or the existing 10-inch main replaced with a 15-inch diameter main.

CONCLUSIONS

It is likely that pipe segments in several areas of the City are potentially deficient within the next 5 to 10 years. The highest priority areas are within the Olhava basin, followed by the Noll Road basin. A single pipe segment in the Caldart basin marginally exceeds full build-out flows. Capacity in the Viking basin is adequate with the exception of the Liberty Bay pump station, which needs to be expanded.

Conveyance pipes in the Olhava basin that have long-term capacity concerns are currently flowing at about 20 percent of total capacity. Capacity issues in the Olhava basin will generally not occur until approximately 300 gpm (400+ ERUs) are added to the system. The proposed plat of Cook Addition and other residential development in the Finn Hill basin that is outside Olhava are estimated to add approximately 300 gpm so it may be appropriate for the future residential development outside of Olhava to fund conveyance capacity increases in this basin.

RECOMMENDATIONS

Confirm Assumptions

Capacity issues in the Olhava basin are largely related to residential development located outside the boundaries of the Olhava development. Residential development plans within the Olhava and Finn Hill basins should therefore be confirmed prior to planning for capacity expansion or replacement in this basin.

Slope is a primary factor for determining capacity of a pipe. A small measurement error, especially in measuring down from the rim, could affect the slope resulting in significant change in capacity. Therefore, for relatively flat pipes that appear to be inadequate, it is recommended that the slope be reconfirmed by survey prior to planning for capacity expansion or replacement.

Build-out assumptions should be verified. For example, a reduction in build-out density from 5 to 4 dwelling units per acre would decrease estimated peak flows by 20 percent. A change in build-out assumption would have a significant effect on the capacity analysis. It is therefore recommended that build-out assumptions be verified prior to decisions to increase capacity.

Additional As-Built Information

No as-built information was available for a number of pipe runs that could potentially be a concern if the slopes are flat. The following areas should be surveyed to obtain accurate slopes and then be evaluated to verify capacity:

- In the Caldart/Hostmark basin, the pipe run across SR 305 to the point where it connects with the flow from the Village Pump Station.
- In the 8th and 9th Street basins, pipes identified as pipe runs 50 through 53 and beyond to the new SR 305 interceptor.

Update Sewer System Hydraulic Model

The City's last hydraulic model of the sewer system was completed approximately 10 years ago. Because of the growth that has occurred during the last 10 years, and the need for a more precise capacity assessment, it is recommended that a new hydraulic model be developed to more accurately identify existing and potential future capacity concerns.

Update Capital Improvement Plan

Based on this assessment, the following projects in the Olhava basin are recommended to be added to the 6-year Capital Improvement Plan (CIP) that is included in the Sanitary Sewer Comprehensive Plan:

- Olhava basin near Wal-Mart, Pipe Run 18. Increase 246-ft of 8-inch diameter pipe to 10 or 12-inches diameter. The preliminary cost estimate for this project is $40,000.
- Olhava basin on Bond Road, Pipe Run 94. Increase 70-ft of 8-inch diameter pipe to 10 or 12-inches diameter. The preliminary cost estimate for this project is $25,000.

Projects to increase capacity of the other segments in the Olhava basin that exceed capacity for 100 percent of full build-out should be added to the CIP after development assumptions and as-built conditions are confirmed. These pipe segments appear to have adequate capacity in the near term to allow completion of a more detailed hydraulic model and back water analysis that would verify capacity conditions.

The following additional projects should be added to the CIP:

- Viking basin. Liberty Bay pump station. Increase capacity from 100 gpm to 400 gpm. The preliminary cost estimate for this project assumes a complete rebuild of the pump station at a cost of $250,000.
- Hydraulic model update. The preliminary cost estimate for this project is $50.000.

If you have any questions or need additional information, please contact us anytime at 360-377-0014. Thank you.

Attachments:

A Capacity Analysis
B Figures

ATTACHMENT A

Capacity Analysis

FINN HILL / OLHAVA BASINS

Three sub basins feed through the Olhava shopping center sewer system. Flow from the Finn Hill Lift Station installed to serve the Cook Residential Plat and other properties along Finn Hill was computed by Norm Olsen (Mar 2007) to be 372 gpm based on serving 105 acres of medium density housing. Based on Poulsbo guidance of 189 gpd per ERU, we have used a flow of 276 gpm for this area. The second basin is located north and east of the Cook Plat, is 107 acres of medium density housing, and is planned to be routed through Olhava. This sewer system would connect behind the Home Depot store. The estimated flow is 281 gpm (based on 189 gpd/ERU).

Current estimated peak flow is what is now flowing through the system, which is very small since no housing in any of the three basins flows through the system. **Projected estimated peak flow** is what will ultimately be flowing through the system when all housing in the Finn Hill area is complete, and all commercial development and housing in Olhava is complete.

Calculated full flow capacity is based on the Manning Equation Q=1.486/n(AR^2/3)S^1/2, where n = 0.013. The n value is conservative and is based on the Department of Ecology Orange Book. For the pipe in this system, an n value of 0.012 may be more realistic. Using the smaller value would provide a theoretical increase in Q capacity of about 8%. Our formula uses the more conservative n = 0.013 value.

Brief Summary and Conclusion of Findings: The Olhava sanitary sewer distribution system was designed to serve only the Olhava development. Pipes are all 8-inch diameter and many are placed on very flat slopes. Using the Olhava system to carry sanitary sewer flows from the Finn Hill developments to the east is not feasible without upsizing the pipes. Upsizing to 10- and 12-inch pipes by pipe bursting may be feasible. Also, the 8-inch main down SR 305 to the new Bond Road PS will eventually exceed capacity as new residential developments come on line. A flat section of pipe on Bond Road just upstream of the pump station is especially undersized and will reach capacity soon.

Shading indicates future sewer flows >/- 80% of pipe capacity.
Shading indicates future sewer flows >/- 100% of pipe capacity.

Basin: Finn Hill/Olhava	Pipe Run	10	COMMENTS
Dia: 8 in.	A =	0.349	Inflow from Finn Hill P.S.
Slope: 0.53 %	R =	0.167	
Current estimated peak flow		0 gpm	0 % of full capacity
Projected estimated peak flow		276 gpm	
Calculated full flow capacity		395 gpm	70 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run	11	COMMENTS
Dia: 8 in.		A = 0.349	Walmart inflow added
Slope: 0.48 %		R = 0.167	
Current estimated peak flow		6 gpm	2 % of full capacity
Projected estimated peak flow		276 gpm	
Calculated full flow capacity		376 gpm	73 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 12	COMMENTS
Dia: 8 in.	A = 0.349	Future business inflow added
Slope: 0.37 %	R = 0.167	
Current estimated peak flow	6 gpm	2 % of full capacity
Projected estimated peak flow	282 gpm	
Calculated full flow capacity	330 gpm	86 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 13	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.72 %	R = 0.167	
Current estimated peak flow	6 gpm	1 % of full capacity
Projected estimated peak flow	292 gpm	
Calculated full flow capacity	460 gpm	63 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 14	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.49 %	R = 0.167	
Current estimated peak flow	6 gpm	2 % of full capacity
Projected estimated peak flow	292 gpm	
Calculated full flow capacity	379 gpm	77 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 15	COMMENTS
Dia: 8 in.	A = 0.349	Business inflow (Starbucks?)
Slope: 0.48 %	R = 0.167	
Current estimated peak flow	40 gpm	11 % of full capacity
Projected estimated peak flow	300 gpm	
Calculated full flow capacity	376 gpm	80 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 16	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.44 %	R = 0.167	
Current estimated peak flow	40 gpm	11 % of full capacity
Projected estimated peak flow	300 gpm	
Calculated full flow capacity	360 gpm	83 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 17	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.44 %	R = 0.167	
Current estimated peak flow	40 gpm	11 % of full capacity
Projected estimated peak flow	310 gpm	
Calculated full flow capacity	360 gpm	86 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 18	COMMENTS
Dia: 8 in.	A = 0.349	Home Depot, Olympic College, Housing
Slope: 0.45 %	R = 0.167	
Current estimated peak flow	50 gpm	14 % of full capacity
Projected estimated peak flow	760 gpm	
Calculated full flow capacity	364 gpm	209 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 19	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.76 %	R = 0.167	
Current estimated peak flow	50 gpm	6 % of full capacity
Projected estimated peak flow	760 gpm	
Calculated full flow capacity	901 gpm	84 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 20	COMMENTS
Dia: 8 in.	A = 0.349	Olympic College inflow from Pump Station
Slope: 0.67 %	R = 0.167	
Current estimated peak flow	61 gpm	14 % of full capacity
Projected estimated peak flow	61 gpm	
Calculated full flow capacity	444 gpm	14 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 21	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.36 %	R = 0.167	
Current estimated peak flow	61 gpm	7 % of full capacity
Projected estimated peak flow	65 gpm	
Calculated full flow capacity	833 gpm	8 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 22	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.94 %	R = 0.167	
Current estimated peak flow	61 gpm	7 % of full capacity
Projected estimated peak flow	65 gpm	
Calculated full flow capacity	929 gpm	7 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 23	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: xx %	R = 0.167	
Current estimated peak flow	0 gpm	#VALUE! % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	#VALUE! gpm	Need Olhava Sheet C3.17 from City

Basin: Finn Hill/Olhava	Pipe Run 24	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: xxd %	R = 0.167	
Current estimated peak flow	0 gpm	#VALUE! % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	#VALUE! gpm	Need Olhava Sheet C3.17 from City

Basin: Finn Hill/Olhava	Pipe Run 25	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 3.39 %	R = 0.167	
Current estimated peak flow	61 gpm	6 % of full capacity
Projected estimated peak flow	81 gpm	
Calculated full flow capacity	998 gpm	8 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 26	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.52 %	R = 0.167	
Current estimated peak flow	61 gpm	5 % of full capacity
Projected estimated peak flow	81 gpm	
Calculated full flow capacity	1274 gpm	6 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 27	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.02 %	R = 0.167	
Current estimated peak flow	61 gpm	5 % of full capacity
Projected estimated peak flow	81 gpm	
Calculated full flow capacity	1330 gpm	6 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 28	COMMENTS
Dia: 8 in.	A = 0.349	Future Finn Hill housing inflow at Home Depot
Slope: 2.81 %	R = 0.167	
Current estimated peak flow	61 gpm	7 % of full capacity
Projected estimated peak flow	362 gpm	
Calculated full flow capacity	909 gpm	40 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 29	COMMENTS
Dia: 8 in.	A = 0.349	Home Depot added
Slope: 0.53 %	R = 0.167	
Current estimated peak flow	75 gpm	19 % of full capacity
Projected estimated peak flow	380 gpm	
Calculated full flow capacity	395 gpm	96 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 30	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.38 %	R = 0.167	
Current estimated peak flow	75 gpm	22 % of full capacity
Projected estimated peak flow	380 gpm	
Calculated full flow capacity	334 gpm	114 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 31	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.39 %	R = 0.167	
Current estimated peak flow	75 gpm	22 % of full capacity
Projected estimated peak flow	380 gpm	
Calculated full flow capacity	339 gpm	112 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 32	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.37 %	R = 0.167	
Current estimated peak flow	75 gpm	23 % of full capacity
Projected estimated peak flow	380 gpm	
Calculated full flow capacity	330 gpm	115 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 33	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.54 %	R = 0.167	
Current estimated peak flow	75 gpm	19 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	398 gpm	100 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 34	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.50 %	R = 0.167	
Current estimated peak flow	75 gpm	20 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	383 gpm	104 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 35	COMMENTS
Dia: 8 in.	A = 0.349	Bank added
Slope: 0.44 %	R = 0.167	
Current estimated peak flow	80 gpm	22 % of full capacity
Projected estimated peak flow	410 gpm	
Calculated full flow capacity	360 gpm	114 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 36	COMMENTS
Dia: 8 in.	A = 0.349	Hotel/Resturant added
Slope: 0.68 %	R = 0.167	
Current estimated peak flow	80 gpm	18 % of full capacity
Projected estimated peak flow	430 gpm	Hotel/Resturant added
Calculated full flow capacity	447 gpm	96 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 37	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.48 %	R = 0.167	
Current estimated peak flow	80 gpm	6 % of full capacity
Projected estimated peak flow	450 gpm	Upper Finn Hill flow added
Calculated full flow capacity	1269 gpm	35 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 38	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.36 %	R = 0.167	
Current estimated peak flow	80 gpm	6 % of full capacity
Projected estimated peak flow	450 gpm	
Calculated full flow capacity	1367 gpm	33 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 41	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 1.31 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	620 gpm	2 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 42	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.00 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	1328 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 43	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.00 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	15 gpm	
Calculated full flow capacity	1328 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 44	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 3.70 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	20 gpm	
Calculated full flow capacity	1043 gpm	2 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 50	COMMENTS
Dia: 8 in.	A = 0.349	Housing and maybe portions of Oly College
Slope: 5.89 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	1316 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 51	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.01 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	1329 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 52	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.66 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	1290 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 53	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.88 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	15 gpm	
Calculated full flow capacity	1314 gpm	1 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 54	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 1.02 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	20 gpm	
Calculated full flow capacity	547 gpm	4 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 55	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 1.05 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	20 gpm	
Calculated full flow capacity	555 gpm	4 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 56	COMMENTS
Dia: 8 in.	A = 0.349	Housing along Road E
Slope: 2.80 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	50 gpm	
Calculated full flow capacity	907 gpm	6 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 57	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 6.27 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	50 gpm	
Calculated full flow capacity	1357 gpm	4 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 58	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.70 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	50 gpm	
Calculated full flow capacity	1294 gpm	4 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 59	COMMENTS
Dia: 8 in.	A = 0.349	Housing from Road D
Slope: 4.53 %	R = 0.167	
Current estimated peak flow	10 gpm	1 % of full capacity
Projected estimated peak flow	100 gpm	
Calculated full flow capacity	1154 gpm	9 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 60	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.32 %	R = 0.167	
Current estimated peak flow	10 gpm	1 % of full capacity
Projected estimated peak flow	100 gpm	
Calculated full flow capacity	826 gpm	12 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 61	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.86 %	R = 0.167	
Current estimated peak flow	10 gpm	2 % of full capacity
Projected estimated peak flow	121 gpm	
Calculated full flow capacity	503 gpm	24 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 70	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 1.93 %	R = 0.167	
Current estimated peak flow	10 gpm	1 % of full capacity
Projected estimated peak flow	121 gpm	
Calculated full flow capacity	753 gpm	16 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 71	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.99 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1211 gpm	73 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 72	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 5.77 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1302 gpm	68 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 73	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 5.33 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1251 gpm	70 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 74	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 6.07 %	R = 0.167	
Current estimated peak flow	60 gpm	4 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1335 gpm	66 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 75	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 8.83 %	R = 0.167	
Current estimated peak flow	60 gpm	4 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1611 gpm	55 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 76	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.93 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1204 gpm	73 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 77	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 11.5 %	R = 0.167	
Current estimated peak flow	60 gpm	3 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	1837 gpm	48 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 78	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 2.06 %	R = 0.167	
Current estimated peak flow	60 gpm	8 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	778 gpm	113 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 79	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 2.88 %	R = 0.167	
Current estimated peak flow	60 gpm	7 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	920 gpm	96 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 80	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 2.88 %	R = 0.167	
Current estimated peak flow	60 gpm	7 % of full capacity
Projected estimated peak flow	881 gpm	
Calculated full flow capacity	920 gpm	96 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 81	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 6.05 %	R = 0.167	Viking Ave Added
Current estimated peak flow	150 gpm	11 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1333 gpm	74 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 82	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.10 %	R = 0.167	
Current estimated peak flow	150 gpm	14 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1098 gpm	89 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 83	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 2.02 %	R = 0.167	
Current estimated peak flow	150 gpm	19 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	770 gpm	127 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 84	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 3.68 %	R = 0.167	
Current estimated peak flow	150 gpm	14 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1040 gpm	94 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 85	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 6.32 %	R = 0.167	
Current estimated peak flow	150 gpm	11 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1363 gpm	72 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 86	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 5.54 %	R = 0.167	
Current estimated peak flow	150 gpm	12 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1276 gpm	77 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 87	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.91 %	R = 0.167	
Current estimated peak flow	150 gpm	12 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1201 gpm	82 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 88	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.14 %	R = 0.167	
Current estimated peak flow	150 gpm	14 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1103 gpm	89 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 89	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 2.77 %	R = 0.167	
Current estimated peak flow	150 gpm	17 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	902 gpm	109 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 90	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.60 %	R = 0.167	
Current estimated peak flow	150 gpm	13 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1163 gpm	84 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 91	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 3.09 %	R = 0.167	
Current estimated peak flow	150 gpm	16 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	953 gpm	103 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 92	COMMENTS
Dia: 8 in.	A = 0.349	Down SR 305 to Bond Rd Pump Sta
Slope: 4.10 %	R = 0.167	
Current estimated peak flow	150 gpm	14 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1098 gpm	89 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 93	COMMENTS
Dia: 8 in.	A = 0.349	**BOND ROAD**
Slope: 2.68 %	R = 0.167	
Current estimated peak flow	150 gpm	17 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	887 gpm	110 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 94	COMMENTS
Dia: 8 in.	A = 0.349	**BOND ROAD**
Slope: 0.80 %	R = 0.167	
Current estimated peak flow	150 gpm	31 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	485 gpm	202 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 95	COMMENTS
Dia: 8 in.	A = 0.349	**BRANCH TO BOND PS**
Slope: 2.77 %	R = 0.167	
Current estimated peak flow	150 gpm	17 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	902 gpm	109 % of full capacity

Basin: Finn Hill/Olhava	Pipe Run 96	COMMENTS
Dia: 12 in.	A = 0.785	**BRANCH TO BOND PS**
Slope: 1.18 %	R = 0.250	
Current estimated peak flow	150 gpm	9 % of full capacity
Projected estimated peak flow	980 gpm	
Calculated full flow capacity	1736 gpm	56 % of full capacity

CALDART AND HOSTMARK BASIN

The majority of this basin has been built out and is low density residential. There are several high density residential zones, and they have been assumed to eventually be built out at 14 dwelling units per acre. The new Chateau Ridge and Talon Glenn housing areas at the end of Caldart flow down thru Forrest Rock and do therefore not enter this system. Snowberry Bungalow does enter this system.

Where actual housing lots exist, they were counted to determine the ERUs. Where vacant property exists, it is assumed that they will be developed at 5 dwelling units per acre for low density residential. The criteria of 189 gpd per ERU was used. In accordance with the Orange Book criteria, a peaking factor of 4.0 was used.

Current estimated peak flow is what is now flowing through the system. **Projected estimated peak flow** is what will ultimately be flowing through the system when all housing, including high density housing, is complete.

Calculated full flow capacity is based on the Manning Equation Q=1.486/n(AR^2/3)S^1/2, where n = 0.013.

Brief Summary and Conclusion of Findings: The City should reconfirm that all lines in Caldart are 12-inch. Reference to 10-inch lines is made in the survey. The 12-inch mains in the relatively flat Caldart Street carry the sewer flow adequately. The 8-inch mains in the relatively steep Hostmark Street are likely adequate, but slopes should be determined by survey or asbuilt information to confirm capacity.

Shading indicates future sewer flows >/- 80% of pipe capacity.
Shading indicates future sewer flows >/- 100% of pipe capacity.

Basin: Caldart/Hostmark	Pipe Run 10	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 1.46 %	R = 0.250	
Current estimated peak flow	350 gpm	18 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1931 gpm	21 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 11	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.48 %	R = 0.250	
Current estimated peak flow	350 gpm	32 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1107 gpm	36 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 12	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.89 %	R = 0.250	
Current estimated peak flow	350 gpm	23 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1508 gpm	27 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 13	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.84 %	R = 0.250	
Current estimated peak flow	350 gpm	24 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1465 gpm	27 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 14	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.58 %	R = 0.250	
Current estimated peak flow	350 gpm	29 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1217 gpm	33 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 15	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.58 %	R = 0.250	
Current estimated peak flow	350 gpm	29 % of full capacity
Projected estimated peak flow	400 gpm	
Calculated full flow capacity	1217 gpm	33 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 16	COMMENTS
Dia: 12 in.	A = 0.785	
Slope: 0.85 %	R = 0.250	
Current estimated peak flow	450 gpm	31 % of full capacity
Projected estimated peak flow	585 gpm	
Calculated full flow capacity	1473 gpm	40 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 17	COMMENTS
Dia: 12 in.	A = 0.785	Caldart in front of NK High School
Slope: 0.40 %	R = 0.250	
Current estimated peak flow	450 gpm	45 % of full capacity
Projected estimated peak flow	585 gpm	
Calculated full flow capacity	1011 gpm	58 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 18	COMMENTS
Dia: 12 in.	A = 0.785	Caldart in front of NK High School
Slope: 0.63 %	R = 0.250	
Current estimated peak flow	485 gpm	38 % of full capacity
Projected estimated peak flow	620 gpm	
Calculated full flow capacity	1269 gpm	49 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 19	COMMENTS
Dia: 12 in.	A = 0.785	Caldart in front of NK High School
Slope: 0.36 %	R = 0.250	
Current estimated peak flow	485 gpm	51 % of full capacity
Projected estimated peak flow	620 gpm	
Calculated full flow capacity	959 gpm	65 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 20	COMMENTS
Dia: 8 in.	A = 0.349	Downstream of Caldart/Holstmark intersect
Slope: 1.80 %	R = 0.167	
Current estimated peak flow	600 gpm	83 % of full capacity
Projected estimated peak flow	770 gpm	
Calculated full flow capacity	727 gpm	106 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 21	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.20 %	R = 0.167	
Current estimated peak flow	660 gpm	59 % of full capacity
Projected estimated peak flow	830 gpm	
Calculated full flow capacity	1111 gpm	75 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 22	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.20 %	R = 0.167	
Current estimated peak flow	660 gpm	59 % of full capacity
Projected estimated peak flow	830 gpm	
Calculated full flow capacity	1111 gpm	75 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 23	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 11.2 %	R = 0.167	
Current estimated peak flow	670 gpm	37 % of full capacity
Projected estimated peak flow	840 gpm	
Calculated full flow capacity	1814 gpm	46 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 24	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 10.5 %	R = 0.167	
Current estimated peak flow	670 gpm	38 % of full capacity
Projected estimated peak flow	840 gpm	
Calculated full flow capacity	1756 gpm	48 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 25	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.50 %	R = 0.167	
Current estimated peak flow	670 gpm	53 % of full capacity
Projected estimated peak flow	840 gpm	
Calculated full flow capacity	1271 gpm	66 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 26	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 5.50 %	R = 0.167	
Current estimated peak flow	730 gpm	57 % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	1271 gpm	71 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 27	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 3.31 %	R = 0.167	
Current estimated peak flow	740 gpm	75 % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	986 gpm	91 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 28	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 7.00 %	R = 0.167	
Current estimated peak flow	740 gpm	52 % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	1434 gpm	63 % of full capacity

Basin: Caldart/Hostmark	Pipe Run 29	COMMENTS
Dia: 8 in.	A = 0.349	Need data for this short connection
Slope: xx %	R = 0.167	Connects to inflow from Village PS
Current estimated peak flow	740 gpm	#VALUE! % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	#VALUE! gpm	#VALUE! % of full capacity

VIKING NORTH AND SOUTH

Viking Way south of Finn Hill and Lindvig is relatively flat. All sewage south of Liberty Road flows to the Liberty Bay PS, where it is pumped back up to Viking Avenue in a 4-inch force main to a 10-inch main running north on Viking. There are 0.43% and 0.5% slopes upstream of the PS, and 0.35% slopes downstream of the PS. Flows to the Liberty Bay PS (100 gpm capacity) will exceed capacity in the relatively near future if new homes are constructed.

Current estimated peak flow is what is now flowing through the system. **Projected estimated peak flow** assumes a full build out of the residential zoning and includes a rebuild of the Liberty Bay pump station.

Calculations assume build-out of vacant land at 5 homes per acre and 189 gallons per day per ERU. In accordance with the Orange Book criteria, a peaking factor of 4.0 was used.

Calculated full flow capacity is based on the Manning Equation Q=1.486/n(AR^2/3)S^1/2, where n = 0.013.

Brief Summary and Conclusion of Findings: The analysis of this basin is not fully complete. Additional pipe data north of Finn Hill on Viking Ave is needed.

Shading indicates future sewer flows >/- 80% of pipe capacity.
Shading indicates future sewer flows >/- 100% of pipe capacity.

Basin: Viking South	Pipe Run 10		COMMENTS
Dia: 8 in.	A =	0.349	North on Viking
Slope: 0.53 %	R =	0.167	
Current estimated peak flow		30 gpm	8 % of full capacity
Projected estimated peak flow		142 gpm	
Calculated full flow capacity		395 gpm	36 % of full capacity

Basin: Viking South	Pipe Run 11		COMMENTS
Dia: 8 in.		A = 0.349	North on Viking
Slope: 1.93 %		R = 0.167	
Current estimated peak flow		30 gpm	4 % of full capacity
Projected estimated peak flow		307 gpm	
Calculated full flow capacity		753 gpm	41 % of full capacity

Basin: Viking South	Pipe Run 12	COMMENTS
Dia: 8 in.	A = 0.349	North on Viking
Slope: 0.43 %	R = 0.167	Retirement Center assumed to enter here
Current estimated peak flow	70 gpm	20 % of full capacity
Projected estimated peak flow	307 gpm	
Calculated full flow capacity	355 gpm	86 % of full capacity

Basin: Viking South	Pipe Run 13	COMMENTS
Dia: 8 in.	A = 0.349	North on Viking
Slope: xx %	R = 0.167	Poulsbo RV enters
Current estimated peak flow	75 gpm	#VALUE! % of full capacity
Projected estimated peak flow	307 gpm	No pipe slope available
Calculated full flow capacity	#VALUE! gpm	#VALUE! % of full capacity

Basin: Viking South	Pipe Run 14	COMMENTS
Dia: 8 in.	A = 0.349	North on Viking
Slope: xx %	R = 0.167	
Current estimated peak flow	75 gpm	#VALUE! % of full capacity
Projected estimated peak flow	307 gpm	No pipe slope available
Calculated full flow capacity	#VALUE! gpm	#VALUE! % of full capacity

Basin: Viking South	Pipe Run 15	COMMENTS
Dia: 8 in.	A = 0.349	Down Bay to Liberty Bay PS
Slope: xx %	R = 0.167	
Current estimated peak flow	75 gpm	#VALUE! % of full capacity
Projected estimated peak flow	317 gpm	No pipe slope available
Calculated full flow capacity	#VALUE! gpm	#VALUE! % of full capacity

Basin: Viking South	Pipe Run 16	COMMENTS
Dia: 8 in.	A = 0.349	Down Bay to Liberty Bay PS
Slope: 2.20 %	R = 0.167	
Current estimated peak flow	80 gpm	10 % of full capacity
Projected estimated peak flow	317 gpm	
Calculated full flow capacity	804 gpm	39 % of full capacity

Basin: Viking South	Pipe Run 17	COMMENTS
Dia: 8 in.	A = 0.349	Down Bay to Liberty Bay PS
Slope: 5.60 %	R = 0.167	
Current estimated peak flow	80 gpm	6 % of full capacity
Projected estimated peak flow	337 gpm	
Calculated full flow capacity	1283 gpm	26 % of full capacity

Basin: Viking South	Pipe Run 18	COMMENTS
Dia: 8 in.	A = 0.349	Down Bay to Liberty Bay PS
Slope: 5.34 %	R = 0.167	
Current estimated peak flow	80 gpm	6 % of full capacity
Projected estimated peak flow	337 gpm	
Calculated full flow capacity	1253 gpm	27 % of full capacity

Basin: Viking South	Pipe Run 19	COMMENTS
Dia: 8 in.	A = 0.349	Down Bay to Liberty Bay PS
Slope: 0.50 %	R = 0.167	
Current estimated peak flow	90 gpm	23 % of full capacity
Projected estimated peak flow	337 gpm	
Calculated full flow capacity	383 gpm	88 % of full capacity

Basin: Viking South	Pipe Run 20	COMMENTS
Dia: 8 in.	A = 0.349	North along beach
Slope: 0.50 %	R = 0.167	
Current estimated peak flow	100 gpm	26 % of full capacity
Projected estimated peak flow	337 gpm	
Calculated full flow capacity	383 gpm	88 % of full capacity

Basin: Viking South	Pipe Run 21	COMMENTS
Dia: 8 in.	A = 0.349	Discharges to Liberty Bay PS
Slope: 0.50 %	R = 0.167	
Current estimated peak flow	100 gpm	26 % of full capacity
Projected estimated peak flow	337 gpm	
Calculated full flow capacity	383 gpm	88 % of full capacity

Basin: Viking South	Pipe Run 30	COMMENTS
Dia: 10 in.	A = 0.545	Viking North after 4" force main enters
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	110 gpm	19 % of full capacity
Projected estimated peak flow	410 gpm	
Calculated full flow capacity	581 gpm	71 % of full capacity

Basin: Viking South	Pipe Run 31	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	110 gpm	19 % of full capacity
Projected estimated peak flow	410 gpm	
Calculated full flow capacity	581 gpm	71 % of full capacity

Basin: Viking South	Pipe Run 32	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	125 gpm	21 % of full capacity
Projected estimated peak flow	435 gpm	
Calculated full flow capacity	581 gpm	75 % of full capacity

Basin: Viking South	Pipe Run 33	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	125 gpm	21 % of full capacity
Projected estimated peak flow	435 gpm	
Calculated full flow capacity	581 gpm	75 % of full capacity

Basin: Viking South	Pipe Run 34	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	130 gpm	22 % of full capacity
Projected estimated peak flow	460 gpm	
Calculated full flow capacity	581 gpm	79 % of full capacity

Basin: Viking South	Pipe Run 35	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	140 gpm	24 % of full capacity
Projected estimated peak flow	460 gpm	
Calculated full flow capacity	581 gpm	79 % of full capacity

Basin: Viking South	Pipe Run 36	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	145 gpm	25 % of full capacity
Projected estimated peak flow	540 gpm	
Calculated full flow capacity	581 gpm	93 % of full capacity

Basin: Viking South	Pipe Run 37	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 0.35 %	R = 0.208	
Current estimated peak flow	145 gpm	25 % of full capacity
Projected estimated peak flow	540 gpm	
Calculated full flow capacity	581 gpm	93 % of full capacity

Basin: Viking South	Pipe Run 40	COMMENTS
Dia: 10 in.	A = 0.545	East on Lindvig Way
Slope: 1.48 %	R = 0.208	
Current estimated peak flow	260 gpm	22 % of full capacity
Projected estimated peak flow	890 gpm	
Calculated full flow capacity	1196 gpm	74 % of full capacity

Basin: Viking South	Pipe Run 41	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 5.13 %	R = 0.208	
Current estimated peak flow	260 gpm	12 % of full capacity
Projected estimated peak flow	890 gpm	
Calculated full flow capacity	2226 gpm	40 % of full capacity

Basin: Viking South	Pipe Run 42	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 4.00 %	R = 0.208	
Current estimated peak flow	260 gpm	13 % of full capacity
Projected estimated peak flow	895 gpm	
Calculated full flow capacity	1966 gpm	46 % of full capacity

Basin: Viking South	Pipe Run 43	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 2.60 %	R = 0.208	
Current estimated peak flow	265 gpm	17 % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	1585 gpm	57 % of full capacity

Basin: Viking South	Pipe Run 44	COMMENTS
Dia: 10 in.	A = 0.545	
Slope: 1.10 %	R = 0.208	
Current estimated peak flow	265 gpm	26 % of full capacity
Projected estimated peak flow	900 gpm	
Calculated full flow capacity	1031 gpm	87 % of full capacity

Basin: Viking North	Pipe Run 50	COMMENTS
Dia: 8 in.	A = 0.349	Viking and SR 305
Slope: 5.10 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	5 gpm	
Calculated full flow capacity	1224 gpm	0 % of full capacity

Basin: Viking North	Pipe Run 51	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.01 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	769 gpm	1 % of full capacity

Basin: Viking North	Pipe Run 52	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 1.09 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	38 gpm	
Calculated full flow capacity	566 gpm	7 % of full capacity

Basin: Viking North	Pipe Run 53	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 3.32 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	38 gpm	
Calculated full flow capacity	988 gpm	4 % of full capacity

Basin: Viking North	Pipe Run 54	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 3.32 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	98 gpm	
Calculated full flow capacity	988 gpm	10 % of full capacity

Basin: Viking North	Pipe Run 55	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.33 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	98 gpm	
Calculated full flow capacity	1128 gpm	9 % of full capacity

Basin: Viking North	Pipe Run 56	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.42 %	R = 0.167	
Current estimated peak flow	50 gpm	4 % of full capacity
Projected estimated peak flow	148 gpm	
Calculated full flow capacity	1140 gpm	13 % of full capacity

Basin: Viking North	Pipe Run 57	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.53 %	R = 0.167	
Current estimated peak flow	50 gpm	4 % of full capacity
Projected estimated peak flow	148 gpm	
Calculated full flow capacity	1154 gpm	13 % of full capacity

Basin: Viking North	Pipe Run 58	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.20 %	R = 0.167	
Current estimated peak flow	50 gpm	5 % of full capacity
Projected estimated peak flow	148 gpm	
Calculated full flow capacity	1111 gpm	13 % of full capacity

Basin: Viking North	Pipe Run 59	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.29 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	158 gpm	
Calculated full flow capacity	1123 gpm	14 % of full capacity

Basin: Viking North	Pipe Run 60	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 4.32 %	R = 0.167	
Current estimated peak flow	60 gpm	5 % of full capacity
Projected estimated peak flow	168 gpm	
Calculated full flow capacity	1127 gpm	15 % of full capacity

Basin: Viking North	Pipe Run 61	COMMENTS
Dia: 8 in.	A = 0.349	East on Lindvig Way
Slope: 2.16 %	R = 0.167	
Current estimated peak flow	75 gpm	9 % of full capacity
Projected estimated peak flow	180 gpm	
Calculated full flow capacity	797 gpm	23 % of full capacity

Basin: Viking North	Pipe Run 62	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.22 %	R = 0.167	
Current estimated peak flow	75 gpm	9 % of full capacity
Projected estimated peak flow	190 gpm	
Calculated full flow capacity	808 gpm	24 % of full capacity

Basin: Viking North	Pipe Run 63	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.59 %	R = 0.167	
Current estimated peak flow	75 gpm	18 % of full capacity
Projected estimated peak flow	190 gpm	
Calculated full flow capacity	416 gpm	46 % of full capacity

Basin: Viking North	Pipe Run 64	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 0.90 %	R = 0.167	
Current estimated peak flow	75 gpm	15 % of full capacity
Projected estimated peak flow	200 gpm	
Calculated full flow capacity	514 gpm	39 % of full capacity

Basin: Viking North	Pipe Run 65	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.13 %	R = 0.167	
Current estimated peak flow	75 gpm	9 % of full capacity
Projected estimated peak flow	200 gpm	
Calculated full flow capacity	791 gpm	25 % of full capacity

Basin: Viking North	Pipe Run 70	COMMENTS
Dia: 8 in.	A = 0.349	Vetter Road south on Viking to SR 305
Slope: 2.00 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	10 gpm	
Calculated full flow capacity	767 gpm	1 % of full capacity

Basin: Viking North	Pipe Run 71	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.00 %	R = 0.167	
Current estimated peak flow	0 gpm	0 % of full capacity
Projected estimated peak flow	79 gpm	
Calculated full flow capacity	767 gpm	10 % of full capacity

Basin: Viking North	Pipe Run 72	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.20 %	R = 0.167	
Current estimated peak flow	50 gpm	6 % of full capacity
Projected estimated peak flow	79 gpm	
Calculated full flow capacity	804 gpm	10 % of full capacity

Basin: Viking North	Pipe Run 73	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.20 %	R = 0.167	
Current estimated peak flow	50 gpm	6 % of full capacity
Projected estimated peak flow	99 gpm	
Calculated full flow capacity	804 gpm	12 % of full capacity

Basin: Viking North	Pipe Run 74	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.20 %	R = 0.167	
Current estimated peak flow	50 gpm	6 % of full capacity
Projected estimated peak flow	99 gpm	
Calculated full flow capacity	804 gpm	12 % of full capacity

Basin: Viking North	Pipe Run 75	COMMENTS
Dia: 8 in.	A = 0.349	
Slope: 2.20 %	R = 0.167	
Current estimated peak flow	50 gpm	6 % of full capacity
Projected estimated peak flow	99 gpm	
Calculated full flow capacity	804 gpm	12 % of full capacity

NOLL ROAD BASIN

This basin does not currently have a gravity collection system. The Alasund development has a pump station that conveys sewage into the Caldart Basin. Most of the basin is zoned as residential low density. Further development cannot occur until a sewer system is installed. A new sewer main is proposed for installation along the east boundary of the basin. This new main will tie to the existing 10-inch sewer exiting the Deer Run housing area.

Projected flows are based on 189 gpd per ERU. In accordance with the Orange Book criteria, a peaking factor of 4.0 was used.

Current estimated peak flow is what is now flowing through the system. **Projected estimated peak flow** is what will ultimately be flowing through the system when all housing, including high density housing, is complete.

Calculated full flow capacity is based on the Manning Equation Q=1.486/n(AR^2/3)S^1/2, where n = 0.013.

Brief Summary and Conclusion of Findings: The new sewer main will be placed in an area with adequate slope. Final design will size the pipes and set the ie's to provide adequate flow. The existing 10-inch DI main from Deer Run to the Johnson Road Chlorination station is undersized for the future Noll Road flows and must be upsized by pipe bursting or installing a new parallel main.

Shading indicates future sewer flows >/- 80% of pipe capacity.
Shading indicates future sewer flows >/- 100% of pipe capacity.

Basin: Noll Road		Pipe Run 10		COMMENTS
Dia:	8 in.	A =	0.349	Future proposed sewer main
Slope:	1.14 %	R =	0.167	
Current estimated peak flow			0 gpm	
Projected estimated peak flow			145 gpm	
Calculated full flow capacity			579 gpm	25 % of full capacity

Basin: Noll Road		Pipe Run 11		COMMENTS
Dia:	8 in.		A = 0.349	Future proposed sewer main
Slope:	1.14 %		R = 0.167	
Current estimated peak flow			0 gpm	
Projected estimated peak flow			166 gpm	Alasund added
Calculated full flow capacity			579 gpm	29 % of full capacity

Basin: Noll Road	Pipe Run 12	COMMENTS
Dia: 10 in.	A = 0.545	Future proposed sewer main
Slope: 1.09 %	R = 0.208	
Current estimated peak flow	0 gpm	
Projected estimated peak flow	325 gpm	
Calculated full flow capacity	1026 gpm	32 % of full capacity

Basin: Noll Road	Pipe Run 13	COMMENTS
Dia: 10 in.	A = 0.545	Future proposed sewer main
Slope: 3.42 %	R = 0.208	
Current estimated peak flow	0 gpm	
Projected estimated peak flow	470 gpm	
Calculated full flow capacity	1818 gpm	26 % of full capacity

Basin: Noll Road	Pipe Run 14	COMMENTS
Dia: 10 in.	A = 0.545	Future proposed sewer main
Slope: 1.30 %	R = 0.208	
Current estimated peak flow	0 gpm	
Projected estimated peak flow	522 gpm	
Calculated full flow capacity	1121 gpm	47 % of full capacity

Basin: Noll Road	Pipe Run 15	COMMENTS
Dia: 12 in.	A = 0.785	Future proposed sewer main
Slope: 0.66 %	R = 0.250	
Current estimated peak flow	0 gpm	
Projected estimated peak flow	532 gpm	
Calculated full flow capacity	1298 gpm	41 % of full capacity

Basin: Noll Road	Pipe Run 16	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.47 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	24 % of full capacity
Projected estimated peak flow	655 gpm	
Calculated full flow capacity	674 gpm	97 % of full capacity

Basin: Noll Road	Pipe Run 17	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.49 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	24 % of full capacity
Projected estimated peak flow	670 gpm	
Calculated full flow capacity	688 gpm	97 % of full capacity

Basin: Noll Road	Pipe Run 18	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.50 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	23 % of full capacity
Projected estimated peak flow	682 gpm	
Calculated full flow capacity	695 gpm	98 % of full capacity

Basin: Noll Road	Pipe Run 19	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.57 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	22 % of full capacity
Projected estimated peak flow	697 gpm	
Calculated full flow capacity	742 gpm	94 % of full capacity

Basin: Noll Road	Pipe Run 20	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.48 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	24 % of full capacity
Projected estimated peak flow	697 gpm	
Calculated full flow capacity	681 gpm	102 % of full capacity

Basin: Noll Road	Pipe Run 21	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.45 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	25 % of full capacity
Projected estimated peak flow	721 gpm	
Calculated full flow capacity	659 gpm	109 % of full capacity

Basin: Noll Road	Pipe Run 22	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 0.90 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	17 % of full capacity
Projected estimated peak flow	721 gpm	
Calculated full flow capacity	932 gpm	77 % of full capacity

Basin: Noll Road	Pipe Run 23	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 13.00 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	5 % of full capacity
Projected estimated peak flow	721 gpm	
Calculated full flow capacity	3544 gpm	20 % of full capacity

Basin: Noll Road	Pipe Run 24	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 10.00 %	R = 0.208	Existing Ductile Iron pipe
Current estimated peak flow	162 gpm	5 % of full capacity
Projected estimated peak flow	741 gpm	
Calculated full flow capacity	3108 gpm	24 % of full capacity

Basin: Noll Road	Pipe Run 25	COMMENTS
Dia: 10 in.	A = 0.545	Deer Run and Meridith Heights
Slope: 1.04 %	R = 0.208	PVC Pipe
Current estimated peak flow	162 gpm	16 % of full capacity
Projected estimated peak flow	741 gpm	
Calculated full flow capacity	1002 gpm	74 % of full capacity

Basin: Noll Road	Pipe Run 26	COMMENTS
Dia: 10 in.	A = 0.545	PVC pipe acros hwy. No info available
Slope: 0.00 %	R = 0.208	
Current estimated peak flow	162 gpm	#DIV/0! % of full capacity
Projected estimated peak flow	760 gpm	
Calculated full flow capacity	0 gpm	#DIV/0! % of full capacity

8TH AND 9TH MAINS

This spreadsheet checks the 10- and 12-inch gravity mains in 8th and 9th Avenues downstream of where the 8-inch force main from the Village Pump Station connects.

The 8-inch gravity main flowing north along 8th Avenue to the Village pump station has very small flows. It primarily serves commercial buildings and future high density residential. Maximum flows are estimated to be 160 gpm. An 8-inch main with a 0.5% slope has a 383 gpm carrying capacity. If as-built drawings showing the slopes or ie's are provided, then the actual capacities can be computed.

Current estimated peak flow is what is now flowing through the system. **Projected estimated peak flow** is what will ultimately be flowing through the system when all housing, including high density housing, is complete.

Calculated full flow capacity is based on the Manning Equation Q=1.486/n(AR^2/3)S^1/2, where n = 0.013.

Brief Summary and Conclusion of Findings: Pipe slope information is not available. Capacity problems in the pipes leading to the Village pump station are not anticipated. However, there could be a capacity problem in the pipe run between the juncture of the flows from the Caldart basin and the Village pump station, and the location where the gravity main discharges to the SR 305 interceptor main.

Shading indicates future sewer flows >/- 80% of pipe capacity.

Basin: 8th 9th Mains	Pipe Run 10	COMMENTS
Dia: 10 in.	A = 0.545	Survey info needed.
Slope: xx %	R = 0.208	
Current estimated peak flow	0 gpm	
Projected estimated peak flow	450 gpm	Inflow from Finn Hill P.S.
Calculated full flow capacity	#VALUE! gpm	

Basin: 8th 9th Mains	Pipe Run 11	COMMENTS
Dia: 10 in.	A = 0.545	Survey info needed.
Slope: xx %	R = 0.208	
Current estimated peak flow	gpm	
Projected estimated peak flow	450 gpm	
Calculated full flow capacity	#VALUE! gpm	

Basin: 8th 9th Mains	Pipe Run 12	COMMENTS
Dia: 12 in.	A = 0.785	Survey info needed.
Slope: xx %	R = 0.250	
Current estimated peak flow	gpm	
Projected estimated peak flow	gpm	
Calculated full flow capacity	#VALUE! gpm	

Basin: 8th 9th Mains	Pipe Run 13	COMMENTS
Dia: 12 in.	A = 0.785	Survey info needed.
Slope: xx %	R = 0.250	
Current estimated peak flow	gpm	
Projected estimated peak flow	gpm	
Calculated full flow capacity	#VALUE! gpm	

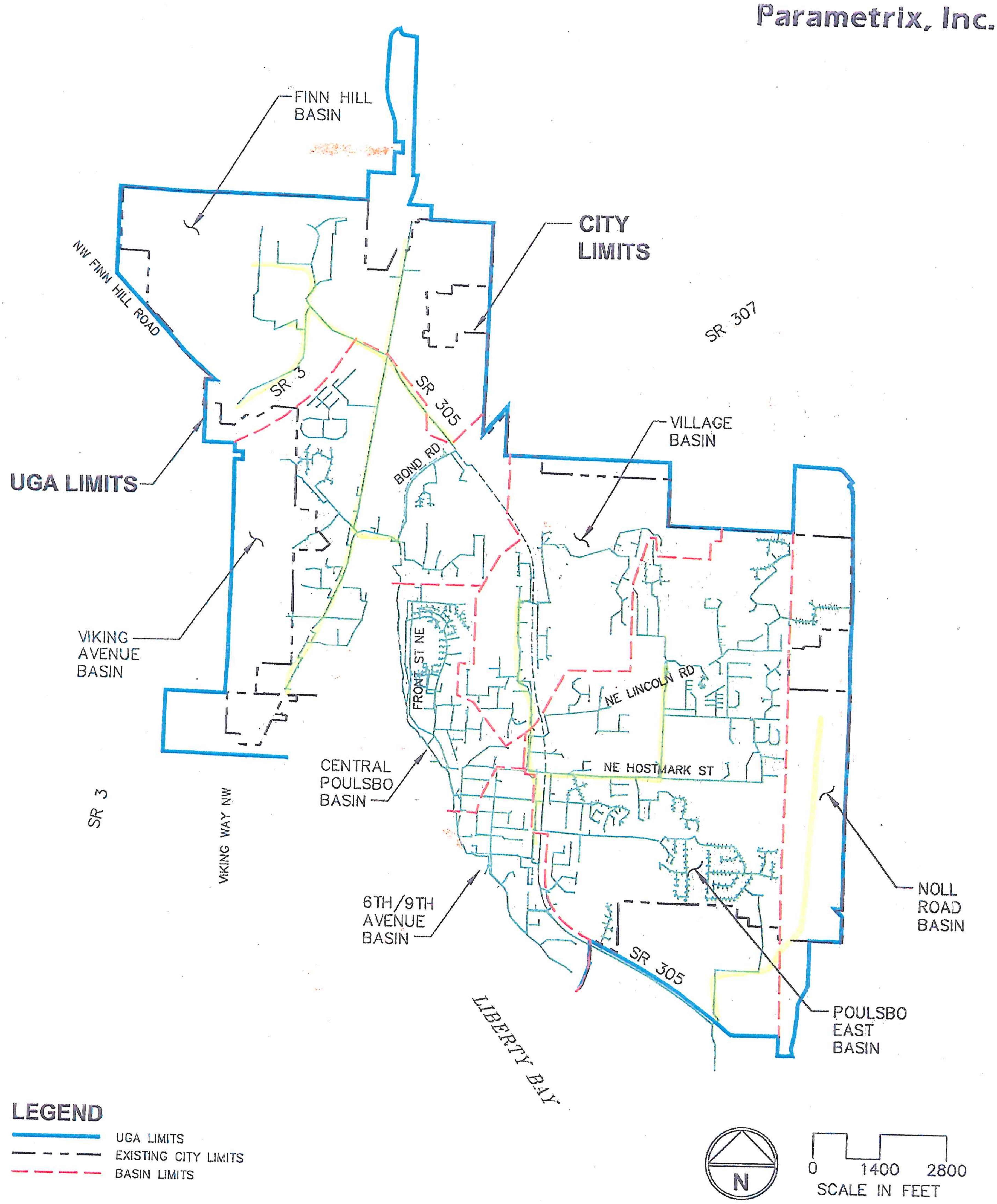
Basin: 8th 9th Mains	Pipe Run 14	COMMENTS
Dia: in.	A = 0.000	Survey info needed.
Slope: %	R = 0.000	
Current estimated peak flow	gpm	
Projected estimated peak flow	gpm	
Calculated full flow capacity	0 gpm	

Basin: 8th 9th Mains	Pipe Run 15	COMMENTS
Dia: in.	A = 0.000	Survey info needed.
Slope: %	R = 0.000	
Current estimated peak flow	gpm	
Projected estimated peak flow	gpm	
Calculated full flow capacity	0 gpm	

ATTACHMENT B

Figures

Parametrix, Inc.

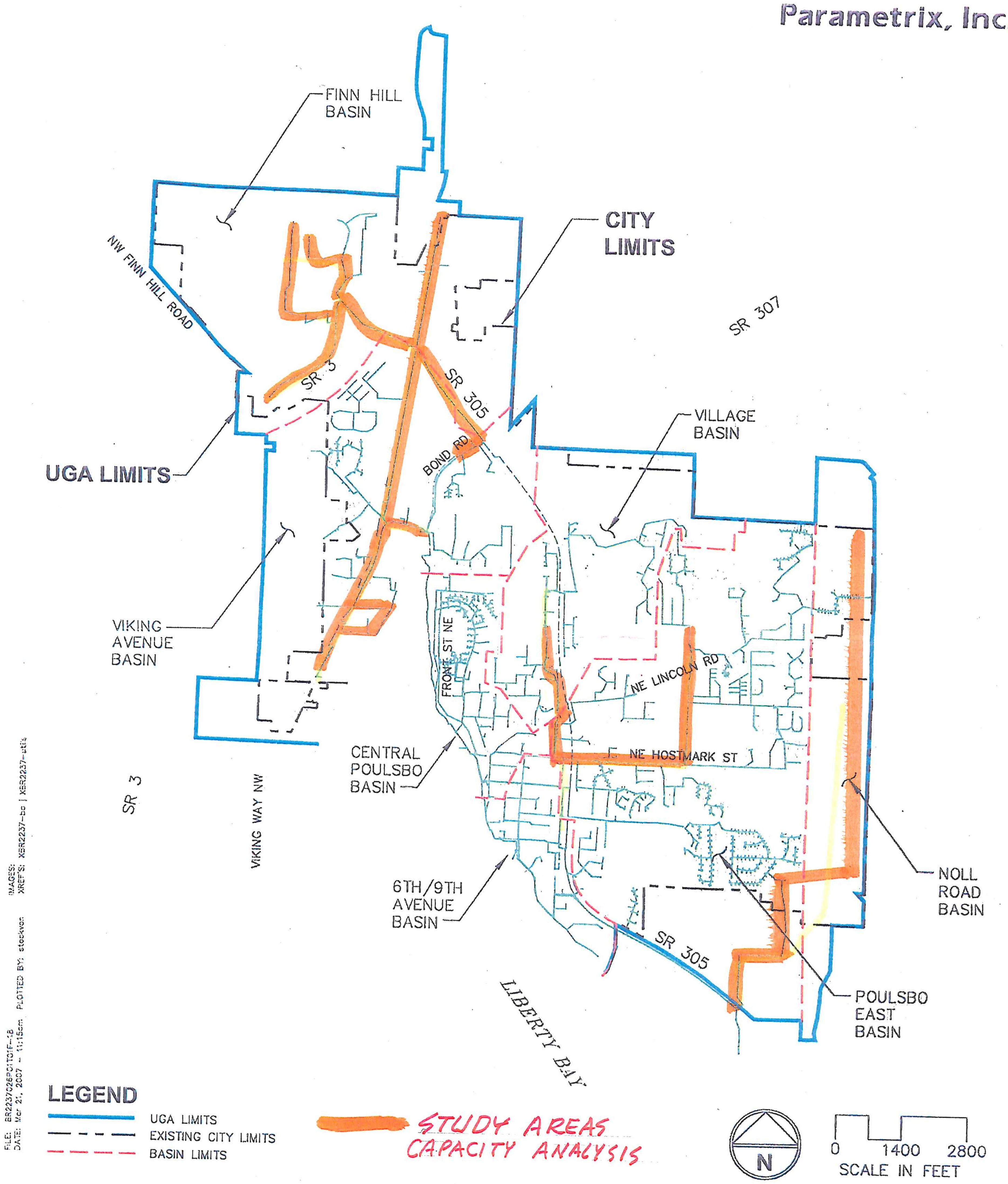


CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Sewer Collection System Map

FIGURE 1

Parametrix, Inc.

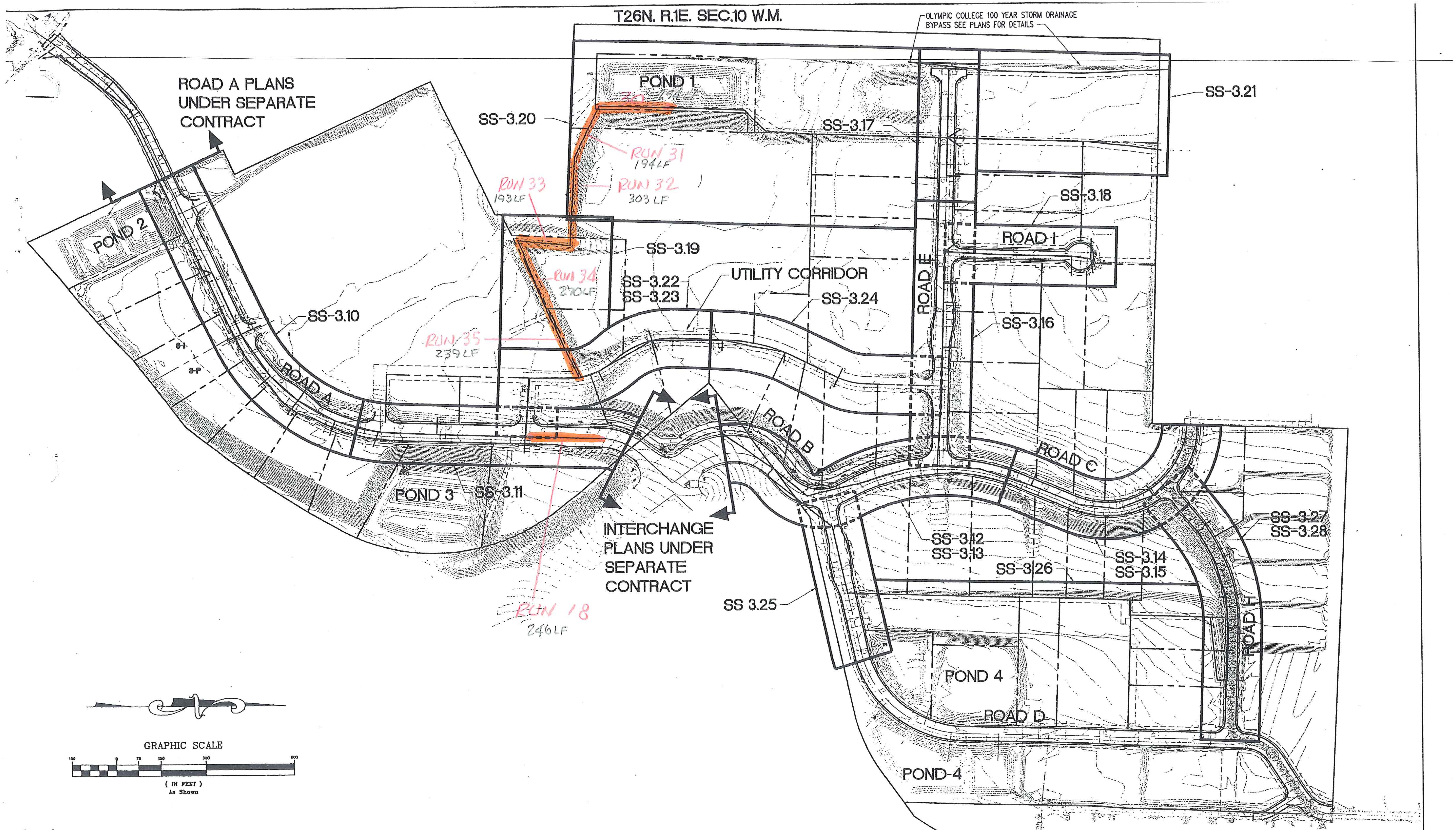


CITY of POULSBO VIKING CITY

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

Sewer Collection System Map

FIGURE 1



AMERICAN LAND SCIENCE
PROFESSIONAL LAND SURVEYING
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FINIS H. BREWER
STATE OF WASHINGTON
36791
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES: 03 / 05 / 05

ASBUILT CERTIFICATE:
I HEREBY CERTIFY THAT THE HORIZONTAL AND VERTICAL LOCATIONS OF THE ON-SITE GRADING & UTILITIES SHOWN HERE ON ARE THE RESULT OF A FIELD SURVEY PERFORMED BY ME OR UNDER MY DIRECTION.

THIS CERTIFICATE IS BASED UPON MEASUREMENTS PERFORMED IN ACCORDANCE WITH THE SOUND PRINCIPLES AND METHODS OF LAND SURVEYING AND THE INFORMATION SHOWN HEREON IS TRUE AND CORRECT.

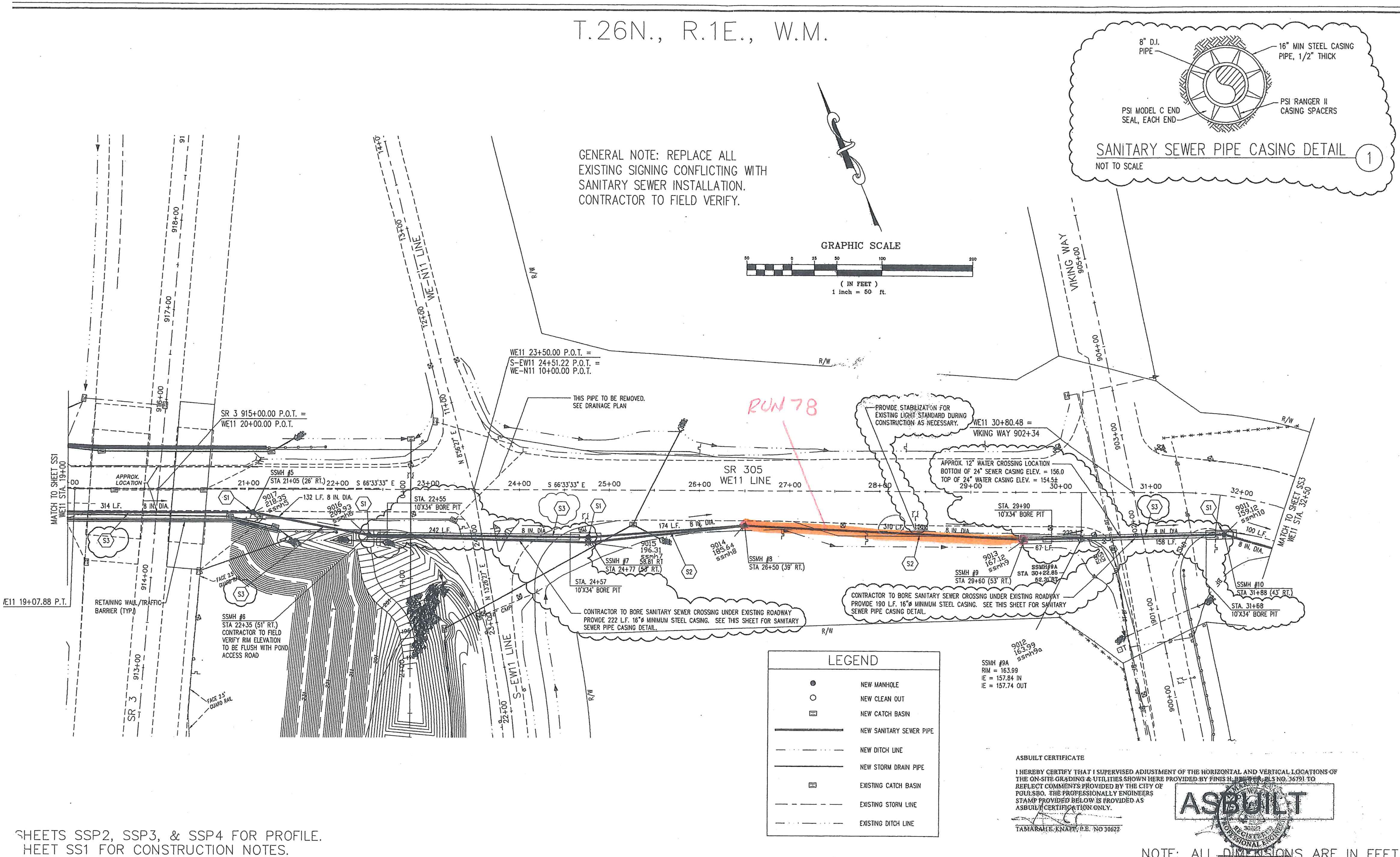
Finis Brewer 12/28/04
FINIS H. BREWER, NO. 36791

ASBUILT

OLHAVA ASSOCIATES
ONSITE ROADWAY AND UTILITIES
POULSBO, WASHINGTON

SEWER PLAN KEY MAP

SS-3.00



DATE	BY	REVISION DESCRIPTION
1/28/03	PACLAND	REVISED PER CITY OF POULSBO COMMENTS
11/25/02	PACLAND	REVISED PER WSDOT COMMENTS
8/22/02	PACLAND	REVISED PER CITY OF POULSBO COMMENTS

DESIGNED BY: REJ/KAS
DRAWN BY: KAS/WHL
CHECKED BY: REJ
ISSUE DATE: 09/27/01
PROJECT NO. 2001096.010

PREPARED FOR
OLHAVA ASSOCIATES L.P.

SR 3/SR 305 INTERCHANGE
MP 52.29 TO MP 53.15
SANITARY SEWER PLAN

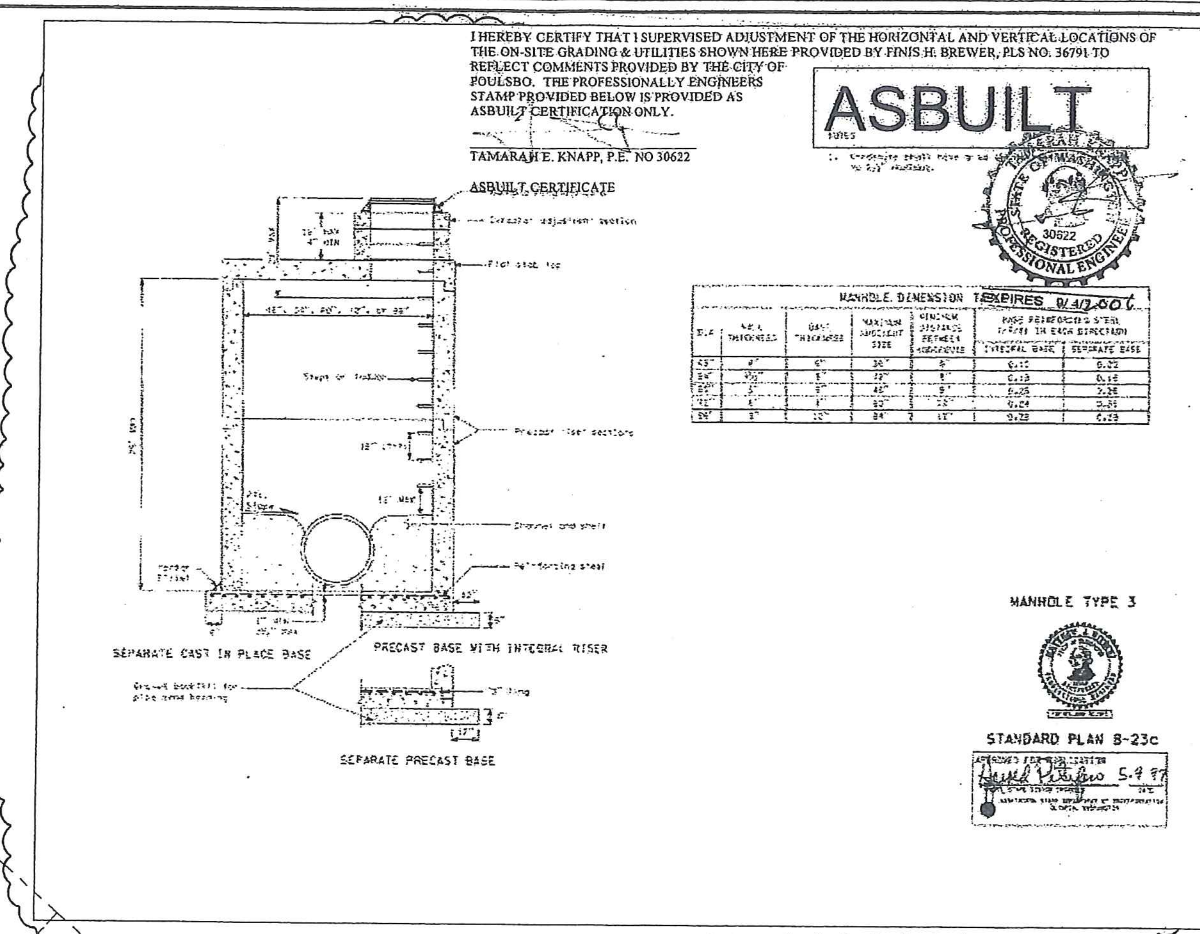
SS2
5 OF ~~17~~ 16

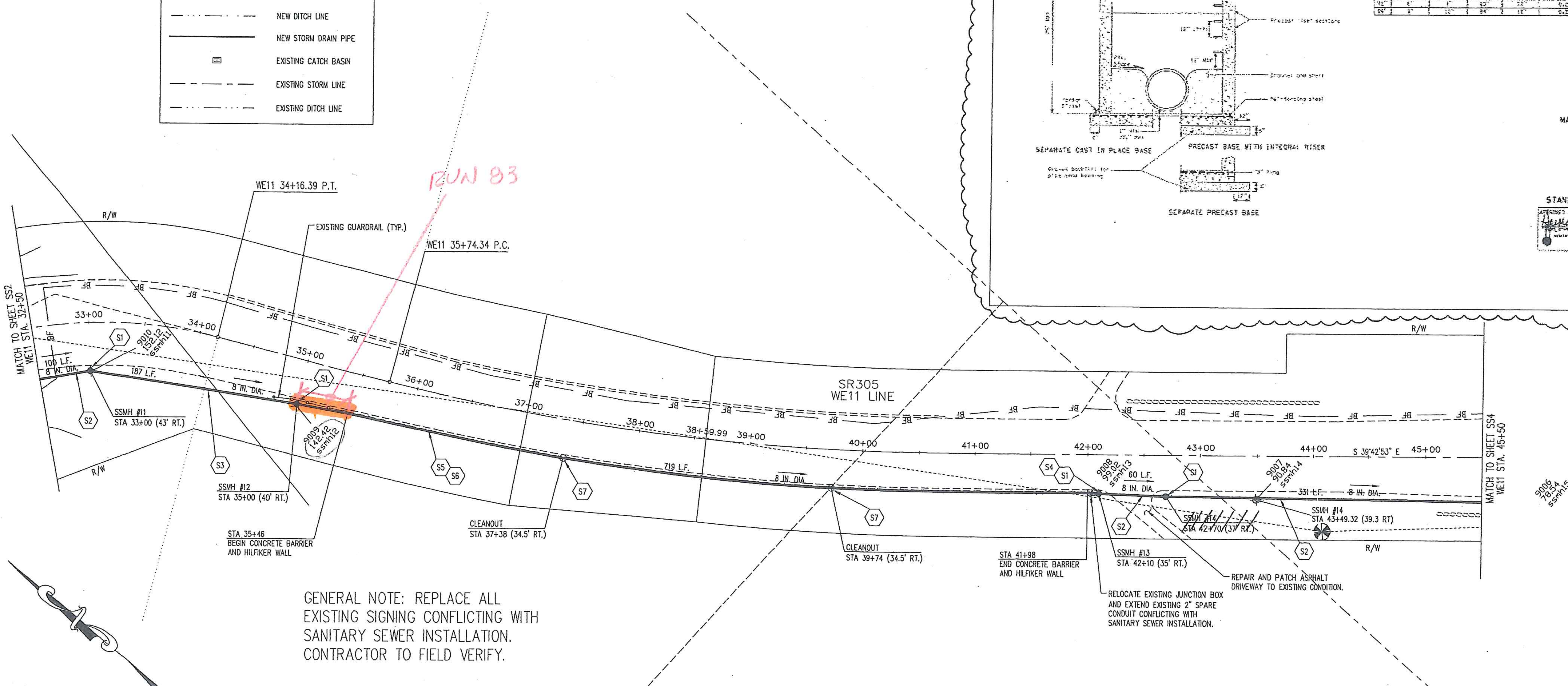
	CURVE DATA					SPIRAL DATA		
I. STATION	DELTA	RADIUS	TANGENT	LENGTH	S	a	DE	Ls
32+72.76	11° 19' 30"	1909.86'	336.61'	377.50'	0.04 ft/ft	1.5	3	2
[illegible]+16.51	41° 10' 10"	399.88'	150.18'	287.33'	0.04 ft/ft			

T.26N., R.1E., W.M.

LEGEND

●	NEW MANHOLE
○	NEW CLEAN OUT
▭	NEW CATCH BASIN
———	NEW SANITARY SEWER PIPE
— · — · —	NEW DITCH LINE
———	NEW STORM DRAIN PIPE
▭	EXISTING CATCH BASIN
— — —	EXISTING STORM LINE
— · · · —	EXISTING DITCH LINE





GENERAL NOTE: REPLACE ALL EXISTING SIGNING CONFLICTING WITH SANITARY SEWER INSTALLATION. CONTRACTOR TO FIELD VERIFY.

GRAPHIC SCALE

(IN FEET)
1 inch = 50 ft.

ALL DIMENSIONS ARE IN FEET.

NOTES:

1. CONTRACTOR TO REPLACE EXISTING GUARDRAIL/ANCHOR ATTACHED TO EXISTING CONCRETE BARRIER CONFLICTING WITH SEWER INSTALLATION.
2. EXISTING DITCHLINE NEEDS TO BE REPLACED IN DISTURBED AREAS WITH SOD OR RIP RAP WITHIN 48 HOURS.

SEE SHEETS SSP4 & SSP5 FOR PROFILE.
SEE SHEET SS1 FOR CONSTRUCTION NOTES

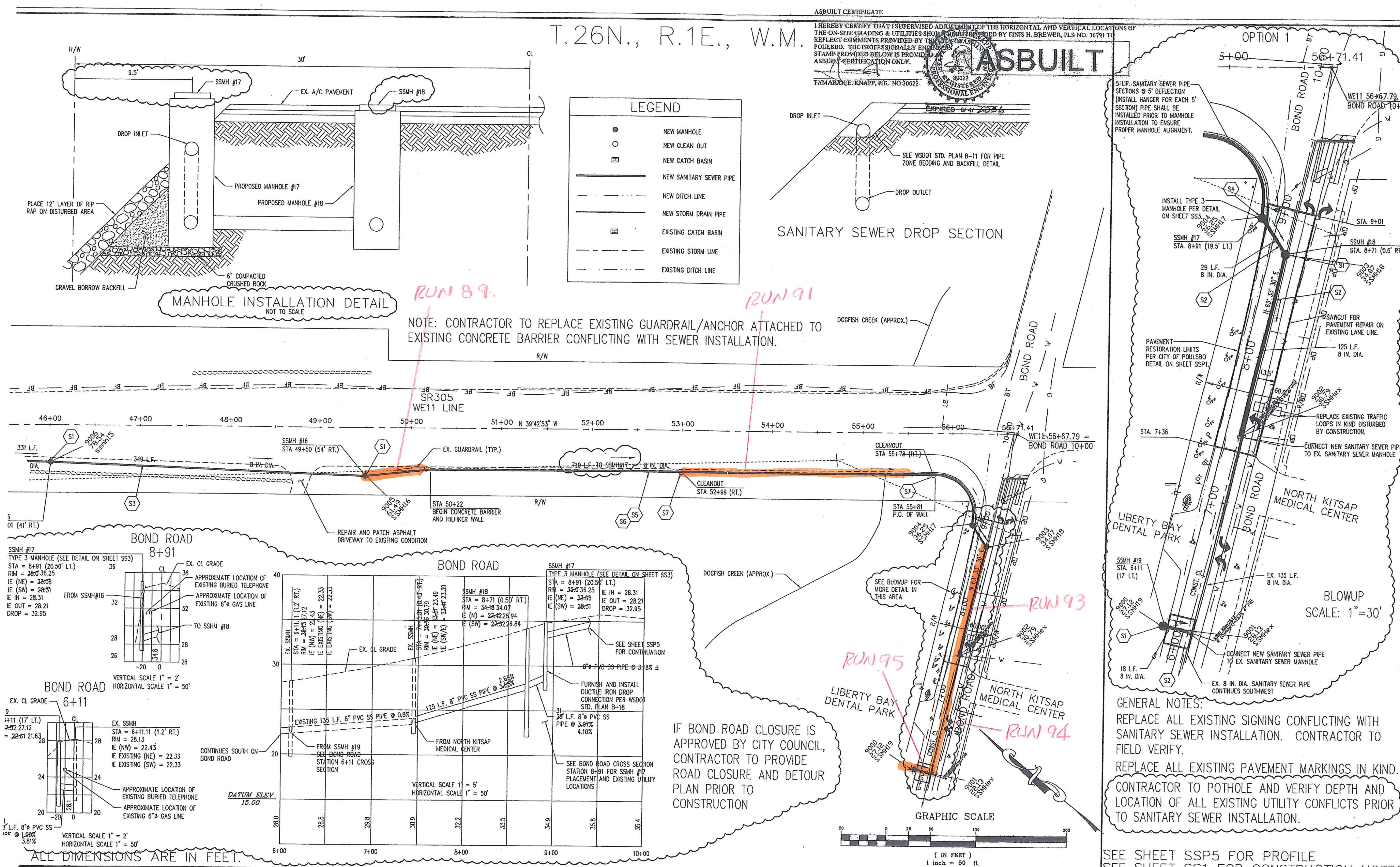
DATE	BY	REVISION DESCRIPTION
1/28/03	PACLAND	REVISED PER CITY OF POULSBO COMMENTS
8/22/02	PACLAND	REVISED PER CITY OF POULSBO COMMENTS

DESIGNED BY: REJ/KAS	ISSUE DATE: 09/27/01
DRAWN BY: JRM/WHL	PROJECT NO. 2001096.010
CHECKED BY: REJ	

PREPARED FOR
OLHAVA ASSOCIATES L.P.

SR 3/SR 305 INTERCHANGE
MP 52.29 TO MP 53.15
SANITARY SEWER PLAN

SS3



GENERAL NOTES:

REPLACE ALL EXISTING SIGNING CONFLICTING WITH SANITARY SEWER INSTALLATION. CONTRACTOR TO FIELD VERIFY.

REPLACE ALL EXISTING PAVEMENT MARKINGS IN KIND.

CONTRACTOR TO POTHOLE AND VERIFY DEPTH AND LOCATION OF ALL EXISTING UTILITY CONFLICTS PRIOR TO SANITARY SEWER INSTALLATION.

SEE SHEET SSP5 FOR PROFILE
SEE SHEET SS1 FOR CONSTRUCTION NOTES

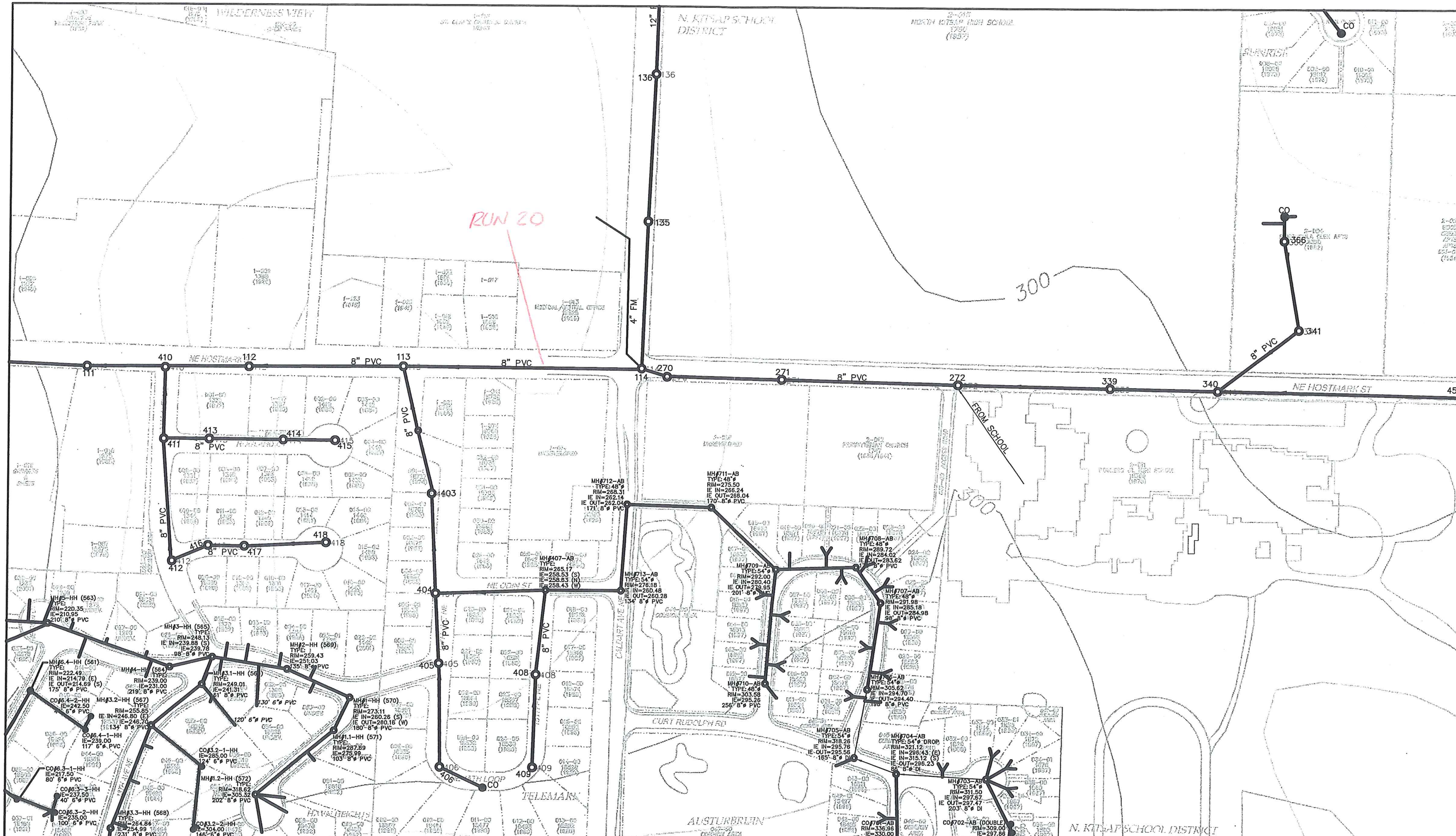
DATE	BY	REVISION DESCRIPTION
1/28/03	PACLAND	REVISED PER CITY OF POULSBO COMMENTS
11/25/02	PACLAND	REVISED PER WSDOT COMMENTS
8/22/02	PACLAND	REVISED PER CITY OF POULSBO COMMENTS

DESIGNED BY: REJ/KAS
DRAWN BY: JRM/WHL
CHECKED BY: REJ
ISSUE DATE: 09/27/01
PROJECT NO. 2001096.010

PREPARED FOR
OLHAVA ASSOCIATES L.P.

SR 3/SR 305 INTERCHANGE
MP 52.29 TO MP 53.15
SANITARY SEWER PLAN

SS4



SEWER COMPREHENSIVE PLAN

DEPARTMENT OF PUBLIC WORKS & UTILITIES

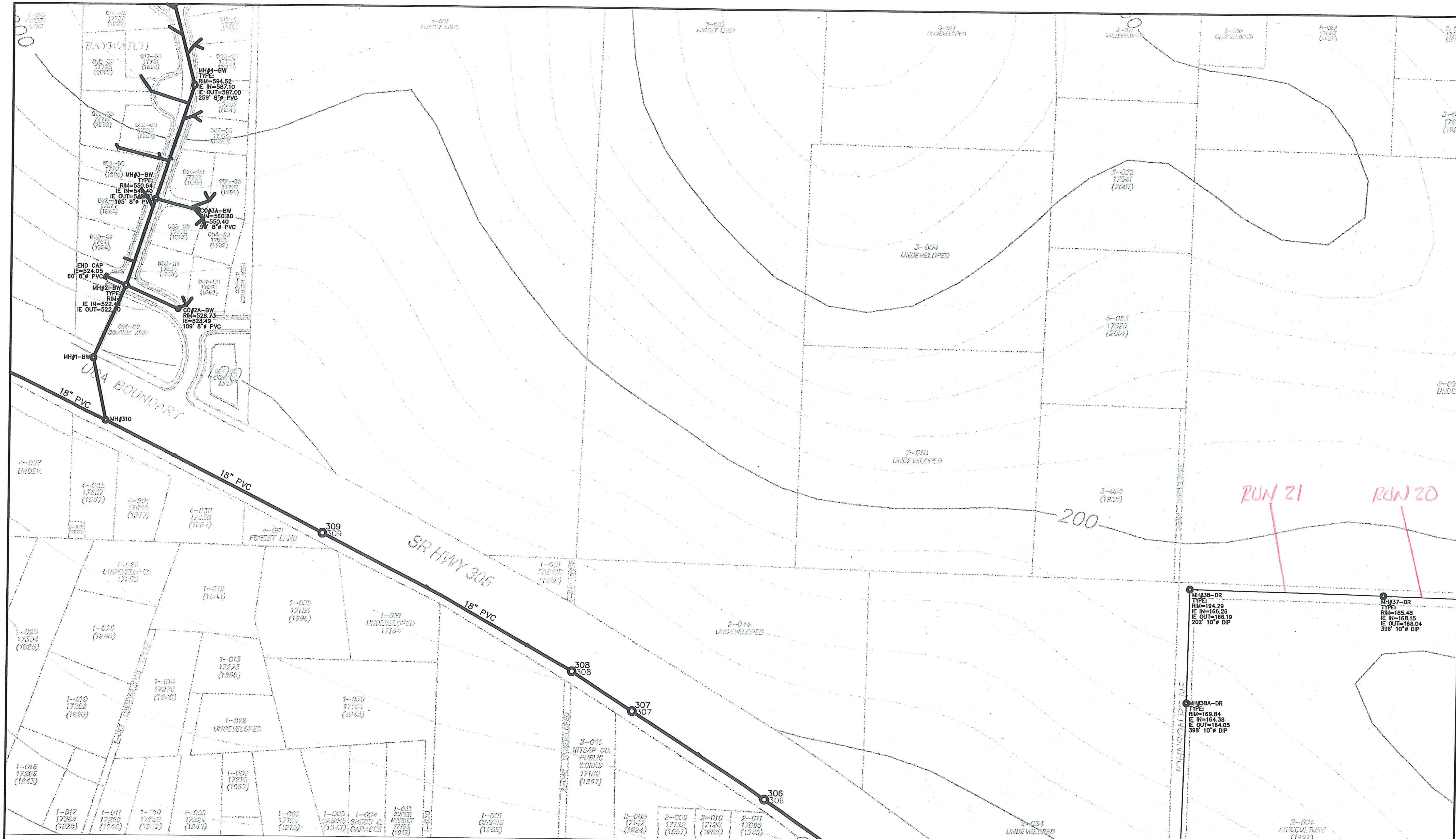
LEGEND

- MANHOLE (MH)
- LIFT STATION
- COUPLING
- GATE VALVE
- CLEAN OUT (CO)
- DIRECTION OF FLOW
- END CAP
- EASEMENT/SETBACK
- GRAVITY MAIN (SEE CONNECTIONS FOR SIZE AND MATERIAL)
- FORCE MAIN (SEE CONNECTIONS FOR SIZE AND MATERIAL)

SCALE: 1" -200'

UPDATED: 06/22/05

51	65	79
52		80
53	67	81



SEWER COMPREHENSIVE PLAN

DEPARTMENT OF PUBLIC WORKS & UTILITIES

LEGEND

- MANHOLE (MH)
- LIFT STATION
- COUPLING
- GATE VALVE
- CLEAN OUT (CO)
- DIRECTION OF FLOW
- END CAP
- EASEMENT/SETBACK
- GRAVITY MAIN (SEE CONNECTIONS FOR SIZE AND MATERIAL)
- FORCE MAIN (SEE CONNECTIONS FOR SIZE AND MATERIAL)

SCALE: 1" - 200'
UPDATED: 06/22/05

53	67	81
54	+	82
55	69	83

June 4, 2007

CITY OF POULSBO – PUBLIC WORKS DIVISION
P.O Box 2275
Poulsbo, WA 98370

Attn: Jeff Bauman
Director of Public Works

Re: City of Poulsbo
Draft Comprehensive Sanitary Sewer Plan 2007 Update

Dear Mr. Bauman,

The Lemolo Citizens Club appreciates your invitation to comment on the Draft Comprehensive Sanitary Sewer Plan 2007 prepared for the City of Poulsbo by Parametrix of Bremerton, Washington, dated March 2007. Six members of the Lemolo Citizens Club reviewed the Draft Comprehensive Sanitary Sewer Plan 2007 Update and concluded that it is a well organized document that offers a conservative, worst case analysis of the problems facing the City of Poulsbo regarding upgrades to their sanitary sewer system.

We believe the conservative nature of the document could lead to greater expenditures of rate payer funds than is necessary and offer the following comments for your consideration:

- The empirical data provided in the document suggests the City of Poulsbo has a significant Inflow problem into the sanitary sewer system rather than an Infiltration problem; however a minimal amount of funding is committed to address this problem (See Table ES-3).
- The long-term flow projections analysis performed by Parametrix utilizes a very conservative peaking factor of 4.02., until the year 2050. The utilization of this peaking factor to the year 2050 overstates the problem as new sanitary sewer pipe technologies installed in areas of new development will lower this rate. We suggest that the City of Poulsbo apply their criteria for pump stations to their entire sanitary sewer conveyance system. The first paragraph on page 3-13 notes that "The City's policy is to identify and implement the ultimate design of a collection and conveyance system to eliminate the proliferation of interim facilities and pump stations. In the future, all pump stations shall be designed according to Ecology and City standards …". EPA and Department of Ecology recommend the peaking factor not exceed 3.08. How long could the existing sanitary sewer system function if this peaking factor were utilized? What improvements would need to be implemented to achieve this peaking factor? at what cost?
- The cost analysis need to provide a clear comparison of the alternatives – "apples to apples" and as currently stated over inflates the cost of the West Side alternative by eliminating the split flow alternative discussed in previous documents. The Lemolo Citizens Club continues to advocate for system redundancy and does not concur with eliminating this option.
- Costs for slip lining the existing piping appear woefully inadequate.
- Can Parametrix identity in their basin by basin summary the type of material utilized for the existing pipes and the percentage of each type? This information would help the City of Poulsbo determine where resources should be spent to address inflow and infiltration problems.

I have also attached several informal e-mails from other members of the Lemolo Citizens Club that either amplify questions posed above or provide further comments or questions for your consideration. Again, we appreciate your soliciting our comments concerning this draft document and look forward to working with you to successfully resolve this matter.

If you have any questions, please contact me at 360-779-4943 (home) or 360-662-8275 (work).

Sincerely,

LEMOLO CITIZENS CLUB

Richard Best, President

City of Poulsbo,

I get the impression that the City people are more interested in Infiltration than in Inflow. I suspect, without any hard evidence, that this is because it is easier to just fix the deteriorated and obsolescent pipes than it is to deal with individual property owners, even though it would probably be less costly, in dollars per mgd to work on the Inflow than on the Infiltration.

Actually both need to be done. Infiltration sets up a base flow during the rainy season which, added to the actual sewage flow, leaves less room for the short duration peaks that come with a rain storm. The result is that a large peak can push the total flow beyond the short term capacity limit, and the base flow plus the peaks can push the monthly average above the 0.95 mgd reserved in the County treatment facilities for Poulsbo.

The contract with the County establishes that if the Poulsbo average flow for any month exceeds 0.95 mgd Poulsbo must pay an extra amount for not only that month but for every month for the rest on the contract year. The contract year starts on the first of October, just at the beginning of the rainy season. This means that if the flow is going to exceed the allotted limit at any time during the year it is almost certain to happen near the beginning of the year and thus will maximize the cost to the taxpayers of Poulsbo.

It looks to me as if the people who set up the contract, and those who are planning for future sewer capacity requirements, expect the sewer flow rates to depend solely on population and have nothing to do with weather or the condition of the sewer system, i.e. I&I.

Table 4-4 says that -"I&I has been almost eliminated" from the Central Poulsbo Basin. There is still more than a normal amount of I&I in the Poulsbo system as a whole as indicated in table 2-6 on page 2-29. Where is all this coming from?

The projected flow requirements indicated in table 2-6 are based on the assumption that any new sewer construction done to meet population growth requirements will be no better in quality than the present condition of the pipes that were installed many decades ago and made of the materials that were normally used at that time, but are now obsolete and decayed.

Paragraph 2.4.2.1 points out that as of Jan 2006 I&I flow was still excessive in the Poulsbo system.

The Peaking Factor used in table 2-6 i.e. 4.02 seems high. With the data given there is no direct way to calculate this but comparing the ratio between Poulsbo's wet season average monthly flow for Jan. '06, 1.10 mgd (table 2-5) and the peak hourly flow for '06, 2.70 (table 2-6), which is 2.45, with the ratio between the USEPA figures for high groundwater conditions and storm events, 120 and 275 gpcd, a ratio of 2.29 (paragraph 2.4.2), we see that Poulsbo's peak flows are high.

Paragraph 7.4.1 says that "I&I reduction will be a high priority--".
Paragraph 7.4.1.2 says that "An approximately $20,000 budget is allocated --" for identifying and repairing inflow sources. THAT'S PEANUTS.
The next paragraph says that $110,000is provided in 2009 for I&I assessment and possibly design of capacity improvements. TOO LITTLE AND TOO LATE.

Allan Saunders

City of Poulsbo,

I would like to follow Allan's comments on I & I and flow growth in general.

Table ES-2 provides summary flow rate projections for "Executive" review. I believe it overstates the estimates of future flows for the following reasons:

GALLONS PER CAPITA PER DAY

1) the gallons per capita per day should not be on the increase. New appliances and plumbing are more efficient and utilize less water.

2) I & I per capita will decrease since the newly built houses and infrastructure will not be susceptible to nearly as much I & I. Note:

Design goal is no I & I. There will be 9000 to 17000 (double to triple) more water efficient homes in 2050. This should reduce the I & I per capita by half (moderately improved old I & I and twice as many "capitas")
Conclusion: The per capita I & I for the out years should not be 91 but more like something in the 80's.

PEAKING FACTOR

As discussed above all new infrastructure and homes will have absolutely minimal I & I. This will reduce the peaking factor (ratio of peak flow to base flow). As the base flow increases due to new water efficient homes (as in double or triple by 2050), the I & I portion of peak flow will reduce slightly due to Poulsbo's I&I program. The peaking factor ratio could gradually drop below 3.0 in 2050 vice the 4.1 presented.

Using the 2006 peak flow (which includes base flow of .67mgd for the 2006 calculation year) and a doubled 2050 population in water efficient homes (which adds an additional .67mgd; a peaking factor 1st order approximation for 2050 would look like:

Current Peak Flow plus an additional 'average daily rate' (for 2006) of .67 mgd (to account for the twice people) divided by twice the current average daily flow (to account for doubling of the population in 2050) equals peaking factor for 2050 Or (2.7 + .67) divided by (2 x .67) = 2.5 peaking factor.

WEST SIDE ALTERNATIVE

The west side alternative was never meant to be the only conveyance; we applauded the proposal that included completely redundant path. I suspect that the City wished to make it a completely impractical alternative by mandating that the new West side proposal include vacating the Lemolo Siphon. When I dropped the expenses associated with vacating the Lemolo Siphon, I came out with $29,450K vice the $52,034K presented in the Draft Plan. A redundant West Side conveyance should still be in play.

POTENTIAL CAPACITY UPGRADES TO EXISTING

5.3.1 We need to have the City/County explain the details of how they plan to push the siphon to 4.4 and 5.1 mgd.

Don Anderson

City of Poulsbo,

Just a bit concerned about two things:

1. Poulsbo Public Works wants to believe that the inflow problem is at the manholes. (questionable)

2. The program calls for "slip lining" after pressurizing on the assumption that the technology will improve in the two year lapse. (maybe)

Tom

City of Poulsbo,

I still think that the cost estimates for the slip lining projects are unrealistic, please confirm

Luis

APPENDIX E

Downstream Conveyance Capacity Documentation

Kitsap County Department of Public Works
614 Division Street (MS-27), Port Orchard, WA 98366-4699
R.W. Casteel, P.E., Director

RECEIVED
MAR 05 2007
By Bremerton

March 2, 2007

Phil Struck
Parametrix
4660 Kitsap Way
Bremerton, WA 98312

RE: City of Poulsbo Comprehensive Sewer Plan Update
<u>Kitsap County Conveyance System Capacity Downstream of Poulsbo</u>

Dear Phil,

I have reviewed your letter dated February 26, 2007 and concur with the contents. The County's conveyance system has adequate capacity (3.2 mgd) in the near term to accommodate City wastewater flows. Determining capacity through the 20-year planning horizon will require additional analysis and coordination between the City and County.

Please feel free to contact me at (360) 337-4896 if you have any questions.

Sincerely,

Barry K. Loveless

Barry K. Loveless, P.E.
Senior Program Manager-Wastewater

Parametrix

ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCE

4660 KITSAP WAY, SUITE A
BREMERTON, WA 98312
T. 360 . 377 . 0014 F. 360 . 479 . 5961
www.parametrix.com

February 26, 2007
236-2237-026 01/01

Mr. Barry Loveless
Kitsap County Department of Public Works
614 Division Street
Port Orchard, WA 98366

Re: City of Poulsbo Comprehensive Sewer Plan Update
Kitsap County Conveyance System Capacity Downstream of Poulsbo

Dear Barry:

The City of Poulsbo is in the process of finalizing its Comprehensive Sewer Plan (CSP) and has retained Parametrix, Inc. to provide technical assistance. The Department of Ecology (Ecology) has informed the City that the final plan must document that the County's conveyance system has adequate capacity for wastewater flows generated by the City. The purpose of this letter is to therefore request confirmation from Kitsap County on conveyance system capacity.

Existing Capacity

We understand that recent pressure tests performed by the County determined the existing capacity of the Lemolo siphon is 3.2 mgd. We also understand that Pump Station 16 in Keyport has a capacity of 3.8 mgd with two of the three pumps operating (firm capacity as required by Ecology). The capacity of the existing system is therefore limited by the siphon to 3.2 mgd.

Future Potential Capacity

We understand that there are several actions that have potential to increase the capacity of the County's conveyance system, subject to additional engineering analysis and concurrence by Ecology. Reports prepared by Kitsap County have concluded that with the installation of a third air and vacuum valve, the capacity of the two siphons could increase to between 4.4 to 5.1 mgd, depending on the condition of the interior walls of the pipe. We understand that an additional pressure test and concurrence from Ecology would be needed to verify that this increase in capacity is feasible.

We also understand that under other operating scenarios, the capacity of Pump Station 16 could be as high as 4.5 mgd. Additional study and confirmation from Ecology would also be needed before this additional capacity can be verified as available.

Parametrix

City of Poulsbo Flow Projections

The City's most recent flow estimates (May 2005) show existing peak hourly flows of about 2.1 mgd, and projected flows in 2025 of about 3.8 mgd. We are currently reviewing these flow estimates as part of the CSP process. However, it appears at this time that peak flows from the City may exceed 3.2 mgd (existing capacity) within approximately 10-years. The City will be evaluating options for addressing conveyance capacity issues as part of the CSP currently being prepared, and will coordinate with Kitsap County on potential long term alternatives for ensuring adequate capacity is available.

Summary and Conclusion

Based on the information presented in this letter, we conclude that the County's conveyance system has adequate capacity (3.2 mgd) in the near term to accommodate City wastewater flows. Determining capacity through the 20-year planning horizon will require additional analysis and coordination between the City and County.

We appreciate your review of this letter and would appreciate a response by February 28, 2007 if at all possible, Please contact me anytime at (360) 377-0014 or Andre Kasiniak at (360) 779-5111 if you have any questions or need additional information.

Thank you.

Sincerely,
PARAMETRIX, INC.

Phil Struck
Project Manager

Attachment

cc: Jeff Bauman, Public Works Director
Andre Kasiniak, P.E., City Engineer

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

September 11, 2006

Mr. Andrzej Kasiniak, P.E.
Project Engineer
City of Poulsbo
P O Box 98
Poulsbo, WA 98370

Dear Mr. Kasiniak:

RE: Approval of Plans and Specifications for Bond Road Pump Station, Poulsbo, Washington; Parametrix, January 2006

The above-referenced plans and specifications were submitted by the City of Poulsbo (City) to the Department of Ecology (Department) for review and approval.

In a letter dated April 7, 2006, regarding plans and specifications for the *Bond Road Pump Station and SR 305 Force Main* project, the Department notified the City that the plans and specifications for the project could not be approved until the City could show to the Department's satisfaction that adequate capacity is available downstream for conveyance and treatment of additional sewage flows that would be generated after completion of these projects. This was due to the limitations in the capacity of Kitsap County's sewage conveyance system (Liberty Bay Sewer Undercrossing) downstream of the City of Poulsbo's connection. As you know, the west siphon of the undercrossing failed to meet the allowable leakage criteria during the pressure test conducted by Kitsap County in October 2002.

From June 2006 through August 2006, Kitsap County tested, repaired, and retested the west siphon for leakage under pressure. On August 18, 2006, the Department received a memorandum from Kitsap County discussing the results of the pressure test conducted by the County on August 14, 2006. The pressure test was conducted on the full length of the west siphon across Liberty Bay. The test results show that the make-up water required after the 2-hour test was lower than the allowable leakage as specified in *Criteria for Sewage Works Design, Department of Ecology, December 1998.* The County concluded that the west siphon passed the pressure test conducted on August 14, 2006. Based on the pressure test results presented in Kitsap County's August 15, 2006 memorandum to the Department, the west siphon of the undercrossing meets the Department's criteria for allowable leakage. This determination is made under the proviso that the pipes in the Liberty Bay Sewer Undercrossing are used in the siphon mode only.

In accordance with the Revised Code of Washington (RCW) 90.48.110, and Washington Administrative Code (WAC) 173-240-010 through 180, the Department of Ecology hereby approves the above-referenced plans and specifications with the condition that the City of Poulsbo shall own, operate and maintain the Bond Road pump station. This approval of the Bond Road Pump Station plans and specifications is conditioned upon the use of the Liberty Bay Sewer Undercrossing in the siphon mode only.

If you have any questions, please contact Mike Dawda of my staff at telephone number (425) 649-7027. I can also be reached at (425) 649-7033.

Sincerely,

Kevin C. Fitzpatrick

Kevin C. Fitzpatrick
Water Quality Section Manager

KCF:MD:bl
cc: Barry Loveless, Kitsap County Public Works

MEMORANDUM

To: Mike Dawda
Washington State Department of Ecology

From: Barry K. Loveless, PE
Kitsap County Public Works

Date: August 15, 2006

Re: Liberty Bay Sewer Undercrossing
Hydrostatic Pressure Testing, Results, August 14, 2006

Kitsap County successfully pressure tested the Liberty Bay sewer undercrossing West siphon on June 28, 2006. Following this test, the County replaced approximately 300 LF of the west pipeline from the flow divider manhole to the joint near the beach where the pressure test of the undercrossing was performed. This length of pipe has been most susceptible over the years to hydrogen sulfide corrosion due to standing sewage in the pipe and exposure to the atmosphere in this section. It was suspected by the successful undercrossing pressure test, that the likely reason the west pipeline failed the previous pressure test in 2002 was due to corrosion in this section of the pipe.

This section of the pipe was replaced from August 7 to 11, 2006 with 12" PVC C900 pipe. See attached construction photos. Another pressure test on the complete west pipeline "system" from the flow divider manhole in Lemolo to Pump Station No. 16 in Keyport was conducted on August 14, 2006 in accordance with the attached testing protocol.

Hydrostatic pressure testing of the 12" D.I. and PVC C900 West Siphon Liberty Bay Sewer Undercrossing was performed on August 14, 2006.

Results: **<u>12" D.I. and PVC C900 Pipe (West)</u>**
Passed 08-14-06

On 08-14-06, the West 12" D.I. and PVC C900 Pipe successfully passed the 40 psi hydrostatic pressure test. During the 40-psi/120 minute test some minor losses were observed. The actual make-up water required after 2-hour final test was 0.75 gallons, as compared with a calculated allowable of 2.26 gallons.

This memorandum is intended to serve as a record of events and documentation of results.

ATTACHMENTS:

- Photographs of PVC C900 replacement work
- Pressure Test Protocol dated July 18, 2006
- Photographs of pressure testing procedures

TECHNICAL MEMORANDUM

To: Mike Dawda
Washington State Department of Ecology

From: Barry K. Loveless, PE
Kitsap County Public Works

Date: July 18, 2006

Re: Lemolo Sewer and Liberty Bay Sewer Undercrossing Pressure Test Protocol

---

Purpose and Scope

This memorandum has been prepared to recommend procedures for pressure testing of the repaired existing west Liberty Bay sewer undercrossing. The tests will be conducted by County Staff.

Liberty Bay Sewer Undercrossing

The Liberty Bay sewer undercrossing consists of two (east and west) 12-inch ductile iron pipes approximately 1,900 feet long between the flow divider manhole in To-Ke-Tec Road just north of Yoot-Skut Road in Lemolo and Pump Station No. 16 in Keyport. Pipeline elevations taken from record drawings are shown in Table 1.

TABLE 1

Liberty Bay Undercrossing Elevations

Location	Elevation
Johnson Way Metering Manhole	40'
Flow Divider Manhole	15'
North Side Joint of Replaced Pipe	2'
Lowest Point Under Bay	-57'
Pump Station No. 16	0

Previous Test

The west undercrossing was tested on June 28, 2006 by County Staff, and a test report of forwarded to DOE. During this test, a pressure of 150-psi was applied for a duration of 2 hours at the North side joint of replaced pipe. This would have resulted in a pressure of 176-psi at the lowest point under the bay. The pipe successfully passed all incremental and the ultimate 150-psi test.

Objectives of Proposed Test

Following the successful pressure test of the undercrossing, the County plans to replace approximately 300 LF of the west pipeline from the flow divider manhole to the joint near the beach where the pressure test of the undercrossing was performed. This length of pipe has been most susceptible over the years to hydrogen sulfide corrosion due to standing sewage in the pipe and this length being exposed to atmosphere. It was suspected, and proven by the recent successful undercrossing pressure test, that the likely reason the west pipeline failed the previous pressure test in 2002 was due to corrosion in this section of the pipe. Once this section of the pipe has been replaced, it is appropriate to perform another pressure test on the complete west pipeline "system" from the flow divider manhole in Lemolo to Pump Station No. 16 in Keyport.

Test Duration

The current edition of the Washington State Department of Ecology *Criteria For Sewage Works Design* requires sewer leakage testing for new sewer construction to be performed in accordance with the Washington State Department of Transportation and the Washington State Chapter of the American Public Works Association (Standard Specifications). The Standard Specifications do not, however, include any test duration requirements for testing of sewers. Leakage testing for water mains in the Standard Specifications is specified to be for a 15-minute duration.

In order to maintain consistency with the pressure testing of 2002 and this year, a 2-hour test duration is recommended.

Test Pressures

The *Criteria For Sewage Works* Section C2-3.7) requires newly constructed force mains to be tested at a pressure at least 50 percent greater than the pressure under which they will operate. The *Criteria For Sewage Works* Section C1-5.4) also requires states that gravity pipelines subject to hydraulic pressure be tested at a pressure 150-psi in excess of that under which they will operate, but not less than 200 psi. Because Liberty Bay undercrossing acts as a force main, the force main criteria described in Section C2-3.7 seems more applicable.

As mentioned previously the undercrossing was recently successfully tested at 150 psi (176 psi at the lowest point) and this is over five times the normal operating pressure of the line (27 psi). In addition the, the *Criteria For Sewage Works* test pressure are for new construction. The Liberty Bay undercrossing was constructed in 1977 and we do not know what design criteria were used at the time. Some deterioration can be expected to have occurred over the succeeding 29 years. Continuing to apply excessive pressures many times more than normal operating pressures will threaten the longevity of this critical piece of sewer infrastructure that appears to have many more years of useful life based upon recent testing and CCTV inspection.

In order to meet future City of Poulsbo flow requirements the sewer line from the Johnson Way metering manhole under Liberty Bay to Keyport may sometime in the future be sealed and put under additional gravity pressure, thereby acting as a force main for the entire length of approximately 8000 LF. Table 2 shows potential future operating pressures for this scenario.

TABLE 2
Potential Future Operating Pressures on Lemolo Sewer/Liberty Bay Undercrossing

Location	Elevation	Future Resulting Gravity Pressure
Johnson Way Metering Manhole	40'	0
Flow Divider Manhole	15'	10.8 psi
North Side Joint of Replaced Pipe	2'	16.5 psi
Lowest Point Under Bay	-57'	42.0 psi
Pump Station No. 16	0	17.3 psi

As shown in Table 2, the potential future operating pressure for the section of pipe that will be replaced is between 10.8 and 16.5 psi. A pressure test of 50% greater than potential future operating pressure would be approximately 17 to 25 psi. Therefore, a reasonable test pressure for the complete west pipeline "system" from the flow divider manhole in Lemolo to Pump Station No. 16 in Keyport is 40 psi. This will also cause the lowest point under the Bay to realize a pressure of 71 psi, which is also more than 50% greater than potential future operating pressure for the undercrossing.

Equipment
Equipment similar to that used in the previous test will be used.

- Blind flange to seal the end of the pipe at Pump Station No. 16.
- Pump to apply and maintain the required pressure at the end of the newly constructed pipe near the flow divider manhole.
- Vented cap to stop the flow at the end of the newly constructed pipe near the flow divider manhole.
- Calibrated pressure gauge having a range to accurately indicate the pressure in the pipe.
- Calibrated cylinder to measure the quantity of makeup water to allow the quantity of leakage, if any, to be measured.
- A watch to monitor test time.
- Piping, hose, valves, fittings, and appurtances.

Procedures
The test will be conducted as follows.

- A maximum test pressure of 40 psi shall be held for a period of two hours.
- Isolate the pipe by installing the blind flange at Pump Station No. 16 and installing the vented cap at the end of the new line near the flow divider manhole.
- Fill the pipe completely with water and vent air at the pump station and the flow divider manhole.

- Pressurize the pipe at 40 psi and maintain for two hours.
- If the pressure has dropped at the end of two hours, the pipeline shall again be pumped to 40 psi and the volume of any makeup water shall be recorded and compared with the allowable leakage.
- If the volume of makeup water only marginally exceeds allowable leakage the test shall be repeated to verify results.

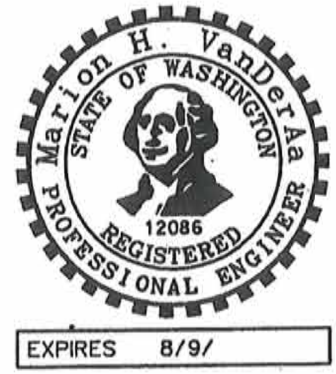
Allowable Leakage
The maximum allowable leakage during each hydrostatic pressure test shall be as specified in the *Criteria For Sewage Works* (Section C2-3.7). The allowable leakage for a 12-inch pipe based upon an estimated 110 pipe joints has been pre-calculated at the pressure and duration which will be employed during testing as follows:

L = ((110 joints)(12 inches)(SQRT (40 psi)))/7400

L =1.13 gallons/hour

2-Hour Test: L = 2.26 gallons

Existing Lemolo Pipeline and Pump Station No. 16 Analysis



PREPARED FOR: Kitsap County

PREPARED BY: Marion H. (Bud) VanDerAa, P.E.
Tina Hastings, E.I.T.

DATE: July 9, 2001

As requested by Kitsap County, CH2M HILL has performed an analysis to estimate the flow capacity of the existing Lemolo pipeline and Pump Station No. 16. The results of that analysis are presented in this technical memorandum. Information on the Lemolo Pipeline and Pump Station No. 6 used for the analysis and presented below was obtained from record drawings of those facilities, site observations, and from County operations staff.

Lemolo Pipeline

The Lemolo pipeline extends south from Manhole 3 just south of SR 305 across Liberty Bay and discharges to Pump Station No. 16 which is located on the south shore of Liberty Bay. The northerly 4,075 feet is 14-inch ductile iron pipe. The remainder consists of dual 12-inch ductile iron pipe. There are valves at the transition between the single 14-inch and the dual 12-inch pipes to direct flow to either or both of the 12-inch pipes. The pipeline is gravity/pressure, that is the flow is produced by the difference in elevation of the discharge to Pump Station No. 16 and the upstream end at Manhole 3. Topography along the pipeline alignment results in two reaches of the 14-inch pipe and the southerly ___ feet of the dual 12-inch pipelines always being full. The rest of the pipeline may be full only at high flows. The 14-inch pipeline is open to the atmosphere between Manhole 3 and Liberty Bay at two locations along Tuk-Wil-La Road. These vents are for the purpose of allowing air to enter and escape from portions of the pipeline that are not always full.

The analysis was performed using the Hazen-Williams formula. Since the condition of the pipeline interior (mainly solids accumulation, etc.) is not known, the analysis was performed using values of the coefficient "C" of 110, 120, and 130 to identify a range of conditions. The lower the value of "C" (more solids accumulation, etc.) the more resistance to flow in the pipeline and thus the lower the pipeline's flow capacity. The "C" = 110 and "C" = 130 conditions do not necessarily represent the worst and best case conditions, respectively The condition may actually be worse or better, yielding a lower or higher flow capacity than those shown here. It was assumed for the analysis that the existing pipeline vents were sealed and fitted with air and vacuum valves to prevent sewage from escaping if the hydraulic grade rose above the ground surface.

The results of the analysis are as follow:

Value of "C"	Flow Capacity
130	5.1 million gallons per day
120	4.8 million gallons per day
110	4.4 million gallons per day

The analysis also showed that a third air and vacuum valve will need to be installed near the intersection of Yoot-Skut Road and To-Ke-Tec Road to obtain maximum flow through the pipeline. The values shown above are based on the third air and vacuum valve being in place.

Pump Station No. 16

Pump station No. 16 is a factory-made wet well/dry well station located on the south shore of Liberty Bay. It has three pumps of the same make and model, each rated for 950 gallons per minute at 114 feet of total head. Data provided by the County for tests of these pumps conducted by Brown and Caldwell Consultants show the following:

Pump Number	Flow In Gallons Per Minute	Total Dynamic Head In Feet
1	1,051	88
1	0	170
2	1,001	88
2	0	169
3	968	86
3	0	176

The head for zero flow is called the shutoff head. This data is of special importance because for most pump testing, pressures can be readily measured while flow measurement is usually more difficult and more uncertain. Shutoff is a condition where the flow is certain. The County also provided published factory performance curves for the pumps. Data for flow values do not match the published factory performance curves very well whereas the shutoff data more closely match the published curves. Shutoff head data indicate better performance (greater pumping capacity) than does the flow value data. Two conditions of pump performance were evaluated. One condition was pump performance estimated based on the pump test data together with the general characteristics shown by the manufacturer's published curves. The second condition was pump performance as shown by the manufacturer's published curves.

Pump Station No. 16 originally pumped to Pump Station No. 15 with flow from Bangor entering the force main between Pump Station No. 16 and Pump Station No. 15 at Tagholm

Road. Pump Station No. 15 has recently been abandoned and Pump Station No. 16 now pumps to Pump Station No. 24 which is approximately 1,600 feet closer to Pump Station No. 16 and 60 feet lower than Pump Station No. 15. The effect, especially because of the lower elevation of Pump Station No. 24 is a large decrease in the pumping head at Pump Station No. 16. Pump Station No. 16 also used to pump sewage from Keyport as well as from Poulsbo. Pump Station No. 67 has subsequently been built to pump almost all of the Keyport and discharges to the force main between Pump Station No. 16 and Pump Station No. 24.

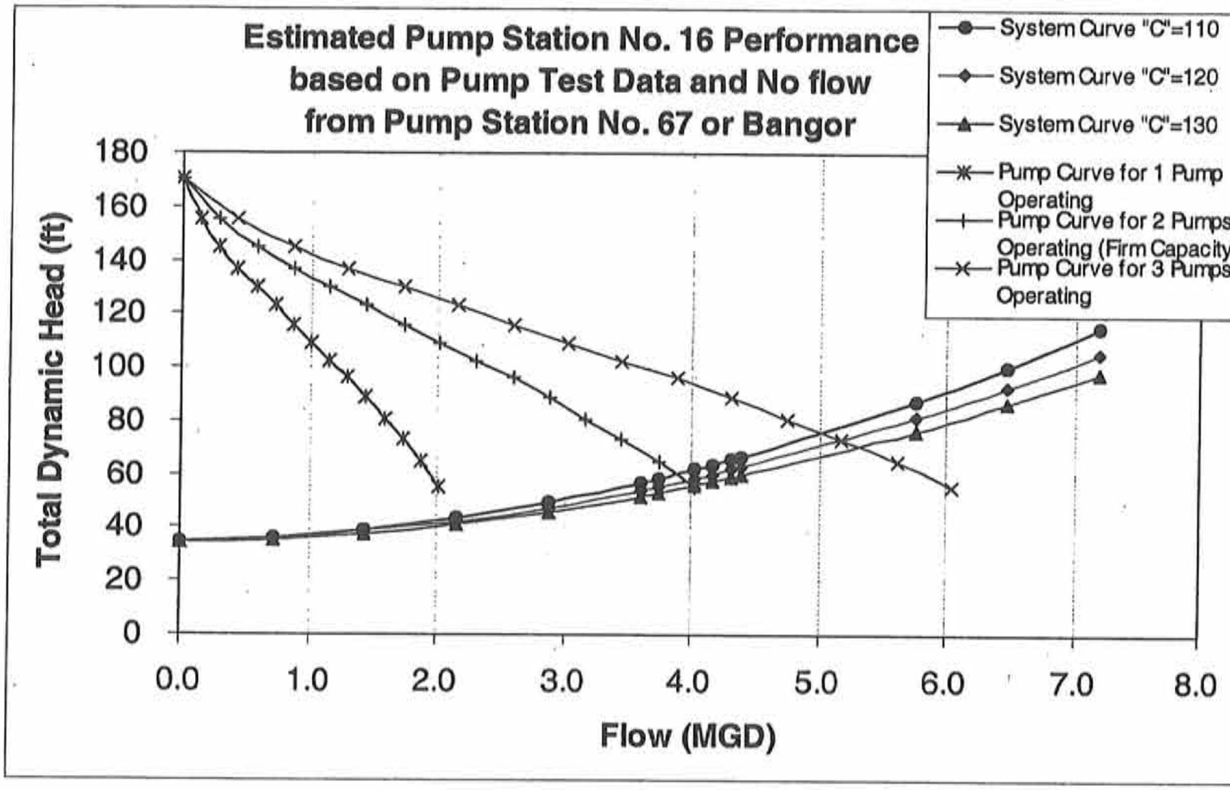
The analysis was performed for two conditions. One condition was Pump Station No. 16 pumping with no flow from Pump Station No. 67 or from Bangor. The other condition was for Pump Station No. 16 operating when 1.1 mgd (million gallons per day) was being pumped by Pump Station No. 67 and 3.0 mgd from Bangor is also being discharged to the force main. The three "C" values used for the Lemolo pipeline analysis were also used for the Pump Station No. 16 analysis.

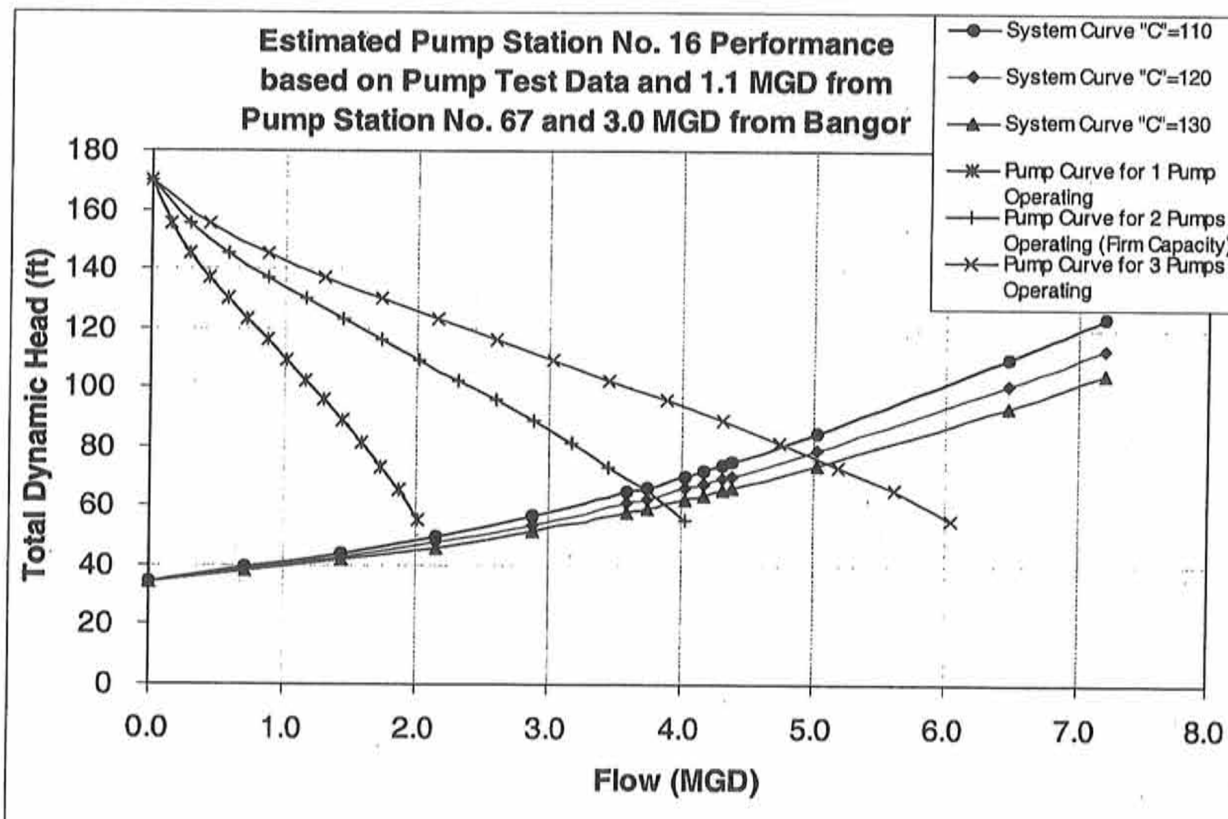
The results of the Pump Station No. 16 analysis are shown on the four charts at the end of this memorandum. Pump performance curves for 1, 2, and three pumps operating together with system curves for the three values of "C" are plotted. The "firm capacity" of the pump station, as required by the Washington Department of Ecology, is it's flow capacity assuming that the largest pump is out of service (Criteria for Sewage Works Design, C2-1.2.3). Since all three pumps are identical, the firm capacity is the flow capacity of any two pumps. The analysis also included, however, evaluation of the condition of all three pumps operating. The first two charts are for pump performance based on the pump tests and the second two charts are for pump performance as shown by the manufacturer's published curves. Estimated Pump Station N0. 16 flow capacities for various conditions are summarized in Table 1.

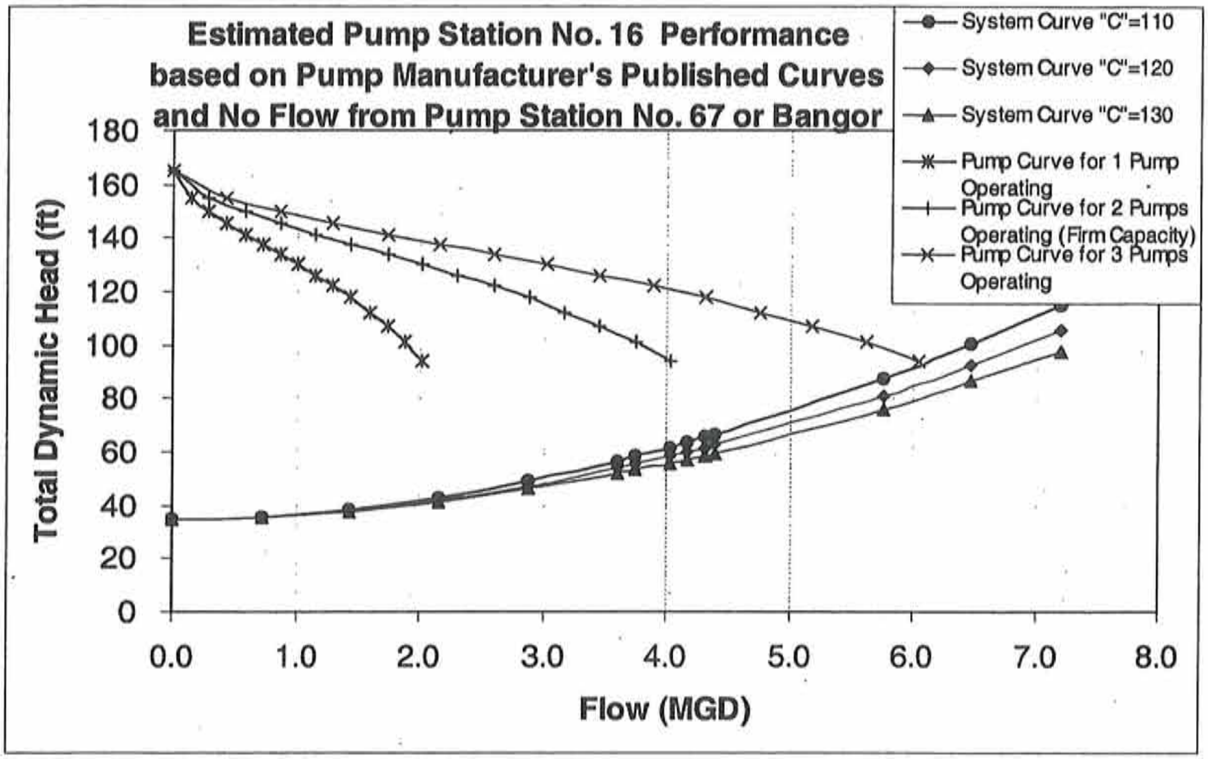
TABLE 1
Pump Station N0. 16 Analysis

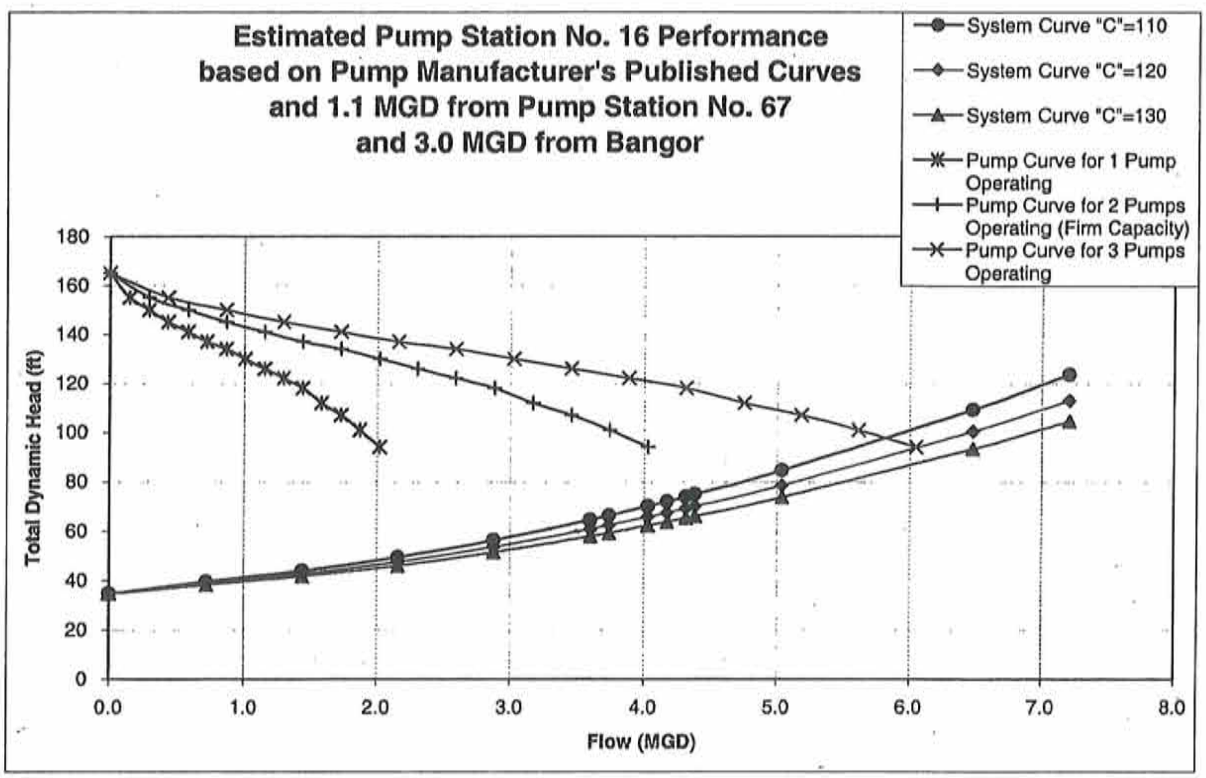
Condition	Firm Pumping Capacity (mgd) [1]	Pumping Capacity With All Pumps Operating (mgd) [1]
Pump performance based on pump test data, no flow from Pump Station No. 67 or from Bangor	4.0	5.1
Pump performance based on pump test data, 1.1 mgd from Pump Station No. 67 and 3.0 mgd from Bangor	3.8	5.0
Pump performance based on manufacturer's published curves, no flow from Pump Station No. 67 or from Bangor	4.6	6.2
Pump performance based on manufacturer's published curves, 1.1 mgd from Pump Station No. 67 and 3.0 mgd from Bangor	4.5	6.0

[1] Based on Hazen-Williams coefficient "C" =120. See charts for variation of capacity for "C" = 110 and "C" = 130.


Estimated Pump Station No. 16 Performance based on Pump Test Data and No flow from Pump Station No. 67 or Bangor
System Curve "C"=110
System Curve "C"=120
System Curve "C"=130
Pump Curve for 1 Pump Operating
Pump Curve for 2 Pumps Operating (Firm Capacity)
Pump Curve for 3 Pumps Operating
Total Dynamic Head (ft)
0
20
40
60
80
100
120
140
160
180
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Flow (MGD)


Estimated Pump Station No. 16 Performance based on Pump Test Data and 1.1 MGD from Pump Station No. 67 and 3.0 MGD from Bangor
System Curve "C"=110
System Curve "C"=120
System Curve "C"=130
Pump Curve for 1 Pump Operating
Pump Curve for 2 Pumps Operating (Firm Capacity)
Pump Curve for 3 Pumps Operating
Total Dynamic Head (ft)
0
20
40
60
80
100
120
140
160
180
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Flow (MGD)


Estimated Pump Station No. 16 Performance
based on Pump Manufacturer's Published Curves
and No Flow from Pump Station No. 67 or Bangor
System Curve "C"=110
System Curve "C"=120
System Curve "C"=130
Pump Curve for 1 Pump Operating
Pump Curve for 2 Pumps Operating (Firm Capacity)
Pump Curve for 3 Pumps Operating
Total Dynamic Head (ft)
0
20
40
60
80
100
120
140
160
180
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Flow (MGD)


Estimated Pump Station No. 16 Performance
based on Pump Manufacturer's Published Curves
and 1.1 MGD from Pump Station No. 67
and 3.0 MGD from Bangor
System Curve "C"=110
System Curve "C"=120
System Curve "C"=130
Pump Curve for 1 Pump Operating
Pump Curve for 2 Pumps Operating (Firm Capacity)
Pump Curve for 3 Pumps Operating
Total Dynamic Head (ft)
0
20
40
60
80
100
120
140
160
180
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Flow (MGD)

APPENDIX F

West Side Conveyance Analysis

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES

4660 KITSAP WAY, SUITE A
BREMERTON, WA 98312-2357
T. 360.377.0014 F. 360.479.5961
www.parametrix.com

TECHNICAL MEMORANDUM

Date:	October 10, 2007
To:	Andre Kasiniak, P.E., City of Poulsbo
From:	Phil Struck, Ken Brown
Subject:	Westside Sewer Routing Alternative Analysis
cc:	File
Project Number:	233-2237-026 (01/01)
Project Name:	Poulsbo Comprehensive Sanitary Sewer Plan

INTRODUCTION

The purpose of this Technical Memorandum (TM) is to evaluate two alternatives for routing some or all of the Poulsbo generated wastewater along the west side of Liberty Bay to the Central Kitsap County Wastewater Treatment (CKWWTP) plant located near Brownsville. The alternatives are:

1. **Alternative 1** would route all wastewater along the west side of Liberty Bay and therefore allow the elimination of the two Lemolo siphons. This would require reversing the wastewater flow through Poulsbo from a southerly flow (to the siphons) to a northerly flow (to the Lindvig pump station). The Lindvig pump station would send all wastewater through a new force main to Scandia and then on to the existing 20-inch main in SR 308.

2. **Alternative 2** would retain the siphons for all wastewater generated on the east side of Liberty Bay, and pump all wastewater from Olhava and Viking Way (starting at the Lindvig pump station) through a new force main to Scandia and then on to the existing 20-inch main in SR 308.

BACKGROUND

Kitsap County prepared and published the Final Supplemental Environmental Impact Statement (FSEIS) to the Final Environmental Impact Statement for the Central Kitsap County Wastewater Facilities Plan on December 7, 2000. This document evaluated six alternatives for conveying wastewater from Poulsbo to the CKWWTP. This TM relies heavily on data developed for the FSEIS.

The FSEIS evaluated several alternatives, one of which was Alternative 2 (Westside Option). This alternative routed existing wastewater through the siphons but routed all future wastewater generation along the west side of Liberty Bay in a future transmission main. This alternative is similar to the Alternative 2 described above.

The costs generated in the FSEIS are used as the technical basis in developing Alternative 1 described above. Costs for reversing the flow through the east side of Poulsbo have been developed by Parametrix.

Project Description—Alternative 1

Prior to the elimination of the siphons, a new conveyance pipe must be constructed from the Bond Road Pump Station south on Bond Road, and then south on Viking Way to SR 308 where it would tie into the transmission main from Subase Bangor. This main would cross Dogfish, Johnson, and Scandia Creeks. It would be a pressure main (assumed to be 18-inch, since Alt 2 proposed a 14-inch) from Bond Road to the crest of the hill south of Sherman Road and then a gravity main (probably 24-inch, since Alt 2 proposed an 18-inch) along Viking Way to SR 308.

All wastewater flow on the east side of Liberty Bay (essentially the City of Poulsbo) would have to be reversed to flow north. This would require a new pump station near Johnson Road, a larger pump station at Bond Road, and an upgraded pump station at Lindvig. Changes to the Village pump station may be required to inject wastewater into the reversed main nearer to the pump station. Figure 1 shows a schematic layout of this alternative.

Project Description—Alternative 2

No modifications to the existing wastewater collection system on the east side of Liberty Bay will be accomplished. The Bond Road pump station will be modified to pump to a new force main along the west side of Liberty Bay leading to the new Johnson Creek pump station. The pressure main along the west side of Liberty Bay will be similar to the Alternative 1 proposal except that it will be 14-inch diameter, as approved in the December 2000 FSEIS. The pump stations will be slightly smaller, but not significantly lower in cost.

Estimated Costs

Table 1 presents a summary of the estimated cost to construct the west side alternative, assuming elimination of the two siphons. Table 2 presents a summary of the estimated costs for a west side wastewater system assuming retention of the two siphons for carrying wastewater from the east side of Liberty Bay. Costs are based on the FSEIS estimates, and have been escalated to 2007 dollars.

Table 1. Conceptual Cost Estimate — Alternative 1 Elimination of Siphon

Project Description	Unit	Quantity	Cost	Comment
Mobilization	LS	1	$1,500,000	
Lemolo PS	LS	1	$1,000,000	
Force Main to SR 305	LF	3500	$270,000	
Johnson Road PS	LS	1	$2,500,000	
Force Main to Hostmark	LF	6500	$650,000	
Gravity main to Forest Rock	LF	4500	$450,000	
Forest Rock PS	LS	1	$4,000,000	
Force Main to Bond Road PS	LF	2000	$200,000	
Upgrade Bond Road PS	LS	1	$200,000	
Force Main to Johnson Creek PS	LF	8000	$960,000	
Johnson Creek PS (Ph 1)	LS	1	$4,500,000[1]	FSEIS cost was $3,211,000 in 1999
Johnson Creek PS (Ph 2)	LS	1	$2,125,000[1]	FSEIS cost was $1,518,000 in 1999
Force and Gravity Mains to Scandia Creek PS	LF	6500	$3,740,000[1]	FSEIS cost was $2,067,000 in 1999
Scandia Creek PS (Ph 1)	LS	1	$4,500,000[1]	FSEIS cost was $3,211,000 in 1999
Scandia Creek PS (Ph 2)	LS	1	$2,125,000[1]	FSEIS cost was $1,518,000 in 1999
Force Main to SR 308 20" Main leading to WWTP	LF	4000	$1,300,000[1]	FSEIS cost was $934,000 in 1999
Upgrade PS 24	LS	1	$950,000[1]	FSEIS cost was $677,000 in 1999
Modify MSC pump station	LS	1	$250,000	
Modify Village pump station	LS	1	$250,000	
Other modifications to reverse flow	LS	1	$1,000,000	
Subtotal Construction Cost			$32,470,000	
Construction contingency	20%		$6,494,000	
Total Construction Cost			$38,964,000	
Tax	8.5%		$3,312,000	
Permitting	6%		$2,340,000	
Engineering	12%		$4,676,000	
Total Project Cost			**$49,292,000**	

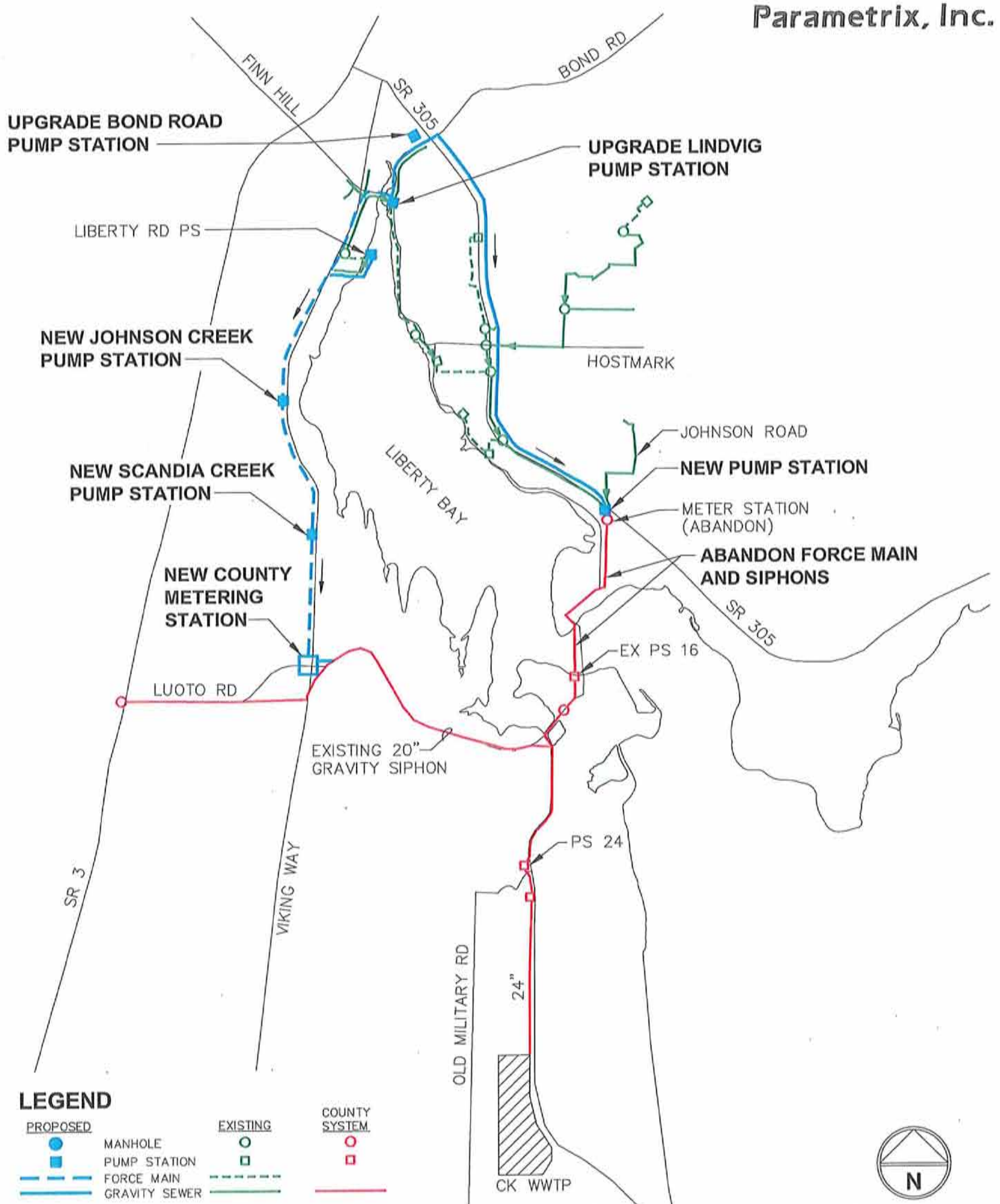
[1] Costs escalated 4% per year since 1999.

Table 2. Conceptual Cost Estimate — Alternative 2 Retain Siphon

Project Description	Unit	Quantity	Cost	Comment
Mobilization	LS	1	$1,000,000	
Force Main to Bond Road PS	LF	2000	$200,000	
Upgrade Bond Road PS	LS	1	$200,000	
Force Main to Johnson Creek PS	LF	8000	$920,000	
Johnson Creek PS (Ph 1)	LS	1	$4,500,000[1]	FSEIS cost was $3,211,000 in 1999
Johnson Creek PS (Ph 2)	LS	1	$2,125,000[1]	FSEIS cost was $1,518,000 in 1999
Force and Gravity Mains to Scandia Creek PS	LF	6500	$3,740,000[1]	FSEIS cost was $2,067,000 in 1999
Scandia Creek PS (Ph 1)	LS	1	$4,500,000[1]	FSEIS cost was $3,211,000 in 1999
Scandia Creek PS (Ph 2)	LS	1	$2,125,000[1]	FSEIS cost was $1,518,000 in 1999
Force Main to SR 308 20" Main leading to WWTP	LF	4000	$1,300,000[1]	FSEIS cost was $934,000 in 1999
Upgrade PS 24	LS	1	$950,000[1]	FSEIS cost was $677,000 in 1999
Subtotal Construction Cost			$21,560,000	
Construction contingency	20%		$4,312,000	
Total Construction Cost			$25,872,000	
Tax	8.5%		$2,200,000	
Permitting	6%		$1,550,000	
Engineering	12%		$3,094,000	
Total Project Cost			**$32,716,000**	

[1] Costs escalated 4% per year since 1999

Parametrix, Inc.



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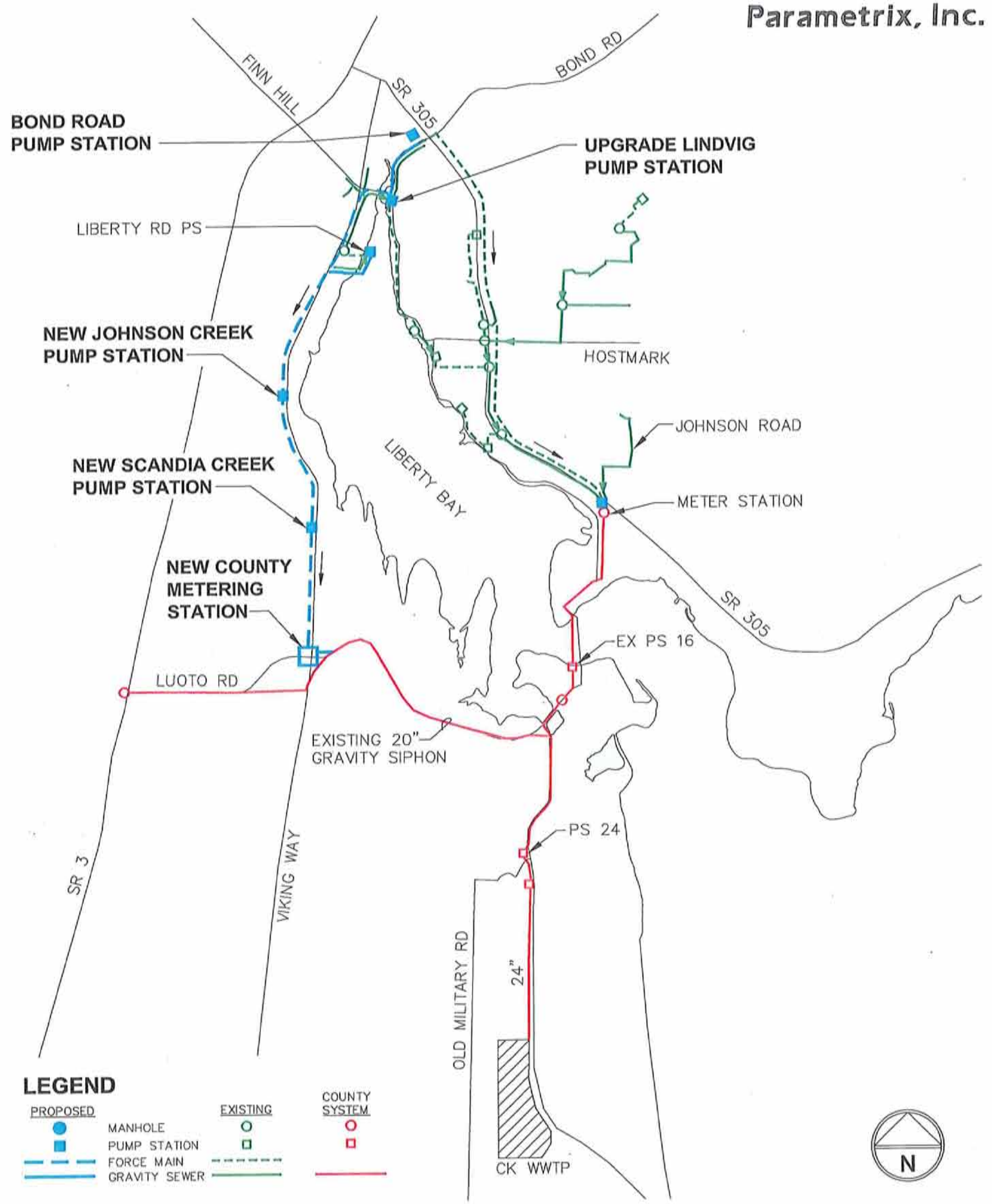
DATE: Feb 08, 2008 - 2:55pm PLOTTED BY: kugenrob XREF'S: XBR2237RD

CITY of POULSBO
COMPREHENSIVE SEWER PLAN

West Side
Sewer Alternative 1
Eliminate Siphons

FIGURE
1

Parametrix, Inc.



CITY of POULSBO
COMPREHENSIVE SEWER PLAN

West Side
Sewer Alternative 2
Retain Siphons

FIGURE
1

APPENDIX G

CIP Cost Estimates

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: Noll Road (North) Collection System

DESCRIPTION:
Construct new collection system in Noll Road between Lincoln Ave and Deer Park. Locate the northern 4,500 feet of pipe in Noll Road ROW. Where Noll Road turns west, route the pipe south to intersect with Noll Road where it turns back east. Route the pipe west along this section of Noll Road and discharge to the existing 10-inch DI pipe from Deer Park. Total length of this section of pipe is 5,300 feet. Most of the existing 10" pipe (about 2,500 feet) must be replaced with larger 15" diameter pipe due to the existing flat slope (0.5%).

JUSTIFICATION:
Required to allow development of Noll Road properties.

FUNDING: LID funding with Late Comer Agreements for Developers

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$90,000	$90,000
2	Temporary Erosion Control	1	LS	$30,000	$30,000
3	10" Sanitary Sewer	9800	LF	$50	$490,000
4	Manhole	36	EA	$3,000	$108,000
5	Pavement Repair	1	LS	$6,000	$6,000
6	Replace exist 10" with 15" main (pipe burst)	2500	LF	$45	$112,500
7	Traffic Control	1	LS	$35,000	$35,000
8	Cleanup and Restoration	1	LS	$20,000	$20,000
	Subtotal				**$891,500**
	Contingency	20%			$178,300
	Tax	8.6%			$76,669
	Construction Total				**$1,146,469**
	Pre Design and Permitting	8%			$91,718
	Design	12%			$137,576
	Total Project Cost (2007 dollars)				**$1,375,763**
	Escalate to 2008 at 5% per year	5%			$68,788
	Total Project Cost (2008 dollars)				**$1,444,551**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Noll Road (South) Collection System

DESCRIPTION:
Construct new collection system in Noll Road south of Deer Park for property at too low an elevation to discharge to the Noll Road North system. Place 3,300 lf of pipe in road terminating in a pump station wet well located at SR 305. Construct small pump station. Place 2,200 feet of force main in SR 305 terminating in the Chlorination manhole at Johnson Road.

JUSTIFICATION:
Required to allow development of Noll Road properties.

FUNDING: Developer

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$63,000	$63,000
2	Temporary Erosion Control	1	LS	$20,000	$20,000
3	8" Sanitary Sewer	3300	LF	$50	$165,000
4	Manholes	12	EA	$3,000	$36,000
5	Force Main	2200	LF	$40	$88,000
6	Pavement Repair	1	LS	$45,000	$45,000
7	Pump Station	1	EA	$150,000	$150,000
8	Traffic Control	1	LS	$50,000	$50,000
9	Cleanup and Restoration	1	LS	$10,000	$10,000
	Subtotal				**$627,000**
	Contingency	20%			$125,400
	Tax	8.6%			$53,922
	Construction Total				**$806,322**
	Pre Design and Permitting	8%			$64,506
	Final Design	12%			$96,759
	Total Project Cost (2007 dollars)				**$967,586**
	Escalate to 2014 at 5% per year	35%			$338,655
	Total Project Cost (2014 dollars)				**$1,306,242**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: South Viking Way Collection System

DESCRIPTION:
Construct new collection system to serve the south end of Viking Way. Place new pump station at low end of Anderson Lane. Install gravity main in Viking to collect uphill property west of Viking. Install gravity main down Norfinn and over to the new pump station. Install force main to connect to existing gravity system in Viking Way.

JUSTIFICATION:
Required to provide sewer service to existing homes and new developments west of Viking Way.

FUNDING: Developer

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$53,000	$53,000
2	Temporary Erosion Control	1	LS	$20,000	$20,000
3	8" Sanitary Sewer	3100	LF	$50	$155,000
4	Manholes	12	EA	$3,000	$36,000
5	Force Main	1300	LF	$40	$52,000
6	Pavement Repair	1	LS	$30,000	$30,000
7	Pump Station	1	EA	$150,000	$150,000
8	Traffic Control	1	LS	$25,000	$25,000
9	Cleanup and Restoration	1	LS	$10,000	$10,000
	Subtotal				**$531,000**
	Contingency	20%			$106,200
	Tax	8.6%			$45,666
	Construction Total				**$682,866**
	Pre Design and Permitting	8%			$54,629
	Final Design	12%			$81,944
	Total Project Cost (2007 dollars)				**$819,439**
	Escalate to 2014 at 5% per year	35%			$286,804
	Total Project Cost (2014 dollars)				**$1,106,243**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: Central Viking Way Collection System

DESCRIPTION:
Construct new collection system to serve properties located west of Viking Way that can flow by gravity to either the Liberty Road pump station or the Lindvig pump station. Gravity mains to be installed by developers as new property is developed.

JUSTIFICATION:
Required to provide sewer service to existing homes and new developments west of Viking Way in areas that can flow by gravity to existing pump stations. Properties west of Viking that cannot flow to the Liberty Road PS will be served by the Viking South project.

FUNDING: Developer

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$40,000	$40,000
2	Temporary Erosion Control	1	LS	$20,000	$20,000
3	8" Sanitary Sewer	4500	LF	$50	$225,000
4	Manholes	18	EA	$3,000	$54,000
5	Pavement Repair	1	LS	$30,000	$30,000
6	Traffic Control	1	LS	$20,000	$20,000
7	Cleanup and Restoration	1	LS	$10,000	$10,000
	Subtotal				**$399,000**
	Contingency	20%			$79,800
	Tax	8.6%			$34,314
	Construction Total				**$513,114**
	Pre Design and Permitting	8%			$41,049
	Final Design	12%			$61,574
	Total Project Cost (2007 dollars)				**$615,737**
	Escalate to 2009 at 5% per year	10%			$61,574
	Total Project Cost (2009 dollars)				**$677,310**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Replace 6th to 9th Pump Station Force Main

DESCRIPTION:
Replace the existing force main between the 6th Avenue pump station and the 9th Avenue pump station with a new 6 inch HDPE force main routed up Matson Street to the new Central Interceptor in SR 305. The existing force main could be retained and used as an emergency backup system.

JUSTIFICATION:
The existing AC force main along the waterfront is old and subject to failure. The 9th Ave pump station performance and efficiency is affected if pumping occurs while the line is full of effluent being pumped from the 6th Ave Station. Retain the existing force main as an emergency redundant backup.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$23,000	$23,000
2	Temporary Erosion Control	1	LS	$20,000	$20,000
3	6 inch HDPE force main	1300	LF	$70	$91,000
4	Pavement Repair	1	LS	$30,000	$30,000
5	Traffic Control	1	LS	$40,000	$40,000
6	Cleanup and Restoration	1	LS	$20,000	$20,000
	Subtotal				**$224,000**
	Contingency	20%			$44,800
	Tax	8.6%			$19,264
	Construction Total				**$288,064**
	Pre Design and Permitting	8%			$23,045
	Final Design	12%			$34,568
	Total Project Cost (2007 dollars)				**$345,677**
	Escalate to 2009 at 5% per year	10%			$34,568
	Total Project Cost (2009 dollars)				**$380,244**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: New FM between Lindvig and Bond Road Pump Stations

DESCRIPTION:
Install new 8-inch HDPE force main between the Lindvig Pump Station and the new Bond Road Pump Station. Locate in Bond Road.

JUSTIFICATION:
This project will allow sewage to be routed via the SR 305 force main so that the current beach force main to the Marine Science Center pump station can be used for emergency back up only.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$55,000	$55,000
2	Temporary Erosion Control	1	LS	$30,000	$30,000
3	8 inch HDPE force main	2400	LF	$100	$240,000
4	Jack across Viking Way	1	LS	$25,000	$25,000
5	Pump station tie in and upgrade	1	LS	$50,000	$50,000
6	Pavement Repair	1	LS	$50,000	$50,000
7	Traffic Control	1	LS	$70,000	$70,000
8	Cleanup and Restoration	1	LS	$30,000	$30,000
	Subtotal				**$550,000**
	Contingency	20%			$110,000
	Tax	8.6%			$47,300
	Construction Total				**$707,300**
	Pre Design and Permitting	8%			$56,584
	Final Design	12%			$84,876
	Total Project Cost (2007 dollars)				**$848,760**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Central Poulsbo I&I Reduction

DESCRIPTION:
Repair existing gravity sewer mains in Central Poulsbo (3rd Ave, 4th Ave, 5th Ave, Moe St, Lincoln, Hostmark, and Swanson Way). Accomplish by pipe bursting. Design plans were completed in 2003.

JUSTIFICATION:
Required to reduce infiltration and inflow by replacing existing mains by pipe bursting methods and by eliminating roof downspout drainage into the sewer system.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$75,000	$75,000
2	Pipe Burst 8-inch sewer	6050	LF	$40	$242,000
3	Pipe Burst or Replace Side Sewers	5360	LF	$35	$187,600
4	Open Cut side sewers	1335	LF	$35	$46,725
5	Manholes	30	EA	$3,000	$90,000
6	Pavement and Sidewalk Repair	1	LS	$65,000	$65,000
7	Traffic Control	1	LS	$15,000	$15,000
8	Cleanup and Restoration	1	LS	$20,000	$20,000
	Subtotal				**$741,325**
	Contingency	20%			$148,265
	Tax	8.6%			$63,754
	Construction Total				**$953,344**
	Permitting	2%			$19,067
	Final Design	5%			$47,667
	Total Project Cost (2007 dollars)				**$1,020,078**
	Escalate to 2008 at 5% per year	5%			$51,004
	Total Project Cost (2008 dollars)				**$1,071,082**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: Slipline Beach Force Main

DESCRIPTION:
Slipline the 8-inch force main between the Lindvig pump station and the Marine Science pump station with a 6-inch diameter HDPE line. Total length is 4,700 feet. Assume six access pulling points required.

JUSTIFICATION:
This project will repair the deteriorated ductile iron force main so that it can be used as a backup to the Bond Road pump station in an emergency.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$65,000	$65,000
2	Temporary Erosion Control	1	LS	$50,000	$50,000
3	6 inch HDPE force main	4700	LF	$60	$282,000
4	Access pull stations	6	EA	$35,000	$210,000
5	Cleanup and Restoration	1	LS	$30,000	$30,000
	Subtotal				**$637,000**
	Contingency	20%			$127,400
	Tax	8.6%			$54,782
	Construction Total				**$819,182**
	Pre Design and Permitting	10%			$81,918
	Final Design	12%			$98,302
	Total Project Cost (2007 dollars)				**$999,402**
	Escalate to 2013 at 5% per year	30%			$299,821
	Total Project Cost (2013 dollars)				**$1,299,223**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: 6th Ave Pump Station Upgrade

DESCRIPTION:
Rebuild pump station by replacing pumps and electrical systems, providing metering, and installing an emergency generator.

JUSTIFICATION:
Pump station is old and equipment is deteriorating. Replacement of major components is required.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$9,000	$9,000
2	Replace pumps and electrical controls	1	LS	$40,000	$40,000
3	Meter	1	LS	$5,000	$5,000
4	Emergency Generator	1	LS	$20,000	$20,000
5	Cleanup and Restoration	1	LS	$15,000	$15,000
	Subtotal				**$89,000**
	Contingency	20%			$17,800
	Tax	8.6%			$7,654
	Construction Total				**$114,454**
	Permits and Design	15%			$17,168
	Total Project Cost (2007 dollars)				**$131,622**
	Escalate to 2008 at 5% per year	5%			$6,581
	Total Project Cost (2008 dollars)				**$138,203**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: 9th Ave Pump Station Upgrade

DESCRIPTION:
Provide complete rebuild of pump station, including new pumps, valves, electrical control, flow metering, and telemetry.

JUSTIFICATION:
Pump station is old and equipment is deteriorating. Safety is a concern because the electrical float control contacts are directly above the wet well, which could result in ignition of sewer gases. Replacement of major components is required.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$15,000	$15,000
2	Replace pumps and electrical controls	1	LS	$70,000	$70,000
3	Flow metering	1	LS	$5,000	$5,000
4	Valves, telemetry and emergency generation	1	LS	$45,000	$45,000
5	Cleanup and Restoration	1	LS	$20,000	$20,000
	Subtotal				**$155,000**
	Contingency	20%			$31,000
	Tax	8.6%			$13,330
	Construction Total				**$199,330**
	Permits and Design	15%			$29,900
	Total Project Cost (2007 dollars)				**$229,230**
	Escalate to 2008 at 5% per year	5%			$11,461
	Total Project Cost (2008 dollars)				**$240,691**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Marine Science Pump Station Repair

DESCRIPTION:
Pumps are generally in good condition, but gate valves need replacement, as well as other minor repairs.

JUSTIFICATION:
Pump station is generally in good condition, but some repair and maintenance required to ensure reliability and safety.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$3,000	$3,000
2	Repair pump station	1	LS	$25,000	$25,000
3	Cleanup and Restoration	1	LS	$5,000	$5,000
	Subtotal				**$33,000**
	Contingency	20%			$6,600
	Tax	8.6%			$2,838
	Construction Total				**$42,438**
	Permits and Design	15%			$6,366
	Total Project Cost (2007 dollars)				**$48,804**
	Escalate to 2009 at 5% per year	10%			$4,880
	Total Project Cost (2009 dollars)				**$53,684**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Village Pump Station Repair

DESCRIPTION:
Provide repairs to pump station

JUSTIFICATION:
Pump station is generally in good condition, but some repair and maintenance required to ensure reliability and safety.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$5,000	$5,000
2	Repair pump station	1	LS	$40,000	$40,000
3	Cleanup and Restoration	1	LS	$5,000	$5,000
	Subtotal				**$50,000**
	Contingency	20%			$10,000
	Tax	8.6%			$4,300
	Construction Total				**$64,300**
	Permits and Design	15%			$9,645
	Total Project Cost (2007 dollars)				**$73,945**
	Escalate to 2009 at 5% per year	10%			$7,395
	Total Project Cost (2009 dollars)				**$81,340**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Purchase Portable Trash Pumps

DESCRIPTION:
Purchase portable trash pumps for use at the Bond Road, Lindvig and Marine Science Center pump stations.

JUSTIFICATION:
Trash pumps required to operate pump stations when the installed pumps are clogged or malfunctioning.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Purchase trash pumps	1	LS	$130,000	$130,000
	Subtotal				**$130,000**
	Contingency	20%			$26,000
	Tax	8.6%			$11,180
	Construction Total				**$167,180**
	Permitting	0%			$0
	Design	0%			$0
	Total Project Cost (2007 dollars)				**$167,180**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project: Replace Force Main between MSC PS and Harrison

DESCRIPTION:
Replace the 12-inch force main from the Marine Science Center pump station that runs south along the beach. Install new 12 inch main along Fjord Drive and tie to the existing 12 inch main at Harrison Street.

JUSTIFICATION:
The existing force main is buried on the beach and any leak or failure results in sewage discharge to Liberty Bay.

FUNDING: City of Poulsbo Sewer Utility

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$20,000	$20,000
2	Temporary Erosion Control	1	LS	$15,000	$15,000
3	12 inch HDPE force main	600	LF	$125	$75,000
4	Pavement Repair	1	LS	$20,000	$20,000
5	Traffic Control	1	LS	$35,000	$35,000
6	Cleanup and Restoration	1	LS	$20,000	$20,000
	Subtotal				**$185,000**
	Contingency	20%			$37,000
	Tax	8.6%			$15,910
	Construction Total				**$237,910**
	Permits and Design	15%			$35,687
	Total Project Cost (2007 dollars)				**$273,597**
	Escalate to 2011 at 5% per year	20%			$54,719
	Total Project Cost (2011 dollars)				**$328,316**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 3/20/07

Project:Finn Hill Collection System

DESCRIPTION:
Construct new collection system to serve the Finn Hill and Urdahl properties. A new gravity main in Finn Hill and in the south half of Urdahl will flow to a new pump station near SR 305. The pump station will lift the wastewater to the gravity system in front of Walmart, which will carry it to the Bond Road PS. Provide gravity sewers for the north half of Urdahl that can connect to the Olhava gravity system that flows to the Bond Road PS.

JUSTIFICATION:
Required to allow development of Finn Hill area properties. Developer funded.

FUNDING: Developer

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Mobilization (10%)	1	LS	$100,000	$100,000
2	Temporary Erosion Control	1	LS	$30,000	$30,000
3	8" Sanitary Sewer	8500	LF	$45	$382,500
4	10" Sanitary Sewer	1000	LF	$50	$50,000
5	Manhole	45	EA	$3,000	$135,000
6	4" Force Main	700	LF	$45	$31,500
7	Pavement Repair	1	LS	$30,000	$30,000
8	Pump Station	1	EA	$250,000	$250,000
9	Traffic Control	1	LS	$45,000	$45,000
10	Cleanup and Restoration	1	LS	$30,000	$30,000
	Subtotal				**$1,084,000**
	Contingency	20%			$216,800
	Tax	8.6%			$93,224
	Construction Total				**$1,394,024**
	Pre Design and Permitting	8%			$111,522
	Final Design	12%			$167,283
	Total Project Cost (2007 dollars)				**$1,672,829**
	Escalate to 2008 at 5% per year	5%			$83,641
	Total Project Cost (2008 dollars)				**$1,756,470**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: 2/19/07

Project: Repair or Replace Johnson Road Metering Station

DESCRIPTION:
Study the County's flow measuring flume to determine cause of reading failures above 2.5 mgd. Replace sonic reader or flume as determined by the study.

JUSTIFICATION:
The flume in the County's flow measuring manhole located at Johnson Way peaks out at 2.5 mgd during heavy rainfall events. The capacity of the Lemolo siphons is 3.2 mgd. It is not possible to determine how close to capacity the siphon is without accurate readings.

FUNDING: City of Poulsbo Sewer Utility and/or Kitsap County

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	Perform flume study	1	LS	$10,000	$10,000
2	Repair or replace flume	1	LS	$20,000	$20,000
	Subtotal				**$30,000**
	Contingency	20%			$6,000
	Tax	8.6%			$2,580
	Construction Total				**$38,580**
	Permits and Design	0%			$0
	Total Project Cost (2007 dollars)				**$38,580**

POULSBO COMPREHENSIVE SANITARY SEWER CIP
PROJECT SUMMARY SHEET

Date: **3/20/07**

Project: Engineering Report and Siphon Improvements Design

DESCRIPTION:
Evaluate effectiveness of I & I reduction program and if warranted, prepare a design report followed with design plans and specifications for sliplining the siphon, installing valves or any other recommendations of the study.

JUSTIFICATION:
Required to increase capacity and improve reliability of the Lemola siphon.

FUNDING: City

Item	Description	Quant./Units	Unit	Unit Cost	Total
1	I & I Assessment	1	LS	$25,000	$25,000
2	Design Report	1	LS	$25,000	$25,000
3	Design Plans	1	LS	$50,000	$50,000
	Subtotal (2007 dollars)				**$100,000**
	Escalate to 2009 at 5% per year	10%			$10,000
	Total Project Cost (2009 dollars)				**$110,000**

APPENDIX H

Johnson Road Metering Station Analysis

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TECHNICAL MEMORANDUM

Date:	February 6, 2008
To:	Andrzej Kasiniak, City of Poulsbo
From:	Phil Struck
Subject:	Johnson Road Metering Station Evaluation
cc:	Guy McCabe, PMX, file
Project Number:	236-2237-026
Project Name:	City of Poulsbo Comprehensive Sanitary Sewer Plan

SUMMARY

The Johnson Road Metering Station (JRMS) measures wastewater flow from the City of Poulsbo into the Kitsap County conveyance system. The JRMS is not currently able to record flows above 2.5 million gallons per day (MGD) due to flooding of the sonic measuring device in the existing Parshall flume, which is set at 14 inches. The sonic measuring device could potentially be raised about 4 inches and thereby measure flows up to approximately 3.2 MGD. However, at flows above 3.2 MGD, the capacity of the 18 inch diameter pipe just downstream of the existing flume is exceeded, the pipe floods and the resulting backwater effect floods out the existing flume. Options for improving flow measurement performance include:

- Relocate the JRMS ultrasonic sensor four inches higher than currently mounted, allowing the Parshall flume to measure to up to 3.2 MGD. The estimated cost to raise the existing metering device and recalibrate the system is $5,000.

- Remove the rock trap dam in the first manhole downstream of the JRMS to improve flow characteristics into the 14-inch pipe and reduce backwater into the JRMS. The estimated cost for this action is $5,000.

- Replace the current 175-foot section of 18-inch diameter pipe downstream of the JRMS with a 24-inch diameter PVC pipe. This would reduce backwater into the JRMS and increase flow capacity downstream of the JRMS. The estimated cost for design and construction is $68,000.

- Install a new flow metering station upstream of the JRMS consisting of a new Flow Dar sonic measuring device, with web based data delivery via wireless modem available to both the City of Poulsbo and Kitsap County. The estimated cost for equipment and installation is $25,000.

- Install a new in-line metering device in the 14-inch line downstream of the JRMS that is capable of measuring full pipe flow. Estimated installation cost for labor and materials is $35,000.

The lowest cost option is to raise the height of the existing meter sensor by 4 inches. This would improve peak flow measurement for about four years, but may result in loss of accuracy at normal to low flow. Flow measurement accuracy is an important consideration given the relatively large amount of cost associated with treatment fees (over $500,000 in 2006). This option also does not provide electronic data delivery to the City or County. This option is not recommended given the relatively short duration of improvements, potential reduction in measurement accuracy, and lack of electronic data delivery to City.

The potentially optimal combination of improvements may be installation of a new flow meter upstream of the JRMS, and replacement of 175-ft 18-in pipe with new 24-in diameter PVC pipe. This would allow for accurate flow measurement for both the City and County, reduction of uncertainty regarding the affect of downstream hydraulics on the existing flow meter, and increase capacity of the siphon due to improved hydraulics. This option could also be implemented in two phases, with phase 1 consisting of flow meter installation in the immediate short term, and phase 2 consisting of pipe replacement sometime before approximately 2012 when peak flows are expected to reach 3.2 MGD.

Because of the potential impacts to both City and County operations, we recommend that the City and County coordinate and jointly determine a set of actions that best addresses both short and long term needs and objectives.

INTRODUCTION

The JRMS measures wastewater flow from the City into the Kitsap County conveyance system. These flow measurements are used as the basis for determining treatment costs, performance of the City's inflow and infiltration (I&I) reduction program, and available capacity in the Lemolo siphon and downstream conveyance facilities owned by Kitsap County. The flume at the JRMS currently is able to measure flows only up to 2.5 million gallons per day (MGD). The flume should theoretically be able to measure flows up to 5.7 MGD. During peak rain events, flows exceed 2.5 MGD. The purpose of this Technical Memorandum is to evaluate the function and performance of the JRMS and determine why the flow meter does not record flows above 2.5 MGD, and develop recommendations for repair/retrofit.

BACKGROUND AND EXISTING CONDITIONS

The JRMS was installed in the late 1970's by Kitsap County as part of a 4,300-foot conveyance project that starts at the intersection of Johnson Road and State Highway 305 and connects with two 12-inch diameter siphons under Liberty Bay. The JRMS consists of a standard 9-inch Parshall flume installed in a manhole on Johnson Road. Incoming flows arrive via a 24-inch diameter RCP pipe and exit via an 18-inch RCP pipe. Fluid levels in the flume are measured by an ultrasonic measuring device located above the flume metering point set to read at a maximum depth of 14-inches. Flow depths are recorded as a percentage of the 14-inch depth on a seven day radial chart and also summed on a totalizer. The 14-inch depth represents a flow through the flume of about 2.5 MGD.

On a typical daily basis, the JRMS peak-hour flows run at about 5 inches deep through the flume (flows of about 0.6 to 0.8 MGD). However, during high precipitation periods, the rate of flow increases dramatically, the flume level raises to 14-inches and above, and the flow readings go off the recording chart. During the larger storms the JRMS will completely flood out as evidenced by water rings on the inside of the manhole.

The City collection system suffers from high rates of inflow and infiltration. Attachment (1) is a copy of the JRMS recording wheel for the week of 11/26/07 to 12/4/07. Subsequent to the onset of the recent December 3, 2007 storm, the level through the JRMS flume rose from it's normal reading of 45-percent, to an off the chart spike in excess of 100-percent in just 4-hours. This short response time spike is indicative of direct inflow into the system. Two hours later the reading stabilized at an 80-percent reading, and then gradually again rose off the chart and remained off the chart for 17-hours. This high flow is indicative of combined inflow and infiltration into the system. Recorded flows remained high for the next two days before normalizing as infiltration subsided.

Kitsap County staff have cleaned and calibrated the flume and flow monitoring device; however, no change was observed. The flume is 10 to 15-ft down and off set from the center line of the manhole, making observation of actual operations difficult. The existing metering system reports flow as weekly summary only. Peak day and peak hourly flow data is not available (Brown and Caldwell 2008).

ANALYSIS AND ALTERNATIVES

Analysis of the JRMS conducted for this TM consisted of the following activities:

- Coordination with Kitsap County Public Works staff to discuss existing conditions at the JRMS and downstream.
- Preliminary hydraulic analysis of the JRMS and near vicinity conveyance system.
- Review of recent JRMS flow measurements.
- Analysis of potential flow metering options.

Based on this analysis, the following alternatives were developed to address identified issues:

Reconfigure Existing Flow Meter

This option consists of relocating the JRMS ultrasonic sensor four inches higher than currently mounted. (Note: The ability to do this is dependent on how much overhead is available immediately above the metering point of the flume.) This will allow the Parshall flume to measure to up to 3.2 MGD (3.7 MGD after correction of the downstream hydraulic constraint – see discussion below). The estimated cost to raise the existing ultrasonic metering device and recalibrate the system is $5,000. As an alternative, a second ultrasonic sensor and recording device could be installed, if overhead clearance permits. Kitsap County personnel have indicated, however, that low-end accuracy may be sacrificed by raising the recording device.

Remove Downstream Obstruction

This option consists of removing the rock trap dam in the first manhole downstream of the JRMS to improve flow characteristics into the 14-inch pipe. The original design provided a rock trap dam and grate at this location. The grate no longer exists but the rock trap dam is still in place and, by design, interrupts flow through this manhole. We understand that a pipe sweeping pig launch has been added to the 14-inch diameter line such that the low points in that line are now periodically cleaned. Because of this the rock trap could be omitted, flow through the manhole potentially improved, and backwater into the JRMS reduced. Estimated cost to remove the dam is $5,000.

Increase Downstream Pipe Size

This alternative would replace the existing 175-foot section of 18-inch diameter RCP downstream of the JRMS with a new 24-inch diameter PVC pipe. This would help reduce backwater into the JRMS and increase flow capacity downstream of the JRMS. Estimated cost for labor, materials and engineering to replace the 175-feet of 18-inch RCP with 24-inch PVC is $58,000.

The conveyance from Johnson Road and State Route 305 leaves the JRMS in an 18-inch diameter RCP. One hundred and seventy-five feet away the conveyance turns into a 14-inch diameter ductile iron pipe force main. This pipe connects into the two 12-inch diameter siphons under Liberty Bay (see plans in Attachment 1). Per calculations contained in Attachment (1), the capacity of the conveyance is estimated to be about 3.2 MGD based on the limitations of the 18-inch diameter RCP leaving the JRMS. If the 175-foot long 18-inch diameter pipe leaving the JRMS was replaced with a 24-inch diameter PVC pipe, the capacity of the conveyance could potentially be increased to about 3.8 MGD.

Improvements resulting from this action are based on preliminary analysis only. It is therefore recommended that a more comprehensive hydraulic and preliminary engineering analysis be conducted of the entire siphon and conveyance system to evaluate and confirm the effects of this alteration. It is estimated that this preliminary engineering analysis would add approximately $10,000 to the project cost, making the total cost of this option $68,000.

Install New Metering Station Downstream of JRMS

This option would consist of installation of an in-line metering device downstream of the JRMS in the 14-inch line. The meter unit considered for this option is $22,500 for the meter and would require the installation of mounting flanges in the 14-inch line. Data delivery would be via modem and web based data management system. The estimated cost for all labor and materials is $35,000.

Install New Flume Metering Station Upstream of JRMS

This option would consist of installing a new metering system in the 24 inch diameter pipe located upstream of the JRMS, above the backwater affected area. Flow measurement would be done with a Marsh-McBirney Flow-Dar flow meter for open channel application with ultrasonic transducer in the manhole. This meter has memory storage and software for downloading the data to a laptop or modem for remote communications. Equipment and data delivery system information is provided in Attachment 3. The estimated cost for instrumentation is estimated at $12,000. Equipment and installation, including permanent power supply to enable remote communication is estimated at $25,000. Annual web hosted data management costs are estimated at $700 (see Attachment 3).

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the above analysis:

- If feasible, remove the rock trap dam in the first manhole downstream of the JRMS. The dam is no longer needed and removal will likely improve flow characteristics into the 14-inch pipe, reduce backwater and potentially increase capacity of the system.

- Raising the height of the existing sonic meter would increase peak flow measurement capability to 3.2 MGD. This would likely measure all but the most extreme peak flow events, and would be sufficient for measuring peak hourly flow through at least 2012 [1]. After 2012, peak flows may exceed 3.2 MGD. Unless the downstream backflow constraint is addressed, this would therefore be a temporary correction.

- Replacing 175 feet of 18-in RCP pipe with new 24-in pipe may eliminate the backwater effect, increase capacity of the siphon system to about 3.8 MGD, and allow the metering station to measure up to about 3.7 MGD, which would be sufficient for measuring peak hourly flow through approximately 2020. The capacity of Pump Station 16 is 3.8 MGD, so this alternative extends siphon capacity and flow measurement capability to the capacity of the pump station. Additional engineering and hydraulic analysis would be necessary to confirm this conclusion.

- Installing a new metering station upstream of the existing JRMS would provide long term, reliable data to both the City and County regardless of downstream hydraulic constraints.

- Installing a new flow meter downstream of the JRMS is a more costly option, and is therefore eliminated from future consideration.

Table 1 summarizes costs for the various options.

Table 1 – Summary of JRMS improvement alternatives.

Option	Est. Cost	Benefits	Potential Disadvantages
Remove rock dam downstream of JRMS	$5,000	Improve hydraulics	None
Raise height of existing meter sensor by 4-in	$5,000	Increase meter capacity to 3.2 MGD. Extends use of existing system to approximately 2012. Low cost.	Loss of meter accuracy at average flows. Uncertain downstream hydraulics. May not capture extreme flow events. Limited period of functionality. No data delivery to City.
Replace 175 feet of 18-in pipe with 24-in diameter pipe	$68,000	Potential increase of siphon capacity to 3.8 MGD.	Hydraulics and capacity increase needs to be verified through preliminary engineering study.
Raise height of existing meter 4-in, and replace 175 feet 18-in pipe with 24-in diameter PVC pipe	$73,000	Increase siphon capacity to 3.8 MGD, increase flow meter capacity to 3.7 MGD. Extends use of existing system to approximately 2020.	Assumes that hydraulic and capacity increases are verified. No data delivery to City.
Install new flow meter upstream of JRMS	$25,000	Increase flow meter capacity, data delivery to City and County	Cost
Install new flow meter downstream of JRMS	$35,000	Increase flow meter capacity, data delivery to City and County	Higher cost

The lowest cost option is to raise the height of the existing meter sensor by 4 inches. This would likely improve peak flow measurement for about four to five years, but may result in loss of accuracy at normal to low flow. Flow measurement accuracy is an important consideration given the relatively large amount

[1] Based on flow projections updates dated January 2008.

of cost associated with treatment fees (over $500,000 in 2006). This option also does not provide data delivery to the City. This option is not recommended given the relatively short duration of improvements, limitations of the existing system, potential reduction in measurement accuracy, and lack of electronic data delivery to the City and/or County.

Raising the height of existing meter sensor by 4 inches, and replacing 175 feet of 18-inch pipe with 24-in diameter PVC pipe would improve peak flow measurement for about 12 years, but may result in loss of accuracy at normal to low flow. This option would also require an additional engineering study to verify hydraulic conditions and improvements. The option is not recommended as a preferred option for addressing flow monitoring given the relatively high cost ($73,000), uncertainty regarding hydraulic conditions, potential loss of accuracy, and lack of data delivery system. Pipe replacement should be considered an element of future capacity increases within the system.

The installation of a new flow monitoring station upstream of the JRMS would allow for flow measurement and data delivery to both the City and County, and would eliminate the uncertainty regrading the effect of downstream hydraulics on the existing flow meter. It is likely the flow meter would be installed by City crew, with the assistance of the instrumentation vendor. Web hosted data management would be provided by a vendor at a nominal annual cost of about $700.

The potential optimal combination of improvements may be installation of a new flow meter upstream of the JRMS, and replacement of 175-ft 18-in pipe with new 24-in diameter pipe. This would allow for flow measurement improvements as noted above, and increase the capacity of the siphon due to improved hydraulics. This option could be implemented in two phases, with phase 1 consisting of flow meter installation and phase 2 consisting of pipe replacement. Phase 1 could be implemented immediately, and phase 2 could be deferred until approximately 2012 when peak flows are expected to be near 3.2 MGD.

Based on Table 1, it is likely that a combination of actions, phased over time, may be the most cost effective solution to improve both flow measurement and flow capacity. Because of the potential impacts to both City and County operations, we recommend that the City and County coordinate and jointly determine a set of actions that best addresses both short and long term needs and objectives.

NEXT STEPS

The next step in the process would consist of providing this memorandum to the County, and coordinating a meeting to review options and action plans. Additional items that may be considered for the meeting with the City could include 1) additional pressure testing/analysis for siphon to verify potential future capacity, and 2) the process and schedule for developing new agreement with County for conveyance and treatment.

We appreciate the opportunity to perform this work for the City. If you have any questions or need additional information, please do not hesitate to contact me anytime at (360) 850-5340.

REFERENCES

Brown and Caldwell 2008. Central Kitsap Wastewater GMA Compliance Plan. February 20008.

Poulsbo Draft Comprehensive Sanitary Sewer Plan. Prepared by Parametrix, Inc. March, 2007.

Kitsap County Interceptor Sewers, Plan/Profile and Details, URS Company, Seattle, WA, sheets 8/12 and 10/12, dated 6/6/77

ATTACHMENTS

(1) JRMS recording wheel for the week of 11/26/07 to 12/4/07

(2) Calculations by Parametrix, 2 sheets plus attachment

(3) Flow meter information

PROJECT: City of Poulsbo Comprehensive Sanitary Sewer Plan - 2007 Update SHEET 1 OF 2
BY: Guy McCabe DATE: 1/3/08 CHECKED: DATE:
SUBJECT: JRMS Evaluation JOB NO.: 2362237026 PHASE: 02 TASK: 01

Background:

The Johnson Road Metering Station (JMRS) was installed based on URS Company (Seattle, WA) drawings dated 6/6/1977. These calculations are based on the geometry contained in those drawings, input from Kitsap County personnel, and field observations. Per the drawings, the metering station consists of a standard 9-inch Parshall flume set in the bottom of a manhole with a 24-inch inlet pipe and an 18-inch outlet pipe. The system receives flows from the Poulsbo sanitary sewer collection system via the 24-inch line and transports them via a gravity force main and two siphons under Liberty Bay, to the Kitsap County sewage treatment plant at Brownsville.

Parshall flumes were developed in the 1930's to measure flows in irrigation canals. The depth of flow is measured at a prescribed metering point in the flume, and then converted to flow rates/volumes based on standard tables. Parshall flumes are sensitive to backwater conditions and flow measuring characteristics will change when the outlet begins running submerged or is, of course, flooded out. The flume at the JRMS is 24-inches deep and has the capability to meter up to 5.7 mgd if not subjected to backwater influences.

Evaluate the Johnson Road Metering Station system for flow capacity at the following relevant flows:

a. 2.5 mgd representing the flow through the Parshall flume at 14-inches depth. *(1)
b. 3.2 mgd representing the maximum capacity of the Lemolo (Liberty Bay) siphons as determined by Kitsap County based on recent pressure testing. *(2) (Note: Per these calculations the capacity of the siphons may be more around 5.0 mgd. Overall system characteristics need to be evaluated to make accurate determinations.)
c. 3.8 mgd representing the maximum capacity of KC's Pump Station 16 in Keyport. *(3)

See sketch of system on sheet 2 showing available head for each section of pipe, and the attached Excel spreadsheet printout showing the total head loss at various Q's. Based on the system sketch and Excel spreadsheet, the following observations can be made:

a. The 24-inch diameter JRMS inlet pipe can deliver 3.8 mgd with the available head (without surcharge)
b. The 18-inch diameter JRMS outlet pipe can carry 3.2 mgd with the available head (without surcharge)
c. The 14-inch diameter gravity force main beginning 175-feet south of the JRMS is capable of carrying 4.2 mgd with the available head (without surcharge).

*Notes:

(1). The ultrasonic sensor is currently set to read up to a 14-inch fluid depth at the flume metering point. The 14-inch depth represents a 2.5 mgd flow. (Note: Per Kitsap County personnel, the sensor has been set at this location so there is adequate lower end accuracy for the recording device and totalizer. The physical location of the ultrasonic device is about 18-inches above the 14-inch mark, located in accordance with the manufacturer's installation instructions. The elevation of the ultrasonic measuring device could be reset to measure higher fluid levels if there is adequate overhead above the metering point, but in so doing may compromise lower end recording device accuracy.)

(2). Per Kitsap County letter of March 7, 2007, contained in the Comprehensive Sanitary Sewer Plan 2007 Update – Appendix C.

(3). Per the Comprehensive Sanitary Sewer Plan 2007 Update – Appendix C

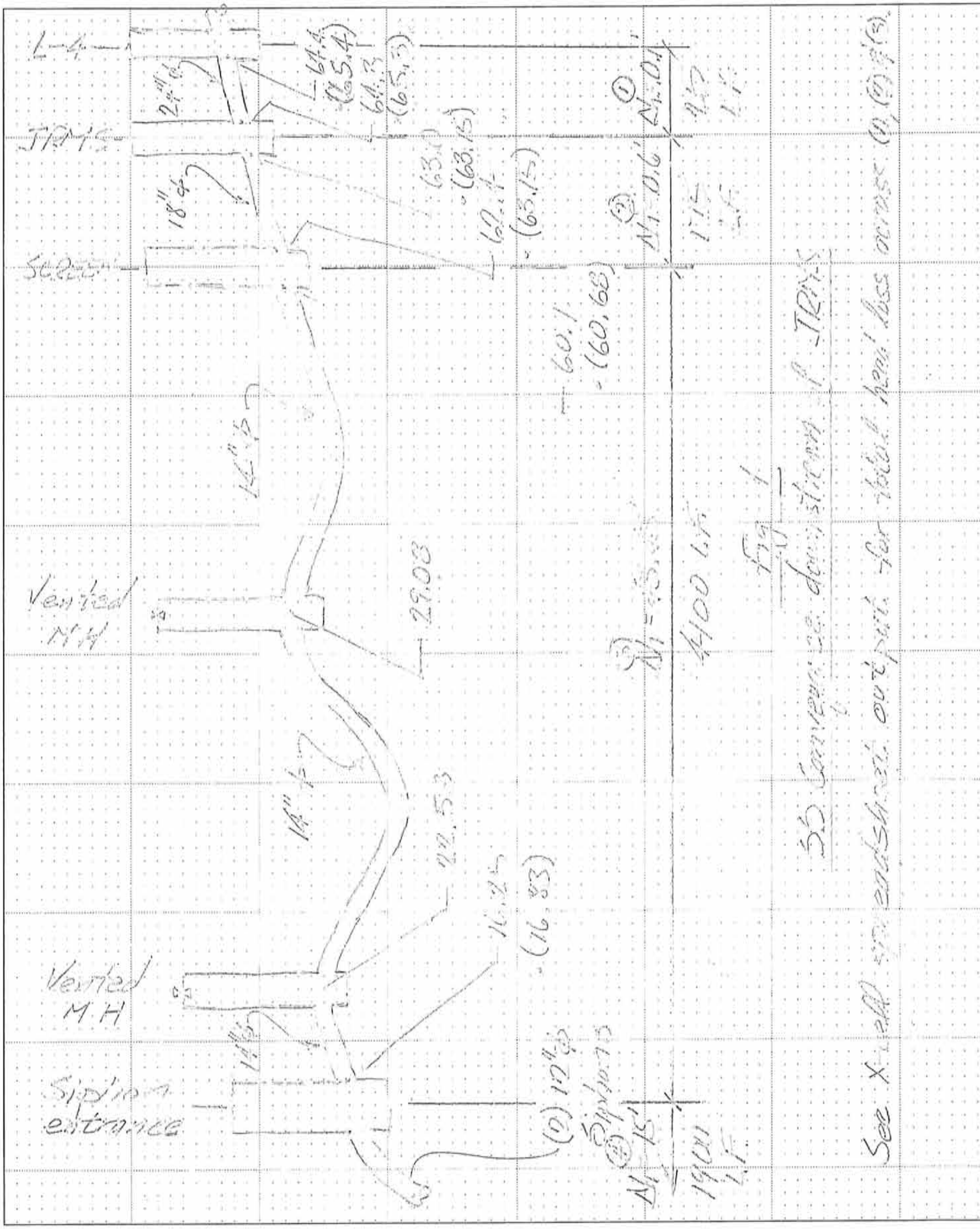
ATTACHMENT 1

Parametrix

PROJECT City of Poulsbo Comprehensive SS Plan SHEET 2 OF 2

BY G. McCabe DATE 1/3/07 CHECKED DATE

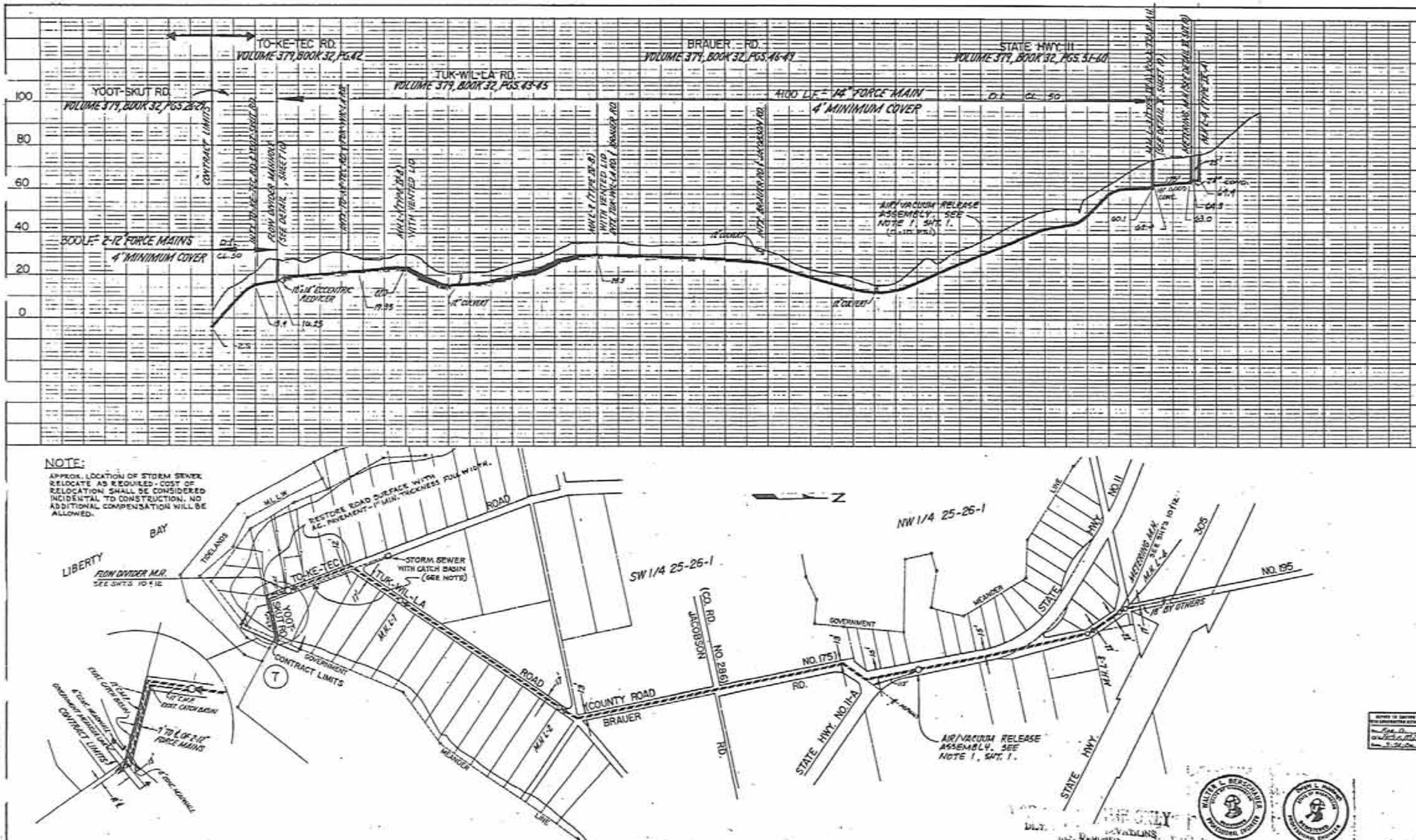
SUBJECT JRMS & KC Conveyance JOB NO. PHASE TASK



Q(d) mgd	Q cfs	Dia ft	Rad ft	π	A ft*2	Vel fps	e ft	e/D	Vd	f	L ft	V*2/2g ft	h(f) ft	C(in)	h(l) ft	C(out)	h(l) ft	h(t) ft	
1.29	2	2	1	3.1416	3.14	0.64	0.005	0.0025	15.28	0.0266	25	0.006	0.002	0.5	0.003	1	0.006	0.012	
1.62	2.5	2	1	3.1416	3.14	0.80	0.005	0.0025	19.10	0.0263	25	0.010	0.003	0.5	0.005	1	0.010	0.018	
1.94	3	2	1	3.1416	3.14	0.95	0.005	0.0025	22.92	0.026	25	0.014	0.005	0.5	0.007	1	0.014	0.026	
2.26	3.5	2	1	3.1416	3.14	1.11	0.005	0.0025	26.74	0.0257	25	0.019	0.006	0.5	0.010	1	0.019	0.035	
2.42	3.75	2	1	3.1416	3.14	1.19	0.005	0.0025	28.65	0.0257	25	0.022	0.007	0.5	0.011	1	0.022	0.040	
2.50	3.87	2	1	3.1416	3.14	1.23	0.005	0.0025	29.56	0.0257	25	0.024	0.008	0.5	0.012	1	0.024	0.043	
2.59	4	2	1	3.1416	3.14	1.27	0.005	0.0025	30.56	0.0253	25	0.025	0.008	0.5	0.013	1	0.025	0.046	
2.75	4.25	2	1	3.1416	3.14	1.35	0.005	0.0025	32.47	0.0253	25	0.028	0.009	0.5	0.014	1	0.028	0.052	
2.91	4.5	2	1	3.1416	3.14	1.43	0.005	0.0025	34.38	0.025	25	0.032	0.010	0.5	0.016	1	0.032	0.058	
3.20	4.95	2	1	3.1416	3.14	1.58	0.005	0.0025	37.82	0.025	25	0.039	0.012	0.5	0.019	1	0.039	0.070	1
3.23	5	2	1	3.1416	3.14	1.59	0.005	0.0025	38.20	0.0248	25	0.039	0.012	0.5	0.020	1	0.039	0.071	
3.55	5.5	2	1	3.1416	3.14	1.75	0.005	0.0025	42.02	0.0246	25	0.048	0.015	0.5	0.024	1	0.048	0.086	
3.80	5.88	2	1	3.1416	3.14	1.87	0.005	0.0025	44.92	0.0246	25	0.054	0.017	0.5	0.027	1	0.054	0.098	
3.88	6	2	1	3.1416	3.14	1.91	0.005	0.0025	45.84	0.0245	25	0.057	0.017	0.5	0.028	1	0.057	0.102	
4.20	6.5	2	1	3.1416	3.14	2.07	0.005	0.0025	49.66	0.0245	25	0.066	0.020	0.5	0.033	1	0.066	0.120	
4.52	7	2	1	3.1416	3.14	2.23	0.005	0.0025	53.48	0.0245	25	0.077	0.024	0.5	0.039	1	0.077	0.139	
4.85	7.5	2	1	3.1416	3.14	2.39	0.005	0.0025	57.30	0.0245	25	0.088	0.027	0.5	0.044	1	0.088	0.160	
5.70	8.82	2	1	3.1416	3.14	2.81	0.005	0.0025	67.38	0.0245	25	0.122	0.037	0.5	0.061	1	0.122	0.221	
1.29	2	1.5	0.75	3.1416	1.77	1.13	0.005	0.003333	20.37	0.027	175	0.020	0.063	0.5	0.010	1	0.020	0.092	
1.62	2.5	1.5	0.75	3.1416	1.77	1.41	0.005	0.003333	25.46	0.0269	175	0.031	0.098	0.5	0.016	1	0.031	0.144	
1.94	3	1.5	0.75	3.1416	1.77	1.70	0.005	0.003333	30.56	0.0268	175	0.045	0.140	0.5	0.022	1	0.045	0.207	
2.26	3.5	1.5	0.75	3.1416	1.77	1.98	0.005	0.003333	35.65	0.0267	175	0.061	0.190	0.5	0.030	1	0.061	0.281	
2.50	3.87	1.5	0.75	3.1416	1.77	2.19	0.005	0.003333	39.42	0.0267	175	0.074	0.232	0.5	0.037	1	0.074	0.344	
2.59	4	1.5	0.75	3.1416	1.77	2.26	0.005	0.003333	40.74	0.0266	175	0.080	0.247	0.5	0.040	1	0.080	0.366	
2.91	4.5	1.5	0.75	3.1416	1.77	2.55	0.005	0.003333	45.84	0.0265	175	0.101	0.311	0.5	0.050	1	0.101	0.462	
3.20	4.95	1.5	0.75	3.1416	1.77	2.80	0.005	0.003333	50.42	0.0265	175	0.122	0.377	0.5	0.061	1	0.122	0.559	
3.20	4.95	2	1	3.1416	3.14	1.58	0.005	0.0025	37.82	0.025	175	0.039	0.084	0.5	0.019	1	0.039	0.142	
3.23	5	1.5	0.75	3.1416	1.77	2.83	0.005	0.003333	50.93	0.0264	175	0.124	0.383	0.5	0.062	1	0.124	0.569	
3.55	5.5	1.5	0.75	3.1416	1.77	3.11	0.005	0.003333	56.02	0.0264	175	0.150	0.463	0.5	0.075	1	0.150	0.689	2
3.80	5.88	1.5	0.75	3.1416	1.77	3.33	0.005	0.003333	59.89	0.0264	175	0.172	0.530	0.5	0.086	1	0.172	0.787	
3.80	5.88	2	1	3.1416	3.14	1.87	0.005	0.0025	44.92	0.0246	175	0.054	0.117	0.5	0.027	1	0.054	0.199	
3.88	6	1.5	0.75	3.1416	1.77	3.40	0.005	0.003333	61.12	0.0263	175	0.179	0.549	0.5	0.090	1	0.179	0.818	
4.20	6.5	1.5	0.75	3.1416	1.77	3.68	0.005	0.003333	66.21	0.0263	175	0.210	0.645	0.5	0.105	1	0.210	0.960	
4.52	7	1.5	0.75	3.1416	1.77	3.96	0.005	0.003333	71.30	0.0263	175	0.244	0.748	0.5	0.122	1	0.244	1.113	
5.70	8.82	1.5	0.75	3.1416	1.77	4.99	0.005	0.003333	89.84	0.0263	175	0.387	1.187	0.5	0.193	1	0.387	1.767	
5.70	8.82	2	1	3.1416	3.14	2.81	0.005	0.0025	67.38	0.0245	175	0.122	0.262	0.5	0.061		0.000	0.324	
1.29	2	1.17	0.585	3.1416	1.08	1.86	0.0018	0.001538	26.12	0.0224	4100	0.054	4.218	0.5	0.027	1	0.054	4.298	
1.62	2.5	1.17	0.585	3.1416	1.08	2.33	0.0018	0.001538	32.65	0.0222	4100	0.084	6.532	0.5	0.042	1	0.084	6.658	
1.94	3	1.17	0.585	3.1416	1.08	2.79	0.0018	0.001538	39.18	0.022	4100	0.121	9.321	0.5	0.060	1	0.121	9.502	
2.26	3.5	1.17	0.585	3.1416	1.08	3.26	0.0018	0.001538	45.71	0.0219	4100	0.165	12.629	0.5	0.082	1	0.165	12.876	
2.50	3.87	1.17	0.585	3.1416	1.08	3.60	0.0018	0.001538	50.54	0.0219	4100	0.201	15.440	0.5	0.101	1	0.201	15.742	
2.59	4	1.17	0.585	3.1416	1.08	3.72	0.0018	0.001538	52.24	0.0218	4100	0.215	16.420	0.5	0.107	1	0.215	16.742	
2.91	4.5	1.17	0.585	3.1416	1.08	4.19	0.0018	0.001538	58.76	0.0217	4100	0.272	20.686	0.5	0.136	1	0.272	21.094	
3.20	4.95	1.17	0.585	3.1416	1.08	4.60	0.0018	0.001538	64.64	0.0217	4100	0.329	25.030	0.5	0.165	1	0.329	25.524	
3.23	5	1.17	0.585	3.1416	1.08	4.65	0.0018	0.001538	65.29	0.0216	4100	0.336	25.420	0.5	0.168	1	0.336	25.924	
3.55	5.5	1.17	0.585	3.1416	1.08	5.12	0.0018	0.001538	71.82	0.0215	4100	0.406	30.616	0.5	0.203	1	0.406	31.226	
3.80	5.88	1.17	0.585	3.1416	1.08	5.47	0.0018	0.001538	76.79	0.0215	4100	0.464	34.993	0.5	0.232	1	0.464	35.690	3
3.88	6	1.17	0.585	3.1416	1.08	5.58	0.0018	0.001538	78.35	0.0214	4100	0.484	36.266	0.5	0.242	1	0.484	36.992	
4.20	6.5	1.17	0.585	3.1416	1.08	6.05	0.0018	0.001538	84.88	0.0213	4100	0.568	42.364	0.5	0.284	1	0.568	43.215	
4.52	7	1.17	0.585	3.1416	1.08	6.51	0.0018	0.001538	91.41	0.0212	4100	0.658	48.901	0.5	0.329	1	0.658	49.888	
4.85	7.5	1.17	0.585	3.1416	1.08	6.98	0.0018	0.001538	97.94	0.0211	4100	0.756	55.872	0.5	0.378	1	0.756	57.005	
5.17	8	1.17	0.585	3.1416	1.08	7.44	0.0018	0.001538	104.47	0.021	4100	0.860	63.268	0.5	0.430	1	0.860	64.558	
5.49	8.5	1.17	0.585	3.1416	1.08	7.91	0.0018	0.001538	111.00	0.021	4100	0.971	71.424	0.5	0.485	1	0.971	72.880	
5.70	8.82	1.17	0.585	3.1416	1.08	8.20	0.0018	0.001538	115.18	0.021	4100	1.045	76.903	0.5	0.523	1	1.045	78.471	

1.29	2	1	0.5	3.1416	0.79	2.55	0.0018	0.0018	30.56	0.0222	1900	0.101	4.247	0	0	0	0	4.247
1.62	2.5	1	0.5	3.1416	0.79	3.18	0.0018	0.0018	38.20	0.0221	1900	0.157	6.606	0	0	0	0	6.606
1.94	3	1	0.5	3.1416	0.79	3.82	0.0018	0.0018	45.84	0.022	1900	0.227	9.470	0	0	0	0	9.470
2.26	3.5	1	0.5	3.1416	0.79	4.46	0.0018	0.0018	53.48	0.0219	1900	0.308	12.831	0	0	0	0	12.831
2.50	3.87	1	0.5	3.1416	0.79	4.93	0.0018	0.0018	59.13	0.0218	1900	0.377	15.616	0	0	0	0	15.616
2.59	4	1	0.5	3.1416	0.79	5.09	0.0018	0.0018	61.12	0.0217	1900	0.403	16.606	0	0	0	0	16.606
2.91	4.5	1	0.5	3.1416	0.79	5.73	0.0018	0.0018	68.75	0.0216	1900	0.510	20.920	0	0	0	0	20.920
3.20	4.95	1	0.5	3.1416	0.79	6.30	0.0018	0.0018	75.63	0.0215	1900	0.617	25.196	0	0	0	0	25.196
3.23	5	1	0.5	3.1416	0.79	6.37	0.0018	0.0018	76.39	0.0215	1900	0.629	25.708	0	0	0	0	25.708
3.55	5.5	1	0.5	3.1416	0.79	7.00	0.0018	0.0018	84.03	0.0214	1900	0.761	30.962	0	0	0	0	30.962
3.80	5.88	1	0.5	3.1416	0.79	7.49	0.0018	0.0018	89.84	0.0213	1900	0.870	35.223	0	0	0	0	35.223
3.88	6	1	0.5	3.1416	0.79	7.64	0.0018	0.0018	91.67	0.0213	1900	0.906	36.675	0	0	0	0	36.675
4.20	6.5	1	0.5	3.1416	0.79	8.28	0.0018	0.0018	99.31	0.0212	1900	1.064	42.840	0	0	0	0	42.840
4.52	7	1	0.5	3.1416	0.79	8.91	0.0018	0.0018	106.95	0.0212	1900	1.233	49.684	0	0	0	0	49.684
4.85	7.5	1	0.5	3.1416	0.79	9.55	0.0018	0.0018	114.59	0.0211	1900	1.416	56.766	0	0	0	0	56.766
5.17	8	1	0.5	3.1416	0.79	10.19	0.0018	0.0018	122.23	0.0211	1900	1.611	64.587	0	0	0	0	64.587
5.49	8.5	1	0.5	3.1416	0.79	10.82	0.0018	0.0018	129.87	0.021	1900	1.819	72.568	0	0	0	0	72.568
5.70	8.82	1	0.5	3.1416	0.79	11.23	0.0018	0.0018	134.76	0.021	1900	1.958	78.134	0	0	0	0	78.134

4



No.	DATE	BY	REVISION

Job No. 4464-05-97
Scale Vert. 1"=20' Horiz. 1"=200'
Designed RLM/RLP Drawn by LGE Checked by R.L.H.
Proj. Engr. Apprd by Date 6-6-77

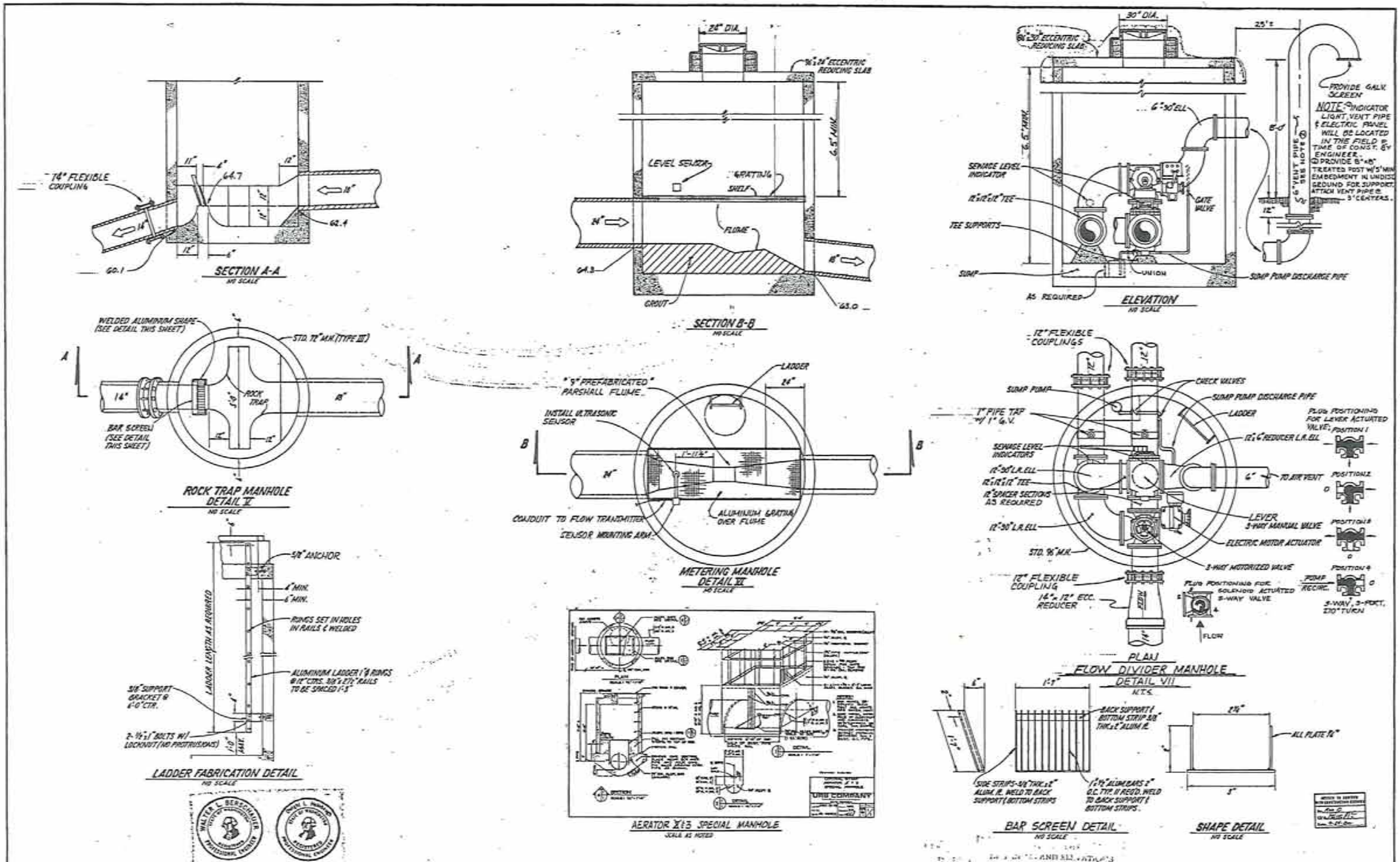
URS COMPANY
A Professional Services Organization
Seattle, Washington

KITSAP COUNTY
CENTRAL KITSAP WASTEWATER FACILITIES

INTERCEPTOR SEWERS
PLAN & PROFILE
CONTRACT VI

Sheet 8 / 12

3.616-8



No.	DATE	BY	REVISION

Job No. 4464-05-97
SCALE: AS SHOWN
Designed: RLM & RLP
Drawn by: L.E.
Date: 6-7-77

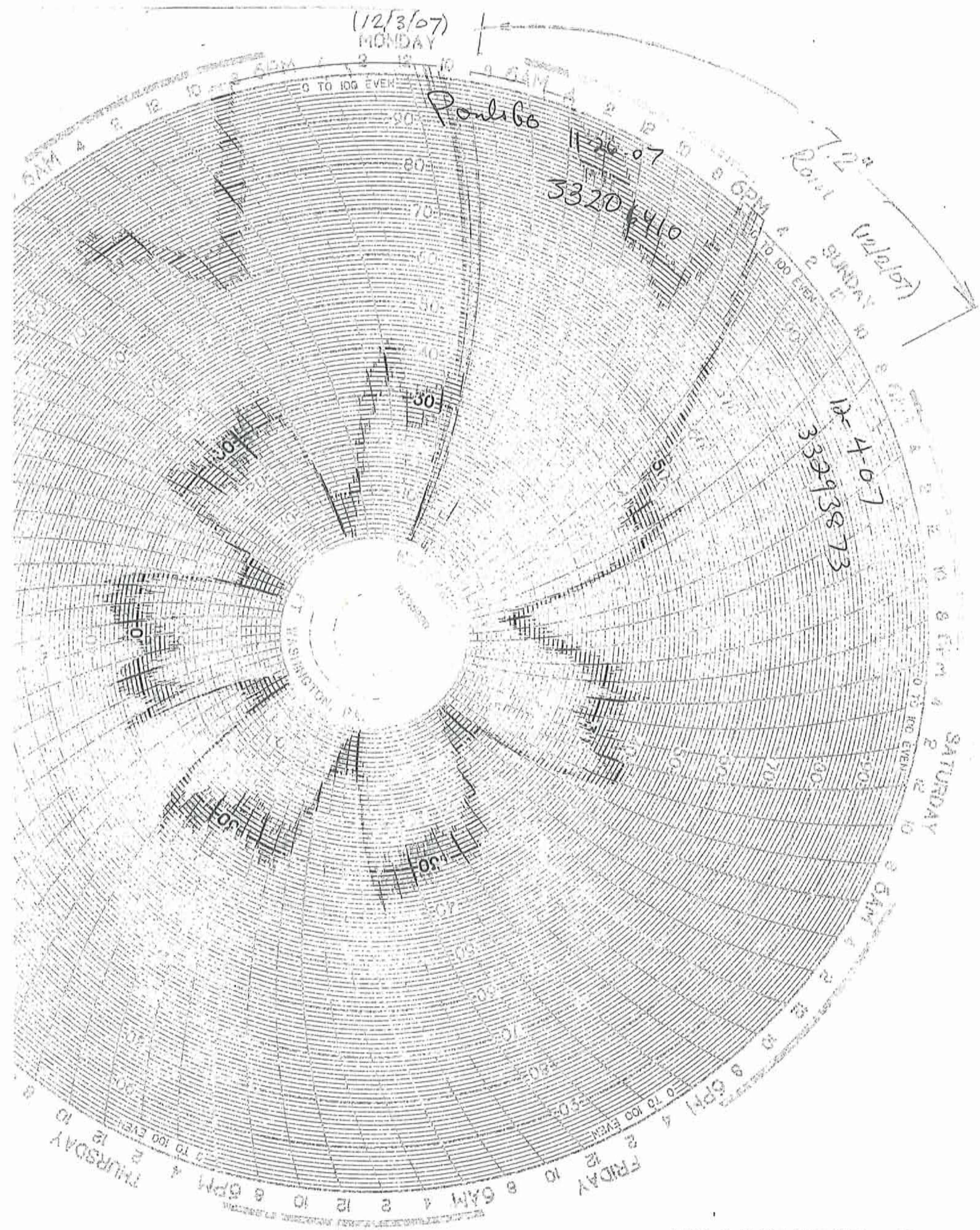
URS COMPANY
A Professional Services Organization
Seattle, Washington

KITSAP COUNTY
CENTRAL KITSAP WASTEWATER FACILITIES

INTERCEPTOR SEWERS
DETAIL SHEET
CONTRACT VI

Sheet 10 / 12

3.616-10



ATTACHMENT 2

ATTACHMENT 3

MARSH McBIRNEY
A Higher Level of Flow Measurement

Understanding the Flo-Dar™ Flow Measuring System

Independent tests verify non-contact flowmeter is highly accurate under both open channel and surcharge conditions

Flo-Dar is the only non-contact open channel velocity/area type flow meter available for measurement of flows in municipal wastewater and storm water sewers. Flo-Dar consists of a radar-based velocity measurement system and an ultrasonic-based pulse echo depth measurement system.

Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides the continuation of accurate flow data where intermittent, surcharged flow conditions are experienced.

Flo-Dar combines the information from the velocity and depth systems along with site specific data (pipe size, pipe shape, velocity profile) and provides the user with highly accurate, reliable flow data under a wide range of flow velocities and depths. Since the radar velocity sensor and the ultrasonic depth sensor cease to provide useful data when submerged, Flo-Dar has an optional surcharge velocity sensor (electromagnetic type) and depth sensor (pressure transducer) that provides for the continuous measurement of accurate flow data where intermittent, surcharged flow conditions are experienced.

The data system merges the data from these two independent flow systems and provides the user with a single flow signal that accurately represents flow over a range from a dry pipe to extreme surcharge conditions. Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Accuracy tests performed at Alden Research Labs have shown that the Flo-Dar is highly accurate under both open channel and surcharge (submerged) conditions.

Measurement of Flow Under Free Flow, Non-submerged Conditions

Open Channel Velocity

Open channel flow is any flow in a channel that has a free surface. Flo-Dar measures open channel flow as depicted in Figure 1. The radar velocity sensor measures flow in a manner similar to how radar guns measure the velocity of a baseball or an automobile.

Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

A radar "horn" contained inside of the watertight housing transmits a microwave beam through the housing at a defined angle to the flow surface. Disturbances on the surface reflect some of the microwaves back to the horn. The frequency of these returning microwave signals have been shifted (the Doppler effect) by an amount directly proportional to the speed of the moving surface. This frequency shift is detected and measured by the Flo-Dar flow meter and the data is stored as a measure of the surface velocity.

Since the accurate measurement of open channel flow requires the accurate determination of the average velocity of the flow stream, the measured surface velocity must be dynamically modified to obtain an accurate average velocity for use in the Continuity Equation, Q= Vav x A). Marsh-McBirney has developed and patented a process that yields an accurate determination of the average velocity from the measurement of the surface velocity at a known point on the flow surface.

Factors that influence the accuracy and stability of the measured surface velocity signal:

1. *Transmitted Frequency*
2. *Speed of Microwaves in Air*
3. *Angle of Microwave Beam*
4. *Calculation of Mean Velocity*

If one analyzes each of the four factors that influence the accuracy and stability of the measured surface velocity signal, it becomes obvious that a Doppler Radar based velocity sensor is very accurate and stable:

1. Transmitted Frequency - The transmitted frequency of 24.175 GHz is controlled to an accuracy of +/- 0.065%
2. Speed of Microwaves in Air - Essentially constant at the speed of light
3. Angle of Microwave Beam - The sensor is placed in a rigid mount that is positioned parallel to the water surface (i.e. nearly level). The sensor can be removed from the mount and reinstalled while easily maintaining its original mounting location.
4. Calculation of Average Velocity—The relationship between the sensed (surface) velocity and the average velocity varies with pipe size and water depth.

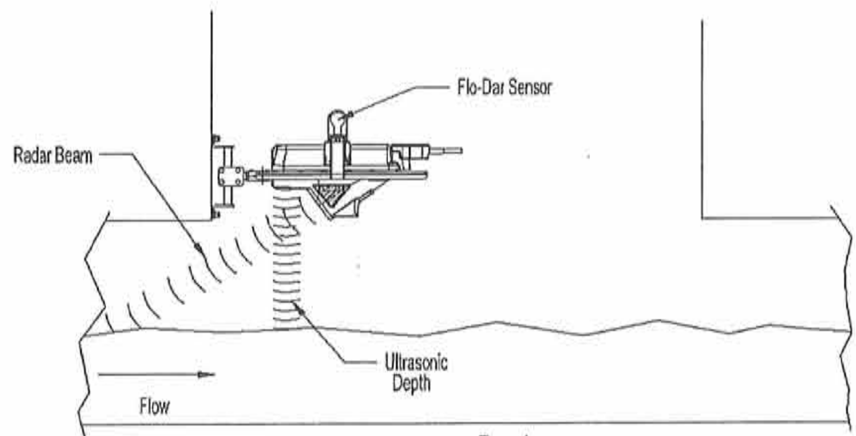


Figure 1

Since the location of the sensing region on the flow surface is known, the repeatability of the surface velocity measurement is excellent and its relationship to the mean velocity is very predictable.

The accuracy of the calculated average velocity, after correction, is typically between 2% to 5%.

By applying algorithms developed through basic hydraulic principles and from actual flow data taken at Alden Labs and at various customer sites, the surface velocity is transformed into an accurate representation of the mean velocity.

Since the location of the sensing region on the flow surface is known, the repeatability of the surface velocity measurement is excellent and its relationship to the mean velocity is predictable.

Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different depth/Diameter ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface - essentially creating a "finger-print" of the velocity contours that exist beneath the surface.

As one might expect, the velocities near the wall are less than the mean velocity and those near the surface are greater than the mean velocity. Since a) the radar sensor measures surface velocity at a know location on the flow surface, and b) these various surface velocities have known relationships to the mean velocity, then the mean velocity can be reliably and accurately calculated.

Note that the velocities present on the surface are typically within 10% of the average velocity. The accuracy of the calculated mean velocity, after correction, is typically between 2% to 5%. (See Note 1.)

Ultrasonic Pulse Echo Depth Measurement

Ultrasonic pulse echo depth sensors operate by energizing a piezoelectric transducer with an electronic pulse. This pulse creates an ultrasonic pulse of energy that travels to the flow surface where a portion of the energy returns to the transducer.

The transit time to the flow surface and back is recorded and the distance calculated by knowing the speed of sound at the site which has been corrected by an embedded temperature sensor. The accuracy of the depth measurement is 1%, +/- 0.1 inch .

Measurement of Flow Under Submerged Conditions

Electromagnetic (EM) Surcharge Velocity Sensor

As stated previously, the radar based velocity sensor measures the surface velocity of the flowing stream by detecting the average speed of the surface irregularities. When the radar sensor becomes totally submerged, it becomes "blind" and is no longer capable of measuring the fluid velocity.

*Figures 2a, 2b, 2c and 2d depict the relationship that exists between various velocity contours and the mean velocity at different depth/***D***iameter ratios. Note that the velocity gradients that exist throughout the flow cross section are generally represented at the flow's surface—essentially creating a "finger-print" of the velocity contours that exist beneath the surface.*

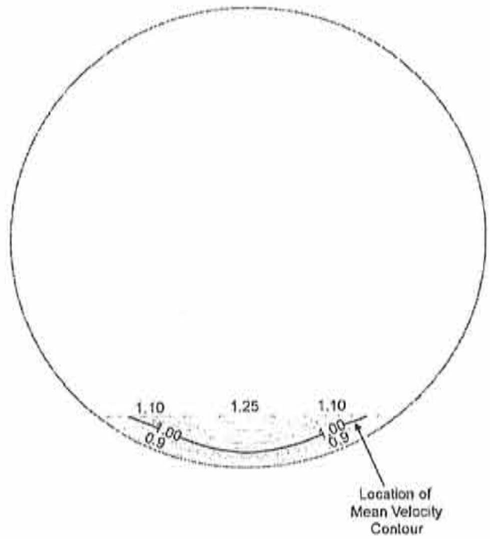


Figure 2a:
d/D= 0.10

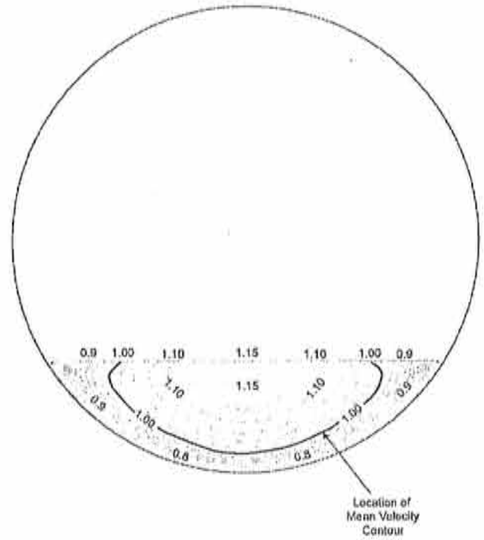


Figure 2b:
d/D= 0.25

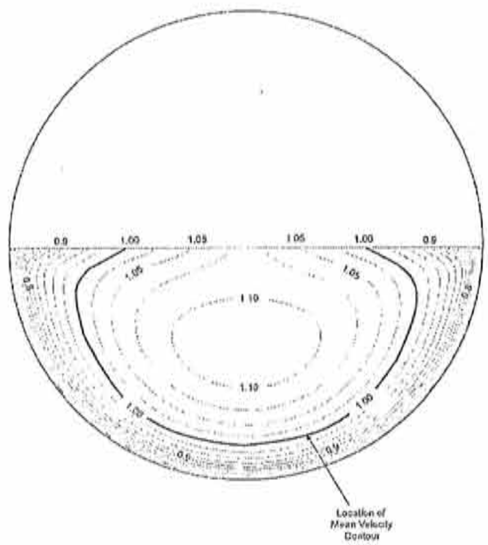


Figure 2c:
d/D= 0.50

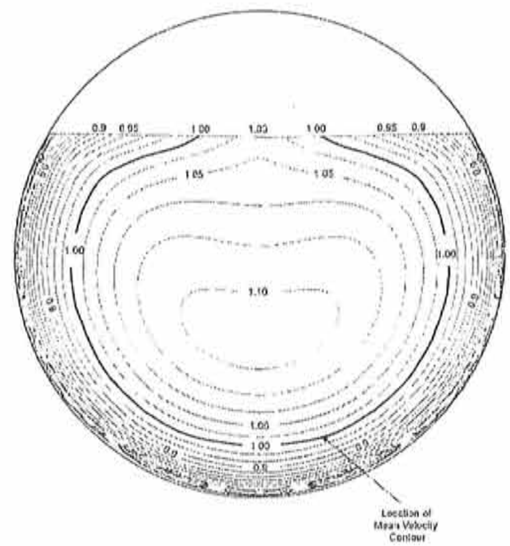


Figure 2d:
d/D= 0.75

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor.

Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within 4 inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

To allow for the uninterrupted measurement of flow under conditions that change from open channel flow to submerged flow as experienced in sewers that surcharge, Marsh-McBirney has added an additional surcharge velocity sensor. Placed on the underside of the standard Flo-Dar sensor, this electromagnetic sensor becomes active when the flow level rises to within four inches of the Radar horn and remains activated until the flow once again falls beneath that depth.

The optional surcharge velocity sensor is based on the Faraday Principle of Electromagnetic Induction. This is the same well-proven principle that "full bore" or "spool-piece" magmeters utilize, the most widely used method of measuring wastewater flow in full pipes.

In the Marsh-McBirney design, an electromagnet embedded within the streamlined sensor generates a magnetic field in the flowing stream. The flow of the water passing through this magnetic field generates voltages in the water that are directly proportional to the speed of the water passing the sensor. Marsh-McBirney uses an in-house 120 foot long towing basin for calibration of electromagnetic sensors. Tow carriage accuracy is better than +/- 0.5%.

Surcharge Depth Sensor

Once submerged conditions exist, the ultrasonic depth sensor ceases to provide useful depth information. To measure depth of the flow during surcharge conditions, a pressure transducer embedded in the Flo-Dar sensor is used in the system.

The location of the surcharge velocity sensor relative to the crown of the pipe is shown in Figure 3. This location provides sensing of the velocity stream just below the crown of the pipe where the flow exits the upstream piping. Empirical data, verified by independent tests at Alden Labs in Holden, Massachusetts indicate that the velocity measured at this location, when multiplied by 0.9, is typically equal to the average velocity.

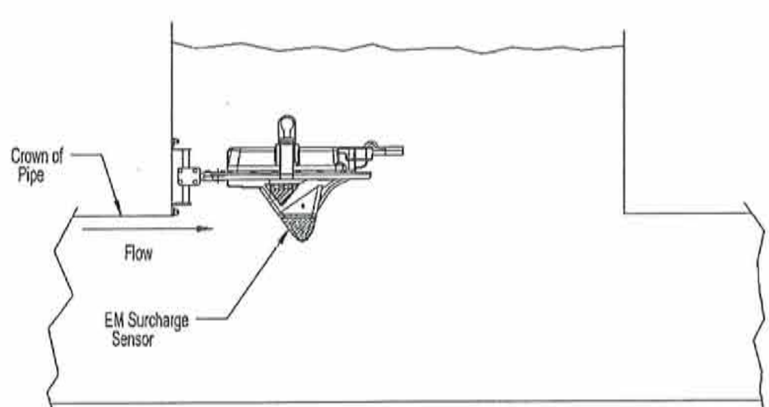


Figure 3

Laboratory Tests

In September 2002 Marsh-McBirney contracted Alden Research Labs of Holden, Massachusetts to perform flow accuracy tests on the Flo-Dar sensor with an electromagnetic surcharge sensor. The Flo-Dar was subjected to a flow range of 400 gpm to over 9000 gpm in a pipe size of 23.5 inches. The pipe had a slope of approximately zero. The test results are shown in Figure 4, Figure 5, Figure 6 and Figure 7.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

The flow tests showed that the Flo-Dar compared very favorably with the Alden flow standard (weigh tank) over a wide range of flows where the open channel flow ranged from 400 gpm to 6000 gpm, and the surcharge (submerged) flow ranged from 6000 gpm to 9000 gpm.

Tests were also run to depict how Flo-Dar performs under transition conditions where the flow goes from an open channel condition to a surcharge (submerged) condition.

Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard. Tests were run under both free flow conditions as well as where the pipe outlet was partially blocked so as to create an entirely different velocity/depth relationship.

Additional flow accuracy tests were run on a 36" pipe at Alden on July 17, 2003. All of the data points were shown to be within 3.5% of the Alden Standard.

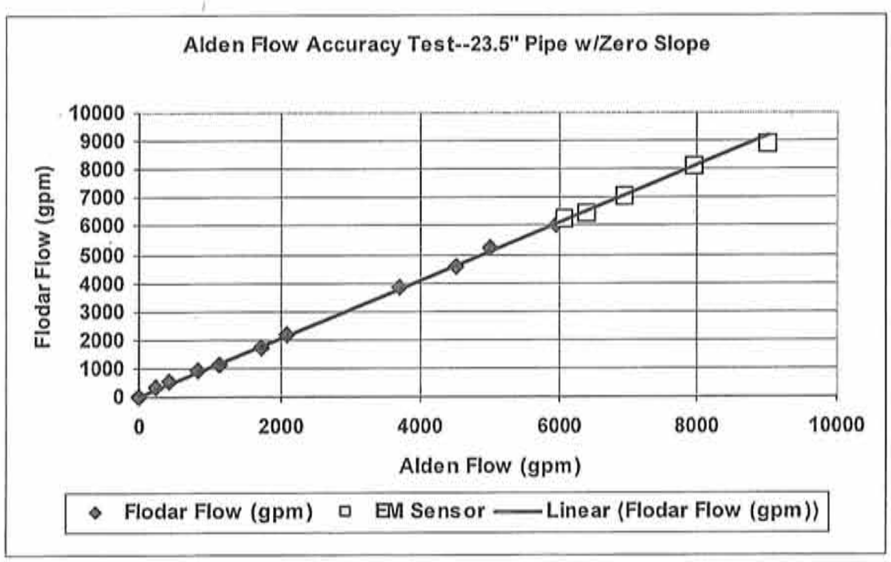
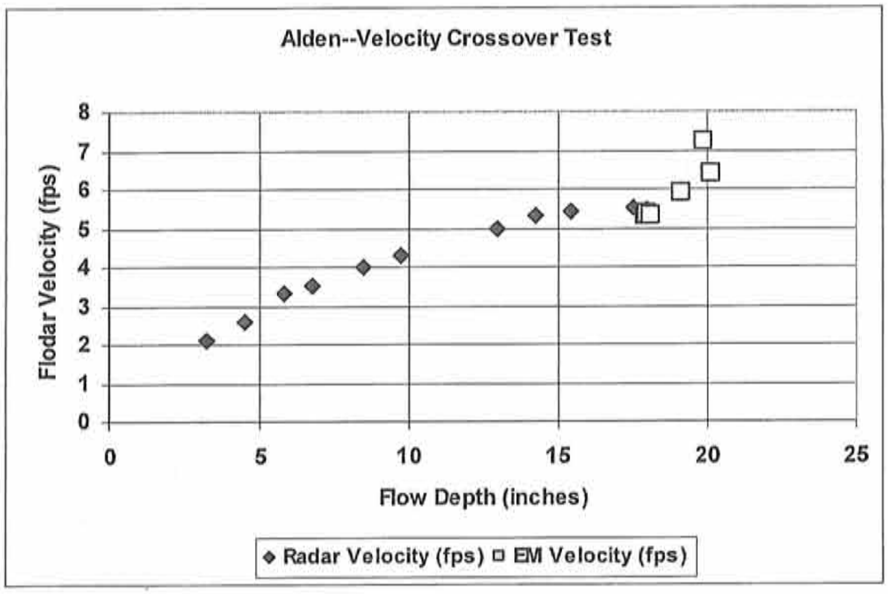


Figure 4 compares the Flo-Dar flow vs. the Alden Standard (weigh tank). The flow condition for this test was both open channel flow and surcharge (submerged) flow.



Test results show that the data from the open channel radar sensor and surcharge electromagnetic sensor overlay each other and the Alden Standard.

Figure 5 compares the velocity measured by the Radar sensor plotted against flow depth. Note that when the depth reaches approximately 18 inches the EM surcharge sensor has been activated. There is one data point where both sensors are active and then the EM surcharge sensor continues to measure after the radar sensor has become submerged and inoperative.

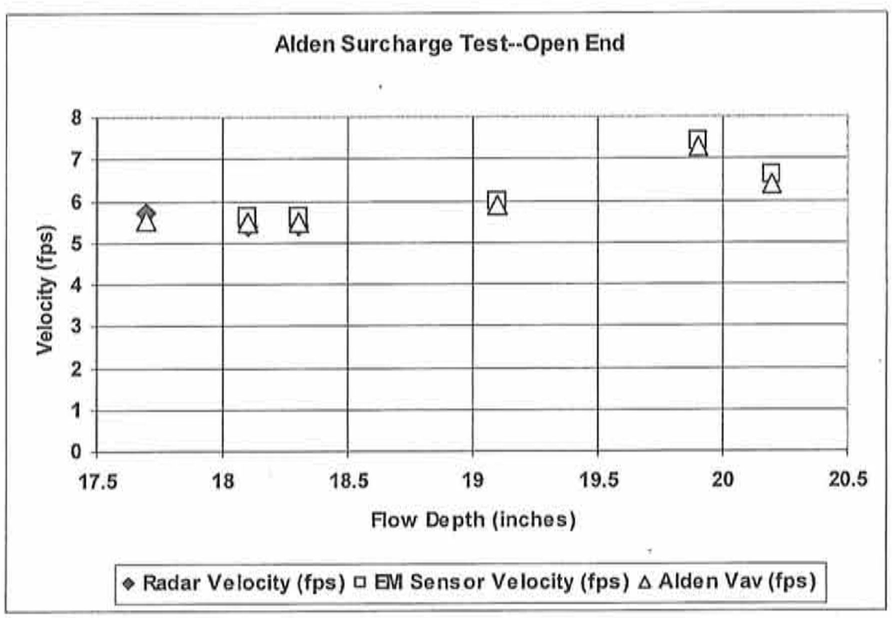


Figure 6 depicts a second surcharge test where the flow was incremented more slowly in order to achieve additional data points in the area where both the Radar sensor and the EM surcharge sensors are active simultaneously. Note that both the Radar sensor and the EM sensor are active between flow depths of 18 inches and 18.5 inches. Also, note how both the Radar and EM data points overlay each other and the Alden standard.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

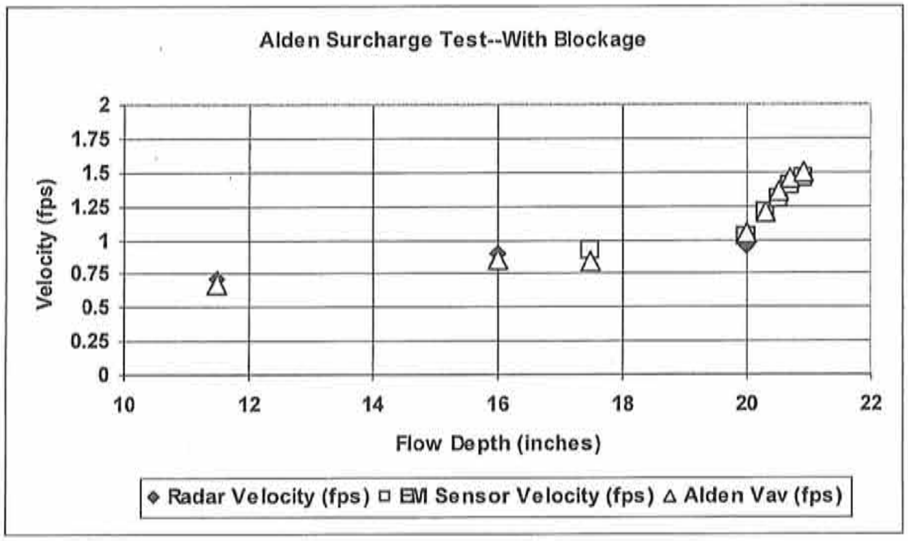


Figure 7 depicts the result of a surcharge test at a lower flow rate. In this test, a round plate with multiple holes was placed at the outlet of the test pipe so as to achieve submerged flow at a lower velocity. Note the consistency of both the Radar velocity data and the EM velocity data as compared to the Alden standard.

Additional tests performed at Alden in 2003 on a 36" pipe again validated Flo-Dar's accuracy under open channel and surcharge flow.

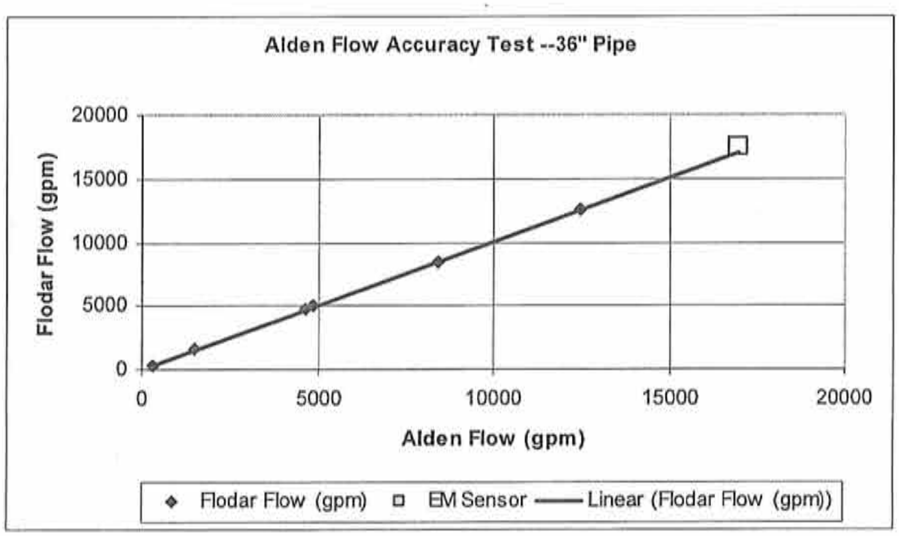


Figure 8 compares the Flo-Dar flow vs. the Alden Standard (weigh tank) for flow accuracy tests in a 36" pipe. These tests were performed on July 17, 2003. Note that at 17,000 gpm the sensor was under surcharge conditions. All of the data points were shown to be within 3.5% of the Alden Standard.

Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors.

Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The Flo-Dar data logger records all four of the flow parameters - open channel surface velocity and depth, and surcharged velocity and depth. When the water depth is below the bottom of the Flo-Dar sensor, only the surface velocity and the flow depth of the open channel flow are used in the flow calculation.

Once the flow depth is such that both the surcharge depth sensor is activated and a conductivity switch is activated, then flow is calculated using the full pipe dimensions for area and the surcharge velocity sensor for velocity.

Conclusions

Flo-Dar is a rugged, general purpose flow meter for use in most open channels such as sanitary sewers, storm water sewers and other man-made channels such as aqueducts as well as certain natural channels such as small streams. Flo-Dar measures open channel velocity and depth by non-contact means virtually eliminating the need to periodically clean the sensors as required by all submerged type sensors. Data recovery from Flo-Dar deployments ranges between 98% to 100% even under site conditions that render most submerged sensors inoperable.

The accuracy of Flo-Dar under both open channel conditions as well as surcharge (submerged) conditions is more than adequate for the most demanding of metering applications including open channel billing applications.

Note 1. The accuracy of open channel flow meters can be affected by adverse conditions present at any metering site. The accuracy specifications of most manufacturers are generally stated under ideal conditions.

Technical Proposal

HACH / MARSH-McBIRNEY
FLOW MONITORING DATA DELIVERYSERVICES
Utilizing
FLO-DAR™ SENSOR WITH FLO-LOGGER

For
Parametrix, Inc.

Re: Poulsbo, WA Flow Monitoring Station

Equipment and Services Supplied by Marsh-McBirney

(1)	**Marsh-McBirney FloDar Sensor with Portable Battery-Powered Data Logger (Web-Enabled and equipped with AC-DC converter for use with AC power source)**
(1)	**Permanent Mounting Hardware assemblies**
(1)	**Day of Installation**
■	**24/7 Password Protected Access to Flow Data via Web Interface**
■	**90% Data Uptime Guarantee**
■	**Factory Certified Installation**
■	**Secure Data**
■	**Daily Back-Ups**

Overview

Marsh-McBirney proposes to install a permanent collection system flow metering network utilizing non-contact area-velocity open channel flow meters equipped with wireless data transmission. Data will be delivered via a web server application. This enables the owner to share data across a network (or the Internet) to operating workstations with common Internet Browser software. Data access is controlled by password permissions. Marsh-McBirney will provide a universal, integrated application to monitor flow metering instruments to allow the user to produce consolidated reports and data sharing tools across the user's network.

Flow data presented to the user via a graphical web server format provides collection system information that can be utilized to resolve a variety of critical issues, from Inflow and Infiltration analyses, to daily O&M. Marsh-McBirney will provide collection system flow data for:

- Inflow and Infiltration Analysis
- Operations and Maintenance
- Capacity Analysis
- Rehabilitation, Repair, or Replacement
- Reporting
- Billing and Custody Transfer
- Alarming
- Modeling

- Master Planning

The details of the scope of work (number of meters, sampling frequency, contract duration and pricing) are presented at the end of this proposal. Information obtained during the monitoring period can be used to determine the following:

1) Average daily flow - dry weather
2) Peak flow - dry weather
3) Average daily flow - wet weather
4) Peak flow - wet weather
5) Peak inflow rates
6) Total I/I volume
7) In-situ pipe capacity (dry and wet weather)
8) Custody transfer and billing application information

Meter site selection will be accomplished after reviewing the collection system maps and preliminary field inspection of any sanitary sewer overflow (SSO) locations. Each monitoring site will be selected so that the footage of the collection system upstream of the meter can be isolated for the purposes of determining extraneous infiltration/inflow and for various engineering analysis. All meter sites will be approved by the Owner/Engineer prior to installation.

FLO-DAR™ SENSOR WITH FLO-LOGGER SPECIFICATION

FLOWMETER

General

The Marsh-McBirney Flo-Dar™ Sensor with Flo-Logger flow meter consists of three components; an electronics unit, sensor, and interconnecting cable. The sensor shall combine advanced radar velocity sensing technology with ultrasonic pulse echo level sensing to remotely measure open channel flow. Flow shall be calculated based on the Continuity Equation ($Q= V \times A$), where Q= Flow, V= Average Velocity and A= Area. The flow meter is of assured quality and provided by an ISO 9001:2000 Certified Manufacturer.

Sensor

The sensor shall consist of four transducers housed in a single polystyrene watertight enclosure. The sensors shall be mounted above the flow surface. The four transducers shall be a digital Doppler radar for surface velocity, an ultrasonic pulse echo for fluid level, a piezo-resistive pressure measurement for surcharge level and an electro-magnetic sensor for surcharge velocity measurement. The radar beam shall transmit signals, which interact with the fluid and reflect back at a different frequency. These reflected signals shall be compared with the transmitted frequency, resulting in a frequency shift. The frequency shift shall provide an accurate measurement of the flow velocity. Fluid level shall be measured with an ultrasonic pulse echo transceiver by transmitting a sound wave to the fluid surface. The sensor shall accurately measure flows in circular and rectangular channels down to flow depths of ¼ inch. A Piezo-resistive pressure sensor shall be used to measure the level of fluid above the sensor if a surcharge condition occurs. An electro-magnetic sensor shall be used to measure surcharge velocity by measuring the change in the magnetic field caused by the velocity of the water flow.

Electronics

The electronics shall consist of the FloDar FloLogger Controllers to receive, process, and transmit the data received from the FloDar Sensors. Each remote panel will transmit level, velocity and flow signals via 1xRTT packet switched cellular wireless technology. The data will be transmitted to the user via a password protected secure web application.

The Flo-Logger will have a data storage capacity of 64K (16 cycles of velocity/level data). The electronics housing material shall be sealed, watertight Polystyrene and is an IP68 rated enclosure. Electronics operating temperature range shall be 14° Fahrenheit to 125° Fahrenheit with relative humidity non-condensing 10-90%. Storage temperature for electronics will be -4° Fahrenheit to 125° Fahrenheit.

Sensor Cable
The standard sensor cable shall be abrasive resistant polyurethane jacket with waterproof connectors on each end. The connectors shall allow for each connection of the logger unit to the Flo-Dar™ sensor. The FloDar Sensors shall be provided with 30 feet of cable. Additional sensor cable lengths are available.

SPECIFICATIONS

SENSOR

Flow Calculation
Method: Based on Continuity Equation, Q=V x A
Accuracy: ±5.0% of reading typical where flow is in a channel with uniform flow conditions and is not surcharged.

Velocity Measurement
Method: Radar
Range: 0.75 to 20 ft/s (0.23 m/s to 6.10 m/s)
Accuracy: ±0.5%; ±0.1 ft/s (±0.03 m/s)

Level Measurement
Method: Ultrasonic

Operating Range: 0.25 to 60 in. (0.634 to 152.4cm)
Optional Operating Range: 0 (0 cm) to 224" (5.7M) with 16" dead band)
Temperature Compensated
Accuracy: ±0.25 in. (±0.64 cm)

Surcharge Level Measurement
Method: Piezo-resistive pressure transducer
Maximum Range: 138 inches (3.5 meters)

Surcharge Velocity Measurement
Method: Electromagnetic
Range: -5 to +20 ft/s

Enclosure
Material: Polystyrene (IP68)
Dimensions: 6.9"W X 16.65"L X 11.7"D (17.5 cm X 42.3 cm X 29.7 cm)
Weight: 10.5 lbs.
Operating Temperature Range: 14°F to 122°F (-10° C to 50°C)
Storage Temperature Range: -40°F to 140°F (-40°C to 60°C)

Sensor Cable
Material: Polyurethane jacketed
Standard Length: 30 feet

FLO-LOGGER

Data Storage: 64K (16K cycles of velocity/level data)

Local Terminal
RS232C @ 19.2K baud

Power Requirements
Two 7.5-volt lithium batteries

Housing
Material: Sealed Watertight Polystyrene – meets IP68 rating
Dimensions: 13.85" L x 7" DIA. (35.179cm L x 17.78 cm DIA.)
Weight: 7.5 lbs. (3.4 kg)
Temperature Operating Range: 14° F to 125° F (-10° C to 51° C)
Temperature Storage Range: -4°F to 125°F (-10°C to 51°C)

DATA DELIVERY SERVICES

Secure Data

MMI DATA DELIVERY SERVICES takes full advantage of the tight security features provided by the Web server, enabling control on the user access according to IP address or selected Web pages. In addition, MMI DATA DELIVERY SERVICES offers security features for controlling the contents of each page according to users' authorization.

RTU Communications

Remote Communications –

The remote RTU/flow meter shall communicate with the host computer to:

Transfer data and alarms
Reconfigure computations, schedules and site parameters
Perform clock maintenance
1xRTT - Packet switched IP protocol data over the Verizon 800 MHz Cellular Network will be supported with an FCC and Verizon approved embedded cellular modem.

Communication Methodology: The RTU configured with a 1xRTT cellular modem will automatically transfer data to the host computer following each flow measurement then power off the modem between calls. This effectively provides real time flow data on the network while consuming far less total energy than a method that permits direct call access to collect flow data.

A data call following a flow measurement over the Verizon 1xRTT network consists of two IP data packets; one from the RTU to the host; the second from the host to the RTU confirming valid receipt of error free data. The contents of the RTU packet will include the level, velocity and flow for all flow measurements since the previous data call. The battery voltage and any alarm messages will also be included.

Data Security - Wireless 1xRTT data occurs over the Verizon network between specific IP addresses. The RTU will only generate data calls to pre-programmed IP addresses, and will never answer incoming, unsolicited calls from unknown IP addresses. Similarly, the host computer firewall will accept data calls only from RTUs with known IP addresses transferred over the Verizon network.

Equipment and Calibration

Flow monitoring equipment and accessories are stored at our factory at all times. Prior to storage, all meters are checked for proper operation. Prior to shipment to a project, all meters are visually checked and calibrated.

Site Selection Criteria

Selection of the appropriate site to perform flow monitoring is critical to obtaining accurate data. The ideal site will have a straight run of pipe with at least three pipe diameters upstream and downstream of the probe location, and no dimensional variations that will change the hydraulic characteristics of the flow. Understanding that the probe will generally be placed in close proximity to a manhole, flow direction should not change abruptly going through the manhole, i.e., there should be a straight run through the manhole. The manhole should not have debris, brick or any other objects that might disrupt the flow. There should be a smooth transition through the manhole with flow conditions resembling that of pipe flow; and the incoming pipe invert should be higher than the outgoing pipe invert. The manhole must also be accessible, not only for installation and recovery of the meter, but also for periodic inspections during the flow monitoring period. Flow conditions at the ideal site (prior to installation of the sensor) should have a minimum velocity of 0.75 feet per second.

Meter site selection will be accomplished after reviewing the collection system maps and preliminary field inspection of any sanitary sewer overflow (SSO) locations. Each monitoring site will be selected so that the footage of the collection system upstream of the meter can be isolated for the purposes of determining extraneous infiltration/inflow and for various engineering analysis. All meter sites will be approved by the Owner/Engineer prior to installation.

Meter Installation and Calibration

The flow sensor will be mounted securely above the flow stream on a stainless steel bracket permanently affixed to the manhole inner wall. The data logger will be securely installed at the top of the manhole or sewer entry structure. The sensor cables and connectors will be secured to prevent disruption of operation or debris collection.

After the sensor is in place, a velocity profile will be taken using a portable velocity meter and will be recorded on the velocity profile worksheet. The average velocity determined by the velocity profile will be compared to the velocity measured by the meter.

Also, the depth of flow will be physically measured and compared against the depth measured by the meter. The depth measurement of the meter will be adjusted to the depth measured manually and then verified that the depth has not changed.

Meter Repairs and Maintenance

All repairs and maintenance to the flow meters will be the responsibility of Marsh-McBirney, Inc. Any costs associated with repairs and/or maintenance shall be paid by Marsh-McBirney, Inc. and will not be incurred by the customer. Routine replacement of batteries is considered routine maintenance and should only have to be performed once a year.

Deliverables

The following represents typical project deliverables:

- Installation of flow meters as defined by this project scope
- Flow monitoring data, both graphical and tabular formats
- Password protected web-based data.
    - SQL database
    - High performance graphical user interface and report generator.
    - Flow analysis and computation utility
    - Web server application for sharing data across an Intranet or the Internet.
- Guaranteed 90% up-time
- Guaranteed "No Lost Data"

Scope of Work

Marsh-McBirney is prepared to accomplish the work based on the following scope:

- Install (1) non-contact area velocity open channel flow meter for a period of 12 months, or more.
- Meters will be programmed for 15 minute readings
- Inspect each site and prepare recommendations for approval
- Complete installation within 45 days of receipt of NTP and executed contract
- Submit digital photo of each site
- Perform hydraulic calibrations
- Perform all work in safe manner
- Request and obtain permission from private property owners, as required

Summarized below is an estimate for performing the work:

ITEM	ESTIMATED QUANTITY	UNITS	UNIT PRICE	
Project Startup & Installation of Equipment				
Flow Meter per 12 month, or more, monitoring period	(1)	Meter/Month	$700.00/Meter/Month	
Site selection/certification	(1)	Site	Included	
Installation	(1)	Site	$1,800.00/Site	
Alarms	(1)	Alarm Parameter/Site	Included	