RECEIVED
MAY 7 2004
DEPT OF ECOLOGY

City of Mount Vernon

City of Mount Vernon
Comprehensive Sewer Plan Amendment

April 2004

APPROVED
DEPARTMENT OF ECOLOGY
ENGINEERING MANAGEMENT
SIGNATURE
DATE 8/18/05

Prepared by

HDR Engineering, Inc.
500-108th Avenue NE, #1200
Bellevue, WA 98004

HDR

CITY OF MOUNT VERNON, WASHINGTON

COMPREHENSIVE SEWER PLAN AMENDMENT

Prepared by:	**Kenneth Hui**
Reviewed by:	**Dan Olson, John Koch**
Date:	**April 22, 2004**
Subject:	**Comprehensive Sewer Plan Amendment**
Project Number:	**09637-006070**

1.0 BACKGROUND

After the latest update to the Mount Vernon Comprehensive Sewer Plan (CSP) was approved by the Washington Department of Ecology (Ecology) in February 2003, the City of Mount Vernon requested that HDR further refine the upgrade concept proposed in the CSP.

The following guidelines were used when refining the upgrade concept:

- Minimize impact on the operations of the existing plant during upgrade construction
- Investigate the feasibility of incorporating new and emerging technologies that could improve treatment efficiencies and reliability
- Explore potential cost savings

Three configurations and several new technologies were investigated as described in the *Alternative Facility Concepts and Layouts* technical memorandum issued in July 2003. The recommendations of this study formed the basis for further evaluation. The feasibility was explored for treating peak storm flows with an innovative high rate clarification process in conjunction with the preferred modified treatment configuration. High rate clarification (HRC) has gained acceptance recently as an effective means of treating peak storm flows and minimizing combined sewer overflows (CSOs). HRC has been accepted as more municipalities pilot test the technology with promising results and as more full-scale facilities are installed throughout the country. This proposed modified treatment scheme fits into and further improves the overall long-term vision of the City of Mount Vernon as originally proposed in the 1991 Comprehensive Sewer and Combined Sewer Overflow Reduction Plan (the 1991 Plan). A separate technical memorandum summarizing the performance of the HRC process during pilot studies in the Pacific Northwest and other parts of the country was issued in November 2003. This technical memorandum is attached as Appendix A.

Subsequent correspondence and meetings with Ecology resulted in conceptual agreement by Ecology for the use of HRC treatment for flows above the maximum month level. Letters to Ecology from the City of Mount Vernon on this issue and related meeting minutes are attached as Appendix B.

A public hearing was held on January 30, 2004 to inform the public about the modified treatment scheme, which would result in an amendment to the City Comprehensive Plan. A copy of the public hearing notice and the project narrative are included as Appendix C.

The purpose of this technical memorandum is to document proposed changes to the upgrade concept for the primary and secondary liquid-stream treatment processes at the City of Mount Vernon Wastewater Treatment Plant. This memorandum focuses on HRC as a new technology and its associated benefits to the City of Mount Vernon.

1.1 Sections Affected in the Comprehensive Sewer Plan Update

The following sections in the February 2003 Comprehensive Sewer Plan are affected by this amendment:

- The 'Combined Sewer Overflow' section, 'Wastewater Treatment Facility Improvements' section, Figure ES-1, Table ES-1, and Table ES-4 of the Executive Summary
- The 'Projected Flows and Loads' section, and Tables 3-5 through 3-9 of Chapter 3 – Basic Planning Data
- The 'Recommended CSO Reduction Alternative' section, Table 4-4 and Table 4-5 of Chapter 4 – Combined Sewer System
- The 'Capacity Analysis' section, Tables 8-3 through 8-5 of Chapter 8 – Wastewater Treatment Plant Analysis
- The 'Primary Clarifiers' section, the 'Activated Sludge Process' section, Figure 10-1, Figure 10-2, and Table 10-1 of Chapter 10 – Recommended WWTP Alternatives
- Table 11-1 and Table 11-2 of Chapter 11 – Capital Improvement Plan

2.0 REVISED PROJECTED FLOWS AND LOADS

Projected flows and loads developed in the CSP were further refined during the Predesign Phase based on recent growth rate. The refined projected flows and loads values served to provide the basis of a BIOWIN computer simulation, to allow further evaluation of the treatment process capacity, and to provide a means of evaluating upgrade options. This section replaces the 'Projected Flows and Loads' section and Tables 3-5 through 3-9 of Chapter 3 – Basic Planning Data of the CSP.

2.1 Revised Projected Flow

Table 1 shows the revised projected flow.

Table 1: Revised Projected Flow (New CSP Table 3-5)

	2010	2015	2020	Build-Out
Average Wet Weather Flow, mgd	4.35	5.14	6.07	10.50
Maximum Month Average Design Flow, mgd	7.26	8.57	10.14	17.80
Peak Daily Flow, mgd	11.40	13.47	15.90	26.78
Peak Hour Flow, mgd	17.00	25.90	25.90	45.10

2.2 Revised Projected Loads

Tables 2 through 4 show the revised projected biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia loads, respectively.

Table 2: Revised Projected Biochemical Oxygen Demand (BOD) Loads (New CSP Table 3-6)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	6,566	7,759	9,163	15,850
Maximum Month, lb/d	8,356	9,863	11,670	20,486
Peak Daily Flow, lb/d	14,261	16,847	19,895	33,502
Peak Hour Flow, lb/d	14,261	16,847	19,895	33,502

Table 3: Revised Projected Total Suspended Solids (TSS) Loads (New CSP Table 3-7)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	6,240	7,373	8,707	15,062
Maximum Month, lb/d	8,840	10,435	12,347	21,674
Peak Daily Flow, lb/d	13,501	15,948	18,834	31,715
Peak Hour Flow, lb/d	13,501	15,948	18,834	31,715

Table 4: Revised Projected Ammonia Loads (New CSP Table 3-8)

	2010	2015	2020	Build-Out
Average Annual, pounds per day (lb/d)	762	900	1,063	1,839
Maximum Month, lb/d	951	1,122	1,328	2,331
Peak Daily Flow, lb/d	1,046	1,235	1,459	2,456
Peak Hour Flow, lb/d	1,046	1,235	1,459	2,456

3.0 MODIFICATION TO CSO REDUCTION PLAN

This section replaces The 'Recommended CSO Reduction Alternative' section, Table 4-4 and Table 4-5 of Chapter 4 – Combined Sewer System in the CSP.

3.1 Long-Term Vision of CSO Reduction Plan

On April 11, 1996, an Order on Consent was issued by the Washington Department of Ecology and signed by the City of Mount Vernon to implement the vision of the CSO Reduction Plan. The vision of the CSO Reduction Plan is to provide a combination of storage facilities and peak storm flow treatment facilities to achieve the greatest reasonable reduction of CSOs. This means limiting the frequency of untreated CSOs to an average of no more than one per year, per requirement of Chapter 90.48.480 of the Revised Code of Washington (RCW).

The CSO Reduction Plan proposed in the 1991 Plan consisted of a 3-phase approach. In Phase 1, it was proposed that inline storage be provided for CSO flows that would have been discharged to the Skagit River. Stored CSO flows are conveyed to the wastewater treatment plant (WWTP) for treatment and disposal as capacity allows. The City concluded Phase 1 of the CSO Reduction Plan when the Central CSO Regulator was completed and put online in December 1997. The Central CSO Regulator has a volume of close to 1 million gallons and the storage capacity ranges between 0.6 and 0.8 million gallons, depending on the volume used in conveyance of storm flow. Installation of the Central CSO Regulator was projected to reduce overflows to 12 events per year; however, the overflows event from 1998 to 2003 has averaged 8 per year.

Phase 2 of the originally proposed CSO Reduction Plan consists of upgrading the WWTP treatment capacity to accommodate the combined maximum conveyance capacity (25.8 mgd) of the Hazel Street Interceptor and the West Mount Vernon Pump Station. A total of 18.3 mgd would receive full secondary treatment after building of new aeration basins, while 7.5 mgd of peak storm flow would be treated separately in a CSO clarifier. The existing primary clarifier would be converted to a CSO clarifier after new primary clarifiers are constructed upstream of the upgraded secondary treatment units. Details of the original CSO and WWTP secondary treatment upgrade are discussed in Section 3.2 and Section 4.1, respectively.

Innovative HRC technology for treating peak storm flows has recently matured, and the Central CSO Regulator has been successful in reducing CSOs to a level beyond the original expectation. In light of these factors, the CSP amendment seeks to implement this technology at Phase 2 with the goal of successfully reducing CSOs to less than one untreated event per year during this phase. By maximizing capacity of the existing aeration basin and utilizing the enhanced performance of two proposed 6 mgd HRC units, it would be possible to achieve a lower pollutant loading to the Skagit River with the revised treatment scheme. Details of the proposed changes to the CSO upgrades, proposed changes to the WWTP secondary treatment upgrades, and mass balance analyses are presented in Section 3.3, Section 4.2, and Section 5.0, respectively.

It was proposed in the 2003 Comprehensive Sewer Plan Update that HRC technology be implemented during Phase 3 to increase the combined treatment capacity of the WWTP to 48 mgd; this would reduce CSOs to less than one untreated event per year. Depending on the performance of the revised Phase 2 upgrade, the number and capacities of extra HRC units may be further revised in the future. At present, it is proposed that two more 6-mgd HRC units be installed, bringing the total to four units with a total HRC capacity of 24 mgd.

Monitoring the performance of the Central CSO Regulator system through 2010 will provide an additional six years of flow data. The data collected will be used to further refine the CSO compliance alternative and optimize the ultimate execution of the Phase 2 and Phase 3 CSO Reduction Plan.

3.2 CSO Reduction Plan Improvement Proposed in the Comprehensive Sewer Plan

In the February 2003 Comprehensive Sewer Plan Update, the following upgrades were proposed for installation between 2004 and 2009:

- The Influent Pump Station would be upgraded to handle a flow of 24 mgd. The West Mount Vernon Pump Station would be upgraded to handle a flow of 1.8 mgd. The peak flow to the wastewater treatment plant would be 25.8 mgd.
- The new headworks (fine screens and degritting) would be sized to handle the combined peak flow of 25.8 mgd.
- Two new 75-foot-diameter primary clarifiers would be built to handle a peak flow of 9.2 mgd each (18.3 mgd total). The primary effluent would then be treated by the upgraded secondary treatment process (18.3 mgd capacity).
- The existing primary clarifier would be converted to a CSO clarifier for CSO treatment via the internal shunt mechanism to treat the remaining 7.5 mgd flow that would not be treated by secondary treatment.
- Effluent from the secondary treatment process (18.3 mgd) and the CSO clarifier (7.5 mgd) would be blended at the disinfection facility for disinfection and disposal via a common outfall.

The following upgrades were proposed for the next and final phase of the CSO Reduction Plan in 2013, as described in Chapter 4 of the Comprehensive Sewer Plan Update:

- Park Street Pump Station would be upgraded to separately convey CSO and storm flow.
- CSOs would be pumped to the WWTP via a new CSO force main to a new HRC system for treatment. The proposed peak hour HRC treatment capacity was 22.2 mgd.
- The HRC effluent would be disinfected by an ultraviolet (UV) disinfection system and pumped to the treatment plant outfall for final disposal.

3.3 Proposed Modification to CSO Reduction Plan Improvement

The following modifications to the CSO Reduction Plan were proposed:

- Two 6 mgd HRC modules would be installed at the WWTP to handle flows above the maximum capacity of the secondary treatment process. It is proposed that the HRC modules be installed prior to January 1, 2015. The combined treatment capacity of the upgraded system would be sufficient to handle the projected 2020 peak hour flow of 25.9 mgd.

- The HRC effluent would be disinfected and blended with the disinfected secondary effluent before final disposal via the treatment plant outfall.
- Beyond 2020, two more HRC modules could be installed at the WWTP, together with other improvements in the liquid-stream treatment, to provide a combined treatment capacity sufficient to handle the projected build-out peak hour flow of 45.1 mgd.

4.0 MODIFICATIONS TO LIQUID-STREAM TREATMENT UPGRADE

This section replaces the following sections in the CSP: the 'Primary Clarifiers' section, the 'Activated Sludge Process' section, Figure 10-1, Figure 10-2, and Table 10-1 of Chapter 10 – Recommended WWTP Alternatives.

4.1 Liquid-Stream Treatment Upgrade Proposed in the Comprehensive Sewer Plan

The upgrades to the Influent Pump Station, West Mount Vernon Pump Station, headworks, and primary treatment proposed in the February 2003 Comprehensive Sewer Plan Update were summarized in Section 3.1. Proposed improvements to the secondary treatment process include:

- New selector basins for filament control would be added in two phases. The selector basins would be operated in aerobic mode in the first phase to accommodate the non-nitrifying mode of the plant. In the second phase, additional tanks would be installed and the selector basins would be operated in anoxic mode to accommodate the anticipated nitrifying mode of the plant.
- The existing 0.5 million gallon Aeration Basin No. 4 would be used for secondary treatment instead of for waste activated sludge (WAS) storage.
- The existing coarse bubble diffusers would be replaced with fine bubble membrane disc diffusers to improve aeration efficiency.
- An additional 1.2 million gallons of aeration basin tankage would be added in the second phase improvement. This would allow the secondary treatment to achieve full nitrification, reducing the occasional ammonia peak from solids treatment internal recycle, and thus complying with the discharge permit requirement.
- The existing Secondary Clarifier No. 1 would be taken offline and would be converted to WAS storage.
- Two new 85 foot diameter clarifiers and distribution structure would be added by 2010. A third new 85 foot diameter clarifier would be added by 2020.

4.2 Proposed Modification to Liquid-Stream Treatment Upgrade

Based on the revised projected flows and loads, several BIOWIN computer simulations were conducted to: (a) analyze existing secondary treatment system capacity, and (b) evaluate options for upgrading the existing secondary process to provide sufficient capacity for the projected future flows and loads.

The following changes are proposed:

- Sufficient fine-screen capacity would be installed to handle the projected 2020 peak hour flow of 25.9 mgd. An additional channel would be constructed for installation of a third screen to handle build-out peak flows.
- Flow splitting to HRC would be installed upstream of the degritting system. The high rate clarification process manufacturers indicate that degritting is not required upstream of the HRC.

- Degritting system capacity would be sized to match the maximum flow of 16.4 mgd to secondary treatment.
- Two new 80 foot diameter primary clarifiers would be constructed to handle maximum flow to secondary treatment.
- The internal recycle from solids treatment processes would be routed to the re-aeration zone of the aeration basin.
- The original coarse bubble diffusers were replaced with fine bubble membrane disc diffusers in December 2002.
- An interim change was made in operation of the treatment plant in mid June, 2003. Aeration Basin 4 has been converted from WAS storage to an anoxic zone and the secondary treatment process is operated in the Modified Ludzack Ettinger (MLE) mode for nitrification and denitrification. Aeration Basin 1 is currently being used as WAS storage instead of Basin 4. In the proposed upgrade, Aeration Basin 1 will be divided into a re-aeration basin and anoxic basin. The re-aeration basin is designed to handle the periodic ammonia loading spikes from the solids treatment internal recycle and to maintain the effluent ammonia level within the discharge permit requirement. Basins 2 through 4 will be used as aerobic basins. Between 2020 and build-out, space will be allocated for an additional aeration basin.
- Based on the results of the BIOWIN computer simulations, the maximum capacity of the existing aeration basin, with the Aeration Basin No. 4 back in operation, was estimated to be sufficient to treat the projected 2020 peak day flow of 15.9 mgd and 0.5 mgd of internal recycle flow from solids treatment processes. Flow above this level (16.4 mgd) would be diverted to the HRC system for enhanced primary treatment.
- The new 1.2 million gallon aeration basin would be delayed until after Phase 2 and would be designed at a later date to handle the projected build-out peak day flow.
- Two new 85 foot diameter secondary clarifiers would be installed by 2015. Of the two existing secondary clarifiers, the peripheral feed Secondary Clarifier No. 1 would be removed from service. A total of three (two new and one existing) would be in service by 2015. Space for two more 85 foot diameter secondary clarifiers would be allocated for the build-out scenario to bring the total number of clarifiers in operation to five.

5.0 REVISED MASS BALANCES

Mass balances were prepared based on the results of the BIOWIN computer simulations. The mass balances compared the amount of projected pollutants discharged into the Skagit River by: (a) the CSP-proposed treatment scheme, and (b) the modified treatment scheme proposed in the CSP amendment. The years compared were 2005, 2010, 2015, and 2020. The revised flow projection indicates that re-routing of excess peak flow around primary treatment units and the secondary biological treatment unit would occur under the peak hour flow scenarios in 2015 and 2020. Results of mass balances for these two scenarios for both treatment schemes are presented in Figure 1 and Figure 2.

The following assumptions were used in preparing the mass balances:

- The CSP treatment scheme could treat up to 18.3 mgd of peak hour flow before re-routing is needed. Excess peak flow above 18.3 mgd would be re-routed to a dedicated CSO clarifier for primary treatment. Secondary effluent would be blended with the CSO clarifier effluent before discharge.

- The treatment scheme proposed in the amendment could treat up to 16.4 mgd of peak hour flow before re-routing is needed. Excess peak flow above 16.4 mgd would be re-routed to a dedicated HRC for enhanced primary treatment. Secondary effluent would be blended with the HRC effluent before discharge.

- The primary clarifier is anticipated to have a BOD removal efficiency of 35 percent, a TSS removal efficiency of 55 percent, and an ammonium (NH_4) removal efficiency of 0 percent.

- The CSO clarifier originally proposed in the CSP is anticipated to have the same performance as the primary clarifier (35 percent BOD removal, 55 percent TSS removal, and 0 percent NH4 removal).

- The high rate clarifier is anticipated to have an enhanced BOD removal efficiency of 60 percent, an enhanced TSS removal efficiency of 80 percent, and an NH_4 removal efficiency of 0 percent.

- Both the secondary biological treatment unit in the CSP treatment scheme and the secondary biological treatment unit in the amendment treatment scheme are anticipated to produce an effluent with 10 milligrams per liter (mg/L) of BOD, 15 mg/L of TSS, and 4 mg/L of NH_4, based on BIOWIN computer simulation results.

As shown in Figure 1 and Figure 2, the amendment treatment scheme is anticipated to discharge significantly lower BOD (979 lb/d in 2015 and 1,141 lb/d in 2020) and TSS (1,247 lb/d and 1,442 lb/d in 2020) loadings, and a similar amount (within 30 lb/d difference in 2015 and 2020) of NH_4 loading into the Skagit River as compared with the CSP treatment scheme. The effluent qualities of either treatment scheme would satisfy the anticipated future National Pollutant Discharge Elimination System (NPDES) requirement. However, the amendment treatment scheme would provide a net positive environmental benefit over the CSP treatment scheme based on the results of the mass balance analyses.

Figure 1: Amendment Option

Influent

		2015	2020
Flow	mgd	25.90	25.90
BOD Load	lb/d	16847	19885
BOD Conc	mg/L	78.0	92.1
TSS Load	lb/d	15948	18834
TSS Conc	mg/L	73.8	87.2
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.7	6.8

Plant Drain Recycle

		2015	2020
Flow	mgd	0.51	0.61
BOD Load	lb/d	233	275
BOD Conc	mg/L	54.3	54.3
TSS Load	lb/d	221	261
TSS Conc	mg/L	51.6	51.6
NH4 Load	lb/d	0	0
NH4 Conc	mg/L	0.0	0.0

Influent + Solids Treatment Recycle

		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	17080	20170
BOD Conc	mg/L	77.5	91.2
TSS Load	lb/d	16170	19095
TSS Conc	mg/L	73.4	86.4
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.6	6.6

1° Clarification

		2015	2020
Flow	mgd	16.40	16.40
Inf BOD	lb/d	10605	12479
	mg/L	77.5	91.2
Eff BOD	lb/d	6893	8112
	mg/L	50.4	59.3
Inf TSS	lb/d	10039	11814
	mg/L	73.4	86.4
Eff TSS	lb/d	4518	5316
	mg/L	33.0	38.9
Inf NH4	lb/d	767	903
	mg/L	5.6	6.6
Eff NH4	lb/d	767	903
	mg/L	5.6	6.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%

ACTIFLO High Rate Clarification

		2015	2020
Flow	mgd	10.01	10.11
Inf BOD	lb/d	6475	7691
	mg/L	77.5	91.2
Eff BOD	lb/d	2590	3076
	mg/L	31.0	36.5
Inf TSS	lb/d	6130	7281
	mg/L	73.4	86.4
Eff TSS	lb/d	1226	1456
	mg/L	14.7	17.3
Inf NH4	lb/d	468	556
	mg/L	5.6	6.6
Eff NH4	lb/d	468	556
	mg/L	5.6	6.6
Efficiencies			
BOD	%	60%	60%
TSS	%	80%	80%
NH4	%	0%	0%
Vs CSP Treated CSO Effluent			
BOD	lb/d	-820	-983
TSS	lb/d	-1009	-1204
NH4	lb/d	34	39

Dewatering Filtrate Recycle

		2015	2020
Flow	mgd	0.00	0.00
BOD Load	lb/d	0	0
BOD Conc	mg/L	NA	NA
TSS Load	lb/d	0	0
TSS Conc	mg/L	NA	NA
NH4 Load	lb/d	180	213
NH4 Conc	mg/L	NA	NA

Reaeration

		2015	2020
Flow	mgd	0.00	0.00
Inf BOD	lb/d	0	0
	mg/L	NA	NA
Eff BOD	lb/d	0	0
	mg/L	NA	NA
Inf TSS	lb/d	0	0
	mg/L	NA	NA
Eff TSS	lb/d	0	0
	mg/L	NA	NA
Inf NH4	lb/d	180	213
	mg/L	NA	NA
Eff NH4	lb/d	18	21
	mg/L	NA	NA
Efficiencies			
BOD	%	NA	NA
TSS	%	NA	NA
NH4	%	90%	90%

Activated Sludge

		2015	2020
Flow	mgd	16.40	16.40
Inf BOD	lb/d	6893	8112
	mg/L	50.4	59.3
Eff BOD	lb/d	1368	1368
	mg/L	10.0	10.0
Inf TSS	lb/d	4518	5316
	mg/L	33.0	38.9
Eff TSS	lb/d	2052	2052
	mg/L	15.0	15.0
Inf NH4	lb/d	785	924
	mg/L	5.7	6.8
Eff NH4	lb/d	547	547
	mg/L	4.0	4.0
Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	30%	41%
Applied to Secondary			
BOD	lb/d	6893	8112
TSS	lb/d	4518	5316
NH4	lb/d	947	1115
Removed by Secondary			
BOD	lb/d	5525	6744
TSS	lb/d	2466	3265
NH4	lb/d	400	568
Overall Secondary Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	42%	51%
Vs CSP Secondary Effluent			
BOD	lb/d	-158	-158
TSS	lb/d	-238	-238
NH4	lb/d	-63	-63

Blended Effluent

		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	3958	4444
BOD Conc	mg/L	18.0	20.1
TSS Load	lb/d	3278	3508
TSS Conc	mg/L	14.9	15.9
NH4 Load	lb/d	1015	1103
NH4 Conc	mg/L	4.6	5.0
Total Applied			
BOD	lb/d	17080	20170
TSS	lb/d	16170	19095
NH4	lb/d	1415	1672
Total Removed			
BOD	lb/d	13122	15726
TSS	lb/d	12897	15587
NH4	lb/d	400	568
Total Efficiencies			
BOD	%	77%	78%
TSS	%	80%	82%
NH4	%	28%	34%
Vs CSP Blended Effluent			
BOD	lb/d	-979	[illegible]
TSS	lb/d	-1247	-1442
NH4	lb/d	-30	-25

Figure 2: CSP Option

Influent

		2015	2020
Flow	mgd	25.90	25.90
BOD Load	lb/d	16847	19895
BOD Conc	mg/L	78.0	92.1
TSS Load	lb/d	15948	18834
TSS Conc	mg/L	73.8	87.2
NH4 Load	lb/d	1235	1459
NH4 Conc	mg/L	5.7	6.8

Plant Drain Recycle

		2015	2020
Flow	mgd	0.51	0.61
BOD Load	lb/d	233	275
BOD Conc	mg/L	54.3	54.3
TSS Load	lb/d	221	261
TSS Conc	mg/L	51.6	51.6
NH4 Load	lb/d	180	213
NH4 Conc	mg/L	42.0	42.0

Influent + Solids Treatment Recycle

		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	17080	20170
BOD Conc	mg/L	77.5	91.2
TSS Load	lb/d	16170	19095
TSS Conc	mg/L	73.4	86.4
NH4 Load	lb/d	1415	1672
NH4 Conc	mg/L	6.4	7.6

1° Clarification

		2015	2020
Flow	mgd	18.30	18.30
Inf BOD	lb/d	11833	13925
	mg/L	77.5	91.2
Eff BOD	lb/d	7692	9051
	mg/L	50.4	59.3
Inf TSS	lb/d	11203	13183
	mg/L	73.4	86.4
Eff TSS	lb/d	5041	5932
	mg/L	33.0	38.9
Inf NH4	lb/d	981	1154
	mg/L	6.4	7.6
Eff NH4	lb/d	981	1154
	mg/L	6.4	7.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%

CSO Clarification

		2015	2020
Flow	mgd	8.11	8.21
Inf BOD	lb/d	5247	6245
	mg/L	77.5	91.2
Eff BOD	lb/d	3410	4059
	mg/L	50.4	59.3
Inf TSS	lb/d	4967	5912
	mg/L	73.4	86.4
Eff TSS	lb/d	2235	2660
	mg/L	33.0	38.9
Inf NH4	lb/d	435	518
	mg/L	6.4	7.6
Eff NH4	lb/d	435	518
	mg/L	6.4	7.6
Efficiencies			
BOD	%	35%	35%
TSS	%	55%	55%
NH4	%	0%	0%
Vs Amendment ACTIFLO Effluent			
BOD	lb/d	820	983
TSS	lb/d	1009	1204
NH4	lb/d	-34	-39

Activated Sludge

		2015	2020
Flow	mgd	18.30	18.30
Inf BOD	lb/d	7692	9051
	mg/L	50.4	59.3
Eff BOD	lb/d	1526	1526
	mg/L	10.0	10.0
Inf TSS	lb/d	5041	5932
	mg/L	33.0	38.9
Eff TSS	lb/d	2289	2289
	mg/L	15.0	15.0
Inf NH4	lb/d	981	1154
	mg/L	6.4	7.6
Eff NH4	lb/d	610	610
	mg/L	4.0	4.0
Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	38%	47%
Applied to Secondary			
BOD	lb/d	7692	9051
TSS	lb/d	5041	5932
NH4	lb/d	981	1154
Removed by Secondary			
BOD	lb/d	6165	7525
TSS	lb/d	2752	3643
NH4	lb/d	370	544
Overall Secondary Efficiencies			
BOD	%	80%	83%
TSS	%	55%	61%
NH4	%	38%	47%
Vs Amendment Secondary Effluent			
BOD	lb/d	158	158
TSS	lb/d	238	238
NH4	lb/d	63	63

Blended Effluent

		2015	2020
Flow	mgd	26.41	26.51
BOD Load	lb/d	4937	5585
BOD Conc	mg/L	22.4	25.3
TSS Load	lb/d	4525	4950
TSS Conc	mg/L	20.5	22.4
NH4 Load	lb/d	1045	1128
NH4 Conc	mg/L	4.7	5.1
Total Applied			
BOD	lb/d	17080	20170
TSS	lb/d	16170	19095
NH4	lb/d	1415	1672
Total Removed			
BOD	lb/d	12143	14585
TSS	lb/d	11645	14145
NH4	lb/d	370	544
Total Efficiencies			
BOD	%	71%	72%
TSS	%	72%	74%
NH4	%	26%	33%
Vs Amendment Blended Effluent			
BOD	lb/d	979	1141
TSS	lb/d	1247	1442
NH4	lb/d	30	25

6.0 CONCLUSIONS

The Comprehensive Sewer Plan Amendment seeks to include an HRC option to treat peak storm flow at the WWTP. The capacity of the existing aeration basin would be maximized to provide peak flow capacity of 16.4 mgd for full secondary treatment, without construction of new aeration basins.

Based on results of the BIOWIN computer simulation using the revised flow projections, it is anticipated that the small reduction (1.9 mgd) in full secondary treatment capacity is more than compensated by the additional HRC capacity of 12 MGD and the enhanced treatment efficiency of the HRC technology over the conventional primary-type CSO clarifier described in the original proposal.

The amendment treatment scheme is anticipated to discharge significantly lower BOD (979 lb/d in 2015 and 1,141 lb/d in 2020) and TSS (1,247 lb/d and 1,442 lb/d in 2020) loadings, and a similar amount (within 30 lb/d difference in 2015 and 2020) of NH_4 loading into the Skagit River as compared with the CSP treatment scheme. The effluent qualities of either treatment scheme would satisfy the anticipated future National Pollutant Discharge Elimination System (NPDES) requirement. However, the amendment treatment scheme would provide a net positive environmental benefit over the CSP treatment scheme based on the results of the mass balance analyses.

The City would also be prudent to continue to monitor the performance of the Central CSO Regulator system through 2010 to provide an additional six years of flow data. The data collected will be used to further refine the CSO compliance alternative and optimize the ultimate execution of the Phase 2 and Phase 3 CSO Reduction Plan.

APPENDIX A

Alternative Peak Flow Treatment

CITY OF MOUNT VERNON, WASHINGTON

WASTEWATER TREAMENT PLANT UPGRADE

PREDESIGN TECHNICAL MEMORANDUM

Prepared by:	Kenneth Hui, PE
Reviewed by:	Dan Olson, PE John Koch, PE
Date:	November 2003
Subject:	High Rate Clarification Pilot Testing Performance Summary
Project Number:	09637-006070

1.0 INTRODUCTION

Full-scale high rate clarification (HRC) systems for treatment of combined sewer overflows (CSOs) or sanitary sewer overflows (SSOs) have been installed in various parts of the country. The two major players in HRC systems are USFilter (Actiflo® system) and Ondeo (DensaDeg® system). A selected installation list of full-scale HRC systems in North America is shown in the appendix.

Five cities or counties in Washington and Oregon have conducted pilot studies of one or both types of HRC systems in the past five years. Summaries of these pilot studies are included in the appendix. Pilot study performances conducted across the United States are also included in the appendix as summary tables.

At present, there is one full-scale HRC system in Bremerton, Washington. It has been in operation since 2002.

Table 1 shows the performance summary of HRC pilot studies conducted in the Pacific Northwest.

Table 1: Performance Summary of HRC Pilot Studies in the Pacific Northwest

Location	HRC Unit	Coagulant	Dosage (mg/L)	Eff TBOD (mg/L)	% Removal	Eff TSS (mg/L)	% Removal	Startup Time to Steady State	Overflow Rate (gpm/sf)
Bremerton	A	Ferric Chloride	15 to 45	47	63%	9	71%	10 min to 5 NTU	55
King County	A	Ferric Chloride	110	48	78%	15	94%	10 to 15 min	60
		PACl	34	51	63%	11	96%		60
		Alum	110	45	74%	11	94%		60
Salem	A	Ferric Chloride	40 to 50	NA	NA	NA	>85%	<20[a]	80
		PACl	20	NA	NA	NA	NA		NA
		Alum	80	NA	NA	NA	85%		30
		ACH	20	NA	NA	NA	90%	<10[a]	100
Tacoma	A	Ferric Chloride	100	112	62%	6	98%	10 to 15 min	60
		PACl	45	31	70%	17	87%		60
Portland	A	Ferric Chloride	58	141	41%	5.2	97%	20 min	20
		Alum	120	210	36%	6	96%		40

Location	HRC Unit	Coagulant	Dosage (mg/L)	Eff TBOD (mg/L)	% Removal	Eff TSS (mg/L)	% Removal	Startup Time to Steady State	Overflow Rate (gpm/sf)
Bremerton	D	Ferric Chloride	60	167	61%	21	85%	75 to 95 min to 5 NTU	20 to 30
King County	D	Ferric Chloride	40	NA	NA	11	96%	20 to 55 min	30
		PACl	40	206[b]	57%	41	81%		30
		Alum	60	250[b]	71%	54	87%		30
Salem	D	Ferric Chloride	40	NA	59%	NA	87%		30 to 40
		PACl	30	NA	59%	NA	87%		30 to 40
		Alum	60	NA	59%	NA	87%		30 to 40
		ACH	15	NA	59%	NA	87%	1.5 to 2 hours	30 to 40

Legend: A = ACTIFLO;D = DensaDeg

Note a: Overflow rate not specified for start up test

Note b: COD Value

APPENDIX:

High Rate Clarification

Selected Installation List and Summaries of Pilot Studies

SUMMARIES OF HIGH RATE CLARIFICATION PILOT STUDIES

EXECUTIVE SUMMARY

- Five cities or counties in the Pacific Northwest have experience in pilot testing high rate clarification (Actiflo® and/or DensaDeg® system) in the past five years. They are: the City of Portland, Oregon; City of Tacoma, Washington; City of Salem, Oregon; City of Bremerton, Washington; and King County, Washington.
- In studies where both technologies were tested, effluent qualities from Actiflo® and DensaDeg® were similar.
- Actiflo® could achieve a similar level of treatment at twice the surface overflow rate of DensaDeg® (60 to 80 gpm/ft^2 for Actiflo® and 30 to 40 gpm/ft^2 for DensaDeg®). The size of a similar-capacity Actiflo® system could be half that of a DensaDeg® system.
- In the King County pilot study, DensaDeg® required less ferric and less alum as coagulant than was required by the Actiflo® system treating similar influent. Polyaluminum chloride (PACl) dosages for both systems were similar.
- In the City of Salem pilot study, DensaDeg® and Actiflo® required similar dosages in all four coagulants tested (ferric, alum, PACl, and aluminum chlorhydrate).
- DensaDeg® utilizes recycled sludge as ballast to accelerate settling. Actiflo® requires micro-sand as ballast to accelerate settling.
- Actiflo® produces a dilute sludge stream. The result of the King County study indicated that the sludge from the Actiflo® pilot plant had a solids concentration of approximately 0.6 percent. DensaDeg® produces a thickened sludge stream. The result of the Bremerton study indicated that the sludge from the DensaDeg® pilot plant had a solids concentration of 2 percent. If sludge from high rate clarification is to be treated separately, Actiflo® sludge may require a gravity thickener before digestion or dewatering. However, if sludge from high rate clarification could be discharged back to the sewer for handling by remote facilities or back to the front end of the primary clarifier for handling by onsite facilities, then the thickening step may not be necessary for Actiflo®. DensaDeg® sludge requires lower degree of thickening.
- Actiflo® has a much shorter startup (both dry and wet) time than DensaDeg®. Results from five pilot studies showed that Actiflo® required 10 to 20 minutes for dry or wet start. Results from three pilot studies showed that DensaDeg® required 55 to 120 minutes for dry start, and 20 to 75 minutes for wet start.
- At present, there is one full-scale Actiflo® installation in the Pacific Northwest in Bremerton, Washington. There is no full-scale DensaDeg® installation in the Pacific Northwest.

FULL SCALE HIGH RATE CLARIFICATION PROCESS
NORTH AMERICAN SELECTED INSTALLATION LIST

Actiflo®

Treatment of Combined or Sanitary Sewer Overflows (CSO or SSO)

- St. Bernard, Louisiana, 10 mgd[1] (2001)
- Lawrence, Kansas, 40 mgd (2002)
- Bremerton, Washington, 10 mgd (2002)
- Fort Smith, Arizona, 31 mgd (2003)

Side Stream Treatment (Wastewater Treatment Application)

- Burlington, Canada, 5.8 mgd (2001)
- Santa Fe, California, 4 mgd (2002)

DensaDeg® (various models)

Primary Treatment

- Laval Station De Lapiniere, Quebec, Canada, 160 mgd (1998)
- Beloeil, Quebec, Canada, 15 mgd (1997)
- Saint-Jean Sur Richelieu, Quebec, Canada, 31 mgd (1996)
- Repentigny, Quebec, Canada, 14 mgd (1996)
- Saint-Eustache, Quebec, Canada, 14 mgd (1991)
- Sherbrooke, Quebec, Canada, 38 mgd (1988 to 1991)
- Puebla Station De Barranca Del Conde, Mexico, 11 mgd (2001)
- Puebla Station De San Francisco, Mexico, 34 mgd (2001)
- Puebla Station D' Atoyac Sur, Mexico, 14 mgd (2001)
- Puebla Station D' Alseseca Sur, Mexico, 23 mgd (2001)
- Breckenridge, Colorado, 2 mgd (1998)

[1] million gallons per day

BREMERTON Actiflo® HIGH RATE CLARIFICATION PROCESS
PILOT TESTING SUMMARY – CDM, FEBRUARY 2000

Pilot Test Information:

Duration:	December 8, 1999 to December 16, 1999
Test Flow:	320 gallons per minute (gpm)
Test Overflow Rate:	55 gallons per minute per square foot (gpm/ft^2)
Polymer Type:	Unknown
Polymer Dosage:	0.5 to 1.0 milligrams per liter (mg/L)
Coagulant Type:	Ferric chloride
Coagulant Dosage:	15 to 45 mg/L
Startup Time to Peak Efficiency:	10 minutes to reach 5 NTU (5 minutes to reach 15 NTU)

Performance:

Parameters	Influent	Effluent	Removal (percent)
Turbidity, Nephelometric Turbidity Unit (NTU)	22	3	86
Total Suspended Solids (TSS), mg/L	31	9[a]	71
Total biochemical oxygen demand (TBOD), mg/L	127	47[b]	63
Soluble biochemical oxygen demand (SBOD), mg/L	70	38	46[b]
Insoluble biochemical oxygen demand (BOD), mg/L	57	9	84
Phosphorus, mg/L	2	0.1	95

[a] Bremerton Primary effluent TSS and BOD at 90 mg/L and 70 mg/L, respectively
[b] Probably due to removal of BOD in colloidal size range

Recommended Preliminary Design Criteria:

Initial Design Overflow Rate:	43 gpm/ft^2
Ultimate Design Overflow Rate:	60 gpm/ft^2

Note: The initial design overflow rate of 43 gpm/ft^2 will allow the unit to be operated at an overflow rate of up to 60 gpm/ft^2 in the future for higher treatment capacity without expanding the facility.

Department of Ecology (DOE) Comments on Pilot Study Report:

- The report needed to address why only one overflow rate of 55 gpm/ft^2 was selected for this pilot test.
- The report needed to justify how the recommended design overflow rate was selected and why the same unit would be expected to achieve the treatment goal at a higher overflow rate.
- The report needed to justify how a one-week short-term study could be valid for full-scale plant design.
- Whole effluent toxicity (WET), ammonia or fecal coliform test data were requested.

BREMERTON DensaDeg® HIGH RATE CLARIFICATION PROCESS

PILOT TESTING SUMMARY – ONDEO, MARCH TO APRIL 2000

Pilot Test Information:

Duration:	March to April 2000
Test Flow:	No Data
Test Overflow Rate:	20 to 30 gpm/ft^2
Sludge Recycle:	3 and 4 percent of influent flow
Polymer Type Tested:	LT 22S LT 27 (Percol 727) Erpac AS 47 Erpac AS 45 Cytec A100 Cytec 1596
Polymer Selected:	Percol 727 (ultra-high molecular weight, anionic, acrylamide polymer from Ciba Giegy)
Polymer Dosage:	2 mg/L
Coagulant Type:	Ferric chloride
Coagulant Dosage:	60 mg/L
Startup Time to Peak Efficiency:	Dry start at 55 minutes to reach 15 NTU (35 minutes to fill and 20 minutes to reach 15 NTU) Dry start at 95 minutes to reach 5 to 10 NTU (35 minutes to fill and 60 minutes to reach 5 to 10 NTU) Wet start at 40 minutes to reach 15 NTU Wet start at 75+ minutes to reach 5 to 10 NTU

Performance:

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	79	9	89
TSS, mg/L	147	21	85
TBOD, mg/L	437	167	61
SBOD, mg/L	127	92	28
Insoluble BOD, mg/L	310	75	76
Phosphorus, mg/L	No Data	No Data	No Data

KING COUNTY Actiflo® HIGH RATE CLARIFICATION PROCESS
PILOT TESTING SUMMARY – HDR, JUNE 2002

Pilot Test Information:

Duration:	August 27, 2001 to October 5, 2001
Test Flow:	310 to 350 gpm
Test Overflow Rate:	53.4 to 60.3 gpm/ft^2
Polymer Type Tested:	M155 anionic dry polymer by CIBA Specialty Chemical
	E700 cationic dry polymer by Polydyne
	AE1125 anionic liquid polymer by BetzDearborn
Polymer Selected:	M155 anionic dry polymer by CIBA Specialty Chemical
Polymer Dosage:	0.75 to 0.95 mg/L
Coagulant Type:	Ferric chloride
	PACl
	Alum
Coagulant Dosage:	60 to 110 mg/L ferric chloride
	17 to 34 mg/L PACl
	60 to 110 mg/L alum
Startup Time to Peak Efficiency:	Dry start at 15 minutes
	Wet start at 10 minutes

Ferric Chloride (110mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	148	4.9	97
TSS, mg/L	264	15	94
TBOD, mg/L	217	48	78
SBOD, mg/L	78	42	46
Insoluble BOD, mg/L	139	6	96
Total chemical oxygen demand (COD), mg/L	838	260	69
Phosphorus, mg/L	2.64	0.25	91

PACl (34 mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft²):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	166	2.7	98
TSS, mg/L	249	11	96
TBOD, mg/L	136	51	63
SBOD, mg/L	70	42	40
Insoluble BOD, mg/L	66	9	86
Total COD, mg/L	648	180	72
Phosphorus, mg/L	2.58	0.09	97

Alum (110 mg/L) Performance (0.95 mg/L Polymer) (60 gpm/ft²):

Parameters	Influent	Effluent	Removal (percent)
Turbidity, NTU	123	3.7	97
TSS, mg/L	197	11	94
TBOD, mg/L	174	45	74
SBOD, mg/L	72	38	47
Insoluble BOD, mg/L	102	7	93
Total COD, mg/L	894	262	71
Phosphorus, mg/L	2.94	0.24	92

Recommended Preliminary Design Criteria

Injection Tank Detention Time:	1 min
Maturation Tank Detention Time:	3 min
Overflow Rate:	60 gpm/ft²

Other Findings

- Estimated sand loss during the pilot study was 250 pounds per million gallons produced. According to the manufacturer, the pilot plant was not operated to minimize sand loss. Under full-scale optimal conditions, sand loss would be in the range of 8 to 12 pounds per million gallons of water treated.

- Sludge concentrations ranged between 3,900 and 8,020 mg/L. The overall average sludge concentration for all testing stages was 6,000 mg/L (0.6 percent). This concentration is considered to be dilute compared to conventional primary sludge, which is typically in the range of 20,000 to 40,000 mg/L (2 to 4 percent).

KING COUNTY DensaDeg® 4D HIGH RATE CLARIFICATION PROCESS PILOT TESTING SUMMARY – HDR, JUNE 2002

Pilot Test Information:

Duration:	October 22, 2001 to February 8, 2002
Test Flow:	86 to 215 gpm
Test Overflow Rate:	20 to 50 gpm/ft^2
Sludge Recycle:	3 and 5 percent of influent flow
Polymer Type Tested:	Magnafloc LT22S cationic high molecular weight dry polyacrylamides
	Nalco IC34 anionic high molecular weight emulsion polymer
Polymer Selected:	Nalco IC34
Polymer Dosage:	1.0 mg/L
Coagulant Type:	Ferric chloride
	PACl
	Alum
Coagulant Dosage:	10 to 60 mg/L ferric chloride
	10 to 60 mg/L PACl
	20 to 60 mg/L Alum
Startup Time to Peak Efficiency:	Dry start 55 minutes
	Wet start 20 minutes

Ferric Chloride (40 mg/L) Performance (1 mg/L Polymer) (30 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	88	4	96%
TSS, mg/L	258	11	96%
TBOD, mg/L	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	No Data	No Data	No Data
Phosphorus, mg/L	4.25	0.65	85%

PACl (40 mg/L) Performance (1 mg/L Polymer) (30 gpm/ft²):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	120	11	91%
TSS, mg/L	219	41	81%
TBOD, mg/L	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	484	206	57%
Phosphorus, mg/L	No Data	No Data	No Data

Alum Performance (1 mg/L polymer) (30 gpm/ft²):

Parameters	Coag. Dose	Influent	Effluent	Removal
Turbidity, NTU	40 mg/L	96	9	90%
TSS, mg/L	60 mg/L	417[a]	54	87%
TBOD, mg/L	No Data	No Data	No Data	No Data
SBOD, mg/L	No Data	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data	No Data
Total COD, mg/L	60 mg/L	876	250	71%
Phosphorus, mg/L	40 mg/L	2.66	0.76	71%

[a] Based on test records, during an alum dose of 60 mg/L, the influent turbidity was only 40 NTU. It seems highly unusual to have a TSS of 417 mg/L with a turbidity of only 40 NTU. Also, during pilot testing of Actiflo®, the influent TSS concentration was in the range of 200 to 250 mg/L with corresponding turbidity of 120 to 170 NTU.

Recommended Preliminary Design Criteria:

Reaction Tank Detention Time:	7 minutes
Clarifier Detention Time:	10 minutes
Overflow Rate:	30 gpm/ft²

Summary of Findings:

- The King County DensaDeg® 4D high rate clarification process pilot test protocol is organized differently from the King County Actiflo® high rate clarification process pilot test protocol. As a result, the pilot study results are presented differently. An attempt was made to summarize the DensaDeg® 4D performance with influent conditions as close as possible to the Actiflo® testing conditions. However, it was impossible to match all the influent conditions.
- In general, based on the recommended preliminary design criteria, the full-scale DensaDeg® 4D system will be two to three times larger in size than the corresponding Actiflo® system with the same treatment capacity.
- The dry start and wet start times for the DensaDeg® 4D system are estimated to be 3.7 times and 2 times higher than the corresponding start times for a similar Actiflo® system. In a side stream wet weather flow treatment scenario, the shorter startup time for the Actiflo® treatment process provides greater flexibility of operations.
- Using ferric chloride ($FeCl_3$) as a coagulant, the DensaDeg® 4D system has similar turbidity and TSS removal performance as the Actiflo® system, but a slightly lower phosphorus removal performance. There is no information on DensaDeg® 4D BOD and COD removal using $FeCl_3$ as coagulant. Optimum test $FeCl_3$ dosage for the DensaDeg® 4D system is approximately one-third of the optimum test dosage for Actiflo® system.
- Using PACl as a coagulant, the DensaDeg® 4D system has a lower (10 to 15 percent lower) performance in turbidity, TSS, and COD removal compared with the Actiflo® system at the **same dosage**. There is no information on DensaDeg® 4D BOD removal using PACl as a coagulant.
- Using alum as a coagulant, the DensaDeg® 4D system has about a 10 percent lower performance in turbidity removal at one-third the alum dosage compared with the Actiflo® system. DensaDeg® 4D TSS removal performance could not be compared accurately due to significantly different influent TSS concentrations. There is no DensaDeg® 4D BOD removal information. The DensaDeg® 4D system has similar COD removal performance as the Actiflo® system at about one-half of the alum dose. The DensaDeg® 4D system has a lower (20 percent lower) performance in phosphorus removal compared with the Actiflo® system at one-third the alum dose.
- Actiflo® produces a more dilute sludge stream than DensaDeg 4D®. There was no direct measurement of sludge information from DensaDeg® 4D during the pilot study.

PILOT TESTING OF Actiflo®, DensaDeg®, AND UV DISINFECTION

CITY OF SALEM, WILLOW LAKE WASTEWATER TREATMENT PLANT

SUMMARY – BRIAN MATSON, CAROLLO ENGINEERS, WEFTEC 2002

Background Information:

- The Willow Lake Wastewater Treatment Plant (WLTP) serves 200,000 people. It has a treatment capacity of 105 mgd. The conveyance system has a capacity of 155 mgd.
- Winter sanitary flow can peak at 300 mgd. The City is required to eliminate SSOs resulting from 5-year storm in winter and 10-year storm in summer by 2010.
- Investigate use of pretreatment, high rate clarification (HRC), and ultraviolet (UV) disinfection at peak excess flow treatment facilities (PEFTFs) remotely at existing SSO sites or at the WLTP.
- Two successive years of wet weather pilot testing at the WLTP for a total of 19 weeks of tests.
- Based on the results, the City is prepared to begin permitting and predesign efforts for a full-scale PEFTF that will treat up to 160 mgd of dilute wastewater at a point where SSOs are currently discharged.

Equipment Tested:

- Actiflo® tested in 2001 and 2002
- DensaDeg® tested in 2002
- Trojan Technologies UV-4000 medium pressure UV system tested in 2001 and 2002
- WEDECO Ideal Horizons Tak55 2-1/143x3 CW low pressure, high output UV system tested in 2002.

HRC Sampling and Analysis:

- Developed BOD:COD ratio allowing COD be used for benchmarking organic removal efficiency
- Collected sufficient BOD analysis to check the variability of BOD:COD ratio

UV Sampling and Analysis:

- Sample collection by plant staff. Split samples were collected for quality control and correlation between methods.
- Analysis of TSS and UV transmittance performed by plant staff and UV vendor personnel.
- *E.Coli* enumeration performed by plant staff using Most Probable Number (MPN) method and UV vendor personnel by membrane filtration method.
- During dose response runs, grab samples collected in triplicate at each UV dose for *E. Coli* enumeration.
- During extended durations of UV runs, automatic lamp sleeve cleaning was disengaged with lamps being wiped clean only at the conclusion of the data collection period.

Influent Dilution:

- Influent dilution using well water was needed for entire six weeks of 2001 testing and at times during 2002 testing due to insufficient rainfall. Dilution water was obtained from a reserve well. Well water provided more alkalinity than the actual dilute influent.
- De-ionized (DI) water was used as dilution water during bench-scale testing and better reflects alkalinity of the actual dilute influent.

Wastewater Characterization:

- Samples of SSO from two overflow locations were collected over five events and compared to the WLTP samples. The results indicated that SSO water is similar to WLTP influent at its most dilute state, with the exception of higher fluoride concentration at the WLTP than at the SSO sites.
- Industrial discharges from several semiconductor manufacturing sources and a latex paint manufacturer caused elevated fluoride and silica concentration, and turbidity spikes of up to 200 NTU. These industrial discharges exerted additional coagulant demand and affected coagulation chemistry.

Coagulants Used and Bench Scale Optimized Dosage:

Coagulant (with 1 mg/L of dry anionic M155 polymer)	Most Dilute Wastewater (BOD and TSS at 40 to 50 mg/L and alkalinity at 50 mg/L)		Least Dilute Wastewater (BOD and TSS at 100 mg/L and alkalinity at 100 mg/L)	
	Range	Optimum	Range	Optimum
Ferric, mg/L	30 – 50	40	40 – 70	60
Alum, mg/L	25 – 35	30	60 – 100	80
Aluminum Chlorhydrate (ACH), mg/L	10 – 15	12	10 – 20	15
Polyaluminum Chloride (PACl), mg/L	20 – 30	25	N/A	N/A

Mitigation of Sand Binding in Actiflo® in Presence of Latex Paint:

- Using alum as a coagulant, microsand ballast became bound together with polymer to form larger gelatinous floc in the clarifier hopper in the presence of latex paint and could no longer be pumped through the hydro-cyclone and returned to the process.
- Sand binding was mitigated by using ferric chloride as a coagulant, or by using ACH or PACl with increased coagulation contact time prior to polymer addition.
- DensaDeg® was not affected by latex paint.

Actiflo® Performance:

Chemical Dosages

- Optimum dose of dry polymers (M725, M155) was 0.5 to 0.6 mg/L for aluminum-based coagulants. Higher doses caused sand binding. Dosage increased to 1 mg/L for ferric.
- Optimum liquid polymer (AE1125) dose was 2.0 mg/L for both iron and aluminum-based coagulants.
- 40 to 50 mg/L of Ferric, 80 mg/L of Alum, 10 to 20 mg/L of ACH, or 20 mg/L of PACl, all of which are within the ranges of bench scale dosages.

Performance at Different Surface Overflow Rate and Coagulant

- When alum was used as a coagulant, TSS removal efficiency was lower than 85 percent if surface overflow rate was higher than 30 gpm/ft^2. Coagulant contact time was not kept constant at higher surface overflow rate.
- When ferric was used as a coagulant, TSS removal efficiency remained higher than 85 percent even if surface overflow rate was 80 gpm/ft^2. Coagulant contact time was between 4 to 8 seconds.
- If coagulant is injected further upstream in influent piping to provide 40+ seconds of contact time, use of ACH as coagulant can achieve close to 90 percent of TSS removal even at a surface overflow rate of 100 gpm/ft^2.
- At a surface overflow rate of 60 gpm/ft^2, with a 5-second ferric contact time or a 43-second ACH contact time, TSS removal efficiency of 85 to 90 percent and BOD removal efficiency of 50 to 70 percent could be achieved.
- Provided sufficient coagulation time, TSS and BOD removal performance similar to that at a surface overflow rate of 60 gpm/ft^2; could be achieved at a higher surface overflow rate of between 80 and 120 gpm/ft^2.

Startup Time

- Less than 20 minutes was required for the unit to complete a dry startup using ferric as a coagulant. Less than 10 minutes was required for the unit to complete a dry startup using ACH as a coagulant.

DensaDeg® Performance:

Chemical Dosages

- Percol 727 polymer was used at a dose of 1.5 mg/L; Nalclear 8173 polymer was used at a dose of 2.0 mg/L.
- 40 mg/L of ferric, 60 mg/L of alum, 15 mg/L of ACH, or 30 mg/L of PACl, all of which are within the ranges of bench scale dosages.
- Sludge recycle at 3.5 and 7 percent of influent flow

Performance at Different Surface Overflow Rate and Coagulant

- Greater than 2 minutes of coagulant contact time was provided for all surface overflow rates tested.
- To achieve 80 to 85 percent TSS removal, surface overflow rates should be limited to 40 gpm/ft^2. Performance deteriorated rapidly at 50 gpm/ft^2 and solids were washed out of the clarifier ultimately leading to a process failure. Performance at 30 gpm/ft^2 was marginally better than that at 40 gpm/ft^2.
- The reactor solids concentration must reach 600 mg/L to achieve acceptable effluent TSS level (around 5 mg/L) if aluminum-based coagulant is used. This solids concentration could be achieved if the surface overflow rate was between 30 and 40 gpm/ft^2.
- A lower reactor solids concentration of 400 mg/L can achieve the same performance if ferric coagulant is used.
- At surface overflow rate of 30 to 40 gpm/ft^2, TSS removal of 87 percent, COD removal of 67 percent, and BOD removal of 59 percent were achieved.
- TSS removal dropped from 78 percent at a surface overflow rate of 50 gpm/ft^2 to 2 percent at 55 gpm/ft^2. Solids started to wash out of the clarifier at this surface overflow rate. After failure occurred, the surface overflow rate was reduced to 40 gpm/ft^2 and the process could not regain performance to pre-failure level even after one hour of operation at the lower surface overflow rate.

Startup Time

- For both ferric and ACH, the dry startup time is between 1.5 and 2 hours at a surface overflow rate of 30 to 40 gpm/ft^2.

UV Disinfection:

Water Quality

	UVT[1] (%)	**TSS (mg/L)**	**Turbidity (NTU)**	***E.coli* (per 100 mL) (geometric mean of composite samples taken)**
Screened Raw Influent	40 – 50	40 – 100	70 – 200	1,000,000+
Actiflo® Effluent (using ACH or PACl)	70 – 80	3 – 10	2 – 5	10,000 – 100,000
DensaDeg® Effluent (using ACH or PACl)	70 – 80	6 – 28	4 – 10	10,000 – 100,000

[1]Ultraviolet transmission

Collimated Beam Evaluation of HRC Effluent

- Six runs were conducted. Five runs showed a UV dose of 10 to 40 milli-joules per square centimeter (mJ/cm^2) can reach the target level of less than 126 *E.coli* per 100 mL. One run showed a UV dose of 70 mJ/cm^2 would be required to achieve the target level. It was concluded that a UV dose of 30 to 40 mJ/cm^2 would be sufficient to provide disinfection to HRC effluent.

Pilot Dose Response Curves of HRC Effluent

- The UV dose response curve for Actiflo® effluent with ferric coagulant demonstrated that the disinfection goal of 126 *E.coli* per 100 mL was unattainable even at UV doses greater than 100 mJ/cm^2 due to high absorbance of ferric iron in the carryover floc. Only when UV dose was elevated to approximately 200 mJ/cm^2 did the number of *E.coli* drop below 126 per 100 mL.
- When aluminum-based coagulant was used, the Trojan medium pressure system could meet the geometric mean of 126 per 100 mL in all but three samples at UV doses which ranged from 20 to 50 mJ/cm^2.
- The results of the WEDECO pilot runs indicated that the disinfection goal of 126 *E.coli* per 100 mL was met at a calculated dose of 21 mJ/cm^2.
- The HRC effluent quality corresponded with the water quality of the collimated beam runs with 70 to 84 percent UVT, 3 to 9 mg/L of TSS, and less than 6 NTU.

TACOMA Actiflo® PILOT STUDY SUMMARY
USFilter, FEBRUARY 1999

Pilot Test Information:

Duration:	February 15, 1999 to March 5, 1999
Test Flow:	660 gpm
Test Overflow Rate:	60 gpm/ft^2
Polymer Type:	Allied Colloids 725
Polymer Dosage:	1.5 to 1.6 mg/L
Coagulant Type	Ferric chloride
	PACI
Coagulant Dosage:	70 to 100 mg/L of ferric chloride
	17 to 65 mg/L of PACI
Startup Time to Peak Efficiency:	Wet Start at 10 to 15 minutes

Ferric (100 mg/L) Performance (average 1.25 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	91	6	93%
TSS, mg/L	305	6	98%
TBOD, mg/L	294	112	62%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	689	182	74%
Phosphorus, mg/L	No Data	No Data	No Data

PACI (45 mg/L) Performance (average 1.5 mg/L Polymer) (60 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	67	1.5	98%
TSS, mg/L	135	17	87%
TBOD, mg/L	102	31	70%
SBOD, mg/L	28	25	11%
Insoluble BOD, mg/L	74	6	92%
Total COD, mg/L	260	80	69%
Phosphorus, mg/L	No Data	No Data	No Data

Effect of Surface Overflow Rate on Process Performance (45 mg/L PACl and 1.5 mg/L Polymer):

	40 gpm/ft^2 [a] (percent)	60 gpm/ft^2 (percent)	80 gpm/ft^2 [b] (percent)
Turbidity Removal	97	97	97
TSS Removal	93	91	90
COD Removal	69	65	70

[a] Influent flow reduced to lower surface overflow rate, thus increasing coagulation time.
[b] Influent flow was kept the same as the 60-gpm/ft^2 trial and surface overflow rate was increased by blocking off 33 percent of the clarifier area, thus keeping the coagulation time the same as the 60-gpm/ft^2 trial.

Summary of Findings

- The performance of Actiflo® with the optimum coagulant and polymer dosage was consistent at surface overflow rates from 40 gpm/ft^2 to 80 gpm/ft^2.
- Sludge solids content from 0.33 to 0.55 percent.
- Over the long term run (nine days of continuous running), the Actiflo® pilot unit's effluent deteriorated during five time periods. These time periods coincided with experimentation involving the use of a streaming current controller (SCC) to automatically adjust coagulant dose. A full-scale peak wet weather flow facility at this time would not be operated with an SCC until long-term experience has proven its reliability. The CSO Actiflo® plant in Colombier, Switzerland operates with a constant coagulant dose that allows the plant to accept influent with fluctuating characteristics and still produce an effluent quality within permitted limits.

CITY OF PORTLAND Actiflo® PILOT STUDY

BROWN AND CALDWELL, MAY 1998

Pilot Test Information:

Duration:	December 1997
Test Flow:	No Data
Test Overflow Rate:	20 to 60 gpm/ft^2
Polymer Type:	Allied Colloids LT25
Polymer Dosage:	0.75 mg/L
Coagulant Type:	Ferric chloride Alum
Coagulant Dosage:	50 to 75 mg/L of ferric chloride 120 mg/L of alum
Startup Time to Peak Efficiency:	Wet start at 20 minutes (at 20 gpm/ft^2)

Ferric (58 mg/L) Performance (average 0.75 mg/L Polymer) (20 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	135	5	96%
TSS, mg/L	165	5.2	97%
TBOD, mg/L	238	141	41%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	520	270	48%
Phosphorus, mg/L	5.0	0.1	98%
Copper, micrograms per liter (μg/L)	93	20	78%
Zinc, μg/L	105	58	45%
Lead, μg/L	6	0.8	87%

Alum (120 mg/L) Performance (average 0.75 mg/L Polymer) (40 gpm/ft^2):

Parameters	Influent	Effluent	Removal
Turbidity, NTU	120	12	90%
TSS, mg/L	140	6	96%
TBOD, mg/L	330	210	36%
SBOD, mg/L	No Data	No Data	No Data
Insoluble BOD, mg/L	No Data	No Data	No Data
Total COD, mg/L	600	380	37
Phosphorus, mg/L	4	0.5	91%
Copper, µg/L	45	25	45%
Zinc, µg/L	124	27	78%
Lead, µg/L	5.7	0.4	93%

Summary of Findings:

- Effluent quality was strongly dependent on operating pH, with significantly lower effluent contaminant concentrations at a pH value lower than 6.5 for both ferric and alum coagulants.
- The attempt to complete a mass balance calculation for sludge production was unsuccessful. The sludge flow rate data may be incorrect.
- Limited data suggested that organic material did not accumulate on the sand particles. Conditions in the rapid mix tank and hydro-cyclone may be sufficient to scour the sand.
- There is a strong correlation between the BOD and COD data collected.
- Dosage of ferric chloride was expressed as mg/L of iron (Fe) instead of mg/L of ferric chloride ($FeCl_3$). Also, overflow rate was expressed in gallons per day per square foot (gpd/ft^2) instead of gallons per minute per square foot (gpm/ft^2).

OTHER Actiflo® PILOT STUDY PERFORMANCE IN WASTEWATER / WET WEATHER TREATMENT

Location	Study Date	Overflow Rate (gpm/ft^2)	Coagulant Type	Coagulant Dose (mg/L)	Polymer Type	Polymer Dose (mg/L)	TSS Removal	BOD Removal	COD Removal	Phosphorus Removal
Galveston, TX	3/98	20 – 40	Ferric Chloride	75 – 125	LT25	1.0 – 1.5	80 – 97%	60 – 80%	65 – 90%	No Data
Cincinnati, OH	4/98	30 – 60	Ferric Chloride	20 – 100	Allied Colloids 725	1.0 – 1.5	80 – 90%	40 – 90%	30 – 80%	90 – 99%
Fort Worth, TX	10/98	50 – 80	Ferric Sulphate	77	Allied Colloids 725	1.0	86%	56%	No Data	95%
Jefferson County, AL	10/98	40 – 80	Ferric Chloride	40 – 80	Allied Colloids 725	0.85	85 – 100%	20 – 60%	No Data	No Data
Port Clinton, OH	7/99	20 – 40	Ferric Chloride	75 – 125	Allied Colloids 725	1.0	80 – 97%	40 – 60%	45 – 70%	No Data
Belleville, IL	5/00	60 – 75	Ferric Chloride	30 – 75	Allied Colloids 725	0.75	80 – 95%	60 – 85%	45 – 80%	No Data
Little Rock, AR	8/00	30 – 60	Ferric Chloride	65 – 85	Allied Colloids 725	1.25	86 – 99%	50 – 85%	No Data	No Data
Independence, MO	9/2000	60	Ferric Chloride	40	Ciba Percol 725	0.75 – 1.25	90%	47 – 90%	41 – 90%	No Data

DensaDeg® 4D PILOT STUDY PERFORMANCE IN WASTEWATER / WET WEATHER TREATMENT

Location	Study Date	Overflow Rate (gpm/ft^2)	Coagulant Type	Coagulant Dose (mg/L)	Polymer Type	Polymer Dose (mg/L)	TSS Removal	BOD Removal	COD Removal	Phosphorus Removal
Birmingham, AL	6/98-8/98 (CSO)	29 – 59	Fe	45	Percol 727	1.5	86%	47%	No Data	No Data
Fort Worth, TX	10/98-12/98 (CSO)	30 – 60	Fe	70 – 150	Percol 727	0.75 – 1.75	86%	47%	No Data	No Data
26th Ward, NYC	7/99-8/99 (CSO)	25 – 55	Fe	52 – 63	Percol 727	1.4 – 1.8	70%	58%	No Data	No Data
Halifax, Nova Scotia	11/99-6/00 (1^o Inf)	10 – 33	Fe/Al/PACl	18-25 Fe 4-8 Al 8-10 PACl	AS34/ Percol 727	1.0 – 1.2	71%	71%	No Data	No Data
San Francisco, CA	1/00-2/00 (CSO)	30 – 45	Fe	70 – 90	Percol 727	2.0	85%	64%	No Data	No Data
Little Rock, AR	8/00 (1^o Inf & Eff)	20 – 40	FE	60	Percol 727	1.5	85 – 89%	72 – 77%	No Data	No Data
Chesterfield, VA	8/02 (1^o Eff)	20 – 30	Fe	120	Nalclear 8173	1.5 – 2.5	75%	49%	No Data	No Data

HDR | ONE COMPANY *Many Solutions*℠

Meeting Notes

Subject:	Peak Flow Treatment Alternatives for the Wastewater Treatment Facilities – DOE Meeting		
Client:	City of Mount Vernon		
Project:	Wastewater Treatment Plant Upgrade - Predesign	Project No:	09637-06070
Meeting Date:	November 13, 2003, 10:00 am - noon	Meeting Location:	Department of Ecology Offices Northwest Regional Office 3190 160th Avenue SE Bellevue, WA
Notes by:	Dan Olson		

Attendees:

Kevin C. Fitzpatrick, DOE Water Quality Program Section Manager
Bernard Jones, DOE Water Quality Program
Mark Henley, DOE Brightwater Facility Engineer
Walt Enquist, City of Mount Vernon – Wastewater Utility Supervisor
John Koch, HDR – Lead Design Engineer
JB Neethling, HDR – Process Design Expert
Dan Olson, HDR - Project Manager

Topics Discussed, Purpose of meeting:

Discuss attached letter to DOE, dated November 12, 2003, regarding improvements to Mount Vernon WWTP. In that letter and in this meeting, we ask for DOE's opinion on "approval of and proceeding with" improvements somewhat different than that included in the Comprehensive Plan. Specifically, we discussed whether Mount Vernon should pursue the treatment facilities improvement with peak flows (CSO) through a high rate clarification process followed by blending with secondary influent and disinfection. This would include dropping the peak flow secondary treatment down from 24 to 16.4 MGD (max, without nitrification) and installing high rate clarification for treatment of peak flows.
As a goal, we wanted DOE to conceptually approve the change in improvement plans and give direction on how to successfully accomplish the proposed revision to the City of Mount Vernon Comprehensive Plan.
To facilitate discussion, we gave a presentation to further support the proposal and to request direction from DOE on next steps in proceeding with the proposed course of action.

Meeting Notes:
Note: The text of the referenced letter is inserted at the end of these minutes. The presentation is attached in hard copy in the project files.

Kevin and Bernard were present at the beginning of the meeting with Mark coming in after about 30 minutes. Mark's arrival gave us an opportunity to go over most of the presentation twice, which appeared to be very helpful.

Kevin Comment at outset: The EPA blending policy is not the WA DOE policy! WA DOE has a team of 6 to 8 engineers working on a blending policy at this time and expect it to be out mid 2004. It will not be as lenient as the EPA proposal.

Dan, John and JB made a presentation to Bernard, Kevin and Mark outlining suggested changes to the improvement plan contained in the Comprehensive Plan. Dan presented slides one and two as introduction and then John and JB continued through the process discussions, site layout change discussions and into the question and answer time. The question and answer session that followed is documented below. The letter and slides are attached as part of the meeting minutes.

Kevin Q: Clarify total flows through secondary.
JB and John A: JB stated 17, clarified by John to be 16.4 max, BOD only and 15.5 nitrified.

Bernard Q: Do you plan on having redundancy with the high rate clarification (HRC)?
John A: Yes. Initially looking at two 6 MGD units, expandable with time to (total through plant) 50 MGD.

Bernard Q: How do pilot study results show the system results under stress?
JB A: Remarkably stable on Russian River. Incoming NTU varies from 2 to 600 and effluent NTU went from 1 to 2. John A: Most sensitive area is chemical injection system.

Kevin Q: Where are you splitting flow from secondary to HRC? How determined?
All A: Take max through plant secondary at 16.4 MGD and over that to HRC. Compare to the calculated 2020 ADMM flow and design plant to handle that or better, rest through HRC. Can take the 2020 ADMM flow without the second aeration basin.

Bernard Comment: DOE may require a long-term control / monitoring plan.

Dan Q: What steps does DOE see to accomplish this for Mount Vernon?
Kevin A: Just do a Comp Plan revision. This is a long-term control measure, and he (DOE) likes to hear about the long-term thinking of CSO planning in conjunction with the secondary treatment facilities.

Kevin Q: How much work has Mount Vernon done in the collection system to reduce CSO's and to separate CSO flows from sanitary?

Walt A, John, Dan A: Walt and John and Dan described the success of the CSO reduction plan. Walt noted the work the City is doing with separating flows where possible and the thinking about possibilities for the future (Second Street Bridge example given). He noted that the City had reduced CSO overflows by 90% with the 60" interceptor, completed in 1999. He also noted that this proposal was aimed at making a similar level of improvement – from 7 per year now to max 1 per year.

Kevin Comment: Kevin noted that he likes to see the separation work going on and noted that this proposal is much better than others they have seen trying to do much less.

Kevin Q: Does Mount Vernon have a Storm Water Utility? Does this Utility have a source of funds to assist in this project?

Walt A: Yes, City does have a Storm Water Utility, formed in 1996. No funds available in this Utility. Walt noted that the Storm Water Utility has been controversial. Kevin and Mark noted that as a normal problem with Storm Water Utilities.

Mark Q: Would your planned secondary capacity for 2020 be equal to the 2020 ADMM flow?

JB and Dan A: Yes, Comp plan projection is 9.9 MGD ADMM and plan is for over 10 MGD, without the second aeration basin, but making modifications described in presentation. JB noted that the design is for a peak flow of close to 17 (incl. recycle).

Kevin Comment: Don't see a problem with going this way. Treating the sanitary flows at all times, treating all combined flows with only one overflow per year. Don't see a problem.

Kevin Q: Have you done an economic analysis of adding more storage as opposed to HRC?

Walt, Dan and John A: Yes. Walt explained that the initial Comprehensive Sewer Combined Sewer Overflow Reduction Plan did an analysis of reduction alternatives, including separation, in-line storage, and treatment alternatives. We also described the interceptor project and costs associated with that project.

Kevin Comment: Here are the general provisions of the current DRAFT blending policy for WA DOE. "You can't hold me to these, as it is still a draft".

1. To allow blending in design, Community may have to complete I/I program including I/I study, meeting standards for inflow (not applicable to combined). The Community cannot use blending as a way around the I/I improvements.
2. There must be a net environmental benefit, a net reduction in discharge to the environment. A net improvement in annual average and maximum month BOD and TSS discharge.
    a. Kevin noted that, because Mount Vernon is treating the CSO flows that are currently happening, the City should be able to easily demonstrate that.
3. Combined Sewer systems are being categorically exempted from the blending policy. They are being treated under the CSO regulations instead.
4. The Blending policy is primarily focused on newer systems that do not include CSO components.
5. With flow blending, assume additional permit requirements and monitoring.
    a. Limits
    b. Study on soluble BOD
    c. Monitoring for parameters – soluble BOD, metals
    d. WET test for toxicity on blended flows – twice annually, quarterly max.
    e. Record keeping on each bypass
6. Must operate secondary process up to 100% <u>before</u> bypass. This is required to assure a net environmental benefit. Blending process puts more responsibilities on Operators.

Mark Q: What assumptions did your analysis use on ballasted sedimentation for mass balance?
JB A: 50% BOD removal and 80% TSS removal
Mark Comment: That's reasonable.

7. Permit limits must be met at all times.
8. pH limits must be met at all times.
9. There will be an annual assessment / report from flow blending – continued demonstration of environmental benefit.
10. DOE is looking at a separate policy for existing combined systems and CSO.

Kevin and Mark Joint Comment: Your actions on this request need to be the Comp Plan amendment request and the public hearing. The draft policy does not come into play.
You would want to demonstrate a net environmental benefit through analysis. Indicate with a mass balance that you would meet you r effluent quality. You should have your inputs and outputs as part of the revision. If secondary capacity is ≥ max month, you are fine. You cannot treat less than max month through secondary. It is not AKART if less. If you are treating max month at 100% and trying to eliminate CSO's, that is good. Mark noted "Good!" Kevin repeated "Good"!

Bernard Q (to Kevin): How will the DOE or EPA policy development impact this request?

Kevin A: Not at all. Just put this through a comp plan revision process, with the associated public hearing. The proposed policies have no bearing on this.

Bernard Comment: This is new technology, so that is your reason for this comp plan revision.

Kevin and Bernard Comment: Can proceed with this direction if you are:

1. Treating maximum month flow through secondary processes.
2. You meet current permit requirements.

Bernard Q: What schedule do you have for Comp Plan approval?

John and Dan A: Have to talk with Walt (time for City to think). Plan on submitting revision in January or late December with approval in First Quarter of 2004.

Bernard Comment: Good. Submit this as new technology.

Mark Q: When was current Comp Plan approved?

Dan A: February 2003. It is a bit embarrassing, but the technology and the regulations were just not quite there when we did the work (most Comp Plan work complete by mid 2002). Not comfortable at the time with this kind of proposal.

Kevin and Bernard Comment: No need to for embarrassment. New technology and receptivity by regulators is just coming on – note policy work just drafted.

John Q: Do we have a go ahead on this approach?

Bernard and Kevin Comment: Go with this. See no problem with conditional approval of ballasted sedimentation. Watch plant performance for 18 months and then follow with final approval. Note that the plant will not experience anything close to design flows in that 18 months, so may want to force it some way to test.

Mark Comment: You should think about separate disinfection of the secondary and ballasted sedimentation flow streams. UV not too effective for ballasted sedimentation.

Kevin Comment: You should look at the security component, as that is very applicable for wastewater facilities. The legislation will come out soon for that. Especially for the chlorine equipment if you go that way.

Dan Comment: We have thought about the UV issue with HRC and will be discussing that with the City, now that we have conceptual approval to go with HRC.

Kevin Comment: Suggest you have Storm Water Utility ratepayers pick up some of the cost for this improvement – but then they are the same folks.

Dan Q: Can you suggest some funding opportunities for the City to fund part of this project, especially the CSO component?

Bernard A: The City WWTP was funded before, so not likely to get funds again. If UV is included in new plant, funds maybe available. Submit an application for items considered new.

Some financial opportunities were discussed – Mount Vernon being a phase II storm water community. May have funds there.

The meeting ended at 11:45 with Bernard noting that he would expect our request for the Comp Plan amendment in the near future. He sees no problem with approval of that amendment in the first quarter of 2004.

Action/Notes:

1. Now that we have conceptual agreement by DOE for using high rate clarification for peak flows (above Average Day, Maximum Month), Walt and the City of Mount Vernon to confirm internally that integrating the CSO component of the Comprehensive Plan into the WWTP project is the way they want to go. This will be the first step, leading to the others below.
2. Upon approval by City, Dan to confirm intentions with letter to DOE from Walt. Dan will meet with Bernard to go over draft of confirmation letter before finalizing letter and sending to Walt for use.
3. Dan will present cost impacts to the City in combining the two projects. This will help in item 4 below. The construction cost impacts include - not building certain parts of the Secondary system, building the high rate clarification treatment and cost savings of integrating components of the two systems (pumping, disinfection).
4. City and HDR to agree on supplement to existing contract to include scope CSO project work.
5. Following 4 above, HDR to pursue Comprehensive Comp Plan amendment with DOE
6. Proceed with rest of contract as shown, leaving the second aeration basin out of the plan.

TEXT OF LETTER TO DOE - November 12, 2003

Mr. Bernard Jones, P.E.
Department of Ecology Northwest Regional Office
3190 160th Avenue SE
Bellevue WA 98008-5452

Re: City of Mount Vernon Comprehensive Plan Update

Dear Mr. Jones,

Thank you for agreeing to meet with us on November 13, 2003 to discuss proposed improvements to the City's Wastewater Treatment Plant. We appreciate the opportunity to present our recent thinking on what improvements to make in our current upgrade and why we should change somewhat from what is shown in our Comprehensive Plan.

The City of Mount Vernon (City) puts a high priority on water quality in the Skagit River as well as on effective use of ratepayer's dollars. To achieve those goals, we believe a modification to the Comprehensive Plan is warranted for the reasons outlined below.

1. The City has one of nine CSO systems in the State and, as such, the flows in our system are highly influenced by rainfall events. The City's system has recorded flows in excess of 35 MGD when the flow to the wastewater treatment plant, Park Street and Division Street overflows are totalized. These peak flows are usually only a few hours in duration. We have carefully analyzed the quality of the flows in our system, including the CSO flows, for the past ten years. Water quality data from these high flow events indicate that the BOD and suspended solids components are very dilute, usually less than 30 mg/l. The high flows, coupled with the low BOD and SS, can interfere with our secondary treatment processes.

2. Both flows and loadings in the City system have increased at a lower rate since 2000, when compared to the years prior to 2000. This is due to changes in growth patterns, collection system improvements to reduce inflow and infiltration, and better pretreatment of industrial wastes by Draper Valley Farms. Average dry weather flow for 2003 is 2.67 MGD and the projected average dry weather flow for 2020 is 4.8 MGD based on the growth patterns and flow data since 1999.

3. Regulators are thinking progressively about the benefits of blending in certain limited situations, as evidenced by EPA's recent draft policy and six principles on blending. I commend you and your co-workers at DOE and EPA on looking seriously at blending as a viable option for treatment facilities such as Mount Vernon's. This draft policy recognizes the need for some flexibility in regulation to achieve the best overall treatment result for the environment. We note that several Western Washington treatment plants are considering this method of achieving water quality goals. For your information, we have attached a brief summary of pilot study results from plants at Bremerton, King County, Tacoma, Salem and Portland, Oregon.

4. The City is working aggressively toward reducing untreated combined sewer overflows to the Skagit River to one event or less per year. As evidence, the number of untreated CSO events to the Skagit River has been reduced from 90 per year to less than 10 per year since the beginning of 1999. This reduction in untreated CSO events is a direct result of the City's commitment to maintain water quality in the Skagit River. In December of 1998 the City completed construction of a 60-inch CSO storage interceptor that allowed the City to make that 90% reduction in overflow events. The WWTP improvement upgrade plan we will present in our meeting and over the next several weeks should allow us to make another 90% reduction in overflows, bringing the City into compliance with the consent order, perhaps earlier than the stipulated 2015 timeframe.

As you know, the City's current Comprehensive Plan contemplated a complete secondary plant that is double the current capacity, both at average day, max month and at peak hour (24 MGD). Given the reasons above, and with your early support of this direction, the City will begin a process to modify the comprehensive plan.

In short, the City proposes to increase the current plant influent capacity of nitrified maximum month flow to 10.0 MGD during the summer months with a peak day nitrified capacity of 15.5 MGD. These flows are above the stated 2020 flows in the Comprehensive Plan of 9.9 maximum month and 13.9 peak day, but are lower than the planned plant capacity of 24 MGD. We would replace the remaining capacity with a high rate clarification process that is more suitable and more cost effective for the dilute flows experienced during storm events. We believe this will meet our permit requirements, satisfy the six principles listed in EPA's draft blending policy and provide additional benefits as described below.

What this means as far as changes to the Comprehensive Plan is that we propose not building the second aeration basin, instead replacing it with a high rate clarification process (i.e. Actiflo or Densadeg). We will continue, as planned, with the new headworks, primary clarifiers, secondary clarifiers, support buildings, site work and pump stations. We also propose implementing seasonal nitrification and the solids processing improvements contemplated in the Comprehensive Plan. One other impact of this change will be a review of the planned UV disinfection to determine its effectiveness with the high rate clarification effluent.

To support this proposal, HDR has completed plant process modeling and capacity analyses. Using a dynamic simulation model, Biowin, the flows and loads to the treatment plant were analyzed with the ultimate goal of determining the capacity of the existing secondary system while maintaining effluent ammonia of less than 5 mg/l at a wastewater temperature of 10 Degrees C. With three secondary clarifiers and two primary clarifiers (as planned in the Comprehensive Plan), the maximum month plant capacity, including internal recycle is 10.0 MGD with a peak day capacity of 15.5 MGD. This configuration will yield a plant effluent in the range of 10 mg/l BOD and SS and 5 mg/l maximum day (<5 mg/l average) ammonia. We propose that the flows above 13.5 MGD be screened, de-gritted and treated with enhanced sedimentation. The enhanced sedimentation process will typically provide SS reduction in the range of 80 to 90% and BOD reduction in the range of 50 to 70%. Our water quality analyses over the past ten years show typical influent BOD and SS concentrations during flows above 13.5 MGD to be less than 35 mg/l and 30 mg/l respectfully. With a blended effluent and anticipated BOD and SS reduction through enhanced sedimentation, the combined total effluent from the treatment facility will be less than 30 mg/l. Prior to discharge to the Skagit River, the combined effluent will be disinfected.

We believe there are many benefits to this proposal. All of them support our two primary goals of high water quality in the Skagit River, including meeting all of our permit requirements, and effective use of ratepayer dollars. In summary, they are:

- The City can incorporate CSO planning into the current project and plan to increase the delivery of wet weather flows to the treatment facility. This will allow the City to treat a higher overall volume of wastewater.
- The WWTP can meet permit requirements with a higher overall flow than the plan outlined in the Comprehensive Plan.
- This approach provides better protection for the biological treatment units from peak flows experienced during storm events.
- This approach provides for more effective use of ratepayer funds.
- The City has the opportunity to meet their consent decree on CSO flows earlier than the 2015 requirement. Should we decide to do that, it would eliminate discharge of raw sewage during those overflow events.

We believe that the proposed process scenario described above will provide an overall high quality total effluent to the Skagit River, provide the maximum level of treatment at the lowest cost and will make the most effective use of dollars paid by the ratepayers of the City of Mount Vernon.

We look forward to our meeting of November 13, 2003 to discuss this proposal in more detail.

Sincerely,

Walt Enquist, Wastewater Utility Supervisor

January 28, 2004
City Comprehensive Plan Amendment Application
Wastewater Utility Element
Project Narrative

The City of Mount Vernon adopted a Comprehensive Sewer Plan (CSP) February 2003. This proposed amendment addresses changes to the CSP long range needs and expected costs for wastewater treatment plant (WWTP) improvements, sewer repair, sewer replacement, and sewer extensions city wide and in the unincorporated urban growth areas.

The City has initiated pre-design work to further refine work included in the CSP. The CSP includes plans to upgrade and expand the wastewater treatment plant WWTP by 2008. The pre-design report will be incorporated into the CSP and the City Comprehensive Plan. The pre-design work includes upgrading the WWTP, Combined Sewer System, and increasing plant organic and hydraulic capacity. The pre-design report includes a recommendation to include High Rate Clarification (HRC) of wet weather flows. HRC of wet weather flows is presented as a means of complying with an agreement with DOE to reduce Combined Sewer Overflows. This agreement requires Mount Vernon to reduce overflow events to an average of one per year no later than January 1, 2015.

The size of the WWTP is approximately 17 acres. Recommendations to expand the WWTP site, if any, will be identified in the pre-design report. Zoning changes at the WWTP, if any, will be public or commercial/limited industrial which are consistent with current WWTP zoning. Impacts, if any, will be addressed through the SEPA process.

The amendment application is consistent with the stated community vision to "expand the economy to support growth, but not compromise the surrounding environment".

The recommendations and costs identified in the CSP will be incorporated into the City Capital Improvement Plan (CIP).

Expansion of the WWTP and sewer infrastructure is essential to the health, safety, and welfare of the City and areas of the lower Skagit River Basin. The City is required through state and federal rules to provide wastewater services to assure water quality regulations are met as the City grows. The proposed amendment is consistent with the goals of Mount Vernon and Skagit County to maintain the quality of the Skagit River and surrounding environment. This amendment enables the City to expand in accordance with density zonings thereby reducing potential detriment to adjacent property owners that can be caused by failing on-site sewage systems. The amendment generally enhances the City's ability to manage City development in accordance with City and community goals.

APPENDIX C

January 30, 2004 Public Hearing Notice

CITY OF MOUNT VERNON
NOTICE OF APPLICATION FOR COMPREHENSIVE PLAN AMENDMENTS

The City of Mount Vernon is accepting applications for 2004 comprehensive plan amendments. Applications for 2004 amendments must be filed with the City of Mount Vernon Development Services Department by 4:00 p.m., January 30, 2004. Applications must be complete in order to be accepted. Application forms, requirements and procedures are available at the City of Mount Vernon Development Services Department, located at 910 Cleveland Avenue, Mount Vernon, WA 98273. For further information, please call Gloria Rivera or Jenefer Creamer at (360) 336-6214.

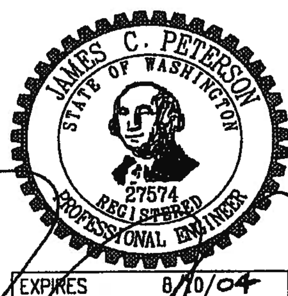
Published December 16, 2003 and January 07, 2004.

CERTIFICATION PAGE

For

City of Mount Vernon
Comprehensive Sewer Plan Update
#09637-005-002

The engineering material and data contained in this Comprehensive Sewer Plan were prepared under the supervision and direction of the undersigned, whose seal as registered professional engineers are affixed below.



James C. Peterson,
Supervising Engineer

Richard D. Olson,
Project Manager