King County
Department of Natural Resources and Parks
Wastewater Treatment Division
King Street Center, KSC-NR-0500
201 South Jackson Street
Seattle, WA 98104-3855

October 31, 2007

Mr. Mark Henley
State of Washington
Ecology Northwest Regional Office
Water Quality
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Bellevue, WA 98008-5442

Dear Mr. Henley:

Enclosed is King County Wastewater Treatment Division's Annual Combined Sewer Overflow Report prepared in accordance with the requirements established within NPDES Permits WA-002918-1 and WA-002901-7 and WAC 173-245-090. The report contains an overview and status of King County's CSO Control Program, and 2006/2007 overflow volume and frequency information.

During this reporting period, the total volume of untreated CSOs was approximately 691 million gallons compared to a baseline of 2,339 million gallons and represents a 70.5 percent reduction in CSO volume over the 1981-1983 baseline average. This control was achieved despite the severe storms experienced by the region in November and December of 2006. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches).

Continued effort was made in starting up the complex Mercer tunnel and Elliott West treatment and storage facilities that came on line May 2005, however, the severe storms of the season severely stressed the facilities and brought more significant problems to light. A contract was let under an emergency waiver for consultant services to develop improvements to the system. Permit limits were again not met during this reporting period, impacted by solids screening failures and disinfection system problems. Compliance continued to be complicated by the base flow to the tunnel from Seattle's Lake Union connection. After a second pipeline cleaning effort by Seattle Public Utilities did not bring the problem into control, the County and the City agreed to make inlet weir modifications to retain the base flows in the City system until the source of the sediments can be found and corrected. This will be implemented under the new contract. The Department of Ecology issued a Notice of Violation on September 6, 2007 in response to the on-going compliance short falls - a response was submitted by the County in early October.

Though many more corrective actions will be needed, these challenges must be seen in the context of what this project has accomplished to date. Of the volume of CSO to be managed at the Mercer/Elliott West facilities during 2006-07, 28.5 percent was captured and received full secondary treatment, 64.0 percent received primary treatment and disinfection, and only 7.5 percent was discharged untreated at the Denny Regulator. The number of untreated discharges at the regulator went from the baseline of 32 events per year to just six (6) events.

Operation of the Henderson/Norfolk facilities, also completed in May 2005, finally occurred this season after adjustments were made to the control program. The facilities functioned fairly well during their first real start up year, with only disinfection system problems requiring corrections.

Compounding the storm stresses on the Alki Plant, new pumps at the 63rd Pump Station caused pulsed flows to the plant and short circuiting of the treatment process. As a result Alki failed to meet solids removal and chlorine permit limits. A modified pumping strategy will be employed to correct this.

The Carkeek Plant performed adequately, meeting permit limits.

The report also describes predesign progress on the first RWSP CSO control projects – at the Puget Sound Beaches.

Please call me at 206-684-1236 or Karen Huber at 206-684-1246 if you have any questions.

Sincerely,

Christie True
Division Director

CT:kh

Enclosure

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Combined Sewer Overflow Control Program

2006–2007 Annual Report

October 2007

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

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Contents

Executive Summary iii
Background iii
Report Requirements iii
CSO Control Status v

Section 1 Overview and Status of King County's CSO Control Program 1
1.1 Overview of CSO Control Program 1
1.2 Programs to Meet EPA's Nine Minimum Controls 2
1.3 Status of CSO Control Projects 4
1.3.1 Completed CSO Control Projects 4
1.3.2 New and Recent CSO Projects 6
Puget Sound Beach Projects 6
Ballard Siphon Replacement 7
Densmore Stormwater System Improvements 7
Denny Way/Lake Union CSO Control Project 8
Henderson/Norfolk CSO Control Project 9
1.3.3 Future CSO Projects 10
1.4 Ongoing CSO Program Elements 11
1.4.1 SCADA (CATAD) System Modifications 11
1.4.2 CSO Notification and Posting Program 12
1.4.3 Lander and Densmore Stormwater Management Program 12
1.4.4 Sediment Management 13
Denny Way Post Control Project Sediment Monitoring 13
Denny Way CSO Interim Sediment Remediation 13
Lower Duwamish Waterway Superfund Site 13
Duwamish East Waterway Superfund 14

Section 2 Summary of CSO Volumes and Frequencies 15
2.1 Dry-Weather Overflows 18
2.2 Annual Rainfall 18
2.3 Annual Untreated CSO Events 18
2.3.1 Untreated CSO Volumes 19
2.3.2 Untreated CSO Frequencies 23
2.4 Annual Treated CSO Events 26
2.4.1 West Point Treatment Plant 27
2.4.2 Alki CSO Treatment Plant 29
2.4.3 Carkeek CSO Treatment Plant 30
2.4.4 Elliot West CSO Treatment Facilities 30
2.4.5 Henderson/Norfolk CSO Control Facilities 31
2.4.6 Ecology Permit Compliance Monitoring System Summaries 31

Appendix A. Alki CSO Plant Annual Report, June 2005–May 2006 ..... A-1
Appendix B. Carkeek CSO Plant Annual Report, June 2005–May 2006 ..... B-1
Appendix C. Elliot West CSO Facilities, June 2005-May 2006 ..... C-1
Appendix C2. Elliot West CSO Control Facilities Notice of Violation and Response C2-1
Appendix D. Henderson/Norfolk CSO Facilities, June 2005-May 2006 ..... D-1

Tables

Table 1. King County's Compliance with EPA's Nine Minimum Controls 2
Table 2. Completed CSO Control Projects 4
Table 3. Completed Associated Projects 5
Table 4. RWSP CSO Control Projects 10
Table 5. Rainfall at Pump and Regulator Stations, June 2006–May 2007 (in inches) 18
Table 6. CSOs Exacerbated by Non-Precipitation Events, June 2006-May 2007 19
Table 7. Untreated CSO Volume Summary, June 2006–May 2007 (in million gallons) 21
Table 8. Untreated CSO Event Frequency Summary, June 2006–May 2007 (based on a 24-hour inter-event interval) 24
Table 9. Five-Year Averages for Untreated Discharge Events from CSO Treatment Facilities, June 2002–May 2007 26
Table 10. Treated CSO Volumes by Month, June 2006–May 2007 (in million gallons) 26
Table 11. Treated CSO Frequency by Month, June 2006–May 2007 (events or days)[a] 27
Table 12. CSO Treatment Summary for West Point from June 06 to May 07 28
Table 13. 2006-07 Ecology Permit Compliance Summary for King County CSO Control Facilities 32

Figures

Figure 1. King County CSO Locations iv
Figure 2. December 14, 2006, Precipitation at East Madison Street 16
Figure 3. December 14, 2006, Citywide Rainfall Distribution Madison and Mercer/30th Flooding Investigation 16
Figure 4. Daily Untreated CSO Volumes, June 2006–May 2007 17
Figure 5. Annual CSO Volume versus Total Rainfall (1989 through 2007) 23

Executive Summary

Background

The King County Wastewater Treatment Division (WTD) provides wholesale wastewater conveyance and treatment for flows from the City of Seattle and 33 other cities and sewer districts. Only the City of Seattle wastewater collection system contains combined sewers that collect both wastewater and stormwater. Seattle's collection system conveys flows to County trunks and interceptors, which then convey flows to the West Point Treatment Plant located in Discovery Park. A small portion of flows from the combined sewer system is treated at the South Treatment Plant in Renton. When medium to large storms occur, flows may exceed the capacity of the collection system pipes, resulting in combined sewer overflows (CSOs) at 38 County CSO locations that discharge to Lake Washington, Lake Union, the Ship Canal, the Duwamish River, Elliott Bay, and Puget Sound. The City of Seattle is responsible for 92 CSO locations in its local sewer systems (Figure 1).

CSOs are a recognized source of water pollution that can result in temporary increases in bacterial counts and aesthetic degradation of shorelines, in long-term adverse effects on sediment quality at discharge points, and in raised public health concerns in areas where there is potential for public contact. Since the 1970s when the basic sewer system infrastructure was in place, King County has been implementing CSO control projects to improve water quality in the Seattle area.

Report Requirements

This report is prepared and submitted to the Washington State Department of Ecology (Ecology) in accordance with the requirements established in the West Point Treatment Plant National Pollution Discharge Elimination System (NPDES) Permit and in WAC 173-245-090. The report provides:

(1) An overview and status of King County's Combined Sewer Overflow (CSO) Control Program.

(2) CSO volumes and frequencies for June 1, 2006, through May 31, 2007.

(3) Annual reports for the four CSO treatments facilities—Alki, Carkeek, Henderson/Norfolk, and Mercer/Elliott West.

(4) Progress on the first Regional Wastewater Services Plan (RWSP) CSO projects at South Magnolia, North Beach, Barton Street, and Murray Avenue CSO locations.

Figure 1. King County CSO Locations

CSO Control Status

Despite near normal rainfall over the year, the unusually intense pattern of rainfall created significant challenges for the region. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. Rains were accompanied by winds up to 70 miles per hour, power outages, and flooding, which severely impacted the County's sewer system.

The total volume of untreated CSOs was down to approximately 691 million gallons (MG) during the year compared to a baseline of 2,339 MG. The total of 691 MG represents 1.7 percent of flow from the West Service Area, and is a 70.5 percent reduction in CSO volume over the 1981–1983 baseline average.

This report includes the annual reports for the Alki, Carkeek, Henderson/Norfolk, and Mercer/Elliott West CSO Treatment Facilities. Continued progress is being made in starting up the Mercer/Elliott West and Henderson/Norfolk treatment and storage facilities that came online May 2005. These are complex facilities that operate intermittently. Experience with past CSO treatment facilities has shown that intermittent operation prolongs the startup process. The infrequent opportunities to assess performance and the need to schedule construction for dry weather periods extend the time required to refine facility performance. King County is working diligently to enable these facilities to achieve their performance goals.

Ecology issued a notice of violation (NOV) September 6, 2007. This NOV requires the County to explain the causes of permit violations and describe corrective measures being taken. King County has kept Ecology informed of the challenges and corrective actions performed since operations began. A copy of the NOV and the County's response is attached as Appendix C2.

Although full control has not yet been achieved at the Denny and Dexter Regulators (controlled by Mercer/Elliott West facilities), much has been accomplished. Of the volume of CSO to be managed at the Mercer/Elliott West facilities, 28.5 percent was captured and received full secondary treatment, 64.0 percent received primary treatment and disinfection, and only 7.5 percent was discharged untreated at the Denny Regulator. The number of untreated discharges went from the baseline of 32 events per year to just 6 events. At the Dexter Regulator, the number of events was nearly unchanged from baseline, but they were smaller in volume—58.5 percent of the baseline volume that had previously discharged untreated at Dexter received treatment at West Point in 2006–2007.

The Henderson/Norfolk project was also completed in May 2005. One treated discharge from the Henderson tunnel to the Norfolk outfall was designated as an "untreated" event for purposes of calculating solids limit performance, otherwise, no untreated discharges occurred at the three system outfalls (Henderson, MLK, and Norfolk). Following adjustments in the influent gate control programming, the Henderson Tunnel began filling and treating CSO in November 2006. In 2006–2007, 61.5 percent of the CSO managed by this system received secondary treatment at the South plant at Renton, while 38.5 percent received primary treatment and disinfection in the Henderson tunnel.

Section 1

Overview and Status of King County's CSO Control Program

This section summarizes the evolution of King County's CSO control program and then describes the status of CSO control projects and ongoing elements of the program.

1.1 Overview of CSO Control Program

King County first formalized CSO control with the development of the *1979 CSO Control Program* (1979 Program). The 1979 Program identified nine projects to reduce the number of CSO events into freshwater (Lake Washington, Lake Union, and the Ship Canal). In 1985, the Washington State Water Pollution Control Act (RCW 90.48) introduced new regulations that required all municipalities with CSOs to develop plans for "...the greatest reasonable reduction at the earliest possible date." The County prepared the *1986 Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control* (1986 Plan) to meet this requirement.

Before the 1986 Plan was implemented, the Washington State Department of Ecology (Ecology) promulgated new regulations (WAC 173-245-020) that defined "greatest reasonable reduction" to mean "control of each CSO such that an average of one untreated discharge may occur per year." The County worked with Ecology to develop an interim goal of 75 percent reduction of CSO volumes system wide by the end of 2005. The County's *Final 1988 Combined Sewer Overflow Control Plan* (1988 Plan) identified 11 CSO control projects designed to meet this interim goal.

As part of the 1995 NPDES permit renewal for the West Point Treatment Plant, King County prepared an update and amendment to the 1988 Plan. The *1995 CSO Update* assessed the effectiveness of CSO reduction efforts to date, reevaluated priorities for control of CSO sites, and identified three control projects for completion in 1995–2000.

In November 1999, the King County Council approved *The Regional Wastewater Services Plan* (RWSP). The RWSP identifies wastewater projects to be built through 2030 to protect human health and the environment, serve population growth, and meet regulatory requirements. The RWSP included a CSO control plan that consists of the amended 1988 Plan, a goal for achieving control at each CSO location by 2030,[1] and identification of 21 CSO control projects at a total cost of $378 million (2005 dollars) to meet this goal.

An update of the RWSP's CSO control plan—*Year 2000 CSO Control Plan Update* (2000 Plan Update)—was included in the June 2000 submission of the West Point Treatment Plant NPDES permit renewal application. The 2000 Plan Update describes King County's progress in

[1] Prior to King County's adoption of the RWSP, Ecology had withdrawn the 1988 Plan's interim goal of 75 percent reduction of CSO volumes by 2005 in favor of allowing the County to prioritize control projects in terms of protection of human health rather than reduction of volumes.

implementing its CSO control program, documented its compliance with state and federal CSO control requirements, and identified two large control projects—Denny Way/Lake Union and Henderson/MLK/Norfolk CSO Control Projects—for completion in the next five-year NPDES permit cycle. The resulting Mercer/Elliott West and Henderson/Norfolk CSO Treatment Facilities came online in spring 2005.

King County is currently developing the 2008 CSO Control Plan Update, which will be submitted in June 2008 as part of the West Point NPDES permit renewal application. It will describe control progress to date and describe the control projects to be implemented during the period of the next NPDES permit.

1.2 Programs to Meet EPA's Nine Minimum Controls

King County has implemented a number of programs to satisfy the requirements of the Nine Minimum Controls, which are a part of U.S. Environmental Protection Agency's (EPA's) codified CSO Control Policy. These programs are summarized in Table 1.

Table 1. King County's Compliance with EPA's Nine Minimum Controls

Nine Minimum Controls	King County Compliance Effort
Proper operation and regular maintenance programs for the sewer system and CSOs	King County regularly maintains CSO outfalls, regulator stations, and pump stations through the asset management programs managed by West Point Treatment Plant, South Treatment Plant, and collection system maintenance divisions. Proper facility operation is managed by West Point staff using SCADA.[a] Collection system staff inspect sewers on a specified schedule and perform corrective actions when deficiencies are found. Maintenance schedules and records of visits are available for inspection upon request.
Maximize use of collection system for storage	SCADA manages regulator stations to maximize flows in interceptors and to store excess flows in large trunk sewers.[a] The RWSP emphasizes storage projects for CSO Control.
Review and modification of pretreatment requirements to ensure that CSO impacts are minimized	King County's Industrial Waste Program issues permits that set limits on the chemical contents of industrial discharges. The program also includes monitoring and permit enforcement, education, and technical assistance to businesses on appropriate waste pretreatment and disposal techniques. King County also helps fund the Local Hazardous Waste Management Program. Current water quality assessment and sediment management plan data indicate that there is no need for CSO-specific pretreatment program modifications.
Maximization of flow to secondary treatment plant for treatment	SCADA is used to maximize flow to the West Point Treatment Plant by operation of regulator and pump stations. All analysis for CSO control project alternatives include varying levels of storage and transfer to the secondary and CSO treatment plants.
Elimination of CSOs during dry weather	King County CSOs do not occur as a result of inadequate dry-weather flow capacity. King County provides capacity to transfer 2.25 times average wet-weather flow to secondary treatment, as negotiated with Ecology. The only overflows seen in the combined system during dry weather result from power outages, mechanical failures, or human error. These events are rare and are immediately reported to Ecology. A list of dry weather overflows that occurred during the 2006-07 season can be found in Table 5.

Nine Minimum Controls	King County Compliance Effort
	Overflows occurring during precipitation (CSOs) can also be exacerbated by power outages, mechanical failures, or human error. Such overflows in 2006-07 are listed in Table 7. Maintenance and operation programs, as described for the first control, focus on preventing dry-weather overflows and exacerbated CSOs. The conveyance system is monitored through SCADA and direct observation; corrective action is taken immediately if a problem occurs. Equipment problems are immediately reviewed, and repair or replacement activity is undertaken in a timely manner.
Control of solid and floatable materials in CSOs	City of Seattle catch basin maintenance limits introduction of floatable materials to sewers. The County also developed an information campaign with brochures and TV spots to educate the public that trash should not be flushed to the sewers. Information is available on the CSO control website under "Resources and Links" at http://dnr.metrokc.gov/WTD/cso/library.htm The majority of floatables in the King County system are captured in the large volume of wastewater transferred to the treatment plant before overflows occur. Overflow weirs in the system also hold back solids and floatables in the conveyance system prior to overflow. Observations of quantity of floatables are noted in logs at each facility and are available for inspection on request. These observations have not shown that additional measures to control floatables and solids are needed at this time. Any additional floatables control found to be needed will be addressed in the CSO control projects implemented under the County's long-term control plan.
Pollution prevention programs to reduce contaminants in CSOs	King County has implemented both the Industrial Waste Program and has been a major participant in the Local Hazardous Waste Management Program to reduce discharge of chemicals and other substances that adversely impact the environment and the wastewater treatment process. Educational materials on controlling trash disposal in the sewer are a part of the larger public information program.
Public notification program to ensure that public receives adequate notice of CSO events and impacts	King County operates a CSO Notification and Posting Program as a joint project with the City of Seattle and Public Health–Seattle & King County. This program includes posting signs at publicly accessible CSO locations and an information phone line, Web site, brochure, and other public outreach activities. A Public Notification Feasibility Study, required in the most recent modification of the West Point NPDES permit, was submitted July 1, 2007. The study identified the potential to provide real-time notification of overflows on a Web site. This site is being piloted, while the County continues to seek public opinion on the usefulness of the Web site approach and format. The study reviewed and recommitted to continuing the other public notification program elements described above.
Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls	Beginning in 1986, King County's sampling program was designed to characterize each CSO and identify any high priority sites for early control. That sampling included collecting overflow quality data for five CSO sites per year, and sediment sampling representative of more industrial sites. Sampling was expanded to meet Sediment Management Standards' needs in the 1990s. This characterization was completed. King County's extensive monitoring for its 1999 *CSO Water Quality Assessment* found that the majority of risks to people, wildlife, and aquatic life would not be reduced by removal of CSOs because most risk-related chemicals come from sources other than CSOs. Overflow

Nine Minimum Controls	King County Compliance Effort
	volume and frequency monitoring will continue after completion of projects to verify achievement of control goals. King County may undertake additional sampling on completion of specific CSO control projects where it is deemed useful to verify project effectiveness. Such monitoring plans will be developed during project implementation as needed.

[a] The Supervisory Control and Data Acquisition (SCADA) system controls the West Point Treatment Plant collection system.

1.3 Status of CSO Control Projects

This section presents an overview of King County's completed, current, and planned CSO control projects. Projects began in the late 1970s. Many early projects involved sewer separation, flow diversion, and new tunnels. Most current and future projects involve construction of storage tanks and treatment facilities.

1.3.1 Completed CSO Control Projects

Tables 2 and 3 summarize CSO control projects and other projects associated with CSO controls that have been completed to date.

Table 2. Completed CSO Control Projects

Project	Description	Completion Date	Status
Ft. Lawton Tunnel	Parallel tunnel to the West Point plant to provide greater transfer capacity.	1991	Completed.
Hanford/Bayview/ Lander Separation & Storage	Partial separation of the Lander and Hanford basins, and reactivation of the Bayview Tunnel. (Joint project with the City of Seattle.)	1992	Remaining control will occur under RWSP projects in 2017 (Hanford), 2019 (Lander), and 2026 (Hanford at Rainier). Lander stormwater management is ongoing.
Carkeek Transfer/CSO Treatment	Transfer of flows up to 9.2 mgd from the Carkeek basin to the West Point plant. Treatment of flows above 9.2 mgd at the Carkeek CSO plant.	Facilities online in 1994; upgrades completed in 2005	The Carkeek plant was receiving more flow than anticipated. Upgrades were made to the pumps that transfer flow to West Point to increase their capacity from 8.4 to 9.2 mgd.
Kingdome Industrial Area Storage & Separation	Installation in 1994 of a pipeline (used for storage) in conjunction with Seattle and WSDOT street projects. Completion by the Public Facilities District in 1999 of 60 percent of the Level 1 separation between Alaska Way and 3rd Ave. in conjunction with Safeco Field construction.	1994 & 1999	Remaining control will occur in 2026 under an RWSP project.

Project	Description	Completion Date	Status
University Regulator Phase 1 and Densmore Drain	Separation of stormwater from northwest Seattle and parts of I-5, and the diversion of Green Lake outflow from the sewer. The Densmore drain was built to convey these flows to north Lake Union for discharge.	1994	Improvements to the hydraulics of the drain and upgrades to the Densmore pumps were completed spring 2007. Remaining control will occur in 2016 under an RWSP project.
Harbor Pipeline	Installation of a pipeline to convey overflow from the Harbor Avenue Regulator Station to the West Seattle Tunnel for storage.	1996	The pipeline was put into operation in 2000–2001.
Alki Transfer/CSO Treatment	Transfer of flows up to 18.9 mgd from the Alki drainage basin to the West Point plant via the West Seattle Tunnel. Treatment of flows above 18.9 mgd at the Alki CSO plant.	1998	Additional Alki CSO plant modifications were completed in 1999. In 2005, further modifications were made of the chlorine system and a dechlorination system was added.
63rd Ave. Pump Station	Diversion of overflows to the West Seattle Tunnel or Alki CSO plant.	1998	Completed.
Denny Way/Lake Union CSO Control Project	Storage and primary treatment of Lake Union flows in the Mercer Tunnel, with screening, disinfection, and discharge at Elliott West.	2005	Major construction completed; see Section 1.2.2 for startup discussion. Ten years of post-construction sediment monitoring is being carried out. See Section 1.4.4.
Henderson/Norfolk CSO Control Project	Storage, primary treatment, and disinfection of Henderson and MLK flows in the Henderson Tunnel; transfer of flows to secondary treatment plants; discharge of excess treated CSOs at Norfolk.	2005	Major construction completed; see Section 1.2.2 for startup discussion.

Table 3. Completed Associated Projects

Project	Description	Completion Date	Status
Renton Sludge Force Main Decommissioning	Pumping of sludge to the Elliott Bay Interceptor for conveyance to the West Point plant for processing until the South plant developed solids management capability; the decommissioning decreased solids discharge from the Interbay Pump Station at Denny during CSO events.	1988	Completed.
Denny Sediment Remediation	Pilot sediment remediation project	1990	Ten-year data review of pilot capping project completed in early 2006. A phase 2 sediment remediation of area in front of original discharge is expected to be completed in early 2008.

Project	Description	Completion Date	Status
Ballinger and York Pump Stations	Construction of two new pump stations that can divert flows to and from the West Point collection system. Flows are currently diverted away from West Point during the wet season.	1992 (York); 1993 (Ballinger)	Completed.
West Point Treatment Plant Expansion	Increase of plant hydraulic capacity from 325 to 440 mgd; the increased capacity enables the conveyance and treatment of more flow from the combined sewer system.	1995	Completed.
Allentown Diversion/ Southern Transfer	Designed to offset addition of Alki flows to the Elliott Bay Interceptor; resulted in significant volume reduction at Norfolk.	1995	Completed.
CSO Monitoring Program	*NPDES Overflow & Sediments:* Initial characterization monitoring to identify project priorities. *Sediment Baseline:* Sediment characterization to identify cleanup needs.	1995 & 1997	Completed.
CSO Water Quality Assessment of the Duwamish River & Elliott Bay	Complex study to determine the existing environment and the relative contribution of CSOs to pollution.	1999	Completed.
North Creek Pump Station	Diversion of flow away from the West Point to the South plant collection system during wet weather.	1999	Completed.
Norfolk Sediment Remediation[a]	Source control, dredging, and capping.	1999	Completed. A 5-year post-construction program was completed in 2005.
Duwamish/Diagonal Sediment Remediation[a]	Source control, dredging, and capping.	2004	A 10-year monitoring program for recontamination potential is in progress.

[a] These projects were done under the Elliott Bay/Duwamish Restoration Panel (EBDRP) under the consent decree to settle the 1990 litigation by National Oceanic and Atmospheric Administration (NOAA) against the City of Seattle and King County (then Metro) for natural resource damages attributed to CSOs and storm drains. These are also identified as early action cleanups in the Lower Duwamish Superfund site.

1.3.2 New and Recent CSO Projects

Puget Sound Beach Projects

Four projects are currently in predesign. These four projects are referred to as the Puget Sound Beach Projects: South Magnolia, North Beach, Barton Street, and Murray Avenue. In January 2007, King County hired Carollo Engineers for the planning and predesign phase of the project. Through May 2007, CSO alternatives to be evaluated for each basin include storing flows, conveying and treating flows, removing stormwater from the combined sewer system, treating CSO at the point of discharge to Puget Sound, and a combination of the alternatives.

Initial alternative screening criteria were developed and will be further refined with community feedback. Community involvement meetings were held in each of the four project basins. Public

comments are being tracked and will be used to involve stakeholders in future community meetings.

During the coming year, technical memorandums will be drafted to document planning confirmation and alternative screening criteria. Flow monitoring in the local Seattle sewer system will be conducted in each of the four basins to assess whether removing stormwater from these sewers is a viable option for CSO control.

Ballard Siphon Replacement

The Ballard Siphon, built in 1935, consists of two woodstave siphon barrels that rest on the bottom of the Washington Ship Canal. The siphon carries flows collected from Seattle's north end near Carkeek Park and from the Ballard area across the Ship Canal. From there, the flows are conveyed to the West Point Treatment Plant.

In November 2005, King County conducted a sonar inspection of the Ballard Siphon. The inspection showed spots of abnormalities in the integrity of the pipe. Since sonar inspections are a new technology, it is unclear how long the abnormalities had been present and how high the risk of failure. Subsequent analyses and inspections indicated that the anomalies were not threatening, and the concern for imminent failure was significantly reduced.

Replacing the siphon is continuing forward as a high priority project in order to maintain siphon integrity and function and because the project will yield CSO control benefits. The completed project will eliminate CSO events at the Ballard Regulator. It will also reduce overflows at 11th Avenue, likely reducing the scope of a future control project at this site. The Ballard siphon project includes two major components: (1) slip-lining the existing woodstave siphon barrels to extend their useful life, and (2) tunneling an 84-inch-diameter pipe below the canal. Final design is scheduled for completion in third-quarter 2008; construction is scheduled to begin in first-quarter 2009.

Densmore Stormwater System Improvements

The Densmore stormwater system was built to reduce CSOs at the University Regulator Station. It collects stormwater from the Haller Lake area and Green Lake drainage, as well as outflow from Green Lake, which had previously entered the combined sewer system. The Densmore system runs from Green Lake to Lake Union. A pump station located to the north of Lake Union discharges to Lake Union just west of the I-5 bridge. In the event of pump failure, high-level weirs allow stormwater to discharge to the combined sewer to prevent damage to the pump station or to Green Lake park facilities.

The Densmore stormwater system began running in 1994, but its operation has not resulted in the expected CSO reduction, mainly because of hydraulic, mechanical, and electrical problems. All three of the pumps in the pump station have been worked on since startup of the station. However, all three pumps could not be used until stormwater system hydraulic improvements were made. This work, including construction of a large vault designed to reduce the surge in the line near the outfall, was completed in October 2007. The system will be evaluated over the next several wet seasons.

Denny Way/Lake Union CSO Control Project

The Denny Way/Lake Union CSO Control project consisted of the construction of several CSO facilities to store and treat CSOs from the County's Dexter Regulator and City of Seattle CSOs around Lake Union, and to control the County's largest CSO at Denny Regulator on Elliott Bay. Construction was completed in May 2005. The Mercer /Elliott West CSO Annual Report (Appendix C) summarizes the performance of the facility over this last wet season.

The project consisted of three major elements: the East Portal, which captures flow from a number of sewer lines in the South Lake Union area; the 14-foot-diameter Mercer Street Storage and Treatment Tunnel; and the Elliott West CSO Treatment Facility located on Elliott Bay. Two new CSO outfalls were built in Elliott Bay—one outfall to replace the outfall structure at the Denny Way Regulator and another outfall for the Elliott West CSO Treatment Facility. The Mercer Tunnel provides storage for up to 7.2 MG and primary clarification for all flows entering the tunnel. The Elliott West Treatment Facility was designed to provide final treatment—screening, disinfection, and dechlorination—to settled flows that exceed the capacity of the tunnel. Such treatment is expected to occur about 14–20 times per year.

During the first two years of operating these CSO facilities, King County faced several challenges, which is typical for such large and complex systems. The seasonal and intermittent operation of these facilities prolongs the commissioning period. During the 2006–2007 season, the Mercer Tunnel operated for 28 CSO events and final treatment at Elliott West with discharge occurred for 13 events. This does not include the steady stream of non-CSO flows from City of Seattle east Lake Union sewers that were overflowing into the tunnel.

A large hurdle to effective operations was the substantial amount of dry-weather flows that entered the Mercer Storage and Treatment Tunnel. These flows were reducing the tunnel's storage capacity for CSO flows by 1–2 MG, causing pump damage, and complicating treatment compliance. Investigation by King County determined that extensive sedimentation in city sewers upstream of the tunnel were causing base flows to back up and overflow into the tunnel.

The City conducted an extensive pipeline cleaning in spring 2006, removing 80 tons of sediment, mainly sand and gravel, from the sewer lines. This cleaning resolved the dry-weather flow problem until about November 2006 when portable monitors placed at the weir indicated that the pipelines were refilling. A second cleaning during spring 2007 removed another 16 tons of sediment. The second cleaning reduced the volume of dry-weather flow to the tunnel but did not resolve it. The City and the County have agreed to make temporary weir modifications to prevent these flows from entering the tunnel. Design will begin under the current emergency contract. The schedule for modifications will depend on the alternative chosen and the period of dry weather required for the construction. In parallel, the City will perform a source investigation of its east Lake Union system. If the sedimentation can be corrected, the weir will be reopened.

Overflow of Effluent from Elliott West - December 15th

The large storms of November 2–15 and December 9–15, 2006, severely challenged the system. The intense rain—up to 1.45 inches on November 6 and 1.8 inches on December 14—demonstrated that the facilities were not hydraulically capable of managing the resulting flows. Flooding at Elliott West and effluent overflows in Myrtle Edwards Park near the Denny

Regulator and the outfalls highlighted the need for improvements.

A consultant was hired under an emergency waiver to assist the County in identifying solutions. The duckbill valve was removed from the outfall in March 2007. The beneficial impacts of this removal will be assessed after wet-weather flows resume.

Removal of Elliott West Outfall Duckbill Valve

On September 6, 2007, Ecology issued Notice of Violation (NOV) 5059, citing monitoring, disinfection, and dechlorination failures. King County's response, submitted October 5, 2007, details the corrective actions completed and under way to bring the facility into compliance. The NOV and King County's response are attached as Appendix C2.

The Dexter CSO was also to be controlled under the Denny/Lake Union CSO Control Project. In the first two wet seasons, the facility continued to have frequent overflows but of much lower volume than before the facilities went online. Investigation identified needed programming changes to the gate controls. A new programmable logic controller was installed and the program changes were made in August 2007. The success of this correction will be assessed during the 2007–2008 wet season.

Although the Denny/Lake Union facilities have not yet achieved complete CSO control, they have made substantial inroads into controlling CSOs at the Denny and Dexter locations:

- Untreated overflows at the Denny regulator have decreased from a baseline of 32 to 6 events (both seasons):
    - Of the 513.57 MG of CSO that would have discharged into Lake Union and Elliott Bay in 2005–2006, 38.4 percent received secondary treatment, 61.4 percent received primary treatment and some disinfection, and 0.2 percent was discharged untreated. This represents a 99.2 percent reduction from pre-project levels.
    - Of the 764.53 MG of CSO that would have discharged into Lake Union and Elliott Bay in 2006–2007, 28.5 percent received secondary treatment, 64 percent received primary treatment and some disinfection, and 7.5 percent was discharged untreated. This represents a 92.5 percent reduction from pre-project levels.
- Untreated overflows at the Dexter regulator have remained close to the baseline of 15 events per year, at 16 events in 2005–2006 and 17 events in 2006–2007; the volume of untreated CSO discharges has decreased from 24 MG to 6.21 MG in 2005–2006 and 8.77 MG in 2006–2007. This is a 74 percent (2005–2006) and 63.5 percent (2006–2007) reduction from pre-project levels.

King County is committed to completing the refinements to these facilities to achieve full control as quickly as possible.

Henderson/Norfolk CSO Control Project

The Henderson/Norfolk CSO control project was implemented to control the Henderson and Martin Luther King (MLK) CSOs into Lake Washington and the Norfolk CSO into the

Duwamish River. King County upgraded the Henderson Pump Station and constructed a large storage and treatment tunnel between Henderson Street and Norfolk Street in the Rainier Valley. The facilities were designed to chlorinate and dechlorinate flows that exceed the capacity of the storage and treatment tunnel and to discharge treated flows at the Norfolk CSO in the Duwamish Waterway. This discharge is expected to occur approximately two to four times per year. Base flows, settled solids, and stored flows from the tunnel are conveyed to the South plant at Renton or to the West Point plant, depending on capacity in the Elliot Bay Interceptor, for secondary treatment.

The Henderson/Norfolk project was also completed in May 2005 but did not operate during its first season. Following adjustments in the influent gate control programming, the Henderson Tunnel began filling and treating CSO in 2006. During the 2006–2007 season, 61.5 percent of the CSO managed by this system received secondary treatment at the South plant and 38.5 percent received primary treatment and disinfection in the tunnel. One treated discharge from the Henderson tunnel to the Norfolk outfall was designated as an "untreated" event for purposes of calculating solids limit performance, otherwise, no untreated discharges occurred at the three system outfalls (Henderson, MLK, and Norfolk).

For additional information on the performance of the Henderson/Norfolk CSO Control Facilities, see Section 2.3.5 and Appendix D.

1.3.3 Future CSO Projects

Table 4 lists future CSO projects included in the RWSP. The table includes a brief description of the facilities to be constructed and a projected completion date.

The schedule shown in Table 4 may change as a result of the 2008 CSO Control Plan Update.

Table 4. RWSP CSO Control Projects

CSO Project	Project Description	Year Controlled
South Magnolia [b]	1.3-MG storage tank	2010
SW Alaska St.[a]	0.7-MG storage tank	2010
Murray Ave.[b]	0.8-MG storage tank	2010
Barton St.[b]	Pump station upgrade	2011
North Beach [b]	Storage tank and pump station upgrade	2011
University/Montlake	7.5-MG storage tank	2015
Hanford	3.3-MG storage and treatment tank	2017
West Point Treatment Plant improvements	Primary and secondary enhancements	2018
Lander St.	1.5-MG storage/treatment at Hanford	2019
Michigan	2.2-MG storage and treatment tank	2022
Brandon St.	0.8-MG storage and treatment tank	2022
Chelan Ave.	4-MG storage tank	2024

CSO Project	Project Description	Year Controlled
Connecticut St.	2.1-MG storage and treatment tank	2026
King St.	Conveyance to Connecticut St. treatment	2026
Hanford at Rainier Ave.	0.6-MG storage tank	2026
8th Ave. S	1.0 MG storage tank	2027
West Michigan	Conveyance upgrade	2027
Terminal 115	0.5-MG storage tank	2027
3rd Ave. W	5.5-MG storage tank	2029
Ballard	1.0-MG storage tank (40 percent King County)	2029
11th Ave. NW	2.0-MG storage tank	2030

[a] The SW Alaska Street project is no longer needed; updated monitoring and modeling data indicate that this CSO is already controlled.
[b] These four projects were in predesign in 2007.

1.4 Ongoing CSO Program Elements

1.4.1 SCADA (CATAD) System Modifications

Supervisory Control and Data Acquisition (SCADA)—formerly called CATAD (Computer Augmented Treatment and Disposal System) when it was an in-house developed system—controls the West Point Treatment Plant collection system.

Projects to enhance the use of storage capacity in existing sewers are part of ongoing improvements to the SCADA system. In 1992, storage levels behind regulator stations were raised to improve capture of CSO. Currently, a modified CSO drawdown strategy is being employed at the Interbay Pump Station. This strategy will provide storage capacity in the upper portion of the Elliott Bay interceptor (EBI) for as long as possible. The available storage will be used when flow exceeds the allowed flow through the pump station.

SCADA computer hardware and software at West Point was replaced with a new system in May 2004 to bolster the reliability of monitoring and control of offsite regulator and pump stations. The system will continue to be tested and refined as necessary. The new hardware includes enough capacity to install and run an optimization program (predictive control) to monitor rainfall and conditions in the major trunks and interceptors, predict inflows to the sewer system, and optimize the regulation of flow through the regulators to minimize CSOs. Predictive control model development and calibration is taking place in 2005–2008; a new updated control program is targeted for 2008–2010.

These improvements to the SCADA system could reduce CSO volumes by as much as 150 MG per year. Additional improvements will be explored as information becomes available.

1.4.2 CSO Notification and Posting Program

The King County Department of Natural Resources and Parks, Public Health–Seattle & King County, and Seattle Public Utilities jointly developed and are implementing a CSO Notification and Posting Program. Ecology approved the program as meeting state and federal requirements for public notification and providing information to the community regarding the possible health impacts of CSOs. Public notification is one of EPA's Nine Minimum Controls. The County's program has evolved to integrate with other public information and involvement programs. The current program includes the following elements:

- Outreach and education through an integrated program that addresses CSO control planning and updates, control projects, public notification, special projects (e.g., sediment remediations and technology pilots), and general wastewater management and water quality topics. Program activities include workshops, open houses, brochures, mailings, briefings, meetings, and treatment plant tours.
- Communication of status and projects through an informative County CSO Web site that contains data, reports, and links to related information and contacts.
- Maintenance of signage at all publicly accessible CSO sites. The warning signs include a graphic and description of a CSO, the information phone number, and a CSO number assigned to each site that corresponds to its NPDES discharge serial number.
- Continued funding of Public Health–Seattle & King County to provide a Web site covering CSO-related public health information, brochures on CSO risks and precautions, business and group CSO educational visits, and a CSO information telephone line.

The recently modified NPDES permit for West Point required the County to conduct a study to determine the feasibility of providing more immediate notification of overflows, including the feasibility of providing a Web-based system. Technology upgrades to the West Point SCADA system may have allowed for provision of "real time" overflow information on the Internet. Such a system is being piloted internally. Having determined the technical possibilities of providing "real time" information King County has been meeting with interested public groups and has been participating in public events such as fairs and farmers markets to discuss the potential of a Web site and to gather information on public preferences. This information and the results of the internal pilot will be evaluated and a decision will be made in early 2008. More detail on this program, the alternatives considered, other agency approaches, and public involvement is provided in the *Final Public Notification Feasibility Study*, submitted to Ecology on July 1, 2007. The report can be accessed on the County's CSO control program Web site (http://dnr.metrokc.gov/wtd/cso/library.htm).

1.4.3 Lander and Densmore Stormwater Management Program

King County and the City of Seattle jointly manage stormwater discharges in the Lander and Densmore drainage basins that occur as the result of County sewer separation projects. This ongoing management program includes Densmore-specific requirements under the NPDES municipal stormwater permit. Program elements include source control, baseline sampling of stormwater discharges, and inspections. As specified in a local agreement between the City and

County, the City maintains the stormwater system and manages any necessary source control enforcement actions.

The Lander stormwater system was built in 1992 to reduce CSOs at the Lander Regulator Station. A new wastewater sewer was built, and the original pipeline was cleaned and converted to a storm drain. A low-flow diversion of stormwater to the new sewer was included to capture any first flush of pollutants during rain. The stormwater and remaining Lander Regulator CSO discharge share the same City-owned outfall to the Duwamish River East Waterway.

The Densmore stormwater system was built in 1994 to reduce CSOs at the University Regulator Station. It collects stormwater from the Haller Lake area and Green Lake drainage, as well as outflow from Green Lake, which had previously entered the combined sewer system. The Densmore system runs from Green Lake to Lake Union. A pump station located to the north of Lake Union discharges to Lake Union just west of the I-5 bridge. In the event of pump failure, high-level weirs allow stormwater to discharge to the combined sewer to prevent damage to the pump station or to Green Lake park facilities.

The Densmore stormwater system has experienced hydraulic, mechanical, and electrical problems since it began operation. An upgrade to the system has just been completed (see Section 1.3.2).

1.4.4 Sediment Management

Denny Way Post Control Project Sediment Monitoring

A 10-year post-control sediment sampling program began in 2006 near the outfall for the new Elliott West CSO Treatment Facility. Surface sediment samples from 16 stations are being collected and analyzed for sediment chemistry and benthic infauna. Monitoring the sediment near the new outfall was part of the requirements for the Section 7 consultation for the U.S. Army Corps of Engineer permit.

Denny Way CSO Interim Sediment Remediation

In mid 2007, design was completed for cleanup of contaminated sediments in front of the old Denny Way CSO site off of Myrtle Edwards Park. An Agreed Order and the interim action work plan were finalized by Ecology in early October 2007. Dredging will occur November 2007–February 2008. A ten-year monitoring program will start in 2008 to evaluate additional areas further offshore with sediments exceeding sediment management standards. After five years of monitoring, alternatives for cleaning up additional areas will be evaluated with Ecology and other stakeholders.

Lower Duwamish Waterway Superfund Site

In 2000, the U.S. Environmental Protection Agency (EPA) declared an area of the Duwamish Waterway from the south end of Harbor Island to the Turning Basin as a Superfund site. King County, City of Seattle, Port of Seattle, and The Boeing Company formed a working group to complete early action cleanups at several locations in the area and complete the work necessary to determine the final Superfund clean up of the waterway. The site risk assessments are

complete and the draft remedial investigation will be out for public review in November 2007. King County has completed two early action cleanups in front of King County CSOs (Norfolk and Duwamish/Diagonal). Monitoring programs are under way at both locations. Design is complete for the cleanup of Slip 4 (in cooperation with the City of Seattle). Cleanup of Slip 4 is on hold while Ecology completes source control actions at North Boeing Field that threaten recontamination of the cleanup site.

Duwamish East Waterway Superfund

In 2006, King County, City of Seattle, and Port of Seattle formed a working group to complete the work necessary to determine the final Superfund cleanup of the East Waterway of the Duwamish River. EPA approved the scope of the remedial investigation/feasibility study spring 2007, and work has started. The Hanford/Lander CSOs are part of the East Waterway cleanup. Cleanup of approximately 20,000 cubic yards of sediment in front of the Lander CSO will occur in winter 2008–2009.

Section 2

Summary of CSO Volumes and Frequencies

King County monitors rainfall and the frequencies and volumes of both untreated and treated CSOs at its regulator and pump stations and treatment facilities in the Seattle area. This section presents the results of this monitoring for the 2006–2007 CSO year.

In summary, the annual rainfall for the reporting period was 37.04 inches as an average over local rain gauges. King County had 268 untreated CSO discharges for a total of approximately 691 MG of CSO. The West Point Treatment Plant, Carkeek and Alki CSO Treatment Plants, and the Elliott West and Henderson/Norfolk CSO Treatment Facilities discharged approximately 1140 MG of treated CSOs.

Despite near normal rainfall over the year, the pattern of rainfall created significant challenges for the region. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. The City of Seattle's investigation into the effects of the severe flooding that occurred during the December storm—including a very tragic drowning—characterized the storm in the following way in *Madison and Mercer/30th Flooding Investigation Findings Report*, CH2MHill, April 2007:

> The storm of December 14, 2006, yielded high-intensity rainfall in Seattle during the late afternoon and early evening hours. Seattle Public Utilities (SPU) rainfall gauge RG020 (Figure 1-1) registered 1.36 inches from 2:00 p.m. through 11:59 p.m., with the most intense rainfall totaling 0.88 inches from 4:05 p.m. to 4:55 p.m.
>
> The maximum 30-minute rainfall of 0.74 inch during that event is greater than a 100-year storm. Stated another way, that amount of rainfall is calculated to have less than a 1 percent chance of occurring in a given year, based on the statistical analysis performed by
>
> Northwest Hydraulic Consultants on rainfall data from this event (NHC, 2007). This 0.74 inch in 30 minutes translates to an intensity of 1.5 inches per hour.
>
> …SPU rain gauge RG020 recorded a maximum 10-minute intensity of 0.33 inch, an hourly intensity of approximately 2 inches per hour which is equivalent to a 20-year recurrence interval or an annual probability of 4.5 percent. The intensity of 2 inches per hour experienced in Madison Valley on December 14, 2006, is categorized by the National Weather Service (NWS) as very heavy or intense.

Figure 2 (following page), taken from the CH2M HILL Report, shows the variation of rainfall intensity over December 14 at the City's East Madison Street gauge.

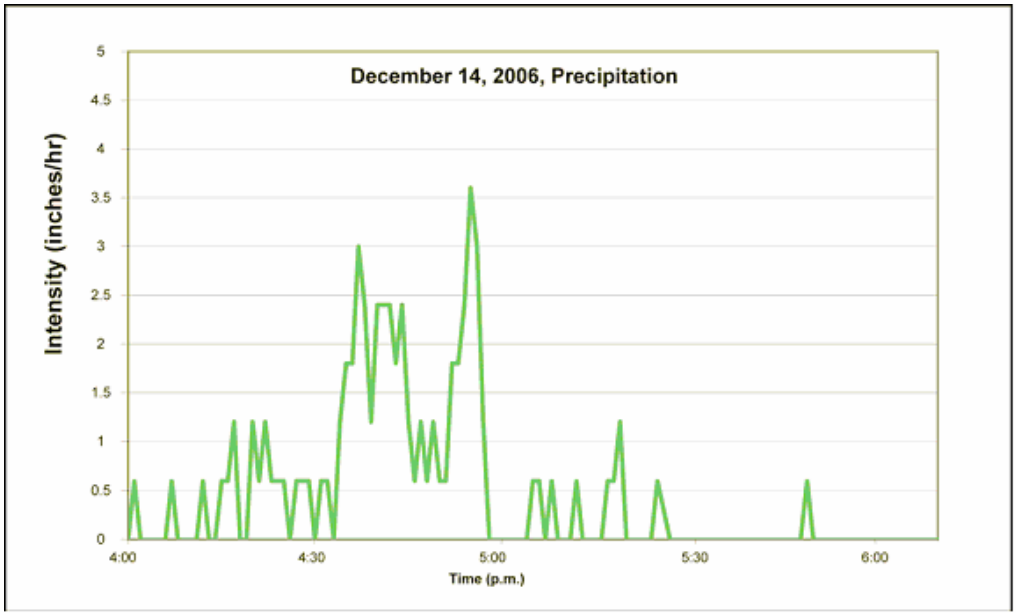

Figure 2. December 14, 2006, Precipitation at East Madison Street

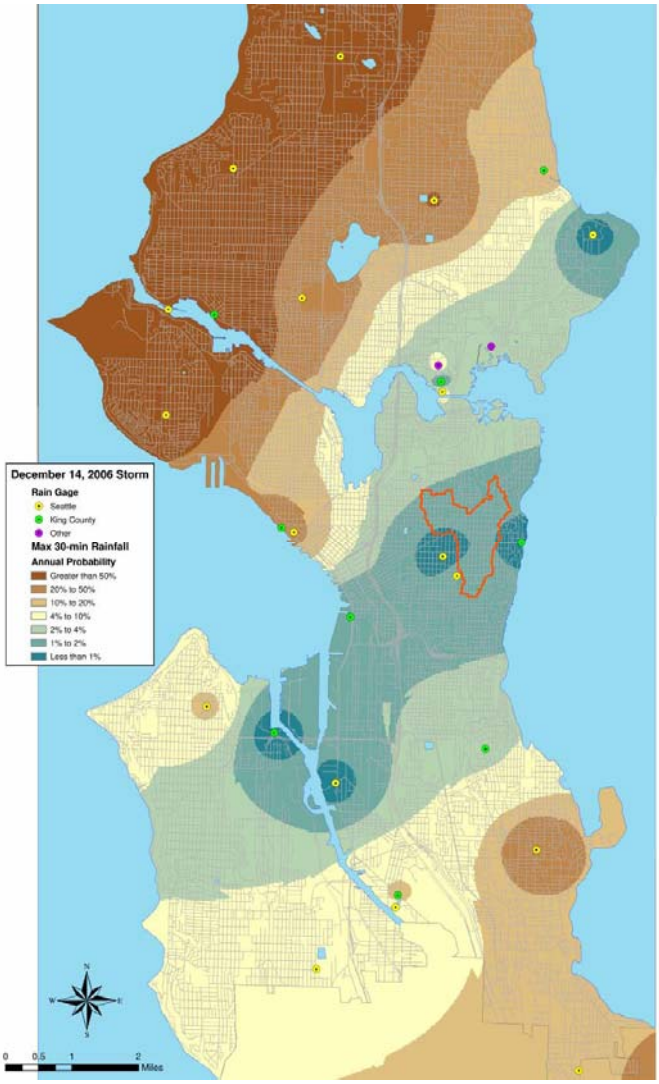

Figure 3, also taken from the CH2M HILL report, shows the probability of such rain over the city and combined sewer area.

These intense rains accompanied by winds up to 70 miles per hour, power outages, and flooding severely impacted the County's sewer system. The storm entered the region from the southeast. Resulting high combined sewer flows impacted County facilities along the Duwamish River and up to the Mercer/Elliott West facilities. Following are a few examples of the impacts to the County system.

Figure 3. December 14, 2006, Citywide Rainfall Distribution Madison and Mercer/30th Flooding Investigation

During this storm West Point Treatment Plant experienced several power fluctuations that resulted in multiple pump shutdowns. Influent overflowed the primary sedimentation area. Severe flooding occurred in the primary area and equipment tunnel. This event resulted in a six to nine hour bypass, with a discharge of about 59 MG of dilute, untreated wastewater into Puget Sound. The plant lost treatment capability December 14 at 7 p.m. Crews restored primary treatment at 11 p.m., and the plant resumed full secondary treatment at 8:30 a.m. on December 15.

The Interbay Pump Station was shut down for a while to limit flows to West Point while flooding was controlled and treatment processes were brought back online at the plant. The pump station shutdown worsened the high flow impacts already being experienced at the Mercer/Elliott West CSO facilities and contributed to flooding and surcharging at the outfall transition structure, dechlorination structure, and the Elliott West CSO effluent transfer line; and overflows of effluent in Myrtle Edwards Park near the Denny Regulator and the outfalls.

The Barton Pump Station lost power the night of December 14. It appears that the wet well level rose very high, a check valve did not work properly, and influent flowed from the wet well into the pump room after the power outage occurred. A temporary pump station was installed while repair work was conducted at the station. The facility was fully functional in 30 hours.

Over 800,000 residents lost power in King County. Some lost power for several days to weeks. At least 20 pump stations in the County's system lost power and operated with emergency generators during and after the storm. There were also generator-related breakdowns that had to be quickly repaired, including 3-4 diesel fuel line breaks, a radiator hose break, and a radiator break. Extended power outages necessitated multiple diesel re-fuelings in adverse conditions, with transportation complicated by congestion on the roadways and depleting diesel supplies in the region. Some pump stations ran for weeks on emergency power until power was restored to neighborhoods.

Figure 4 shows how the overflow volumes resulting from these storms dwarfed the volumes recorded for the rest of the 2006–2007 reporting period. Over 55 percent of the CSOs during the year occurred November 2–15 and December 9–15. Table 6 lists overflows exacerbated by the power outages on December 14 and 15.

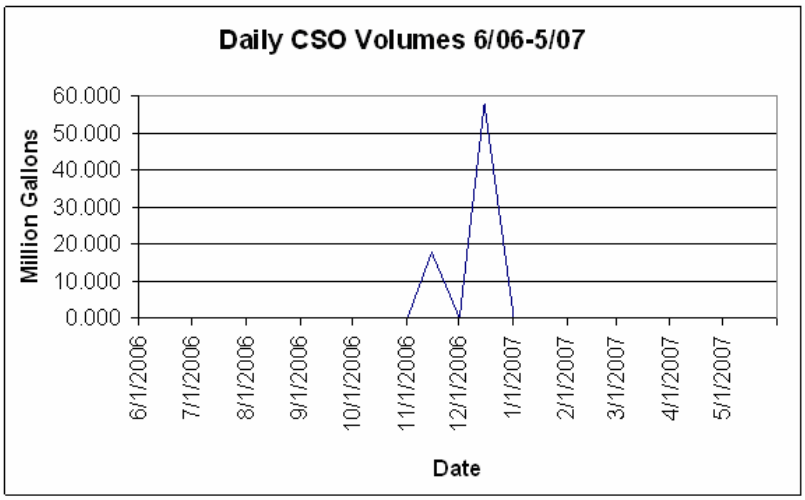

Figure 4. Daily Untreated CSO Volumes, June 2006–May 2007

2.1 Dry-Weather Overflows

Overflows from CSO structures that are not primarily caused by rainfall are called dry-weather overflows (DWOs). In King County's system, DWOs usually result from mechanical failures, power outages, or, occasionally, human error. They often occur during storms, worsening overflows caused by precipitation. Under EPA's Nine Minimum Controls, DWOs are to be prevented. King County's facility inspection and preventive maintenance activities and its program to provide backup generators at all CSO facilities work to prevent DWOs from occurring.

2.2 Annual Rainfall

As shown in Table 5, rainfall measured for the 2006–2007 CSO year was 37.04 inches as an average over local rain gauges; this average is approximately the same as the baseline average of 37 inches per year. Although rain gauge maintenance and calibration have improved, problems occurred with gauges at Chelan, Denny Way/Lake Union, East Marginal, and Rainier. Rainfall for these stations, therefore, is not included in the table.

Table 5. Rainfall at Pump and Regulator Stations, June 2006–May 2007 (in inches)

Station	2006							2007					Total
	June	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Ballard	1.08	0.13	0.16	1.32	1.38	13.38	7.36	2.78	2.15	2.88	0.98	1.65	35.25
Denny Way/Lake Union	1.5	0.11	0.32	1.28	1.25	10.29	6.86	2.52	1.8	2.16	1.28	1.57	30.94
King Street	1.35	0.04	0.22	2.07	1.2	11.1	8.21	2.98	2.02	2.61	1.11	1.56	34.47
Marginal Way, E.	1.88	0.09	0.25	1.72	1.94	11.43	7.6	4.39	2.16	3.51	1.43	1.6	38
Pine Street, E.	1.75	0.1	0.2	1.58	1.82	13.03	9.49	3.97	2.7	3.97	1.89	1.83	42.33
University	2.04	0.15	0.23	1.79	1.7	13.12	8.87	3.75	2.66	3.14	2.07	1.74	41.26
Average	**1.60**	**0.10**	**0.23**	**1.63**	**1.55**	**12.06**	**8.07**	**3.40**	**2.25**	**3.05**	**1.46**	**1.66**	**37.04**

2.3 Annual Untreated CSO Events

Figure 1 on page v shows the locations of existing permitted King County CSO discharges and the discharge serial numbers (DSNs) used in Tables 8 and 9 below.

West Point's SCADA system monitors the volume and frequency of CSOs at regulator and pump stations and makes operating adjustments in response to the monitoring. The County looks at the combined system area as four service areas: (1) the Southern Service Area (south of the Ship Canal), (2) the Northern Service Area (north of the Ship Canal including the Montlake and

Dexter Regulator Stations), and (3) the Alki Service Area which all drain to West Point, and (4) the Henderson Service Area, which drains primarily to the South Plant at Renton.

Portable flow meters are deployed at seven CSO locations not currently monitored by SCADA: 11th Avenue NW, SW Alaska Street, Hanford at Rainier, South Magnolia, North Beach Pump Station, West Duwamish Siphon, and Terminal 115. Portable meters also supplement SCADA in a few locations.

2.3.1 Untreated CSO Volumes

Overflows that occurred during precipitation and were exacerbated by power outages, mechanical failure, or human error in the 2006–2007 CSO year are listed in Table 6. King County is implementing an aggressive program to place permanent emergency generators at all pump stations.

Table 6. CSOs Exacerbated by Non-Precipitation Events, June 2006-May 2007

Dates	Location	Estimated Volume	Estimated Duration	Receiving Water	Cause & Resolution
9/14/2006	S. Michigan	0.5 MG	~1 day	Duwamish River	Stoplogs failed. Occurred during high storm flows but may have been due to improper installation. Was repaired.
12/14/2006	Elliott West	unknown	~1-2 hr	Overland to Elliott Bay	During extreme storm flows, manhole near Denny structure lifted releasing settled & chlorinated CSO into Myrtle Edwards Park and Elliott Bay. Overflow ceased when pressure was reduced. Project to weigh down manhole and improve air release is in design.
12/14–15 /2006	Murray Pump Station	3.4 MG	10.5 hr	Puget Sound	Major wind/rain storm caused widespread power outages. Mobile generator was hooked up morning of the Dec. 15. Seattle City Light restored power on Dec. 19.
12/14–15 /2006	Barton Pump Station	5.0 MG	28 hr	Puget Sound	Major wind/rain storm caused widespread power outages. High flows flooded pumps and motors. A diesel powered temporary pump station was set up and operated until Dec. 17 when Seattle City Light restored power and one rebuilt pump went online.

As shown in Table 7, the total volume of untreated CSOs for 2006–2007 was 690.92 MG (572.76 MG in the South Service Area; 85.77 MG in the North Service Area; and 32.38 MG in the Alki Service Area). The 690.92 MG total represents a 70.5 percent reduction over the 1981–1983 baseline of 2,339 MG.

Figure 5 illustrates the progress King County has made in CSO volume reduction as compared to total annual rainfall over time. A simple volume trend line has been added to illustrate control progress. While a somewhat reasonable relationship between total rainfall and total CSO volume

can be computed, large and/or intense storms can dramatically impact CSO volume, representing most of the year's CSO volume. This impact was evident in the 2006–2007 season when approximately one-third of the annual rainfall occurred during two storms that occurred November 2–15 (8.67 inches) and December 9–15 (4.12 inches) while over 55 percent of the annual overflow volume occurred in relation to the storms.

Railroad construction near the Kingdome site had blocked access to the portable meters at the overflow weir. Upon completion of construction in November 2006, monitoring was restored..

Replacement portable monitors were installed at the Hanford at Rainier site ahead of the 2006-2007 wet season, which restored reliable monitoring. Investigation of unusual data for Montlake identified a corroded/cracked pipe fitting in the line leading to the trunk bubbler, invalidating past measurements. Past data are being reviewed to determine how long this condition may have affected the data. The fitting was repaired immediately to so that flow could be reliably measured in the 2007–2008 wet season. The trunk level sensor at Brandon also was not operating properly, and is being repaired. Overflows were not calculated for these sites. King County is developing a computer program to automatically review overflow data for anomalies so that repair can occur more quickly and data loss can be minimized.

The Magnolia CSO volume remained significantly higher than the calculated baseline. Recent inspections of the downstream line have shown no obstructions, so it is assumed that modifications to the hydrobrake in the upstream City of Seattle system have resulted in the conveyance of much more combined flow to Magnolia than could previously be handled. The City has restored the hydrobrake to its proper function, and that the County will need to recalculate the baseline to represent these corrections. The increased overflow will be managed by the control project currently in predesign.

Barton's volume is inflated because of overflows resulting from both precipitation and the power outage and flooding that put the station out of service December 14 and 15.

Table 7. Untreated CSO Volume Summary, June 2006–May 2007 (in million gallons)

Station	DSN	Service Area	2006							2007					2006-2007 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
11th Ave. NW [b]	004	North	0	0	0	0	0.14	2.04	8.08	0.99	0	0.38	0	0	11.64	
30th Ave. NE	049	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
3rd Ave. W	008	North	0	0	0	0	0	0.13	0.78	0.12	0	0	0	0.06	1.09	106
53rd Ave. SW	052	Alki	0	0	0	0	0	0	0.03	0	0	0	0	0	0.04	<1
63rd Ave. PS	054	Alki	0	0	0	0	0	0	0	0	0	0	0	0	0	10
8th Ave. S/ W. Marginal Way	040	South	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Alaska St., SW [b]	055	Alki	0	0	0	0	0	0	0.06	0	0	0	0	0	0.06	<1
Ballard	003	North	0	0	0	0	0	0	0.47	0	0	0	0	0	0.47	95
Barton St.	057	Alki	0	0	0	0	0	0.92	23.27	0.41	0	0	0	0	24.60	8
Belvoir	012	North	0	0	0	0	0	0	0.15	0	0	0	0	0	0.15	<1
Brandon St. [e]	041	South	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM [e]	64
Canal St.	007	North	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Chelan Ave.	036	South	0	0	0	0	0	0	0.85	0.06	0	0	0	0	0.91	61
Denny Reg. [h]	027a	South	0	0	0	0	0	6.42 [i]	51.13	0	0	0	0	0	57.55 [h]	502
Dexter	009	North	0.37	0	0	0.18	0.18	0.57	6.95	0.42	<0.01	<0.01	0.09	<0.01	8.77	24
Duwamish PS, W. [b]	034	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Duwamish PS, E.	035	South	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hanford (total)	031/2	South	1.55	0	0	0.27	0	81.78	63.76	30.15	0	0	0	3.42	180.93	644
Hanford #1 (Hanford @ Rainier) [b]			*0.64*	*0*	*0*	*0.27*	*0*	*17.29*	*17.91*	*8.54*	*0*	*0*	*0*	*1.45*	*46.10*	
Hanford #2			*0.91*	*0*	*0*	*0*	*0*	*64.49*	*45.85*	*21.61*	*0*	*0*	*0*	*1.97*	*134.83*	
Harbor Ave.	037	South	0	0	0	0	0	3.28	5.54	0.65	0	0	0	0	9.46	36
Henderson [b]	045	South	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Kingdome [d]	029	South	NM	NM	NM	NM	NM	NM	17.60	0.84	0	0	0	0.10	18.54 [d]	90
King Street	028	South	1.00	0	0	0.02	0	12.66	14.42	5.59	0	0	0	1.58	35.26	55
Lander II St.	030	South	0.26	0	0	0	0	69.25	59.13	48.24	0	0	0	6.48	183.36	143
Magnolia, S. [b, f]	006	South	NM	NM	NM	0.03 [g]	1.42	26.00	29.56	8.57	0	2.23	0	3.16	70.97 [f]	14
Marginal Way, E.	043	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Matthews Park	018	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1

Station	DSN	Service Area	2006							2007					2006-2007 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
Michigan	039	South	0	0	0	0	0	3.18	3.48	2.27	0	0	0	0	8.93	190
Michigan, W.	042	South	0	0	0	0	0	0.65	1.16	0.49	0	0	0	0	2.30	2
MLK Jr. Way [b]	013	South	0	0	0	0	0	0	0	0	0	0	0	0	0	60
Montlake [g]	014	North	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM [g]	32
Murray Ave.	056	Alki	0.04	0	0	0	0	3.06	4.58	0	0	0	0	0	7.68	6
Norfolk St.	044	South	0	0	0	0	0	0	0	0	0	0	0	0	0	39
North Beach [b, c]	048a	North	0	0	0	0	0	0.11	0.57	0.04	0	0.02	0	0	0.74	6
North Beach [b, c]	048b	North	0	0	0	0	0	0.01	0.19	0.05	0	0	0	0	0.25	
Pine, E St.	011	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Rainier Ave.	033	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Terminal 115 [b]	038	South	0	0	0	0	0	1.36	2.57	0.63	0	0	0	0	4.56	2
University [h]	015	North	0	0	0	0	0	5.88 [i]	50.16	3.51	0	0	0	3.12	62.67 [h]	126
		Approximate Total	3.22	0.00	0.00	0.50	1.74	217.31	344.48	103.01	0.00	2.62	0.09	17.94	690.92	2339.00
2006-2007 Rainfall Average (baseline is historical average in inches)			1.60	0.10	0.23	1.63	1.55	12.06	8.07	3.40	2.25	3.05	1.46	1.66	37.04	37

NM = not monitored.

[a] Baselines for CSO volumes will occasionally be revised as improvements are made to the computer modeling system to provide more accurate projections on historical and future conditions.

[b] Portable flow meters; not currently monitored by SCADA.

[c] The North Beach Pump Station has two outfalls. A 16-inch outfall (48b) from the wet well and a 30-inch (48a) outfall from the inlet trunk. The 30-inch outfall discharges on the beach, and the 16-inch outfall discharges further out in Puget Sound. The baseline value is for both outfalls together.

[d] Access to the overflow structure and meters was restored in December following railroad construction completion.

[e] Brandon trunk level sensor was not operating properly. Overflows were not calculated for this site.

[f] S. Magnolia portable flow meter was not operating properly. Meter was replaced in mid-September 2006.

[g] Montlake trunk level sensor was not operating properly. Overflows were not calculated for this site.

[h] Partial data at Denny and University in Nov. 2006 due to loss of telemetry during the storms

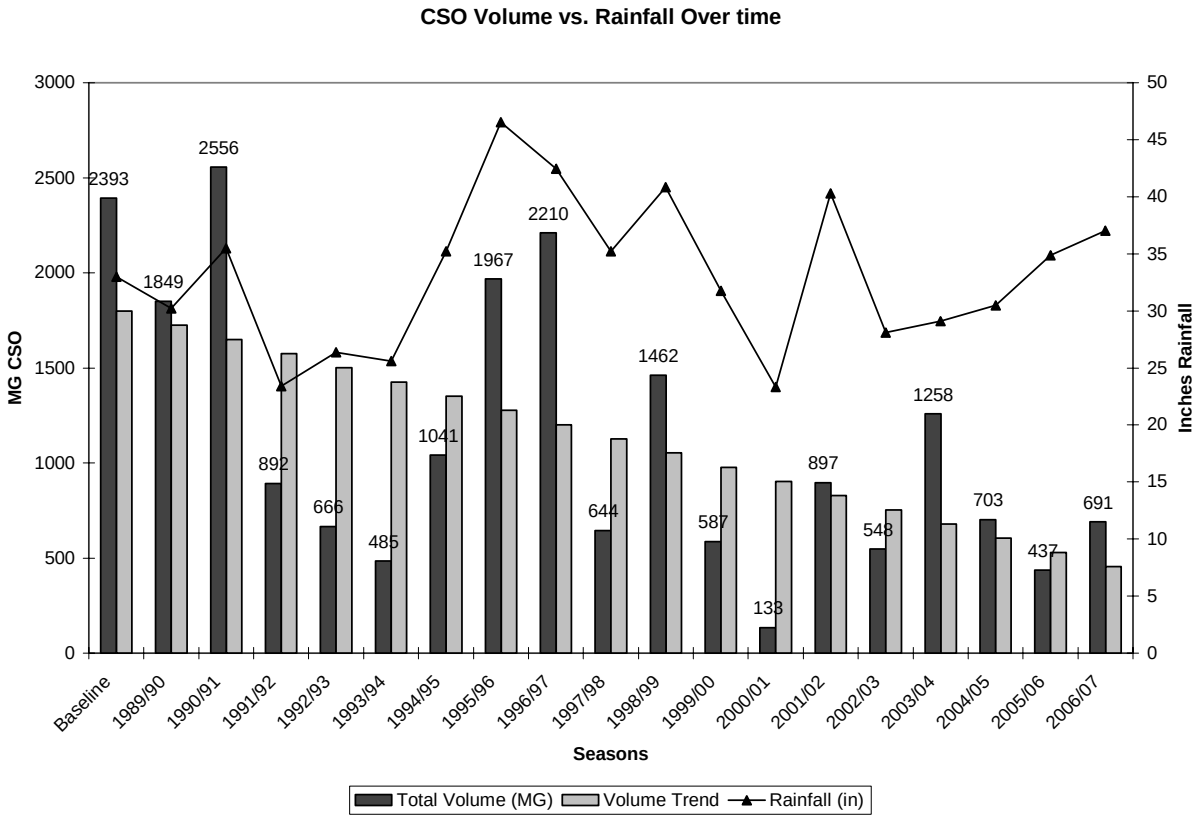

Figure 5. Annual CSO Volume versus Total Rainfall (1989 through 2007)

2.3.2 Untreated CSO Frequencies

As shown in Table 8, there were a total of 268 untreated CSO events in 2006–2007 (162 events in the South Service Area; 87 events in the North Service Area; and 19 events in the Alki Service Area). The total of 268 untreated CSO events represent a 43.3 percent reduction in frequency over the 1981–1983 baseline of 471 events.

Table 8. Untreated CSO Event Frequency Summary, June 2006–May 2007 (based on a 24-hour inter-event interval)

Station	DSN	Service Area	2006							2007					2006–2007 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
11th Ave. NW [b]	004	North	0	0	0	0	1	7	6	3	0	2	0	1	20	16
30th Ave. NE	049	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
3rd Ave. W.	008	North	0	0	0	0	0	1	5	3	0	0	0	2	11	17
53rd Ave. SW	052	Alki	0	0	0	0	0	1	1	0	0	0	0	0	2	<1
63rd Ave. PS	054	Alki	0	0	0	0	0	0	0	0	0	0	0	0	0	2
8th Ave./W. Marginal Way	040	South	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Alaska St. SW [b]	055	Alki	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Ballard	003	North	0	0	0	0	0	0	3	0	0	0	0	0	3	13
Barton	057	Alki	0	0	0	0	0	2	3	2	0	0	0	0	7	9
Belvoir	012	North	0	0	0	0	0	0	1	0	0	0	0	0	1	<1
Brandon St. [d]	041	South	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM [d]	36
Canal St.	007	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Chelan	036	South	0	0	0	0	0	1	2	1	0	0	0	0	4	7
Denny Reg.[h]	027a	South	0	0	0	0	0	4	2 [h]	0	0	0	0	0	6 [h]	32
Dexter	009	North	2	0	0	1	1	4	4	3	0	0	1	1	17	15
Duwamish PS, W. [b]	034	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Duwamish PS, E.	035	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Hanford (total)	031/2	South	4	0	0	1	0	18	9	6	0	0	0	3	41	58
Hanford #1 (Hanford @ Rainier) [b e]			*2*	*0*	*0*	*1*	*0*	*8*	*5*	*3*	*0*	*0*	*0*	*1*	*20*	
Hanford #2			*2*	*0*	*0*	*0*	*0*	*10*	*4*	*3*	*0*	*0*	*0*	*2*	*21*	
Harbor Ave.	037	South	0	0	0	0	0	1	2	1	0	0	0	0	4	30
Henderson	045	South	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Kingdome [e]	029	South	2	0	0	1	0	8	6	3	0	0	0	2	22 [e]	
King Street	028	South	NM	NM	NM	NM	NM	NM	4	3	0	0	0	1	8	16
Lander II St.	030	South	2	0	0	0	0	10	6	3	0	0	0	1	22	26
Magnolia, S. [f]	006	South	NM	NM	NM	1 PD	3	8	7	3	0	3	0	1	26 [f]	25
Marginal, E.	043	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Matthews Park	018	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Michigan St.	039	South	0	0	0	0	0	5	4	3	0	0	0	0	12	34

Station	DSN	Service Area	2006							2007					2006–2007 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
Michigan, W.	042	South	0	0	0	0	0	3	3	3	0	0	0	0	9	5
MLK Jr. Way [b]	013	South	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Montlake [g]	014	North	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM [g]	6
Murray Ave.	056	Alki	1	0	0	0	0	2	4	2	0	0	0	0	9	5
Norfolk St.	044	South	0	0	0	0	0	0	0	0	0	0	0	0	0	20
North Beach Inlet [b, c]	048a	North	0	0	0	0	0	4	5	2	0	1	0	0	12	18
North Beach Wet Well [b, c]	048b	North	0	0	0	1	0	5	5	2	0	0	0	0	13	
Pine, E St.	011	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Rainier Ave.	033	South	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Terminal 115 [b]	038	South	0	0	0	0	0	3	2	3	0	0	0	0	8	4
University [h]	015	North	0	0	0	0	0	2 [h]	5	2	0	0	0	1	10 [h]	13
Approximate Total			11	0	0	4	5	89	90	48	0	6	1	13	268	471
2006-2007 Rainfall Average (baseline is historical average in inches)			1.60	0.10	0.23	1.63	1.55	12.06	8.07	3.40	2.25	3.05	1.46	1.66	37.04	**37**

NM = not monitored.

[a] Baselines for CSO volumes will occasionally be revised as improvements are made to the computer modeling system to provide more accurate projections on historical and future conditions.

[b] Portable flow meters; not currently monitored by SCADA.

[c] The North Beach Pump Station has two outfalls. A 16-inch outfall (48b) from the wet well and a 30-inch (48a) outfall from the inlet trunk. The 30-inch outfall discharges on the beach, and the 16-inch outfall discharges further out in Puget Sound. The baseline value is for both outfalls together.

[d] Access to the overflow structure and meters was restored in December following railroad construction completion.

[e] Brandon trunk level sensor was not operating properly. Overflows were not calculated for this site.

[f] S. Magnolia portable flow meter was not operating properly. Meter was replaced in mid-September 2006.

[g] Montlake trunk level sensor was not operating properly. Overflows were not calculated for this site.

[h] Partial data at Denny Way/Lake Union and University in Nov. 2006 due to loss of telemetry during storms

The modified NPDES permit for West Point requires that the County provide the five-year moving average of untreated CSOs at controlled facilities, identified in the permit as the Carkeek CSO Treatment Plant, Alki CSO Treatment Plant, Elliott West CSO Control Facilities, and Henderson /Norfolk CSO Control Facilities. Table 9 presents the average of partially treated discharges that were reported for the wet seasons from June 2002 through May 2007 for the purposes of calculating compliance with average annual total suspended solids percent removal and settleable solids permit limits.

Table 9. Five-Year Averages for Untreated Discharge Events from CSO Treatment Facilities, June 2002–May 2007

CSO Facility	2002–03	2003–04	2004–05	2005–06	2006–07	5-Year Average
Alki	0	1 (Nov.18)	1 (Jan)	1 (Jan.29)	1 (Dec. 14)	<1 (0.8)
Carkeek	0	1 (Oct. 20)	1 (Aug. 22)	1 (Jan. 8–17)	0	<1 (0.6)
Mercer/ Elliott West				0	1 (1Dec. 9–15)	1 (2-yr average)
Henderson/ Norfolk				0	1 (1Dec. 11–15)	<1 (0.5 2–yr average)

2.4 Annual Treated CSO Events

Tables 10 and 11 provide information on the volume and frequency of treated CSOs discharged from the West Point Treatment Plant; Alki and Carkeek CSO Treatment Plants; and the Elliot West and Henderson/Norfolk CSO Treatment Facilities—the King County facilities that provide primary treatment of CSOs. The text that follows the tables provides detail on the data.

Table 10. Treated CSO Volumes by Month, June 2006–May 2007 (in million gallons)

CSO Facility	June 06	Jul 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Total
Alki Plant	0	0	0	0	0	15.7	43.03	9.60	0	0	0	0	68.23
Carkeek Plant	0	0	0	0	0	2.00	19.50	0.20	0	0	0	0	21.7
Elliott West [(a)]	35.3	0	0	0	0	190.1	223.3	38.08	0	0	0	2.52	489.2
Henderson/ Norfolk [(a)]	0	0	0	0	0	3.3	5.7	0	0	0	0	0	9
West Point CSO Process	1.40	0.04	0	0.3	0.14	225.04	243.33	63.30	0	0	0.04	16.80	551.75
Total Treated	**36.7**	**0**	**0**	**0.3**	**0.14**	**436.14**	**534.86**	**111.18**	**0**	**0**	**0.04**	**19.32**	**1,139.88**

[a] CSO treatment occurred as a result of rainfall, but also reduced plant capacity during scheduled maintenance activities

Table 11. Treated CSO Frequency by Month, June 2006–May 2007 (events or days)[a]

CSO Facility	Jun 06	Jul 06	Aug 06	Sep 06	Oct 06	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07	Apr 07	May 07	Total
Alki Plant (events)	0	0	0	0	0	2	2	2	0	0	0	0	**6**
Carkeek Plant (events)	0	0	0	0	0	4	3	1	0	0	0	0	**8**
Elliott West (events)	2	0	0	0	0	6	2	2	0	0	0	1	**13**
Henderson/Norfolk (events)	0	0	0	0	0	1	2	0	0	0	0	0	**3**
West Point CSO Process (days)	1	1	0	1	2	15	10	7	0	0	1	2	**41**

[a] Events are defined by a 48-hr dry inter-event interval; West Point defines days rather than events.

2.4.1 West Point Treatment Plant

West Point Treatment Plant

In addition to secondary treatment of up to 300 mgd of base wastewater flows (defined as 2.25 times the average wet-weather flow of 133 mgd), the West Point Treatment Plant provides CSO treatment (equivalent to primary treatment) for flows between 300 mgd and the peak of 440 mgd. Combined sewer flows that would otherwise overflow at points around the combined system are transferred to the West Point Treatment Plant. After receiving CSO treatment, these flows are mixed with secondary effluent for disinfection, dechlorination, and discharge from the deep marine outfall. The resulting effluent must meet secondary effluent quality limits, with a small reduction in total suspended solids (TSS) percent removal requirements.

Tables 10 and 11 summarize data from the months CSO treatment occurred at West Point and the volumes of flow receiving CSO treatment for the month. Table 12 provides the daily information. For the 2006–2007 CSO year, there were 40 occurrences totaling 551.75 MG of treated CSO discharges from West Point.

Table 12. CSO Treatment Summary for West Point from June 06 to May 07

Date	Volume Treated at West Point (MG)
29-Jun-06	1.40
13-Jul-06	0.04
1-Sep-06	0.30
7-Oct-06	0.06
24-Oct-06	0.08
2-Nov-06	12.30
4-Nov-06	8.35
5-Nov-06	7.33
6-Nov-06	44.12
7-Nov-06	8.02
8-Nov-06	6.30
10-Nov-06	17.80
12-Nov-06	37.20
15-Nov-06	29.38
19-Nov-06	8.62
20-Nov-06	8.43
21-Nov-06	19.32
22-Nov-06	7.82
23-Nov-06	2.56
26-Nov-06	7.49
11-Dec-06	19.20
12-Dec-06	9.30
14-Dec-06	76.20
15-Dec-06	9.33
20-Dec-06	7.20
22-Dec-06	11.20
23-Dec-06	8.30
24-Dec-06	35.00
26-Dec-06	63.50
27-Dec-06	4.10
1-Jan-07	1.90
2-Jan-07	23.40
3-Jan-07	2.16
5-Jan-07	19.40
6-Jan-07	0.65
7-Jan-07	12.70
15-Jan-07	3.09
17-Apr-07	1.40
20-May-07	8.58
21-May-07	8.22
Total Volume	**551.75**
Number of Days	**40.00**

2.4.2 Alki CSO Treatment Plant

The total volume of treated CSO discharged from the Alki CSO Treatment Plant was 68-MG during six events (Tables 10 and 11).

Intense storms, high tides, and the need to adjust to the operation of new pumps at the the 63rd Avenue Pump Station made for a challenging year for operators of the Alki CSO Treatment Plant.

Alki CSO Treatment Plant

During the 2006–2007 season, the Alki CSO plant achieved only 47 percent of the minimum 50 percent required TSS removal. Complying with the 50 percent TSS removal requirement is influenced by the balance of storm flows treated at Alki and those transferred to West Point via the West Seattle Tunnel. The greater number of smaller storm flows captured and transferred to West Point, the more difficult it is for Alki to achieve solids removal. While Alki was designed to handle a range of storm flows, influent concentrations, and surface overflow rates, the West Seattle Tunnel can receive more of the smaller storms than expected. While this greater volume in the West Seattle Tunnel benefits the environment by managing more Alki flows at West Point, it leaves the Alki CSO plant to treat the more difficult flows and lowering the average TSS removal achievable at Alki.

During 2006–2007, more flow was treated at Alki as a result of an operating approach for the West Seattle Pump Station to relieve pressure on the Elliot Bay Interceptor (EBI) and Duwamish Pump Station. This larger volume slightly improved the annual TSS removal when compared to previous years, but was not sufficient to meet the 50 percent TSS removal requirement for these storms.

For 2007–2008, changes to the pumping strategy of the 63rd Avenue Pump Station may help meet this requirement. This station tended to cycle on-off during high flows in 2006–2007, mimicking a fill-draw pumping mode. The pulsed flows that resulted are not conducive for removing TSS in the clarifiers. A different pumping control strategy will be used for the 2007–2008 season to moderate changes in flow rates and provide a better opportunity to remove TSS.

The pulsed flows resulting from the 63rd Avenue Pump Station operation may also have contributed to exceedances of the chlorine limit when short-circuiting of the dechlorination contact channel occurred. In these instances, chlorinated settled CSO spilled over the wall of the primary tanks into the downstream end of the dechlorination contact channel, diminishing the benefit of the dechlorination. Considerable work to correct the short-circuiting was completed in 2006–2007, and changed pumping strategies are planned for the next season

More detailed information about the Alki CSO Treatment Plant is in Appendix A of this report.

2.4.3 Carkeek CSO Treatment Plant

During this reporting period, the Carkeek CSO Treatment Plant operated 20 times and there were eight discharge events, totally 21.7 MG. NPDES effluent limits were met (Tables 10 and 11).

The new dechlorination system and upgraded chlorination system functioned well during the second year of operation. Refinements to optimize disinfection effectiveness and pump improvements are in progress (Appendix B).

Carkeek CSO Treatment Plant

More detailed information about the Carkeek CSO Treatment Plant is in Appendix B of this report.

2.4.4 Elliot West CSO Treatment Facilities

The Elliot West CSO Treatment Facilities began operation in May 2005. While some refinements in the operating protocols remain to be done to achieve full control at the Denny and Dexter Regulators, much has been accomplished. Of the 764.53 MG of CSO that would have discharged into Lake Union and Elliott Bay in 2006–2007, 28.5 percent received secondary treatment and 64 percent received primary treatment and some disinfection. The number of untreated discharges went from 32 per year to just 6 small ones. Untreated overflows at the Dexter regulator have remained close to the baseline of 15 events per year, at 16 events in 2005–2006 and 17 events in 2006–2007; the volume of untreated CSO discharges has decreased from 24 MG to 6.21 MG in 2005–2006 and 8.77 MG in 2006–2007. This is a 74 percent (2005–2006) and 63.5 percent (2006–2007) reduction from pre-project levels.

Elliott West CSO Control Facility

During this reporting period, there were 13 discharge events from the Elliott West CSO outfall. The total discharge volume for the reporting period was 489.2 MG. Discharge effluent limits were not met.

During the first two years of operating these CSO facilities King County faced several challenges, which is typical for such large and complex systems. The seasonal and intermittent operation of these facilities prolongs the commissioning period. A large hurdle to effective operations was the substantial amounts of dry-weather flows entering the Mercer Storage and Treatment Tunnel. These flows reduced the tunnel's storage capacity for the CSO flows by 1–2 MG, causing pump damage and complicating treatment compliance. Determining when a true CSO treatment event started and stopped could only be estimated. Investigation by King County determined that these dry-weather flows resulted from extensive sedimentation in the City of Seattle's sewers upstream of the tunnel, causing base flows to back up and overflow into the tunnel. To correct this, the City conducted an extensive pipeline cleaning (see Section 1.3.2).

A number of items to improve the operation of these CSO control facilities were identified for achieving regulatory compliance, and all were addressed or are being addressed by King County staff. For a complete list of corrective measures to date, see Appendix C. Now that the base flow problem has been resolved, further adjustments will be considered and implemented to achieve optimal CSO treatment.

More detailed information about the Elliot West CSO Control Facilities is in Appendix C of this report.

2.4.5 Henderson/Norfolk CSO Control Facilities

While the 2005–2006 season was the first time the Henderson/Norfolk CSO Treatment Facilities were available for use, the facilities did not manage CSO flows until November 2006. Mechanical and program control errors with the inlet regulator gate were identified and corrected, and the facility then operated as intended during the 2006–2007 wet season. Thus, 2006-07 was, in effect, the startup year. The facilities were challenged by severe storms in November and December 2006, including weathering a severe wind storm with heavy precipitation in the Puget Sound basin on December 14 and 15 that resulted in numerous power outages. Wind gusts peaked at around 70 mph on December 15. Backup generators provided power at the inlet and outlet structures during the December 14–15 CSO event.

There were seven fill events and three discharge events (9.0 MG of treated CSO were discharged). By excluding the second event of the year (December 11–15, 2006) as the “one untreated discharge event” for calculating solids permit limit compliance, TSS removal averaged 79 percent. All permit conditions were met in 2006–2007, except for the 39 μg/L maximum daily chlorine limit. Modifications to improve chlorine measurement and bisulfite dosing were implemented to correct this deficiency.

More detailed information about the Henderson/Norfolk CSO Control Facilities is in Appendix D of this report.

2.4.6 Ecology Permit Compliance Monitoring System Summaries

Ecology has requested that compliance information for the CSO treatment facilities be summarized. This summary is presented in Table 13.

Table 13. 2006-07 Ecology Permit Compliance Summary for King County CSO Control Facilities

Name	MonPoint	Parameter	Unit	Value Reported	DCHG Min	DCHG Max	Value Type	FirstDt	LastDt
Alki	91	Solids, suspended, % removal	Percent	47	50		Average	31-Dec-03	31-Dec-08
Alki	91	Num of events	Num of events	6		29	Maximum	31-Dec-03	31-Dec-08
Alki	91	Solids, settleable	Ml/l	0.2		0.3	Average	31-Dec-03	31-Dec-08
Alki	91	Flow, in conduit or thru treatment plant	Million gallons/year	68.23		108	Maximum	31-Dec-03	31-Dec-08
Carkeek	46	Solids, suspended, % removal	Percent	50.2	50		Average	31-Dec-03	31-Dec-08
Carkeek	46	Num of events	Num of events	8		10	Maximum	31-Dec-03	31-Dec-08
Carkeek	46	Solids, settleable	Ml/l	0.1		0.3	Average	31-Dec-03	31-Dec-08
Carkeek	46	Flow, in conduit or thru treatment plant	Million gallons/year	21.7		46	Maximum	31-Dec-03	31-Dec-08
Elliott	27	Solids, suspended, % removal	Percent	**29.5**	50		Average	1-Jul-05	31-Dec-08
Elliott	27	Num of events	Num of events	13			Average	1-Jul-05	31-Dec-08
Elliott	27	Solids, settleable	Ml/l	**1.1**		0.3	Average	1-Jul-05	31-Dec-08
Elliott	27	Volume, total	Million gallons	489.2			Average	1-Jul-05	31-Dec-08
Henderson	44	Solids, suspended, % removal	Percent	75.6	50		Average	1-Jul-05	31-Dec-08
Henderson	44	Num of events	Num of events	3			Average	1-Jul-05	31-Dec-08
Henderson	44	Solids, settleable	Ml/l	0.1		0.3	Average	1-Jul-05	31-Dec-08
Henderson	44	Volume, total	Million gallons	9.0			Average	1-Jul-05	31-Dec-08

Headings: Location = CSO name; MonPoint = state discharge serial number; Parameter = what is being measured and reported; Unit = unit of measure; Value Reported = measurement reported for compliance; DCHG Min – the minimum value meeting the permit limit; DCHG Max = the upper value meeting the permit limit;Value Type = how the reported value is calculated; FirstDt = date when limit became effective; LastDt = expiration date of the NPDES permit and limits.

Appendices

Appendix A. Alki CSO Treatment Plant Annual Report, June 2006–May 2007

Appendix B. Carkeek CSO Treatment Plant Annual Report, June 2006–May 2007

Appendix C. Elliot West CSO Control Facilities, June 2006-May 2007

Appendix C2. Elliot West CSO Control Facilities Notice of Violation and Response

Appendix D. Henderson/Norfolk CSO Control Facilities, June 2006-May 2007

Appendix A. Alki CSO Treatment Plant Annual Report, June 2006–May 2007

This report summarizes the performance and operation of the Alki Combined Sewer Overflow (CSO) Treatment Plant for June 2006 to May 2007. This is the seventh annual report of the Alki CSO Treatment Plant. Alki operates under NPDES permit WA-0029181-1 issued to the West Point Treatment Plant, effective until December 31, 2008. The permit limits are shown in Table A-1. One "untreated" CSO discharge event may be excluded from calculation of solids performance for compliance with solids permits limits.

Table A-1. Alki CSO NPDES Permit Limits.

Parameter	Discharge Limits (Monthly)	Discharge Limits[a] (Yearly Average)	Discharge Limits[b] (Long-term Average)
Suspended Solids Removal, %[c]	NA	50%	NA
Settleable Solids, ml/l/hr	1.9 Max per event	0.3	NA
Number of Events per year	NA	NA	29
Discharge Volume, million gallons/yr	NA	NA	108
Fecal Coliform, cfu/100-mL	1700/100	NA	NA
	Average Monthly	**Maximum Daily [d]**	
Total Residual Chlorine, μg/L	NA	290	

[a] The yearly limitations will be calculated using per-event data points. Data shall be collected and reported on a schedule concurrent with the annual CSO report, June 1 to May 31, to include the entire wet season for purposes of determining compliance with these limitations.

[b] Long-term average will be calculated using data collected over a full permit cycle. Data shall be collected and reported for the period of the permit cycle prior to permit renewal.

[c] The total removal efficiency for TSS is to be calculated on a mass balance basis as the percent of solids captured at the CSO Treatment Plant and then permanently removed at the West Point Treatment Plant based on the estimated removal efficiency at West Point.

[d] The maximum daily effluent concentration determined from a continuous measurement is calculated as the average of the pollutant concentrations measured over the day.

Operationally, the Alki CSO Treatment Facility (Alki) receives flow from the 63rd Ave. Pump Station (63rd PS). The 63rd PS has two sets of pump: three main-duty pumps and three annex storm pumps. The duty pumps were renovated over the 2005-06 season. The three main-duty pumps have a combined capacity of about 75 MGD, or 25-mgd each. Duty Pump 1 is a variable speed pump and Pumps 2 and 3 are fixed-speed, soft-start pumps. The duty pumps are programmed to use variable-speed Pump-1 as the lead pump, with Pumps 2 and 3 to follow as wet well levels increase at the 63rd PS. The annex pumps are available for operation at any time, but operate only under manual, local control. Alki's hydraulic capacity is 45-mgd to 67-mgd, depending on the tide; the hydraulic limitation occurs at the outfall structure.

CSO overflows into the wet well of the 63rd PS when the West Seattle Tunnel is full. Liquid sodium hypochlorite has been dosed at the 63rd PS wet well for disinfection, but this will change as later described. Flow to Alki passes through bar screens, parshall flumes, and preaeration channels for grit removal. The six primary clarifiers are sequentially filled before discharging to a collection channel and the final contact channel. Sodium bisulfite is added at the head of the contact channel for dechlorination. Treated CSO effluent overflows the effluent weir and discharges to Puget Sound via an outfall located 2000-ft offshore and 143-ft deep. Sludge and scum collected in the primary clarifiers is pumped to the West Seattle Tunnel during and after an event.

Despite near normal rainfall over the year, the pattern of rainfall created significant challenges for the region. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. These rains accompanied by winds up to 70 miles per hour, power outages and flooding severely impacted the County's sewer system.

Table A-2 summarizes performance of the Alki CSO treatment plant in 2006-07. There were six discharge events. 68 million gallons of treated CSO were discharged. The third event of the year (Dec. 14-15, 2006) has been designated as the "one untreated discharge event" for determining solids limit compliance.

Table A-2. Alki CSO Permit Performance in 2006-07

Parameter	Performance	Permit Conditions
Number of Events in year	6	29 [a]
Total Volume in year, million gallons	68.23	108 [a]
Settleable Solids, Avg. Annual, ml/l/hr [c]	0.2	0.3
Settleable Solids, Max Event in Year, ml/l/hr	0.3	1.9
Suspended Solids Removal, Annual [c]	47%	50%
Fecal Coliform, Maximum Monthly Geometric Mean, cfu/100-mL [b]	75	1700
Total Residual Chlorine, Highest Max Daily, ug/L [b]	359	290

[a] Compliance assessed over a 5-year average..

[b] The fecal coliform and total residual chlorine permit limits went into effect Jan. 1, 2006.

[c] 12/14-15/07 designated as the "one untreated event per year" and dropped from annual solids compliance calculations.

All the permit conditions were met in 2006-07 except for the 50% annual average TSS removal and the 290 μg/L maximum daily chlorine limit. TSS removal averaged 47% for the five treated discharge events. The max-day chlorine limit was exceeded on three of six events.

Table A-3 summarizes the last 5 years of performance.

Table A-3. Five-Year Averages, 2002 - 2007

Year	Treated Discharge Events	Discharge Volume, MG	Number of *Once per Year Untreated" Event [1]
Limit	29	108	
Jun 02– May 03	2	10	No event removed
Jun 03 – May 04	3	34	1 - Nov-03 event removed
Jun 04 – May 05	1	20	1 – Jan. 18-19 event removed
Jun 05– May 06	4	59	1 - Jan. 29 event removed
Jun 06– May 07	6	68	1 - Dec. 14 event removed
5-Year Average (per year)	3.2 events/yr	38. MG/yr	0.8 events/yr

The West Seattle Tunnel was essentially full during all events. Alki's six primary sedimentation tanks were in operation throughout the events along with their sludge collectors, sludge pumps and scum sprays. The sludge pumps operated continually through the events, pumping collected sludge to the West Seattle Tunnel. The primary tanks and channels were emptied and cleaned between events. All three duty pumps at the 63rd PS were available for operation except during the last event.

50% TSS Removal. Complying with the 50% TSS removal requirement will always be influenced by the number of smaller storms treated at Alki as opposed to the number transferred to West Point via the West Seattle Tunnel. While Alki was designed to handle a range of storm flows, influent concentrations, and surface overflow rates, the West Seattle tunnel can actually receive more of the smaller storms than expected. While this benefits the environment by managing more Alki flows at West Point, it leaves the Alki CSO plant to treat more difficult flows. This tends to lower the average TSS removal achievable at Alki.

During 2006-07, more flow was treated at Alki to better reflect the range of flows that Alki was designed to manage. This resulted in an operating approach for the West Seattle Pump Station (WSPS) that relieved pressure on the Elliot Bay Interceptor (EBI) and Duwamish Pump Station. Procedurally, flow from the WSPS was usually decreased when levels in the EBI reached overflow locations. This strategy increased the use of Alki, and slightly increased the annual TSS removal when compared to previous years. Unfortunately, it did not provide the control needed to meet the 50% TSS removal requirement for these storms.

Changes to the pumping strategy of the 63rd PS may help meet the 50% TSS removal. The 63rd PS tended to cycle on-off during high flows in 2006-07, mimicking a fill-draw pumping mode. The pulsed flows that resulted are not conducive for removing TSS in the clarifiers. A different pumping control strategy – described below - will be used for the 2007-08 season to moderate changes in flow rates, and thus better opportunity to remove TSS.

Max-day Chlorine Limit. The max-day chlorine limit was exceeded on three of six events in 2006-07. Short-circuiting of the dechlorination contact channel at higher flow rates was the main reason for exceeding the Cl_2 limit. Specifically, chlorinated settled CSO spilled over the wall separating the primary tanks and the downstream end of the dechlorination contact channel.

Several changes were made during the 06-07 season to reduce the potential for short-circuiting. Earlier in the season, the Alki final effluent weir was lowered slightly to allow more flow without short-circuiting. After the Jan. 2 storm, peak flows were limited to 50-mgd by only operating two pf three duty pumps at the 63rd PS. Operations staff adjusted the bisulfite pump stroke to increase dosing during short-circuiting. The bisulifte dechlorination pump operated properly during all the events in 06-07, with flow-paced controls. Two new bisulfite pumps will soon be installed to increase bisulfite pumping capacity

It's likely the pumping strategy of the 63rd PS had as much, or more, to do with the short-circuiting as the actual storm intensity. This is because the pumps at the 63rd PS tended to cycle on-off during high flows, mimicking a fill-draw pumping mode. The short-circuiting tended to occur during flow surges created when the third duty pump at the 63rd PS kicked on. High tides during the season's storms also exacerbated the problem by raising the water level throughout the Alki plant, allowing the spillover to occur at lower flow rates. The capacity of the three duty pumps at 63rd PS is 70-75 mgd while the capacity of Alki's outfall line is 45-67 mgd, depending on the tide.

This suggests a different pumping strategy – one that better mimics level control - may curtail the need for three pumps to operate. For the 2007-08 season, the pumping strategy will be changed to start each of the three duty pumps at a lower wet well level (i.e., sooner), and have variable-speed Pump 1 respond much quicker to changes in wet well levels. Staff will watch the events of the upcoming season to make further adjustments that will limit the possibility of running the third pump.

Fecal Coliform Limit and Disinfection. The fecal coliform permit limit was met each month in 2006-07. The largest monthly geomean was 54 cfu/100-mL. Prior to the 2006-07 season, several modifications were made to better comply with the fecal coliform and chlorine residual permit limits. Specifically, hypochlorite dosing was moved to the wet well at the 63rd Street Pump Station. This was achieved by installing a larger hypochlorite dosing pump and several diffusers in the 63rd wet well. These modifications provided better mixing and a longer contact time. The hypochlorite pump was flow-paced using a strategy to supply a higher dose during the first 30-minutes of an event. The chlorine residual was measured manually with a pocket colorimeter at Alki's headworks, and pump adjustments made accordingly. On average, the applied hypochlorite dose could be characterized as moderate during 06-07 events.

However, due to concerns about the release of chlorinated flows during any CSO from 63rd, hypochlorite will no longer be dosed into the wet well of the 63rd PS. Beginning in the 2007-08 season, hypochlorite will be injected into the two force mains that run between the 63rd PS and Alki's headworks. While this change will prevent any release of chlorinated combined sewage at 63rd PS, it will also reduce the initial mixing and overall contact time available for disinfection. New sample pumps and a chlorine analyzer will be installed at the Alki headworks prior to the 07-08 season. Cl_2 residual at the headworks will be continuously monitored, and the hypochlorite dosing pump will be automatically adjusted based on the Cl_2 measurement. Staff will pay close attention to fecal coliform results during the initial events in 2007-08 so timely changes can be made to assure compliance.

Table A-4 Summary of Alki CSO Plant 2006-07 Event Data

Month	Day	Alki Inflow Event Number	Alki Inflow Volume (MGD)	Alki Discharge Event Number	Alki Discharge Volume (MGD)	Alki Total Influent TSS (lbs)	Alki Total Effluent TSS Discharged @ Carkeek + WP (lbs)	Alki % TSS Removal	Alki Effl. Settl Solids (ml/l/hr)	Alki Effl. pH	Alki Avg Effl. Fecal Coliform (#/100 ml)	Alki Effl. Residual Chlorine (ug/l)
June	-											
July	-											
August	-											
September	-											
October	-	-	-	-	-	-						
November	4	1	0.38			628	56	91.0%				
	5					0	0					
	6	1	15.18	1	13.50	4304	4691	-9.0%	0.30	7.00	0	85
	12	2	4.25	2	2.20	1524	671	55.9%	0.10	6.80	10	50
	Event/Daily Max								0.3	**6.80/7.00**	10	85
	Mon. Total/Avg	2	19.81	2	15.70	6456	5419	16.1%	0.2		3	68
December	14	1	21.80	1	20.90	16727	11601	30.6%	0.30	6.60	255	1135
	15	1	1.10	1	1.03	844	573	32.1%				
	26	2	6.80	2	6.50	4650	2167	53.4%	0.20	6.85	12	135
	27	2	17.00	2.0	14.60	11626	4963	57.3%				
	Event/Daily Max								0.3	6.60/6.85	255	1135
	Mon. Total/Avg	2	46.70	2	43.03	33847	19305	43.0%	0.3		54	635
January	2	1	9.40	1	7.60	10035	5402	46.2%	0.10	6.75	8	515
	5	2	0.90			360	32	91.0%				
	6	2	0.60			240	22	91.0%			0	
	7	2	3.80	1.9	1.90	1585	546	65.5%	0.10	7.95	2	375
	Event/Daily Max								**0.1**	**6.75/7.95**	**8**	**515**

Month	Day	Alki Inflow Event Number	Alki Inflow Volume (MGD)	Alki Discharge Event Number	Alki Discharge Volume (MGD)	Alki Total Influent TSS (lbs)	Alki Total Effluent TSS Discharged @ Carkeek + WP (lbs)	Alki % TSS Removal	Alki Effl. Settl Solids (ml/l/hr)	Alki Effl. pH	Alki Avg Effl. Fecal Coliform (#/100 ml)	Alki Effl. Residual Chlorine (ug/l)
	Mon. Total/Avg	2	14.70	2	9.50	12220	6003	50.9%	0.1		4	445
Total		6	81.21	6	68.23	52523	30726					
Annual Avg/GEM								41.5%	0.2			
Min/Max or Max										6.60/7.95	54	1135

Table A-5 2006-07 Alki Annual Values

	No.of Dischage Events	Inflow Volume (MGD)	Discharge Volume (MGD)	Total AlkiTSS lbs-in	Total Alki /WP TSS lbs Discharged	Annual Average Alki %TSS Recovery	Annual Average Alki Settleable Solids (ml/l/lhr)	Event Maximum Alki Settleable Solids (ml/l/lhr)	Maximum Monthly Geomean Alki Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Alki Effl. Res. Cl2 (ug/l)
Including All Events	6	81.21	68.23	52523	30726	41.5	0.2	0.3	75	359
Excluding December 14-15th Event				34952	18551	46.9%	0.2	0.3		

Appendix B. Carkeek CSO Treatment Plant Annual Report, June 2006–May 2007

This document is the ninth annual report of the Carkeek plant since it began to operate as a CSO treatment facility on November 1, 1994. The facility operates under the NPDES permit for West Point Treatment Plant, Washington State Department of Ecology permit number WA-0029181-1, in effect from January 1, 2004 through December 31, 2008. Effective January 1, 2006, new permit limits for fecal coliform and residual chlorine went into effect. In 2005 a dechlorination system was designed and installed at Carkeek to meet the new residual chlorine limits and the hypochlorite dosage controls were modified to meet the new fecal coliform limits. 2006-07 CSO year is the second year of operating the improved disinfection system and the newly installed dechlorination system and both the systems worked well in meeting the effluent fecal coliform and the effluent residual chlorine limits. During this period the temporary sodium bisulfite storage tank was replaced with a permanent storage tank. Also, a pre-dechlorination residual chlorine analyzer was added to optimize the bisulfite dosage.

The permit limits, effective beginning January 1, 2006 through the end of the permit, are shown on Table B-1.

Table B-1 Permit Limits During 2006-07

Parameter	Discharge Limitations (Monthly)	Discharge Limitations[a] (Yearly Average)	Discharge Limitations[b] (Long-term Average)
Total Suspended Solids Removal Efficiency[c]		50%	
Fecal Coliform Bacteria	2,800/100 mL geometric mean	NA	NA
Settleable Solids, ml/l/hr	1.9 Maximum	0.3	NA
Number of Events per year	NA	NA	10
Average Volume per year, million gallons	NA	NA	46 million gallons/year

Parameter	Average Monthly	Maximum Daily[d]
Total Residual Chlorine	NA	490 µg/L

[a] The yearly limitations will be calculated using per-event data points. Data shall be collected and reported on a schedule concurrent with the annual CSO report, June 1 to May 31, to include the entire wet season for purposes of determining compliance with these limitations.

[b] Long-term average will be calculated using data collected over a full permit cycle. Data shall be collected and reported for the period of the permit cycle prior to permit renewal.

[c] The total removal efficiency for TSS is to be calculated on a mass balance basis as the percent of solids captured at the CSO Treatment Plant and then permanently removed at the West Point Treatment Plant based on the estimated removal efficiency at West Point.

[d] The maximum daily effluent concentration determined from a continuous measurement is calculated as the average of the pollutant concentrations measured over the day.

Despite near normal rainfall over the year, the pattern of rainfall created significant challenges for the region. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. These rains accompanied by winds up to 70 miles per hour, power outages and flooding severely impacted the County's sewer system.

Table B-2 summarizes performance of the Carkeek CSO treatment plant in 2006-07. There were six discharge events. 68 million gallons of treated CSO were discharged. The third event of the year (Dec. 14-15, 2006) has been designated as the "one untreated discharge event" for determining solids limit compliance.

Table B-2. Carkeek CSO Permit Performance in 2006-07

Parameter	Performance	Permit Conditions
Number of Events in year	8	10 [a]
Total Volume in year, million gallons	21.7	46 [a]
Settleable Solids, Avg. Annual, ml/l/hr	0.1	0.3
Settleable Solids, Max Event in Year, ml/l/hr	1.0	1.9
Suspended Solids Removal, Annual	50.2%	50%
Fecal Coliform, Maximum Monthly Geometric Mean, cfu/100-mL [b]	75	2800
Total Residual Chlorine, Highest Max Daily, ug/L [b]	359	490

[a] Compliance assessed over a 5-year average..
[b] The fecal coliform and total residual chlorine permit limits went into effect Jan. 1, 2006.

Table B-3 summarizes the last 5 years of performance.

Table B-3. Five-Year Average of Events and Flow

Year	Discharge Flow per Year, MG Limit = 46 MG/YR	Treated Discharge Events per Year Limit=10/yr	Number of *Once per Year Untreated" Event [1]
June 02 – May 03	3.68	4	None
June 03 – May 04	27.19	4	1 - 10/20/2003 removed
June 04 – May 05	4.04	4	1 - 8/22/2004 removed
June 05 – May 06	54.72	6	1 - 1/8/06 - 1/17/06 removed
June 06 – May 07	21.68	8	None
5-year average	**22.26**	**5.2**	**0.6**

Operation and Maintenance

After several years of operation it was realized that more flow was arriving at the Carkeek CSO plant than anticipated in design. To meet the agreed-upon transfer of 2.25xAWWF the transfer of flow to WP was increased from 8.4 MGD to 9.2 MGD. This increased pumping has the potential to increase overflows at the downstream 11th Ave Overflow Weir. To prevent this, Ecology agreed to a temporary modified pumping protocol where the Carkeek Pump Station will automatically throttle back to 8.1 MGD if the 11th Ave. weir level reaches 117.96', storing and treating flows above 8.1 MGD at the plant. When the level drops below 117.96' for 10 minutes, the pumps will resume pumping 9.2 MGD. This modified pumping regime will continue until the CSO control project for 11th NW CSO is built.

Pump set 1 was commissioned into service in December 2005 as part of the replacement project, but it continued to experience vibrations and shutdowns as a result of vibrations and high bearing temperatures through January of 2006. It was taken out of service on February 8th for re-design of the shaft and thrust bearing. The reconfigured first stage pump was installed in June 2006 and the second was installed in August 2006. Pump set #1 continued to experience vibrations for most of the 2006-07 reporting period. Maintenance mechanics concluded that the high vibrations were the result of pump base being loose. Mechanics welded the stiffener on the suction side of the pump base to minimize vibrations in April 2007. Pump Sets #2 and #3 were ordered in January 07 for delivery in August and September 2007, respectively, but delivery has been delayed due to manufacturing problems. Problems associated with the existing flapper check valve on Pump set #1 were also identified. Maintenance is awaiting the delivery of a fast closing flapper check valve.

The in-station flowmeter was reading low compared to historical data and a portable meter, Maintenance replaced an electronics card to address this problem. Both Influent and Effluent samplers are scheduled to be purged weekly to keep them clean, operable and ready for an event.

Monthly refresher training for the off-site crew was given during the wet season. Staff will continue to make improvements in training, planning and documentation to maintain smooth operation of the Carkeek CSO Treatment Plant.

Carkeek Dechlorination Project:
This is the second year of operation of the dechlorination system, installed in 2005, to meet the fecal and residual chlorine permit limits that went into effect on January 1, 2006. The disinfection and the dechlorination systems performed very well. A second sodium bisulfite pump was installed in June 2007 as a backup to the primary bisulfite pump and the loop controls were modified to provide automatic switch over to the backup pump in the event the primary were to fail. A pre-dechlorination analyzer was installed in January 2007 to measure the residual chlorine at the end of the sedimentation tank #2. A submersible sampling pump was installed to pump the pre-dechlorinated flows to the new residual chlorine analyzer at the same time. King County is awaiting the delivery of the communication control panel for the dechlorination process. Once the control panel is installed, the dechlorination PLC will be modified to incorporate the pre-dechlorination residual signal to further optimize both disinfection and dechlorination dosage controls. Level sensors and transmitters were installed on the hypochlorite storage tanks in May 2007. An additional baffle was added at the mid-length of each sedimentation tank to improve dispersion of hypochlorite in the CSO flows in January 2007. The temporary stainless steel, double walled bisulfite storage tank was replaced with a 1000-gallon capacity double walled fiber-glass storage tank in May 2007.

Table B-4 Summary of Carkeek CSO Plant 2006-07 Event Data

Month	Day	Carkeek Inflow Event Number	Carkeek Inflow Volume (MGD)	Carkeek Discharge Event Number	Carkeek Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% TSS Removal	Carkeek Effl. Settl Solids (ml/l/hr)	Carkeek Effl. pH	Carkeek Avg Effl. Fecal Coliform(#/100 ml)	Carkeek Effl. Residual Chlorine (ug/l)
June												
July												
August												
September												
October	24	1	0.004	ND	ND	4						
	Event/Daily Max											
	Mon. Total/Avg	1	0.004			4		100.0%				
November	2	1	0.004			5	5					
	4	2	0.0385			61	61					
	6	3	1.005	1	0.55	159	148		<0.1	6.7	2115	52
	8	4	0.279			56	56					
	10	5	0.015			11	11					
	12	6	1.074	2	0.505	654	166		<0.1	6.5	1	63
	15	7	0.64	3	0.14	422	77.17		<0.1	6.4	1	32
	19	7	0.059			107	107					
	20	8	0.035			26	26					
	21	9a	1.024	4a	0.32	128	45		<0.1	6.6	1	234
	22	9b	0.579	4b	0.53	188	94		<0.1	6.6	1	26
	23	10	0.178			131	131					
	26	11	0.184			92	92					
	Event/Daily Max											
	Mon. Total/Avg	11	5.1	4	2.0	2040	1018	50.1%	<0.1	6.6	5	81
December	11	1a	0.6	1	0.1	631	109		<0.1	6.8	1	359

Month	Day	Carkeek Inflow Event Number	Carkeek Inflow Volume (MGD)	Carkeek Discharge Event Number	Carkeek Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% TSS Removal	Carkeek Effl. Settl Solids (ml/l/hr)	Carkeek Effl. pH	Carkeek Avg Effl. Fecal Coliform(#/100 ml)	Carkeek Effl. Residual Chlorine (ug/l)
	12	1b	0.2			70	8					
	14	2a	8.9	2a	8.2	744	892		0.4	6.4	140	31
	15	2b	0.8	2b	0.8	90	72		<0.1	6.6	115000	24
	20	3a	0.2			96	11					
	21	3b	0.03			21	2					
	24	4a	1.7	3a	0.9	1359	280		<0.1	6.4	40	39
	25	4b	0.1			0	0					
	26	4c	7.4	3b	7.3	1052	1039		<0.1	6.4	20	41
	27	4d	2.2	3c	2.1	538	217		<0.1	6.6	1	24
	28	4e	0.01			3	0					
	Event/Daily Max											
	Mon. Total/Avg	4	22.1	3	19.5	4603	2630	42.9%	0.1	6.5	48	86
January	2	1	0.5	1	0.2	122	93		1.0	6.4	75	198
	3		0.1			39	4					
	5	2	0.3			284	31					
	6		0.0			3	0					
	7		0.1			41	4					
	Event/Daily Max											
	Mon. Total/Avg	2	1.0	1	0.2	489	133	72.8%	1.0	6.4	75	198
February												
March	19	1	0.1	ND	ND	452	18					
	Event/Daily Max											
	Mon. Total/Avg	1	0.1			452	18.0	96.0%				
April												

Month	Day	Carkeek Inflow Event Number	Carkeek Inflow Volume (MGD)	Carkeek Discharge Event Number	Carkeek Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ Carkeek + WP (lbs)	% TSS Removal	Carkeek Effl. Settl Solids (ml/l/hr)	Carkeek Effl. pH	Carkeek Avg Effl. Fecal Coliform(#/100 ml)	Carkeek Effl. Residual Chlorine (ug/l)
May	20	1	0.03	ND	ND	38	2.0					
	Event/Daily Max											
	Mon. Total/Avg	1	**0.03**			**38**	**2.0**	**94.7%**				
Total		20	**28.4**	**8**	**21.7**	**7626**	**3801**					
Annual Avg/GEM								**50.2%**	**0.1**			
Min/Max or Max									**1.0**	**6.4/6.8**	**75**	**359**

Table B-5. 2006-07 Carkeek Annual Values

	No.of Dischage Events	Inflow Volume (MGD)	Discharge Volume (MGD)	Total Carkeek TSS lbs-in	Total Carkeek TSS lbs Discharged	Annual Average Carkeek %TSS Recovery	Annual Average Carkeek Settleable Solids (ml/l/lhr)	Event Maximum Carkeek Settleable Solids (ml/l/lhr)	Maximum Monthly Geomean Carkeek Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Carkeek Effl. Res. Cl2 (ug/l)
Including all Discharge Events	8	28.4	21.7	7626	3801	50.2%	0.1	1.0	75	359

Appendix C. Elliot West CSO Control Facilities, June 2006-May 2007

Executive Summary

This document constitutes the first annual report of the Elliott West CSO (EWCSO) pump station as a CSO facility. EWCSO began to operate as a CSO facility in July of 2005. The facility currently operates under the permit for West Point Treatment Plant, Washington State Department of Ecology permit number WA-0029181-1, in effect from January 1, 2004 through December 31, 2008. Effective January 1, 2006, new permit limits for fecal coliform numbers and residual chlorine for Elliott West CSO discharge went into effect.

2006-07 marked the second year of operation of EWCSO facility. Despite near normal rainfall over the year, the pattern of rainfall created significant challenges for the region. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. These rains accompanied by winds up to 70 miles per hour, power outages and flooding severely impacted the County's sewer system. With the storm entering the region from the southeast moving from the Alki area across the City to the Madison Valley area and up to Laurelhurst the resulting high combined sewer flows impacted County facilities along the Duwamish River and upstream of the Mercer/Elliott West facilities.

For the CSO year 2006-07, EWCSO facility received a total of 707 MG of CSO flow out of which 489 MG were treated and discharged out of the EWCSO outfall at the Denny Regulator station located in the Myrtle Edwards Park. The second year was characterized by significantly higher inflow and discharges; improvements to the instrumentation, sampling and equipment reliability; and continued efforts to resolve the issues with hydraulic limitations of the facility, screening of floatable matter, chemical dosing and mixing, and permit compliance. The facility also continued to receive dry weather flows from the City of Seattle sewers, albeit lower compared to the previous CSO year, despite cleaning operations the City conducted in summers of 2006 and 2007. King County established an emergency contract and brought on-board an engineering consultant firm to resolve the facility's performance issues and consequently help the facility meet permit compliance.

Background

EWCSO was built as part of the Denny Way/Lake Union CSO project to meet the federal and state requirements for control of City of Seattle CSO and King County's Dexter CSO discharges into Lake Union and King County's Denny Way CSO discharges into Elliott Bay. Elliott West CSO pumping facility and the 7.2 MG Mercer storage tunnel are the two biggest components of

this project. The 6200 feet long, 14-ft 8-in diameter Mercer tunnel receives CSO flows diverted from Elliott Bay Interceptor (EBI), Lake Union tunnel, Central trunk, City of Seattle Phase 1 & 2 pipelines and Elliott West CSO pipelines. Elliott West pump station is equipped with 2 dewatering sump pumps and 6 main pumps. The PLC for the EW pump station runs in 5 control modes:

1. **Standby mode**: Under this mode, the tunnel is empty and dry and only the dewatering pump(s) operate occasionally to empty any seepage. The station can also be in the standby mode when the tunnel is partially full but the EBI level (≥98.5 ft) is too high to receive the flows returned to West Point from EWCSO;

2. **Storage mode**: During this mode, the combined stormwater and wastewater flows start entering the tunnel and the dewatering pumps continue to run automatically based on level. The dewatering pumps shutoff upon the wetwell level reaching an elevation of 77' (verify) and the main pump suction valves open.

3. **Dewatering mode:** The lead main pump starts upon the wetwell level reaching an elevation of 77'. If selected by the operator, the second main pump can also run in parallel to the lead pump. The pump discharge is recycled to West Point via the 36" pipe connection to EBI. Flows to this 36" pipe are regulated by the pump discharge channel sluice gate. When the EBI level rises above elevation 98.5 (verify), the main pump(s) shutoff and the station goes into Standby mode. During the pump-down cycle, the main pump(s) pumps down the stored flows to an elevation of 74.00 ft before shutting down and the dewatering sump pump(s) pump the wetwell elevation of 65.00 ft (verify).

4. **Pump and Treat mode**: The pump station enters this mode when the wetwell level reaches an elevation of 94.0. The pump discharge channel sluice gates closes and the main pumps automatically start, stop and change speeds to maintain a level set point. The CSOs flows are screened as they overflow a weir into the effluent channel, then flow into the effluent drop structure where they get disinfected with hypochlorite before entering the 96" Elliott West effluent line that heads to the Denny Regulator station. Chlorinated effluent is dechlorinated with sodium bisulfite at the dechlorination vault (just upstream of the Denny Regulator) before it is discharged into Elliott Bay through the Elliott West outfall.

5. **Pump & Treat Extreme Event mode**: An extreme event is when a big storm occurs during a high tide forcing the tide flap gates on stormwater conveyance divert additional stormwater to the EBI, instead of discharging at Elliott Bay, thereby increasing the level in the EBI and at the Denny Way regulator station. To provide additional storage for the extra flows, the pump station goes into pump and treat mode at a lower wetwell level. Any additional inflow that cannot be pumped for CSO treatment, pass through the wetwell overflow into the wetwell drop structure.

6. **Untreated Discharges at Denny Regulator:** When Elliott West CSO facility's planned capacity of 250 MGD is exceeded, untreated CSO discharges occur at Denny Regulator via the Denny Way CSO outfall.

Auto-samplers collect flow-paced composite samples of the untreated CSO flows returned to West Point at Elliott West Pump Station and samples of the treated CSO flows discharged from the new Elliott West Outfall transition structure. The fecal grab samples are collected from a sample tap on the effluent sample line to the effluent composite sampler. For the 2006-06 CSO year, disinfection and dechlorination doses were flow pace controlled. PLC safety interlocks for the chemical control systems abort disinfection in the event of dechlorination system failure.

The permit limits, effective beginning January 1, 2006 through the end of the permit, are shown on Table C-1.

Table C-1 Permit Limits During 2006-07

Parameter	Discharge Limitations (Monthly)	Discharge Limitations[a] (Yearly Average)	Discharge Limitations[b] (Long–term Average)
Total Suspended Solids Removal Efficiency	Report	50%	NA
Fecal Coliform Bacteria	400/100 mL geometric mean	Report	NA
Settleable Solids, ml/l/hr	1.9 Maximum	0.3	NA
Number of Events per year	Report	Report	NA
Average Volume per year, million gallons	Report	Report	NA

Parameter	Average Monthly	Maximum of Daily Averages[d]
Total Residual Chlorine	NA	44 µg/L

[a] The yearly limitations will be calculated using per-event data points. Data shall be collected and reported on a schedule concurrent with the annual CSO report, June 1 to May 31, of the following year, to include the entire wet season for purposes of determining compliance with these limitations.

[b] Long-term average will be calculated using data collected over a full permit cycle. Data shall be collected and reported for the period of the permit cycle prior to permit renewal.

[c] The total removal efficiency for TSS is to be calculated on a mass balance basis as the percent of solids captured at the CSO Treatment Facility and then permanently removed at the West Point Treatment Plant or South Plant. The reported monthly average TSS% removal efficiency at West Point may be used for calculating the total removal efficiency for the CSO Treatment Facility.

[d] The maximum daily effluent concentration determined from a continuous measurement is calculated as the average of the pollutant concentrations measured over the day.

Table C-2 summarizes performance of the Mercer/Elliott West CSO treatment plant in 2006-07. There were 28 inflow events into the Mercer Tunnel and 13 discharge events out of the Elliott West CSO outfall. The total inflow and discharge volumes for the reporting period were 707.0 and 489.2 MGD, respectively.

Table C-2. Mercer/Elliott West CSO Permit Performance in 2006-07

Parameter	Performance	Permit Conditions
Number of Events in year	13	NA [a]
Total Volume in year, million gallons	489.2	NA [a]
Settleable Solids, Avg. Annual, ml/l/hr[c]	1.1	0.3
Settleable Solids, Max Event in Year, ml/l/hr	0.3	1.9
Suspended Solids Removal, Annual [c]	29.5%	50%
Fecal Coliform, Maximum Monthly Geometric Mean, cfu/100-mL[b]	3382	1700
Total Residual Chlorine, Highest Max Daily, ug/L[b]	986	44

[a] Compliance assessed over a 5-year average.
[b] The fecal coliform and total residual chlorine permit limits went into effect Jan. 1, 2006.
[c] 12/9-15/07 designated as the "one untreated event per year" and dropped from annual solids compliance calculations.

During this period:

1. The annual average TSS removal was 29.5% inclusive of all the discharge events for the year. The minimum TSS removal limit of 50% was not met;

2. The annual Settleable Solids concentration for the discharge events averaged 1.11 ml/l/hr did not meet the permit limit of 0.3 ml/l/hr, inclusive of all the discharge events.

3. Discharge events on November 15th, November 28th and December 11th exceeded the Daily maximum Settleable Solids event limit of 1.9 ml/l/hr. Some of the causes for exceeding the daily limits include sediment buildup in the effluent sampler stilling well and sampling under low flow conditions.

4. For early part of this monitoring period, there were several issues with disinfection system that resulted in poor disinfection. As a result, the fecal coliform limit was not met in the month of November. However, the efforts of the startup engineer to improve the dosing controls seemed to pay some dividends as the effluent fecal coliform limit was met the rest of the monitoring period.

5. Effluent residual chlorine limit of 44 µg/, as a maximum daily average, went into effect on January 1st, 2006. For most part of this monitoring period, there were several issues with the disinfection and dechlorination systems that prevented them from effectively dechlorinating the discharged flows. As a result, the effluent residual chlorine limit was not met.

6. Though there has been significant improvement in sample collection compared to previous, on occasion permit samples were not collected. Often it was the result of equipment failure. Monthly refresher training sessions were held for the off-site staff to reinforce the permit sampling requirements.

Table C-3. Five-Year Average of Events and Flow

Year	Discharge Flow, MG	Treated Discharge Events	Number of Once per Year "Untreated" Event
June 05 – May 06			No event removed
June 06 – May 07	489.20	13	1 - 12/9-15/06 removed
5-year average	**NA**	**NA**	**NA**

Operation and Maintenance

The CSO reporting year 2006-07 was the second year of operation for the Elliott West CSO Facility. As stated in the 2005-06 CSO annual report, the facility had not gone through a thorough commissioning phase under CSO conditions due to the construction delays. Some component testing, by means of dry run simulation, was done prior to the start of 2005-06 CSO season. When the storms started occurring, several issues emerged pertaining to the equipment performance, equipment access, equipment warranty and Instrumentation/PLC and posed lots of challenges. A startup engineer was brought on board in February 2006 to start addressing various instrumentation and operational problems. For most part of the previous monitoring period, the startup engineer worked on instrumentation issues that were contributing to the equipment failure. Also, King County worked with City of Seattle to clean up their sewers to minimize dry weather flows into Mercer tunnel, thereby minimizing the problems with the dewatering sump pumps. A flowmeter was installed on the dewatering sump pump discharge line to measure the flow and for collection of a composite sample of these flows. A stand alone sample circulation pump was installed to improve reliability of the sampling of flows retuned to West Point treatment plant by EWCSO's main pump. Electrical modifications to the submersible effluent sample (TSAM) pump were made to enable quick replacement of the pump with a spare unit to ensure sampling of the discharged flows. Also, the effluent sampling set up was modified to ensure the consistent online measurement of effluent residual chlorine and pH. The colorimetric Effluent Chlorine Residual Analyzer (Hach Cl17) was replaced with an amperometric model (Wallace & Tiernan Micro2000).

In 2006-07 CSO year, the startup engineer continued to address various issues in an effort to improve the performance of EWCSO facility in meeting permit compliance. During this CSO monitoring year, significant problems surfaced under high flow and/or high tide conditions. These problems include -

- Surcharging of the Outfall Transition Structure, Dechlorination Structure and the EWCSO effluent transfer line due to hydraulic limitations. These condition lead often to poor disinfection and/or dechlorination and on occasion to surface discharges out of the covers on the outfall transition and dechlorination structures ;

- Poor mixing of the hypochlorite and bisulfite at their points of injection causing poor disinfection and/or poor dechlorination; and
- On one occasion the intensity of the storm events delayed the scheduled hypochlorite delivery which in turn led to total depletion of hypochlorite inventory at EWCSO and disinfection failure.

Dechlorination sample pump intake was installed incorrectly at the time of the construction and as a result the Dechlorination sample (DSAM) pump was pumping dechlorinated discharge sample as opposed to un-dechlorinated discharge sample. The sample intake was extended upstream into the 96" EWCSO effluent transfer line and the DSAM pump was relocated to a stilling well built to isolate the pre-dechlorinated flow from post-dechlorinated flows. However, it was later discovered that the post dechlorinated flows were entering the stilling well during high tide conditions. Also, the DSAM pump was later found to be completely corroded from exposure to hypo chlorite and bisulfite. The stilling well was also silting up. King County has come to the conclusion that the resolution of these problems would require a re-design of the dechlorination structure. Incorporation of a Pre-dechlorination residual chlorine analyzer, installed with the intent of improving the dosing controls of disinfection and dechlorination, had to be held off till the re-design of the dechlorination structure is complete. Modifications made to the effluent sample (TSAM) - mounting the submersible pump on a skid, moving the power connections out of water and purchasing a spare pump- led to significant improvement in collection of permit compliance sampling (effluent composite, effluent fecal grabs, chlorine residual and pH monitoring) compared to previous CSO season.

On-going problems with the hydraulic limitations of EWCSO system observed during November and December of 2006, prompted King County to issue an emergency contract to bring an engineering consultant, on board late December to analyze various performance issues and formulate solutions to achieve consistent permit compliance. Hydraulic analysis indicated removal of the duckbill valve on the outfall would alleviate some of the head loss in the dechlorination structure. The duck bill valve was removed in March of 2007. Hydraulic analysis suggests that there will still likely be hydraulic limitations, especially under high flow and/or high tide conditions that will lead to surcharging of the outfall transition structure, dechlorination structure and the EWCSO transfer line. To avoid the consequences, such as surface discharges in the Myrttle Edwards park, the consultant is designing an above grade structure be built on top of the existing dechlorination structure.

The following sections describe what these issues were and what has been and is being done to address them.

Equipment Issues

1. Dewatering Sump Pumps: Dewatering sump pump float switches which serve as backup controls for the pumps were getting ragged up frequently and were getting ripped off of the wall during high flows. Also, the discharge from the dewatering pumps was the cause for corrosion in the pump discharge channel.

   Corrective Measure: Float switches were replaced with pressure transducers (September 2006). The discharge piping was extended into the drop structure to eliminate the

turbulence that was causing the odors and corrosion and a neoprene flap gate was installed on the 36" sewer connection to the Elliott Bay Interceptor (EBI) to prevent foul air from entering EWCSO (Fall 2006).

2. Sampling of Elliott West Recycled Flows to West Point: The auto-sampler, collecting the flows (pumped by the main pumps) returned to West Point, despite the addition of a stand alone circulation pump due to the distance between the sample intake in the pump discharge channel and the sampler located in the pump room.

   Corrective Measure: Early October 2007, sample intake was modified by making a penetration through the wall between the pump room and the discharge channel and inserting a hard pipe to supply the recycled flow sample to the auto-sampler. This modification greatly reduced the pumping distance and King County is hopeful that it will facilitate reliable sampling of the recycled flows.

3. Pre-Dechlorination Sampling: It was discovered that DSAM pump piping was installed incorrectly at the time of construction. Also, the stilling well design was found to be inadequate since the un-dechlorinated and dechlorinated flows were still mixing together. These discrepancies resulted in DSAM pump pumping dechlorinated flow sample as opposed to un-dechlorinated sample.

   Corrective Measure: Sample intake was moved 10 -15' upstream into the 96" effluent transfer line to deliver un-dechlorinated but disinfected flows into the re-designed stilling well. However, even this re-designed stilling well was found to be inadequate under high-flow and/or high-tide conditions to guarantee strictly un-dechlorinated flow sample to the newly installed pre-dechlorination analyzer. Also, the submersible chemical pump was found to be completely corroded from to exposure to hypochlorite and bisulfite, possibly the result of inappropriate type of pump for the application. A consultant contract was issued in March 2007 to address various permit compliance issues and the pre-dechlorination sampling is a part of the scope of work.

Electrical, Instrumentation, and PLC Issues

1. Main Pump Controls: During one of the discharge events in November, off-site staff observed that the EWCSO main pumps were cycling on and off too frequently as the station was moving back and forth between standby mode and treat and discharge mode.

   Corrective Measure: The startup engineer modified the main pump loop controls to minimize the frequency of pump cycling in January 2007.

2. Dewatering Sump Pump Flow Monitoring and Sampling: Last CSO season the flow returned to West Point by the dewatering sump pumps was not collected since there was no flow meter installed to measure the flows and sample accordingly. These flows, small in comparison to the main pump flows, are often considerably stronger in terms of suspended solids concentration. Hence, no solids removal credit was claimed for the solids removed and returned to West Point by the sump pumps.

Corrective Measure: A Mag-flowmeter was added to measure the flows and PLC controls were modified to enable flow-paced sampling of these flows in May 2006.

3. Critical Equipment Power Loss: Power was lost to the critical equipment circuit inside the Moore Controller, during one of the discharge events in January 2007, as a result of a tripped GFCI breaker. This caused a disinfection failure due to hypochlorite pumps failing to turn on due to power loss. Since, there was no alarm indicating why the power was lost, disinfection was not restored until the source of the problem was discovered.

   Corrective Measure: In January 2007, the startup engineer installed a critical equipment power loss alarm on the Moore Controller panel to alert the operator as to the interruption of power. Also, alarms were added to alert West Point Main Control Center of critical equipment power loss and of any failure of disinfection and dechlorination systems. He also made the Moore Controller the back up equipment control and the PLC the primary control to avoid a repeat of the problem.

4. Auto-restart of EWCSO Pump Station Following a Power Outage: Until January 2007, critical equipment such as the main pumps, chemical pumps etc., had to be reset following a power outage. Depending on whether an operator is on site or not, it would take minutes to over an hour before the pump station would be restored to service. Though this problem had not occurred during a storm event, the potential for it existed.

   Corrective Action: In January 2007, the start up engineer installed auto-restart feature to automatically reset the equipment following a power outage.

5. Pre-dechlorination Analyzer for Dechlorination Dose Optimization: A pre-dechlorination analyzer was installed to optimize bisulfite dosing in December 2006. However, problems associated with the submersible sample pump, its location, incorrect sample intake installation, surcharging of the dechlorination structure and inadequate mixing have all prevented integration of the pre-dechlorination chlorine residual measurement to the dosing control of bisulfite.

   Corrective Action: The startup engineer completed the feedback loop control design to utilize the pre-dechlorination residual to optimize bisulfite dosage. The sample intake line was moved upstream to deliver un-dechlorinated sample to the analyzer. However, implementation of this work is held off until the hydraulic, mechanical, and structural issues are addressed by the consultant contract.

Operational Issues

1. Sampling: Sampling during the second year of operation of the Elliott West CSO facility had improved significantly compared to the first year. The few times the effluent samples were not collected, the culprit happened to be equipment failure. Most of the main pump recycled flow samples were grab samples due to the sampling distance between the pump discharge channel and the auto sampler was found to be too great, even with the booster pump installed

Corrective Measure: Monthly refresher training and debrief sessions were held during the 2006-07 CSO season to reinforce the sampling requirements and to get feedback from the operations staff on necessary improvements to be made through better communications. These efforts seemed to have desired effect. King County will continue with monthly refreshers. Sampling system modifications were completed on the main pump recycled flow sampler to ensure collection of composite sample.

2. Non-CSO Flows into Mercer Tunnel: Non-CSO flows were entering from City of Seattle in spite of removing 80 tons of material from 2006 summer cleaning operations, albeit at lower levels than before.

   Corrective Measure King County collaborated with the City of Seattle to continue cleaning of City of Seattle sewers again this summer. TV inspection of these lines revealed significant build up of debris. King County and the City have agreed to make modifications to the weir to the tunnel to prevent the base flows from entering the tunnel.

3. Hydraulic Limitations: Under high-flow and/high tide conditions, hydraulic limitations of the EWCSO effluent transfer line, dechlorination and outfall transition structures appear to be causing a whole host of problems, ranging from poor disinfection and dechorination to surcharging of the submerged structures and on occasion surface discharges at Denny Regulator.

   Corrective Measure: An emergency consultant contract was issued to investigate and offer solutions to these problems in December 06. One of the first recommendations of the consultant, implemented in March 2007, was to remove the duck bill valve on the outfall to reduce the head loss. Other recommendations include raising the height of the dechlorination structure by erecting an above ground structure to accommodate high hydraulic grade line during heavy storm events and high tide conditions; adding mixers for improving disinfection and dechlorination performance during heavy storm events and high tide conditions.

4. Screening Performance: The horizontal screens at EWCSO facility are not effectively removing floatable solids as they clogged with screenings quickly during a discharge event. Once the screens are blinded, the level in the pump discharge channel rises and rest of the discharges flow over the screen, essentially bypassing the screens.

   Corrective Action: The consultant is assessing options and modifications to the facility to correct this problem. It is also expected that control of the Seattle base flows to the tunnel will reduce the amount of floatables entering the tunnel.

Conclusion

Given the complexity of the facility's design and operation and the challenges posed, King County has been diligently working to bring the facilities into control and compliance. Work that has been completed and additional work planned is detailed in the response to the NOV in Appendix C2..

Table C-4. Summary of Mercer/Elliott West 2006-07 Event Data

Month	Day	EWCSO Inflow Event Number	EWCSO Inflow Volume (MGD)	EWCSO Discharge Event Number	EWCSO Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EWCSO + WP (lbs)	% removal	EWCSO Effl. Settl Solids (ml/l/hr)	EWCSO Effl. pH	EWCSO Avg Effl. Fecal Coliforms (#/100 ml)	EWCSO Effl. Residual Chlorine (ug/l)
June	1	1a	8.4	1	4.8	5919	3478		NS			
	2	1b	7.5	ND	ND	5338	203					
	3	2a	2.4	2a	0.4	1136	212		NS			
	4	2b	39.1	2b	30.1	37127	28969		NS			
	Event/Daily Max											
	Mon. Total/Avg	2	57.3	2	35.3	49521	32862	33.6%				
July												
August												
September	14	1	1.6	ND	ND	848	28	96.7%				
	Event/Daily Max											
	Mon. Total/Avg	1	1.6	0		848	28					
October	15	1	1.2	ND	ND	360	14					
	24	2	3.2	ND	ND	2459	98					
	29	3	1.6	ND	ND	1997	80					
	Event/Daily Max											
	Mon. Total/Avg	3	6.1			4816	193	96.0%				
November	2	1a	12.8	1a	10.48	17553	15893		0.8	5.4	NS	57
	3	1b	8.8	ND	ND	5522	718					
	4	1c	37.5	1b	31.42	51277	41775		1.5	5.6	650000	2
	5	1d	3.4	1c	0.68	878	321			6.3	2000	0
	6	1e	51.2	1d	48.56	19755	19128		<0.1	5.1	34286	2
	7	1f	13.5	1e	5.18	5399	1717		<0.1	6.6	1	119

Month	Day	EWCSO Inflow Event Number	EWCSO Inflow Volume (MGD)	EWCSO Discharge Event Number	EWCSO Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EWCSO + WP (lbs)	% removal	EWCSO Effl. Settl Solids (ml/l/hr)	EWCSO Effl. pH	EWCSO Avg Effl. Fecal Coliforms (#/100 ml)	EWCSO Effl. Residual Chlorine (ug/l)
	8	2	1.0	ND	ND	509	66					
	9	3a	5.2	ND	ND	11676	1518					
	10	3b	10.6	2	5.26	5477	3765		1.2	7.1	250	259
	11	3c	3.7	ND	ND	2140	278					
	12	3d	29.7	3	29.08	120227	120074		NA	8.0	5520	33
	13	4a	1.9	ND	ND	1065	138					
	14	4b	0.4	ND	ND	2291	298					
	15	5a	13.0	4	8.87	16919	15972		13.0	6.9	27775	81
	16	5b	5.9	ND	ND	1586	206					
	19	6a	4.5	ND	ND	5890	766					
	20	6b	3.4	ND	ND	1254	1190					
	21	6c	20.0	ND	ND	2163	2163					
	22	6d	10.7	5a	2.83	1163	1078		0.1	7.1	9000	50
	23	6e	12.5	5b	19.95	3509	1589		<0.1	6.8	300	113
	24	6f	2.7	5c	9.82	774	101		NA	7.0	1	85
	25	6g	0.0	5d	4.46	12	2		NA	7.0	NS	76
	26	7a	15.3	ND	ND	12349	12055					
	27	7b	6.5	ND	ND	593	77					
	28	7c	0.6	6	13.46	21963	2855		2.5	7.0	42500	150
	Event/Daily Max								13.0			259
	Mon. Total/Avg	7	274.4	6	190.1	311943	243742	22%	3.2		3382	79
December	9	1	0.7	ND	ND	641	70					
	11	2a	29.9	1a	29.9	20940	20940		2.0	7.3	77010	51
	12	2b	22.3	1b	22.3	4276	4276		<0.1	7.3	3000	101
	13	2c	12.0	1c	10.7	5764	2689		<0.1	7.2	20	14
	14	2d	88.4	1d	86.1	42761	41762		<0.1	7.3	500	2
	15	2e	16.6	1e	15.2	8708	8419		0.8	7.4	1	105

Month	Day	EWCSO Inflow Event Number	EWCSO Inflow Volume (MGD)	EWCSO Discharge Event Number	EWCSO Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EWCSO + WP (lbs)	% removal	EWCSO Effl. Settl Solids (ml/l/hr)	EWCSO Effl. pH	EWCSO Avg Effl. Fecal Coliforms (#/100 ml)	EWCSO Effl. Residual Chlorine (ug/l)
	16	2f	5.3	ND	ND	1240	136					
	21	3a	8.6	ND	ND	2604	286					
	22	3b	0.9	ND	ND	983	108					
	23	4a	11.0	2a	2.7	3626	1891		0.5	6.9	130	29
	24	4b	12.4	2b	11.9	10851	8443		1.5	7.1	135	17
	25	4c	8.7	ND	ND	3047	335					
	26	4d	42.9	2c	42.3	37527	35840		0.5	7.8	20	29
	27	4e	6.5	2d	2.3	489	205		NS	NS	NS	NS
	28	4f	4.8	ND	ND	1978	218					
	Event/Daily Max								2.0		77010	105
	Mon. Total/Avg	4	271.0	2	223.3	145435	125618	13.6%	0.7	6.9	173	44
January	1	1a	1.5	1a	1.21	4098	892		0.90	8.3	600	22
	2	1b	24.3	1b	23.44	4359	4217		0.10	7.3	5000	96
	3	1c	6.8	1c	0.11	1253	131		0.10	7.3	40	986
	4	1d	2.3	ND	ND	2459	221					
	5	2a	11.1	2a	10.52	3974	3791		<0.1	7.5	1	182
	6	2b	8.1	ND	ND	2712	244					
	7	2c	8.9	2b	2.80	2903	1600		<0.1		3000	
	8	2d	2.3	ND	ND	530	48					
	Event/Daily Max								0.90			986
	Mon. Total/Avg	2	65.4	2	38.08	22287	11144	50.0%	0.2		205	322
February												
March	2	1a	0.7	ND	ND	402	16					
	3	1b	0.3	ND	ND	220	9					
	7	2a	0.8	ND	ND	3904	160					

Month	Day	EWCSO Inflow Event Number	EWCSO Inflow Volume (MGD)	EWCSO Discharge Event Number	EWCSO Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EWCSO + WP (lbs)	% removal	EWCSO Effl. Settl Solids (ml/l/hr)	EWCSO Effl. pH	EWCSO Avg Effl. Fecal Coliforms (#/100 ml)	EWCSO Effl. Residual Chlorine (ug/l)
	8	2b	1.3	ND	ND	656	27					
	11	3a	1.2	ND	ND	2106	86					
	12	3b	1.2	ND	ND	381	16					
	13	3c	0.0	ND	ND	3	3					
	19	4a	0.7	ND	ND	184	8					
	20	4b	0.5	ND	ND	1638	67					
	21	4c	0.5	ND	ND	1497	61					
	Event/Daily Max											
	Mon. Total/Avg	4	7.1			10991	454	95.9%				
April	8	1a	0.4	ND	ND	3503	144					
	9	1b	0.3	ND	ND	91	4					
	14	2a	0.6	ND	ND	626	26					
	15	2b	0.4	ND	ND	946	39					
	17	3a	4.5	ND	ND	2552	105					
	18	3b	1.1	ND	ND	306	13					
	Event/Daily Max											
	Mon. Total/Avg	3	7.3	ND	ND	8023	329	95.9%				
May	2	1	0.3	ND	ND	113	5					
	20	2a	4.4	ND	ND	2183	92					
	21	2b	5.4	1	2.52	3351	1087		<0.1	7.1	NS	28
	22	2c	6.6	ND	ND	1698	71					
	Event/Daily Max											28
	Mon. Total/Avg	2	16.6	1	2.52	7345	1255	82.9%				28
	Total	28	707.0	13	489.2	561208	415624	25.9%				

Month	Day	EWCSO Inflow Event Number	EWCSO Inflow Volume (MGD)	EWCSO Discharge Event Number	EWCSO Discharge Volume (MGD)	Total Influent TSS (lbs)	Total Effluent TSS Discharged @ EWCSO + WP (lbs)	% removal	EWCSO Effl. Settl Solids (ml/l/hr)	EWCSO Effl. pH	EWCSO Avg Effl. Fecal Coliforms (#/100 ml)	EWCSO Effl. Residual Chlorine (ug/l)
	Annual Avg/GEM								1.1			103
	Min/Max								13.0	5.1/8.0		986

Table C-5. 2006-07 Mercer/Elliott West Annual Values

	Inflow Volume (MGD)	Discharge Volume (MGD)	Total EWCSO TSS lbs-in	Total EWCSO TSS lbs Discharged	Annual Average EWCSO %TSS Recovery	Annual Average EWCSO Settleable Solids (ml/l/lhr)	Maximum Monthly Geomean EWCSO Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of EWCSO Effl. Res. Cl2 (ug/l)
Including all Discharge Events	707.0	489.2	561208	415624	25.9%	1.1	3382	986
Excluding discharge event #1 from December 2006 (12/9-12/15)			478760	337538	29.5%	1.1		
Average Infl.TSS	95	mg/l						
Average Effl.TSS	102	mg/l						

Appendix C2. Elliot West CSO Control Facilities Notice of Violation and Response

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

SEP 06 2007

REGISTERED MAIL
RB 336 145 212 US

Ms. Christie True, Director
King County Wastewater Treatment Division
King Street Center
201 South Jackson Street
Seattle, WA 98104-3855

Dear Ms. True:

RE: King County Denny/Elliott West Storage and CSO Treatment Facility

Enclosed is Notice of Violation No. 5059. This Notice is being issued for failure to collect required effluent samples and perform required analyses, and for problems associated with disinfection and dechlorination systems at the Elliott West CSO (EWCSO) treatment facility during the period of June 2006 to May 2007. All correspondence relating to this document should be directed to Enforcement Coordinator at Department of Ecology, Northwest Regional Office, 3190 – 160th Avenue SE, Bellevue, WA 98008-5452. If you have any questions concerning the content of the document, please call Amy Jankowiak, Municipal Compliance Specialist, at (425) 649-7195.

This Notice of Violation is issued under the authority of Chapter 90.48.120(1) of the Revised Code of Washington.

Sincerely,

Kevin C. Fitzpatrick

Kevin C. Fitzpatrick
Water Quality Section Manager

KCF:AJ:ct
Enclosure
cc: Betsy Cooper, King County
Karen Huber, King County
Jim Pitts, West Point
Larry Altose, Ecology PIO
Karen Burgess, Ecology
Raman Iyer, Ecology
Mark Henley, Ecology
Amy Jankowiak, Ecology
Central Files: West Point Treatment Plant; Permit No. WA002918-1; WQ 6.4

DEPARTMENT OF ECOLOGY

IN THE MATTER OF THE COMPLIANCE BY King County Wastewater Treatment Division Denny/Elliott W. Storage & Treatment Facility with Chapter 90.48 RCW and the Rules and Regulations of the Department of Ecology	))))))	NOTICE OF VIOLATION No. 5059

To: Ms. Christie True, Director
King County Wastewater Treatment Division
King Street Center
201 South Jackson Street
Seattle, WA 98104-3855

For the site located at:

King County Denny/Elliott West Storage and CSO Treatment Facility

Chapter 90.48.120 of the Revised Code of Washington (RCW) reads in part: "Whenever, in the opinion of the Department, any person shall violate or create a substantial potential to violate the provisions of this chapter, or fails to control the polluting content of waste discharged, or to be discharged into any waters of the state, the Department shall notify such person of its determination by registered mail . . ." Notice is hereby given in accordance with chapter 90.48.120(1) of the Revised Code of Washington (RCW), as follows for the location known as the King County Denny/Elliott West Storage and CSO Treatment Facility.

The Elliott West Combined Sewer Overflow (EWCSO) facility was dedicated on July 7, 2005, and is covered under King County Wastewater Treatment Division National Pollutant Discharge Elimination System (NPDES) Permit No. WA-002918-1. The period June 2006 to May 2007 represents the second operating year for this facility. From June 2006 to May 2007, there were eight events that constituted numerous violations per the terms and conditions of the County's permit.

Event #1
On June 1, 2006, a control switch for the sample pump for dechlorinated discharged effluent was left in the closed position and therefore, effluent samples were not collected and analyzed. Also, the disinfection and dechlorination systems failed repeatedly during this event due to either a faulty float switch or its relay inside the dechlorination vault.

Event #2
On June 4, 2006, the disinfection and dechlorination systems failed. The cause was either a faulty float switch or relay inside the dechlorination vault.

Event #3
On November 2, 2006, no grab fecal sample was collected due to the pumps cycling on and off. During the first week of November 2006, flow control valve problems on the bisulfite pump caused complete corruption and replacement of the chlorine analyzer.

Event #4
On November 6, 2006, a disinfection failure occurred when the County ran out of hypochlorite.

Event #5
On December 14, 2006, an unregulated discharge of treated CSO flows occurred at the Denny Regulator Station when manholes popped and CSO flows flowed overland near the discharge structure. During this month, it was noted that the pre-dechlorination analyzer sample supply pump located in the dechlorination vault was completely corroded.

Event #6
On January 2, 2007, a tripped breaker caused power loss to the PLC, which caused the disinfection and dechlorination systems to not start. This resulted in a disinfection failure.

Event #7
On January 7, 2007, the sample supply pump in the outfall structure failed on a moisture leak alarm. There was no on-line measurement of pH and residual chlorine.

Event #8
On May 21, 2007, a disinfection failure occurred when the sodium hypochlorite and sodium bisulfite systems did not turn on to initiate the disinfection and dechlorination of the EWCSO flows being discharged at the Denny Regulator. For a total of 36 minutes there was no disinfection or dechlorination as a result of the chemical feed pumps not turning on. The untreated flow volume was 0.56 MG. The event was responded to quickly, and reported properly. However, there was no fecal coliform sample collected due to operator oversight. The County staff investigated the cause of the chemical pump failures but has not yet determined the cause.

Violations:
Chapter 90.48.162 of the Revised Code of Washington (RCW) requires a permit for discharge from the Department of Ecology. Washington Administrative Code (WAC) 173-220 requires a permit for discharges. The Denny/Elliott West Storage and CSO Treatment Facility is covered under the King County Wastewater Treatment Division National Pollutant Discharge Elimination System (NPDES) Permit No. WA-002918-1.

Special Condition S5 of NPDES Permit No. WA-002918-1 states that, "the Permittee shall at all times properly maintain all facilities and systems of treatment and control (and related appurtenances) which are installed to achieve compliance with the terms and conditions of this permit ..."

Effluent Violations

Violation Date	Parameter	Type	Unit	Value	Permit Limit
November 2006	Chlorine, Total Residual	MAX	UG/L	259	44
November 2006	Fecal Coliform	GEM	#/100 ML	3382	400
December 2006	Chlorine, Total Residual	MAX	UG/L	105	44
January 2007	Chlorine, Total Residual	MAX	UG/L	986	44

Based on the number of events for the above-stated period, Ecology concludes that EWCSO treatment facility has not implemented adequate operating and maintenance practices to ensure continuous, effective disinfection and dechlorination. For the period of June 2006 to May 2007, three violations for residual chlorine and one for fecal coliform were related to operation/maintenance of the chlorination and dechlorination feed systems.

Special Condition S2.B of NPDES Permit No. WA-002918-1 states that, "samples and measurements taken to meet the requirements of this permit shall be representative of the volume and nature of the monitored parameters, including representative sampling of any unusual discharge or discharge condition, including bypasses, upsets, and maintenance-related conditions affecting effluent quality…."

Special Condition S3.E of NPDES Permit No. WA-002918-1 states that, "In the event the Permittee is unable to comply with any of the terms and conditions of this permit due to any cause, the Permittee shall: 1. Immediately take action to stop, contain, and clean-up unauthorized discharges or otherwise stop the noncompliance, correct the problem and, if applicable, repeat sampling and analysis of any noncompliance immediately …"

For the period of June 2006 to May 2007, King County staff failed to sample and analyze for a number of required tests at the Elliott West CSO (EWCSO) treatment facility.

This determination does not constitute an order or directive under RCW 43.21B.310.

RCW 90.48.120(1) requires that within thirty (30) days from the receipt of this Notice of Violation, King County shall file with the Department of Ecology (Department) a full report stating:

1. What steps HAVE BEEN taken to control such waste or pollution to otherwise comply with this determination of the Department, and

2. What steps ARE BEING taken to control such waste or pollution to otherwise comply with this determination of the Department, and

Send the report to:

Enforcement Coordinator
Water Quality Program
Department of Ecology
Northwest Regional Office
3190 – 160th Avenue SE
Bellevue, WA 98008-5452

Upon receipt of this report, the Department shall issue such order or directive as it deems appropriate under the circumstances, and shall notify King County by registered mail.

DATED September 5, 2007, at Bellevue, Washington

Kevin C. Fitzpatrick
Water Quality Section Manager

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
King Street Center, KSC-NR-0500
201 South Jackson Street
Seattle, WA 98104-3855

October 5, 2007

Amy Jankowiak
Enforcement Coordinator
Water Quality Program
Department of Ecology
NWRO
3109 160th Avenue SE
Bellevue, WA 98008-5452

RE: Response to Notice of Violation No. 5059 – King County Denny/Elliott West Storage and CSO Treatment Facility

Dear Ms. Jankowiak:

Attached please find our response to the Notice of Violation dated September 6, 2007 regarding aspects of our operation of the Elliott West CSO Storage and Treatment Facility during the wet season of 2006-2007. As specified in your notice we have prepared a report describing the circumstances around the violations cited, and have provided requested information regarding what steps have been taken to address these violations and steps that are being taken to further increase our ability to remain in full compliance with all NPDES permit conditions.

The King County Wastewater Treatment Division shares the Department of Ecology's commitment to reducing combined sewer overflows (CSO) and is working hard to comply with the effluent and sampling requirements of this permit. We believe it should be noted that extreme weather during the Elliott West CSO facility's first two start-up seasons (October –May) significantly influenced the facility's effectiveness to date. The first year was fairly dry and the second year fairly wet, including some extremely intense, long lasting rain and wind storms. These weather patterns created challenges to operating a new, complex, intermittently operated facility to its full potential. Despite these difficulties, the Elliott West facility has realized significant achievements including:

- **Reduced untreated discharges.** Untreated discharges in this area of Myrtle Edwards Park have been reduced from 32 large events per year to seven small events in 05-06 and 13 in 06-07, and now occur at deeper depths.

- **Increased capture and treatment**. During the 05-06 season, 38.4 percent of the 514 million gallons (MG) managed in the system that would have been discharged untreated at Denny Regulator was captured and received full secondary treatment.

CREATING RESOURCES FROM WASTEWATER

Amy Jankowiak
October 5, 2007
Page 2 of 2

In 06-07, 28.5 percent of the 765 MG managed by the facility received secondary treatment. In 05-06, 61.4 percent of the 512 MG received primary treatment and disinfection, and only 0.2 percent was discharged untreated at Denny regulator. In the 06-07, 64 percent of the 765 MG received primary treatment and only 7.5 percent was discharged untreated - during extremely heavy rains.

- **Improved solids removal and disinfection**. Increased treatment removed 30.8 percent of total suspended solids in 05-06 and 28 percent in 06-07, a substantial improvement. The system also provided disinfection and some floatables control.

The City of Seattle's CSOs on Lake Union have also been completely or significantly controlled by this project. The Dexter CSO on Lake Union, which is operated by King County, has shown the following improvements:

- In 06-07 the number of events dropped from 16 pre-project to six, and these events were smaller than pre-project events.
- In 05-06, 74 percent of the volume previously discharged untreated at Dexter was captured and sent to West Point for treatment. In 06-07, 58.5 percent was sent to West Point.

These advances are testament to King County's continuing commitment to reducing CSOs and protecting public health. If you have any future questions on the attached response material or wish to arrange a meeting on these matters please contact Betsy Cooper, our NPDES Permit Administrator at 206-263-3728.

Sincerely,

for Christie True

Christie True
Division Director

Attachment
Cc: Mark Henley, Dept. of Ecology, Permit Manager
Betsy Cooper, KC WTD NPDES permit Administrator
Jim Pitts, KC WTD West Section Manager
Karl Zimmer, KC WTD West Section Offsite Supervisor
Eugene Sugita, KC WTD West Section Process Control Supervisor
Sekhar Palepu, KC WTD West Section Process Control Analyst

King County Response Regarding the Notice of Violation No. 5059 issued by Department of Ecology September 6, 2007

I. Introduction

The Washington State Department of Ecology issued a Notice of Violation (NOV) No. 5059 regarding permit non-compliance at the Elliott West Combined Sewer Overflow (EWCSO) Treatment Facility for the permit report period June 2006 through May 2007. The following information is provided in response to the questions raised in this NOV.

II. History of Mercer/Elliott West/Lake Union Project Start-up Process

The Mercer/Elliott West/Lake Union Project was a multifaceted project including the construction and connection of a large deep storage tunnel with multiple local sewer system sections and regulators. This project was a joint effort between King County and the City of Seattle and took over 12 years to plan and construct. Elliott West CSO Treatment Facility (EWCSO) became operational in May 2005 and is the first of its kind in the region. It combines a large storage tunnel, receiving flow from many inlets, with a dechlorination structure located a considerable distance from the hypochlorite application point, and compliance monitoring at multiple locations.

The lack of rains in late 2005 resulted in only four discharge events by the end of December, affording little opportunity for formal startup testing processes to discover and correct deficiencies prior to the commencement of permit compliance on January 1, 2006. Consequently, numerous issues emerged and continue to surface as the facility receives wet weather flows. Significant issues arose with various instrumentation at the facility. A startup instrumentation controls engineer was brought on board in early 2006 to address these issues individually. This engineer’s work has continued since that time as issues arise. Modifications made at the facility in the first and second wet season are detailed in Section III of this report.

Meetings with Ecology on Elliott West System and Start-up Issues

King County initiated discussions with Ecology about structural, instrumentation and operational challenges shortly after the facility was brought on line. King County's CSO team briefed Ecology staff on the EWCSO's performance at Ecology's office in Bellevue on three occasions: Nov. 21, 2005; Feb. 23, 2006; and Feb. 22, 2007. Materials provided at those meetings can be found in Appendix A. In addition, Ecology’s new permit manager toured the site on March 23, 2007.

Dry Weather Inflow to Mercer Tunnel

The entry of base flow (not precipitation induced) from the Seattle service area upstream of the Mercer tunnel has posed significant challenges to operations at Mercer/Elliott West CSO Treatment facilities. The facility was designed to control CSO's and was not intended to manage such high strength wastes. Due to the concentrated nature of these flows, dewatering sump

pumps expected to run periodically were forced to run constantly. As a result, the pumps experienced excessive wear and repeated failures. They had to be frequently rebuilt due to ragging and other debris in the full strength sewage. This high strength waste also caused significant hydrogen sulfide corrosion. Its high floatables content prevented the use of the flushing gates to move sediment through the tunnel, and plugged sampling equipment. The higher floatables content is a likely contributor to the ongoing screen clogging and overtopping of solids in the effluent channel. The presence of these non-CSO flows has greatly complicated the calculation of the true CSO management period and compliance reporting for NPDES permit limits.

The challenges arising from high strength flows were identified soon after the tunnel was brought on line. King County investigated immediately and identified the Seattle system as the source. The City of Seattle was notified by the county immediately, however county staff carried out much of the problem identification process. The city took longer than was desirable to mobilize their corrective process. In the summer of 2006 the City of Seattle initiated the first of two very costly sewer cleanings in the area which removed 80 tons of solids. This cleaning reduced the dry weather flow rate, but did not eliminate it. The City of Seattle initiated a second cleaning in the summer of 2007, removing another 16 tons of sediment, but still failing to completely eliminate dry weather flow to the facility. Monitoring data suggests that the Seattle system is refilling with sediment and the county has begun the process of making weir changes to control those flows. A chronology of the county's efforts to address this issue can be found in Appendix B.

In-House Cross Team Formed to Support Elliott West Startup

King County initiated a cross-divisional staff team to support the startup of the Henderson/Norfolk CSO treatment and storage facilities and the Mercer/Elliott West CSO treatment facilities in the spring of 2005. This team included the managers of the West Point Plant and South Plant, Offsite and Process Control supervisors and staff, CSO control program staff, modeling and monitoring staff, capital project and asset management staff and the NPDES permit administrator. The team began holding monthly meetings in early fall 2005 to discuss challenges and brainstorm solutions. The meetings continued through the first wet season. The Mercer tunnel dry weather flows issue was first identified in these meetings.

Following the severe storms of Nov. 4-6 and Dec. 14-16, 2006, the King County Wastewater Treatment Division convened cross-divisional “storm debriefs” (Nov.22, 2006 and a follow up Jan. 3, 2007), and a CSO treatment facility-specific debrief on Dec. 20, 2006. Problems and potential solutions were discussed and tasks were assigned to the appropriate staff members at these meetings. Many facility improvements were identified for Mercer/Elliott West and a new capital project – described later in this report – was initiated to address the hydraulic and solids management problems.

An internal effort to improve general employee understanding and support of the county’s CSO control efforts proceeding along parallel lines also benefited the start up of these facilities. The new West Division and West Point Plant manager were briefed monthly and the division's West leadership team was briefed on CSO controls several times. Two on-line CSO control program

employee training modules were also launched. An extensive “one-stop” CSO information intranet site was launched, including a real-time CSO overflow status site (also being used to pilot a possible public notification website). These activities represent a division-wide effort within King County to support the start up of the very complex Mercer/Elliott West CSO control facilities.

III. What Steps HAVE BEEN TAKEN Regarding Violations Cited in Notice of Violation No.5059

This section presents a description of each event listed in NOV No. 5059 along with a discussion of what has been done to resolve or address the issue. A tabular summary of all work undertaken and completed to address issues identified during these two years of operation follows the individual event summaries.

Events

Event #1: June 1, 2006

This event was reported to Ecology in the monthly DMR. The following two permit compliance issues were identified during this event:

1. Issue: Effluent sample was deemed to be non-representative because the discharge sample pump was off.

   Cause: A June 2, 2006 investigation by King County staff found the control switch for the effluent sample pump in the "closed" position. The effluent sample pump is located in the effluent transition structure and pumps the dechlorinated discharged effluent to the auto-sampler and the residual chlorine analyzer. We believe a contractor turned the sample pump to “closed” while working on its moisture sensor and never returned the pump switch back to the "auto" position.

   Resolution: The control switch for the effluent sample pump was put back into "auto" position and tagged to require notification and authorization of any future work on the sampling equipment with off-site supervisor. Also, reminders were issued to off-site staff to verify the pump switch position is in "auto".

2. Issue: No disinfection and dechlorination of the discharged flows.

   Cause: The disinfection and dechlorination systems failed during the June 1, 2006 event because the chemical pumps frequently stopped working. This problem was being investigated when the second discharge event of the month occurred (described below) and the pumps failed again.

   Resolution: Please refer to the event on June 4, 2006 below.

Event #2: June 4, 2006

This event was reported to Ecology in the monthly DMR. The following permit compliance issue was identified during this event:

1. Issue: No disinfection and dechlorination of the discharged flows.

   Cause: The disinfection and dechlorination systems failed during this event since the chemical pumps frequently stopped working.

   Resolution: The second discharge event of the reporting period occurred on June 4, 2006 during heavy localized rainfall. The disinfection and dechlorination system failures were determined to be either a faulty float switch used as an interlock to control the sodium bisulfite pump, or its relay inside the dechlorination vault prevented the sodium bisulfite pumps from engaging. The hypochlorite pumps did not turn on since their interlocks prevented them from engaging without bisulfite pumps operating. As a short term solution, the interlock controls of the float switch were disabled to ensure proper functioning of the systems. The long term solution of replacing the float switch with a pressure transducer was completed in August 2006.

Event #3: November 2, 2006

This event was reported to Ecology in the monthly DMR. The following permit compliance issue was identified during this event:

1. Issue: No fecal coliform sample was collected.

   Cause: The main pumps at the EWCSO treatment facility were cycling on and off during the discharge event due to pump control logic installed at the time.

   Resolution: The pump loop controls were fine-tuned to prevent this from happening again. This problem has been effectively resolved and had not recurred since.

Event #4: November 6, 2006

This event was reported to Ecology verbally at the time of occurrence and was followed up by a letter on November 22, 2006 as well as discussed in the monthly DMR.

The following permit compliance issue was identified during this event:

1. Issue: Disinfection failure due to depletion of hypochlorite inventory at EWCSO.

Cause(s): Multiple factors contributed to the disinfection failure. First, there had been extremely heavy rainfall Nov. 4-6, 2006. According to the National Weather Service's data (Sea-Tac Station), 1.91 inches of rain fell on Saturday, Nov. 4, and 3.29 inches of rain fell on Monday, Nov. 6. The peak discharges out of EWCSO during both events exceeded 275 MGD, with all six main pumps running at 100 percent output. The total discharge on Nov. 4 was 31.4 MG and 49.2 MG on Nov. 6. The combined volume of flow managed at EWCSO facility in these two days was 16.5 percent of the total discharged and 11.4 percent of the inflow the facility received for the whole 2006-07 wet season. These figures provide a measure of the intensity of this particular storm event and the rapid depletion of the hypochlorite inventory.

Second, a hypochlorite delivery ordered on the evening of Saturday, Nov. 4 and scheduled for the morning of Monday, Nov. 6 was delayed due to a traffic jam. King County staff contacted the hypochlorite vendor to expedite the delivery, but was informed that delivery would be delayed even further due to bad traffic resulting from the heavy storms. County staff contacted several alternative vendors only to learn that no hypochlorite could be delivered more quickly than was possible from than the contracted vendor. The hypochlorite truck arrived and was off loaded at around 1515 hours. Disinfection resumed at 1615 hours.

Third, the hypochlorite dosage may have been higher than normal prior to the tanks running empty. We expect that the extremely high flows would have exhausted the county's supply during the second discharge event regardless of dosing level.

Resolution: Such extreme events do not occur often. Operations staff has been directed to order hypochlorite as soon as the tank level drops to the 5-foot mark. A reminder alarm was set up to alert West Point Main Control to impending hypochlorite shortages. Process Control staff also monitors the inventory levels routinely. Section IV of this response report provides additional analysis of the county's future preparedness for extreme events and its efforts to improve disinfection reliability.

Event #5: December 14, 2006

This event was reported to Ecology verbally at the time of occurrence and was followed up by a letter on January 2, 2007 as well as discussed in the monthly DMR.

The following permit compliance issue was identified during this event:

1. Issue: Unregulated discharge on land in the vicinity of the dechlorination structure.

   Cause: Extremely high treated CSO flows discharged from the Elliott West CSO (EWCSO) facility on Thursday, December 14, 2006 during high tide conditions, which caused surcharging of the dechlorination and outfall transition structures at the Denny Regulator Station around noon. Air pressurized in the 96-inch effluent pipe caused manhole covers to open, and resulted in two manhole covers on the dechlorination vault opening. These openings caused unregulated surface discharges until 2:00 p.m. Treated CSO discharges also

leaked out of an access cover hatch on the dechlorination vault. The area flooded by the treated CSO discharges was cordoned off until the surface discharge ceased. The operator was able to secure man-hole covers soon after the surface discharge stopped. The volume of the unregulated surface discharge could not be estimated at the time of the discharge, but offsite staff observed discharge standing six to eight inches above the surface. The discharged volume on that day (88.4 MG) comprised 18.4 percent of the total discharged volume for the 2006-07 wet season. This event also represented 12.5 percent of the total inflow to the facility for that wet season. Here too these volumes illustrate the size of the storm event that led to the surface discharges near the Denny Regulator Station.

Resolution: A hydraulics analysis of EWCSO conducted by an independent consultant indicated that the duckbill valve on the outfall contributed to surcharging of the 96-inch effluent transfer pipe (from EWCSO to Denny Regulator area), the dechlorination vault and the outfall transition structure. The duckbill valve was removed in March 2007 to alleviate the headloss contributing to the surcharging. Removing the duckbill produced immediate benefits, but this event indicates a larger system hydraulics issue that is still being addressed. Additional analysis and work on this issue is discussed in Section IV of this report.

Event #6: January 2, 2007

This event was reported to Ecology by a letter on February 28, 2007 and discussed in the monthly DMR.

The following permit compliance issue was identified during this event:

1. Issue: Disinfection failure due to the hypochlorite pumps' failure to start.

   Cause: Sodium hypochlorite pumps did not engage to initiate disinfection after a discharge event began at 0545 hours on Jan. 2, 2007. The responding operator noticed the power to the chemical pumps' Moore Controller was off and promptly called the startup engineer to investigate the cause of the power failure. The startup engineer noticed the Ground Fault Interruptor (GFI) breaker on the critical instrument circuit, which supplies power to the Moore Controller, was tripped and preventing the Moore Controller from starting the hypochlorite pumps. The GFI had tripped the day before during freeze protection work and went unnoticed until the morning of Jan. 2, 2006. Upon further investigation, the engineer concluded that improper wiring done by the construction contractor led to the breaker trip.

   Resolution: To prevent recurrence, the GFI breaker was replaced with a regular breaker on Jan. 3, 2007. In addition, the startup engineer corrected the improper wiring in the control panel for the critical instrument. Two more alarms have been installed to alert West Point Main Control of problems at the EWCSO facility. The alarms indicate a loss of critical instrument power and any failure of the disinfection or the dechlorination systems.

Event #7: January 7, 2007

This event was reported to Ecology in the EWCSO January 2007 DMR.

The following permit compliance issue was identified during this event:

1. Issue: No online measurement of effluent pH and chlorine residual.

   Cause: The effluent sample pump located in the outfall transition structure kicked out due to a moisture leak alarm on Sunday, Jan. 7, 2007. As a result, the online measurement of both pH and chlorine analyzers was deemed to be non-representative of the effluent. Resolution: The pump was promptly. The moisture sensor run interlock was removed and made an alarm only.

Event #8: May 21, 2007

This event was reported to Ecology verbally at the time of occurrence and was followed up by a letter on May 23, 2007 and in the montly DMR.

The following permit compliance issues were identified during this event:

1. Issue: Disinfection failure due to the hypochlorite pumps failing to start when the discharge event began.

   Cause: The discharge event started at 2334 hours on May 21, 2007. The operator arrived at EWCSO, found that the hypochlorite pumps had failed and promptly reset them. This returned the hypochlorite pumps to operation and disinfection of the discharged flows was restored by 00:11 AM on May 22, 2007. The discharge event continued for approximately another three hours after the restoration of disinfection. The actual cause for the pump failure could not be determined even after a thorough investigation.

   Resolution: The startup engineer simulated discharge event triggers and learned that the hypochlorite pump controls could turn on the pump. No further causes of failure were identified.

2. Issue: Failure to collect fecal coliform sample.

   Cause: Operator overlooked collection of the fecal sample.

   Resolution: Operator was contacted about the oversight and reminded of the need and importance of collecting the fecal sample.

Effluent Violations

In the 2006/2007 wet season four effluent violations occurred over 13 discharge events, spanning over 31 days. Most of these effluent violations were the result of ongoing hydraulics issues and equipment and instrumentation issues within the EWCSO system, including the chemical feed pump controls. All of the events were reported in the monthly DMRs.

Effluent Violation #1: November 2006

1. Issue: Monthly Max Total Residual Chlorine (TRC) of 259 ug/l exceeded permit limit of 44 ug/l, as noted in the monthly DMR.

   Probable Cause(s): Record rainfall during the month, hydraulic limitations and sub-optimal chemical dosing most likely resulted in the effluent monthly maximum TRC exceeding the permit limit.

   Resolution: The startup engineer continued optimizing the hypochlorite and bisulfite dosing in November 2006. At the time, King County could not have done much to alleviate hydraulic limitations. A consultant hired in early 2007 to conduct a hydraulics analysis recommended that the duckbill valve on the outfall be removed to minimize overpressurization in the system. The duckbill valve was removed in March 2007. With no such weather events since March, King County had not yet had a chance to evaluate its effect.

Effluent Violation #2: November 2006

1. Issue: Monthly geomean for effluent fecal coliforms 3382 MPN/100ml exceeded permit limit of 400 MPN/100ml as noted in the monthly DMR.

   Probable Cause(s): Record rainfall during the month (resulting in short contact time), hydraulic limitations (resulting in poor mixing of hypochlorite) and sub-optimum chemical dosing most likely contributed to the monthly geomean for effluent fecal coliforms to exceed the permit limit.

   Resolution: The startup engineer continued to optimize the hypochlorite in the month of November 2006. As a result effort of this effort, the fecal kill during the subsequent months vastly improved and there were no effluent permit violations of fecal coliforms over five events in December 2006 and January 2007 lasting 14 days.

Effluent Violation #3: December 2006

1. Issue: Monthly Max TRC of 105 µg/l exceeded permit limit of 44 µg/l, as noted in the monthly DMR.

Probable Cause(s): Hydraulic limitations during heavy rainfall combined with high tides and sub-optimal chemical dosing resulted in the effluent monthly maximum TRC exceeding the permit limit.

Resolution: The startup engineer continued optimizing the hypochlorite and bisulfite dosing in December 2006. At the time, King County could not have done much to alleviate hydraulic limitations. A consultant hired in early 2007 to conduct a hydraulics analysis recommended that the duckbill valve on the outfall be removed to minimize over-pressurization in the system. The duckbill valve was removed in March 2007. With no such weather events since March, King County had not yet had a chance to evaluate its effect.

Effluent Violation #4: January 2007

1. Issue: Monthly Max TRC of 986 µg/l exceeded permit limit of 44 µg/l.

   Probable Cause(s): The daily maximum TRC of 986 ug/l for the month of January 2007 was based on just 11 minutes of data since the event ended at 0711 hours on January 3rd. The previous day's average effluent TRC was an order of magnitude lower. The data seems to indicate that poor mixing of bisulfite in the dechlorination structure, especially as the discharge event was ending, was a likely cause for incomplete dechlorination of the disinfected flows.

   Resolution: This was an on-going issue and the startup engineer continued to optimize the hypochlorite and bisulfite dosing in the month of January 2007. King County staff determined that chemical mixing system improvements were needed to prevent this situation. Mixing system improvements are in the scope of consultant contract described in Section IV.

Summary of Actions and Improvements

The following table summarizes the items addressed and actions taken over the last two years to identify, diagnose and resolve operational issues at EWCSO. As described earlier, many of these issues emerged, were addressed, and then reemerged. Additional experience operating the facility under varying conditions is adding to the county staff's understanding of the behavior of the facility's various systems.

ELLIOTT WEST COMBINED SEWER OVERFLOW FACILITY

COMPLETED WORK

#	ITEM	ISSUE ADDRESSED	STATUS
Elliott West Pumping Modifications			
1	CSO discharge pump control modifications to minimize Elliott CSO facility from cycling in and out of CSO treatment mode.	Minimize the frequency of EWCSO transition between storage and treatment modes and consequently improve effluent residual chlorine compliance.	Completed - January 07
Elliott West Dewatering Sump Pumps - Flow Measurement and Sampling			
2a	Flow meter added to dewatering pump discharge piping.	Capture the CSO flow volume returned to West Point by the dewatering sump pumps.	Completed - May 06
2b	Dewatering sump pump flow sampling	Sampling of the dewatering sump pump flows returned to West Point.	Completed - May 06
2c	PLC modifications for sampling frequency of the dewatering sump flows	Flow proportional sampling of the dewatering sump pump flows.	Completed - May 06
2d	Air relief valves added to dewatering pumps.	Dewatering sump pumps were getting frequently air bound.	Completed - March 06
2e	Dewatering pump discharge piping extended nearer the bottom of the dewatering drop structure.	Pump discharge was causing turbulence and release of high H_2S levels and odors in the pump discharge room.	Completed - August 06
Dechlorination System Modifications			
3a	Sample piping in the dechlorination vault extended to get pre-dechlorination sample.	Dechlorination sample (DSAM) pump piping installed incorrectly. DSAM pump was collecting post dechlorinated sample, not pre-dechlorinated sample.	Completed - Fall 06
3b	Stilling well for Pre-dechlorination residual sample pump installed in the Dechlorination structure.	Collection of pre-dechlorinated sample by the DSAM pump for pre-dechlorination residual chlorine analyzer.	Completed - Fall 06

ELLIOTT WEST COMBINED SEWER OVERFLOW FACILITY COMPLETED WORK			
#	**ITEM**	**ISSUE ADDRESSED**	**STATUS**
3c	Pre-Dechlorination Residual Chlorine Analyzer installed at Denny Regulator.	To measure pre-dechlorination residual for replacing flow paced chemical dosing with feed back loop based chemical dosing.	Completed - December 06
Chemical System Instrumentation			
4	Dechlorination Feed loop controls modified from flow-paced only to flow-paced and residual control.	Existing flow paced chemical dosing found to be inadequate in meeting permit compliance on effluent residual chlorine.	Completed - Fall 06. Further improvements are needed.
5	Chlorination-Dechlorination system reliability improvement: permissive/Alarms modifications.	Unnecessary permissives/alarms were frequently shutting the chemical systems off.	Completed - January 06
6	Alarms added to notify West Point Main Control Centre of Disinfection and/or Dechlorination system failures.	These alarms were originally located only at EWCSO. Since the EWCSO is normally an unstaffed facility, relaying these alarms to West Point is critical for timely response.	Completed – June 07
Effluent Sampling and Monitoring Improvements			
7	Transition (TSAM) and dechlorination structure (DSAM) sample pump Interlock modifications.	Moisture leak alarm interlocks on pump seals were shutting off the TSAM & DSAM pumps and consequently disinfection and dechlorination systems.	Completed - January 07
8	Effluent Auto-sampler reliability improvements.	Sample dilution from city water due to failing solenoid valves on the sampling system.	Completed - Summer 06
9a	Effluent Residual Chlorine Monitoring Improvement - Analyzer upgraded from colorimetric to amperometric.	Interference with the colorimeteric analyzer's (Hach CL17) performance during the events with high effluent solids.	Replaced CL17 with Micro2000 TRC analyzer - Summer 06
9b	Effluent Residual Chlorine Monitoring Improvement - Analyzer sampling setup modification.	Flow to the Micro 2000 sample cell is by gravity as opposed to having to pressurize the sample into sample cell of CL17 analyzer.	Completed - Summer 06

ELLIOTT WEST COMBINED SEWER OVERFLOW FACILITY

COMPLETED WORK

#	ITEM	ISSUE ADDRESSED	STATUS
Dechlorination Structure			
10a	Addition of vent structure on Dechlorination structure to provide air relief.	Over pressurization of the dechlorination vault hatch under high flow conditions.	Design being revised
10b	Replacement of bisulfite pump level interlock float switch with level transducer.	Float switch was getting stuck in closed position due to rag build up thereby preventing the bisulfite pump from turning on.	Completed Summer 2007
Elimination of Non CSO Flow into Mercer Tunnel			
11	Cleaning of City of Seattle sewers	Non CSO overflows from City of Seattle sewers into Mercer CSO tunnel under dry conditions.	Summers of 2006 & 2007
Dewatering Drop Structure - Odors & Corrosion			
12	Addition of neoprene flap gate at station drain connection to EBI.	Odors and corrosion in the pump discharge room from the air being vented from the Elliott Bay Interceptor (EBI) during non CSO conditions.	Completed - Fall 06.
13	Extension of Odor Control duct to dewatering drop structure.	Release of odors and corrosive gases from the turbulence generated as the dewatering sump pump flows discharged into the drop structure connecting the pump discharge channel to the 36" connecting sewer to EBI.	Completed – Fall 06
Dewatering Sump Pumps - Level Controls			
14	Replacement of Low Level float with pressure transducer in dewatering wet well sump.	Floats serving as the backup controls for the pump were failing due to ragging up and getting ripped off in high flows.	Completed - September 06
Returned Flow by Main Pump - Sampling			
15	Addition of a booster pump to supply the sample of flows returned to West Point by the main pumps.	Loss of suction due to sampler being too far away from the sample line.	Completed – May 06
EWCSO Power System			
16a	Installation of critical equipment power loss alarm.	There was no local alarm installed to indicate a GFI breaker on the critical equipment circuit was tripped. This led to a disinfection failure.	Completed - January 07

ELLIOTT WEST COMBINED SEWER OVERFLOW FACILITY COMPLETED WORK			
#	ITEM	ISSUE ADDRESSED	STATUS
16b	Installation of auto-restart of the Elliott West CSO station following a power outage.	In the past, the power to EWCSO had to be reset manually following a power outage. This could potentially lead to untreated discharges if an operator is not present at the station at the time of power outage.	Completed - January 07
Hydraulics Analysis			
17a	Consultant performed hydraulics analysis of EWCSO effluent pipeline, dechlorination and outfall transition structures.	Hydraulic limitations under high flow and/or high tide conditions contributing to over-pressurization, surface discharges and poor chemical mixing.	Completed - February 2007
17b	Removal of duckbill valve on the EWCSO outfall.	Duckbill valve was found to be responsible for significant head loss based on the hydraulics analysis.	Completed - March 2007

IV. Steps that ARE BEING TAKEN to Achieve Optimum Operation of the Facility and Bring Operations into Compliance with Permit Conditions

Continuing Work of Seattle's Dry-Weather Inflow to Tunnel

The county determined that sediments in the City of Seattle's system cannot be managed by their cleaning efforts. Therefore King County will initiate weir modifications at the Valley Street connection to prevent further dry-weather flow from entering the Mercer Tunnel. As this may hamper the city's CSO control effort along East Lake Union, these weir modifications can be reversible if the City can find and correct the sources of the sediment. Final discussions between the city and King County occurred Sept. 26, 2007, with hope that a collaborative process will proceed toward completing the necessary refinements and achieving CSO control at the relevant facilities.

Work Being Done at Elliott West by King County to Address Facility Deficiencies

The table below summaries the work that is underway or being planned by King County staff or contractors to diagnose and successfully address operational problems in the Elliott West system.

WORK IN PROGRESS			
#	ITEM	ISSUE TO BE ADDRESSED	STATUS
Screening			
1	Improve screenings removal	Existing screens are not effectively removing floatables. Consultant contract to address screening improvements.	Ongoing work under consultant contract
Returned Flow by Main Pumps - Sampling			
2	Modify the sampling pipe intake to ensure collection of composite sample.	Loss of suction due to sampler being too far away from the sample intake.	To be completed in October 2007
Returned Flow by Dewatering Sump Pumps - Sampling			
3	Relocate the dewatering composite sampler closer to the dewatering sump pumps.	Current location of the sample intake on the discharge piping was at times under negative pressure.	To be completed in October 2007
EWCSO - Power			
4	Installation of automatic transfer switch	Currently, power to EWCSO needs to be switched manually if the power supply to the facility is switched to alternative feeder.	To be completed by combination of consultant contract and work order contract
Chemical System Improvements			
5a	Hypochlorite mixing equipment upgrade	Inadequate mixing is causing poor disinfection of discharged flows and excessive usage of hypochlorite.	Ongoing work under consultant contract
5b	Bisulfite mixing equipment upgrade	Inadequate mixing is causing poor dechlorination of discharged flows and excessive usage of sodium bisulfite.	Ongoing work under consultant contract
5c	Pre-dechlorination sample system installation.	Existing sampling system is need of replacement due to poor design, location and corrosion.	Ongoing work under consultant contract
5d	Feedback loop control installation for disinfection and dechlorination systems to optimize chemical usage and meet permit compliance.	Existing controls are inadequate for optimal chemical dosing.	Awaiting completion of pre-dechlorination sampling system (see item 5c above).
Dechlorination Structure Modifications			
6	Addition of an above ground structure over the dechlorination structure to overcome hydraulic grade line limitations.	During large storm events, the hydraulic grade line (HGL) in the Elliott West Effluent Pipeline is higher than the tops of the dechlorination structure and the transition structure, forcing flow to escape the structures and flow overland through Myrtle Edwards Park and into Elliott Bay.	Ongoing work under consultant contract

Consultant Contracts for Continuing the Investigation of Problems and Solutions for the Elliott West System

King County sought permission from the King County Council in late 2006 for an emergency procurement waiver (granted Dec. 15, 2006) to contract quickly for engineering and design services for the Mercer/Elliott West system as noted in Table 2. This contract was initiated to: (1) determine the cause of a sewer overflows in Myrtle Edwards Park; (2) design solutions to prevent such overflows; and, (3) achieve permit compliance for the Elliott West facilities. This work is being undertaken in phases to provide: 1) analysis of current operating conditions and identification of design-related issues that limit the system's effectiveness; and, 2) to provide technical and design expertise in order to recommend effective solutions and initiate steps toward implementation of the appropriate remedies selected achieve optimum operation and compliance with all NPDES permit conditions.

Preliminary Investigation and Action

King County recognizes the operational issues with the Elliott West System require significant analysis and remediation, and in some cases, significant modification to the system.

Initial work undertaken in early 2007 evaluated and suggested modification to the facility after the system failed to operate as designed during the 2006 storms. The scope for this work included initial evaluations of: 1) screens and solids overflow from screening area; 2) sodium hypochlorite mixing; 3) effluent samplers; and, 4) structure hydraulics in Myrtle Edwards Park (dechlorination and transition structures). Initial conclusions and recommendations of this investigation were presented in a draft Technical Memorandum *Elliott West CSO Facility Evaluation, Tetra Tech, Inc. August 20, 2007* (Appendix C). This analysis identified the need to remove the duckbill valve.

The next phase of work will launch into design and construction support services for design of essential modifications determined necessary to improve the facilities operations. This work will include a flow analysis, operations analysis, and an examination/evaluation of any additional physical modifications to the facility in order to comply with all NPDES permit conditions (Appendix D).

At Myrtle Edwards Park facilities:

- Raise the top elevation of the dechlorination structure.
- Replace or modify the sodium bisulfite mixers in the dechlorination structure.
- Replace or modify the sampling pumps in the dechlorination structure.
- Replace subgrade under the plaza/landing slab adjacent to the Denny Way Regulator Station.
- Re-armor the rip-rap slope around the plaza/landing.
- Modify the lid to the outfall transition structure.
- Augment landscaping and artwork around the plaza/landing.

At the Elliott West CSO Treatment facility:

- Replace the hypochlorite mixing equipment

System-wide analyses

- A flow analysis and assessment to determine if the quantity of flow arriving at the facility is consistent with the original design assumptions.
- An estimate of solids loading and concentrations at the facility.
- System analyses to determine whether operation of the Interbay Pump Station and Elliott Bay Interceptor (EBI) flows are consistent with the original design assumptions.
- An assessment of treatment performance of the facility based on currently installed equipment.
- Identification of corrective actions that may be implemented to bring the facility into compliance with regulatory requirements.

In conclusion, actions taken to date and on-going efforts demonstrate King County's commitment to ensuring these facilities operate effectively. All the efforts described above represent significant investments of time, funds and personnel to make these facilities function well. The contract services described above are an additional investment of approximately $1 million and will identify future needs. We intend, as we have since the startup of this facility, to communicate openly and frequently with Ecology about our progress.

List of Appendices – Appendices not included with this annual report – they are available on request

Appendix A – Status Materials shared with Ecology at meeting from 2005 -2007

Appendix B – Dry Weather Discharge Actions – Chronology events

Appendix C – Draft Technical August 2007

Appendix D – Draft Scope from Design services for the Denny Way/Elliott West CSO Project – Elliott West Modifications

Appendix D. Henderson/Norfolk CSO Control Facilities, June 2006-May 2007

This report summarizes the performance and operation of the Henderson/Norfolk CSO Treatment Facility during the June 2006-May 2007 reporting year. This document constitutes the second annual report of the Henderson/Norfolk CSO facility. The facility operates under Washington State Department of Ecology NPDES permit WA-0029181-1, effective until December 31, 2008. Table D-1 summarizes the permit limits for the Henderson/Norfolk CSO facility. One untreated CSO discharge event is allowed each season when determining permit compliance.

Table D-1. Henderson/Norfolk CSO NPDES Permit Limits.

Parameter	Discharge Limits (Monthly)	Discharge Limits [a] (Yearly Average)	Discharge Limits [b] (Long-term Average)
Suspended Solids Removal, % [c]	NA	50%	NA
Settleable Solids, ml/l/hr	1.9 Max per event	0.3	NA
Number of Events per year	NA	NA	NA
Discharge Volume, million gallons/yr	NA	NA	NA
Fecal Coliform, cfu/100-mL	400/100	NA	NA
	Average Monthly	**Maximum Daily [d]**	
Total Residual Chlorine, μg/L	NA	39	

[a] The yearly limitations will be calculated using per-event data points. Data shall be collected and reported on a schedule concurrent with the annual CSO report, June 1 to May 31, to include the entire wet season for purposes of determining compliance with these limitations.

[b] Long-term average will be calculated using data collected over a full permit cycle. Data shall be collected and reported for the period of the permit cycle prior to permit renewal.

[c] The total removal efficiency for TSS is to be calculated on a mass balance basis as the percent of solids captured at the CSO Treatment Plant and then permanently removed at the West Point Treatment Plant based on the estimated removal efficiency at West Point.

[d] The maximum daily effluent concentration determined from a continuous measurement is calculated as the average of the pollutant concentrations measured over the day.

Operationally, the Henderson/Norfolk Tunnel fills when the inlet regulator gate modulates (closes) based on the wastewater level in the Henderson Trunk. Wastewater backs up behind the Inlet Regulator gate into the 72-inch Regulator Influent Tunnel. Eventually wastewater overflows the inlet weir of the storage/treatment tunnel. Wastewater is disinfected with 12.5% sodium hypochlorite solution as it flows into the tunnel. After the event is over, wastewater stored in the tunnel is drained to the Henderson Trunk for treatment at South Plant or West Point. Settled CSO overflows from the tunnel into the Henderson/Norfolk Outlet Regulator. The settled CSO is dechlorinated with sodium bisulfite, and passed through fine screens to remove floatable debris. The treated CSO is discharged to the Duwamish River through the Treated CSO Pipeline. The pipeline connects to the Norfolk Regulator outfall downstream of the Norfolk Regulator.

The 2005-06 season was the first time the Henderson/Norfolk CSO Treatment Facilities were available for use. During that year, these facilities did not store or treat CSO. Mechanical and program control errors with the inlet regulator gate were the primary reasons. The problems with the inlet regulator gate were identified and corrected, and operated as intended during this second wet season. Thus, the 2006-07 season was really the first opportunity to operate and fine-tune this complex facility under actual storm conditions.

November 2006 was the first time that the Henderson/Norfolk CSO facility discharged treated CSO. November and December 2006 brought several large storms and intense rain. Approximately one-third of the annual rainfall occurred during two storms occurring November 2–15 (8.67 inches) and December 9–15 (4.12 inches). 1.8 inches of rain fell on 12/14 alone. Although producing less total rainfall than the November storm, the December storm was extremely intense. These rains accompanied by winds up to 70 miles per hour, power outages and flooding severely impacted the County's sewer system. Power was supplied at the Henderson Tunnel inlet and outlet structures with backup generators during the Dec. 14-15 CSO event.

Table D-2 summarizes performance of the Henderson/Norfolk CSO treatment plant in 2006-07. There were were 7 inflow events into the Henderson Tunnel and 3 treated discharge events out of the Norfolk CSO outfall. The total inflow and discharge volumes for the reporting period were 23.0 and 9.0 MGD, respectively.

Table D-2. Henderson/Norfolk CSO Permit Performance in 2006-07

Parameter	Performance	Permit Conditions
Number of Events in year	3	NA [a]
Total Volume in year, million gallons	9.0	NA [a]
Settleable Solids, Avg. Annual, ml/l/hr [c]	0.1	0.3
Settleable Solids, Max Event in Year, ml/l/hr	0.2	1.9
Suspended Solids Removal, Annual [c]	75.6%	50%
Fecal Coliform, Maximum Monthly Geometric Mean, cfu/100-mL [b]	325	400
Total Residual Chlorine, Highest Max Daily, ug/L [b]	300	39

[a] Compliance assessed over a 5-year average..
[b] The fecal coliform and total residual chlorine permit limits went into effect Jan. 1, 2006.
[c] 12/11-15/07 designated as the "one untreated event per year" and dropped from annual solids compliance calculations.

All permit conditions were met in 2006-07 except for the 39 μg/L maximum daily chlorine limit. The max-day chlorine limit was exceeded in November and December; there was no discharge in Jan. 2007. The annual and maximum settlable solids permit limits were met, as was the monthly fecal coliform limit.

A misapplied control system – rather than storm flows - resulted in flow going to the tunnel on Dec. 11-13. An old PLC program was inadvertently reloaded into the control system after a PLC failure earlier in the month. The old program prematurely diverted flows into the tunnel. The correct program was subsequently reloaded into the PLC, and a new level signal was selected for regulating the inlet gate. Samples collected Dec. 11-13 were used to determine permit compliance.

The influent TSS sample from the January 5-6 event was lost. Nonetheless this sample was used to calculate annual %TSS removal by assuming no influent lbs-TSS for that event. This provides some conservatism in the annual %TSS calculation.

Table D-3 summarizes the last 5 years of performance.

Table D-3. Five-Year Average of Events and Flow

Year	Discharge Flow, MG	Treated Discharge Events	Number of Once per Year "Untreated" Event
June 05 – May 06	0	0	None
June 06 – May 07	9.0	3	1 – 12/11-15/07 removed
5-year average	**NA**	**NA**	**NA**

Dechlorination System Challenges

The maximum daily chlorine residual was exceeded on all three discharge events. The effluent Cl_2 values for the three discharge events averaged 188, 210, and 300 μg/L, respectively. A manual field method was used to confirm compliance with the 39 μg/L permit limit. Effluent samples were collect at the Outlet Regulator Structure. An on-line chlorine analyzer with a detection limit of 50 μg/L can monitor Cl_2 levels at the tunnel outlet. The analyzer receives its sample from the effluent sample pump. This analyzer is used for process monitoring only.

The inability to meet the Cl_2 limit in November was mostly due to an inconsistent application of bisulfite. For example, the effluent Cl_2 on the 0-2 hour sample was 390 μg/L while the Cl_2 residual on the 4-8 hour sample was 5 μg/L. The effluent Cl_2 monitor did not work during the first discharge event because the effluent sample pump failed. The effluent sample pump was replaced November 11. The effluent Cl_2 residuals were measured manually in the field.

The inability to meet the Cl_2 limit in December was due to a failure of the bisulfite dosing system. In fact, no bisulfite was applied during any of the December discharge events. This was mainly due to the bisulfite pumps being gas-bound (bisulfite solution will off-gas). Vent lines were subsequently installed on the bisulfite pumps in January 2007 to address this problem. The effluent Cl_2 residuals in December, which were produced without bisulfite addition, suggests that the hypochlorite disinfection dose was appropriate; the hypochlorite dose in December averaged 4.2 mg/L

Difficulties obtaining a reliable effluent Cl_2 measurement also played a role in the lack of dechlorination. Not having a reliable effluent Cl_2 measurement made it difficult for operators to make appropriate process changes. For example, the effluent Cl_2 residual analyzer was not getting the appropriate sample during December events due to a malfunction of the float switch that controls whether effluent flows through the analyzer or only potable water to keep the analyzer moist.

Several changes were made to increase the ability of staff to monitor the dechlorination process, and make appropriate changes. Adjustments were made to the float switch to make sure effluent flows through the sampler during discharge events. Sample access ports were also installed to allow operators to manually checked Cl_2 residuals before and after bisulfite addition. The effluent sample pump is also checked on a weekly basis.

The hypochlorite dosing pumps operated properly during all filling events. These pumps are flow-paced controlled. The bisulfite dosing pumps are also flow-paced controlled. Both pump's stroke length can be manually adjusted based on Cl_2 measurements. There is no on-line instrument to measure chlorine residual prior to bisulfite addition.

Table D-4 Summary of Henderson/Norfolk 2006-07 Event Data

Month	Day	Hen/Nor Inflow Event Number	Hen/Nor Inflow Volume (MGD)	Hen/Nor Discharge Event Number	Hen/Nor Discharge Volume (MGD)	Hen/Nor Total Influent TSS (lbs)	Hen/Nor Total Effluent TSS Discharged @ Hen/Nor + WP (lbs)	Hen/Nor % TSS Removal	Hen/Nor Effl. Settl Solids (ml/l/hr)	Hen/Nor Effl. pH	Hen/Nor Avg Effl. Fecal Coliform(#/100 ml)	Hen/Nor Effl. Residual Chlorine (ug/l)
June	-											
July	-											
August	-											
September	-											
October	-	-	-	-	-	-						
November	4	1	0.29	1		358	32					
	6	1	5.33	1	3.3	4267	1186		0.20	7.1	0	188
	12	2	0.13			37	3					
	22	3	0.41			123	11					
	Event/Daily Max								0.2	**7.10/7.10**	10	188
	Mon. Total/Avg	**3**	**6.2**	**1**	**3.3**	4785	**1232**	16.1%	0.2		3	68
December	11	1	2.81			1266	101	92.0%	-	-	-	
	12	1	0.81			365	29	92.0%	-	-	-	
	13	1	0.39			176	14	92.0%	-	-	-	
	14	1	5.77	1	3.82	5871	3166	46.1%	0.10	7.0	2160	210
	15	1	0.77	1	1.01	783	776	1.0%	0.10			
	26	2	1.0			284	23	92.0%				
	27	2	3.31	2	0.88	939	278	70.4%	0.10	7.2	49	300
	Event/Daily Max								0.10	7.0/7.2	2160	300
	Mon. Total/Avg	**2**	**14.9**	**2**	**5.7**	9682	**4387**	54.7%	0.10		325	255
January	2	1	1.31			415.1652	37	91.1%	-			
	5	2	0.88			NM	NM	NM				
	6	2	0.23			NM	NM	NM				

Month	Day	Hen/Nor Inflow Event Number	Hen/Nor Inflow Volume (MGD)	Hen/Nor Discharge Event Number	Hen/Nor Discharge Volume (MGD)	Hen/Nor Total Influent TSS (lbs)	Hen/Nor Total Effluent TSS Discharged @ Hen/Nor + WP (lbs)	Hen/Nor % TSS Removal	Hen/Nor Effl. Settl Solids (ml/l/hr)	Hen/Nor Effl. pH	Hen/Nor Avg Effl. Fecal Coliform(#/100 ml)	Hen/Nor Effl. Residual Chlorine (ug/l)
	Event/Daily Max											
	Mon. Total/Avg	2	2.4			415	37	91.1%				
Total		7	23	3	9	14883	5656					
Annual Avg/GEM								62.1%	0.1		168	174
Min/Max or Max									0.2	7.0/7.2	325	300

Table D-5 2006-07 Henderson/Norfolk Annual Values

	No.of Dischage Events	Inflow Volume (MGD)	Discharge Volume (MGD)	Total Hen/Nor TSS lbs-in	Total Hen/Nor /WP TSS lbs Discharged	Annual Average Hen/Nor %TSS Recovery	Annual Average Hen/Nor Settleable Solids (ml/l/lhr)	Event Maximum Hen/Nor Settleable Solids (ml/l/lhr)	Maximum Monthly Geomean Hen/Nor Effl. Fecal Coliforms (#/100 ml)	Maximum of Daily Averages of Hen/Nor Effl. Res. Cl2 (ug/l)
Including All Events	3	23	9	14883	5656	62.1%	0.1	0.2	325	300
Excluding December 11-15th Event				6423	1569	75.6%				