Combined Sewer Overflow Control Program

2005–2006 Annual Report

October 2006

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

For comments or questions, contact:
Karen Huber
King County Wastewater Treatment Division
CSO Control Program
201 S. Jackson St.
KSC-NR-0512
Seattle, WA 98104-3855
206-684-1246
karen.huber@metrokc.gov

Alternative Formats Available
206-684-1280 TTY Relay: 711

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

October 30, 2006

Ms. Karen Burgess
Washington State Department of Ecology
3190 160th Avenue SE
Bellevue, WA 98008-5442

Dear Ms. Burgess:

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, 2005/2006 overflow volume and frequency information.

During this reporting period, the total volume of untreated CSOs was approximately 436 million gallons compared to a baseline of 2,339 million gallons. The volume of 436 million gallons is a 81 percent reduction in CSO volume over the 1981-1983 baseline average.

Significant progress was made in starting up the complex Mercer tunnel and Elliott West treatment and storage facilities that came on line May 2005. As can be expected in such a facility, modifications and refinements to equipment and controls have been needed. Refinements to complete control at both facilities are underway.

The Henderson/Norfolk project was also completed in May 2005. The tunnel has not yet filled, suggesting that some controls need balancing.

Carkeek and Alki performed well, meeting permit limits.

The report informs Ecology that predesign of the first RWSP CSO control projects – at the Puget Sound Beaches – will begin early 2007.

Please call me at 206-684-1551 or Karen Huber at 206-684-1247 should you have any questions.

Sincerely,

Don Theiler
Division Director

DT:jp

Enclosure

cc: Greg Bush, Manager, Planning & Compliance (P&C) Section, Wastewater Treatment Division (WTD)
Karen Huber, Wastewater Engineer IV, Comprehensive Planning & Technical Resources (CPTR) Unit, P&C, WTD
John Phillips, Water Quality Planner III, CPTR, P&C, WTD
Laura Wharton, Supervisor, CPTR, P&C, WTD

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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 the CSO 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 the 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–King County area.

Report Requirements

This report is prepared and submitted to the Washington State Department of Ecology in accordance with the requirements established in the West Point Treatment Plant 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, and

(2) CSO volumes and frequencies for June 1, 2005, through May 31, 2006.

During this reporting period, the total volume of untreated CSOs was approximately 436 million gallons compared to a baseline of 2,339 million gallons. 436 million gallons represents 1.1 percent of flow from the West Service Area, and is a 81 percent reduction in CSO volume over the 1981-1983 baseline average.

This report includes the first operational reports for the Henderson/Norfolk CSO Treatment Facilities and the Mercer/Elliott West CSO Treatment Facilities. Significant progress was made in starting up the complex Mercer tunnel and Elliott West treatment and storage facilities that came on line May 2005. While some refinements in the operating protocols remain to be done to achieve full control at Denny and Dexter Regulators, much has been accomplished. Of the volume of CSO to be managed at the Mercer/Elliott West facilities 38.4 percent was captured

and received full secondary treatment, 61.4 percent received primary treatment and disinfection, and only 0.2 percent was discharged untreated at Denny regulator. The number of untreated discharges went from 32 per year to just seven small ones. At Dexter Regulator, the number of events was unchanged, but they were very small in volume. Seventy-four percent of the volume that had previously discharged untreated at Dexter now received full secondary treatment. The Henderson/Norfolk project was also completed in May 2005. One-hundred percent of the volumes that previously discharged untreated at those CSOs was captured and received full secondary treatment and disinfection. The tunnel has not yet filled.

In addition, this report includes a report on the Alki and Carkeek CSO Treatment Plants new fecal coliform and chlorine limits; and a discussion of the initiation of the first Regional Wastewater Services Plan (RWSP) CSO projects at South Magnolia, North Beach, Barton Street and Murray Avenue.

Figure 1. King County CSO Locations

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 CSO control 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 CSO Update)—was included in the June 2000 submission of the West Point Treatment Plant NPDES permit renewal application. The 2000 CSO 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, documents its compliance with state and federal CSO control requirements, and identifies two large control projects—Denny Way/Lake Union and Henderson/MLK/Norfolk CSO Control Projects—for completion in the next 5-year NPDES permit cycle.

The resulting Mercer/Elliott West and Henderson/Norfolk CSO Treatment Facilities came online in spring 2005. The West Point NPDES permit was modified to include requirements for these facilities. The modification set effluent limits that are similar to the limits for the Carkeek and Alki CSO Treatment Plants. The modification also requires the reevaluation of public notification approaches for the entire CSO control program and the assessment of any opportunities to provide more immediate overflow information to the public.

The *2006 CSO Control Program Review, required in the RWSP,* went to the King County Council in April 2006. Ecology will receive the CSO Control Plan Update in 2008 as part of the NPDES permit renewal application.

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 EPA's codified CSO Control Policy. These programs are summarized in Table 1.

As shown in the Table 1, the 2005 modifications of the West Point NPDES permit contain a new requirement for the Public Notification and Posting Program.

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 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.
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.

Nine Minimum Controls	King County Compliance Effort
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 treatment plants.
Elimination of CSOs during dry weather	King County's maintenance and operation programs focus on preventing dry-weather overflows. Dry-weather overflows may occur as a result of equipment malfunction or loss of power. The conveyance system is monitored through SCADA, and 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. Dry-weather overflows are reported to Ecology as sanitary sewer overflows.
Control of solid and floatable materials in CSOs	City of Seattle catch basin maintenance limit introduction of floatable materials to sewers. City of Seattle is running a street sweeping pilot project in Southeast Seattle, West Seattle, and Duwamish Watershed neighborhoods is underway to look at routine street sweeping's affect on water quality. This should have a positive impact on the County's floatables control. The majority of floatables in 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 screen any floatables that may remain. Any additional floatable control found to be needed will be addressed in future CSO projects. Procedures to record observations of floatable materials are being revisited.
Pollution prevention programs to reduce contaminants in CSOs	King County has implemented both the Industrial Waste Program and the Local Hazardous Waste Management Program to reduce discharge of chemicals and other substances that adversely impact the environment and the wastewater treatment process.
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, an information phone line, Web site, brochure, and other public outreach activities. The recently modified NPDES permit requires the County to conduct a study to determine the feasibility of providing more immediate public notification of overflows, including the possibility of providing a Web-based system. A draft report was submitted to Ecology July 1, 2006. King County is addressing Ecology's comments on the draft and the response is due December 1, 2006. A final report is due July 1, 2007. The final report will include public involvement activities related to the notification plan. The County and City will discuss the possibility of doing the study jointly, as was done for development of the original CSO Notification and Posting Program.
Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls	Beginning in 1986, King County's sampling program included collecting data for five CSO sites per year. Sampling was expanded to meet Sediment Management Standards' needs in the 1990s. This characterization was completed. The King County 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. King County may undertake additional sampling on completion of specific CSO control projects.

[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.
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. Further modifications in 2005 of the chlorine system and addition of a dechlorination system
63rd Ave. Pump Station	Diversion of overflows to the West Seattle Tunnel or Alki CSO plant.	1998	Modification in 2005 of chlorination system and addition of dechlorination system

Project	Description	Completion Date	Status
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	Construction completed; start up discussion in Section 1.2.2
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	Construction completed; start up discussion in Section 1.2.2

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 Cap	Pilot sediment remediation project	1990	Ten-year data review of pilot remediation project is due in early 2006. Sediment remediation of area in front of original discharge is expected to be completed in 2007.
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.

Project	Description	Completion Date	Status
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 CSO 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.
Carkeek Overflow Reduction Study	Resulted in projects to improve operational controls and to upgrade the pumps that transfer flow to West Point to increase their capacity from 8.4 to 9.2 mgd.	2003	Study was completed in 2003; the recommended increase in pumping capacity was completed in 2005.
Norfolk Sediment Remediation	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] This project was 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 clean ups in the Lower Duwamish Superfund site.

1.3.2 New and Recent CSO Projects

Denny Way/Lake Union Sediment Monitoring

Post-operational sediment sampling will begin in 2006. Surface sediment samples from 16 stations will be collected and analyzed for sediment chemistry and benthic infauna. Some sediment toxicity testing may also be performed on a subset of the samples. Monitoring the sediment near the outfall was part of the requirements for the Section 7 consultation for the U.S. Army Corps of Engineer permit.

Ballard Siphon Emergency Replacement

A system maintenance project will provide an opportunity to achieve early CSO control of the Ballard, and possibly the 11th Ave. NW, CSOs. In November 2005, King County conducted a sonar inspection of the Ballard Siphon Pipes. 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 have been present and how long the pipe will last. A contingency plan has been prepared if the pipeline fails. King County is designing a project to replace the existing siphon

constructed in 1935 and expect to start construction in early 2007. The new siphon should reduce CSOs in the area.

Barton Street Pump Station Forcemain Emergency Repair

On January 17, 2006 King County responded to a break in the forcemain caused by wear of the pipe over the past 50 years. This initial break was repaired by January 25. Inspection of the pipe by television cameras revealed a significant amount of damage to the bottom of the pipe. King County formed a project team to design alternatives for replacing the forcemain immediately.

On February 4, the forcemain ruptured again further upstream from the January break. King County began the replacement of the forcemain at that time. In three months the forcemain had been repaired and replaced. An emergency pump station and temporary bypass pipe was installed within a week of the second break. Overflows from the Barton Street Pump Station were reported to Ecology as sanitary sewer overflows (SSO) and not CSOs. Therefore, the volume of discharges is not discussed in this report.

Puget Sound Beach Projects

Four projects have started predesign during the period of this report. Four projects are referred to as the Puget Sound Beach Projects: South Magnolia, North Beach, Barton Street and Murray Avenue. King County underwent a consultant selection process for these projects in late summer 2006. Also the King County project manager formed an internal team and started public outreach.

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 March 2005.

The project consisted of three major elements, the East Portal 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 treatment facility was designed to treats flows that exceed the capacity of the tunnel, expected to occur about 14-20 times per year.

During the first year of operating these CSO facilities King County faced several challenges - not unexpected for such large and complex systems. The seasonal and intermittent operation of these facilities prolongs the commissioning period. Operation of the facilities was further complicated by the steady stream of non-CSO flows from City of Seattle sewers that were overflowing into the Mercer Storage and Treatment Tunnel.

A large hurdle to effective operations was the substantial amounts of dry weather flows entering the Mercer Storage and Treatment Tunnel. These flows were reducing the tunnel's storage capacity for the CSO flows by 1-2 million gallons, causing pump damage and complicating

treatment compliance. Investigation by King County determined that these dry weather flows resulted from extensive sedimentation of the City of Seattle's sewers upstream of the tunnel, causing base flows to backup and overflow into the tunnel.

To correct this, the City of Seattle conducted an extensive pipeline cleaning. Eighty tons of sediment, mainly sand and gravel were removed from the sewer lines. Since the conclusion of the cleaning operations in the summer, this source of dry weather flow has been removed from entering the Mercer Tunnel. Seattle will clean one last section of pipe in the near future to assure dry weather flows will no longer be an issue.

A number of items concerning the operation of these new and complex CSO control facilities were identified during this first wet season of operation. Facility modification and sampling system changes assure to improve the operators ability for improving regulatory compliance and have been addressed or are being addressed by King County. 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 the project's control goals.

Full control is expected to be achieved in the 2006-2007 period. In the 2005-2006 reporting period there were 16 discharge events from the Dexter CSO, and six events from the Denny Way CSO.

For information about the performance of the Elliot West CSO Treatment Facilities see Section 2.3.4 and Appendix C.

Henderson/Norfolk CSO Control Project

The Henderson/Norfolk CSO control project was implemented to control the Henderson, Martin Luther King CSOs into Lake Washington, as well as 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. Chlorination and dechlorination of flows exceeding the capacity of the storage and treatment tunnel will be provided and treated discharges will occur at the Norfolk CSO in the Duwamish Waterway approximately 2-4 times per year. Base flows, and settled solids and stored flows from the tunnel, are conveyed to the South Plant at Renton or West Point, depending on capacity in the Elliot Bay Interceptor, for secondary treatment.

During this reporting period the treatment tunnel did not operate, and there were no discharge events from any of the facilities controlled by this project. While it appears the project was successful, it will require the return of a more normal rain pattern to fully assess effectiveness along with some level settings adjustments made in the first year of operation. As a result, little startup experience with the tunnel facilities has been gained. Limited problems encountered with the new system included automatic control settings and an electrical short in a control panel in the inlet regulator station. These problems have been corrected.

For information about 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 2005 CSO 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
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 will be in pre-design 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 tested at the Interbay Pump Station. This strategy will provide storage capacity in the upper portion of the interceptor 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 will occur in 2005–2007; a new updated control program is targeted for 2007–2009.

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 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 of Seattle and King County, the City maintains the stormwater system, develops compliance schedules, and manages enforcement actions.

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 that had previously entered the combined sewer system. The Densmore system runs from Green Lake to Lake Union. A pump station is located to the north of Lake Union and 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 1995, 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 the start up of the pump station. However, all three pumps cannot be used until the stormwater system hydraulic improvements are completed. This work will start in late 2006 and is expected to be fully completed in early 2007.

From October to approximately December 2006 the pump station will be shut down for the construction of improvements to the stormwater system. A contractor will construct a large vault designed to reduce the surge in the line near the outfall. Once the project is completed, the system will be able to operate all pumps and handle more stormwater.

1.4.3 CSO Notification and Posting Program

The King County Department of Natural Resources and Parks, Seattle & King County Public Health, 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. Program elements include a phone number for the public to request information from Seattle and King County Public Health on questions concerning CSOs, warning signs posted at King County and City of Seattle CSO locations, a brochure, a Web site, and other outreach efforts. 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.

The recently modified NPDES permit requires 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. King County will meet with interested public groups in developing changes to the plan. The County will expand their draft feasibility study report of July 2006 at Ecology's request by December, with a final due next July.

1.4.4 Lower Duwamish Superfund

In 2000, the U.S. Environmental Protection agency declared an area of the Duwamish Waterway from the south end of Harbor Island to the Turning Basin a Superfund. 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 Superfund and complete the work necessary for a final Superfund clean up in the waterway. The phase one risk investigation was completed using existing data in late 2004. A phase two risk investigation and feasibility study are underway. King County has completed two early action clean ups in front of King County CSOs (Norfolk and Duwamish/Diagonal). Monitoring programs are underway at both locations.

1.4.5 CSO Management Program

This section describes projects at several CSO locations that had activities at them during the reporting period resulting in either a change in CSO volumes and frequency oe our understanding of the conditions in the system.

Brandon Street CSO

A review of overflow data showed that the Brandon Street CSO location overflowed even though there was capacity in the Elliott Bay Interceptor (EBI). A project was completed in March 2006 to upsize the pipe leading from the Brandon Street Regulator Station to the EBI. The project should provide some reduction of the volume of overflows ahead of the RWSP control project. Since completion there has not been any significant rainfall to evaluate the success of the project.

Kingdome CSO

This regulator was built as part of a two-phased project in the Kingdome area. The County first constructed elements of a planned future CSO control project to coordinate with road improvements to Royal Brougham Way, laying a new pipeline and building the new Kingdome Regulator; private contractors for construction of Safeco Field later separated area sewers to meet drainage code requirements for their project. This resulted in the management of area combined flows by the new Kingdome Regulator Station and pipelines, and the conversion of the old pipeline to convey stormwater only. The County's Connecticut Regulator Station was left in place to provide only a low-flow diversion of stormwater to the County's Elliott Bay Interceptor in hopes of catching any "first flush" of stormwater pollution. Overflows from the new Kingdome regulator occur at the City's Connecticut outfall, along with the separated City stormwater.

In fall 2004, inspections revealed that flow monitors shown on drawings had not been installed by the stadium contractors. Temporary monitors were placed in service in 2004, but access to maintain them was prevented by a railroad construction project and as a result data is not available for this location for this reporting period. With completion of the railroad project, new monitors have been put in service in 2006.

Montlake CSO

The frequency of overflows at the Montlake CSO location had risen above the 1981-1983 baseline during this reporting period. A sonar investigation of the line showed that the Montlake siphon was obstructed. A complex cleaning effort was completed in December 2004. Since the cleaning, the number of overflows has decreased to below the 1981-1983 baseline.

University CSO

Although no direct work was done at the University regulator, the volume and frequency of the CSO is impacted by the work done at the Montlake CSO explained above, the Densmore Stormwater System explained above and a City of Seattle Ravenna Creek Daylighting project. The Montlake CSO work seemed to have the most substantial affect on the volumes at the University Regulator. The creek daylighting did not impact flows significantly.

Ravenna Creek flows were removed by a City of Seattle creek day-lighting project several years ago. These flows were returned to the County sanitary system on May 27, 2006 at the City's request because of localized flooding associated with a high intensity storm. After the investigation of the flooding in late 2006, flows were transferred back into the daylighting project.

Duwamish and West Seattle Pump Stations

Changes in the pump station's operation were made to prevent street flooding, although it was recognized that these changes carried the risk of increased CSOs. As an added precaution, portable monitors were installed to help better characterize conditions at the pump station and siphons. To help remedy the overflows at the Duwamish Pump Station, a new strategy was developed to adjust the flow split between the Alki CSO Plant and the West Seattle Tunnel so that it is closer to the original design. In 2006–2007, changes to the operating strategy will be implemented and evaluated.

South Magnolia CSO

The South Magnolia CSO is located at the north end of Elliott Bay. Over the past few reporting periods this CSO has significantly increased in volume. King County is beginning an investigation into the cause of the increase. Because recent City of Seattle projects upstream coincide with the observed increased overflow at Magnolia, and because solutions could impact their system, City staff will participate in the investigation.

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 in the Seattle area. This section presents the results of this monitoring for the 2005–2006 CSO year.

In summary, the annual rainfall for the reporting period was 34.86 inches as an average over local rain gauges. King County had 217 CSO discharges for a total of approximately 436 million gallons of CSO. The West Point Treatment Plant; Carkeek and Alki CSO Treatment Plants; and the Elliott West CSO Treatment Facilities discharged approximately 954 million gallons of treated CSOs.

2.1 Annual Rainfall

As shown in Table 5, rainfall measured for the 2005–2006 CSO year was 34.86 inches as an average over local rain gauges; this is 94 percent of the baseline average of 37 inches per year. Rain gauge maintenance and calibration have improved. Problems occurred with gauges at the Denny Way local and Matthews Park and so they are not included in the table below.

Table 5. 2005–2006 Rainfall at Pump and Regulator Stations (in inches)

Station	2005							2006					2005-2006 Total
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Ballard	1.31	0.61	0.48	0.75	2.72	4.36	7.09	9.65	2.51	1.51	2.17	0.9	34.06
Denny Way/Lake Union	1.43	0.73	0.19	0.93	2.4	4.84	6.85	9.7	2.62	1.91	1.92	1.17	34.69
King Street	1.21	0.93	0.15	0.8	2.27	4.84	6.59	10.25	2.35	1.61	1.79	0.98	33.77
Marginal Way, E.	1.51	0.81	0.42	0.63	2.29	4.22	5.97	9	2.35	1.41	1.92	1.17	31.7
Pine Street, E.	1.67	1.1	0.28	1.43	2.53	4.27	6.75	9.46	2.58	1.63	1.74	1.49	34.93
Rainier Avenue	1.61	1.08	0.47	1.3	3.64	5.07	6.6	10.84	2.92	1.77	2.35	1.74	39.39
University	1.83	0.9	0.28	1.52	1.12	1.65	7.55	11.15	3.12	2.06	2.41	1.88	35.47
Average	1.51	0.88	0.32	1.05	2.42	4.18	6.77	10.01	2.64	1.70	2.04	1.33	34.86

2.2 Annual Untreated CSO Events

Figure 1 on page iv shows the locations of existing permitted King County CSO discharges and the discharge serial numbers (DSNs) used in Tables 6 and 7 below.

West Point's SCADA system monitors the volume and frequency of CSOs at regulator and pump stations that have the ability to make adjustments in CSO flows. The County looks at the combined system area as four service areas: the Southern Service Area (south of the Ship Canal), the Northern Service Area (north of the Ship Canal including the Montlake and Dexter Regulator Stations), and the Alki Service Area which all drain to West Point, and the Henderson area that drains primarily to the South Plant at Renton.

Portable flow meters are deployed at the six CSO locations not currently monitored by SCADA: 11th Avenue NW, SW Alaska Street, Hanford at Rainier, South Magnolia, North Beach Pump Station, and Terminal 115.

2.2.1 Untreated CSO Volumes

As shown in Table 6, the total volume of untreated CSOs for 2005–2006 was 436.79 MG (257.4 MG in the South Service Area; 135.30 MG in the North Service Area; and 44.09 MG in the Alki Service Area). 435.78 MG represents a 81 percent reduction over the 1981–1983 baseline of 2,339 MG.

Figure 2 illustrates the progress King County has made in CSO volume reduction as compared to total annual rainfall over time. 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, contributing most of the year's CSO volume. This impact was evident in the 2005-2006 season when approximately 80 percent of the annual volume overflowed during the extended period of rain in late December and January. About half of the total rainfall for this reporting period fell during those months. The last three days of January had a high amount of rain and subsequent overflows at almost all of King County's CSOs. 116 million gallons of CSO overflowed – or more than a quarter of the years total in just three days.

Two sites are reported as not monitored (NM) during the reporting period. The Kingdome site had portable meters at the overflow weir, but staff could not access the overflow structure to maintain the meters due to railroad construction.

The Hanford at Rainier site is also showing as not monitored (NM). The portable meter data shows that there was no overflow at this site during the reporting period, but end of year data review cast doubt on the meter's accuracy. The data is therefore not reported. New flow meters are being installed this month.

Table 6. 2005–2006 Untreated CSO Volume Summary (in million gallons)

Station	DSN	Service Area	2005							2006					2005-2006 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
11th Ave. NW [b]	004	North	0.04	<0.01	<0.01	<0.01	<0.01	0.26	2.46	4.21	0.48	<0.01	<0.01	<0.01	7.45	
30th Ave. NE	049	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
3rd Ave. W	008	North	<0.01	<0.01	<0.01	<0.01	<0.01	0.20	3.80	5.65	0.07	<0.01	0.03	<0.01	9.75	106
53rd Ave. SW	052	Alki	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
63rd Ave. PS	054	Alki	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10
8th Ave. S/ W. Marginal Way	040	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	8
Alaska St., SW [b]	055	Alki	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
Ballard	003	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.05	<0.01	<0.01	<0.01	<0.01	0.08	95
Barton St.	057	Alki	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.19	0.14	<0.01	0.94	0.04	<0.01	1.35	8
Belvoir	012	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
Brandon St.	041	South	1.48	<0.01	<0.01	<0.01	2.31	6.67	1.98	3.38	0.98	<0.01	<0.01	<0.01	16.80	64
Canal St.	007	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1
Chelan Ave.	036	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.32	0.72	<0.01	<0.01	<0.01	<0.01	1.03	61
Denny Way [g]	027a	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.87	0.17	0.03	<0.01	<0.01	<0.01	1.07	502
Dexter	009	North	0.03	<0.01	<0.01	0.04	0.11	0.79	2.48	1.35	0.87	0.50	<0.01	0.03	6.21	24
Duwamish P.S., W.	034	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	<1
Duwamish P.S., E.	035	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.01	
Hanford	031/2	South	0.46	<0.01	<0.01	<0.01	1.82	13.64	30.58	67.50	3.69	0.01	0.61	<0.01	118.33	644
Hanford #1 (Hanford @ Rainier) [b]			*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	
Hanford #2			*0.46*	*<0.01*	*<0.01*	*<0.01*	*1.82*	*13.64*	*30.58*	*67.50*	*3.69*	*0.01*	*0.61*	*<0.01*	*118.33*	
Harbor Ave.	037	South	<0.01	<0.01	<0.01	0.15	1.16	<0.01	1.11	10.03	<0.01	<0.01	<0.01	<0.01	12.45	36
Henderson [b]	045	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	15
Kingdome	029	South	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	90
King Street	028	South	0.17	<0.01	<0.01	0.03	<0.01	1.89	7.32	14.52	0.95	0.45	0.45	0.02	25.81	55
Lander II St.	030	South	<0.01	<0.01	<0.01	<0.01	<0.01	3.63	34.65	49.19	7.02	1.05	<0.01	<0.01	95.54	143
Magnolia, S. [b]	006	South	1.39	<0.01	1.20	<0.01	1.75	9.93	15.59	29.26	1.81	0.95	<0.01	<0.01	61.89	14
Marginal Way, E.	043	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
Matthews Park	018	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1

Station	DSN	Service Area	2005							2006					2005-2006 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
Michigan	039	South	<0.01	<0.01	<0.01	<0.01	0.48	<0.01	1.40	2.40	0.08	<0.01	<0.01	<0.01	4.36	190
Michigan, W.	042	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.26	1.55	<0.01	<0.01	<0.01	<0.01	1.81	2
MLK Jr. Way [b]	013	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	60
Montlake	014	North	<0.01	<0.01	<0.01	1.15	<0.01	0.40	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.55	32
Murray Ave.	056	Alki	<0.01	<0.01	0.38	<0.01	0.18	<0.01	5.67	3.54	5.87	<0.01	<0.01	<0.01	15.64	6
Norfolk St.[g]	044	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	39
North Beach [b] [d]	048a	North	0.05	<0.01	<0.01	<0.01	<0.01	0.03	0.13	0.53	<0.01	<0.01	<0.01	<0.01	0.74	6
North Beach[b)] [d]	048b	North	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.14	<0.01	<0.01	<0.01	<0.01	0.55	
Pine, E St.	011	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
Rainier Ave.	033	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<1
Terminal 115 [b]	038	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.73	3.15	<0.01	<0.01	<0.01	<0.01	3.88	2
University	015	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.37	29.50	2.02	<0.01	<0.01	6.38	49.28	126
Total			4.00	0.00	1.62	1.36	7.81	37.44	122.22	226.99	24.34	3.93	1.12	6.43	436.79	2339.0
2005-2006 Partially Treated CSO volumes from CSO Treatment Facilities																
Alki Plant	051	Alki	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	33.6	<0.01	<0.01	<0.01	<0.01	33.6	
Carkeek Plant	046	North	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	22.99	<0.01	<0.01	<0.01	<0.01	22.99	
Elliott West [f]	27b	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	66.8	<0.01	<0.01	<0.01	<0.01	66.8	
Henderson/Norfolk [g]	044[f	South	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
2005-2006 Rainfall Average (baseline is historical average in inches)			1.51	0.88	0.32	1.05	2.42	4.18	6.77	10.01	2.64	1.70	2.04	1.33	34.86	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 CATAD.

[c] The Kingdome site had portable meters at the overflow weir, but we could not access the overflow structure to maintain the meters due to railroad construction.

[d] The North Beach Pump Station has two outfalls. A 16” outfall (48b) from the wet well and 30” (48a) outfall from the inlet trunk. The 30” outfall discharges on the beach and the 16” outfall discharges further out in Puget Sound.

[e] We are purchasing a new flow meter specifically for this site.

[f] “Poorly treated” discharges from the treatment tunnel, or untreated discharges from the Denny Regulator, together may occur once per year on average.

[g] “Poorly treated” discharges from the treatment tunnel, or untreated discharges from the Norfolk Regulator, together may occur once per year on average.

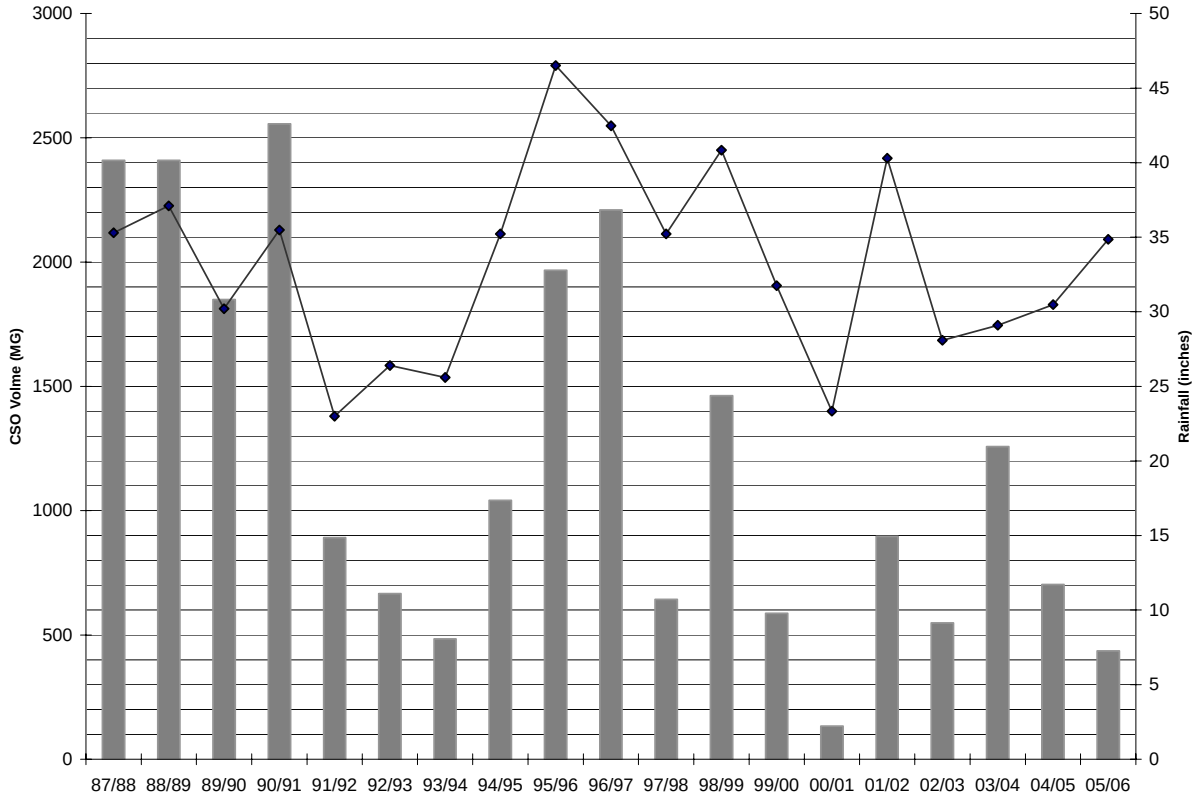

Figure 2. Annual CSO Volume versus Total Rainfall (1987 through 2006)

2.2.2 Untreated CSO Frequencies

As shown in Table 7, there were a total of 217 untreated CSO events in 2005–2006 (159 events in the South Service Area; events in the 53 North Service Area; and 15 events in the Alki Service Area). 217 untreated CSO events represent a 54 percent reduction in frequency over the 1981–1983 baseline of 471 overflows.

The modified NPDES permit requires that the County provide the 5-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. For the wet seasons during the period from June 2000 through May 2005, the following average of partially treated discharges were reported for the purposes of calculating compliance with average annual total suspended solids percent removal and settleable solids permit limits:

- Carkeek CSO Treatment Plant—less than 1 event per year
- Alki CSO Treatment Plant—less than 1 event per year
- Elliott West CSO Treatment Facility—The Denny Way CSO discharged 7 untreated events.
- Henderson/Norfolk CSO Treatment Facility—has not yet discharged

Table 7. 2005–2006 Untreated CSO Event Frequency Summary (based on a 24-hour inter-event interval)

Station	DSN	Service Area	2005							2006					2005–2006 Total	1981–1983 Baseline [a]
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May		
11th Ave. NW [b]	004	North	1	0	0	0	0	2	3	6	2	0	0	0	14	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	1	5	1	0	1	0	9	17
53rd Ave. SW	052	Alki	0	0	0	0	0	0	0	0	0	0	0	0	0	<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	0	0	0	0	0	0	0	1
Ballard	003	North	0	0	0	0	0	0	1	2	0	0	0	0	3	13
Barton	057	Alki	0	0	1	0	0	0	2	2	0	3	1	0	9	9
Belvoir	012	North	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Brandon St.	041	South	2	0	0	0	2	6	3	9	2	0	0	0	24	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	0	1	2	0	0	0	0	3	7
Denny Way [f]	027a	South	0	0	0	0	1	0	2	2	1	0	0	0	6	32
Dexter	009	North	1	0	0	1	1	2	3	3	2	1	0	2	16	15
Duwamish P.S., W.	034	South	0	0	0	0	0	0	1	0	0	0	0	0	1	<1
Duwamish P.S., E.	035	South	0	0	0	0	0	0	1	0	0	0	0	0	1	<1
Hanford (total)	031/2	South	1	0	0	0	1	5	2	6	2	1	1	0	19	58
Hanford #1 (Hanford @ Rainier) [b] [e]			*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	
Hanford #2			*1*	*0*	*0*	*0*	*1*	*5*	*2*	*6*	*2*	*1*	*1*	*0*	*19*	
Harbor Ave.	037	South	0	0	0	1	1	0	1	2	0	0	0	0	5	30
Henderson [b]	045	South	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Kingdome[c]	029	South	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	*NM*	
King Street	028	South	1	0	0	1	0	6	4	6	1	1	1	1	22	16
Lander II St.	030	South	0	0	0	0	0	2	2	6	3	1	0	0	14	26
Magnolia, S. [b]	006	South	2	0	1	0	3	6	4	10	1	1	0	0	28	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	1	0	1	3	1	0	0	0	6	34

Station	DSN	Service Area	2005							2006					2005–2006 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	0	1	2	0	0	0	0	3	5
MLK Jr. Way [b]	013	South	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Montlake	014	North	0	0	0	1	0	1	0	0	0	0	0	0	2	6
Murray Ave.	056	Alki	0	0	1	0	1	0	3	2	1	0	0	0	8	5
Norfolk St. [g]	044	South	0	0	0	0	0	0	0	0	0	0	0	0	0	20
North Beach Inlet [b] [d]	048a	North	1	0	0	0	0	2	1	3	1	0	0	0	8	18
North Beach Wet Well [b] [d]	048b	North	1	0	0	0	0	0	2	3	1	0	0	0	7	18
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	0	1	2	0	0	0	0	3	4
University	015	North	0	0	0	0	0	0	1	3	1	0	0	1	6	13
Total			10	0	3	4	11	33	41	79	21	9	4	4	217	**471**
2005-2006 Partially Treated Events from CSO Treatment Facilities																
Alki Plant	51	Alki	0	0	0	0	0	0	0	1	0	0	0	0	1	
Carkeek Plant	46	North	0	0	0	0	0	0	0	1	0	0	0	0	1	
Elliott West[f]	27b	North	0	0	0	0	0	0	0	1	0	0	0	0	1	
Henderson/Norfolk [g]	044[f]	South	0	0	0	0	0	0	0	0	0	0	0	0	0	
2005-2006 Rainfall Average (baseline is historical average in inches)			1.51	0.88	0.32	1.05	2.42	4.18	6.77	10.01	2.64	1.70	2.04	1.33	34.86	**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 CATAD.

[c] The Kingdome site had portable meters at the overflow weir, but we could not access the overflow structure to maintain the meters due to railroad construction.

[d] The North Beach Pump Station has two outfalls. A 16” outfall (48b) from the wet well and 30” (48a) outfall from the inlet trunk. The 30” outfall discharges on the beach and the 16” outfall discharges further out in Puget Sound.

[e] We are purchasing a new flow meter specifically for this site.

[f] “Poorly treated” discharges from the treatment tunnel, or untreated discharges from the Denny Regulator, together may occur once per year on average.

[g] “Poorly treated” discharges from the treatment tunnel, or untreated discharges from the Norfolk Regulator, together may occur once per year on average.

2.3 Annual Treated CSO Events

This section provides information on the frequency and volume of 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.

2.3.1 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.

Table 8 shows the months CSO treatment occurred and the volumes of flow receiving CSO treatment for the month. For the 2005–2006 CSO year, there were 32 occurrences totaling 546.98 MG of treated CSO discharges from West Point.

Table 8. West Point Annual CSO Treatment Summary

Date	Treated CSO (MG)
June 2005	0
July 2005	0
August 2005	0
September 2005	0
October 2005	14.89
November 2005	66.4
December 2005	87.65
January 2006	323.62
February 2006	21.72
March 2006	7.50
April 2006	10.30
May 2006	0
Annual Volume receiving CSO treatment	546.98
Days with CSO treatment	32 days

2.3.2 Alki CSO Treatment Plant

Starting January 1, 2006, additional permit limits went into effect for total residual chlorine and fecal coliform. January 2006 was the first time that dechlorination was practiced at the Alki CSO treatment Plant. All disinfection and dechlorination permit conditions were met during the month, though there were challenges with both the hypochlorite and dechlorination systems during the last storm.


Alki CSO Treatment Plant

The total volume of treated CSO discharged from the Alki CSO Treatment Plant was 39.2-MG during four events. Discharge effluent limits were met.

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

2.3.3 Carkeek CSO Treatment Plant

In 2006, a dechlorination system was designed and installed at Carkeek CSO Treatment Plant to meet the new residual chlorine limits. The hypochlorite dosage controls were modified to meet the new fecal coliform limits. The improved disinfection system and the newly installed dechlorination system worked well in meeting the permit compliance for the effluent fecal coliforms and the effluent residual chlorine.


Carkeek CSO Treatment Plant

During this reporting period, there were six discharge events at the Carkeek CSO Treatment Plant. The total discharge volumes for the reporting period was 54.72 MGD. Discharge effluent limits were met.

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

2.3.4 Elliot West CSO Treatment Facilities

The Elliot West CSO Treatment Facilities began operation in May of 2005. While some refinements in the operating protocols remain to be done to achieve full control at Denny and Dexter Regulators, much has been accomplished. Of the volume of CSO to be managed at the Mercer/Elliott West facilities 38.4 percent was captured and received full secondary treatment, 61.4 percent received primary treatment and disinfection, and only 0.2 percent was discharged untreated at Denny regulator. The number of untreated discharges went from 32 per year to just seven small ones. At Dexter Regulator, the number of


Elliott West CSO Control Facility

events was unchanged, but they were very small in volume. Seventy-four percent of the volume that had previously discharged untreated at Dexter now received full secondary treatment.

During this reporting period, there were eight discharge events from the Elliott West CSO outfall. The total discharge volumes for the reporting period was 315.6 MGD. Discharge effluent limits were not met.

During the first year of operating these CSO facilities King County faced several challenges - not unexpected 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 were reducing the tunnel's storage capacity for the CSO flows by 1-2 million gallons, 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 of the City of Seattle's sewers upstream of the tunnel, causing base flows to backup and overflow into the tunnel. To correct this, the City of Seattle conducted an extensive pipeline cleaning – this is described in Section 1.3.2.

A number of items concerning the operation of these CSO control facilities were identified for improving 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.

2.3.5 Henderson/Norfolk CSO Control Facilities

The facilities began operation in May 2005.


Inlet Structure to the Henderson CSO Storage/Treatment Tunnel

During this reporting period the treatment tunnel did not need to operate, and there were no discharge events from any of the facilities controlled by this project. One-hundred percent of the volumes that previously discharged untreated at those CSOs was captured and received full secondary treatment and disinfection. While it appears the project was successful, it will require the return of a more normal rain pattern to fully assess effectiveness. As a result, little startup experience with the tunnel facilities has been gained. Limited problems encountered with the new system included automatic control settings and an electrical short in a control panel in the inlet regulator station and incorrect setpoints at some locations. These problems have been corrected.

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

Appendices

Appendix A. Alki CSO Treatment Plant Annual Report, June 2005–May 2006

Appendix B. Carkeek CSO Treatment Plant Annual Report, June 2005–May 2006

Appendix C. Elliot West CSO Control Facilities, June 2005-May 2006

Appendix D. Henderson/Norfolk CSO Control Facilities, June 2005-May 2006

Appendix A
Alki CSO Treatment Plant Annual Report
June 2005– May 2006

This report summarizes the performance and operation of the Alki CSO Treatment Plant during the June 2005-May 2006 reporting year. This document constitutes the sixth annual report of the Alki CSO Treatment Plant since converting from a primary treatment plant.

The plant currently operates under Washington State Department of Ecology permit number WA-0029181-1 issued to the West Point Treatment Plant, effective January 1, 2004 to December 31, 2008. Under this permit, there are interim and final permit criteria to be met. Interim permit parameters are effective January 1, 2004 through December 31, 2005. Starting Jan. 1, 2006, additional permit limits for total residual chlorine and fecal coliform went into effect. Table 1 summarizes the interim and final permit limits for the Alki CSO Treatment Plant.

Table 1. Alki CSO Treatment Plant Permit Limits (January 1, 2004 to December 31, 2008).

Parameter	Discharge Limits (Monthly)	Discharge Limits[a] (Yearly Average)	Discharge Limits[b] (Long-term Average)
Effective Jan. 2004 – Dec. 2008			
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

[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.

Effective Jan. 2006 – Dec. 2008		
Fecal Coliform, cfu/100-mL	1700/100	NA	NA
	Average Monthly	**Maximum Daily [d]**	
Total Residual Chlorine, ug/L	NA	290	

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

There were four filling and discharging events at the Alki CSO Treatment Plant between June 2005 and May 2006. One event occurred at the end of Dec. 2005 and the other three occurred throughout January 2006. Rainfall from the middle of Dec. 2005 to the end of January 2006 was extreme. January 2006 was the second wettest January on record with 11.65-inches of rain; the historic average for January is 5.1-inches. In fact, the rainfall from Dec. 18, 2005 to Jan. 31, 2006 totaled 18.2-inches. Record flows were treated at both the West Point and South Plant Treatment Plants in January 2006.

Table 2 summarizes the permit performance of the Alki CSO Treatment Plant over the past reporting year. Performance is presented for all discharge events as well as for all the "treated" discharge events. The last event of the year (Jan. 29, 2006) has been designated as the "one untreated discharge event". The Alki CSO Treatment Plant complied with all applicable discharge permit conditions in 2005-06. Table 3 compares the annual performance from this past year to the previous six years.

Table 2. Alki CSO Treatment Plant Permit Performance in 2005-06

Parameter	All Discharge Events	All "Treated" Discharge Events	Permit Conditions
Number of Events per year	4	3	29
Avg. Volume per year, million gallons	59.8	25.8	108
Settleable Solids, Avg. Annual, ml/l/hr	0.3	0.3	0.3
Settleable Solids, Max per Event, ml/l/hr	1.9	0.7	1.9
Suspended Solids Removal, Annual	46%	57.1%	50%
Fecal Coliform, Geometric Mean, cfu/100-mL[a]	>65	19	1700
Total Residual Chlorine, Max Daily, ug/L[a]	40	40	290

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

Table 3. Alki CSO Treatment Plant Operating Data, Oct. 1999 - May 2006

Year	Avg. TSS mg/l, or Avg. TSS removal %[a]	Average Settleable Solids, ml/l/hr	Discharge Volume per Year, MG	Discharge Events per Year	*once per year untreated event
Limit	**60 mg/l or 50%**	**0.3 ml/l/hr**	**108**	**29**	
Oct 99 – May 00	26	0.15	4.0	2	No events removed
Jun 00 – May 01	No filling or discharge events				
Jun 01 – May 02	36	0.26	59.8	6	12/13/02 removed from avg. TSS and settleable solids calculation.
Jun 02 – May 03	33	<0.1	9.8	2	No events removed
Jun 03 – Dec 03 Jan 04 - May 04	44 41 %	0.14 0.15	36.9 8.6	2 2	No events removed No events removed
Jun 03 – May 04	40 %	0.13	34.0	3	Nov-03 event removed from TSS calculation
Jun 04 – May 05	41 %	0.2	20.4	1	No events removed
Jun 04 – May 05	82 %[b]	NA	NA	0	January event removed
Jun 05– May 06	56.7 %	0.3	39.2	3	Jan. 29 event removed
Jun 05– May 06	46.0 %	0.3	59.4	4	No events removed

a 50% minimum TSS removal replaced 60 mg/L maximum TSS permit limit on Jan. 1, 2004

b Besides the one discharge event in 04-05 which was designated as "untreated:, there was another filling event with a TSS removal equal to West Point's TSS removal that day = 82%

A total of 59.4-million gallons (MG) was discharged from the Alki CSO Treatment Plant to Puget Sound during the four storms. The total volume of treated CSO discharged from Alki was 25.8-MG (i.e., when the last storm is designated as an untreated event). These totals are well under the 108 MGD annual limit. The four discharge events (or three when we consider the one "untreated event") are also well under the limit of 29 times per year. The West Seattle Tunnel was full during all events with the West Seattle Pump Station pumping 18-19 mgd.

CSO is pumped from the 63rd Avenue Pump Station to the Alki CSO Treatment Plant. The pump station contains three duty pumps (which allows variable speed) and three storm pumps (fixed speed). The three duty pumps were not available this year since they were in the process of having their drives replaced. Instead, the storm water pumps were used to send flow to Alki. These constant-speed pumps are each rated at about 15 mgd, and operate in a fill-n-draw mode. The fill-n-draw operation tends to send waves of flow through Alki, making it difficult to optimize chemical addition. Plant flows peaked above 45-mgd during all storm events.

All six primary tanks were in operation throughout the events (and empty before each), along with their sludge collectors, sludge pumps and scum sprays. The sludge pumps operated continually through the events, collected sludge to the West Seattle Tunnel. The primary tanks were emptied in the middle of the Jan. 9-13 event when there was a lull in the storm fronts and pumped back to West Point

Alki's effluent settleable solids averaged 0.3 ml/L/hr during the reporting year with a maximum concentration for an event of 0.7 ml/L/hr. Both of these values comply with permit conditions: 0.3 ml/L/hr annual average and 1.9 ml/L/hr maximum allowable per event.

The calculation of suspended solids (TSS) removal over the past year is shown in Table 4. TSS removal averaged 46% when data from all events are included. TSS removal averaged 57.1% when the January 29 storm is designated as the one untreated discharge. The TSS removal calculation is based on mass of TSS entering Alki, discharged from Alki, and Alki TSS discharged from West Point. The Alki TSS discharged from West Point is based on West Point's monthly average TSS removal.

Table 4. Suspended Solids Removal, 2005-2006

Event Date	No. of Inflow Event	Alki Inf TSS, lbs	Alki Eff TSS, lbs	Alki TSS Rem %	Alki TSS to WP, lbs	WP TSS Rem %	Alki TSS as WP Eff, lbs	Overall TSS Rem %
Dec. 24-25	1	9,107	5,141	43	3,966	94	238	41
Jan 5 -6	2	6,976	2,072	70	4,904	88	588	62
Jan 9-13	3	17,270	4,774	72	12,497	88	1,500	64
Jan 29	4	18,054	12,804	29	5,251	88	631	26
Total/Avg.	4 Total	51,408	24,790	52	26,618		2,956	46%
Total/Avg if Jan 29 storm designated "untreated"	3 Total	33,353	11,987	64%	21,367		2326	57.1%

Starting Jan. 1, 2006, additional permit limits went into effect for total residual chlorine and fecal coliform. January 2006 was the first time that dechlorination was practiced at the Alki CSO Treatment Plant. Table 5 summarizes the performance of Alki's disinfection and dechlorination systems during January 2006. 2006 was the first year Cl2 and FC requirements were imposed on this facility. The hypochlorite and bisulfite volumes are shown to indicate the type of dosing required for disinfection and dechlorination. All disinfection and dechlorination permit conditions were met during the month (see Table 2), though there were challenges with both the hypochlorite and dechlorination systems during the last storm event.

To achieve an adequate chlorine contact time, Hypochlorite (4%) solution was injected into the 42-inch influent force main at 63rd Ave. Pump Station to provide disinfection. The hypochlorite-dosing pump started automatically and was flow-paced based on Alki influent flow. The average hypochlorite doses ranged from 4.6 mg/L to 6.7 mg/L as Cl_2 based on the volume of hypochlorite used in an event. This dose range compares well with doses needed at Alki when it was a primary treatment plant. The hypochlorite dose during the last event only averaged 1.8 mg/L as Cl_2 because of problems with the hypochlorite pump.

Bisulfite solution (38%) was dosed into the end of the chlorine contact channel through a diffuser. The bisulfite pump started automatically and could be flow-paced based on the Alki effluent flow. Occasionally operators needed to adjust the bisulfite dose manually. Modifications continue to the dechlorination facilities and to provide a greater level (or range) of control and operation.

Table 5. Disinfection & Dechlorination Performance, 2005-2006

Date	4% NaOCl (gallons)	38% NaHSO3 (gallons)	Cl2 residual – Prim. Tank Inlet - Grab (µg/L)	Cl2 residual – Final Effluent – Grab (µg/L)	Fecal Coliforms (cfu/100mls)
01/05-06	803	29	1600@2020hrs	30@2020hrs	102@2020hrs
01/09-10	2315	77	2200@0025hrs	10@0025hrs	34@0025hrs
			660@0750hrs	10@0750hrs	6 @0750hrs
01/11	845	15	1880@2340hrs	40@2340hrs	10@2340hrs
01/12-13	1014	9	650@2305hrs	0@2305hrs	6@2305hrs
01/29-30	1175	38	420@2020hrs	40@2020hrs	>2000@2020hrs
			420@0325hrs	20@0325hrs	>2000@0325hrs

As mentioned, there were challenges with both the hypochlorite and dechlorination systems during the last storm event of January. The hypochlorite dosing pump mechanically failed during the event. A back-up pump was put into service though with limited capacity. The bisulfite pump failed to start automatically. It was soon started manually by operations staff. The failure to start was related to a PLC problem.

The loss of the hypochlorite pump was only one factor in the fairly high fecal coliform counts of Jan. 29. The other factor was the fact that bisulfite was mistakenly moved to the influent channel (of the primary clarifiers) before the start of the event. Thus, the initial flow of chlorinated influent was neutralized before it had been disinfected sufficiently. The result was >2000 cfu/100-mL fecal coliform values. The bisulfite in the influent channel came from Alki's bisulfite storage tank, which needed to be emptied to accept the next trucker load of bisulfite

solution. Staff has developed a procedure for moving excess bisulfite completely to the West Seattle Tunnel to avoid this mishap in the future.

Equipment and Operational Activities

Considerable effort was put into preparing the Alki CSO Treatment Plant for the new coliform and chlorine residual requirements over the past reporting system. Below is a list of actions taken over this past year:

- Relocated hypochlorite injection point to six diffusers in the 63rd Ave. Pump Station, allowing significant more contact time (force mains approx. 2 city blocks distance to head works.) Dosing points will be at the convergence of the North and South Inlet overflows wet wells.

- Successfully leak-tested the abandoned water line from Alki CSO treatment Plant to 63rd Ave. Pump Station that will convey hypochlorite to 63rd Ave. Pump Station diffusers.

- A hydraulic test found the existing hypochlorite pumps were unable to pump adequate hypochlorite to 63rd Ave. Pump Station diffusers. A larger-capacity pump (15 gpm) was installed in May 2006. During the interim, the existing pumps (8 gpm) were used to pump hypochlorite to the influent force main, which is the current practice. The new pump is capable of pumping enough hypochlorite to reach the desired dose of 10 mg/L. Backup pumping capacity will be provided in the future.

- Installed an additional Hach CL17 chlorine analyzer to monitor residual just as it enters the plant (i.e., downstream of the bar screens). Two submersible pump heads (allows flexibility if one bar screen out of service) installed to pump to analyzer.

- Bar screen Hach CL17 analyzer was consistently fouled by precipitate on analyzer light-cell, and plugging of the Y-strainer. Staff will evaluate the use of another indicator for example amperometric or oxidation-reduction potential (ORP) electrode and relocated this analyzer for hypochlorite and/or bisulfite control.

- Moved the existing post-chlorination chlorine-analyzer suction point to the clarifier collection channel, i.e., just prior to the new bisulfite diffuser. Measures chlorine just prior to dechlorination for controlling bisulfite dosing-pumps. Staff evaluating moving analyzer closer to suction point for better control for better control of chemical dosing.

- Installed a stainless steel 500 gallon tank for $NaHSO_3$ (bisulfite) storage and an additional chemical feed pump to inject $NaHSO_3$ through existing post chlorination diffuser. Will be ordering and installing an additional tank.

- Added stop-logs on top of clarifier overflow channel to prevent short- circuiting around bisulfite injection point. Lowered overflow weir to Puget Sound to minimize short-circuiting.

- A successful mechanical test was performed in October of the bisulfite pumps and sampling pumps for the newly installed headwork's chlorine analyzer. Dye was put in bisulfite tank so diffusers could be checked.

- Variable frequency drives of duty pumps at 63rd Ave. Pump Station were replaced over this reporting system. Three fixed-speed "storm" pumps were available for operation, each capable of pumping 15 MGD.

- A hydraulic test of the 63rd Ave. Pump Station fixed-speed pumps was conducted on November 17. Flow was backed up, and the fixed-speed pumps were ran one at a time and together for approximately three hours. The West Seattle tunnel was not used for storage to run this test. Operators checked existing filling sequence of the clarifiers, ran hypochlorite pumps and chlorine analyzer sampling pumps.

- Immersion heater installed in bisulfite tank and heat-tracing installed on bisulfite feed line to prevent crystallization during cooler weather. This work was completed in Dec. 2005.

- Control strategies were drafted and plc programs yet to be loaded to provide the following operational controls:

    - Hypochlorite control is flow-proportioned to meet a set dose, and trimmed by chlorine residual measurement at the bar screen room analyzer. Installing an amperometric residual chlorine analyzer during last quarter of 2006.

    - Bisulfite control is based on a feed-forward residual measurement at the end of the clarifier, proportioned to flow, and trimmed by residual at outfall pending improved operation of analyzer at end of clarifiers.

    - Alarms sent to South Plant control for bisulfite pump or immersion heater failure

    - Data acquisition into plant's new historian and existing Forney checked for accuracy and completeness to document compliance, optimize plant performance and track costs. Real-time data-trends available from South Plant's Forney DCS system were used for monitoring the performance of the Alki Plant.

It was our hope to thoroughly test the operational strategies of the chlorination and the dechlorination system this past year. However, some of that plan was hampered by the limited capacity and control of the pumps in the 63rd Ave. Pump station. In August 2005, King County started the electrical upgrade project at the 63rd Ave. Pump Station. The project replaced variable frequency drives and electrical switchgear, increased pumping capacity and improved ventilation and lighting.

Construction was essentially completed on the 63rd Ave. Pump Station in April 2006. 63rd Ave. Pump Station sends CSO flows to the Alki CSO plant for treatment. The three main duty pumps were rebuilt. They received new impellors and rotating assemblies while retaining their existing volutes. New motors were installed on all three pumps while one pump (Pump 1) received a new variable frequency drive (VFD). In other words, Pump 1 is a variable flow pump while Pumps 2 and 3 are fixed speed pumps. Each of the three lead pumps is rated at 50,000 gpm. Pump 1 will be the lead duty pump. Pump 2 (and then Pump 3) will only operate when the flow exceeds the capacity of Pump 1. Pumps 4, 5, 6, are the annex pumps or storm water pumps and will operate in "standby mode" and only operate if the level in wet well reaches 101.5 feet with the lead pumps running.

In April 2006, Operators started a 30-day commissioning period on the upgraded pump station on April 27. During this commissioning, the renovated pumps are operated to send wastewater to the Alki CSO plant without discharging. Pumping continues until several primary clarifiers are filled. These tanks are then drained to the West Seattle Tunnel for ultimate treatment at West Point.

During the week of May 12th installation of the new hypochlorite pump was completed. This larger capacity hypochlorite pump is designed to inject disinfectant through diffusers into the wet well at the pump station increasing the effective contact time. This pump will deliver 9 gallons per minute at 50% output, or dose up to 9 mg/l at 60 MGD with a 4% hypochlorite solution.

Appendix B
Carkeek CSO Treatment Plant Annual Report
June, 2005– May, 2006

This document constitutes the ninth annual report of the Carkeek plant as a CSO Treatment Plant. Carkeek began to operate as a CSO Treatment Plant on November 1, 1994. The treatment plant 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 the Carkeek CSO Treatment Plant discharge went into effect. 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. The improved disinfection system and the newly installed dechlorination system worked well in meeting the permit compliance for the effluent fecal coliforms and the effluent residual chlorine. Also, the raw sewage pump set #1 was replaced with a new pump set during this reporting period.

Carkeek CSO Treatment Plant permit limits
(effective January 1, 2006 through January 1, 2008)

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.

The annual monitoring period is concurrent with the annual CSO reporting period, June 1 - May 31. This report summarizes the performance and operation of the facility during June 2004 - May 2005.

Performance for reporting period June 01, 2005 through May 31, 2006

As of January 1, 2004, Carkeek effluent limits are defined as follows:

- Annual average **total suspended solids removal** is a **minimum of 50%**;
- **Maximum Settleable solids** is limited to **1.9 ml/l/hr or less as a monthly average**;
- **Settleable solids** is limited **an annual average of 0. 3 ml/l/hr or less**;
- **Monthly geomean of the effluent fecal coliform bacteria count is limited to 2900#/100 ml;**
- **Maximum of the daily averages for the effluent residual chlorine in any given month is limited to 490 µg/l;**
- During the permit cycle, the treatment plant flow limits are an average of 10 events and an average of 46 million gallons per year, to be averaged over 5 years or the period of the permit if it were to be extended;

During the June 1, 2005 - May 31, 2006 period, there were 18 inflow events and 6 discharge events at the Carkeek CSO Treatment Plant. The total inflow and discharge volumes for the reporting period were 60.54 and 54.72 MGD, respectively. The discharge event on January 8th through January 17th was excluded in the annual average TSS and Settleable Solids calculations as the "one untreated discharge event per year" for measuring compliance for those parameters' respective permit limits. The discharge volume for this event was 22.99 MG.

During this period:

1. The 5-year running average for the discharge events was 5.2 events/year, meeting the permit limit of 10 events/year;
2. The 5-year running average for the discharge volume was 25.2 MG/year, meeting the permit limit of 46 MG/year;
3. The annual average TSS removal was 55.8%, meeting the permit limit of a minimum TSS removal of 50%, excluding the TSS removal data for the discharge event that occurred January 8th through January 17th, 2006, as "one untreated overflow event per year". The annual average was 48.3% inclusive of all the discharge events for the year ;
4. The annual Settleable Solids concentration for the discharge events averaged 0.08 ml/l/hr met the permit limit of 0.3 ml/l/hr, inclusive of all the discharge events.
5. None of the discharge events exceeded the Settleable Solids limit of 1.9 ml/l/hr.
6. New effluent fecal coliform count limit of 2800#/100 ml, as a monthly geomean, went into effect on January 1st, 2006. For the period January 1 through May 31, 2006, the maximum monthly average was 32#/100 ml.
7. New effluent residual chlorine limit of 490 µg/l, as a maximum daily average, went into effect on January 1st, 2006. For the period January 1 through May 31, 2006, the maximum daily average was 271 µg/l.

Table 1 summarizes the annual performance data for Carkeek CSO Treatment Plant in the last 5 years (through May 31st, 2006).

Table1:

Year	Discharge Flow per Year, MG	Discharge Events per Year	"once per year untreated event"
	Limit = 46 MG/YR	**Limit=10/yr**	
June 01-May 02	36.26	8	11/27/01
June 02-May 03	3.68	4	None
June 03– May 04	27.19	4	10/20/03
June 04– May 05	4.04	4	8/22/04
June 05– May 06	54.72	6	1/8/06 through 1/17/06
5-year average	25.18	5.2	

Operation and Maintenance

After several years of operation it was realized that more flow was arriving at the Carkeek CSO Treatment Plant than anticipated in design. This higher AWWF meant that the transfer of flow to WP needed to be increased from 8.4 mgd to 9.2 mgd to meet the agreed-upon transfer of 2.25xADWF. It was also realized that increasing the pumping capacity at Carkeek Pump Station has a potential of increasing the number and volume of overflows at the11th Avenue Overflow Weir. To prevent such a problem, instrumentation was installed at the 11th Ave. Overflow Weir to signal potential overflow so the pump station would automatically throttle back to 8.1 MGD. In October 2003, 11th Ave. Overflow Weir feed back loop control was incorporated into the PLC controls for the raw sewage pumps at Carkeek Pump Station. The pumping capacity at Carkeek is reduced to prevent untreated CSO discharges at 11th Ave. When the second follow pump is enabled (9.2 MGD max. flow), maximum flow will be reduced to 8.1 MGD if the 11th Ave. weir level reaches 117.96'. If the level drops below 117.96' for 10 minutes, the pumps will resume pumping 9.2 MGD. In such a flow scenario, flows at Carkeek Pump Station above 8.1 MGD will be stored and treated at the plant. This modified pumping regime will continue until the CSO control project for 11th Ave. CSO is built.

Pump set 1 replacement project was done during the current reporting period. The new pump set was delivered during the last week of August 2005. The plug valve on force main was replaced to facilitate the removal of the old pump set #1 in late September. Pump set #1 replacement work began on October 10th and was commissioned into service early December. Pump set #1 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.

Seal water pump was replaced in October. The barscreen was rebuilt with new drive unit and a rake and put back into service in August 2005. First deliveries of Sodium Hypochlorite and Sodium Bisulfite were received on October 14thand October 17th, respectively.

Annual refresher training for the off-site crew was given during the first week of October. Both Influent and Effluent samplers are scheduled to be purged weekly to keep them clean, operable

and ready for an event. Staff will continue to make improvements in training, planning and documentation to maintain smooth operation of the Carkeek CSO Treatment Plant.

Carkeek Dechlorination Project:

King County staff finished the design and installation of dechlorination system. A five hundred gallon double-walled stainless steel tank was installed for storage of 38% bisulfite in the chemical feed room in the operations building. The chemical feed room has climate controls to ensure that the bisulfite does not freeze during cold weather. The storage tank is vented to a caustic impregnated carbon canister and out to the atmosphere. An 8-gal/hour Milton Roy diaphragm pump was installed for pumping the bisulfite required for dechlorination. A 30 psi C-2 water line with a solenoid valve supplies dilution water at 15 gpm and is followed by a static mixer to ensure thorough mixing of bisulfite and water. The post-diluted bisulfite is conveyed through two-tiered diffuser at the head of the chlorine contact channel to inject bisulfite solution into the CSO flows during a discharge event.

The bisulfite on/off status is determined the water level in the sedimentation tank and the flow. The out put of the pump is determined by the flow rate, intermediate chlorine residual and the sedimentation tank level. The bisulfite dosage is determined by multiplying the intermediate chlorine residual, the flow rate and a multiplying factor of 2. The multiplying factor of 2 is set higher than the stoichiometric ratio of 1.55 to build in a factor of safety.

Also, modifications were done to the disinfection pump controls as means of achieving high fecal kills during CSO events. An internal multiplier of 2.0 is activated for the first 2 hours of each CSO event to double the dosage of hypochlorite since the CSO flows tend to be the strongest early into the storm event. Another modification involved maintaining the intermediate chlorine residual (measured at the head of sedimentation tank #1) at a minimum of 1.0 mg/l.

The first CSO discharge event of the reporting period occurred on November 5th, 2005, during which the dechlorination system failed to turn on. The short discharge event ended before the operator had a chance to determine the cause for the failure. An instrument tech later on determined that the "On" trigger for the bisulfite pump was programmed incorrectly, preventing it from turning on. The programming error was corrected and dry loop control test was done on November 8th to verify the dechlorination system responded per design.

Modified disinfection and newly installed dechlorination systems were tested, under controlled inflow event conditions, in mid December. A plug was installed in the effluent outfall to prevent any discharges to Puget Sound. Carkeek Pump station pumps were turned off to allow the wetwell level rise and consequently overflow into Carkeek CSO Treatment Plant. The inflows were regular sewage strength and hence exerted lot higher chlorine demand than the CSO inflows would have. The controlled inflow was disinfected at the chemical feedbox, upstream of the grit tank, and dechlorinated at the head of the contact channel. Coliform samples were grabbed from the wet well, head of the sedimentation tank and at the effluent weir. Results of the coliform tests indicated that the modified disinfection and newly installed dechlorination systems functioned well. The feedback loop controls for hypochlorite and bisulfite dosing were tuned further during the CSO events that occurred late December through mid January. Overall, the chemical systems performed very well and all the CSO discharge events met the new fecal and residual chlorine permit limits.

As part of the second phase of the dechlorination project, a pre-dechlorination analyzer will be installed to further optimize dosing of hypochlorite and bisulfite. A backup sodium bisulfite pump

will be added to ensure redundancy. Also, the existing 500 gallon bisulfite storage tank will be replaced with a larger (800-1000 gallon) capacity storage tank. There will be an additional baffle added at the mid-length of each sedimentation tank to improve dispersion of hypochlorite in the CSO flows.

Appendix C
Elliott West CSO Treatment Facilities Annual Report
June, 2005– May, 2006

This document constitutes the first annual report of the Elliott West CSO Treatment Facilities. The Elliott West CSO Treatment Facilities began to operate in July 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.

During the first year of operation of these CSO facilities, King County had faced several challenges in trying to meet the objective of minimizing the CSO discharges. Despite these, and while some refinements in the operating protocols remain to be done to achieve full control at Denny and Dexter Regulators, much has been accomplished. Of the volume of CSO to be managed at the Mercer/Elliott West facilities 38.4% was captured and received full secondary treatment, 61.4% received primary treatment and disinfection, and only 0.2% was discharged untreated at Denny regulator. The number of untreated discharges went from 32 per year to just seven small ones. At Dexter Regulator, the number of events was unchanged, but they were very small in volume. 74% of the volume that had previously discharged untreated at Dexter now received full secondary treatment. Several of the start up challenges arose out of the complexity of the facility's design. Due to the delay in the scheduled completion of the project, King County had a very limited opportunity to commission the CSO facility, especially the PLC (Programmable Logic Controls) for the main pumps and the treatment systems for disinfection and dechlorination systems. Consequently, the chemical systems did not perform as per design during most of the CSO events. Operation of the facility was further complicated by the steady stream of non CSO flows from City of Seattle sewers that were overflowing into the Mercer Street Storage and Treatment Tunnel. Warranty issues pertaining to the sample pumps in transition structure and dechlorination vault led to sampling issues. The complexity of the facility and lack of prior operational experience posed a challenge in determining when a CSO event began. The sampling was less than desirable during the first year of the facilities operation. A number of items were identified for improving regulatory compliance and most are addressed or being addressed.

Background

The Elliott West CSO Treatment Facilities was built as part of the Denny Way/Lake Union CSO Control Project to meet the federal and state requirements for control of City of Seattle CSOs and King County's Dexter Avenue CSO discharges into Lake Union and King County's Denny Way CSO discharges into Elliott Bay. Elliott West CSO Treatment Facilities and the 7.2 MG Mercer Street Storage and Treatment Tunnel are the two biggest components of this project. The 6200 feet long, 14-ft 8-in diameter Mercer Street 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. The Elliott West CSO Treatment Facility 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;
2. **Storage mode:** During this mode, the combined stormwater and wastewater flows start entering the Mercer St. Storage and Treatment 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' 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 will also run in parallel to the lead pump. The pump discharge is recycled to West Point Treatment Plant 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 98.0, the main pump(s) shutoff.
4. **Pump and Treat mode:** The pumps enter 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 CSO 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 CSO.
5. **Pump & Treat Extreme Event mode:** An extreme event is when a large 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 Treatment facilities planned capacity of 250 MGD is exceeded, untreated CSO discharges occur at the Denny Way CSO.

Auto-samplers collect flow-paced composite samples of the untreated CSO flows returned to West Point Treatment Plant at the Elliott West CSO Treatment Facilities and samples of the treated CSO flows discharged from the new Elliott West CSO Transition Structure. The fecal grab samples are collected from a sample tap on the effluent sample line to the effluent composite sampler. For the 2005-2006 reporting period, 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.

Elliott West CSO Treatment Facilities interim permit limits
(Effective June 1, 2005 through December 31, 2005)

Parameter	Discharge Limitations (Monthly)	Discharge Limitations[a] (Yearly Average)	Discharge Limitations[b] (Long-term Average)
Total Suspended Solids Removal Efficiency[c]	Report	50%	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

[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.

Elliott West CSO Treatment Facilities final permit limits
(Effective January 1, 2006 through the expiration date of the permit)

Parameter	Discharge Limitations (Monthly)	Discharge Limitations[a] (Yearly Average)	Discharge Limitations[b] (Long–term Average)
Total Suspended Solids Removal Efficiency[c]	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.

The annual monitoring period is concurrent with the annual CSO reporting period, June 1 - May 31. This report summarizes the performance and operation of the facility during June 2005 - May 2006.

Performance for reporting period June 01, 05 through May 31, 06

As of January 1, 2006, Elliott West CSO Treatment Facilities effluent limits are defined as follows:

- Annual average **total suspended solids removal** is a **minimum of 50%**;
- **Maximum Settleable solids** is limited to **1.9 ml/l/hr or less as a monthly average**;
- **Settleable solids** is limited **an annual average of 0. 3 ml/l/hr or less**;
- **Monthly geomean of the effluent fecal coliform bacteria count is limited to 400#/100 ml;**
- **Maximum of the daily averages for the effluent residual chlorine in any given month is limited to 44 µg/l;**

During the June 1, 2005 - May 31, 2006 period, there were 23 inflow events into the Elliott West CSO Treatment Facilities and 8 discharge events out of the Elliott West CSO. The total inflow and discharge volumes for the reporting period were 512.5 and 315.6 MGD, respectively.

During this period:

1. The annual average was 30.8% 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 0.53 ml/l/hr did not meet the permit limit of 0.3 ml/l/hr, inclusive of all the discharge events.
3. Discharge event on January 29th, 2006 exceeded the Settleable Solids event limit of 1.9 ml/l/hr.
4. New effluent fecal coliform count limit of 400#/100 ml, as a monthly geomean, went into effect on January 1st, 2006. For most part of this period, there were several issues with the disinfection and dechlorination systems that prevented them from adequately disinfecting the discharged flows. As a result, the fecal coliform limit was not met.
5. New effluent residual chlorine limit of 44 µg/, as a maximum daily average, went into effect on January 1st, 2006. . For most part of this period, there were several issues with the disinfection and dechlorination systems that prevented them from adequately disinfecting the discharged flows. As a result, the effluent residual chlorine limit was not met.
6. Because of various challenges with sample collection, samples called for in the permit were not always collected.

Operation and Maintenance

This reporting period was the first year of operation for the Elliott West CSO Treatment Facilities. The construction of the project was behind schedule and was completed in March 2005. 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 the CSO season. When storms started occurring, several issues emerged pertaining to the equipment performance, equipment access, equipment warranty and instrumentation/PLC and posed lots of challenges. Also, there were significant amounts of dry weather flows entering from the City of Seattle sewers, which created additional operational issues that were not possible to anticipate. A startup engineer was

brought on board in February 2006 to start addressing various instrumentation and operational problems. The following sections describe what these issues were and what corrective measures occurred.

Equipment Issues - Performance, Access and Warranty

1. Dewatering Sump Pumps: Dewatering sump pumps were frequently getting air bound, losing suction and heating up in spite of operators regularly bleeding the air off. The pumps would need a long time to cool off before they could be returned to service. In addition to the above problem, the dewatering pumps were running even under dry weather flow conditions due to the City of Seattle sediment issues into the Mercer St. Storage and Treatment Tunnel. This led to rebuilding of the dewatering sump pumps sooner than expected. Also, there was no flowmeter installed to measure the dewatered flows from the sump pump. As a result, there was no TSS credit claimed for the CSO flows that were returned to West Point Treatment Plant (the discharge location for this flow is at different location from the main pump discharge) during the periods the station was in operation.
Corrective Measure: An air relief valve was installed to rectify loss of suction due to the pumps getting air bound. Both the pumps have since been rebuilt. Also, a flowmeter was installed on the dewatering sump pump discharge line to measure the volume. Sampling provisions have been made to capture a representative sample by plumbing this flow into the dual composite sampler at Elliott West CSO Treatment Facility. PLC programming for the sampling frequency will be done by the end of October.

2. Discharge Channel Gate: During the first couple of CSO events, the discharge channel gate frequently failed open on high torque alarms. This led to the pumped flows overflowing the weir but since the gate failed open, it was recognized by the PLC that the facility was in dewatering mode. Consequently, the PLC permissives for the hypochlorite pumps prevented them from turning on and disinfecting the CSO overflows.
Corrective Measure: The reason for the high torque alarms was found to be the torque settings on the gate operator were set too tight. After adjusting the torque settings, the discharge channel gate did not pose any more problems. Also, the discharge channel gate PLC permissive on the hypochlorite pump loop control was removed.

3. Elliott West Recycled Flows to West Point Auto-Sampler: The auto-sampler, collecting the flows (pumped by the main pumps) returned to West Point, often failed to collect the sample during some of the events. The reason was found to be the auto-sampler timing out on sampling sequence as the sampler's pump, at times, was taking too long to draw the sample into the sampling chamber. There were other times the sampler failed to collect a sample because it was not reset properly after the composite sample was collected for the previous day.
Corrective Measure: A stand alone sample circulation pump has since been installed. When the Elliott West CSO Treatment Facility is in dewatering mode with the main pumps on the circulation pump automatically starts circulating the sample from the pump discharge channel. The auto-sampler pump pulls off from this circulation line per flow-paced signal. Also, instructions were attached and the operators were reminded about the proper procedure to reset the sampler after the composite sample is collected for the previous day's CSO event.

4. Effluent Sampler Pump (warranty and access): The effluent sample is pumped to the auto-sampler with the help of a submersible pump located in the CSO outfall transition structure, just west of the Denny Regulator Station. Same pumped flow is accessed by the effluent residual chlorine and pH analyzers. The effluent sample pump failed several times as a

result of the moisture-in-the-motor alarms. The pump was under warranty and could not be pulled out for inspection and repair of the motor until the storm event had ceased. Consequently, this resulted in loss of effluent sample collection and signal loss from the effluent residual chlorine and pH analyzers.

Corrective Measure: After much deliberation on the warranty issues, the pump controls were jumpered around the moisture leak alarms to allow the sample pump to continue to operate and allow for effluent sampling. A standby submersible pump has since been acquired. Changes were made to the pump power connections so that in case of a pump failure on mechanical or electrical faults, it can be de-energized, pulled out and be replaced with the standby pump without having to wait for the storm event to subside. Also, a secure cover will be installed on the CSO outfall transition structure to enable manual grabs to be collected in the event of pump failure. However, when there is a heavy discharge under high tide conditions, a manual sample may not be collected as the transition structure might be surcharged.

Instrumentation and PLC Issues

1. Loss of Effluent Chlorine Analyzer Signal: Loss of effluent chlorine residual signal resulted from the effluent sample pump failure. Another reason for this failure resulted from the effluent sample delivery set up that involved pinching down some valves in order to pressurize the sample to flow through the analyzer cell. Effluent chlorine residual signal was critical for effective function of disinfection and dechlorination systems.
Corrective Measure: Effluent sample pump issues have been addressed above. The effluent sample delivery set up has been totally revamped. The solenoid valves, which had been the greatest source of problem previously, have been replaced with actuator ball valves. Also, the sample delivery no longer has to be pressurized for the sample to flow through the analyzer cell. Hach CL-17 analyzer (colorimetric analysis) has been replaced with an USFilter Micro 2000 analyzer (amperometric analysis). The new residual chlorine analyzer has minimum detection limit of 1 μg/l.

2. PLC Controls for Hypochlorite and Bisulfite Pumps: Hypochlorite and Sodium Bisulfite dosing was designed strictly based on flow-paced control. There are no manual controls for hypochlorite and bisulfite pumps. Consequently, the pump control logic was designed to turn off the hypochlorite pumps whenever bisulfite pumps failed. Bisulfite pump control permissive includes effluent residual chlorine signal from the analyzer. In the event of effluent residual chlorine signal loss, dechlorination is and subsequently disinfection would be disabled to prevent water quality impacts. Frequent loss of signal due to the effluent sample pump failures prevented disinfection and dechlorination of the effluent.
Corrective Measure: The problems with effluent sample pump have been addressed under item 1. King County concluded that for a complex system, such as the Elliott West CSO Treatment Facilities, it is critical to have a feedback loop control for disinfection and dechlorination dosing. The PLC controls have been redesigned to include a pre-dechlorination residual chlorine analyzer that monitors the chlorine residual of the effluent upstream of the bisulfite injection point. Pre-dechlorination residual chlorine measurement, along with final effluent residual, is incorporated into loop controls for the hypochlorite and bisulfite pumps. Installation of a pre-dechlorination analyzer is expected to be completed by mid-October. King County staff anticipates some loop control logic tuning is likely to occur under CSO discharges in the 2006-2007 CSO season.

3. Effect of High Tide on Dechlorination: Under certain circumstances when the Elliott West CSO Treatment Facilities move out of treat and pump mode during extreme high tide conditions, the flap gate in the outfall transition structure is closed. This situation will result in substantial volume of disinfected yet un-dechlorinated effluent being held in the 96" effluent pipeline downstream of the Elliott West CSO Treatment Facility. Once the high tide recedes, this volume of effluent starts discharging out to Elliott Bay, with out being dechlorinated. Since there was no flow signal from the Elliott West CSO Treatment Facility, the bisulfite pumps would not operate and consequently resulting in un-dechlorinated discharges under these special circumstances.
Corrective Measure: PLC loop controls were modified for the bisulfite pump controls to take into account such scenarios. The water levels on either side of the flap gate (in the dechlorination vault and the outfall structure) will be used to determine if the yet to be dechlorinated volume of effluent is flowing. Once the flow is confirmed, the bisulfite pump starts up and the dosage is controlled based on the pre-dechlorination and final effluent residual chlorine feedback loop. King County staff anticipates fine tuning of the logic during the 2006-2007 CSO season.

Operational Issues

1. Sampling: Sampling during the first year of operation of the Elliott West CSO Treatment Facilities has been less than complete. Some of the reasons being: lack of operating experience, confusion as to when an "inflow" or a "discharge" event began auto-sampler and/or sampling pump failures to collect the samples and new staff undergoing training. Corrective Measure: Auto-sampler reset instructions have been posted on both the samplers. Monthly refresher training and debrief sessions are being held during the 2006-2007 CSO season to reinforce the sampling requirements and to get feedback from the operations staff on necessary improvements to be made through better communications. Also, provisions are being made for a grab sample to be collected during most the CSO events.

2. Dry Weather Flows into Mercer Street Storage and Treatment Tunnel: Substantial amounts of dry weather flows were entering into Mercer St. Storage and Treatment Tunnel during the 2005-2006 CSO year. These flows, at times, were reducing the tunnel's storage capacity for the CSO flows by 1 - 2 MG. Upon investigation by King County's facilities inspection group, it was determined that these dry weather flows were resulting from the City of Seattle's Valley Street system having extensive sedimentation upstream of the Valley Street connection. Also, this caused significant odor issues in the wetwell room of Elliott West CSO Treatment Facility and continuous operation and frequent ragging of the dewatering pumps. Corrective Measure: King County staff worked with the City of Seattle staff on the sedimentation cleanup. Eighty tons of sediment, mainly made of sand and gravel, were removed from 1675 LF of sewer lines. The cleaning operation began in late April and concluded in June 2006. Since the conclusion of cleaning operation, there is very little dry weather flow entering the Mercer St. Storage and Treatment Tunnel.

Conclusion

Given the complexity of the facility's design and operation and the challenges posed, King County staff had learned a great deal during the first year of operating and maintaining. A number of areas of improvement have been identified and addressed. A few items are still being addressed. King County staff is confident that the second year of operation will see significant improvement in both performance and compliance.

Appendix D
Henderson/Norfolk CSO Treatment Facilities Annual Report
June 2005– May 2006

This report summarizes the performance and operation of the Henderson/Norfolk CSO Treatment Facilities during the June 2005-May 2006 reporting year. This document constitutes the first annual report of the Henderson/Norfolk CSO Treatment Facilities. The inlet and outlet regulator stations and storage and treatment tunnel were turned over to King County Wastewater Operations on June 24, 2005. Operations, lab and maintenance staff began training at the CSO treatment facilities in June 2005. This project was intended to bring into control the Henderson Pump Station, the Martin Luther King Jr. Way CSO and to reduce the overflow from the Norfolk CSO, while providing treatment and disinfection to flows that are released from the Norfolk CSO.

The facility operates under Washington State Department of Ecology permit number WA-0029181-1 issued to the West Point Treatment Plant, effective, as modified on June 20, 2006 to December 31, 2008. Under this permit, there are interim and final permit criteria to be met. Interim permit parameters were effective January 1, 2004 through December 31, 2005. Starting Jan. 1, 2006, additional permit limits for total residual chlorine and fecal coliform went into effect. Table 1 summarizes the interim and final permit limits for the Henderson/Norfolk CSO Treatment facilities.

Table 1. Henderson/Norfolk CSO Treatemnt Facilities Permit Limits (January 1, 2004 to December 31, 2008).

Parameter	Discharge Limits (Monthly)	Discharge Limits[a] (Yearly Average)	Discharge Limits[b] (Long-term Average)
Effective Jan. 2004 – Dec. 2008			
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

[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.

Effective Jan. 2006 – Dec. 2008			
Fecal Coliform, cfu/100-mL	1700/100	NA	NA
	Average Monthly	**Maximum Daily [d]**	
Total Residual Chlorine, ug/L	NA	290	

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

Facility Operation

The Henderson/Norfolk CSO Treatment Facilities were built to eliminate CSOs into Lake Washington. The system consists of the inlet regulator; the 14-foot 8-inch inside diameter, 3,100-foot long 42nd Avenue Storage andTreatment Tunnel; the outlet regulator; several junction manholes, and auxiliary equipment. Related facilities include the Henderson Pump Station and force mains (covered in a separate manual), the Henderson Diversion Structure (included in section 12 and the Norfolk Regulator (covered in a separate manual).

The system is located between South Henderson Street and South Norfolk Street just west of Martin Luther King Jr. Way (MLK Way) in the City of Seattle.

These facilities provide storage and treatment of potential CSO during peak, storm events. The diversion of wastewater into the tunnel prevents the discharge of CSO to surface waters during all but the most severe storms. CSOs that are discharged, receive primary treatment by settling, screening, disinfection, and dechlorination.

Wastewater from the Henderson Pump Station force mains and the MLK (Empire) trunk sewer join at the MLK Junction Manhole and enter the inlet regulator. Under normal, dry weather conditions wastewater flows through the inlet regulator and out the Fairbanks Tunnel to the Henderson Junction Manhole in the Henderson Trunk.

During peak flows and storm events, the inlet regulator gate modulates automatically to prevent the Henderson Trunk from surcharging. Wastewater backs up behind the gate in the inlet regulator and the 72-inch regulator influent tunnel, eventually overtopping a weir and entering the storage and treatment tunnel. Wastewater is disinfected with sodium hypochlorite as it enters the tunnel. After the peak flow event is over, wastewater stored in the tunnel slowly drains to the Henderson Trunk sewer for treatment at South or West Point Treatment Plant.

If the tunnel fills before the peak flow event is over, it will overflow the tunnel at the outlet regulator. The overflow is dechlorinated with sodium bisulfite, and passed through fine screens to remove floatable debris. Treated CSO discharges to the Duwamish Waterway through the treated CSO pipeline connected to the Norfolk CSO.

Equipment and Operational Activities

There were no discharge events from the Henderson/Norfolk CSO treatment Facilities during this reporting period. There were several fill events though each event was associated with start-up and with a malfunction of equipment rather than high flows. During June 2005, the Henderson Pump Station upgrades were completed raising the pumping capacity to 21.9 MGD and this capacity was available for use by June 24, 2005. Henderson Pump Station was limited to 10-12 MGD during the storms of 2005-2006.

The lack of filling or discharge events is an unexpected result given the fact that the Seattle area experienced the second wettest January on record (11.65-inches), and 6.5-inches that fell during the last 12-days during December 2005. It was even more unexpected since King County's other CSO treatment plants operated frequently during the month. It seemed likely the Henderson/Norfolk CSO Treatment Facilities should have had filling events and a discharge event during this time.

One reason the tunnel did not go into service last season is related to the inlet-gate control strategy. This sluice gate located between the Fairbanks Tunnel and the inlet regulator is

supposed to modulate/close when the 60- inch diameter Henderson Trunk is half-full. Closing the gate forces flow into the inlet regulator, and ultimately into the storage and treatment tunnel. During several storms, the Henderson Trunk was almost completely full and the gate didn't close. King County flow modelers confirmed that the gate should have closed during these storms.

King County's control engineers subsequently discovered that the inlet-gate control problem stemmed from the use of different units for depth (ft. vs. inches) in the level instrument and the control strategy. Specifically, the trunk's level indicator transmitted in "feet" while the gate control strategy is based on "inches". Thus, while the tunnel may have been at the 30 inches necessary to close the gate, the programmable logic controller (PLC) was receiving a signal of 2.5. In late January 2006, the level indicator in the Henderson Tunnel was changed to transmit in "inches" rather than feet.

Another reason that no flow went to the storage and treatment tunnel last season was related to the inlet-gate actuator. On January 10, 2006, the actuator was shorted-out when groundwater entered the inlet regulator. Groundwater seeped through a slab in the inlet regulator, overflowed into the motor control panel, and drained through conduits (at the panel bottom) down to the flow control room where it shorted out the actuator. The gate failed in the closed position which consequently allowed the storage and treatment tunnel to partially fill. Approximately three million gallons flowed into the storage and treatment tunnel. Hypochlorite was automatically injected for disinfection. Operators were dispatched to manually open the gate. An inlet composite sample was collected during the event. Sampling results are in Table 2. No flow was discharged from the tunnel to the Duwamish Waterway. The gate was left in the open position until a replacement actuator was installed in February. During the interim, levels in the system were continuously monitored so staff could be dispatched to close the gate. The Henderson Junction ultrasonic level indicators were calibrated after the actuator was installed.

The storage and treatment tunnel received approximately one million gallons of flow over 15 minutes on March 8, due to a communication failure between the inlet-gate's positioner and the programmable logic controller. This filling event was not caused by precipitation. Maintenance staff corrected the communication problem within the following week by installing a feedback card. The inlet regulator hypochlorite pumps operated as designed during this inflow event, starting automatically and applying a flow-paced dose. An inlet composite sample was collected during the event. Sapling results are in Table 2. The tunnel was ultimately drained and sent to South Treatment Plant through the Allentown Trunk.

Table 2 Results of sampling data from fill events

Date	Influent BOD (mg/L)	Influent Suspended Solids (mg/L)
January 10, 2006	19	23
March 8, 2006	28	84

An on-line chlorine analyzer is installed at the tunnel outlet with a detection limit is 50 µg/L Cl_2. Because this detection limit is above the permit's maximum daily limit of 39 ug/L Cl_2, staff had to identify a different method for measuring discharge chlorine levels. During the fall of 2005, the South Plant lab validated a portable low-level total-chlorine method that would accurately measure residual at 39 µg/L Cl_2. The portable method will be used to confirm residuals comply with the 39 ug/L permit limit while the on-line analyzer will be used for monitoring.

On January 6, an ISCO 3700ZR Explosion proof sampler was permanently installed in the inlet regulator to collect flow-composite influent samples. The sampler is located in the flow control room above the inlet wet well. The sampler's suction line is located in the wet well just upstream of the tunnel inlet weir, at the same depth. The sampler is flow-paced using a 4-20 mA pulse from the PLC.