King County
Water Pollution Control Division
Department of Natural Resources
821 Second Avenue
Seattle, WA 98104-1598

October 14, 1996

Mr. Bernard Jones
Washington Department of Ecology
3190 160th Avenue S.E.
Bellevue, WA 98008-5442

1995/96 Annual Combined Sewer Overflow Report

Dear Mr. Jones:

Enclosed is King County Water Pollution Control Division's Annual Combined Sewer Overflow (CSO) 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
- 1995/96 overflow volume and frequency information
- An overview of King County's CSO Monitoring Program

The system performed well during the 1995/96 reporting period despite higher than average rainfall. The reporting period rainfall was about 47 inches compared to the baseline average of 36 inches. Total CSO volume continues to remain below baseline levels.

Please call me at 684-1356 or Laura Wharton at 684-1238 if you have any questions or concerns.

Sincerely,

Maureen Welch

Maureen Welch, Acting Manager
Water Pollution Control Division

Enclosure

cc: Christie True
Laura Wharton
Karen Huber

1995/96 Annual Combined Sewer Overflow (CSO) Report

October 1996

KING COUNTY
Department of Natural Resources

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Section 1 - Overview and Status of CSO Control Program

Introduction

This report is prepared and submitted to the Department of Ecology (Ecology) in accordance with the requirements established within NPDES Permits WA-002918-1 and WA-002901-7 and WAC 173-245-090. As outlined in the WAC, this report includes:

- An overview and status of King County Department of Natural Resources, Water Pollution Control Division's (WPCD's) CSO Control Program
- 1995/96 overflow volume and frequency information
- An overview of WPCD's CSO Monitoring Program

Background

King County Water Pollution Control Division (formerly Metro) provides wholesale wastewater conveyance and treatment for flows from the City of Seattle and thirty-two other cities and sewer districts. The City of Seattle collection system contains combined sewers that collect both sanitary sewage and stormwater. Seattle's wastewater collection system conveys flow to County trunks and interceptors which then convey flow to the County's West Point treatment plant. When storm events occur, flows may exceed the capacity of the collection system pipes, resulting in combined sewer overflows into Lake Washington, Lake Union, the Ship Canal, the Duwamish River and Elliott Bay. CSOs are a recognized source of water pollution that can result in aesthetic degradation of shorelines during CSO events and impact sediment quality at discharge sites. CSOs may raise public health concerns in areas where there is potential for public contact.

Since the 1960s, King County has been conducting CSO control projects to improve water quality in the Seattle-King County area. The County first formalized its CSO control program with the development of its *1979 CSO Control Program (1979 Program)*. The *1979 Program* identified nine projects to control CSO events into fresh water areas (i.e. Lake Washington, Lake Union, and the Ship Canal).

In 1985, new regulations were introduced with the Washington State Water Pollution Control Act (RCW 90.48) requiring all municipalities with CSOs to develop plans for "..the greatest reasonable reduction at the earliest possible date." The County's *1986 Plan for Secondary Treatment Facilities and Combined Sewer Overflow Control (1986 Plan)* met this state requirement.

Before the *1986 Plan* was implemented, new regulations were promulgated by Ecology. The new regulations (WAC 173-245-020) 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 eleven CSO control projects designed to meet this interim goal. In the *1988 Plan*, the County evaluated CSO control projects based on the "knee of the cost/benefit curve." This curve was used to determine the cost-effectiveness of projects by identifying the point at which costs rose disproportionately to the achievable CSO reduction.

As part of the renewal process for the West Point NPDES permit, King County recently prepared an update/amendment to the *1988 Plan*. The *1995 CSO Update* includes an assessment of the effectiveness of CSO reduction efforts to date, a re-evaluation of priority for CSO sites, and a list of projects for the next five years.

Regional Wastewater Services Plan

King County WPCD's CSO planning is one component of WPCD's current long-range wastewater planning effort, the *Regional Wastewater Services Plan (RWSP)*.

The *Metropolitan Seattle Sewerage and Drainage Survey* was prepared in 1958 to guide a long-range program of sewerage and drainage services for the Seattle area. That first comprehensive planning document was intended to provide a concise, up-to-date, central source of information concerning King County's long-range plans. Since that time, numerous changes have been made to the original comprehensive plan. The *RWSP* will be an amendment to the *Metropolitan Seattle Sewerage and Drainage Survey* that will integrate long-range planning in all areas of wastewater services, including treatment and conveyance, biosolids management, CSO control, and water reuse. The *RWSP* planning process will establish the priorities for all wastewater programs, including those that affect CSO controls. The *Draft RWSP* will be under review by the Metropolitan King County Council in 1997.

Status of CSO Control Projects

CSO Control Projects from the *1988 Plan*

The *1988 Plan* identified several CSO control projects that King County would undertake through late 2005 to meet the interim goal of 75 percent reduction of CSO volumes system-wide. Table 1-1 summarizes *1988 Plan* projects that have been completed.

Table 1-1. Completed Projects from the *1988 Plan*

Project	Year Started	Year Completed
Hanford Separation	1986	1987
Lander Separation/Bayview Storage	1986	1992
Fort Lawton Parallel Tunnel	1987	1991
University Regulator (Densmore Diversion)	1986	1994
Carkeek Transfer/CSO Treatment Plant	1988	1994

Table 1-2 summarizes projects from the 1988 Plan that are in progress or have been modified since the 1988 Plan was issued. Project descriptions follow the table.

Table 1-2. Other Projects from the *1988 Plan*

Project	Year to Start	Year to be Completed
CATAD Modifications	1987	Ongoing
Alki Transfer/CSO Facilities	1989	1998/1999
Denny Way CSO Control	1993	2005[a]
Kingdome/Industrial Area Storage and Separation	2000	To be determined in RWSP
Michigan Street Separation	1997	To be determined in RWSP
Diagonal Separation	1995	City of Seattle project

[a] Delayed and modified as discussed in text. See pages 4 and 6.

CATAD Modifications

The Computer Augmented Treatment and Disposal System (CATAD) controls the West Point collection system. A new control program for the CATAD system was developed to improve system efficiency by increasing utilization of storage capacity in existing sewers. Prior to the improvements, the CATAD system utilized 17 to 28 million gallons (MG) or 28 to 47 percent of storage within the collection system's estimated 60 MG capacity. Initial estimates projected that modifications to the system would reduce CSO volumes by 150 MG per year. Computer simulations indicate that the overflow reduction achieved by these improvements may total 200 MG per year. The project is mostly complete, although calibration work on level sensors is continuing.

Alki Transfer/CSO Facilities

The Alki project is designed to transfer flows up to 18.9 mgd from the Alki drainage basin to the West Point plant for secondary treatment. Combined sewer flows above 18.9 mgd up to a maximum of 65 mgd will receive primary treatment and disinfection at a modified Alki plant with discharge through the existing outfall. The modifications at the Alki plant will allow for intermittent treatment. In order to protect the treatment facility, flows in excess of 65 mgd will be discharged via the 63rd Avenue Pump Station outfall, which is a permitted CSO location.

A new Tunnel and West Seattle Pump Station will provide conveyance of Alki flows to the Elliott Bay Interceptor (EBI) and West Point. To avoid exacerbating CSOs in the West Point system due to the addition of Alki flows, pipelines were constructed in 1995-96 to transfer approximately 18.9 mgd from the southern part of the West Point service area to the East Section Reclamation Plant at Renton via the Allentown Trunk and Interurban Pump Station.

A pipeline to convey Harbor Regulator Station overflows to the new West Seattle Pump Station for storage in the new West Seattle Tunnel is being added to this project as discussed later in this report.

The Alki project began design in 1989, and construction of major project components has begun. Final completion and start-up for the project have been delayed as a result of a bid protest on the tunnel portion of the project. Completion of the Alki Transfer project is expected to occur by May 1998. Completion of the Alki Treatment Plant modifications is expected to occur by early 1999. Specific permit conditions for operation of the Alki facility will be negotiated with Ecology.

Denny Way CSO Control

The *1986 Plan* identified a storage and treatment approach to controlling Denny Way overflows. In the *1988 Plan*, the Denny Way project was changed to include partial separation of 584 acres in the Denny/Lake Union and Denny Local drainage basins. Predesign for the project was scheduled to begin in 1993 with construction ending in 1999.

In late 1991, the Seattle Drainage and Wastewater Utility (DWU) requested that King County participate in a joint analysis of CSO alternatives to control discharges into Lake Union from Seattle's system and into Elliott Bay from the County's system at the Denny Way Regulator Station. In 1992, a joint Denny Way/Lake Union CSO Control project was submitted as a candidate for federal Infrastructure Grant funds. During 1994, a specific joint City of Seattle/King County Denny Way/Lake Union CSO Control project was identified for the next five years, and a $35 million Infrastructure Grant was awarded by the Environmental Protection Agency. This joint project is discussed later in this report.

Kingdome/Industrial Area Storage and Separation Project

In the *1988 Plan*, the Kingdome project included total separation of the Kingdome parking lot and the industrial area south of the Lander project. The project was one of the final *1988 Plan* projects, with design to begin in 2000 and completion to occur by the end of 2005. The predesign effort for the Kingdome project was accelerated to 1992 in conjunction with work undertaken by the City of Seattle to improve Royal Brougham Way for car/ferry access.

The predesign report indicated that total separation was not cost-effective due to the cost of disconnecting building drains on private property and the limited capacity of the existing combined sewers to convey stormwater. The project was then modified to include partial separation of the industrial area to remove street drainage and Kingdome parking lot runoff from the combined sewer system via new storm drains. The revised project also includes a new 96-inch sanitary trunk in Royal Brougham Way, 11.3 MG of off-line storage, and a new regulator station and connection to the Elliott Bay Interceptor. Recent County modeling results indicate that the storage could be reduced to 9 MG.

In order to coordinate with the City of Seattle's Royal Brougham street-widening project, construction of a portion of the 96-inch line was accelerated to 1994 and completed in 1995. King County is also working with the Public Facilities District designing the Mariners stadium to possibly do some stormwater separation in the basin in conjunction with the new stadium construction. The remaining components of the project are under review as part of the *RWSP* effort.

Michigan Separation Project

The Michigan project, as described in the *1988 Plan*, included total separation in the Michigan basin. The project was scheduled for completion by the end of 2005. The predesign effort for the Michigan project was accelerated to 1992 in conjunction with work being undertaken by the Washington Department of Transportation to upgrade the First Avenue South Bridge.

The predesign report rejected total separation as too costly and disruptive to private property and instead recommended installation of approximately 3,430 feet of sanitary trunk sewer in South Michigan Street/Corson Avenue South, separation of industrial areas identified in the basin, construction of a new regulator station, and a 4.2 MG storage tank. Recent County modeling

results indicate that the storage will need to be increased to 5.5 MG. Final design of the project will depend on action recommended by the *RWSP*.

Diagonal Separation Project

The Diagonal project would provide total separation of sanitary and storm drainage by installing new sewers in about 720 acres of combined or partially-separated industrial area. The project would compliment the City of Seattle's project that separated areas adjacent to the County's Duwamish pump station. In the final *1988 Plan*, the Diagonal storage/separation project was identified as a City of Seattle project and not as a County project.

1995 CSO Update Projects

Since the *1988 Plan*, four new projects for CSO control have emerged primarily as a result of more accurate modeling information. The projects are discussed in the *1995 CSO Update* and are as follows:

- Harbor CSO Pipeline
- Henderson/Martin Luther King Jr. Way CSO Control
- North Beach Storage/Pump Station Upgrade
- Brandon Separation

The Harbor CSO Pipeline and Henderson/Martin Luther King Jr. Way CSO Control projects, along with a revised Denny Way project, form the basis of the CSO Control Program for the next five years. Timing for the North Beach project and the Brandon project will be determined in the *RWSP*. The projects are described below:

Denny Way/Lake Union CSO Control Project

As discussed earlier, a joint City of Seattle/King County Denny Way/Lake Union project was identified in 1994. One of the selection criteria used to determine a preferred project was the County's desire that the project be able to integrate with any program recommended by the *RWSP*.

The Denny Way/Lake Union project was phased to both coincide with the *RWSP* process while still qualifying for the Infrastructure Grant funding. Four phases were identified:

Phase 1: City of Seattle's project to upsize pipes along Eastlake to control several of the City's Lake Union CSOs.

Phase 2: Continuation of the City's project that will connect the City's Eastlake project to the County's Phase 3.

Phase 3: King County's project to accommodate the increased flows from the City's Lake Union system, reduce the Dexter CSO discharge to one event per year, and reduce the Denny Way discharges to 50 percent of the baseline annual CSO volume. The

preferred alternative would consist of a new 14 to 18 ft. diameter CSO storage tunnel, a 2.5 MG storage tank, two pump stations, and a new outfall in Elliott Bay.

Phase 4: King County's project to control CSOs at Denny to one event per year by adding CSO treatment facilities to the storage tank.

Design for Phase 1 has been completed by the City of Seattle and construction began in spring 1996. The City will complete design of Phase 2 after design of the County's project is determined in more detail.

The County's Phase 3 project was recognized as an interim phase, to accommodate the RWSP decision-making process. At that time (1994), the County was considering an RWSP alternative with a Duwamish CSO plant, which would have eliminated the need for Phase 4 (but still required implementation of Phase 3). As of 1996, this alternative has been eliminated, and three of four RWSP alternatives require implementation of Phase 4. In addition, timing of other CSO control projects has been revised, prompting the need to implement Phase 4 control of the Denny Way CSO by 2006.

The County has agreed with Ecology to reduce CSOs system-wide by 75 percent by 2006. Because the Denny Way CSO is the largest CSO in the system, it has been targeted for control. Current cost-effectiveness analysis shows that controlling this CSO to the one-event-per-year level is cost effective and should be completed as part of the effort to meet the 2006 deadline for 75 percent reduction of CSOs in the County system.

Project refinement work was undertaken in 1995-96 to develop more detail on the project. Schedule analysis in Spring 1996 showed that the likely completion of Phase 3 would be in 2003, and construction of Phase 4 facilities would need to begin almost immediately to achieve ultimate control of the Denny Way CSO by 2006. Therefore, it was decided to combine Phases 3 and 4 and implement CSO treatment as part of the initial project. The impact of this decision is that it is not necessary to design and construct an interim CSO storage facility at the Elliott West site to reduce CSO volume by 50 percent (Phase 3). The objective of the current County project is to control CSOs to Lake Union and at the Denny regulator to one untreated event per year.

Facilities required for the Phase 3-4 project include:

- A CSO storage and treatment tunnel (14-18 ft. diameter) between south Lake Union and the Elliott West site
- CSO pumping and treatment at the Elliott West site
- New marine outfalls at Myrtle Edwards Park to discharge treated CSO and allow offshore discharge of untreated CSO during very large storms (once per year or less)
- Pipelines and regulators to connect the existing collection system to the new CSO control facilities

A general milestone schedule for project implementation is shown below:

- Preliminary Design Begins — Fall 1996

• Facilities Plan Submitted to Ecology	Summer 1997
• Final Design Begins	Fall 1997
• Construction Begins	2000
• Construction Complete	2005

A joint State Environmental Policy Act (SEPA) environmental impact statement/National Environmental Policy Act (NEPA) environmental assessment and facilities plan for Phases 2-4 are underway, with completion scheduled in 1997. Construction of the City and County projects is scheduled to be completed by 2005.

Harbor CSO Pipeline Project

The Harbor CSO Pipeline project will convey overflows from the Harbor Regulator to the new West Seattle Pump Station for storage in the new West Seattle Tunnel, controlling events at the Harbor Regulator station to one event per year or less. This is a change from the *1988 Plan* which recommended partial separation to control Harbor CSOs. The project was revised when recent County modeling indicated that partial separation would not control Harbor CSOs to the one event per year level, requiring the addition of storage. The availability of nearby storage in the West Seattle Tunnel made the Harbor CSO Pipeline a cost effective alternative.

The current Harbor project has been reprioritized to be done sooner than scheduled in the *1988 Plan* due to the cost and environmental benefits from constructing the pipeline concurrently with the Alki project's West Seattle Forcemain. The Harbor pipeline portion of the project enlarges the trench for the forcemain and lays a new 54-inch pipe underneath. The cost of the current Harbor project is much less than the cost of excavating a new pipeline and trench for the 54-inch pipe. Risk of affecting the integrity of the forcemain in the future is also avoided.

The Alki project's West Seattle Forcemain contract has been awarded and work will be completed in 1997. CSOs from the Harbor Regulator will be stored in the tunnel beginning in 1998 when the tunnel and pump station are complete.

Henderson/Martin Luther King Jr. Way CSO Control

At the time of adoption of the *1988 Plan*, the County believed that all CSOs into Lake Washington, including the discharge from the Henderson Street Pump Station and Martin Luther King Jr. Way overflow weirs, had been controlled to the one event per year level. However, recent monitoring data indicate that overflows occur more frequently than once per year at these locations.

As a result, in 1995 the County developed an engineering evaluation of the basin tributary to the Henderson/Martin Luther King Jr. Way CSOs to determine the sources and causes of the overflows at these locations, and identify interim and permanent corrective measures to control overflows. The evaluation also considered the impact of these measures on the downstream Norfolk Regulator.

Based on this evaluation, the preferred alternative is to construct a 3.2 MG storage tank/CSO treatment facility near the Norfolk Regulator Station along with associated conveyance and pumping improvements. A consultant will be selected in Fall 1996 to perform predesign and final design. The design phase is scheduled to be completed in 1997. Construction is scheduled to be completed in 1999.

North Beach Storage/Pump Station Upgrade

King County believed in 1988 that overflows from the North Beach Pump Station had been controlled to one event per year. However, during predesign for the Carkeek Park CSO Treatment Plant, overflows exceeding one event per year were identified at North Beach. As a result, the County initiated a predesign effort to control these overflows and a report was completed in July 1993. The report recommended construction of a new storage basin at the pump station site, an increase in pump station capacity, and construction of a new pipeline in Carkeek Park to reroute flows from two City of Seattle gravity sewer lines that discharge directly to the County's forcemain. The schedule for implementation of the predesign report recommendations will be determined in the *RWSP*.

Brandon Separation Project

During predesign of the Michigan Separation project, the predesign team recommended the addition of a Brandon partial separation and storage project. Recent County modeling for the *RWSP* indicates that CSO control at Brandon would be best achieved via on-site CSO treatment. The schedule for implementation of a Brandon project will be determined in the *RWSP*.

Other Related Projects

King County's Water Quality Assessment

To gain a better understanding of CSO impacts in Elliott Bay and the Duwamish River, King County is conducting a water quality assessment to:

- Determine existing conditions in Elliott Bay and the Duwamish River by sampling, monitoring, and computer modeling the water column and sediments.
- Understand the relative significance of CSO pollutants compared to other pollutant sources by studying CSO impacts on human health and aquatic life.

Based on the results of these tasks, additional tasks may include assessing the benefits from various levels and types of CSO control or linking the results of the Water Quality Assessment to watershed management programs currently proposed by King County and other agencies.

Lander and Densmore Stormwater Management Program

King County and the City of Seattle are jointly undertaking a stormwater management program in the Lander and Densmore drainage basins as required by the NPDES municipal stormwater permit. This is an on-going program which includes the following elements: source control, baseline sampling of stormwater discharges, surveys, inspections, educational outreach, and development of compliance and enforcement schedules.

Sediment Baseline Monitoring Plan

A Sediment Baseline Monitoring Plan was submitted to Ecology and approved in August 1995. The Plan provides for monitoring of marine sediments in the vicinity of wastewater treatment plant outfalls and CSOs. Each CSO site is characterized in the Plan according to the status of clean-up activities as follows:

- For five sites, a cleanup study is already underway or contemplated in the near future; therefore, no new baseline sampling is being proposed under the plan.
- For five sites, baseline sampling is complete, and no additional sampling is planned unless requested by Ecology.
- For three sites, cleanup activities are anticipated, and sampling is required to facilitate those activities. These sites were sampled in 1995.
- For seven sites, new baseline sampling is proposed. For these sites, the monitoring plan specifies the manner in which sampling will be carried out. Three of these sites will be sampled in 1996.

The table below summarizes the sampling activities for CSO sites:

Table 1-3. Sediment Baseline Monitoring Plan for CSO Sites

Year	CSO Sampling Site	Purpose
1995	Connecticut Street	Sampling required to facilitate anticipated cleanup activities
	Chelan Avenue	
	Hanford Street	
1996	S. Magnolia	New Baseline Sampling
	North Beach	
	53rd Avenue SW	
1997	Barton Street	New Baseline Sampling
	63rd Avenue	
	Murray Avenue	
	SW Alaska Street	

Section 2 - 1995/96 CSO Volume and Frequency Summary

Introduction

The volume and frequency of CSOs at regulator and pump stations in the West Point System are monitored by the County's CATAD System. Figure 2-1 shows the location of existing King County and City of Seattle CSO discharges. The area south of the Ship Canal is referred to as the Southern Service Area, and the area north of the Ship Canal is referred to as the Northern Service Area. The County deploys portable flowmeters at the following six CSO locations not currently monitored by CATAD: S. Magnolia, East Ballard (11th Ave. NW), North Beach, Martin Luther King Jr. Way, Henderson Street, and SW Alaska Street (Beach Drive).

Baseline Conditions

For any selected time period, the actual volume and frequency of CSOs depend on the pattern of rainfall. The existence and extent of overflows are also functions of the physical characteristics of the system. King County and Ecology determined that the County CSO collection and conveyance system, as it existed in 1981-1983, would be an appropriate baseline from which to measure the progress of CSO control. Thus the term "baseline" refers to the physical characteristics of the system during 1981-1983, as well as the average volumes and frequencies of overflows which were thought to have occurred from that system. The baseline overflow volumes are an estimate of average annual CSO volumes that would have occurred in the collection system as it existed in 1981-1983 for the average rainfall of 36 inches per year that occurred from 1943-1988.

In the *1988 Plan*, the baseline conditions were characterized by a computer model. Seven design storms which occurred in 1981-1983 were selected for use in estimating annual CSO volumes. These storms were selected to cover a range of rainfall intensities and durations. Adequate CATAD flow and overflow data existed for the system during these storms. From the CATAD overflow records, factors were determined to apply to the overflows from the design storms so that they could be used to represent overflows from other storms of similar magnitude. When the overflows computed from the design storms were multiplied by these factors and the results for all design storms summed, an estimate of the total system annual overflow volume was obtained.

Baseline Overflow Volumes

In the *1988 Plan*, the baseline overflow volumes were generated using the Seattle Area Combined Sewer Routing Organizer (SACRO) to model the system. SACRO computes overflow volumes by adding all of the inflows to a given location and subtracting the estimated capacity of the pipes or pump station leaving that location. Recorded CATAD data provided the bulk of the information used in the *1988 Plan* modeling effort. Locations which were not monitored by the CATAD system were not included in the model because they were thought to be controlled to the one event per year level or because there was not enough information to determine their level of

control. Results of this analysis are shown in Table 2-1 under the column entitled "*1988 Plan* Baseline."

Since the *1988 Plan* was prepared, the County has developed a new, more sophisticated computer model for simulating the behavior of its conveyance system during storms. The new model, known as "UNSTDY," computes flow velocities and water surface levels throughout the system. This allows the computer to simulate backwater, flow reversal, surcharged and open channel flow, as well as correct regulator and pump station operation. "UNSTDY" provides a degree of detail and accuracy which was not available with older models.

Using the new model with the same rainfall data and system characteristics from the *1988 Plan* has resulted in revised baseline overflow volumes that give a better, more accurate picture of the location and volumes of overflows under the 1981-1983 baseline conditions. As shown on Table 2-1, the difference between the *1988 Plan* total baseline volume of 2,409 million gallons and the revised total baseline volume of 2,393 million gallons is small.

Although the *1988 Plan* total baseline volume and the revised total baseline volume are not very different, the variations at specific CSO locations is sometimes significant. Development of the new model required an investigation of the collection system and the previous CATAD control software. During this analysis, the County discovered and corrected errors in the computer code used for the old control program, errors in pipe characteristics in the system, and inaccuracies in the level sensors at certain control points. The new model was then recalibrated. Due to this error-location, error-correction effort, the new baseline volumes for the University and Montlake Regulators and Duwamish Pump Station are notably lower. At the same time, the Chelan and Norfolk Regulator baseline overflow volumes are higher than previously modeled. Denny Way baseline overflow volume is also higher. Some overflows which were thought controlled to one event per year are not and are included in the revised baseline volumes.

•Baseline CSO Frequency of Events•

In the *1988 Plan*, baseline CSO frequency of events was estimated using CATAD reported overflows during the baseline years 1981-1983. King County has traditionally defined a CSO event as a period of rainfall during which an overflow was recorded that was preceded by three hours with no rain and followed by three hours without rain after the overflows from the system ceased. Frequency estimates were not given for the Duwamish Pump Station, Canal Street, and 3rd Avenue West due to a lack of CATAD data.

Upon development of the new model, the baseline CSO frequency of events was re-examined. For overflow locations monitored by portable flowmeters during the past few years, an average of the overflow frequencies during the monitored years was used to estimate CSO frequency of events. For stations which have not been monitored such as the Alki stations, the new model was used to estimate CSO frequencies based on the seven design storms. Each design storm has a recurrence interval which defines the number of times similar storms occur in a one year period. Table 2-2 displays the results of this analysis.

Table 2-1. Baseline Overflow Volumes

Station	*1988 Plan* Baseline (MG)	Revised Baseline (MG)[c]	Difference in Volume (MG)
Southern Service Area			
8th Avenue South	15	15	0
W. Michigan Street	2	2	0
Terminal 115	N/A	5	5
Harbor Avenue	55	55	0
East Marginal Way	N/A	0	0
Chelan Avenue	25	65	40
Norfolk Street	4	70	66
Michigan Street	250	190	(60)
Brandon Street	35	60	25
Hanford #1	N/A		
Hanford #2	N/A		
Total Hanford	680[b]	605	(75)
Lander Street	215	190	(25)
Connecticut Street	90	90	0
King Street	70	55	(15)
Denny Local	N/A		
Denny Lake Union	N/A		
Interbay	N/A		
Total Denny	370[b]	405	35
Duwamish	130	1	(129)
Martin Luther King Jr. Way[a]	N/A	88	88
Rainier Avenue	N/A	0	0
Henderson Street[a]	N/A	10	10
S. Magnolia[a]	N/A	15	15
Northern Service Area			
Dexter Avenue	12	15	3
Canal Street	10	1	(9)
East Pine Street	N/A	0	0.
30th Avenue NE	N/A	0	0
Belvoir	N/A	0	0
Matthews Park	N/A	0	0
University	211	110	(101)
Montlake	40	10	(30)
Ballard	N/A		
11th Ave. NW (E. Ballard)	N/A		
Total Ballard	90[b]	90	0
3rd Ave. W. (& Ewing St.)	105	125	20
North Beach[a]	N/A	2	2
Alki			
Murray Street[a]	N/A	5	5
Barton Street[a]	N/A	7	7
53rd Avenue SW[a]	N/A	<1	<1
SW Alaska Street[a]	N/A	12	12
63rd Avenue SW[a]	N/A	95	95
Total (MG)	**2409**	**2393**	**(16)**

[a]Stations not connected to CATAD and for which data was limited or non existent in 1988.
[b]Methodology used to make these estimates necessitated the reporting of totals for closely associated overflows.
[c]Revised 1981-83 baseline estimate based on new model.

Table 2-2. Baseline CSO Frequency of Events

Station	*1988 Plan* Baseline Frequencies (overflows/year)	Revised Baseline[c] Frequencies (overflows/year)	Difference in Frequencies (overflows/year)
Southern Service Area			
8th Avenue South	12	12	0
W. Michigan Street	9	9	0
Terminal 115	N/A	8	8
Harbor Avenue	46	56	10
East Marginal Way	N/A	<1	<1
Chelan Avenue	16	25	9
Norfolk Street	7	12	5
Michigan Street	31	40	9
Brandon Street	25	40	15
Hanford #2	27	40	13
Lander Street	19	29	10
Connecticut Street	25	34	9
King Street	31	31	0
Denny Local[b]	N/A		
Denny Lake Union[b]	N/A		
Interbay[b]	N/A		
Total Denny	51	51	0
Duwamish	N/A	<1	<1
Martin Luther King Jr. Way[a]	N/A	23	23
Rainier Avenue	N/A	<1	<1
Henderson Street[a]	N/A	16	16
S. Magnolia[a]	N/A	21	21
Northern Service Area			
Dexter Avenue	4	4	0
Canal Street	0	<1	<1
East Pine Street	N/A	<1	<1
30th Avenue NE	N/A	<1	<1
Belvoir	N/A	<1	<1
Matthews Park	N/A	<1	<1
University	14	14	0
Montlake	16	16	0
Ballard	13	13	0
11th Ave. NW (E. Ballard)	13	13	0
3rd Ave. W. (& Ewing St.)	N/A	20	20
North Beach[a]	N/A	18	18
Alki			
Murray Street[a]	N/A	8	8
Barton Street[a]	N/A	23	23
53rd Avenue SW[a]	N/A	<1	<1
SW Alaska Street[a]	N/A	23	23
63rd Avenue SW[a]	N/A	<1	<1
Total (overflows/yr)	**359**	**599**	**240**

[a]Stations not connected to CATAD and for which data was limited or non existent in 1988.
[b]Stations which overflow at the same discharge point are reported as one total.
[c]Revised 1981-83 baseline estimate based on new model and additional monitoring data.

As shown on Table 2-2, the revised total baseline CSO frequency of events is larger than the *1988 Plan* total baseline CSO frequency of events. Stations which were not connected to CATAD and for which data was limited or non-existent in 1988 have now been included, resulting in a larger number of CSO events per year. The new model error-location, error-correction effort also resulted in a larger number of CSO events.

The new revised baseline volumes and frequencies reflect the increase in knowledge gained since the *1988 Plan*. As the County continues to improve and refine its modeling capabilities, the baseline conditions will be revised as demonstrated necessary.

1995/96 CSO Volumes

The total system overflow volume for this reporting period, June 1995 through May 1996, was 1,967 MG compared to a baseline volume of 2,393 MG.

As shown on Table 2-3, rainfall measured by County rain gauges at pump and regulator stations averaged 46.52 inches for the 1995/96 reporting period. This is higher than the average rainfall of 36 inches per year, and the most rainfall during a reporting period over the seven years that the annual CSO report has been produced.

Rainfall for the four month rainy season, November 1995 through February 1996, was 32.46 inches at Seattle-Tacoma International Airport. This was the most rainfall for the four month rainy season since observations began at the airport in the mid-1940s.

The monthly variation of rainfall followed a normal trend with the wettest months occurring from November through April. Correspondingly, the majority of overflows occurred during these months.

The total system overflow volume for the reporting period was less than the baseline volume even though rainfall was considerably higher than average during the reporting period. Table 2-4 contains the monthly overflow volumes and comparisons to revised baseline conditions for each station. Figure 2-2 graphically illustrates the relationship between rainfall and CSO volumes.

While the establishment of baseline conditions identifies average annual volume and frequencies of discharge, year-to-year comparisons to baseline conditions can be misleading. Annual rainfall cannot indicate year-to-year variations in CSO volumes for individual basins, as rainfall can be extremely variable in the Seattle area. Individual storm events can disproportionately influence total overflow volume. This is illustrated during the reporting period by the storm which occurred from February 7, 1996 to February 9, 1996. This storm accounted for 412 MG, approximately twenty-one percent of the total overflow volume for the reporting period.

Table 2-3

1995/96 Rainfall at Pump and Regulator Stations

(in inches)

Station	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	1995/96 Total
Denny Local	1.32	1.19	1.19	0.84	2.97	6.45	6.92	5.11	6.82	1.65	5.22	3.11	42.77
King Street	1.43	0.87	1.77	0.84	2.46	5.63	6.07	4.32	6.35	1.44	4.78	3.43	39.39
Chelan Avenue	1.59	1.14	2.14	0.92	2.92	8.19	7.58	5.39	7.29	1.79	6.7	3.49	48.14
Denny Way Lake Union	2.72	0.03	2.15	1.41	4.19	6.39	10.23	6.55	8.87	2.45	7.15	4.88	57.02
Ballard	1.04	1.3	2.2	1.06	3.34	7.01	7.22	4.57	6.64	1.67	5.55	2.6	44.42
University	1.51	1.53	2.92	1.38	3.74	7.85	8.49	5.8	7.95	1.88	5.28	3.85	52.18
Hollywood	1.92	1.78	2.48	1.6	4.62	7.44	8.2	5.96	6.85	1.67	4.79	3.55	49.26
Rainier Avenue	1.37	0.89	1.5	0.61	3.16	7.58	6.69	5.28	6.95	1.77	4.7	3.69	44.19
East Marginal Way	0.94	1.03	1.74	0.78	2.63	6.16	6.53	5.44	6.79	1.62	5.2	2.75	43.61
Henderson	1.74	0.81	1.4	0.99	2.94	8.87	5.91	6.13	7.28	1.8	2.43	2.86	43.16
East Pine Street	1.93	1.17	1.64	1.18	3.63	7.02	7.45	5.12	6.5	1.64	5.27	3.91	46.56
Matthews Park	1.25	1.53	2.8	1.43	4.15	6.91	6.68	4.63	7.17	1.85	4.46	3.63	46.49
Kenmore	1.1	1.52	2.78	1.27	4.29	7.04	8.82	5.06	7.47	1.68	5.21	3.29	47.53
Average	1.53	1.14	2.07	1.10	3.47	7.27	7.14	5.34	7.15	1.78	5.06	3.48	46.52

[96raindy.wg2]

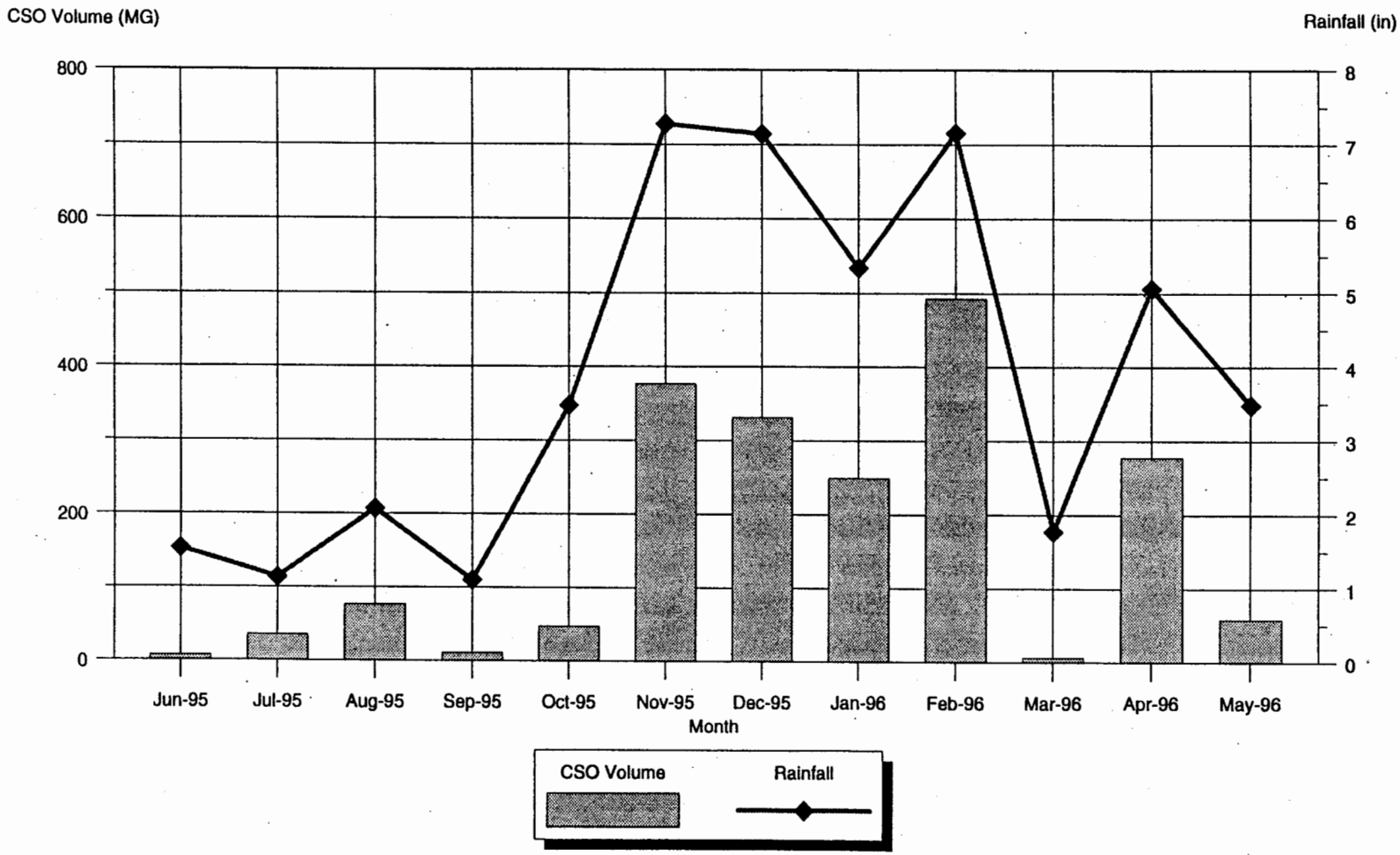
Table 2-4
1995/96 CSO Volume Summary by Service Area
(in million gallons)

Station	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	1995/96 Total (MG)	Revised Baseline (MG)
SSA														
Denny Way	3.5	23.6	97.2	2.2	20.7	117.0	138.0	78.2	91.7	2.1	53.1	14.0	581	405
King Street	0.2	1.1	2.9	0.1	1.5	8.8	6.8	6.4	10.9	0.1	2.9	1.7	43	55
Connecticut	0.0	0.4	4.3	0.0	3.1	7.7	2.8	3.8	8.8	0.2	9.6	9.7	50	90
Hanford (2)	0.5	3.0	9.5	0.0	4.0	44.3	51.8	38.8	105.5	0.4	56.4	12.5	327	605
Lander II St.	0.0	0.0	0.3	0.0	0.1	10.7	12.6	26.4	23.3	0.0	6.6	1.9	82	190
Harbor Ave.	1.3	0.7	1.6	0.5	2.3	17.2	11.9	9.6	19.1	1.1	9.5	3.2	78	55
Chelan	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.9	11.2	0.0	7.8	0.1	21	65
W. Michigan	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.4	0.0	0.5	0.0	2	2
8th Ave.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	1	15
Brandon St.	1.7	1.2	4.7	1.5	10.3	78.4	42.9	26.9	15.6	0.2	10.7	1.9	196	60
Michigan St.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	190
Norfolk St.	0.0	0.0	1.3	0.2	0.0	23.8	14.8	26.6	28.1	0.0	4.0	1.3	100	70
Duwamish P.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1
Henderson (1)	0.0	0.0	0.1	0.0	0.0	1.4	0.7	5.3	9.0	0.0	4.8	0.2	21	10
MLK Jr. Way (1)	0.0	0.0	1.5	0.0	0.4	22.8	10.8	20.0	44.8	0.0	28.1	2.9	132	88
Rainier Ave.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
E. Marginal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
W. Marginal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
S. Magnolia (1)	0.0	0.3	0.4	0.0	0.2	1.4	3.4	1.1	5.4	0.0	4.9	0.7	18	15
Terminal 115													N/A	5
SSA SUBTOTAL	7.2	30.3	63.9	4.5	42.6	333.9	297.1	244.3	375.1	4.1	199.0	50.0	1652	1921
NSA														
Ballard	0.0	1.3	0.6	0.9	10.5	7.3	7.7	1.6	16.6	0.0	10.9	0.5	48	90
Dexter	0.1	0.0	1.9	4.8	2.1	16.0	1.5	0.2	0.5	0.9	0.7	6.4	35	15
University (3)	0.0	0.0	2.9	0.2	0.0	11.9	17.2	0.1	42.8	0.3	52.5	0.7	129	110
Montlake	0.0	3.2	7.3	0.2	0.7	0.0	0.0	0.0	38.0	0.0	0.0	0.0	49	10
Canal St. (Lake City)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1
Third Ave. W.	0.0	0.0	0.0	0.0	0.0	7.3	7.0	2.5	16.2	1.1	13.7	0.4	48	125
E. Pine St.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Belvoir	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Matthews Park	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
30th Ave. NE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
North Beach (1)	0.0	0.0	0.0	0.2	0.9	0.6	0.5	0.2	2.9	0.0	0.5	0.0	6	2
NSA SUBTOTAL	0.1	4.5	12.8	6.2	4.1	43.0	33.9	4.5	117.0	2.3	78.3	8.0	315	353
Carkeek														
Carkeek CSO Plant													See Carkeek Annual Report	
Alki														
Murray													N/A	5
Barton													N/A	7
53rd Ave. SW													N/A	<1
SW Alaska St. (Beach Dr.) (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	12
63rd Ave.													N/A	95
TOTAL	7.3	34.8	76.7	10.7	46.8	376.9	331.0	248.9	492.2	6.3	277.3	58.0	1967	2393

(1) Portable flow meters; not currently monitored by CATAD.
(2) Hanford total includes overflow from Hanford at Rainier which discharges through the Hanford #1 outfall. Monitoring of the Hanford at Rainier overflow began in January 1996.
(3) The outfall gate position indicator was not operating properly from Nov. 1995 - Feb. 1996. Overflow volumes are estimated using the flow pattern at Montlake.

[96csovol.wg2]

Figure 2-2. 1995/96 CSO Volume vs. Rainfall



Northern Service Area (NSA)

Overflow volumes in the Northern Service Area for 1995/96 were 315 MG compared to a baseline of 353 MG. Due to the large amount of rainfall during the reporting period, overflow volumes were above baseline at the following NSA stations: Dexter, University, Montlake, and North Beach.

- Dexter overflowed 35 MG compared to a baseline of 15 MG. The higher Dexter volume continues to be investigated. The CATAD overflow calculation may be resulting in inflated overflow volumes and will be checked this year.

- After the big February 1996 storm, it was found that the outfall gate position indicator was not working properly at the University Regulator station. Based on CATAD data, it was not working properly from November 1995 through February 1996. Overflow volumes have been estimated for this time period using the flow pattern at Montlake. The estimated overflow volume at University is 129 MG compared to a baseline of 110 MG. The Densmore diversion, the project to reduce stormwater through the University Regulator by diverting stormwater runoff from the Densmore drain, Interstate 5 and outflow from Green Lake, was not fully operational for most of the reporting period due to pump problems.

- Overflow volumes at North Beach were also slightly higher than baseline; however, a CSO control project has not been implemented at this site.

Carkeek Park CSO Plant

The Carkeek CSO Treatment Facility began operation in the Fall of 1994. Discharge events at Carkeek begin when treated effluent leaves the CSO facility and is discharged into Puget Sound. Discharges occurring less than 48 hours apart are considered to be associated with an individual rainfall event.

Further information on plant performance can be found in the monthly Carkeek discharge monitoring reports and the Carkeek annual report.

Alki

The calibration of the County model has not been completed at the Alki CSO locations. Data is now being collected to confirm the baseline estimates. Flow calculations were not available for the Alki stations so overflows were not recorded for the reporting period. Flow calculations are being developed so that overflow data will be included in future CSO reports.

Southern Service Area (SSA)

Overflow volumes in the Southern Service Area for 1995/96 were 1,652 MG compared to a baseline of 1,921 MG. Due to the large amount of rainfall during the reporting period, overflow volumes were above baseline at the following SSA stations: Denny Way, Harbor, Brandon, Norfolk, Henderson, Martin Luther King Jr. Way, and South Magnolia. As expected, these are sites where CSO control projects have not been completed.

- The Denny Way overflow volume for the reporting period was 581 MG compared to a baseline of 405 MG. The Denny Way overflow represents the total overflow volume from Denny Way Lake Union, Denny Way Local, and the Interbay Pump Station. Last year, it was discovered that a broken spring on the outfall gate transmitter caused erroneous CATAD readings. The transmitter was fixed in November 1995. Overflow volumes were estimated from June 1995-November 1995 based on the relationship developed last year between the CATAD outfall gate reading and the real gate opening.

  Last year, it was also determined that the equation to calculate overflows at Interbay was resulting in inflated numbers. Overflow volumes were recalculated for Interbay based on a corrected equation.

- The overflow volume at the Harbor Regulator station was 78 MG compared to a baseline of 55 MG. The higher than baseline overflow volume is likely due to higher than average rainfall. An event in November 1995 did contribute a small amount of additional overflow volume at Harbor. During construction of the West Seattle Tunnel, a Seattle sewer was damaged. While the sewer was repaired, flow was routed through the Harbor Regulator station. The outfall gate was opened, resulting in about 0.3 MG additional overflow volume at this site.

- Brandon experienced overflow volumes of 196 MG compared with a baseline of 60 MG. This is likely due to the fact that the flow through the Michigan Regulator station was not restricted by a gate to the EBI.

  There is a significant operating relationship between the Michigan and Brandon basins, and flows to the EBI from one basin affects the operation of the regulator gate in the other basin. This may account for unusually high or low volumes and frequencies at either location. An assessment of the total volume at both regulator stations may more accurately reflect volume and frequency reductions. Using this method, Brandon and Michigan experienced overflow volumes of 196 MG compared to a baseline of 250 MG.

  Due to the unresponsiveness of the manufacturer to repair the Michigan regulator gate, a new gate has been ordered. The new gate should be installed by the end of 1996. No overflows occurred at Michigan during this reporting period due to the fact that all flow was being conveyed to the EBI. Also, the wires from the control building to the outfall gate were torn out in May 1995 due to First Avenue South bridge construction activities. The outfall gate was essentially inoperable until August 1995 when the wires were repaired.

Northern Service Area (NSA)

Overflow volumes in the Northern Service Area for 1995/96 were 315 MG compared to a baseline of 353 MG. Due to the large amount of rainfall during the reporting period, overflow volumes were above baseline at the following NSA stations: Dexter, University, Montlake, and North Beach.

- Dexter overflowed 35 MG compared to a baseline of 15 MG. The higher Dexter volume continues to be investigated. The CATAD overflow calculation may be resulting in inflated overflow volumes and will be checked this year.

- After the big February 1996 storm, it was found that the outfall gate position indicator was not working properly at the University Regulator station. Based on CATAD data, it was not working properly from November 1995 through February 1996. Overflow volumes have been estimated for this time period using the flow pattern at Montlake. The estimated overflow volume at University is 129 MG compared to a baseline of 110 MG. The Densmore diversion, the project to reduce stormwater through the University Regulator by diverting stormwater runoff from the Densmore drain, Interstate 5 and outflow from Green Lake, was not fully operational for most of the reporting period due to pump problems.

- Overflow volumes at North Beach were also slightly higher than baseline; however, a CSO control project has not been implemented at this site.

Carkeek Park CSO Plant

The Carkeek CSO Treatment Facility began operation in the Fall of 1994. Discharge events at Carkeek begin when treated effluent leaves the CSO facility and is discharged into Puget Sound. Discharges occurring less than 48 hours apart are considered to be associated with an individual rainfall event.

Further information on plant performance can be found in the monthly Carkeek discharge monitoring reports and the Carkeek annual report.

Alki

The calibration of the County model has not been completed at the Alki CSO locations. Data is now being collected to confirm the baseline estimates. Flow calculations were not available for the Alki stations so overflows were not recorded for the reporting period. Flow calculations are being developed so that overflow data will be included in future CSO reports.

1995/96 CSO Volumes Compared to Previous Years

Figure 2-3 illustrates the progress King County has made in CSO control. During the 1989/90 and 1990/91 reporting periods, a number of CSO control projects were still under construction and benefits had not yet been realized. Below average rainfall during the 1991/92, 1992/93, and 1993/94 reporting periods resulted in decreased overflow volumes. Average rainfall returned during the 1994/95 reporting period and higher than average rainfall occurred in 1995/96, but overflow volumes continue to remain below baseline overflow volumes. Benefits from the completed CSO control projects are now being observed.

1995/96 CSO Frequency of Events

During the 1995/96 reporting period, 643 overflow events occurred compared to a baseline of 599 events as shown in Table 2-5. Figure 2-4 graphically illustrates the relationship between rainfall and overflow events.

The County has traditionally defined an overflow event as a period of rainfall during which an overflow was recorded that was preceded by three hours with no rain and followed by three hours without rain after the overflows from the system ceased. Thus, each event is separated by a three-hour period of non-discharge.

For comparison purposes, the 1995/96 CSO frequency of events were re-calculated based on a 48-hour period of non-discharge. The 48-hour period of non-discharge was chosen since it is used to characterize discharge events at Carkeek. This resulted in 410 events during the reporting period (see Table 2-6), a significant decrease from the 643 events earlier calculated. This significant decrease suggests that many of the overflow events occur within a few hours of each other. A single independent rainfall event may be resulting in more than one CSO event.

An evaluation of the event definition is underway to determine if the current definition is appropriate based on historical rainfall record for the area. In reporting CSO events, a single independent rainfall event should produce only one CSO event. The three-hour period of non-discharge is being examined to determine if rainfall patterns in the King County service area may require a longer period of non-discharge to define independent events.

To date, the County has controlled the following CSO locations to one event per year: E. Pine St., Belvoir, Matthews Park, Rainier Ave., E. Marginal, 30th Ave. NE, Duwamish Pump Station, Canal St., and 53rd Avenue SW.

Figure 2-3. Annual CSO Volumes

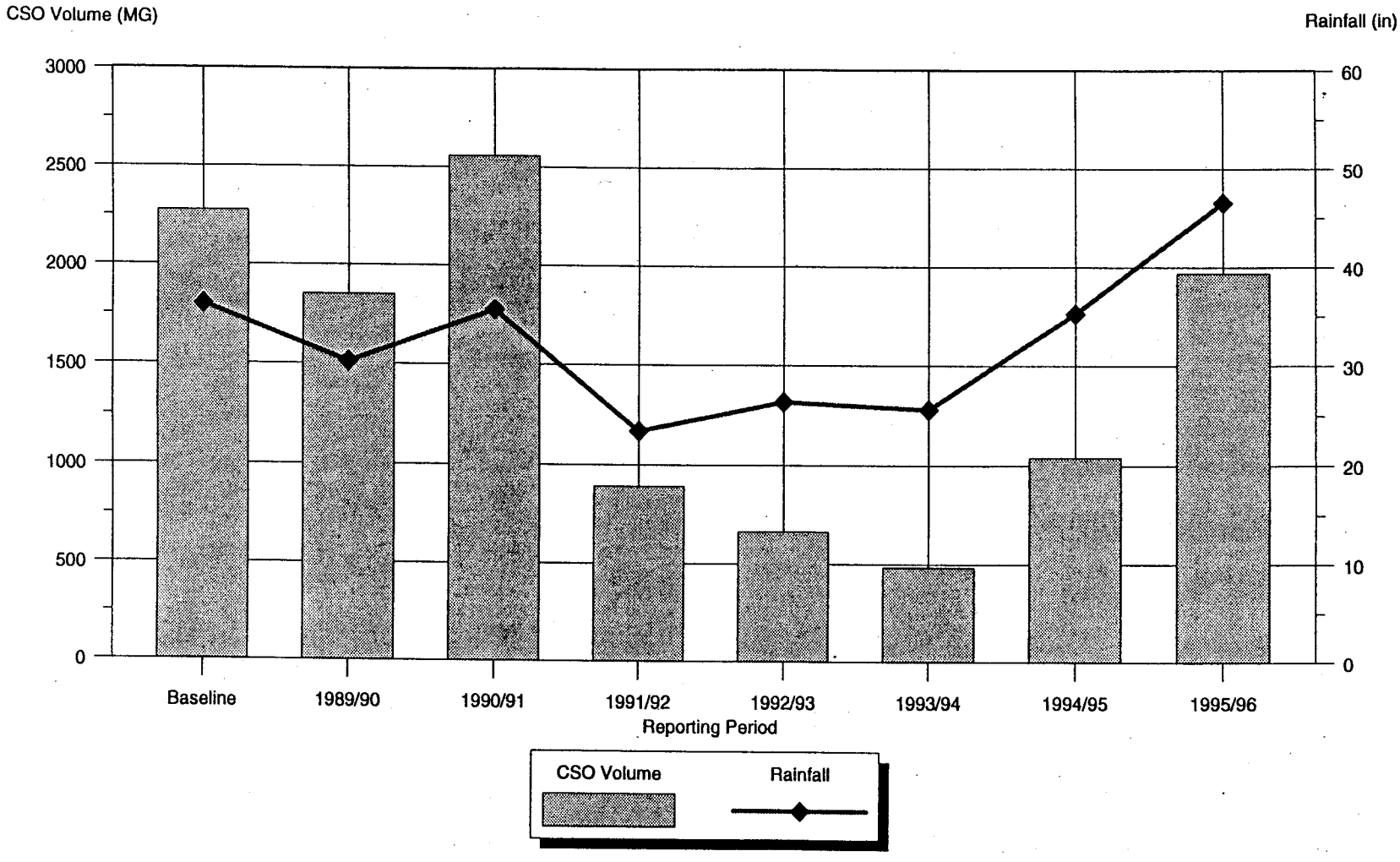


Table 2-5
1995/96 Frequency of CSO Events
(Based on 3 hour non-discharge definition)

Station	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	1995/96 Total (overflows/yr)	Revised Baseline (overflows/yr)
SSA														
Denny Way	2	2	2	1	5	7	10	8	10	1	5	5	58	51
King Street	2	2	2	1	3	4	6	3	4	1	1	2	31	31
Connecticut	0	1	2	0	2	3	4	3	2	1	2	2	22	34
Hanford #1 (2)								4	1	0	3	2	10	
Hanford #2	1	2	2	0	2	4	9	6	6	1	3	2	38	40
Lander II St.	0	2	2	0	2	3	7	4	4	0	1	3	28	29
Harbor Ave.	2	2	2	2	5	10	10	7	13	3	6	6	68	56
Chelan	0	0	0	0	0	1	3	3	3	0	1	1	12	25
W. Michigan	0	0	0	1	0	2	1	1	1	0	1	0	7	9
8th Ave.	0	0	0	0	0	0	0	0	1	0	1	0	2	12
Brandon St.	3	2	2	1	7	10	11	6	11	0	6	3	63	40
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Norfolk St.	1	1	1	1	3	6	10	5	6	0	2	4	40	12
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Henderson (1)	1	1	1	0	4	7	9	4	7	1	3	4	42	16
MLK Jr. Way (1)	0	0	1	0	2	5	6	5	3	0	2	4	28	23
Rainier Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
E. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
W. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0	
S. Magnolia (1)	1	2	2	0	3	5	10	6	7	0	6	4	46	21
Terminal 115													N/A	8
SSA SUBTOTAL	13	17	19	7	38	67	96	65	79	11	41	42	495	447
NSA														
Ballard Reg.	0	2	1	1	0	2	2	0	4	0	1	0	13	13
E. Ballard (11th Ave. NW) (1)	0	2	1	1	3	5	8	6	4	0	4	3	37	13
Dexter	1	0	2	1	4	4	4	2	3	1	2	3	27	4
University (9)	0	1	1	1	1	2	9	1	3	1	2	1	17	14
Montlake	0	1	2	1	2	0	0	0	1	0	0	0	7	16
Canal St. (Lake City)	0	0	0	0	0	0	0	0	1	0	1	0	2	<1
Third Ave. W.	0	0	0	0	0	3	5	4	4	1	1	1	19	20
E. Pine St.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Belvoir	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Matthews Park	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
30th Ave. NE	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
North Beach (1)	0	1	1	1	2	3	7	3	3	0	2	3	26	18
NSA SUBTOTAL	1	7	8	6	12	19	29	16	29	3	13	11	148	98
Carkeek														
Carkeek CSO Plant													See Carkeek Annual Report	
Alki														
Murray													N/A	8
Barton													N/A	23
63rd Ave. SW													N/A	<1
SW Alaska St. (Beach Dr.) (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	23
63rd Ave.													N/A	N/A
TOTAL	14	24	27	13	50	86	125	81	102	14	54	53	643	599

(1) Portable flow meters; not currently monitored by CATAD.
(2) Monitoring of the Hanford at Rainier overflow, which discharges through the Hanford #1 outfall, began in January 1996.
(3) The outfall gate position indicator was not operating properly from Nov. 1995 - Feb. 1996.

[96csofrq.wg2]

Figure 2-4. 1995/96 CSO Events (Based on 3 hr non-discharge) vs. Rainfall

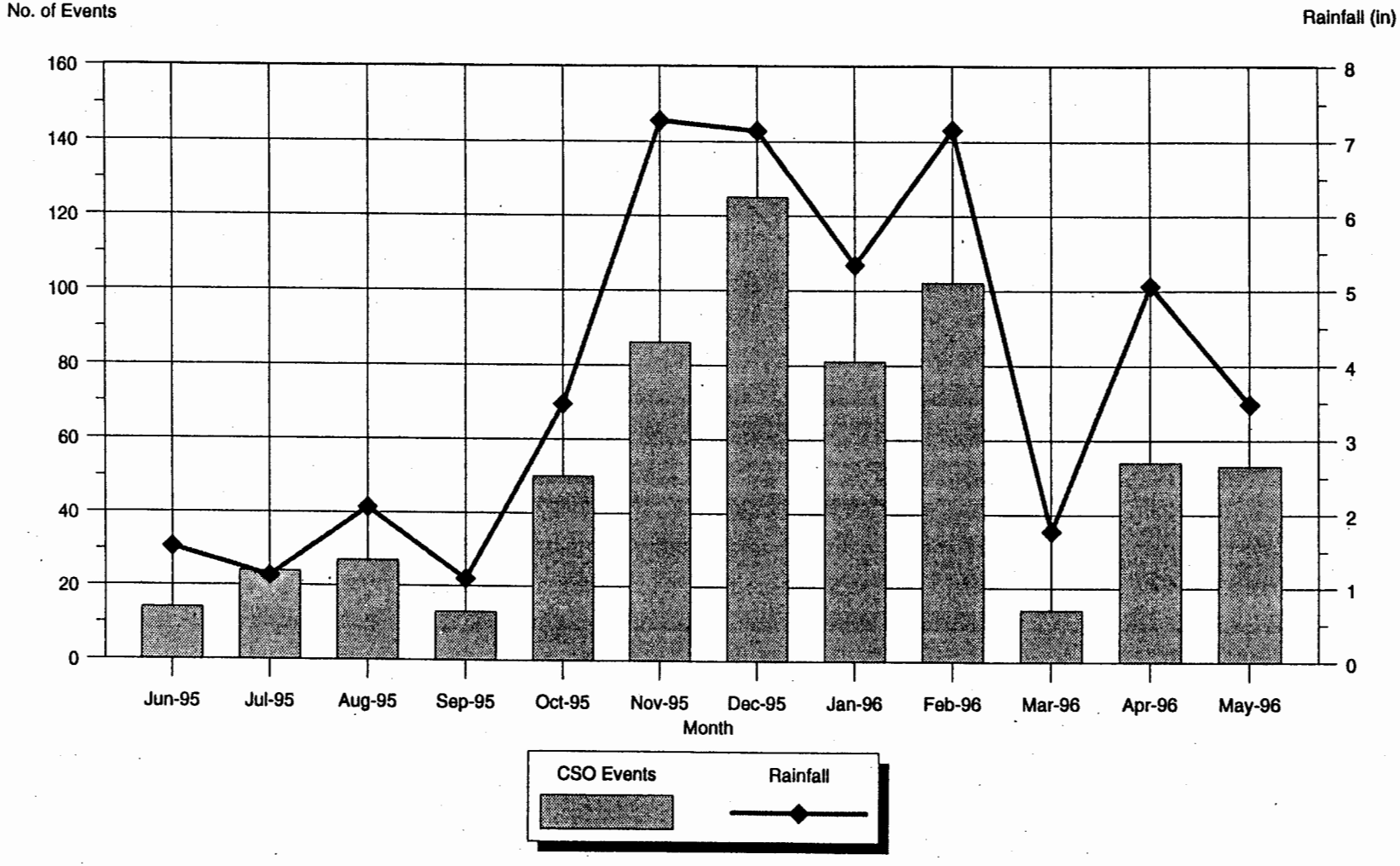


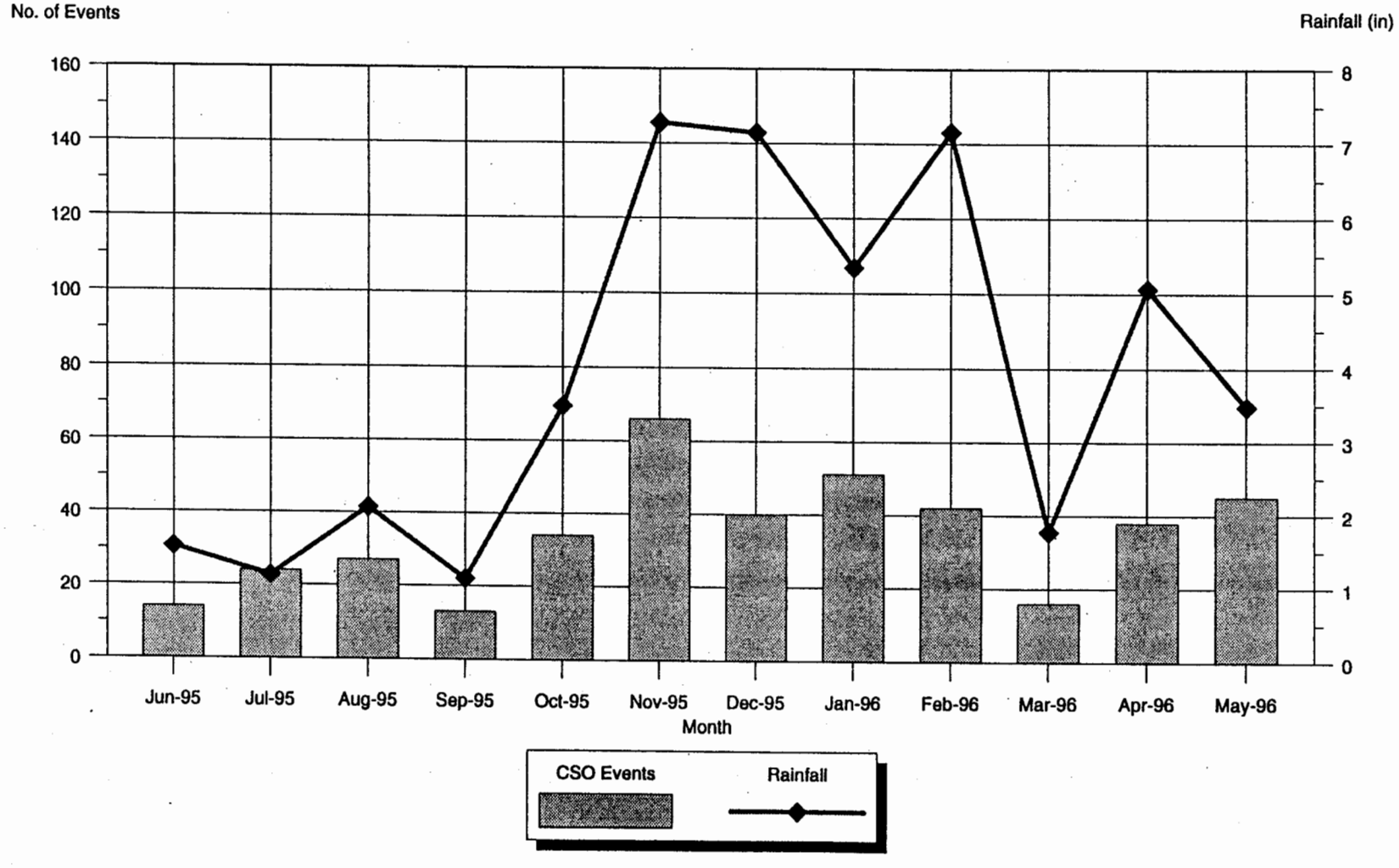
Table 2-6
1995/96 Frequency of CSO Events
(Based on 48 hour non-discharge definition)

Station	Jun-95	Jul-95	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	1995/96 Total (overflows/yr)
SSA													
Denny Way	2	2	2	1	3	5	3	3	2	1	3	4	31
King Street	2	2	2	1	2	4	2	3	2	1	1	2	24
Connecticut	0	1	2	0	1	3	2	2	2	1	1	2	17
Hanford #1 (2)								3	1	0	3	2	9
Hanford #2	1	2	2	0	1	4	3	3	2	1	2	2	23
Lander II St.	0	2	2	0	1	3	2	3	2	0	2	2	19
Harbor Ave.	2	2	2	2	4	5	3	4	2	2	4	4	37
Chelan	0	0	0	0	0	1	1	3	2	0	1	1	9
W. Michigan	0	0	0	1	0	2	1	1	1	0	1	0	7
8th Ave.	0	0	0	0	0	0	0	0	1	0	1	0	2
Brandon St.	3	2	2	1	4	5	3	3	2	2	2	3	32
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Norfolk St.	1	1	1	1	2	4	3	3	2	0	2	3	23
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0
Henderson (1)	1	1	1	0	3	4	3	3	2	2	1	4	25
MLK Jr. Way (1)	0	0	1	0	2	4	1	3	2	0	2	3	18
Rainier Ave.	0	0	0	0	0	0	0	0	0	0	0	0	0
E. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0
W. Marginal	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Magnolia (1)	1	2	2	0	2	3	3	3	2	1	3	3	25
Terminal 115													N/A
SSA SUBTOTAL	13	17	19	7	25	48	30	40	27	11	29	35	301
NSA													
Ballard Reg.	0	2	1	1	0	2	1	0	3	0	1	0	11
E. Ballard (11th Ave. NW) (1)	0	2	1	1	2	4	3	3	2	1	2	3	24
Dexter	1	0	2	1	3	4	1	2	2	1	2	2	21
University (3)	0	1	1	1	1	2	1	1	2	1	1	1	13
Montlake	0	1	2	1	2	0	0	0	1	0	0	0	7
Canal St. (Lake City)	0	0	0	0	0	0	0	0	1	0	1	0	2
Third Ave. W.	0	0	0	0	0	3	2	3	2	1	1	1	13
E. Pine St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Belvoir	0	0	0	0	0	0	0	0	0	0	0	0	0
Matthews Park	0	0	0	0	0	0	0	0	0	0	0	0	0
30th Ave. NE	0	0	0	0	0	0	0	0	0	0	0	0	0
North Beach (1)	0	1	1	1	1	3	2	2	2	1	1	0	16
NSA SUBTOTAL	1	7	8	6	9	18	10	11	15	5	9	10	109
Carkeek													
Carkeek CSO Plant													See Carkeek Annu
Alki													
Murray													N/A
Barton													N/A
53rd Ave. SW													N/A
SW Alaska St. (Beach Dr.) (1)	0	0	0	0	0	0	0	0	0	0	0	0	0
63rd Ave.													N/A
TOTAL	14	24	27	13	34	66	40	51	42	16	38	45	410

(1) Portable flow meters; not currently monitored by CATAD.
(2) Monitoring of the Hanford at Rainier overflow, which discharges through the Hanford #1 outfall, began in January 1996.
(3) The outfall gate position indicator was not operating properly from Nov. 1995 - Feb. 1996.

[96csofrq.wg2]

Figure 2-5. 1995/96 CSO Events (Based on 48 hr non-discharge) vs. Rainfall



Section 3 - CSO Monitoring Program

Introduction

King County's CSO monitoring program includes discharge and sediment sampling of selected CSO sites to meet the requirements of WAC 173-245-040 and conditions in NPDES Permit WA-002918-1. As described in the *1988 Plan*, the County's sampling program was to collect data for five CSO sites per year. Discharge samples were to be taken four times per year under overflow conditions to characterize the CSO effluent at each site. Discharge monitoring requirements were completed in 1995 as shown in Table 2-7.

The *1988 Plan* also provided for sediment samples to be taken at nine CSO sites. These requirements were completed in 1990 as shown in Table 2-8. However, the County has developed a comprehensive, site-specific baseline study plan for chemical and biological analysis of the sediment to meet additional NPDES requirements. Refer to the first section of this report for a description of this Sediment Baseline Monitoring Plan.

Table 2-7. CSO Discharge Monitoring Program

CSO Location	Serial	Date	Sample #	Status of Program
Michigan Street	W039	03/26/88	8800300	Permit Requirements Met
Lander Street	W030	03/26/88	8800301	Permit Requirements Met
Denny Way	W027	03/25/88	8800302	Permit Requirements Met
11th Ave. NW (E. Ballard)	W004	02/22/89 04/06/88 01/14/88 11/02/88	8801743 8800352 8800052 8802026	Permit Requirements Met
3rd Avenue West (& Ewing Street)	W008	02/22/89 01/14/88 03/26/88 11/02/89	8801742 8800053 8800303 8802027	Permit Requirements Met
Ballard	W003	12/02/89 03/09/90 10/04/90 01/06/90	8909776 9000286 9000880 9000002	Permit Requirements Met
Connecticut Street	W029	08/22/89 10/22/89 04/23/90 02/07/90	8900832 8909689 9000394 9000215	Permit Requirements Met
Brandon Street	W041	03/14/90 06/03/90 10/04/90 12/04/90	9000289 9000510 9000881 9010003	Permit Requirements Met
Norfolk Street	W044	10/14/90 06/06/90 04/03/91 12/04/90	9000887 9000524 9100612 9010006	Permit Requirements Met
W. Michigan Street	W042	01/12/91 04/03/91 01/28/92 10/06/93	9100012 9100613 9200134 L2224-1	Permit Requirements Met
8th Avenue	W040	12/27/94	L5152-1	Further Monitoring Not Required
Chelan Avenue	W036	10/26/94 11/30/94 01/31/95	L4817-1 L5032-1 L5357-1	Further Monitoring Not Required
Dexter Avenue	W009	12/19/94 02/18/95	L5122-1 L5494-1	Further Monitoring Not Required
Montlake	W014	12/04/90 04/03/91 02/21/92 03/23/95	9100009 9010609 9010006 L5766-1	Permit Requirements Met

Table 2-8. CSO Sediment Monitoring Program

CSO Location	Serial	Date	Sample #	Status of Program
Ballard	W003	05/30/89	8900560	Permit Requirements Met
11th Ave. NW (E. Ballard)	W004	05/30/89	8900561	Permit Requirements Met
3rd Ave. W. (& Ewing St.)	W008	05/30/89	8900563	Permit Requirements Met
Dexter Avenue	W009	05/30/89	8900565	Permit Requirements Met
Montlake	W014	05/30/89	8900564	Permit Requirements Met
8th Avenue	W040	05/23/90	9006690	Permit Requirements Met
Brandon Street	W041	05/23/90	9006687	Permit Requirements Met
Michigan Street	W042	05/23/90	9006691	Permit Requirements Met
Norfolk Street	W044	05/23/90	9006688	Permit Requirements Met