1996/97 ANNUAL COMBINED SEWER OVERFLOW REPORT

King County Department of Natural Resources
Wastewater Treatment Division

October 1997

KING COUNTY
Department of Natural Resources

This Page Intentionally Left Blank

TABLE OF CONTENTS

List of Tables iii

List of Figures iii

Section 1 - Overview and Status of CSO Control Program 1

1.1 Introduction 1

1.2 Background 1

Regional Wastewater Services Plan 2

1.3 Status of CSO Control Projects 2

1.3.1 CSO Control Projects from the 1988 Plan 2

1.3.1.1 CATAD Modifications 4

1.3.1.2 Alki Transfer/CSO Facilities Project 4

1.3.1.3 Denny Way CSO Control Project 4

1.3.1.4 Kingdome/Industrial Area Storage and Separation Project 5

1.3.1.5 Michigan Street Separation Project 6

1.3.1.6 Diagonal Separation Project 8

1.3.2 1995 CSO Update Projects 8

1.3.2.1 Denny Way/Lake Union CSO Control Project 8

1.3.2.2 Harbor CSO Pipeline Project 9

1.3.2.3 Henderson/Martin Luther King Jr. Way CSO Control Project 10

1.3.2.4 North Beach Storage/Pump Station Upgrade 10

1.3.2.5 Brandon Separation Project 10

1.3.3 Other Related Projects 10

1.3.3.1 King County's Water Quality Assessment 10

1.3.3.2 Lander and Densmore Stormwater Management Program 11

1.3.3.3 Sediment Baseline Monitoring Plan 11

Section 2 - 1996/97 CSO Volume and Frequency Summary 13

2.1 Introduction 13

2.2 Baseline Conditions 13

2.2.1 Baseline Overflow Volumes 13

2.2.2 Baseline CSO Frequency of Events 14

2.3 1996/97 CSO Volumes 17

2.3.1 Southern Service Area (SSA) 17

2.3.2 Northern Service Area (NSA) 20

2.3.3 Carkeek Park CSO Plant 21

2.3.4 Alki Transfer/CSO Facilities 21

2.3.5 1996/97 CSO Volumes Compared to Previous Years 21

2.4 1996/97 CSO Frequency of Events 21

Section 3 - CSO Monitoring Program 25

Introduction 25

List of Tables

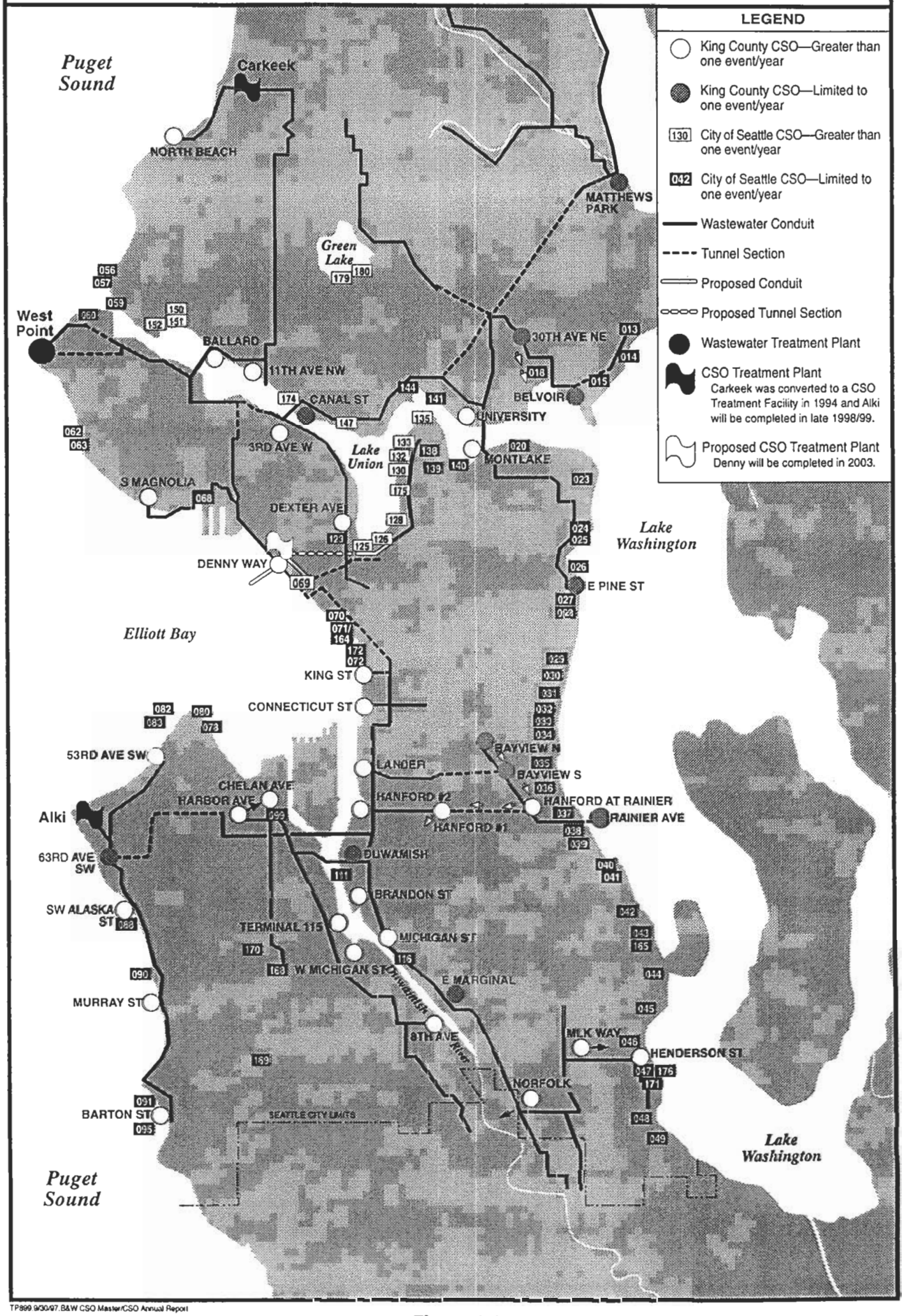
1-1	Completed Projects from the *1988 Plan*	3
1-2	Other Projects from the *1988 Plan*	3
1-3	Kingdome Area Separation Status	7
1-4	Sediment Baseline Monitoring Plan for CSO Sites	12
2-1	Baseline Overflow Volumes	15
2-2	Baseline CSO Frequency of Events	16
2-3	1996/97 Rainfall at Pump and Regulator Stations	18
2-4	1996/97 CSO Volume Summary by Service Area	19
2-5	1996/97 Frequency of CSO Events (Based on 3 hour non-discharge definition)	22
2-6	1996/97 Frequency of CSO Events (Based on 48 hour non-discharge definition)	24
3-1	CSO Discharge Monitoring Program	26
3-2	CSO Sediment Monitoring Program	27

List of Figures

		After Page
1-1	Combined Sewer Overflow (CSO) Map	iii
2-1	1996/97 CSO Volume vs. Rainfall	19
2-2	Annual CSO Volumes	21
2-3	1996/97 CSO Events (Based on 3 hr non-discharge) vs. Rainfall	22
2-4	1996/97 CSO Events (Based on 48 hr non-discharge) vs. Rainfall	24

This Page Intentionally Left Blank

Combined Sewer Overflow (CSO) Map



TP899.9/30/97.B&W CSO Master/CSO Annual Report

Figure 1-1

This Page Intentionally Left Blank

Section 1 - Overview and Status of CSO Control Program

1.1 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, Wastewater Treatment Division's (WTD's) CSO Control Program
- 1996/97 overflow volume and frequency information
- An overview of King County WTD's CSO Monitoring Program

1.2 Background

King County WTD (formerly Metro) provides wholesale wastewater conveyance and treatment for flows from the City of Seattle and thirty-five 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 treatment plant located off West Point in Discovery Park. When storm events occur, flows may exceed the capacity of the collection system pipes, resulting in combined sewer overflows (CSOs) into Lake Washington, Lake Union, the Ship Canal, the Duwamish River, and Elliott Bay (Figure 1-1). 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 points. 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 systemwide 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.

As part of the renewal process for the West treatment plant NPDES permit, King County 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.

In November 1996, King County WTD successfully renegotiated the requirement to reduce CSO discharges by 75 percent system-wide by 2005. Working with Ecology, King County WTD identified an approach that would allow control of CSOs along public access areas and bathing beaches sooner than under the previous agreement.

Regional Wastewater Services Plan

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 amendments have been made to the original comprehensive plan.

King County WTD's CSO planning is one component of WTD's current long-range wastewater planning effort, the *Regional Wastewater Services Plan (RWSP)*. 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* was issued in May 1997. The King County Executive is expected to issue a report describing the Executive's preferred alternative in April 1998. The King County Council is expected to adopt a Final Plan and EIS in late 1998. All CSO projects defined by the *RWSP* will be included in the year 2000 CSO Plan Update, including project descriptions and schedules for project completion.

1.3 Status of CSO Control Projects

1.3.1 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 systemwide. Table 1-1 summarizes *1988 Plan* projects that have been completed. 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 for modified projects or projects underway follow.

Since the *1988 Plan*, all separation projects include low flow diversion of stormwater into the sanitary sewer system, and source control efforts are applied to new stormwater discharges.

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. 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	2003[a]
Kingdome/Industrial Area Storage and Separation	2000	RWSP[b]
Michigan Street Separation	1997	RWSP[b]
Diagonal Separation	1995	City of Seattle project

[a] Delayed and modified as discussed in text. See pages 4 and 8.

[b] To be determined in the Regional Wastewater Services Plan.

1.3.1.1 CATAD Modifications

The Computer Augmented Treatment and Disposal System (CATAD) controls the West treatment plant 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. Modifications are needed to incorporate new flow transfer projects and to improve the efficiency and robustness of the optimization program.

1.3.1.2 Alki Transfer/CSO Facilities Project

The Alki project is designed to transfer flows up to 18.9 mgd from the Alki drainage basin to the West treatment 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 (estimated to occur, on average, about once per year) 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 treatment plant. To avoid exacerbating CSOs in the West treatment plant 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 treatment plant 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 tunnel for storage is being added to this project as discussed later in this report (see Section 1.3.2.2).

Design for the Alki project began in 1989, and construction of major project components has begun. Flow transfer will begin in Spring 1998. Completion of the Alki Transfer project is expected in 1999. Completion of Alki CSO treatment plant modifications is expected to occur by 1999. Specific permit conditions for operation of the Alki facility will be negotiated with Ecology.

1.3.1.3 Denny Way CSO Control Project

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 Public Utilities (formerly Seattle Drainage and Wastewater Utility) 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 (see Section 1.3.2.1).

1.3.1.4 Kingdome/Industrial Area Storage and Separation Project

Under the *1988 Plan*, the Kingdome/Industrial Basin was identified as an area for partial separation of CSOs scheduled to be completed by the year 2006.

In 1990, the City of Seattle and State of Washington Department of Transportation announced a major road widening and improvement project on South Royal Brougham Way, coupled with a conversion of the road to a state route. The County accelerated the Kingdome predesign work to study the feasibility of doing sewer separation at the same time as the road improvements.

The Kingdome Separation Predesign report was completed in October 1991. The predesign report studied 5 different levels of sewer separation. Each Separation Level required an associated storage component to achieve the goal of one event per year.

The recommended alternative was to construct the Level 1 separation and a 11.2 MG storage tank. The total cost of the alternative was $25.7 million (1991 dollars).

Because the one per year CSO improvements were not needed until the year 2006, the report recommended deferring the storage tank until after the year 2000. The near term recommendation was to construct the Level 1 separation and 3,050 linear feet (lf) of 96-inch trunk, (extending from Alaskan way to Airport Way) prior to road widening.

Due to budget constraints, the recommended alternative was scaled back prior to construction. In 1993-94, the County constructed approximately half of the 96-inch trunk line (1500 lf), extending from Alaskan Way to 3rd Avenue South. No actual separation work was done, although laterals were placed so separation could occur at a later date. The 96-inch pipe presently functions as a storage tank with limited CSO benefit.

In November 1995, the Washington State Legislature authorized funding for construction of a new professional baseball stadium. The Washington State Major League Baseball Stadium Public Facilities District (PFD) was formed to administer the project. Design of the project began in early 1996. King County staff began working closely with the PFD's engineers to resolve significant utilities issues created by the location of the stadium directly over the EBI.

In the summer of 1996, the PFD was devising a means to deal with stormwater from the new stadium. Since the EBI lacked adequate capacity, the only two options were to build a large retention basin or construct a new storm drain to Puget Sound. Both options were costly.

County staff developed an idea for resolving the PFD's storm drainage problem that provided advantages for both the County and the PFD. The idea was to have the PFD complete work on most of the Level 1 separation between Alaskan Way and 3rd Avenue South, and to construct the necessary diversion and overflow structures to allow the 72-inch line to be converted to a separate storm sewer from 3rd Avenue to Elliott Bay. The idea has been approved, and the PFD is proceeding with implementation.

Construction of the new baseball stadium has sparked major new development in the Kingdome / Industrial basin. In addition to the baseball stadium, a new football stadium is proposed north of Royal Brougham and the Washington Department of Transportation (DOT) is proposing new freeway access ramps on Royal Brougham and Atlantic Streets. The spur in new construction is an impetus to again look at the Kingdome Separation Project to see if additional opportunities for separation exist.

With the Kingdome Separation Work already initiated by the PFD, the County is in a good position to achieve 78 acres of the original 128.5 proposed for the Level 1 separation, as laid out in the 1991 report. The PFD has committed to separate 49.5, Football NW will be asked to separate 23.5 by running a new line down Occidental during construction of the new football stadium, and DOT plans to separate around 5 when it builds the new Royal Brougham access ramp. Of the areas listed for separation, Table 1-3 provides a brief status of what is definite, planned or likely. The partial separation can be completed at no cost to the County. The County will provide a source control program to reduce pollutants associated with new stormwater discharges into the Duwamish River that result from partial separation projects.

Of the remaining 50.5 acres, 33.5 are King County Transit Bases--Ryerson (7.5 Acres), North Central Base (8 Acres) and South Central Base (18 Acres). It is more difficult to separate these areas because it involves extension of the 96-inch line eastward to Airport Way. This would likely need to be funded by the County, however, there are no plans to separate these areas at present. In order to reach the one event per year level of reduction, storage would also be needed.

1.3.1.5 Michigan Street 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 DOT to upgrade the First Avenue South bridge.

Recent County analysis for the *RWSP* indicates that CSO control at Michigan would be best achieved via on-site CSO treatment. The schedule for implementation of a Michigan project will be determined in the *RWSP*.

Table 1-3. Kingdome Area Separation Status

Area	Acres Planned/ Scheduled for Separation in Kingdome Separation Study	Acres Separated by PFD	Potential Acres Separated by Football NW	Potential Acres Separated by DOT	Acres Remaining Unseparated
S Royal Brougham (1st - 4th)	4	3.5	0	0	0.5
Railroad Yard	28.5	25	0	0	3.5
Kingdome	43.5	20	23.5	0	0
Ryerson Base	7.5	0	0	0	7.5
S Royal Brougham (Alaskan-1st)	1	1	0	0	0
S Royal Brougham (4th-Airport)	2	0	0	0	2
5th Avenue Transit Corridor	6	0	0	0	6
I-90 Ramps	10	0	0	5	5
North Central Base	8	0	0	0	8
South Central Base	18	0	0	0	18
Total Level 1 Separation	**128.5**	**49.5**	**23.5**	**5**	**50.5**

1.3.1.6 Diagonal Separation Project

In the *1988 Plan*, the Diagonal storage/separation project was identified as a City of Seattle project and not as a County 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.

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

The revised Denny Way project, the Harbor CSO Pipeline Project and the Henderson/Martin Luther King Jr. Way CSO Control 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.

1.3.2.1 Denny Way/Lake Union CSO Control Project

As discussed in Section 1.3.1.3, the Denny/Lake Union Project was identified in 1994 as a joint project for King County and the City of Seattle. One of the selection criteria used to determine a preferred alternative was the County's desire that the project be able to integrate with any of the programs included in the *RWSP*. The Denny/Lake Union project was phased to coincide with the *RWSP* process while still qualifying for the Infrastructure Grant funding.

The project has been divided into phases. The City is currently completing construction of Phase 1; a project to increase wet-weather capacity in the east and south Lake Union areas. Its Phase 2 project will connect the Phase 1 facilities to the County's Phase 3/4 facilities.

Phase 3 was originally the County project to provide 50 percent volume reduction of the Denny Way CSO, and Phase 4 was a future project to provide the ultimate level of control (one untreated overflow per year per outfall). These phases have since been combined into Phase 3/4 to provide the ultimate level of control by combining storage and at-site treatment.

The Phase 3/4 project will control Lake Union and Denny Way CSOs by 1) storing CSO flows during moderate storms and transferring them to the West treatment plant after the storm subsides; and 2) providing at-site treatment at the Elliott West site with discharge of treated flows through a new outfall during heavy rain conditions. Required facilities include:

- a 5,800 ft. long tunnel under Mercer Street between Dexter Avenue and Elliott Avenue West (for CSO storage and conveyance)
- CSO control facilities at the Elliott West site (with floatable removal, disinfection, and dechlorination)
- piping and regulators to convey CSO flows from the existing County sewer system to the new facilities
- an outfall into Elliott Bay at Myrtle Edwards Park (to discharge treated flows from the Elliott West facilities)
- an extension of the existing outfall at the Denny regulator at Myrtle Edwards Park (to discharge untreated CSO flows expected to occur about once per year)

A general milestone schedule for project implementation is shown below:

Preliminary Design Begins	Spring 1997
Facilities Plan Submitted to Ecology	Late 1997
Final Design Begins	Early 1998
Construction Begins	2000
Construction Complete	2003

A joint draft State Environmental Policy Act (SEPA) Environmental Impact Statement/National Environmental Policy Act (NEPA) Environmental Assessment for Phases 2 and 3/4 was issued in May 1997. The final document and facilities plan for Phases 2 and 3/4 is scheduled for completion in late 1997 or early 1998. Construction of the City and County projects is scheduled to be completed by 2003.

1.3.2.2 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 CSO 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 was re-prioritized 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 enlarged the trench for the forcemain and laid a new 54-inch pipe underneath. The cost of the current Harbor project was 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 by future construction is also avoided.

The Alki Project's West Seattle Forcemain contract was completed in 1996. CSOs from the Harbor Regulator will be stored in the tunnel beginning in 1998 when the tunnel and pump station are complete.

1.3.2.3 Henderson/Martin Luther King Jr. Way CSO Control Project

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 identified interim and permanent corrective measures to control overflows. The evaluation also considered the impact of these measures on the downstream Norfolk regulator station.

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. The design phase is scheduled to be completed in 1997. Final design will occur in 1998. Construction is scheduled to begin in 1999 with project completion scheduled in the year 2000.

1.3.2.4 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*.

1.3.2.5 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*.

1.3.3 Other Related Projects

1.3.3.1 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.

1.3.3.2 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. The maintenance of the stormwater system, the development of compliance schedules and enforcement actions are to be managed by the City of Seattle as specified in an Interlocal Agreement by and between the City of Seattle and King County. Future separation projects will add areas to this program; the Kingdome project will be the next one.

1.3.3.3 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. As shown on Table 1-4, these sites were initially sampled in 1995, and additional biological and chemical analyses were completed in 1996.
- For three sites, baseline sampling was completed in 1996 (see Table 1-4), and no additional sampling is planned unless requested by Ecology.
- For four sites, new baseline sampling is proposed. For these sites, the monitoring plan specifies the manner in which sampling will be carried out. These sites will be sampled in late 1997.

Table 1-4. Sediment Baseline Monitoring Plan for CSO Sites

CSO Location	Serial	Date	Sample #	Status of Program
Hanford	W031	06/27/95-06/29/95	L6393-1 - L6393-11	Permit Requirements Met
Connecticut Street	W029	06/26/95-06/27/95	L6392-1 - L6392-11	Permit Requirements Met
Chelan Avenue	W036	06/28/95-06/29/95	L6397-1 - L6397-6	Permit Requirements Met
Magnolia	W006	10/16/96	L9695-1 - L9695-6	Permit Requirements Met
53rd Avenue SW	W053	10/16/96	L9697-1 - L9697-6	Permit Requirements Met
North Beach	W048	10/15/96	L9696-1 - L9696-6	Permit Requirements Met
SW Alaska Street	W055	---	---	To be sampled in Fall 1997
Murray Street	W056	---	---	To be sampled in Fall 1997
Barton Street	W057	---	---	To be sampled in Fall 1997
63rd Street	W054	---	---	To be sampled in Fall 1997

Section 2 - 1996/97 CSO Volume and Frequency Summary

2.1 Introduction

The volume and frequency of CSOs at regulator and pump stations in the West treatment plant system are monitored by the County's CATAD System. Figure 1-1 at the front of this report 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 (with the exception of the Montlake regulator station). The County deploys portable flowmeters at the following six CSO locations not currently monitored by CATAD: South Magnolia, East Ballard (11th Ave. NW), North Beach, Martin Luther King Jr. Way, Henderson Street, and SW Alaska Street (Beach Drive).

2.2 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.

2.2.1 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 re-calibrated. 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 to be controlled to one event per year are not and are included in the revised baseline volumes.

2.2.2 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 time during which an overflow was recorded that was preceded by three hours with no rain and followed by three hours without overflows system-wide. 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 Overflow Volume (MG)	Revised Baseline Overflow Volume (MG)[c]	Difference in Overflow 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. The new model error-location, error-correction effort also resulted in a larger number of CSO 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 total number of CSO events per year.

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 necessary.

2.3 1996/97 CSO Volumes

The total system overflow volume for the June 1996 through May 1997 reporting period was 2,210 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 for the 1996/97 reporting period averaged 42.47 inches. This is 18 percent higher than the average rainfall of 36 inches per year.

Table 2-4 contains the monthly overflow volumes and comparisons to revised baseline conditions for each station. Figure 2-1 graphically illustrates the relationship between rainfall and CSO volumes. 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.

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 throughout 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 December 29, 1996 to January 3, 1997. This storm was very unusual as driving rains combined with and quickly melted 18 to 24 inches of snowfall resulting in damaging mudslides, washed out roads, and large overflow volumes. This storm accounted for 1,336 MG, approximately sixty percent of the total overflow volume for the reporting period. Another storm which occurred from March 18, 1997 to March 20, 1997 accounted for 422 MG, approximately nineteen percent of the total overflow volume for the reporting period. Thus, almost eighty percent of the total overflow volume for the reporting period occurred in just two storms.

2.3.1 Southern Service Area (SSA)

Overflow volumes in the Southern Service Area for 1996/97 were 1,454 MG compared to a baseline of 1,921 MG. Due to the increased amount of rainfall during the reporting period, overflow volumes were above baseline at the following SSA stations: Connecticut, W. Michigan, Henderson, Martin Luther

Table 2-3
1996/97 Rainfall at Pump and Regulator Stations
(in inches)

Station	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96 (1)	Nov-96 (1)	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	1996/97 Total
Denny Local	0.4	0.52	0.7	1.68	1.68	4.14	8.04	5.85	1.37	8.2	4.06	2.15	38.79
King Street	0.32	0.56	0.62	1.62	2.17	3.58	6.1	5.99	1.37	7.27	3.48	2.82	35.9
Chelan Avenue	0.49	0.65	1.31	1.68	2.62	4.16	8.82	6.21	1.65	8.6	4.31	2.64	43.14
Denny Way Lake Union	0.56	0.8	1.13	3.75	3.54	6	10.44	7.84	1.79	10.7	4.7	3.52	54.77
Ballard	0.46	0.65	0.84	2.21	2.73	4.35	9.83	5.58	1.33	8.19	4.53	2.69	43.39
University	0.43	0.75	0.98	1.93	2.64	4.51	7.29	4.22	1.31	8.17	2.21	1.49	35.93
Hollywood	0.41	0.96	1.35	1.86	2.96	5.12	5.81	6.78	2.02	8.11	5.26	3.59	44.23
Rainier Avenue	1	0.92	1.25	2.25	2.28	5.96	9.47	6.99	1.85	9.21	4.67	2.8	48.65
East Marginal Way	0.4	0.88	1.02	1.34	1.66	4.55	8.22	6.07	1.63	7.5	4.01	2.54	39.82
Henderson	0.33	1.12	0.86	0.67	1.34	5.31	5.88	4.8	1.85	8.52	2.02	2.62	35.32
East Pine Street	0.52	0.95	0.9	1.72	1.90	5.82	8.22	6.72	1.85	7.88	4.63	3.17	44.28
Matthews Park	0.42	0.73	1.16	1.9	3.23	4.14	8.87	6.29	1.86	8.16	5.35	2.95	45.06
Kenmore	0.75	0.66	0.67	2.66	2.78	4.51	7.78	5.5	1.99	7.71	4.88	2.95	42.84
Average	0.50	0.78	0.98	1.94	2.43	4.78	8.06	6.06	1.68	8.32	4.16	2.76	42.47

(1) The West treatment plant computers were down from 10/17/96-11/7/96. Data was calculated for this period using the cumulative rainfall total which was still recording. Data for this period is included in the Oct. 1996 total.

Table 2-4
1996/97 CSO Volume Summary by Service Area
(in million gallons)

Station	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96 (2)	Nov-96 (2)	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	1996/97 Total (MG) (3)	Revised Baseline (MG)
SSA														
Denny Way (4)	0.0	0.0	0.5	4.5	7.6	17.3	132.8	68.5	1.3	88.4	11.1	6.4	338.5	405
King Street	0.0	0.0	0.0	0.0	0.9	2.5	10.9	5.8	0.0	12.0	2.1	1.8	35.9	55
Connecticut	0.0	0.0	0.0	0.0	1.0	6.8	39.3	15.3	0.0	33.9	3.1	2.6	102.1	90
Hanford	0.0	0.0	0.0	0.0	2.1	11.9	216.0	42.4	0.0	113.2	13.9	10.1	409.7	605
Lander II St.	0.0	0.0	0.0	0.0	0.0	19.9	53.2	47.9	0.0	8.9	1.1	0.9	131.9	190
Harbor Ave.	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	55
Chelan	0.0	0.0	0.0	0.0	0.1	3.0	26.6	12.2	0.0	5.2	0.1	0.2	47.3	65
W. Michigan	0.0	0.0	0.0	0.0	0.0	0.1	3.7	0.7	0.0	2.5	0.0	0.0	6.9	2
8th Ave.	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.9	0.0	0.0	0.0	0.0	3.7	15
Brandon St.	0.3	0.0	0.7	0.2	0.2	4.5	23.8	10.1	0.2	8.9	2.9	3.2	55.1	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	0.0	0.0	190
Norfolk St.	0.0	0.0	0.0	0.0	0.0	0.4	47.4	7.5	0.0	2.4	0.1	1.6	59.3	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	0.0	1
Henderson (1)	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0	2.1	0.0	0.1	13.6	10
MLK Jr. Way (1)	0.2	0.0	0.2	0.0	0.5	8.0	128.4	15.6	0.0	51.0	3.1	3.3	210.2	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	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	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	0
S. Magnolia (1)	0.0	0.0	0.3	1.1	1.4	1.8	24.4	0.6	0.0	6.1	1.7	1.7	39.1	15
Terminal 115													N/A	5
SSA SUBTOTAL	0.8	0.1	1.7	5.8	13.8	76.2	719.7	228.5	1.5	334.6	39.1	31.8	1453.7	1921
NSA														
Ballard	0.0	0.0	0.0	0.1	0.0	0.3	1.8	1.7	0.0	0.8	0.7	0.0	5.5	90
Dexter	0.0	0.0	0.1	7.2	4.8	5.1	7.0	4.2	0.0	13.1	4.2	9.3	54.9	15
University	0.0	0.0	2.9	0.0	0.5	16.5	294.7	117.0	0.0	108.3	8.1	9.5	557.5	110
Montlake	0.0	0.0	0.0	1.1	0.0	14.6	35.1	32.0	0.0	0.0	0.0	0.0	82.8	10
Canal St. (Lake City)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.1	0.0	0.0	0.7	1
Third Ave. W.	0.0	0.0	0.0	0.0	0.0	3.7	22.5	5.2	0.0	4.7	0.6	1.0	37.7	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	0
Belvoir	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	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	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	0
North Beach (1)	0.0	0.0	0.2	1.2	0.7	0.3	10.3	0.6	0.0	3.2	0.4	0.2	17.0	2
NSA SUBTOTAL	0.0	0.0	3.1	9.5	6.0	40.5	372.1	160.9	0.0	130.1	14.0	20.0	756.2	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	0.0	12
63rd Ave.													N/A	95
TOTAL	0.8	0.1	4.8	15.3	19.8	116.7	1091.7	389.5	1.5	464.7	53.2	51.8	2209.9	2393

(1) Portable flow meters; not currently monitored by CATAD.
(2) The West treatment plant computers were down from 10/17/96-11/7/96. Data was calculated for this period using the cumulative overflow total which was still recording. Data for this period is included in the Oct. 1996 total.
(3) About eighty percent of the total overflow volume for the reporting period occurred in just two storms.
(4) Outfall gate position transmitters malfunctioned. Overflow volume may be underestimated.

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 339 MG compared to a baseline of 405 MG. The Denny Way overflow represents the total overflow volume from Denny Way Lake Union regulator station, Denny Way Local regulator station, and Interbay pump station. The overflow volume for Denny Way may be underestimated due to incorrect readings from the outfall gate transmitters at the Denny Way Lake Union site and the Denny Local site during a portion of the reporting period. The problem at the Denny Way Lake Union site was detected and fixed during the reporting period. The problem at the Denny Local site was fixed in September 1997.

- Flow through the Michigan regulator station continues to be unrestricted due to removal of a gate to the EBI. No overflows occurred at Michigan during this reporting period as all flow was being conveyed to the EBI. A new regulator gate and associated parts are being manufactured and should be installed by the end of 1997.

- 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 55 MG compared to a baseline of 250 MG.

- Level sensors at the Harbor regulator station do not appear to be working properly, and overflow volume at this site may be underestimated. The level sensors will be checked this year.

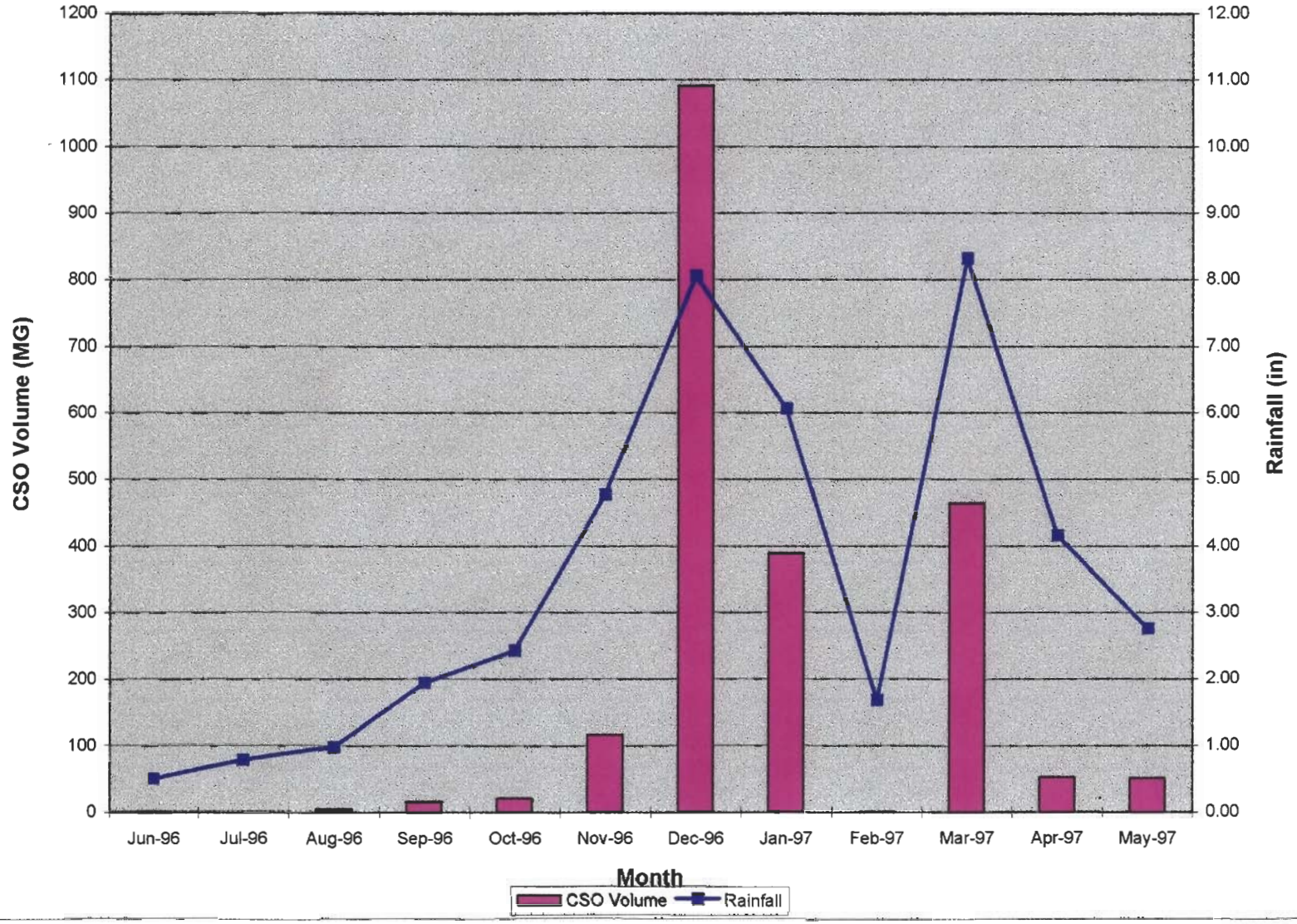
2.3.2 Northern Service Area (NSA)

Overflow volumes in the Northern Service Area for 1996/97 were 756 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, Belvoir, and North Beach.

- Dexter overflowed 55 MG compared to a baseline of 15 MG. The higher volume at Dexter continues to be investigated. The CATAD overflow calculation may be resulting in inflated overflow volumes and will be checked this year.

- The overflow volume at University was 558 MG compared to a baseline of 110 MG. About 402 MG or seventy-two percent of the overflow volume at this site occurred during the unusual December 29, 1996 to January 3, 1997 storm. 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 operating at full

Figure 2-1. 1996/97 CSO Volume vs. Rainfall



This Page Intentionally Left Blank

capacity for most of the reporting period due to a problem with one of the three pumps at the station. The pump was fixed and re-installed in May 1997.

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

2.3.3 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.

2.3.4 Alki Transfer/CSO Facilities

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.

2.3.5 1996/97 CSO Volumes Compared to Previous Years

Figure 2-2 illustrates the progress King County has made in CSO control; the baseline volumes are illustrated by the first column with yearly measurements in the subsequent columns. 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 and 1996/97, however, overflow volumes continue to remain below baseline overflow volumes. Thus, benefits from completed CSO control projects are now being observed.

2.4 1996/97 CSO Frequency of Events

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

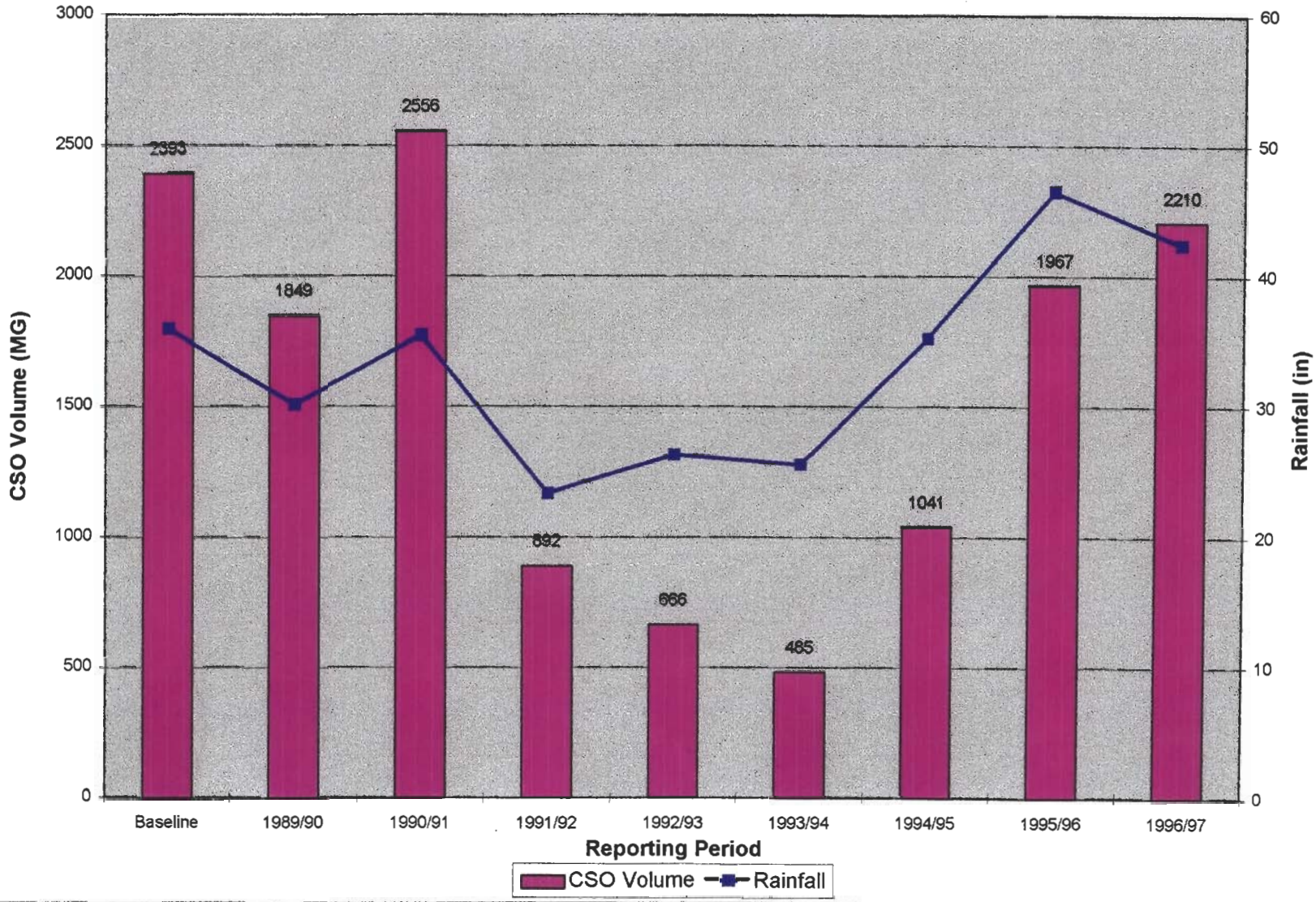
During the 1996/97 reporting period, 364 overflow events were recorded compared to a baseline of 599 events as shown in Table 2-5. Figure 2-3 graphically illustrates the relationship between rainfall and overflow events for the reporting period. To date, the County has controlled the following CSO locations 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.

Table 2-5
1996/97 Frequency of CSO Events
(Based on 3 hour non-discharge definition)

Station	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96 (2)	Dec-96 (2)	Jan-97	Feb-97	Mar-97	Apr-97	May-97	1996/97 Total (overflows/yr) (2)	Revised Baseline (overflows/yr)
SSA														
Denny Way	0	0	3	2	3	5	12	7	1	8	5	1	47	51
King Street	0	0	0	0	2	1	3	4	0	4	1	1	16	31
Connecticut	0	0	0	0	1	1	2	4	0	3	1	1	13	34
Hanford #1 (@Rainier) (1)	0	0	0	0	3	3	4	3	0	1	2	1	17	
Hanford #2	0	0	0	0	1	0	3	4	0	4	1	1	14	40
Lander II St.	0	0	0	1	0	1	2	1	0	1	1	1	8	29
Harbor Ave.	2	2	0	0	0	0	0	0	1	0	0	0	5	56
Chelan	0	0	0	0	1	1	5	3	0	1	1	1	13	25
W. Michigan	0	0	0	0	0	1	2	0	0	1	1	1	6	9
8th Ave.	0	0	0	0	0	0	1	0	0	0	0	0	1	12
Brandon St.	1	0	3	4	3	10	7	7	1	8	6	2	52	40
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Norfolk St.	0	0	0	0	0	1	4	0	0	1	1	3	10	12
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0	<1
Henderson (1)	0	0	0	0	0	0	1	1	0	1	1	1	5	16
MLK Jr. Way (1)	1	0	1	0	4	2	3	1	0	3	3	2	20	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	0	2	2	5	7	8	8	1	4	6	2	46	21
Terminal 115													N/A	8
SSA SUBTOTAL	5	2	9	9	23	33	57	43	4	40	30	18	273	447
NSA														
Ballard	0	0	0	2	1	1	2	0	0	1	1	1	9	13
E. Ballard (11th NW) (1)	0	0	0	0	0	0	1	4	0	2	3	0	10	13
Dexter	0	0	1	2	2	2	4	1	0	4	3	1	20	4
University	0	0	1	0	1	1	2	0	0	2	2	1	10	14
Montlake	0	0	0	1	0	2	3	1	0	0	0	0	7	16
Canal St. (Lake City)	0	0	0	0	0	0	1	0	0	1	0	0	2	<1
Third Ave. W.	0	0	0	1	0	1	2	1	0	2	2	1	10	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	1	0	0	0	0	0	1	<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	0	1	1	3	3	3	2	0	3	4	2	22	18
NSA SUBTOTAL	0	0	3	7	7	10	19	9	0	15	15	6	91	98
CARKEEK														
Carkeek CSO Plant												See Carkeek Annual Report		
ALKI														
Murray													N/A	8
Barton													N/A	*23
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	23
63rd Ave.													N/A	N/A
TOTAL	5	2	12	16	30	43	76	52	4	55	45	24	364	599

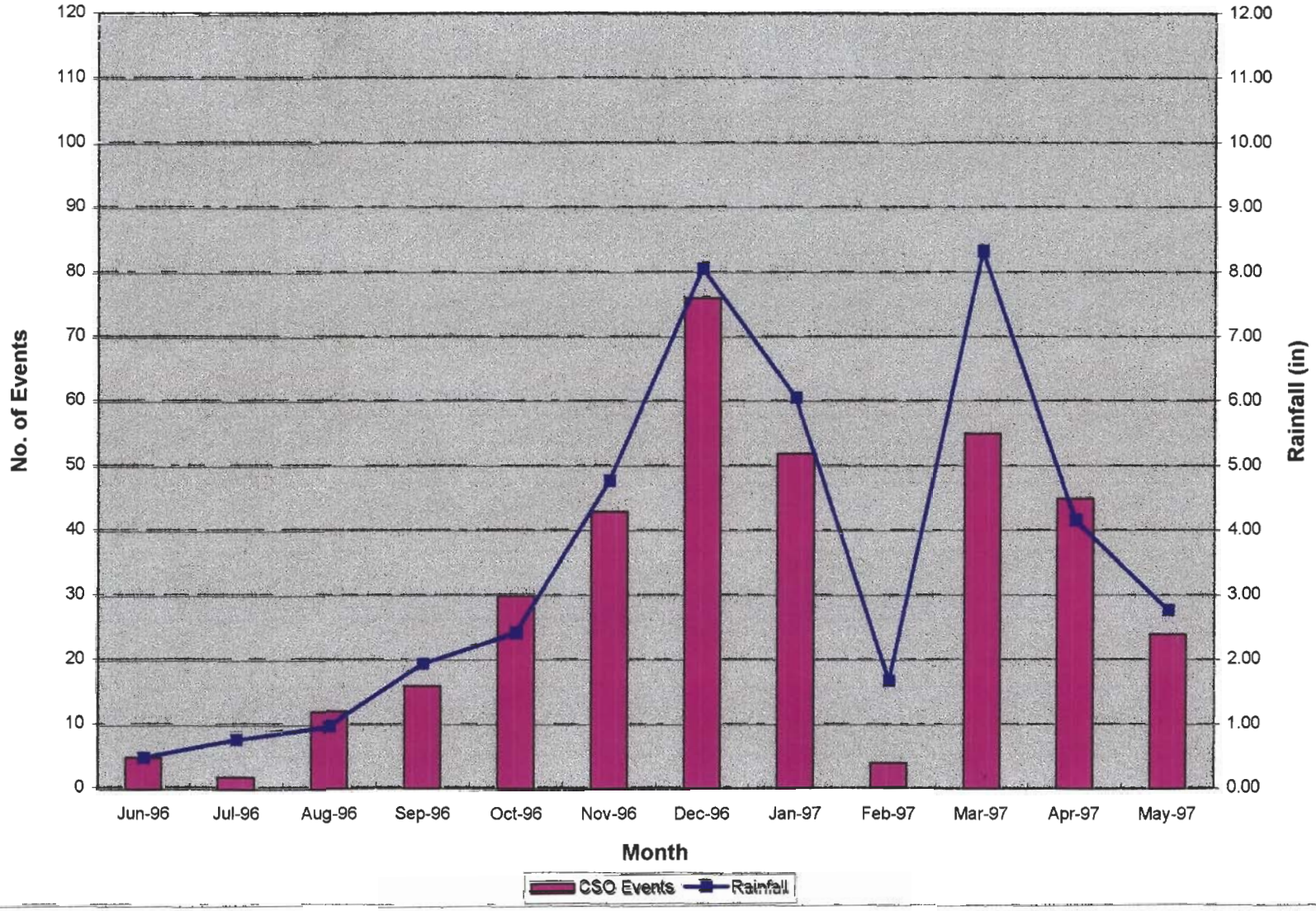
(1) Portable flow meters; not currently monitored by CATAD.
(2) The West treatment plant computers were down from 10/17/96-11/7/96.
Frequency data for CSO events is not available for this time.

Figure 2-2. Annual CSO Volumes



This Page Intentionally Left Blank

Figure 2-3. 1996/97 CSO Events (Based on 3 hr non-discharge) vs. Rainfall



This Page Intentionally Left Blank

King County is currently evaluating the event definition to determine if the current three hour 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.

The current event modeling effort is comparing overflows for a three hour inter-event period and a 48 hour inter-event period. The 48-hour period of non-discharge was chosen since it is used to characterize discharge events at Carkeek. The model is being run for both event periods using the years of mid-1978 to mid-1987 and mid-1994 to mid 1996 for simulation. These time periods were selected because the average annual rainfall over these periods is the same as the 36 inches annual average from historical data. The 1996 conditions are without the Alki Transfer and with the Norfolk Diversion.

The early modeling results show a significant decrease in number of annual average CSO events using the 48 hour rather than 3 hour inter-event period. The model is being refined and requires verification before the results are reported. However, a comparison of the 3 hour and 48 hour inter-event periods will be included either in the 1997/98 or 1998/99 Annual CSO Report and/or the 2000 5-Year Update. CSO projects are designed to accommodate peak flows associated with the one-year storm; therefore, re-defining the event interval is not expected to appreciably affect the scale and cost of CSO capital projects.

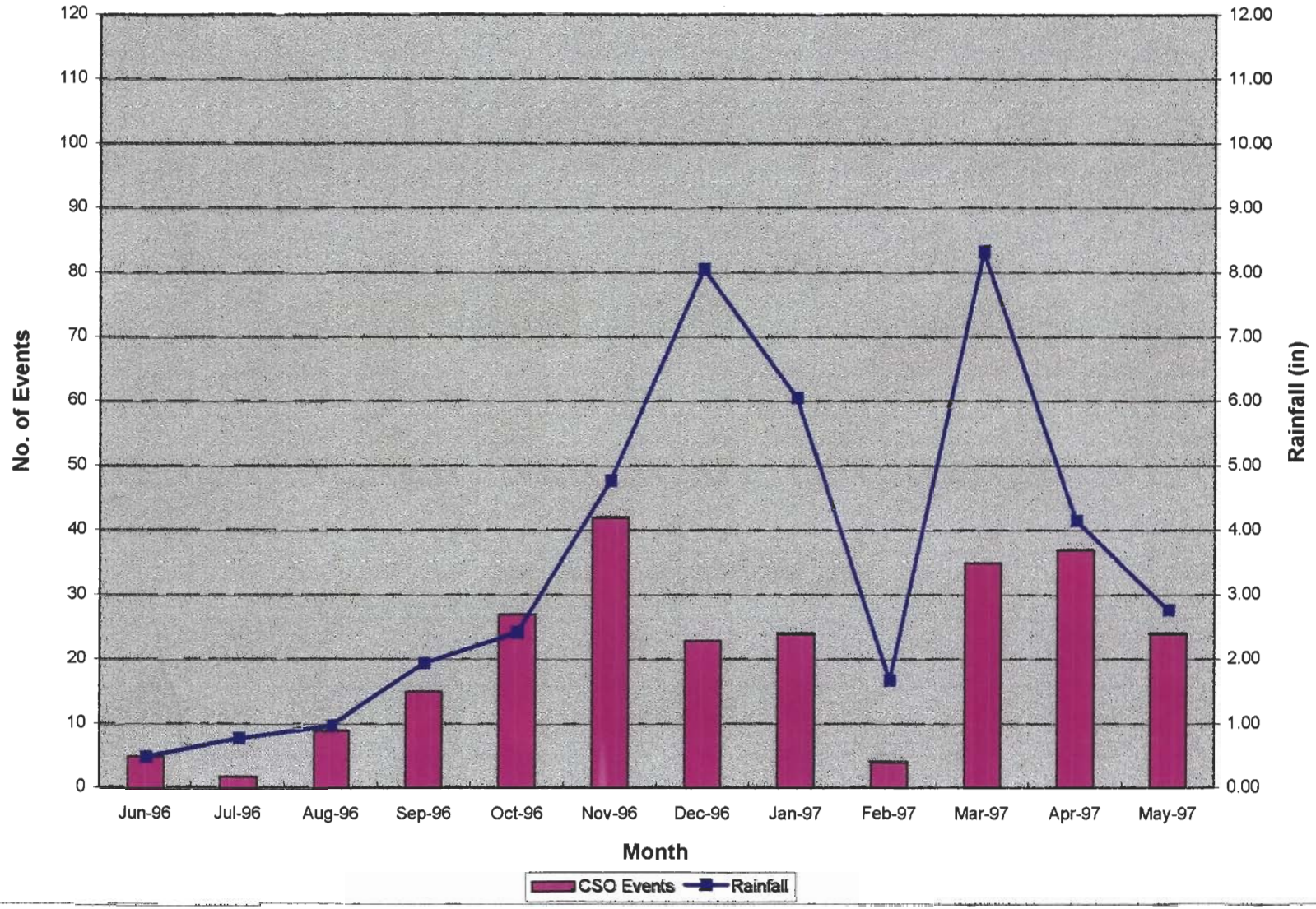
For comparison purposes, the 1996/97 CSO frequency of events were re-calculated based on a 48-hour period of non-discharge for the measured data during the reporting period. This resulted in 247 events during the reporting period (see Table 2-6 and Figure 2-4), a significant decrease from the 364 events calculated with the 3 hour inter-event period. This significant decrease suggests that many of the overflow events occur within a few hours of each other; thus, a single independent rainfall event may be resulting in more than one CSO event when the 3 hour inter-event definition is used.

Table 2-6
1996/97 Frequency of CSO Events
(Based on 48 hour non-discharge definition)

Station	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96 (2)	Nov-96 (2)	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	1996/97 Total (overflows/yr) (2)
SSA													
Denny Way	0	0	2	2	3	4	1	2	1	4	3	1	23
King Street	0	0	0	0	2	1	1	2	0	3	1	1	11
Connecticut	0	0	0	0	1	1	1	2	0	2	1	1	9
Hanford #1 (@ Rainier)(1)	0	0	0	0	3	3	1	1	0	1	2	1	12
Hanford #2	0	0	0	0	1	0	1	2	0	3	1	1	9
Lander II St.	0	0	0	1	0	2	1	1	0	1	1	1	8
Harbor Ave.	2	2	0	0	0	0	0	0	1	0	0	0	5
Chelan	0	0	0	0	1	2	1	1	0	1	1	1	8
W. Michigan	0	0	0	0	0	2	1	0	0	1	1	1	6
8th Ave.	0	0	0	0	0	0	1	0	0	0	0	0	1
Brandon St.	1	0	2	3	2	4	1	2	1	4	5	2	27
Michigan St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Norfolk St.	0	0	0	0	0	2	1	0	0	1	1	3	8
Duwamish P.S.	0	0	0	0	0	0	0	0	0	0	0	0	0
Henderson (1)	0	0	0	0	0	0	1	1	0	1	1	1	5
MLK Jr. Way (1)	1	0	1	0	4	3	1	1	0	2	2	2	17
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	0	1	2	4	5	1	2	1	1	4	2	24
Terminal 115													N/A
SSA SUBTOTAL	5	2	6	8	21	29	14	17	4	25	24	18	173
NSA													
Ballard	0	0	0	2	1	2	1	0	0	1	1	1	9
E. Ballard (11th Ave. NW) (1)	0	0	0	0	0	0	1	2	0	1	3	0	7
Dexter	0	0	1	2	2	2	1	1	0	3	2	1	15
University	0	0	1	0	1	2	1	0	0	1	2	1	9
Montlake	0	0	0	1	0	2	1	1	0	0	0	0	5
Canal St. (Lake City)	0	0	0	0	0	0	1	0	0	1	0	0	2
Third Ave. W.	0	0	0	1	0	2	1	1	0	1	2	1	9
E. Pine St.	0	0	0	0	0	0	0	0	0	0	0	0	0
Belvoir	0	0	0	0	0	0	1	0	0	0	0	0	1
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	0	1	1	2	3	1	2	0	2	3	2	17
NSA SUBTOTAL	0	0	3	7	6	13	9	7	0	10	13	6	74
CARKEEK													
Carkeek CSO Plant									See Carkeek Annual Report				
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	5	2	9	15	27	42	23	24	4	35	37	24	247

(1) Portable flow meters; not currently monitored by CATAD.
(2) The West treatment plant computers were down from 10/17/96-11/7/96.
Frequency data for CSO events is not available for this time.

Figure 2-4. 1996/97 CSO Events (Based on 48 hr non-discharge) vs. Rainfall



This Page Intentionally Left Blank

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 3-1.

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 3-2. 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 3-1. 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 3-2. 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