ANNUAL CSO REPORT

1989/1990

METRO

DECEMBER 1990

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CSO CONTROL PROGRAM IMPLEMENTATION

CSO CONTROL PROGRAM IMPLEMENTATION

In 1988, the Metro Council adopted a comprehensive CSO control plan for the Metro system. This plan, which was subsequently approved by DOE, calls for a 75 percent CSO volume reduction from baseline conditions by the year 2005. Ten separate CSO control projects were identified within the plan as was a proposed schedule for their implementation. That schedule is as follows:

Project	Year of Design Initiation	Year On-Line
Hanford/Bayview/Lander	1986	1992
CATAD Modifications	1987	1991
Parallel Fort Lawton Tunnel	1987	1991
Carkeek Transfer/CSO Treatment Facility	1988	1992
University Regulator	1986	1992
Alki Transfer/CSO Treatment Facility	1989	1995
Denny Partial Separation	1993	1999
Diagonal Total Separation	1995	1999
Michigan Total Separation	1997	2003
Kingdome Total Separation	2000	2006

Recognizing the need to fine tune the proposed project schedule to maximize opportunities to achieve a 75 percent CSO volume reduction, the plan as adopted requires a routine re-evaluation of projects and schedules at a minimum of five-year intervals.

STATUS OF CURRENT CSO CONTROL PROJECTS

CSO abatement projects undertaken in 1990 and planned for 1991 are summarized as follows:

Hanford/Bayview/Lander

Scope

This project consists of partial separation of the Lander and Hanford basins and was the most cost-effective CSO control alternative investigated for the basins.

Hanford:

The Hanford separation project was on-line in October 1987. The project involved installation of a new 36-inch sanitary sewer inside an existing 108-inch tunnel that was used to convey combined flows from Rainier Valley to the Elliott Bay Interceptor. The 36-inch line is used to convey partially separated flow to the Elliott Bay Interceptor and the 108-inch tunnel is used to convey stormwater to the Diagonal Way storm drain and then to the Duwamish River. The project partially separated about 1,132 combined acres upstream of the tunnel and eliminated CSOs from the Hanford No. 1 Regulator.

Lander/Bayview:

The Lander Separation Project consists of two phases, the first of which is currently under way. Phase 1 provides partial separation of the Lander basin through the installation of a new 96-inch sanitary trunk line to convey flows from the existing combined collection system to the Elliott Bay Interceptor. The existing 84-inch line will be used for stormwater. The new 96-inch line will provide about 1.4 million gallons of storage capacity. The project also requires the installation of a new stormwater collection system in the basin that will be operated and maintained by the City of Seattle. The Bayview Tunnel will be used to divert flows from the Hanford Basin to the Lander sanitary trunk line. The components of Phases 1 and 2 are as follows:

Phase 1:
- o 96-inch Lander sanitary trunk.
- o New Lander regulator.
- o Elliott Bay Interceptor connection.
- o Bayview diversion structure.
- o New stormwater collection system from existing 84-inch Lander trunk to the limits of the Lander Street right-of-way.
- o Connection of existing combined collection system to new 96-inch sanitary trunk through drop manhole structures.

Phase 2:
- o New stormwater collection pipeline in Lander Basin.
- o Connect existing street drainage and parking lots to new stormwater collection pipelines within right-of-way limits.

Status

The following schedule depicts project tasks for 1988 through 1993.

```
1988       1989       1990       1991       1992       1993

-- Predesign
 ---- Final Design Phase 1
      -- Permits, Phase 1
       -- Bid/Award, Phase 1
         ------------- Construction, Phase 1
        -------------- Final Design, Phase 2
                    -- Bid/Award, Phase 2
                      --------------------------- Construction,
                                                         Phase 2
```

Consultant selection, predesign and final design of Phase 1 occurred in 1988. Final design has been completed and construction began on schedule and was completed in October 1990. Phase 2 construction began in November 1990.

<u>CATAD Modifications</u>

Scope

Modifications to the CATAD control system will improve the system's efficiency by more fully utilizing the storage capacity in existing sewers.

The previous computer control system took advantage of 17 to 28 million gallons or 28 to 47 percent of the storage within the system's estimated 60 million gallons. Planning level estimates anticipate the improvements will increase the capture rate to 73 percent or about 44 million gallons and reduce CSO volumes in the West Point service area by about 175 millions annually from the estimated total of 2.4 billion gallons.

Status

The project consists of two elements: software development/ testing and flow sensors installation. The schedule for implementation is as follows:

	1986	1987	1988	1989	1990	1991
Software Development & Testing	-------	-------	-------	-------	-------	
Software Calibration & Documentation					---	---
Flow Sensors			-------	-------	-------	

Development of adaptive control software will improve the use of collection system pipe storage for reducing combined sewer overflows in the West Point collection system. Hydraulic and hydrological models were complete in 1987. Forecast programs were completed at the end of 1988. Control strategies, adaptive control development, and the testing of adaptive control are scheduled to be complete by mid-1991. Control strategies tuning is scheduled to occur during October 1990 through March 1991.

Selection, purchase and installation of new flow sensors in the collection system will provide more accurate calibration of software and improvement of storage control. The flow sensors were tested in early 1989 and are being installed in 1990.

All elements of the project are on schedule.

Fort Lawton Parallel Tunnel

Scope

The new parallel tunnel will accommodate an additional capacity of 82 mgd for combined sewer flows over the secondary base flow capacity of 358 mgd. The combined sewer flows will receive treatment at West Point. This project will provide CSO relief in the Ship Canal, especially at the Ballard regulator and Third Avenue West weir.

Status

The project schedule through completion of construction is as follows:

```
1987       1988       1989       1990       1991

    ---- Predesign
       ------------------ Final Design
                   ------ Project Permits
                    ----   Environmental Process
                        -- Bid & Award
                         ----------------------- Construction
```

Construction began in 1990. Tunnel excavation was completed in early November. The project is presently ahead of its planned construction schedule. The present plan is to activate the new tunnel by the summer of 1991.

Carkeek Transfer/CSO Treatment Facility

Scope

The Carkeek project is designed to transfer base flows (2.25 x AWWF) from the Carkeek drainage basin to the West Point plant where they will receive secondary treatment. Flows above this will receive primary treatment and disinfection at the existing Carkeek Treatment Plant and be discharged through the existing outfall. The present facilities will undergo minor modifications to enable the intermittent treatment of peak storm related flows. Specific permit conditions for operation of the Carkeek stormweather plant have been negotiated with DOE.

Status

The project schedule from consultant selection through start-up is as follows:

1989 1990 1991 1992 1993 1994 1995

--------------- 8th Ave Pipeline-90th to Market (Final Design)
--------------------- Force Main (Final Design)
--------------------------- Pump Station and CSO Plant (Final Design)
--------- 8th Ave NW Interceptor (Construction)
------------ Force Main (Construction)
------------------- Pump Station/CSO Plant (Construction)

Final design of all elements will be complete in 1991.

University Regulator

Scope

Storm runoff from the Densmore drain, Interstate-5, Ravenna Park, and outflow from Green Lake will be diverted from the North Interceptor system to a new storm drain. The results of this project will be a reduction of CSOs into Portage Bay and ultimately to the Ship Canal-Lake Union system by an estimated 150 million gallons annually.

Status

The project schedule is briefly summarized below.

1989 1990 1991 1992 1993 1994 1995

------ Consultant Selection
------------------- Final Design
--------------- Pumping Station Construction
-------- Gravity Pipeline Construction
--------- Ravenna Park Line
--------- Force Main Construction
----------- Restoration

Design is under way and will continue through late 1991.

Alki Transfer/CSO Treatment Facility

Scope

The Alki project is designed to transfer base flows (2.25 x AWWF) from the Alki drainage basin to the West Point plant for secondary treatment. Flows above this level and up to a maximum of 74 mgd will receive primary treatment and disinfection at the existing facility which will be modified to permit intermittent discharges. Flows will be discharged from the existing outfall. Specific permit conditions for operation of the Alki stormweather plant have been negotiated with DOE.

Status

The project schedule from project scope development through construction completion is as follows:

```
1988     1989     1990     1991     1992     1993     1994     1995

      ---------------- Predesign
      ------------------ EIS Process
                         ------------ Permits
                         -------------- Final Design
                                        ----- Bid & Award
                                              Transfer
                      Construct Transfer     ----------------
               Bid & Award Treat Plant Mods  ----
                     Construct Treat Plant Mods  ------------
```

Predesign was completed in 1990 and final design will begin in 1991.

Denny Way Capping Project

Scope

A sediment capping project was conducted at the Denny Way CSO (Figure 1) as an experimental demonstration project to evaluate the benefits of capping as a way of improving sediment quality in Elliott Bay. This project occurred during March 1990 and was a cooperative effort between the Municipality of Metropolitan Seattle (Metro) and the U.S. Army Corps of Engineers (COE), which supports using dredge material for beneficial uses. The COE obtained clean sand for capping during routine maintenance dredging in the upper Duwamish River. A total of 13 barge loads were delivered and slowly spread over a rectangular capping site with an area of about three acres (200 ft. x 600 ft.). A modified COE survey system allowed control of the application rate from the split hulled barge. Several applications were used to obtain the desired 3-foot-thick cap that should isolate marine biota from contaminated sediment.

Status

Metro is conducting a post-cap monitoring program for five years to evaluate the effectiveness of the sediment cap. Baseline monitoring data has been collected for the following: 1) Chemical profiles of sediment cores used to check for migration of contaminants up into the cap; 2) benthic taxonomy samples used to document recolonization of the site; 3) surface sediment chemistry used to identify any recontamination of the cap; 4) underwater video camera surveys used to identify changes in the cap surface; and 5) bottom stake measurements used to verify

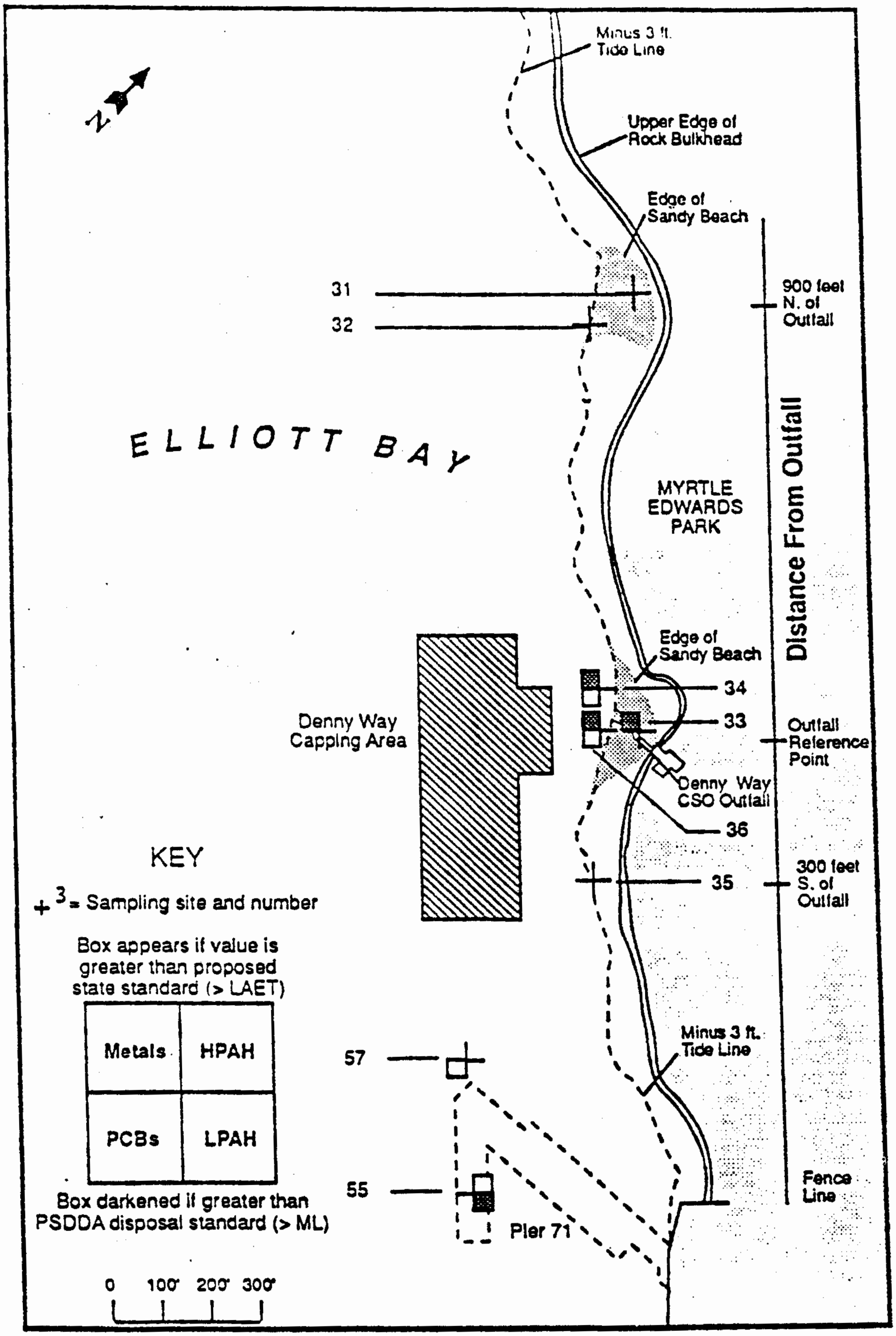

Figure 1 Northern Sampling Region, Illustrating Chemical Quality of Intertidal Sediments Collected at Sampling Sites 31 - 36 (sampled in 1988) and subtidal Sites 55 and 57 sampled in 1989

stability of the cap against erosion. Monitoring results will be presented in the annual report required by the permitting agencies (Seattle Shoreline Master Use, Corps of Engineers and Department of Natural Resources). Annual meetings and a five-year follow-up are also required by the permitting and regulatory agencies. Any monitoring beyond five years will be negotiated at the five-year review meeting.

Other CSO Abatement Projects

Work on the remaining CSO projects, Denny Partial Separation, the Diagonal, Michigan and Kingdome separation projects are not anticipated until after 1993 based on current scheduling.

1989/1990 CSO VOLUME SUMMARY

1989/1990 COMBINED SEWAGE OVERFLOW VOLUME SUMMARY

Metro's Computer Augmented Treatment and Disposal system (CATAD) monitors the volume and frequency of combined sewage overflows at 17 regulator stations in the West Point system. Overflow reports are generated daily, evaluated by staff and archived for future use. In addition to CATAD reports, Metro deploys portable flow meters at stations currently not monitored by CATAD which include the overflow weirs at 3rd Avenue West and the Ballard Siphon. For this year's reporting period, monthly and total overflow volumes have been compiled in Table 1 for the 17 overflows monitored by CATAD and for two overflows monitored by portable meter for the period from June 1989 through May 1990.

CATAD system development was under way from June 1989 through October 1989 which precluded overflow monitoring during this period. To compensate for the shortfall in total overflow volume represented by this period of missing data, overflow volumes for the same period in 1990 were substituted into this year's summary. Although this method is not entirely accurate, it does provide a reasonable estimate of the expected overflow volumes during the drier months of summer and autumn.

Overflow Volume Comparison with Baseline Conditions

CATAD recorded a total system overflow volume for the period June 1989 through May 1990 of 1.85 billion gallons. This is appreciably less than the 2.4 billion-gallon baseline condition which represents the average volume of overflow occurring during an average rainfall year prior to implementation of the 75 percent reduction program. Overflow volumes for the Southern Service Area (SSA) and Northern Service Area (NSA) were 450 MG and 100 MG below the baseline condition, respectively, as shown in Table 2.

Table 2
1989/1990 Combined Sewage Overflow Volume Summary

Service Area	1988 CSO Plan	1989/1990
NSA	468 MG	359 MG
SSA	1,941 MG	1,490 MG
TOTAL	2,409 MG	1,849 MG

Discussion

Total overflow volumes for the period from June 1989 to May 1990 were nearly 560 million gallons below the baseline condition established in 1981-1983. The following factors may have influenced the total overflow volume for this reporting period.

Table 1

1989/1990 COMBINED SEWAGE OVERFLOW VOLUME SUMMARY
(volumes in million gallons)

CATAD not on-line during this period.
1990 Representative Data Substituted.

STATION	1989							1990					1989/1990 TOTAL	CSO PLAN
SSA	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May		
Denny Way	23.30	3.36		0.36	67.18	57.76	150.05	228.91	66.16	28.82	9.18	11.63	646.71	370.00
King St.	5.18	0.62			1.54	6.66	8.88	13.89			2.31		39.08	70.00
Connecticut	10.90	1.00	0.11		4.91	14.81	27.50	41.21	12.03	11.00	1.46	1.11	126.04	90.00
Hanford #2	9.81	0.13			3.00	16.78	33.35	108.42	36.50	9.46		1.49	218.94	680.00
Lander St.					15.71	15.74	30.16	64.61	4.80	4.06			135.08	215.00
Harbor	2.26	0.28	0.09		1.60	1.51	11.00	24.74	0.98	1.77	0.88	1.27	46.38	55.00
Chelan		0.01						1.55					1.56	25.00
W. Michigan		0.02					0.29	0.76					1.07	2.00
Eighth Ave. S.	0.45						0.09	3.58					4.12	15.00
Brandon St.	0.22	3.29	0.22		6.74	74.88	0.95	44.59	2.68	3.90	0.57	11.16	149.20	35.00
Michigan St.	3.45	0.73			0.22	0.12	13.36	30.38	0.21	1.22		3.61	53.30	250.00
Norfolk	0.85				3.85	2.85	23.88	34.75		2.41		0.22	68.81	4.00
Duwamish P.S.														130.00
NSA											SSA TOTAL	=	1490.29	1941.00
Ballard					16.83		55.11	44.02	0.84	1.40			118.20	90.00
Dexter	1.05	1.63			3.47	0.50	3.08	10.31			0.49	1.82	22.35	12.00
University					0.26		3.99	18.28					22.53	211.00
Montlake	0.38	1.12				1.47	21.75	63.58					88.30	40.00
3rd Ave. W.			0.08		4.71	9.51	24.04	38.06			0.03		76.43	105.00
Ballard Siphon	0.81				2.91	8.96	12.63	5.60				0.21	31.12	0.00
											NSA TOTAL	=	358.93	458.00
TOTALS	58.66	12.19	0.50	0.36	132.93	211.55	420.11	777.24	124.20	64.04	14.92	32.52	1849.22	2399.00

- Below Average Rainfall - The Seattle average rainfall for the period June 1989 through May 1990 averaged 30.2 inches (Appendix A) compared to the 42-year average for the Seattle area of 36 inches/year. The volume and frequency of CSO varies as the amount of rainfall varies from the average. During development of the 1988 CSO Plan, 42 years of hourly rainfall data was entered into a predictive model to estimate CSO volumes from the Metro system based on historical annual rainfall. This relationship is approximated by the following formulas:

  Baseline NSA
  CSO Volume = (19.3 x Annual Rainfall) - 190
  1989/1990 = 393 million gallons

  Baseline SSA
  CSO Volume = (66.7 x Annual Rainfall) - 460
  1989/1990 = 1,374 million gallons

  Based on the recorded rainfall for this period, total predicted overflow for 1989/1990 would be 1,767 million gallons. This corresponds closely with the actual overflow volume for 1989/1990 of 1,849 MG.

- Total overflow volumes for this reporting period were exacerbated by a 100-year storm which occurred during the period January 8-10, 1990. This extreme storm event alone accounted for over 400 million gallons of CSO contributing to a 777 million gallon total for the month of January, over 40 percent of the yearly total. This illustrates the effect of peak storm events which contribute significant rainfall accumulations in relatively short time periods, accounting for large overflow volumes compared to long-duration low-intensity storm conditions which generally prevail in the northwest. To this effect, year-to-year comparisons of total average rainfall and resultant CSO volumes can be misleading since individual events, such as the January 1990 100-year storm, can disproportionately influence total overflow volume. Likewise, yearly annual rainfall is not a good indicator of year-to-year variations in CSO volumes for individual basins since rainfall is often extremely variable in the Seattle area. Where possible, rainfall should be compared by basin to derive a true understanding of the system response.

- Hanford/Bayview/Lander Project - During development of the CSO Plan in 1988, the Hanford Project was combined with the Lander Separation Project to form the Hanford/Bayview/Lander Project. Work was completed in 1987 on the installation of a 36-inch pipe within the Hanford tunnel to convey partially separated flows from 3,800 acres of Rainier Valley to the Elliott Bay Interceptor (Hanford Project). Although the

Lander and Bayview elements of this project had not been completed by this reporting period, overflows at Hanford No. 2 in 89/90 were nearly 460 MG below baseline conditions. This 460 million gallon reduction of overflow at the Hanford No. 2 Regulator can be partially attributed to completion of the Hanford project component, rainfall and system operation also being pertinent. It is expected that future overflows will be reduced further by completion of Phase II of the Lander separation project in 1991.

NSA Overflow Volume Comparison

1989/1990 overflows in the NSA were approximately 100 million gallons less than baseline conditions. Overflow volumes at E. Ballard, Dexter Ave., 3rd Ave. W. and the Ballard Siphon correspond well with baseline conditions (see Table 1), however, overflow volumes were roughly 50 MG higher at the Montlake Regulator and 190 MG lower at the University Regulator. Metro is currently evaluating the possible causes of these apparent fluctuations from baseline conditions at these two regulator stations within the scope of the University Regulator CSO Control Project.

SSA Volume Comparison

SSA overflow volumes were approximately 500 million gallons less than baseline volumes with significant reductions at the Hanford No. 2, Lander and Michigan Regulator Stations. As noted previously, reductions at Hanford No. 2 can be attributed to some degree to completion of the Hanford portion of the Hanford/Bayview/Lander project. Lower volumes at the Michigan Regulator may be attributed to higher volumes at the adjacent Brandon and Norfolk Regulators. For these three regulators, the sum total of CSO for 89/90 (270 MG) is roughly equivalent to baseline levels (290 MG).

West Duwamish Interceptor regulator stations (Harbor, Chelan, Eighth Ave, W. Michigan) overflowed 53.3 MG in 1989/1990 which was considerably less than the baseline condition (97 MG). This decreased overflow volume is likely a direct result of the below-average precipitation experienced in 1989/1990.

The Denny Way CSO overflowed a total of 647 million gallons during 89/90 compared to the modeled baseline volume of 370 million gallons.

Summary

Overflow volumes for 89/90 were considerably less (550 MG) than the baseline condition established for the Metro system prior to implementation of the 75 percent reduction program in 1988. Possible reasons for this reduction can be attributed to less than average rainfall in the Seattle area and partial implementation of Metro's Hanford/Bayview/Lander project, however, reductions may have been attenuated somewhat by a 100-year storm which occurred in January, 1990 which was responsible for 400 million gallons of overflow. Overflow volumes at Metro's Hanford No. 2 Regulator were approximately 460 MG lower than baseline volumes, which indicates apparent reduction from implementation of the Hanford/Bayview/Lander Project, however, the efficacy of specific control projects should not be judged solely on a single year of data, rather, reductions attributed to project implementation are best demonstrated through long-term system monitoring of individual basins.

1988-1992 COMBINED SEWAGE OVERFLOW MONITORING PROGRAM

COMBINED SEWER OVERFLOW MONITORING PROGRAM

Metro's NPDES sampling program calls for discharge sampling of five CSO sites annually through 1992 to meet the requirements of WAC 173-245-040(2)(a)(i) and condition S11.C1 of the West Point Treatment Plant's NPDES permit. The program plan was to collect four discharge samples a year for each CSO under overflow conditions. In addition, nine stations were selected for sediment quality sampling from 1989 to 1992. Table 3 shows the present and future availability of monitoring data from the 1988-1992 monitoring program. This program's focus has been to supplement previous monitoring efforts. Appendix B lists the dates when each sample was taken and the sample number. It also serves as a checklist to determine Metro's progress in meeting the program schedule.

Table 3
1988-1992 Monitoring Program Data Availability

CSO	Discharge	Sediment
Northern Service Area		
E. Ballard #1 (W004)	89/90 Report	88/89 Report
Third Ave. W. (W008)	89/90 Report	88/89 Report
Ballard Siphon (W003)	90/91 Report	88/89 Report
Dexter Ave. (W009)	91/92 Report	88/89 Report
Montlake (W014)	91/92 Report	88/89 Report
Southern Service Area		
Connecticut (W029)	89/90 Report	not scheduled
Brandon St. (W041)	90/91 Report	89/90 Report
W. Michigan (W042)	91/92 Report	89/90 Report
Norfolk St. (W044)	90/91 Report	89/90 Report
Eighth Ave. (W040)	91/92 Report	89/90 Report
Chelan Ave. (W036)	91/92 Report	not scheduled

1990/1991 Marine Sediment Sampling Results

As part of Metro's NPDES CSO Monitoring Program, composite samples of sediments were taken at the Brandon, Norfolk, West Michigan and Eighth Avenue Regulator Stations in 1990. Samples were analyzed and the results are reported in Table 4. Blanks indicate that the parameter was below the detection limit. This report supplements sediment sampling results for freshwater CSOs which were submitted in the 1988/1989 report.

Table 4

MARINE SEDIMENT DATA

Station	Unit	LTPH01 Brandon	LTXQ01 Norfolk	LTRI07 W Mich	LTTK06 8th Av W
NPDES Serial Number		W041	W044	W042	W040
PRIORITY POLLUTANT ORGANICS					
ACIDS	ppb (ug/kg)				
PHENOL					
2-CHLOROPHENOL					
4-CHLORO-3-METHYL PHENOL					
2,4-DICHLOROPHENOL					
2,4,5-TRICHLOROPHENOL					
2,4,6-TRICHLOROPHENOL					
2,3,4,6-TETRACHLOROPHENOL					
PENTACHLOROPHENOL					
2-NITROPHENOL					
4-NITROPHENOL					
2,4-DINITROPHENOL					
2,4-DIMETHYLPHENOL					
4,6-DINITRO-2-METHYLPHENOL					
2-METHYLPHENOL (O-CRESOL)					
3-METHYLPHENOL (M-CRESOL)					
4-METHYLPHENOL (P-CRESOL)					
BENZOIC ACID		616.438	725.806	233.766	
BASES					
N-NITROSODIMETHYLAMINE	ppb (ug/kg)				
N-NITROSODI-N-PROPYLAMINE	ppb (ug/kg)				
N-NITROSODIPHENYLAMINE	ppm carbon				
BENZIDINE	ppb (ug/kg)				
3,3-DICHLOROBENZIDINE	ppb (ug/kg)				
PYRIDINE	ppb (ug/kg)				
ANALINE	ppb (ug/kg)				
4-CHLOROANILINE	ppb (ug/kg)				
2-NITROANILINE	ppb (ug/kg)				
3-NITROANILINE	ppb (ug/kg)				
4-NITROANILINE	ppb (ug/kg)				
NEUTRALS					
1,2-DICHLOROBENZENE	ppm carbon				
1,3-DICHLOROBENZENE	ppb (ug/kg)				
1,4-DICHLOROBENZENE	ppm carbon		596.774		
1,2,4-TRICHLOROBENZENE	ppm carbon				

Table 4a

MARINE SEDIMENT DATA

Station	Unit	LTPH01 Brandon	LTXQ01 Norfolk	LTRI07 W Mich	LTTK06 8th Av W
NPDES Serial Number		W041	W044	W042	W040
HEXACHLOROBENZENE	ppm carbon				
NITROBENZENE	ppb (ug/kg)				
HEXACHLOROETHANE	ppb (ug/kg)				
HEXACHLOROCYCLOPENTADIENE	ppb (ug/kg)				
HEXACHLOROBUTADIENE	ppm carbon				
TRICHLOROBUTADIENE	ppb (ug/kg)				
TETRACHLOROBUTADIENE	ppb (ug/kg)				
PENTACHLOROBUTADIENE	ppb (ug/kg)				
BIS(2-CHLOROETHYL)ETHER	ppb (ug/kg)				
BIS(2-CHLOROISOPROPYL)ETHER	ppb (ug/kg)				
4-CHLOROPHENYL PHENYL ETHER	ppb (ug/kg)				
4-BROMOPHENYL PHENYL ETHER	ppb (ug/kg)				
BIS(2-CHLOROETHOXY)METHANE	ppb (ug/kg)				
2,4-DINITROTOLUENE	ppb (ug/kg)				
2,6-DINITROTOLUENE	ppb (ug/kg)				
NAPHTHALENE	ppm carbon				
FLUORENE	ppm carbon	89.041	59.677	27.273	
ACENAPHTHENE	ppm carbon	84.931	41.935	23.377	
ACENAPHTHYLENE	ppm carbon		20.968	19.480	
ANTHRACENE	ppm carbon	106.849	106.452	83.117	
PHENANTHRENE	ppm carbon	520.548	661.291	259.740	59.459
2-METHYLNAPHTHALENE	ppm carbon				
FLUORANTHENE	ppm carbon	808.219	838.709	1090.908	132.432
PYRENE	ppm carbon	698.630	741.935	948.052	93.243
CHRYSENE	ppm carbon	520.548	483.871	506.493	71.622
BENZO (A) ANTHRACENE	ppm carbon	452.054	387.096	454.545	60.811
BENZO (A) PYRENE	ppm carbon	273.972	354.838	402.597	39.189
BENZO (B) FLUORANTHENE} TOTAL BENZO	ppm carbon	273.972	354.838	441.558	56.757
BENZO (K) FLUORANTHENE}FLUORANTHENE	ppm carbon	246.575	370.968	298.701	43.243
INDENO (1,2,3-C,D) PYRENE	ppm carbon	150.685	225.806	155.844	
DIBENZO (A-H) ANTHRACENE	ppm carbon		62.903		
BENZO (G,H,I) PERYLENE	ppm carbon	136.986	209.677	142.857	
2-CHLORONAPHTHALENE	ppb (ug/kg)				
DIMETHYL PHTHALATE	ppm carbon				
DIETHYL PHTHALATE	ppm carbon				
DI-N-BUTYL PHTHALATE	ppm carbon				
BENZYL BUTYL PHTHALATE	ppm carbon				
DI-N-OCTYL PHTHALATE	ppm carbon				

Table 4b

MARINE SEDIMENT DATA

Station	Unit	LTPH01 Brandon	LTXQ01 Norfolk	LTRI07 W Mich	LTTK06 8th Av W
NPDES Serial Number		W041	W044	W042	W040
BIS(2-ETHYLHEXYL)PHTHALATE	ppm carbon	1109.59	1596.77	428.57	
BENZYL ALCOHOL	ppb (ug/kg)				
DIBENZOFURAN	ppm carbon	49.315			
1-2,DIPHENYLHYDRAZINE	ppb (ug/kg)				
ISOPHORONE	ppb (ug/kg)				
PCBS AND PESTICIDES					
TOTAL PCBs	ppm carbon				
AROCLOR 1016	ppm carbon				
AROCLOR 1221	ppm carbon				
AROCLOR 1232	ppm carbon				
AROCLOR 1242	ppm carbon				
AROCLOR 1248	ppm carbon				
AROCLOR 1254	ppm carbon	82.19	96.77		
AROCLOR 1260	ppm carbon	136.986	48.387		
ALPHA-BHC	ppb (ug/kg)				
BETA-BHC	ppb (ug/kg)				
DELTA-BHC	ppb (ug/kg)				
GAMMA-BHC (LINDANE)	ppb (ug/kg)				
4,4-DDE	ppb (ug/kg)				
4,4-DDD	ppb (ug/kg)			2.47	
4,4-DDT	ppb (ug/kg)				
ALDRIN	ppb (ug/kg)				
DIELDRIN	ppb (ug/kg)				
ENDRIN	ppb (ug/kg)				
ENDRIN ALDEHYDE	ppb (ug/kg)				
CHLORDANE	ppb (ug/kg)				
HEPTACHLOR	ppb (ug/kg)				
HEPTACHLOR EPOXIDE	ppb (ug/kg)				
METHOXYCHLOR	ppb (ug/kg)				
ALPHA-ENDOSULFAN	ppb (ug/kg)				
BETA-ENDOSULFAN	ppb (ug/kg)				
ENDOSULFAN SULFATE	ppb (ug/kg)				
TOXAPHENE	ppb (ug/kg)				
2,3,7,8-TCDD	ppb (ug/kg)				
DEMETON	ppb (ug/kg)				
GUTHION	ppb (ug/kg)				
MALATHION	ppb (ug/kg)				
MIREX	ppb (ug/kg)				
PARATHION	ppb (ug/kg)				

Table 4c

MARINE SEDIMENT DATA

Station	Unit	LTPH01 Brandon	LTXQ01 Norfolk	LTRI07 W Mich	LTTK06 8th Av W
NPDES Serial Number		W041	W044	W042	W040
VOLATILES					
METHYL CHLORIDE	ppb (ug/kg)				
METHYLENE CHLORIDE	ppb (ug/kg)				
CHLOROFORM	ppb (ug/kg)				
CHLOROETHANE	ppb (ug/kg)				
1,1-DICHLOROETHANE	ppb (ug/kg)				
1,2-DICHLOROETHANE	ppb (ug/kg)				
1,1,1-TRICHLOROETHANE	ppb (ug/kg)				
1,1,2-TRICHLOROETHANE	ppb (ug/kg)				
1,1,1,2-TETRACHLOROETHANE	ppb (ug/kg)				
1,1,2,2-TETRACHLOROETHANE	ppb (ug/kg)				
VINYL CHLORIDE	ppb (ug/kg)				
1,1-DICHLOROETHYLENE	ppb (ug/kg)				
TRANS-1,2-DICHLOROETHYLENE	ppb (ug/kg)				
CIS-1,2-DICHLOROETHYLENE	ppb (ug/kg)				
TRICHLOROETHYLENE	ppb (ug/kg)				
TETRACHLOROETHYLENE	ppb (ug/kg)				
1,2-DICHLOROPROPANE	ppb (ug/kg)				
CIS-1,3-DICHLOROPROPENE	ppb (ug/kg)				
TRANS-1,3-DICHLOROPROPENE	ppb (ug/kg)				
METHYL BROMIDE	ppb (ug/kg)				
DICHLOROBROMOMETHANE	ppb (ug/kg)				
CHLORODIBROMOMETHANE	ppb (ug/kg)				
BROMOFORM	ppb (ug/kg)				
DICHLORODIFLUOROMETHANE	ppb (ug/kg)				
TRICHLOROFLUOROMETHANE	ppb (ug/kg)				
ACROLEIN	ppb (ug/kg)				
ACRYLONITRILE	ppb (ug/kg)				
CARBON TETRACHLORIDE	ppb (ug/kg)				
BENZENE	ppb (ug/kg)				
CHLOROBENZENE	ppb (ug/kg)				
TOLUENE	ppb (ug/kg)				
ETHYLBENZENE	ppb (ug/kg)				
BIS (CHLOROMETHYL) ETHER	ppb (ug/kg)				
2-CHLOROETHYL VINYL ETHER	ppb (ug/kg)				
CARBON DISULFIDE	ppb (ug/kg)				
ISOBUTANOL	ppb (ug/kg)				
ACETONE	ppb (ug/kg)				
VINYL ACETATE	ppb (ug/kg)				
2-BUTANONE (MEK)	ppb (ug/kg)				
4-METHYL-2-PENTANONE (MIBK)	ppb (ug/kg)				

Table 4d

MARINE SEDIMENT DATA

Station	Unit	LTPH01 Brandon	LTXQ01 Norfolk	LTRI07 W Mich	LTTK06 8th Av W
NPDES Serial Number		W041	W044	W042	W040
2-HEXANONE	ppb (ug/kg)				
TOTAL XYLENES	ppb (ug/kg)				
STYRENE	ppb (ug/kg)				
METALS	ppm (dry)				
ALUMINUM		7123.29	15967.74	8571.42	12981.75
ANTIMONY		4.11		6.49	
ARSENIC		9.59	14.52	12.99	28.31
BERYLLIUM			0.32		0.11
CADMIUM		0.27	0.32	0.26	
CHROMIUM		60.27	22.58	27.27	19.32
COPPER		39.73	40.32	37.66	24.23
IRON		15068.49	20967.74	14285.00	17392.00
LEAD		27.40	38.71	168.83	15.16
MANGANESE		356.16	241.94	181.82	162.16
MERCURY		0.18	0.90	0.39	0.06
NICKEL		164.38	17.74	20.78	15.20
SELENIUM					
SILVER		1.23	0.48		
THALLIUM					
TIN			1.16		
ZINC		102.74	111.29	111.69	63.30
CONVENTIONALS					
CYANIDE	ug/g	l.t. 0.6	1.16	l.t. 0.6	l.t. 0.6
TOTAL SOLIDS	mg/kg	730000.00	620000.00	77000.00	740000.00
COD		32876.71	48387.09	11688.31	13513.51
TOTAL VOLATILE SOLIDS	mg/kg (wet)	16000.00	29000.00	12000.00	10000.00
TOC	ppm	6849.31	22580.65	3766.23	6351.35
SULFIDES	mg/kg(wet)	52.00	59.00	19.00	5.80
OIL AND GREASE (MG/K) DRY					
OIL	mg/kg (dry)	1780.82	1096.77	441.56	148.64
OIL(NP)	mg/kg (dry)	1100.00	420.00	210.00	65.00

Sampling indicates that low and high molecular weight polyaromatic hydrocarbons (LPAH & HPAHs) were detected in the Duwamish sediments. No volatile organics were detected in any of the samples. PCBs were detected at low levels in the Brandon and Norfolk samples, and semivolatile organics included dichlorobenzene, PAHs, phthlaltes, benzoic acid, and dibenzofuran.

Metals analysis indicate the presence of priority pollutant metals in each of the stations sampled. Cadmium was detected at low levels in three of four stations sampled and silver was detected at the Brandon and Norfolk stations. In general, metals concentrations were relatively uniform among the stations sampled.

Conventionals analysis indicate % total organic carbon (TOC) ranging from 0.27 to 0.15 percent. Cyanide was below the detection limits for all of the stations with the exception of Norfolk which was slightly above (0.72 ppm).

Table 5

CSO DISCHARGE DATA
(in ppb or ug/L)

Sample #	021244	012165	043103
Station	3rd Av W	E Ballard	Connecticut
NPDES Serial Number	W008	W004	W029
PRIORITY POLLUTANT ORGANICS			
ACIDS			
PHENOL	3.200		
AC17 OMITTED 890406			
AC18 OMITTED 890406			
2-CHLOROPHENOL			
4-CHLORO-3-METHYL PHENOL			
2,4-DICHLOROPHENOL			
2,4,5-TRICHLOROPHENOL			
2,4,6-TRICHLOROPHENOL			
2,3,4,6-TETRACHLOROPHENOL			
PENTACHLOROPHENOL			
2-NITROPHENOL			
4-NITROPHENOL			
2,4-DINITROPHENOL			
2,4-DIMETHYLPHENOL			
4,6-DINITRO-2-METHYLPHENOL			
2-METHYLPHENOL (O-CRESOL)	1.400		
3-METHYLPHENOL (M-CRESOL)			
4-METHYLPHENOL (P-CRESOL)			2.800
BENZOIC ACID			12.000
BASES			
BA4 OMITTED 890406			
N-NITROSODIMETHYLAMINE			
N-NITROSODI-N-PROPYLAMINE			
N-NITROSODIPHENYLAMINE			
BENZIDINE			
3,3-DICHLOROBENZIDINE			
PYRIDINE			
ANALINE			
4-CHLOROANILINE			
2-NITROANILINE			
3-NITROANILINE			
4-NITROANILINE			

Table 5a

CSO DISCHARGE DATA
(in ppb or ug/L)

Station	021244	012165	043103
	3rd Av W	E Ballard	Connecticut
NPDES Serial Number	W008	W004	W029
NEUTRALS			
1,2-DICHLOROBENZENE			
1,3-DICHLOROBENZENE			
1,4-DICHLOROBENZENE			
1,2,4-TRICHLOROBENZENE			
HEXACHLOROBENZENE			
NITROBENZENE			
HEXACHLOROETHANE			
HEXACHLOROCYCLOPENTADIENE			
HEXACHLOROBUTADIENE			
TRICHLOROBUTADIENE			
TETRACHLOROBUTADIENE			
PENTACHLOROBUTADIENE			
BIS(2-CHLOROETHYL)ETHER			
BIS(2-CHLOROISOPROPYL)ETHER			
4-CHLOROPHENYL PHENYL ETHER			
4-BROMOPHENYL PHENYL ETHER			
BIS(2-CHLOROETHOXY)METHANE			
2,4-DINITROTOLUENE			
2,6-DINITROTOLUENE			
NAPHTHALENE	0.940		
2-METHYLNAPHTHALENE			2.300
FLUORENE			0.700
ACENAPHTHENE			
ACENAPHTHYLENE			
ANTHRACENE			
PHENANTHRENE	0.710	0.520	3.200
FLUORANTHENE	0.770	1.200	3.200
PYRENE	0.830	1.000	3.800
CHRYSENE	0.460	0.540	2.400
BENZO (A) ANTHRACENE	0.310	0.360	1.300
BENZO (A) PYRENE			
BENZO (B) FLUORANTHENE			
BENZO (K) FLUORANTHENE			
INDENO (1,2,3-C,D) PYRENE			
DIBENZO (A-H) ANTHRACENE			
BENZO (G,H,I) PERYLENE			
2-CHLORONAPHTHALENE			
DIMETHYL PHTHALATE			

Table 5b

CSO DISCHARGE DATA
(in ppb or ug/L)

Station	021244	012165	043103
	3rd Av W	E Ballard	Connecticut
NPDES Serial Number	W008	W004	W029
DIETHYL PHTHALATE	1.800	1.300	1.800
DI-N-BUTYL PHTHALATE			
BENZYL BUTYL PHTHALATE	1.200	0.810	4.700
DI-N-OCTYL PHTHALATE			
BIS(2-ETHYLHEXYL)PHTHALATE			22.000
BENZYL ALCOHOL			
DIBENZOFURAN			
1-2,DIPHENYLHYDRAZINE			
ISOPHORONE			
PCBS AND PESTICIDES			
TOTAL PCBs			
AROCLOR 1016			
AROCLOR 1221			
AROCLOR 1232			
AROCLOR 1242			
AROCLOR 1248			
AROCLOR 1254			
AROCLOR 1260			
ALPHA-BHC			
BETA-BHC			
DELTA-BHC			
GAMMA-BHC (LINDANE)			
4,4-DDE			
4,4-DDD			
4,4-DDT			
ALDRIN }			
DIELDRIN }			
ENDRIN			
ENDRIN ALDEHYDE			
CHLORDANE			
HEPTACHLOR			
HEPTACHLOR EPOXIDE			
METHOXYCHLOR			
ENDOSULFAN I }			
ENDOSULFAN II }			
ENDOSULFAN SULFATE			
TOXAPHENE			
2,3,7,8-TCDD			

Table 5c

CSO DISCHARGE DATA
(in ppb or ug/L)

Station	021244	012165	043103
	3rd Av W	E Ballard	Connecticut
NPDES Serial Number	W008	W004	W029
DEMETON			
GUTHION			
MALATHION			
MIREX			
PARATHION			
VOLATILES			
V040 OMITTED 890406			
METHYL CHLORIDE			
METHYLENE CHLORIDE		5.600	
CHLOROFORM	1.200		
CHLOROMETHANE			
CHLOROETHANE			
1,1-DICHLOROETHANE			
1,2-DICHLOROETHANE			
1,1,1-TRICHLOROETHANE			
1,1,2-TRICHLOROETHANE			
1,1,1,2-TETRACHLOROETHANE			
1,1,2,2-TETRACHLOROETHANE			
VINYL CHLORIDE			
1,1-DICHLOROETHYLENE			
TRANS-1,2-DICHLOROETHYLENE			
CIS-1,2-DICHLOROETHYLENE			
TRICHLOROETHYLENE			
TETRACHLOROETHYLENE	2.800	6.500	
1,2-DICHLOROPROPANE			
CIS-1,3-DICHLOROPROPENE			
TRANS-1,3-DICHLOROPROPENE			
METHYL BROMIDE			
DICHLOROBROMOMETHANE			
CHLORODIBROMOMETHANE			
BROMOFORM			
DICHLORODIFLUOROMETHANE			
TRICHLOROFLUOROMETHANE			
ACROLEIN			
ACRYLONITRILE			
CARBON TETRACHLORIDE			
BENZENE	1.500		1.700

Table 5d

CSO DISCHARGE DATA
(in ppb or ug/L)

Sample #	021244	012165	043103
Station	3rd Av W	E Ballard	Connecticut
NPDES Serial Number	W008	W004	W029
TOLUENE	1.000		5.200
ETHYLBENZENE			
BIS (CHLOROMETHYL) ETHER			
2-CHLOROETHYL VINYL ETHER			
CARBON DISULFIDE			
ISOBUTANOL			
ACETONE			22.000
VINYL ACETATE			
2-BUTANONE (MEK)			
4-METHYL-2-PENTANONE (MIBK)	9.800		
2-HEXANONE			
TOTAL XYLENES	11.000		5.20
STYRENE			