BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

DEPARTMENT OF ENVIRONMENTAL QUALITY,	)	AMENDED STIPULATION AND
OF THE STATE OF OREGON,	)	FINAL ORDER
	)	No. WQMW-NWR-92-247
	)	CLATSOP COUNTY
Department,	)	
v.	)	
CITY OF ASTORIA	)	
Respondent.	)	

WHEREAS:

1. On January 13, 1993, the Department of Environmental Quality (Department or DEQ) issued National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit Number 101028 (Permit) to the City of Astoria (Respondent), pursuant to Oregon Revised Statutes (ORS) 468B.050 and the Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500 as amended. The Permit authorizes the Respondent to construct, install, modify or operate wastewater treatment control and disposal facilities (facilities) and discharge adequately treated wastewaters into the Columbia River–, waters of the state, in conformance with the requirements, limitations and conditions set forth in the Permit.

2. Respondent's sewage collection system is comprised in part of combined sewers designed to collect both sanitary sewage and storm runoff water. The combined sewer system is designed and intended to collect and transport all sanitary sewage to Respondent's sewage treatment plant during periods of dry weather; however, during some periods of wet weather, the combined sanitary sewage and storm runoff entering the system exceeds the system's capacity to collect and transport sewage to the sewage treatment plant. At such times, the excess combined sanitary sewage and storm runoff are discharged through Combined Sewer Overflows directly to the Columbia River or to Young's Bay, waters of the state, without treatment. Respondent's system includes 36 as of August 15, 2010, Combined Sewer Overflows discharge points. The

discharges of combined sanitary sewage and storm runoff from the Combined Sewer Overflows (discharges or CSOs) may cause violations of Oregon's applicable water quality standards Columbia River and Young's Bay.

3. On January 7, 1993, Stipulation and Final Order No. WQMW-NWR-92-247 (Order) came into effect. The Order requires Respondent to carry out the necessary studies, planning and corrective actions to eliminate all discharges from CSOs that violate applicable water quality standards up to a five year return winter storm and a ten year return summer storm.

4. Respondent has completed the studies and planning activities required by the Order, and on September 30, 1998 submitted a CSO Facility Plan to the Department. Two updates to the Facility Plan were submitted by the Respondent in 2005 and 2010. The Facility Plan (as updated, "The Facility Plan") analyzes Respondent's combined sewer system; characterizes the CSOs with respect to volume, frequency and duration of discharges; and identifies the facilities and estimated costs necessary for various levels of CSO control and reduction, including the level specified in the Order.

5. As described in the Facility Plan, Respondent has determined that the facilities needed to meet the level of CSO control required by the Order would cost approximately $50 million in 2010 dollars. This level of control would reduce the current volume of CSO discharges by roughly 98% in a typical rainfall year. Alternatively, Respondent has determined that it would cost approximately $39 million in 2010 dollars for the facilities needed to meet the level of control required by the Order at the CSO discharge points on Young's Bay and the embayment area adjacent to the Alderbrook residential neighborhood, while achieving a 2 year return summer storm and achieving, on average, a six-in-a-winter storm level of control at the CSO discharge points to the Columbia River shipping channel. This level of CSO control would reduce the current volume of CSO discharges by approximately 96% in a typical rainfall year. Based on this analysis, Respondent has concluded that expenditures beyond the level of control achievable at an estimated cost of $39 million in 2010 dollars rise sharply to achieve only small increments in additional control and water quality improvement, and are not cost effective, particularly given the nature and capacity of the receiving water. Respondent, after conferring with the Department, has therefore proposed that the Order be amended to establish this more

cost effective level of control as the requirement.

6. Paragraph 10 of the Order allows for its amendment by mutual agreement of the Department and Respondent.

7. The Department agrees that the level of CSO control proposed by Respondent in the Facility Plan is appropriate because it is cost effective and will be highly protective of water quality and the beneficial uses of the Columbia River and Young's Bay in the vicinity of Astoria, especially during the summer when the potential for contact recreational use of these waters is higher. The Department and Respondent are in agreement that the Order should be amended to be consistent with the CSO control program proposed in the Facility Plan.

8. DEQ and Respondent recognize that until new or modified facilities are constructed and put into full operation, Respondent may cause violations of water quality standards at times when discharges from the Combined Sewer Overflows occur.

9. The Department and Respondent recognize that the Commission has the power to impose a civil penalty and to issue an abatement order for violations of conditions of the Permit. Therefore, pursuant to ORS 183.415(5), the Department and Respondent wish to limit and resolve potential future violations referred to in Paragraph 8 in advance by this Amended Stipulation and Final Order (ASFO).

10. This ASFO is not intended to limit, in any way, the Department's right to proceed against Respondent in any forum for any past or future violations not expressly settled herein.

NOW THEREFORE, it is stipulated and agreed that:

11. The Environmental Quality Commission hereby issues a final order:

[Note: The NPDES Permit CSO discharge point identification numbers are used in this ASFO]

a. Requiring respondent to eliminate all untreated CSO discharges from discharge points 001 through 004 inclusive and 034 through 038 inclusive from October 15 through May 21 except during storms greater than or equal to a 24 hour duration storm with a five year return frequency and from May 22 through October 14 except during storms greater than or equal to a 24 hour duration storm with a ten year return frequency; and requiring Respondent to eliminate all untreated CSO discharges from all other discharge points from October 15 through May 21 except during storms greater than or equal to a 24 hour duration storm with a six-in-a-year return frequency and from May 22 through October 14 except during storms greater than or equal to a 24 hour duration storm with a 2 year return frequency, as soon as reasonably practicable, but no later than the following schedule:

(1) By December 1, 2003, Respondent shall eliminate untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a. of the ASFO, at discharge points 001, 002, 004, and 034 through 38 inclusive, consistent with the Facility Plan approved by the Department;

(2) By December 1, 2003, the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 11.a.(4);

(3) By May 1, 2005, Respondent shall begin construction required to comply with Paragraph 11.a.(4);

(4) By December 1, 2007, Respondent shall eliminate untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a. of this ASFO, at eleven (11) of the remaining CSO discharge points, consistent with the Facility Plan approved by the Department;

(5) By December 1, 2012 the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 11.a.(7);

(6) By May 1, 2013, Respondent shall begin construction required to comply with Paragraph 11.a.(7);

(7) By December 1, 2013, Respondent shall eliminate untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a. of this ASFO, at seven (7) of the remaining CSO discharge points, including 003, consistent with the facilities plan approved by the Department;

(8) By December 1, 2015 Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 11.a.(10);

(9) By May 1, 2016 Respondent shall begin construction required to comply with

Paragraph 11.a.(10);

(10) By December 1, 2016 Respondent shall eliminate untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a. of this ASFO, at ten (10) of the remaining CSO discharge points consistent with the Facility Plan approved by the Department;

(11) By December 1, 2020 Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 11.a.(13);

(12) By May 1, 2021 Respondent shall begin construction required to comply with Paragraph 11.a.(13);

(13) By December 1, 2022 Respondent shall eliminate untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a. of this ASFO, at all remaining CSO discharge points, consistent with the Facility Plan approved by the Department;

(14) By September 1 of each year that this ASFO is in effect, Respondent shall submit to the Department an annual progress report on efforts to meet the requirements of this ASFO. These annual reports shall include at a minimum work completed in the previous fiscal year and work scheduled to be completed in the current fiscal year.

b. Requiring Respondent, within twelve months of the scheduled date when compliance is required in Paragraph 11.a., to demonstrate by a means approved by the Department that at each discharge point untreated CSO discharges have been eliminated, subject to the storm return frequencies specified in Paragraph 11.a. The demonstration shall be reported to the Department within the twelve month period (unless weather conditions require an extension) in a document called <u>CSO Outfall Control Compliance</u> <u>Report: Outfall(s) Number--</u>.

c. Requiring Respondent to take corrective action for each discharge point for which elimination of untreated CSO discharges cannot be demonstrated as specified in Paragraph 11.b, as follows:

(1) Within three months of the end of the demonstration period specified in Paragraph 11.b, Respondent shall submit for Department review and approval for each discharge point or group of discharge points having the same compliance schedule in

Paragraph 11.a., a Corrective Action Plan that analyzes the causes of the failure to achieve elimination of untreated CSO discharges, subject to the storm return frequencies specified in Paragraph 11.a, and proposes facilities required to comply with Paragraph 11.c.(4);

(2) Within six months of Department approval of the Corrective Action Plan Respondent shall submit for Department review and approval final engineering plans and specifications required to comply with Paragraph 11.c.(4) notwithstanding any exemption from plan submittal Respondent may have under OAR 340-052-0045;

(3) Within three months of Department approval of the plans and specifications specified in Paragraph 11.c.(2) Respondent shall begin construction required to comply with Paragraph 11.c.(4);

(4) Within fifteen months of Department approval of the plans and specifications specified in Paragraph 11.c. (2) Respondent shall eliminate untreated CSO discharges, subject to the applicable storm return frequencies specified in Paragraph 11.a. for the subject discharge point(s);

(5) Within twenty seven months of Department approval of the plans and specifications specified in Paragraph 11.c.(2) (subject to any extensions required by adverse weather conditions) Respondent shall demonstrate by a means approved by the Department but which at a minimum includes 10 months of continuous monitoring of overflow time, duration and volume estimate for each subject discharge point, that untreated CSO discharges have been eliminated subject to the applicable storm return frequencies specified in Paragraph 11.a. The demonstration shall be reported to the Department within the twelve month period in a document called Corrective Action Evaluation Report: Outfall(s) Number-- .

d. Requiring Respondent to take additional corrective action for each discharge point for which elimination of untreated discharges cannot be demonstrated as specified in Paragraph 11.c.(5) until elimination of untreated discharges, subject to the storm return frequencies specified in Paragraph 11.a., can be demonstrated. Respondent shall monitor discharge points subject to this paragraph and shall report within five days of occurrence all untreated discharges from each discharge point that result from storms smaller than the applicable storm return frequency.

e. Requiring Respondent to inform the Department in writing of each CSO discharge point that is converted to a storm sewer only discharge within six months of conversion.

f. Requiring Respondent, upon receipt of a written Penalty Demand notice from the Department, to pay the following civil penalties:

(1) five hundred dollars ($500) for each day of each violation of each provision of the compliance schedule set forth in Paragraph 11.a.;

(2) five hundred dollars ($500) per CSO discharge point per day for failure to submit a CSO Outfall Control Compliance Report as specified in Paragraph 11.b;

(3) two thousand five hundred dollars ($2,500) for each discharge point requiring a Corrective Action Plan as specified in Paragraph 11.c;

(4) one thousand dollars ($1,000) per discharge point per 24 hour period for each violation of each provision of the compliance schedule in Paragraph 11.c;

(5) one thousand dollars ($1,000) per discharge point per 24 hour period for each overflow reported as specified in Paragraph 11.d;

(6) two-hundred fifty dollars ($250) for each 24 hour period of each violation of any other requirement of this ASFO.

g. Allowing respondent to violate water quality standards as a result of each combined sewer overflow discharge until the schedule and terms of Paragraph 11.a for each CSO discharge point (001 through 038 inclusive) are met. (However, this paragraph is not applicable to the wastewater treatment plant outfall (039) and nothing in this paragraph relieves Respondent of the requirement to comply with all other terms, schedules and conditions of the NPDES Permit or of any other NPDES waste discharge permit issued to Respondent while this ASFO is in effect.)

12. If any event occurs that is beyond Respondent's reasonable control and that causes or may cause a delay or deviation in performance of the requirements of this ASFO, Respondent

shall immediately notify the Department verbally of the cause of delay or deviation and its anticipated duration, the measures that have been or will be taken to prevent or minimize the delay or deviation, and the timetable by which Respondent proposes to carry out such measures. Respondent shall confirm in writing this information within five (5) working days of the onset of the event. It is Respondent's responsibility in the written notification to demonstrate to the Department's satisfaction that the delay or deviation has been or will be caused by circumstances beyond the control and despite due diligence of Respondent. If Respondent so demonstrates, the Department shall extend times of performance of related activities under this ASFO as appropriate. Circumstances or events beyond Respondent's control include, but are not limited to, acts of nature, unforeseen strikes, work stoppages, fires, explosion, riot, sabotage, or war. Increased cost of performance or consultant's failure to provide timely reports shall not be considered circumstances beyond Respondent's control.

13. Respondent and the Department hereby waive any and all of their rights to any and all notices, hearing, judicial review, and to service of a copy of this ASFO. The Department reserves the right to enforce this ASFO through appropriate administrative and judicial proceedings.

14. Regarding the schedules set forth in Paragraph 11., Respondent agrees to diligently pursue federal and state grant and loan funds to facilitate implementation of its CSO control program, but acknowledges that Respondent is responsible for complying with that schedule regardless of the availability of any federal or state grant and loan monies.

15. The terms of this ASFO may be amended by the mutual agreement of the Department and Respondent. The storm return frequencies as defined in Paragraph 11.a. above may be amended based on future determinations, regarding combined sewer systems, made by the Environmental Quality Commission.

16. Respondent acknowledges that it has actual notice of the contents and requirements of the ASFO and that failure to fulfill any of the requirements hereof would constitute a violation of this ASFO and subject Respondent to payment of civil penalties pursuant to Paragraph 11.f above.

17. Any stipulated civil penalty imposed pursuant to Paragraph 11.f shall be due upon written demand. Stipulated civil penalties shall be paid by check or money order made payable to

the "State Treasurer, State of Oregon" and sent to: Business Office, Department of Environmental Quality 811 S.W. Sixth Avenue, Portland, OR 97204. Within 21 days of receipt of a "Demand for Payment of Stipulated Civil Penalty" Notice from the Department, Respondent may request a hearing to contest the Demand Notice. At any such hearing, the issue shall be limited to Respondent's compliance or non-compliance with this ASFO. The amount of each stipulated civil penalty for each violation and/or day of violation is established in advance by this ASFO and shall not be a contestable issue.

18. Providing Respondent has paid in full all stipulated civil penalties pursuant to Paragraph 17 above, this ASFO shall terminate 60 days after respondent demonstrates full compliance with the requirements of the schedules set forth in Paragraph 11. above.

RESPONDENT

________________________ ____________________________________

Date Willis L. Van Dusen Mayor

DEPARTMENT OF ENVIRONMENTAL QUALITY

________________________ ____________________________________

Date Nina DeConcini, Administrator, Northwest Region

FINAL ORDER

IT IS SO ORDERED:

ENVIRONMENTAL QUALITY COMMISSION

________________________ ____________________________________

Date Nina DeConcini, Administrator, Northwest Region

Department of Environmental Quality

Pursuant to OAR 340-11-136(1)

ATTACHMENT-1

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

DEPARTMENT OF ENVIRONMENTAL QUALITY, OF THE STATE OF OREGON, Department, v. CITY OF ASTORIA Respondent.	STIPULATION AND FINAL ORDER No. WQMW-NWR-92-247 CLATSOP COUNTY

WHEREAS:

1. On January 13, 1993, the Department of Environmental Quality (Department or DEQ) issued National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit Number 101028 (Permit) to the City of Astoria (Respondent), pursuant to Oregon Revised Statutes (ORS) 468B.050 and the Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500 as amended. The Permit authorizes the Respondent to construct, install, modify or operate wastewater treatment control and disposal facilities (facilities) and discharge adequately treated wastewaters into the Columbia River and Young's Bay, waters of the state, in conformance with the requirements, limitations and conditions set forth in the Permit.

2. Respondent's sewage collection system is comprised in part of combined sewers designed to collect both sanitary sewage and storm runoff water. The combined sewer system is designed and intended to collect and transport all sanitary sewage to Respondent's sewage treatment plant during periods of dry weather; however, during some periods of wet weather, the

combined sanitary sewage and storm runoff entering the system exceeds the system's capacity to collect and transport sewage to the sewage treatment plant. At such times, the excess combined sanitary sewage and storm runoff are discharged through Combined Sewer Overflows directly to the Columbia River or to Young's Bay, waters of the state, without treatment. Respondent's system includes 38 Combined Sewer Overflows. The discharges of combined sanitary sewage and storm runoff from the Combined Sewer Overflows (Discharges or CSOs) may cause violations of Oregon's water quality standards for fecal coliform bacteria, visible solids and floatable material, and possibly other parameters in the Columbia River and Young's Bay.

3. DEQ and the Respondent recognize that until new or modified facilities are constructed and put into full operation, Respondent may cause violations of the water quality standards at times when discharges from the Combined Sewer Overflows occur.

4. The Department and Respondent recognize that the Commission has the power to impose a civil penalty and to issue an abatement order for violations of conditions of the Permit.

Therefore, pursuant to ORS 183.415(5), the Department and Respondent wish to limit and resolve the future violations referred to in Paragraph 4 in advance by this Stipulation and Final Order (SFO).

5. This SFO is not intended to limit, in any way, the Department's right to proceed against Respondent in any forum for any past or future violations not expressly settled herein.

NOW THEREFORE, it is stipulated and agreed that:

6. The Environmental Quality Commission hereby issues a final order:

a. Requiring respondent to eliminate all discharges from combined sewer overflows that violate applicable water quality standards from November 1 through April 30 except during storms greater than or equal to a storm with a five year return frequency and to eliminate all Discharges that violate applicable water quality standards from May 1 through October 31 except during storms greater than or equal to a storm with a ten year return frequency, as soon as reasonably practicable, but no later than the following schedule:

(1) By March 31, 1993, the Respondent shall submit to the Department a draft scope of study for the facilities plan. The scope of study shall include an outline of the final facilities plan content, and sufficient detail on how the necessary information is to be obtained to complete the facilities plan. The facilities plan shall, at a minimum, include a characterization of the Discharges including volume, times of discharge, and bacterial and chemical content; alternatives for eliminating water quality violations attributable to CSOs; the environmental and other impacts of the alternatives evaluated; the estimated cost of the alternatives; an evaluation of the impact of the CSO control alternatives on the City of Astoria wastewater treatment facility; if the CSO alternatives will cause permit violations at the treatment facility, an evaluation of alternatives to

expand or upgrade the treatment plant so as to maintain compliance with existing discharge standards; recommended control alternatives including any required plant upgrades that will result in compliance with water quality standards for the CSO discharges and compliance with the existing treatment plant discharge standards; a detailed implementation schedule for completing the recommended actions; and a mechanism for financing the recommended improvements. The facilities plan shall include detailed implementation plans and financing plans for attaining compliance with applicable water quality standards at all CSOs by December 1, 2022;

(2) By July 1, 1996, the Respondent shall submit a draft facilities plan to the Department;

(3) Within six months of receiving written comments from the Department, the Respondent shall submit to the Department a final facilities plan that is approvable by the Department.

(4) By December 1, 2000, the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 6.a.(6);

(5) By July 1, 2001, the Respondent shall begin construction required to comply with Paragraph 6.a.(6);

(6) By December 1, 2003, the Respondent shall eliminate discharges that violate applicable water quality standards, subject to the storm return frequencies specified in Paragraph 6.a. of this Order, at 8 of the CSO discharge points including all the Young's Bay CSO discharge points, consistent with the

facilities plan approved by the Department;

(7) By December 1, 2003 the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 6.a.(9);

(8) By May 1, 2005 the Respondent shall begin construction required to comply with Paragraph 6.a.(9);

(9) By December 1, 2007 the respondent shall eliminate discharges that violate applicable water quality standards, subject to the storm return frequencies specified in Paragraph 6.a. of this Order, at 8 of the remaining CSO discharge points, consistent with the facilities plan approved by the Department;

(10) By December 1, 2007 the Respondent shall submit engineering plans and specifications for construction work required to comply with Paragraph 6.a.(12);

(11) By May 1, 2009, the Respondent shall begin construction required to comply with Paragraph 6.a.(12);

(12) By December 1, 2011, the Respondent shall eliminate discharges that violate applicable water quality standards, subject to the storm return frequencies specified in Paragraph 6.a. of this Order, at 8 of the remaining CSO discharge points, consistent with the facilities plan approved by the Department;

(13) By December 1, 2011 the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 6.a.(15);

(14) By May 1, 2013 the Respondent shall begin construction required to comply with Paragraph 6.a.(15);

(15) By December 1, 2015 the respondent shall eliminate discharges that violate applicable water quality standards, subject to the storm return frequencies specified in Paragraph 6.a. of this Order, at 8 of the remaining CSO discharge points, consistent with the facilities plan approved by the Department;

(16) By December 1, 2015 the Respondent shall submit final engineering plans and specifications for construction work required to comply with Paragraph 6.a.(18);

(17) By May 1, 2018 the Respondent shall begin construction required to comply with Paragraph 6.a.(18);

(18) By December 1, 2022 the respondent shall eliminate discharges that violate applicable water quality standards, subject to the storm return frequencies specified in Paragraph 6.a. of this Order, at all remaining CSO discharge points, consistent with the facilities plan approved by the Department;

(19) By September 1 of each year that this Order is in effect, the Respondent shall submit to the Department an annual progress report on efforts to minimize and eliminate discharges that violate water quality standards. These annual reports shall include at a minimum work completed in the previous fiscal year and work scheduled to be completed in the current fiscal year.

ANNUAL REPORT

b. Requiring Respondent to demonstrate that each discharge is in compliance with applicable water quality standards, by a means approved by the Department, within twelve months of the scheduled date when compliance is required in this Order. (Nothing in this paragraph shall prevent the Department from enforcing this Order during the twelve month demonstration period.)

c. Requiring Respondent to identify each discharge that is converted to a storm sewer discharge only.

d. Requiring Respondent, in the event that Respondent chooses to retain a Discharge with any connected sanitary wastes, to apply for a modification of Respondent's permit requesting a waste load increase and appropriately sized mixing zone. (Nothing in this paragraph shall affect the Department's or the Commission's discretion over granting such a request.)

e. Requiring Respondent to comply with all the terms, schedules and conditions of the Permit except as specified by Paragraphs 6.g, or of any other NPDES waste discharge permit issued to Respondent while this SFO is in effect.

f. Requiring Respondent, upon receipt of a written Penalty Demand notice from the Department, to pay the following civil penalties:

(1) five hundred dollars ($500) for each day of each violation of each provision of the compliance schedules set forth in Paragraph 6.a.;

(2) one thousand dollars ($1,000) per outfall per day for each CSO outfall for which Respondent fails to demonstrate compliance with applicable water quality

standards as specified in Paragraph 6.a.;

(3) two hundred fifty dollars ($250) for each day of each violation of any other requirement of this SFO.

g. Allowing respondent to violate water quality standards as a result of each combined sewer overflow discharge until the schedule and terms of Paragraph 6.a for each discharge point are met.

7. If any event occurs that is beyond Respondent's reasonable control and that causes or may cause a delay or deviation in performance of the requirements of this SFO, Respondent shall immediately notify the Department verbally of the cause of delay or deviation and its anticipated duration, the measures that have been or will be taken to prevent or minimize the delay or deviation, and the timetable by which Respondent proposes to carry out such measures. Respondent shall confirm in writing this information within five (5) working days of the onset of the event. It is Respondent's responsibility in the written notification to demonstrate to the Department's satisfaction that the delay or deviation has been or will be caused by circumstances beyond the control and despite due diligence of Respondent. If Respondent so demonstrates, the Department shall extend times of performance of related activities under this SFO as appropriate. Circumstances or events beyond Respondent's control include, but are not limited to, acts of nature, unforeseen strikes, work stoppages, fires, explosion, riot, sabotage, or war. Increased cost of performance or consultant's failure to provide timely reports shall not be

considered circumstances beyond Respondent's control.

8. Respondent and the Department hereby waive any and all of their rights to any and all notices, hearing, judicial review, and to service of a copy of this SFO. The Department reserves the right to enforce this SFO through appropriate administrative and judicial proceedings.

9. Regarding the schedules set forth in Paragraphs 6.a., Respondent acknowledges that Respondent is responsible for complying with that schedule regardless of the availability of any federal or state grant monies.

10. The terms of this SFO may be amended by the mutual agreement of the Department and Respondent. The storm return frequencies as defined in Paragraph 6.a. above may be amended based on future determinations, regarding combined sewer systems, made by the Environmental Quality Commission.

11. Respondent acknowledges that it has actual notice of the contents and requirements of the SFO and that failure to fulfill any of the requirements hereof would constitute a violation of this SFO and subject Respondent to payment of civil penalties pursuant to Paragraph 6.f. above.

12. Any stipulated civil penalty imposed pursuant to Paragraph 6.f. shall be due upon written demand. Stipulated civil penalties shall be paid by check or money order made payable to the "State Treasurer, State of Oregon" and sent to: Business Office, Department of Environmental Quality, 811 S.W. Sixth Avenue, Portland, OR 97204. Within 21 days of receipt of a "Demand for

Payment of Stipulated Civil Penalty" Notice from the Department, Respondent may request a hearing to contest the Demand Notice. At any such hearing, the issue shall be limited to Respondent's compliance or non-compliance with this SFO. The amount of each stipulated civil penalty for each violation and/or day of violation is established in advance by this SFO and shall not be a contestable issue.

13. Providing Respondent has paid in full all stipulated civil penalties pursuant to Paragraph 12 above, this SFO shall terminate 60 days after respondent demonstrates full compliance with the requirements of the schedules set forth in Paragraph 6.a. above.

RESPONDENT

January 4, 1993
Date

(Name) Willis I. Van Dusen
(Title) Mayor

DEPARTMENT OF ENVIRONMENTAL QUALITY

January 7, 1993
Date

Fred Hansen, Director

FINAL ORDER

IT IS SO ORDERED:

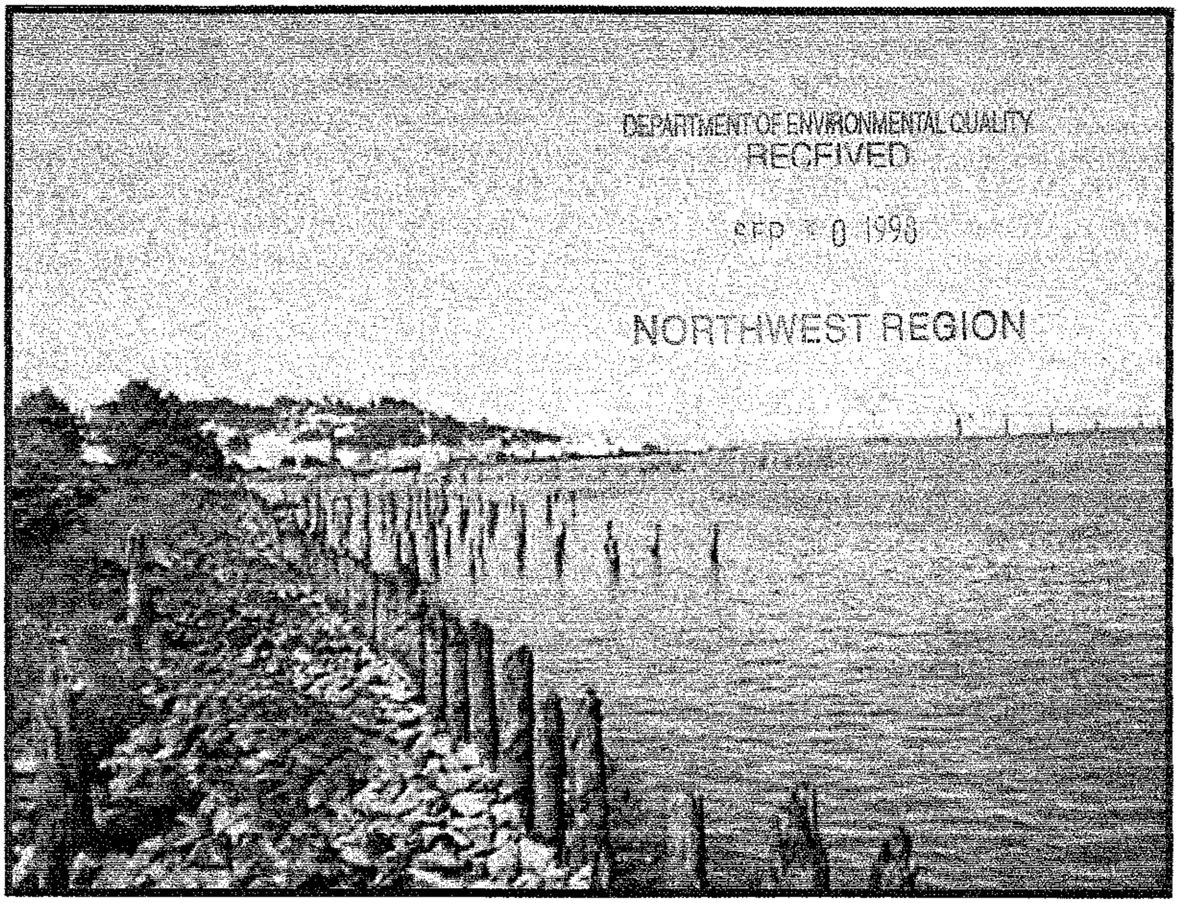
ENVIRONMENTAL QUALITY COMMISSION

January 7, 1993
Date

Fred Hansen, Director
Department of Environmental Quality
Pursuant to OAR 340-11-136(1)

FINAL REPORT

CITY OF ASTORIA



CSO FACILITY PLAN

Crawford Engineering Associates

REGISTERED PROFESSIONAL ENGINEER
17497
David Crawford
OREGON
NOV. 15, 1994
DAVID CRAWFORD

September 1998

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Contents, Continued

Contents, Continued

Acknowledgements

The plan resulted from contributions of many people over the past five years. The following individuals are acknowledged for their important role in the preparation and adoption of the Astoria CSO Facility Plan

City Council

Mayor Willis Van Dusen
Councilman Tom Porter
Councilman Ralph Norgaard
Councilman Doug Thompson
Councilman Don Morden

City Staff

Mike Caccavano, City Engineer
Mitch Mitchum, Director of Public Works
John Garland, Wastewater Treatment Plant Operator
Ken Cook, Public Works Superintendent

Oregon Department of Environmental Management

Richard Santner, Municipal Project Officer, Northwest Region
Steve Schnurbusch

Consultants

David Crawford, Project Manager, Crawford Engineering Associates
Chris Crawford, Crawford Engineering Associates
Shelley Go, CH2M Hill
Phillip Cheung, CH Gore and Storrie

Executive Summary

Summary of Project

The City of Astoria has prepared a plan that eliminates approximately 96 percent of the combined sewer overflows (CSO) and limits the number of events that have been occurring since the City's interceptor was constructed in 1973. The plan was developed as part of an agreement with the Oregon Department of Environmental Quality (DEQ) to control combined sewer overflows. The Astoria City Council has reviewed and approved implementation of the plan. The report submitted herein details the steps taken to develop the plan components and the implementation schedule. The projects in the plan represent the largest public works projects the City has undertaken.

The plan balances the controls needed to protect the beneficial uses of receiving waters with other community values, particularly the ability of Astoria to implement a large public works project. Figure ES-1 shows the relationship between levels of control and project costs and the associated community values assigned for the series of control alternatives developed. Control alternatives consider the level of control achieved through implementation of a series of projects or plan components.

The recommended plan exceeds the schedule in the Stipulation and Final Order (SFO) by controlling more CSOs sooner than specified. The plan protects the more sensitive areas such as Youngs Bay and an embayment in the Alderbrook neighborhood to the SFO design storm level. The plan, however, also balances the high control levels at Youngs Bay and Alderbrook with a lower level of control at some of the other CSOs located adjacent to the main shipping channel. This balance in control levels was developed by considering the frequency of CSO events, project costs and rate impacts, community characteristics, the ability to implement large public works projects, and the nature and uses of the receiving water. Once accepted by DEQ and the Environmental Quality Commission (EQC), the SFO and National Pollutant Discharge Elimination System (NPDES) permit will be revised. Pre-designs of the control measures will be produced in accordance with the amended SFO schedule for control of CSOs.

Overall the plan limits the number of CSO events per year at Youngs Bay, Alderbrook and selected other sensitive areas to the SFO level of control targets. The SFO targets are once on average every ten years during the summer months and once on average every five years during the winter months. At other locations the level of control is once every three years during summer months and no more than six CSO events during a typical winter.

Combined Sewer Overflows

The City of Astoria has a sewage collection system that combines sanitary sewer flow and stormwater inflow and infiltration. The sewerage system consists of house laterals, sewer trunk lines, catchbasins and subsurface drains that make up the collection system. The collection system conveys combined sewage to diversion structures that divert dry weather

Costs 9/27/98

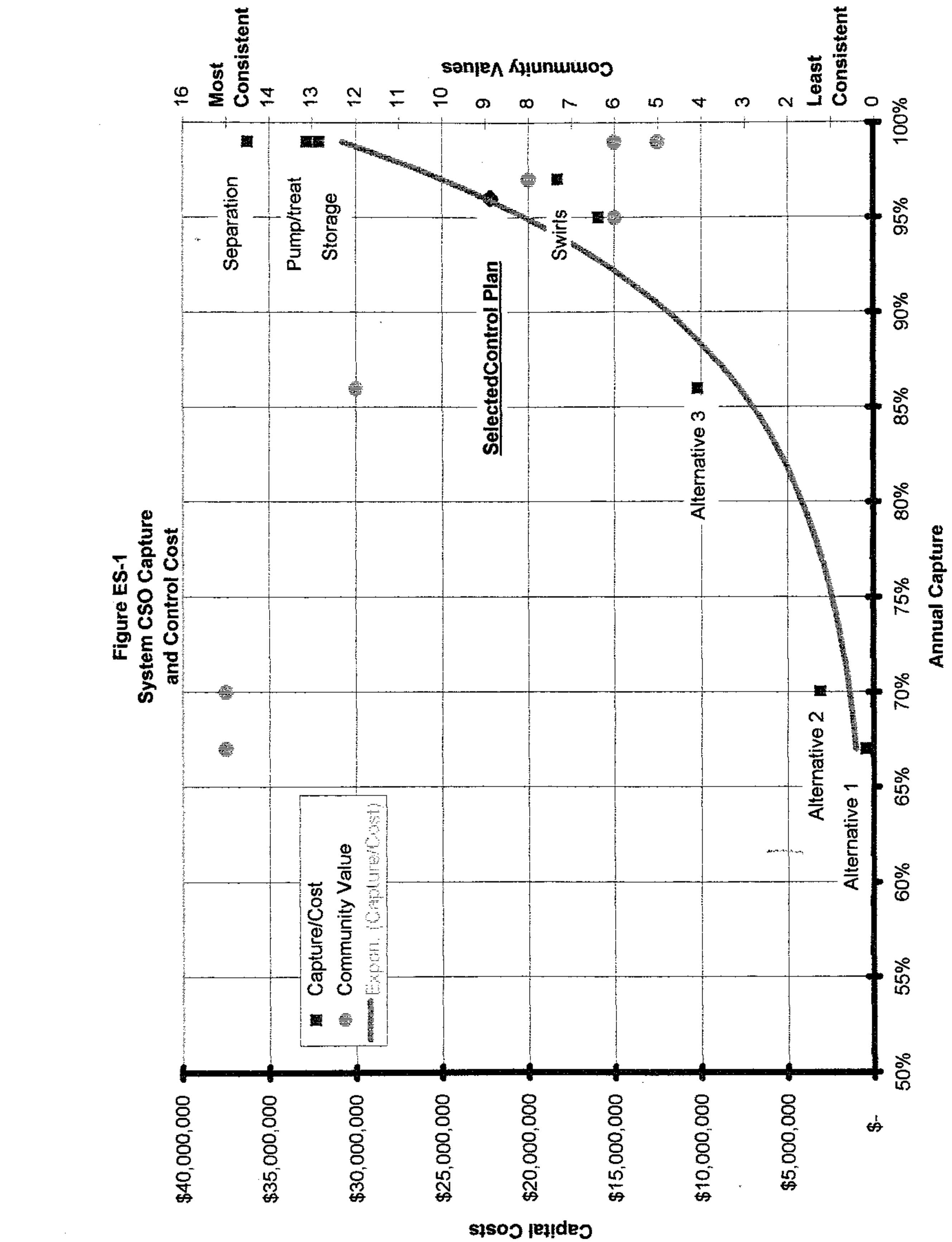
Figure ES-1
System CSO Capture
and Control Cost
Capital Costs
$40,000,000
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
Community Values
16
Most
Consistent
14
13
12
11
10
9
8
7
6
5
4
3
2
Least
Consistent
0
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Annual Capture
Capture/Cost
Community Value
Expon. (Capture/Cost)
Separation
Pump/treat
Storage
Swirls
SelectedControl Plan
Alternative 3
Alternative 2
Alternative 1

flows to an interceptor pipe that carries water to a series of pump stations and an interceptor that delivers the flow to a wastewater treatment plant (WWTP). During wet weather, the diversion structures control the amount of flow entering the interceptor that conveys flow to the WWTP. The excess flow, which is produced mainly by rainfall runoff, is diverted to the Columbia River, Young's River or Young's Bay through a series of combined sewer overflows (CSOs). The majority of the sewered service area is a combined sewer system. However, the downtown business district and some residential areas are served by separate sanitary and storm sewer systems.

During dry weather, the Astoria combined sewer system transports a combination of sanitary flow and groundwater infiltration to the WWTP. During wet weather, stormwater runoff from approximately 1,900 acres out of 2,200 acres of study area enters the system, resulting in overflows of combined sewage at one or more of the 38 CSO locations.

The total overflow volume for the existing CSO system under typical annual rainfall conditions is approximately 378 million gallons (MG). For the typical year, the total inflow carried by the CSO system is about 3,213 MG, 2,833 MG of which are treated at the WWTP. Therefore, the CSO system conveys for treatment about 88 percent of the total annual wet weather and dry weather inflow to the system.

Under the typical year conditions, the number of overflow events and the duration of the events vary with the outfall and the season. The typical number of overflow events is about 25, with a range of number of events from no overflows at some outfalls to 68 events. For all the overflows, the average event duration is about 20 hours. Table ES-1 shows the number of events, volume, and total CSO duration results for each of the outfalls for the typical year. One outfall at 47th Street accounts for 269 MG or 70 percent of the total annual CSO volume. This outfall receives a large contribution of stormwater from an undeveloped and unsewered area.

For analysis and comparison of control alternatives the typical year is split into three parts to represent two winter periods and one summer period. Figure ES-2 shows the distribution of CSO volume and the number of events at each of the CSO locations.

Summary of Control Alternatives

The control plans developed recognize and reflect the community characteristics of Astoria. The values include recognition of the ability to afford the elimination of CSOs and the benefits received for the expenditures. The relative size and nature of the receiving waters to the size of the CSO event volume is an important factor in the City of Astoria's approach to controlling CSOs. The vitality of the economy of Astoria and the population's income are low, which greatly influences the community's ability and willingness to embark on major public works projects unless there is a clear and significant benefit produced. The components of the control plans outlined below incorporate the values of Astoria and the hydrologic and hydraulic factors that produce CSOs from each of the basins.

Alternative 1: Sewer System Enhancement

The review and modeling of the sewer system produced a series of recommendations that would reduce CSO volume and frequency without major construction of new facilities. The projects in the alternative are widespread and effect almost every basin in

Table ES-1
Statistics of CSO Events for Synthetic Year
City of Astoria CSO Facility Plan

Overflow	Number of CSO Events				Total CSO Volume (MG)				Total Event Duration (hr)			
Number	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual
OF02	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF03	11	17	6	34	7.01	1.65	12.99	21.64	2,041	694	1,715	4,450
OF04	13	18	6	37	111.13	35.91	121.68	268.72	2,206	767	516	3,489
OF06	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF07	25	23	20	68	2.78	0.94	2.46	6.18	1,545	545	982	3,072
OF08	7	3	13	23	0.07	0.03	0.16	0.26	23	13	66	102
OF09	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF10	5	1	5	11	0.02	0.01	0.03	0.05	4	1	23	28
OF11	27	10	23	60	1.59	0.66	2.65	4.89	356	86	353	795
OF12	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF13	27	10	23	60	1.11	0.43	1.76	3.30	357	45	365	767
OF15	15	6	19	40	0.42	0.20	0.85	1.47	108	27	163	297
OF17	12	5	16	33	0.17	0.09	0.39	0.65	75	18	104	197
OF18	25	9	21	55	1.09	0.94	7.24	9.28	281	39	309	629
OF19	7	3	12	22	0.08	0.05	0.24	0.38	23	14	68	105
OF20	14	6	18	38	0.31	0.15	0.59	1.05	124	23	147	294
OF21	5	1	5	11	0.02	0.01	0.03	0.06	4	1	23	28
OF22	8	5	15	28	0.11	0.06	0.24	0.41	27	16	86	129
OF23	8	5	15	28	0.10	0.06	0.21	0.37	26	16	85	126
OF24	7	3	13	23	0.07	0.03	0.14	0.24	23	4	64	90
OF25	0	1	3	4	0.00	0.00	0.01	0.01	0	0	2	2
OF26	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF27	4	1	4	9	0.01	0.00	0.02	0.04	3	1	22	26
OF28	5	1	5	11	0.01	0.01	0.03	0.04	3	1	23	27
OF29	1	0	3	4	0.00	0.000	0.00	0.00	0	0	1	1
OF30	24	12	19	55	2.61	0.91	4.35	7.87	670	169	662	1,501
OF31	0	0	1	1	0.00	0.00	0.00	0.00	0	0	0	0
OF32	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF33	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF34	20	8	20	48	0.50	0.23	0.90	1.62	160	32	236	428
OF36	18	7	18	43	4.04	1.94	8.56	14.54	126	31	183	339
OF38	8	5	15	28	0.12	0.07	0.28	0.48	67	20	98	185
OF39	8	5	15	28	0.11	0.06	0.26	0.44	27	16	87	131
OF40	25	10	22	57	1.21	0.53	2.17	3.91	313	40	330	683
OF41	8	5	15	28	0.09	0.05	0.21	0.35	25	15	85	125
OF43	21	14	17	52	5.95	1.88	9.75	17.59	917	209	907	2,033
OF44	8	5	15	28	0.12	0.07	0.27	0.47	60	20	89	168
OF45	27	10	23	60	3.85	1.58	6.27	11.70	362	87	366	814
Total Volume					144.70	48.54	184.75	377.99				

Note: See Table 2-2 for relationship between overflow number, street name and NPDES outfall number

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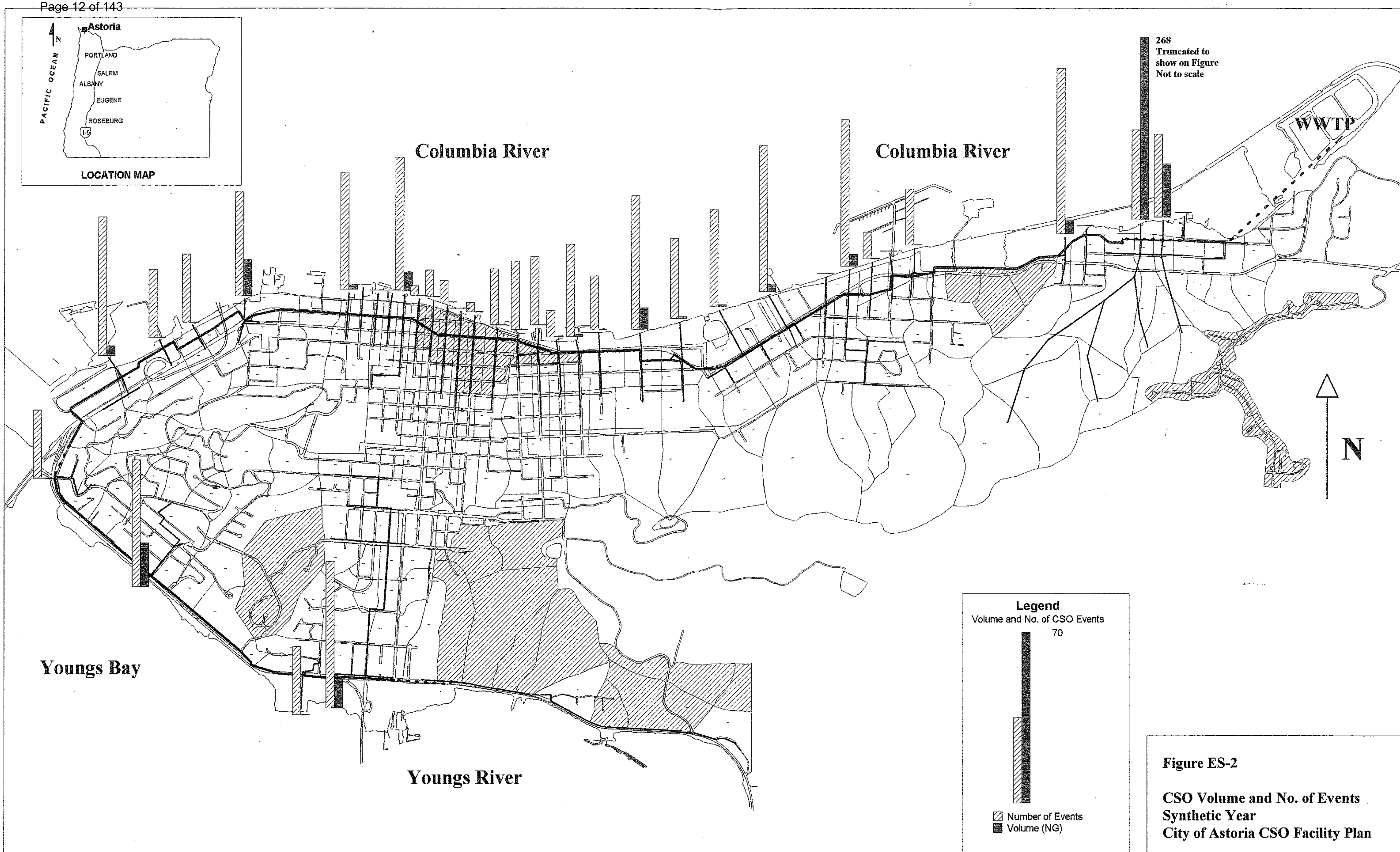


Figure ES-2

CSO Volume and No. of Events
Synthetic Year
City of Astoria CSO Facility Plan

the system. The majority of the projects entails re-construction or modifications to diversion structures and generally consists of raising the weir structures.

Alternative 2: Existing System Optimized

Alternative 2 builds upon Alternative 1 by further refining the existing system with weirs and additions to the sewer system to produce better flow connections and flow hydraulics. Component 1 and 2 of the plan together makes Alternative 2 in the following Figures and discussions. The alternative also includes removal of additional stormwater inflows though construction of additional stormwater pipes in two areas. This additional refinement to the system further reduces the overflow volume.

Alternative 3: Storage Enhancements and Inflow Controls

Alternative 3 uses the optimized system projected with the facilities constructed in Alternative 2 to produce a control plan that begins to meet the requirements of the SFO and the values of Astoria. The primary objective is the control of CSOs to Youngs Bay and the Alderbrook embayment. This is accomplished through construction of additional flow controls at inlets but primarily by adding storage facilities in the vicinity of the diversion structures or major outfalls. Storage facilities consist of rectangular tanks or large diameter conduits. These storage facilities capture overflow and return flows to the interceptor for treatment.

Inflow control consists of widespread installation of vortex valves in catch basins and the slipping of flow to a downstream stormwater collection system. To enhance the capture for first flush pollutants and at the same time maximize the reduction of CSO, it is recommended that the facility plan include a series of pilot tests within selected basins. These pilot tests will show the before and after inlet control conditions, illustrate the level of difficulty in implementing this technology, and provide a basis for controlling flows for other parts of the Astoria CSO system. Final plans will document the full extent of inlet controls, roof drain disconnection and the extent of new storm drain discharges. For the purposes of this evaluation, the inflow controls and flow slipping were assumed to effect no more than 25 percent of the impervious surfaces. Pilot testing and more detailed analysis will probable demonstrate an increase in this effective percentage.

Alternative 4: Storage and Treatment

Capture and treatment consists of construction of facilities at the two major overflows, OF18 (20^{th} Street) and OF36 (Columbia). The facilities are designed to capture and treat the summer and winter SFO storms. The modifications and facilities in Alternatives 1 through 3 would also be part of this alternative. OF18 and OF36 are major overflow locations because of the concentration of flows into the interceptor and the pump station relief provided at these locations. Three sub-alternatives were considered for capture and treatment at the overflows:

a. Construction of pump stations and force mains that would convey the overflow to the existing WWTP

b. Construction of swirl concentrators and disinfection facilities at the overflows.

c. Construction of storage facilities at the outfalls.

Capture and treatment for the SFO storms at all the other remaining overflows would consist of additional storage in the vicinity of the overflow or diversion structures. Component 4 along with Components 1 through 3 of the plan forms Alternative 4. The proposed plan recommends use of storage (option c) for control. However the implementation of the first components, particularly inflow controls, will effect the sizing of the facilities. Advances in technology of swirl concentrators or other control technologies may also result in a shift in final selection of controls at the major outfalls. The overall goal of volume captured and number of events would not be impacted if smaller storage facilities or other control technologies were ultimately selected

Alternative 5: Sewer Separation

The sewer separation alternative would include a completely new drainage system to convey stormwater only and would discharge to the receiving waters. The separation of the basins would require the construction of a new storm drain system rather than a new sanitary system because of the commingling of sewage and stormwater at house connections and the drainage of streets and other areas into the same system. The existing sewer system would carry sanitary flow with some basement and roof drains. Partial separation of some basins and removal of undeveloped area drainage are included in previous alternatives.

Selected Control Plan

The alternatives considered in the facility plan were evaluated for performance in controlling the winter and summer SFO storm events and the rainfall events in the typical year. The subjective values of meeting the community values and characteristics were also assigned for each of the alternatives. The much higher costs for small incremental increases in annual capture rates or controlling CSOs to the SFO storm event level are reflected in the graph shown in Figure ES-1. The technologies in the control alternatives and the relationship shown in Figure ES-1 forms the basis for the alternative selected by the City of Astoria.

The series of control components that form the plan results in a target capture of approximately 96 percent of the typical year annual system-wide CSO. Also, the plan captures most of the CSO events in a typical year by concentrating flows and control projects to a few outfalls. Overall, in a typical year there will be on average 6 CSO events during the winter months at several of the outfalls. At most outfalls the number of events will range from zero to 3 on average in the typical winter. More importantly the frequency of events during the summer will be reduced to about once every three years.

An important feature of the selected alternative is the control to SFO storm level the overflows to Youngs Bay and other more sensitive areas while providing a high annual capture but not SFO level of control at less sensitive areas. The SFO level of control results in CSO overflows on average once every five years during the winter and once every ten years during the summer.

The selected alternative consists of the following major components:

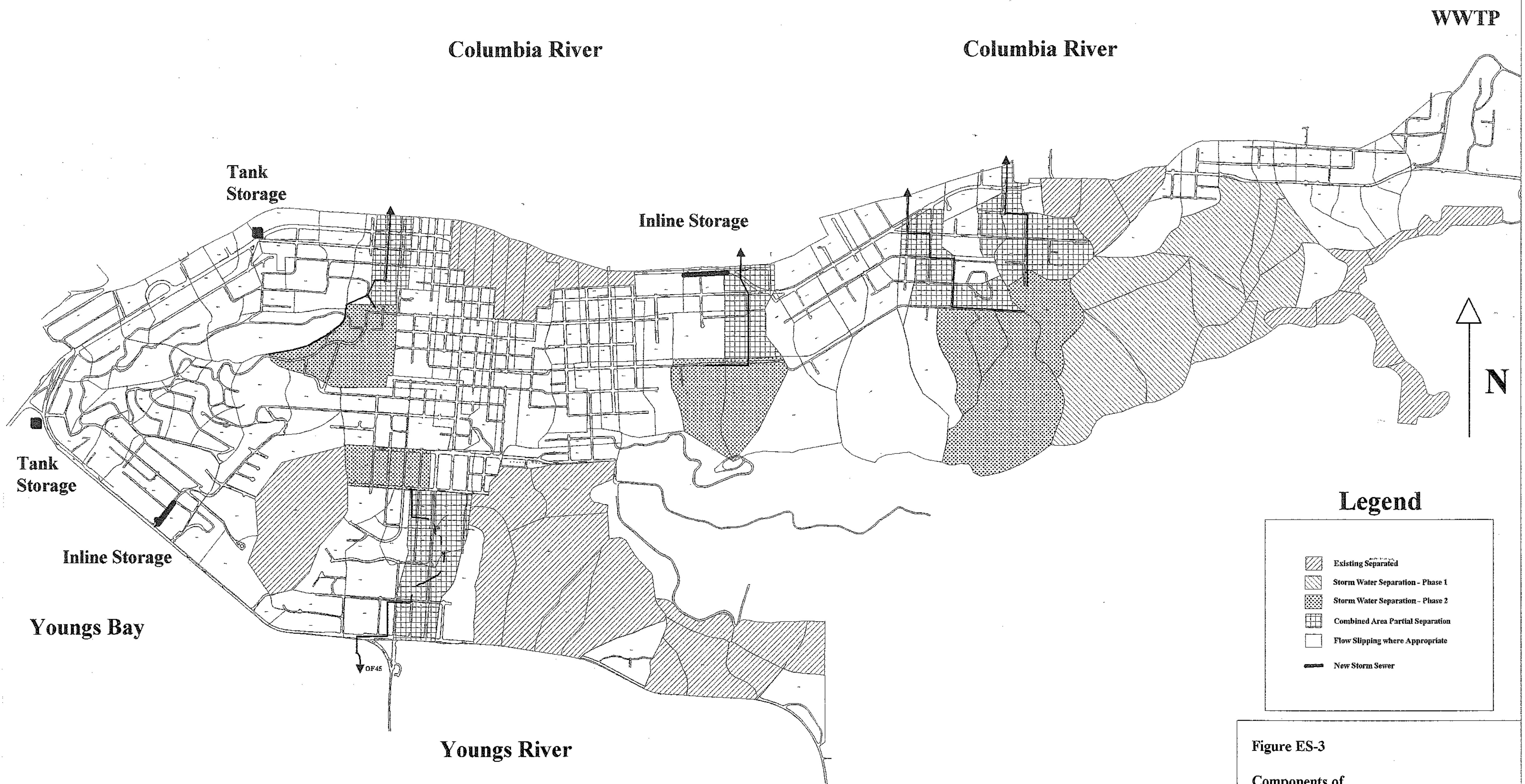


Figure ES-3

Components of
Selected Control Plan
City of Astoria CSO Facility Plan

1. **Stormwater separation.** Conversion of stormwater drainage from undeveloped forested areas into separate stormwater discharges. Figure ES-3 shows the major stormwater separation projects.

2. **Partial street stormwater separation.** In conjunction with the construction of new stormwater separation pipes, connect street drainage to the new stormwater line along the pipe route.

   Flow slipping. Installation of vortex valves or other flow restriction devices at catch basins and inlets throughout appropriate areas of the system. Area-wide installation of devices is anticipated after pilot testing of technology for Astoria conditions. When appropriate, flow slipped on streets may be connected to existing or new storm drainage pipes.

3. **Diversion structure modifications and system optimization.** Increase weir heights and other diversion structure modifications to improve the performance of the diversions and make full use of existing inline storage. For example, most diversion structures could be modified by adding a brick layer on top of the weir.

4. **Inline storage.** Construction of new inline storage facilities consisting of large diameter pipes parallel to existing combined sewer lines or at outfalls parallel to the shoreline and used as a promenade. Inline storage is suggested for OF43 (5th Street) in an existing park and at OF18 (20th Street) with the storage pipe also serving as a waterfront promenade.

5. **Storage tanks.** Construction of rectangular tanks at CSO outfalls, which store CSO for return to the existing interceptor for treatment. Tanks are sized to capture a high number of CSO events at specific outfalls. Storage tanks are suggested for SFO level of control at OF41 (Florence), and as discussed above at OF36 (Columbia).

The locations of the control components are as shown in Figure ES-3. The remaining estimated annual CSO is 17 MG, constituting an annual CSO reduction of about 96 percent. For the typical year of rainfall, it is estimated that 26 of the existing 38 CSO overflows will not discharge. Those that will continue to overflow, will do so during the wet months of the typical year.

Costs of Selected Plan

The costs developed for the selected control plan are planning level costs. They encompass both construction and associated implementation costs. A contingency allowance has also been applied to account for the uncertainties at this planning level. The total cost of the selected plan is approximately $22,200,000.

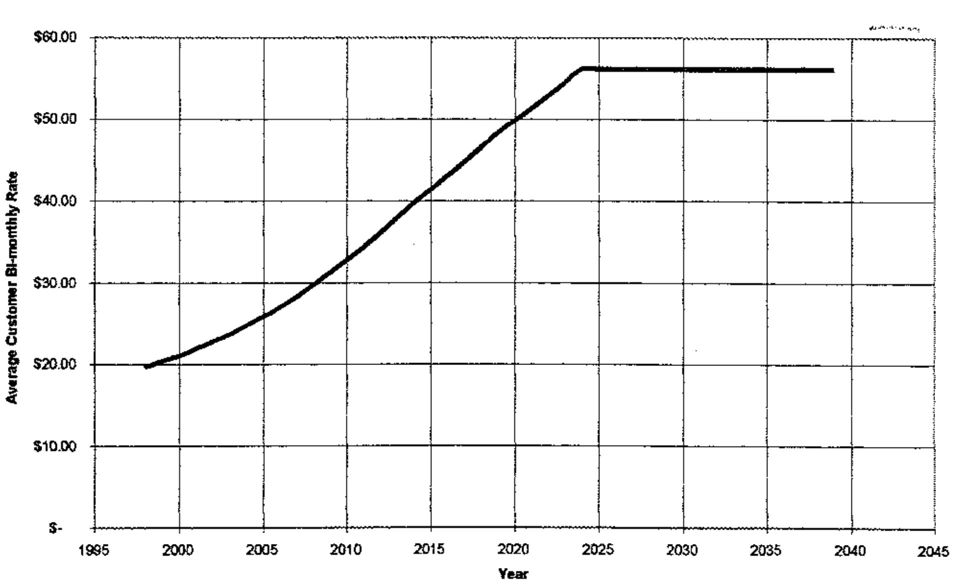
It is the intent of the City of Astoria to seek State grants and other sources of funds to assist in the construction of these facilities. Generally, however, the bulk of the funds will come from the proceeds of bonds that are paid for by sewer rates.

Financial Plan

The phasing of projects in the Draft Facility Plan resulted in erratic and large increases in sewer rates during the early years of the project. To stabilize rate increases and reduce the 'sticker shock' of the program rate increases and to make the implementation of the plan more feasible the phasing of project components have been revised from that in the Draft Plan. The major change was accelerating roof-drain disconnection and other inflow reduction programs to Phase 1 and shifting the large capital project for CSO43 to Phase 3. The inflow reduction projects will have an immediate benefit upon CSO volumes and number of events throughout the system. CSO43 would only effect a portion of Youngs Bay that is little used and has difficult access.

Re-arranging plan components have a significant effect upon the timing and magnitude of rate increases, particularly in early years of the plan implementation. Figure ES-4 shows the rates and increases for the Final Plan with proposed project phasing. Ultimately the bi-monthly sewer rates will increase for the average customer from about $19.60 to $55.00 or about 5 percent per year for the next twenty years or 280 percent increase over the life of the plan implementation.

Figure ES-4:
Average Customer Bi-monthly Rate



Public Involvement

The public input process initiated for Astoria is primarily directed at providing the public opportunity to comment on the plans presented herein. The public involvement process will consist of informational meetings, City Council presentations, and mailings to sewer customers. City staff, DEQ and consultants in September 1998 conducted a workshop for the Astoria City Council. Several detailed newspaper articles have been produced on the CSO plan. It is expected that the public will continue to be informed, and will provide input to the plan approval process and negotiations with DEQ whenever the SFO and NPDES permit are presented for public notice. The City of Astoria plans to educate the citizens about the CSO situation in a number of ways. Some of these are detailed below:

- **Public Meetings** - CSO occurrence and plans for reducing them have been and will continue to be discussed at City Council meetings that are advertised and are open to the public. Open house meetings will be held to allow more detailed discussion and more opportunity for review of maps and plans and for questions and input
- **Environmental Education at Schools** - A number of environmental programs are already in place in the Astoria School District. These involve studies of the local streams, Youngs Bay and the Columbia River. We plan to work with school teachers, the Marine Environmental Research and Training Station (part of Clatsop Community College) and the Columbia River Estuary Study Taskforce to educate students about the existing overflow problem and plans to correct it as well as involve them in monitoring flows and water quality
- **CSO Brochure** - A brochure is currently being developed for public distribution. It is being modeled on existing brochures distributed by Portland and Corvallis
- **Signs** - Signs will be produced for placement at significant overflow locations. Again these will be modeled after those produced by Corvallis and Portland
- **CSO Event Notification** – Integration with the prediction and pollutant transport capabilities of the "Pilot Now-cast Forecast System" for the Columbia River Estuary will be investigated.
- **River Tours** - Groups such as H2O, Headwaters to Ocean, have proposed tours of the river that concentrate on environmental issues. We will provide information on CSOs and if when possible a City representative on the tour.

Implementation of Selected Plan

The proposed implementation plan removes 86 percent of the total annual overflow within the first two phases of the program with a substantial decrease in the number of events. The first two phases are completed by December 1, 2007, or just 10 years from submission of this Facility Plan. The proposed implementation schedule is given in Figure ES-5. This schedule depends upon acceptance of the plan, especially the construction start date of July 1, 2001, for Phase 1.

Flexibility of Plan

The plan consists of components that build on one another to create the overall control plan. Each component has features that control CSO at specific outfalls and can effect the performance of the collection system and CSOs at other outfalls. Therefore depending upon the effectiveness of each of the plan components it may be possible to reduce or scale back the sizes of latter components. This is particularly true for the cumulative effects of inflow reductions on proposed storage facilities. It is planed that reviews of effectiveness of the components will be conducted throughout the phased implementation of the plan. Future plans will therefore be adjusted based upon the performance of each phase of the plan. Adjustments would however not reduce the targeted levels of controls at the CSO outfalls.

Figure ES-5

Phased Implementation of CSO Controls

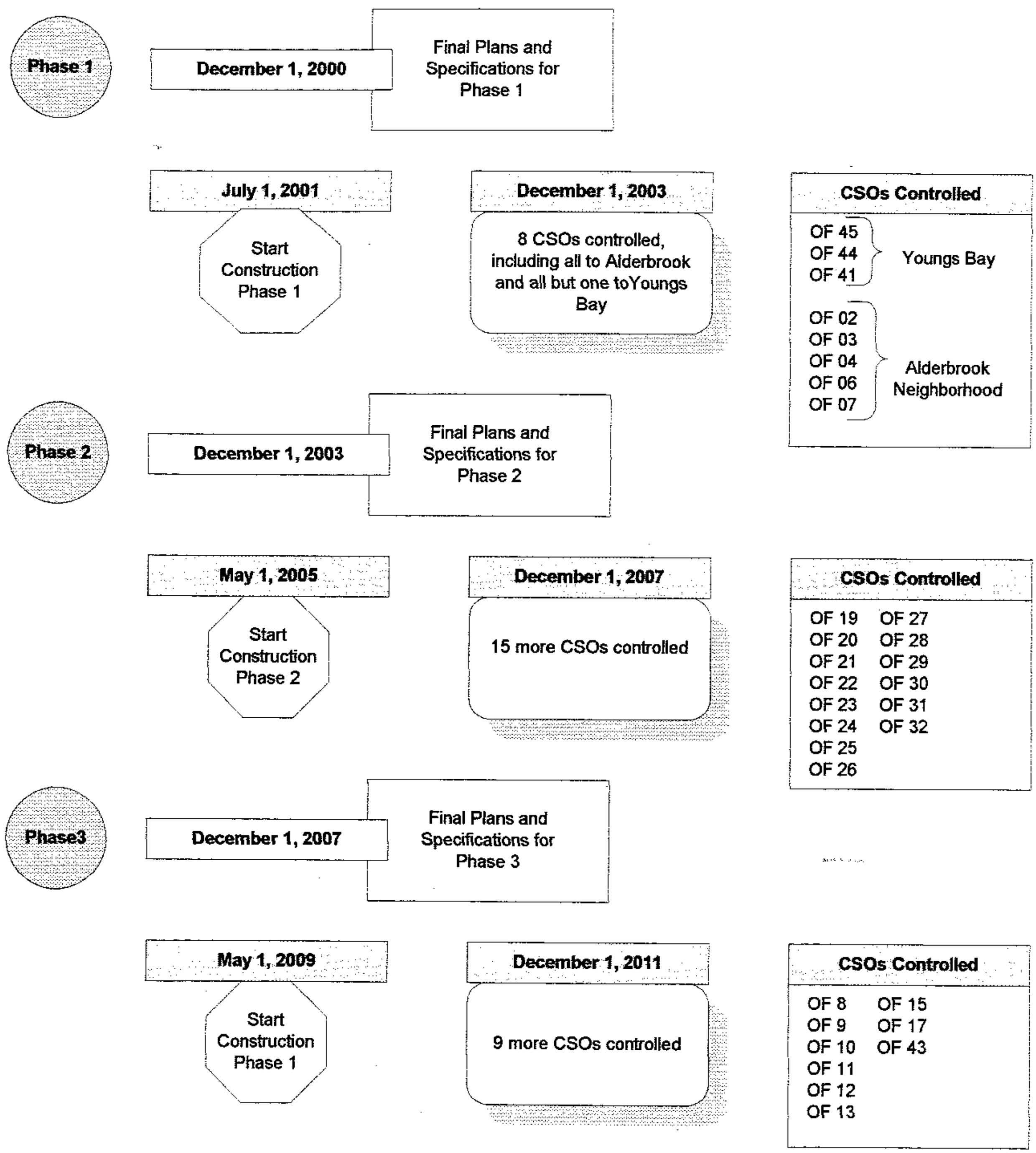
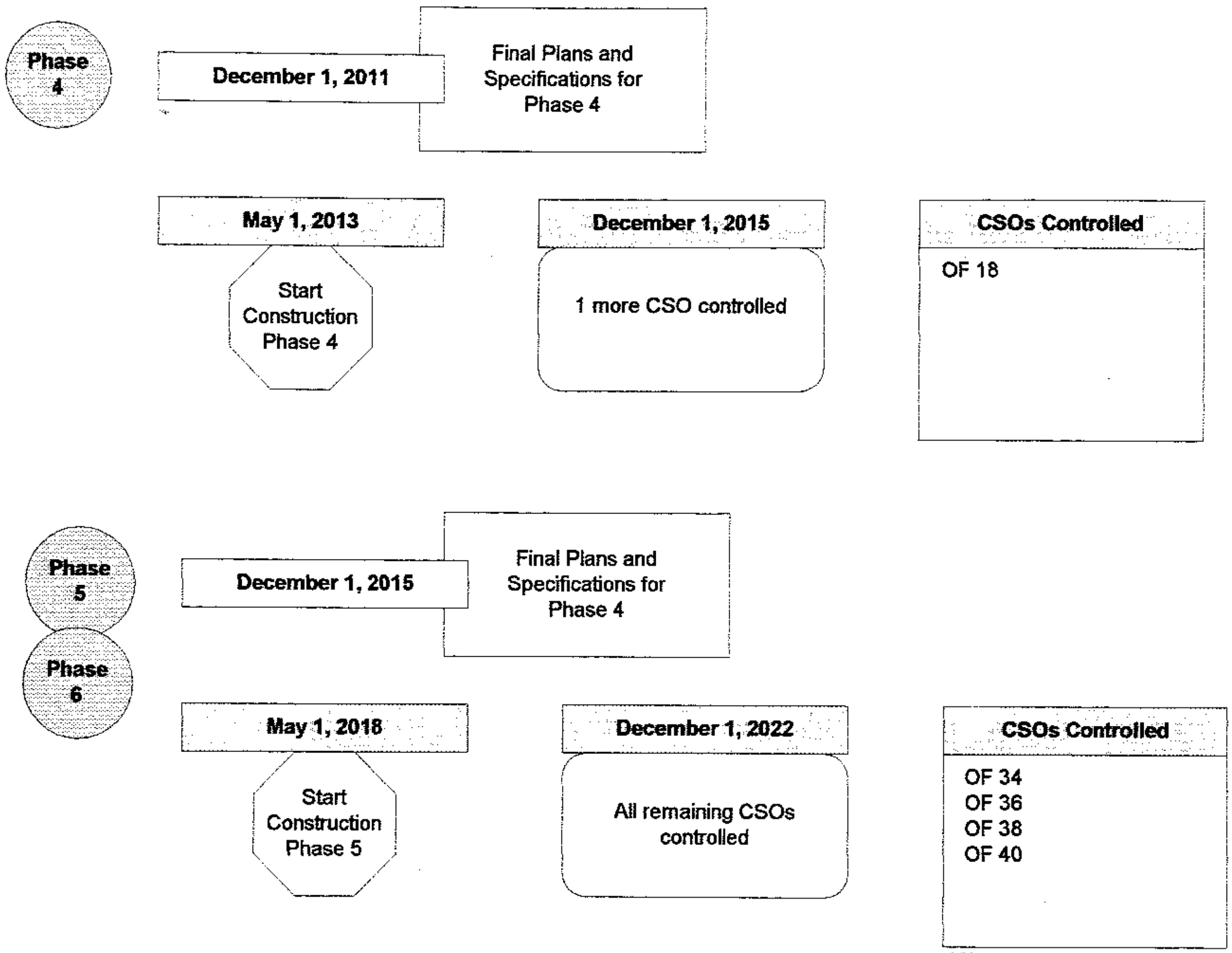


Figure ES-5 (continued)

Phased Implementation of CSO Controls



SECTION 1

Introduction

Combined Sewer Overflows

The City of Astoria has a sewage collection system that combines sanitary sewer flows and stormwater inflow and infiltration. The sewerage system consists of house laterals, sewer trunk lines, and catch basins that make up the collection system. The collection system conveys combined sewage to diversion structures that divert dry weather flow to an interceptor system that carries water to a series of lift and pump stations and delivers the flow to a wastewater treatment plant (WWTP) located east of the City of Astoria. During wet weather, the diversion structures control the amount of flow entering the interceptor that conveys flow to the WWTP. Flow in excess of the diversion structure capacity is diverted to the Columbia River, Youngs River, or Youngs Bay through a series of combined sewer overflow (CSO) outfalls. There are 38 CSO outfalls in the Astoria system. Figure 1-1 shows the combined sewered area and the location of the CSO outfalls.

The majority of the sewered area of Astoria is served by the combined sewer system. However, there are pockets of separated systems, the most notable being the central business district. Also, the sewered area contains large tracts of undeveloped areas that produce only stormwater flow. This stormwater is discharged to the combined sewer system. These undeveloped areas are upstream of developed areas and contribute substantial flows during wet weather months. The total service area is approximately 2,200 acres, of which 1,880 acres are combined and 320 acres are separated. Figure 1-1 also shows the existing combined sewer and separated sewer areas.

CSOs may degrade the quality of the surrounding water bodies: Columbia River and Youngs Bay. The sanitary sewage component, combined with the stormwater runoff, contributes pathogens, bacteria, sanitary sewage "floatables," and elevates nutrient levels (phosphorus and nitrogen) and other pollutants that contaminate and effect the use of the receiving waters. The recreational (human contact) uses of the receiving waters are limited, however, because of high tidal and streamflow currents, cool water temperatures, and extensive ship traffic.

Purpose of CSO Facility Plan

The purpose of the Astoria CSO Facility Plan is to evaluate alternatives that reduce the impact of CSOs on the use of the receiving waters and to develop an implementation plan for the control or elimination of CSOs for specific storm conditions. This Draft Final Facility Plan is a product required by a Stipulation and Final Order (SFO) agreed to by the City of Astoria and the Oregon Department of Environmental Quality (DEQ). The Draft Final Facility Plan is a product of the review process of a Draft Facility Plan submitted to DEQ in November 1997. Based on comments and additional analysis by the City and consultant the final selected plan is proposed and detailed herein. The Draft Final Plan may be modified based on comments from City of Astoria Council and the DEQ who are concurrently reviewing this plan. The Draft Final Plan incorporates features introduced in the Draft Facility Plan and reflects additional and negotiated control measures. Comments received by DEQ and response to these comments are included in the Final Draft Plan. Appendix A contains DEQ's comments. Appendix B contains details and additional analysis in response to comments received.

Stipulation and Final Order

In January 1993, the DEQ and the City of Astoria signed a negotiated SFO that sets out a schedule and certain requirements for the control of CSOs to the Columbia River and Youngs Bay. Coordination with DEQ has occurred during the preparation of the scope of work to conduct studies to characterize the system, collection of monitoring data, and evaluation of the alternatives to provide the level of control that will be implemented.

The SFO stipulates that CSOs should be controlled between November 1 and April 30 for a storm event with a 5-year return frequency and controlled between May 1 and October 31 for a storm event with a 10-year return frequency. These are considered the winter and summer events, respectively. The storm events have been defined based on an analysis of long-term rainfall records collected by the National Weather Service at Astoria airport. The winter storm is expected to be a storm that would occur, on average, once every 5 years. Similarly, the summer storm is expected to occur, on average, once every 10 years.

The SFO provides a time frame for developing the facility plan and for implementing the CSO controls. The plan follows a phased implementation of CSO controls and consists of controlling eight CSOs in each phase. The system should be completely controlled by 2022. The first phase of controls target CSOs into Youngs Bay and has a target completion date of December 1, 2003. Figure 1-2 shows the schedule for conducting the facility studies and implementation of controls.

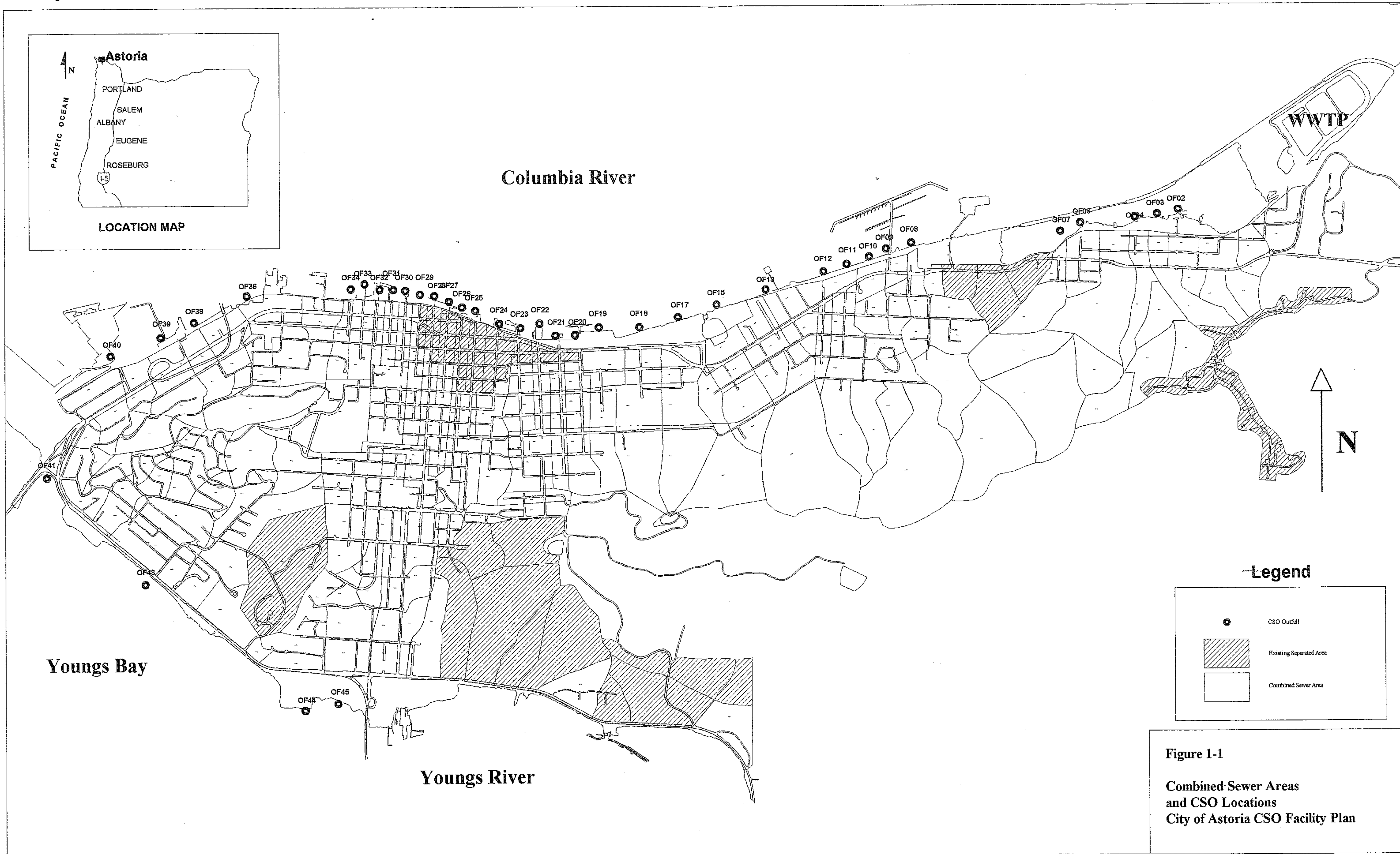


Figure 1-1

Combined Sewer Areas and CSO Locations City of Astoria CSO Facility Plan

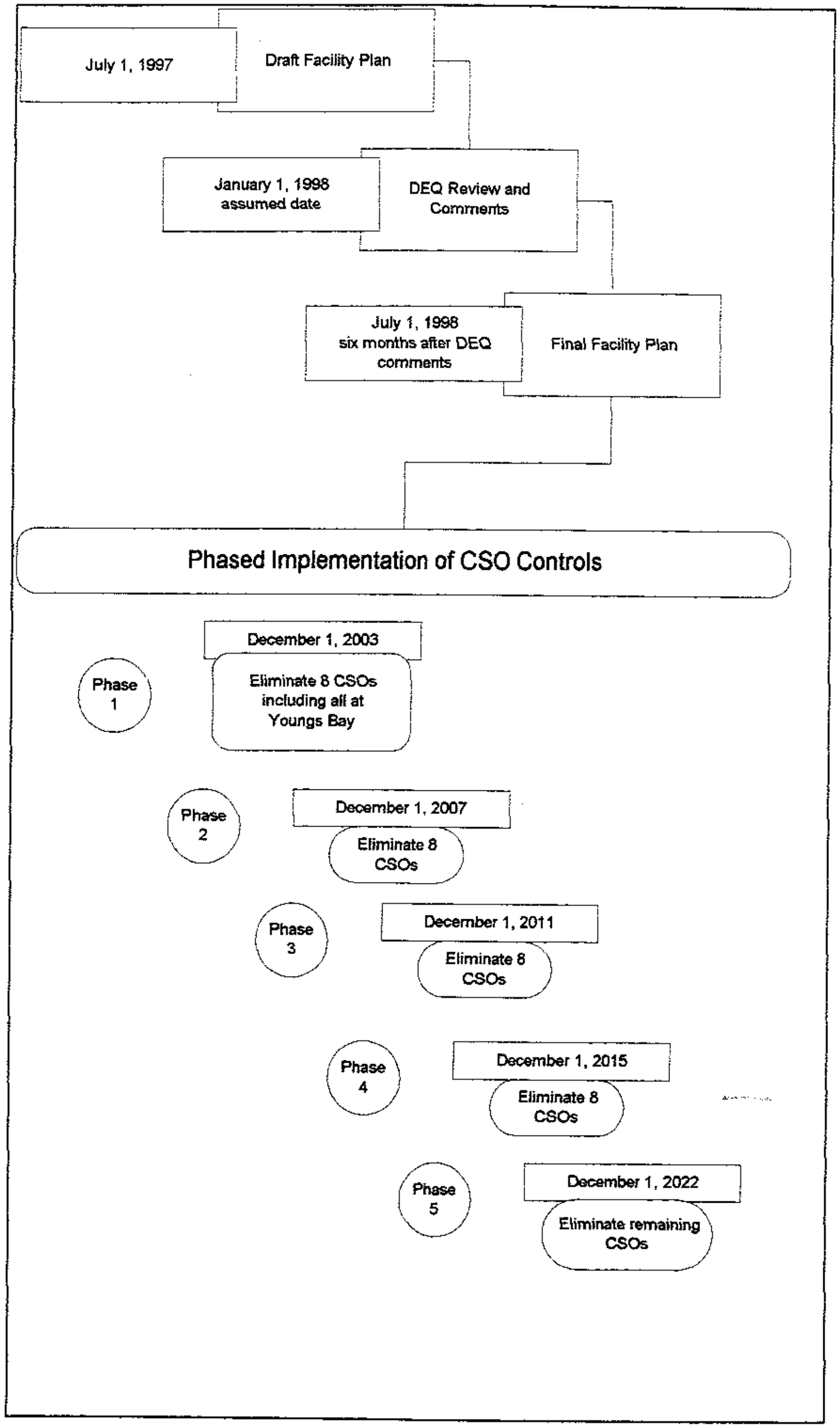


Figure 1-2
Astoria CSO Control Schedule

SECTION 2

Service Area Characteristics

Background

Development of the Astoria sewer system began in the late 1800s when the first public works facilities were built to serve a rapidly growing community. These first portions, which are in the downtown area, are still in service today. The interceptor system and wastewater treatment plant were built in 1973 to collect and treat combined sewage. Up until the completion of the interceptor, all sewage and stormwater were collected through a system of gravity flow sewers. This system eventually drained to the Youngs Bay estuary and the Columbia River. The interceptor, WWTP, pump stations and major gravity sewers are shown in Figure 2-1.

Study Area Boundaries and Topography

The City of Astoria is located near the mouth of the Columbia River on a rock peninsula. The study area encompasses the combined sewer service area within the limits of the City (Figure 1-1). The City provides sewer and storm drainage services to areas within the City limits and to additional areas outside the City limits.

The peninsula location of the City of Astoria results in steep streets and long narrow basins that are generally perpendicular to the surrounding water bodies. Elevations within the basins range from sea level to over 500 feet in the space of 1 to 2 miles. The peninsula is approximately 7.4 miles long and on average about 1.3 miles wide. The steep streets of the City generally end at a flat section of the peninsula near the water's edge. The typical drainage pattern is indicated in Figure 2-1.

The flatter area of the peninsula contains the major roads, the densest development, and forms the major service and industry corridor, including the interceptor and pump stations.

Drainage Basins

Drainage basins are generally defined by the steep topography of the peninsula and the sewer system. Figure 2-2 shows the basins defined for characterization of the combined sewer overflows (CSOs). The shaded areas highlight the separated areas and undeveloped forested areas. The total sewered area is about 2,200 acres; about 1,880 acres of the area are served by the combined sewer system. The basins were selected from review of sewer maps, aerial city topography, and U.S. Geological Survey (USGS) topographical maps. The average basin has an area of about 11 acres. The overall imperviousness of the study area is 16 percent, which is indicative of a residential community such as Astoria with large underdeveloped areas.

Soils

Soils in Astoria are derived primarily from the Astoria formation, a claystone that is frequently located at a depth of 20 feet below the ground surface. It provides an impervious surface that directs rainfall infiltration downslope. The clay soils derived from the Astoria formation have a fairly low permeability. Also present in the Astoria area are outcrops of sandstone and fractured basalt. Many of the flatter areas along the waterfront were created by pumping sand from river dredging behind dikes.

Climate

The climate of Astoria is dominated by the proximity of the Pacific Ocean. The Pacific moderates temperatures and provides a large source of moisture resulting in the damp, temperate climate. Temperatures are moderate with average monthly temperatures ranging from 41.9°F in January to 60.6°F in July. Freezing temperatures are infrequent.

Frontal systems rolling off the Pacific provide the moisture that produces an average annual rainfall of 67 inches in the City of Astoria in a typical year. Approximately 74 percent of the annual average rainfall occurs during November through April. This average is based on analysis of precipitation records collected by the National Weather Service, National Oceanic and Atmospheric Administration (NWS), from 1953 to 1994 at the Astoria Airport. Figure 2-3 shows the typical ranges of monthly precipitation. Technical Memorandum 3.2, dated April 12, 1994, provides additional details of the rainfall analysis.

Water Quality

The water bodies surrounding Astoria are large. This includes the confluence of the Columbia River and Youngs Bay. The Columbia River at Astoria has an estimated average annual discharge of 170,000 million gallons per day (mgd), or about 500 times the estimated annual CSO volume discharged from Astoria. In the summer, the average Columbia River flow is about 65,000 mgd; in the winter the flow is 300,000 mgd (*The Health of the River 1990-1996—Integrated Technical Report*, Tetra Tech, May 1996). The Columbia River is approximately 4 miles wide and 20 to 30 feet deep near Astoria; the shipping channel is up to 40 feet deep. Water quality is therefore dominated by the quality of the Columbia River and the sources of pollution upstream that include agricultural runoff, industrial discharges, and point source discharges from municipal and industrial WWTPs.

The quality of the local area waters is affected by the tidal influences and currents generated from the changing tides, and the high flows and velocities of the Columbia River. The tidal height ranges from about -1.7 to 10.2 feet, and tidal current velocities range from zero at ebb tide to over 3 to 4 feet per second at flood tide. Local area waters include Youngs River, Youngs Bay, and several embayments created by a railway embankment on the northern side of the peninsula. Local impacts from CSO discharges are primarily related to elevated bacteria levels at the outfalls. Rapid mixing caused by the tidal and river currents, quickly disburses CSO discharges. No impairment of uses has been documented or observed to be caused by CSO discharges from Astoria.

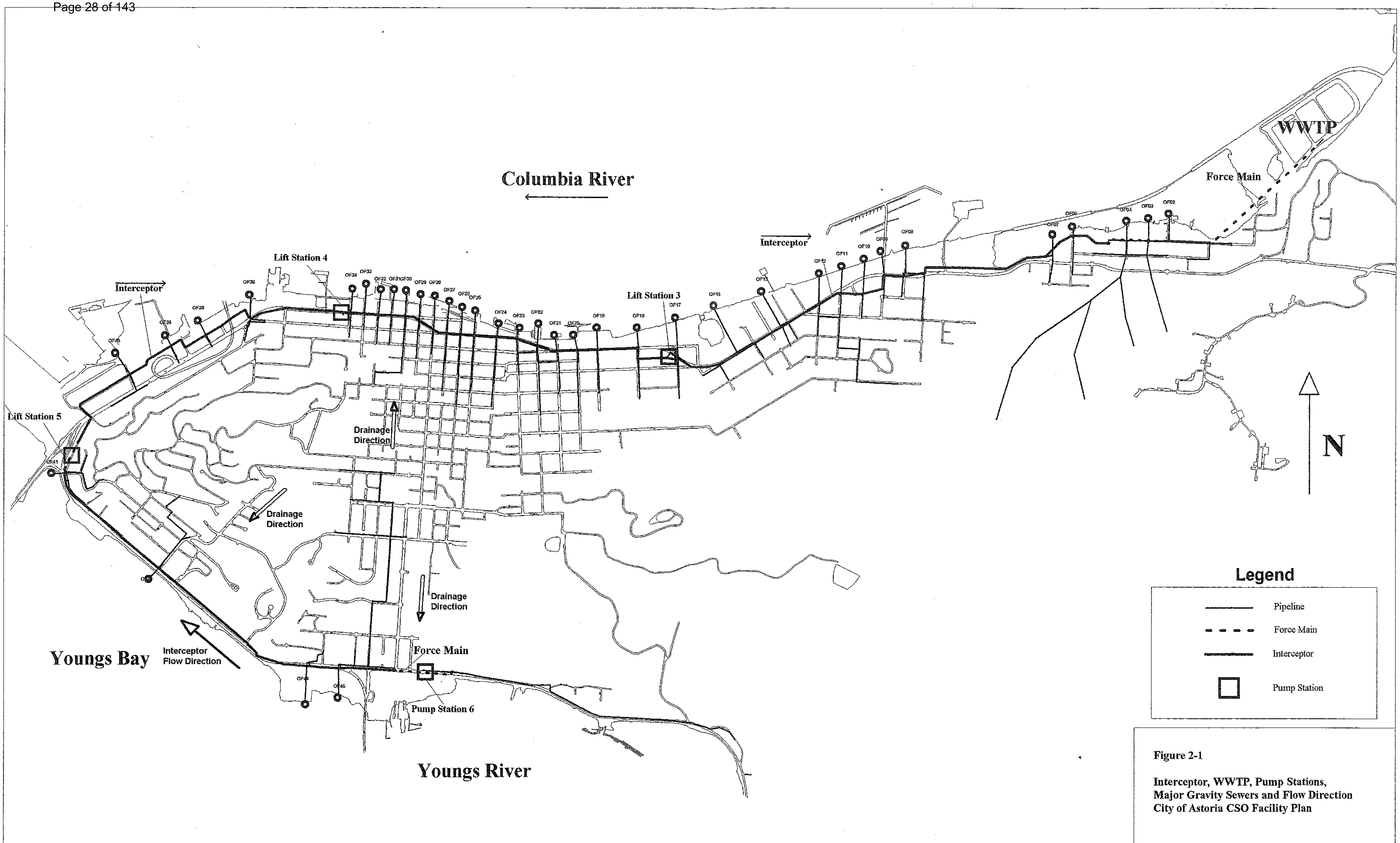


Figure 2-1

Interceptor, WWTP, Pump Stations, Major Gravity Sewers and Flow Direction City of Astoria CSO Facility Plan

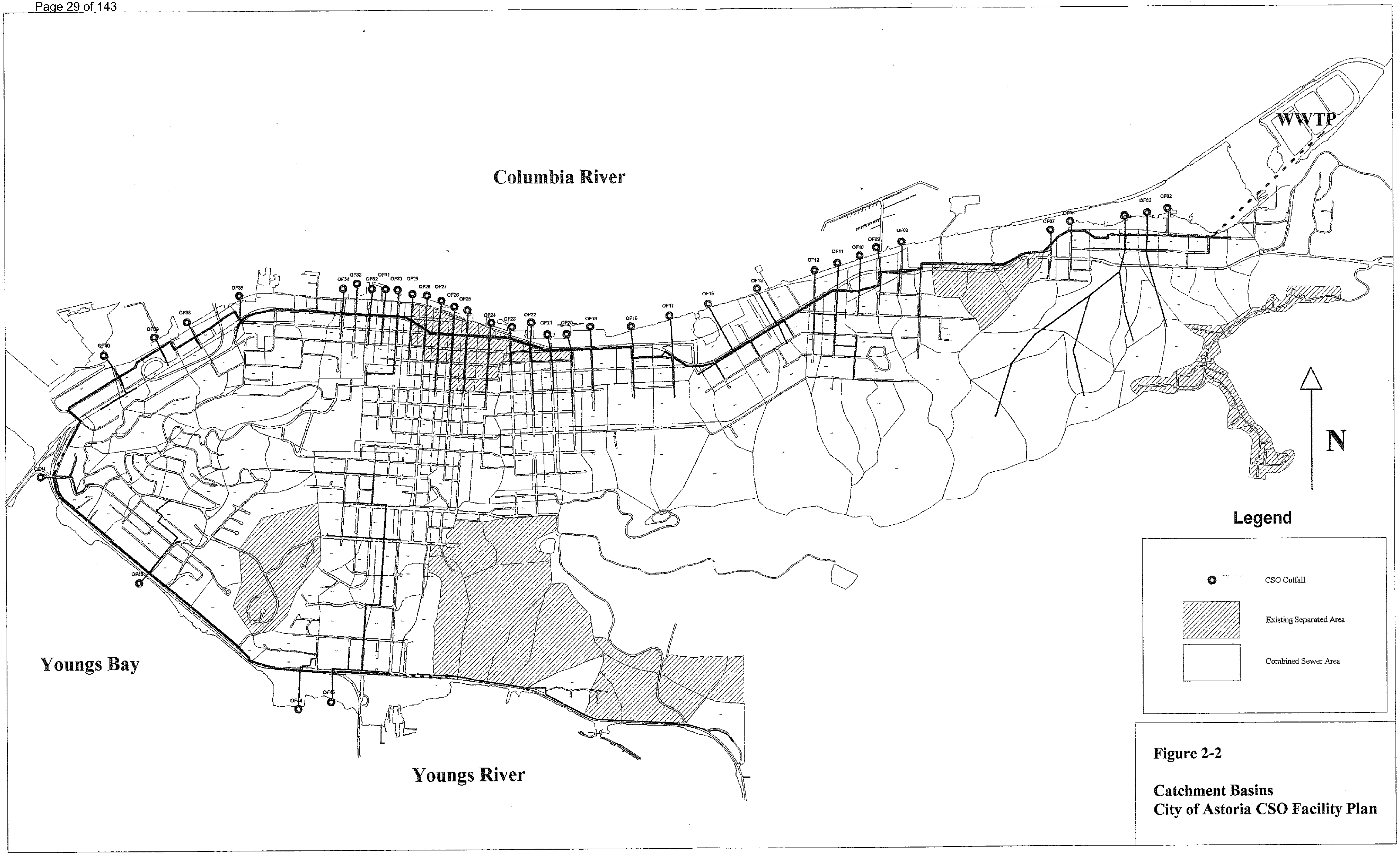
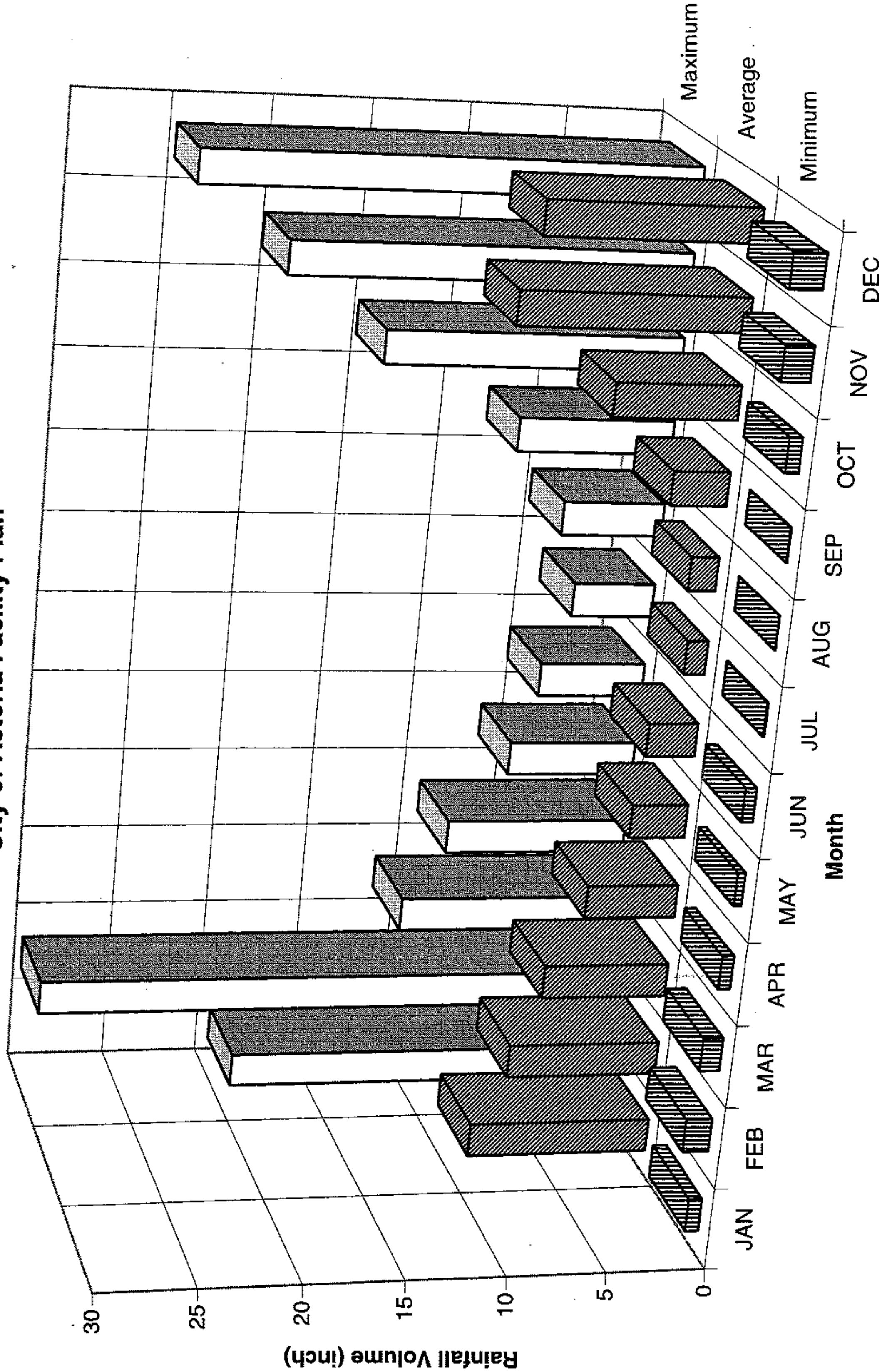


Figure 2-2

Catchment Basins
City of Astoria CSO Facility Plan

Figure 2-3
Rainfall Statistics (1953 - 1994)
City of Astoria Facility Plan



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Land Uses and Population

Residential development is the primary developed land use in Astoria. Industry is limited and consists mainly of fishing and shipping related activities. There are large areas of undeveloped and forested lands within the City boundary. Commercial development is along the waterfront and in the downtown area. Industry is related to fishing with canning facilities located also on the waterfront. Shipping and docking facilities are not extensive, although the shipping lanes just offshore have a significant effect upon river uses. The Coast Guard has a major facility in Astoria.

The population of Astoria saw its major growth over 70 years ago. The projected growth rate is close to 1 percent with a build-out population of approximately 15,000 (compared with a current population of 10,000). Sanitary sewer flows are dominated by stormwater flows in the combined sewer system. For the purposes of this facility plan, the future sanitary sewer flow peak has been assumed at 5 mgd, representing an average daily flow of about 100 gallons per capita per day (*Water Supply Study*, CH2M HILL, November 1996). The flow peak includes the contribution from dry weather inflow and infiltration (assumed at 150 gallons per capita per day) and a 2 to 1 peaking factor for the diurnal change in sanitary flow.

Collection System

Dry weather flow, and portions of wet weather flows, are diverted by means of elaborate diversion manholes designed to intercept sewage lines above elevation 13.0 feet. This elevation was selected to mitigate against high tide effects. The interceptor sewer is constructed below all existing sewers and is connected to the existing outfall sewers. Combined sewage flows by gravity into the interceptor system. The diversion structures consist of a low flow orifice and a weir. The low flow orifice is off-center to the pipe entering the structure. This creates a vortex, or swirl, that improves the hydraulic performance and capture of dry weather flows. During wet weather, the capacity of the orifice is exceeded and the water level rises, eventually reaching the top of the weir; then it overflows to the CSO. The orifices were constructed with orifice plates to restrict flows going to the interceptor. These plates have been removed, and flows to the interceptor and WWTP are being maximized.

The topography of Astoria prevented the construction of an interceptor pipe to the WWTP that was completely gravity flow. At required locations, low head lift and pump stations have been installed to lift combined sewage to the next segment of the gravity interceptor. The lift and pump station capacities are given in Table 2-1 with Pump Station 6 located at the uppermost end of the interceptor. Pump Station 2 does not exist. The interceptor is circular and mostly 36 inches in diameter, but it changes to 42 inches in diameter at Lift Station 3. The elevation of the interceptor varies from 10 feet as it exits the pump or lift station down to 1 foot as it enters the pump or lift station.

TABLE 2-1
Astoria Pump Station Capacities

Station	Number of Pumps	Capacity (gpm)	Total Station Capacity (mgd)
Pump Station 6	2	220	0.3
Lift Station 5	2	3,600	5.2
Lift Station 4	2	4,800	6.9
Lift Station 3	1	8,100	11.7
Pump Station 1	2	8,200	11.8
	1	7,500	10.8

gpm = gallons per minute
mgd = million gallons per day

The downtown area accepts sewage from the old lines that formally discharged into the river. In this area, separate storm sewers were constructed in 1973. Street runoff is collected by catch basins and conveyed directly into the Columbia River through storm sewers.

Pump Station 1 delivers combined sewage to the WWTP. It is the last facility in the interceptor system. Three pumps are installed in Pump Station 1. Two variable speed centrifugal pumps with a design capacity of 8,200 gpm (11.8 mgd) move the raw sewage to the treatment plant via a 30-inch-diameter force main. Each pump is capable of pumping normal daily peak dry weather flow. The third pump has a 7,500-gpm (10.8-mgd) capacity and is only used during high flows. Pump Station 1 has a total design capacity of 15,700 gpm (22.6 mgd). The pumps move the sewage from elevation 1.00 foot at the wet well to approximately 20.00 feet at the WWTP. Flows to the WWTP treatment lagoons are controlled by a series of gates.

Wastewater Treatment Plant

The wastewater treatment plant consists of three lagoons. The lagoons treat the raw combined sewage through the action of oxygen (supplied through mechanical aeration of the lagoons) and by algae. The first and second lagoons are aerated; the third performs polishing. These are followed by the disinfection facilities. Each of the two aerated lagoons has a surface area of approximately 7.2 acres with a volume of 21.9 million gallons. The polishing pond has a surface area of approximately 9.8 acres with a volume of 48 million gallons. The total surface area of the three lagoons is about 24 acres.

The mechanical aerators provide oxygen for the sewage, making a healthy environment for bacteria to digest the sewage and decompose the heavier particles. A chlorine contact chamber disinfects the effluent before it is discharged into the Columbia River. The outfall lies approximately 800 feet north of the Burlington-Northern Railroad to the south side of the shipping channel. The outfall is planned to be modified to meet chlorine residual requirements.

The existing treatment plant capacity is approximately 22 mgd. Based on WWTP reports from August 1992 to September 1994, dry season influent flows have averaged 2.4 mgd. During the wet season, flows to the treatment plant have averaged 6.2 mgd, with sustained peak flows of 22 mgd.

Outfalls

The combined sewer system discharges through 38 outfalls to the Columbia River and Youngs Bay. Figure 1-1 shows the outfalls to those receiving waters. The naming convention for the outfalls has varied, depending upon the study requirements and ease of use. For this study, the outfalls were given identification numbers with the prefix "OF." This convention facilitated modeling and data reduction; and matched the convention used in the interceptor construction drawings. The designations used in this study are cross referenced in Table 2-2 with the corresponding street locations and NPDES identification numbers that have been used elsewhere to identify the same outfalls.

TABLE 2-2
Outfall Naming Convention

CSO Plan	City Street Name	NPDES Outfall
OF45	3rd & E of Hanover	001
OF44	Hanover	002
OF43	Denver	003
OF41	Florence	004
OF40	Portway	005
OF39	Kingston	006
OF38	Melbourne	007
OF36	Columbia	008
OF34	2nd Street	009
OF33	3rd Street	010
OF32	4th Street	011
OF31	5th Street	012
OF30	6th Street	013
OF29	7th Street	014
OF28	8th Street	015
OF27	9th Street	016
OF26	10th Street	017
OF25	11th Street	018
OF24	12th Street	019
OF23	14th Street	020
OF22	15th Street	021
OF21	16th Street	022
OF20	17th Street	023

TABLE 2-2
Outfall Naming Convention

CSO Plan	City Street Name	NPDES Outfall
OF19	19th Street	024
OF18	20th Street	025
OF17	22nd Street	026
OF15	28th Street	027
OF13	30th Street	028
OF12	33rd Street	029
OF11	34th Street	030
OF10	35th Street	031
OF09	37th Street	032
OF08	44th Street	033
OF07	45th Street	034
OF06	47th Street	035
OF04	48th Street	036
OF03	49th Street	037
OF02	52nd Street	038

SECTION 3

Flow Monitoring and Rainfall Analysis

Flow Monitoring

In April 1994, the recommended monitoring program was initiated (see Technical Memorandum No. 3.1). The purpose of the monitoring program was to collect data to assist in the calibration and verification of hydraulic models. The models serve to characterize the system; determine combined sewer overflow (CSO) volumes, frequencies, and durations; and identify their effects on the City's collection system.

The monitoring program was designed to collect three types of data: flow monitoring, rainfall, and water quality. Portable flow monitors were recommended to be installed in the collection system at representative locations. In 1994, four locations were monitored; see Table 3-1. Flow is also recorded on a regular basis at the wastewater treatment plant. Flow records from Lift Station 4 reflect the cumulative flow from the upper half of the collection system, while flow from the wastewater treatment plant reflects cumulative flow from the entire collection system. Flow records from the remaining monitoring locations reflect individual drainage basin flows. In 1995 and 1996, the portable flow monitors were relocated to other representative areas and for specific refinement of the system characterization. The monitoring locations, and the years they were operating, are summarized in Table 3-1.

TABLE 3-1
Monitoring Locations and Monitoring Years

Year of Operation	Flow Monitoring Location	Recording Interval
1994	5th Street and McClure Street	5-minute
	Denver Street and alley south of Erie Street	5-minute
	Lift Station 4	5-minute
	34th Street and Franklin Street	5-minute
1995	Denver Street and alley south of Erie Street	5-minute
	Outfall at Denver Street and Erie Street	5-minute
	38th Street and Franklin Street	15-minute
1996	3rd Street and east of Hanover Street	5-minute
	Outfall at 3rd Street and east of Hanover Street	15-minute
	Cedar Street and 47th Street	5-minute

Rainfall gages have been installed at the City Shops (30th Street near the Columbia River), Astoria High School on the south side of the peninsula, and Reservoir No. 3, which is centrally located near the top of the ridge. The physical locations of flow monitors and rainfall gages are shown on Figure 3-1.

The number of available non-zero flow monitoring data records for 1994, 1995, and 1996 are summarized in Figures 3-2 and 3-3. An example plot of flow hydrograph versus rainfall is shown on Figure 3-4. Monitoring data are stored in a Microsoft Access database for future uses.

Rainfall Analysis

In April 1994, Technical Memorandum 3.2 presented the results of the rainfall analysis. This rainfall analysis examined historical rainfall events with different durations for production of the 5-year winter and 10-year summer design storms defined in the SFO. The durations for the design storms were not specified in the SFO. Precipitation data were used in the model to estimate the volume, frequency, and duration of CSO activity and their effect on the Astoria sewer system. For this evaluation, two approaches were employed:

- Characterization of the system based on a synthetic annual rainfall pattern
- Characterization of the system for SFO summer and winter storm events with 24-hour duration

Typical Year

Based on long-term National Weather Service precipitation data (1953-1994) recorded at Astoria Airport and a 26-hour interval between events, the average number of rainfall events is 61 per year, with an average event duration of 51 hours. The average annual rainfall is 66.8 inches. The interevent duration was selected based on a statistical analysis of rainfall interevent periods. Monthly and annual rainfall statistics for the period of record are summarized in Table 3-2. Table 3-2 shows the monthly volume and number of rainfall events for each month of the historical record.

The typical year is based on selecting historical monthly data that best fit the long-term average. The criteria used to select the typical year data are monthly volume, number of events in the month, and rainfall intensity. The shaded area of Table 3-2 shows the selected months that best fit the long-term average and the months that are used to produce the synthetic year of rainfall. An additional check was performed on large storm events to ensure that no extreme rainfall events were included in the typical year. Total rainfall volume of the representative year is 68 inches from 63 events. The hourly rainfall for the synthetic or representative year is shown in Figure 3-5.

SFO Storms

The rainfall analysis presented in Technical Memorandum 3.2 (1994) results in a 10-year 24-hour summer storm of 2.7 inches total volume and 5-year 24-hour winter storm of 3.5 inches in volume. The distribution of these 24-hour storms follows the pattern of Type 1A storm distribution recommended by the Soil Conservation Service. The rainfall distributions of the summer and winter SFO storms are shown in Figures 3-6 and 3-7, respectively.

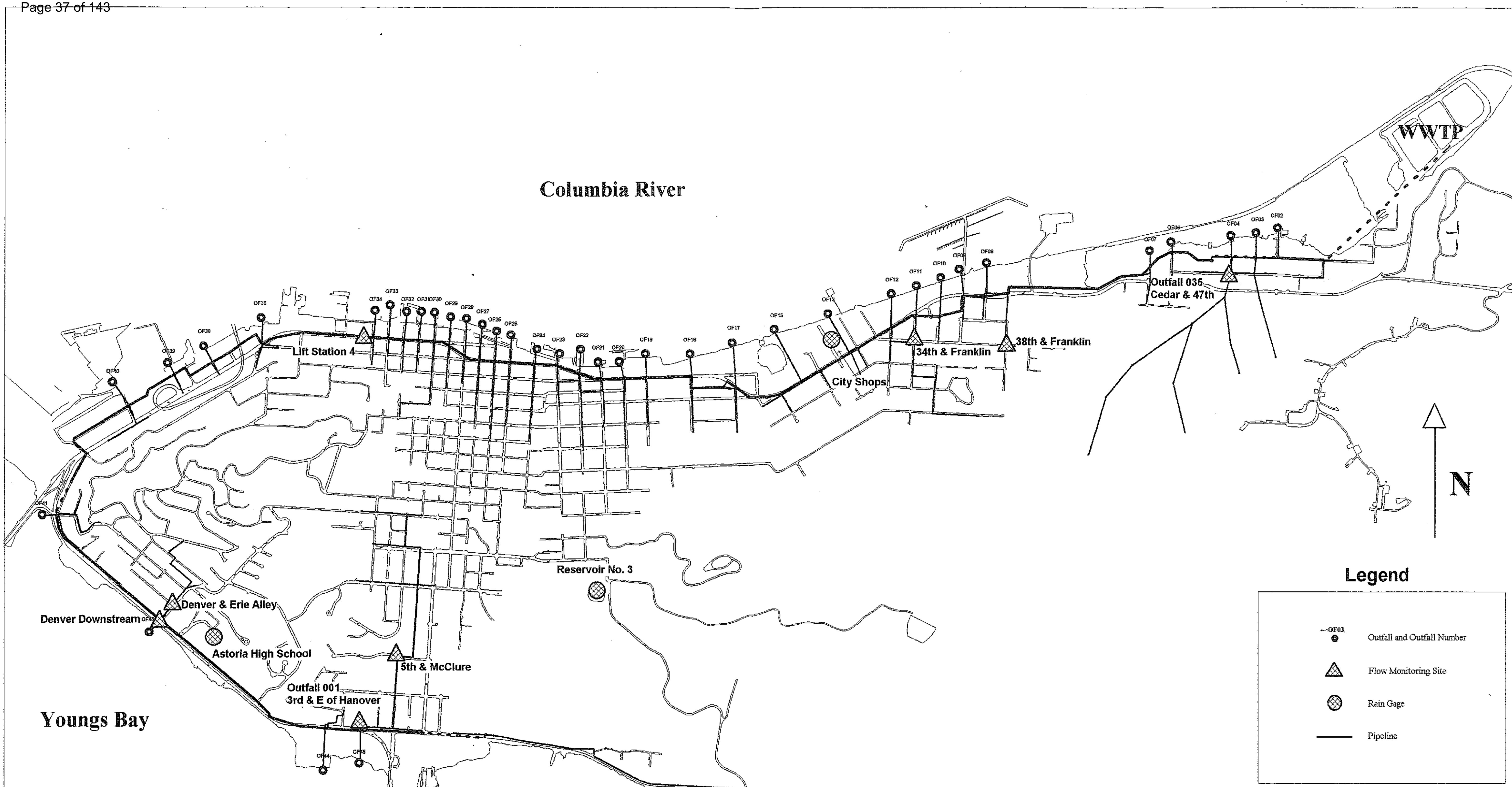

Figure 3-1

Flow Monitoring Sites and Rain Gages
City of Astoria CSO Facility Plan

Periods.xls 6/26/97

Figure 3-2
Available Non-Zero Flow Monitoring Data for 1994 and 1995
City of Astoria CSO Facility Plan

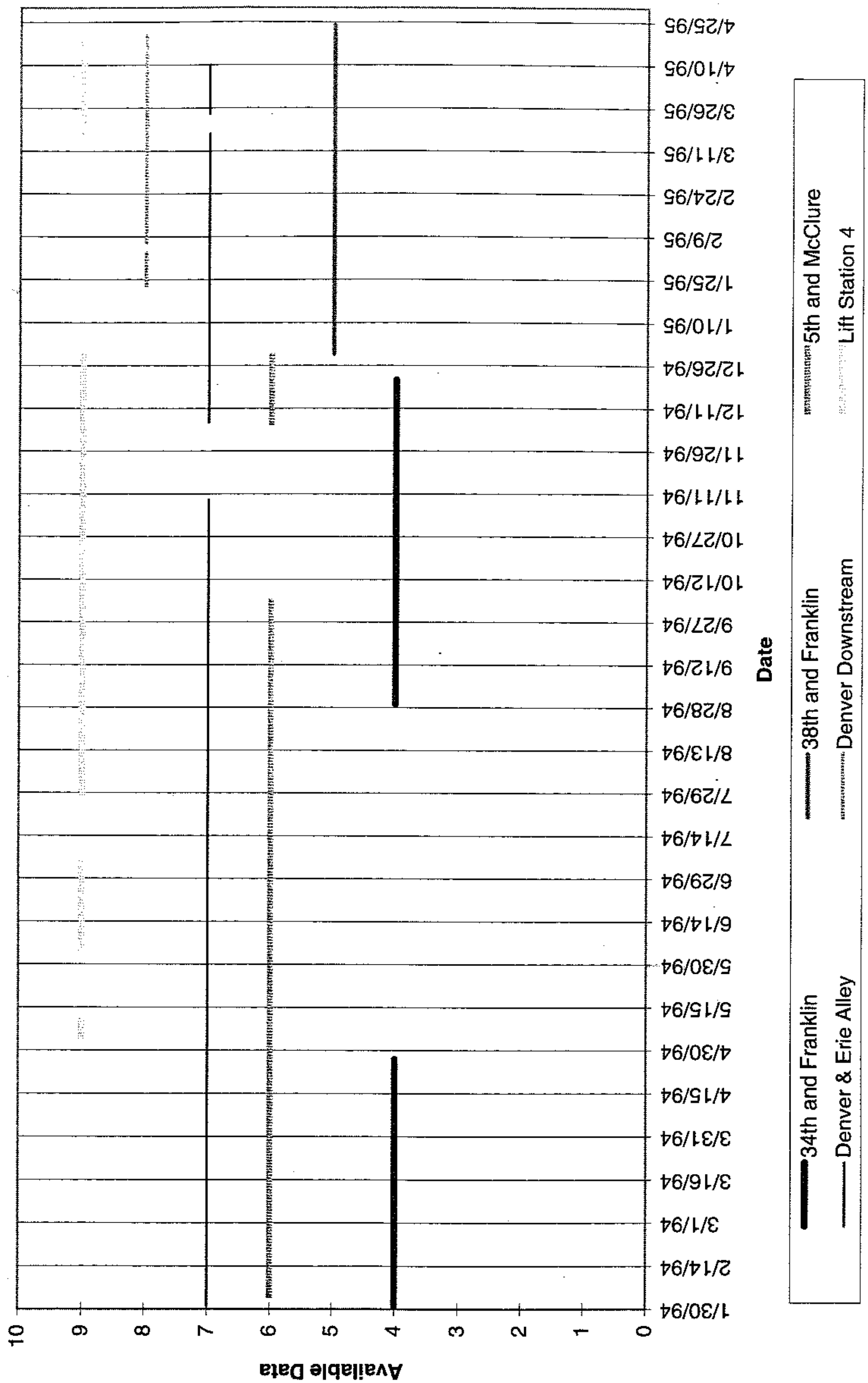

Figure 3-3
Available Non-Zero Flow Monitoring Data for 1996
City of Astoria CSO Facility Plan

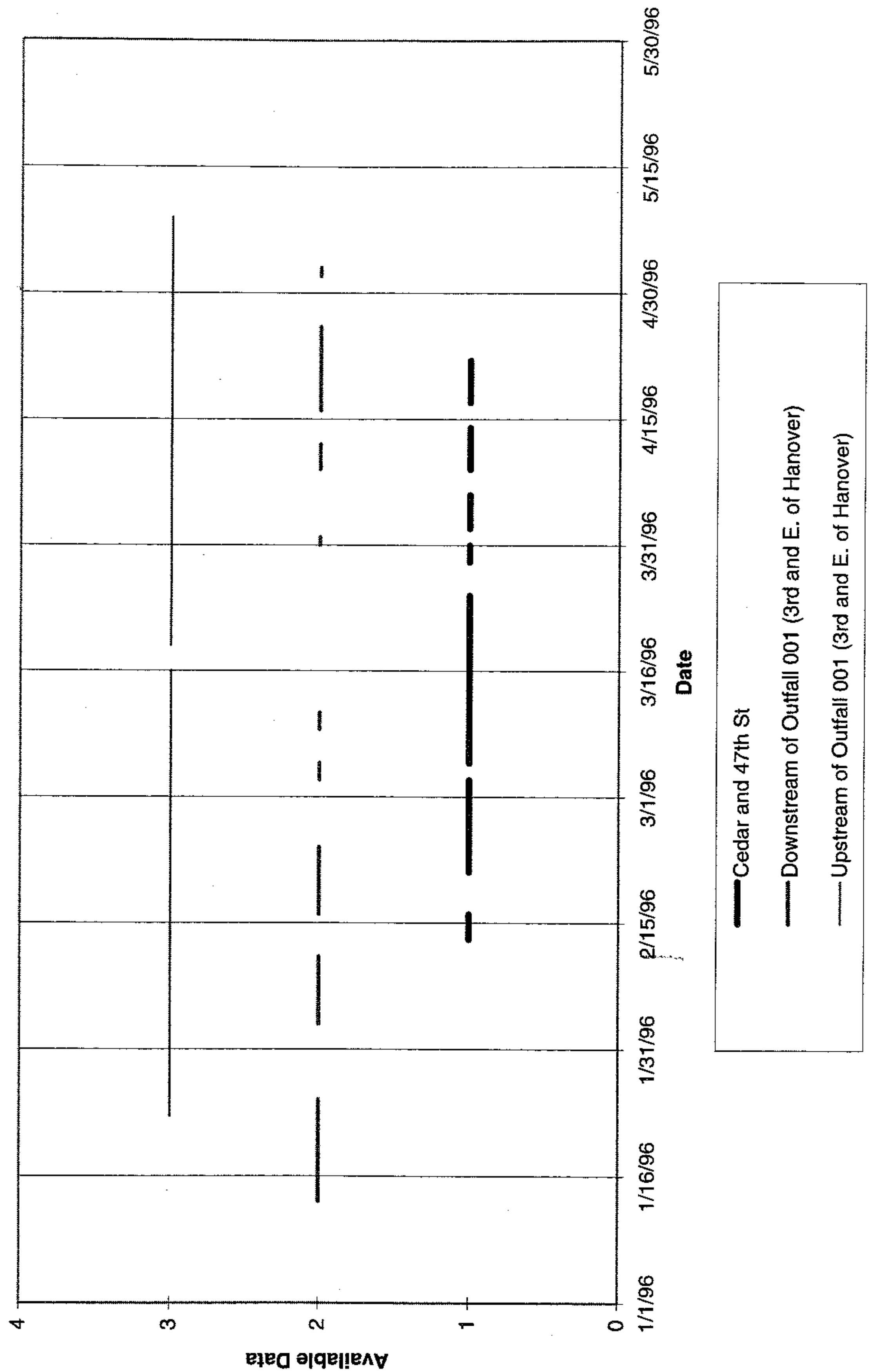

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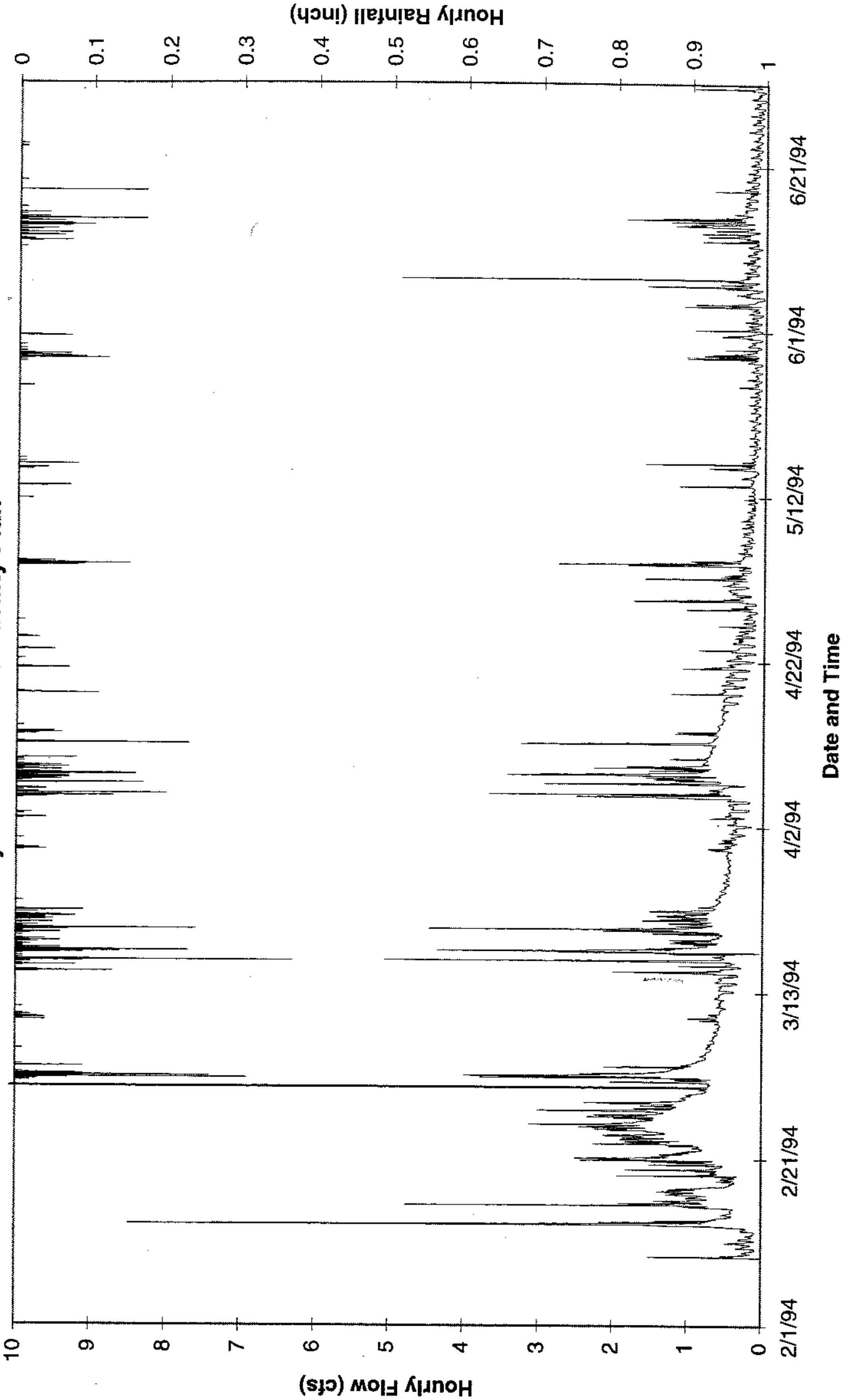
Figure 3-4
Flow vs. Rainfall at 5th and McClure; Rain Gage at Astoria High School
City of Astoria CSO Facility Plan

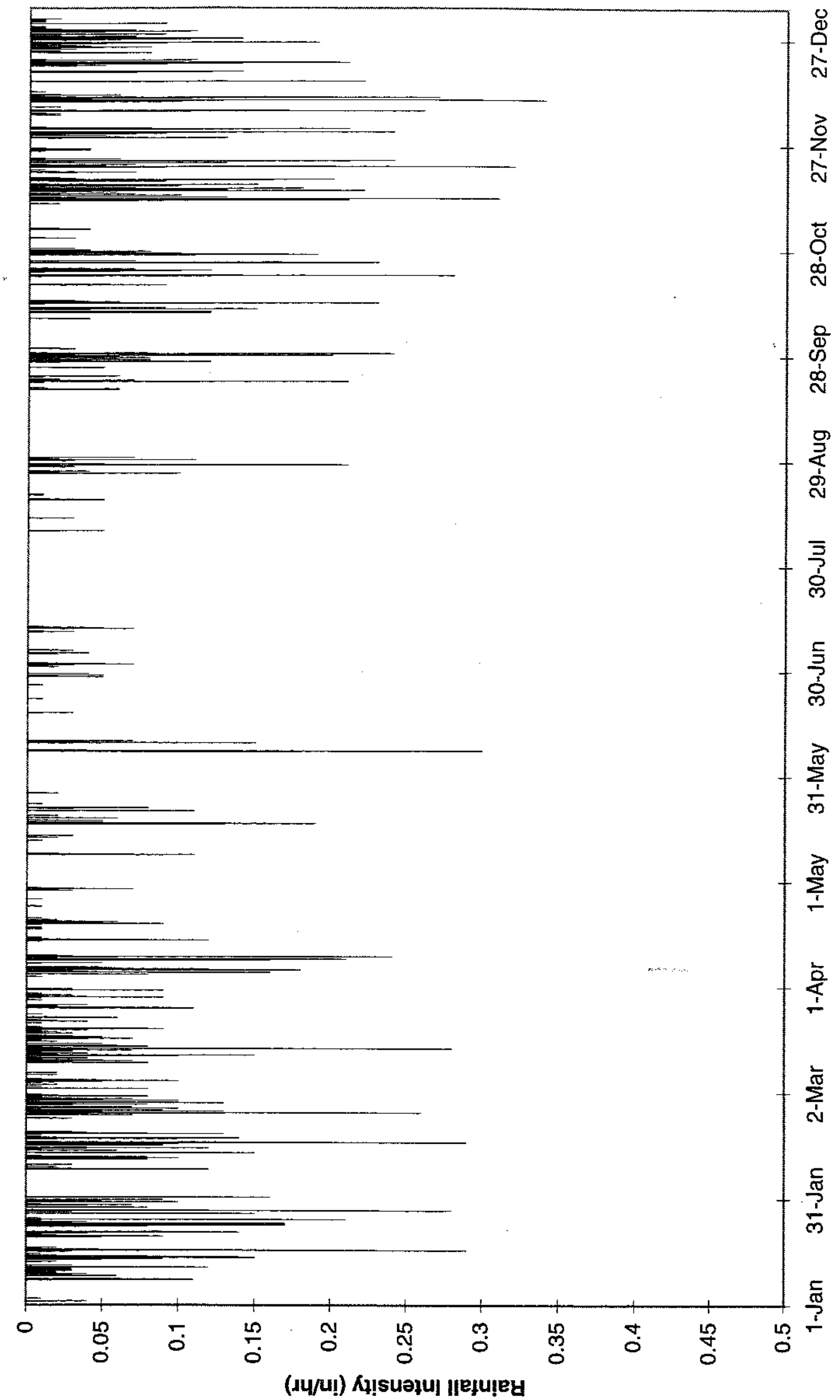


Rainflow.xls 6/26/97

Table 3-2
Monthly Precipitation Volume and Number of Events
Astoria Airport Data 1953-1994
City of Astoria CSO Facility Plan

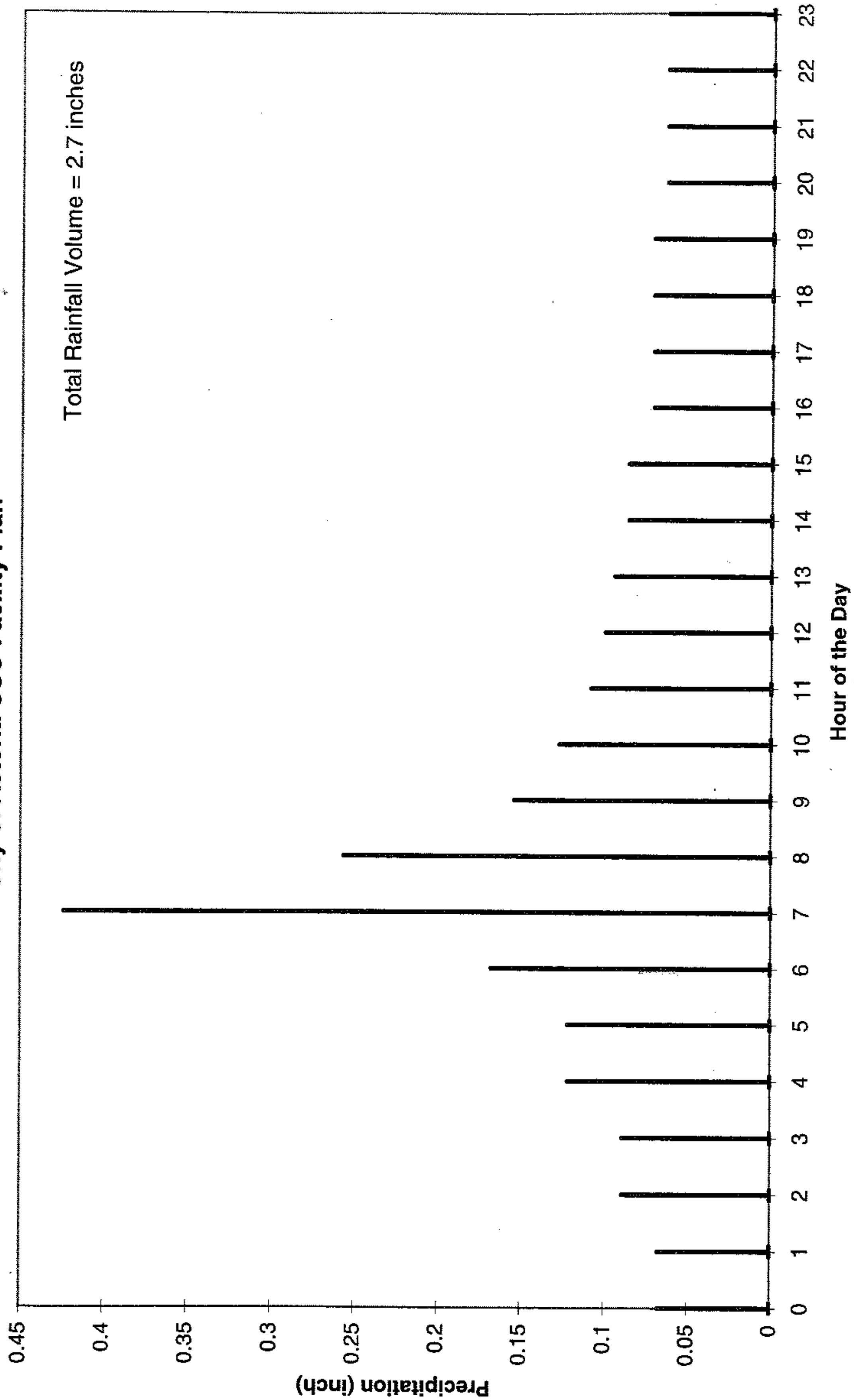
Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event	Volume	Event
1953					6.43	8	2.92	9	4.01	6	2.90	6	0.65	4	3.12	7	4.60	7	4.34	6	20.27	2	12.59	6
1954	10.37	4	9.56	3	7.18	8	1.69	4	1.80	6	5.39	8	1.72	5	2.24	6	2.01	6	4.44	6	10.10	5	10.36	6
1955	10.08	10	2.38	5	9.31	5	7.06	5	1.62	7	2.89	6	3.35	5	0.01	1	3.57	4	15.16	5	12.32	5	24.96	4
1956	8.10	4	12.86	3	10.02	3	1.24	6	1.43	7	4.64	5	0.18	2	2.15	6	3.76	5	11.55	5	2.39	3	9.02	4
1957	6.21	7	5.45	4	9.81	6	4.09	5	**2.59**	**6**	3.31	6	1.63	6	1.34	4	0.82	5	5.43	7	8.28	5	11.37	3
1958	**9.61**	**5**	10.96	3	5.32	4	6.33	2	1.03	7	2.80	6	0.09	2	0.52	5	1.94	8	7.33	6	15.39	7	**11.01**	**6**
1959	13.15	3	8.04	6	8.14	7	4.94	4	2.65	4	3.77	8	0.91	3	0.92	6	5.56	6	6.48	5	11.40	5	8.36	8
1960	13.59	6	4.97	4	7.79	3	5.53	5	6.60	8	1.87	3	0.07	1	1.78	7	1.69	3	7.81	6	13.46	2	6.17	7
1961	8.95	3	29.84	1	4.07	3	5.56	6	1.48	6	1.10	6	0.50	5	2.06	6	0.69	7	7.32	3	9.45	7	9.29	2
1962	6.53	5	6.85	6	3.94	5	8.19	6	2.13	9	1.87	2	0.34	3	2.49	5	3.50	3	7.40	7	16.30	6	4.69	4
1963	7.18	8	4.44	5	5.71	6	6.57	5	1.10	4	1.80	10	1.52	6	1.20	2	2.20	5	9.58	5	13.16	3	13.24	7
1964	14.51	3	9.52	5	2.23	5	3.50	7	1.95	7	2.70	9	3.16	7	**1.64**	**6**	2.91	8	5.60	5	8.60	3	18.17	3
1965	11.47	2	6.77	6	0.99	3	6.89	7	1.26	4	0.75	4	0.46	4	1.95	5	0.51	2	3.97	8	11.82	7	17.91	5
1966	2.48	4	6.34	6	7.98	3	2.90	5	2.18	6	2.13	9	0.54	5	1.01	4	2.18	7	5.83	8	16.80	5	10.61	3
1967	11.61	2	6.52	7	7.93	3	5.52	7	1.37	4	1.14	5	0.22	2	0.19	3	7.95	6	**6.18**	**7**	12.70	6	2.44	4
1968	12.31	5	6.67	2	10.42	4	4.24	9	6.55	9	2.15	4	1.23	3	5.22	5	4.60	5	8.03	8	14.65	9	19.84	3
1969	4.87	4	4.19	5	4.10	5	2.85	4	3.92	4	3.63	6	0.56	4	0.62	8	7.14	6	4.69	5	5.77	6	11.69	5
1970	14.51	4	5.24	5	4.28	8	7.74	7	1.92	7	1.19	5	0.31	3	0.08	4	3.65	4	5.80	3	15.91	5	9.88	5
1971	17.58	2	5.78	4	9.96	5	4.09	7	2.30	6	2.97	8	1.55	4	2.44	2	3.35	5	6.39	5	9.03	4	13.98	4
1972	10.47	4	10.60	4	8.33	6	6.51	6	1.22	5	0.92	6	2.01	2	0.37	4	4.72	5	2.63	5	6.23	7	13.28	6
1973	5.72	8	3.66	6	4.65	6	2.38	4	3.16	7	4.26	5	0.07	4	0.46	4	4.19	2	5.92	7	16.89	5	13.79	2
1974	13.36	2	15.72	3	4.71	2	2.67	6	4.37	7	2.33	4	4.20	5	0.29	2	0.67	1	1.85	5	8.95	5	13.84	5
1975	19.66	6	4.17	4	5.07	4	3.90	8	2.41	6	1.99	5	0.22	3	2.82	6	0.04	1	12.56	8	17.89	8	10.05	5
1976	11.67	4	**7.88**	**3**	7.68	7	3.02	7	2.24	7	1.51	6	2.18	5	2.55	8	1.58	3	2.96	5	1.45	4	4.20	7
1977	3.28	4	6.49	5	8.39	5	1.65	9	6.08	7	1.28	3	0.44	7	3.85	3	5.44	5	5.92	9	10.83	5	14.34	5
1978	9.68	6	4.41	4	4.40	5	6.35	6	4.75	5	3.07	5	0.90	3	3.21	7	6.33	8	1.01	6	8.50	5	4.92	6
1979	3.83	6	11.76	4	5.04	5	3.86	5	4.19	5	2.28	4	0.46	2	0.81	4	4.35	5	8.46	7	7.87	4	13.66	4
1980	8.85	3	7.48	5	**6.31**	**5**	**4.85**	**6**	1.68	6	1.34	5	0.64	3	1.24	6	2.51	7	4.54	6	13.41	9	9.30	5
1981	2.63	6	8.69	4	6.64	9	6.46	5	2.97	8	5.47	6	1.06	6	0.62	4	**2.77**	**5**	8.67	2	**11.83**	**5**	11.39	7
1982	13.22	4	12.65	4	7.59	5	4.34	4	0.37	3	1.22	5	0.75	5	0.63	4	3.72	8	8.31	6	13.93	4	7.83	3
1983	13.52	4	8.66	5	8.84	7	4.26	7	3.79	7	5.06	6	3.66	5	1.31	4	1.66	6	1.87	7	16.75	3	9.44	7
1984	6.60	5	8.64	6	5.60	3	6.13	7	4.23	6	3.90	5	0.05	3	0.53	6	3.15	4	8.10	6	15.19	5	6.51	6
1985	0.69	6	4.09	6	7.00	3	2.95	5	2.14	9	2.85	4	0.78	1	1.11	3	3.23	5	11.26	6	5.21	6	1.62	1
1986	10.96	5	7.81	2	6.11	7	3.58	7	3.30	7	0.94	5	1.69	5	0.14	2	3.62	5	5.45	3	11.42	6	9.36	8
1987	9.35	3	8.26	6	4.35	4	4.21	6	2.85	5	0.58	2	1.10	9	0.16	2	0.95	4	0.67	1	7.36	7	5.67	5
1988	6.57	6	3.60	5	7.86	4	5.06	7	4.03	7	**2.49**	**6**	**0.96**	**3**	0.88	2	1.23	5	2.14	6	13.06	4	8.58	8
1989	7.02	6	6.80	3	11.50	5	0.59	3	3.01	4	3.24	4	1.46	5	0.36	3	0.50	4	5.30	6	6.73	7	16.94	6
1990	16.17	6	2.21	3	5.15	6	4.44	7	4.00	8	3.47	6	0.54	5	1.57	7	0.67	1	8.46	8	13.32	6	3.09	4
1991	9.24	4	8.58	4	3.12	6	9.47	3	2.68	7	1.86	5	0.33	3	2.31	3	0.07	1	2.53	6	10.86	7	6.18	9
1992	9.83	8	5.20	6	1.19	6	7.49	5	0.52	2	0.55	5	0.24	5	0.77	2	2.66	5	4.80	6	9.41	7	5.99	7
1993	6.27	6	1.35	4					4.83	6	3.57	6	1.81	10	0.57	5	0.12	3	2.23	6	8.85	7	12.29	3
1994	1.90	2	11.27	2	6.48	4	4.15	9	2.59	9	2.19	7	0.80	7	1.49	6	2.86	5	10.09	7	12.44	6	14.26	3
Minimum	0.69	2	1.35	1	0.99	2	0.59	2	0.37	2	0.55	2	0.05	1	0.01	1	0.04	1	0.67	1	1.45	2	1.62	1
Maximum	19.66	10	29.84	7	11.50	9	9.47	9	6.60	9	5.47	10	4.20	10	5.22	8	7.95	8	15.16	9	20.27	9	24.96	9
Average	9.36	5	7.72	4	6.38	5	4.64	6	2.84	6	2.51	6	1.08	4	1.41	5	2.85	5	6.17	6	11.34	5	10.53	5

Figure 3-5
Hourly Precipitation of Synthetic Year
City of Astoria CSO Facility Plan



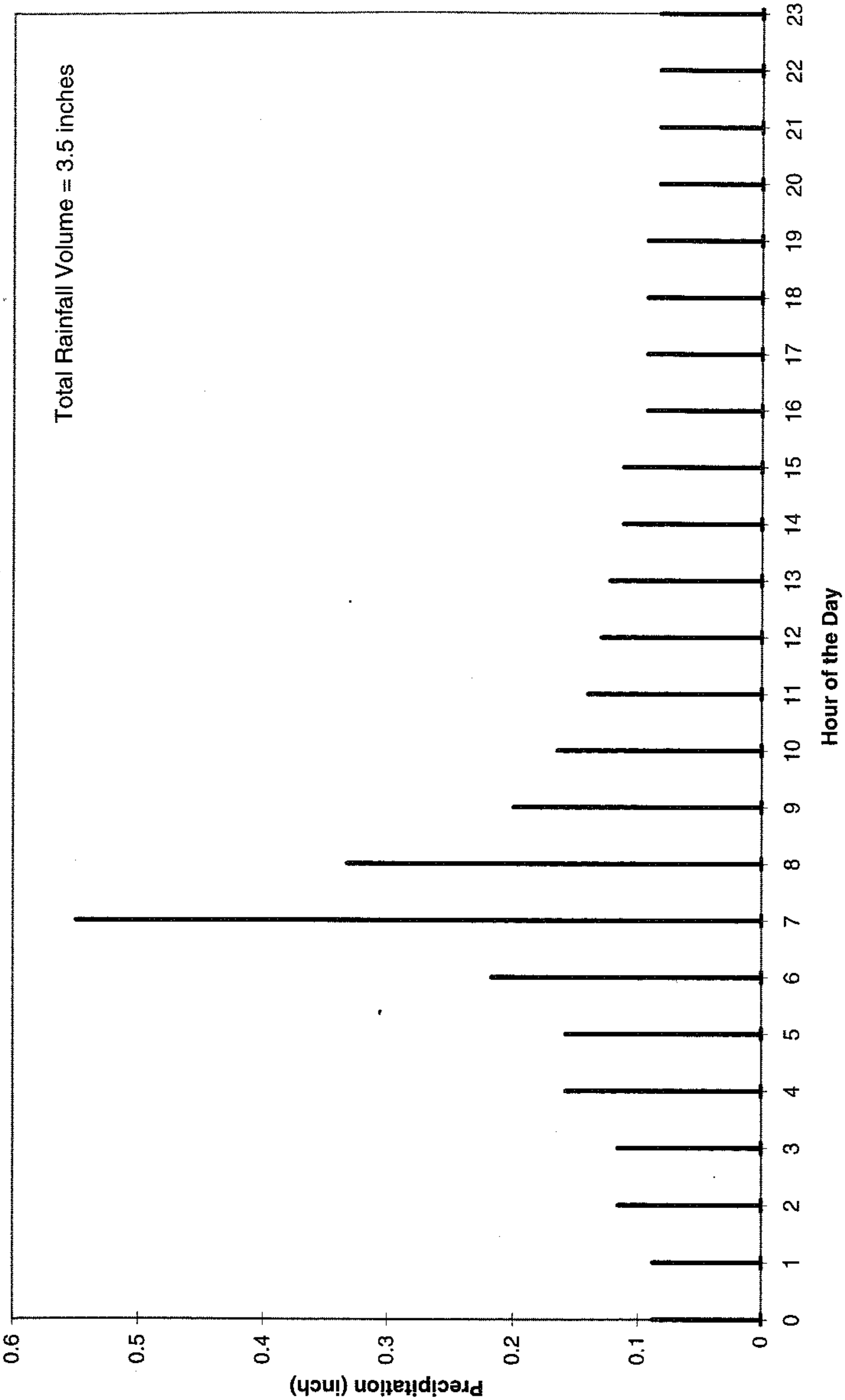
Synoptic.xls 6/26/97

Figure 3-6
SFO 10-year Summer Storm Distribution
City of Astoria CSO Facility Plan



Sfostorm.xls 6/26/97

Figure 3-7
SFO 5-year Winter Storm Distribution
City of Astoria CSO Facility Plan



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SECTION 4

Combined Sewer System Hydrologic/Hydraulic Models

A precipitation watershed runoff and conveyance model was developed to analyze the City of Astoria's combined sewer collection system. The objective of the modeling was to gain an understanding of the sewer system hydraulics and to develop a tool for comparing and testing the effectiveness of various combined sewer overflow (CSO) control technologies. The model was calibrated and verified against measured data at representative monitoring sites for several significantly large storm events.

The model was used to quantify the CSO frequency, volume, and duration at each of the system's 38 CSO outfalls under synthetic year rainfall conditions and under the summer and winter SFO storm conditions. The modeled system consists of 174 basins representing 1,880 acres of combined sewered area. Flows generated in the basins are conveyed through over 500 pipes. The model simulates flow through the pipes, manholes, and representations of the diversion structures and pump/lift stations to the treatment plant or the outfalls.

The U.S. Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM) as modified by XPSOFT (the XP-SWMM modeling package) was selected as the analytical tool to analyze the Astoria CSO system. The model consists of the physical representation of the drainage basins, the rainfall to runoff response of the basins, and the hydraulic representation of the sewer pipes, diversion structures, and lift and pump stations of the system.

Model Construction—Physical Sewer Network Representation

The data for the model are based on the City's ARC-CAD database of the collection system and utility maps. Not all sewer pipes in the system have been modeled because some system data are not available, such as manhole inverts, ground elevations, pipe diameters, and lengths. The model, however, includes the diversion structures, main interceptor, pump stations, and most of the trunk sewers of the system, and is believed adequate for characterization of CSOs and development of control alternatives.

The model includes 41 diversion structures. Each diversion structure is presented in the model as the combination of a weir allowing overflow to an outfall and an orifice conveying flow to the interceptor. System data have been corrected based on initial model results and data collected in the field. Figure 4-1 shows the extent of the modeled system.

Runoff Model

The wet weather component of combined sewage flow in the Astoria system is a direct result of surface runoff from rainfall and rainfall derived inflow and infiltration into the sewer pipes. Direct inflow connections exist through street catch basins, roof downspouts, and basement drainage. The runoff from the basins is a function of basin area, percent imperviousness, soil characteristics, and antecedent moisture conditions. The runoff from the basins has been calibrated and predicted using the Runoff block of SWMM.

The entire service area for the City of Astoria represented by the model is segregated into discrete sub-basins or "subcatchments." Physical characteristics of each subcatchment are used as input to the model, along with precipitation data. Output from the Runoff block is in hydrograph format, which is combined with dry weather flow components in the Transport block of SWMM. This combination of flows provides the input to the main hydraulic calculations performed by the Extran block of SWMM. The Extended Transport (Extran) model is used to route flow through the combined sewer system.

Hydrologic characteristics for each subcatchment are listed in Table 4-1. The parameters are subcatchment area, hydraulic width, percent imperviousness, average surface slope, Manning's roughness, depression storage, the infiltration rate, and the decay rate for infiltration. The last three parameters are used in the infiltration calculation. More than one subcatchment can be connected to an inlet as shown by inlet 0042HN at the beginning of Table 4-1. These parameters are described in the following paragraphs.

The subcatchment **drainage areas** were delineated using sewer system base maps. The areas serviced by separate storm sewers are excluded from the model. The subcatchment delineation is shown in Figure 4-1, where subcatchments are represented as a series of identification numbers starting with the associated outfall number. The hatched areas in Figure 4-1 are separated sewer areas. Runoff from the separated areas was not modeled in the system.

Subcatchment **width** is a representation of the average width of overland flow in the subcatchment. Width is a parameter that governs the hydrograph shape and to a lesser extent the hydrograph time to peak. A subcatchment with a large width will reach runoff equilibrium (all points in drainage area contributing to runoff at the most downstream point) quicker than one with a small width. The large width causes the resulting hydrograph to have a sharp peak that occurs sooner in time. A small width results in a more rounded hydrograph spread out over a larger time period. The flow length was used as an initial estimate of width.

The **percent imperviousness** describes the percentage of impervious cover in the effective areas of the basin that drain to the combined sewer system. An effective area is the area where water can flow to the combined sewer system or is hydraulically connected to the system. This includes street drainage, parking lots, roofs, and foundation drains that have a direct flow connection to the sewers. Rooftops draining onto adjacent pervious areas are not usually treated as effective impervious areas. The percentage was determined from city maps and aerial photographs of the City. Table 4-2 lists the land-use types and associated percentages of impervious area.

The average ground **slope** of the subcatchment in feet per foot was calculated by subtracting the downstream elevation of the subcatchment from the upstream elevation and dividing by the length between. The subcatchment slope should reflect the average along the pathway of overland flow to inlet locations. The ground slope in Astoria is generally steep, and a lot of the slopes are greater than 0.1 foot per foot.

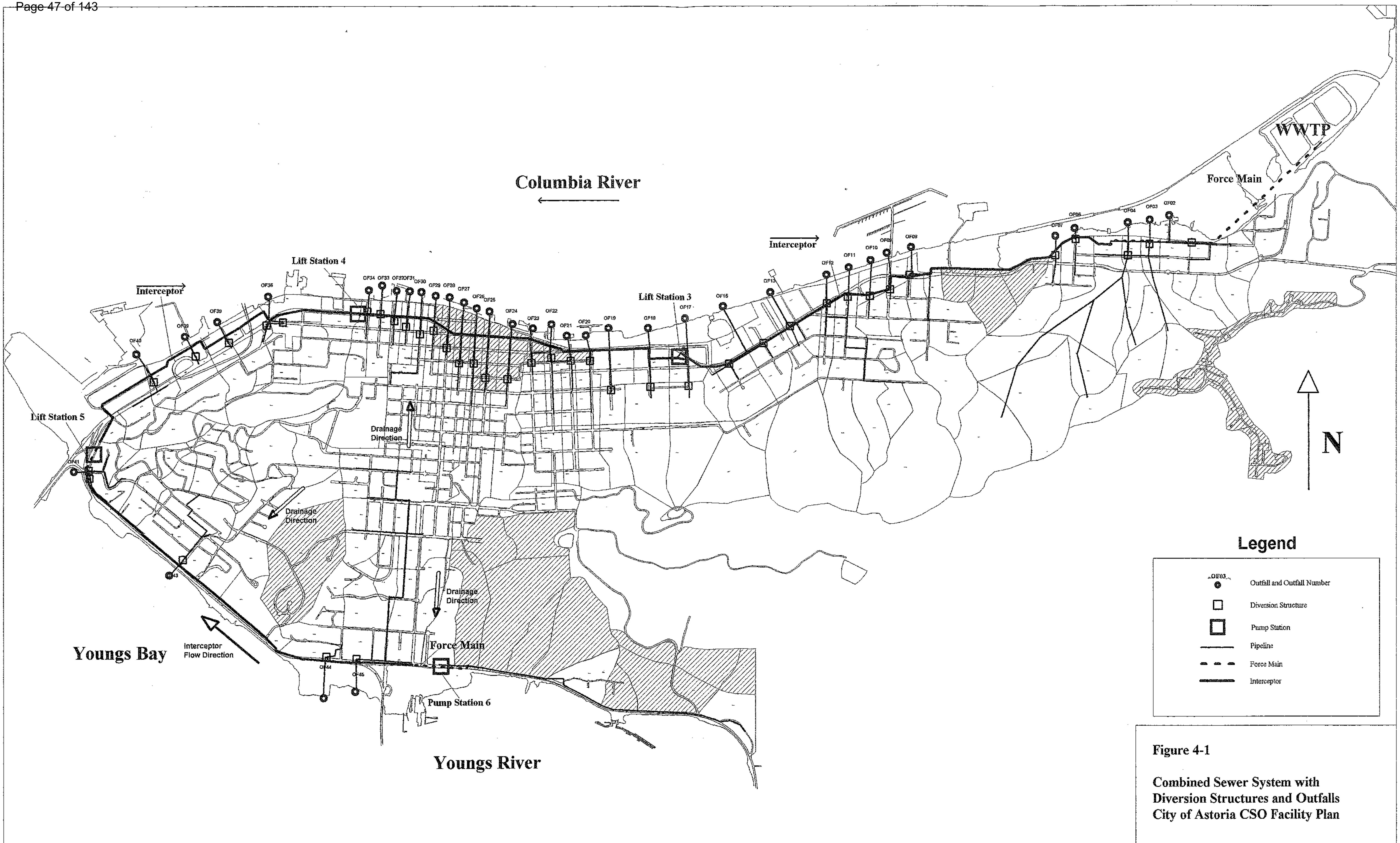


Figure 4-1

Combined Sewer System with Diversion Structures and Outfalls City of Astoria CSO Facility Plan

Table 4-1
Runoff Catchment Characteristics
City of Astoria CSO Facility Plan

Inlet Name	Subcatchment Name	Catchment No. On Figures	Drainage Area (ac)	Width (ft)	Percent Imperviousness (%)	Slope (ft/ft)	Manning's Roughness		Depression Storage		Zero Detention (%)	Green Ampt. Method		
							Impervious	Pervious	Impervious	Pervious (in)		Average Capillary Suction (in)	Initial Moisture Deficit	Saturated Hydraulic Conductivity (in/hr)
0042HN	0042HN#1	44020	13.86	500	20	0.142	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0042HN	0042HN#2	44030	5.45	280	19.3	0.6071	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0042HN	0042HN#3	44040	8.03	500	19.3	0.1538	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0042HN	0042HN#4	44050	2.59	260	8	0.375	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0042HN	0042HN#5	44050	2.59	260	16	0.375	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0088PO	0088PO#1	40040	12.02	300	36.5	0.0325	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0088PO	0088PO#2	40060	4.75	240	36.5	0.035	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0188CB	0188CB#1	36010	26.93	600	9.5	0.275	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0188CB	0188CB#2	36020	8.92	400	19.3	0.1927	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0188CB	0188CB#3	36030	11.68	400	34	0.086	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0205KL	0205KL#1	45040	10.01	600	20	0.0778	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0214LE	0214LE#1	45010	9.48	300	20	0.0667	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0297WM	0297WM#1	38010	6.90	580	9.5	0.2189	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0297WM	0297WM#2	38020	6.71	280	36	0.11	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0297WM	0297WM#3	38030	5.53	320	33	0.0471	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0327DE	0327DE#1	43010	18.57	780	5.44	0.1833	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0327DE	0327DE#2	43040	8.95	380	13.9	0.1129	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0327DE	0327DE#3	43910	14.40	680	9.94	0.1307	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0327DE	0327DE#4	43920	18.88	1000	7.69	0.1389	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0327DE	0327DE#5	43930	10.97	680	6.56	0.15	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0349WM	0349WM#1	39010	12.99	900	11	0.262	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0349WM	0349WM#2	39020	11.33	460	36	0.074	0.014	0.3	0.1	0.2	20	8	0.2	0.1
035808	035808#1	27010	14.02	200	18.5	0.125	0.014	0.3	0.1	0.2	20	8	0.2	0.1
035808	035808#2	28010	5.26	400	38.3	0.0661	0.014	0.3	0.1	0.2	20	8	0.2	0.1
037837	037837#1	8050	7.66	330	22	0.1512	0.014	0.3	0.1	0.2	20	8	0.2	0.1
045734	045734#1	11100	4.61	250	40	0.015	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0486CO	0486CO#1	31010	6.35	840	33	0.1349	0.014	0.3	0.1	0.2	20	8	0.2	0.1
04HOBLOC	04HOBLOC#1	45160	11.08	540	14.8	0.1574	0.014	0.3	0.1	0.2	20	8	0.2	0.1
04HOBLOC	04HOBLOC#2	45190	11.74	400	20	0.1	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0503EX	0503EX#1	30020	19.76	500	17.8	0.1796	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0518MC	0518MC#1	45080	7.53	560	11	0.1172	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0518MC	0518MC#2	45090	5.13	480	18.5	0.0446	0.014	0.3	0.1	0.2	20	8	0.2	0.1
053815	053815#1	22040	3.95	640	38.3	0.0744	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0571RI	0571RI#1	41060	9.74	300	13.3	0.1948	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0580MC	0580MC#1	45140	4.82	440	16.3	0.1477	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0588LE	0588LE#1	45020	11.04	400	20	0.0889	0.014	0.3	0.1	0.2	20	8	0.2	0.1
059204	059204#1	30010	36.39	1100	13.3	0.1014	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0597DU	0597DU#1	30030	6.29	800	34	0.0622	0.014	0.3	0.1	0.2	20	8	0.2	0.1
060109	060109#1	27020	11.95	240	19.3	0.1492	0.014	0.3	0.1	0.2	20	8	0.2	0.1
060109	060109#2	27030	4.75	200	35	0.1202	0.014	0.3	0.1	0.2	20	8	0.2	0.1

Table 4-1
Runoff Catchment Characteristics
City of Astoria CSO Facility Plan

Inlet Name	Subcatchment Name	Catchment No. On Figures	Drainage Area (ac)	Width (ft)	Percent Imperviousness (%)	Slope (ft/ft)	Manning's Roughness		Depression Storage		Zero Detention (%)	Green Ampt. Method		
							Impervious	Pervious	Impervious	Pervious (in)		Average Capillary Suction (in)	Initial Moisture Deficit	Saturated Hydraulic Conductivity (in/hr)
060327	060327#1	15040	7.28	300	31.3	0.0286	0.014	0.3	0.1	0.2	20	8	0.2	0.1
061116	061116#3	2.555	3.02	260	40	0.0967	0.014	0.3	0.1	0.2	20	8	0.2	0.1
061116	061116#1	21010	6.89	260	17.8	0.18	0.014	0.3	0.1	0.2	20	8	0.2	0.1
061116	061116#2	21020	4.20	380	22	0.15	0.014	0.3	0.1	0.2	20	8	0.2	0.1
061131	061131#1	13040	10.73	400	36.5	0.04	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0614NI	0614NI#1	45200	9.23	480	19.3	0.1316	0.014	0.3	0.1	0.2	20	8	0.2	0.1
062918	062918#1	19010	11.58	1000	25	0.2325	0.014	0.3	0.1	0.2	20	8	0.2	0.1
062918	062918#2	19020	7.38	600	14	0.2279	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0647WM	0647WM#1	42010	7.23	580	20	0.1274	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0647WM	0647WM#2	42020	7.38	540	19.3	0.1557	0.014	0.3	0.1	0.2	20	8	0.2	0.1
065020	065020#1	18020	13.62	660	15.5	0.2471	0.014	0.3	0.1	0.2	20	8	0.2	0.1
065020	065020#2	18030	10.22	300	36.5	0.0211	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0659FL	0659FL#1	41010	3.12	240	20	0.15	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0659FL	0659FL#2	41020	5.83	320	20	0.1288	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0659FL	0659FL#3	41030	6.42	260	19.3	0.125	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0659FL	0659FL#4	41040	3.83	440	20	0.09	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0659FL	0659FL#5	41050	7.25	400	17	0.1294	0.014	0.3	0.1	0.2	20	8	0.2	0.1
068712	068712#1	24010	13.72	640	17.8	0.1623	0.014	0.3	0.1	0.2	20	8	0.2	0.1
068712	068712#2	24020	10.73	300	32	0.1932	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069231	069231#1	13030	8.27	400	17.8	0.0944	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069534	069534#1	11090	7.21	440	26	0.19	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069544	069544#1	7010	15.09	1360	5.75	0.1866	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069544	069544#2	7020	4.25	390	19.3	0.1776	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069829	069829#1	14010	7.74	680	13.3	0.2917	0.014	0.3	0.1	0.2	20	8	0.2	0.1
069829	069829#2	14020	6.67	300	19.3	0.1438	0.014	0.3	0.1	0.2	20	8	0.2	0.1
070833	070833#1	12010	4.97	600	18.5	0.2398	0.014	0.3	0.1	0.2	20	8	0.2	0.1
070833	070833#2	12020	3.56	320	17	0.0839	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0710KL	0710KL#1	45060	10.19	420	20	0.0714	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0710KL	0710KL#2	45070	5.68	320	19.3	0.0786	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0710KL	0710KL#3	46610	12.13	460	15.5	0.0781	0.014	0.3	0.1	0.2	20	8	0.2	0.1
074415	074415#1	22010	6.41	440	17	0.075	0.014	0.3	0.1	0.2	20	8	0.2	0.1
074415	074415#2	22020	6.71	360	28	0.1837	0.014	0.3	0.1	0.2	20	8	0.2	0.1
074415	074415#3	22030	4.36	280	31	0.0968	0.014	0.3	0.1	0.2	20	8	0.2	0.1
075034	075034#1	11030	20.12	1900	5.75	0.1786	0.014	0.3	0.1	0.2	20	8	0.2	0.1
075034	075034#2	11060	5.78	480	14	0.2414	0.014	0.3	0.1	0.2	20	8	0.2	0.1
075034	075034#3	11080	5.39	460	20	0.1	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0784AL	0784AL#1	43020	15.38	400	12.8	0.1727	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0784AL	0784AL#2	43030	9.67	400	13.9	0.1938	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0784AL	0784AL#3	43050	4.46	320	27.8	0.1548	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0787GL	0787GL#1	43060	17.71	420	14.4	0.1855	0.014	0.3	0.1	0.2	20	8	0.2	0.1

Table 4-1
Runoff Catchment Characteristics
City of Astoria CSO Facility Plan

Inlet Name	Subcatchment Name	Catchment No. On Figures	Drainage Area (ac)	Width (ft)	Percent Imperviousness (%)	Slope (ft/ft)	Manning's Roughness Impervious	Manning's Roughness Pervious	Depression Storage Impervious	Depression Storage Pervious (in)	Zero Detention (%)	Green Ampt. Method Average Capillary Suction (in)	Green Ampt. Method Initial Moisture Deficit	Green Ampt. Method Saturated Hydraulic Conductivity (in/hr)
07OLLOC1	07OLLOC1#1	45110	5.22	520	8	0.1429	0.014	0.3	0.1	0.2	20	8	0.2	0.1
07OLLOC1	07OLLOC1#2	45150	7.21	860	15.5	0.1196	0.014	0.3	0.1	0.2	20	8	0.2	0.1
07OLLOC1	07OLLOC1#3	45170	6.02	580	14.8	0.1	0.014	0.3	0.1	0.2	20	8	0.2	0.1
07OLLOC1	07OLLOC1#4	45180	6.69	800	16.3	0.1726	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0836OL	0836OL#1	46660	17.98	1300	11.8	0.1324	0.014	0.3	0.1	0.2	20	8	0.2	0.1
0849FL	0849FL#1	43080	7.59	400	16.9	0.0845	0.014	0.3	0.1	0.2	20	8	0.2	0.1
085135	085135#1	11050	9.56	940	19.3	0.1278	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1005GR	1005GR#1	26010	9.77	420	18.5	0.1285	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1005GR	1005GR#2	26020	3.31	200	24	0.1635	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1076OL	1076OL#1	46640	45.97	2500	17.3	0.16	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1099FR	1099FR#1	25010	10.12	460	19.3	0.1389	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1099FR	1099FR#2	25020	5.20	240	26	0.1092	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1385NI	1385NI#1	45030	12.14	400	20	0.0865	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1411EX	1411EX#1	23010	11.64	400	20	0.1346	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1411EX	1411EX#2	23020	8.13	300	20	0.15	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1411EX	1411EX#3	23030	4.69	320	40	0.0552	0.014	0.3	0.1	0.2	20	8	0.2	0.1
146406	146406#1	45050	9.25	340	20	0.0429	0.014	0.3	0.1	0.2	20	8	0.2	0.1
153WBLOC	153WBLOC#1	36040	17.28	540	8.75	0.217	0.014	0.3	0.1	0.2	20	8	0.2	0.1
153WBLOC	153WBLOC#2	36050	6.56	420	26	0.25	0.014	0.3	0.1	0.2	20	8	0.2	0.1
153WBLOC	153WBLOC#3	36060	10.90	100	39	0.0267	0.014	0.3	0.1	0.2	20	8	0.2	0.1
155606	155606#1	45100	5.19	500	19.3	0.0648	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1699EX	1699EX#1	20030	4.31	270	38.3	0.0559	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1699GR	1699GR#1	20010	12.82	740	23	0.2222	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1699GR	1699GR#2	20020	6.72	320	25	0.1544	0.014	0.3	0.1	0.2	20	8	0.2	0.1
1802EX	1802EX#1	19030	11.28	320	38.3	0.0333	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2004EX	2004EX#1	18010	22.46	1500	8	0.2415	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2200GR	2200GR#1	17010	24.18	1460	7.25	0.2532	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2200GR	2200GR#2	17020	12.04	800	19	0.265	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2202EX	2202EX#1	17030	12.09	300	33	0.0217	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2600FR	2600FR#1	16010	30.92	1440	5.75	0.24	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2600FR	2600FR#2	16020	7.47	1100	9.5	0.1945	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2700GR	2700GR#1	15010	8.44	600	6.5	0.2258	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2700GR	2700GR#2	15020	10.78	660	8	0.2266	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2700GR	2700GR#3	15030	8.03	440	21	0.254	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2903MD	2903MD#1	14030	7.60	320	36.5	0.0211	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2NCOLOC	2NCOLOC#1	34010	5.22	440	15.5	0.2071	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2NCOLOC	2NCOLOC#2	34020	3.71	450	30	0.15	0.014	0.3	0.1	0.2	20	8	0.2	0.1
2NCOLOC	2NCOLOC#3	34030	10.71	480	34	0.1714	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3061GR	3061GR#1	13010	63.56	2200	5.75	0.1505	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3061GR	3061GR#2	13020	8.80	800	14.8	0.1696	0.014	0.3	0.1	0.2	20	8	0.2	0.1

Table 4-1
Runoff Catchment Characteristics
City of Astoria CSO Facility Plan

Inlet Name	Subcatchment Name	Catchment No. On Figures	Drainage Area (ac)	Width (ft)	Percent Imperviousness (%)	Slope (ft/ft)	Manning's Roughness		Depression Storage		Zero Detention (%)	Green Ampt. Method		
							Impervious	Pervious	Impervious	Pervious (in)		Average Capillary Suction (in)	Initial Moisture Deficit	Saturated Hydraulic Conductivity (in/hr)
3499GR	3499GR#1	11070	6.09	280	20	0.1071	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3499IR	3499IR#1	11020	16.18	1620	5.3	0.1701	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3500FR	3500FR#1	10010	8.56	380	34.8	0.2429	0.014	0.3	0.1	0.2	20	8	0.2	0.1
35LOC05	35LOC05#1	10020	6.58	360	19	0.03	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3603DU	3603DU#1	9010	7.30	340	22	0.1375	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3603DU	3603DU#2	9020	4.04	490	35	0.0625	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3695IR	3695IR#1	11010	62.81	2800	5.3	0.1857	0.014	0.3	0.1	0.2	20	8	0.2	0.1
36IRLOC	36IRLOC#1	11040	9.04	1000	5.75	0.1902	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3795FR	3795FR#1	8020	6.82	440	8.87	0.1486	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3795FR	3795FR#2	8030	12.78	660	9.25	0.2663	0.014	0.3	0.1	0.2	20	8	0.2	0.1
38LOC03	38LOC03#1	8060	3.84	540	8.81	0.3161	0.014	0.3	0.1	0.2	20	8	0.2	0.1
38LOC07	38LOC07#1	8010	22.92	880	5.75	0.193	0.014	0.3	0.1	0.2	20	8	0.2	0.1
399WMLOC	399WMLOC#1	40050	5.02	440	17.8	0.287	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3BOLOC	3BOLOC#1	33010	5.95	620	13.3	0.1566	0.014	0.3	0.1	0.2	20	8	0.2	0.1
3BOLOC	3BOLOC#2	33020	6.94	260	32	0.1588	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4010	4010#1	4010	13.70	1680	5.75	0.18	0.014	0.3	0.1	0.2	20	8	0.2	0.1
407COLOC	407COLOC#1	32010	4.61	800	33	0.1615	0.014	0.3	0.1	0.2	20	8	0.2	0.1
435INT	435INT#1	43960	9.24	380	20	0.0823	0.014	0.3	0.1	0.2	20	8	0.2	0.1
445INT	445INT#1	43970	15.57	600	30	0.1233	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4503LED	4503LED#1	6010	7.77	340	20	0.2339	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4503LED	4503LED#2	6020	6.76	280	19.3	0.0524	0.014	0.3	0.1	0.2	20	8	0.2	0.1
465WMLOC	465WMLOC#1	40010	12.79	840	15.5	0.1573	0.014	0.3	0.1	0.2	20	8	0.2	0.1
465WMLOC	465WMLOC#2	40020	11.57	440	17.8	0.2144	0.014	0.3	0.1	0.2	20	8	0.2	0.1
465WMLOC	465WMLOC#3	40030	4.37	540	14	0.2294	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4700CE	4700CE#1	5160	5.00	200	19.3	0.1087	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4808CE	4808CE#1	4020	4.91	280	30	0.11	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4908CE	4908CE#1	3020	7.52	220	24	0.1413	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4987CE	4987CE#1	2110	8.31	1000	5.75	0.2604	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4987CE	4987CE#2	2130	9.81	620	19.3	0.1667	0.014	0.3	0.1	0.2	20	8	0.2	0.1
4987CE	4987CE#3	3010	3.70	480	5.75	0.2841	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5010	5010#1	5010	40.90	2020	5	0.1667	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5020	5020#1	5020	21.57	1800	5	0.1206	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5030	5030#1	5030	45.48	2010	5	0.1775	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5040	5040#1	5040	13.36	1040	5	0.28	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5050	5050#1	5050	33.69	1700	5.75	0.1903	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5110	5110#1	5110	11.44	1500	5	0.1643	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5120	5120#1	5120	14.19	1640	5	0.1494	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5130	5130#1	5130	12.06	1000	5	0.1611	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5140	5140#1	5140	10.70	1180	5	0.194	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5150	5150#1	5150	10.76	1840	5	0.2093	0.014	0.3	0.1	0.2	20	8	0.2	0.1

Table 4-1
Runoff Catchment Characteristics
City of Astoria CSO Facility Plan

Inlet Name	Subcatchment Name	Catchment No. On Figures	Drainage Area (ac)	Width (ft)	Percent Imperviousness (%)	Slope (ft/ft)	Manning's Roughness		Depression Storage		Zero Detention (%)	Green Ampt. Method		
							Impervious	Pervious	Impervious	Pervious (in)		Average Capillary Suction (in)	Initial Moisture Deficit	Saturated Hydraulic Conductivity (in/hr)
5205BI	5205BI#1	2010	2.84	360	5.75	0.2679	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5205BI	5205BI#2	2020	6.45	500	12.5	0.2167	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5205BI	5205BI#3	2030	7.21	560	28	0.1439	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5205BI	5205BI#4	2040	8.02	440	17	0.2375	0.014	0.3	0.1	0.2	20	8	0.2	0.1
5205BI	5205BI#5	2120	8.26	900	5.75	0.2384	0.014	0.3	0.1	0.2	20	8	0.2	0.1
7DULOC1	7DULOC1#1	29010	8.89	200	19.3	0.1429	0.014	0.3	0.1	0.2	20	8	0.2	0.1
7DULOC1	7DULOC1#2	29020	4.08	260	38.3	0.016	0.014	0.3	0.1	0.2	20	8	0.2	0.1
H20204	H20204#1	46080	15.19	1080	9.5	0.1845	0.014	0.3	0.1	0.2	20	8	0.2	0.1
H20218	H20218#1	46020	15.83	1020	5.75	0.1087	0.014	0.3	0.1	0.2	20	8	0.2	0.1
mhDENVER	mhDENVER#1	43070	16.2	300	14.4	0.104	0.014	0.3	0.1	0.2	20	8	0.2	0.1
mh5TH	mh5TH#1	45120	6.66	440	14.8	0.182	0.014	0.3	0.1	0.2	20	8	0.2	0.1
mh5TH	mh5TH#2	45130	4.88	400	16.3	0.125	0.014	0.3	0.1	0.2	20	8	0.2	0.1
mh38TH	mh38TH#1	8040	7.04	620	13.3	0.159	0.014	0.3	0.1	0.2	20	8	0.2	0.1
mhOF035	mhOF035#1	5060	7.43	240	18.5	0.1	0.014	0.3	0.1	0.2	20	8	0.2	0.1

TABLE 4-2
Imperviousness of Land Use Types

Land Use	Impervious
Commercial/Industrial	80%
Open/Undeveloped Area	5%
Residential	40%
Institutional	60%
Vacant	10%

The **depression storage** must be filled before runoff occurs. It represents the loss or "initial abstraction" caused by such phenomena as surface ponding, surface wetting, interception, and evaporation. Depression storage may be treated as a calibration parameter, particularly to adjust runoff volumes. Water stored as depression storage on impervious areas is depleted by evaporation, while water stored as depression storage on pervious areas is subject to both infiltration and evaporation. A value of 0.1 inch was used as depression storage for impervious areas, and 0.2 inch was used for pervious areas in the model.

The **Manning's roughness** coefficient was used to describe overland flow for impervious and pervious surfaces within the subcatchment. Choosing from a range of Manning's roughness coefficients (n) recommended in the SWMM User's Manual for various ground covers, roughness values 0.014 and 0.030 were used for impervious and pervious areas, respectively.

Green-Ampt equation was selected to model **infiltration** into pervious areas within each subcatchment. The Green-Ampt equation computes the infiltration capacity of a soil using a function based on the soil's hydraulic characteristics such as porosity and hydraulic conductivity. The Green-Ampt parameters were estimated based on literature guidance for the type of soils found in Astoria.

Large areas of the service area are undeveloped and forested. These areas produce stormwater and are combined down slope with parts of the combined sewer system. The responses from these areas are very dependent upon antecedent conditions and reflect the storage capacity of the forest floor. Monitoring data at several locations show that this is true. This affects CSO characterization substantially. In the areas where it is known to occur, the flows produced are delayed and can produce larger storm flows from smaller rainfall events. The wet weather infiltration components from groundwater have been modeled in the Runoff block.

Transport Model

The dry-weather component of combined sewer flow or sanitary flow with a diurnal pattern is added to the runoff hydrograph using the Transport block provided by SWMM. The total base sanitary flow for each subcatchment is obtained by distributing the flow to each of the runoff manholes proportional to the ratio of subcatchment area to total service area. The total base sanitary flow used was 6.2 mgd, representing an approximation of future base sanitary flow based on a population of 15,000.

Extran Model

Extran is a complex model used extensively for evaluation of storm, sewer, and CSO systems. Extran receives hydrograph input at specific nodal locations by interface file from upstream blocks (first the Runoff block, and then the Transport block). The model performs dynamic routing of combined sewer flows throughout the drainage system to the WWTP and other outfall points of the receiving water system.

Extran is a model that solves the full gradually varied flow equations (the St. Venant equations). The Extran model is suitable for simulating branched or looped networks; backwater caused by pressure or surcharge flow; flow reversals; and flow transfer by weirs, orifices, and pumping facilities. The Astoria sewer network is represented in Extran as a system of conduits, manholes or junctions, diversion structures (orifices and weirs), pumping stations, and outfall junctions. The Extran system components are described below.

Conduits transmit flow from junction to junction. They are represented in Extran by shape, size, length, hydraulic roughness, connecting junctions, and upstream and downstream invert elevations. Approximately 570 pipes were simulated for the Astoria sewer network, including the overflow and underflow pipes at the diversion structures and the interceptor.

Junctions or manholes in Extran have the attributes of ground elevation and invert elevation. During the Extran simulation, when the hydraulic head exceeds the ground elevation to maintain continuity at the junction, the model allows the excess junction inflow to flood onto the ground. Generally this "flooding" is lost from the system.

Diversion structures are represented in Extran with orifices or weirs. The orifices route the combined sewer flow to the interceptor. The physical characteristics that are input into the Extran model are type (side outlet is used in the model), invert level, orifice area, and discharge coefficient. Weirs provide relief or overflow to the sewer system during periods of storm runoff. The input parameters for weirs consist of type (transverse weir is used in the model), length, crest elevation, and discharge coefficient. Forty-one diversion structures were included in the Astoria Extran model. Table 4-3 summarizes the diversion structure data used in the Extran model.

Pump and lift stations in Extran are conceptually represented as either an in-line lift station or an off-line node representing a wet well, or, alternatively, in-line or off-line pumps using a three-point pump curve (head versus pumped outflow). Both in-line lift stations and off-line wet-well pumps exist in the model. Input data for both in-line or off-line stations are low, mid, and high pumping rates. Particularly for in-line pumps, water levels for high and mid rate pumps are needed. Total well volume, levels for high and mid rate pumps, and initial well volume are needed for off-line pumps. Pumping station data are listed in Table 2-1.

Outfall junctions are the ending point of the system and represent the CSO discharges and the discharge from the WWTP. Free outfalls have been used in the Astoria Extran model, which represents the normal case for CSO discharges.

Table 4-3
Summary of Diversion Structure Data Used in the Extran Model
City of Astoria CSO Facility Plan

Diversion Number	Type	Orifice Data: Diameter (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Discharge Coefficient	Mannings Roughness	Weir Data: Type	Crest Height (ft)	Weir Top (ft)	Weir Length (ft)	Discharge Coefficient
46	Bottom Outlet	0.58	12.44	12.43	1	0.0036	Transverse	0.35	3	1	3
45	Bottom Outlet	0.79	33.24	33.23	1	0.0044	Transverse	1	9	4	3
44	Bottom Outlet	0.50	14.02	14.01	1	0.0033	Transverse	0.35	10.5	3	3
43	Bottom Outlet	0.58	12.44	12.43	1	0.0036	Transverse	0.7	5.5	1.75	3
42	Bottom Outlet	0.50	12.12	12.11	1	0.0033	Transverse	0.3	6.4	2	3
41	Bottom Outlet	0.50	13.52	13.51	1	0.0033	Transverse	0.5	4	1.5	3
40	Bottom Outlet	0.50	12.52	12.51	1	0.0033	Transverse	0.55	4.5	1.5	3
39	Bottom Outlet	0.50	12.52	12.51	1	0.0033	Transverse	0.35	9	1.5	3
38	Bottom Outlet	0.50	12.52	12.51	1	0.0033	Transverse	0.35	12	1.5	3
36	Bottom Outlet	0.58	12.44	12.43	1	0.0036	Transverse	0.5	7	1.25	3
35	Bottom Outlet	1.11	10.64	10.63	1	0.0051	Transverse	0.3	3.3	2	3
34	Bottom Outlet	0.50	12.72	12.71	1	0.0033	Transverse	0.3	8.8	1	3
33	Bottom Outlet	0.50	14.13	14.12	1	0.0033	Transverse	0.3	7.39	1	3
32	Bottom Outlet	0.50	12.35	12.34	1	0.0033	Transverse	1.47	10.27	1	3
31	Bottom Outlet	0.50	12.52	12.51	1	0.0033	Transverse	0.3	9	1.25	3
30	Bottom Outlet	0.50	13.23	13.22	1	0.0033	Transverse	0.6	7.79	1.5	3
29	Bottom Outlet	0.50	12.47	12.46	1	0.0033	Transverse	0.3	9.05	1.5	3
28	Bottom Outlet	0.50	15.20	15.19	1	0.0033	Transverse	0.5	9.12	1.5	3
27	Bottom Outlet	0.50	16.69	16.68	1	0.0033	Transverse	0.3	7.83	1.5	3
26	Bottom Outlet	0.50	16.47	16.46	1	0.0033	Transverse	0.3	8.05	2	3
25	Bottom Outlet	0.50	19.77	19.76	1	0.0033	Transverse	0.3	6.75	2.5	3
24	Bottom Outlet	0.50	16.31	16.30	1	0.0033	Transverse	0.65	5.21	2.5	3
23	Bottom Outlet	0.50	14.17	14.16	1	0.0033	Transverse	0.35	19.35	2.5	3
22	Bottom Outlet	0.50	17.52	17.51	1	0.0033	Transverse	0.3	11	2.5	3
21	Bottom Outlet	0.50	24.32	24.31	1	0.0033	Transverse	0.3	9.2	2.5	3
20	Bottom Outlet	0.50	13.52	13.51	1	0.0033	Transverse	0.3	14	2.5	3
19	Bottom Outlet	0.50	12.41	12.40	1	0.0033	Transverse	0.26	15.81	2.5	3
18	Bottom Outlet	0.50	12.19	12.18	1	0.0033	Transverse	0.3	4.83	1.5	3
17	Bottom Outlet	0.50	12.02	12.01	1	0.0033	Transverse	0.5	7.5	2.5	3
16	Bottom Outlet	0.50	16.02	16.01	1	0.0033	Transverse	0.6	9	1.5	3
15	Bottom Outlet	0.50	15.02	15.01	1	0.0033	Transverse	0.3	10.5	1.5	3
13	Bottom Outlet	0.50	12.52	12.51	1	0.0033	Transverse	0.3	13	2	3
12	Bottom Outlet	0.50	20.22	20.21	1	0.0033	Transverse	0.3	5.3	1.25	3
11	Bottom Outlet	0.63	12.40	12.30	1	0.0038	Transverse	0.3	4.9	2.5	3
10	Bottom Outlet	0.50	13.74	13.73	1	0.0033	Transverse	0.3	4.78	1	3
9	Bottom Outlet	0.54	12.83	12.82	1	0.0035	Transverse	0.3	3.65	1	3
8	Bottom Outlet	0.54	12.82	12.81	1	0.0035	Transverse	0.6	8.76	1.5	3
7*	Bottom Outlet	1.00	28.56	28.55	1	0.0049					
7*	Bottom Outlet	0.50	29.52	29.51	1	0.0033					
6	Bottom Outlet	0.50	12.72	12.71	1	0.0033	Transverse	0.3	6.9	1	3
4	Bottom Outlet	0.50	12.42	12.41	1	0.0033	Transverse	0.3	9.1	4	3
3	Bottom Outlet	0.50	9.92	9.91	1	0.0033	Transverse	0.3	4.3	2.5	3
2	Bottom Outlet	0.50	13.52	13.51	1	0.0033	Transverse	0.35	4	1.5	3

* - Diversion #7 has two orifices with one connecting to the interceptor, the other to the outfall

Figure 4-1 represents the Extran model for the Astoria combined sewer system with diversion structure and outfall numbers.

Model Calibration and Verification

The Runoff-Transport-Extran model described in the previous section was calibrated and verified by using historical rainfall data and running the model to obtain results in pipes at which monitoring data were collected. Model results were compared with monitoring data collected during the 1994-1996 monitoring period from the pump stations, treatment plant records, and portable flow monitors located throughout the system.

From the flow monitoring data, three storm events were selected to calibrate and verify the model for the existing collection system. Table 4-4 summarizes the storm events in terms of event period, maximum 24-hour precipitation volume, total rainfall volume, and the flow monitor data that are available from the event.

TABLE 4-4
Storm Events Used in Model Calibration

Event Period	Maximum 24-Hour/ Total Rainfall Volume (inches)	Flow Monitors Involved in Calibration
12/14/94 to 12/21/94	2.54/7.33	5th St. and McClure St.
		Denver St. & Erie Alley
		Lift Station 4
		34th St. and Franklin St.
1/27/95 to 2/3/95	2.75/6.31	Denver St. & Erie Alley
		Outfall at Denver St. & Erie Alley
		38th St. and Franklin St.
2/5/96 to 2/11/96	4.13/9.55	Upstream of Outfall 001 at 3rd St. and east Hanover St.
		Downstream of Outfall 001 at 3rd St. and east Hanover St.

Three model runs were performed for these selected events. During the calibration process, appropriate changes for catchment width, impervious percent, and other parameters were made. The calibration results are shown in Figures 4-2 to 4-10.

As in all modeling exercises, it is not possible to fully duplicate the flow data recorded at the monitor. This is due primarily to inconsistencies in flow monitor performance, areal changes in rainfall over the model catchments and selected rain gage, and the assumptions made in the model. Some of the above inconsistencies and phenomena are shown in Figures 4-2 to 4-10. For example, Figure 4-3 shows a model response to rainfall on December 19, whereas monitor data are not responding. This could be indicative of a mis-reading of rainfall data or temporary interruption in monitor data collection.

Diurnal flow changes have the greatest impact on the visual comparisons of the model with monitor data. However, because the diurnal component represents a small fraction of the peak flow response, the effort expended in attempting to replicate diurnal or dry weather flow responses was limited. The model characterization also assumed a high peak flow rate for dry flow conditions. The wet weather response was superimposed on top of this.

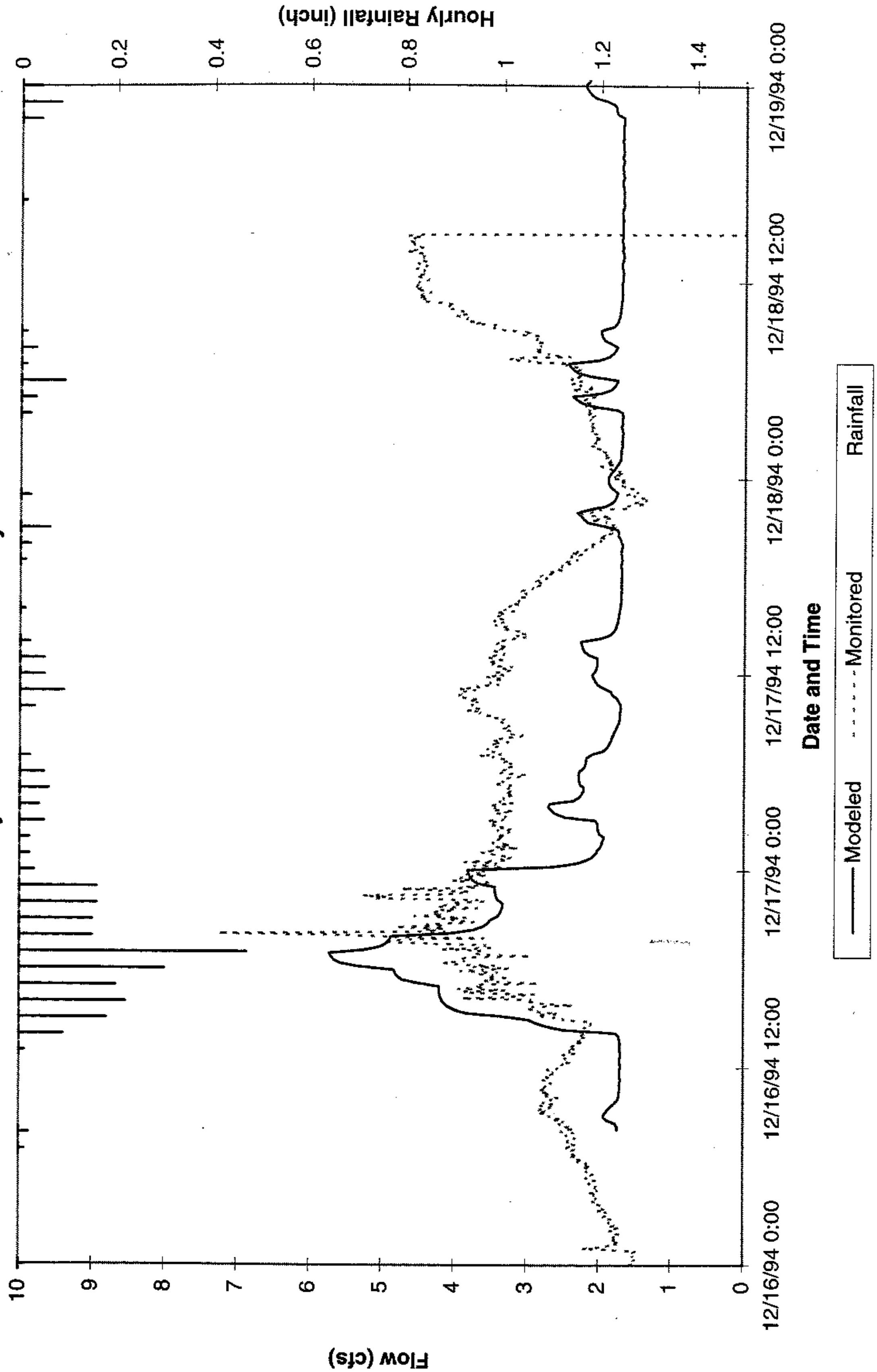
The model parameters in Runoff, Transport, and Extran were calibrated to simulate monitoring data. Principal data changes were made to the percent imperviousness of the subcatchments and the time and peak flow response through adjustment of "width" parameter. The latter was simulated by holding back flow in subcatchments by adding storage nodes at upstream ends of the basin and limiting the flow into the system.

Groundwater effects are shown in Figures 4-4 and 4-6 by the increase in responsiveness of the watershed to rainfall between the beginnings of the periods and the ends of the periods. Groundwater was modeled to reflect this phenomenon for basins that were identified as potential groundwater sources. These included undeveloped and forested areas that have large contributory drainage areas.

Figures 4-9 and 4-10 illustrate a problem with the monitoring not responding to potential flow; the model shows flow. Figure 4-9 shows upstream flow arriving at the diversion structure near 3rd and Hanover (OF45 or outfall 001). The peak flow is about 17 to 18 cfs. Figure 4-10 shows the monitored flow and model prediction for the same storm in the overflow pipe. Obviously, the monitor data are incorrect because the diversion orifice has a capacity of about 3 to 4 cfs (depending upon surcharged level at the diversion structure). The model shows an overflow on February 6, 1996, at about 6:00 a.m. of about 14 cfs and the monitor shows a 2 cfs response. The model in this case is believed to be more representative of flow conditions.

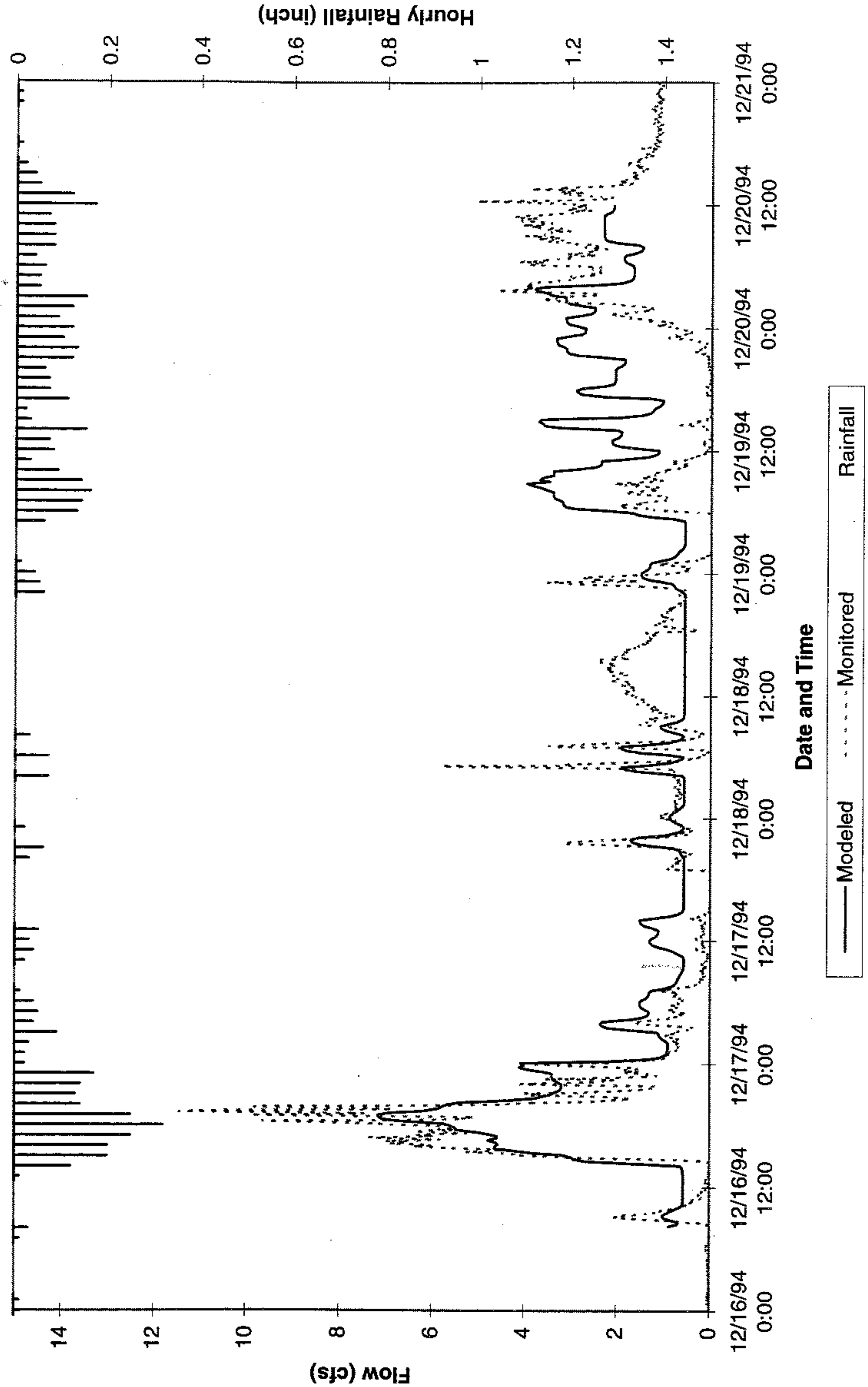
The calibration and verification of the Astoria model is believed adequate for the purposes of characterizing CSOs and in evaluating control alternatives. This is based on the replication of peak flows at critical monitors and the duplication of groundwater and the variable runoff response caused by saturated soil conditions. In general, the model is conservative in that it over predicts peak flows and runoff volume.

Figure 4-2
Modeled Flow vs. Monitored Flow at 34th & Franklin
City of Astoria CSO Facility Plan



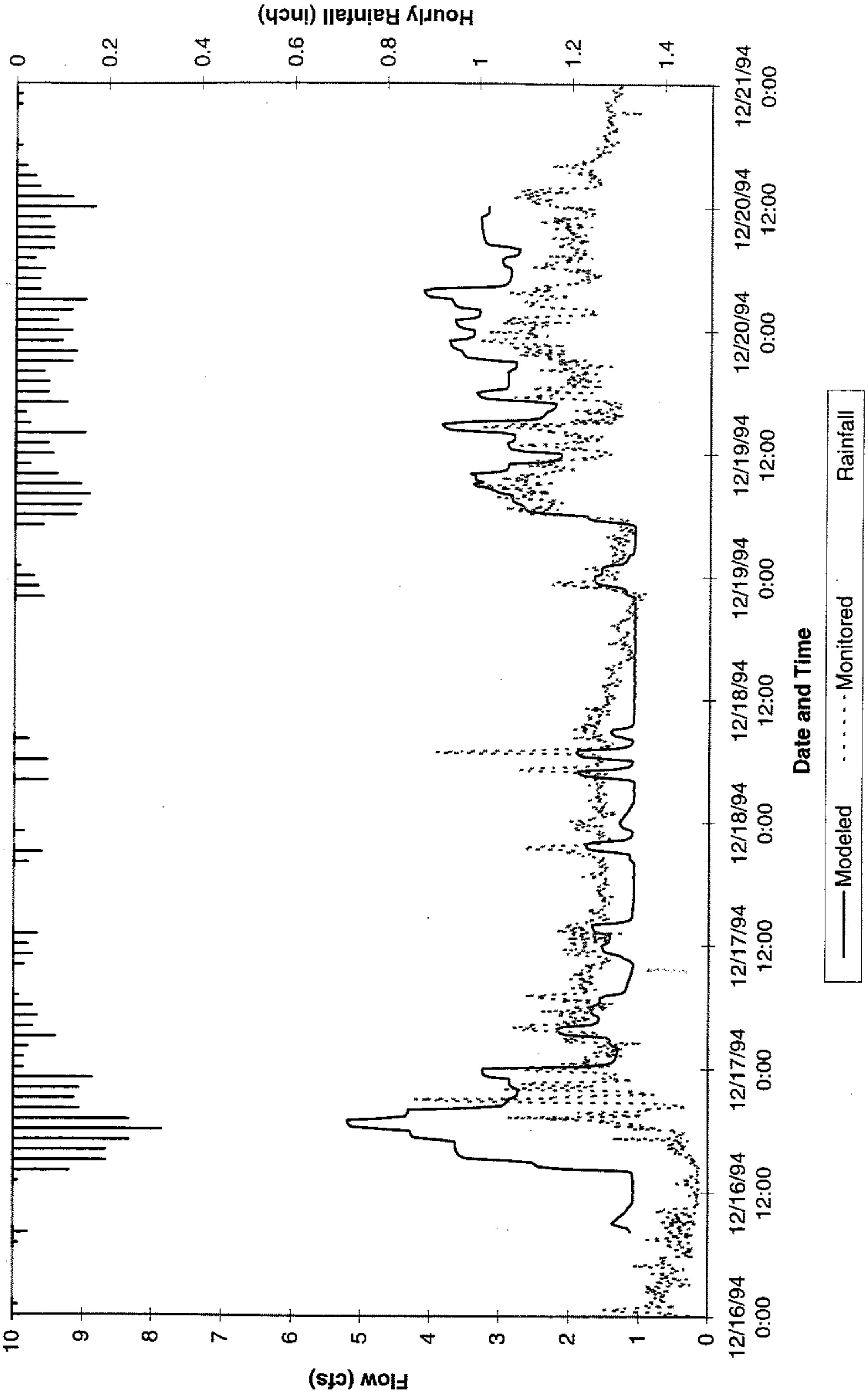
Records.xls c 94 34th

Figure 4-3
Modeled Flow vs. Monitored Flow at 5th & McClure
City of Astoria CSO Facility Plan



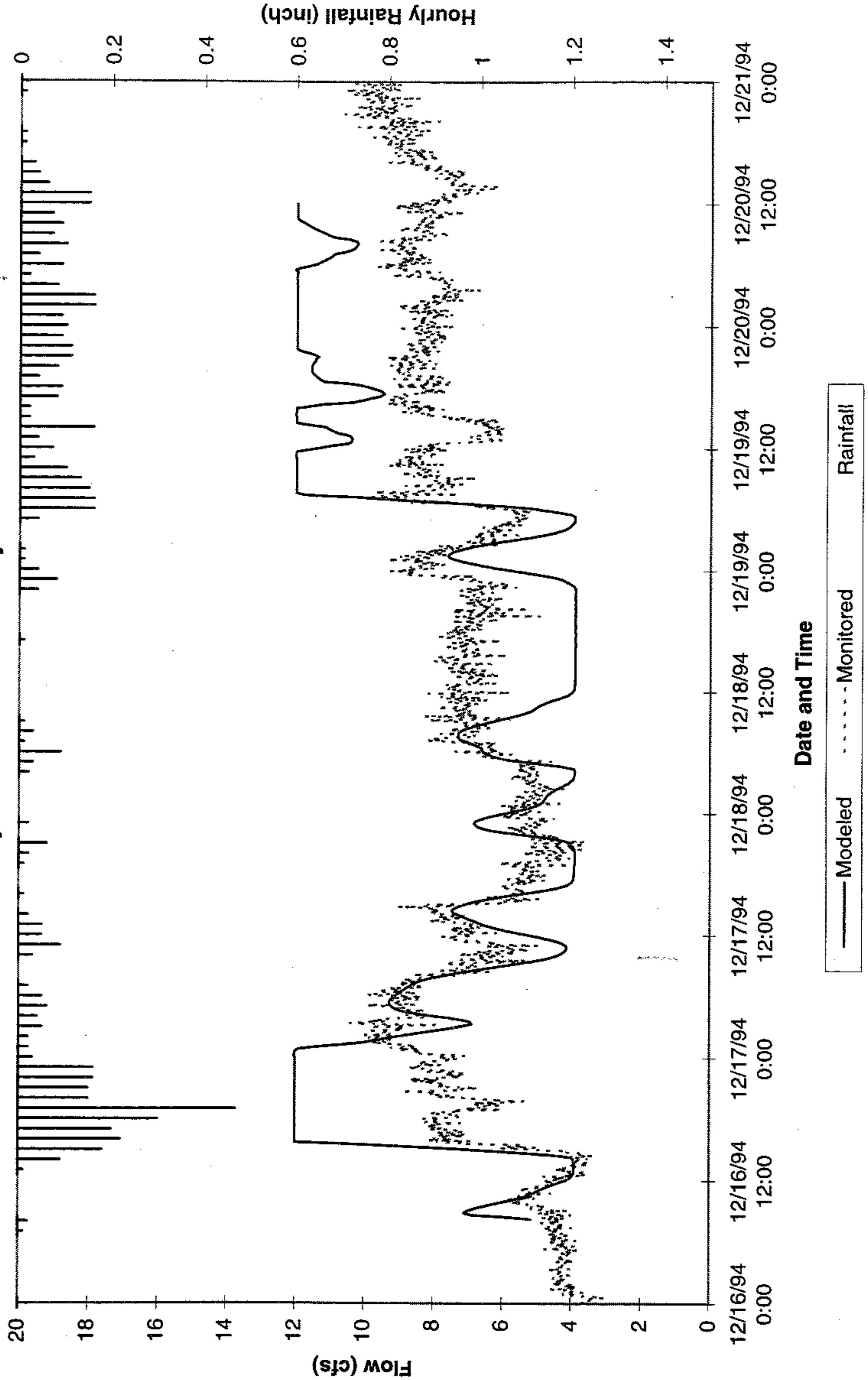
Records.xls c 94 5th

Figure 4-4
Modeled Flow vs. Monitored Flow at Denver & Erie Alley
City of Astoria CSO Facility Plan



Records.xls c 94 denver

Figure 4-5
Modeled Flow vs. Monitored Flow at Lift Station 4
City of Astoria CSO Facility Plan



Records.xls c 94 lift4

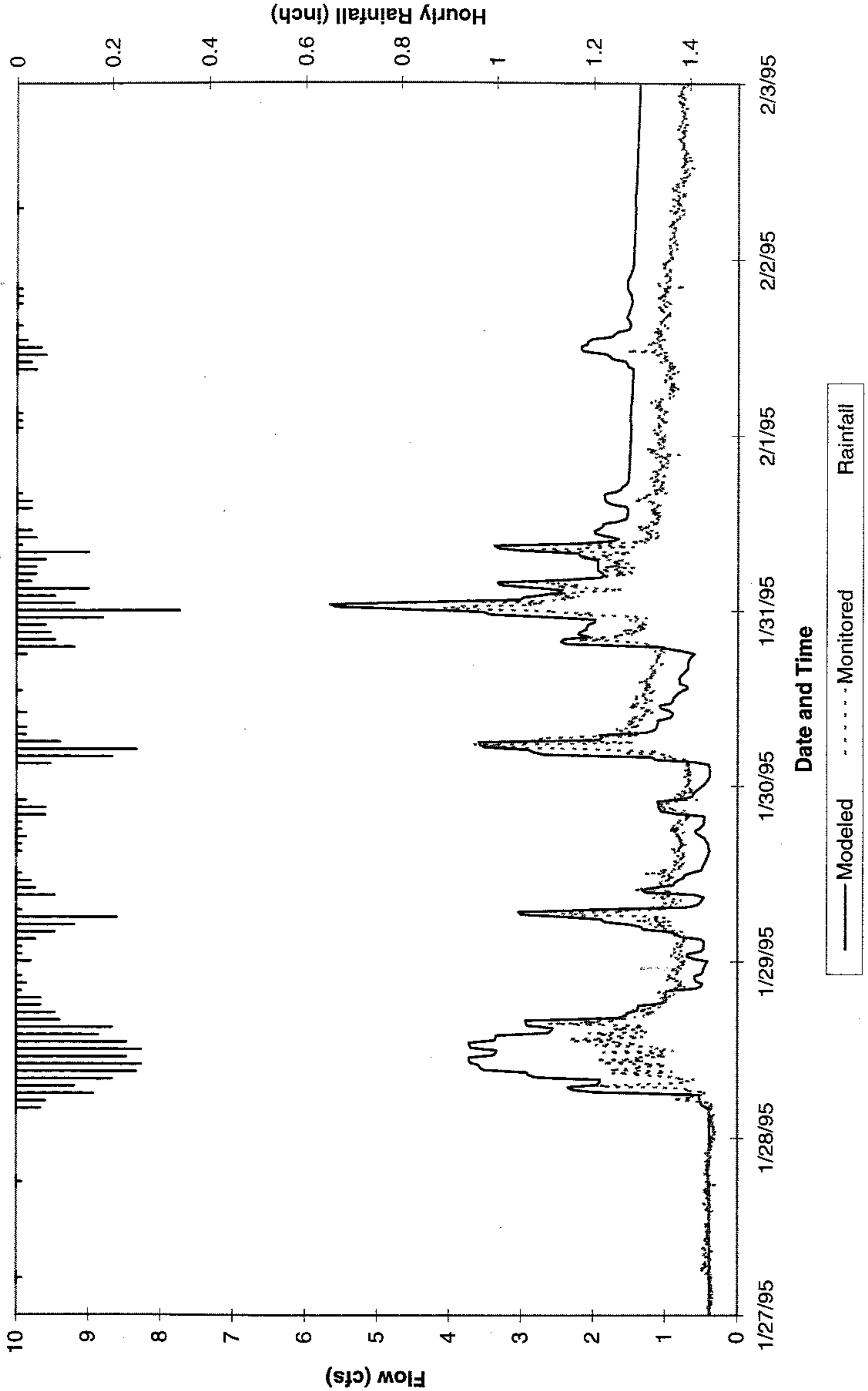


Figure 4-6
Modeled Flow vs. Monitored Flow at Denver & Erie Alley
City of Astoria CSO Facility Plan

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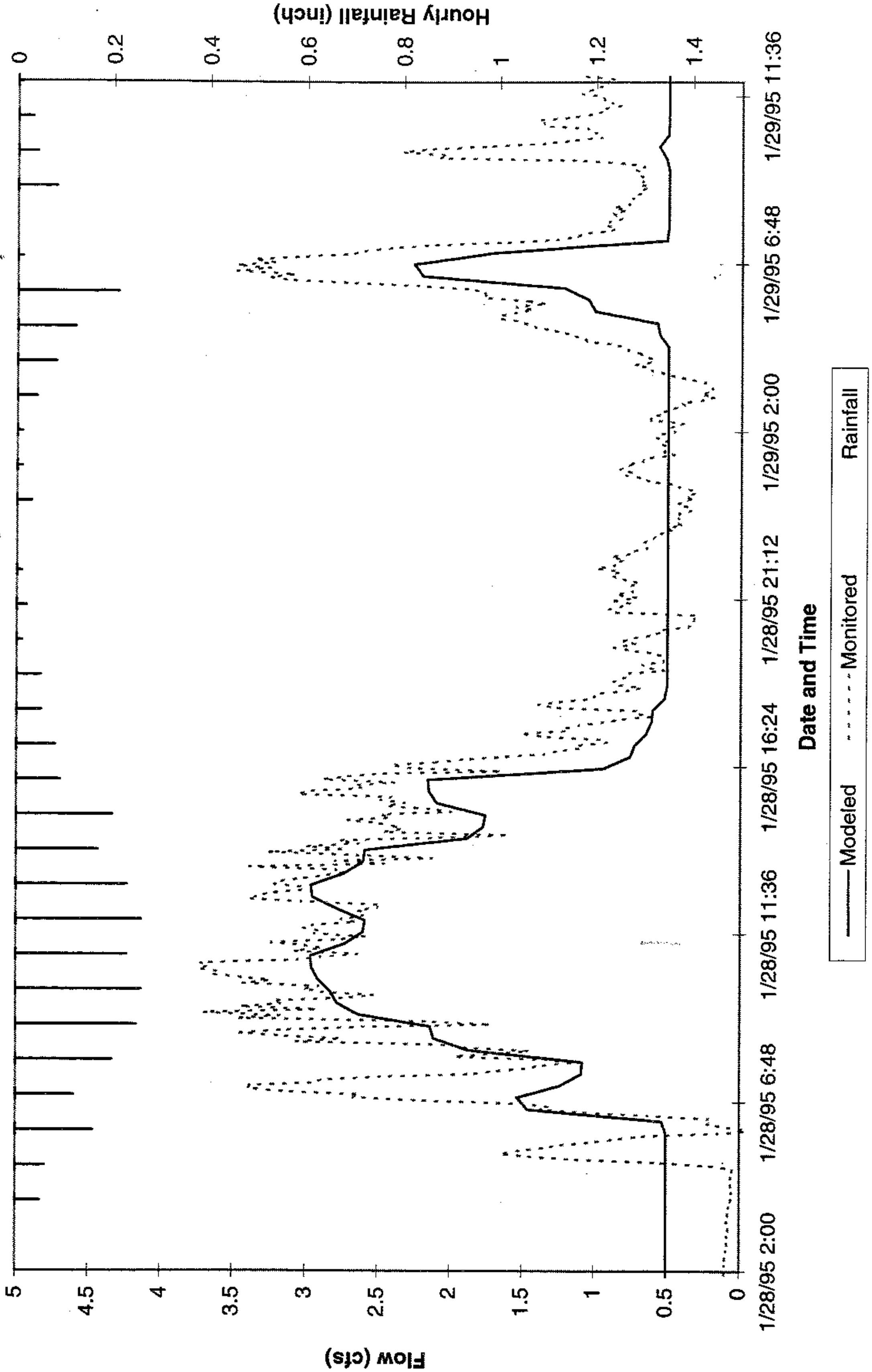
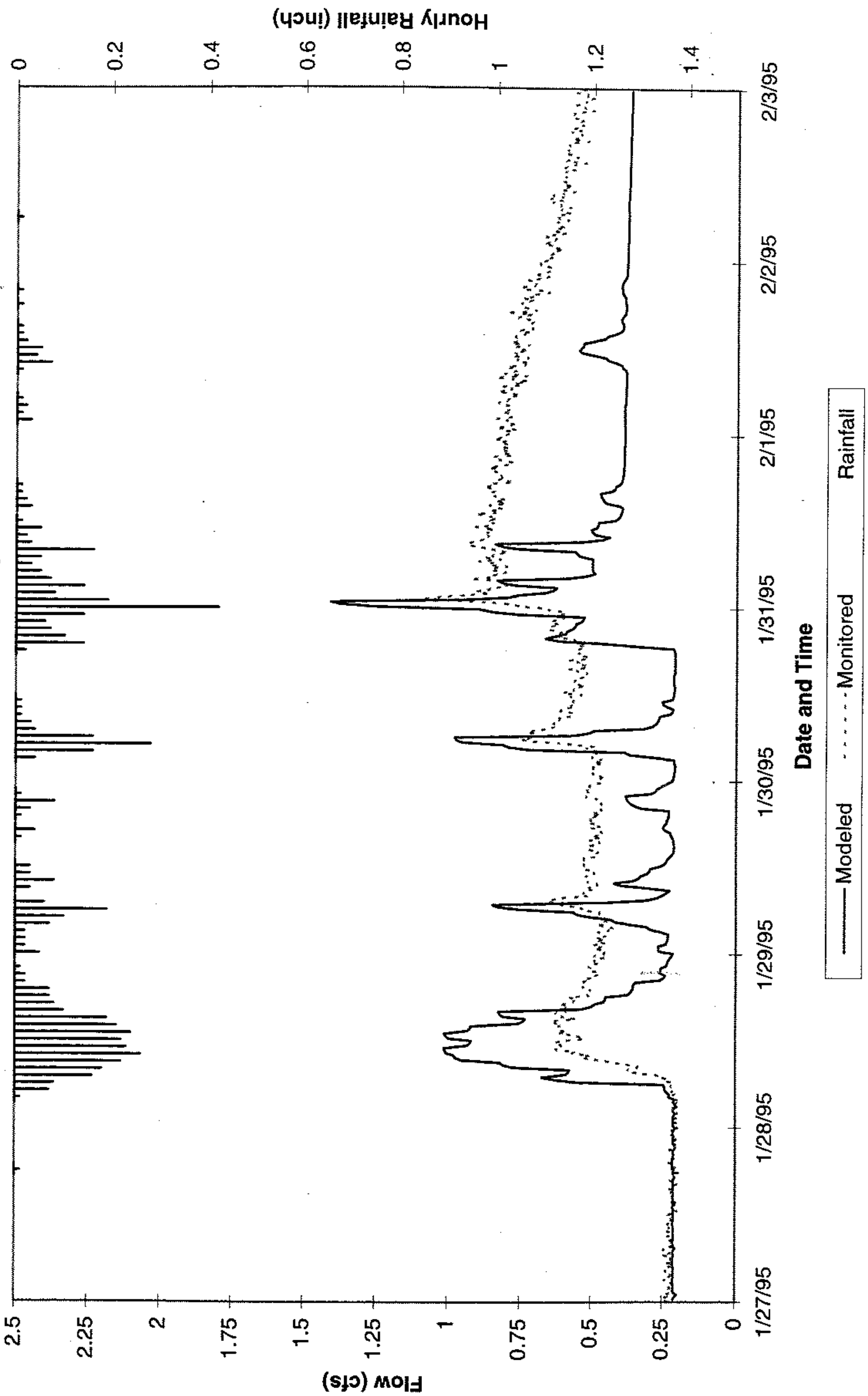
Figure 4-7
Modeled Flow vs. Monitored Flow Downstream of Denver and Erie Alley
City of Astoria CSO Facility Plan



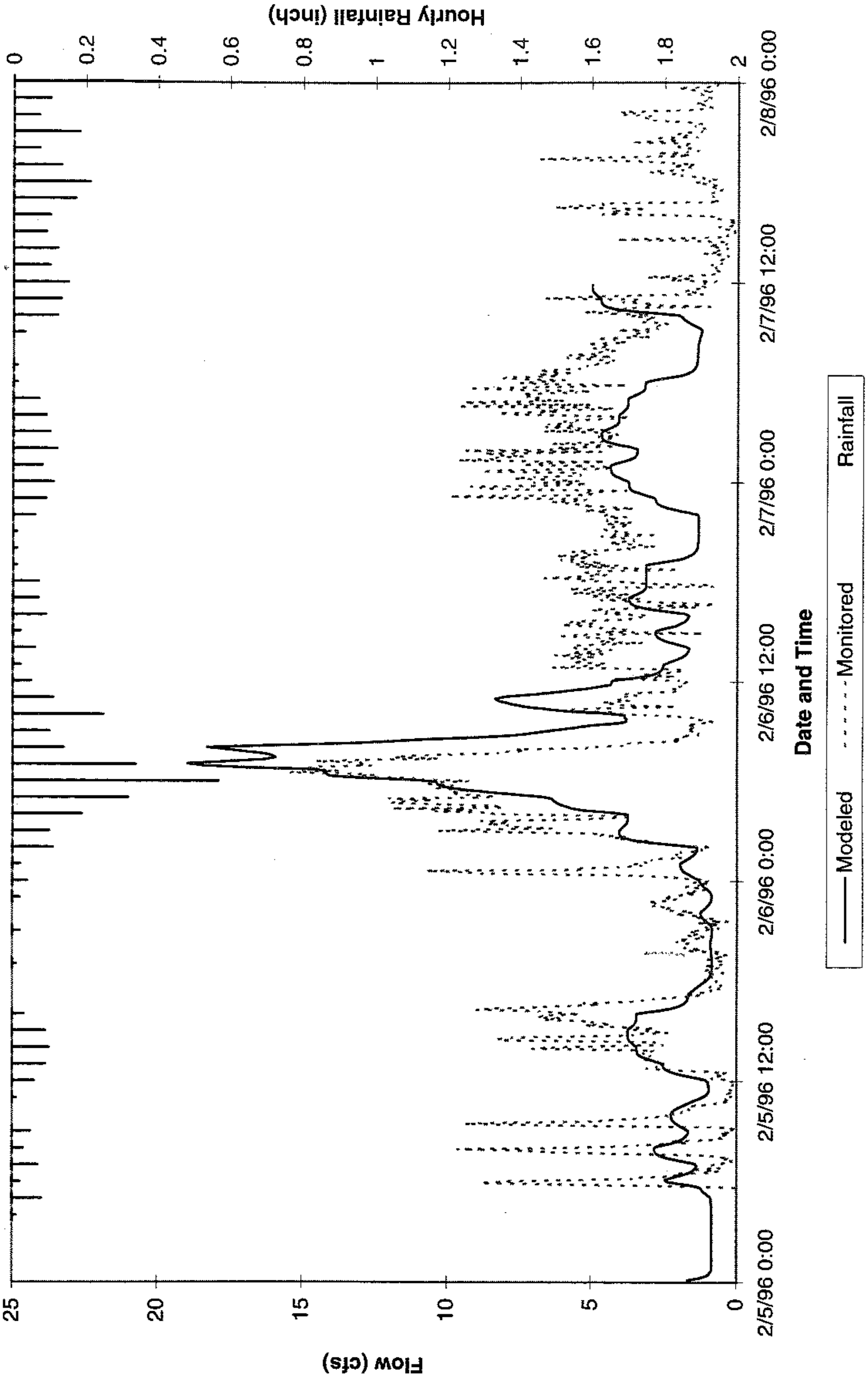
Records.xls c 95 denver ds

Figure 4-8
Modeled Flow vs. Monitored Flow Downstream of 38th and Franklin
City of Astoria CSO Facility Plan



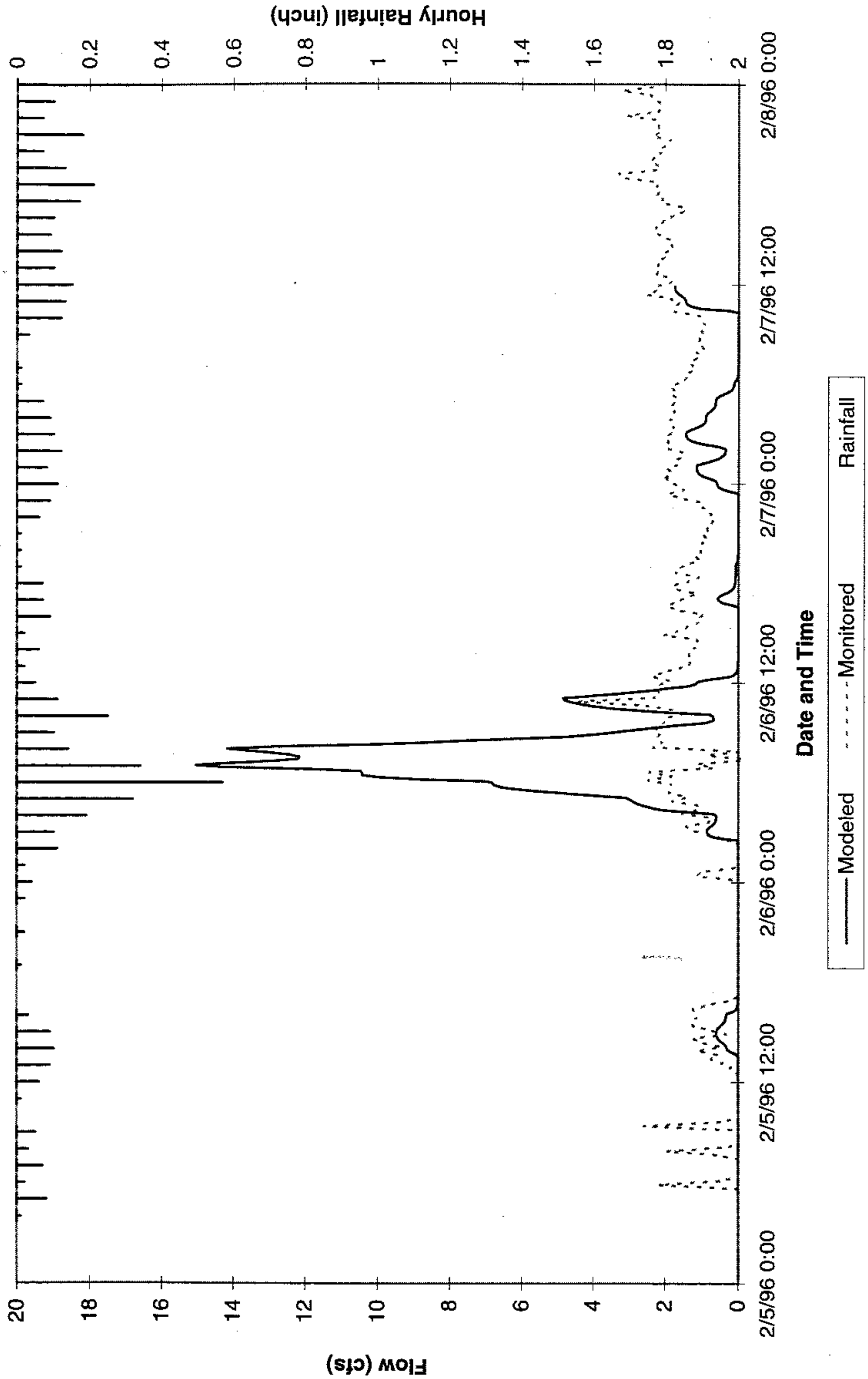
Records.xls c 95 38th

Figure 4-9
Modeled Flow vs. Monitored Flow Upstream of Outfall 001
City of Astoria CSO Facility Plan



Records.xls c 96 of001us

Figure 4-10
Modeled Flow vs. Monitored Flow at Outfall 001
City of Astoria CSO Facility Plan



Records.xls c 96 of001ds

SECTION 5

Characterization of CSOs

The purpose of this portion of the project is to quantify the volume, duration, and number of combined sewer overflow (CSO) events from each of the CSO outfalls under various rainfall conditions and to identify the systematic conditions that cause CSOs to occur from the Astoria system. System and monitoring data, with computer model simulations, were used to determine how large the CSO problem is, where CSO related problems occur, and why they occur. The Section also provides a summary of water quality data and typical annual loading to the receiving waters.

Annual CSO Characterization

A representative year of hourly rainfall data has been created as described in Section 3. The rainfall data of the representative year were used to generate the typical monthly and annual average CSO characteristics from each of the CSO outfalls. The calibrated CSO model described in Section 4 was run for the hourly rainfall series, and the results were produced. Because of the large size of the model output created and the long time required for the model runs, the model run was spilt into three periods: Part 1 for January through April, Part 2 for May through September, and Part 3 for October through December. Splitting the model this way also facilitates system performance review for winter and summer periods.

The CSO characteristics considered included overflow frequency, duration, and volume of CSO. The stage in each manhole and the flow in each conduit can also be obtained from the model results. This makes it possible to identify critical areas and the degree of sensitivity the Astoria system has to short-duration and long-duration rainfall events.

The total annual CSO volume produced from the Astoria system during the synthetic year of rainfall is 378 million gallons (MG). The annual inflow to the model (from the Runoff and Transport blocks) during the annual series is 3,213 MG. Therefore, the overflow volume represents about 12 percent of the total system inflow. The model simulation indicates that the WWTP processes a total flow of 2,833 MG or about 88 percent of the total inflow to the system. A small volume (2 MG) represents the change in storage in the system between the beginning and ending of the simulation, the numerical continuity error, and minor amounts of flooding.

The number of CSO events, total overflow volume, and total overflow duration for each of the CSO outfalls during the synthetic year are presented in Table 5-1. The total CSO volumes and numbers of events at the outfalls are illustrated in Figure 5-1. The data in Table 5-1 show the difference in summer and winter rainfall patterns and the subsequent difference in CSO characteristics. The summer period (May to September or Part 2 in Table 5-1) has a total volume of CSO of about 50 MG, whereas the winter months (sum of Part 1 and Part 3) have a total volume from all CSOs of about 330 MG.

Table 5-1
Statistics of CSO Events for Synthetic Year
City of Astoria CSO Facility Plan

Overflow	Number of CSO Events				Total CSO Volume (MG)				Total Event Duration (hr)			
Number	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual
OF02	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF03	11	17	6	34	7.01	1.65	12.99	21.64	2,041	694	1,715	4,450
OF04	13	18	6	37	111.13	35.91	121.68	268.72	2,206	767	516	3,489
OF06	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF07	25	23	20	68	2.78	0.94	2.46	6.18	1,545	545	982	3,072
OF08	7	3	13	23	0.07	0.03	0.16	0.26	23	13	66	102
OF09	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF10	5	1	5	11	0.02	0.01	0.03	0.05	4	1	23	28
OF11	27	10	23	60	1.59	0.66	2.65	4.89	356	86	353	795
OF12	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF13	27	10	23	60	1.11	0.43	1.76	3.30	357	45	365	767
OF15	15	6	19	40	0.42	0.20	0.85	1.47	108	27	163	297
OF17	12	5	16	33	0.17	0.09	0.39	0.65	75	18	104	197
OF18	25	9	21	55	1.09	0.94	7.24	9.28	281	39	309	629
OF19	7	3	12	22	0.08	0.05	0.24	0.38	23	14	68	105
OF20	14	6	18	38	0.31	0.15	0.59	1.05	124	23	147	294
OF21	5	1	5	11	0.02	0.01	0.03	0.06	4	1	23	28
OF22	8	5	15	28	0.11	0.06	0.24	0.41	27	16	86	129
OF23	8	5	15	28	0.10	0.06	0.21	0.37	26	16	85	126
OF24	7	3	13	23	0.07	0.03	0.14	0.24	23	4	64	90
OF25	0	1	3	4	0.00	0.00	0.01	0.01	0	0	2	2
OF26	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF27	4	1	4	9	0.01	0.00	0.02	0.04	3	1	22	26
OF28	5	1	5	11	0.01	0.01	0.03	0.04	3	1	23	27
OF29	1	0	3	4	0.00	0.000	0.00	0.00	0	0	1	1
OF30	24	12	19	55	2.61	0.91	4.35	7.87	670	169	662	1,501
OF31	0	0	1	1	0.00	0.00	0.00	0.00	0	0	0	0
OF32	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF33	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF34	20	8	20	48	0.50	0.23	0.90	1.62	160	32	236	428
OF36	18	7	18	43	4.04	1.94	8.56	14.54	126	31	183	339
OF38	8	5	15	28	0.12	0.07	0.28	0.48	67	20	98	185
OF39	8	5	15	28	0.11	0.06	0.26	0.44	27	16	87	131
OF40	25	10	22	57	1.21	0.53	2.17	3.91	313	40	330	683
OF41	8	5	15	28	0.09	0.05	0.21	0.35	25	15	85	125
OF43	21	14	17	52	5.95	1.88	9.75	17.59	917	209	907	2,033
OF44	8	5	15	28	0.12	0.07	0.27	0.47	60	20	89	168
OF45	27	10	23	60	3.85	1.58	6.27	11.70	362	87	366	814
Total Volume					144.70	48.54	184.75	377.99				

Note: See Table 2-2 for relationship between overflow number, street name and NPDES outfall number

Avgcso.xls annual summary

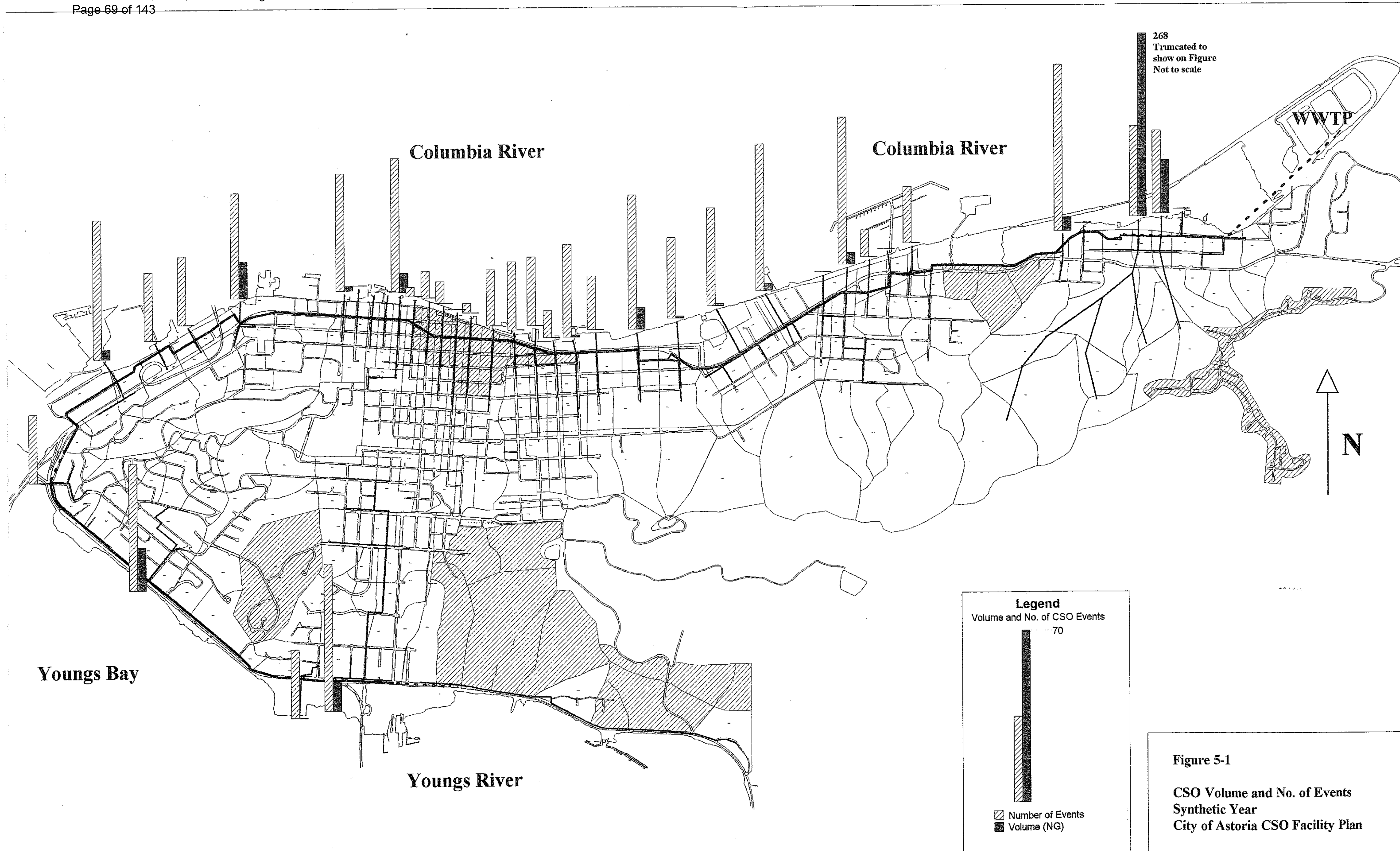


Figure 5-1

CSO Volume and No. of Events
Synthetic Year
City of Astoria CSO Facility Plan

The largest overflow is OF04, located in the northeast part of the system at 47th Street. This CSO receives substantial flows from large undeveloped and forested areas, which contribute substantial flows during wet weather. The wet spring months also contribute substantial flows, as shown by the extent of overflow during Part 2 simulations (Table 5-1). Similarly, at other overflows, undeveloped areas contribute substantial portions of the wet weather flow and contribute high infiltration amounts during dry periods (for example, OF45—3rd and Hanover and OF43—5th and McClure).

These flows were represented in the model through groundwater contributions. The simulation of groundwater and moisture conditions caused by antecedent rainfall is important in characterizing Astoria CSOs. For example, small storms can, with wet antecedent conditions, produce higher flows than larger storms with dry antecedent conditions. Antecedent moisture conditions and the large differences in rainfall amounts (see Figure 3-5 for hourly rainfall for the synthetic year) between the summer and winter months account for the substantial differences in character between summer and winter CSOs.

The patterns of the number of CSO events at each of the outfalls and the total overflow durations reflect the CSO volume. Number of events and duration are further tied together because a low number of events can be the result of a long duration and the high volume character of a particular CSO. For example, OF04 has 37 events with about 3,500 hours of overflow, but OF13 has 60 events with about 770 hours of overflow. Events for large-volume and long-duration CSOs often overlap and are counted as a single event that lasts several days.

Many of the Astoria outfalls only discharge during severe storm events, while other CSOs overflow frequently. Outfall OF31, for example, has one event annually and discharges a total volume of less than 5,000 gallons in less than 1 hour. The system simulation shows that nine overflows do not overflow during a typical year: OF02, 0F06, 0F09, OF12, OF25, OF26, OF31, OF32, and OF33. The simulation does not indicate overflows at these outfalls for a variety of reasons, but primarily because of the small contributing drainage area and sufficient capacity for the diversion structure to pass flow to the interceptor without exceeding the weir elevation, which would cause an overflow. This flow, however, may result in additional overflow downstream, as discussed below.

The locations of the diversion structures in the system generally result in little interaction between CSO overflows. The overflow is controlled by the amounts of flow generated in the basin and the diversion structure performance. A typical interaction would be the reversal of flows from the interceptor into a diversion structure and discharge to the outfall. The interceptor has also several relief points to prevent severe flooding. The relief points are located upstream of Lift Station 3 and Lift Station 4. They provide "safety valves" for the system and a mechanism for the interceptor to deliver as much sewage to the lift stations, and ultimately to the WWTP for treatment, as possible. If the flow delivered is in excess of the capacity of the lift station, the interceptor water level rises until it reaches the invert of the relief pipe. The relief pipes connect with CSO outfalls OF18 and OF36. This flow relief for the interceptor contributes to the discharge volumes at these two overflows, making them larger than would be expected based on the sizes of their contributing drainage areas (Table 5-1 and Figure 4-1).

SFO Characterization

The characterization of the CSO system during the summer and winter design storms given in the SFO and determined in Technical Memorandum 3.2 followed a process similar to the annual simulation. Model runs were made with the same collection system representation and basin values as those in the calibration and annual simulations. One significant difference, however, is the length of the simulation period. For the SFO storms, a 24-hour rainfall period has been assumed. For the simulation and characterization of these events, it has also been assumed that for the summer period, typical dry antecedent conditions existed. For the winter design storm, the simulation included a winter month of rainfall (December of the typical year) preceded the winter storm. This ensured that wet antecedent conditions prevailed before the winter storm occurred, and that the appropriate amount of groundwater inflow and wet condition runoff occurred. The winter SFO storm is a 5-year event, and the summer SFO storm is a 10-year event.

The number of CSO events, CSO volumes, and the durations of overflows at each of the CSO outfalls for the winter and summer SFO storms are summarized in Table 5-2. Figure 5-2 shows the CSO volumes for the winter and summer SFO storms. The total system inflow for the winter storm was 69 MG, with 42 MG (61 percent) treated at the WWTP and about 27 MG as CSO overflow or about 39 percent of the total inflow. The summer storm had a total inflow of 40 MG, with 32 MG (80 percent) treated, and 8 MG (20 percent) discharged as CSO. All overflows show some CSO discharge under design storm conditions.

Table 5-2 shows the effects of antecedent conditions on the responses of the basins and CSO system to the design storms. The effects are evident by the relative responses of OF04 and OF18. In the summer, OF04 has one of the lower CSO volumes, but it has the largest winter storm volume. OF18, however, in the summer has the largest volume of all the overflows, and the second largest overflow during the winter SFO storm. OF18 is impacted by the amount of relief overflow from the interceptor, whereas OF04 has large areas of undeveloped forested areas.

Water Quality Characterization

In October 1994 and February 1995, the City of Astoria collected water quality samples at three representative sites. The collection program was presented in Technical Memorandum 3.1 (April 13, 1994) and discussed with representatives of the Oregon Department of Environmental Quality (DEQ) in a meeting in June 1994. As discussed with DEQ, no data were collected in the receiving waters, nor was a water quality assessment performed to determine the impacts of CSO discharges on the receiving water. The discussions suggested that it would be premature to perform such an analysis, and the analysis would be very difficult, given the expected water quality of CSO discharges, the large sizes of the receiving water bodies, and the high tidal and flow influences. Additional water quality data was collected in March 1998 to supplement metals data.

Combined sewage was collected for two events at three diversion structures, where flow-monitoring data were also collected and two events at CSO 18 outfall. The samples at the diversion structures were taken in the influent pipe of the diversion structure and not at the overflow or outfall. The four events are indicative of dry conditions (no preceding rainfall

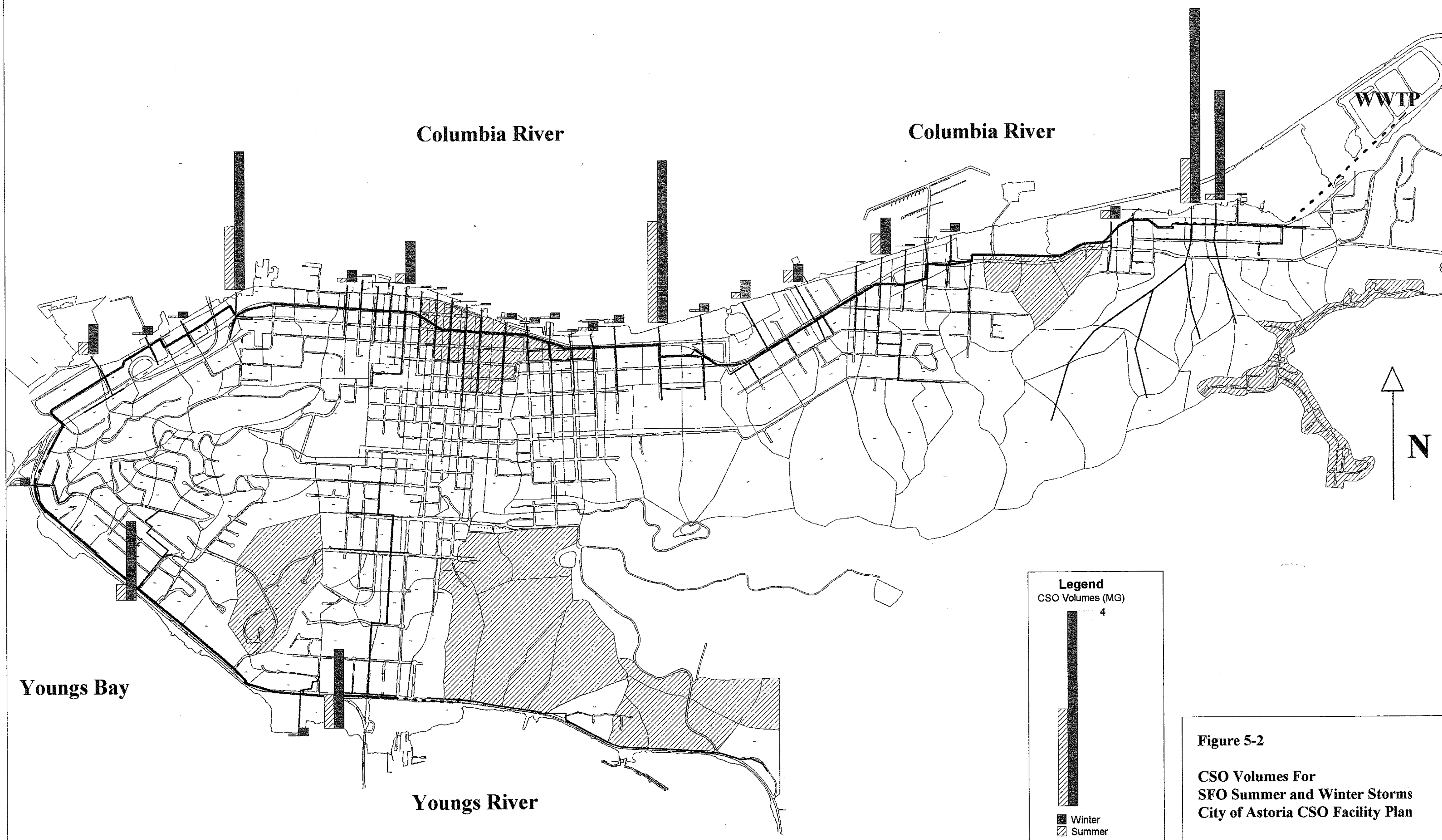


Figure 5-2

CSO Volumes For SFO Summer and Winter Storms City of Astoria CSO Facility Plan

Table 5-2
Statistics of CSO Events for Summer & Winter Design Storms
City of Astoria CSO Facility Plan

Overflow Number	Summer 10-year Storm		Winter 5-year Storm	
	CSO Volume (MG)	Duration (hr)	CSO Volume (MG)	Duration (hr)
OF02	0.01	1	0.03	2
OF03	0.11	26	2.25	12
OF04	0.92	34	8.39	0
OF06	0.00	1	0.02	2
OF07	0.18	29	0.23	26
OF08	0.03	2	0.16	5
OF09	0.00	0	0.01	2
OF10	0.02	2	0.05	3
OF11	0.41	18	0.77	22
OF12	0.00	66	0.00	70
OF13	0.25	18	0.39	22
OF15	0.13	4	0.37	12
OF17	0.06	2	0.17	7
OF18	2.09	20	3.35	23
OF19	0.07	2	0.18	5
OF20	0.09	4	0.19	8
OF21	0.02	2	0.06	3
OF22	0.05	2	0.12	5
OF23	0.05	2	0.12	5
OF24	0.04	2	0.11	4
OF25	0.01	1	0.04	2
OF26	0.00	1	0.02	2
OF27	0.02	1	0.04	3
OF28	0.02	1	0.05	3
OF29	0.01	1	0.04	2
OF30	0.19	9	0.86	26
OF31	0.00	57	0.01	2
OF32	0.00	81	0.00	0
OF33	0.01	1	0.03	2
OF34	0.07	7	0.23	18
OF36	1.30	15	2.83	21
OF38	0.05	3	0.12	5
OF39	0.05	2	0.16	5
OF40	0.24	9	0.61	22
OF41	0.06	2	0.18	5
OF43	0.33	14	1.63	0
OF44	0.05	2	0.16	5
OF45	0.70	14	1.62	23
Total Volume	7.62		25.60	

Note: See Table 2.2 for relationship between overflow number, street name and NPDES outfall number.

for a number of days) and wet conditions. The sites represent the typical range of land uses found in Astoria and are at the following locations (see also Figure 3-1):

- Site 1: 5th and McClure, a Youngs Bay discharge
- Site 2: Denver and Erie, a Youngs Bay discharge
- Site 3: 34th and Franklin, a Columbia River discharge
- CSO 18: 20th Street, one of the major CSO locations discharging to the Columbia River

The data collected, and the corresponding data for the WWTP influent, are given in Table 5-3 for 1994 events and Tables 5-4 and 5-5 for additional metals data at CSO18. The October event had dry antecedent conditions, and the February event had wet antecedent conditions. The March event had dry antecedent conditions. Data from March 1998 was collected and analyzed to a lower detection limit to better determine metal concentrations. The metal detection limits from 1994 generally exceeded water quality criteria. March data showed mixed results, with most parameters within acute limits and exceeding chronic limits. However the analysis does not consider a mixing zone for chronic conditions. The final SFO and NPDES permit for the CSO discharges may therefore contain a mixing zone designation for the CSO outfalls to enable compliance with water quality criteria.

TABLE 5-3
Water Quality Sampling Data

Site	BOD (mg/L)	TSS (mg/L)	Fecal Coliform (million/100 mL)
10/20/94 Event			
Site 1: 5th and McClure	17	49	0.6
Site 2: Denver and Erie	18	38	0.1
Site 3: 34th and Franklin	13	40	0.2
WWTP Influent	105	297	2.1
2/17/95 Event			
Site 1: 5th and McClure	21	22.2	6.7
Site 2: Denver and Erie	19.8	13.7	0.7
Site 3: 34th and Franklin	1.5	0.9	0.0008
WWTP Influent	43.5	41	4.8
Typical Range of Other Cities (from Table 2, TM 3.1)	17-222	85-727	0.2-2.5

BOD = Biochemical Oxygen Demand
TSS = Total Suspended Solids

The sampling data that were collected showed that the water quality of Astoria's CSOs is within the range typical for other comparable cities or better than typical (see Table 2 of TM 3.1 for complete range of data at other cities). The WWTP influent data show that during wet weather, the flow to the treatment plant has levels of BOD and TSS that are towards the low end of values for CSO discharges in other communities. Fecal coliform values are higher at the WWTP influent because a high percentage of the sanitary flow is captured.

Because the sample data showed that the water quality of CSOs in Astoria is within typical CSO ranges, it was not considered necessary to collect additional data as part of this planning effort or initiate a receiving water impact assessment.

TABLE 5-4
Exceedance of Acute Metal Criteria

Metal	Acute (µg/L)	Marine/Fresh	Sample Date and Value (µg/L)				
			10/21/94			3/1/98	3/9/98
			CSO45 3rd and Hanover	CSO43 Denver Ave.	CSO11 34th Street	CSO18 Marine& Columbia	CSO18 Marine& Columbia
Chromium	16	Fresh	<10	<10	<10	<2	<2
Copper	2.9	Marine	30	40	30	18	16
Lead	34 (50 mg/L $CaCO_3$)	Fresh(hardness					
	82 (100 mg/L $CaCO_3$)						
	16 (28 mg/L $CaCO_3$)					4	7
Mercury	2.1	Marine/Fresh	<1	<1	<1		0.014
							0.013
Nickel	75	Marine	<20	<20	<20	<4	<4
Zinc	95	Marine	450	540	550	160	60

Shaded values within limits. Does not consider mixing zone dilution.

TABLE 5-5
Exceedance of Chronic Metal Criteria

Metal	Acute (µg/L)	Marine/Fresh	Sample Date and Value (µg/L)				
			10/21/94			3/1/98	3/9/98
			CSO45 3rd and Hanover	CSO43 Denver Ave.	CSO11 34th Street	CSO18 Marine& Columbia	CSO18 Marine& Columbia
Chromium	11	Fresh	<10	<10	<10	<2	<2
Copper	2.9	Marine	30	40	30	18	16
Lead	.6 (28 mg/L $CaCO_3$) Fresh(hardness dependent)					4	7
Mercury	0.012	Marine/Fresh	<1	<1	<1		0.014
							0.013
Nickel	8.3	Marine	<20	<20	<20	<4	<4
Zinc	86	Marine	450	540	550	160	60

Shaded values within limits. Does not consider mixing zone dilution.

Receiving Water Character

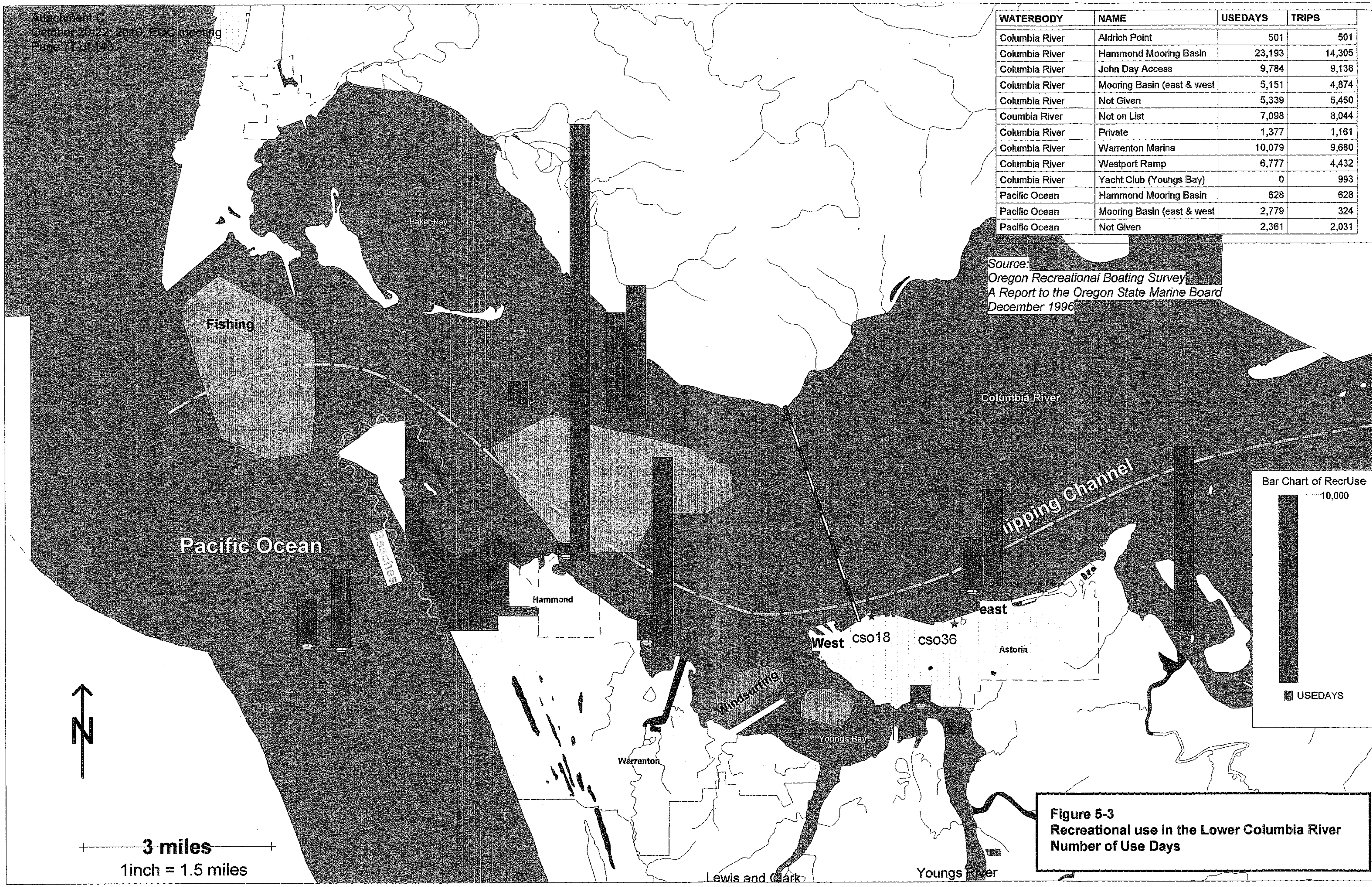
Characterization of the receiving water is difficult. The Columbia River at Astoria is approximately 3 to 5 miles wide and is subject to 8- to 10-foot tidal ranges. Flow discharge data are not regularly measured, but estimates at annual average flow are in the 300,000-mgd range. Some water quality data exist from the early 1980s. DEQ collects water quality data in some tributary rivers but not in the Columbia River near Astoria, the Columbia Estuary, or Youngs Bay (Personal Communication, Kathy Taylor, CREST; Larry Caiton, DEQ, June 1997).

Warrenton High School has recently received a grant for water quality data collection on the Scuppernog River and Columbia River. These data may be useful in future studies. The most comprehensive study to date is the Bi-State program for the Lower Columbia River. This study encompassed the Lower Columbia River from the Bonneville Dam to the mouth of the Willamette River and other tributaries. The *Health of the River: 1990-1996 – Integrated Technical Report* provides a summary of the over 50 reports produced during the 6-year period. The overall summary of the river's health indicates some evidence of beneficial use impairment, principally due to sediment and fish tissue evidence.

Recreational Uses

The recreational uses specifically water contact activities, is limited in the immediate areas to CSO outfalls because of the high tidal changes and cool water temperatures. Recreational and commercial boating are the primary uses of the Columbia River with some wind surfing in the southern portions of Young's Bay. Data on actual usage is limited. However, in 1996 the Oregon Marine Board issued a report detailing a survey of recreational boating in Oregon (*Oregon State Marine Board, "Oregon Recreational Boating Survey, 1996", December 1996)*. Data from this report and additional queries on data compilation and interpretation was obtained for analysis (*Brida Monoz-Hernadez, Personal Communication, May-June 1998)* of recreational of the water bodies near Astoria. The data compiles boater's response to a survey on boating use, water body use, launch site and other data.

Figure 5-3 shows the uses of the waters around Astoria and the number of use days indicated by the data for the launch site. Local experience of the waters has also been included to indicate the major use areas of the area waters. The heaviest uses are in the fishing areas near Hammond or about 5 miles from Astoria's CSO. Figure 5-4 shows extraction of the annual data to reflect the seasonal uses of all the water bodies in the Astoria area. Figure 5-4 shows the heavy use of the waters during the summer months with much lower use in the winter months.

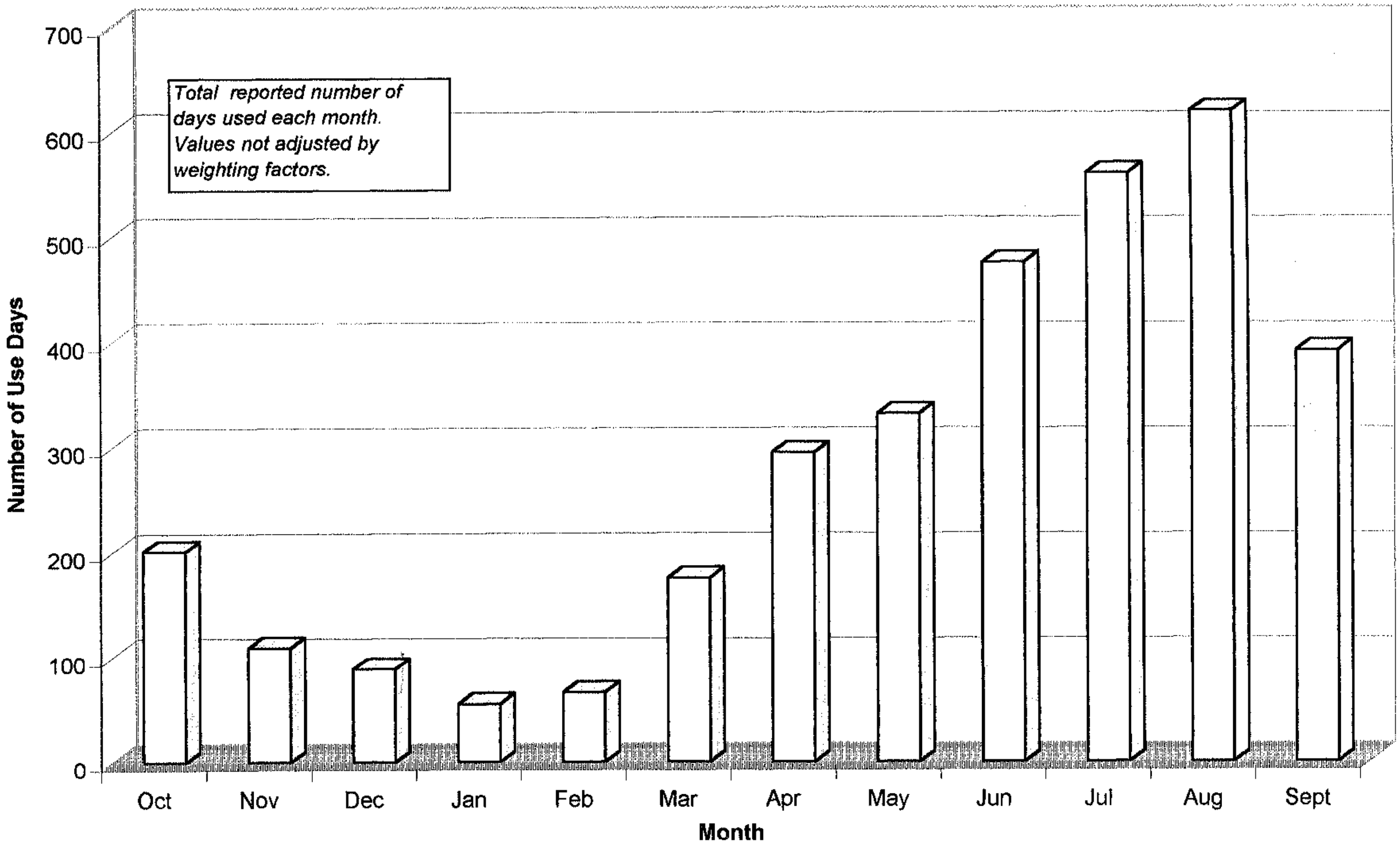


WATERBODY	NAME	USEDAYS	TRIPS
Columbia River	Aldrich Point	501	501
Columbia River	Hammond Mooring Basin	23,193	14,305
Columbia River	John Day Access	9,784	9,138
Columbia River	Mooring Basin (east & west	5,151	4,874
Columbia River	Not Given	5,339	5,450
Coumbia River	Not on List	7,098	8,044
Columbia River	Private	1,377	1,161
Columbia River	Warrenton Marina	10,079	9,680
Columbia River	Westport Ramp	6,777	4,432
Columbia River	Yacht Club (Youngs Bay)	0	993
Pacific Ocean	Hammond Mooring Basin	628	628
Pacific Ocean	Mooring Basin (east & west	2,779	324
Pacific Ocean	Not Given	2,361	2,031

Source:
Oregon Recreational Boating Survey
A Report to the Oregon State Marine Board
December 1996

Figure 5-3
Recreational use in the Lower Columbia River
Number of Use Days

Figure 5-4: Seasonal Use of Astoria Area Water Bodies Users from Clatsop and Washington Counties



SECTION 6

Evaluation of Control Plans

The City of Astoria and the consultants for this plan have investigated many site specific combined sewer overflow (CSO) control technologies and strategies for controlling the discharges at each of the CSO outfalls. The assessment of control technologies and the control plans developed considered the locations of the outfalls and particularly the usage of the receiving water. The uses of the receiving waters are limited because of the harbor and commercial nature of most of the shoreline, the high flow currents generated by tides, and the generally cool water temperatures. The plans, however, consider that Youngs River, Youngs Bay, and the embayments in the Alderbrook neighborhood on the northern side of the peninsula, into which overflows OF03 and OF04 discharge, are more sensitive than other reaches. Control plans developed in this Section form the foundation for the recommended plan detailed in Section 7 and provide a basis for comparing alternative schemes for controlling CSOs.

Control Technologies

Six general control technologies are available to Astoria for control of CSOs. Although these technologies can be used individually, they are often best used in combination to form a overall control alternative. The six control technologies considered are:

1. Inflow control through delay or removal of stormwater runoff
2. Sewer system optimization
3. Conveyance
4. Storage in offline tanks or in inline pipes
5. Treatment at the existing WWTP and at other points in the system
6. Sewer separation (partial basin or complete basin separation)

Complete separation of the entire sewer system has also been considered as an alternative and is presented herein. Each of the general control technologies are described below.

Inflow Control

The reduction or removal of stormwater from the combined sewer system is often one of the most effective control technologies for implementation. For example, the City of Portland through implementation of the series of Cornerstone Projects that target inflow reduction and flow removal projects a reduction in CSO of about 50 percent. The City of Astoria considered similar inflow controls including stream separation, control of flow into inlets through vortex valves, and street slipping of stormwater. The main technology considered for Astoria was the installation of vortex valves into catchbasins or inlets.

Installation of vortex controls at catchbasin inlets would reduce the instantaneous peak flow arriving at the diversion structure while continuing to capture the first flows of a storm event. The peak flow from most storms usually exceeds the orifice capacity and results in a CSO over the weir at the diversion structure. The inlet controls stores water at the inlet or causes the flow to slip downhill to the next inlet. Eventually the flow reaches the bottom of the hill where it either ponds or is captured by a stormwater only system. How inlet controls and flow slipping would work for the steep streets of Astoria is illustrated in the photographs of Figure 6-1.

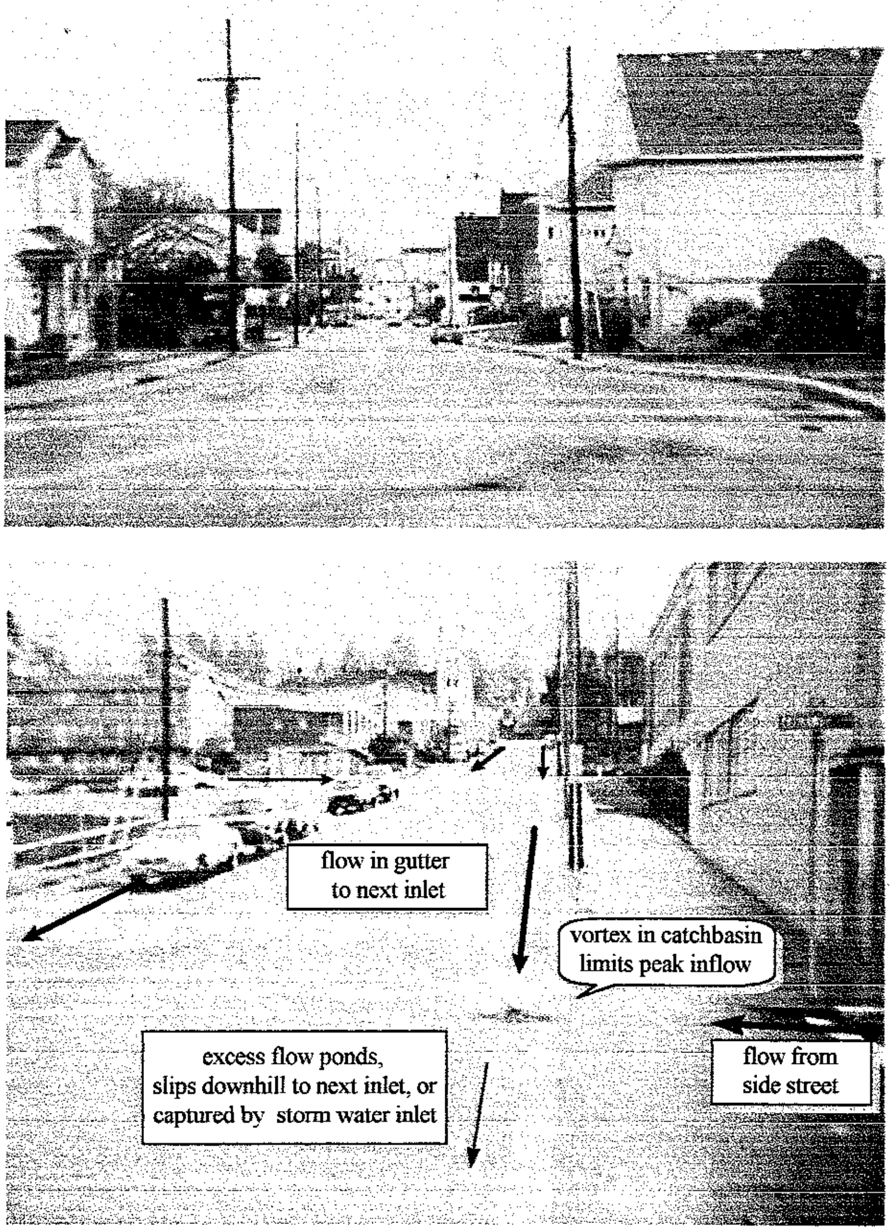


FIGURE 6-1
Street Slipping of Stormwater

The first photograph in Figure 6-1 shows a typical downhill view of the streets of Astoria. The Columbia River is in the background. Inlet controls are placed in each inlet. The capacity of each vortex limits the flow so that the sum of peak inlet flow does not exceed the capacity of the diversion orifice. The flow from side streets is also collected at the inlets at intersections. Inlet controls are also placed at catchbasins along streets. The second photograph is an uphill view of the same street and further illustrates the concept of inlet control and street flow slipping.

An additional feature of the basin inlet controls proposed for Astoria is the diversion of roof drains to driveways and to streets. This roof drain disconnection removes a fast response connection to the combined sewer system and allows the flow to be detained in the street or slipped downhill. However, not all houses or roof drains can be disconnected because of site limitations and the locations of the roof drains.

The majority of basins in Astoria are suitable for this type of CSO control. The northern basins however, are more suitable for installation of inlet flow controls because of the linear nature of the basins and streets. In some basins the flow slipped downhill can be captured at the bottom of the hill in an existing storm drain system.

To enhance the capture rate or limit ponding at intersections, cross street connections may be added to convey flow from one side of the street to the other. The street conveyed stormwater might also be collected in selected locations into a new stormwater system that reconnects to the existing CSO outfall.

System Optimization

The construction of the interceptor system eliminated a high percentage (over 88 percent) of combined sewage overflows or direct connections to the Columbia River and Youngs Bay. The interceptor system receives water from the basin drainage system. This drainage system is very effective in collecting and conveying sanitary sewage and stormwater from the basins to the interceptor at the waterfront. The collection system also ensures that the basins are adequately drained to prevent the soils from becoming saturated. Adequate subsurface drainage is important because the soils in Astoria are poorly drained and subject to slipping or failure if they become saturated. Therefore, the modifications to the system to enhance performance cannot effect the drainage of the basins and the removal of water to prevent soil saturation. At the diversion structures, however, the combination of orifice low flow discharge and overflow weirs can be adjusted to ensure that full use is made of the pipe system. This has already been accomplished by the City of Astoria through removal of the orifice plates that limited flow to the interceptor. Therefore, system optimization consists of adjusting weir heights and orifice openings to further enhance flow to the interceptor and reduce CSO volume and number of events. System optimization also includes evaluation of pump station operation.

Conveyance

Conveyance is defined as the construction of new pipes to capture and convey combined sewage flow to treatment or storage. The new pipes could replace or parallel existing sewers to provide the conveyance of combined sewer flow. Construction of the new sewer lines would require open cut of streets or tunneling.

Storage (Offline and Inline)

Storage of combined sewer flows would detain peak flows generated from the basins. The operation of the diversion structure is very dependent on the peak flow rate and the capacity of the orifice and underflow pipe. Offline storage would consist of tanks situated adjacent to the existing sewer system to receive flow by gravity. They would be pumped or would discharge by gravity to the interceptor. Inline storage usually consists of oversized conveyance pipes or flow control devices that use existing large diameter sewers to reduce peak flows. Storage does not effect the overall volume of flow conveyed by the system but results in more flow into the interceptor and hence to the WWTP. Storage tanks can be above or below ground; they can be open tanks, closed tanks, or earthen basins. Covered storage facilities can provide the opportunity for multiple-use benefits such as sports fields, parks, or promenades on top of the facility.

Treatment

For this plan, treatment was generally considered as being equivalent to primary treatment, which includes screening, solids removal, and disinfecting. This level of treatment physically removes 30 to 50 percent of the floatables and solids before discharge to the receiving waters. Providing treatment equivalent to primary treatment with disinfection is consistent with the U.S. Environmental Protection Agency (EPA) CSO policy. Several technologies exist to remove solids, including sedimentation basins (similar to the existing WWTP) and swirl or vortex separators. Chlorinating the CSO would prevent bacteria from reaching the receiving waters. Dechlorination would control any toxic effects of the chlorinated effluent. Dechlorination, however, may not be required, depending upon the mixing zone requirements adopted by DEQ. Neither state nor federal water quality regulations require secondary treatment of CSO discharges.

Sewer Separation

Sewer separation is usually the installation of a completely new drainage system to convey stormwater only and discharge it to the receiving waters. Sewer separation in the basins would require the construction of a new storm drain system rather than a new sanitary system because of the commingling of sewage and stormwater at house connections and the drainage of streets and other areas into the same system. The existing sewer system would carry sanitary flow with flow from some basement and roof drains. In some areas a new sanitary system could be constructed with the existing CSO system acting as the storm drain system. This latter method is much harder to ensure complete removal of sanitary wastes.

Partial separation of some basins and removal of undeveloped area drainage are also viable technologies for Astoria CSO reduction. This is particularly true in areas that are already partially separated or where street or impervious-area storm drainage can be diverted to a nearby stream.

Control Plans

The control components that were developed for evaluation and the overall control plan or alternatives were formulated so as to reflect the nature and community values of Astoria. This includes recognizing the extent to which the City is able to afford the elimination of

CSOs and weighing the benefits received for the expenditures. The relatively large size of the receiving waters compared to the size of the CSO event volume is an important factor in the City of Astoria's approach to controlling CSOs. The vitality of the economy of Astoria and the population's income are low, which greatly influences the community's ability and willingness to embark on major public works projects, unless there is a clear and significant benefit produced. The range of plans outlined below incorporates the values of Astoria and the hydrologic and hydraulic factors that produce CSOs from each of the basins.

The CSO control alternatives described below form the basis of the draft recommended plan contained in the Draft Facility Plan and the Final Plan presented in Section 7. The alternatives consist of a series of projects or components that use one or more of the control technologies described above. Each major component step or series of steps produces an alternative that could be the stopping point for the CSO control plan. Each alternative produces a level of control over CSO volume and CSO events. The "do nothing" alternative was nor directly evaluated but is represented by the existing definition of the CSO discharges and effects upon the beneficial uses of the Columbia and other area water bodies. The alternatives build upon other alternatives by incorporating other alternative components or expanding upon the size or extent of the components.

Alternative 1: Sewer System Enhancement

The review and modeling of the sewer system produced a series of recommendations that would reduce CSO volume and frequency without major construction of new facilities. The projects in the alternative are widespread and effect almost every basin in the system. The majority of the projects consist of reconstruction or modifications to existing diversion structures—primarily raising the weir structures.

Significant CSO volume is produced by contributions from the undeveloped and forested areas on the northern side of the peninsula, particularly at outfalls OF04 (47th Street) and OF03 (48th Street). Therefore common component (Component 1) of most alternatives includes removal of the stormwater contribution to OF04. Reconstruction of the overflow diversion structure accomplishes the removal of combined sewer overflows to the outfall. Several houses would also be disconnected and new sewers constructed to capture the sanitary flow from the houses. The outfall would remain and become a stormwater only discharge.

Component 1 is the first step in building the first control alternative – Alternative 1. The modifications to the system and the stormwater removal have been simulated for the Stipulation and Final Order (SFO) winter and summer storms and for Part 3 (October to December) of the typical year. The net effect of the projects is a reduction of overflow volume by 63 percent from an estimated 185 million gallons (MG) to 69 MG for October-December of the typical year. For the winter and summer design storms, the reductions are 44 percent and 21 percent, respectively. Tables 6-1 and 6-2 and Figures 6-2 to 6-4 show the results at each of the CSOs for Alternative 1 compared with existing conditions for synthetic year and design storms.

Alternative 2: Existing System Optimized

Alternative 2 builds upon Alternative 1 by further refining the existing system with weir modifications and additions to the sewer system to produce better flow connections and

Table 6-1
Comparison of Alternatives 1 and 2 with Base Case
October through December of Synthetic Year
City of Astoria CSO Facility Plan

Overflow Number	Number of CSO Events			Total CSO Volume (MG)			Total Event Duration (hr)		
	Base	Alt. 1	Alt. 2	Base	Alt. 1	Alt. 2	Base	Alt. 1	Alt. 2
OF02	0	2	2	0.00	0.11	0.11	0	7	7
OF03	6	8	0	12.99	7.39	0.00	1,715	1,667	0
OF04	6	0	0	121.68	0.00	0.00	516	0	0
OF06	0	1	1	0.00	0.04	0.04	0	3	3
OF07	20	0	0	2.46	0.00	0.00	982	0	0
OF08	13	5	5	0.16	0.61	0.58	66	40	40
OF09	0	1	1	0.00	0.04	0.04	0	2	2
OF10	5	4	4	0.03	0.13	0.14	23	9	9
OF11	23	19	19	2.65	3.50	3.50	353	201	213
OF12	0	0	0	0.00	0.00	0.00	0	0	0
OF13	23	14	14	1.76	1.09	1.11	365	72	73
OF15	19	8	8	0.85	0.96	0.87	163	45	45
OF17	16	10	11	0.39	0.83	1.27	104	53	60
OF18	21	20	13	7.24	14.72	18.15	309	259	171
OF19	12	0	0	0.24	0.00	0.00	68	0	0
OF20	18	11	9	0.59	0.45	0.44	147	47	44
OF21	5	4	4	0.03	0.16	0.16	23	10	10
OF22	15	4	5	0.24	0.21	0.27	86	13	34
OF23	15	4	5	0.21	0.19	0.28	85	9	37
OF24	13	5	5	0.14	0.28	0.28	64	40	40
OF25	3	1	1	0.01	0.06	0.06	2	3	3
OF26	0	1	1	0.00	0.01	0.01	0	2	2
OF27	4	1	1	0.02	0.03	0.04	22	3	3
OF28	5	1	2	0.03	0.04	0.05	23	3	7
OF29	3	4	11	0.00	0.116	0.73	1	21	103
OF30	19	19	12	4.35	3.29	1.27	662	221	112
OF31	1	1	7	0.00	0.01	0.08	0	1	22
OF32	0	0	1	0.00	0.00	0.00	0	1	0
OF33	0	1	1	0.00	0.02	0.04	0	52	2
OF34	20	10	14	0.90	0.51	3.00	236	196	161
OF36	18	18	15	8.56	18.15	15.55	183	46	167
OF38	15	10	6	0.28	0.41	0.21	98	57	17
OF39	15	12	12	0.26	0.61	0.62	87	141	54
OF40	22	16	16	2.17	2.34	2.53	330	45	146
OF41	15	8	9	0.21	0.66	0.66	85	365	45
OF43	17	19	19	9.75	4.56	4.56	907	10	379
OF44	15	4	4	0.27	0.38	0.38	89	231	10
OF45	23	19	18	6.27	6.77	5.33	366	220	188
Total Volume				184.75	68.68	62.39			

Note: November in Base Case has a less severe storm than Alternatives 1 and 2. Alternatives 1 and 2 values would therefore be lower.

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Table 6-2
CSO Volume Comparison of Alternatives 1 and 2 with Base Case
Summer and Winter SFO Design Storms
City of Astoria CSO Facility Plan

Overflow Number	CSO Volume of Summer 10-year Storm (MG)			CSO Volume of Winter 5-year Storm (MG)		
	Base	Alternative 1	Alternative 2	Base	Alternative 1	Alternative 2
OF02	0.01	0.01	0.01	0.03	0.02	0.02
OF03	0.11	0.12	0.00	2.25	0.72	0.00
OF04	0.92	0.00	0.00	8.39	0.00	0.00
OF06	0.00	0.00	0.00	0.02	0.00	0.00
OF07	0.18	0.00	0.00	0.23	0.00	0.00
OF08	0.03	0.03	0.03	0.16	0.16	0.15
OF09	0.00	0.00	0.00	0.01	0.01	0.01
OF10	0.02	0.01	0.01	0.05	0.04	0.04
OF11	0.41	0.32	0.31	0.77	0.64	0.63
OF12	0.00	0.00	0.00	0.00	0.00	0.00
OF13	0.25	0.12	0.11	0.39	0.21	0.20
OF15	0.13	0.09	0.08	0.37	0.23	0.22
OF17	0.06	0.06	0.10	0.17	0.18	0.28
OF18	2.09	2.23	2.39	3.35	3.97	4.33
OF19	0.07	0.00	0.00	0.18	0.00	0.00
OF20	0.09	0.04	0.04	0.19	0.11	0.11
OF21	0.02	0.01	0.01	0.06	0.05	0.05
OF22	0.05	0.02	0.02	0.12	0.06	0.08
OF23	0.05	0.02	0.02	0.12	0.05	0.07
OF24	0.04	0.02	0.02	0.11	0.07	0.07
OF25	0.01	0.00	0.00	0.04	0.01	0.01
OF26	0.00	0.00	0.00	0.02	0.00	0.00
OF27	0.02	0.00	0.00	0.04	0.01	0.01
OF28	0.02	0.00	0.00	0.05	0.01	0.02
OF29	0.01	0.01	0.06	0.04	0.03	0.15
OF30	0.19	0.14	0.07	0.86	0.64	0.29
OF31	0.00	0.00	0.00	0.01	0.00	0.02
OF32	0.00	0.00	0.00	0.00	0.00	0.00
OF33	0.01	0.00	0.00	0.03	0.00	0.00
OF34	0.07	0.03	0.29	0.23	0.11	0.76
OF36	1.30	1.79	1.79	2.83	3.89	3.59
OF38	0.05	0.04	0.02	0.12	0.10	0.06
OF39	0.05	0.04	0.04	0.16	0.13	0.13
OF40	0.24	0.17	0.19	0.61	0.43	0.49
OF41	0.06	0.04	0.04	0.18	0.14	0.14
OF43	0.33	0.17	0.17	1.63	0.88	0.88
OF44	0.05	0.02	0.02	0.16	0.11	0.11
OF45	0.70	0.50	0.36	1.62	1.29	1.00
Total Volume	7.62	6.03	6.23	25.60	14.29	13.91

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flow hydraulics. Component 2 also includes removal of stormwater inflows though construction of additional stormwater pipes in three areas. The areas are shown in Figure 6-5. This additional refinement to the system further reduces the overflow volume during October-December of the typical year from 185 MG to 62 MG and the SFO winter and summer storms to 14 MG and 6.2 MG, respectively. Figures 6-2 and 6-4 show the CSO volumes at each of the overflows, and Tables 6-1 and 6-2 present the values. The combination of control plan components 1 and 2 forms Alternative 2 of the plan.

Alternative 3: Storage Enhancements and Inflow Controls

Alternative 3 uses the optimized system projected with the facilities constructed in Components 1 and 2 to produce a control plan that begins to meet the requirements of the SFO and the values of Astoria. The primary objective is the control of CSOs to Youngs Bay and other sensitive areas. This is accomplished partially through construction of additional flow controls at inlets, but primarily by adding storage facilities in the vicinity of the diversion structures or major outfalls. Storage facilities consist of rectangular tanks or large diameter conduits. These storage facilities capture overflow and return flows to the interceptor for treatment.

Inflow controls consist of widespread installation of vortex valves in catch basins and the slipping of flow to a downstream stormwater collection system. To enhance the capture of first flush pollutants and at the same time maximize the reduction of CSO, it is recommended that the facility plan include a series of pilot tests within selected basins. These pilot tests will show the before and after inlet control conditions, illustrate the level of difficulty in implementing this technology, and provide a basis for controlling flows for other parts of the Astoria CSO system. Final plans will document the full extent of inlet controls, roof drain disconnection, and the extent of new storm drain discharges. For the purposes of this evaluation, the inflow controls and flow slipping were assumed to affect no more than 25 percent of the impervious surfaces. From experience in Portland, were the Roof-Drain Disconnection Program has been in operation for several years, the amount of CSO area removed approaches 70 to 100 percent. The amount of CSO flow reduction depends upon the ultimate disposal of the storm water generated. At the least the delay and ponding of flows allows the system to capture the maximum amount of flow possible and reduces the number of CSO events and volume of CSOs.

Pilot testing and more detailed analysis will probably increase the assumed effective percentage, which will reduce the volume of CSO and increase the capture rates specified herein for this component of the plan. Increased amounts of storm water interception and capture and reduction in the number of CSO events and CSO volume will effect the sizes of other components of the plan. The plan is designed to be flexible and has several points at which CSO system performance is re-evaluated without compromising the level of control specified in the final SFO. The re-evaluation occurs before the final commitment to CSO control component sizes.

The facilities of Component 3 have been added to the model and simulated. The results show control of the overflow for the SFO events at the Youngs Bay overflows and the Alderbrook Lagoon and reduction of flows at most other CSO locations. The total October-December overflow volume is reduced to 32 MG or by 83 percent from the existing

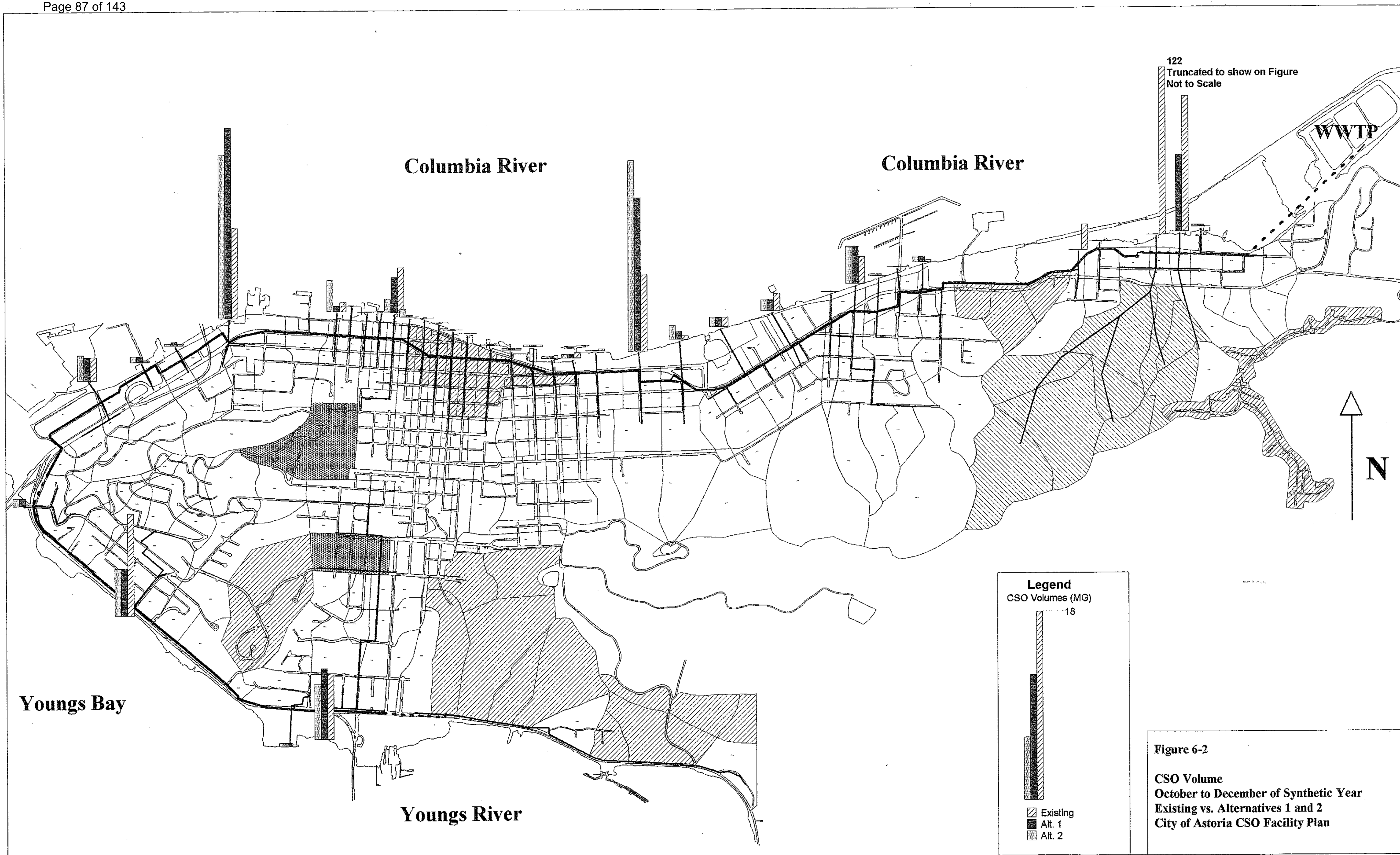

Figure 6-2

CSO Volume
October to December of Synthetic Year
Existing vs. Alternatives 1 and 2
City of Astoria CSO Facility Plan

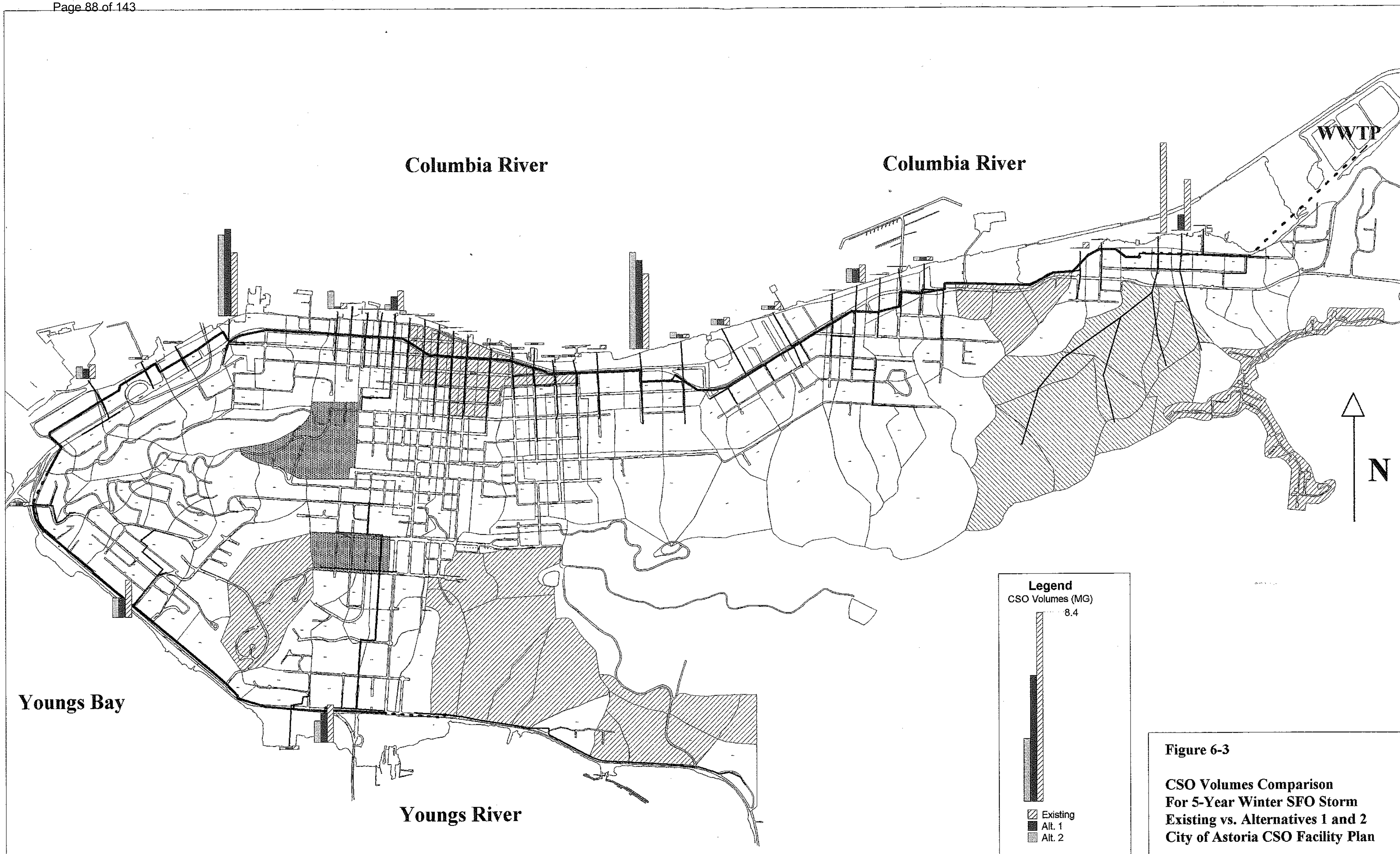

Figure 6-3

**CSO Volumes Comparison
For 5-Year Winter SFO Storm
Existing vs. Alternatives 1 and 2
City of Astoria CSO Facility Plan**

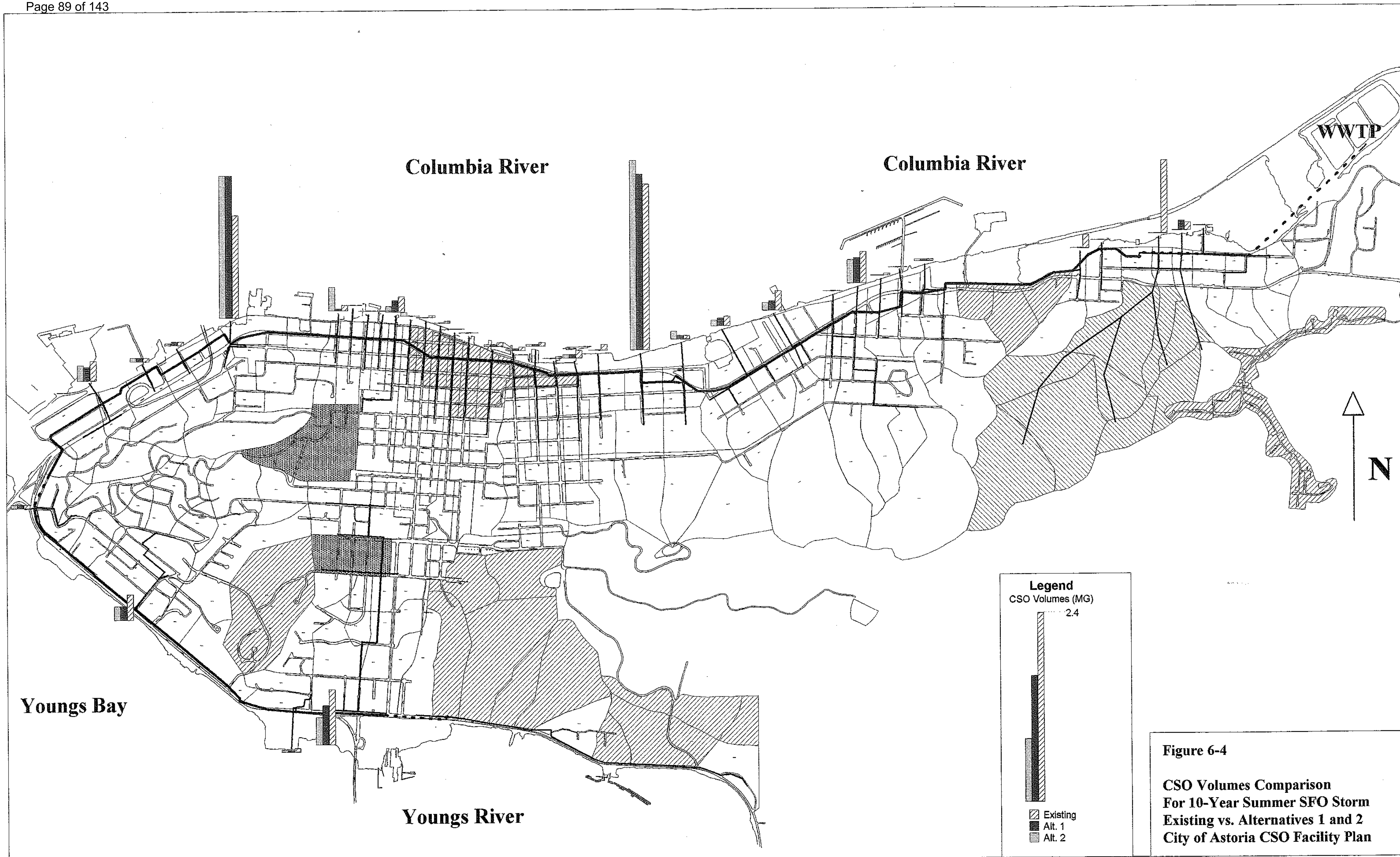

Figure 6-4

**CSO Volumes Comparison
For 10-Year Summer SFO Storm
Existing vs. Alternatives 1 and 2
City of Astoria CSO Facility Plan**

condition. Table 6-3 gives the comparison of Alternative 3 with the existing flow conditions for the October-December period. Table 6-4 gives the results for the complete synthetic year. For the year, the total reduction is about 86 percent.

Figures 6-6 to 6-9 provide the results for the three parts of the synthetic year and the complete year compared with existing conditions. Table 6-5 and Figures 6-10 and 6-11 provide the model result for Alternative 3 compared to the existing base case condition for the summer and winter SFO storms. This forms the basis for sizing of full SFO control facilities discussed in Alternative 4. Alternative 3 has a large impact on many of the CSOs, with twelve overflows showing no discharge during the summer SFO event. The winter SFO overflow is reduced by 65 percent to 8.9 MG, and the summer SFO is reduced by 24 percent to 5.8 MG.

Alternative 4: Storage and Treatment

The storage or capture and treatment alternative consists of construction of facilities at the two major overflows, OF18 (20th Street) and OF36 (Columbia). The facilities are designed to capture by storage and treat the summer and winter SFO storms. The modifications and facilities in Components 1 through 3 in conjunction with Component 4 would form Alternative 4. OF18 and OF36 are major overflow locations because of the concentration of flows into the interceptor and the lift station relief provided at these locations.

Three sub-alternatives have been considered for capture and treatment at the overflows:

- Construction of pump stations and force mains that would convey the overflow to the existing WWTP
- Construction of swirl separators and disinfection facilities at the overflows.
- Construction of large storage facilities at the outfalls.

Capture and treatment for the SFO storms at all the other overflows remaining would consist of additional storage in the vicinity of the overflow or diversion structures. This additional storage and the sizes of the storage or other facilities recommended for this component would be adjusted depending upon the success of flow reductions achieved after implementation of Components 1 through 3.

Alternative 5: Sewer Separation

In comparison to the alternatives described above, Alternative 5 is a completely different approach to CSO control based on replacing the CSO collection system with a dual storm water and sanitary system. The sewer separation alternative would install a completely new drainage system to convey stormwater only and would discharge to the receiving waters. The separation of the basins would require the construction of new storm drain system rather that a new sanitary system because of the co-mingling of sewage and stormwater at house connections and the drainage of streets and other areas into the same system. The existing sewer system would carry sanitary flow with some basement and roof drain flows. Partial separation of some basins and removal of undeveloped area drainage is included in previous alternatives.

Table 6-3
Comparison of Statistics of CSO Events
Base Case versus CSO Control Alternative 3
October through December of Synthetic Year
City of Astoria CSO Facility Plan

Overflow Number	Number of CSO Events		Total CSO Volume (MG)		Total Event Duration (hr)	
	Existing	Alternative 3	Existing	Alternative 3	Existing	Alternative 3
OF02	0	0	0.00	0.00	0	0
OF03	6	0	12.99	0.00	1,715	0
OF04	6	0	121.68	0.00	516	0
OF06	0	0	0.00	0.00	0	0
OF07	20	0	2.46	0.00	982	0
OF08	13	1	0.16	0.00	66	0
OF09	0	0	0.00	0.00	0	0
OF10	5	3	0.03	0.01	23	2
OF11	23	13	2.65	0.31	353	66
OF12	0	0	0.00	0.00	0	0
OF13	23	15	1.76	0.56	365	100
OF15	19	9	0.85	0.10	163	51
OF17	16	12	0.39	0.51	104	72
OF18	21	12	7.24	12.07	309	113
OF19	12	0	0.24	0.00	68	0
OF20	18	11	0.59	0.10	147	60
OF21	5	3	0.03	0.01	23	2
OF22	15	4	0.24	0.03	86	22
OF23	15	5	0.21	0.03	85	23
OF24	13	4	0.14	0.03	64	22
OF25	3	0	0.01	0.00	2	0
OF26	0	0	0.00	0.00	0	0
OF27	4	0	0.02	0.00	22	0
OF28	5	0	0.03	0.00	23	0
OF29	3	11	0.00	0.39	1	81
OF30	19	10	4.35	0.17	662	36
OF31	1	5	0.00	0.02	0	22
OF32	0	0	0.00	0.00	0	0
OF33	0	1	0.00	0.00	0	0
OF34	20	14	0.90	2.05	236	126
OF36	18	17	8.56	15.21	183	188
OF38	15	8	0.28	0.03	98	5
OF39	15	13	0.26	0.25	87	71
OF40	22	12	2.17	0.14	330	62
OF41	15	8	0.21	0.09	85	27
OF43	17	0	9.75	0.00	907	0
OF44	15	1	0.27	0.00	89	0
OF45	23	1	6.27	0.00	366	0
Total Volume			184.75	32.10		

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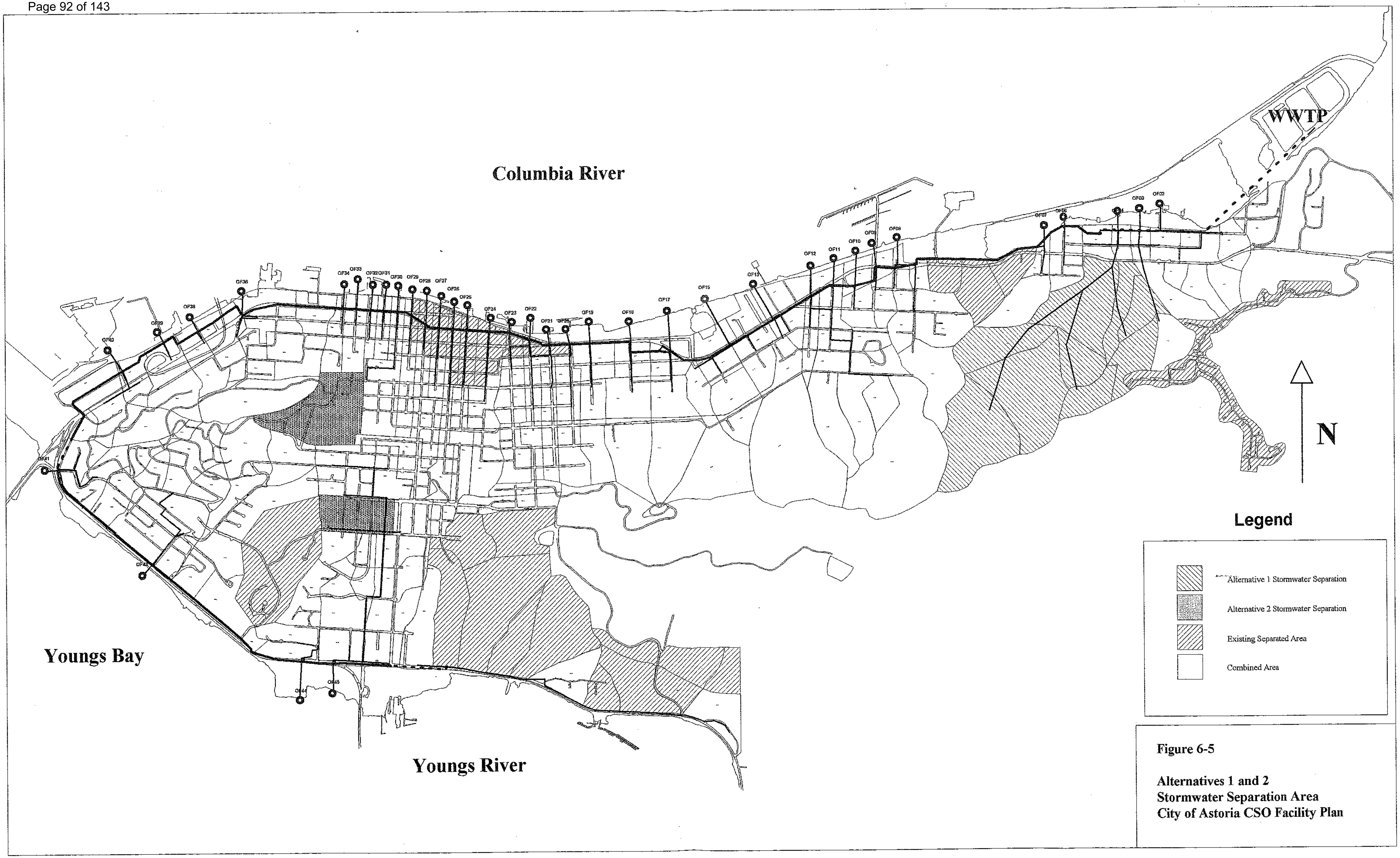

Figure 6-5

Alternatives 1 and 2
Stormwater Separation Area
City of Astoria CSO Facility Plan

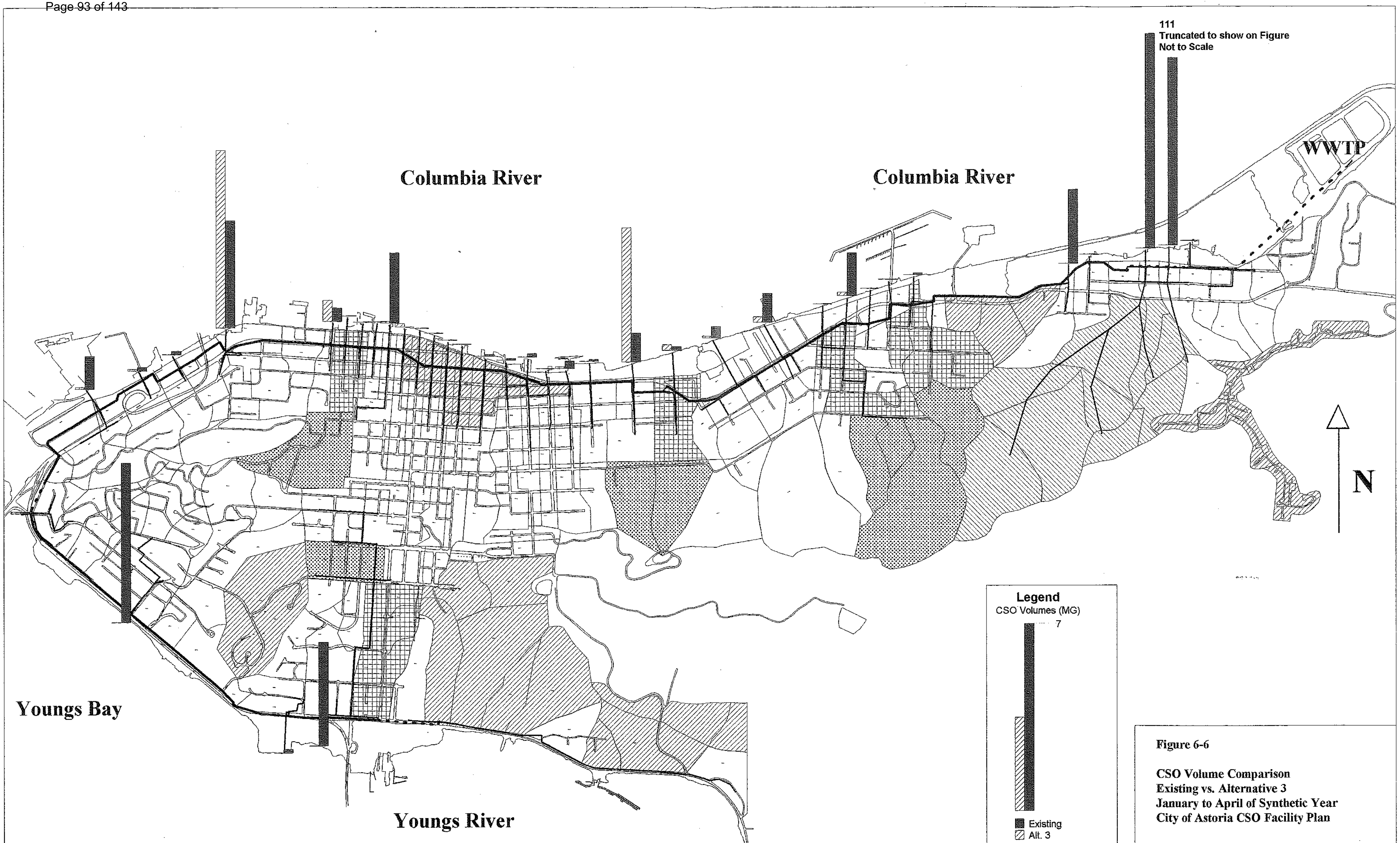

Figure 6-6

CSO Volume Comparison
Existing vs. Alternative 3
January to April of Synthetic Year
City of Astoria CSO Facility Plan

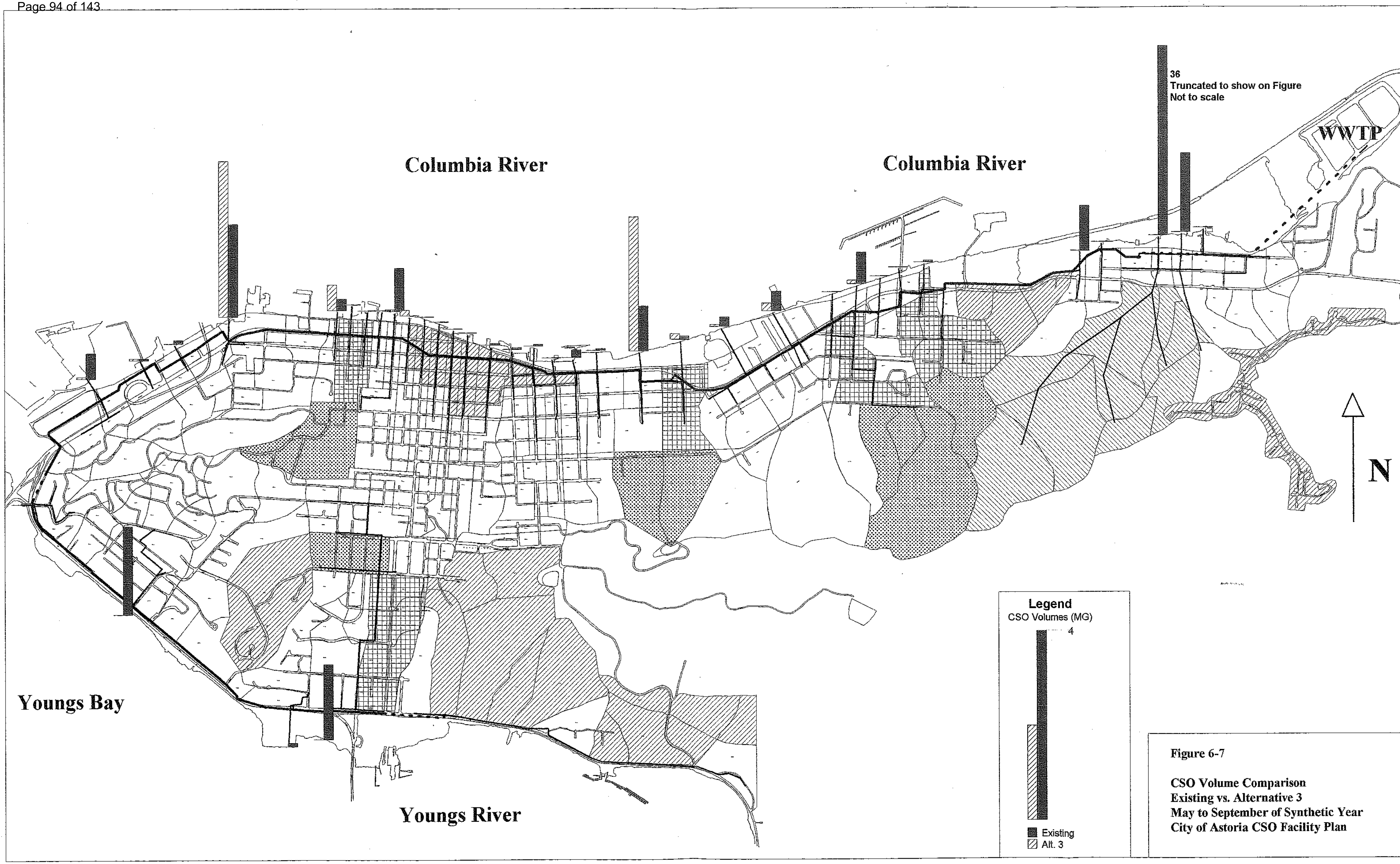

Figure 6-7

CSO Volume Comparison
Existing vs. Alternative 3
May to September of Synthetic Year
City of Astoria CSO Facility Plan

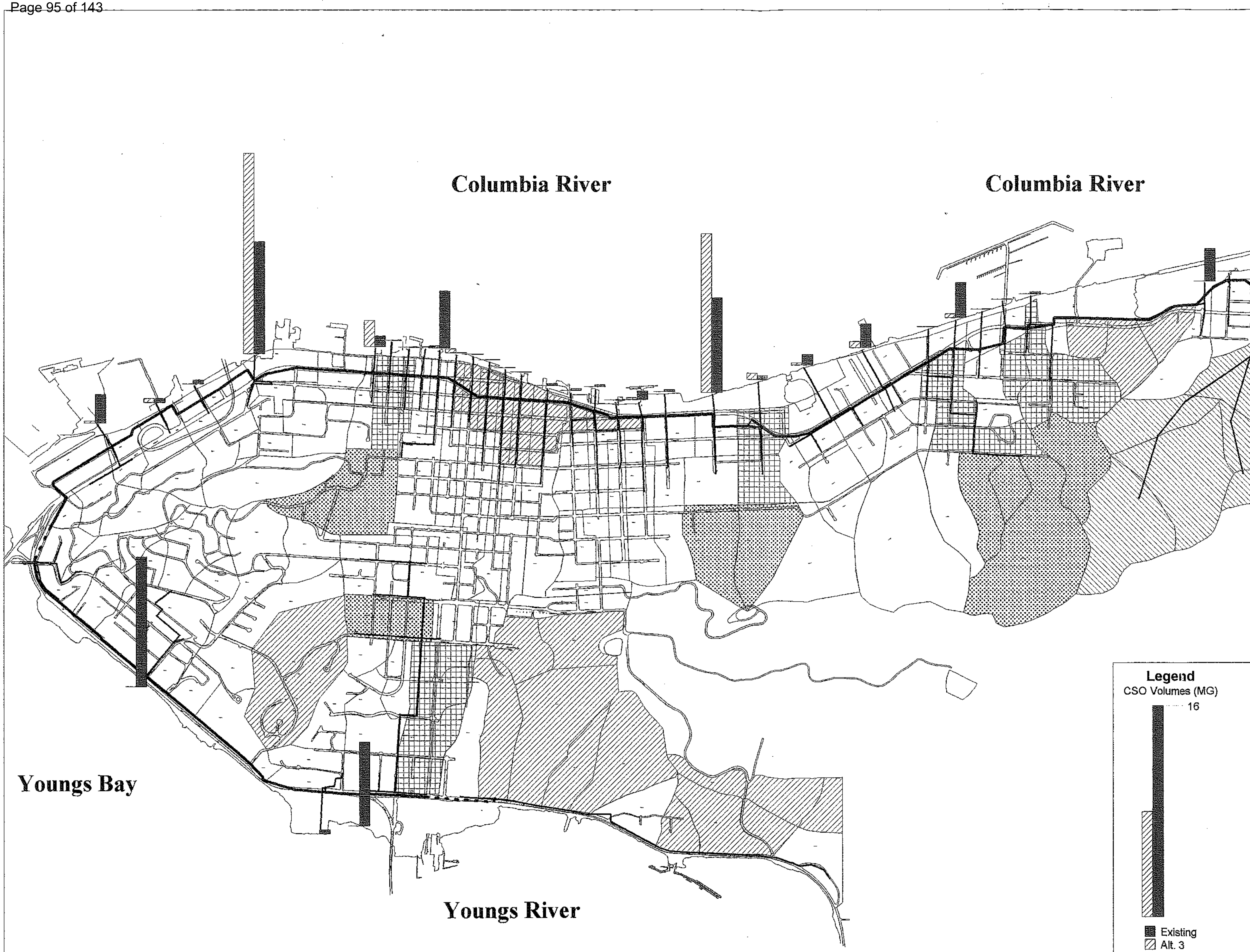

Figure 6-8

**CSO Volume Comparison
Existing vs. Alternative 3
October to December of Synthetic Year
City of Astoria CSO Facility Plan**

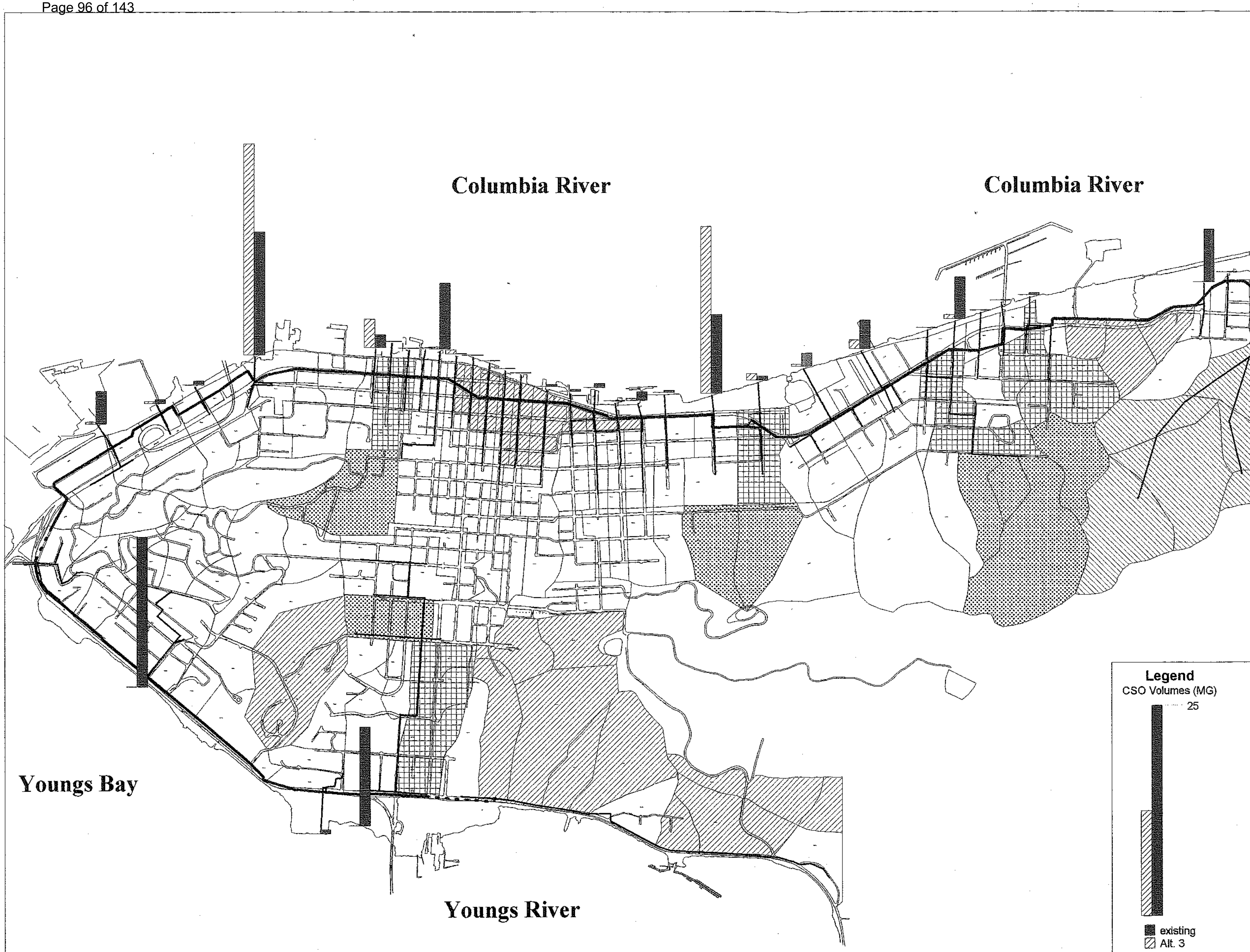

Figure 6-9

Annual CSO Volume Comparison
Existing vs. Alternative 3
Synthetic Year
City of Astoria CSO Facility Plan

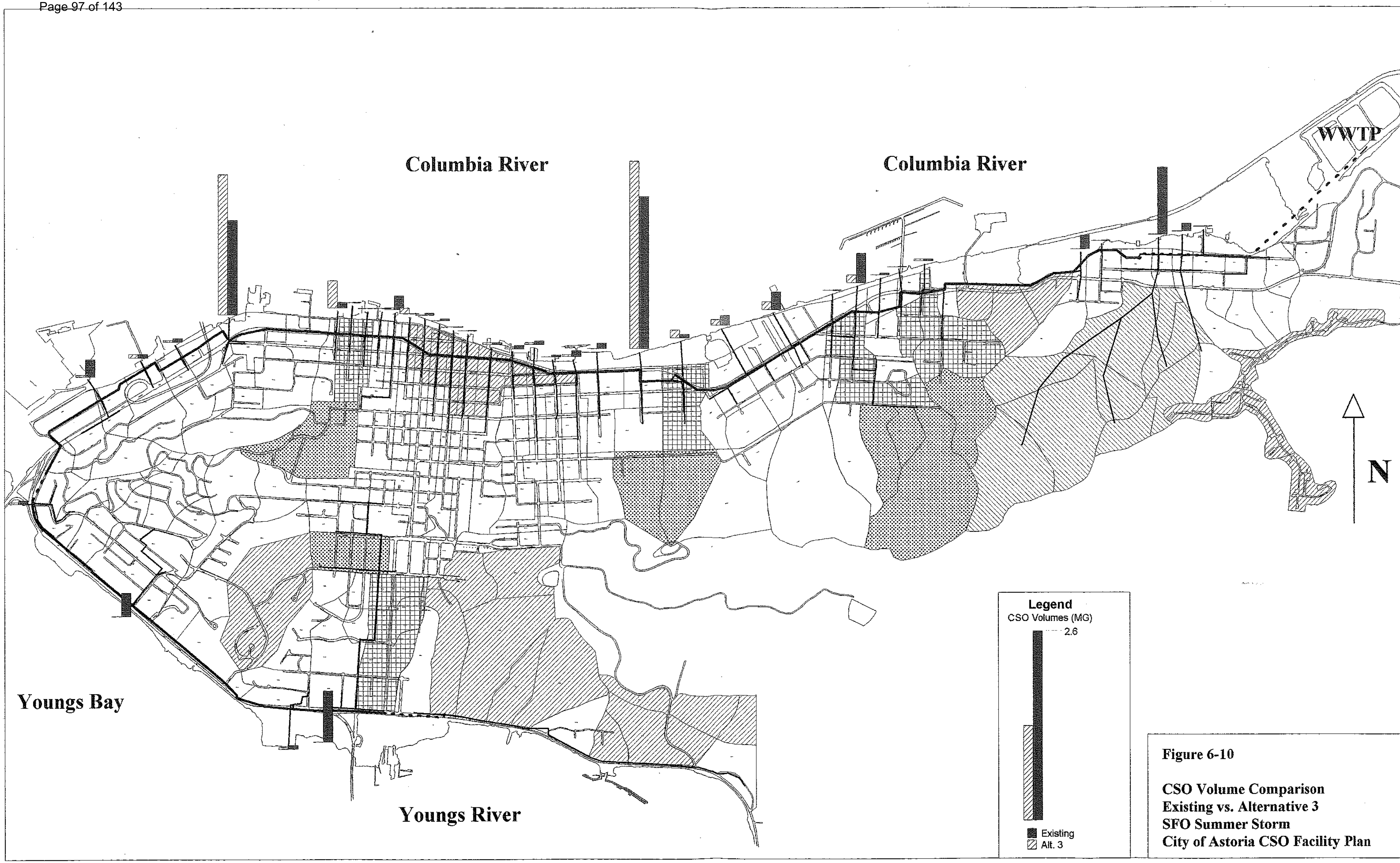

Figure 6-10

CSO Volume Comparison
Existing vs. Alternative 3
SFO Summer Storm
City of Astoria CSO Facility Plan

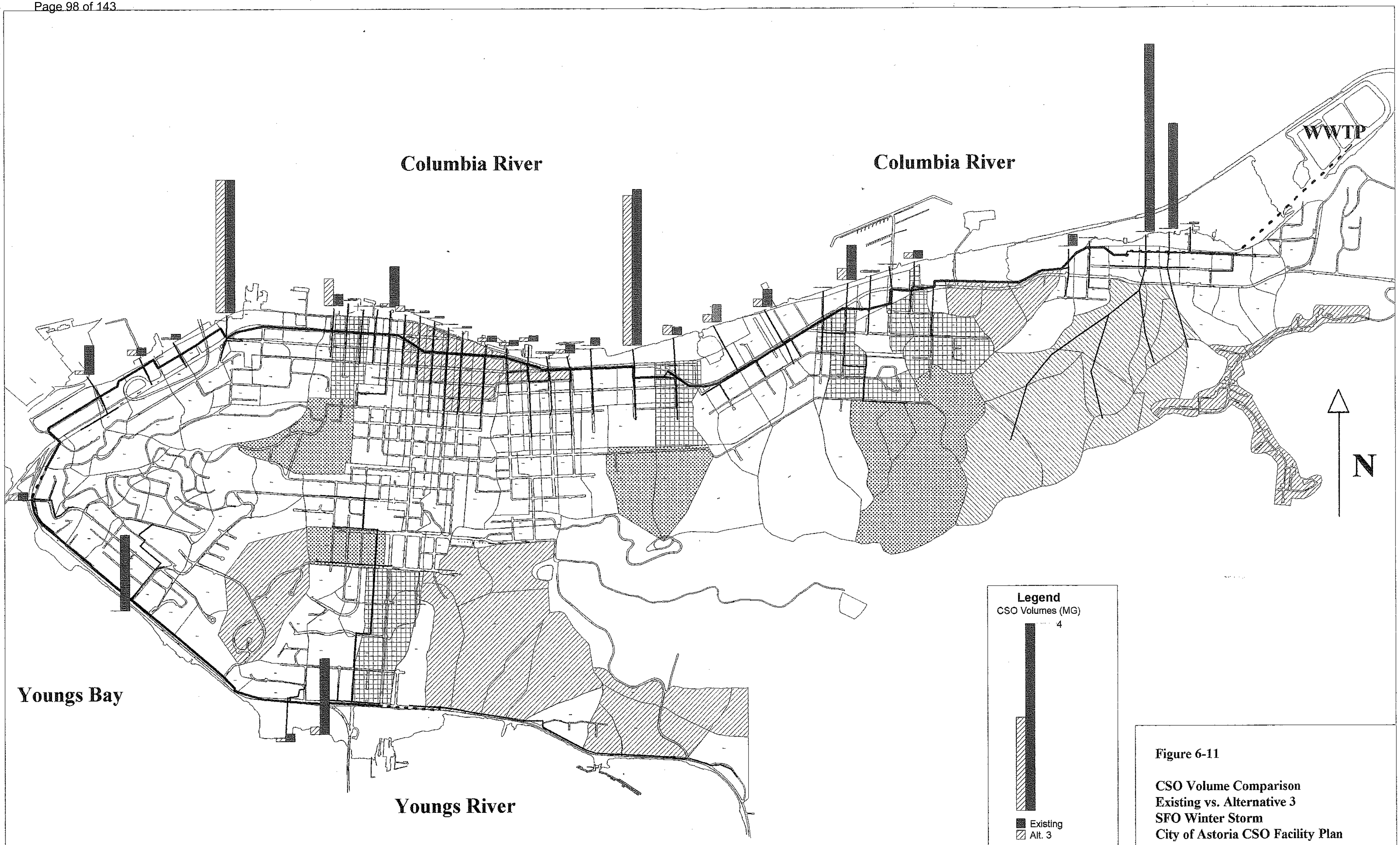

Figure 6-11

CSO Volume Comparison
Existing vs. Alternative 3
SFO Winter Storm
City of Astoria CSO Facility Plan

Table 6-4
CSO Control Alternative 3
Statistics of CSO Events for Synthetic Year
City of Astoria CSO Facility Plan

Overflow	Number of CSO Events				Total CSO Volume (MG)				Total Event Duration (hr)			
Number	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual	Jan. - Apr.	May - Sep.	Oct. - Dec.	Annual
OF02	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF03	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF04	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF06	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF07	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF08	0	0	1	1	0.00	0.00	0.00	0.00	0	0	0	0
OF09	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF10	0	1	3	4	0.00	0.00	0.01	0.01	0	0	2	2
OF11	7	4	13	24	0.14	0.09	0.31	0.53	24	15	66	104
OF12	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF13	8	5	15	28	0.22	0.15	0.56	0.93	73	18	100	191
OF15	6	2	9	17	0.04	0.03	0.10	0.17	5	3	51	59
OF17	6	3	12	21	0.19	0.13	0.51	0.83	28	7	72	107
OF18	10	5	12	27	5.00	2.85	12.07	19.92	67	25	113	205
OF19	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF20	7	3	11	21	0.06	0.02	0.10	0.18	6	3	60	69
OF21	1	1	3	5	0.00	0.00	0.01	0.02	0	1	2	3
OF22	4	1	4	9	0.01	0.01	0.03	0.04	2	2	22	25
OF23	4	1	5	10	0.01	0.01	0.03	0.06	2	2	23	26
OF24	3	1	4	8	0.01	0.01	0.03	0.04	2	1	22	25
OF25	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF26	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF27	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF28	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF29	7	3	11	21	0.15	0.12	0.39	0.65	18	12	81	111
OF30	6	2	10	18	0.06	0.05	0.17	0.27	12	6	36	54
OF31	3	2	5	10	0.01	0.01	0.02	0.03	1	2	22	25
OF32	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF33	2	1	1	4	0.00	0.00	0.00	0.00	0	0	0	0
OF34	11	5	14	30	0.77	0.53	2.05	3.35	60	22	126	208
OF36	16	7	17	40	6.66	3.28	15.21	25.15	117	36	188	340
OF38	6	3	8	17	0.02	0.01	0.03	0.06	4	2	5	10
OF39	6	4	13	23	0.08	0.06	0.25	0.39	24	6	71	101
OF40	6	2	12	20	0.05	0.03	0.14	0.23	21	3	62	86
OF41	6	2	8	16	0.04	0.02	0.09	0.15	5	2	27	34
OF43	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0
OF44	0	0	1	1	0.00	0.00	0.00	0.00	0	0	0	0
OF45	2	1	1	4	0.00	0.00	0.00	0.00	0	0	0	0
Total Volume					13.52	7.39	32.10	53.01				

0.859757799

Avga3cso.xls annual summary

Table 6-5
CSO Volume Comparison of Alternative 3 with Base Case
Summer and Winter SFO Design Storms
City of Astoria CSO Facility Plan

Overflow Number	CSO Volume of Summer 10-year Storm (MG)		CSO Volume of Winter 5-year Storm (MG)	
	Base	Alternative 3	Base	Alternative 3
OF02	0.01	0.01	0.03	0.02
OF03	0.11	0.00	2.25	0.00
OF04	0.92	0.00	8.39	0.00
OF06	0.00	0.00	0.02	0.00
OF07	0.18	0.00	0.23	0.00
OF08	0.03	0.03	0.16	0.13
OF09	0.00	0.00	0.01	0.00
OF10	0.02	0.01	0.05	0.04
OF11	0.41	0.11	0.77	0.23
OF12	0.00	0.00	0.00	0.00
OF13	0.25	0.12	0.39	0.16
OF15	0.13	0.08	0.37	0.18
OF17	0.06	0.11	0.17	0.21
OF18	2.09	2.57	3.35	3.22
OF19	0.07	0.00	0.18	0.00
OF20	0.09	0.04	0.19	0.10
OF21	0.02	0.01	0.06	0.04
OF22	0.05	0.03	0.12	0.07
OF23	0.05	0.03	0.12	0.07
OF24	0.04	0.02	0.11	0.07
OF25	0.01	0.01	0.04	0.01
OF26	0.00	0.01	0.02	0.01
OF27	0.02	0.00	0.04	0.01
OF28	0.02	0.00	0.05	0.02
OF29	0.01	0.09	0.04	0.14
OF30	0.19	0.03	0.86	0.07
OF31	0.00	0.01	0.01	0.02
OF32	0.00	0.00	0.00	0.00
OF33	0.01	0.00	0.03	0.00
OF34	0.07	0.38	0.23	0.59
OF36	1.30	1.91	2.83	2.84
OF38	0.05	0.02	0.12	0.06
OF39	0.05	0.05	0.16	0.13
OF40	0.24	0.04	0.61	0.10
OF41	0.06	0.04	0.18	0.11
OF43	0.33	0.00	1.63	0.00
OF44	0.05	0.02	0.16	0.10
OF45	0.70	0.01	1.62	0.16
Total Volume	7.62	5.79	25.60	8.92

Sfoea123.xls summary ea3

Evaluation of Alternatives

Evaluation of the alternatives was based on a review of the alternative performance in controlling summer and winter SFO and annual CSOs and other factors important to the City of Astoria. Each Alternative represents a 'stopping' point in the control of CSO and produces a set control of CSO volume and number of events. The evaluation of the alternatives consisted of development of a matrix that compared the alternatives with the following criteria:

- Overall consistency with community values including perceptions of benefit received for expenditures made. This is a subjective criterion, given a rank from high (does meet community values) to low (is not consistent with community value). An intermediate ranking of moderate is also possible. A numerical value is assigned to differentiate between alternative impacts.
- Impacts on community such as street construction. This criterion is subjective, with high value representing high community impacts and disruption, and low representing minimal impacts. A moderate value is also possible. A numerical value is assigned to differentiate between alternative impacts.
- Operation and maintenance of the facilities. The City of Astoria has limited human resources for operation and maintenance; therefore, the addition of staff for operation and maintenance of CSO facilities or the impact upon existing staff is an important consideration. This criterion is evaluated as high (high negative impact) or low (manageable with existing or minor staff increase). A numerical value is assigned to differentiate between alternative impacts.
- Total project costs. Costs are provided as planning level cost estimates. The estimates are based, for example, on unit rates for new pipe construction and estimated values from manufacturers for major facilities such as vortex separators. The costs include allowances for contingencies and administration and engineering.
- Performance in meeting SFO requirements. This criterion is evaluated by considering the total system percent capture of the summer and winter SFO storms and the overflow charts for individual overflows.
- Annual performance in reducing CSO volumes and number of events remaining. This criterion is evaluated by considering the total system percent capture of the synthetic year and the overflow charts for individual overflows.

Table 6-6 gives the results of the alternative evaluation. Alternatives 1, 2, and 3 best meet the City of Astoria community values while controlling CSO annual values. The alternatives, however, only protect certain areas to the SFO level of control. The relationship between community values, annual control, selective control to SFO levels, and the incremental costs for gaining additional control amounts is the basis of the selected alternative presented in the following section.

Table 6-6
Evaluation of Alternatives Matrix

Alternative	Consistent With Community Values	Community Impacts	Operation And Maintenance Impacts	Total Project Costs	SFO Performance Winter		SFO Performance Summer		Annual Performance
					Volume	CSOs	Volume	CSOs	Volume
1 Sewer System Enhancement	5	5	5	$490,190	43%	13	17%	22	67%
2 Existing System Optimized	5	5	5	$3,143,545	44%	13	17%	22	70%
3 Storage Enhancements and Inflow Controls	4	4	4	$10,183,295	66%	16	28%	22	86%
4 Capture and Treatment									
4a. Pump and Treat	3	1	1	$32,095,695	100%	38	100%	38	99%
4b. Swirl*	3	3	2	$18,305,780	100%	38	100%	38	98%
4c. Large Storage	2	2	1	$32,803,295	100%	38	100%	38	99%
5 Sewer Separation	1	1	4	$36,250,000	100%	38	100%	38	99%
	1=not consistent 5=very consistent	1= High impacts 5= Low impacts	1=High impacts 5=Low impacts		control percent	number of CSO Controlled	control percent	number of CSO Controlled	Percent controlled based on period of October to December of Synthetic Year

* Assumes capture of 70% of overflow solids.

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SECTION 7

Selected CSO Control Plan

Section 6 discussed and evaluated seven alternatives that addressed control of the City of Astoria combined sewer overflows (CSOs). The alternatives were evaluated for performance in controlling the winter and summer CSO storm events and the typical year or wet part of the year and assigned values for meeting the community values. The much higher costs for small incremental increases in annual capture rates or controlling the SFO events are best reflected in comparing the cost of the alternatives developed in Section 6 with the CSO annual capture percentage. Additionally, the sum of the community values can be superimposed on this representation. Figure 7-1 shows the comparison of percent annual capture with the sum of community value factors. The technologies in the control alternatives and the relationship shown in Figure 7-1 forms the basis for the alternative selected by the City of Astoria. The alternative selected has a target capture of approximately 95 percent of the typical year annual system-wide CSO. An important feature of the selected alternative is that it provides SFO-storm-level control at the overflows to Youngs Bay and other selected areas while providing a high annual volume capture and low number of events, but not SFO level of control, at less sensitive areas.

The final selected plan detailed in this section reflects the comments by DEQ on the draft plan and negotiated levels of CSO control at the outfalls. Comments by DEQ and responses to the comments are included in Appendix 1 and 2 respectively. The level of control achieved by the final plan extends that suggested in the Draft plan to include more control over the number of events at outfalls. Analysis of CSO events showed that many of the indicated events (Draft Plan Section 7) had small volumes and small duration and therefore could be controlled by either additional assumptions for runoff capture (through inlet controls or partial basin separation) or additional storage and other 'active' controls. The Plan assumes the latter case to ensure true reflection of possible program costs. However the plan also is flexible and allows for re-evaluation of the facility sizes depending upon the success of inflow controls achieved with Components 1 and 2 of the plan.

Development of Selected Plan

The base of the selected alternative consists of components 1 through 3 (described as Alternative 3 in Section 6) and the storage option of Alternative 4. The final plan also extends CSO event and volume control by adding the following components:

- additional CSO capture through expanded storage at the two largest overflows (OF18—20th Street and OF36—Columbia)
- refinement of the inflow capture or small storage additions at other CSO locations to reduce the number of events at these low volume overflows (see Table 6-4).

OF18 and OF36 represent 85 percent of the total remaining overflow, assuming the components of Alternative 3 are in place. Figures 7-2 and 7-3 show the typical year overflow event summary at these two overflows and reflect the results obtained from the hydraulic

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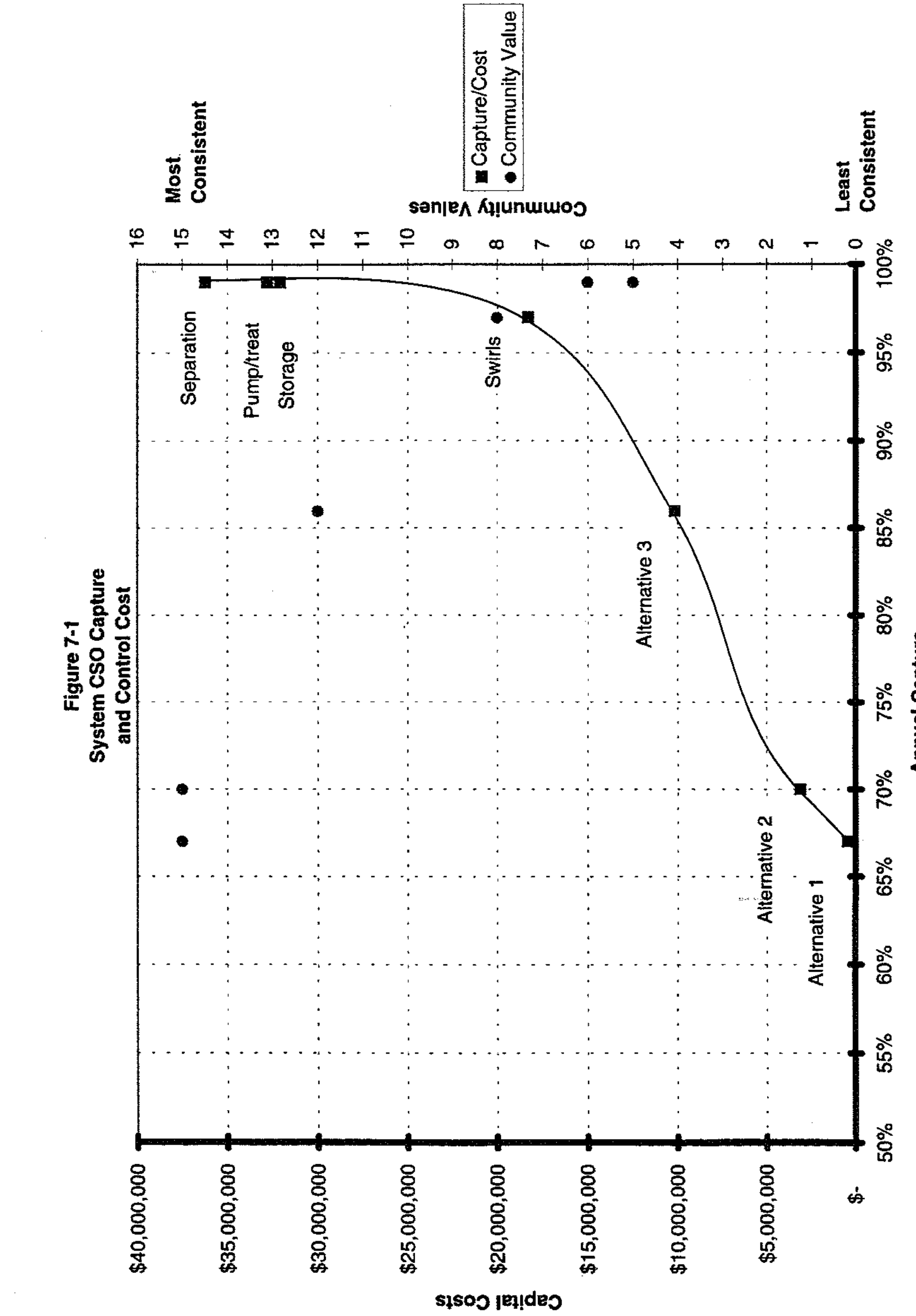
Figure 7-1
System CSO Capture and Control Cost



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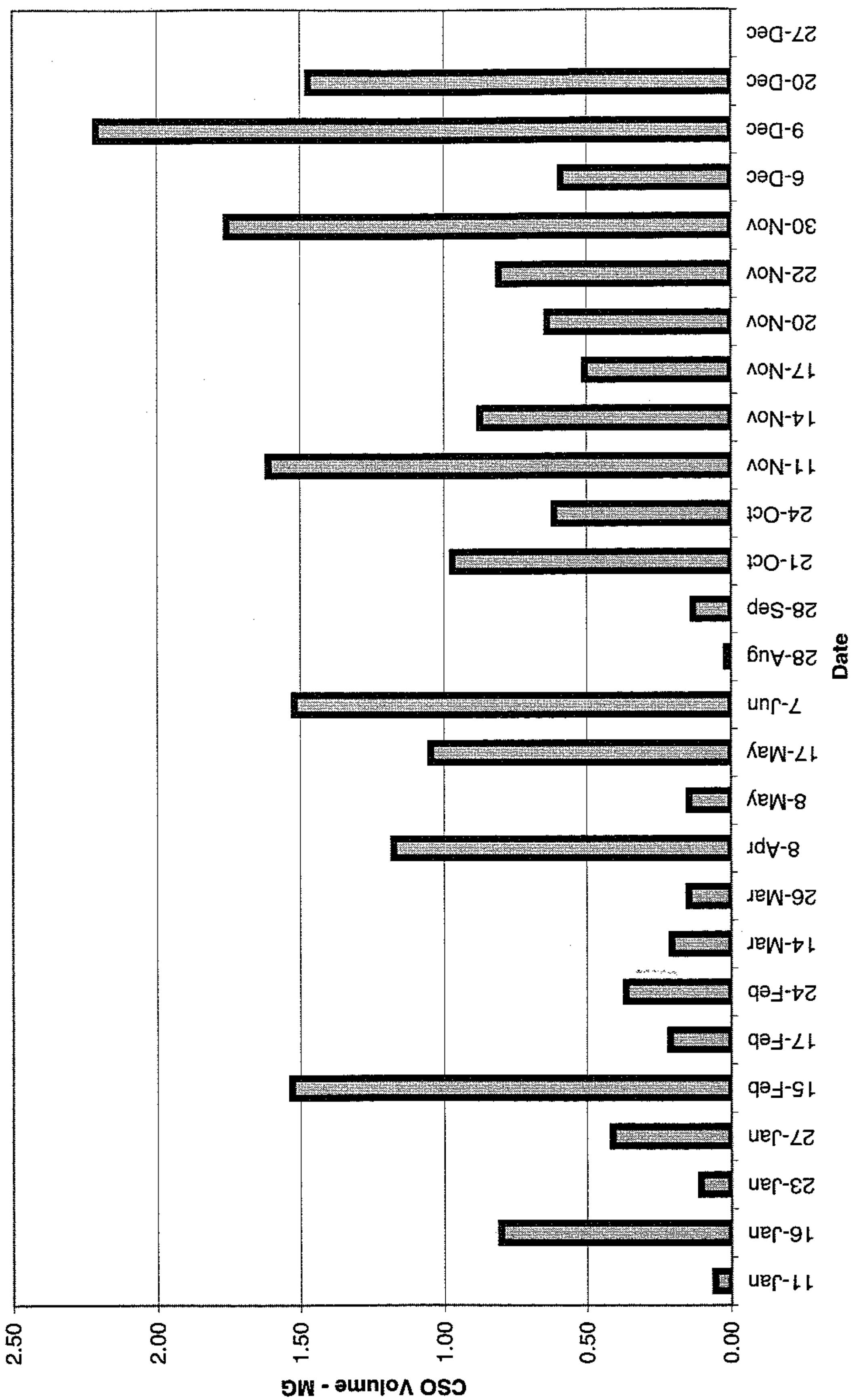
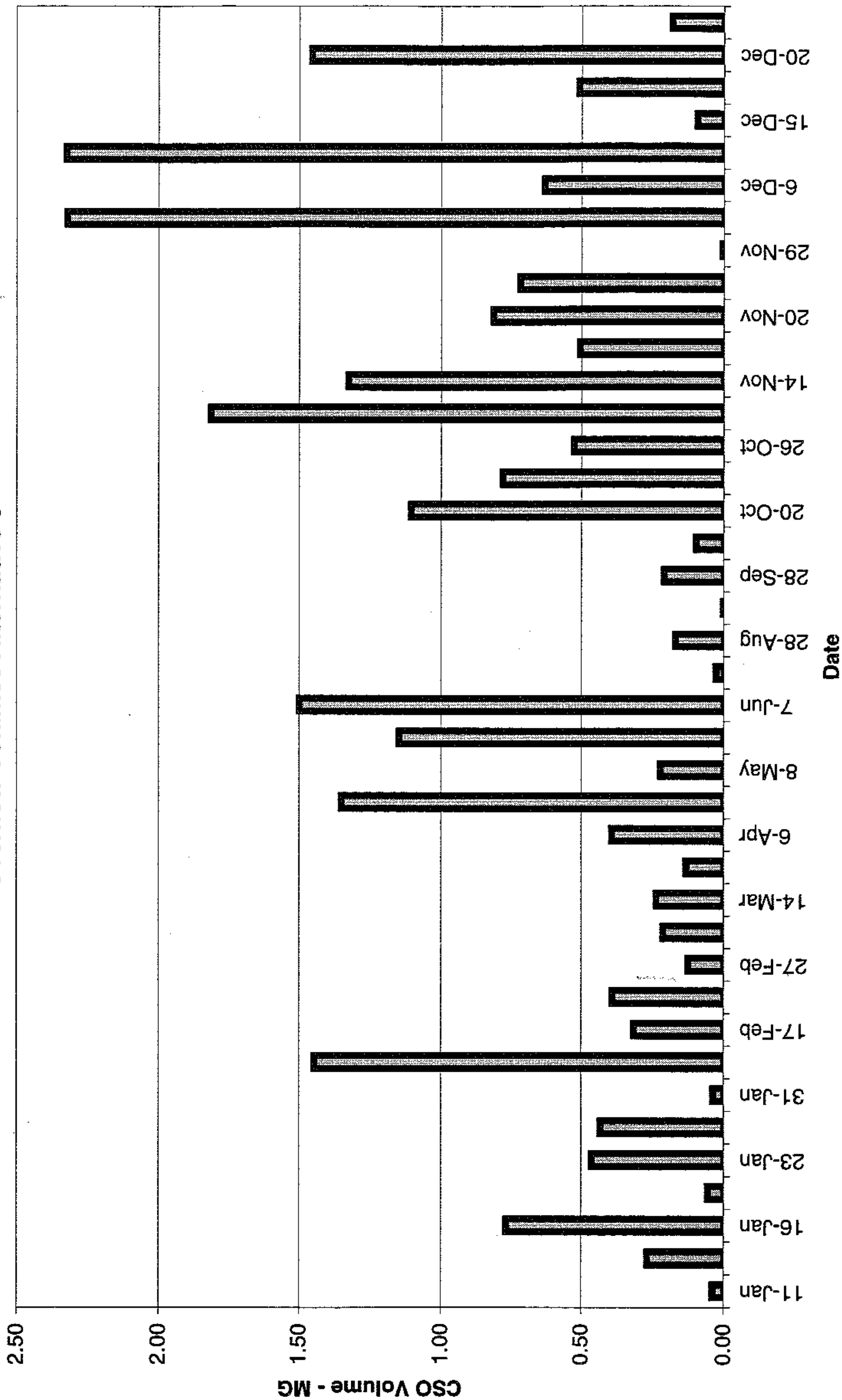


Figure 7-2
Outfall 18
Overflow Volumes Alternative 3

Figure 7-3
Outfall 36
Overflow Volumes Alternative 3



model presented in Table 6-4 and modified in Tables 7-1 and 7-2. Appendix 2 provides additional details on the analysis methods used to refine the event analysis and sizing of facilities. The overflows at the outfalls follow similar patterns with the summer period of late June, July, August, and September having no or very small overflows. The small summer overflow in the synthetic year is due to inclusion of a 3-year summer event in the rainfall record to achieve targeted levels of control during summer months. Therefore end-of-pipe control at OF18 and OF36 could greatly extend the overall level of control for both the typical year and the SFO storm events.

There are 40 events at OF36 and 27 events at OF18. This number of events is due to the rainfall pattern and the concentration of flows, made possible by the control measures suggested for Alternative 3. The selected alternative also targets a reduction in the number of events at these overflows. At other CSOs the number of events are variable, but the overall volume is small. For example, at OF11 there are 20 events that have a total annual volume of 530,000 gallons (Table 7-2). Generally the events occur at the same time – when a large event occurs then most CSO will overflow with the difference being the duration of overflow.

Additional storage at selected outfalls greatly reduces the number of events by capturing small events. The shaded area in Table 7-1 shows the extent of the events controlled by addition of the amount of storage at the outfall and a 'guide' to the extent of the facility by showing the length of 5' foot pipe needed to control the flow.

To meet the extended volume control target and also reduce the number of events, the selected alternative includes installing storage facilities at or near OF18 and OF36. The storage at each of the overflows would be approximately 1 million gallons (MG). This storage would eliminate an additional 35-MG from the annual CSO total and reduce the system-wide overflow volume from the current annual volume of 378 MG to.18 MG for a total reduction of 95 percent. The number of events is also greatly reduced, with no events during July, August, and September for the typical rainfall year.

For the high event count but low volume overflows, it is assumed that more inflow reduction or more inline storage will be provided near selected overflows. In most cases the additional storage is less than 20,000 gallons. The total reductions are believed to be conservative given the assumption that only 25 percent of impervious area is removed for inflow control. After the recommended pilot study for inflow controls (particularly flow slipping) is completed, the reductions at these CSOs can be re-evaluated and the plan refined. The controls at these overflows have a larger impact upon the number of events than on CSO volume. The estimated annual overflows and number of events at the remaining CSOs are reduced to that given in Table 7-2 for the synthetic year and the extended analysis with 1953-94 rainfall record (see Appendix 2).

The remaining estimated annual CSO volume is 16.6 Mg for the synthetic year rainfall or about 17.8 MG on average per year for the extended period, which means the annual CSO reduction produced by the selected control plan is approximately 96 percent. For the typical year of rainfall, it is estimated that 14 of the existing 38 CSO overflows will not discharge. Of those remaining, overflows will occur in the wet months of the typical year. The large CSOs (CSO18 and CSO36) would discharge about 6-7 events per winter on average. Most

Table 7:1 : Synthetic Year Summary Event Volume Analysis

		Number of Events in Volume Range													
Volume Ft^3	Vol - gallons	CSO11	CSO13	CSO15	CSO17	CSO18	CSO20	CSO29	CSO30	CSO34	CSO36	CSO38	CSO39	CSO40	*CSO41*
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	2244	0	0	0	0	1	0	2	2	5	1	6	3	2	4
500	3740	0	0	0	1	0	0	0	1	1	0	4	1	2	4
1000	7480	3	1	4	2	0	5	1	3	1	1	5	4	5	3
1500	11220	1	2	3	1	0	4	3	4	0	0	2	3	4	2
2000	14960	4	4	1	2	0	2	2	3	1	0	0	5	2	2
3000	22440	5	5	2	2	1	3	1	1	3	0	0	1	1	2
10000	74800	6	9	2	11	1	1	10	4	3	4	0	6	4	1
50000	374000	1	3	0	2	7	0	2	0	15	12	0	0	0	0
75000	561000	0	0	0	0	2	0	0	0	1	7	0	0	0	0
100000	748000	0	0	0	0	3	0	0	0	0	2	0	0	0	0
150000	1122000	0	0	0	0	5	0	0	0	0	4	0	0	0	0
200000	1496000	0	0	0	0	2	0	0	0	0	5	0	0	0	0
250000	1870000	0	0	0	0	4	0	0	0	0	2	0	0	0	0
500000	3740000	0	0	0	0	1	0	0	0	0	2	0	0	0	0
															0
control volume - ft^3		5000	10000	2000	10000	150000	2000	5000	3000	30000	200000	1000	4000	3000	2000
control volume - gallons		37400	74800	14960	74800	1122000	14960	37400	22440	224400	1496000	7480	29920	22440	14960
feet of 5' pipe		255	510	102	510	7653	102	255	153	1531	10204	51	204	153	102
total events		20	24	12	21	27	15	21	18	30	40	17	23	20	18
remaining event		5	3	4	2	5	4	4	4	4	4	2	4	4	3
Approximate cost		168,300	336,600	67,320	336,600	in plan	67,320	168,300	100,980	1,009,800	in plan	33,660	134,640	100,980	67,320

Notes: Control volume -- storage needed to control overflows in additional to Phase 3 controls.

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Table 7-2: Determination of Additional Storage Required to Reduce Number of Events to <7

	Synthetic Year			Period of record 53-94 rainfall events				
OFNo	Events	CSO MG	Duration - Hours	CSO Events	CSO Volume - MG	Additional Storage - MG	Adjusted CSO Volume - MG	Adjusted CSO Events
OF02	0	0.00	0.00		*0.00*		**0.00**	**0**
OF03	0	0.00	0.00		*0.00*		**0.00**	**0**
OF06	0	0.00	0.00		*0.00*		**0.00**	**0**
OF08	0	0.00	0.11		*0.00*		**0.00**	**0**
OF09	0	0.00	0.00		*0.00*		**0.00**	**0**
OF10	1	0.01	2.40		*0.01*		**0.01**	**1**
OF11	20	0.53	104.35		*0.53*	**0.015**	**0.30**	**4**
OF13	24	0.93	190.86	34	1.09	**0.050**	**3.00**	**6**
OF15	12	0.17	58.77		*0.17*	**0.015**	**0.10**	**4**
OF17	21	0.83	106.75	45	1.17	**0.050**	**0.25**	**6**
OF18	27	19.91	204.90	31	19.4	**1.000**	**5.70**	**6**
OF20	15	0.18	69.41	18	0.29	**0.020**	**0.03**	**4**
OF21	2	0.02	3.24		*0.02*		**0.02**	**2**
OF22	5	0.04	24.98		*0.04*		**0.04**	**5**
OF23	6	0.06	26.29		*0.06*		**0.06**	**6**
OF24	4	0.04	24.63		*0.04*		**0.04**	**4**
OF25	0	0.00	0.00		*0.00*		**0.00**	**0**
OF26	0	0.00	0.00		*0.00*		**0.00**	**0**
OF27	0	0.00	0.00		*0.00*		**0.00**	**0**
OF28	0	0.00	0.00		*0.00*		**0.00**	**0**
OF29	21	0.65	111.30	31	0.86	**0.040**	**0.21**	**6**
OF30	18	0.27	54.35	24	0.39	**0.020**	**0.10**	**6**
OF31	4	0.03	25.22		*0.03*		**0.03**	**4**
OF32	0	0.00	0.00		*0.00*		**0.00**	**0**
OF33	0	0.00	0.12		*0.00*		**0.00**	**0**
OF34	30	3.35	207.55	50	4.3	**0.200**	**0.83**	**5**
OF36	40	25.14	340.41	54	27.2	**1.000**	**6.90**	**7**
OF38	17	0.06	10.29		*0.06*	**0.008**	**0.06**	**0**
OF39	23	0.39	100.70	38	0.55	**0.035**	**0.06**	**3**
OF40	20	0.23	85.76	23	0.3	**0.020**	**0.04**	**3**
OF41	18	0.15	34.19		*0.15*	**0.015**	**0.05**	**3**
OF44	0	0.00	0.20		*0.00*		**0.00**	**0**
OF45	0	0.00	0.40		*0.00*		**0.00**	**0**
Totals		53.00	1787.18		**56.32**		**17.83**	**3**

Figure 7-4 Projected Number of Summer Events at CSO36

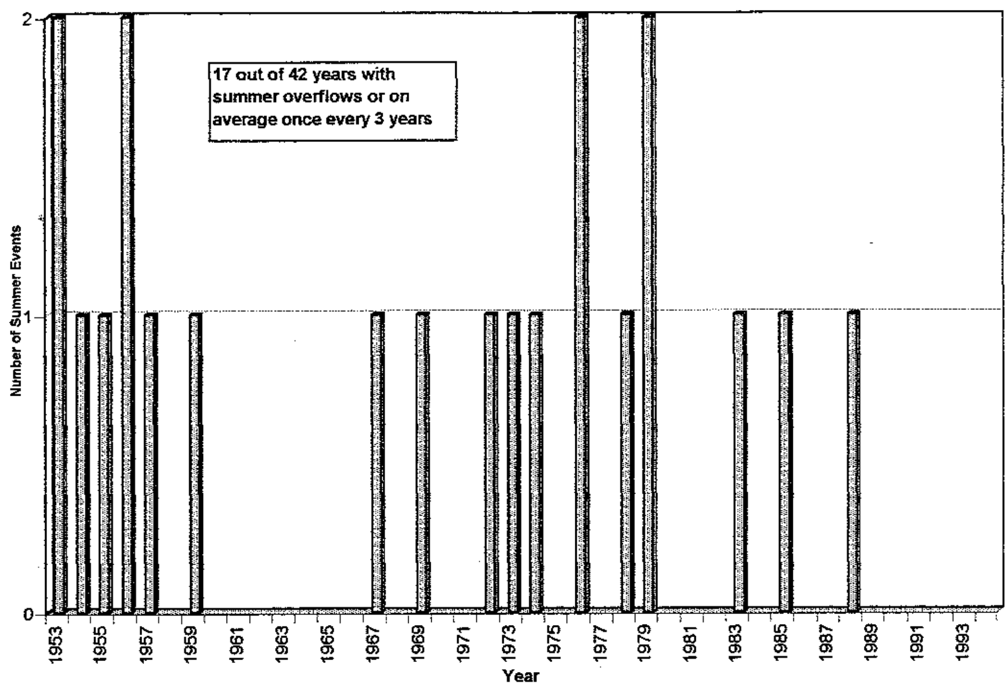
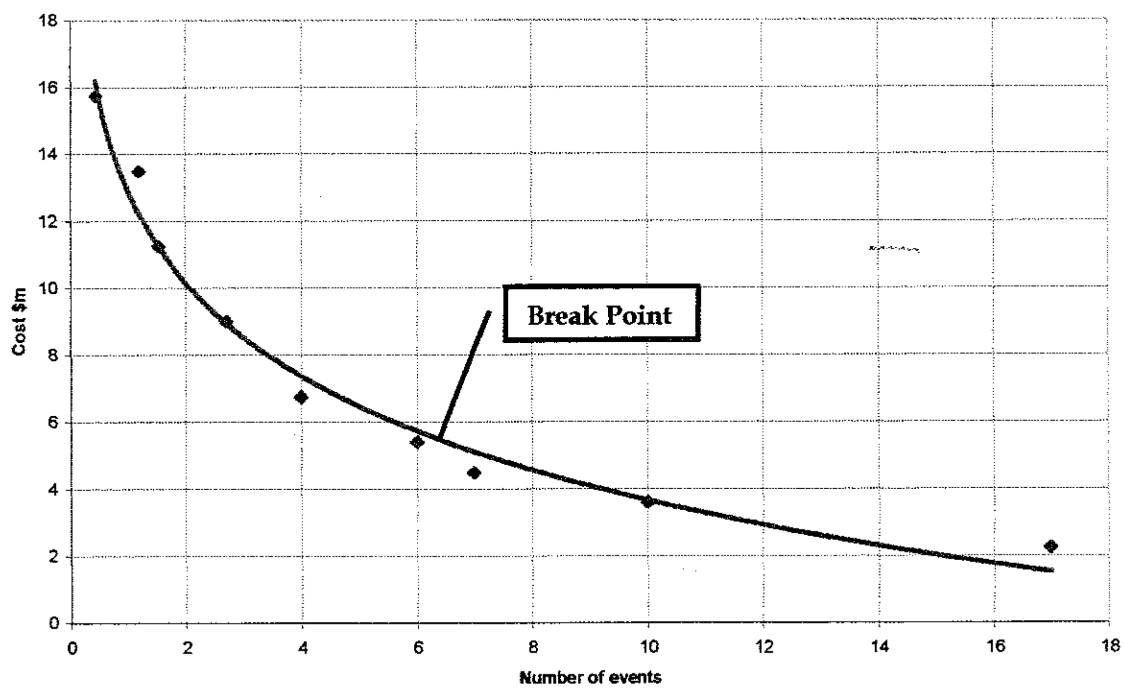


Figure 7-5: Incremental COsts for additional event control



others would discharge 3 times per year. Therefore the winter target is for no more than 6-7 events at several targeted CSO outfalls and three or less at other outfalls.

During summer months the control plan has a much more dramatic effect on limiting CSO events. The summer period is when receiving waters are used the most (see Figure 5-4) and rainfall patterns provide for the driest weather. Typically the summer months are much drier than the winter months with only 16 percent of the total annual precipitation. Figure 7-4 shows the estimated number of CSO events at CSO36 (Columbia) based on the extended CSO analysis for the rainfall period of record. Flows are concentrated to CSO 36. Many years (Figure 7-4) have no overflows during the summer months with one or two overflows occurring, on average, once every 3 years. Table 7-2 shows the estimated number of CSO events at the major CSOs after the plan is implemented.

The control of additional events is limited by the return or incremental benefit obtained by increasing facility sizes and therefor costs. The incremental costs for controlling additional events is illustrated by Figure 7-5. In Figure 7-5 the 'break-point' or the point when costs for additional event controls accelerate at about 7 events. This pattern can be repeated at other CSO locations and matches the incremental costs for other high volume CSOs.

The control plan selected by the City of Astoria is a balanced approach that reduces annual CSO volumes and number of events while protecting sensitive river reaches. The plan addresses the values of the community and the ability of the City to implement, finance, operate, and maintain the proposed facilities. The effects of the selected control plan are illustrated in Figure 7-6. Color-coding is used to designate the level of control provided at the outfall. Figure 7-6 also shows the number of winter events for the typical year for each of the affected outfalls.

Components of Selected Plan

The selected alternative consists of the following major components:

1. Stormwater separation. Conversion of stormwater drainage from undeveloped forested areas into separate stormwater discharges. Figure 7-7 shows the three major stormwater separation projects.

2. Partial street stormwater separation. In conjunction with the construction of new stormwater separation pipes, connect street drainage to the new stormwater line along the pipe route. Figure 7-7 shows the areas subject to partial separation by connection to stormwater separation projects.

3. Flow slipping. Installation of vortex valves or other flow restriction devices at catch basins and inlets throughout appropriate areas of the system. Area-wide installation after pilot testing of technology for Astoria conditions. When appropriate, flow slipped on streets may be connected to existing or new storm drainage pipes.

4. Diversion structure modifications and system optimization. Increase weir heights and other diversion structure modifications to improve the performance of the diversions and make full use of existing inline storage. For example, most diversion structures could be modified by adding a brick layer on top of the weir.

5. Inline storage. Construction of new in-line storage facilities consisting of large diameter pipes parallel to existing combined sewer lines or at outfalls parallel to the shoreline and used as a promenade. Inline storage is suggested for OF43 (5th Street and McClure) in an existing park and at OF18 (20th Street) with the storage pipe acting also as a waterfront promenade.

6. Storage tanks. Construction of rectangular tanks at CSO outfalls which store CSO for return to the existing interceptor for treatment. Tanks are sized to capture a high percentage of the annual CSOs at specific outfalls. Storage tanks are suggested for SFO level of control at OF41 (Florence) and as discussed above at OF36 (Columbia).

The locations of the control components are shown in Figure 7-8.

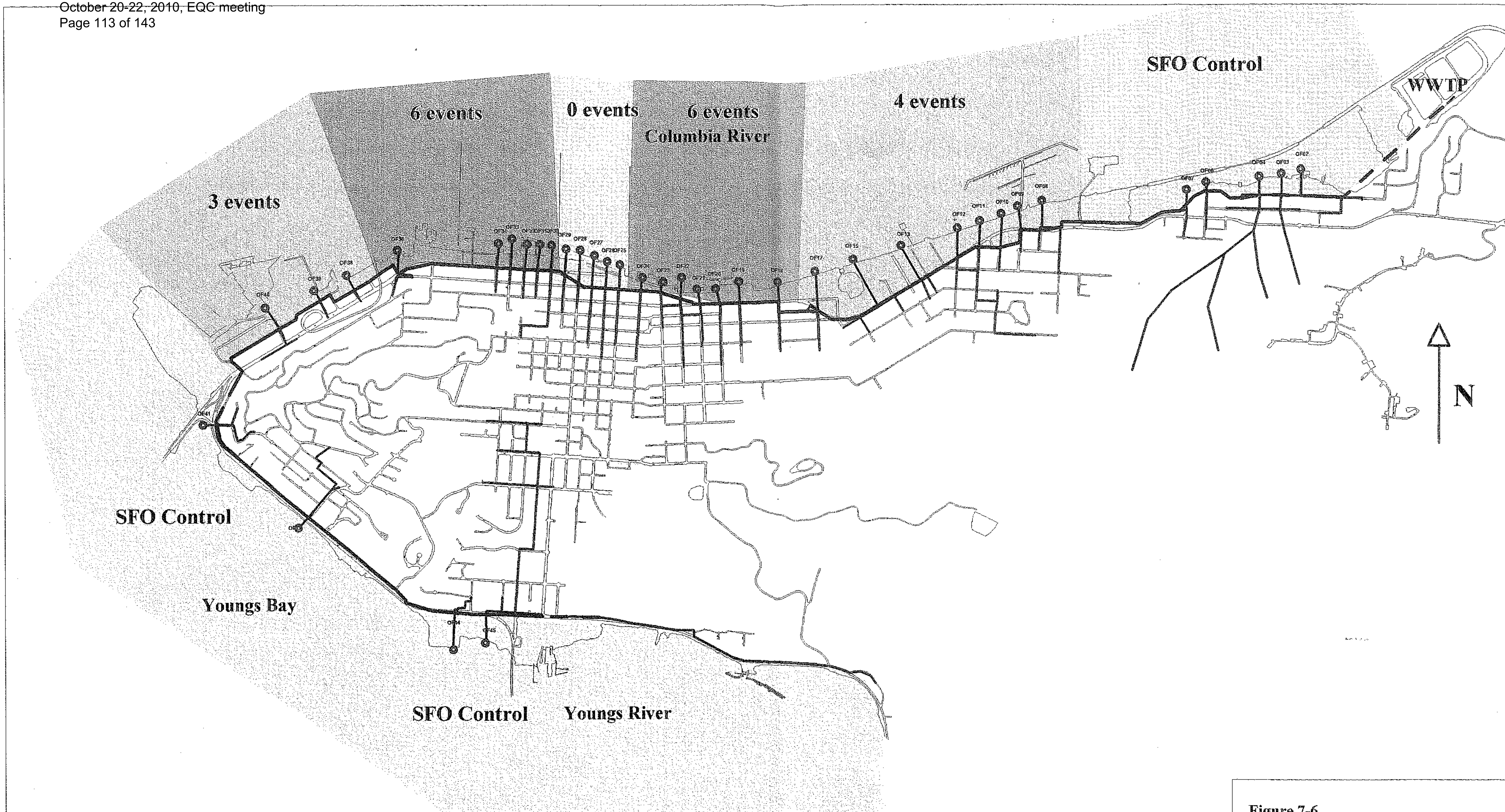


Figure 7-6

CSO Level of Control
For Selected Control Plan
City of Astoria CSO Facility Plan

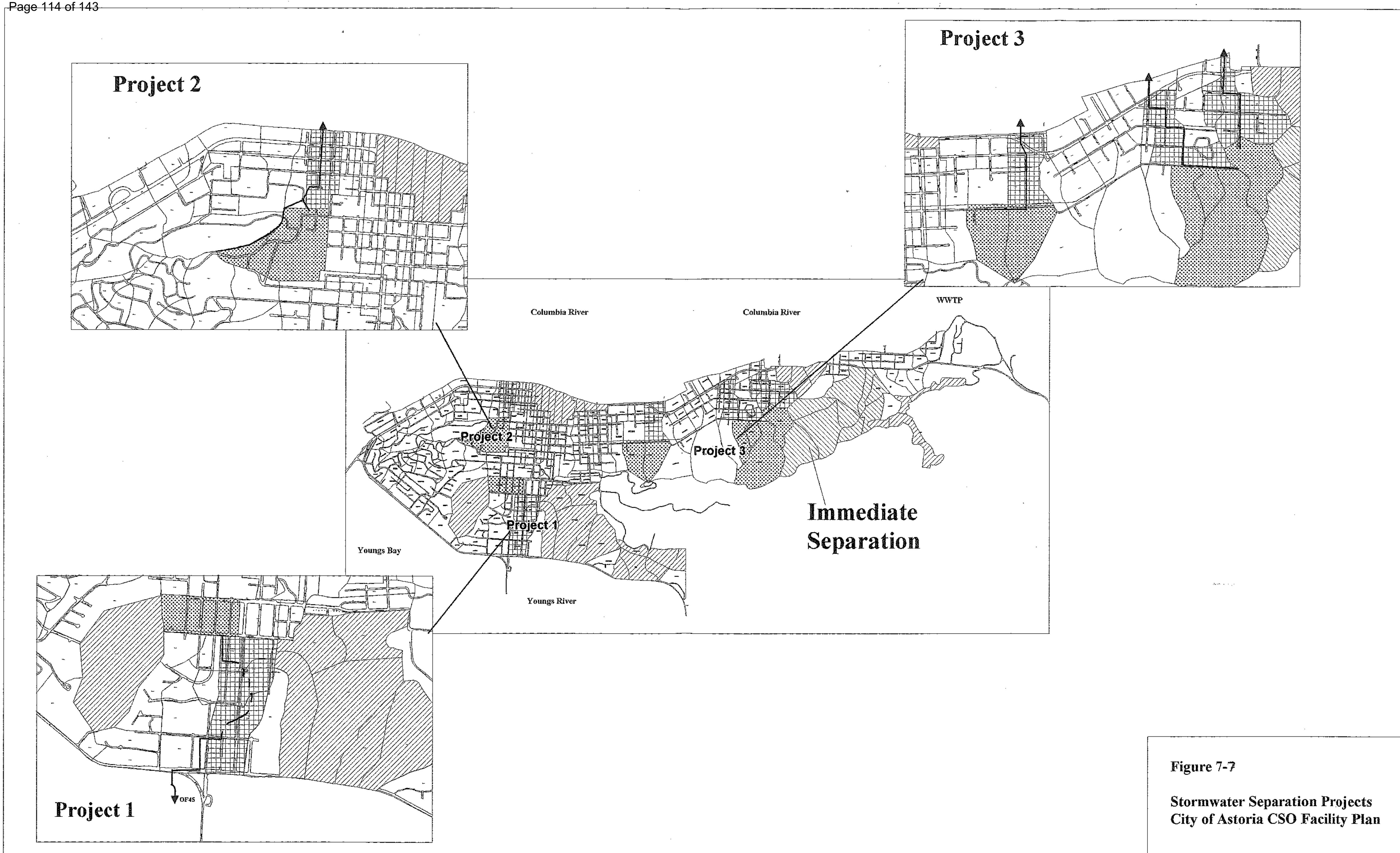


Figure 7-7

Stormwater Separation Projects City of Astoria CSO Facility Plan

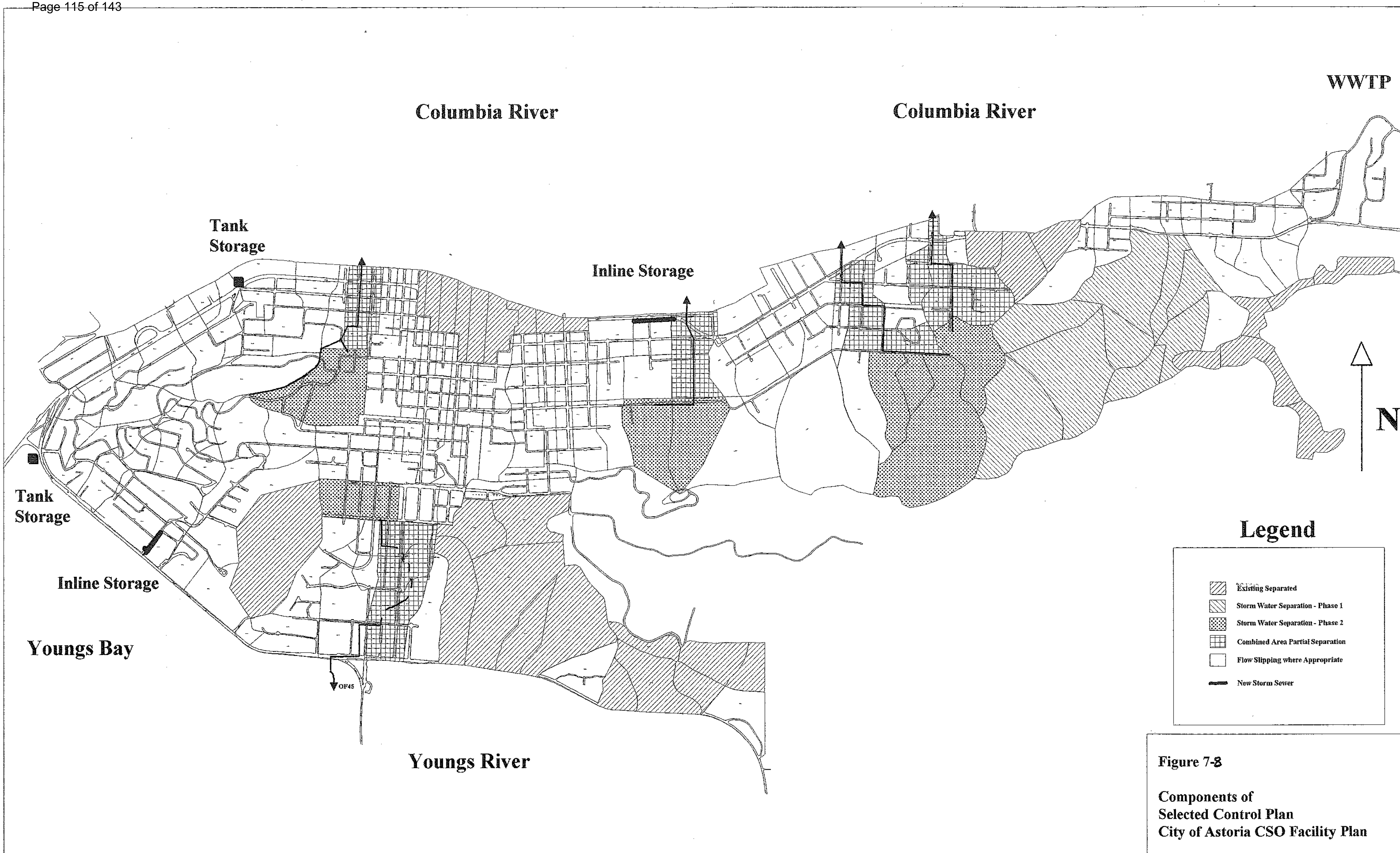


Figure 7-8

Components of
Selected Control Plan
City of Astoria CSO Facility Plan

Implementation of Selected Plan

The SFO stipulates a schedule for the control of CSO discharges. The City has developed a phased implementation plan that exceeds the SFO stipulated schedule by controlling more CSOs earlier and completing the total plan within the schedule specified in the SFO. The plan protects Youngs Bay and Alderbrook lagoon to the SFO level in the first phase. The proposed implementation plan also removes about 80 percent of the total annual overflow within the first two phases of the program. The first two phases are completed by December 1, 2007, or just 10 years from submission of this draft facility plan. The proposed implementation schedule is given in Figure 7- 9. This schedule depends on acceptance of the plan, particularly the first phase construction which will start by July 1, 2001.

As stipulated in the SFO, the 4 overflows to Youngs Bay are controlled in the first phases of the plan. Also by 2003, 5 other overflows in the Alderbrook neighborhood are controlled. Because the plan moves the control for one of Young's Bay CSOs to a latter phase the SFO would need to be amended. The CSOs are controlled by installation of in-line storage and storage tanks and stormwater separation. The second phase, completed by December 2007, controls another 15 CSOs though installation of area-wide inflow controls and diversion structure modifications. The third phase is completed by December 2011; it controls 8 additional CSOs. Because of the acceleration of controls at other CSOs, Phase 4 consists of one major facility to control overflows at OF18 (20th Street). The last and final phase is completed by December 2022; it controls the remaining 4 CSOs. Figure 7- 10 shows the areas scheduled for control in each of the phases of the plan.

Costs of Selected Plan

The costs developed for the selected control plan are planning level costs. They encompass both construction and associated implementation costs. A contingency allowance has also been applied to account for the uncertainties at this planning level. Table 7-3 shows the cost estimates for each of the phases of the selected plan.

TABLE 7-3
Order-of-Magnitude Cost Estimates for the Selected CSO Control Plan

Component	Cost
Phase 1	
CSO facility plan	$400,000
Diversion structure modifications	$53,000
Reconstruction of diversion structure	$37,000
Partial separation project 3 (OF45)	$559,000
Roof drain disconnection program	$783,000
Storage facility at OF44	$464,000
Storage facility at OF41	$464,000
Subtotal	**$2,760,000**
Phase 2	
Partial separation project 2 (OF30)	$1,272,000
Additional enhancements allowance	$218,500

TABLE 7-3
Order-of-Magnitude Cost Estimates for the Selected CSO Control Plan

Component	Cost
Vortex valves throughout system	$689,000
Subtotal	**$2,179,000**
Phase 3	
Storage Facility at OF43	$4,640,000
Partial separation project 1 (OF8, OF11, OF13)	$605,085
Subtotal	**$5,245,000**
Phase 4	
Storage facility at OF18	$4,500,000
Subtotal	**$4,500,000**
Phase 5	
Storage facility at OF36	$4,500,000
Subtotal	**$4,500,000**
Phase 6	
Additional Storage Projects and system enhancements	$3,000,000
Subtotal	**$3,000,000**
Total for Selected Plan	**$22,184,000**

Planning level costs are order-of-magnitude estimates, which have a possible cost range of +50 percent or -30 percent from actual construction costs. These cost opinions have been prepared using quantity takeoffs and extension of unit prices for the major identifiable components of the selected plan. The quantity of materials necessary and the associated costs reflect the nature of construction and the conditions expected for the work in Astoria. Associated implementation costs have been added by including an allowance for administrative, engineering, and legal services. The allowance would typically provide for services that are required on major projects such as special studies, pre-design engineering, engineering reports and contract documents, construction management, startup, legal services, and liaison with regulatory and funding agencies.

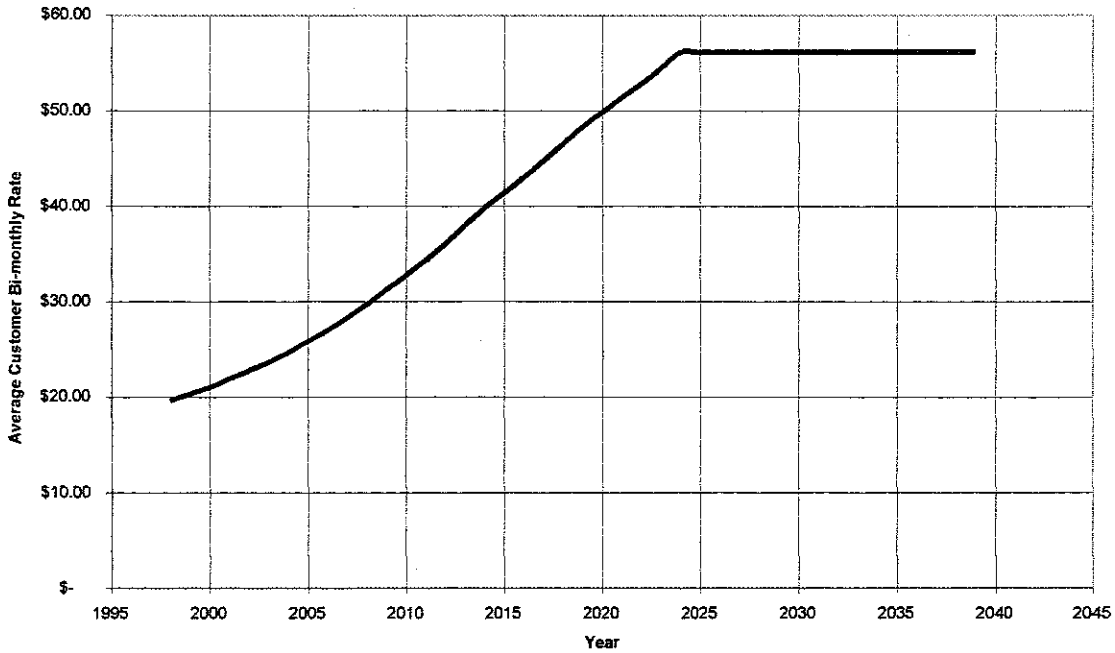
It is the intent of the City of Astoria to seek state grants and other sources of funds to assist in the construction of these facilities. Generally, however, the bulk of the funds will come from the proceeds of bonds that are paid by sewer rates.

Financial Plan

The phasing of projects in the Draft Facility Plan resulted in erratic and large increases in sewer rates during the early years of the project. To stabilize rate increases and reduce the 'sticker shock' of the program rate increases and to make the implementation of the plan more feasible the phasing of project components have been revised from that in the Draft

Plan. The major change was accelerating roof-drain disconnection and other inflow reduction programs to Phase 1 and shifting the large capital project for CSO43 to Phase 3. The inflow reduction projects will have an immediate benefit upon CSO volumes and number of events throughout the system. CSO43 would only effect a portion of Youngs Bay that is little used and has difficult access. Re-arranging plan components have a significant effect upon the timing of rate increases. Ultimately the bi-monthly sewer rates will increase for the average customer from about $19.60 to about $55.00 or a 280 percent increase over the life of the plan implementation. The change in rates is gradual (averaging about 5% per year) over the plan life as shown in Figure 7-11.

Figure 7-11:
Average Customer Bi-monthly Rate



Public Involvement

The public input process initiated for Astoria is primarily directed at providing the public opportunity to comment on the plans presented herein. The public involvement process will consist of informational meetings, City Council presentations, and mailings to sewer customers. City staff, DEQ and consultants in September 1998 conducted a workshop for the Astoria City Council. Several detailed newspaper articles have been produced on the CSO plan. It is expected that the public will continue to be informed, and will provide input to the plan approval process and negotiations with DEQ whenever the SFO and NPDES permit are presented for public notice. The City of Astoria plans to educate the citizens about the CSO situation in a number of ways. Some of these are detailed below:

- **Public Meetings** - CSO occurrence and plans for reducing them have been and will continue to be discussed at City Council meetings that are advertised and are open to the public. Open house meetings will be held to allow more detailed discussion and more opportunity for review of maps and plans and for questions and input

- **Environmental Education at Schools** - A number of environmental programs are already in place in the Astoria School District. These involve studies of the local streams, Youngs Bay and the Columbia River. We plan to work with school teachers, the Marine Environmental Research and Training Station (part of Clatsop Community College) and the Columbia River Estuary Study Taskforce to educate students about the existing overflow problem and plans to correct it as well as involve them in monitoring flows and water quality

- **CSO Brochure** - A brochure is currently being developed for public distribution. It is being modeled on existing brochures distributed by Portland and Corvallis

- **Signs** - Signs will be produced for placement at significant overflow locations. Again these will be modeled after those produced by Corvallis and Portland

- **CSO Event Notification** – Integration with the prediction and pollutant transport capabilities of the "Pilot Now-cast Forecast System" for the Columbia River Estuary will be investigated.

- **River Tours** - Groups such as H2O, Headwaters to Ocean, have proposed tours of the river that concentrate on environmental issues. We will provide information on CSOs and when possible provide a City representative on the tour.

Flexibility of Plan

The plan consists of components that build on one another to create the overall control plan. The nature of the components allows flexibility in implementing the components. Each component has certain features that limit and control CSO at specific outfalls and can effect the performance of the collection system and CSOs at other outfalls. Therefore depending upon the effectiveness of each of the plan components it may be possible to reduce or scale back the sizes of latter components. This is particularly true for the cumulative effects of inflow reductions on proposed storage facilities. It is planed that reviews of effectiveness of the components will be conducted throughout the phased implementation of the plan. Future plans will therefore be adjusted based upon the performance of each phase of the plan. Adjustments would however not reduce the targeted levels of controls at the CSO outfalls.

Figure 7-9

Phased Implementation of CSO Controls

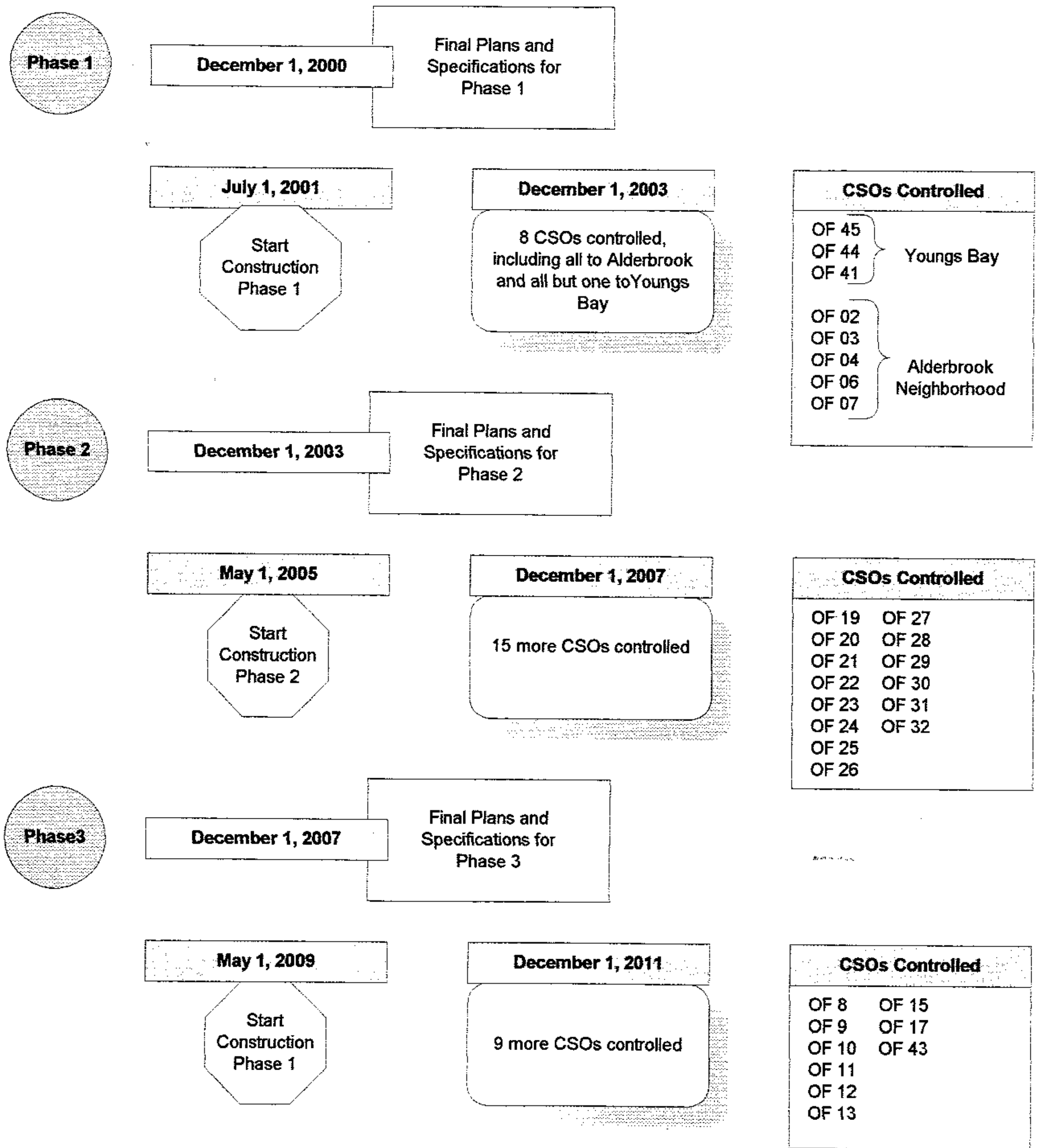
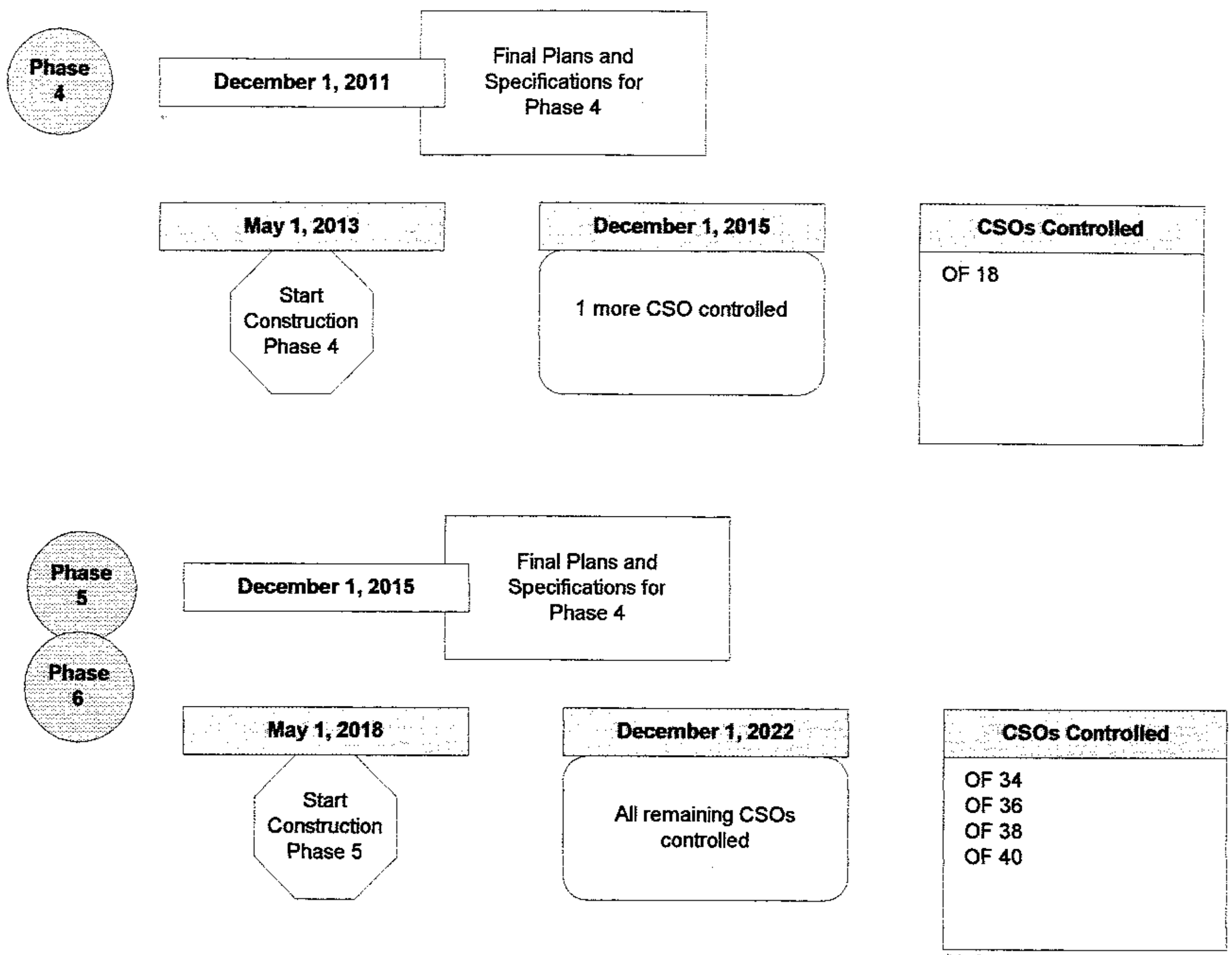


Figure 7- 9 (continued)

Phased Implementation of CSO Controls



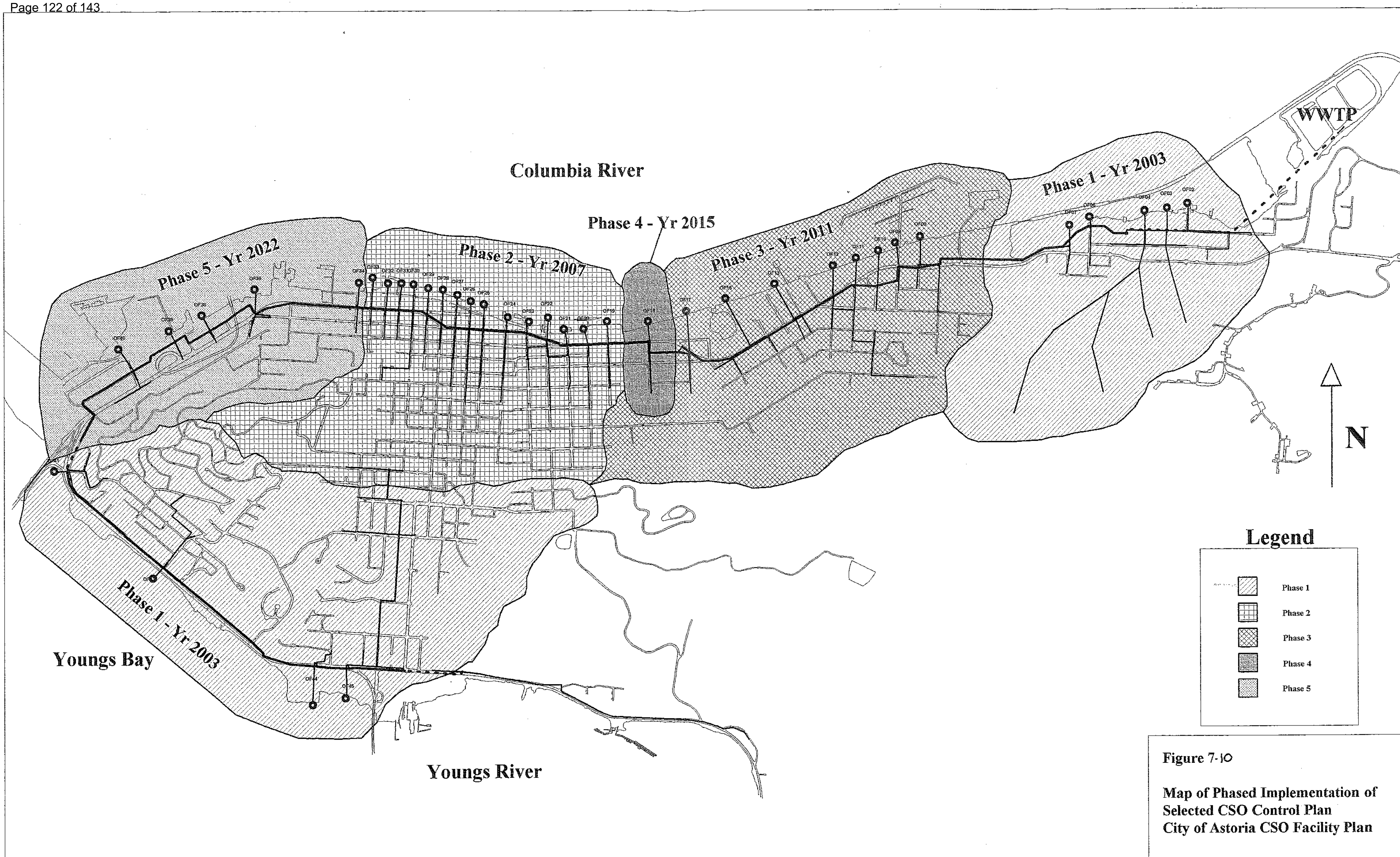


Figure 7-10

Map of Phased Implementation of Selected CSO Control Plan City of Astoria CSO Facility Plan

City of Astoria
Combined Sewer Overflow – Facility Plan Update
September 2005

Introduction

In September 1998, as required by Stipulation and Final Order WQMW-NWR-92-247 (SFO), the City of Astoria produced a final CSO Facility Plan detailing plans for the control of combined sewer overflows (CSO). The Facility Plan specified the projects and schedule for implementing the controls. There were 5 phases of projects with the final projects to be completed by December 2022. Each phase of controls targeted specific outfalls with more sensitive areas controlled in earlier phases. An important aspect of the facility plan was the varying level of control around the Astoria peninsula, with sensitive areas designed with a higher level of control than less sensitive areas.

Phase 1 projects are near completion with 3 outfalls to Youngs Bay and 5 outfalls to Alderbrook Lagoon controlled. The design standard for the projects is the 5-year winter and 10-year summer design storm. Upcoming winters and monitoring will demonstrate how well the CSOs control projects function and a report will be submitted to the Oregon Department of Environmental Quality (DEQ) to demonstrate compliance to the design events. Submission of the report is dependent on occurrence of adequately sized rainfall events.

Revisions to Facility Plan

The DEQ has not presented the 1998 Facility Plan to the Environmental Quality Commission (EQC) because of uncertainties with acceptance of a level of control less than a 5-year winter and 10-year summer storm for certain outfalls in the system. The City and DEQ agreed to pursue a modification to the Facility Plan to increase the level in Phase 2 to the 5-year and 10-year design events. To accomplish this, the number of outfalls targeted for control would be reduced in Phase 2 from 15 to at least 8 as required by the SFO.

Later phases (phase 3 onwards) would also likely see adjustments to the level of control and number of outfalls controlled in each phase although control to the 5-year winter and 10-year summer storm may not be feasible at all locations. All outfalls would however be controlled by the existing scheduled 2022 date.

The City has developed plans for control of 9 outfalls to the 5-year and 10-year event standard in Phase 2, and partial control at a 10th outfall. (One of the 9 outfalls was actually controlled in 2000 and does not require further work.)

The Phase 2 plans call for connection to stream inflows and springs, separation of streets and large impervious areas, and selected disconnection of roof drains in four areas of the City as detailed below. Work on final designs of the projects is expected to be completed during the winter of 2005-2006 with construction starting in the spring of 2006.

Phase 2 controls are required by the SFO to be in place by December 2007. Therefore approval by DEQ of this revision by February 2006 is required to ensure compliance with the control schedule.

Table 1 shows a preliminary schedule for Phase 2 controls and expected Phase 1 completion and compliance monitoring.

Phase 2 Control Projects

Nine CSO outfalls are planned for control during the revised Phase 2 of the overall control plan. CSO 08 will be partially controlled; all others will be controlled to the 5-year winter and 10-year summer design storms. The following sections details controls envisioned and outfalls controlled.

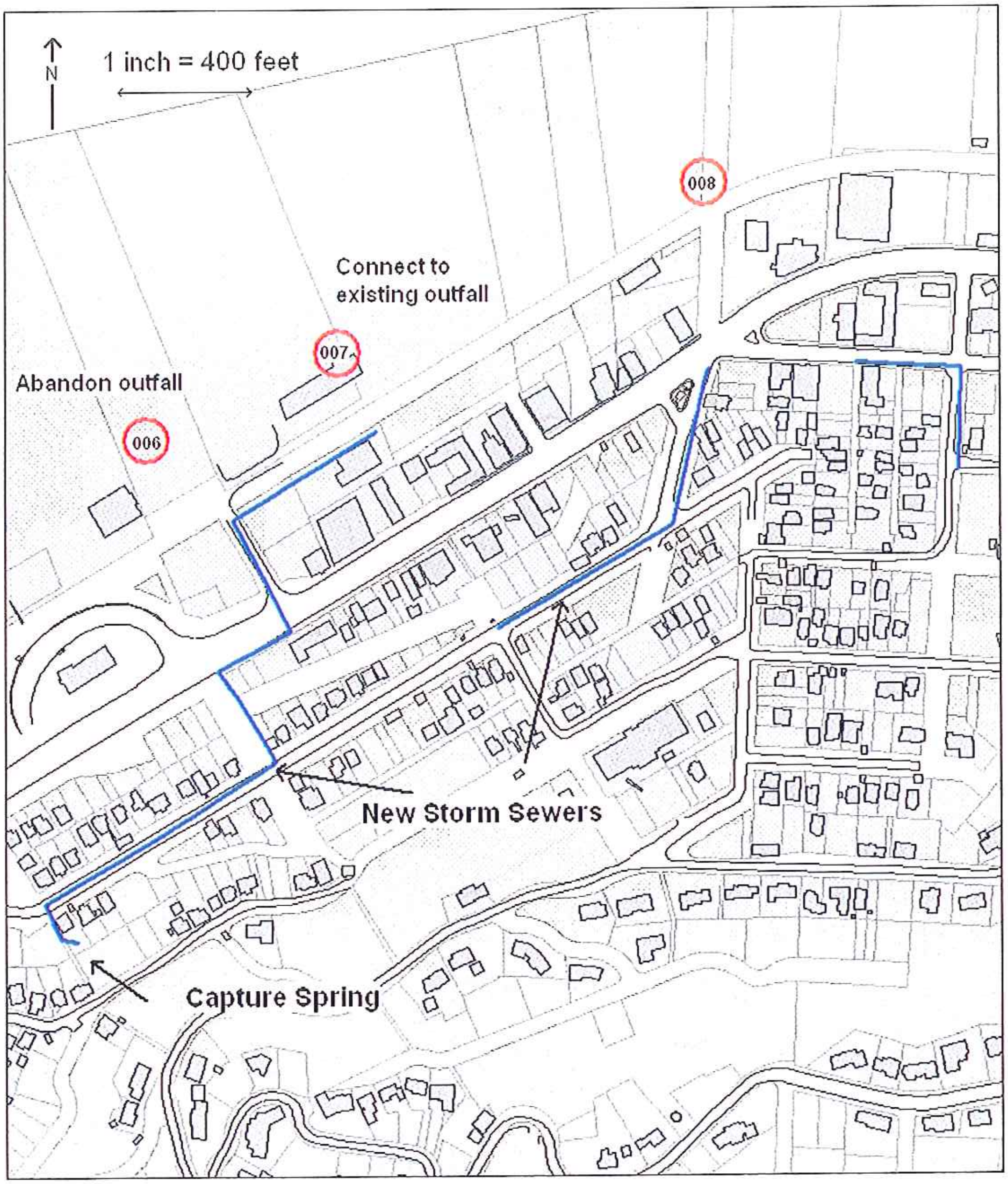
Alameda Separation Project (CSO 06 and CSO 07 and partial control at CSO 08):

Separation in the Alameda area will affect three CSO outfalls as shown in Figure 1. The Alameda separation (western area - CSO 06) will capture a continuous flowing spring, street drainage and selected parking and other impervious areas. The Alameda project will also correct a poorly sloped sanitary sewer. The plan will combined two CSO outfalls and abandon a deteriorated outfall that discharges near the West Mooring Basin. Changes to Oregon Department of Transportation (ODOT) road drainage is not included in the project with the existing separated areas remaining connected to the ODOT system which discharges to a storm only outfall.

The Melbourne Street CSO (CSO 07) will be controlled by capture of street drainage along Alameda and selected parking and roof separation. Storm flows are routed away from the Melbourne outfall to downstream of the diversion structure on Columbia (CSO 08). The Melbourne outfall receives flows from the Alameda separation project.

The Columbia outfall will have higher storm water flows but reduced CSO amounts because of the third portion of the Alameda project. The third portion is separation of a continuous flowing spring, street drainage and selected parking and roof disconnections along Bond and Hume. The project also connects to a partial separation project completed by the City in 2001 along Commercial.

Design storm level control of Columbia CSO (CSO 08) is scheduled for Phase 5. Columbia is the relief outfall for Lift Station No.4 and therefore CSO controls are dependent on operations at the lift station and flows received by the station. The amount of flow received at the station will be reduced because of the large amount of storm separation proposed upstream. The actual amount of flow reduction will be monitored and used to determine the flow amounts required to control CSO at this outfall. The 1998 Facility Plan suggested a storage project at the outfall

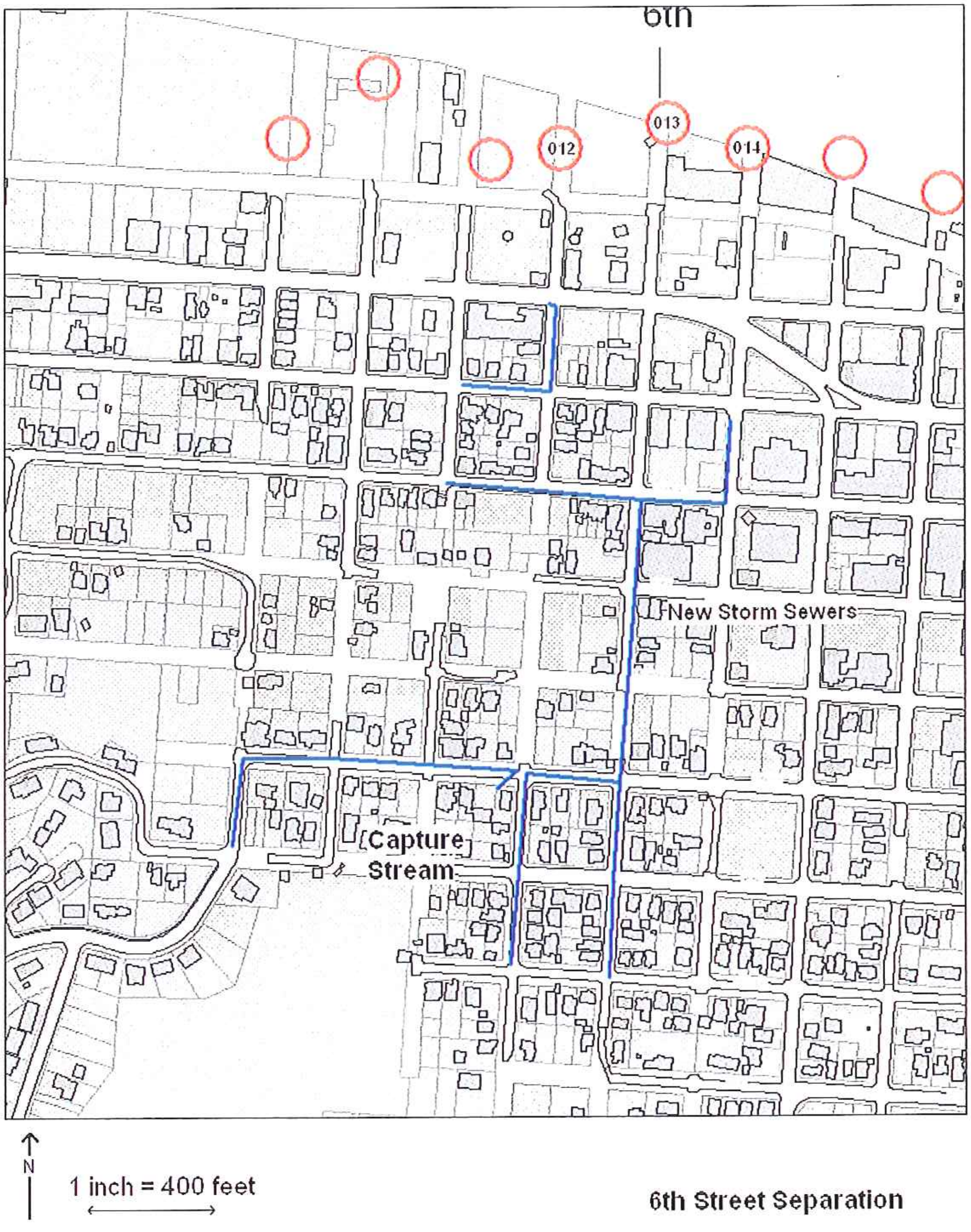


Alameda Separation

6th Street Separation (CSO 11, CSO 12 and CSO 13):

Near 4th and Franklin there is a major stream inlet from a large forested area that flows into the combined sewer system year round. The 6th Street separation project will disconnect this stream from the combined system and separate streets, parking lots and other larger impervious areas and selected roof drains. A new storm sewer system will be built to convey storm to just downstream of the CSO 14 (7th Street) diversion structure to utilize the existing outfall.

Associated with the 6th Street projects are smaller separation segments that will disconnect streets and roof drains drainage from CSO 11 and CSO 12. Separation for the CSO 11 project will connect to the proposed 6th Street storm sewer. Separation for the CSO 12 project will connect a new storm line to just downstream of the CSO 12 (4th Street) diversion structure.

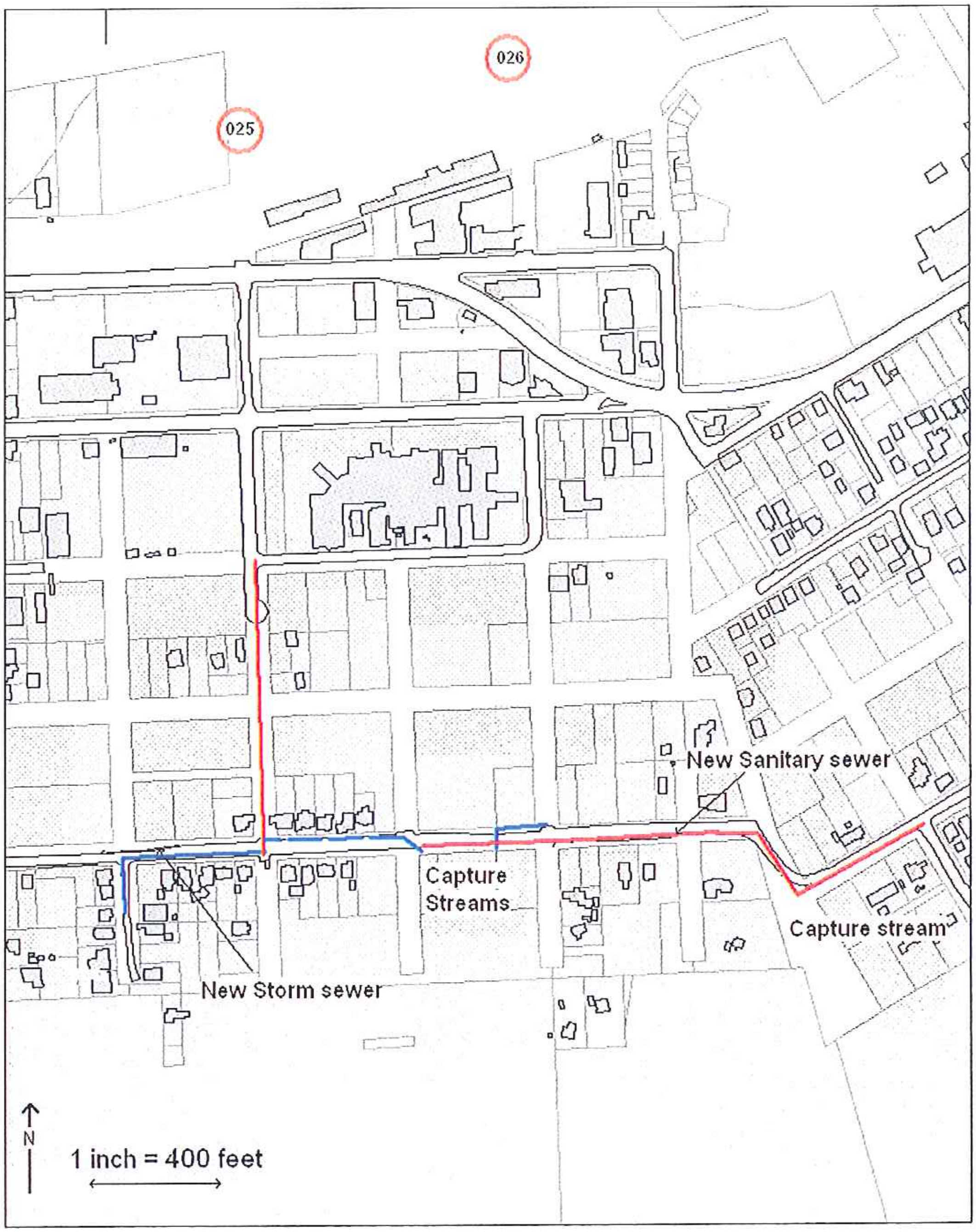


6th Street Separation

22nd Street/Irving Separation (CSO 25 and CSO 26):

Along Irving there are several streams inlets that connect to the combined sewer system. The inlets near 22nd carry steady base flow and larger storm flows with relatively large amounts of sediment. This sediment drops out of the system near the diversion structure where sewer slopes flatten. The deposition of sediments causes increased frequency of maintenance and increased risk of diversion blockage and possible overflows. The separation project will remove the stream flows and separate streets and selected roof drains.

Rather than construct a new storm system throughout, the 22nd Street project will construct a new sanitary system for portions of the collection system. This will enable the use of parts of the collection system for storm flows with sanitary flows diverted to the new sanitary sewer. Final design may however result in slightly differing proportions of new sanitary or new storm but the separation objectives would not be changed.

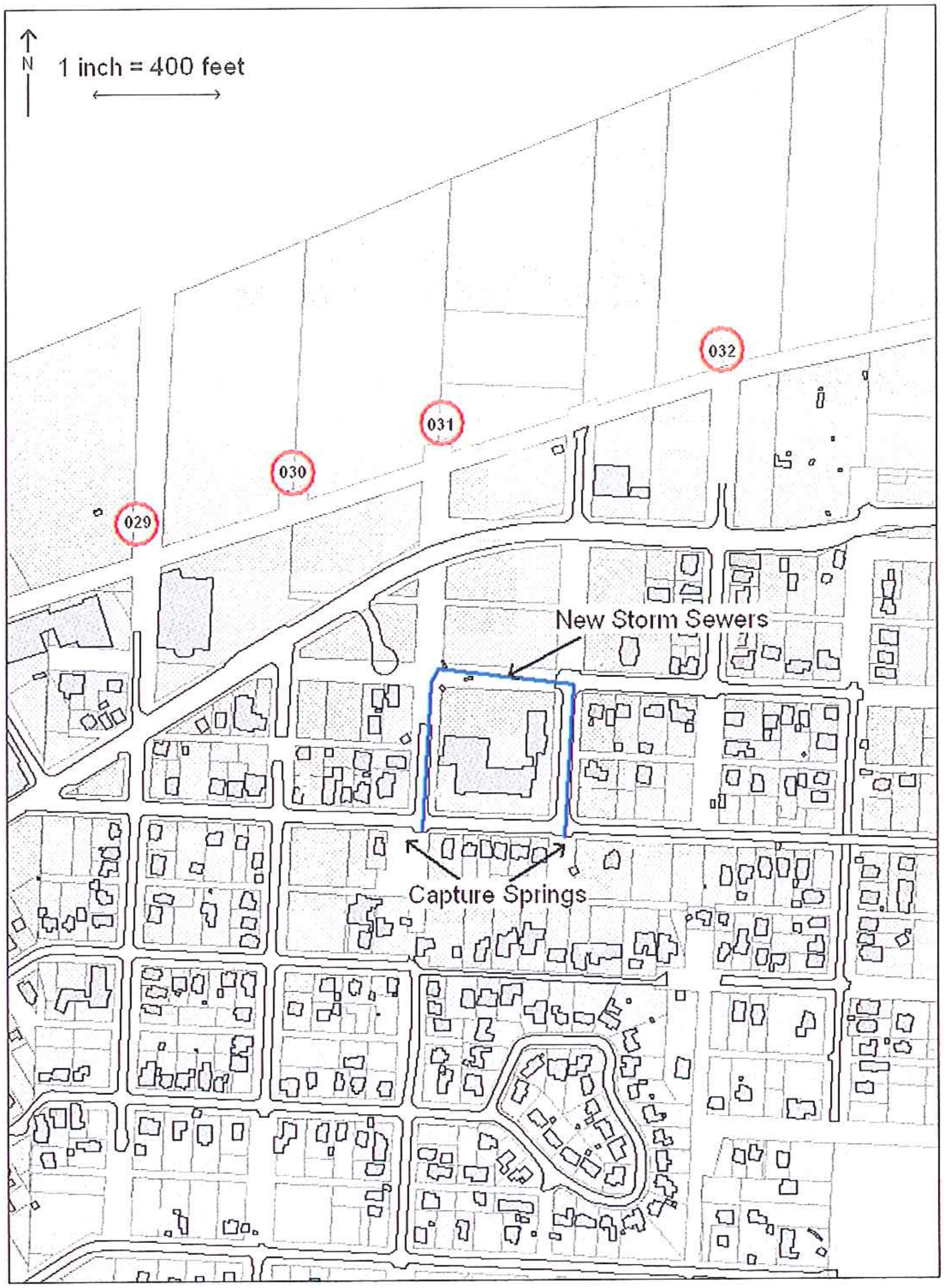


22nd Street Separation

35th Street Separation (CSO 31 and CSO 32):

The drainage areas for subbasins connected to CSO 31 are relatively small therefore not many new storm sewers are required. However the new storm sewers will connect to several perforated drain fields and a storm flume. Where possible the roof drains and playground area drainage of the elementary school near the project will be connected to the storm sewers. The project will also capture street drainage and selected residential roof drains. The new storm sewers will connect downstream of the diversion structure and use the existing CSO outfall.

CSO 32 was included in the 1998 Facility Plan. This outfall no longer exists due to changes to the system since the plan. Outfall (CSO 32) is no longer considered for control.



35th Street Separation

Phase 3 and Latter Phases

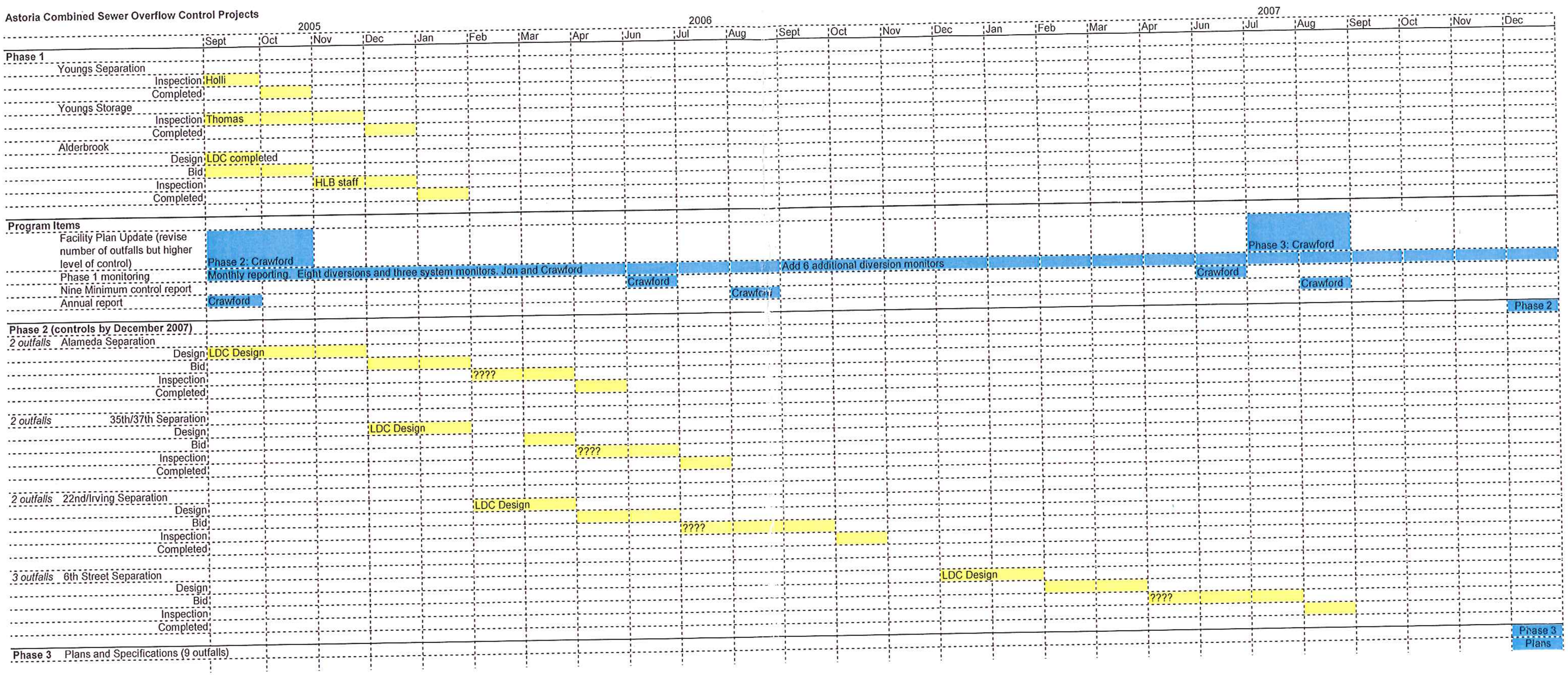
Success of Phase 1 and Phase 2 projects may dictate the controls implemented for latter control projects. Revisions to the Facility Plan are therefore expected as additional information is collected on the performance of implemented controls and system flows. System flows will be monitored to determine storm and base flow reductions achieved with Phase 1 and Phase 2 projects.

Level of control for latter phases will also depend on DEQ acceptance of revisions of the Facility Plan. The City will however attempt to achieve the highest level of control possible within engineering and economic feasibility. Table 2 and Figure 1 show the current schedule for control at outfalls for Phase 3 and latter phases.

Table 2: Phased Implementation of CSO Controls

Phase 1	December, 2003 Actual: December 2005	Outfalls: CSO 01 CSO 02 CSO 04 CSO 34 CSO 37 CSO 35 CSO 38 CSO 36
Phase 2	December, 2007	Outfalls: CSO 06 CSO 07 CSO 08 (partial) CSO 11 CSO 12 CSO 13 CSO 25 CSO 26 CSO 31 CSO 32 (removed)
Phase 3	December, 2011	Outfalls: CSO 03 CSO 09 CSO 10 CSO 23 CSO 24 CSO 27 CSO 28 CSO 29 CSO 30 CSO 33
Phase 4	December, 2015	Outfalls: CSO 14 CSO 15 CSO 16 CSO 17 CSO 18 CSO 19 CSO 20 CSO 21 CSO 22
Phase 5	December, 2022	Outfalls: CSO 05 CSO 08

Crawford Engineering Associates
City of Astoria
10/28/2005



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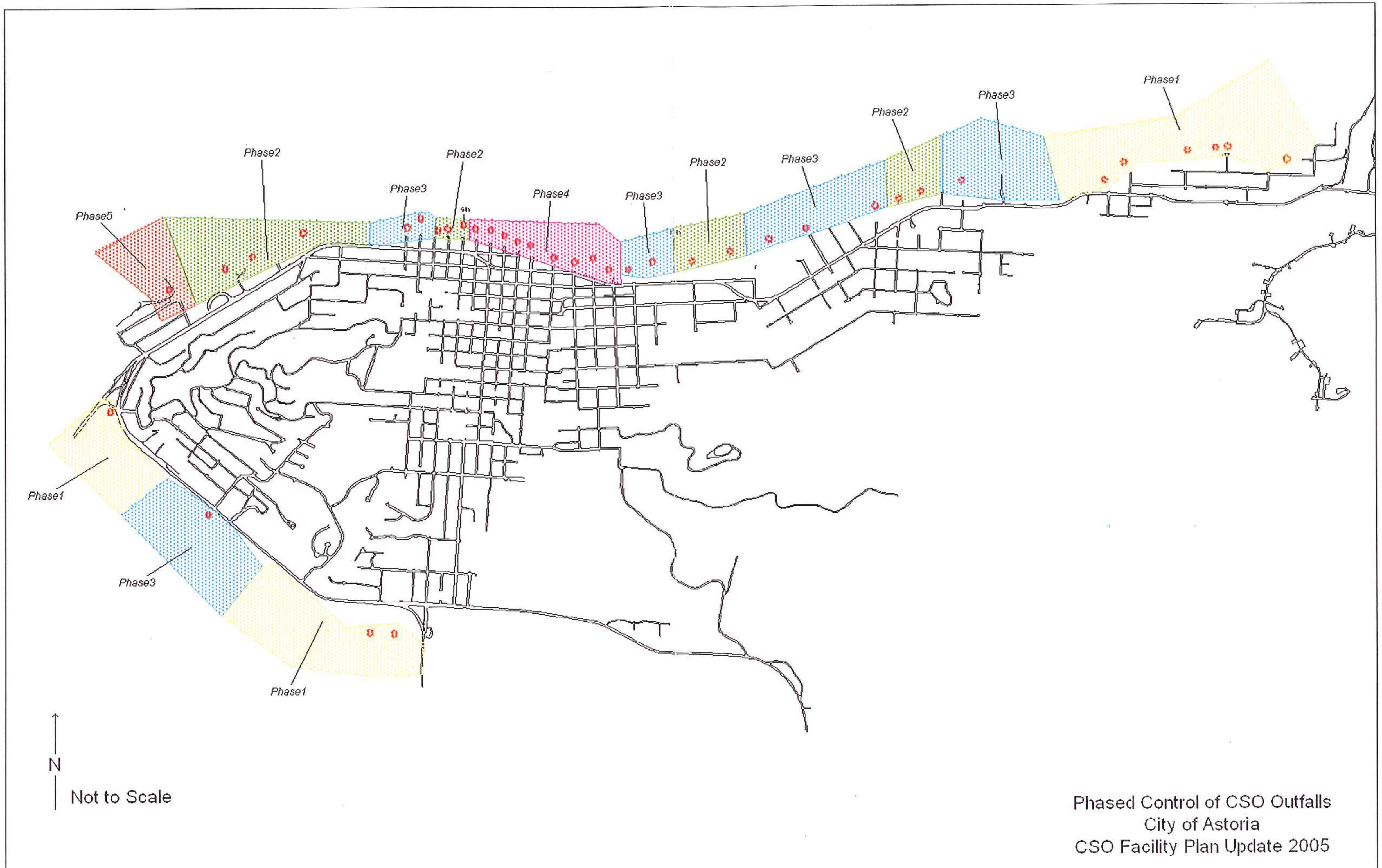


Figure 1: Current CSO Phases and Outfalls Controlled.

City of Astoria
Combined Sewer Overflow–Facility Plan Update
June 2010

Introduction

In January 1993, the City of Astoria ("Astoria") and the Oregon Department of Environmental Quality ("DEQ") entered into a Stipulation and Final Order (WQMW-NWR-92-247) (the "SFO") that set out certain requirements and a compliance schedule for control of combined sewer overflows ("CSOs") to the Columbia River and Young's Bay. As required by the SFO, Astoria produced and submitted to DEQ a final CSO Facility Plan in 1998. The 1998 Facility Plan included a comprehensive examination of Astoria's combined system and the nature and extent of its CSOs, as well as an evaluation of control options and selection of a final control plan. Astoria worked closely with DEQ throughout the process of drafting the 1998 Plan and submitted a draft plan to DEQ prior to finalization.

The final plan selected and proposed in the 1998 Facility Plan consists of a variety of control components, including diversion structure modifications, system optimization, partial street storm water separation, storm water separation in undeveloped areas, flow slipping in catch basins and inlets, and the increased use of inline storage and storage tanks. These components are combined in 5 discreet project phases, each targeting a certain subset of CSO outfalls in Astoria's system, with the final phase to be completed in 2022 in accordance with the SFO. The selected plan would eliminate approximately 96 percent of Astoria's total CSO volume, with outfalls to more sensitive receiving waters around Youngs Bay and Alderbrook Lagoon being controlled in earlier phases.

Astoria has made substantial progress towards the completion of its selected control plan, as detailed in both this Update and a previous Update submitted to DEQ in 2005. To date, the city has spent approximately $17 million and achieved an overall control level of approximately 80-85% of its total CSO average annual discharge volume.

Phase 1 projects were completed in 2006 with three outfalls to Youngs Bay and five outfalls to Alderbrook Lagoon controlled. In September 2007, a Phase 1 compliance report was submitted to the Oregon Department of Environmental Quality (DEQ) and this reported that the five outfalls to the Alderbrook Lagoon and one outfall to Youngs Bay met the control requirements specified in the SFO. Two outfalls (CSO 001 and CSO 002) to Youngs Bay did not fully meet control requirements because of high inflows from an intermediate CSO (CSO 003 – Denver Street) that is set to be controlled in Phase 3. Discussions and agreements with DEQ have accelerated the completion date for this CSO (CSO 003) to fall 2010. Upon completion of the Denver Street project all four CSOs to Youngs Bay will be controlled to the SFO required level. Remaining projects in Phase 3 are planned for completion by December 2011.

Phase 2 projects were completed in 2008, resulting in the control of ten additional CSO outfalls. Based on monitoring, six of those outfalls currently meet the SFO 5-year winter and 10-year summer control requirement. The remaining four outfalls are controlled to levels consistent with the 1998 Plan and 2005 Update with removal of about 80% of the annual average CSO volume. As with Phase 1, a full compliance report, in addition to ongoing monthly reports, will be submitted to the DEQ to demonstrate compliance of Phase 2 projects to control requirements. Timing for the submission of the final Phase 2 compliance report is dependent on occurrence of rainfall events of adequate size to obtain accurate monitoring information.

Full implementation of the remaining phases of the control plan set forth in the 1998 Facilities Plan will require a modification to the control levels required in the original SFO. The 1993 SFO required that CSOs at all 38 of Astoria's CSO outfalls be controlled to what is known as a 10 year return summer storm, 5 year return winter storm level. While this SFO level will be achieved for projects in the Alderbrook and Youngs Bay, the control level for other CSOs that discharge to the shipping channel of the Columbia River are designed to a slightly lesser, but still strict standard of limiting CSO discharges to six-in-one-year winter and on average once every 2 years in the summer.

This level of control, which represents a difference of only 3-4 % in total average annual CSO volume captured from the volume captured if controlled to the SFO requirement, would save the City at least $10 million or about 25% of the total program cost. This level of control therefore represents a fair balance between the capture of CSO volume, where CSOs occur and cost.

Astoria and DEQ have been negotiating this modification since completion of the original facility plan in 1998, but its approval has not been accomplished, partially because most of the early phases were designed to the SFO level of control. DEQ prepared and submitted a Director's Dialogue Memorandum outlining the requested modification to the SFO control level to the Environmental Quality Commission (the "EQC") in late May 2010. The agency has advised the City that it is planning to present the full modification request (in the form of an Amended Stipulation and Final Order) to the EQC for consideration and approval at its meeting on August 18-19, 2010. A final decision is expected from EQC in fall 2010.

Revisions to Facility Plan

As the modified level of control has not yet been approved, the City executed Phase 2 projects to a target of control required in the SFO. As discussed in Astoria's 2005 facility Plan Update, in order to accomplish this without severe financial impacts to the City, the number of outfalls originally targeted for control was reduced in Phase 2 from fifteen to the eight, the minimum number required to remain in compliance with the SFO. The order of the actual CSOs controlled was also modified to better match the City's repaving and other programs.

As mentioned above, Astoria and DEQ negotiated an accelerated schedule for completion of the portion of the Phase 3 work known as the Denver Street Storage Project. The Denver Street Storage Project is intended to control CSO 003 and complete the control of CSO 001 and CSO 002. Construction is well underway and the project is set to be completed by this fall. DEQ has separately reviewed and approved design and construction plans related to the Denver Street Project and therefore this update does not restate those details. The remainder of Phase 3 projects will be outlined in the following sections. Phase 3 is targeted for full completion by December 2011.

The extent of work needed and the completion schedule for all remaining phases of the control plan is dependent upon approval of the modified control level discussed above. In addition, the sequencing of CSO controlled may be adjusted to reflect other public works projects in the City.

Control of overflow volume

Current projects have controlled about 80-85% of the estimated average annual CSO volume. Remaining projects are projected to capture 96% if a variable number of events (up to 6 at some locations) are adopted. Controlling to the 5-year winter and 10-year summer would capture almost all of the estimated average annual CSO but would have a large incremental cost: capturing an additional 3-4% would cost in the range of $10-15 million.
The cost of capturing 96% is estimated to cost in total about $39 million. Capturing an additional 3-4% would cost in excess of $50 million: this 3-4% additional capture has an incremental cost of about 30% of the total cost to capture the first 96%. Figure 1 shows the steep rise in project cost with the small incremental change in CSO capture for different level of control requirements.

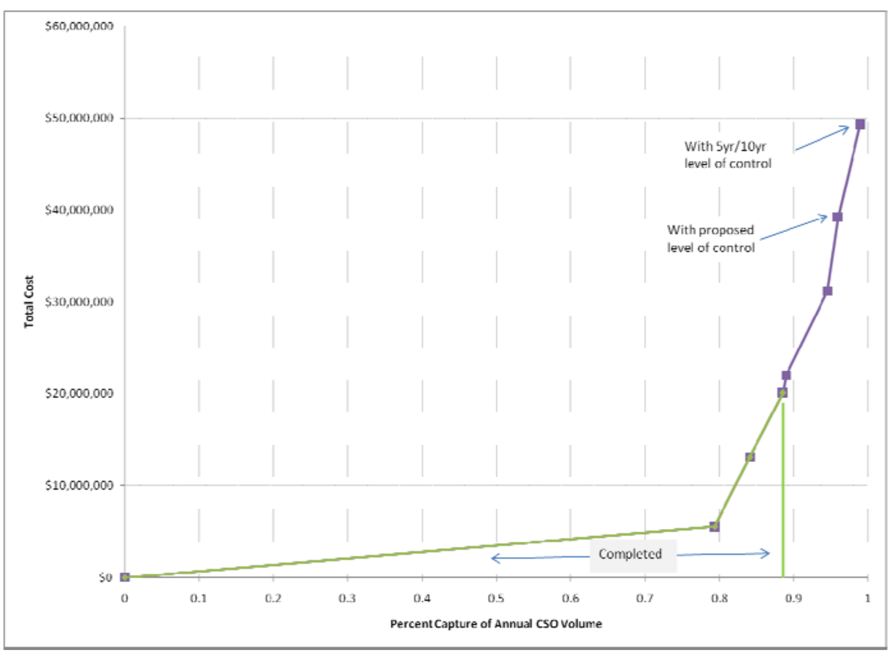


Figure 1: Project costs versus CSO volume and level of control

Phase 3 Control Projects

In addition to the Youngs Bay CSO (CSO 003) controlled by the Denver Street Storage Project, six additional CSO outfalls are planned for control during the revised Phase 3 of the overall control plan. The CSOs to be addressed in the second part of Phase 3 are in the area between 2nd and 12th streets and all discharge to the Columbia River. The general name of this part of Phase 3 is the 11th Street Separation Project. The following sections detail controls envisioned and the outfalls that will be controlled.

11th Street Separation Project – Part 1: 2nd and 3rd streets separation (CSO 09 and CSO 10):

Storm water separation in the area will affect two CSO outfalls as shown in Figure 1. The separation will capture several small springs and street drainage. About 1,200 feet of 12-inch to 15-inch pipe of new storm drainage and about 400 feet of new sanitary sewer of minimum size is estimated for the project. The plan will redirect flow to the two existing CSO outfalls with the outfalls continuing to carry separated storm water. Changes to Oregon Department of Transportation (ODOT) road drainage (along Marine Drive) are not currently included in the project but additional field investigations will confirm if ODOT road drainage is connected to the CSO system and, if connected, additional work may be required.

Figure 2: 11th Street Separation Project Part 1 between 2nd and 3rd streets

11th Street Separation Project – Part 2: 9th to 12th streets separation (CSO 16, 17, 18 and CSO 19):

This part of Phase 3 also separates streets and large parking and other impervious areas. Included in the project are inflow facilities, such as pedestrian refuges or parking strip inlets, at appropriate street intersections. These inflow control projects are intended to reduce the peak flow to the CSO system thereby avoiding the need for new storm sewers. Selected large roof areas are also targeted for disconnection to the street where new storm sewers are proposed.

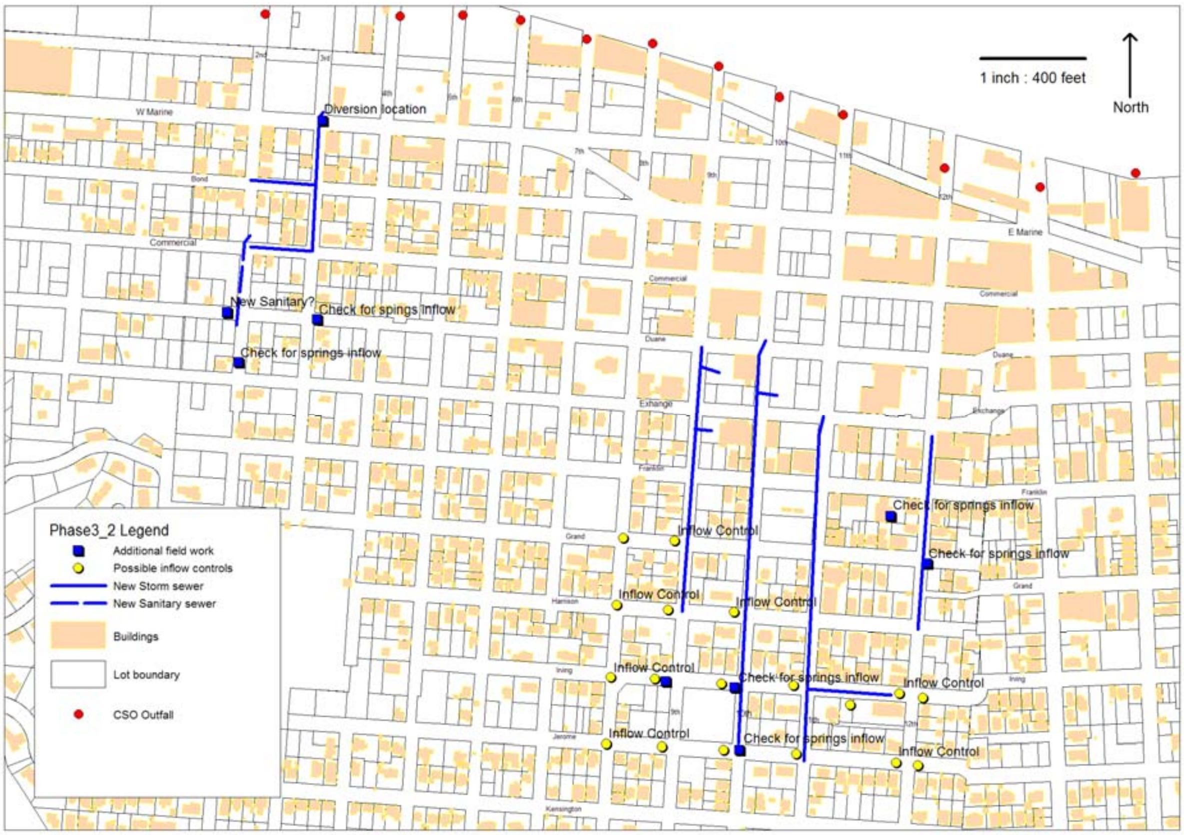


Figure 3: 11th Street Separation Project between 9th and 12th streets

Approximately 5,000 feet of new storm sewer ranging from 12-inch to 18-inch is estimated for this part of Phase 3. The new storm sewers would connect downstream of diversion structures to existing overflow pipes. These overflow pipes also carry separated storm water from the downtown area of Astoria. As the existing outfall pipes carry overflows no increased capacity in the outfalls is required.

TV investigation of the outfalls has indicated they are in reasonable condition and no remedial work is required. However, inspections have discovered that the diversion at 9th Street (CSO 016) is no longer connected to the outfall and therefore all flow is entering the Interceptor

Sewer. This has a high potential for surcharging the Interceptor Sewer and may be instrumental in the difficulties encountered at Lift Station No. 4. Additional site review will be carried out to determine the connections and revisions needed at 9th Street. Additional field investigations planned for this summer will determine location of any large spring inflows and the condition of the existing sewer system. These field investigations may result in modification to the plan but the work outlined in Figure 2 is believed to be a reasonable representation of the work needed to control the six CSOs to the proposed six per winter and once every two year requirements.

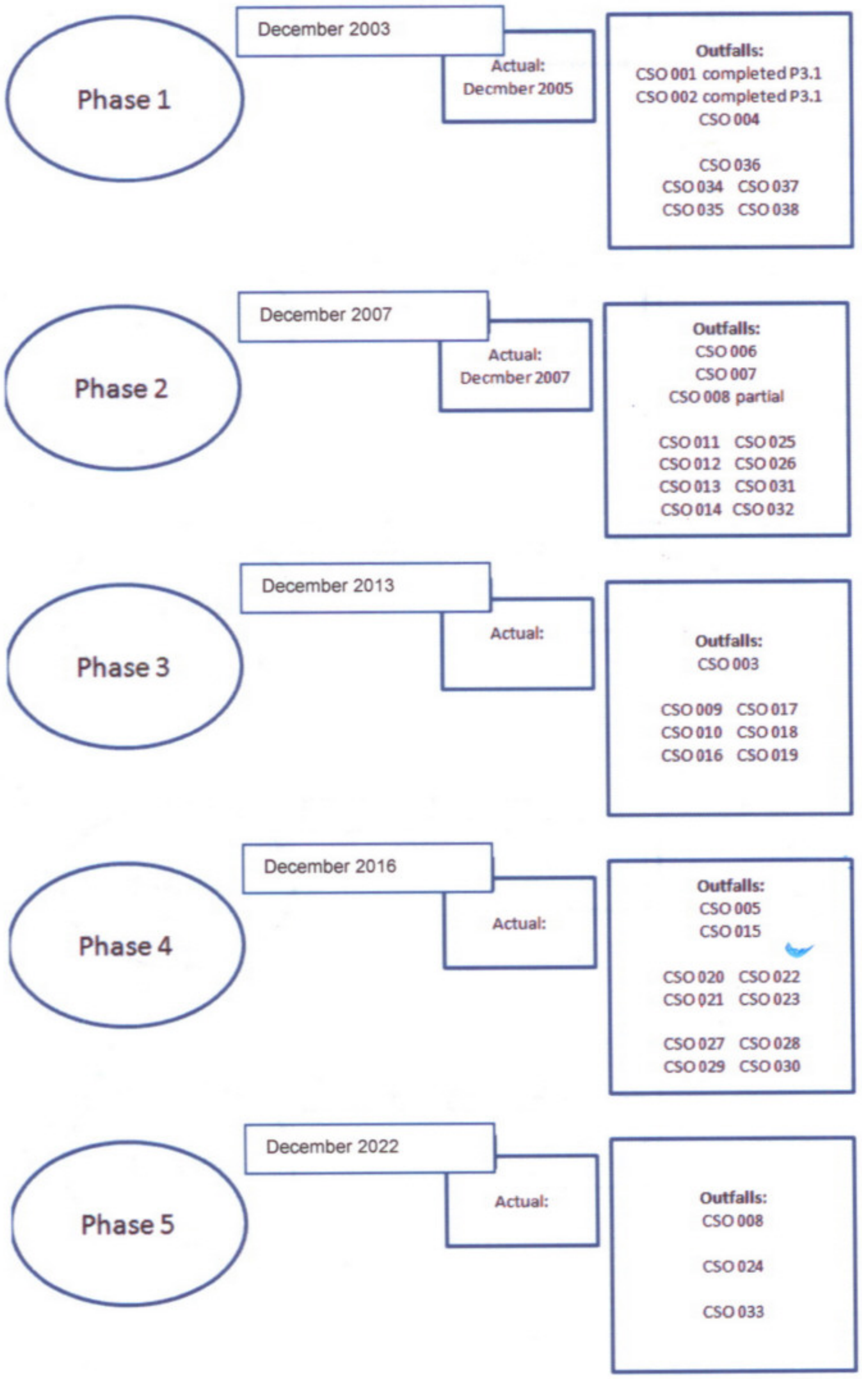
Phase 4 and Later Phases

Success of Phase 1 through Phase 3 projects in reducing flows to the Interceptor Sewer will influence the controls needed for later phases. This is particularly true for the last, Phase 5 projects, where overflows from Lift Station 4 (CSO 008) and Lift Station 3 (CSO 024 and partially at CSO 025) are set to be controlled. Further revisions to the 1998 Facility Plan are therefore expected as additional information is collected on the performance of implemented controls and system flows. System flows will be monitored to determine storm and base flow reductions achieved with the first three phases of the control plan.

Work in later phases will primarily continue with storm water separation, except for controls at CSO 024 in Phase 5 which will likely be a major storage facility (20th Street Storage Project) in the parking lot of the Maritime Museum. This storage facility is needed to limit surcharging in the Interceptor Sewer and produce the needed final control facility for the Columbia River CSOs. The storage facility would serve in a similar manner as the Denver Street Storage Project which avoids the need to expand the capacity of Lift Station No. 5 and the downstream interceptor and controls the pass forward flow. The 20th Street Storage Project will aid in improving controls between CSO 024 and CSO 033.

As discussed above, the level of control for later phases is also dependent on the approval of a modification to the original SFO control level by the EQC. Control levels may be further impacted if there are changes to applicable laws and regulations affecting CSO discharges and treatment plant requirements. Because of the differences in connected areas and the nature of CSOs in Astoria, the city intends to continue to attempt to achieve the highest level of control possible within engineering and economic feasibility. Table 1 and Figure 3 show the current schedule and phases for CSO controls at outfalls.

Table 1: General Completion Schedule (as defined in the SFO) for CSO Phases and outfalls controlled



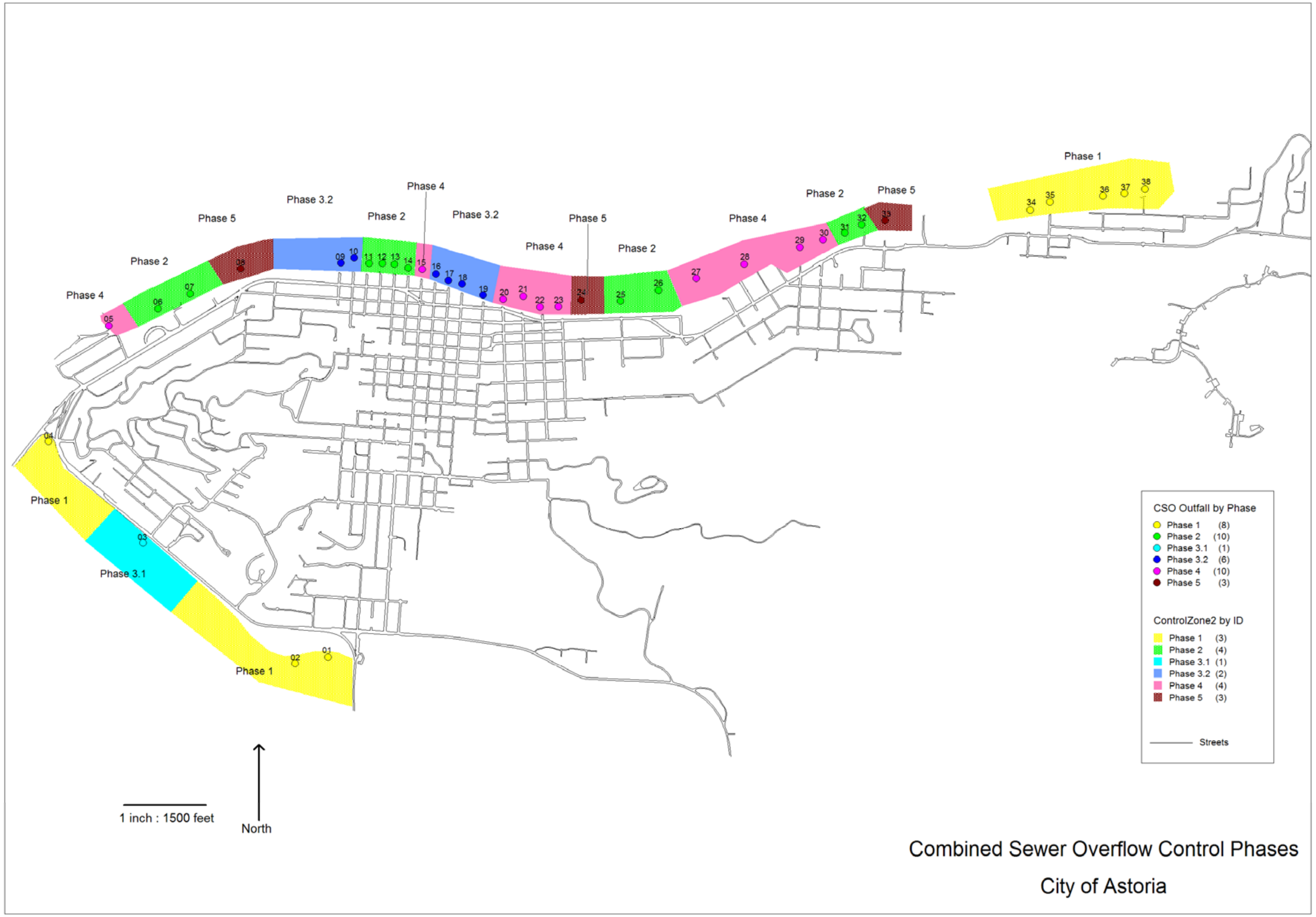


Figure 4: Current CSO Control Phasing

City of Astoria Combined Sewer Overflow Program

Implementation of the Nine Minimum Controls
Report to Oregon Department of Environmental Quality

July, 2010

Introduction

The following is the annual update of the implementation of the nine minimum controls. The nine minimum controls are part of the overall CSO Control Plan for the City of Astoria. The report steps through each of the nine minimum controls with details on any changes to the City's programs. Additional information and details can be provided by the City staff.

Control Number 1:

Proper Operation and Maintenance Programs for the Sewer System and CSO Outfalls

The Public Works Director, the Public Works Superintendent and City Manager produced an operation and capital improvement budget for submission to the City Council for review, adjustment and approval. The budget includes employee expenses, operational expenses, replacement costs, funds for repairs and funds for new equipment and major improvements to the various public works within the City. The position for a CSO Technician is currently open and the City is actively recruiting for the position.

The City also obtained and drew against funds from the Clean Water Act State Revolving Loan Funds and additional funds from the Stimulus monies released to the State by the federal government. The later funds are financing the construction of the Denver Street Storage Project. Loan funds are continued to be used for coordination, program management and planning and for the later phases of the control plan.

The City continued to apply the sewer CSO surcharge to pay back loans.

Control Number 2:

Maximum Use of the Collection System for Storage

The normal process of increasing the level of diversion weirs after project completion (mainly Phase 2 projects) was not carried out in the last year. This was due to inconsistent data from monitors and therefore there was uncertainty and implied risk of adverse impacts. Additional work will be performed in the next year. However, review of waste water treatment plant (WWTP) flow records indicates that during rainfall events the WWTP is receiving the maximum flow possible from the collection system.

In 2007, emergency generators were installed at Lift Stations 3, 4 and 5, and Pump Stations 1 and 6 for back-up power in case of an electrical outage. The generators are an essential component of the collection system that conveys flow to the treatment plant. Proper operation during an electrical outage is important since outages are more likely to occur during a rain storm when there is in increased potential for CSO events. According to the City's telemetry data the generators operated outside of their regular Wednesday exercise cycle according to the following table:

Pump Station	Total number of operations
1	18
6	16
Lift Station	Total number of operations
3	9
4	11
5	13

The City reiterated to the engineering staff, building inspectors and developers the requirement that new home construction direct roof and other drainage to a separate storm pipe within the property boundaries. This pipe would run to the curb, existing storm system or drainageway whenever possible. As most of the sewer system remains a combined system the new home storm pipe at times must be connected to the combined sewer at the street. When future storm sewers are available then these separated systems can be more readily connected. New residential and commercial developments are required to provide a separate storm system.

Control Number 3:

Review and Modification of Pretreatment Programs

No changes to this control item.

Control Number 4:

Maximization of Flow to the POTW for Treatment

Same as that discussed under Control Number 2.

Over the next several years the system will start to receive flows from Miles Crossing. This flow will be managed to limit any increase in overflows from the Astoria system by requiring storage of sanitary flows at Miles Crossing.

Control Number 5:

Prohibition of CSOs during Dry Weather

No systematic dry weather flows occur from the City of Astoria system. However dry weather flows have occurred from the system due to sediment build-up or blockages at diversion manholes. Periodic inspections (at least monthly) are performed at each of the system diversion structures. When diversions are slow moving they are cleared of debris or other blockage material. The following table shows the inspection dates and observations.

DATES INSPECTED	DIVERSIONS PLUGGED	DATE DIVERSIONS CLEARED
7-14-09	OK	
8-11-09	OK	
9-21-09	032/028A	09-21-09
10-09-09	OK	
11-16-09	OK	
12-17-09	028B	12-17-09
1-08-10	028B	01-08-10
2-08-10	OK	
3-12/15-10	OK	
4-14-10	OK	
5-18-10	OK	
6-14-10	OK	

Control Number 6:

Control of Solid and Floatable Material in CSO Discharges

Observations of the conditions around outfalls before, during and after rainfall events do not indicate any aesthetic problems. There is a large use by the public of the accessible waterfront area and complaints and comments have not been received regarding any degradation of the aesthetics of the waterfront area due to CSO discharges.

The City has a dedicated street sweeper and crew that continue to maintain the aesthetics of the receiving waters. The street sweeper operates each work day. The street sweeping program entails complete sweeping of the downtown area streets and main traveled roads/streets three times per week. Neighborhood streets are swept once a month. During leaf fall, street sweeping is increased by 50% by adding an additional half shift to the work day.

Control Number 7:

Pollution Prevention Programs to Reduce Contaminants in CSOs

No changes or additions from the 2004 report.

Control Number 8:

Public Notification

City staff inspected signage at outfalls to ensure that warnings of the potential problem and the need to avoid water contact are readable.

Information that describes the CSO program and specific CSO projects were distributed to the public. Several City Council briefings and public meeting occurred to discuss the Denver Street Storage Project. A public meeting was held for the submission of materials to the Environmental Quality Commission for the revision of CSO control requirements. Additional public meetings, targeted to neighborhoods affected by specific projects, are planned before commencement of remaining Phase 3 projects.

Control Number 9:

Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls

The City continued with monitoring of the system at Phase 1 and Phase 2 overflows and selected locations to collect information for reporting CSOs, refining CSO estimates and in calibrating/verifying the hydrologic/hydraulic model of the collection system. The City continued to maintain a detailed XP-SWMM based model of the collection system to reflect changes to the system.

The monitoring program consists of three rain gages across the peninsula at the City Shops, Water Reservoir No.2 and at the Astoria High School. Local rain gage data is augmented by the NWS Astoria Airport gage. Two to three flow monitors are used in the system to aid in model maintenance and CSO characterization. To date ten of the 28 main subbasins have been monitored with re-monitoring of the Denver Street basin continuing. Not all basins require monitoring because of the uniformity of basin characteristics between many of the basins. In addition twenty depth recorders are in place to monitor CSO overflows at Phase 1 and Phase 2 overflow locations. Total system flow is recorded at the WWTP.