Chapter 4.
Future Conditions

Any wastewater system expansion must be designed and sized to adequately serve future populations. This chapter examines population and land use trends within the project area and identifies the long-term flows and waste loads that will constitute system demand through the year 2020.

4.1. Population and Land Use

Existing population and land use within the study area are described in Section 3.2. Discussed below is the anticipated future population growth and land use development within the project area.

4.1.1. Future Population Growth

In the Puget Sound region, population estimates and projections are developed by the Puget Sound Regional Council (PSRC). The PSRC combines census tracts to create Forecast Analysis Zones (FAZs). The project area encompasses three FAZs. Future population estimates are derived from FAZ population forecasts the PSRC has drafted to reflect the City of Seattle's *Comprehensive Plan* growth targets for the next 20 years.

The combined population for the area represented by the FAZs for 1990 was approximately 37,700. Total populations for the year 2000, 2010, and 2020 are listed in Table 4-1 below. The total population increase over the 30-year forecast period is approximately 31,600.

Table 4-1. Project Area Population

Year	Population	10-Year Increase	Average Annual % Increase
1990	37,648		
2000	44,063	6,415	1.7
2010	55,718	11,655	2.6
2020	69,267	13,549	2.4

Source: FAZ 6020, 6123, 6124 (PSRC 1995).

One of the City's primary housing policies in the 1994 *Comprehensive Plan* is to maintain a sufficient amount of residentially-zoned land to accommodate Seattle's projected population growth over the next 20 years. Forecasts developed for the *Comprehensive Plan* called for 1,700 additional households in the south Lake Union area and 1,312 households in the Seattle Center planning area by 2014 (City of Seattle, 1994). However, with the defeat of the Seattle Commons proposal, the projected number of additional households in south Lake Union will likely be greater and may reach 2,500. Because much of the land in the project area is already developed, most new housing will be provided by re-developing land presently used for commercial or industrial purposes or intensifying land use on existing residential properties. The exact locations and densities of this future residential growth will be determined through ongoing neighborhood planning efforts in the project area. It is a City land use policy to establish population growth targets that do not exceed 80 percent of zoned capacity for development and to maintain this zoned capacity when zoning is changed.

4.1.2. Future Major Land Use Development

There are no major development proposals that are currently under formal review by the City in the south Lake Union neighborhood planning area, and one development (Immunex headquarters) has been proposed for the Seattle Center neighborhood planning area. There are also several speculative commercial projects with a high technology focus in both planning areas. However, with a projected combined employment growth of 7,800 jobs in the area, along with the proximity of the project area to major employment and housing centers, such major development proposals are likely in the future.

From a CSO control perspective, it is not anticipated that future land use and population growth will impact the existing sewer system within the project area. Because most of the land in the project area is already developed, redevelopment would not be expected to increase the impermeable surface area, and therefore stormwater inflow, to a large degree. Furthermore, any major redevelopment will come within the provisions of Seattle's drainage ordinance, resulting in the removal of stormwater runoff from any large redevelopment.

4.2. Projected Flows

Project planning began with an estimate of total overflows within the Denny Way / Lake Union basin. Also, since much of the reduction in discharges at the Denny Way and Lake Union overflow points would eventually be transported to West Point Treatment Plant for treatment and discharge, it was necessary to determine whether West Point had the capacity to accommodate the additional flows a successful Denny Way / Lake Union project would store and convey there.

4.2.1. 1998 CSO Conditions

King County recently modified its computer hydraulic model to better maintain continuity in the Elliott Bay interceptor. As a result of this modification, predicted overflows from the Elliott bay interceptor during design storms have increased over those used in the 1995 Denny Report and the 1995 CSO Update. The County performed new computer model simulations using the modified hydraulic model to determine the effectiveness of the conveyance system based upon the implementation of specific King County and City of Seattle CSO control projects by the year 1998. The King County projects incorporated into the revised model included:

- Hanford / Bayview / Lander separation projects.
- University regulator, including removal of Densmore drain and Green Lake flows.
- Carkeek Park transfer and CSO treatment facility.
- Parallel Fort Lawton tunnel.
- CATAD modifications and level sensor repairs.
- 96-inch trunkline in Royal Brougham Way.
- Alki transfer / CSO facilities.
- West Point Treatment Plant expansion to 440 mgd peak flow capacity.
- Interbay pumping station upgrade to 133 mgd capacity.

The City of Seattle projects incorporated into the revised model included 29 storage projects, four storage and separation projects, and six stormwater separation projects. In addition, it was assumed the City of Seattle Denny Way / Lake Union CSO Control project Phases 1 and 2 were completed.

The predicted annual combined sewer overflow volume, based on the revised computer model, is estimated to be 550 million gallons as shown on Table 4-2.

Table 4-2. Annual Denny CSO Volumes

	1988 CSO Baseline Annual CSO Volume (MG per year)	1998 Conditions, Annual CSO Volume (MG per year)
Denny Way regulator station	405	449
Dexter and Lake Union CSOs	101	101
Total annual overflow volume	**506**	**550**

4.2.2. Impact of CSO Flows on West Point Treatment Plant

The Denny Way / Lake Union CSO Control Project will store combined sewage flows until the Elliott Bay interceptor has sufficient capacity to accommodate additional flows without overflowing into Elliott Bay. The stored flow will eventually be released into the Elliott Bay interceptor and conveyed to the West Point Treatment Plant for treatment, disinfection, and disposal. The minimum treatment required for these flows is primary treatment: during times when West Point is providing secondary treatment to its peak base flows of 300 mgd the transferred CSO flows will only receive primary treatment. But, more often than not, CSO flows will arrive at West Point when base flows are below 300 mgd and so will receive secondary treatment. As discussed in

Chapter 10, secondary treatment of the stored Denny CSO flows is necessary to meet the CSO control requirement of 50 percent reduction in TSS.

Since the Interbay pump station will have a fixed pumping capacity of 133 mgd, peak Denny Way/Lake Union flows to West Point will not exceed the current peak flows, and there will be no increase in maximum West Point peak flow of 440 mgd resulting from the project. However, there will be an increase in annual flow volume treated at West Point due to the diversion of stored flows to West Point that previously overflowed into Elliott Bay. The increased volume of flow diverted to West Point is dependent upon the level of CSO control to be obtained. Chapter 6 describes the various levels of CSO control and presents the corresponding flow volumes diverted to West Point.

4.3. Influent CSO Waste Loads

This section summarizes the total suspended solids and settleable solids that are found in the influent at the Denny Way regulator station. CSO monitoring was initiated at the regulator station in late 1996 to verify the preliminary waste load information provided below.

4.3.1. Total Suspended Solids

The analysis of historical CSO waste load information in Chapter 3 indicated that the average influent CSO total suspended solids (TSS) concentration ranged from 35 to 1,000 milligrams per liter (mg/L), with an average of 160 mg/L and a median of 125 mg/L. An estimate of the influent total suspended solids waste load must be predicted in order to determine the best CSO control approach. The relationship between CSO influent TSS concentration and the CSO flow volume is generally inverse, in that higher flow volumes are generally associated with lower TSS loads. Based on the historical CSO waste load information, that relationship can be expressed by the following equation:

$$TSS_{Influent} = - 23.94 \ Ln(V_{Influent}) + 158.14$$

where $TSS_{Influent}$ represents influent CSO TSS concentration in mg/L, and $V_{Influent}$ represents the CSO volume in million gallons.

Based on that equation and on the overflow volumes associated with King County's seven design storms (see Chapter 10), an annual influent mass of 405,900 pounds of TSS was predicted.

4.3.2. Settleable Solids

There was insufficient historical CSO waste load information to provide a statistically significant relationship between CSO flows rates and either influent or effluent settleable solids concentrations. The only available data resulted from the Vortex Separator Pilot Project, which was conducted at West Point during the spring of 1995. The pilot project results indicate that settleable solids (in milliliters per liter per hour [mL/L/hr]) constitute approximately 4 percent of the total suspended solids (in mg/L) present in the CSO influent flows. The pilot project indicated that the average influent settleable solids concentrations amounted to 3 to 5 mL/L/hr. Preliminary data from the CSO monitoring program begun in late 1996 tends to confirm those values.

4.3.3. Impact of CSO Waste Loads on West Point Treatment Plant

The West Point Treatment Plant will provide secondary treatment for peak wet weather flows up to 300 mgd, and flows over 300 mgd are considered CSO flows and receive primary treatment, chlorination, and dechlorination. When flows are above 300 mgd, the CSO and secondary effluents are blended prior to discharge through the outfall. The Denny Way/Lake Union CSO Project will store combined sewage flows until the Elliott Bay interceptor and the West Point Treatment Plant have capacity to accommodate the additional flows and treat the majority of flows to secondary standards.

Based on the first year of full secondary treatment operation (January 1 through December 31, 1996), the plant treated an annual flow volume of 42,829 million gallons for an average daily flow rate of 117 mgd, maximum month flows for 1996 and 1997 were 167 and 168 mgd, respectively. During 1996, a total of 691 million gallons of West Point CSO flows received primary treatment only during 31 separate 24-hour periods. West Point CSO volumes during a 24-hour period ranged from 1 million gallons to 106 million gallons. Table 4-3 summarizes the 1996 monthly total and CSO flows.

Table 4-3. 1996 West Point Treatment Plant Flows

1996 Month	Daily Average Flow (mgd)	Total West Point Volume (MG)	Secondary Treated Volume (MG)	CSO Flow Volume (MG)
January	149.8	4,643	4,611	32
February	167.1	4,849	4,736	113
March	98.4	3,050	3,049	1
April	122.6	3,678	3,602	76
May	116.2	3,603	3,587	16
June	96.4	2,893	2,893	0
July	90.4	2,801	2,801	0
August	89.7	2,782	2,779	3
September	92.0	2,761	2,745	14
October	104.6	3,243	3,189	54
November	115.4	3,463	3,409	54
December	163.4	5,065	4,737	328
Ann. Flow Volume		42,829	42,138	691

The West Point plant continued to produce TSS effluent concentrations within the NPDES limits even during CSO events there as shown on Table 4-4. During the 31

West Point CSO events in 1996, the average TSS effluent concentration was 21 mg/L, which is below the average wet weather weekly NPDES effluent TSS concentration limit of 45 mg/L.

The impact of the increased suspended solids waste load on West Point was evaluated based on the assumption that the CSO baseline volume is 611 million gallons per year and the total CSO-related suspended solids waste load is 405,900 pounds per year. If stored Denny flows were conveyed to West Point during a large storm event, the additional Denny flows would be limited by the Elliott Bay interceptor and Interbay pump station capacities, and the total West Point flow could reach its 440 mgd maximum daily flow design condition.

Table 4-4. Final Effluent TSS Concentrations During West Point CSO Events During 1996 --> revise table to indicate TSS in those flows receiving primary treatment only during West Pt CSO events. (if data are available)

1996 Month	Number of CSO Events in Month	Secondary Diverted Flow Monthly Volume (mg)	Range of TSS in CSO Blended Effluent (mg/L)
January	5	32	8 to 25
February	6	113	11 to 36
March	1	1	24
April	3	76	18 to 24
May	3	16	10 to 67
June	0	0	No Events
July	0	0	No Events
August	1	3	21
September	1	14	13
October	4	54	8 to 21
November	1	54	77
December	6	328	9 to 27
Totals	31	691	
Diversion Event Averages		22.3	21

Increased suspended solids waste loads diverted to the West Point Treatment Plant will not affect the ability of the plant to meet its NPDES permit discharge limits during large storm events because the amount of stored flows conveyed to the West Point plant will not cause flows to exceed the plant's maximum design flow condition of 440 mgd, and the stored flow release can be controlled to allow the highest level of treatment to be provided. For example, the stored flows can be conveyed to the West Point plant when the plant flows are less than 300 mgd, and the Denny flows can then receive full secondary treatment.

If the stored flows are released to the treatment plant when the plant flows are above 300 mgd, the influent waste strength will be decreased, and the plant would not have to obtain high removal efficiencies to meet wet weather NPDES discharge limit. If the stored Mercer Street tunnel CSO flows were released to West Point, the maximum peak flow rate would be limited to 440 mgd, but the daily flow volume could be increased. The maximum daily CSO volume that could be transferred would be equal to the estimated tunnel storage capacity that is 7.2 million gallons. If the stored CSO flows only received primary treatment, the estimated increase in the final TSS effluent concentration would still be less than 1 mg/L.

On a weekly basis, the estimated increased CSO flow volume to West Point based on hydraulic model simulations is 5 percent. Assuming the CSO flows only receive primary treatment and bypass the secondary treatment system, it is estimated that the TSS effluent concentration would increase by less than 3 mg/L.

These minor increases in TSS effluent concentrations are not likely to result in NPDES permit exceptions or decreased effluent quality. For example, the West Point treatment plant produced final TSS effluent concentrations ranging from 9 to 77 mg/L with an average of 21 mg/l for each 1996 secondary treatment flow diversion event. The maximum weekly average wet weather TSS effluent concentration for the entire year was 37 mg/l with an average weekly value of 19 mg/L. There were no NPDES permit exceptions for TSS removal or final TSS effluent concentrations for either weekly or monthly discharges during 1996. In addition, the plant averaged 92 percent monthly TSS removal, with the lowest monthly TSS removal of 82 percent.