35452

Outfall Mixing Zones

The water-quality-related regulations address additional issues beyond simply water quality criteria Guidelines regarding outfall mixing zones and minimum treatment criteria are also addressed in *OAR* 340-41

A mixing zone is a specified area of a receiving water where wastewater is permitted to blend with the receiving waters, and water quality standards are suspended or relaxed Mixing zones are a practical means of using a receiving water's resiliency to limit wastewater treatment costs while controlling areas of potential deterioration

Mixing-Zone Standards DEQ may allow a designated portion of a receiving water to serve as a zone of initial dilution (ZID) for wastewaters and receiving waters to mix thoroughly DEQ may suspend all or part of the water quality standards, or set less restrictive standards, in the defined mixing zone

On the basis of receiving water and effluent characteristics, DEQ must define a mixing zone in the immediate area of a wastewater discharge by the following phenomena

- It is as small as feasible
- It avoids overlap with any other mixing zones to the extent possible and is less than the total stream width as necessary to allow passage of fish and other aquatic organisms
- It minimizes adverse effects on the indigenous biological community, especially when species that warrant special protection because of their economic importance, tribal significance, ecological uniqueness, or similar reasons, as determined by DEQ, are present
- It does not threaten public health
- It minimizes adverse effects on other designated beneficial uses outside its boundaries

DEQ may require mixing-zone monitoring studies or bioassays to evaluate water quality or biological status within and outside the mixing-zone boundary DEQ may change mixing-zone limits or require relocation of an outfall if it determines that the water quality within the mixing zone adversely affects any existing beneficial uses in the receiving waters

New CBWTP Outfall Diffuser and Mixing Zone Water quality standards are defined as concentrations that should not cause acute or chronic toxicity in the receiving stream DEQ evaluates the concentrations that will not cause acute toxicity at the edge of the ZID With the existing permit and outfall configuration, the effluent discharge from the CBWTP should not exceed the short-term toxicity standard outside a 10-foot radius from a point of discharge or the long-term toxicity standard outside a 100-foot radius from a point of discharge

A new diffuser has been installed on the existing outfall. The mixing zone provided by this diffuser, in combination with a residual chlorine concentration of 1.0 mg/L, meets the chlorine concentration requirement of 0.019 mg/L at the ZID boundary (the most stringent requirement for this outfall) and results in adequate mixing of all currently identified metals. With this new diffuser, the chlorine concentration is significantly less than the 0.011-mg/L limit at the regulatory mixing-zone boundary.

Minimum Treatment Criteria

Rules and regulations promulgated by EPA in 1973 defined the minimum level of effluent quality that must be attained by secondary treatment of municipal wastewaters. Acceptable secondary treatment was defined in terms of 5-day biochemical oxygen demand (BOD_5), TSS, fecal coliform, and pH. The arithmetic mean of BOD_5 and TSS concentrations for effluent samples collected in a period of 30 consecutive days must not exceed 30 mg/L, and, during any 7-consecutive-day period, the average must not exceed 45 mg/L. Removal efficiencies must not be less the 85 percent. The geometric mean of fecal coliform counts for effluent samples collected in a period of 30 consecutive days must not exceed 200 per 100 mL, and the geometric mean of fecal coliform bacteria for any 7-consecutive-day period must not exceed 400 per 100 mL. The effluent values for pH must remain within the limits of 6 to 9.

The minimum standards established by DEQ for the Willamette Basin either meet or exceed EPA standards. During the summer (May 1 to October 31), monthly average effluent concentrations are not to exceed 20 mg/L for BOD_5 and 20 mg/L for suspended solids. During the winter (November 1 to April 30), a minimum of secondary treatment performed at maximum practicable efficiency and effectiveness is required. Effluent BOD_5 concentrations, expressed as mg/L, divided by the dilution factor (ratio of receiving stream flow to effluent flow), must not exceed 1. Disinfection of sewage wastes, after treatment, must be equivalent to thorough mixing with sufficient chlorine to provide a residual of at least 1 part per million after 60 minutes of contact. Positive protection must be provided to keep raw or inadequately treated sewage from reaching public waters, unless otherwise approved by DEQ, where elimination of inflow and infiltration would be necessary but is not currently practicable.

The basin standards will be applied to the CBWTP when the City of Portland applies for the permit for its next plant expansion. At that time, the CBWTP will have to meet the "20/20" limits for BOD_5 and suspended solids.

Combined Sewer Overflows

Stipulation and Final Order

In August 1991, the City of Portland and DEQ entered into a stipulation and final order (SFO) agreement. The SFO agreement requires the City to examine a level of control that will eliminate overflows except for once in 10 years for summer months (May through October) and once in 5 years for winter months (November through April).

A draft combined sewer overflow (CSO) facilities plan was submitted to DEQ in June 1993 in compliance with the SFO The draft plan reflected sewer system conditions as of March 1992 and City policies or preferences as of April 1993

In that document, the SFO level of CSO control was recommended for the Columbia Slough Several target levels of CSO control for the Willamette River, including the SFO level, were identified in the draft facilities plan Four levels of control were examined

- Sewer separation, technology-based approach
- SFO level of control, statistics-based approach
- Draft federal policy level of control, results-based approach
- Enhanced draft federal policy level of control, results-based approach

For each level of control except sewer separation, alternative configurations of CSO storage, conveyance, and treatment were developed and analyzed The preferred configuration for each level of control was identified through comparison of the configurations for environmental impacts, technical considerations, and economic impacts

The draft CSO facilities plan provided a technical basis for a discussion of the appropriate level of control for the Willamette River A collaborative process was initiated in the winter of 1993 to consider the environmental, cultural, and socioeconomic impacts of the three levels of control The recommendation of the collaborative process committee to select the enhanced draft federal level of control was approved by the Portland City Council and adopted by the Oregon Environmental Quality Commission On August 11, 1994, the SFO was amended to reflect the recommendations of the committee

The amended SFO (ASFO) modified the size of the storms for which Willamette River CSOs must be controlled Paragraph 12a of the ASFO defines these storms as follows

> 12 The Commission hereby issues a final order
>
> a Requiring the Respondent to eliminate all untreated CSO discharges to the Columbia Slough 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 untreated CSO discharges from May 1 through October 31 except during storms greater than or equal to a storm with a ten year return frequency, and requiring Respondent to eliminate all untreated CSO discharges to the Willamette River from November 1 through April 30 except during storms greater than or equal to a storm with a four in one year return frequency and to eliminate all untreated CSO discharges from May 1 through October 31 except during storms greater than or equal to a storm with a three year return frequency

For the Columbia River CSOs, however, the 5-year winter and 10-year summer design storms were retained

Table 5-2 summarizes the key milestones included in the ASFO A second SFO was agreed upon in July 1992, it requires development and implementation of a strategy to eliminate dry-weather overflows A separate study performed for City of Portland Environmental Services provided recommended modifications to the system to comply with this second SFO (HDR Engineering and Black and Veatch, 1993)

Table 5-2 Key ASFO Milestones Columbia Boulevard Wastewater Treatment Plant	
Due Date	**Stipulation and Final Order Requirement**
December 1, 2000	Eliminate discharges at the 13 Columbia Slough outfalls
December 1, 2001	Submit updated facilities plan
December 1, 2001	Eliminate discharges at 7 Willamette River outfalls
December 1, 2006	Eliminate discharges at 16 additional Willamette River outfalls
December 1, 2011	Eliminate discharges at all remaining Willamette River outfalls
Source Oregon Department of Environmental Quality, 1994c	

City of Portland CSO Program Elements

The Portland CSO management plan has several program elements

- **Common elements:** activities that are fundamental to the CSO program and that are common to any storage and treatment configuration alternative Examples are as follows
  - Stormwater best management practices
  - Nine minimum controls
  - Pipeline structural assessment
  - Inverness wastewater conveyance and treatment

- **Cornerstone projects:** activities that are basic to CSO control because they immediately begin to reduce inflow (and therefore overflow) Examples are listed below
  - Stormwater infiltration sumps
  - Roof drain disconnections
  - Stream diversions
  - Local sewer separation
  - System optimization

- **Columbia Slough components:** storage and treatment components required to capture the SFO-required portion of the CSO remaining after the cornerstone projects are implemented, and additional components that provide community benefits The following are examples

- Columbia Slough consolidation conduit
- Wet-weather treatment facility (WWTF), influent and effluent pump stations, and new effluent outfall to the Columbia River

• **Willamette River components:** storage and treatment components required to capture a portion of the CSO remaining after cornerstone projects are implemented, and additional components that provide community benefits Examples are listed below

- Willamette River consolidation conduits and conveyance and storage tunnels
- West-side underground CSO storage tank
- Willamette River pump station improvements and river crossing
- WWTF, influent pump station, and effluent outfall to the Willamette River

In this facilities plan, alternatives for treatment of CSOs from the Columbia Slough and Willamette River basins at the CBWTP are evaluated

Biosolids Management

Both federal and state regulations apply to land application of biosolids from wastewater treatment plants Federal regulations include 40 *Code of Federal Regulations* (*CFR*) Part 257 and newly approved Part 503 regulations The Oregon regulations include *OAR* 340-50 The State of Oregon also publishes guidance documents for interpreting and following the regulations

Current federal regulations for land application of biosolids are listed in the *Federal Register* under 40 *CFR* Part 257, Criteria for Classification of Solid Waste Disposal Facilities and Practices, dated September 13, 1979 In the past, Part 257 3 through Part 257 5 has regulated solid waste application to food chain crops, however, these regulations have been considered too general Therefore, new regulations under 40 *CFR* Part 503 were required by Section 405(d) of the 1977 CWA (as amended by the Water Quality Act of 1987) The new regulations under 40 *CFR* Part 503 were released as final regulations in late 1992

In December 1984, DEQ defined rules for land application and disposal of sewage treatment plant biosolids and biosolid-derived products, including septage (*OAR* 340-50) These regulations remain current for the State of Oregon, although the state is in the process of updating the rules to conform to the recently adopted federal regulations

Various alternatives for the treatment and beneficial reuse of biosolids have been reviewed Alternatives to provide a Class A product for bulk marketing and a Class B product for application to agricultural lands will be provided to maintain a diversified program for the CBWTP

Air Quality

The CBWTP does not have an air containment discharge permit (ACDP) at this time Air quality issues currently being evaluated in the Portland area, as well as future growth and regulation of the plant, will require air discharge permitting

Air pollutants are broadly grouped as either criteria pollutants or hazardous air pollutants (HAPs) The regulated criteria pollutants or criteria pollutant precursors are particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds (VOCs), and lead Regulated HAPs are a defined list of 189 pollutants designated by EPA and adopted by DEQ However, the DEQ list of HAPs includes hydrogen sulfide, which is not on the EPA list

There are two distinct air permitting programs in Oregon the ACDP program and the Title V permit program The ACDP program, which has been in effect in Oregon for many years, regulates both major and minor sources of criteria pollutants The Title V permit program was created as a result of the Clean Air Act Amendments of 1990 and regulates major sources of criteria pollutants and HAPs The two permitting programs define major sources differently The differences add confusion to the process of determining the levels at which pollutant emissions require permitting action

Minor source permits generally require a straightforward and relatively simple permitting process for addressing emissions, determining air pollution control equipment requirements, and meeting permit conditions for monitoring, recordkeeping, and emission reporting to DEQ Major source permit applications under the ACDP program usually require dispersion modeling Higher levels of air pollution control, monitoring, recordkeeping, and emission reporting to DEQ are usually required for major sources The Title V permitting process is extensive and usually fairly expensive Title V permits require monitoring, recordkeeping, and emission reports for most emission sources on the site, including very minor ones A *synthetic minor permit* is an ACDP with special conditions to keep potential plant emissions below the Title V thresholds A synthetic minor permit is a hybrid permit combining characteristics of the ACDP and Title V programs It usually requires monitoring, recordkeeping, and emission reports for the most significant onsite sources

ACDP Program

The CBWTP must address both the ACDP program and the Title V permit program. All facilities are required to notify DEQ of the installation of air pollution control equipment, fuel-burning equipment rated at 400,000 British thermal units per hour or greater, and process equipment sending emissions to the atmosphere This requirement applies to existing and new plants The notification is accomplished with a DEQ notice of construction form

The criteria pollutant emission estimates for the CBWTP are larger than the minor source emission levels that typically require a permit, but below the major source emission rates that require significant additional analysis under the ACDP program The regulations are unclear about whether plants constructed before 1971 need minor source permits It is recommended that the CBWTP take a proactive approach and file for an ACDP before a determination of necessity Liquid stream VOC emissions from publicly owned treatment works (POTWs) are not currently regulated by DEQ as process emissions and are not typically included in POTW air permit emission limits The emissions are now considered fugitive emissions, but may not be so considered in the future

Title V Requirements

If a facility has the potential to emit more than the threshold quantities of pollutants, it must submit a Title V permit application to DEQ by early January 1996 Alternatively, permit conditions limiting the potential emissions can be incorporated into an ACDP (synthetic minor permit) issued before the January deadline

The plant combustion sources are the primary emitters of criteria pollutants The quantity of emissions is limited by the available digester gas and the amount of time that backup electrical generation is required The largest potential emission of a single pollutant is carbon monoxide at 33 tons per year Consequently, on the basis of its potential to emit criteria pollutants other than VOCs, the plant currently is not a Title V source

For VOC emissions and HAP emissions, it is more difficult to determine the plant's potential to emit Although they affect the emissions, the plant's design and operating characteristics are not directly related to the VOC and HAP emissions Of more relevance are the types of industrial facilities that contribute influent to the plant, the effectiveness of the industrial pretreatment program, and potentially, the effectiveness of educational programs to reduce HAP influent concentrations from residential areas Because the threshold for VOC emissions is 100 tons per year and actual emissions are estimated to be only 20 percent of this level for the existing facility, it is unlikely that potential emissions will exceed the threshold However, the thresholds for HAP emissions are 10 tons per year for a single pollutant and 25 tons per year for the total plantwide site These lower thresholds are more significant in determining a plant's potential to emit and the consequences of the potential emissions

On the basis of an analysis of a fairly large database developed from air emission testing programs in California and influent loading data from a large number of facilities, few POTWs emit above (or even close to) the Title V HAP thresholds, however, definition of a plant's potential to emit has been a difficult issue Consequently, the POTW potential to emit has been defined as anything from a plant's actual emissions to an infinite amount, at different times, by different jurisdictions EPA eventually will define (in a regulation) the potential to emit for POTWs when it promulgates the maximum achievable control technology standard for the POTW source category However, a substantial amount of potential liability is associated with not submitting a Title V permit application by the January 1996 deadline if a source is eventually determined to have been subject to Title V The liability could take the form of civil or criminal enforcement action by DEQ and EPA or citizen lawsuits For this reason, it is recommended that the CBWTP request a synthetic minor permit condition to limit the plant's potential to emit HAPs in an ACDP application If Environmental Services decides to proceed with this approach, the permit application should be filed by early September 1995

A synthetic minor condition includes specific monitoring requirements (NPDES data already collected at the plant might be of use) to show that HAP emissions will be kept below 10 tons per year for any single pollutant and below 25 tons per year for any combination of pollutants

Future Issues

The estimated future facility emissions are below the Title V thresholds for the criteria pollutants, but may exceed the Title V thresholds for HAPs under the maximum combined emission scenario The actual facility emissions could vary substantially if the equipment selected or process modifications used differ from those assumed for the emission estimates The CBWTP's volume of emissions will be large enough to potentially trigger significant air permitting requirements if air emissions are not given appropriate attention during facility development and design tasks

Air quality regulations can be expected to change in the future Two trends are likely to occur (1) air regulation will become increasingly stringent as the population of the Portland metropolitan area increases (with commensurate air pollution increases) and compliance with National Ambient Air Quality Standards therefore becomes more difficult to maintain, and (2) industrial sources will reduce the use and discharge to the sewer system of VOC HAPs as a result of the impact of air quality regulations developed for industrial sources In planning, Environmental Services can expect to contend with more extensive air quality permitting Future influent loadings are difficult to predict, but may actually decrease, if they do, compliance with stricter emission limits will be easier to achieve

Redundancy and Reliability Requirements

New or expanding treatment works are required to meet minimum standards for mechanical, electrical, fluid system, and component reliability in accordance with EPA's policy These standards help treatment facilities operate effectively on a day-to-day basis and provide the capability for satisfactory operation during power failures, flooding, peak loads, equipment failures, and maintenance shutdowns Reliability and redundancy standards are important to ensure that the receiving water is not unacceptably degraded as a result of the interrupted operation of specific treatment units or processes In that regard, standards have been established for three classes of wastewater treatment works

Which reliability class is appropriate depends on the effluent disposal receiving stream or body of water For CBWTP discharge to the Columbia River, it is assumed that reliability Class I is appropriate

Table 5-3 contains the minimum reliability requirements for plant components that may be provided at the CBWTP in accordance with EPA's works design criteria, Reliability Class I, for sewage treatment plants Unit operations must be designed to pass the peak hydraulic flow with the largest unit out of service Also, mechanical components in the facility must be designed to enable repair or replacement without violation of the effluent limitations or diversion of control

The reliability criteria for sludge processes are presented in Table 5-4

Table 5-3
Reliability Class I Requirements

Plant Component or Process	Requirement
Raw sewage pumps	Peak flow with largest unit out of service Peak flow is defined as the maximum wastewater flow expected during the design period of the treatment works
Mechanical bar screens	One backup with either manual or mechanical cleaning (manual cleaning if only two screens are used)
Grit removal	Minimum of two units
Primary sedimentation	Fifty percent of design flow capacity with largest unit out of service Design flow is defined as the flow used as the design basis of the component
Activated sludge process	A minimum of two equal volume basins, no backup basin required
Aeration blowers	Design air capacity with the largest unit out of service, minimum of two units
Air diffusers	Isolation of largest section of diffusers (within a basin) without measurable impairment of oxygen transfer
Secondary sedimentation	Seventy-five percent of design flow capacity with largest unit out of service Design flow is defined as the flow used as the design basis of the component
Disinfectant contact basin	Fifty percent of the design flow with largest unit out of service Design flow is defined as the flow used as the design basis of the component
Effluent pumps	Peak flow with largest unit out of service Peak flow is defined as the maximum wastewater flow expected during the design period of the treatment works
Electrical power	Two separate and independent sources of electrical power, either from two separate utility substations or from a single substation and a works-based generator Designated backup source capable of operating all vital components, critical lighting, and ventilation during peak flow conditions, except that components used to support the secondary processes need not be included as long as treatment equivalent to sedimentation and disinfection is provided.

Table 5-4 Sludge-Handling System Reliability	
System Component or Process	**Required Capacity and Backup**
Sludge holding tanks	The volume of the holding tank based on the expected time necessary to perform maintenance and repair of the component in question
Anaerobic sludge digestion	At least two digestion tanks, at least two of the digestion tanks designed to permit processing of all types of sludges normally digested
Sludge pumping	Pumps sized to pump peak sludge quantity and maintain velocities greater than 2 feet per second, at least two pumps

Chapter 6

Development of Process Alternatives

Chapter 6
Development of Process Alternatives

Planning Criteria

The planning criteria for this facilities plan consisted of the objectives of the Columbia Boulevard Wastewater Treatment Plant (CBWTP) vision statement (Columbia Boulevard Citizens Advisory Committee [CAC], 1995), the existing deficiencies of the plant, the flow and load projections, and the pertinent environmental regulatory issues, including the 1994 amended stipulation and final order (ASFO) These planning criteria are discussed in Chapters 2, 4, and 5 The existing capabilities of the CBWTP were compared with the criteria to identify modifications that must be implemented for the planning period 1995 to 2040

Treatment Needs

Combined Sewer Overflows

The most significant source of change at the plant is the imminent requirement to treat combined sewer overflows (CSOs) In the future, the CBWTP site must accommodate two or three related treatment facilities a dry-weather plant to treat sanitary sewer flows, a wet-weather plant to treat CSOs from the Columbia Slough Basin, and possibly another wet-weather plant to treat CSOs from the Willamette River Basin The wet-weather plant for Willamette Basin CSOs may be located on the Willamette River, but this facilities plan addresses the possibility that it may be located at the CBWTP All of the alternatives developed for this plan must take into account this fundamental requirement for the site and the degree to which the dry-weather and wet-weather facilities will be integrated

The dry-weather plant will be an upgraded and expanded version of the current CBWTP to treat increasing domestic flows The wet-weather plants will include screening, primary sedimentation, and disinfection, but will not provide secondary or tertiary treatment The Columbia Slough wet-weather plant must be online by the end of the year 2000 Willamette River CSOs must be progressively eliminated 7 outfalls by 2001, 16 more by 2006, and the rest by 2011 Four of the Willamette River CSO outfalls have been removed from service, and four more will be eliminated by the end of 1995 The alternatives developed for this plan address the CSO treatment requirements

Primary Treatment

Primary treatment requirements for wet-weather treatment facilities, as recommended during preparation of the Portland CSO facilities plan, were reviewed in conjunction with the draft CSO control policy being finalized at that time by the U S Environmental Protection Agency (EPA) Primary clarifiers were selected as the process units of choice for the wet-weather facility Design of the clarifiers for CSO control will be based on a maximum overflow rate of approximately 3,000 gallons per day per square foot (gpd/ft^2) Design of the primary clarifiers for dry-weather flows, however, will be based on an average overflow rate of 1,700 to 1,800 gpd/ft^2

Outfall

To meet National Pollutant Discharge Elimination System (NPDES) regulations and water quality standards, the City of Portland is developing plans for a second diffuser-equipped outfall to the Columbia River, similar to the outfall diffuser that was put in service in 1995 for discharge of the secondary effluent from the CBWTP The controlling parameter for the secondary effluent diffuser is the chlorine residual For wet-weather primary effluent, the controlling parameter could be the chlorine residual or metals The chlorine-residual issue will be addressed by use of dechlorination facilities Data on CBWTP primary effluent metals are currently limited, so for this plan, metal-removal estimates were based on solids-removal estimates The levels of metals of concern indicate that about a 12 1 dilution ratio at the boundary of the mixing zone would be required to meet the water quality standards This is well within the design limits of standard diffusers

Several primary effluent mixing scenarios were analyzed with the CORMIX2 software model for multiport diffusers supported by EPA The modeled flows ranged from 100 million gallons per day (mgd) to 336 mgd Because these discharges could take place during the late summer months, the 7-day, 10-year (7Q10) low flow for the Columbia River was used for modeling as a safety factor Dilution factors for a diffuser like the one currently permitted for the plant ranged from 35 1 for 336 mgd to 97 1 for 100 mgd Thus, it appears that a diffuser-equipped outfall could meet the water quality requirements of an NPDES permit

Liquid Processes

After a review of Oregon water quality standards for the Willamette Basin (*Oregon Administrative Rules* 340-41-442 through 470), Oregon Department of Environmental Quality (DEQ) issue papers, DEQ Technical Advisory Committee and Policy Advisory Committee reports, CBWTP effluent monitoring data, and sampling data from the Lower Columbia River Bi-State Water Quality Program, the following future treatment criteria were assumed for the liquid processes at the CBWTP

- **Nutrient removal.** Provisions for nitrogen removal during the dry season should be considered for future CBWTP expansions Of the 15 stations sampled in the Lower Columbia River Bi-State Water Quality Program, 5 exceeded Oregon's action level of 15 milligrams per liter (mg/L) for chlorophyll *a* Total phosphorus was measured in concentrations sufficient to support nuisance algal growth Although soluble nitrogen concentrations were relatively low, nitrogen is thought to be the limiting nutrient in the summer Provisions for biological nutrient removal are assumed for future expansions

- **Nitrification.** Ammonia has been identified as one of the primary toxic components in the CBWTP biomonitoring program The new diffuser mitigates ammonia toxicity, but provisions for ammonia removal by biological nitrification during the dry season are assumed for future CBWTP expansions

- **Effluent filtration.** The plant layouts should provide space for the possible addition of chemical coagulation and effluent filtration for removal of metals during the dry season Data from the Lower Columbia River Bi-State Water Quality Program indicate concentrations of metals that exceed the available long-term criteria Copper and lead have been identified as particular concerns

- **Disinfection.** Alternative methods such as ultraviolet disinfection or dechlorination should be considered to address concerns about chlorine toxicity and formation of chlorinated hydrocarbons

- **The 20/20 5-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) limits.** More stringent dry-season (May 1 to October 31) discharge limits of 20 mg/L for BOD_5 and 20 mg/L for TSS may be applied to the CBWTP in the future

Solids Processes

Future quantities of solids were estimated for comparison with existing plant process capabilities It was necessary to estimate maximum-month and maximum-week production of solids because solids-handling facilities must process the actual peak quantities that are produced, with only limited equalization in the upstream processes

Table 6-1 summarizes the solids projections for the CBWTP These include the Tryon Creek Wastewater Treatment Plant (TCWTP) biosolids, which may or may not continue to be hauled undigested to the CBWTP for digestion, and the effects of the CSO loads from the Columbia Slough Basin and Willamette River Basin

In keeping with the objectives of the CBWTP vision statement (CAC, 1995), the plant has a biosolid utilization goal of 100 percent—all biosolids are to be recycled Accomplishing this goal requires a diversified beneficial reuse program that is flexible enough to be maintained over the years The State of Oregon is currently updating its biosolid rules to conform to recently adopted federal regulations The facility plan's alternatives for treating biosolids must comply with the new requirements as they evolve for Class A biosolids for bulk marketing and Class B biosolids for application to agricultural lands

Nonrecyclable Solids

The following nonrecyclable solids are currently handled at the CBWTP

- Grit and screenings generated by wastewater treatment at the CBWTP

- Imported grit and screenings trucked to the CBWTP from the Tryon Creek, Gresham, and Troutdale wastewater treatment plants

- Septage

- Vactor truck materials from cleaning the City's sanitary sewer system

Table 6-1
Quantities of Solids for Facilities Planning
Columbia Boulevard Wastewater Treatment Plant

Condition	Primary Sludge (lb/day)	Waste Activated Sludge (lb/day)	Thickened Sludge (lb/day)	Digested Sludge (lb/day)	Dewatered Biosolids (lb/day)
1993 Dry Season					
Average	84,104	63,603	132,937	83,439	75,095
Maximum month	92,514	69,963	146,231	91,782	82,605
Maximum week	109,335	82,684	172,818	108,471	97,264
1993 Wet Season					
Average	87,313	54,273	127,428	80,014	72,013
Maximum month	104,776	65,128	152,914	96,017	86,416
Maximum week	113,507	70,555	165,656	104,018	93,617
2040 Dry Season					
Average	171,952	109,353	253,175	158,183	142,365
Maximum month	189,147	120,288	278,493	174,001	156,602
Maximum week	223,538	142,159	329,128	205,638	185,075
2040 Wet Season					
Average	187,660	107,665	265,793	169,156	152,241
Maximum month	225,192	129,198	318,952	202,987	182,689
Maximum week	243,958	345,965	345,531	219,903	197,913

Abbreviation lb/day = pounds per day

Before 1995, stormwater sump cleanings were also delivered to the CBWTP after being dewatered at the old Inverness treatment plant These solids are currently hauled directly to a landfill from Inverness

Grit and Screenings

The CBWTP generates a significant amount of wastewater grit and screenings It also currently serves as a transfer point for wastewater grit and screenings from the Gresham and

Troutdale wastewater treatment plants, but this service will be discontinued soon because Gresham and Troutdale materials will be hauled directly to the Hillsboro Landfill Grit and screenings are hauled to a landfill by the Metropolitan Disposal Corporation under a contract with the Metropolitan Service District

The current and projected grit and screening capacities are summarized in Table 6-2 Currently, the CBWTP produces 5 4 cubic feet of grit and screenings per million gallons of treated wastewater The new headworks design production rates are 9 5 cubic feet per million gallons

Landfilling, the current disposal method for grit and screenings, will continue to be the choice for future disposal because of its simplicity and cost Incineration is not feasible in this application for the CBWTP

Table 6-2
Grit and Screening Projections
Columbia Boulevard Wastewater Treatment Plant

Condition	Grit and Screening Amount (cubic yards)	Approximate Flow Basis (million gallons/day)	Grit and Screenings Production (cubic feet/million gallons)
1992-1994			
Annual average	5,096	69 5	5 4
Dry-season average	2,247	61	5 4
Wet-season average	2,849	79	5 3
2040 at Current Production Rates			
Annual average without Willamette CSO	9,059	124 1	5 4
Annual average including Willamette CSO	9,563	131 0	5 4
2040 at New Headworks Design Production Rates			
Annual average without Willamette CSO	15,938	124 1	9 5
Annual average including Willamette CSO	16,824	131 0	9 5
Abbreviation CSO = combined sewer overflow			

Imported Grit, Screenings, and Vactor Materials

Imported materials will be handled at an upgraded tipping berm Because of the potential for odor and nuisance, an enclosed facility is currently being designed

Septage

Septage is delivered to the CBWTP by a number of private haulers Upon completion of the new headworks, the septage receiving station will hold septage and meter its entry into the headworks Because of the small quantity of septage, the regulatory requirement to hold and test deliveries, and the need to remove screenings and grit from the septage, the headworks is the appropriate place for these activities

Liquid-Process Alternatives

Influent Pumping

The new headworks under construction will provide influent pumping of up to 300 mgd for all flows entering the plant through the interceptor This capacity may need to be increased by the year 2010 to accommodate peak flows from the new Inverness force main The eventual capacity of the headworks influent pumping station is predicted to be 319 mgd Capacity increases at the headworks can be accomplished through increases in the speed of the installed pumps

The Columbia Slough wet-weather plant influent pump station will require a 75-mgd firm capacity (with one pump out of service) The depth of the Columbia Slough consolidation conduit (CSCC), which will carry CSOs from the Columbia Slough Basin, is expected to be approximately 50 feet, the depth of the Willamette River consolidation conduit (WRCC) is expected to be approximately 150 feet Therefore, it is assumed that separate pumping stations will be constructed for the CSCC and WRCC flows The Willamette River wet-weather plant influent pump station will require a firm capacity of 336 mgd (with one pump out of service)

The Columbia Slough wet-weather plant influent pump station can be constructed to the south of the headworks currently under construction The minimum diameter of the pump station is expected to be 60 feet A staging area of at least 20 feet should be provided around the station for construction The flows will be discharged to a force main for conveyance to a new headworks facility adjacent to the one currently under construction Odor control facilities for the pumping station can be provided with packed-bed towers adjacent to and providing treatment for the foul air from the headworks and consolidation conduit Ventilation and treatment of foul air from the CSCC will also be provided upstream at the drop shafts

The Willamette River influent pump station can be constructed immediately adjacent to the headworks The minimum diameter of this station is expected to be 104 feet Again, a staging area of at least 20 feet should be provided around the station Submersible pumps may not be possible for this pump station because of the head requirements A wet well/dry well configuration with nonclogging pumps is assumed until the actual tunnel depth and head requirements for the pump are determined Packed-bed towers would be used for treatment of the foul air from the pump station and associated headworks

Pretreatment

The new headworks currently under construction is designed to handle a peak hydraulic flow of 300 mgd The peak interceptor flow (sanitary sewer system) is estimated to be 278 mgd, this includes flows from the *existing* Inverness force main In the future, an eventual peak of 41 mgd is expected from the *new* Inverness force main, this increase will result in a total peak interceptor flow of 319 mgd Thus, the new headworks will be able to accommodate the projected 19-mgd dry-weather plant flow without modification

Additional headworks facilities will be needed to handle CSOs from the Columbia Slough Basin and Willamette River Basin They will need to be sized to provide 75 mgd of hydraulic capacity for Columbia Slough CSOs and an additional 336 mgd of hydraulic capacity for Willamette River CSOs

To the extent practical, the wet-weather plant headworks should include equipment similar to that included in the headworks currently being constructed in order to simplify plant operation and maintenance The facilities can be oriented so that in the future units could be added immediately adjacent to similar units This concept would provide continuity for the expansion required to meet varying flow conditions

Table 6-3 presents the suggested preliminary treatment processes for the wet-weather treatment facilities, for these processes, systems similar to those under construction at the new headworks are assumed These suggested wet-weather treatment facility processes reflect a reasonable estimate of the type and size of facilities required Exact process selection and sizing would be part of the wet-weather treatment facility design These processes are consistent with both the EPA CSO policy and the CSO facilities plan Grit removal is added to minimize the effects of grit on the primary clarifiers and to provide better digestion of the primary sludge

Primary Treatment

With the addition of CSOs, new primary clarifiers will be necessary The projected peak dry-weather flow (PDWF) for the year 2040 is 160 mgd Flows less than or equal to 160 mgd, which represent primarily sanitary sewage, will receive treatment by the CBWTP The CBWTP (also called the dry-weather plant) will continue to include full secondary treatment and possibly tertiary treatment Flows greater than 160 mgd will receive wet-weather treatment, which does not include secondary or tertiary treatment

The existing CBWTP has eight primary clarifiers, each of which measures 58 feet wide by 225 feet long At the PDWF design flow rate of 160 mgd, this equipment provides for an overflow rate of 1,530 gpd/ft^2 with all eight clarifiers in operation, or 2,040 gpd/ft^2 with six clarifiers in operation Currently, during wet-weather flows at the maximum interceptor hydraulic flow rate of 278 mgd, the overflow rate is 2,660 gpd/ft^2 with all eight clarifiers in operation, or 3,550 gpd/ft^2 with six clarifiers in operation

Table 6-3 Estimate of Type and Size of Pretreatment Facilities Required for CSO Flows Columbia Boulevard Wastewater Treatment Plant		
Item	**Columbia Slough Basin CSOs Only**	**Columbia Slough Basin and Willamette River Basin CSOs**
Flow measurement magmeters	Three with 14 to 60 mgd	Three at 14 to 60 mgd Four at 24 to 112 mgd
Screening mechanical bar screens	Three with 5/8-inch clear opening, 4-foot-wide by 8-foot-deep water depth, 25-mgd capacity each	Three with 5/8-inch clear opening, 4-foot-wide by 8-foot-deep water depth, 25-mgd capacity each Seven with 5/8-inch clear opening, 8-foot-wide by 8-foot-deep water depth, 50-mgd capacity each
Grit removal vortex grit separators	Three with approximately 20-foot diameter, 25-mgd capacity each	Three with approximately 20-foot diameters, 25-mgd capacity each Six with 24-foot diameters, 56-mgd capacity each
Odor control packed tower	One at 28,500 cfm	Four at 28,500 cfm each

Abbreviations
cfm = cubic feet per minute
CSOs = combined sewer overflows
mgd = million gallons per day

Primary Clarifier Alternatives

Six alternatives were developed for primary treatment These are based on the amount of wet-weather flow being treated, site layout alternatives developed during the site planning workshops (see Chapter 7), and the use of either existing or new primary clarifiers for dry-weather treatment

Differences in the following six alternatives for primary treatment include whether they accommodate only Columbia Slough CSOs or all CSOs, whether they fit with Site Master Plan 3 or 5, and whether the new primaries will treat dry-weather (CBWTP) flows or CSO flows (P1 or P2)

Alternative A3&5/P1 This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough for site layout Alternatives 3 and 5 (identified in the site planning workshops) New primary clarifiers would be used to treat dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flow from the CSCC (75 mgd) Four new primaries would be constructed to treat the PDWF of 160 mgd Six of the existing primaries would be required to handle the remaining wet-weather flow of 234 mgd, at an overflow rate of 2,990 gpd/ft^2 The remaining two existing primaries could be modified and reserved for backup However, for the purpose of comparing alternatives, only six of the clarifiers are required

Alternative A3/P2 This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough for site layout Alternative 3 Existing primary clarifiers would be used for treatment of dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flow from the CSCC (75 mgd) Six of the existing primary clarifiers would be used for the PDWF, at an overflow rate of 2,040 gpd/ft^2 The future interstage pumping rate would be 80 mgd The remaining two existing primary clarifiers would be used for the additional flow from the interceptor Four new primary clarifiers would be constructed for the CSCC flow, at an overflow rate of 2,470 gpd/ft^2

Alternative A5/P2. This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough for site layout Alternative 5 Existing primary clarifiers would be used for treatment of dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flow from the CSCC (75 mgd) Six of the existing primary clarifiers would be used for the PDWF, at an overflow rate of 2,040 gpd/ft^2 The future interstage pumping rate would be 160 mgd The remaining two existing primary clarifiers would be used for the additional flow from the interceptor Four new primary clarifiers would be constructed for the CSCC flow, at an overflow rate of 2,470 gpd/ft^2

Alternative B3&5/P1. This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough and Willamette River for site layout Alternatives 3 and 5 New primary clarifiers would be used for treatment of dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flows from the CSCC (75 mgd) and the WRCC (336 mgd) Four new primaries would be constructed to handle the PDWF of 160 mgd At the PDWF, the clarifier overflow rate would be 2,560 gpd/ft^2 The eight existing primaries would be used to handle 289 mgd of wet-weather flow, at an overflow rate of 2,770 gpd/ft^2 Six additional new primary clarifiers would be constructed to handle the remaining 281 mgd of wet-weather flow, at an overflow rate of 3,000 gpd/ft^2

Alternative B3/P2. This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough Basin and Willamette River Basin for site layout Alternative 3 Existing primary clarifiers would be used for treatment of dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flows from the CSCC (75 mgd) and WRCC (336 mgd) Six of the existing primary clarifiers would be used for the PDWF, at an overflow rate of 2,040 gpd/ft^2 The future interstage pumping rate would be 80 mgd The remaining two existing primary clarifiers would be used for additional flows at the same overflow rate Eleven new primary clarifiers would be constructed for the CSCC and WRCC flows, at an overflow rate of 2,860 gpd/ft^2

Alternative B5/P2. This alternative provides wet-weather treatment for the CSO flow from the Columbia Slough Basin and Willamette River Basin for site layout Alternative 5 Existing primary clarifiers would be used for treatment of dry-weather flows Primary clarifiers would be required to treat the peak interceptor flow (278 mgd), the peak sanitary flow from the Inverness pump station (41 mgd), and the peak wet-weather flows from the CSCC (75 mgd) and WRCC (336 mgd) Six of the existing primary clarifiers would be used for the PDWF, at an overflow rate of 2,040 gpd/ft^2 The future interstage pumping rate would be 160 mgd The remaining two existing primary clarifiers would be used for additional flows at the same overflow rate Eleven new primary clarifiers would be constructed for the CSCC and WRCC flows, at an overflow rate of 2,860 gpd/ft^2

Cost Comparison of the Primary Clarifier Alternatives

Costs were developed for the primary clarifier alternatives The costs included influent pumping stations, headworks, primary clarifiers, and odor control Present worth costs were added for items that are significantly different between the alternatives, such as the energy cost for interstage pumping and the operation and maintenance cost for sludge thickening Currently, thin primary sludge is pumped from the existing primaries to cyclone degritters and then thickened in three 55-foot-diameter gravity thickeners With construction of the new headworks with grit removal facilities and new primary clarifiers for treatment of dry-weather flows (Alternative P1), the gravity thickeners would not be needed The primary sludge can be thickened in new primary clarifiers constructed with deep sludge hoppers with steep walls The sludge from the existing primaries used during wet weather can be pumped to the new primaries for thickening If existing primary clarifiers are used for treatment of dry-weather flows, the gravity thickeners will still be used because sludge cannot be thickened in the hoppers in the existing clarifiers Thus, the additional operation and maintenance cost for operating the gravity thickeners has been added to the P2 alternatives

Conclusions

A summary of the cost comparisons for each of the primary clarifier alternatives is shown in Table 6-4 For both series of alternatives–A, treatment of the CSCC wet-weather flows only, and B, treatment of the CSCC and WRCC flows–the costs are similar for the three configurations They vary from $33 2 million to $39 4 million for the CSCC-only set of configurations and from $89 2 million to $97 2 million for the CSCC and WRCC configurations The least-cost and preferred alternatives are A3&5/P1 and B3&5/P1 In other words, construction of new primary clarifiers for treatment of dry-weather flows keeps costs the lowest Alternatives A3&5/P1 and B3&5/P1 also provide the best reliability and operability

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Recommendations

It is recommended that a configuration with four new primary clarifiers for the dry-weather flows, either Configuration A3&5/P1 for the CSCC treatment alternative or Configuration B3/P2 or B3&5/P1 for the CSCC and WRCC treatment alternative, be selected This design will provide new primaries for the treatment of dry-weather flows, which occur more often than wet-weather flows, and keep the existing primaries for the more intermittent use associated with wet-weather treatment The total capital cost for Alternative A3&5/P1 is $33 2 million The cost comparison for this alternative was based on modifying only six of the existing primary clarifiers We recommend that all eight be modified so that two can be reserved for backup

Table 6-4
Cost Comparison of Primary Clarifier Alternatives
Columbia Boulevard Wastewater Treatment Plant

Alternative	Present Worth Cost ($)
75-mgd WWTF (for Columbia Slough Basin)	
A3&5/P1 Site Layouts 3 and 5 New clarifiers for dry weather Existing clarifiers for wet weather	33,212,000
A3/P2 Site Layout 3 Existing clarifiers for dry weather New clarifiers for wet weather	37,945,000
A5/P2 Site Layout 5 Existing clarifiers for dry weather New clarifiers for wet weather	39,425,000
75- and 336-mgd WWTF (for Columbia Slough Basin and Willamette River Basin)	
B3&5/P1 Site Layouts 3 and 5 New clarifiers for dry weather Existing clarifiers for wet weather	89,236,000
B3/P2 Site Layout 3 Existing clarifiers for dry weather New clarifiers for wet weather	95,754,000
B5/P2 Site Layout 5 Existing clarifiers for dry weather New clarifiers for wet weather	97,234,000
Abbreviations mgd = million gallons per day WWTF = wet-weather treatment facility	

The additional capital cost for these modifications is $1 7 million, for a total capital cost of $34 9 million The total capital cost for Alternative B3&5/P1 is $89 2 million

Secondary Treatment

During preparation of the hydraulic statistics for the wet-weather plants, an effort was made to estimate on an average annual basis the amount of wet-weather flow that should receive secondary treatment if the capacity is available For the purposes of this analysis, wet-weather flow was defined as either of the following (1) flow pumped from either the CSCC or the WRCC or (2) flow from dewatering of the wet-weather primary clarifiers after a storm The resulting hydraulic statistics are presented in Table 6-5

Table 6-5
Average Annual Flow Volumes
Columbia Boulevard Wastewater Treatment Plant

Item	Columbia Slough Basin CSO Flows Only (MG)	Columbia Slough Basin and Willamette River Basin CSO Flows (MG)
Inflow from interceptor	44,900	44,900
Inflow from CSCC	410	410
Inflow from WRCC	Not applicable	2,600
Total CBWTP and CBWWTF inflow	45,300	47,900
Flow to dry-weather primaries and secondaries from interceptor (that is, dry-weather flow)	42,800	42,800
Flow to wet-weather primaries from interceptor (that is, bypass)	2,100	2,100
Flow to wet-weather primaries from CSCC	410	410
Flow to wet-weather primaries from WRCC		2,600
Flow to secondaries from CSCC and WRCC	60	80
Flow to secondaries from wet-weather primaries dewatering*	530	550
Total flow without secondary treatment (4 - (5+9+10))	1,900	4,500

*Dewatering rate of 10 million gallons per day is assumed

Abbreviations
CBWWTF = Columbia Boulevard Wet-Weather Treatment Facility
CSCC = Columbia Slough consolidation conduit
CSO = combined sewer overflow
MG = million gallons
WRCC = Willamette River consolidation conduit

The dry-weather flow arriving at the Columbia Boulevard Wet-Weather Treatment Facility (CBWWTF) constitutes approximately 95 percent of the total flow at the plant for the Columbia Slough Basin CSO flows only alternative, and 89 percent of the total flow for the Columbia Slough Basin and Willamette River Basin CSO flows alternative Of the wet-weather flow for the Columbia Slough Basin CSO flows only alternative, approximately 24 percent will subsequently receive secondary treatment, either as flow directly from the consolidation conduits or as wet-weather primary dewatering flow For the Columbia Slough

Basin and Willamette River Basin CSO flows alternative, this figure is approximately 12 percent

The amount of wet-weather flow, as wet-weather primary dewatering flow, subsequently receiving secondary treatment is highly dependent on the dewatering rate The higher the available dewatering rate, the more flow that can receive secondary treatment, because more of the wet-weather primaries can be dewatered in the limited period when the secondary treatment facilities are below capacity Table 6-6 shows the relationship between the dewatering rate and the total dewatered flow receiving secondary treatment

Table 6-6
Total Annual Dewatered Flow Receiving Secondary Treatment Versus Dewatering Rate
Columbia Boulevard Wastewater Treatment Plant

Dewatering Rate (million gallons per day)	Columbia Slough Basin CSO Flows Only (million gallons)	Columbia Slough Basin and Willamette River Basin CSO Flows (million gallons)
1	238	236
2	335	333
5	454	458
10	529	546
20	573	619
30	584	656
40	589	684

Abbreviation CSO = combined sewer overflow

From this analysis, it appears that 12 to 24 percent of the wet-weather flow can be detained in the wet-weather primaries after the rainfall event and fed to the aeration basins for secondary treatment The amount of wet-weather flow that can receive subsequent secondary treatment depends on the dewatering rate of the wet-weather primaries A dewatering rate of approximately 10 mgd appears to be reasonable, although a more detailed analysis, including costs, is needed to confirm that it is It is recommended that the dry- and wet-weather treatment plants at the CBWTP site be operated to maximize secondary treatment

The key liquid treatment issues and other planning criteria, such as site constraints and projected flows and loads, were taken into account, and several initial secondary treatment alternatives were considered These are listed in Table 6-7 The alternatives were ranked with the screening criteria shown below

- Optimum community investment
- Hydraulic simplification
- Optimum automation
- Mitigation for neighborhood
- Integration of plant into the community
- Maximum safety and minimum risk
- Ease of maintenance
- Operational flexibility
- Ammonia removal and reuse
- Energy efficiency

- Redundancy and reliability
- Cost-effectiveness (capital, operation and maintenance, and total present worth)
- Treatment performance reliability
- Ease of operation
- Effluent reuse (at discretion of City)
- Achievement of projected demands and regulatory requirements
- Implementability with minimum disruption

By consensus, two alternatives were selected for further analysis and renumbered, as summarized in Table 6-8 S1 was named *east secondary expansion*, and S2 was named *west secondary expansion*, as alternatives to be considered in site planning

Table 6-7
Secondary Treatment Alternatives
Columbia Boulevard Wastewater Treatment Plant

Treatment No.	Description
S1	Demolish existing clarifiers
S2	Derate secondary system for nitrification (in year 2040), make solids retention time 10 to 12 days, add phosphorus removal, use nitrification year-round
S3	Extend aeration basin tankage by including square clarifiers as aeration tankage
S4	Replace existing clarifiers with new clarifiers
S5	Use existing system at high rate, build new flocculating clarifiers in series
S6	Build new secondary system to meet all year 2040 needs, when new one is complete, abandon existing secondaries
S7	Build new deep clarifiers (20 feet deep), then add new aeration basins for new clarifiers
S8	Derate existing system, add parallel secondary system with new hydraulic profile
S9	Use high-rate trickling filters, use existing aeration basins as solids contact, build new clarifiers

Abbreviation mgd = million gallons per day

East Secondary Expansion

The activated sludge process with selector technology will provide secondary treatment of plant flows up to 160 mgd The secondary treatment equipment and processes consist of the eight existing activated sludge basins with selector technology and six new aeration basins with selector technology designed to nitrify and denitrify wastewater (complete nitrification and denitrification) during the dry-weather season when the wastewater temperatures are above 15°C

Table 6-8 Secondary Treatment Alternatives Selected for Further Evaluation Columbia Boulevard Wastewater Treatment Plant	
Treatment No.	**Description**
S1	Derate existing system, add parallel secondary system with new hydraulic profile
S2	Extend aeration basin tankage by including square clarifiers as aeration tankage, build new deeper secondary clarifiers

The existing aeration basins are currently designed for a 100-mgd average dry-weather flow (ADWF) The existing anoxic selector was designed only for improved sludge settleability and not complete nitrification and denitrification Therefore, the current aeration basins and selectors will be derated to approximately 72 mgd (at a mixed-liquor concentration of 3,600 mg/L) and will be capable of complete nitrification at wastewater temperatures above 15°C The existing basins can operate in the plug-flow mode, plug-flow selector mode (anoxic or anaerobic), and step-feed mode

The existing secondary clarifiers are limited because of their shape, influent configuration, and return activated sludge (RAS) capacity The existing clarifiers are 125 feet square, with a side-water depth ranging from 12 4 to 13 3 feet They have peripheral feed and peripheral effluent, which promote short circuiting The freeboard value is 4 84 feet The RAS capacity is limited to 60 mgd The secondary clarifiers will be derated to the same capacity as the activated sludge basins

The six new activated sludge basins will be located east of the headworks, adjacent to the new primary clarifiers The new basins will be able to operate in the same modes as the existing basins and will be designed for complete nitrification and denitrification The new basins will be 50 feet wide by 380 feet long by 21 feet deep The deeper basins will achieve better oxygen transfer than the existing basins, which are only 17 feet deep There is sufficient activated sludge basin tank capacity to operate at a mixed-liquor concentration of 3,600 mg/L

An alternative form of operation and design is the step-feed plug-flow selector technology This relatively new technology is being implemented on a large scale It provides not only advanced selector technology but also increased capacity This alternative should be considered once full-scale operational experience at large plants has been obtained

The new secondary clarifiers will be 140-foot-diameter circular basins with center-feed and peripheral-effluent weirs The new clarifiers will have in-board launders and Stamford baffling The scum removal mechanism will have a large capacity to remove scum because the selector technology is prone to scum generation and scum must be removed from the treatment process

The disadvantage of this secondary treatment alternative is that it will basically operate in parallel as two secondary treatment processes separated by a distance of 1,500 feet Because the two secondary systems will be operated independently, the labor required for operation and maintenance will be greater

West Secondary Expansion

Additional activated sludge capacity will be obtained from conversion of the existing secondary clarifiers into activated sludge basins The new activated sludge basins will contain the anoxic selector The effluent from the new aeration basins will then flow through the existing basins to complete the activated sludge treatment

The existing 125-square-foot secondary clarifiers will be modified by internal walls that separate each clarifier basin into four cells Baffle walls added to each cell will achieve plug flow Mixers will be installed in the selector cells to provide mixing The attained activated sludge volume will allow operation of the new tankage and existing tankage in series at a mixed-liquor concentration of 4,300 mg/L

The mixed liquor from the aeration basins will flow to new clarifiers The new clarifiers will be constructed west of North Portland Road and the elevated railroad tracks Fourteen new 140-foot-diameter and 18- to 20-foot-deep secondary clarifiers are needed to replace the existing secondary clarifiers and provide sufficient settling capacity for the new activated sludge system The new secondary clarifiers will be 140-foot-diameter circular basins with center-feed and peripheral-effluent weirs The new clarifiers will have in-board launders and Stamford baffling The scum removal mechanism will have a large capacity to remove scum because the selector technology is prone to scum generation and scum must be removed from the treatment process

The advantage of the west secondary expansion alternative is that the secondary process can be operated in series as one unit to minimize the labor requirements for operation and maintenance

The step-feed and plug-flow selector technologies are advantageous in this alternative They provide increased capacity within the limited area available for expansion This alternative should be considered after full-scale operational experience has been obtained at large plants

Cost Comparison

The costs of the east and west secondary treatment alternatives are compared in Table 6-9

Effluent Filtration

Space was reserved in the CBWTP site plan for chemical coagulation and effluent filtration These facilities could be used for removal of metals, which may or may not become an important treatment consideration for the CBWTP It is estimated that removal of metals will not become an issue until after the year 2020 Chapter 7 discusses site planning in more detail

Table 6-9 Cost Comparison of Secondary Treatment Alternatives Columbia Boulevard Wastewater Treatment Plant			
Alternative	**Capital Costs* ($1,000)**	**Annual O&M Costs* ($1,000)**	**Present Worth in 1995 Dollars ($1,000)**
East secondary expansion	60,590	1,811	26,372
West secondary expansion	84,808	1,644	20,112

*Costs are in 1995 dollars They include categories for planning, engineering, administration, and contingencies at 45 percent and categories for mobilization and demobilization, bonds and insurance, and interface at 18 percent

Abbreviation O&M = operation and maintenance

Disinfection

The current disinfection system at the CBWTP uses chlorine gas Because of increasing environmental and public concerns about the handling of chlorine and its water quality effects, two new disinfection treatment alternatives were selected for analysis

- Alternative 1 Chlorine gas disinfection with sodium bisulfite dechlorination
- Alternative 2 Ultraviolet light disinfection

For planning purposes, it was assumed that chlorine disinfection would require dechlorination to meet NPDES discharge limits for residual chlorine and coliform during dry-season and wet-season flows Dechlorination is not currently used at the CBWTP because a new outfall diffuser provides the dilution necessary to counteract the chlorine residual concentration as long as two conditions are sustained (1) the plant's effluent chlorine residual is less than or equal to 1 0 mg/L and (2) the flows during the critical dry-weather period do not exceed 100 mgd

Sulfur dioxide and sodium bisulfite were considered for dechlorination Sodium bisulfite was recommended because it satisfied environmental and safety considerations and was more cost-effective

The advantages and disadvantages of two disinfection alternatives were evaluated for three flow scenarios, shown in Table 6-10 The existing chlorination facilities are adequate to disinfect the Scenario 1 flows, but will have to be expanded to treat flows for Scenarios 2 and 3 Comparative cost estimates were developed for both alternatives for the three flow scenarios, as shown in Tables 6-11 and 6-12

Table 6-10 Flow Scenarios Used to Compare Disinfection Alternatives Columbia Boulevard Wastewater Treatment Plant			
Scenario	**Effluent Type**	**Flow Description**	**Flow Rate**
1 Secondary effluent from the CBWTP (interceptor flows less than or equal to 160 mgd)	Secondary effluent	Peak rate and day Annual average Year total	160 mgd 129 mgd 43,100 mgy
2 Secondary effluent from the CBWTP plus primary effluent from the future wet-weather treatment facility (will include interceptor wet-weather flows and Columbia Slough Basin CSOs)	Secondary effluent	Peak Annual average Year total	160 mgd 129 mgd 43,100 mgy
	Primary effluent	Peak rate Peak day Year total	234 mgd 110 mgd 2,463 mgy
3 Secondary effluent from the CBWTP plus primary effluent from the future wet-weather treatment facility (will include interceptor wet-weather flows and Columbia Slough Basin and Willamette River Basin CSOs)	Secondary effluent	Peak rate and day Annual average Year total	160 mgd 129 mgd 43,100 mgy
	Primary effluent	Peak rate Peak day Year total	570 mgd 295 mgd 5,259 mgy

Abbreviations
CBWTP = Columbia Boulevard Wastewater Treatment Plant
CSOs = combined sewer overflows
mgd = million gallons per day
mgy = million gallons per year

Table 6-11 Summary of Estimated Costs for Alternative 1 Chlorination and Dechlorination with Chlorine Gas and Sodium Bisulfite Columbia Boulevard Wastewater Treatment Plant							
Scenario	**Effluent Type**	**Process**	**Flow Rate (mgd)**	**Construction Cost ($)**	**Capital Cost ($)**	**Annual Operating Cost ($)**	**Net Present Worth ($)***
1	Secondary	Chlorination/ dechlorination	160	1,631,000	2,365,000	182,000	4,155,000
2	Secondary plus primary	Chlorination/ dechlorination	160+234	2,229,000	3,232,000	307,000	6,245,000
3	Secondary plus primary	Chlorination/ dechlorination	160+570	6,561,000	9,513,000	369,000	13,134,000

*Determined at 7 percent interest rate over 20 years
Abbreviation mgd = million gallons per day

Table 6-12 Summary of Estimated Costs for Alternative 2 Ultraviolet Disinfection Columbia Boulevard Wastewater Treatment Plant							
Scenario	Effluent Type	Process	Flow Rate (mgd)	Construction Cost ($)	Capital Cost ($)	Annual Operating Cost ($)	Net Present Worth ($)*
1	Secondary	UV low pressure	160	4,876,000	7,070,000	300,000	10,259,000
	Secondary	UV medium pressure	160	4,134,000	5,994,000	371,000	9,944,000
2	Secondary plus primary	UV medium pressure	160+234	13,034,000	18,900,000	577,000	25,042,000
3	Secondary plus primary	UV medium pressure	160+570	26,731,000	38,759,000	1,110,000	50,572,000

*Determined at 7 percent interest rate over 20 years
Abbreviations
mgd = millions gallons per day
UV = ultraviolet

Alternative 1, chlorine gas disinfection with sodium bisulfite dechlorination, is the recommended alternative at this time because it costs less and because medium-pressure ultraviolet light disinfection is not a proven technology for primary effluent at this scale Low-pressure ultraviolet light disinfection works well for secondary effluent but is not appropriate for the more turbid primary effluent In the future, environmental and public concerns may necessitate a change in this recommendation, and it may be worthwhile to consider modification of the existing chlorine gas disinfection facilities for ultraviolet disinfection

It is expected that medium-pressure ultraviolet disinfection will eventually become a proven technology for treatment of primary effluent at the high flows projected for the CBWTP wet-weather facilities A small ultraviolet disinfection system is being planned for onsite reclaimed water application at the CBWTP This system will give plant staff operational experience with ultraviolet disinfection of secondary effluent New installations of ultraviolet disinfection systems for treatment of primary effluent in other parts of the country should be monitored for future implementation at the CBWTP should this method become necessary Before ultraviolet disinfection is implemented, however, the effluent parameter transmittance should be measured for varying dry- and wet-weather effluent qualities

Effluent Pumping

During a plant expansion in the early 1970s, effluent pumping was added to the existing treatment plant outfall system to provide increased hydraulic capacity during periods of high plant flows or high river stages Gravity flow is practical during most periods, but high river stages can reduce the available water surface differential between the plant and the river to a minimum level and thus necessitate effluent pumping

Existing Effluent Pumping Station

The existing effluent pumping station (EPS) consists of three low-head effluent pumps, each with a capacity of 78 mgd, that discharge flow to the inlet end of the existing outfall One of these existing low-head pumps is considered a reserve unit There are also two high-head pumps, each with a capacity of 72 mgd, that discharge flow into a 72-inch-diameter pipeline that originally discharged to the Oregon Slough The high-head pumps are used only for extremely high river stages The 72-inch pipe was recently connected to the existing outfall conduit at a location south of the Oregon Slough to minimize the potential for discharge to the Oregon Slough This connection, however, reduced the capacity of the overall outfall system.

The existing EPS has a firm pumping capacity of 300 mgd with one of the 78-mgd pumps out of service Although the total capacity with all pumps in service is 378 mgd, the existing effluent lines to the outfall cannot convey more than 300 mgd

New Effluent Pumping Station

The addition of wet-weather flows from the Columbia Slough Basin will necessitate increasing the effluent pumping capacity through a new EPS This new facility will need to be operational by the year 2000

The new EPS should be located on the same side of the existing outfall as the corresponding new outfall line to avoid construction conflicts with the existing pipeline system There are two potential locations for the new pumping station The first location is on the west side of the Burlington-Northern Railroad (BNRR) line that forms the west boundary of the treatment plant In this location, the new EPS would be in the same area as the secondary treatment expansion in the Alternative 5 site layout, as identified in the site planning workshops (see Chapter 7)

The second potential EPS site location is on the main treatment plant site, adjacent to the west side of the proposed nonpotable water treatment facility and existing EPS This location is compatible with the site layouts for Alternatives 3 and 5

How the existing and proposed new outfalls will be connected will affect the capacity requirements of the new EPS Two main scenarios have been considered The numbers of pumps and their capacities have been developed for planning purposes only They will need to be refined during the predesign phase

Under the first scenario, the new EPS would be designed to pump the peak flow from the secondary treatment process without mixing it with primary effluent This design would be compatible with the Alternative 5 site layout The flow rate would be approximately 160 mgd Consequently, the new EPS would need five 40-mgd low-head pumps One pump would be a reserve unit, and four pumps would be service units The pump characteristics would be selected so that additional high-head pumps would not be required Wet-weather flows would be handled by the low-head and high-head pumps at the existing EPS

Under the second scenario, the new and existing EPSs and outfalls would be connected so that they would function interchangeably as an operational unit This design would be compatible with the site layouts for Alternatives 3 and 5

The minimum firm capacity of the new EPS would be 94 mgd This is the difference between 394 mgd (sum of 160-mgd dry-weather flow and 234-mgd wet-weather flow) and 300 mgd (firm capacity of the existing EPS) To meet this requirement, the new EPS would need three 47-mgd low-head pumps One pump would be a reserve unit, and two pumps would be service units The pump characteristics would be selected so that additional high-head pumps would not be required

Willamette River CSO Effluent Pump Station

If Willamette River Basin CSOs are treated at the CBWTP site, a third EPS will be required The locations considered for this facility are on the east side of the existing EPS, either just east of the existing EPS or farther east, near the new primary clarifiers The Willamette River CSO EPS would have a capacity of 340 mgd and would discharge flow to its own outfall to the Columbia River

Comparison of Alternatives

Costs were estimated for the EPS alternatives In Table 6-13, these are compared in terms of capital cost, annual operation and maintenance cost, and net present worth

The least-cost alternative for the new EPS is to locate it west of the existing EPS, per the Alternative 3 site layout An advantage of this alternative is that less additional pumping capacity would be required and pumping operations could be more easily consolidated and integrated into a single functioning unit Conceptually, the new EPS would be a mirror image of the existing EPS, except that there would be no high-head pumps Certain support facilities, such as those for utility water, could also be shared The new EPS with this alternative would pump secondary effluent, the existing EPS would pump primary effluent from wet-weather flows or a combination of the two treated wastewater streams

The preferred alternative, however, ultimately will depend on which overall site layout and outfall alignment are selected

Outfall

The CBWTP discharges treated effluent to the Columbia River through an existing outfall system constructed around 1950 The outfall system, which is approximately 11,500 feet long, consists mainly of a cast-in-place, 102-inch semielliptical concrete conduit The conduit has twin-barrel inverted siphon sections beneath both the Columbia Slough and the Oregon Slough (also called the North Portland Harbor on navigation charts) The outfall converts to an 84-inch-diameter, circular reinforced concrete pipe for the final 668 feet, which is called the terminal outfall structure The outlet from the 84-inch terminal outfall consists of a single, open-pipe discharge to the Columbia River

Table 6-13
Cost Estimates for Effluent Pumping Station Alternatives
Columbia Boulevard Wastewater Treatment Plant

Alternative	Firm Pumping Capacity[a] (mgd)	Capital Costs[b]	Annual O&M Costs[c]	Net Present Worth[d]
New EPS, west of BNRR (Alternative 5 site layout)	160	$9,860,000	$31,400	$10,195,000
New EPS, west of existing EPS (Alternative 3 site layout)	94	$7,141,000	$16,100	$7,312,000
New EPS, west of existing EPS (Alternative 5 site layout)	94	$8,265,000	$16,100	$8,479,000
Willamette River CSO EPS, both locations east of existing EPS (Alternative 3 and Alternative 5 site layouts)	340	$15,515,000	$64,200	$16,198,000

[a]With one pump out of service
[b]Capital costs include 45 percent of construction cost to account for construction contingency, engineering , and owner overhead
[c]Pumping stations are assumed to operate 20 days per year
[d]At 8 percent interest for 20 years

Abbreviations

BNRR = Burlington Northern Railroad
CSO = combined sewer overflow
EPS = effluent pumping station
mgd = million gallons per day
O&M = operation and maintenance

In 1995, a new multiport outfall and diffuser system was constructed at the existing outfall to the Columbia River The new outfall and diffuser system is connected to the existing conduit through a diversion structure near the river's edge on Hayden Island The existing 84-inch outfall pipe was left in place as an emergency diversion outfall for use when the plant flow or river stage is high The new multiport outfall and diffuser system has a flow capacity of approximately 240 mgd under high-river-stage conditions

The addition of Columbia Slough wet-weather flows will require the addition of a second outfall and diffuser system to discharge plant effluent The addition of Willamette River wet-weather flows will require the addition of a third outfall and diffuser system

Operational Flexibility

For operational flexibility during maintenance or under emergency conditions, it would be advantageous to design the second outfall with a capacity of 240 mgd, the capacity of the existing outfall, and to design the piping configuration so that the outfalls can be used interchangeably Whether this is a cost-effective approach depends on the preferred site layout and selected outfall alignment

Hydraulic Constraints

The following hydraulic constraints affect both the existing and the proposed new outfall systems

- The elevation difference between the CBWTP and the Columbia River is relatively small under normal low-river-stage conditions (approximately 23 feet) and decreases to essentially zero at the 100-year flood elevation

- The distance between the treatment plant and the river, approximately 2 miles, creates substantial hydraulic losses because of pipe friction and other minor losses

- The outfalls cross below both the Columbia Slough and the Oregon Slough in twin-barrel inverted siphons These siphons create additional hydraulic losses

- Installation of new secondary clarifiers and ultraviolet disinfection equipment may lower the hydraulic grade line at the treatment plant site and thus further reduce the head for gravity flow

Alternative Pipeline Corridors

The selection of pipeline corridors for a second and third outfall is limited by existing and planned development of property along the proposed routes, and by environmental concerns It is desirable that neither of the new outfalls crosses the existing outfall A crossing would create a difficult construction problem because of the size of the conduits and the potentially fragile condition of the existing conduit Seven outfall alignment alternatives were proposed for evaluation five west of the BNRR right-of-way and two east of it The advantages and disadvantages of these alternatives are discussed below See Technical Memorandum 5 3 for figures illustrating these alignments

Alignment W-1. Alignment W-1 is located on the west side of the BNRR right-of-way and the existing outfall pipeline The alignment crosses the Columbia Slough near the new effluent pumping station and runs west of the existing outfall along North Portland Road adjacent to the Smith Lake wetland area This section may require pile support and wetland mitigation The alignment then undercrosses the Oregon Slough adjacent to the Hayden Island houseboat development The alignment crosses, or interconnects with, the existing outfall on Hayden Island and crosses beneath the BNRR right-of-way at the existing access road The outfall to the river and the diffuser are located about 500 feet east of the BNRR bridge This location is within an existing pipeline and cable-crossing corridor

This alignment is the most attractive for the second outfall in terms of ease of construction, low costs, and discharge to the Columbia River in a protected area where adequate mixing exists The alignment may need to run west of the houseboat marina to avoid conflicts with existing users If the pipeline is placed at the edge of the Smith and Bybee Lakes area, mitigation may be needed The pipeline route could be combined with a walking or bicycle path to minimize conflicts The pipes could be interconnected on Hayden Island so that secondary effluent continues to go to the existing outfall, if necessary for permitting reasons

Alignment W-2. Alignment W-2 is located on the west side of the BNRR right-of-way, between the railroad line and North Portland Road The route crosses the Oregon Slough near the BNRR bridge and crosses Hayden Island between the existing outfall and the railroad right-of-way The outfall and diffuser are at the same location as Alignment W-1

This alignment offers the shortest possible route to the Columbia River Its costs may not be lower because of the difficulty of undercrossing the Oregon Slough near the BNRR bridge This area, where Marine Drive turns south and becomes North Portland Road, is congested and would disrupt traffic significantly Also, it would be difficult to construct the Oregon Slough crossing so close to the railroad bridge

Alignment W-3. Alignment W-3 is located west of both the BNRR right-of-way and the existing outfall The alignment is similar to Alignment W-1, except that the proposed outfall and diffuser are downstream of the existing outfall and mixing zone This is an excellent alignment location in terms of directness and low cost, but it encroaches on land that the Port of Portland plans to use for the proposed Hayden Island marine terminal It also requires mitigation of wetland impacts for construction adjacent to Smith Lake

Alignment W-4. Alignment W-4 is located west of the BNRR right-of-way and the existing outfall The outfall route is adjacent to Smith Lake (as are Alignments W-1, W-2, and W-5) but then follows the BNRR spur line in a westerly direction to a point opposite the west end of Hayden Island The alignment then crosses the Oregon Slough to Hayden Island and has an outfall to the Columbia River west of the proposed Port of Portland terminal site

This alignment avoids conflict with the Port of Portland's proposed development It is relatively long, and therefore expensive, and the outfall and diffuser would be located in a shallow portion of the river where good mixing might be difficult The portion of the outfall in the Columbia River may conflict with shipping channels planned by the Port of Portland, although no information is available on this possibility

Alignment W-5. Alignment W-5 is similar in most respects to Alignment W-4 except that it crosses the Oregon Slough near the existing outfall crossing and then runs west of the outfall near the west end of the Hayden Island

Alignment E-1. Alignment E-1 is located east of the BNRR right-of-way It crosses the Oregon Slough east of the existing crossing and then runs east along the levee to the

Southern Pacific Railroad right-of-way It then crosses beneath the right-of-way and continues north along the west boundary of the Heron Lakes golf course The alignment passes through the James River Corporation (JRC) site on Marine Drive and crosses Marine Drive and the Oregon Slough to Hayden Island It then crosses Hayden Island and terminates with an outfall and diffuser at a site 500 feet east of the BNRR bridge

This alignment is relatively short and direct, but it has several major disadvantages It crosses the levees operated by Peninsula Drainage District 2, in two locations According to drainage district officials, the crossings must use siphons rather than cutting directly through the levee Siphons would substantially reduce the ability of the outfall to flow by gravity and might necessitate pumping of the effluent The alignment would interfere with access to the JRC site Crossing Marine Drive and the Oregon Slough in this location would be difficult because of the lack of land area for construction activities and the volume of traffic on Marine Drive

Alignment E-2. Alignment E-2 is also located east of the BNRR right-of-way It crosses the Oregon Slough and Southern Pacific Railroad right-of-way in the same location as Alignment E-1 but then crosses through the center of the Heron Lakes golf course After passing through the golf course, it crosses through the center of the JRC site, Marine Drive, and the Oregon Slough to Hayden Island The diffuser would be located as described for Alignment E-1 This alignment has the same major disadvantages as Alignment E-1 because it crosses through the drainage district levees and JRC site Unlike Alignment E-1, it crosses through the center of the golf course rather than staying along the west boundary

Outfall Sizing and Cost Estimates

Preliminary sizes were estimated for each of the seven outfall alignments for four design flow rates 75, 160, 240, and 336 mgd The 75 mgd corresponds to the projected year 2040 peak flow for Columbia Slough Basin CSOs to the plant 160 mgd with the peak dry-weather flow that will receive secondary treatment, 240 mgd with the capacity of the current outfall and multiport diffuser system, and 336 mgd with the projected year 2040 peak flow for Willamette River Basin CSOs The sizing estimates were based on the following assumptions

- Full pipe flow conditions at peak rate of flow
- Manning's *n* value of 0 012
- Profile and fitting losses similar to those at the existing outfall
- Use of low-head pumping at high river stages
- Sizing for the 10-year flood stage elevation of 23 7 feet
- Provision of additional pumping capacity for the 100-year flood stage
- Provision of a multiport diffuser comparable to the existing one

On the basis of the estimated outfall sizes, cost estimates were prepared for each of the alignments and design flow conditions The results of the sizing and cost estimates are presented in Table 6-14

Table 6-14 Outfall Alignment Sizing and Cost Estimate Columbia Boulevard Wastewater Treatment Plant									
		Flow Rate							
		75 mgd		160 mgd		240 mgd		336 mgd	
Route Alternative	Route Length (feet)	Diameter (inches)	Capital Cost* ($1,000)	Diameter (inches)	Capital Cost* ($1,000)	Diameter (inches)	Capital Cost* ($1,000)	Diameter (inches)	Capital Cost* ($1,000)
W-1	14,700	66	$11,735	90	$19,453	102	$23,229	102	$23,229
W-2	12,900	66	$11,145	90	$18,106	102	$21,516	102	$21,516
W-3	14,400	66	$11,637	90	$19,228	102	$22,943	102	$22,943
W-4	19,900	72	$16,065	96	$27,253	114	$34,347	114	$34 347
W-5	19,200	72	$15,814	96	$26,665	114	$33,562	114	$33,562
E-1	13,300	66	$11,244	90	$18,330	102	$21,802	102	$21,802
E-2	15 200	66	$11,899	90	$19,827	102	$23,704	102	$23,704

*Costs include 45 percent markup for contingency, engineering, and owner administration Costs include the outfall diffuser, but not dechlorination

Abbreviation mgd = million gallons per day

The less expensive alignments are W-1, W-2, W-3, E-1, and E-2 Alignments W-4 and W-5 are significantly more expensive because of their greater lengths

Conclusions

The preferred mixing-zone location for the second outfall is immediately downstream of the existing outfall mixing zone This location is a part of the Alignment W-3 alternative but may not be possible because of conflicts with the Port of Portland's proposed terminal facility The next most desirable diffuser location is 500 feet upstream of the BNRR bridge This location is available with Alignments W-1 and W-2 The difficulty of constructing an outfall on Alignment W-2, however, makes Alignment W-1 the preferred alternative for the second outfall It is suggested that the existing and second outfalls be connected on Hayden Island so that secondary effluent can be directed to the existing outfall and the primary effluent can be directed to the second outfall, if desired

An alignment on the east side of the BNRR line is not considered feasible because of the problems associated with crossing the drainage levees, which may restrict or eliminate gravity flow capacities

The City of Portland should begin a detailed pipeline alignment investigation to further clarify the advantages and disadvantages of the recommended alignments (W-1 and W-3) for the second outfall This evaluation should include a property ownership search and an investigation of environmental constraints The alignment should be finalized concurrently with completion of the CBWTP predesign activities, and property or easement acquisition should begin as soon as possible Further private property development along the recommended alignment during the next 5 years could have serious cost and performance impacts if the alignment is not obtained as soon as possible The City should not wait until the final outfall design phase to obtain the property easements

The recommended alignment for the third outfall is W-4, which terminates in an outfall and diffuser at the west end of Hayden Island Because the need for the third outfall is not certain at this time and the outfall will not be needed for at least 10 years, there is no pressing need to finalize the alignment now The City should select a planning corridor for the outfall and work with the Port of Portland, the City of Portland Planning Department, and private owners to ensure that future site development activities do not restrict the potential for construction of the third outfall

Solids-Process Alternatives

Table 6-15 summarizes a comparison of existing solids-processing capabilities with projected processing requirements, it includes the key values used to compare conditions at the existing facilities with the year 2040 required conditions

This comparison does not address nonrecyclable solids such as grit, screenings, and vactor materials Disposal of these materials at area landfills will be performed on a contract basis

Table 6-16 shows the projected impact of CSO wet-weather treatment facilities on CBWTP generation of solids The wet-weather quantities of solids are based on TSS production information from the 1994 CSO facilities plan

Next, maximum-month and maximum-week solids were projected by use of a peaking factor applied to the average seasonal values presented in Table 6-16

The following "sludge quantity" peaking factors were selected for this evaluation to convert seasonal averages to peak-month and peak-week values

- Dry season
  - Maximum month average 1 1
  - Maximum week average 1 3
- Wet season
  - Maximum month average 1 2
  - Maximum week average 1 3

Primary Sludge Thickening

Primary sludge thickening is currently performed in gravity thickeners With grit removal taking place in the new headworks, primary sludge thickening can now be performed in the primary clarifiers

Table 6-15
Evaluation of Process Capacity for Handling Solids
Columbia Boulevard Wastewater Treatment Plant

Process	Condition		Solids Quantity (lb/day)	Criteria	Required Capacity	Available Capacity (all units in service/ largest unit out of service)
PS thickening	1993	Wet season Peak week	113,507	25 lb/ft^2/day	4,540 ft^2	7,127/4,751 ft^2
	2040	Wet season Peak week	243,958		9,758 ft^2	
WAS thickening	1993	Dry season Peak week	82,684	250 gpm/meter at 6,000 mg/L	1,147 gpm	2,250/1,500 gpm
	2040	Dry season Peak week	142,159		1,972 gpm	
Anaerobic digester	1993	Wet season Maximum month	152,914	20 days at 4% TS	9 2 MG	12 0/9 6 MG[a]
	2040	Wet season Maximum month	318,952		19 1 MG	
Lagoon	1993	Annual average	81,727	1 year at 6%	59 6 MG	182 5 MG[b]
	2040	Annual average	163,670		119 4 MG	
Dewatering	1993	Wet season Maximum month	96,017	825 lb/meter/hr at 22 hr/day	96,017 lb/day	145,200/108,900 lb/day
	2040	Wet season Maximum month	202,987		202,987 lb/day	
Reuse	1993	Annual average	73,554			Per arid lands and compost contracts
	2040	Annual average	147,303			

[a]The available digestion capacity is equal to the primary digester (active digestion) volume and excludes the secondary digestion volume
[b]Lagoon capacity for storage only

Abbreviations

ft^2	=	square feet
gpm	=	gallons per minute
gpm/meter	=	gallons per minute per meter
hr/day	=	hours per day
lb/day	=	pounds per day
lb/ft^2/day	=	pounds per square foot per day
lb/meter/hr	=	pounds per meter per hour
MG	=	million gallons
mg/L	=	milligrams per liter
PS	=	primary sludge
TMs	=	technical memorandums
TS	=	total solids
WAS	=	waste activated sludge

Table 6-16
Projected Solids Production
Columbia Boulevard Wastewater Treatment Plant

Condition	Primary Sludge (lb/day)		Thickened Primary Sludge (lb/day)		WAS (lb/day)		Thickened WAS (lb/day)		Thickened PS and WAS (lb/day)		Digested Sludge (lb/day)		Dewatered Biosolids (lb/day)	
	Without CSOs	With CSOs	Without CSOs	With CSOs	Without CSOs	With CSOs	Without CSOs	With CSOs	Without CSOs	With CSOs	Without CSOs	With CSOs	Without CSOs	With CSOs
1993 dry weather	84,104	NA	75,694	NA	63,603	NA	57,243	NA	132,937	NA	83,439	NA	75,095	NA
1993 wet weather	87,313	NA	78,582	NA	54,273	NA	48,845	NA	127,428	NA	80,014	NA	72,013	NA
2040 dry weather	171,952	NA	154,757	NA	109,353	NA	198,418	NA	253,175	NA	158,183	NA	142,365	NA
2040 wet weather	165,179	187,660	148,661	168,894	107,665	107,665	96,899	96,899	245,560	265,793	153,428	169,156	138,085	152,241

Abbreviations

CSOs = combined sewer overflows
lb/day = pounds per day
NA = not applicable
PS = primary sludge
WAS = waste activated sludge

The new primary clarifiers will be designed with deep hoppers for thickening the primary sludge The sludge pumping system will be designed to pump an average primary sludge concentrate of 4 percent total solids, with concentrations up to 8 percent total solids

Primary solids will be pumped from the wet-weather primaries, as thin solids, to the existing gravity thickeners for thickening and pumping to the digesters This process will provide rapid removal of solids from the wet-weather primaries and thus will make cleaning easier and will minimize the potential for odor production Modifications to the thickened sludge pumping system will be needed to allow pumping of primary sludge at solids concentrations of up to 6 percent

Waste Activated Sludge Thickening

The plant has an adequate gravity belt thickener (GBT) capacity for well into the study period, and the equipment is relatively new and in good condition The plant has a history of periods of extremely thin waste activated sludge (WAS), if these periods continue, the hydraulic capacity of the GBTs could be stressed earlier than predicted This situation, however, has improved in the past year with the secondary process configuration improvements, and the situation is expected to improve as the plant continues operation It is realistic to view the future of the GBTs in conjunction with the future of dewatering and the dewatering building that currently houses both processes Adding a fourth GBT unit, or at least configuring the building layout to accommodate a fourth unit, should be done in conjunction with more imminent dewatering capacity expansion

Anaerobic Digestion

The anaerobic digestion process was evaluated to provide a 15-day digestion time as required by regulations under the conditions of maximum-week solids production The digesters were evaluated under two operational modes codigestion and separate digestion Codigestion is digestion of primary sludge and secondary sludge together, separate digestion is digestion of the two solids streams separately

Primary and secondary solids are currently being digested separately This method is being used to improve dewatering of solids for composting and to eliminate the problems that could occur during codigestion Separate digestion of solids requires additional redundancy and does not result in optimum use of the existing digester tankage The digesters are currently operating at design hydraulic loadings, and the necessary redundancy for equipment breakdown or digester cleaning does not exist The hydraulic loading is limited because the primary sludge pumped from the thickeners is thin, and thickening of secondary sludge is constrained to 4 percent solids because of the potential for ammonia toxicity in the digesters The necessary digestion capacity can be provided by pumping of thicker primary sludge and by incorporation of recuperative thickening into the digestion process

It is necessary to modify the primary sludge pumping systems and piping to pump the thicker primary sludges After installation of a digested sludge recirculation loop or a booster pump station, primary sludges can be pumped at solids concentrations of up to 6 percent instead of at the current solids concentration of 2 to 3 percent This modification will make it possible for the present digestion system to provide adequate capacity through the year 2010 with all units in service The system, however, will not be able to meet the minimum 15-day detention time with one unit out of service The necessary redundant capacity can be provided through the use of recuperative thickening, which will require installation of a thickening centrifuge at the digester complex The result will be an increase in the digester detention times, which will provide the necessary redundant capacity through the year 2010 This work needs to be done soon to minimize the potential for digester upset

After incorporation of the modifications outlined above, the digester capacity will be adequate through the year 2010 Four additional digesters will be needed by the year 2040 to handle the projected increase in solids production These can be added in two phases, two digesters per phase Factors that can affect when additional digestion capacity will be needed are future regulation requirements, potentially changing the process to codigestion, and the actual quantities of solids that will be received from the CSO treatment facilities

Sludge Storage

The sludge lagoon adds a great deal of flexibility to the plant's handling of solids Sizing criteria for a storage feature such as a lagoon are arbitrary For example, DEQ encourages municipalities in the Willamette Valley to have 3 to 6 months of wet-weather biosolids storage to accommodate a land application program in western Oregon A year of storage is desirable to accommodate almost any emergency

The sludge lagoon will be compartmentalized and lined to improve operational efficiency and minimize the potential for leakage

The existing 36-acre lagoon will be modified to a 26-acre lagoon with the restoration of the wetland at the southern end This restoration will provide environmental enhancement for the area between the lagoon and the 40-mile loop

Operation of the lagoon in an odor-free manner will require that the volatile solids loading not exceed 20 pounds of volatile solids per 1,000 square feet per day This loading may be increased if operational experience shows that a higher loading will not result in an odor episode

The 26-acre lagoon will have the ability to store up to 1 year's worth of biosolids at the year 2040 loadings, but will not be able to do so at the 20 pounds of volatile solids per 1,000 square feet per day level For this reason, alternative programs for biosolids should be incorporated into the CBWTP biosolids management plan in the future to reduce the program's reliance on storage

Dewatering

The existing belt presses dewater digested and lagoon-stored solids for composting and for hauling to eastern Oregon for application to farmland Increasing the dryness of the solids product will lower the costs of composting by lowering the amount of sawdust required to obtain the proper water balance The increased dryness will also lower the hauling costs for the application program and increase the amount of solids that can be hauled in each truck load Available new technology can provide an additional high-pressure dewatering zone for the existing belt presses This might increase the total solids concentration by 2 to 3 percent This technology needs to be pilot tested and incorporated into the process if it proves to be cost-effective

The firm dewatering capacity (one belt filter press [BFP] out of operation) exceeds the current maximum-month conditions by only approximately 13 percent (108,900 pounds per day available versus 96,017 pounds per day required) The redundancy is related to use of the lagoon, however, for this evaluation, use of the lagoon to allow downsizing of dewatering needs was not considered Because the hauling and land application program depends to some extent on the weather, dewatering should be capable of increasing the output as conditions change

The BFP equipment is now 15 years old and, although recently completely refurbished, is near the end of what is normally considered its useful life Repeated major refurbishing can extend the life of high-quality equipment such as the CBWTP BFPs by 10 to 15 years per cycle, but other factors affect the dewatering decision These factors include available cake solids and the basic configuration of the building The cost-effectiveness of both of the plant reuse methods (composting and long-haul and land application) is directly related to the cake solids available from dewatering Newer technologies such as dry-solids centrifuges and higher-solids belt presses should be considered and tested as part of the dewatering modification and expansion Also, the BFPs (and the GBTs) were retrofitted into an existing building, and since the BFP modifications, the composter and the truck loadout facility for the land application program have been added

Given the dewatering process requirements and the age of the existing equipment, the system should be modified, and the capacity should be increased A logical expansion scenario is vertical expansion of the existing dewatering building with placement of dewatering equipment on the upper floor to facilitate a new conveyance system The existing at-grade floor could then be used for expansion of the thickening processes and miscellaneous dewatering support functions For this scenario, it is assumed that reuse of the existing dewatering, composting, and truck loadout facilities would be maximized

Major modification and expansion of the existing dewatering building should include new storage and blend tanks, rehabilitation and expansion of the GBT WAS thickening, probably at the at-grade level, and expansion and improvement of filtrate storage and return pumping

Utilization of Biosolids

The CBWTP produces two types of biosolids for reuse compost and dewatered cake The compost is distributed to local landscaping markets The dewatered cake is taken in trucks to the Madison Ranch near Hermiston, Oregon, for direct land application With the present operation mode at the plant, the compost is made almost exclusively with digested primary solids The dewatered cake is made with secondary clarifier digested solids blended with lagoon solids and some primary clarifier solids

Table 6-17
Generation and Reuse of Biosolids
Columbia Boulevard Wastewater Treatment Plant

New CBWTP Solids (dry tons/day)	1994 (actual)[a] (dry tons/year)	1994 (projected) (dry tons/year)	2040 (projected) (dry tons/year)
Land application	6,710	5,782	17,046
Compost feed	3,809	7,000	7,300
Storage in lagoon during winter	920	832	2,500
Total new solids	11,439	13,614	26,846
New CBWTP solids production rate	31 3	37 3	73 6
Old lagoon solids	10,036	10,000	None[c]
Total solids reused	20,555	22,782[b]	26,846[d]

[a]Actual 1994 and projected values taken from the 1995 CBWTP biosolids management plan
[b]Does not include new solids stored in lagoon during the winter
[c]Lagoon renovation project to be completed by the year 2000
[d]Includes new solids stored in lagoon during the winter

The volume of biosolids used for compost feed has a direct bearing on the acreage required for land application Table 6-17 indicates that just under 20,000 dry tons of biosolids (17,046 + 2,500) will be directly land applied in the year 2040 At the current annual application rate of 2 5 dry tons per acre on dry range land, 8,000 acres will be required CBWTP staff are currently negotiating with DEQ to increase the authorized land area at the Madison Ranch to 4,500 acres From a simplistic analysis, it appears that the current land area capacity is adequate to accommodate the year 2040 biosolid volumes We do not presume that the current Madison Ranch contract will still be in effect at that time, however, this analysis indicates that future capacity requirements are not greater than the present land availability

Two elements of the existing program, composting and direct agricultural use, provide some flexibility and stability through diversity If one element breaks down, the capacity of the other program can be increased to meet the need, or the biosolids can be stored onsite in the lagoon Programs that could be used in addition to the existing programs were evaluated The addition of a third utilization alternative to the existing program would increase program reliability and reduce future storage needs

Composting, heat drying, and alkaline stabilization were evaluated to determine their potential as an alternative to the existing program Incineration and landfilling were not evaluated because these alternatives are discouraged by DEQ and do not meet the State of Oregon's goal of 100 percent utilization of biosolids The technologies were evaluated in increments of 10, 20, 30, and 40 dry tons per day to provide the information necessary to evaluate whether the alternatives could be implemented effectively into the existing program and thus improve program diversity

Each of the programs was developed to be sited on the existing treatment plant site, and odor control was incorporated to meet the odor requirements for all new processes The programs were compared in terms of their capital and operating costs, their impacts on the existing plant, and their operabilities Table 6-18 is a summary of the alternative program costs The existing programs were included in the evaluations for comparison Table 6-19 is a weighted matrix evaluation of program costs, impacts, and operabilities

The existing arid lands program is the preferred program in terms of costs, impacts, and operability This program has the lowest operating cost and does not require any additional capital costs The existing composting program has the highest operating cost but does not require any additional capital costs Of the alternatives that were evaluated, both heat drying and a new composting system could improve the reliability of the existing system Before implementation, these alternatives will require a detailed analysis of the local market for compost and dried sludge

The preferred program would add more agricultural land to increase the flexibility of the existing program and to provide a contingency capacity The increased acreage should be sufficient to accommodate solids used in the existing composting program (approximately 3,000 acres at 2 5 dry tons per acre every 2 years) The land should be at a location separate from the existing reuse site on the Madison property to further increase the program's diversity

Odor Control

Odor control was recognized as a critical issue in development of the facilities plan The concerns and recommendations of the CAC were expressed at three odor control workshops In the supporting detail of the CBWTP vision statement, as approved by the CAC, the following principle was established "Never emit offensive odors that can be detected off the site " In keeping with this principle, the plan calls for existing and future sources of foul air to be contained and treated

The particular types of odor control measures selected for analysis were developed from limited empirical data on emissions Thus, the odor control measures selected are necessarily conservative To more accurately determine concentrations, further sampling should be performed during the summer months when odors are expected to peak To more accurately determine the optimum treatment methods, pilot tests should be performed The results might lead to recommendations for less expensive odor control measures

Table 6-20 summarizes the odor control measures that were evaluated for containment and treatment of potential odor in the existing and future facilities Tables 6-21 and 6-22 show the estimated construction and operation costs for these control measures, for existing and future sources of foul air

At the CBWTP, biosolids are used with authorization from DEQ The operation complies with all applicable regulatory requirements, including 40 *Code of Federal Regulations (CFR)* Part 503 Details on the management of biosolids programs are available in the *CBWTP Biosolids Management Plan* (Brown and Caldwell, 1995b)

The CBWTP biosolids compost is produced through a controlled system that meets all requirements as a "process to further reduce pathogens" It is designated an "exceptional quality" product because it meets strict standards for both pollutant (metal) and pathogen reduction Therefore, detailed recordkeeping and management restrictions are not applicable (40 *CFR* 503 10[c][1])

Solids have been collected at the CBWTP lagoon for several years, since before a successful industrial pretreatment program was implemented Thus, pollutant concentrations are higher in the lagoon solids than in new solids produced at the CBWTP The new solids generally meet 40 *CFR* Part 503 requirements for exceptional quality (clean) biosolids (503 13[a][2][ii]) and would not be subject to any limits for cumulative metal loading in the soil However, because the biosolids transported to the Madison Ranch consist of a blend of new CBWTP solids and solids from the lagoon, land application must conform with cumulative pollutant loading rates so that metals do not accumulate above the 40 *CFR* Part 503 specified limits Land application records are kept to document compliance with this requirement

Currently, the CBWTP reuses 22,782 dry tons of biosolids a year Approximately 10,000 dry tons of this are the older solids being removed from the lagoon as part of the renovation As shown in Table 6-17, new biosolids generation at the plant is projected to increase to 26,846 dry tons per year by the year 2040 When the sludge lagoon renovation is finished in 1999, additional reuse treatment capacity will become available Therefore, the year 2040 reuse facilities will be required to manage only 17 percent more than the current volume

For the summary of biosolids volume and use presented in Table 6-17, a compost production rate comparable to the current target level of 20 dry tons per day was assumed An operating capacity of up to 30 dry tons per day is believed achievable However, this volume has to be balanced with sawdust amendment cost and quality, as well as year-to-year market demand for the product Actual production in 1994 was approximately 10 dry tons per day Thus, the projected year 2040 production level is maintained at a conservative level of 20 dry tons per day This value may be affected by future operation costs, compost market demand, regulatory policies, and availability of agricultural land for direct application of dewatered biosolids

The Triangle Lake lagoon renovation project, which is removing past accumulations of solids, should be finished by the year 2000 Lagoon solids after the year 2000 will consist of new solids stored in the lagoon during the winter Therefore, metal and other pollutant concentrations in the dewatered cake will be less Ongoing source control efforts will probably further reduce pollutant concentrations The higher quality of the biosolids will facilitate successful reuse

Table 6-18
Cost Summary of Alternatives for the Biosolids Utilization Program
Columbia Boulevard Wastewater Treatment Plant

Alternative Technology	10 DT/Day		20 DT/Day		30 DT/Day		40 DT/Day	
	Capital ($ Million)	O&M ($/DT)	Capital ($ Million)	O&M ($/DT)	Capital ($ Million)	O&M ($/DT)	Capital ($ Million)	O&M ($/DT)
Arid land application	-	160 - 170	-	160 - 170	-	160 - 170	-	160 - 170
Existing composting	-	429	-	322	-	285	-	-
New composting	16 5	250	27 6	225	33 8	215	40 0	215
Heat drying	16 6	210	21 5	175	29 7	170	33 6	170
Alkaline stabilization	11 8	310	19 3	300	25 6	300	31 3	300

Abbreviations
DT = dry tons
O&M = operation and maintenance

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Table 6-19 Matrix for Evaluating Biosolids Utilization Program Alternatives Columbia Boulevard Wastewater Treatment Plant						
Criterion	**Weight**	**Existing Composting Program**	**New Composting Program**	**Arid Lands Program**	**Heat Drying**	**Akaline Stabilization**
Cost/Benefit						
Capital		3	1	3	1	2
Operation and maintenance		1	1	3	1	2
Revenue		2	2	1	2	1
Marketability		2	2	1	2	1
Subtotal	35	2 0	1 5	2 0	1 5	1 5
Impacts/Mitigation						
Space		3	1	3	1	1
Odor potential		2	2	3	2	1
Noise		2	2	2	2	2
Transportation		1	1	2	3	1
Groundwater		2	2	2	2	2
Diversification		1	2	3	1	1
Legal liability		2	2	1	2	2
Community impacts		2	1	3	1	1
Public acceptability		2	2	2	2	1
Jurisdictional acceptance		2	2	1	2	1
Subtotal	35	1 9	1 7	2 2	1 8	1 3
Operability						
Technical reliability		2	2	3	1	2
Adaptability		1	1	3	1	1
Sizing flexibility		1	2	3	2	2
Technological flexibility		1	1	2	1	1
Operational expertise		2	2	3	1	2
Marketing expertise		2	2	3	1	1
Permitting and regulation		2	2	1	1	1
Subtotal	30	1 6	1 7	2 6	1 1	1 4
Total	-	5 5	4 9	6 8	4 4	4 2
Average	-	1 8	1 6	2 3	1 5	1 4
Weighted Average	100	1 8	1 6	2 2	1 5	1 4

Table 6-20
Odor Control Measures for Existing and Future Facilities
Columbia Boulevard Wastewater Treatment Plant

Four Air Source	Containment	Treatment
Primary clarifiers	Add flat cover	Chemical packed-bed wet scrubbers
Primary clarifier effluent weirs	Add flat cover (alternatively, replace exposed weirs with submerged weirs)	Two-stage system chemical packed-bed wet scrubber followed by biofilter
Aeration basins	Use flat cover	Carbon adsorber
Secondary clarifiers	Use flat cover	Carbon adsorber
Digesters	Modify floating covers to fixed covers*	No treatment
Compost process building	Use equipment covers	Two-stage system chemical scrubber followed by biofilter
Compost scrubber outlet	Use existing duct	Two stages first stage, sulfuric acid for ammonia control, second stage, packed-bed wet scrubber with an oxidant for control of reduced sulfur compounds
Compost storage building	Use duct	Two stages of chemical scrubbing
Dewatering building	Use heating, ventilation, and air-conditioning duct	Carbon adsorber

* If an existing cover does not need to be fixed for reasons other than odor control, a short-term solution should be investigated because of the high capital cost of this approach Escape of digester gas through safety vents is caused by equipment malfunction Improving operational and maintenance practices can solve this problem If leakage is expected to continue, a local carbon canister should be added

Table 6-21
Estimated Construction and Operating Costs
Foul Air Containment and Treatment for Existing Sources
Columbia Boulevard Wastewater Treatment Plant

Foul Air Source	Odor/H_2S Concentration	Airflow (cfm)	Containment Cost ($)	Treatment Cost ($)	Total Const. Cost[e] ($)	Annual Operating Cost[f] ($)
Primary clarifier weirs	H_2S (2 ppm), organic compounds, VOCs	24,000	882,000	747,925[a]	1,629,925	60,319
Digesters	H_2S (3 3 ppm)	NA	5,600,000	NA	5,600,000	NA
Compost scrubber outlet	H_2S (0 14 ppm), ammonia	19,200	14,400	398,750[b]	413,150	13,466
Compost process building	Ammonia, H_2S (0 14 ppm)	16,200	12,150	508,589[a]	520,739	35,830
Dewatering building	H_2S (0 1 ppm), ammonia	111,250	83,438	1,316,250[c]	1,399,688	130,229
Primary clarifiers	H_2S (0 1 ppm), organic compounds	31,200	1,146,450	494,450[d]	1,640,900	18,619
Aeration basins	H_2S (0 1 ppm)	95,960	2,264,370	1,170,000[c]	3,434,370	112,330
Secondary clarifiers	H_2S (0 05 ppm)	63,000	2,315,250	731,250[c]	3,046,500	73,747
Total costs		5 93	336,810	12,318,058	5,367,214	444,540

[a] Two-stage treatment with chemical packed-bed wet scrubber and biofilter
[b] Packed-bed scrubber, as second stage to existing first stage
[c] Carbon adsorber
[d] Packed-bed scrubber
[e] Construction costs include 20 percent for contingency but exclude contractor's overhead and profit, engineering costs, legal costs, and taxes
[f] Operating costs are based on an electric power cost of $0 05 per kilowatt-hour, 25 percent caustic and 12 5 percent hypochlorite at $0 60 per gallon, and carbon at $1 50 per pound

Abbreviations

cfm = cubic feet per minute
NA = not applicable
ppm = parts per million
VOCs = volatile organic compounds

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Table 6-22
Estimated Construction and Operating Costs
Foul Air Containment and Treatment for Future Sources
Columbia Boulevard Wastewater Treatment Plant

Foul Air Source	Odor/H_2S Concentration	Airflow (cfm)	Containment Cost ($)	Treatment Cost ($)	Total Const Cost[e] ($)	Annual Operating Cost[f] ($)
Primary clarifier weirs	H_2S (2 ppm), organic compounds, VOCs	31,000	1,139,250	934,906[a]	2,074,156	76,483
Compost storage building	H_2S (0 1 ppm), ammonia, organic compounds	100,000	75,000	2,340,000[b]	2,415,000	97,744
Dewatering building	H_2S (0 1 ppm), ammonia	111,250	83,438	1,316,250[c]	1,399,688	130,229
Primary clarifiers	H_2S (0 1 ppm), organic compounds	41,000	1,506,750	653,950[d]	2,160,700	22,928
Aeration basins	H_2S (0 1 ppm)	97,800	2,265,750	1,170,000[c]	3,435,750	114,484
Secondary clarifiers	H_2S (0 05 ppm)	34,200	1,256,850	511,875[c]	1,768,725	40,034
Total costs		415,250	6,327,038	6,926,981	13,254,019	481,902

[a]Two-stage treatment with chemical packed-bed wet scrubber and biofilter
[b]Two stages of chemical scrubbing
[c]Carbon adsorber
[d]Packed-bed scrubber
[e]Construction costs include 20 percent for contingency but exclude contractor's overhead and profit, engineering costs, legal costs, and taxes
[f]Operating costs are based on an electric power cost of $0 05 per kilowatt-hour, 25 percent caustic and 12 5 percent hypochlorite at $0 60 per gallon, and carbon at $1 50 per pound

Abbreviations

cfm = cubic feet per minute
ppm = parts per million
VOCs = volatile organic compounds

Chapter 7

Site Planning

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Chapter 7

Site Planning

Development of Alternatives

At the outset of the facilities planning, site planning workshops were identified as an approach that emphasized collaboration, recognition of the full range of siting issues and needs, and a coordinated way to address the impacts of various plant needs The site plan brought together the various project aspects, technical and nontechnical, for a complete picture of the facility and its conflicts and opportunities Recognized as a tool for synthesizing the various elements of the facility in order to address and promote the goals of the Columbia Boulevard Wastewater Treatment Plant (CBWTP) vision statement, the site plan was essential to development of the treatment alternatives and site environmental enhancement plans

Nine site conceptual plans were developed These addressed the liquid-process alternatives and general solids-handling requirements At the workshop, each alternative was ranked by consensus The alternatives were evaluated against four main criteria and their attributes

- Vision and public values
- Implementability
- Operability and maintainability
- Cost-effectiveness

Evaluation criteria and their attributes were itemized and agreed to by the workshop participants These assumptions are shown in Table 7-1

After a detailed analysis of the nine alternatives (see Figures 7-1 through 7-9), Alternatives 3 and 5 we selected for further evaluation on the basis of the evaluation criteria

Final Alternatives

Site plan Alternatives 3 and 5 were further evaluated and refined in light of the five environmental enhancement areas identified for the site (see Chapter 9, Environmental Enhancements) Potential tankage sizes derived from the planning criteria established in Chapters 2, 3, 4, and 5 were used to develop the preliminary site layouts shown in Figures 7-10 and 7-11 They include spacing for potential facilities needs such as filtration, ultraviolet disinfection, and maintenance of structures The existing chlorination facility would be modified for disinfection of wet-weather flows, and the sodium bisulfite dechlorination facility would be sited on Hayden Island near the outfalls

Table 7-1
Evaluation Criteria for Site Plans
Columbia Boulevard Wastewater Treatment Plant

Criterion	Attribute
Vision and Public Values	
Odor control	All primary clarifiers, including existing units to remain in service, are to be covered As secondary clarifiers and residuals facilities move closer to the general public or neighborhoods, the score decreases
Control of air toxic compounds	This is the same as odor control
Visual aesthetics	High profiles on or near the property line near the public (particularly the south property line) are inferior, low profiles are superior Buildings can be made to be aesthetically more pleasing than industrial-looking structures
Multiple use	This is similar to visual aesthetics Space left around the site periphery is superior for multiple uses Dry-weather primary clarifiers just east of North Portland Road limit the potential for a bike path adjacent to the railroad and thus weaken this option Amount of equipment in southeast corner of site limits areas for multiple uses, including bike paths and trails, and compromises the associated options
Traffic mitigation	Primary, secondary, and emergency accesses to site are the same in all alternatives Alternatives with only residuals west of North Portland Road are better than others because all solids will be conveyed (for instance, pneumatically) instead of trucked to the west of North Portland Road
Public education	The following are assumed placement of a two-lane access road plus piping gallery under the railroad and North Portland Road to connect the western property with the existing site when any liquid-process units are located west of North Portland Road, a railroad undercrossing and grade crossing of North Portland Road if only residuals facilities are located west of North Portland Road Tours will be of the whole site if liquid-process facilities are located west of North Portland Road If only residuals facilities are located west of North Portland Road, these would not be included in tours and public education programs
Lighting	Uncovered basins and high-profile processes require heavy lighting Heavy lighting close to neighborhoods is not favored

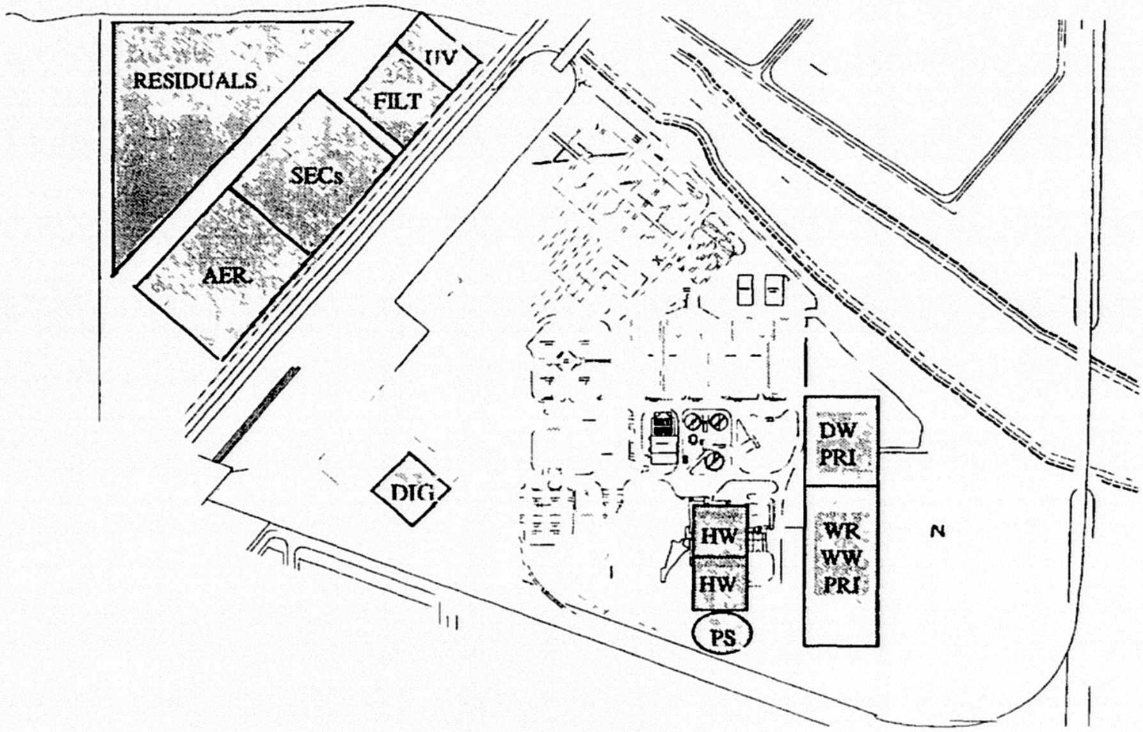
Table 7-1 Evaluation Criteria for Site Plans Columbia Boulevard Wastewater Treatment Plant	
Criterion	**Attribute**
Vision and Public Values (continued)	
Ecosystem	Open space is the primary concern, and all alternatives have essentially the same open space, in either the southeast corner or the northwest corner of the site Proximity to Columbia Slough could affect slough bank. Existing plant is already extremely close to slough, and no alternative can get any closer to the slough Therefore, all alternatives are equal
Ease of reuse	All alternatives can easily transfer effluent to nearby golf course (or wetlands etc)–the transfer cost, however, is another issue (considered under cost criteria)
Innovation	No significant, differentiating innovation is seen in any of the alternatives
Implementability	
Compliance with regulations	All alternatives are good
Solution of hydraulics problems	Long distances between processes are not favored Grouping all of one process (such as all primary clarifiers) in same location is favored
Effective staging	Nitrification is important to all alternatives Split systems are easier to stage because existing flow is maintained until new components are built, and incremental construction is easy
Space utilization	Smaller footprints are preferred Alternatives with only residuals to west of North Portland Road use a tight, small footprint
Ammonia removal	There are no differences between all alternatives
Operability and Maintainability	
Process reliability	Keeping secondary system as on-flow train (not split) is preferred
Operation ease	Split flow is not favored Flexibility is preferred Long distances between treatment units in the same processes are not favored

Table 7-1
Evaluation Criteria for Site Plans
Columbia Boulevard Wastewater Treatment Plant

Criterion	Attribute
Operability and Maintainability (continued)	
Maintenance ease	When all units of a process are in same location, all liquid-process units are together, and all similar residuals processes are together, maintenance is more efficient and effective A newer facility is preferred because of its much reduced maintenance requirements
Automation ease	Newer equipment is easier to automate and therefore is preferred Automating older treatment facilities is difficult and never totally satisfactory
Safety	New facilities are built more safely because safety regulations and practices have evolved
Security	If all plant processes were on one side of North Portland Road, the rating would be superior No alternative fits this layout, so no alternative is superior However, alternatives with only residuals facilities west of North Portland Road are marginally preferred to those with liquid-process units west of North Portland Road
Redundancy	Split-flow options are not favored because they do not allow optimization of in-service units within a treatment train For example, in a simple two units per process example, keeping both aeration basins together as an operating group and both secondary clarifiers together as a linked operating group gives flexibility because Aeration Basin A is out of service while Secondary Clarifier B is out of service, with only a 50% capacity loss The alternative to this example would have tight links between the different process units of a train and would result in loss of all capacity if Aeration Basin A failed when Secondary Clarifier B was out of service
Cost-effectiveness	When creating a need for access to liquid-process units west of North Portland Road, the cost goes up by a significant increment Cost for constructing primary clarifiers on the bank of the railroad tracks near the existing digesters is greater than cost for constructing such clarifiers elsewhere However, the cost difference in this scenario is much less significant than costs for access to liquid-process units west of North Portland Road
Operation and maintenance costs	New process units are more efficient and cost-effective than old ones Split flows require more personnel because of distances between like processes and difficulties in operating "two plants instead of one "
Energy efficiency	Newer designs are more energy efficient than older designs For instance, new, deep aeration basins are more efficient and new blowers are more energy efficient than old blowers

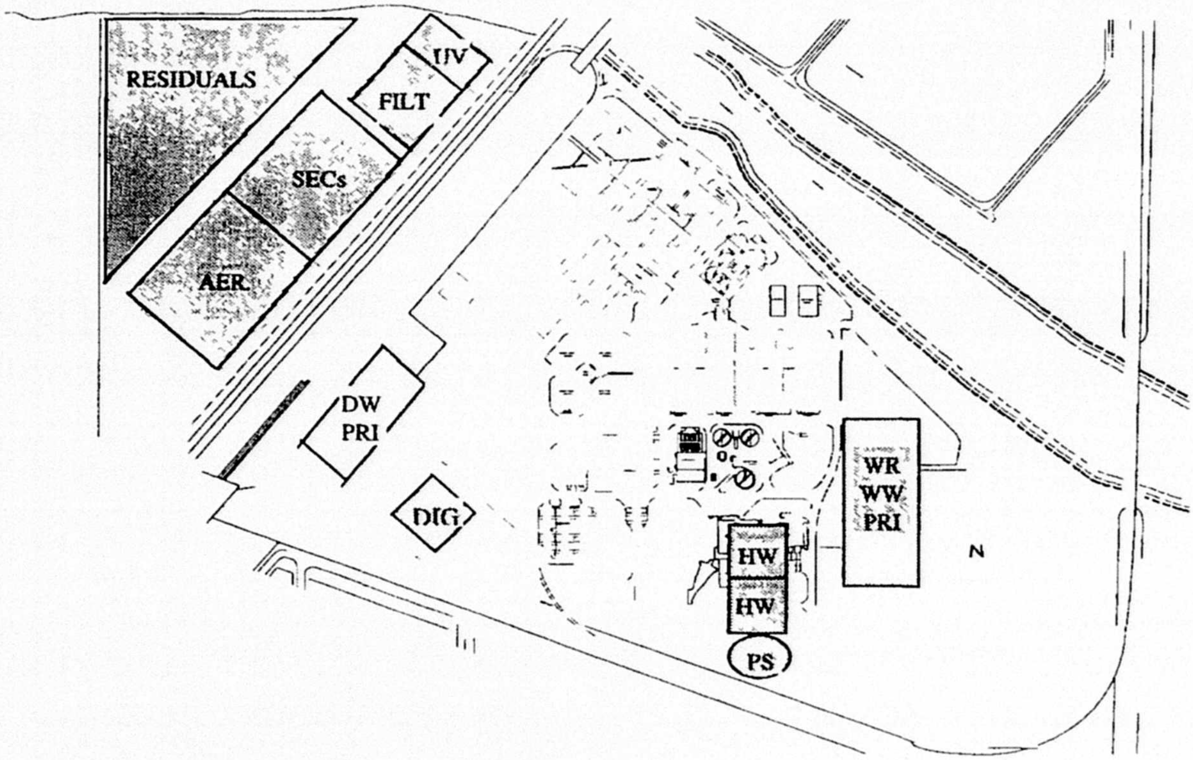
The major difference between the alternatives is that the secondary, tertiary, and disinfection facilities are located east of the existing facilities in Alternative 3 and west of the existing facilities in Alternative 5 Thus, the alternatives are renamed for simplicity east secondary expansion and west secondary expansion The locations for effluent pumping and the outfall alignments are also different, but the locations for influent pumping, pretreatment (headworks), primary treatment, anaerobic digestion, thickening and dewatering (modification of existing facility), and handling of solids are the same or similar

Both site plans include the facilities necessary to treat flows from the Willamette Basin combined sewer overflows If the facility is eventually sited elsewhere, these areas can be made available for increasing the environmental enhancements



Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the east of the headworks
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers, to the south of the dry-weather primary clarifiers
- Existing secondary system derated and supplemented by a new parallel secondary system built west of North Portland Road
- Filtration and ultraviolet treatment (if required) facilities west of North Portland Road
- Additional postdigestion residuals facilities west of North Portland Road



Principal distinguishing features include the following

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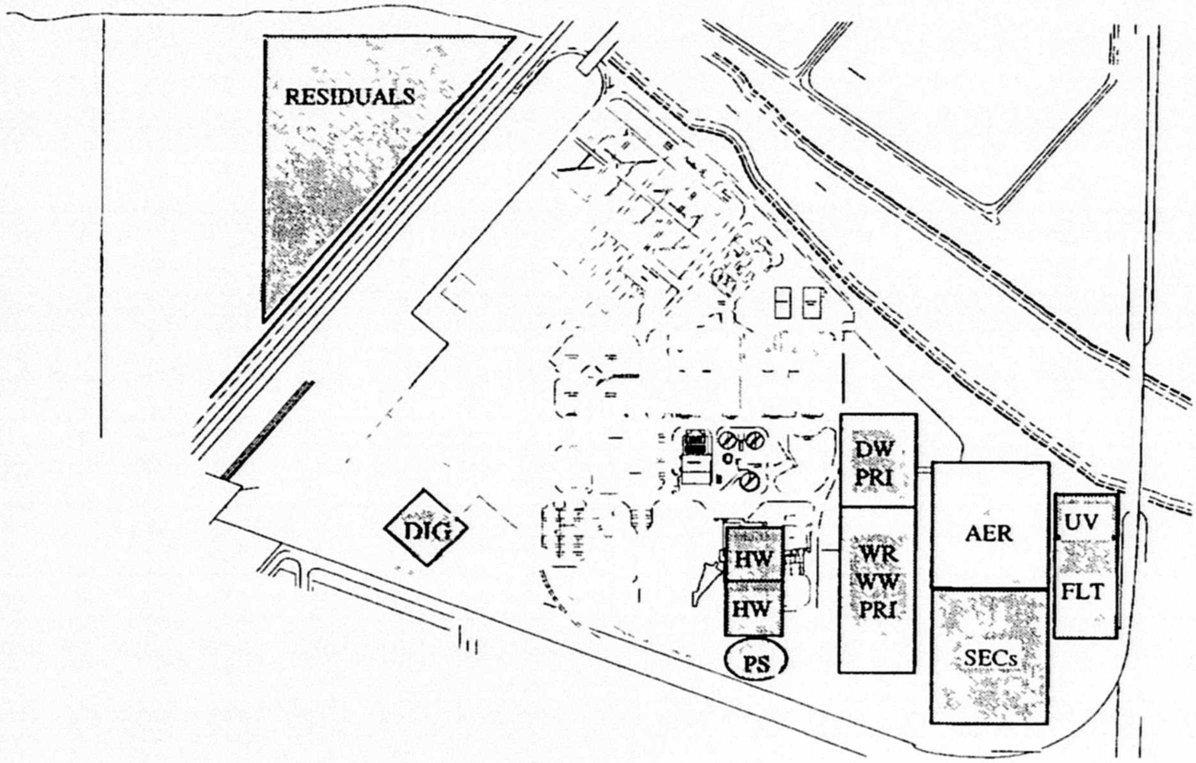
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the west of the digesters
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers, to the east of the headworks
- Existing secondary system derated and supplemented by a new parallel secondary system built west of North Portland Road
- Filtration and ultraviolet treatment (if required) facilities west of North Portland Road
- Additional postdigestion residuals facilities west of North Portland Road

CBWTP Facilities Plan	CH2M HILL BROWN AND CALDWELL and Associated Firms	Alternative 2, Site Plan Columbia Boulevard Wastewater Treatment Plant	FIGURE 7-2



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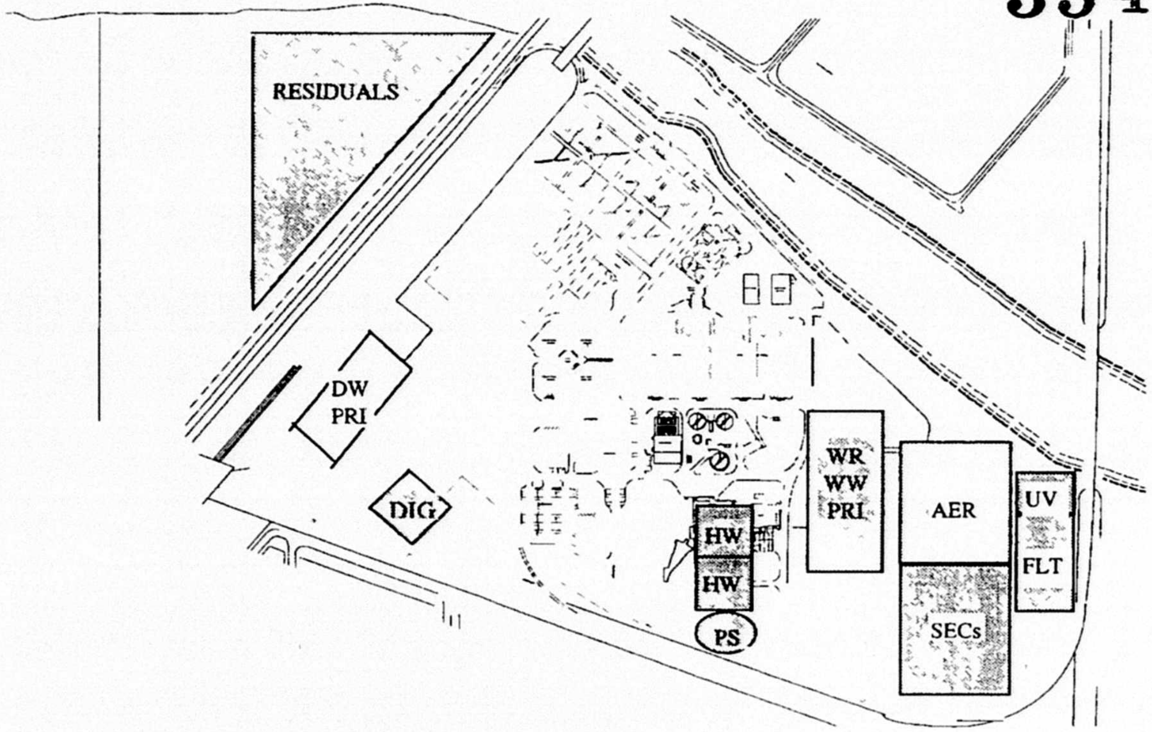
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers to the south of the dry-weather primary clarifiers
- Existing secondary system derated and supplemented by a new parallel secondary system built east of the primary treatment facilities
- Filtration and ultraviolet (if required) facilities east of new secondary facilities
- Additional postdigestion residuals facilities west of North Portland Road

Alternative 3, Site Plan
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
7-3



Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the west of the digesters
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers, to the east of the headworks
- Existing secondary system derated and supplemented by a new parallel secondary system built east of the primary treatment facilities
- Filtration and ultraviolet treatment (if required) facilities east of new secondary facilities
- Additional postdigestion residuals facilities west of North Portland Road

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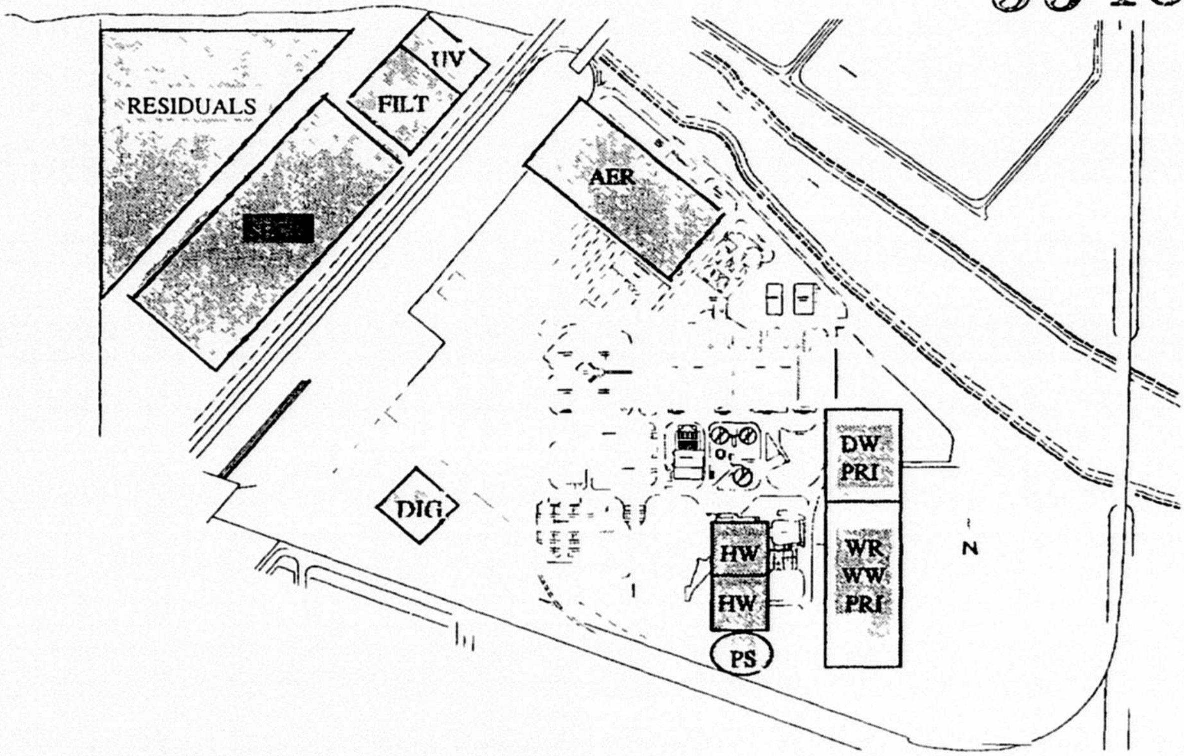

Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers to the east of the headworks
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers to the south of the dry-weather primary clarifiers
- Existing secondary clarifiers demolished, additional aeration basins constructed in their place, and all secondary clarifiers constructed west of North Portland Road
- Filtration and ultraviolet treatment (if required) facilities west of North Portland Road
- Additional postdigestion residuals facilities west of North Portland Road

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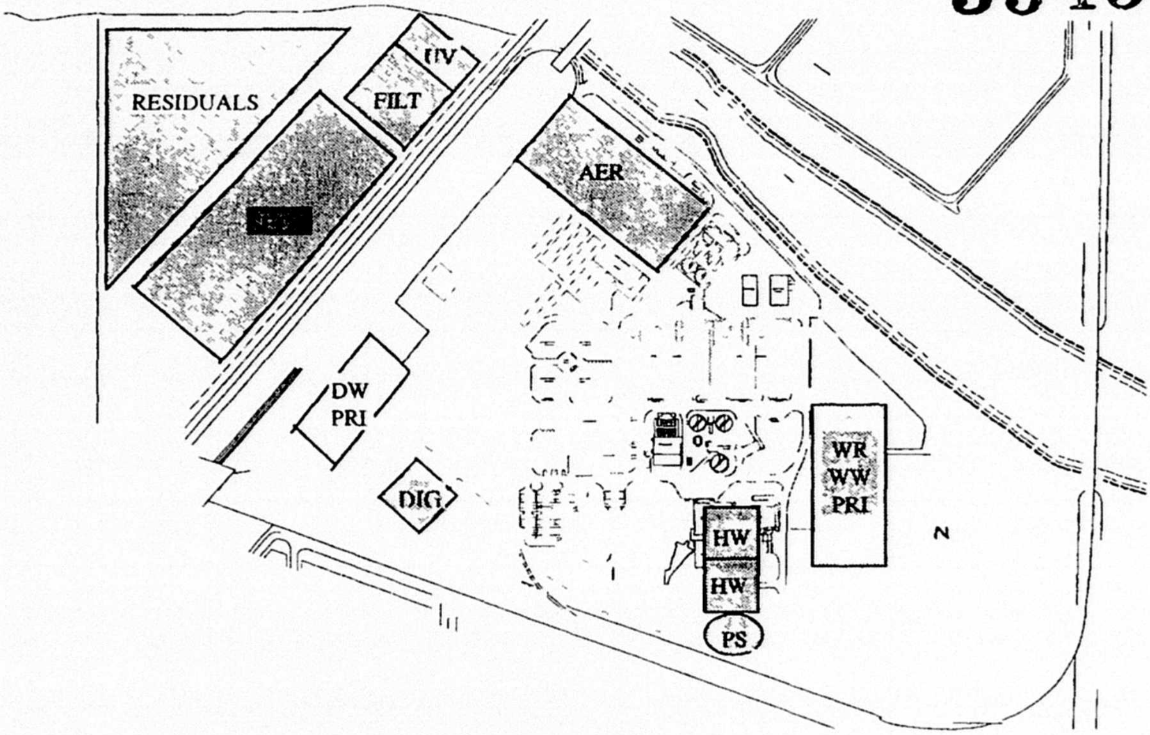

Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the west of the digesters
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers, to the east of the headworks
- Existing secondary clarifiers demolished, additional aeration basins constructed in their place, and all secondary clarifiers placed east of the wet-weather primaries
- Filtration and ultraviolet treatment (if required) facilities east of the secondary clarifiers
- Additional postdigestion residuals facilities west of North Portland Road

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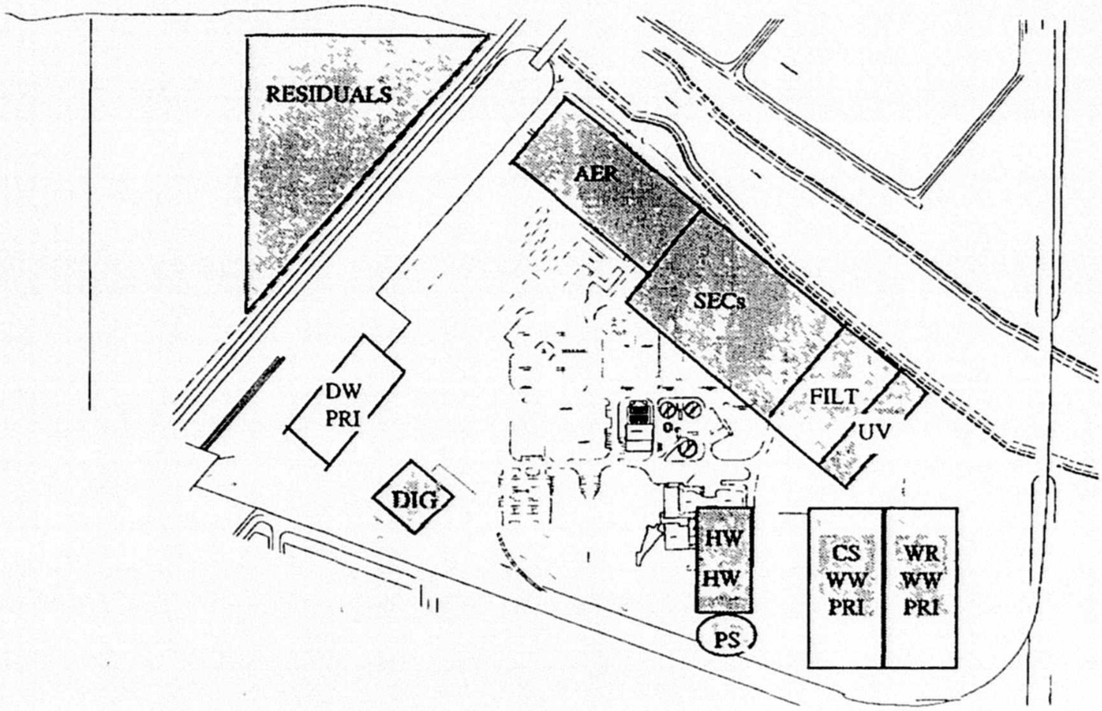
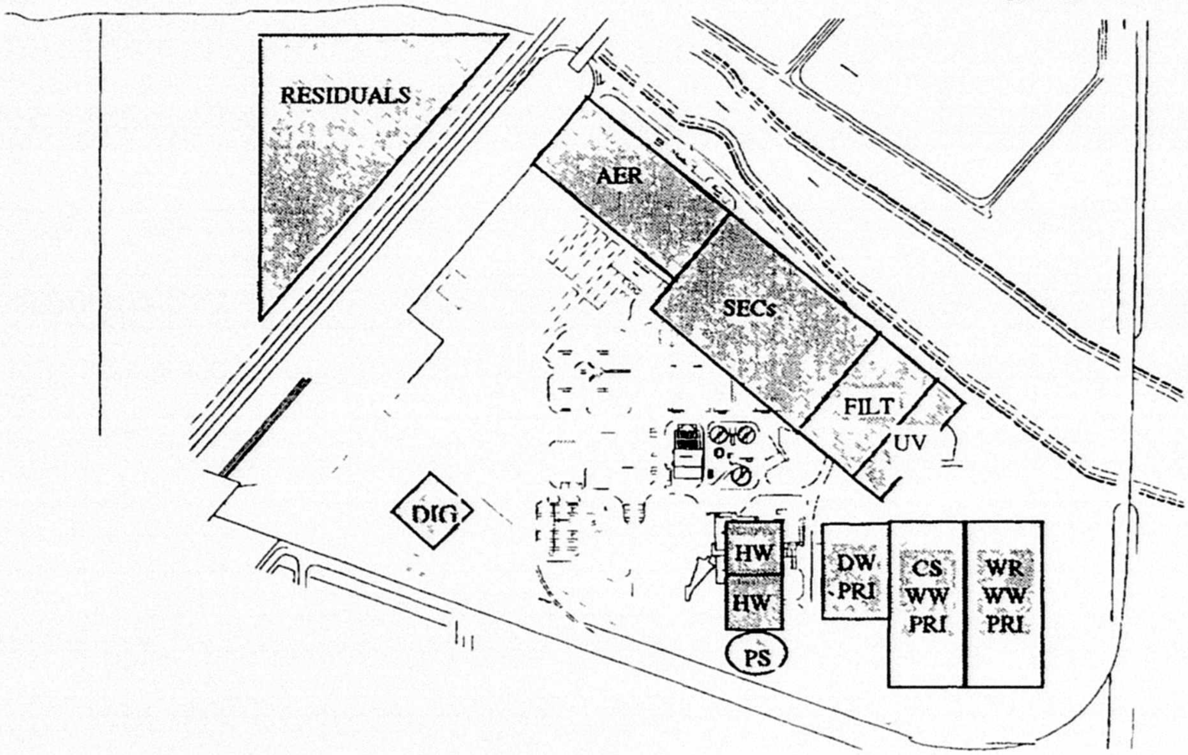


Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the west of the digesters
- All wet-weather flow treated through new covered and air-scrubbed primary clarifiers, to the east of the headworks
- Existing secondary clarifiers demolished and additional aeration basins constructed in their place
- Existing primary clarifiers demolished and new secondary clarifiers constructed in their place
- Filtration and ultraviolet treatment (if required) facilities east of the wet-weather primaries (far east end of site)
- Additional postdigestion residuals facilities west of North Portland Road



Principal distinguishing features include the following

- New headworks south of headworks currently under construction
- New wet-weather pump station (or stations) south of new headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to east of the headworks
- All wet-weather flow treated through new covered and air-scrubbed primary clarifiers, adjacent to the dry-weather primary clarifiers
- Existing secondary clarifiers demolished and additional aeration basins constructed in their place
- Existing primary clarifiers demolished and new secondary clarifiers constructed in their place
- Filtration and ultraviolet treatment (if required) facilities east of the wet-weather primaries (far east end of site)
- Additional postdigestion residuals facilities west of North Portland Road

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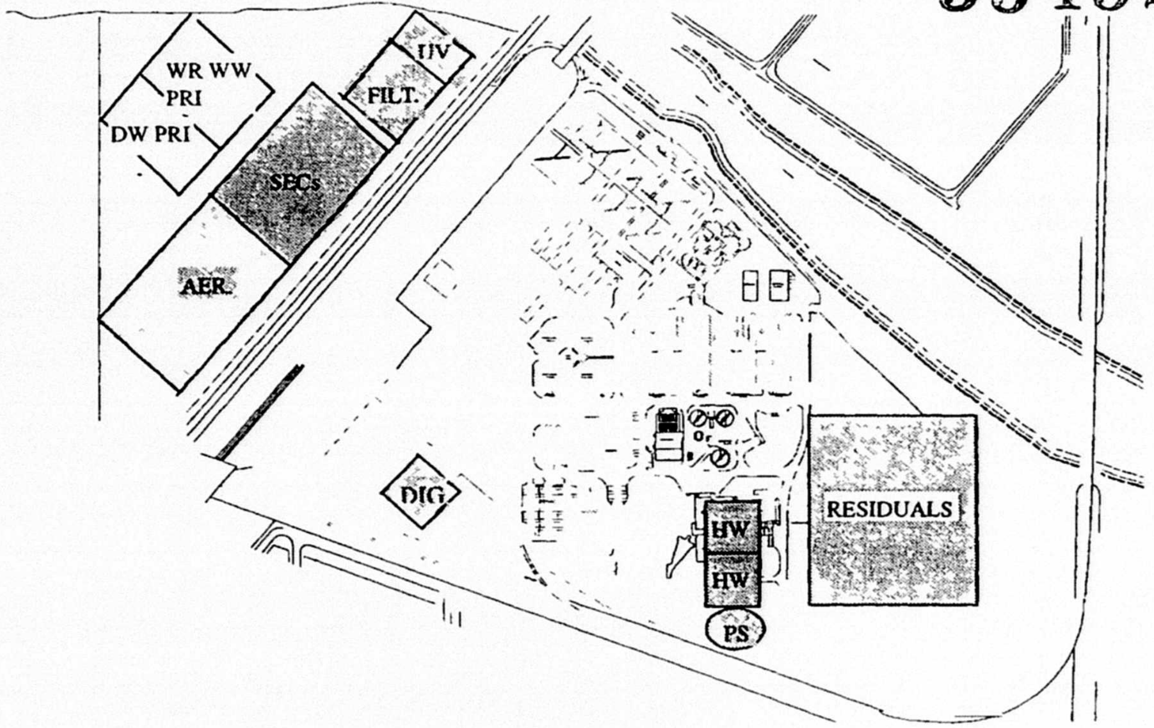
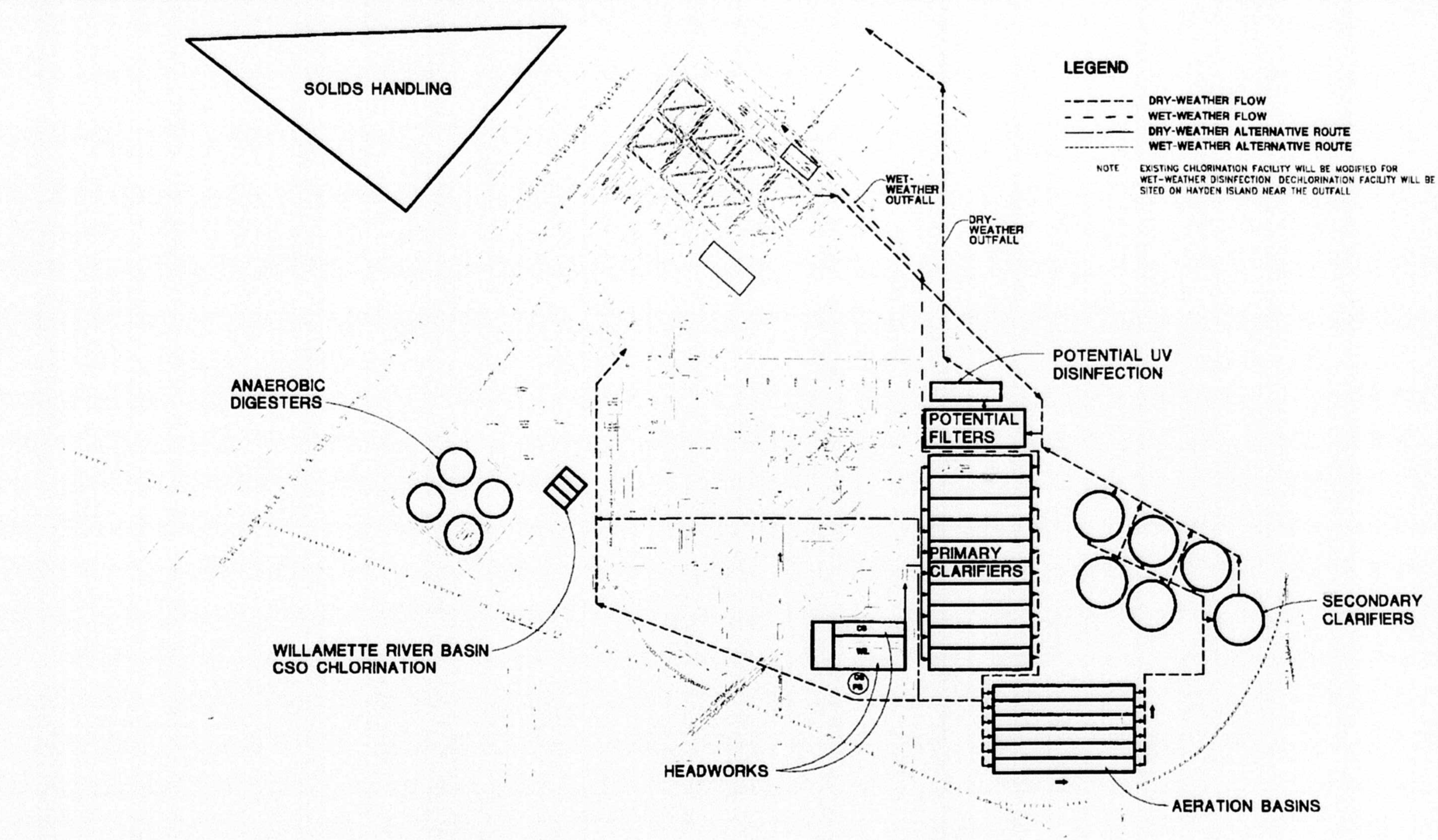


Principal distinguishing features include the following

- New headworks south of the headworks under construction
- New wet-weather pump station (or stations) south of the headworks
- Dry-weather flow treated through new covered and air-scrubbed primary clarifiers, to the west of North Portland Road
- Columbia Slough wet-weather flow treated through the existing primary clarifiers
- Willamette River wet-weather flow treated through new covered and air-scrubbed primary clarifiers, sited at same location as the dry-weather primary clarifiers
- Existing secondary system derated and supplemented by a new parallel secondary system built west of North Portland Road
- Filtration and ultraviolet treatment (if required) facilities west of North Portland Road
- Additional residuals facilities located east of North Portland Road



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...es Plan

East Secondary Expansion Alternative (Alternative 3) Columbia Boulevard Wastewater Treatment Plant

FIGURE 7-10

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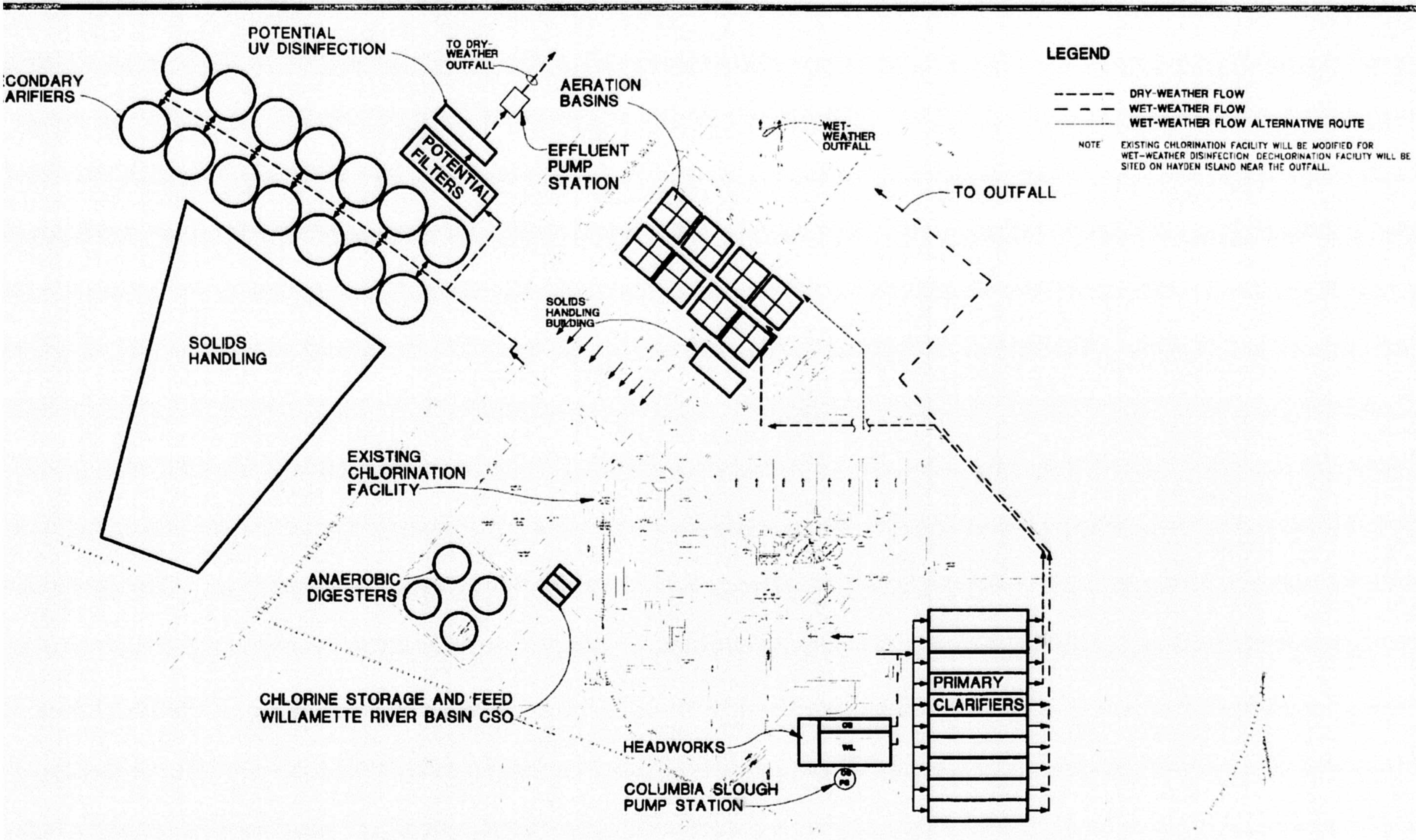

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s Plan

West Secondary Expansion Alternative
(Alternative 5)
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
7-11

DWG

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Chapter 8

Support Facilities

Chapter 8
Support Facilities

The following items regarding support facilities at the Columbia Boulevard Wastewater Treatment Plant (CBWTP) were evaluated for this facilities plan

- Centralized monitoring and control
- Laboratory facilities
- Treatment plant front entrance
- Treatment plant access and egress roads
- Traffic patterns
- Fueling station
- Access to tunnels for materials and equipment
- Access to identified plant site areas
- Opportunities to create green spaces onsite
- Community bike path access

The recommendations or plans that were developed to address these items are discussed below

Centralized Monitoring and Control

Purpose

As the City's wastewater collection and treatment systems expand in size and complexity, a centralized monitoring and control capability becomes increasingly important A conceptual plan for a centralized monitoring and control facility (CMCF) at the CBWTP was developed in 1992 (CH2M HILL, 1992) The need for a CMCF was reevaluated and affirmed for this facilities plan The CMCF will eventually provide a central location for monitoring and controlling the following facilities

- CBWTP
- Tryon Creek Wastewater Treatment Plant (TCWTP)
- Collection system pump stations (85 or more)
- Combined sewer overflow (CSO) system
- Potential new treatment systems

The CMCF is needed to accomplish the following

- Increase efficiency and cost-effectiveness by consolidating monitoring and control functions currently performed at different locations Some existing area control centers will remain at the CBWTP and other locations, but the needed system will provide linkage and redundancy

- Replace antiquated and inefficient equipment, use current technology to provide automated system

- Provide additional capabilities needed to serve anticipated new treatment facilities (for example, the CSO system and Columbia Boulevard Wet-Weather Treatment Facility (CBWWTF), include expansion capacity sufficient for growth of the system until the year 2040

- Comply with existing and new regulatory requirements

Alternatives

Three CMCF alternatives were evaluated

- New building for the CMCF (Alternative 1)
- CMCF added above the existing administration building (Alternative 2)
- Remodeling of existing CMCF in blower building

These alternatives were evaluated in light of the essential functions needed, site plans for CBWTP, and costs The results are presented in Table 8-1

Selected Alternative

Alternative 2, CMCF added above the administration building, was selected because it satisfies the functional requirements of the program while maximizing existing capabilities, and significantly improves the appearance of the plant, in keeping with the overall site planning program—all at significantly less cost than Alternative 1 Although Alternative 3 was the least-cost option, it was not selected because it would be only a short-term solution

Laboratory Facilities

The space, equipment, and staffing needs for laboratory facilities at the CBWTP were evaluated for the planning period 1995 to 2040, with two major goals in mind (1) optimize facility space and staff utilization and (2) minimize overall system cost

Five laboratories currently operate within the CBWTP The basic functions and general locations are as follows

- **Industrial laboratory.** There is one industrial laboratory in the administration building It is used for testing samples from the CBWTP and offsite locations

- **Industrial laboratory.** There is another industrial laboratory in the satellite laboratory building It is also used for testing samples from the CBWTP and

Table 8-1
Comparison of Centralized Monitoring and Control Facility Alternatives
Columbia Boulevard Wastewater Treatment Plant

Alternative	Advantages	Disadvantages	Cost Without Furniture (1995 $)	Cost with Furniture (1995 $)
Alternative 1 New building for CMCF	Maximizes control and monitoring capability by replacing existing technology with new technology Allows side-by-side phase-in of new facility Increases systemwide flexibility by adding functions not now available Maximizes visual contact with the plant	Maintains existing departmental structure and does not improve interdepartmental communication	$3,079,197	$3,246,548
Alternative 2 CMCF added above administration building	Maximizes control and monitoring capability by replacing existing technology with new technology Allows side-by-side phase-in of new facility Maximizes reuse of existing available space for new functions Maximizes interdepartmental communication potential Consolidates visual impact of the site Provides limited visual contact with all plant functions from third (top) floor	Reduces overall flexibility by minimizing space available for future expansion Requires maintaining administrative operations during construction	$2,142,024	$2,285,696
Alternative 3 Remodeling of CMCF in blower building	Requires minimal new construction Maximizes reuse of existing monitoring and control equipment Provides interim solution until new facilities are built.	No visual access to site Maintains existing departmental structure and does not improve interdepartmental communication potential Further reduces flexibility for future expansion Eliminates functions considered part of the original program, provides only monitoring and control functions Allows decentralized control and monitoring	$870,540	$976,085

Abbreviation CMCF = centralized monitoring and control facility offsite locations The processing building is used for testing secondary sludge operations

- **Liquids process control laboratory.** The liquids laboratory, located in the blower building, is used for testing secondary liquid operations

- **Sludge process control laboratory.** The sludge laboratory, located in the sludge processing building, is used for testing secondary sludge operations

- **Compost process control laboratory.** The compost laboratory, located in the compost building, is used for testing compost plant operations

The existing sludge and compost laboratories will remain part of the CBWTP onsite laboratory function during the planning period

The existing industrial laboratories will be consolidated and removed from the site and relocated sometime in 1995 to offsite facilities now under construction Industrial sampling, collection, and preparation for transport will, however, still be needed at the CBWTP Specifically, onsite daily, weekly, and monthly samples will continue to be collected and prepared at the CBWTP and then transported to the new industrial laboratory location This sampling work will be done by both in-plant personnel and offsite industrial laboratory staff, who will routinely visit the CBWTP to conduct this work

A new addition to the liquid process laboratory is proposed to provide nutrient and other process-related testing This new addition will be part of the onsite laboratory function during the planning period

Onsite Laboratory Location Alternatives

Two alternative location configurations were developed and evaluated for accommodating the remaining onsite industrial laboratory needs and the additional liquid process control laboratory needs

Alternative 1

Under Alternative 1, the remaining onsite industrial laboratory sampling, collection, and preparation area and the liquids process control laboratory addition will remain in the administration building The existing satellite laboratory building will be reassigned to other uses or removed

The advantage of Alternative 1 is that it meets the space requirements for the onsite industrial laboratory and the process control laboratory It also provides for future laboratory space needs in the administration building The satellite laboratory building can be used for other purposes or removed

The disadvantage of Alternative 1 is that the administration building laboratory space, which could be used for other needs, must be reserved for future laboratory needs and thus will not be fully used for some time

Alternative 2

Under Alternative 2, the space requirements for the remaining onsite industrial laboratory sampling, collection, and preparation area and the liquid process control laboratory will be met by use of the existing satellite laboratory building The laboratory space in the administration building will be reassigned to other uses

The benefit of Alternative 2 is that it satisfies the space requirements for the remaining onsite industrial laboratory and the process control laboratory, including all future space requirements, in existing laboratory space in the existing satellite laboratory building Alternative 2 also allows other functions requiring space in the system to be immediately served without major cost increases

The disadvantage of Alternative 2 is that the existing laboratory space must be maintained as a separate entity requiring support services Similarly, separate administrative services, including clerical services, may have to be maintained for the laboratory function

Selected Alternative

Alternative 2 was selected With Alternative 2, the existing satellite laboratory building will satisfy the space requirements for the remaining onsite industrial laboratory and the liquid process control laboratory addition The existing laboratory space in the administration building will be reassigned to other uses There is an immediate need for funding to support full implementation Funding and implementation should be coordinated with relocation of the industrial laboratory offsite Periodic upgrades to the existing satellite laboratory building will also be required during the planning period to accommodate other capital cost, staff, or space requirements arising from process and other system changes

One benefit of removing all laboratory functions from the existing administration building is the opportunity to use the resulting space for other functions Environmental Services can relocate other functions, such as engineering and construction management, to the existing administration building to occupy the space vacated by the industrial laboratory

Laboratory Space Needs

The following spaces should be reserved for laboratories during the planning period

- **Remaining onsite industrial laboratory.** This laboratory will be located in the existing satellite laboratory building It requires a minimum of 10 to 12 linear feet of laboratory bench space, installation of an existing fume hood near the shipping and receiving area, and a separate room for the existing inductively coupled plasma unit for future sludge drying

- **Liquid process control laboratory addition.** This addition may occupy the rest of the existing satellite laboratory building We recommend that one fume hood from the administration building laboratories be moved to the satellite laboratory building for testing of nutrients

- **Sludge process control laboratory.** The existing space will be used, and no additional space is required

- **Compost process control laboratory.** The existing space will be used, and no additional space is required

Plant Front Entrance

The existing front entrance to the CBWTP was evaluated for visual impacts and public access to the treatment plant Three items were identified for improvement at the main plant entrance signage, landscaping, and arrangement of the entrance road

Signage

The signs for the plant's front entrance from North Columbia Boulevard need improvement The existing entrance sign lacks significant visual impact and does not adequately identify the main plant entrance It does not express the importance of the facility Along with other improvement recommendations, the aesthetic characteristics of this sign and its placement are part of the overall solution for improving the visual impact of the plant's front entrance

Because there is a shortened visual sight line as the plant is approached from the east along North Columbia Boulevard, a smaller sign, consistent with Oregon Department of Transportation highway standard signs, should announce the upcoming plant entrance

Signage should be an integral part of the overall design of the plant's front entrance The plant entry design should reflect the strength, importance, and permanence of the CBWTP The signs should be visible and legible for the entire sight line in both directions along North Columbia Boulevard Sign lighting should not intrude into the surrounding neighborhoods and should be in keeping with good-neighbor policies

Landscaping

The plant front entry from North Columbia Boulevard needs to blend better with existing plantings at the entrance Landscaping, including regrading, should be considered for this area

The property on both sides of the main plant entry, between North Columbia Boulevard and the existing railroad property (and the railroad property if possible), should be included in the overall landscaping program

Road Arrangement

The front entrance road appears somewhat informal because of the arrangement of the existing main entrance road, especially near the North Columbia Boulevard entrance

Three alternatives for improvement were considered

- **Alternative 1.** Eliminate the existing main entrance road in favor of another access roadway This alternative reduces the importance of the main entrance concept The idea behind this alternative is to make access to the plant as unobtrusive as possible

- **Alternative 2.** Keep the existing main entrance road as a two-way entrance roadway This alternative maintains the importance of the main entrance road concept It identifies the existing access, with other recommended improvements, as acceptable and compatible with the plant front entrance design

- **Alternative 3.** Upgrade the existing main entrance road as a boulevard and thus visually increase the importance of the main entrance road in the overall site improvement program

Alternative 3 is recommended because it visually increases the importance of the main entrance relative to the other planned and recommended plant entrances The primary purpose of the main entrance road is to provide public access to the site The plant entrance design should be inviting to the public

Traffic Patterns

All plant access currently occurs at the single entrance to the plant along North Columbia Boulevard, south of the plant CBWTP staff have tested the adequacy of the existing emergency plant access and egress road at the northwest corner of the site and found it to be inadequate for some types of emergency vehicles, such as hook-and-ladder fire trucks

A Union Pacific Railroad track runs the full width of the site between North Columbia Boulevard and the plant Periodically, the train blocks all access to the site When the headworks comes on-line, a new east service road will be added as a second plant access roadway This access will also be periodically blocked by railroad activity, at this access point, during a train blockage, a long-wheel-base vehicle must wait to enter the site on the North Columbia Boulevard right-of-way We recommend a new all-weather access near the west boundary of the site adjacent to North Portland Road, to be designated the main plant service entrance for plant personnel traffic and for truck and emergency traffic

Additional surface vehicular access will be needed west of the plant, from North Portland Road, to facilitate future expansion of the plant west of North Portland Road Subsurface access for a pipe and cart tunnel (or tunnels) also will be required west of the plant, below the

Burlington Northern Railroad right-of-way, to facilitate future expansion of the plant west of North Portland Road

Surface pipe, cart, and pedestrian access across the Columbia Slough will be required to improve public access to the forty-mile-loop bike trail and improve the plant personnel's access to Triangle Lake north of the slough

All areas of the CBWTP should be easily accessible Some access points need to be upgraded, and the proposed additions need new access points to provide both ease of access and enhanced emergency access

Public access should be separate from other plant traffic to better manage visitors who are unfamiliar with the operating hazards of the plant This recommendation includes separating all connecting roads within the plant from the main entrance road, as discussed in the Access to Specific Site Areas subsection, as well as from North Columbia Court This separation will simplify the main plant entrance and main entrance road

A new west service road to the plant should be built when the emergency access and egress road is built This construction will involve reconfiguring the southeast corner of the site for a new traffic pattern to accommodate the new roadway, and maximizing the use of and securing the area around the new roadway and bridge

An improved underpass will be needed below the Burlington Northern Railroad to provide access to the new proposed plant area west of North Portland Road

On the basis of an onsite evaluation of the traffic patterns, the following improvements are recommended for the planning period

- Construct a new main entrance as a separate public access point and reconstruct the main entrance along North Columbia Boulevard, include new acceleration and deceleration lanes to facilitate access and egress

- Construct a new west service road as part of the new emergency access road

- Construct a new entrance from North Portland Road to the proposed plant area west of North Portland Road for surface truck access

- Improve the existing underpass below the Burlington Northern Railroad at the north site boundary on the south bank of the Columbia Slough for light-vehicle access to the area west of North Portland Road

- Upgrade existing in-plant roadways to tie the east service road and the west service road together

Fueling Station

The fueling station is currently located near the eastern edge of the plant, immediately south of the primary tanks The fueling pumps are supplied by an 8,000-gallon diesel fuel tank, an 8,000-gallon unleaded gasoline tank, and a 5,000-gallon leaded gasoline tank A 1,000-gallon diesel fuel tank in the same area is reserved for the CBWTP emergency generator All four tanks are buried The Oregon Department of Environmental Quality requires updating or modification of the fueling station

This fueling station currently services all City vehicles Arrival of these vehicles onsite creates in-plant traffic The current monthly fuel use at the CBWTP is shown in Table 8-2

Table 8-2
Fuel Use
Columbia Boulevard Wastewater Treatment Plant

Fuel Type	Tank Capacity (gallons)	Monthly Use (gallons)	Time per Tank
Diesel fuel	8,000	1,700-2,000	4-4 5 months
Unleaded gasoline	8,000	1,500-1,600	5-5 3 months
Leaded gasoline	5,000	30-40	Indefinite

The City currently delivers all fuel in 6,000-gallon trucks This delivery method is expected to continue throughout the planning period

The fueling station creates three major risks for the plant

- It is an environmental hazard because of the buried tanks Unmonitored tank leakage is possible in the future
- The increased in-plant traffic is a safety risk for in-plant personnel
- The increased in-plant traffic increases the security risk to in-plant personnel because it makes quick identification of unauthorized plant visitors more difficult

Recommended Improvements to the Fueling Station

On the basis of an evaluation of the existing fueling station, the following are recommended

- Relocate the fueling station to the front (south) of the plant near North Columbia Boulevard Relocation will significantly reduce the need for nonplant traffic within the plant and will improve nonplant vehicle access to the fueling station

- Use an aboveground storage tank system in the fueling station with appropriate tank monitoring devices An aboveground tank and monitoring will significantly reduce the environmental hazard created by the buried tanks

- Design the new fueling station to accommodate all possible vehicles

- Discontinue use of leaded fuels

- Design the station with two tanks of equal size

- Keep the tanks small enough to ensure a fresh product every 3 to 4 months (plant is on a priority delivery list)

Recommended Tank Sizes

As long as the Portland area continues to meet the air quality standards of an attainment area as required by the Clean Air Act, the following configuration of fuel tanks is recommended

- **Diesel fuel.** Over the planning period, diesel fuel use at the CBWTP is likely to increase 15 percent This fuel use is based on an expected 35 percent increase in the total number of vehicles fueled, which should be offset by a 20 percent increase in fuel efficiency over the planning period The expected 3- to 4-month design fuel requirement is 6,000 to 9,000 gallons of diesel fuel Two 4,000-gallon abovegrade storage tanks should be installed to accommodate this requirement

- **Gasoline (unleaded).** Over the planning period, gasoline use at the CBWTP is likely to increase 20 percent overall This increase is based on a 50 percent increase in the total number of vehicles fueled and offset by an expected 40 percent increase in fuel efficiency over the planning period The expected 3- to 4-month design fuel requirement is 5,000 to 7,000 gallons of unleaded gasoline Two 3,000-gallon abovegrade storage tanks should be provided to accommodate this requirement

A 3- to 4-month storage capacity for both diesel fuel and gasoline is recommended for this installation This capacity was selected to provide maximum CBWTP fueling flexibility in two areas fuel price and fuel availability

The total capacity of the fuel tanks, 14,000 gallons, complies with the existing *Uniform Fire Code (UFC)*, which mandates a maximum allowable aggregate fuel storage of 18,000 gallons

Should the City of Portland not meet the minimum requirements of the Clean Air Act, these recommendations must be revised to include fleet modifications, with requirements to provide vehicles capable of burning alternative and cleaner burning fuels, these revisions would necessitate a revised fueling storage format as dictated by the Clean Air Act

Recommended Onsite Location for Fueling Station

Two potential fueling site locations were evaluated One is at the southeast corner of the plant on the east service road near North Columbia Boulevard The other is at the southwest corner of the plant on the west service road near North Columbia Boulevard The location in the southwest corner of the plant near the Burlington Northern Railroad right-of-way is recommended There are three reasons for preferring this southwestern location over the southeastern location

- It is more protected and less visible from North Columbia Boulevard
- It is closer to the most accessible plant entrance
- It is somewhat less valuable aesthetically because it is less important to future plant development

Tunnel Access

Current Conditions

The existing tunnels and pipe galleries are accessible from drop-hoist locations in the blower building and at each of the four primary sludge transfer buildings The blower building drop-hoist location consists of a large (10- by 10-foot) handrail-protected floor opening on the at-grade level of the building This opening services the lowest building level, which is also the pipe gallery level An adjacent secondary drop-hoist floor opening of similar size at the at-grade level services an intermediate floor in the blower building

Each primary transfer building (four total) has a drop-hoist shaft associated with the stair shaft to the primary tank pipe gallery at the south end of the primary clarifiers Each is accessible only from the tank side of the building

The pipe tunnels connecting the aeration basin pipe gallery and the primary tank pipe gallery are too narrow for passage of vehicular equipment

Alternative Solutions

On the basis of field review and evaluation of the existing tunnel accesses, two possible alternatives were evaluated (1) construction of a new ramp access to each pipe gallery and (2) construction of a new hydraulic lift elevator access to each pipe gallery

It is recommended that access to the primary sludge transfer building be upgraded to a truck-accessible format on the side of the building away from (south of) the primary clarifiers

Evaluation of the site identified the need for two separate accesses one for the primary tank pipe gallery and one for the aeration basin and blower building pipe gallery Two separate accesses are needed because the tunnels connecting these two pipe galleries cannot support vehicular traffic without major reworking of the piping Furthermore, ramping to improve access is not feasible given a lack of surface area Therefore, hydraulic elevators are recommended at two locations, as follows

- Replace the secondary drop-hoist shaft with a 20-ton hydraulic lift elevator Keep the existing drop-hoist intact Retain the existing transfer-hoist capacity to facilitate loading and unloading of the elevator

- Replace the existing drop-hoist shaft in the westernmost primary sludge transfer building with a 5-ton hydraulic lift elevator Upgrade the existing access to this elevator to a truck access on the south side of the existing building Provide a 5-ton-maximum-capacity hoist rail to support loading and unloading of the elevator Also upgrade the three remaining drop-hoist shafts to provide truck access on the south side of the existing buildings and the hoist rail capacity to support loading and unloading, with a lift capacity to match the existing hoist capacity

Access to Specific Site Areas

Easy access to all areas of the plant improves traffic flow and reduces the potential for accidents Several elements of the existing plant and some elements of the new plant configuration require access upgrades These were evaluated, and the following changes are recommended

- Eliminate fueling station roadway turnouts to simplify traffic flow

- Widen the roadway north of the maintenance building to support two-way truck traffic (22-foot minimum) When the main entrance road is isolated, this roadway becomes a primary means for cross-plant access

- Provide a separate 15-car visitor parking lot at the administration building

- Restrict public access to the administration building and eliminate public vehicular access to the treatment facilities from the main entrance road to reduce the number of nonplant personnel on the site Add acceleration and deceleration lanes at the North Columbia Boulevard entrance

- Provide a new two-way, truck-accessible roadway south of the blower building to support the new railroad underpass

- Provide a new two-way, truck-accessible roadway north of the primary tanks south of the compost facility

- Improve the roadway turning radius at the northwest corner of the site to allow truck traffic

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Chapter 9

Environmental Enhancements

Chapter 9
Environmental Enhancements

As the alternative treatment processes and interrelated site layouts for the Columbia Boulevard Wastewater Treatment Plant (CBWTP) were screened and developed for evaluation (see Chapter 6), the project staff identified five areas for potential environmental enhancement These were seen to be common for all of the alternatives They were derived from the objectives expressed in the CBWTP Vision Statement (Chapter 2) as approved by the Columbia Boulevard Citizens Advisory Committee (CAC) Working with project staff, the CAC directed development and refinement of the environmental enhancement concepts Figure 9-1 outlines the five environmental enhancement areas at the plant site

A Plant entrance
B Public link to the Columbia Slough
C Triangle Lake
D Columbia Slough screening to west expansion site
E North Portland Road screening to west expansion site

The project staff selected two of the various processes and site layouts considered (Alternatives 3 and 5) as the preferred alternatives for more detailed development and evaluation These layouts were named the "east secondary expansion" and the "west secondary expansion" because one alternative entailed more expansion on the east side of the plant and the other entailed more expansion on the west side of the plant site, respectively, as shown in Figures 9-2 and 9-3 These site layouts also incorporated the improvements for support facilities recommended in Chapter 8

Criteria for addressing the relevant area goals of the CBWTP vision statement were established in workshops with the project team and the CAC It was assumed for planning purposes that City of Portland combined sewer overflows (CSOs) for the Columbia Slough and Willamette River basins could be treated at the CBWTP If only Columbia Slough CSOs will be treated at the CBWTP, there will be fewer facilities in the southeast corner of the site and a larger buffer area can be incorporated

Plant Entrance: Landscape Area A

The function of the main plant entrance will be changed from general service to public access for meetings, picnics, tours, hikes, and administrative business At present, it is not visually obvious which of the roads into the plant is the main entrance The existing main entrance road will be upgraded for public access, with a public entrance into the treatment plant through the administration building

Safer traffic patterns in the area are a concern for the neighborhood and the plant personnel A new entrance at North Portsmouth Avenue will be created for service traffic entering and leaving the plant This entrance will be easier for drivers to negotiate because of the signal-equipped intersection at North Columbia Boulevard

Moreover, the new entrance will include an overpass that crosses the railroad tracks in front of the plant and thus will eliminate traffic congestion caused by trains traveling through the area It will also allow vehicles to enter and leave the site in an unrestricted manner and will provide unrestricted access for emergency vehicles The service road that is located east of the main entrance will be used secondarily, as needed

As a result of these modifications, the security arrangements for the treatment facilities will be greatly improved Access will be controlled at the gates for the east and west service entrance Visitors will need to pass through the administration building to enter the grounds of the treatment complex This control will allow the facility to meet requirements outlined in the plant's emergency response program document

The appearance of the main plant entrance will be made more inviting and an asset to the neighborhood Figure 9-4 is an artist's rendering of the area concept The grounds will be landscaped to be a parklike area with lawns and a water garden The new landscaping will complement that of the new headworks Visitor parking will be provided near the administration building

Community access is an important element of the landscape concepts for Area A The bicycle and pedestrian path from North Portsmouth Avenue will enter the plant site in this area and continue on through the east end to connect with the 40-mile-loop trail on the north bank of the Columbia Slough To supplement this amenity, a new parking lot will be provided near the railroad tracks at the entrance

Public Link to Columbia Slough: Landscape Area B

The Area B landscape concepts provide public access to the Columbia Slough and thereby enhance the value of the plant site to the City and the neighborhood

The grounds will be landscaped with low-maintenance meadow grasses to create an environmental transition from the parklike surroundings of the plant entrance to the riparian vegetation of the Columbia Slough The banks of the slough will be improved with native materials and restored to natural vegetation In the slough, wildlife conservation rafts, which consist of logs tied together and anchored instream, will be constructed to promote plant growth and create refuges for waterfowl

In Area B, the bicycle and pedestrian path from the main plant entrance will continue on to a new bicycle or light-vehicle bridge that crosses the slough and connects with the 40-mile-loop trail in Area C An overlook of the primary treatment facilities will be provided for public education activities A canoe landing on the Columbia Slough will be a resting spot for recreational users of the slough Figure 9-5 illustrates the type of landscaping envisioned for this area

Triangle Lake: Landscape Area C

The primary goals of the Area C landscape concepts are to improve the quality of the natural Columbia Slough surroundings, reduce the visual impacts of the CBWTP facilities, provide interpretive displays about the CBWTP, and provide a natural corridor for the 40-mile-loop trail

The southeast portions of Triangle Lake will be restored to a native wetland marsh in phases, as the biosolids are removed and the lake is upgraded for storage of biosolids Walking paths and interpretive displays will be constructed

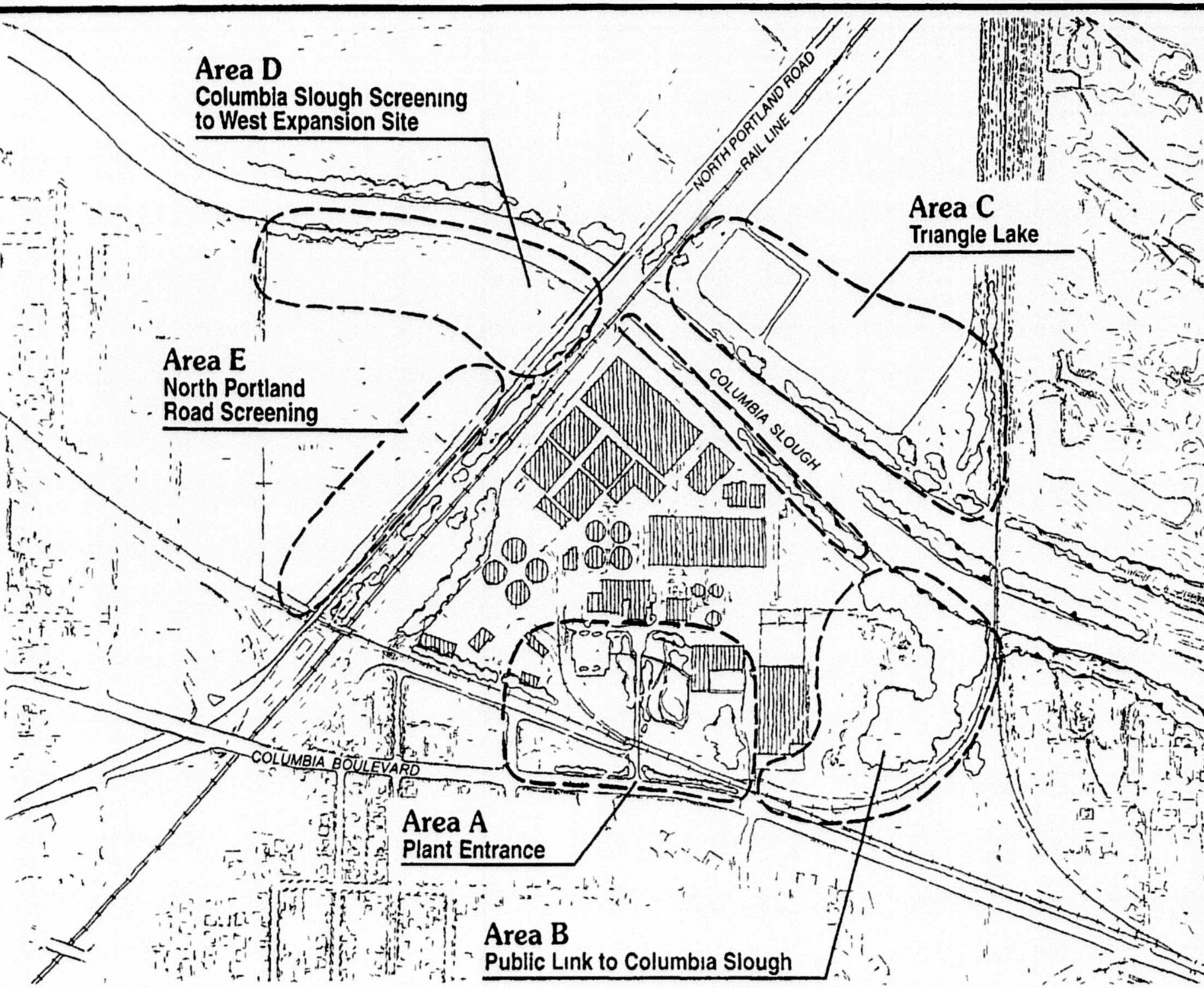
The banks of the Columbia Slough will be improved and restored to native riparian vegetation The bicycle path along the north shore will provide views of the slough and will have areas for resting or public education activities Native vegetation and berms will be used on the slough's south shore to screen the CBWTP from the trails on the north shore Figure 9-6 illustrates the mitigation concepts for this area

Columbia Slough Screening to West Expansion Site: Landscape Area D

The proposed Smith and Bybee Lakes Interpretive Center will be located on the north shore of the Columbia Slough opposite the west secondary expansion area The banks of the Columbia Slough in the west expansion area will be restored with natural materials The landscape concept for this area is for users of the Smith and Bybee Lakes Interpretive Center to see no industrial facilities while at the center Screening will consist of berms and natural plantings A 150-foot buffer between the slough and treatment facilities will be maintained Figure 9-7 shows the degree of screening desired

North Portland Road Screening: Landscape Area E

The west secondary expansion area of the CBWTP will be screened with berms and native plantings along the North Portland Road corridor The landscape concept for Area E is to provide a nonindustrial corridor between the residential neighborhood and the Smith and Bybee Lakes Interpretive Center and to link the neighborhoods to the wetland The area will be landscaped so that it can accommodate a bike trail in the future Figure 9-8 shows the concept for the corridor



CBWTP Facilities Plan

CH2M HILL
BROWN AND CALDWELL
and Associated Firms

Environmental Enhancement Areas
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
9-1

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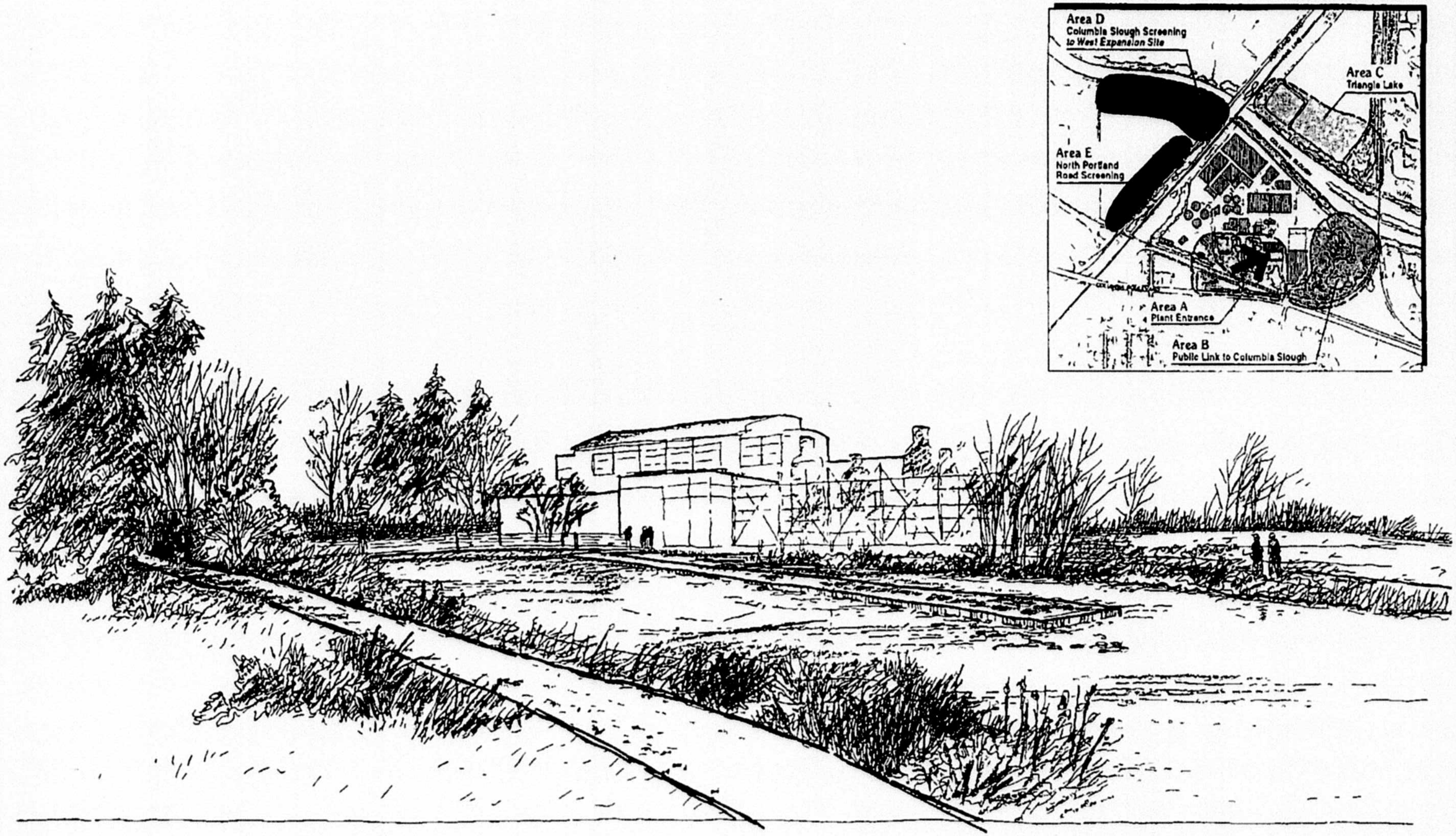
Area A



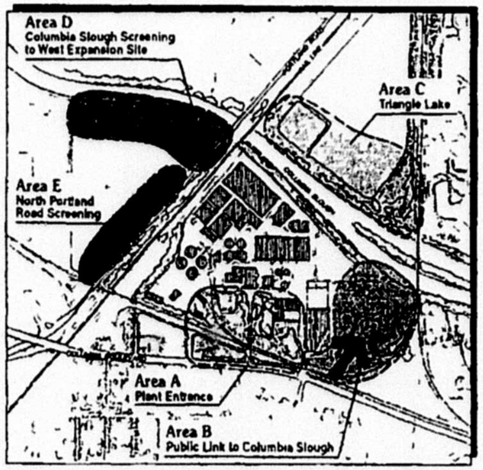
CBWTP Facilities Plan

CH2M HILL
BROWN AND CALDWELL
and Associated Firms

Plant Entrance
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
9-4

Area B



CBWTP Facilities Plan

CH2M HILL
BROWN AND CALDWELL
and Associated Firms

Public Link to Columbia Slough
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
9-5

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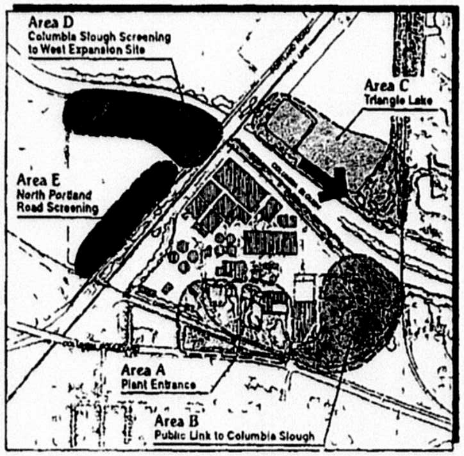

Area C

CBWTP Facilities Plan

CH2M HILL
BROWN AND CALDWELL
and Associated Firms

Triangle Lake
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
9-6

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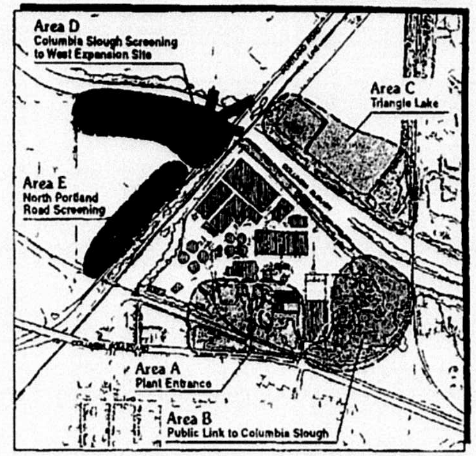
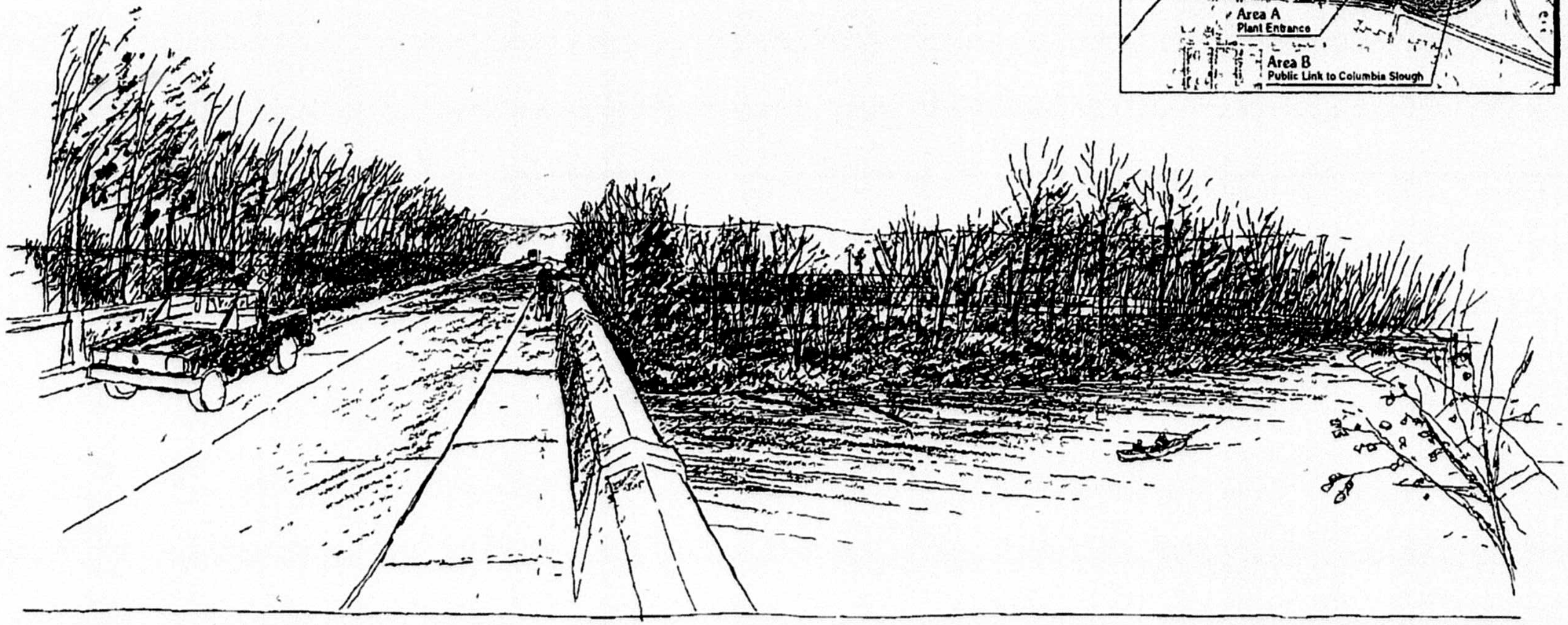
Area D

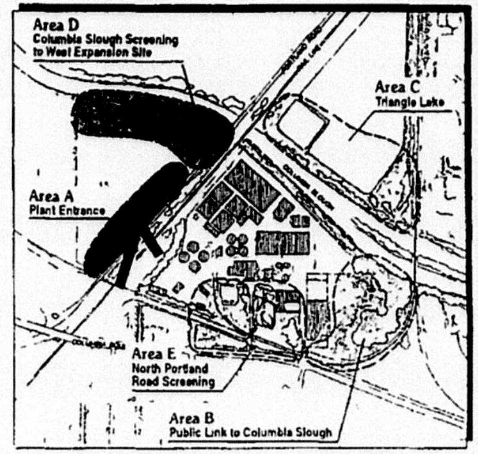


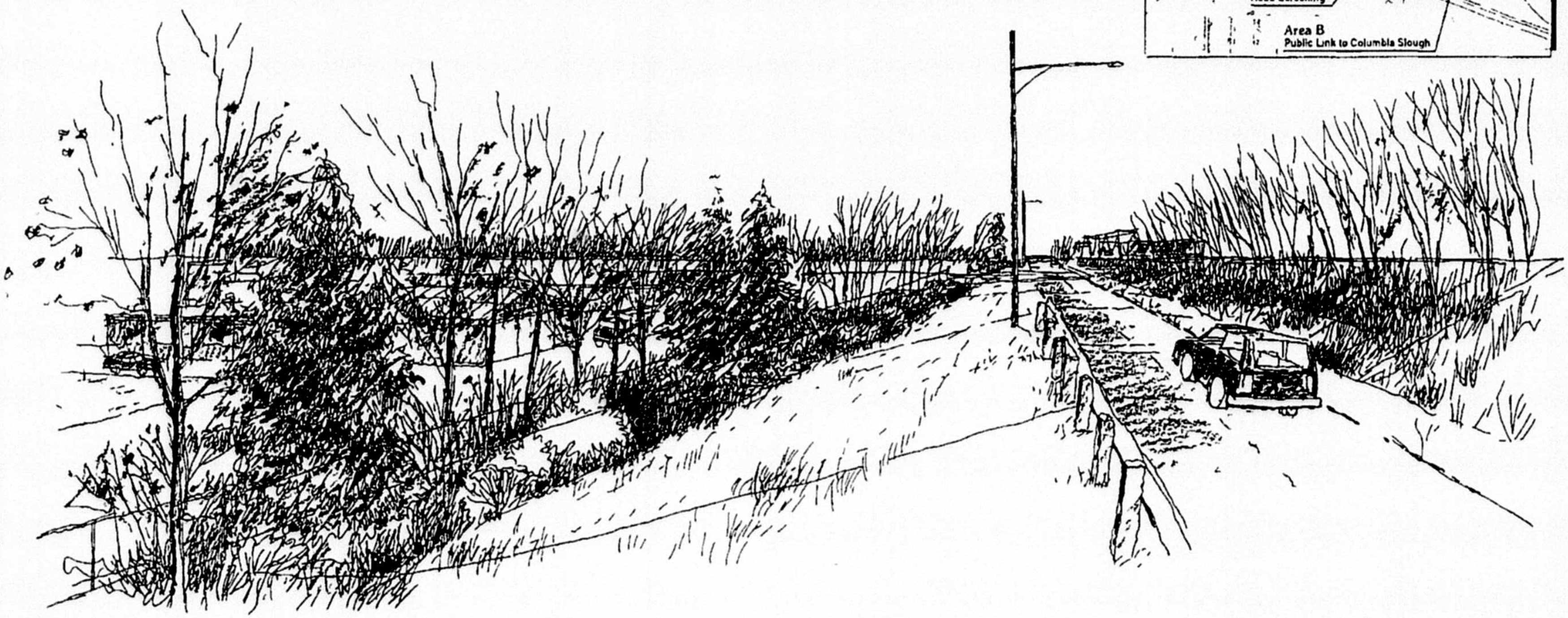


Columbia Slough Screening
Columbia Boulevard
Wastewater Treatment Plant

FIGURE
9-7

Area E





CBWTP Facilities Plan

CH2M HILL
BROWN AND CALDWELL
and Associated Firms

North Portland Road Screening
Columbia Boulevard
Wastewater Treatment Plant

FIGURE 9-8

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Chapter 10

Recommended Plan

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Chapter 10
Recommended Plan

Evaluation of the two final site plan alternatives, the east secondary expansion and the west secondary expansion, was based on the costs (capital, annual operation and maintenance, and present value) and on how easily the alternatives could be implemented and the facilities could be constructed and operated Moreover, the alternatives were evaluated in terms of the objectives of the Columbia Boulevard wastewater treatment plant (CBWTP) facilities plan vision statement (provided in Chapter 2)

The west secondary expansion alternative was preferred by the City of Portland Environmental Services engineering staff and plant staff, and by the Citizens Advisory Committee (CAC) It was favored because it would cost less and the plant would be easier to operate With the east secondary expansion alternative, the secondary clarifiers would have to be split into two groups, and this split arrangement would complicate operation and maintenance With the west secondary expansion alternative, all of the secondary clarifiers would be located together on the west side of North Portland Road

The west secondary expansion alternative affords the additional advantage of a broader corridor on the east side of the site for a public link to the Columbia Slough Otherwise, both alternatives are comparable and meet all of the criteria

The site plan for the recommended west secondary expansion alternative is shown in Figure 10-1 This illustrates the conceptual layout of all the new process facilities that will be constructed for the planning year 2040 and the potential facilities such as filters and ultraviolet disinfection equipment See Chapter 9 for information about the environmental enhancements that will complement the facilities and Chapter 11 for information about the implementation phases

Description of Liquid Treatment Facilities

The year 2040 liquid process flow diagram for the recommended west secondary expansion alternative is illustrated in Figure 10-2 The processes shown address projected sewage flow increases in the service area, new sewage flows from the Inverness area, and combined sewer overflows (CSOs) from the Columbia Slough Basin, but they do not address Willamette River Basin CSOs because it is currently uncertain whether they will be treated at the CBWTP site Willamette River Basin CSO treatment is addressed later in this chapter, under Description of Willamette River Wet-Weather Treatment Facilities

In the flow diagram, the liquid processes are organized into four groups headworks, primary treatment, secondary treatment, and disinfection The following process flow description is organized in the same way

Headworks

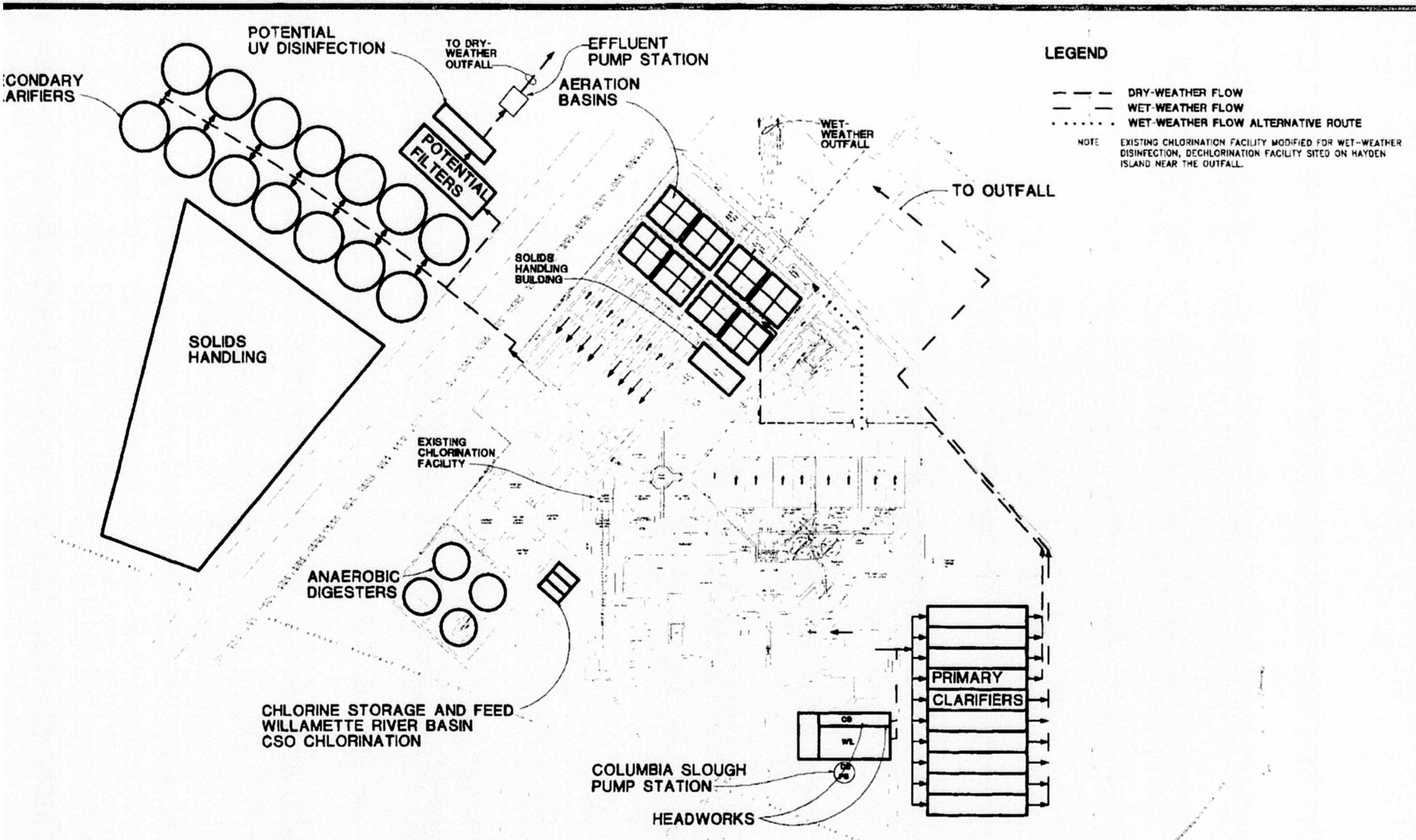
Flow will enter the treatment plant from three sources the existing interceptor, the Inverness force main, and the Columbia Slough consolidation conduit (CSCC) The Inverness force main flows will be combined with the interceptor flow upstream of the plant pump station wet well The flows from the CSCC will be pumped to either the CSCC headworks or to the interceptor upstream of the main plant pump station wet well

The flows entering the main plant pump station wet well are pumped up to the screening facility through six influent pumps The firm pumping capacity is currently 300 million gallons per day (mgd) The capacity of this wet well can be upgraded by an increase in pump speed to 319 mgd Influent flow is measured by a magmeter located on the discharge line of each pump Five mechanically cleaned bar screens with 5/8-inch spacing will screen the flow with six 24-foot-diameter vortex units used for grit removal All grit and screenings will be disposed of as nonrecyclable waste at a landfill Flows leaving the headworks building will be split to either the dry-weather primaries or the wet-weather primaries All flows up to 160 mgd will go to the dry-weather primaries, flows in excess of 160 mgd will go to the wet-weather treatment facility

It is assumed that the CSCC headworks will be constructed with a process configuration similar to that of the new plant headworks The flows will enter the plant through the CSCC between 30 and 60 feet below the ground surface These flows will be pumped to the CSCC headworks by three pumps with a firm capacity of 75 mgd The flow will be measured by a magmeter on the discharge side of each pump Three mechanically cleaned bar screens with 5/8-inch spacing will screen the flow with three 20-foot-diameter vortex units used for grit removal All grit and screenings will be conveyed to the new headworks grit and screenings handling facility Flows leaving the headworks structure will be combined with any flows leaving the new headworks at rates in excess of 160 mgd and will be directed to the wet-weather primaries

The CSCC pump station will also have the capability to pump flow to the main plant interceptor line This mode of operation will be used when flows to the plant are less than 160 mgd and when the CSCC is being cleaned after a storm The conduit may be cleaned with flushing water to push settled sludge and grit from the floor of the conduit toward the wet well so that they can be pumped to the treatment plant Because flushing will occur after the storm is over, the plant flows will be less than 160 mgd and will receive secondary treatment Therefore, these flows will be pumped to the plant interceptor upstream of the plant headworks

The new headworks, as well as the CSCC headworks, will have full containment of the air, and all air will be wet scrubbed for odor control Odor control will occur along the consolidation conduit, as well as at the treatment plant Wet scrubbing of the wet well with air flow rates adequate to treat air from the conduit will be part of the headworks odor control system



CH2M HILL
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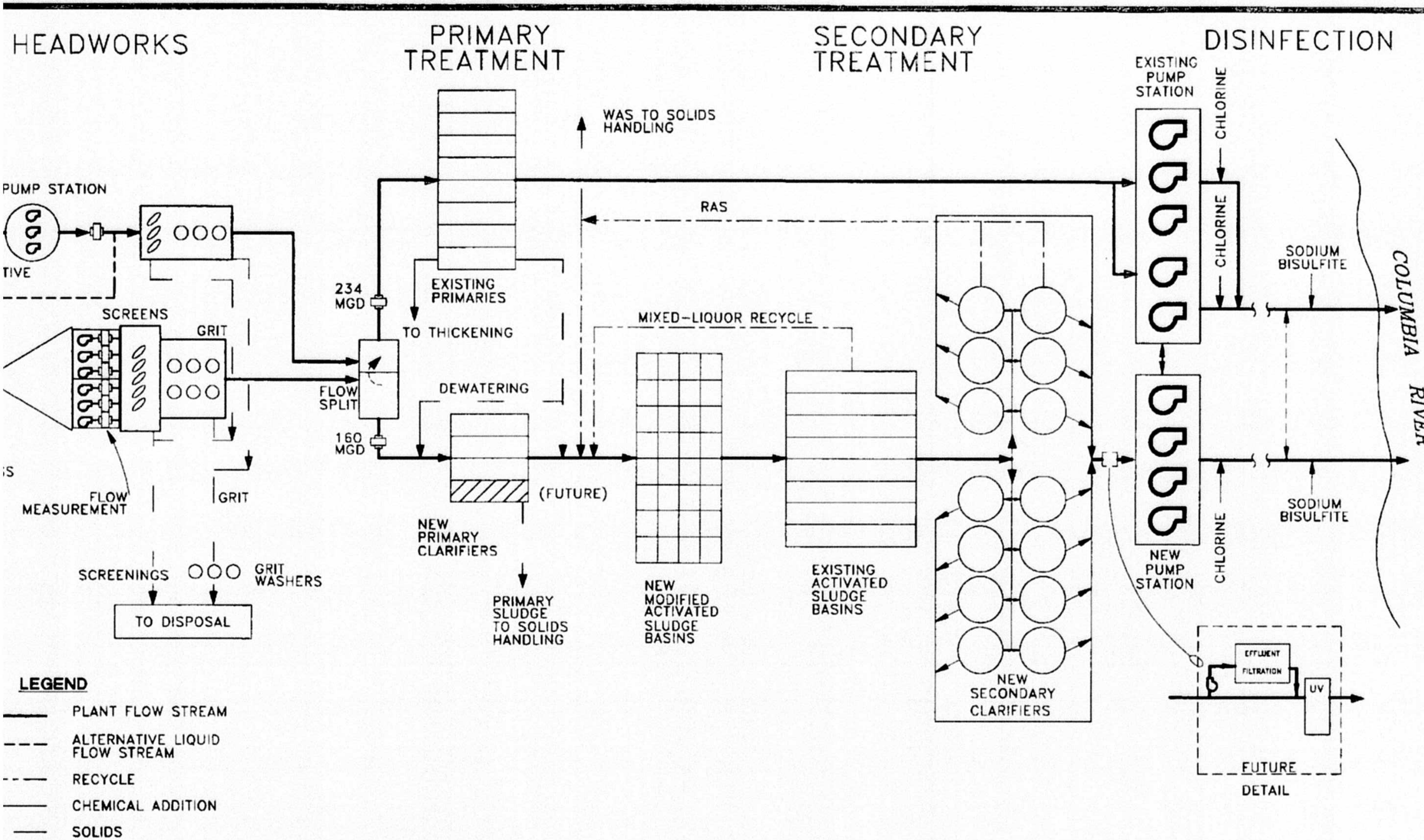
s Plan

Conceptual Layout
Recommended Plan
Columbia Boulevard Wastewater Treatment Plant

FIGURE
10-1

DWG



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...s Plan

Planning Year 2040
Liquid Process Flow Diagram
Recommended Plan
Columbia Boulevard Wastewater Treatment Plant

FIGURE
10-2

422G20Z DWG

Primary Treatment

The primary treatment process will consist of two treatment trains One train will include four new dry-weather primary clarifiers with the ability to treat flows up to 160 mgd These flows will then be directed to secondary treatment The other primary treatment train will be used to provide primary treatment of wet-weather flows The existing eight primary clarifiers will be used as the wet-weather primaries Wet-weather flows are those in excess of 160 mgd

Dry-Weather Primary Clarifiers

A new primary treatment facility will be constructed for treatment of dry-weather flows (those up to 160 mgd) This facility will consist of four rectangular primary clarifiers measuring 60 by 260 feet each The clarifier depth will be determined during the predesign phase to optimize performance efficiency Flow will be split evenly between the tanks by use of flumes or channels

Scum will be collected near the downstream end of each basin and will be removed by a helical scum skimmer to a trough A structure will be constructed over the scum skimmers for cleaning and maintenance of the system Flushing water will direct the scum down the trough to a decanting scum pit The underflow will be returned to the primary influent The scum will accumulate on the surface of the pit, where it will be pumped to the digesters on a routine basis

Sludge will be thickened in deep hoppers contained within each basin The sludge will be pumped directly to the digesters at a concentration of at least 5 percent solids

Concrete covers for the primary clarifiers will be designed to support light vehicle traffic and the odor treatment equipment Access hatches will be provided along the length of the covers for operation and maintenance activities Wet scrubbers will treat all air from within the primary treatment process and the scum handling building The scrubbers will be located on the primaries to minimize the footprint required by the facility Chemical receiving and storage for both the dry-weather and the wet-weather primary scrubbers will be located in an odor control chemical handling facility This facility will be adjacent to the primaries on the northwest corner

Wet-Weather Primary Clarifiers

The existing primary clarifiers will be used as the wet-weather treatment system Plant influent flows in excess of the secondary treatment peak design flow (160 mgd) will be diverted to these primaries for treatment as wet-weather flows The diversion of flows to these tanks will occur in the new headworks building outlet structure Flows will be directed under the existing screenings building and will be split between the primaries through the existing flume structure The existing screening equipment will be removed, and the channels will be covered Wet-weather flows leaving the existing primary clarifiers will go directly to the effluent pump station

Primary sludge will be pumped from each tank directly to the primary sludge thickeners The sludge will be thickened in the existing primary sludge thickeners to a concentration of 5 percent New sludge pumps will pump the thickened sludge from the thickeners to the digesters

The existing scum collection system will be taken out and replaced with a new system in the same location Scum will be collected at each basin and will be removed automatically by a helical scum skimmer to a trough Flushing water will direct the scum down the trough to a decanting scum pit The underflow will be returned to the primary influent The scum will accumulate on the surface of the pit, where it will be pumped to the digesters on a routine basis

Odor control covers will be provided on all eight of the existing primary clarifiers The method of covering will be determined during design of the system At that time, it will be determined whether covering just the weirs, instead of the complete tank, will be adequate For the cost estimate, it was assumed that the primary clarifiers would be covered Aluminum covers will be used for this system Access hatches will be provided along the length of the covers for operation and maintenance activities Wet scrubbers will be used to treat all captured air The scrubbers will be installed adjacent to the primaries Chemicals for the wet scrubbers will be received and stored at the dry-weather primary odor control chemical handling facility

Secondary Treatment

The secondary treatment system will ultimately treat flows up to 160 mgd It is expected that the existing permit of 30 milligrams per liter (mg/L) of 5-day biochemical oxygen demand (BOD_5) and 30 mg/L of total suspended solids (TSS) (30/30 permit) will later be modified to a 20/20 permit It is thought that complete nitrification and denitrification may be necessary in the future For these reasons, the secondary process plan includes the ability to provide biological nitrification and denitrification during the dry season with anoxic selectors

The existing secondary treatment process operates in a plug-flow mode with an anaerobic selector to improve settleability The capacity of the existing system is 100 mgd, with a daily peak of 130 mgd and a hydraulic peak of 160 mgd The limiting units of the existing system are the secondary clarifiers These units are shallow and square They are peripheral-feed, peripheral-effluent tanks with circular collection mechanisms As such, they are limited in their capacity, and short circuiting of solids occurs in the corners

The recommended alternative is to eventually replace the secondary clarifiers with new center-feed, deep, circular clarifiers The existing secondary clarifier tanks will then be used for activated sludge basins The strategy is to eventually reverse the flow through the secondary system by using the clarifiers' tankage as the influent end of the activated sludge basins Each of the existing clarifiers will be divided into quarters to provide the capability for anoxic selectors or aeration cells The existing effluent channel between the clarifiers will be used as the primary effluent feed channel The existing line between each secondary clarifier and its dedicated aeration basin will be used to direct flow from the new aeration basins (converted clarifiers) to the existing aeration basins in the direction opposite that in which the mixed liquor now flows The hydraulic head to this system will be raised with the construction of the new headworks and new dry-weather primary clarifiers

The existing process air system has the capacity to meet the air requirements for the expansion When these modifications occur, the aeration diffuser system will need to be evaluated and modified

The new secondary system will operate with anoxic selectors for biological nitrification and denitrification To maximize use of the existing volume, step feed with anoxic selectors is recommended In this mode, an anoxic zone will be located at each step-feed point Mixed-liquor recycle pumping is not required for step-feed anoxic operation Step-feed anoxic selectors have been in operation in Europe Currently, step-feed anoxic systems are being retrofitted at all the New York City plants Full-scale operational experience will be available by the time the new activated sludge system is implemented If the step-feed selector process is used, only 14 new secondary clarifiers will be required

If plug-flow selector technology is used, approximately 16 secondary clarifiers will be needed for solids settling In either case, the sludge volume index (SVI) is assumed to be less than or equal to 150 milliliters per gram (mL/g)

The new secondary clarifiers will be built west of North Portland Road The new clarifiers will be 140 feet in diameter and 18 to 20 feet deep The optimum return activated sludge (RAS) return rate will be 400 to 450 gallons per day per square foot (gpd/ft^2) The scum removal capacity of the clarifiers will be sized for anoxic selector operation Sludge removal will involve a suction manifold collector mechanism The periphery will include standard baffles or in-board launders to prevent short circuiting of solids

Disinfection

The process group designated as disinfection on the liquid process flow diagrams consists of effluent pumping, chlorination, dechlorination, and outfalls

Effluent Pumping

Flows leaving the secondary system will flow by gravity through a new 160-mgd outfall line or will be pumped by a new effluent pump station when gravity flow cannot occur The effluent pump station will consist of four pumps with a firm capacity of 160 mgd It can be located on the west side of North Portland Road with the new facilities or on the east side, just to the west of the new nonpotable water disinfection system The pump station location must be selected after the outfall route has been selected

Wet-weather flows will be directed to the existing effluent pump station from the wet-weather clarifiers These flows, up to 234 mgd, will be pumped from the plant through the existing outfall line

Chlorination

Plant effluent will be disinfected by chlorine provided by the existing chlorine handling system with minor expansion Additional chlorinators will be needed to provide the capacity and the feed capability to treat wet-weather flows Chlorine contact will occur in the outfalls

Dechlorination

The existing mixing zone is adequate for treatment effluent chlorine residuals up to 1 mg/L Dechlorination may be required for chlorine residuals that exceed this amount It is expected that it will be possible to keep the chlorine residual concentration below 1 mg/L during treatment of dry-weather flows, but not during treatment of wet-weather flows Therefore, dechlorination will be necessary to meet the water quality standards for chlorine Dechlorination of the wet-weather flows will be required whenever the wet-weather facility is in operation If necessary at a future date, dechlorination of the dry-weather flows will be provided

A dechlorination facility will be needed on Hayden Island near the outfall locations Dechlorination with sodium bisulfite is recommended in this plan to eliminate safety concerns related to gas

Outfalls

The existing outfall has a 240-mgd capacity and is equipped with a 350-foot multiport diffuser This diffuser has a 600-foot by 370-foot mixing zone downstream and a 600-foot by 100-foot mixing zone upstream A new outfall with a 160-mgd capacity will be required to handle the peak flow capacity of 394 mgd The new outfall must direct the flows to the river at a point where a new mixing zone can be established A new 160-mgd outfall and mixing zone downstream of the existing mixing zone have been recommended

An intertie between the outfalls will provide the capability to perform diffuser maintenance when flows are less than 160 mgd This intertie should be located on Hayden Island

Advanced Treatment Features

The liquid process flow stream was developed with the capability to provide advanced treatment alternatives These included nitrification, effluent filtration, ultraviolet disinfection, and effluent reuse These alternatives were incorporated in the planning to ensure that the plant could meet regulatory requirements that might arise in the future