Future Treatment Requirements

Redwood Sanitary Sewer Service District
Josephine County, Oregon

Parametrix, Inc.

INTRODUCTION TO CHAPTER 5

FUTURE TREATMENT REQUIREMENTS

Since the preparation of the *1994 Redwood Facilities Plan Report*, several water quality standards have been revised. In 1996, new temperature, bacteria, pH, and dissolved oxygen standards were affected.

For the Facilities Plan Update, these parameters would have been reevaluated in Section 5.3 had a treatment plant upgrade been the preferred alternative. Since the outcome of this document is to convey the wastewater to Grants Pass WRP and abandon the Redwood WWTP, it is immaterial to review the new water quality standards. Therefore, Chapter 5 has been extracted from the *1994 Facilities Plan Report* and has not been updated to include these revisions.

However, changes have been made to wastewater flow and load projections to update them from year 2012 to year 2020.

5. FUTURE TREATMENT REQUIREMENTS

5.1 WASTEWATER FLOW AND LOAD PROJECTIONS

Regardless of whether the District's future wastewater treatment occurs at the Redwood WWTP or the Grants Pass WRP, the District's projected waste stream flow and load had to be determined. To determine wastewater treatment capacity needs for the District, the existing Redwood WWTP flow, load, and population were analyzed. Based on this analysis, wastewater flow/load design criteria for year 2020 were developed for presentation in this section of the report. Water conservation measures are also evaluated in this section.

5.1.1 Flow Projections

Based on the population projections in Subsection 2.8, and existing flow data presented in Subsection 4.1, flows were projected for year 2020 (Table 5-1). Flow projections are based on existing wastewater flow plus a typical flow per capita assumed for all future connections. Although the existing wastewater flow per capita is relatively high, the per capita flow assumed for future connections is typical for newer construction. If new sewer pipes are properly installed and inspected, these pipes should not allow the amount of I&I flow the District's sewers currently experience.

Table 5-1
Wastewater Flow Projections, Year 2020

	1996/1998		2020	
	Actual (mgd)	1998 Actual (Gal/cap-day)	Design (mgd)	1998-2020 (Gal/cap-day)
Summer, Max. Month	0.54	120	1.01	100
Winter, Max. Month	1.16	240	1.77	130
Summer Max. Week	0.58	126	1.10	110
Winter Max. Week	1.20	254	1.90	150
Summer, Peak Day	0.76	157	1.42	140
Winter, Peak Day	1.48	364	2.77	275
Summer Average	0.49	99	0.89	85
Winter Average	0.63	129	1.22	125
Annual Average	0.56	114	1.05	105

Projected flows were developed based on the following assumptions:

- Future flows for maximum month during the summer dry weather were calculated using the current maximum month dry weather flow (MMDWF) of 0.59 mgd and adding 100 gallons/person/day for future population.

- Future flows for maximum month during the winter wet weather were calculated using the current MMWWF of 1.18 mgd and adding 130 gallons/person/day for future population.

Projected flows for summer and winter conditions are shown on Figure 5-1.

5.1.2 Impact of Water Conservation

In recent years, two factors have influenced Americans' water use habits. This has included, on one hand, drought-stricken communities restricting the use of potable water and/or escalating water rates in response to increased regulations to protect public health. The District can be impacted by both factors in the future.

To evaluate any potential impacts, it is necessary to review where potable water is used, the source of water into the sanitary system, and the Redwood WWTP design criteria. A large portion of the potable water is used for irrigation, and this water does not enter the wastewater system. Additionally, a significant part of the wastewater flow is inflow and infiltration and this is not impacted by water conservation.

The treatment plant design criteria are based on a number of conditions, both hydraulic and organic loads, which occur at different times of the year. Organic loading will not be impacted by water conservation. A reduction in wastewater flows does not significantly impact peak flows which are highly influenced by inflow and infiltration into the system.

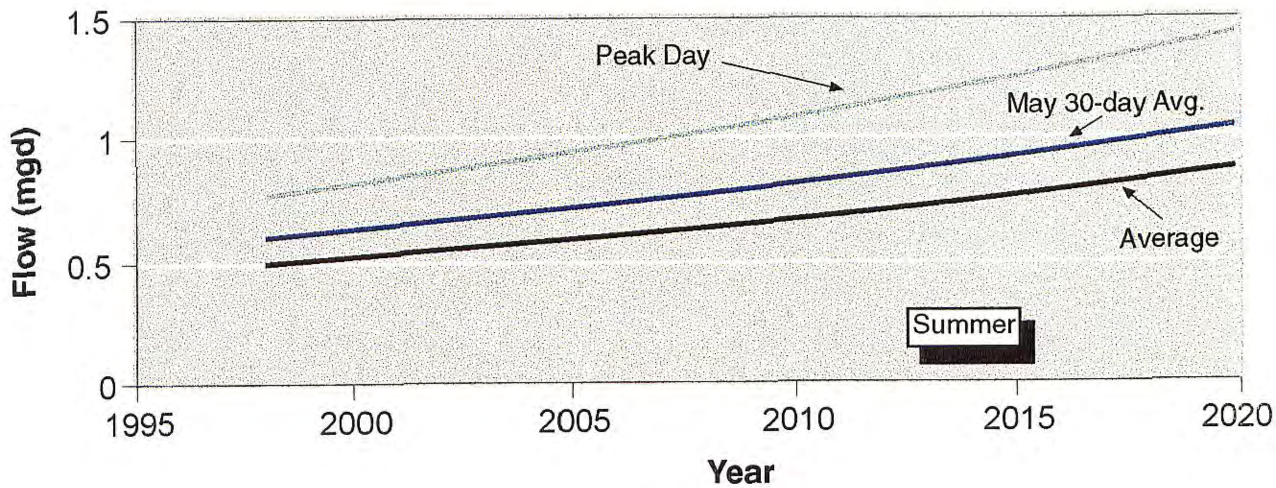
In the western United States, water conservation programs have been implemented in California and Seattle due to drought conditions. California conservation efforts (Table 5-2) had the following results:

Table 5-2
Water Conservation Efforts vs. Sewer Flow

Location	Reduction in Water Demand (%)	Reduction in Sewer Flows (%)
Marin County	20 to 60	15 to 40
Santa Barbara	37	34
Santa Clara	19	17

An equal wastewater flow reduction cannot be expected in the District because of inflow and infiltration. In these California communities inflow and infiltration was negligible; therefore, the conservation measures had a greater impact on wastewater flows. In the District, inflow and infiltration make a much larger contribution to total wastewater flow.

A more relevant example of water conservation's effect on wastewater flows can be seen in Seattle from 1991 to 1992. The Seattle Water Department, which imposed water restrictions for the first time in almost 40 years, witnessed a 17 percent reduction in total system water



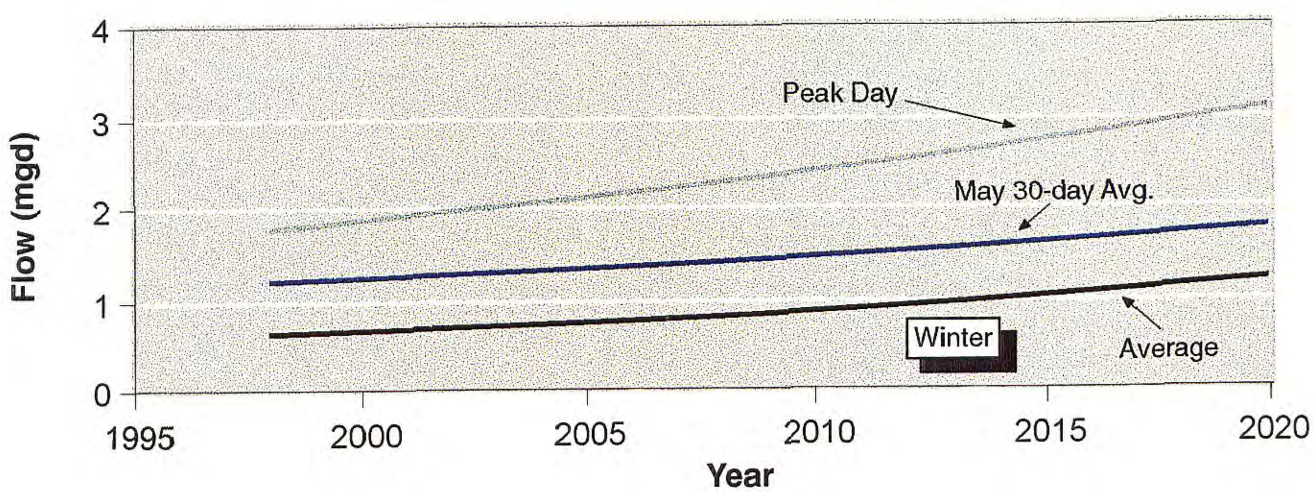


Figure 5-1
Wastewater Flow Projections

demand between 1991 and 1992. The summer demand in the three highest consumption months was reduced by a dramatic 33 percent. The sewage flow into Metro's West Point treatment plant, however, dropped only 5.8 percent during dry-weather flow. During winter months, water consumption dropped only 8 percent. This reduction in winter water usage did not appear to have a significant impact on the sewage treatment plant flow or operation.

Our review suggests that the District could anticipate a reduction in wastewater flows up to 10 percent annually if an aggressive water conservation program was instituted. To institute such a conservation program requires individual water meters, which the District lacks.

The District is currently served by either individually owned small community water systems or by individual wells serving single or multiple residences. Since none of these systems measure water usage, an aggressive water conservation program was not considered feasible.

5.1.3 Load Projections

Another important design parameter for wastewater facilities is wastewater pollutant concentrations or load. Wastewater load projections are based on existing wastewater load plus a typical load per capita assumed for all future connections. A summary of existing and future pollutant load estimates is shown in Table 5-3.

Table 5-3
Redwood WWTP BOD and TSS Load (lbs/day)

	1996-1998 Actual	2020 Projection
BOD		
Summer, Max. 30-day average(1)	1,122	2,400
Winter, Max. 30-day average(2)	1,589	3,100
Annual average(3)	843	2,070
TSS		
Summer, Max. 30-day average(4)	1,398	2,340
Winter, Max. 30-day average(5)	1,315	2,500
Annual Average(6)	879	1,980

(1) Existing BOD load plus 0.27 lbs/day-capita.
(2) Existing BOD load plus 0.32 lbs/day-capita.
(3) Existing BOD load plus 0.2 lbs/day-capita.
(4) Existing TSS load plus 0.20 lbs/day-capita.
(5) Existing TSS load plus 0.25 lbs/day-capita.
(6) Existing TSS load plus 0.20 lbs/day-capita.

5.2 REGULATORY TREATMENT CRITERIA

To evaluate upgrading the existing Redwood WWTP, future NPDES discharge limits needed to be determined. This report subsection presents future discharge requirements for the Redwood WWTP as set by Oregon Administrative Rules. *Because the design flows vary only slightly from those used in the 1994 report, the analysis in this section was not revised.*

The existing NPDES permit effluent limitations for the Redwood WWTP are shown in Section 4.3 of this report.

The treatment level for future wastewater flows and loadings has been evaluated based on three (3) requirements:

- Treatment Requirements contained in Oregon Administrative Rules (OAR) 340-41-375.
- Treatment Requirements contained in OAR 340-41-026.
- Treatment Requirements based on receiving water quality criteria for the Rogue River.

5.2.1 OAR 340-41-375

Future criteria for the treatment plant are subject to the regulations outlined in OAR 340-41-375. A summary of those requirements is listed here:

- Monthly average for BOD and TSS shall not exceed 10 mg/L during "low stream flows" (summer period).
- Treatment shall meet secondary requirements during "high stream flows" (winter period).
- Effluent BOD concentrations in mg/L divided by the dilution factor (ratio of receiving stream flow to effluent flow) is not to exceed one (1) unless otherwise authorized by ODEQ. *This will not apply, however, since the minimum river flow is 1,100 times the peak day discharge.*
- Sixty (60) minutes of contact time will be provided to ensure adequate disinfection with 1 mg/L residual.

Based on these regulations, the anticipated future BOD and TSS effluent limitations for the Redwood plant would be as shown in Table 5-4.

Table 5-4 Anticipated Future BOD and TSS Effluent Limitations Based on OAR 340-41-375							
	Flow (mgd)	Effluent Concentration (mg/L)			Mass Discharge (lbs/day)		
		Monthly	Weekly	Daily	Monthly	Weekly	Daily
Permit Limits Based On Effluent Quality							
Summer, MMDWF	1.05	10	15	—	88	132	176
Winter, MMWWF	1.80	30	45	—	450	675	900
Permit Limits Based On 85 Percent Removal							
Winter							
AWWF	1.30	(1) 24			260		
MMWWF	1.80	30			450		
Max. Week	1.85		44			675	
Max. Day	2.52			43			900
Summer							
ADWF	.94	10			(2) 78		
MMDWF	1.05	10			88		
Max. Week	1.12		14			132	
Max. Day	1.47			14			176

(1) Limit determined by 85 percent removal requirement and minimum influent load condition.
(2) Load limitation required by maximum concentration.

5.2.2 OAR 340-41-026

In addition to the regulations noted above, OAR 340-41-026 further requires that growth and development be accommodated by increased waste treatment efficiency and effectiveness rather than by increased permitted mass discharges. Based on these requirements, the anticipated future BOD and TSS effluent limitations for the Redwood WWTP would be as shown in Table 5-5.

Table 5-5 Anticipated Future BOD and TSS Effluent Limitations Based on OAR 340-41-026							
	Maximum Monthly Flow (mgd)	Effluent Concentration (mg/L)			Mass Discharge (lbs/day)		
		Monthly	Weekly	Daily	Monthly	Weekly	Daily
Permit Limits Based On Effluent Quality							
Summer, Dry Weather	1.05(1)	9	14	18	80	120	160
Winter, Wet Weather	1.80(2)	8	12	16	120	180	240

(1) Monthly dry weather flow with 5-year recurrence - MMDWF.
(2) Monthly wet weather flow with 5-year recurrence - MMWWF.

Since the proposed mass discharge limitations shown in Table 5-3 exceed those listed in Table 5-4, ODEQ approval for increased permitted mass discharges for the Redwood WWTP would be required for these effluent limitations to apply to any plant expansion. Otherwise, Table 5-4 effluent limitations would apply for any Redwood WWTP expansion.

Increases have been accepted by ODEQ, provided that:

(1) No other reasonable alternatives exist except to lower water quality.

(2) This action is necessary and justifiable for economic or social development benefits and outweighs the environmental costs of lowered water quality.

(3) All water quality standards will be met and beneficial uses protected.

The suggested increase in the summer period (Table 5-5) is only from 80 to 88 lbs/day, or a 10 percent increase. This should be acceptable to ODEQ provided the provisions for exceptions are met; these will be reviewed in Section 6. This mass increase is based on the maximum month dry weather flow. The mass discharge for the average summer flow would not likely increase above existing NPDES permit levels. Since the proposed increase is small and would only occur for a brief period, it is also not likely to impact water quality (see Section 5.3).

During the winter period, a significant increase is proposed, due to increases in wastewater flows, while maintaining only secondary treatment standards. Allowable mass discharges are controlled, however, by the 85 percent removal requirement, as demonstrated in Table 5-5. If minimum load is experienced at or near average flows, the mass discharge limitations for the plant would be restricted to only 260 lbs/day, just over double the current NPDES permit monthly limit.

5.3 RECEIVING WATER QUALITY CRITERIA

5.3.1 Introduction

The Redwood WWTP discharges secondary effluent to the Rogue River, which is a valuable resource to the region, with beneficial uses downstream of the sewage treatment plant (as listed in OAR 340-41-362):

- Public Domestic water supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Anadromous Fish Passage
- Salmonid Fish Rearing and Spawning
- Resident Fish and Aquatic Life Habitat

- Fishing, Boating, and Water Contact Recreation
- Aesthetic Quality
- Commercial Navigation and Transportation

Each of these beneficial uses depends, to varying degrees, on water quality. Local and state agencies and the public recognize the need to protect the Rogue River from further water quality degradation, both from increased point and non-point discharges. The ODEQ has indicated that *"An expansion of the treatment plant could prompt tighter effluent limits, increased monitoring, and possible restrictions on discharge to surface waters (Belsky, D., ODEQ, 1991 Personal Communication)."*

Receiving water quality standards are promulgated in *Management Plan, Beneficial Uses, Policies, Standards, and Treatment Criteria in the Rogue River Basin*, OAR 340-41-362 and OAR 340-41-365. This section evaluates the ability of the existing and future discharge to meet Oregon's receiving water quality standards, thereby assuring protection of beneficial uses.

5.3.2 Discharge Description

Figure 5-2 shows the Redwood WWTP outfall from effluent outlet structure to discharge location in the Rogue River at river mile 97.7. From the chlorine contact chamber to Manhole #3, the outfall consists of 300 feet of 18-inch concrete pipe. From Manhole #3 to the discharge point, the outfall consists of 62 feet of 18-inch corrugated metal pipe (CMP). The open-ended discharge is located approximately 25 feet from the south bank at ordinary low river flows. Water depth from water surface to outfall crown is approximately 1.5 feet at ordinary low river flows.

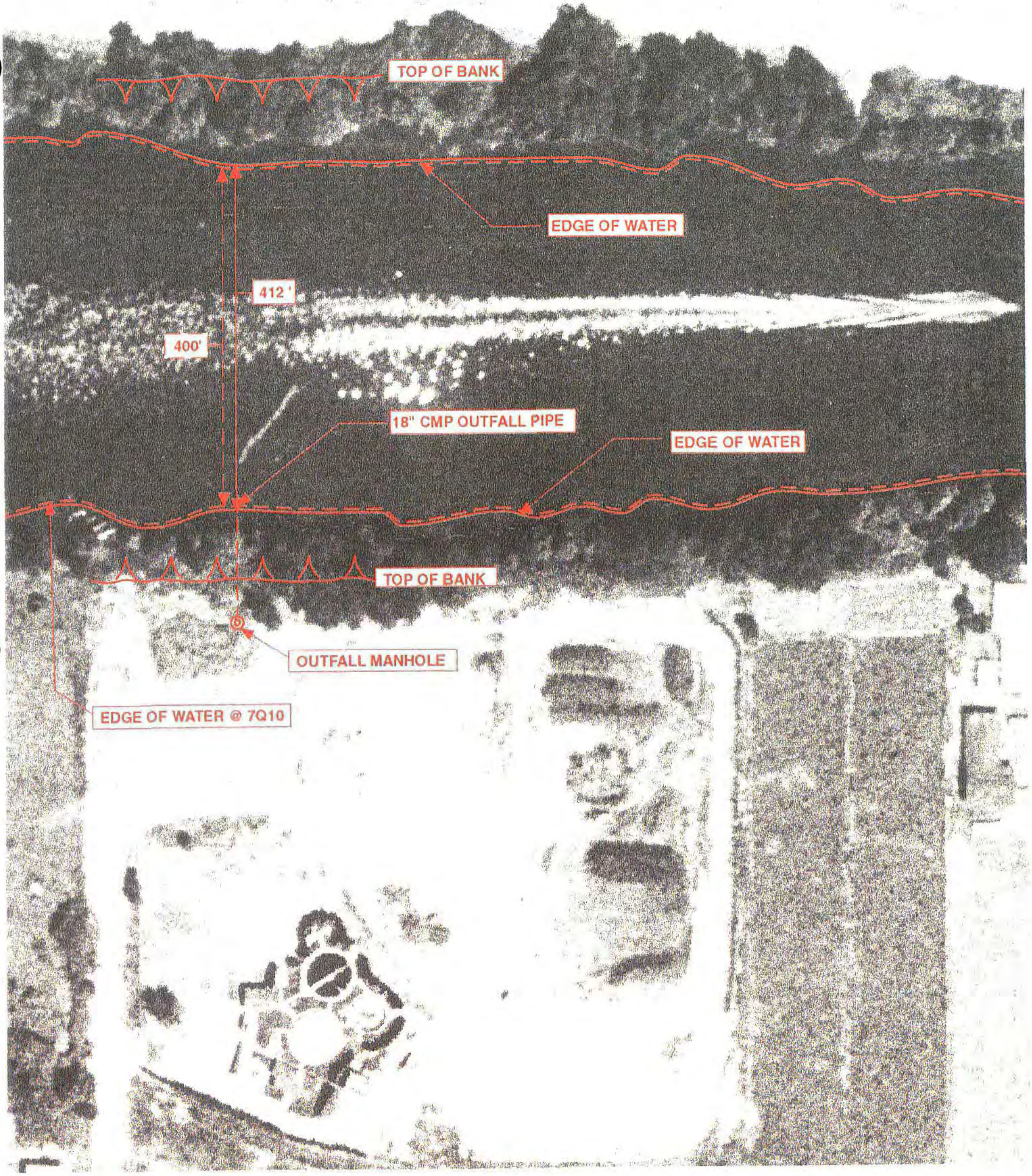
The invert of the 18-inch open-ended discharge pipe is six inches off the river bottom, facing offshore and downstream at a horizontal angle of 45 degrees. A riprap apron protects from scouring 10 feet downstream of the outfall. Appendix F shows the as-built outfall (CH2M Hill May 1974).

5.3.3 Receiving Water Conditions

Receiving water conditions, including river flows, channel characteristics, current speed, and ambient water quality, are discussed in the subsections that follow.

5.3.3.1 River Flow

The United States Geological Survey (USGS) operates a number of river flow gaging stations on the Rogue River, including a nearby station at Grants Pass, 0.6 miles upstream from the Highway 99 bridge at river mile 101.8. Since February 1977, Rogue River flow has been regulated by Lost Creek Dam with slight regulation by Fish Lake and Emigrant Lake. There are many water diversions from the Rogue River and its tributaries, the largest being 5.5 miles upstream for Savage Rapid Dam of the Grants Pass Irrigation District (USGS 1990).



Redwood Wastewater Treatment Plant
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Figure 5-2
Outfall and Vicinity
Redwood Sanitary Sewer Service District

River flow statistics (monthly, minimum, maximum, and mean flows) compiled by USGS from 1978 to 1987 are listed in Table 5-6. As Table 5-6 indicates, the season of lowest river flows is late summer to early autumn; during this low-flow period, ambient mixing is least, and receiving water quality most impaired. In this report, receiving water impacts will be evaluated at these critical low-flow conditions.

Table 5-6
Statistical Flow Summaries for Rogue River
After Regulation of Lost Creek Lake (1978-1987)

Month	Minimum (cfs)	Maximum (cfs)	Mean (cfs)	Standard Deviation (cfs)	Percent of Annual Runoff (%)
October	1,420	2,280	1,720	305	4.1
November	1,580	7,670	3,400	1,800	7.9
December	2,020	14,000	6,200	4,330	14.9
January	1,710	7,750	4,300	1,900	10.3
February	2,150	11,000	5,740	3,260	12.6
March	1,510	8,120	4,340	2,150	10.4
April	1,750	6,850	4,310	1,920	10.0
May	1,960	5,590	3,440	1,370	8.3
June	1,810	4,520	2,530	838	5.9
July	1,850	3,130	2,340	355	5.6
August	1,880	3,080	2,260	379	5.4
September	1,330	2,640	1,930	382	4.5
Annual	**1,930**	**5,270**	**3,530**	**1,160**	**100.0**

The regulatory low-flow for evaluation of water quality impacts is the 7Q10, or the 7-day low-flow that occurs, on average, once every 10 years (USEPA 1991). Data records are inadequate to compute this statistical measure for the Rogue River following flow regulation in 1977; however, the *Rogue River Management Plan* (1972) specifies that a minimum flow of 1,200 cfs be maintained.

5.3.3.2 Channel Characteristics and Current Speeds

Channel dimensions and water surface elevation near the outfall were measured by cross-section survey on November 30, 1993 (Gary Wicks 1993). The surveyed cross section is reproduced in Figure 5-3. River flow during the survey was approximately 1,360 cfs (Miller, J., USGS 1993).

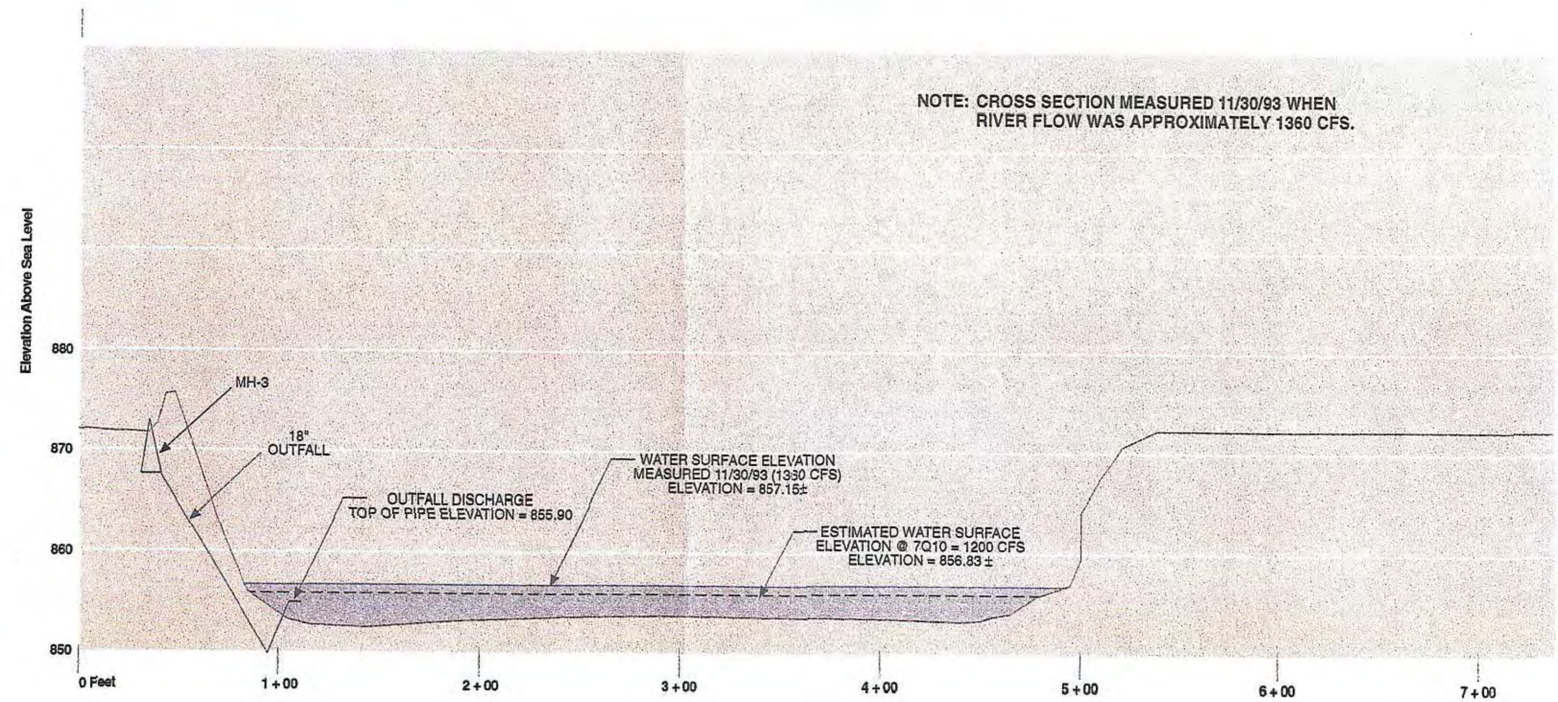


Figure 5-3
Rogue River Cross Section at Outfall
Scale: 1" Horiz = 50 ft
1" Vert = 10 ft

Manning's Equation was used to estimate average river depth and velocity at the regulatory low river flow of 1,200 cfs:

$$U = \frac{1.49}{n} R^{2/3} S^{1/2} \qquad \text{(Equation 5.1)}$$

where:

U = Average River Velocity
n = Manning's Roughness Coefficient
R = Hydraulic Radius (Area/Wetted Perimeter)
S = River Slope

R is approximately equal to the river depth, and Equation 5.1 can be rearranged to yield:

$$d = \left[\frac{Qn}{1.49\, W S^{1/2}} \right]^{3/5} \qquad \text{(Equation 5.2)}$$

where:

d = Average River Depth
Q = River Discharge
W = River Width

Table 5-7 summarizes channel characteristics and current speeds at field survey conditions and estimated at regulatory low-flow conditions.

Table 5-7
River and Channel Characteristics

Flow Condition	River Discharge	River Width	River Depth		Average Current Speed
			Average	At Outfall	
Nov. 30, 1993 Survey	1,380 cfs	412 ft	2.6 ft	2.8 ft	1.29 ft/s
Regulatory Low	1,200 cfs	400 ft	2.4 ft	2.6 ft	1.25 ft/s

5.3.3.3 Ambient Water Quality

The USGS maintains a database of Rogue River water quality measurements. Approximate monthly records for two stations were obtained and analyzed to determine statistical measures of water quality parameters (Marxer, L., November 1993, Personal Communication). Sample stations are located 2.5 miles west of Grants Pass, upstream of the Redwood outfall, and at the Robertson Bridge, approximately 11 miles downstream of the Redwood outfall.

A larger record is available at the Robertson Bridge station; however, the Robertson Bridge data must be interpreted with caution if used to represent conditions near the Redwood plant because the Applegate River contributes to the Rogue River flow upstream of the Robertson Bridge sampling station and downstream of the outfall. The annual mean flow of the Applegate River is 716 cfs (river mile 7.6), or 20 percent of the Rogue River mean flow. The influence of the Applegate River diminishes during the season of lowest river flows. Mean flow of the Applegate River is 26 cfs in August and 40 cfs in September, or less than 4 percent of the Rogue River flow during these months (USGS 1990). Table 5-8 summarizes water quality statistics for the Rogue River at both stations for the period of record since flow regulation (August 1977 - March 1993).

5.3.4 Water Quality Standards

In September 1991, ODEQ completed its most recent triennial review of State Water Quality Standards, as required by the Clean Water Act. The resulting amendments to OAR 340, Chapter 41, pertaining to receiving water quality, have profound effects on municipal and private dischargers. Amendments include changes in policies involving:

- Antidegradation
- Bacteria
- Mixing Zones
- Toxic Substances
- Biological Criteria
- Turbidity

ODEQ is implementing new policies to be used both to detect and address potential toxics problems. The steps of this policy framework will be executed through the NPDES permitting program and will include:

- *Basic Testing and Reporting Program* - Includes both chemical analysis and biomonitoring. Frequency will be determined through key factors such as dry weather design flow, industrial inputs to the treatment system, and quantity of sludge produced.

- *Evaluation of Receiving Water* - Analyses dilution at the point of discharge and at the mixing zone boundary to determine compliance with instream water quality standards.

- *Accelerated Testing Program* - Initiated basic monitoring program if results indicate that water quality standards violations could occur.

- *Effluent Limits* - Established when discharges cause an adverse effect on beneficial uses by violating water quality standards outside of an authorized mixing zone.

- *Implementation Plans and Schedules* - When needed to eliminate toxicity problems.

Table 5-8
Ambient Water Quality Statistics for Rogue River Near Redwood Wastewater Treatment Plant

		Number of Samples		Maximum		Minimum		Mean		5th Percentile		50th Percentile (Median)		95th Percentile	
Conventionals	Units	G.P.(1)	R.B.(2)	G.P.	R.B.	G.P.	R.B.	G.P.	R.B.	G.P.	R.B.	G.P.	R.B.	G.P.	R.B.
Temperature	°C	31	113	22.0	23.5	4.0	4.0	12.1	12.7	5.0	5.0	11.0	12.5	20.2	20.7
pH	SU	31	113	8.2	9.0	6.2	7.0	7.4	8.0	6.3	7.3	7.5	8.0	8.2	8.6
Dissolved Oxygen	mg/ℓ	31	109	13.9	14.6	9.9	9.3	11.7	11.5	10.2	9.9	11.7	11.5	13.3	13.4
Turbidity	HACH FTU	31	112	56.0	46.0	1.0	1.0	6.9	4.6	1.0	2.0	3.0	2.0	29.0	12.5
Total Hardness	mg/ℓ as $CaCO_3$	31	72	48	53	28	28	38	38	31	29	38	39	47	47
Total Ammonia	mg/ℓ as N	31	113	0.210	0.150	0.030	0.020	0.091	0.051	0.050	0.020	0.080	0.040	0.140	0.104
Fecal Coliforms	MPN/100 mℓ	31	106	4,600	2,400	30	<2	368	232	<30	23	91	<93	940	930
Metals(3)															
Arsenic	μg/ℓ	8	4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	μg/ℓ	8	4	<1	4	<1	<1	<1	<1.75	<1	<1	<1	<1	<1	4
Chromium	μg/ℓ	8	4	<50	<50	<2	<2	<20	<38	<2	<2	<2	<50	<50	<50
Copper	μg/ℓ	8	4	<50	<50	<2	<2	<21	<36	<2	<2	3	<50	<50	<50
Lead	μg/ℓ	8	4	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mercury	μg/ℓ	8	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	μg/ℓ	5	4	<10	<10	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10
Selenium	μg/ℓ	4	4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	μg/ℓ	8	4	40	39	3	<10	<14	<17	3	<10	11	10	40	39

(1) G.P. - 2.5 miles downstream of Grants Pass.

(2) R.B. - Robertson Bridge, 11 miles downstream of Redwood WWTP.

(3) Total metals, including dissolved and particulate fractions.

The Rogue River, downstream of the confluence with the Applegate River, is designated as a Wild and Scenic River under the *1968 Wild and Scenic Rivers Act* (Public Law 90-542). The Wild and Scenic Rivers Act stipulates that the Rogue River must remain in a free-flowing condition without water quality degradation.

The Bureau of Land Management (BLM) and the U.S. Forest Service administer the Rogue River Wild and Scenic Rivers Act. In 1972, they published a joint *Rogue River Management Plan* for the development, operation, and management of the Rogue River. The management plan outlines the responsibilities of all local, county, and state jurisdictions. The ODEQ is responsible for ensuring that water quality and waste treatment standards are met.

The ODEQ has responded to the need for water quality protection in the Rogue River by promulgating OAR 340-41-362 and OAR 340-41-365, outlining specific receiving water criteria to be met in the Rogue River Basin. These criteria are discussed here.

5.3.4.1 Anti-Degradation

Notwithstanding the water quality standards described below, the highest and best practicable treatment and/or control of wastes, activities, and flows shall in every case be provided to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

5.3.4.2 Dissolved Oxygen (DO)

DO concentrations shall not be less than 90 percent of saturation at the seasonal low flow or less than 95 percent of saturation in salmonid fish spawning areas during spawning, incubation, hatching, and fry stages.

5.3.4.3 Temperature

No measurable temperature increases shall be allowed outside the assigned mixing zone, as measured relative to a control point immediately upstream from a discharge when stream temperatures are 58°F or greater; or more than 0.5°F increase due to a single-source discharge when receiving water temperatures are 57.5°F or less; or more than 2°F increase due to all sources combined when stream temperatures are 56°F or less.

5.3.4.4 Turbidity

The measurement standard for turbidity is the Nephelometric Turbidity Unit (NTU) reflecting current analytical procedures. No more than a 10 percent cumulative increase in natural stream turbidities is allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. Some dredging and limited duration activities are exempt.

5.3.4.5 pH

The pH levels must not fall outside the 6.5 - 8.5 range.

5.3.4.6 Bacteria

Effluent limitations for fecal coliform will remain in effect until permit renewal, or until the ODEQ reopens existing permits to include an effluent limit and compliance schedule for enterococci [OAR 340-41-365(2)(e)(D)].

The Redwood WWTP is currently monitoring under the fecal coliform standard. The NPDES limitation is a monthly geometric mean of 200 fecal coliforms per 100 mL and weekly geometric mean of 400 fecal coliforms per 100 mL. The fecal coliform standard is an "end of pipe" limitation. The new enterococci bacteria standard in the Rogue River is a monthly average geometric mean of 33 per 100 mL, with no sample exceeding 61 per 100 mL.

5.3.4.7 Total Dissolved Solids

Total dissolved solids are not to exceed 500.0 mg/L.

5.3.4.8 Toxic Substances

Acute and chronic numeric criteria for a wide range of toxicants must be met within the zone of immediate dilution (ZID) and authorized mixing zone. Numeric criteria are listed in Table 20 of OAR 340-41, which is based on *Quality Criteria for Water* (EPA 1986). Where the natural quality parameters of waters of the Rogue River basin are outside the numerical limits of the above-assigned water quality standards, the natural water quality shall be the standard.

5.3.4.9 Ammonia

Recently, a standard has been added to the toxicant list in Table 20, OAR 340-41, to acknowledge the need for aquatic life protection from un-ionized ammonia. Allowable ammonia concentrations are dependent on receiving water temperature and pH, which are most critical during the summer low-flow period.

5.3.5 Mixing Zone Evaluation

This section outlines the approach and results of hydrodynamic model mixing predictions. Section 5.3.5.1 discusses the Redwood WWTP mixing zone.

5.3.5.1 Authorized Mixing Zone

The ODEQ has allowed a mixing zone for the Redwood discharge. A mixing zone is defined in OAR 340-41-365 as a "designated portion of a receiving water to serve as a zone of dilution for wastewaters and receiving waters to mix thoroughly." The department may suspend all or part of the water quality standards or set less restrictive standards in the authorized mixing zone.

Redwood WWTP's mixing zone is described in NPDES Permit #100868 as having a radius of 100 feet from the point of discharge.

In determining the size of the mixing zone, the department may use appropriate mixing zone guidelines to assess the biological, physical, and chemical character of the receiving waters and effluent and the most appropriate placement of the outfall to protect instream water quality, public health, and other beneficial uses. The mixing zone must also:

- Be as small as possible.
- Avoid overlap with any other mixing zones to the extent possible and be less than the total stream width as necessary to allow passage of fish and other aquatic organisms.
- Be free of materials in concentrations that cause acute and chronic toxicity to aquatic life as measured by an approved bioassay.

Acute and chronic toxicity is defined in OAR 340-41-365(4) as follows:

> *Acute Toxicity* - Acute toxicity is lethality to aquatic life as measured by a significant difference in lethal concentration between the control and 100 percent effluent in an acute bioassay test. Lethality in 100 percent effluent may be allowed due to ammonia and chlorine only when it is demonstrated on a case-by-case basis that immediate dilution of effluent within the mixing zone reduces toxicity below lethal concentrations. The department may, on a case-by-case basis, establish a ZID if appropriate for other parameters.
>
> *Chronic Toxicity* - Chronic toxicity is measured as the concentration that causes long-term sublethal effects, such as significantly impaired growth or reproduction in aquatic organisms, during a testing period based on test species life cycle.

The Redwood WWTP NPDES permit does not define the ZID; however, EPA guidance suggests a distance 10 percent of the distance to the mixing zone boundary is appropriate. This translates to 10 feet with the current Redwood WWTP mixing zone (USEPA 1991).

Redwood WWTP's current authorized mixing zone may be too restrictive. For comparison, the City of Grants Pass WRP, several miles upstream of the Redwood plant, has a mixing zone three times that allotted for the Redwood plant, although average discharge is ten times greater than the Redwood plant. The Grants Pass mixing zone is defined in the Grants Pass NPDES Permit #100989 as follows:

> The allowable mixing zone is that portion of the Rogue River from 10 feet above the point of discharge to 300 feet downstream of the discharge point. In addition,

the ZID shall not exceed 10 percent of the defined mixing zone in any direction from the point of discharge.

The current average dry weather design flow for the Grants Pass plant is 4.7 mgd (Brown and Caldwell 1992).

OAR 340-41-365(4) suggests that the size of Redwood WWTP's mixing zone be reevaluated. Prior to adjusting mixing zone dimensions, acute and chronic bioassay testing should be completed as required for assessing toxicity in the mixing zone. The mixing zone should not occupy greater than 25 percent of the river width to allow passage of fish and other aquatic organisms. Additional monitoring recommendations are given in Section 5.3.8.

5.3.5.2 Mixing in Rivers

A submerged river discharge has two distinct mixing regions: near-field and far-field. Mixing in the near-field is vigorous from rapid dissipation of jet momentum. Near-field mixing is primarily a function of port size and outlet velocity. Dispersion of effluent in the far-field is driven by turbulence in the receiving waters which is a function of current speed and channel characteristics. Far-field mixing rates are greatly reduced from near-field mixing rates.

5.3.5.3 Model Methodology

Several EPA-approved river mixing models are available to predict acute and chronic mixing ratios. Those used in the Redwood analysis included:

- PLUMES (Baumgartner, D.J.; Frick, W.E.; Roberts, P.J.W.; and Bodeen, C.A.; June 1993)
- Turbulent Advective Dispersion Equation (Fischer 1979)

Each model is discussed in the sections that follow.

PLUMES

The PLUMES Model was used to predict near-field mixing ratios. PLUMES is an interface linking the near-field model UM (Updated UMERGE) and a far-field model based on Brooks Equation (Fischer 1979). PLUMES is normally run in marine environments; however, the model does support shallow river discharges. In the shallow discharge mode, PLUMES is constrained to co-flowing jets and weakly or unstratified receiving waters. The Redwood discharge fits these criteria.

Turbulent Advective Dispersion Equation

The turbulent advective diffusion equation is a conservative estimate of dilution since there is no consideration for near-field mixing. The turbulent advective diffusion equation in three dimensions for a continuous point source (Fischer 1979) is as follows:

$$C = \frac{\dot{M}}{4\pi x\sqrt{\epsilon_v \epsilon_t}} \exp^{-}\left[\frac{U}{4x}\left(\frac{y^z}{\epsilon_t} + \frac{z^2}{\epsilon_v}\right)\right] \qquad \text{(Equation 5.3)}$$

where:

- C = Concentration at Coordinate (x, y, z)
- $\dot{M}$ = Mass Flux (Concentration x Effluent Discharge)
- x = Downstream Distance from Outfall
- ϵ_v = Vertical Turbulent Diffusion Coefficient
- ϵ_t = Lateral Turbulent Diffusion Coefficient
- U = Average River Current Speed
- y = Lateral Distance from Outfall
- z = Vertical Distance from Outfall

Lateral and vertical turbulent diffusion coefficients are a measure of river-induced mixing. A larger diffusion coefficient indicates a higher degree of effluent mixing. The lateral turbulent diffusion coefficient is calculated as follows (Fischer et al. 1979):

$$\epsilon_t = 0.6du* \qquad \text{(Equation 5.4)}$$

where:

- d = Average River Depth
- g = Acceleration due to Gravity (32.2 ft/sec^2)
- S = River Slope
- $u*$ = *Shear Velocity* = $\sqrt{gdS}$

The vertical turbulent diffusion coefficient is roughly 1/10 the lateral mixing coefficient and is calculated as follows:

$$\epsilon_v = 0.067du* \qquad \text{(Equation 5.5)}$$

where:

d and $u*$ are as previously described.

The three-dimensional form of the advective diffusion equation is used when the discharge cannot be considered completely vertically mixed; however, if the plume does become completely vertically mixed, the two-dimensional form of Equation 5.5 may be used:

$$C = \frac{\dot{M}}{d\sqrt{4\pi\epsilon_t xU}} \exp^{-}\left[\frac{Uy^2}{4x\epsilon_t}\right] \quad \text{(Equation 5.6)}$$

Complete vertical mixing can be predicted using the following equation (Fischer, 1979).

$$L = \frac{C' UW^2}{\epsilon_v} \quad \text{(Equation 5.7)}$$

where:

C' = 0.1 (mid-depth discharge)
U = Average River Current Speed
W = River Width
ϵ_v = Vertical Turbulent Diffusion Coefficient

Distance to complete vertical mixing in the Rogue River using Equation 5.7 is 30 feet at regulatory low river flow. Actual distance to complete vertical mixing will be somewhat less than this prediction due to near-field mixing, which is not taken into account. Complete vertical mixing occurs prior to the current authorized mixing zone boundary, 100 feet downstream; therefore, Equation 5.6 can be used for far-field mixing predictions.

When the plume interacts with the river banks, surface, or bottom, image sources must be used to compensate for plume spread beyond these boundaries. One image source was used to account for near-bank interaction, 25 feet distant.

Another useful calculation is plume width at a fixed downstream distance:

$$b = 4\sigma = 4\sqrt{\frac{2\epsilon_t x}{U}} \quad \text{(Equation 5.8)}$$

where:

b = Plume Width
σ = Standard Deviation of Guassian Plume Concentration Profile
ϵ_t = Lateral Turbulent Diffusion Coefficient
x = Downstream Distance
U = Average River Current Speed

5.3.5.4 Far-Field Model Calibration

The far-field model was calibrated using the results of the *City of Grants Pass Mixing Zone Study* (Brown and Caldwell 1992). In this mixing zone study, a fluorescent dye tracing study was used to measure lateral and vertical mixing of the Grants Pass discharge downstream of the outfall. The Grants Pass outfall discharges near the north bank of the Rogue River at river mile 100.9.

Each river has particular mixing characteristics, that depend on channel characteristics such as roughness, current speed, tortuosity, and depth. Plume width measurements at 250 and 1,000 feet downstream of the Grants Pass discharge allowed calculation, using Equation 5.8, of the lateral turbulent diffusion coefficient (ϵ_t) for the Rogue River near Grants Pass.

The Grants Pass study results were used to determine u^* (shear velocity), and Equation 5.4 was used to extrapolate ϵ_t for application near the Redwood WWTP. The lateral turbulent diffusion coefficient for the Rogue River near the Redwood discharge—under regulatory, low-flow conditions–is estimated as 0.22 ft^2/sec. The vertical turbulent diffusion coefficient is estimated as 0.024 ft^2/sec.

5.3.5.5 Model Input

Near- and far-field model input parameters are summarized in Table 5-9. Two statistical measures of effluent flows were used in the modeling analysis. Acute mixing ratios are calculated at peak day effluent flows to correspond with the short duration exposures leading to acute toxicity. Acute criteria are evaluated at the ZID. Chronic mixing ratios are calculated at peak month flows to correspond with the longer duration exposures associated with chronic toxicity. Chronic criteria are evaluated at the mixing zone boundary. Effluent flow projections are discussed in more detail in Section 5.1.

5.3.5.6 Model Results

Table 5-10 summarizes near- and far-field model results. The dilution ratio is the inverse of percent effluent. Results are given for both the current authorized mixing zone boundaries as well as at distances which may be considered for mixing zone expansion. Complete model results appear in Appendix F.

Table 5-9
Near- and Far-Field Model Input Parameters

Parameter	Source	Near-Field Model (PLUMES)	Far-Field Model (Advective Dispersion Equation)	Comment
PLANT				
Existing Flow	Oct. 1992-Sept. 1993 Daily Monitoring Reports (DMRs)	0.54 mgd (summer peak day)	0.48 mgd (summer peak month)	
Future Flow	Projected (see Section 5.1)	1.1 mgd (summer peak day)	1.0 mgd (summer peak month)	
Effluent Temperature	Estimate	21°C	N/A	Mixing not sensitive to this parameter
Effluent Salinity	Estimate	0	N/A	Mixing not sensitive to this parameter
OUTFALL				
Port Diameter	As-built Drawings (see Appendix F)	18"	18"	
Vertical Angle	As-built Drawings (see Appendix F)	0°	0°	
Horizontal Angle	As-built Drawings (see Appendix F)	Co-Flowing	Co-Flowing	Actual angle 45° with respect to currents
Contraction Coefficient	Estimate	0.95	N/A	
Port Depth	November 30, 1993 Survey (Gary Wicks Engineering)	1.85 ft	Mid Level	To center of port
Port Elevation	November 30, 1993 Survey (Gary Wicks Engineering)	1.3 ft	Mid Level	To center of port
RECEIVING WATERS				
River Flow	USGS, 1990	1,200 cfs	1,200 cfs	Regulatory low flow
Average Current	Equation 5.1	1.25 ft/s	1.25 ft/s	Regulatory low flow
River Depth	November 30, 1993 Survey (Gary Wicks Engineering)	2.8 ft (at outfall)	2.4 ft (average)	Regulatory low flow

Table 5-10 Mixing Model Results						
		Percent Effluent		Dilution Ratio		
Mixing Criteria	Distance (ft)	Existing[1] (%)	Future[2] (%)	Existing	Future	Plume Width (ft)
Acute	10	24	50	4.2	2.0	7.5
	20	15	36	6.5	2.8	10.6
	30	12	29	8.5	3.4	13.0
Chronic	100	1.7	3.5	59.8	28.7	23.7
	200	1.2	2.6	80.2	38.5	33.6
	300	1.1	2.3	90.4	43.4	41.1

(1) At existing summer plant flows (May-November).
(2) At future summer plant flows (May-November).

5.3.6 Effluent Quality

5.3.6.1 Chlorine

Chlorine residual statistical variability was determined from Discharge Monitoring Reports (DMRs) for the period October 1992 to September 1993. The following results were obtained:

Number of Samples: 365

Low: 0.0 mg/L
High: 1.1 mg/L
Mean: 0.44 mg/L

5th Percentile: 0.10 mg/L
50th Percentile: 0.40 mg/L
95th Percentile: 0.80 mg/L

5.3.6.2 Fecal Coliforms

Fecal coliform samples are collected once each week. DMRs for the period January 1992 to September 1993 show that permit limits are consistently met:

Number of Samples: 156

Low: 0/100 mL
High: 109/100 mL
Weekly Average: 6/100 mL
Monthly Average: 7/100 mL

These results would suggest that the chlorine dose could be reduced and still meet permit limits.

5.3.6.3 Biochemical Oxygen Demand (BOD)

Summer and winter BOD concentrations for the past six-year period are shown in Appendix C. Maximum summer month BOD was 25 mg/ℓ (October 1992).

5.3.6.4 Total Suspended Solids (TSS)

Summer and winter TSS concentrations for the past six-year period are shown in Appendix C. Maximum summer month TSS was 20 mg/ℓ (June 1991).

5.3.6.5 Turbidity and Suspended Solids

The Redwood WWTP does not sample for turbidity; however, results from the Pullman WWTP in Pullman, Washington, can be used to represent typical secondary effluent values. The Pullman WWTP uses a process similar to the Redwood WWTP; however, turbidity values for the Redwood WWTP may be less than for Pullman, which has a higher summer suspended solids effluent limitation of 30 mg/L monthly and 45 mg/L weekly.

Turbidity of the Pullman effluent was measured three times daily from January 1993 to March 1993. Results of sampling are given below:

Average ± Standard Deviation:	3.62 ± 3.04
Maximum:	18.6
Minimum:	0.5
95th Percentile:	9.7

5.3.6.6 Temperature

High effluent temperatures are critical for receiving water impacts. At high river temperatures, dissolved oxygen (DO) concentrations are lowered, which can adversely affect aquatic life. Effluent temperature is not measured at the Redwood WWTP; however, records from the Grants Pass WRP show effluent temperatures there may reach as high as 76°F. Similar summer effluent temperatures are expected at the Redwood WWTP and will likely periodically exceed 70°F (Brown and Caldwell 1992). Effluent temperature monitoring at the Redwood WWTP should be initiated.

5.3.6.7 Ammonia, Metals, Cyanide, Phenols

A grab effluent sample was analyzed for ammonia, metals, cyanide, and phenols in December 1993 by Nielson Laboratories, Medford, Oregon. Toxicants including pesticides, PCBs, and volatile organic chemicals (VOCs) were not tested in the effluent, because they were not likely to pose a concern for the primarily municipal influent.

EPA guidance from the *Technical Support Document for Water Quality Based Toxics Control* (USEPA 1991) requires use of a reasonable potential multiplier to account for effluent variability when less than 20 effluent samples have been measured. The multiplier used for evaluating water quality standards compliance will be based on a 95th percentile probability basis and 95th percentile distribution. A coefficient of variation of 0.6 is assumed unless data are available for its calculation.

No ammonia was detected in the Redwood sample. Typical secondary effluent ammonia concentrations are highly variable and depend in part on effluent temperature, pH, hydraulic detention time in the plant, and wastewater composition and strength. Each of these parameters can vary seasonally.

To better represent ammonia variability in the Redwood effluent, testing results for the Grants Pass WRP will be used in lieu of the single Redwood sample. Results of limited ammonia testing in June 1991 are presented below (Brown and Caldwell 1992):

Number of Samples:	5
Low:	9.5 mg/L
High:	12.3 mg/L
Average:	11.1 mg/L

5.3.6.8 pH

Redwood's NPDES permit stipulates that effluent pH be in the range 6.0 to 9.0. Effluent pH is measured three times weekly and ranges from 6.7 to 7.8 (January 1992-September 1993).

5.3.7 Water Quality Analysis

In this section, the ability of the existing and future Redwood discharge to comply with water quality standards is evaluated. Tables 5-11 and 5-12 summarize the water quality analysis and compliance determination for each parameter analyzed. Information provided in Table 5-12 includes:

- Ambient concentrations from STORET data (see Table 5-3).
- Effluent concentrations from DMRs, laboratory effluent scan (see Appendices B and D) or are estimated based on typical secondary treatment plant performance (i.e., Pullman WWTP and Grants Pass WRP).
- Laboratory detection limits, when not detected.
- Number of samples analyzed.
- Reasonable potential multipliers for toxicants with less than 20 representative samples (USEPA 1991).
- Freshwater acute and chronic water quality standards from Table 20, OAR-340-41 and from numeric criteria in OAR 340-41-365.
- Mixing ratios required to meet water quality standards.

Table 5-11
Water Quality Analysis Summary

Parameter	Units	Critical Ambient Concentration	Effluent			Water Quality Standard OAR 340-41		Mixing Ratio Required	
			Critical Concentration	Number of Samples	RPM	Acute	Chronic	Acute (ZID)	Chronic (Mixing Zone)
CONVENTIONAL									
Dissolved Oxygen	mg/L	10.2	4.0	NA	1	—	95% saturation	—	13.4
Temperature	°F	58°	68°	NA	1	—	<0.25 decrease	—	40
pH	SU	6.3-8.2	6.7-7.8	252	1	—	6.5-8.5	—	1
Total Suspended Solids	mg/L	NA	(4) 30	365	1	—	500	—	1
Turbidity	NTU	1.0	9.7	NA	1	—	<10% increase	—	87
Fecal Coliforms	MPN/100 mL	940	109	156	1	—	200	—	1
TOXICANTS									
Chlorine	mg/L	0	(3) 0.80	365	1	0.019	0.011	42.1	72.7
Ammonia	mg/L as N	0.14	(5) 12.3	1	1	(1) 3.3	(1) 0.45	3.8	39.2
Cyanide	µg/L	NA	<20	1	6.2	22	5.2	5.6	23.8
Phenols	µg/L	NA	<50	1	6.2	10,200	2,560	1	1
Arsenic	µg/L	<5	<1	1	6.2	360	190	1	1
Cadmium	µg/L	<1	0.2	1	6.2	(2) 1.05	(2) 0.45	4.8	(6) 1
Chromium (III)	µg/L	<2	<50	1	6.2	(2) 665	(2) 79.3	1	4.0
Copper	µg/L	3	24	1	6.2	(2) 5.9	(2) 4.4	50.3	10.4
Lead	µg/L	<10	<1	1	6.2	(2) 18.4	(2) 0.72	1	(6) 8.6
Mercury	µg/L	<0.5	<0.2	1	6.2	2.4	0.012	1	(6) 103
Nickel	µg/L	NA	<40	1	6.2	(2) 527	(2) 58.5	1	4.2
Selenium	µg/L	<5	<2	1	6.2	20.0	5.0	1	(6) 2.5
Silver	µg/L	<1	<10	1	6.2	(2) 0.54	0.12	115	517
Zinc	µg/L	40	85	1	6.2	(2) 43.4	(2) 39.3	143	(7) —

(1) Criteria based on *Ambient Aquatic Life Water Quality Criteria for Ammonia* (USEPA 1989) using highest observed pH and temperature at Grants Pass (pH=8.2, Temp.=22.0°C).
(2) Criteria hardness dependent (95th percentile value of 31 mg/L as $CaCO_3$ critical).
(3) 95% percentile value from daily measurement.
(4) Permit limitation.
(5) Based on maximum of 5 measurements at Grants Pass Water Pollution Control Facility (6/13/91 - 6/28/91)
(6) Background assumed zero.
(7) Background is standard.

NA - Not Available
RPM - Reasonable Potential Multiplier

Table 5-12
Compliance Summary

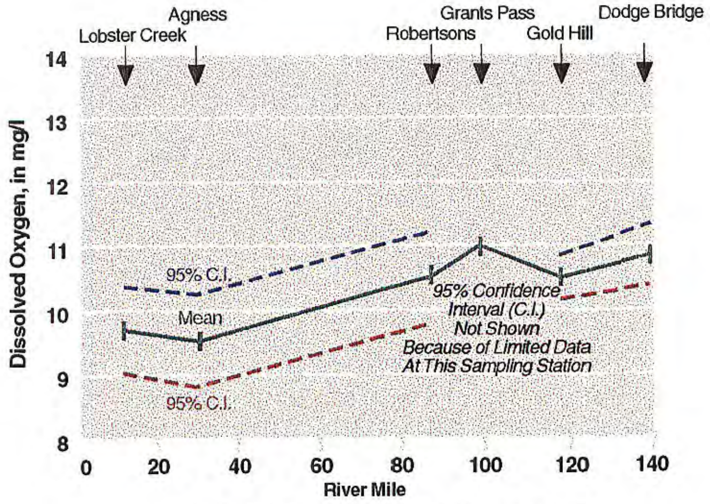
Parameter	Scenario(1)							
	Current Flow				Future Flow			
	100′ Radius		300′ Radius		100′ Radius		300′ Radius	
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
CONVENTIONAL								
Dissolved Oxygen	—	Yes	—	Yes	—	Yes	—	Yes
Temperature	—	Yes	—	Yes	—	No	—	Yes
pH	—	Yes	—	Yes	—	Yes	—	Yes
TSS	—	Yes	—	Yes	—	Yes	—	Yes
Turbidity	—	No	—	Yes	—	No	—	No
Fecal Coliforms	—	Yes	—	Yes	—	Yes	—	Yes
TOXICANTS(2)								
Chlorine	No	No	No	Yes	No	No	No	No
Ammonia	Yes	Yes	Yes	Yes	No	No	No	Yes
Cyanide	LDN	Yes	Yes	Yes	LDN	Yes	LDN	Yes
Phenols	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arsenic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cadmium	LDN	Yes	Yes	Yes	LDN	Yes	LDN	Yes
Chromium (III)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Copper	No	No	No	No	No	No	No	No
Lead	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mercury	Yes	LDN	Yes	LDN	Yes	LDN	Yes	LDN
Nickel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selenium	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Silver	LDN	LDN	LDN	LDN	LDN	LDN	LDN	LDN
Zinc	No	No	No	No	No	No	No	No

(1) All scenarios assume current plant effluent quality.
(2) Compliance based on detection limits when not detected.
LDN - Lower effluent detection limits and more effluent samples needed to assess compliance.

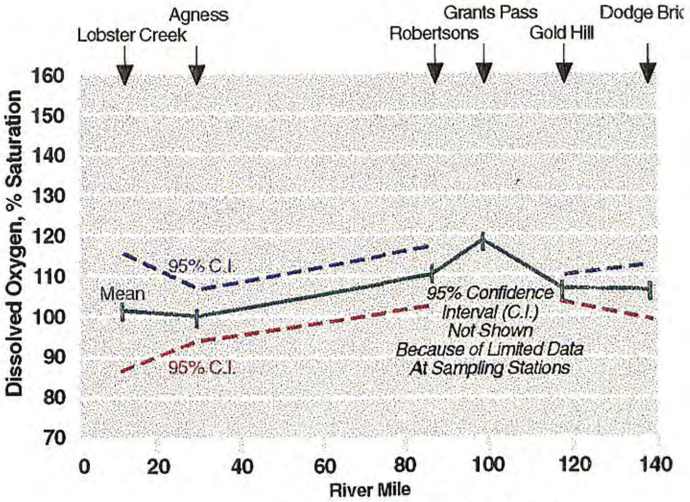
Table 5-11 includes a listing of each parameter and determination of compliance with water quality standards at each combination of existing and future predicted summer plant flows and current and expanded mixing zone boundaries (100 feet to 300 feet). Compliance is discussed for each parameter in the following sections.

5.3.7.1 Dissolved Oxygen

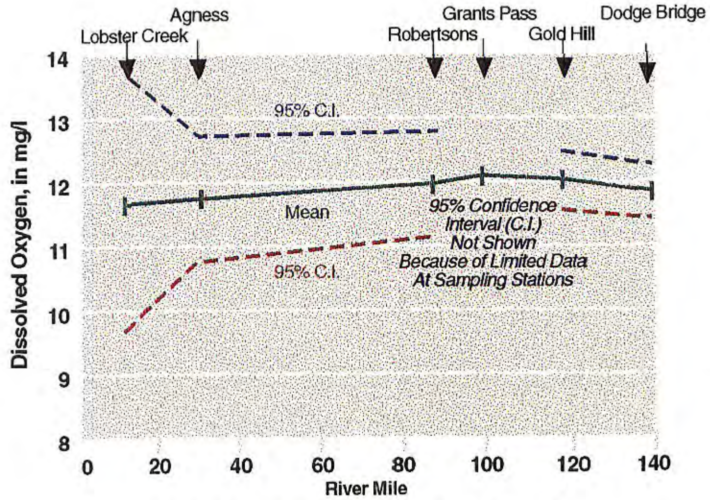
Salmonid species are present in the Rogue River and require that 95 percent DO saturation be maintained. Figure 5-4 shows mean values and 95th percentile confidence limits of DO concentrations and DO saturation for the Rogue River at all STORET ambient monitoring stations. Values are also shown separately by month for the Grants Pass station (Brown and Caldwell 1992).



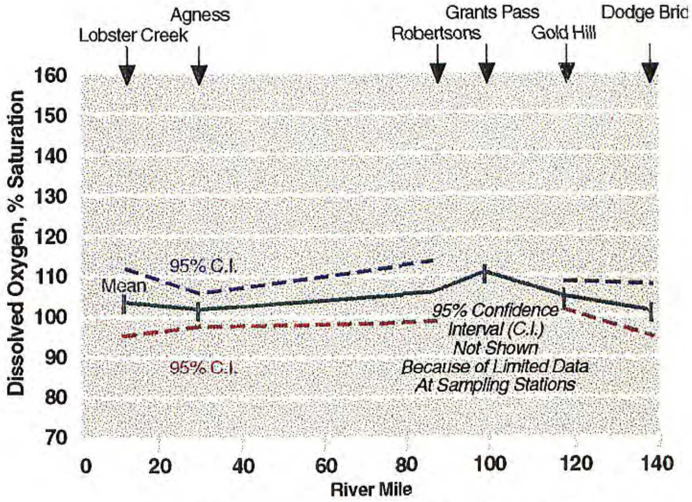
SUMMER DISSOLVED OXYGEN CONCENTRATION



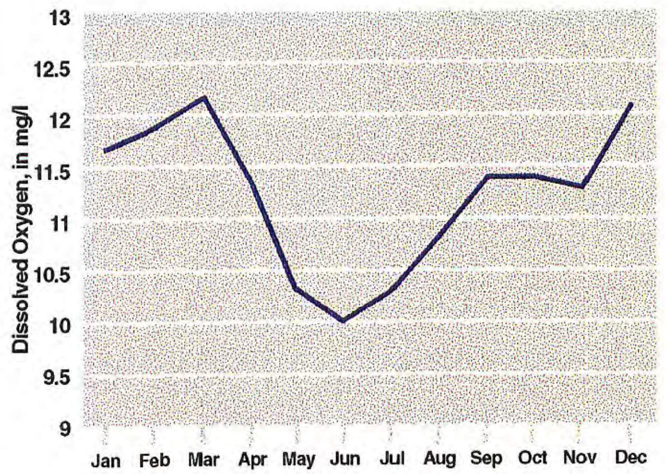
SUMMER DISSOLVED OXYGEN SATURATION



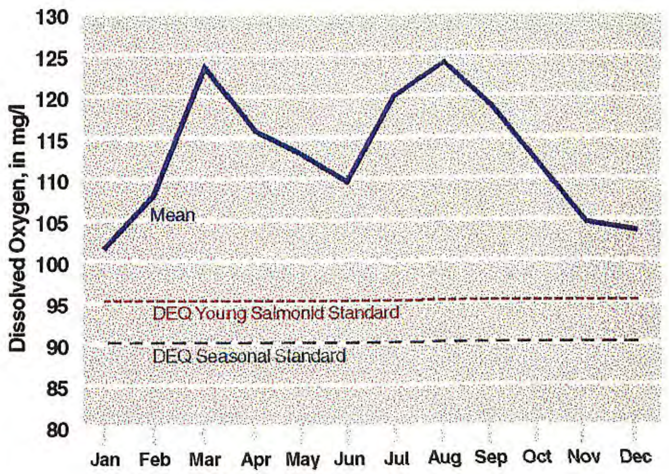
WINTER DISSOLVED OXYGEN CONCENTRATION



WINTER DISSOLVED OXYGEN SATURATION



MINIMUM DISSOLVED OXYGEN CONCENTRATIONS AT GRANTS PASS



DISSOLVED OXYGEN SATURATION AT GRANTS PASS

Redwood Wastewater Treatment Plant
#27-2192-05 02/99

Source: ***Reproduced from Water Restoration Plant Facilities Plan Draft, City of Grants Pass (Brown and Caldwell, 1992)***

Figure 5-4
Rogue River
Dissolved Oxygen

Average DO saturation values exceed 95 percent in both summer and winter for the entire river length. At Grants Pass and Robertson Bridge Stations, annual mean saturation values are in excess of 106 percent. The lower 95th percentile confidence limit of both summer and winter DO saturation at Grants Pass is over 100 percent. The 95th percentile lower confidence limit of DO concentration at Grants Pass is 10.2 mg/L.

A decreasing downstream trend in DO concentrations and DO saturation levels in the Rogue River is apparent from the plots. The decreasing downstream DO trend is a cumulative effect of all point and non-point sources, which appears to weigh against natural re-aeration rates.

Total oxygen demand is composed of both carbonaceous biochemical oxygen demand (CBOD) and nitrogenous biochemical oxygen demand (NBOD). CBOD and NBOD are exerted by bacteria and algae breaking down the effluent's waste materials for cellular production and metabolism. CBOD and NBOD in the effluent can be estimated using empirical relations found in the *Revised Section 301(h) Technical Support Document* (EPA 1982). NBOD is based on total kjheldal nitrogen (TKN), which is not measured at the Redwood WWTP. In lieu of TKN data, Redwood NBOD loadings are based on a conservative effluent ammonia value of 25 mg/L. The ratio of TKN to ammonia nitrogen (found in the effluent of the LOTT Secondary Treatment Plant in Olympia, Washington), when applied to the Redwood WWTP ammonia estimate, is used to obtain TKN concentrations in the Redwood effluent.

Because initial dilution occurs rapidly (approximately 30 to 60 seconds), BOD exertion (a slow process) is negligible during this period. However, an immediate dissolved oxygen demand (IDOD) may occur due to rapidly oxidized reduced substances (i.e., sulfides to sulphates). The DO concentration following initial dilution can be predicted from Equation VI-7 of the *Revised Section 301(h) of the Technical Support Document* (EPA 1982). This equation with conservative input parameters is presented as Equation 5.9.

$$DO_f = DO_a + \frac{(DO_e - IDOD - DO_a)}{S_a} \qquad \text{(Equation 5.9)}$$

where:

Parameter	Definition	Value	Source
DO_a	Critical ambient dissolved oxygen concentration	10.2 mg/L	95th percentile lowest observed value at Grants Pass (STORET, see Table 5-3)
IDOD	Immediate dissolved oxygen demand	1.0 mg/L	Table VI-7 of 301(h) Technical Support Document (TSD). Assumes advanced primary treatment.
S_a	Initial dilution	28.7	Modeling results for future effluent flows at current mixing zone (100 feet)
DO_e	Effluent DO	4.0 mg/L	Low value estimate for secondary effluent.

With this conservative combination of effluent DO, ambient DO, and IDOD, the critical 10.2 mg/L ambient DO concentration is reduced after initial dilution to:

9.95 mg/L

This represents a 2.5 percent decrease in DO at the 100-foot authorized mixing zone boundary. With DO saturation at Grants Pass above 100 percent, a 2.5 percent decrease will allow DO saturation above 97 percent to be maintained, thereby meeting the 95 percent standard.

The DO sag at distances farther downstream can be predicted using Equation VI-17 of the 301(h) TSD. This equation, with conservative input variables, is presented as Equation 5.10.

$$DO(t) = DO_a + \frac{DO_f - DO_a}{D_s} - \left[\frac{L_{fc}}{D_s}(1-e^{-k_c t})\right] - \left[\frac{L_{fn}}{D_s}(1-e^{-k_n t})\right] \quad \text{(Equation 5.10)}$$

where:

Parameter	Definition	Value	Source
DO_f	Dissolved oxygen concentration at completion of initial dilution (100 feet).	9.95 mg/L	Results of Equation 5.9.
D_s	Dilution obtained subsequent to initial dilution.	24.6	Full mixing of 1.1 mgd effluent flow with 1,200 cfs river flow.
L_{fc}	Ultimate CBOD concentration above ambient at completion of initial dilution (100 feet).	1.53 mg/L	$CBOD_{max}$ = 1.46 x BOD_5[30 mg/L (summer NPDES permit limit)]
L_{fn}	NBOD concentration above ambient at completion of initial dilution (100 feet).	4.50 mg/L	$NBOD_{max}$ = 4.57x1.13xNH_3 [25 mg/L]
K_c	Decay rate for CBOD @ 22°C.	0.60/day	Conservative Value from QUAL2E (EPA 1987)
K_n	Decay rate for NBOD @ 22°C.	0.40/day	Conservative Value from QUAL2E (EPA 1987)
t	Travel time, in river.	3 days	From discharge to mouth of Rogue River assuming 2 ft/sec current speed.

As with Equation 5.9, the least favorable combination of input variables is used. The analysis gives the following DO decreases:

River Mile 50:	0.13 mg/L
Gold Beach (river mouth):	0.19 mg/L

This simplistic analysis neglects re-aeration. With typical re-aeration rates of 3 mg/L to 5 mg/L per day (EPA 1987), re-aeration will negate the DO impacts from the Redwood discharge. Decreases in DO due to BOD exertion are so minimal at future predicted effluent flows that a measurable DO decrease outside of the mixing zone could never be attributed to the Redwood discharge.

5.3.7.2 Temperature

State water quality standards do not allow a measurable increase in receiving water temperature outside of the mixing zone when ambient water temperature is above 58°F. Mean water temperatures at Grants Pass are above 58°F for most of the summer (May-October), as shown in Figure 5-5.

To analyze water quality impacts, it is assumed the maximum difference between effluent and receiving water temperature is 10°F. This is a conservative estimate based on DMRs from similar secondary treatment plants in which effluent temperature is measured (Parametrix, Inc., 1993). For example, when the receiving water temperature is 58°F, the effluent temperature would be 68°F.

The definition of "measurable increase" supported by ODEQ is an increase of 0.25°F at the mixing zone boundary (Brown and Caldwell 1992). With this allowance, a mixing ratio of 40 is required at critical low river flows to assure compliance. This mixing ratio is achieved at current summer effluent flows at the current authorized mixing zone boundary; however, at increased future summer effluent flows, the mixing ratio is not achieved at mixing zones from 100 to 200 feet from the outfall. If the mixing zone size were increased to a distance of 300 feet from the outfall, the temperature standard would be met.

Although any increase in temperature is technically a violation, temperature impacts due to the discharge are expected to be minimal. Natural temperature fluctuations in the Rogue River are expected to mask any apparent increases.

5.3.7.3 pH

Redwood WWTP effluent pH ranges from 6.7 to 7.8 (January 1992 to September 1993), meeting the standard with no dilution. The buffering capacity of the effluent is anticipated to increase river pH when ambient pH is below neutral. This is a benefit when river pH levels are below the standard, as has occurred on occasion (see Table 5-8).

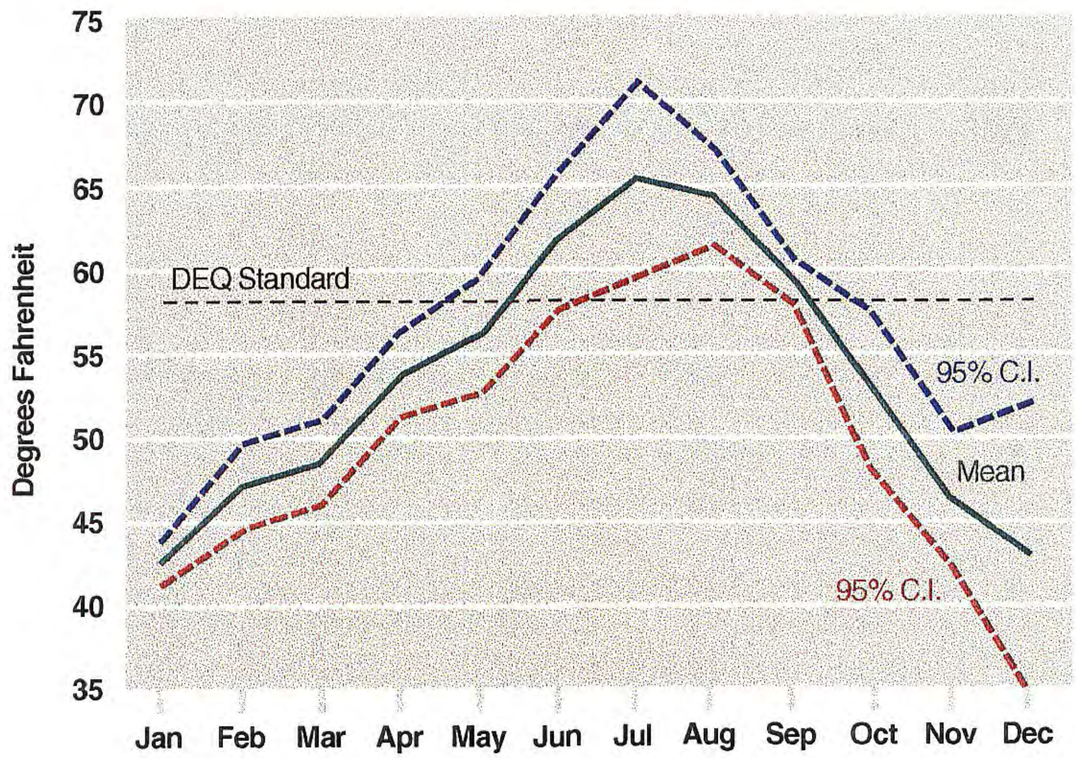


Figure 5-5
Rogue River Temperature
(at Grants Pass)

5.3.7.4 Total Suspended Solids

The TSS standard of 500 mg/L will be met by virtue of the 30 mg/ℓ summer effluent permit limit.

5.3.7.5 Turbidity

Low river turbidities attest to the high clarity of the Rogue River. Critical 95th percentile ambient turbidity is less than 1.0 NTU. Using the 95th percentile effluent value of 9.7 NTU from the Pullman WWTP (see Section 5.3.6.5), a mixing ratio of 87 would be required to meet the turbidity standard, which allows a 10 percent increase. This mixing ratio will not be met under current or future discharge scenarios during critical summer river flows. At a median river turbidity of 3.0 NTU, the mixing ratio required is lowered to 22.3. This mixing ratio is met at the current mixing zone under existing and future summer discharge conditions.

5.3.7.6 Fecal Coliforms

Median fecal coliform count of the Rogue River near Grants Pass is 91/100 mL. In the past, exceedances above the river coliform standard of 200/100 mL have occurred. Mean effluent concentrations are less than median river concentrations; therefore the Redwood discharge, on average, reduces river coliform concentrations. Even at the highest observed effluent concentration of 109/100 mL, the fecal coliform standard is met. Current NPDES permit limits are adequately protective of water quality.

5.3.7.7 Chlorine

At a 95th percentile highest chlorine residual of 0.80 mg/L and current plant flow, acute and chronic water quality standards are exceeded. The chronic standard could be met at a 200-foot or 300-foot mixing zone. At future predicted effluent flows, the acute and chronic standards could not be met, regardless of mixing zone size.

5.3.7.8 Ammonia

Acute and chronic ammonia water quality standards are currently met with the assumption that effluent ammonia concentrations are similar to the Grants Pass WRP (Brown and Caldwell 1992). Acute and chronic ammonia standards may not be met at future discharge. Prior to assessing compliance at future plant flows, seasonal effluent ammonia measurements are required. Testing frequency is discussed in Section 5.3.8.

5.3.7.9 Cyanide, Phenols, Metals

With the limited effluent and river data available, copper and zinc are of notable concern. Before an adequate compliance assessment can be made, more effluent testing is required. Testing frequencies and other monitoring requirements are discussed in Section 5.3.8.

5.3.8 Recommendations

Based on the receiving water quality criteria analysis, the following treatment and monitoring recommendations can be asserted:

5.3.8.1 Treatment Recommendations

Lower chlorine doses can be applied yet wastewater can still achieve adequate disinfection. At lower effluent residuals, chronic chlorine standards can be met under existing and future effluent flows. However, it is highly unlikely that more efficient chlorination or outfall modifications would improve compliance within the ZID; therefore, dechlorination is recommended.

Ammonia removal should be included in this facilities plan; however, final judgment on whether ammonia removal is necessary should be reserved until seasonal ammonia sampling results are available (see Section 5.3.8.2).

5.3.8.2 Monitoring Recommendations

Water quality analysis and compliance determination depends, to a large degree, on the number of effluent and receiving water samples collected. With larger numbers of samples, statistical uncertainties will be reduced, lowering reasonable potential multipliers and confidence limits. Reducing test detection limits will likewise reduce uncertainty. Monitoring recommendations for parameters showing a potential to exceed water quality standards are presented in Table 5-13. When sample collection is completed, further treatment recommendations can be made, such as the need for outfall modifications, pretreatment, or ammonia removal.

Table 5-13
Monitoring Recommendations

Parameter	Frequency/Duration	Location		Sample Type
		Effluent	River[1]	
Dissolved Oxygen	2/month for one year	X		Grab
Temperature	1/week for one year	X	X	Grab
Turbidity	1/week for one year	X	X	24-hr Composite
Ammonia	1/week for one year	X		24-hr Composite
Bioassay	Quarterly for one year			
Acute		X		
Chronic		X		

Table 5-13 Monitoring Recommendations				
		Location		
Parameter	Frequency/Duration	Effluent	River[1]	Sample Type
Toxicants	Quarterly, using 3 consecutive days between Monday and Friday, inclusive.			
Cyanide		X	X	24-hr Composite
Cadmium		X	X	24-hr Composite
Copper		X	X	24-hr Composite
Lead		X	X	24-hr Composite
Mercury		X	X	24-hr Composite
Selenium		X	X	24-hr Composite
Silver		X	X	24-hr Composite
Zinc		X	X	24-hr Composite

(1) Upstream of outfall.

5.4 FUTURE TREATMENT REQUIREMENTS

This section summarizes the requirements, discussed in Sections 5.1 through 5.3, which addressed future wasteload and flow, regulatory treatment criteria, and water quality criteria. In addition, the analysis of the existing treatment plant in Section 4 has shown a need for plant improvements to increase treatment efficiency and to meet critical needs if this plant continues to be used to treat wastewater from the District. The following is a list of requirements for future treatment:

- If the District's wastewater flow is to be treated by either the Redwood WWTP or the City of Grants Pass WRP, either of these facilities should be designed for a maximum monthly dry weather flow (MMDWF) of 1.50 mgd, a maximum monthly wet weather flow (MMWWF) of 2.36 mgd, and a peak instantaneous flow of 4.3 mgd in the year 2020 from the District.

- Further, if the Redwood WWTP is to be used to treat this flow, it should be designed for effluent limitations at the plant for one of two possible situations:

    - Effluent limitations as established by OAR 340-41-375 or as shown in Table 5-4.

    - Effluent limitations as established by OAR 340-41-026 or as shown in Table 5-5.

    An evaluation of the cost and consequences of each of these effluent limitations should be conducted.

Also, if the Redwood WWTP is to be used to treat flow from the District, the plant should be upgraded to include the following:

- Significantly reduce or remove chlorine residual in effluent at all times.
- Provide for partial ammonia removal *in the* treatment process as part of any plant modifications.
- Provide automatic composite sampling equipment to assist making data consistent and reliable.
- Provide variable speed controls on the influent pumps to minimize the impacts of this pump station on the treatment abilities of the plant.
- Add blower capacity to maintain adequate oxygen levels in the aeration basin during peak loadings.

To meet these requirements, a number of alternatives have been developed and analyzed. These alternatives are presented in Section 6.

5.3.5.4 Far-Field Model Calibration

The far-field model was calibrated using the results of the *City of Grants Pass Mixing Zone Study* (Brown and Caldwell 1992). In this mixing zone study, a fluorescent dye tracing study was used to measure lateral and vertical mixing of the Grants Pass discharge downstream of the outfall. The Grants Pass outfall discharges near the north bank of the Rogue River at river mile 100.9.

Each river has particular mixing characteristics, that depend on channel characteristics such as roughness, current speed, tortuosity, and depth. Plume width measurements at 250 and 1,000 feet downstream of the Grants Pass discharge allowed calculation, using Equation 5.8, of the lateral turbulent diffusion coefficient (ϵ_t) for the Rogue River near Grants Pass.

The Grants Pass study results were used to determine u^* (shear velocity), and Equation 5.4 was used to extrapolate ϵ_t for application near the Redwood WWTP. The lateral turbulent diffusion coefficient for the Rogue River near the Redwood discharge—under regulatory, low-flow conditions–is estimated as 0.22 ft^2/sec. The vertical turbulent diffusion coefficient is estimated as 0.024 ft^2/sec.

5.3.5.5 Model Input

Near- and far-field model input parameters are summarized in Table 5-9. Two statistical measures of effluent flows were used in the modeling analysis. Acute mixing ratios are calculated at peak day effluent flows to correspond with the short duration exposures leading to acute toxicity. Acute criteria are evaluated at the ZID. Chronic mixing ratios are calculated at peak month flows to correspond with the longer duration exposures associated with chronic toxicity. Chronic criteria are evaluated at the mixing zone boundary. Effluent flow projections are discussed in more detail in Section 5.1.

5.3.5.6 Model Results

Table 5-10 summarizes near- and far-field model results. The dilution ratio is the inverse of percent effluent. Results are given for both the current authorized mixing zone boundaries as well as at distances which may be considered for mixing zone expansion. Complete model results appear in Appendix F.

Table 5-9
Near- and Far-Field Model Input Parameters

Parameter	Source	Near-Field Model (PLUMES)	Far-Field Model (Advective Dispersion Equation)	Comment
PLANT				
Existing Flow	Oct. 1992-Sept. 1993 Daily Monitoring Reports (DMRs)	0.54 mgd (summer peak day)	0.48 mgd (summer peak month)	
Future Flow	Projected (see Section 5.1)	1.1 mgd (summer peak day)	1.0 mgd (summer peak month)	
Effluent Temperature	Estimate	21°C	N/A	Mixing not sensitive to this parameter
Effluent Salinity	Estimate	0	N/A	Mixing not sensitive to this parameter
OUTFALL				
Port Diameter	As-built Drawings (see Appendix F)	18"	18"	
Vertical Angle	As-built Drawings (see Appendix F)	0°	0°	
Horizontal Angle	As-built Drawings (see Appendix F)	Co-Flowing	Co-Flowing	Actual angle 45° with respect to currents
Contraction Coefficient	Estimate	0.95	N/A	
Port Depth	November 30, 1993 Survey (Gary Wicks Engineering)	1.85 ft	Mid Level	To center of port
Port Elevation	November 30, 1993 Survey (Gary Wicks Engineering)	1.3 ft	Mid Level	To center of port
RECEIVING WATERS				
River Flow	USGS, 1990	1,200 cfs	1,200 cfs	Regulatory low flow
Average Current	Equation 5.1	1.25 ft/s	1.25 ft/s	Regulatory low flow
River Depth	November 30, 1993 Survey (Gary Wicks Engineering)	2.8 ft (at outfall)	2.4 ft (average)	Regulatory low flow

Table 5-10 Mixing Model Results						
		Percent Effluent		Dilution Ratio		
Mixing Criteria	Distance (ft)	Existing[1] (%)	Future[2] (%)	Existing	Future	Plume Width (ft)
Acute	10	24	50	4.2	2.0	7.5
	20	15	36	6.5	2.8	10.6
	30	12	29	8.5	3.4	13.0
Chronic	100	1.7	3.5	59.8	28.7	23.7
	200	1.2	2.6	80.2	38.5	33.6
	300	1.1	2.3	90.4	43.4	41.1

(1) At existing summer plant flows (May-November).
(2) At future summer plant flows (May-November).

5.3.6 Effluent Quality

5.3.6.1 Chlorine

Chlorine residual statistical variability was determined from Discharge Monitoring Reports (DMRs) for the period October 1992 to September 1993. The following results were obtained:

Number of Samples: 365

Low:	0.0 mg/L
High:	1.1 mg/L
Mean:	0.44 mg/L

5th Percentile:	0.10 mg/L
50th Percentile:	0.40 mg/L
95th Percentile:	0.80 mg/L

5.3.6.2 Fecal Coliforms

Fecal coliform samples are collected once each week. DMRs for the period January 1992 to September 1993 show that permit limits are consistently met:

Number of Samples: 156

Low:	0/100 mL
High:	109/100 mL
Weekly Average:	6/100 mL
Monthly Average:	7/100 mL

These results would suggest that the chlorine dose could be reduced and still meet permit limits.

5.3.6.3 Biochemical Oxygen Demand (BOD)

Summer and winter BOD concentrations for the past six-year period are shown in Appendix C. Maximum summer month BOD was 25 mg/ℓ (October 1992).

5.3.6.4 Total Suspended Solids (TSS)

Summer and winter TSS concentrations for the past six-year period are shown in Appendix C. Maximum summer month TSS was 20 mg/ℓ (June 1991).

5.3.6.5 Turbidity and Suspended Solids

The Redwood WWTP does not sample for turbidity; however, results from the Pullman WWTP in Pullman, Washington, can be used to represent typical secondary effluent values. The Pullman WWTP uses a process similar to the Redwood WWTP; however, turbidity values for the Redwood WWTP may be less than for Pullman, which has a higher summer suspended solids effluent limitation of 30 mg/L monthly and 45 mg/L weekly.

Turbidity of the Pullman effluent was measured three times daily from January 1993 to March 1993. Results of sampling are given below:

Average ± Standard Deviation:	3.62 ± 3.04
Maximum:	18.6
Minimum:	0.5
95th Percentile:	9.7

5.3.6.6 Temperature

High effluent temperatures are critical for receiving water impacts. At high river temperatures, dissolved oxygen (DO) concentrations are lowered, which can adversely affect aquatic life. Effluent temperature is not measured at the Redwood WWTP; however, records from the Grants Pass WRP show effluent temperatures there may reach as high as 76°F. Similar summer effluent temperatures are expected at the Redwood WWTP and will likely periodically exceed 70°F (Brown and Caldwell 1992). Effluent temperature monitoring at the Redwood WWTP should be initiated.

5.3.6.7 Ammonia, Metals, Cyanide, Phenols

A grab effluent sample was analyzed for ammonia, metals, cyanide, and phenols in December 1993 by Nielson Laboratories, Medford, Oregon. Toxicants including pesticides, PCBs, and volatile organic chemicals (VOCs) were not tested in the effluent, because they were not likely to pose a concern for the primarily municipal influent.

EPA guidance from the *Technical Support Document for Water Quality Based Toxics Control* (USEPA 1991) requires use of a reasonable potential multiplier to account for effluent variability when less than 20 effluent samples have been measured. The multiplier used for evaluating water quality standards compliance will be based on a 95th percentile probability basis and 95th percentile distribution. A coefficient of variation of 0.6 is assumed unless data are available for its calculation.

No ammonia was detected in the Redwood sample. Typical secondary effluent ammonia concentrations are highly variable and depend in part on effluent temperature, pH, hydraulic detention time in the plant, and wastewater composition and strength. Each of these parameters can vary seasonally.

To better represent ammonia variability in the Redwood effluent, testing results for the Grants Pass WRP will be used in lieu of the single Redwood sample. Results of limited ammonia testing in June 1991 are presented below (Brown and Caldwell 1992):

Number of Samples:	5
Low:	9.5 mg/L
High:	12.3 mg/L
Average:	11.1 mg/L

5.3.6.8 pH

Redwood's NPDES permit stipulates that effluent pH be in the range 6.0 to 9.0. Effluent pH is measured three times weekly and ranges from 6.7 to 7.8 (January 1992-September 1993).

5.3.7 Water Quality Analysis

In this section, the ability of the existing and future Redwood discharge to comply with water quality standards is evaluated. Tables 5-11 and 5-12 summarize the water quality analysis and compliance determination for each parameter analyzed. Information provided in Table 5-12 includes:

- Ambient concentrations from STORET data (see Table 5-3).
- Effluent concentrations from DMRs, laboratory effluent scan (see Appendices B and D) or are estimated based on typical secondary treatment plant performance (i.e., Pullman WWTP and Grants Pass WRP).
- Laboratory detection limits, when not detected.
- Number of samples analyzed.
- Reasonable potential multipliers for toxicants with less than 20 representative samples (USEPA 1991).
- Freshwater acute and chronic water quality standards from Table 20, OAR-340-41 and from numeric criteria in OAR 340-41-365.
- Mixing ratios required to meet water quality standards.

Table 5-11
Water Quality Analysis Summary

Parameter	Units	Critical Ambient Concentration	Effluent			Water Quality Standard OAR 340-41		Mixing Ratio Required	
			Critical Concentration	Number of Samples	RPM	Acute	Chronic	Acute (ZID)	Chronic (Mixing Zone)
CONVENTIONAL									
Dissolved Oxygen	mg/L	10.2	4.0	NA	1	—	95% saturation	—	13.4
Temperature	°F	58°	68°	NA	1	—	<0.25 decrease	—	40
pH	SU	6.3-8.2	6.7-7.8	252	1	—	6.5-8.5	—	1
Total Suspended Solids	mg/L	NA	(4) 30	365	1	—	500	—	1
Turbidity	NTU	1.0	9.7	NA	1	—	<10% increase	—	87
Fecal Coliforms	MPN/100 mL	940	109	156	1	—	200	—	1
TOXICANTS									
Chlorine	mg/L	0	(3) 0.80	365	1	0.019	0.011	42.1	72.7
Ammonia	mg/L as N	0.14	(5) 12.3	1	1	(1) 3.3	(1) 0.45	3.8	39.2
Cyanide	µg/L	NA	<20	1	6.2	22	5.2	5.6	23.8
Phenols	µg/L	NA	<50	1	6.2	10,200	2,560	1	1
Arsenic	µg/L	<5	<1	1	6.2	360	190	1	1
Cadmium	µg/L	<1	0.2	1	6.2	(2) 1.05	(2) 0.45	4.8	(6) 1
Chromium (III)	µg/L	<2	<50	1	6.2	(2) 665	(2) 79.3	1	4.0
Copper	µg/L	3	24	1	6.2	(2) 5.9	(2) 4.4	50.3	10.4
Lead	µg/L	<10	<1	1	6.2	(2) 18.4	(2) 0.72	1	(6) 8.6
Mercury	µg/L	<0.5	<0.2	1	6.2	2.4	0.012	1	(6) 103
Nickel	µg/L	NA	<40	1	6.2	(2) 527	(2) 58.5	1	4.2
Selenium	µg/L	<5	<2	1	6.2	20.0	5.0	1	(6) 2.5
Silver	µg/L	<1	<10	1	6.2	(2) 0.54	0.12	115	517
Zinc	µg/L	40	85	1	6.2	(2) 43.4	(2) 39.3	143	(7) —

(1) Criteria based on *Ambient Aquatic Life Water Quality Criteria for Ammonia* (USEPA 1989) using highest observed pH and temperature at Grants Pass (pH=8.2, Temp.=22.0°C).
(2) Criteria hardness dependent (95th percentile value of 31 mg/L as $CaCO_3$ critical).
(3) 95% percentile value from daily measurement.
(4) Permit limitation.
(5) Based on maximum of 5 measurements at Grants Pass Water Pollution Control Facility (6/13/91 - 6/28/91)
(6) Background assumed zero.
(7) Background is standard.

NA - Not Available
RPM - Reasonable Potential Multiplier

Table 5-12 Compliance Summary								
	Scenario[1]							
	Current Flow				Future Flow			
	100′ Radius		300′ Radius		100′ Radius		300′ Radius	
Parameter	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic
CONVENTIONAL								
Dissolved Oxygen	—	Yes	—	Yes	—	Yes	—	Yes
Temperature	—	Yes	—	Yes	—	No	—	Yes
pH	—	Yes	—	Yes	—	Yes	—	Yes
TSS	—	Yes	—	Yes	—	Yes	—	Yes
Turbidity	—	No	—	Yes	—	No	—	No
Fecal Coliforms	—	Yes	—	Yes	—	Yes	—	Yes
TOXICANTS[2]								
Chlorine	No	No	No	Yes	No	No	No	No
Ammonia	Yes	Yes	Yes	Yes	No	No	No	Yes
Cyanide	LDN	Yes	Yes	Yes	LDN	Yes	LDN	Yes
Phenols	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Arsenic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cadmium	LDN	Yes	Yes	Yes	LDN	Yes	LDN	Yes
Chromium (III)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Copper	No	No	No	No	No	No	No	No
Lead	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mercury	Yes	LDN	Yes	LDN	Yes	LDN	Yes	LDN
Nickel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selenium	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Silver	LDN	LDN	LDN	LDN	LDN	LDN	LDN	LDN
Zinc	No	No	No	No	No	No	No	No

(1) All scenarios assume current plant effluent quality.

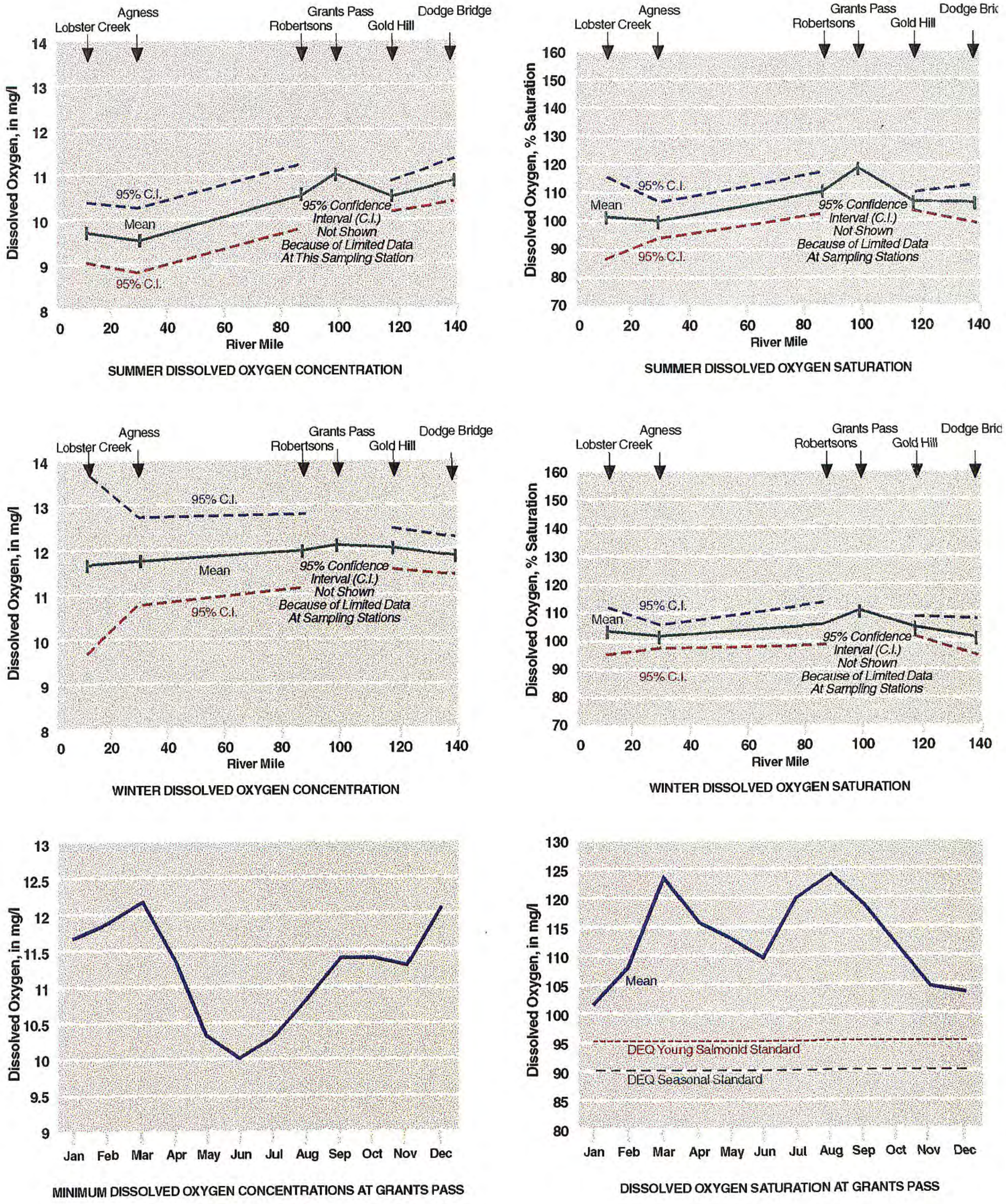
(2) Compliance based on detection limits when not detected.

LDN - Lower effluent detection limits and more effluent samples needed to assess compliance.

Table 5-11 includes a listing of each parameter and determination of compliance with water quality standards at each combination of existing and future predicted summer plant flows and current and expanded mixing zone boundaries (100 feet to 300 feet). Compliance is discussed for each parameter in the following sections.

5.3.7.1 Dissolved Oxygen

Salmonid species are present in the Rogue River and require that 95 percent DO saturation be maintained. Figure 5-4 shows mean values and 95th percentile confidence limits of DO concentrations and DO saturation for the Rogue River at all STORET ambient monitoring stations. Values are also shown separately by month for the Grants Pass station (Brown and Caldwell 1992).



Redwood Wastewater Treatment Plant
#27-2192-05 02/99

Source: ***Reproduced from Water Restoration Plant Facilities Plan Draft, City of Grants Pass (Brown and Caldwell, 1992)***

Figure 5-4
Rogue River
Dissolved Oxygen

Average DO saturation values exceed 95 percent in both summer and winter for the entire river length. At Grants Pass and Robertson Bridge Stations, annual mean saturation values are in excess of 106 percent. The lower 95th percentile confidence limit of both summer and winter DO saturation at Grants Pass is over 100 percent. The 95th percentile lower confidence limit of DO concentration at Grants Pass is 10.2 mg/L.

A decreasing downstream trend in DO concentrations and DO saturation levels in the Rogue River is apparent from the plots. The decreasing downstream DO trend is a cumulative effect of all point and non-point sources, which appears to weigh against natural re-aeration rates.

Total oxygen demand is composed of both carbonaceous biochemical oxygen demand (CBOD) and nitrogenous biochemical oxygen demand (NBOD). CBOD and NBOD are exerted by bacteria and algae breaking down the effluent's waste materials for cellular production and metabolism. CBOD and NBOD in the effluent can be estimated using empirical relations found in the *Revised Section 301(h) Technical Support Document* (EPA 1982). NBOD is based on total kjheldal nitrogen (TKN), which is not measured at the Redwood WWTP. In lieu of TKN data, Redwood NBOD loadings are based on a conservative effluent ammonia value of 25 mg/L. The ratio of TKN to ammonia nitrogen (found in the effluent of the LOTT Secondary Treatment Plant in Olympia, Washington), when applied to the Redwood WWTP ammonia estimate, is used to obtain TKN concentrations in the Redwood effluent.

Because initial dilution occurs rapidly (approximately 30 to 60 seconds), BOD exertion (a slow process) is negligible during this period. However, an immediate dissolved oxygen demand (IDOD) may occur due to rapidly oxidized reduced substances (i.e., sulfides to sulphates). The DO concentration following initial dilution can be predicted from Equation VI-7 of the *Revised Section 301(h) of the Technical Support Document* (EPA 1982). This equation with conservative input parameters is presented as Equation 5.9.

$$DO_f = DO_a + \frac{(DO_e - IDOD - DO_a)}{S_a} \qquad \text{(Equation 5.9)}$$

where:

Parameter	Definition	Value	Source
DO_a	Critical ambient dissolved oxygen concentration	10.2 mg/L	95th percentile lowest observed value at Grants Pass (STORET, see Table 5-3)
IDOD	Immediate dissolved oxygen demand	1.0 mg/L	Table VI-7 of 301(h) Technical Support Document (TSD). Assumes advanced primary treatment.
S_a	Initial dilution	28.7	Modeling results for future effluent flows at current mixing zone (100 feet)
DO_e	Effluent DO	4.0 mg/L	Low value estimate for secondary effluent.

With this conservative combination of effluent DO, ambient DO, and IDOD, the critical 10.2 mg/L ambient DO concentration is reduced after initial dilution to:

9.95 mg/L

This represents a 2.5 percent decrease in DO at the 100-foot authorized mixing zone boundary. With DO saturation at Grants Pass above 100 percent, a 2.5 percent decrease will allow DO saturation above 97 percent to be maintained, thereby meeting the 95 percent standard.

The DO sag at distances farther downstream can be predicted using Equation VI-17 of the 301(h) TSD. This equation, with conservative input variables, is presented as Equation 5.10.

$$DO(t) = DO_a + \frac{DO_f - DO_a}{D_s} - \left[\frac{L_{fc}}{D_s}(1-e^{-k_c t})\right] - \left[\frac{L_{fn}}{D_s}(1-e^{-k_n t})\right] \quad \text{(Equation 5.10)}$$

where:

Parameter	Definition	Value	Source
DO_f	Dissolved oxygen concentration at completion of initial dilution (100 feet).	9.95 mg/L	Results of Equation 5.9.
D_s	Dilution obtained subsequent to initial dilution.	24.6	Full mixing of 1.1 mgd effluent flow with 1,200 cfs river flow.
L_{fc}	Ultimate CBOD concentration above ambient at completion of initial dilution (100 feet).	1.53 mg/L	$CBOD_{max}$ = 1.46 x BOD_5[30 mg/L (summer NPDES permit limit)]
L_{fn}	NBOD concentration above ambient at completion of initial dilution (100 feet).	4.50 mg/L	$NBOD_{max}$ = 4.57x1.13xNH_3 [25 mg/L]
K_c	Decay rate for CBOD @ 22°C.	0.60/day	Conservative Value from QUAL2E (EPA 1987)
K_n	Decay rate for NBOD @ 22°C.	0.40/day	Conservative Value from QUAL2E (EPA 1987)
t	Travel time, in river.	3 days	From discharge to mouth of Rogue River assuming 2 ft/sec current speed.

As with Equation 5.9, the least favorable combination of input variables is used. The analysis gives the following DO decreases:

River Mile 50:	0.13 mg/L
Gold Beach (river mouth):	0.19 mg/L

This simplistic analysis neglects re-aeration. With typical re-aeration rates of 3 mg/L to 5 mg/L per day (EPA 1987), re-aeration will negate the DO impacts from the Redwood discharge. Decreases in DO due to BOD exertion are so minimal at future predicted effluent flows that a measurable DO decrease outside of the mixing zone could never be attributed to the Redwood discharge.

5.3.7.2 Temperature

State water quality standards do not allow a measurable increase in receiving water temperature outside of the mixing zone when ambient water temperature is above 58°F. Mean water temperatures at Grants Pass are above 58°F for most of the summer (May-October), as shown in Figure 5-5.

To analyze water quality impacts, it is assumed the maximum difference between effluent and receiving water temperature is 10°F. This is a conservative estimate based on DMRs from similar secondary treatment plants in which effluent temperature is measured (Parametrix, Inc., 1993). For example, when the receiving water temperature is 58°F, the effluent temperature would be 68°F.

The definition of "measurable increase" supported by ODEQ is an increase of 0.25°F at the mixing zone boundary (Brown and Caldwell 1992). With this allowance, a mixing ratio of 40 is required at critical low river flows to assure compliance. This mixing ratio is achieved at current summer effluent flows at the current authorized mixing zone boundary; however, at increased future summer effluent flows, the mixing ratio is not achieved at mixing zones from 100 to 200 feet from the outfall. If the mixing zone size were increased to a distance of 300 feet from the outfall, the temperature standard would be met.

Although any increase in temperature is technically a violation, temperature impacts due to the discharge are expected to be minimal. Natural temperature fluctuations in the Rogue River are expected to mask any apparent increases.

5.3.7.3 pH

Redwood WWTP effluent pH ranges from 6.7 to 7.8 (January 1992 to September 1993), meeting the standard with no dilution. The buffering capacity of the effluent is anticipated to increase river pH when ambient pH is below neutral. This is a benefit when river pH levels are below the standard, as has occurred on occasion (see Table 5-8).

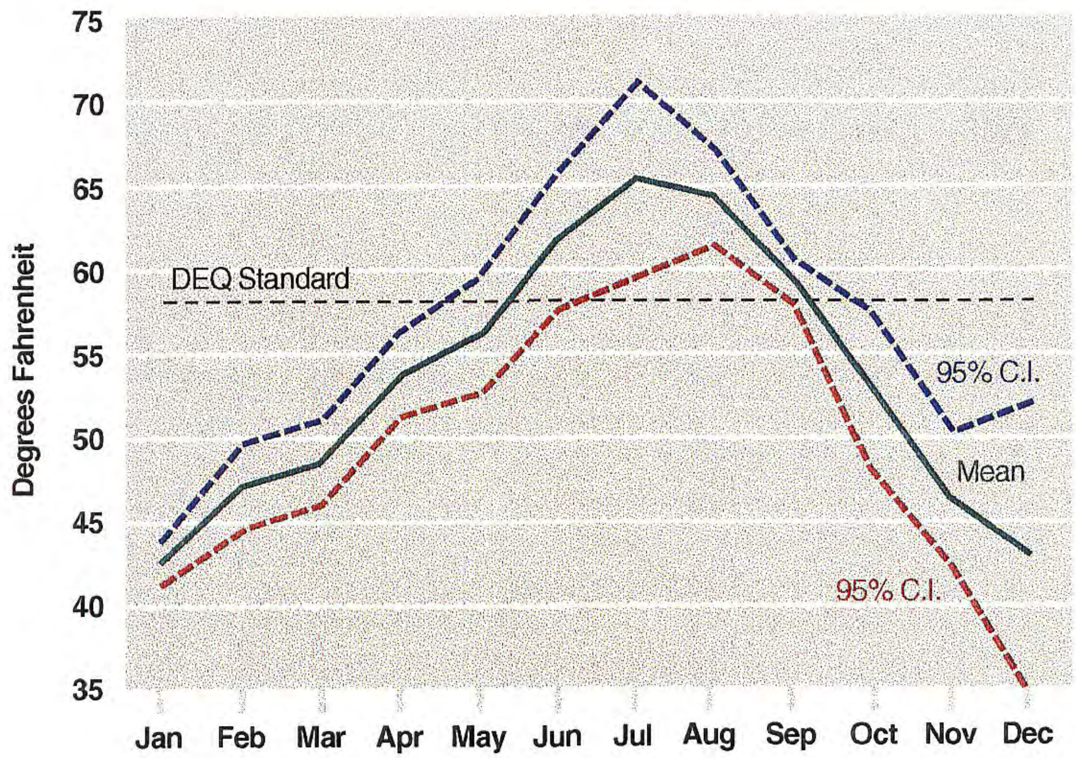


Figure 5-5
Rogue River Temperature
(at Grants Pass)

5.3.7.4 Total Suspended Solids

The TSS standard of 500 mg/L will be met by virtue of the 30 mg/ℓ summer effluent permit limit.

5.3.7.5 Turbidity

Low river turbidities attest to the high clarity of the Rogue River. Critical 95th percentile ambient turbidity is less than 1.0 NTU. Using the 95th percentile effluent value of 9.7 NTU from the Pullman WWTP (see Section 5.3.6.5), a mixing ratio of 87 would be required to meet the turbidity standard, which allows a 10 percent increase. This mixing ratio will not be met under current or future discharge scenarios during critical summer river flows. At a median river turbidity of 3.0 NTU, the mixing ratio required is lowered to 22.3. This mixing ratio is met at the current mixing zone under existing and future summer discharge conditions.

5.3.7.6 Fecal Coliforms

Median fecal coliform count of the Rogue River near Grants Pass is 91/100 mL. In the past, exceedances above the river coliform standard of 200/100 mL have occurred. Mean effluent concentrations are less than median river concentrations; therefore the Redwood discharge, on average, reduces river coliform concentrations. Even at the highest observed effluent concentration of 109/100 mL, the fecal coliform standard is met. Current NPDES permit limits are adequately protective of water quality.

5.3.7.7 Chlorine

At a 95th percentile highest chlorine residual of 0.80 mg/L and current plant flow, acute and chronic water quality standards are exceeded. The chronic standard could be met at a 200-foot or 300-foot mixing zone. At future predicted effluent flows, the acute and chronic standards could not be met, regardless of mixing zone size.

5.3.7.8 Ammonia

Acute and chronic ammonia water quality standards are currently met with the assumption that effluent ammonia concentrations are similar to the Grants Pass WRP (Brown and Caldwell 1992). Acute and chronic ammonia standards may not be met at future discharge. Prior to assessing compliance at future plant flows, seasonal effluent ammonia measurements are required. Testing frequency is discussed in Section 5.3.8.

5.3.7.9 Cyanide, Phenols, Metals

With the limited effluent and river data available, copper and zinc are of notable concern. Before an adequate compliance assessment can be made, more effluent testing is required. Testing frequencies and other monitoring requirements are discussed in Section 5.3.8.

5.3.8 Recommendations

Based on the receiving water quality criteria analysis, the following treatment and monitoring recommendations can be asserted:

5.3.8.1 Treatment Recommendations

Lower chlorine doses can be applied yet wastewater can still achieve adequate disinfection. At lower effluent residuals, chronic chlorine standards can be met under existing and future effluent flows. However, it is highly unlikely that more efficient chlorination or outfall modifications would improve compliance within the ZID; therefore, dechlorination is recommended.

Ammonia removal should be included in this facilities plan; however, final judgment on whether ammonia removal is necessary should be reserved until seasonal ammonia sampling results are available (see Section 5.3.8.2).

5.3.8.2 Monitoring Recommendations

Water quality analysis and compliance determination depends, to a large degree, on the number of effluent and receiving water samples collected. With larger numbers of samples, statistical uncertainties will be reduced, lowering reasonable potential multipliers and confidence limits. Reducing test detection limits will likewise reduce uncertainty. Monitoring recommendations for parameters showing a potential to exceed water quality standards are presented in Table 5-13. When sample collection is completed, further treatment recommendations can be made, such as the need for outfall modifications, pretreatment, or ammonia removal.

Table 5-13
Monitoring Recommendations

Parameter	Frequency/Duration	Location		Sample Type
		Effluent	River[1]	
Dissolved Oxygen	2/month for one year	X		Grab
Temperature	1/week for one year	X	X	Grab
Turbidity	1/week for one year	X	X	24-hr Composite
Ammonia	1/week for one year	X		24-hr Composite
Bioassay Acute Chronic	Quarterly for one year	 X X		

Table 5-13 Monitoring Recommendations				
		Location		
Parameter	Frequency/Duration	Effluent	River(1)	Sample Type
Toxicants	Quarterly, using 3 consecutive days between Monday and Friday, inclusive.			
Cyanide		X	X	24-hr Composite
Cadmium		X	X	24-hr Composite
Copper		X	X	24-hr Composite
Lead		X	X	24-hr Composite
Mercury		X	X	24-hr Composite
Selenium		X	X	24-hr Composite
Silver		X	X	24-hr Composite
Zinc		X	X	24-hr Composite

(1) Upstream of outfall.

5.4 FUTURE TREATMENT REQUIREMENTS

This section summarizes the requirements, discussed in Sections 5.1 through 5.3, which addressed future wasteload and flow, regulatory treatment criteria, and water quality criteria. In addition, the analysis of the existing treatment plant in Section 4 has shown a need for plant improvements to increase treatment efficiency and to meet critical needs if this plant continues to be used to treat wastewater from the District. The following is a list of requirements for future treatment:

- If the District's wastewater flow is to be treated by either the Redwood WWTP or the City of Grants Pass WRP, either of these facilities should be designed for a maximum monthly dry weather flow (MMDWF) of 1.50 mgd, a maximum monthly wet weather flow (MMWWF) of 2.36 mgd, and a peak instantaneous flow of 4.3 mgd in the year 2020 from the District.

- Further, if the Redwood WWTP is to be used to treat this flow, it should be designed for effluent limitations at the plant for one of two possible situations:

    - Effluent limitations as established by OAR 340-41-375 or as shown in Table 5-4.

    - Effluent limitations as established by OAR 340-41-026 or as shown in Table 5-5.

    An evaluation of the cost and consequences of each of these effluent limitations should be conducted.

Also, if the Redwood WWTP is to be used to treat flow from the District, the plant should be upgraded to include the following:

- Significantly reduce or remove chlorine residual in effluent at all times.
- Provide for partial ammonia removal in the treatment process as part of any plant modifications.
- Provide automatic composite sampling equipment to assist making data consistent and reliable.
- Provide variable speed controls on the influent pumps to minimize the impacts of this pump station on the treatment abilities of the plant.
- Add blower capacity to maintain adequate oxygen levels in the aeration basin during peak loadings.

To meet these requirements, a number of alternatives have been developed and analyzed. These alternatives are presented in Section 6.