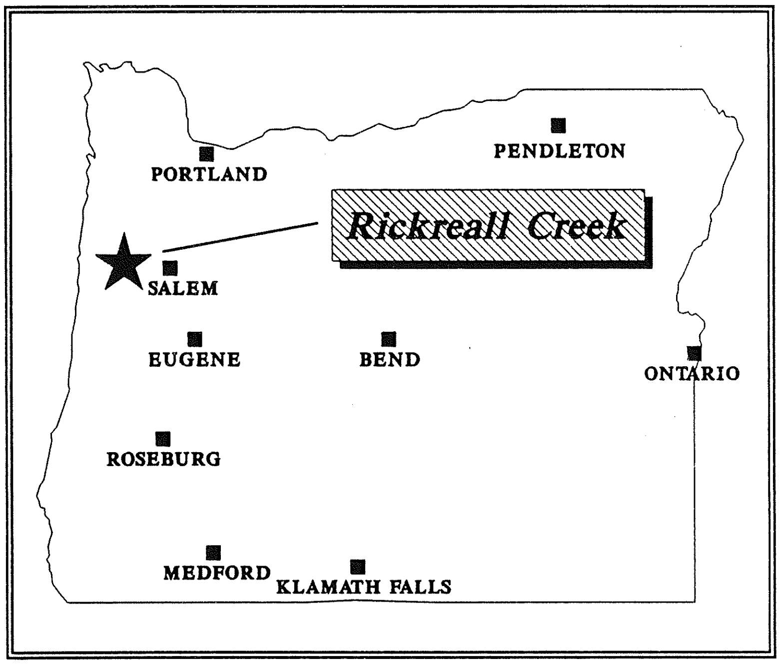
December 1993

Rickreall Creek

Water Quality Report

Total Maximum Daily Load Program



State of Oregon

Department of Environmental Quality
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Rickreall Creek

Water Quality Report

Total Maximum Daily Load Program

This report describes the work that the Oregon Department of Environmental Quality (DEQ) has conducted to address water quality concerns in Rickreall Creek. The assessment is part of the Total Maximum Daily Load (TMDL) process within DEQ's Water Quality Program and reflects the State's water-quality-based approach to water quality problems.

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ACKNOWLEDGMENTS:

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Bonnie Smith .... **Layout Design and Typesetting**
Viola Cinotto .... **Program Support**

Oregon's Total Maximum Daily Load Program

OVERVIEW

BENEFICIAL USES

The quality of Oregon's streams, lakes, estuaries, and groundwaters is monitored by the Department of Environmental Quality (DEQ). The information collected by DEQ is used to determine whether water quality standards are being violated and, consequently, whether the **beneficial uses** of the waters are being threatened. The beneficial uses include fisheries, aquatic life, drinking water, recreation, shellfish, irrigation, hydroelectric power, and navigation. Specific State and Federal rules are used to determine if violations have occurred: these rules include the *Federal Clean Water Act of 1972*, Oregon's Revised Statutes (ORS), and Oregon's Administrative Rules (OAR Chapter 340).

WATER QUALITY LIMITED STREAMS AND TOTAL MAXIMUM DAILY LOADS

The term **water quality limited** is applied to streams and lakes where required treatment processes are being used but violations of water quality standards occur. With a few exceptions, such as in cases where violations are due to natural causes, the State must establish a **Total Maximum Daily Load** or **TMDL** for any waterbody designated as water quality limited. A **TMDL** is the total amount of a pollutant (from all sources) that can enter a specific waterbody without violating the water quality standards.

WASTELOAD AND LOAD ALLOCATIONS

The total permissible pollutant load is allocated to point, nonpoint, background, and future sources of pollution. **Wasteload allocations** are portions of the total load that are allotted to point sources of pollution, such as sewage treatment plants or industries. The wasteload allocations are used to establish effluent limits in discharge permits. **Load allocations** are portions of the total load that are attributed to either natural background sources, such as soils, or from nonpoint sources, such as agricultural or forestry activities. Allocations can also be set aside in reserves for future uses.

TMDL PROCESS

The establishment of TMDLs is required by Section 303 of the Clean Water Act. The process of establishing a TMDL includes studying existing data, collecting additional data to answer specific questions, using mathematical models to predict the effects of changes in wasteloads, evaluating alternative strategies for implementation, and holding public hearings and allowing public comment on the TMDL.

PURPOSE OF THIS REPORT

This report provides information on one of the waterbodies in Oregon's TMDL Program. The report includes background information on the drainage basin, the pollution sources, and the applicable water quality standards; a summary of the monitoring data and the technical analyses; and a discussion of the current pollution control strategy.

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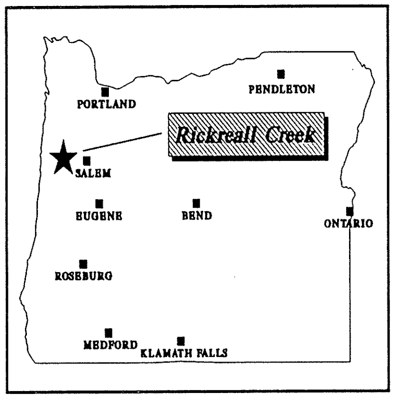
Rickreall Creek

WQ CONCERNS AT A GLANCE:

Water Quality Limited?	Yes
Segment Identifiers:	22H-RICK
Parameter of Concern:	Dissolved Oxygen
Uses Affected:	Aquatic Life
Known Sources:	Point Sources — STP*
	Nonpoint Sources — Agriculture



BACKGROUND INFORMATION

Rickreall Creek is located in the Willamette Basin in northwestern Oregon. The creek drains portions of the Coast Range and flows into the Willamette Valley, eventually meeting the Willamette River at river mile 88, southwest of Salem near the Eola Hills.

The topography of the Rickreall Creek watershed ranges from the relatively flat terraces of the Willamette Valley to the steeper terrain of the Coast Range, which runs north and south through western Oregon. The basin has a mild and temperate climate with a dry summer season and a rainy winter. Over 80 percent of the mean annual precipitation falls between November and April. Land use in the Rickreall Creek drainage basin is predominantly agricultural.

Rickreall Creek bisects the City of Dallas (population 10,000), which is the largest urban area in the basin. The creek runs from west to east through the City, which lies against the foothills of the Coast Range. The creek presently serves as both the drinking water source and the wastewater disposal location for Dallas.

During the summer, flow in Rickreall Creek is controlled by the dam at Aaron Mercer Reservoir, which is located approximately 8.5 miles west of Dallas near the headwaters of the creek.

* Sewage Treatment Plant.

WATER QUALITY CONCERNS

Beneficial Uses Affected

The designated beneficial uses of Rickreall Creek are identified in Oregon's Administrative Rules (OARs). Uses include water supply, aquatic life, recreation, and aesthetics. The beneficial use found to be most at risk in Rickreall Creek is aquatic life, which is listed as "not supported" in the latest Statewide Water Quality Assessment Report [1992 305(b) Report].

The Oregon Department of Fish and Wildlife (ODFW) has reported that the Rickreall Creek Basin supports populations of cutthroat trout and steelhead. Both of these fish are managed in accordance with ODFW's wild-fish management policy; because of limited information, they are listed as "stocks of concern." Coho salmon also use the stream for spawning and rearing. ODFW believes that poor water quality, especially excessive stream temperatures associated with low summer flows, limits use of the mainstem Rickreall Creek by these fish.

Segments and Parameters of Concern

The Rickreall Creek drainage is included in Oregon's water quality standards as part of the Willamette Basin. Water quality monitoring within the creek has shown violations of the State's water quality standard for dissolved oxygen during the summer months. River miles 0 to 20 have been identified as water quality limited for dissolved oxygen in Oregon's 1992 305(b) Report.

The point source discharge from the Dallas sewage treatment plant (STP) has a major influence on the water quality in Rickreall Creek. A total maximum daily load (TMDL) has been prepared to address problems due to low levels of dissolved oxygen and high levels of chlorine and ammonia-nitrogen resulting from the STP discharge. Other parameters of concern which are addressed in the discharge permit for Dallas include temperature, fecal coliform bacteria, total suspended solids, and pH.

Applicable Water Quality Standards

A number of water quality parameters including dissolved oxygen, chlorine, and temperature have criteria values which have been adopted as regulatory standards for the Willamette Basin.

Dissolved Oxygen: Dissolved oxygen is a critical parameter for the protection of aquatic life. ODFW has identified portions of Rickreall Creek immediately below the Dallas STP as salmonid producing. Based on ODFW's reports, DEQ has presumed that the 90-percent and 95-percent saturation criteria apply downstream of the discharge [OAR 340-41-445(2)(a)(E)(i)]. The 95-percent criterion applies during periods of salmonid spawning, incubation, and rearing; 90 percent applies at other times. If more detailed information on the presence of salmonids in the creek is provided, a review of the applicable criteria will be needed.

Chlorine: The Dallas STP does not currently dechlorinate its effluent, and residual chlorine concentrations are above the instream acute toxicity limit of 0.019 milligrams per liter (mg/L) [OAR 340-41-445(2)(p)].

Temperature: High water temperatures can cause adverse impacts on aquatic life. When stream temperatures are 58°F or greater, no measurable increase relative to a control point is allowed; no increase greater than 0.5°F is allowed when stream temperatures are 57.5°F or less [OAR 340-41-445 (2)(b)(C)(i)].

AVAILABLE MONITORING DATA

Very few historical data exist for Rickreall Creek. The largest amount of data which does exist was collected between 1957 and 1973 during the summer months; fewer data are available for the other seasons. The historical data at Highway 51 (river mile 2.2) indicate that dissolved oxygen fell below the 6.0 mg/L concentration criterion for several months during the summer low-flow period; most of the summer values ranged from 5.5 to 6.5 mg/L. Saturation levels of dissolved oxygen also fell below the 90 percent of saturation criterion for several months.

Because of water quality concerns in Rickreall Creek, mixing-zone surveys of the Dallas outfall were conducted by DEQ in August 1988, October 1989, and October 1992. Testing results indicated water quality violations for dissolved oxygen, chlorine, bacteria, and nutrients. (See Appendix C.) During the 1988 mixing-zone survey, poor mixing was observed, with the STP-effluent plume following one bank of the stream.

POLLUTANT SOURCES

Point Sources

The Dallas sewage treatment plant (STP) has been in service since 1969 with year-round discharge to Rickreall Creek at river mile 8.5. The two major industries in the STP's service area — Willamette Industries and Praegitzer Industries — have low levels of biochemical oxygen demand (BOD) and total suspended solids (TSS) in their discharges. Praegitzer Industries uses a pretreatment system.

The average design flow for the STP is 2 million gallons per day (mgd); the maximum design flow is 6 mgd. During extreme wet-weather events, flow to the STP periodically exceeds the hydraulic capacity of the collection system and the plant. Diluted raw sewage overflows to Rickreall Creek during these high-flow events.

Nonpoint Sources

As part of the TMDL process, load allocations for background sources were calculated for ammonia and $CBOD_5$; load allocations for nonpoint sources and reserves were calculated for $CBOD_5$ (Table 1). These load allocations plus the wasteload allocations established for the point source make up the total maximum daily load.

Nonpoint sources can contribute to reduce levels of dissolved oxygen and increased temperatures in streams. Based on available information, however, nonpoint sources do not appear to significantly influence the measured levels of dissolved oxygen saturation in Rickreall Creek above Dallas. Dissolved oxygen measured upstream of the Dallas STP ranges from 90 to 100 percent of saturation. It is DEQ's judgment that the Dallas STP accounts for the majority of the controllable load and the monitored depression in dissolved oxygen near Dallas. It is anticipated that controlling this point source will result in eliminating the observed violations of the dissolved oxygen standard and is a necessary part of the pollution control strategy for the stream.

DEQ does recognize the need to address nonpoint source problems wherever they occur. Interagency agreements between DEQ and the Departments of Agriculture and Forestry will be used to promote Best Management Practices designed to reduce nonpoint sources of pollution in the basin.

POLLUTION CONTROL STRATEGY

Facility Upgrades

DEQ has been conducting evaluations of Rickreall Creek and the impacts of the City's discharge. Results of these evaluations will help to determine the types of facility upgrades which will be needed for the City's discharge to comply with current State water quality standards. Using currently available information, the City of Dallas is developing plans to upgrade its sewage treatment facilities.

TMDLs and Wasteload Allocations

The EPA water quality model QUAL2E was used to analyze the influence of the Dallas STP discharge on Rickreall Creek and to establish total maximum daily loads (TMDLs) and wasteload allocations. The modelling results support the judgment that Rickreall Creek is a water quality limited stream with no remaining assimilative capacity at either low or moderate flows.

The TMDLs and wasteload allocations are intended to limit the introduction of pollutants into Rickreall Creek. TMDLs for a given parameter include wasteload allocations for point sources and load allocations for background and nonpoint sources. Preliminary TMDLs for biochemical oxygen demand (BOD), ammonia, and chlorine in Rickreall Creek were established in 1988; the City of Dallas and the public were notified and provided a chance to comment. Based on additional data collection and mathematical modelling, wasteload allocations were developed for the City of Dallas for BOD, ammonia, and chlorine.

The wasteload allocations for the City of Dallas STP and the loads allocated to background, nonpoint sources, and reserves for BOD and ammonia are listed in Table 1. As listed in the discharge permit for the City of Dallas, the total chlorine residual in the STP effluent shall not exceed a monthly average concentration of 0.012 mg/L and a daily maximum concentration of 0.03 mg/L. (See Appendix F for more information on permit limits.)

Permits

The City's NPDES (National Pollutant Discharge Elimination System) permit expired in August 1989; a renewal permit has been developed based on the TMDLs and wasteload allocations. Because the current treatment facilities cannot meet the revised permit limits, however, the City is operating under a Stipulated and Final Order (SFO) which describes interim limits and imposes a compliance schedule for upgrading the Dallas sewerage facilities. The new Dallas sewerage facilities required by the SFO will be regulated by a new permit with limits and conditions necessary for meeting water-quality and minimum-treatment standards, as appropriate.

Monitoring

The current permit for the City of Dallas STP requires monitoring of influent, effluent, and sludge. Monitoring upstream of the outfall is required for flow and temperature.

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APPENDIX F — PERMIT WASTELOAD ALLOCATIONS

Table 1. Wasteload and Load Allocations for Rickreall Creek

Season and Flow, Q (cfs), in Rickreall Creek	Source	Ammonia (Monthly Average)				$CBOD_5$ (Monthly Average)			
		Concentration (mg/L)	Flow*, Q (cfs)	WLA (lb/d)	UNBOD (lb/d)	Concentration (mg/L)	Flow*, Q (cfs)	WLA (lb/d)	UCBOD (lb/d)
Summer $Q \geq 90$	WLA: STP**	20	3.1	333	1522	10	3.1	170	423
	LA: Background	0.02	90	10	44	2	90	970	2466
	LA: Reserve + NPS	0	0	0	0	2.72	90	1319	3353
Summer $Q < 90$	WLA: STP**	0	0	0	0	0	0	0	0
	LA: Background	0.2	1.5	0.16	0.73	2	1.5	16	41
	LA: Reserve + NPS	0	0	0	0	2.72	1.5	22	56
Winter $Q > 120$	WLA: STP**	20	3.1	333	1522	10	3.1	167	505
	LA: Background	0.02	120	13	59	2	120	1294	3924
	LA: Reserve + NPS	0	0	0	0	1.96	120	1268	3845
Winter $Q = 45$ to 120	WLA: STP**	0.5	3.1	8.3	38.1	5	3.1	83	252
	LA: Background	0.02	45	4.9	22	2	45	485	1471
	LA: Reserve + NPS	0	0	0	0	1.96	45	475	1442
Winter $Q < 45$	WLA: STP**	0	0	0	0	0	0	0	0
	LA: Background	0.02	13	1.4	6.4	2	13	140	425
	LA: Reserve + NPS	0	0	0	0	1.96	13	137	417

* For WLAs, "flow" refers to STP effluent; for LAs, "flow" refers to streamflow.
** City of Dallas Sewage Treatment Plant.

LEGEND:

STP = Sewage Treatment Plant
WLA = Wasteload Allocation
LA = Load Allocation
NPS = Nonpoint Sources
Summer = May 1 to October 31

cfs = Cubic feet per second
CBOD5 = Five-day Carbonaceous Biochemical Oxygen Demand
UNBOD = Ultimate Nitrogenous Biochemical Oxygen Demand
UCBOD = Ultimate Carbonaceous Biochemical Oxygen Demand
Winter = November 1 to April 30

APPENDIX A

BACKGROUND INFORMATION

BASIN DESCRIPTION

Rickreall Creek is located in the Willamette Basin in northwestern Oregon. The creek drains portions of the Coast Range and flows into the Willamette Valley, eventually meeting the Willamette River at river mile 88, southwest of Salem near the Eola Hills.

The creek bisects the City of Dallas (population 10,000), which is the largest urban area in the basin. The creek runs from west to east through the City, which lies against the foothills of the Coast Range. The creek presently serves as both the drinking water source and the wastewater disposal location for Dallas.

During the summer, flow in Rickreall Creek is controlled by the dam at Aaron Mercer Reservoir, which is located approximately 8.5 miles west of Dallas near the headwaters of the creek. The City of Dallas owns and operates the dam. Water is discharged as needed for consumption and to supplement periods of low streamflows. According to the 1989 Dallas Water Supply Study prepared by the City's consultant, Dallas owns water rights totalling 5.33 cubic feet per second (cfs) from streamflow and 10 cfs from reservoir storage.

WILDLIFE

The Oregon Department of Fish and Wildlife (ODFW) has reported that the Rickreall Creek basin supports populations of cutthroat trout and steelhead. Both of these fish are managed in accordance with ODFW's wild-fish management policy; because of limited information, they are listed as "stocks of concern." Coho salmon also use the stream for spawning and rearing. ODFW believes that poor water quality, especially excessive stream temperatures associated with low summer flows, limits use of the mainstem Rickreall Creek by these fish.

ODFW has identified portions of Rickreall Creek immediately below the discharge for the Dallas sewage treatment plant (STP) as salmonid producing. Based on ODFW's reports, DEQ has presumed that the 90- and 95-percent saturation criteria apply downstream of the discharge: the 95-percent criterion applies during periods of salmonid spawning, incubation, and rearing; the 90-percent criterion applies at other times. If more detailed information on the presence of salmonids in the creek is provided, a review of the applicable criteria will be needed.

TOPOGRAPHY AND SOILS

The topography of the Rickreall Creek watershed ranges from the relatively flat terraces of the Willamette Valley to the steeper terrain of the Coast Range, which runs north and south through western Oregon.

Soils found throughout the area are predominantly of the Abiqua series, consisting of well-drained soils formed from mixed silt and clay alluvium. The fine-grained soils occupy nearly level terraces or gently sloping alluvial fans. Permeability is moderately slow, surface runoff is slow, and the erosion hazard is slight. Other soil series found in the area include the Cove, Bellpine, Suver, and Salkum series.

CLIMATE

The Rickreall Creek basin has a mild and temperate climate with a dry summer season and a rainy winter. Moisture from the Pacific Ocean is carried by westerly winds and falls as precipitation on the Coast Range. Precipitation decreases as the winds flow eastward into the Willamette Valley. On the east side of the Coast Range, the amount of rainfall decreases sharply on the lower slopes and on the valley floors.

Between 1951 and 1980, average temperatures (in degrees F) ranged from the low 30s to the mid 80s; average precipitation was 49.1 inches. Lowest temperatures and highest rainfall typically occur in January; highest temperatures and lowest rainfall typically occur in July. Although summer days can be consistently sunny, continuous and prolonged hot weather is rare and nights are generally cool. Similarly, continuous and prolonged subfreezing weather is rare during the winter. Snowfall is usually light, averaging only a few inches per year. Over 80 percent of the mean annual precipitation falls between November and April.

URBAN AREAS — THE CITY OF DALLAS

The City of Dallas (population: 10,000) is located in Polk County. The total area encompassed by the Urban Growth Boundary is 3,884 acres. Land use in the Rickreall Creek drainage basin is predominantly agricultural. Dallas has historically seen cyclical but steady growth. Substantial growth occurred in the 1960s and 1970s, but growth slowed in the early 1980s. The City's growth resumed at a moderate pace during the late 1980s and into the early 1990s. Future growth in Dallas is projected to continue on the basis of a diversified local economy, attractiveness as a place to live, and proximity to the Salem metropolitan area, which is also expecting continued growth.

WATER QUALITY CONCERNS

During summer months, the low streamflow in Rickreall Creek does not provide adequate dilution for assimilation of the effluent from the sewage treatment plant which serves the City of Dallas. The inadequate dilution results in seasonal violations of water quality standards. Specific violations reported by DEQ include an inadequate outfall mixing zone, exceedance of acute and chronic chlorine toxicity levels during summer low-flow conditions, low dissolved oxygen, and high levels of bacteria.

Rickreall Creek has been designated as a water quality limited stream during the summer months because of low levels of dissolved oxygen and high levels of chlorine and ammonia-nitrogen. Additional parameters of concern are fecal coliform bacteria, nutrients, temperature, and total suspended solids.

APPENDIX B

APPLICABLE WATER QUALITY STANDARDS

PROTECTION OF BENEFICIAL USES

Within the State of Oregon, water quality standards are published pursuant to Oregon Revised Statutes (ORS) 468.020. Authority to adopt rules, regulations, and standards as are necessary and feasible to protect the environment and health of the citizens of the State is vested with the Environmental Quality Commission. Through the adoption of water quality standards, Oregon has defined the beneficial uses to be protected in each of its drainage basins and the criteria necessary to protect those uses.

BENEFICIAL USES AFFECTED

Oregon Administrative Rules (OAR) Chapter 340, Division 41, Rule 442, lists the beneficial uses for which water quality will be protected in the Willamette Basin. These are identified in Table B-1. This list of beneficial uses was established by the Oregon Water Resources Commission pursuant to direction given in ORS 536.300. As charged by ORS 468.020, the Oregon Environmental Quality Commission adopted rules and standards that were necessary to protect those recognized beneficial uses. In practice, water quality rules and standards have been set at levels to protect the most sensitive of the uses: aquatic life and human health. Assessment activities in Rickreall Creek have determined that the beneficial use of aquatic life is not fully supported. Criteria by which support levels were evaluated are listed in Table B-2.

SEGMENTS AND PARAMETERS OF CONCERN

The Rickreall Creek drainage is included in Oregon's water quality standards as part of the Willamette Basin. Water quality monitoring within the creek has shown violations of the State's dissolved oxygen standard during the summer months. River miles 0 to 20 have been identified as water quality limited for dissolved oxygen in Oregon's Statewide Water Quality Status Assessment Report [1992 305(b) Report]. Temperature, chlorine, bacteria, and nutrients are also parameters of concern.

APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

A number of water quality parameters have criteria values which have been adopted as regulatory standards for the Willamette Basin. Included are temperature, turbidity (also referred to as total suspended solids or TSS), pH (a measure of acidity), dissolved oxygen, fecal coliform bacteria, and dissolved chemical substances.

Seasonal violations of State water quality criteria have been documented by DEQ in Rickreall Creek. Specific violations reported by DEQ include an inadequate effluent-outfall mixing zone, exceedance of both acute and chronic chlorine-toxicity levels during summer low streamflows, and exceedance of dissolved oxygen criteria. During the summer months, there is inadequate dilution of the Dallas STP effluent by Rickreall Creek. The stream cannot assimilate waste discharges during the low-flow, dry-weather season.

Dissolved Oxygen

The Oregon Department of Fish and Wildlife has identified the area for at least two miles below the STP outfall for the City of Dallas as salmonid producing. The Oregon water quality

Table B-1. Beneficial Uses to be Protected in the Willamette Basin

BENEFICIAL USES	
Public Domestic Water Supply[1]	Resident Fish & Aquatic Life
Private Domestic Water Supply[1]	Anadromous Fish Passage
Industrial Water Supply	Salmonid Fish Passage
Irrigation	Salmonid Fish Spawning
Livestock Watering	Fishing
Boating	Wildlife & Hunting
Water-Contact Recreation	Commercial Navigation & Transportation
Aesthetic Quality	Hydropower

[1]With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

Source:

Oregon Administrative Rules, Chapter 340, Div. 41, — DEQ Table 6, Willamette Basin.

Table B-2. Beneficial Use Support Criteria

FISHERIES AND AQUATIC LIFE	
Partially Supported	10% exceedence of basin DO concentration or DO % saturation standard.
	10% exceedence of basin pH standard.
Not Supported	25% exceedence of basin standard for DO concentration or DO % saturation.
	25% exceedence of basin pH standard.
WATER CONTACT	
Partially Supported	10% exceedence of enterococcus upper-range standard.
Not Supported	25% exceedence of enterococcus upper-range standard.
AESTHETICS	
Partially Supported	10% exceedence of 15 μg/L chlorophyll a.
	25% exceedence of 0.1 mg/L total phosphorus.
Not Supported	25% exceedence of pH standard for basin.

Source:

Oregon's 1992 Water Quality Status Assessment Report (305(b)) Report; pp. B3—6.

standard for dissolved oxygen (DO) in the Willamette Basin states that for salmonid-producing waters, "the DO concentration shall not be less than 90 percent of saturation at seasonal low or less than 95 percent of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes." [OAR 340-41-445-(2)(a)(E)(i)]

Mixing Zone

National Pollutant Discharge Elimination System (NPDES) permits for sewage treatment plants define an outfall mixing zone around the point of discharge. According to OAR 34-41-445 (4)(b)(B)(i) and (ii), "the water outside the boundary of the mixing zone must be free of materials in concentrations that will cause chronic (sublethal) toxicity...," and it must "meet all other water quality standards under normal annual low-flow conditions." According to OAR 340-41-445 (4)(b)(A)(i) and (ii), "the water within the mixing zone shall be free of materials in concentrations that will cause acute toxicity to aquatic life as measured by a Department approved bioassay method." The mixing zone must allow a portion of the stream width for free passage of aquatic life [OAR 340-41-445 (4)(c)(C)].

Chlorine

Instream acute and chronic toxicity criteria for chlorine are defined as concentrations of 0.019 and 0.011 milligrams per liter (mg/L), respectively [OAR 340-41-445(2)(p)]. Although the existing chlorine-gas disinfection system adequately disinfects effluent to meet the existing 200-count fecal coliform standard, chlorine toxicity in Rickreall Creek has been cited by DEQ as a violation of water quality standards. The Dallas STP does not currently dechlorinate its effluent, and residual chlorine concentrations are above the acute toxicity limit. Effluent limits for chlorine (see Appendix F) were established based on mixing zone analyses. A dechlorination system may be required if chlorine disinfection is continued; an alternative disinfection process, such as ultraviolet radiation, should be considered.

Temperature

According to OAR 340-41-445 (2)(b)(C)(i), "no measurable increases shall be allowed outside of 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..."

Bacteria

OAR-340-41-445 (2)(e) establishes numeric criteria for fecal coliform and for enterococci. Part (A) requires for freshwaters: "A log mean of 200 fecal coliform per 100 milliliters based on a minimum of five samples in a 30-day period with no more than ten percent of the samples in the 30-day period exceeding 400 per 100 ml." Part (B) requires for freshwaters: "A geometric mean of 33 enterococci per 100 milliliters based on no fewer than five samples, representative of seasonal conditions, collected over a period of at least 30 days. No single sample should exceed 61 enterococci per 100 ml."

APPENDIX C

AVAILABLE MONITORING DATA

Robert Baumgartner, Water Quality Division, DEQ

HISTORICAL DATA

Very few historical data are available for Rickreall Creek. The largest amount of data which does exist was collected during the summer months; fewer data are available for the other seasons.

Dissolved Oxygen

The most abundant amount of data exists for the monitoring site at Highway 51 (river mile 2.2) near the mouth of Rickreall Creek. Data were collected from 1957 until 1973. The historical data at Highway 51 indicate that dissolved oxygen fell below the 6.0 mg/L concentration criteria for several months during the summer low-flow period; most of the summer values ranged from 5.5 to 6.5 mg/L. Saturation levels of dissolved oxygen also fell below the 90 percent of saturation criteria for several months.

Most of the historical data were collected in the afternoon, when a tendency exists for higher dissolved oxygen values. Recent dissolved oxygen data collected during early October are higher than would be expected from review of the historical data, although the lack of historical data collected in October makes direct comparisons difficult.

Temperature

The temperature data for the site at Highway 51 show typical afternoon temperatures exceeding 20 degrees C for several months during the summer. Recent data collected in October appears to be consistent with the long-term pattern.

RECENT DATA

Mixing-Zone Survey — August 1988

In August 1988, DEQ conducted a mixing-zone survey of the Dallas outfall in Rickreall Creek. During the mixing-zone survey, poor mixing was observed, with the STP-effluent plume following one bank of the stream. Testing results also indicated that state or federal water quality criteria for chlorine, bacteria, and nutrients were exceeded.

During the 1988 survey, STP-effluent and instream fecal coliform and enterococcus were tested. The STP-effluent fecal-coliform count was 60 colonies per 100 ml and the enterococcus count was less than 4 colonies per 100 ml; both values are below water quality criteria. Measured upstream concentrations in Rickreall Creek were 400 for fecal coliform and 100 for enterococcus. At 100 to 200 feet downstream of the outfall, individual sample counts varied from 280 to 1740 for fecal coliform and 80 to 1720 for enterococcus.

Mixing-Zone Survey — October 1989

In October 1989, DEQ conducted an extended mixing-zone survey of Rickreall Creek. Continuous dissolved oxygen monitors were employed to provide information on the diurnal variation in dissolved oxygen, conductance, temperature, and pH. From these data, it was observed that the diurnal range of dissolved oxygen was greater at a site below the STP than at a site above the STP (3.1 mg/L-day versus 1.55 mg/L-day, respectively). The minimum diurnal range of dissolved oxygen on one of the three days sampled fell below 6.0 mg/L.

(See Appendix E for more information.)

Screening Survey — October 1992

A screening water-quality survey using continuous monitors was conducted on Rickreall Creek during October 5-7, 1992. Review of the data showed a larger than expected amount of variation between recordings. This degree of variation is uncommon for these recorders and limits the level of confidence in the data. However, the data were used to describe the diurnal trends in dissolved oxygen. (See Appendix E for more information.)

Streamflow Data Summary

The U.S. Geological Survey maintained a gauge on Rickreall Creek near Dallas at river mile 19.1 for the years 1961 to 1968. Table C-1 lists summary statistics for monthly flows at this station.

Significant additional flow may occur between the gauge site and the municipal discharge. USGS developed a regression equation for extrapolating flows from gauged streams to ungauged streams in western Oregon. Using this equation plus estimates of additional basin area, stream slope, and other factors, a multiplier of 1.5 was developed to extrapolate monthly averaged flows at the gauge at RM 19.1 to monthly averaged flows at Dallas just above the treatment plant discharge.

Table C-1. Flow Statistics — River Mile 19.1 (1961 – 1968)

Month	Mean (USGS)	Min (USGS)	7Q10 Calculated
October	29	3.2	2.5
November	210	20	13.1
December	378	9.6	52.2
January	397	13	80.1
February	273	60	70.1
March	249	72	77.8
April	119	52	41.1
May	61	25	29.2
June	22	8.5	10.9
July	7.5	3.5	3.7
August	4.8	1.0	1.4
September	6.6	1.8	1.7

APPENDIX D

POLLUTANT SOURCE SUMMARY

POINT SOURCES

City of Dallas – Sewage Treatment Plant (STP) — The Dallas sewage treatment plant (STP) has been in service since 1969 with year-round discharge to Rickreall Creek.

System Design

The existing sanitary wastewater collection system for the City of Dallas collects wastewater from residences, businesses, industries, and public facilities and conveys the water to the City's sewage treatment plant. Not including parks and open space, approximately 1,800 acres within the Urban Growth Boundary are presently sewered. The existing STP is located approximately two miles east of the City and is adjacent to Rickreall Creek; the outfall is located at river mile 8.5. The STP provides secondary treatment of waste, with an average design flow of 2 million gallons per day (mgd) and a maximum design flow of 6 mgd. During extreme wet-weather events, flow to the STP periodically exceeds the hydraulic capacity of the collection system and the plant. Diluted raw sewage overflows to Rickreall Creek during these high-flow events.

The plant was originally designed to treat seasonal high-strength food-processing wastes, but the cannery is no longer in operation. The original design criteria included effluent limitations of 30 milligrams per liter (mg/L) each for biochemical oxygen demand (BOD) and total suspended solids (TSS). In 1974, summer effluent limitations in the City's NPDES permit (#3872-J) were lowered to 10 mg/L each for BOD and TSS.

Inflow and Infiltration (I/I)

Flows to the plant follow a conventional wet-season/dry-season pattern: flows are typically at a minimum in September and peak in January. During dry weather (May through October), average daily flow has averaged 1.60 mgd over the 5-year period from 1988 to 1992. During wet weather (November through April), average daily flow has averaged 3.15 mgd. During extreme storm events, maximum flows periodically exceed the plant's nominal hydraulic capacity of 6 mgd due to "inflow and infiltration" (I/I) entering the collection system from runoff and high groundwater conditions. Due to the dilution effect of I/I, BOD and TSS concentrations in wastewater entering the plant are consistently lower in the wet-weather season than in the dry-weather season.

During the past 10 years, the City's locally-funded I/I correction program has achieved a reduction in the number, frequency, and duration of wet-weather bypasses. However, during periods of intense rainfall, bypassing still occurs at the STP-influent pump station, resulting in periodic discharges of untreated sewage to Rickreall Creek.

Industries

Major industries in the area are Willamette Industries and Praegitzer Industries. Willamette Industries processes timber; Praegitzer manufactures printed-circuit boards. Willamette Industries estimates that only 50 percent of the water they use is returned to the sanitary sewer. Currently, neither industry foresees significant increases in their flows to the wastewater collection system.

Because of the large volume of industrial flow from the two major industries, which add little BOD and TSS, wastewater entering the STP (influent) is dilute. Concentrations of BOD and TSS in treated water leaving the plant (effluent) are typically below 10 mg/L during dry weather and wet weather.

The concentration of metals in sludge from the

Dallas STP have been reduced over the last few years. Installation and startup of a new pre-treatment system at Praegitzer Industries has probably contributed to this decrease.

Plans for Facility Upgrade

DEQ has been conducting evaluations of Rickreall Creek and the impacts of the City's discharge. Results of these evaluations will help to determine the types of facility upgrades which will be needed for the City to meet current State water quality standards. Based on information currently available, the City of Dallas is developing plans to upgrade its sewage treatment facilities.

The City's NPDES Waste Discharge Permit expired in August 1989; a renewal permit has been developed based on total maximum daily loads (TMDLs) and wasteload allocations (WLAs) — see Appendix F. Because the current treatment facilities cannot meet the revised permit limits, however, the City is operating under a Stipulated and Final Order (SFO) which describes interim limits and imposes a compliance schedule for upgrading the Dallas sewerage facilities. The new Dallas sewerage facilities required by the SFO will be regulated by a new permit with limits and conditions necessary for meeting water-quality and minimum-treatment standards, as appropriate.

Stipulated and Final Order (SFO)

On December 19, 1991, DEQ presented the City of Dallas with a Notice of Noncompliance relating to the City's NPDES permit limits. Noncompliance issues include:

- Less than 85 percent removal of BOD/TSS. This is largely due to wet-weather infiltration and inflow (I/I) and dilute industrial wastewater. The dilute influent makes it more difficult to achieve 85 percent removal.
- Wet-weather bypasses.
- Inadequate reliability (e.g., inadequate stand-by power and backup equipment).
- Seasonal violations of State water quality criteria for dissolved oxygen, fecal coliform bacteria, and chlorine toxicity.
- Exceedence of outfall mixing-zone limits.

The City and DEQ entered into a Stipulation and Final Order agreement on June 30, 1992. The agreement contained the following compliance needs:

- A public notification plan that describes the process for informing the public during periods of discharge of untreated sewage.
- A comprehensive draft facilities plan that describes proposed facility upgrades.
- Final plans and specifications for new wastewater treatment facilities; these plans must be submitted within 10 months after DEQ issues a new NPDES discharge permit.
- New sewage treatment facilities must be operational within 30 months of DEQ approval of final plans and specifications.

NONPOINT SOURCES

As part of the TMDL process, load allocations for background sources were calculated for ammonia and $CBOD_5$; load allocations for nonpoint sources and reserves were calculated for $CBOD_5$ (See Appendix F). These load allocations plus the wasteload allocations established for the point source make up the total maximum daily load.

Nonpoint sources can contribute to reduce levels of dissolved oxygen and increased temperatures in streams. Based on available information, however, nonpoint sources do not appear to significantly influence the measured levels of dissolved oxygen saturation in Rickreall Creek above Dallas. Dissolved oxygen measured upstream of the Dallas STP ranges from 90 to 100 percent of saturation. It is DEQ's judgment that the Dallas STP accounts for the majority of the controllable load and the monitored depression in dissolved oxygen near Dallas. It is anticipated that controlling this point source will result in eliminating the observed violations of the dissolved oxygen standard and is a necessary part of the pollution control strategy for the stream.

DEQ does recognize the need to address nonpoint source problems wherever they occur. Interagency agreements between DEQ and the Departments of Agriculture and Forestry will be used to promote Best Management Practices designed to reduce nonpoint sources of pollution in the basin.

APPENDIX E

TECHNICAL WATER QUALITY ANALYSIS

Robert Baumgartner, Water Quality Division, DEQ

OVERVIEW

Water quality studies conducted by DEQ have indicated that Rickreall Creek may be unable to fully assimilate effluent from the Dallas sewage treatment plant, particularly at low flows. The results of continuous dissolved oxygen (DO) monitoring conducted above and below the treatment plant in October 1989 indicate that, on a daily basis, oxygen levels drop below the DO criteria applicable to salmonid-producing streams. Downstream DO levels were lower than upstream DO levels. Streamflows which coincided with the monitoring were about five cubic feet per second (cfs).

QUAL2E MODEL

The EPA water quality model QUAL2E was used to analyze the influence of the Dallas STP discharge on Rickreall Creek. Limited data were available to aid in the calibration of the model, thus default values or values recommended by the EPA Center for Exposure Assessment Modelling were used for many parameters. The available data provide a basis for explaining observed conditions and provide a reasonable forecast of what may occur under alternative conditions.

MODELLING RESULTS

The modelling results support the judgement that Rickreall Creek is a water quality limited stream with no remaining assimilative capacity at either low or moderate flows. For DO levels to stay above the DO criteria, flow has to be considerably above the observed minimum, and sewage effluent from the Dallas treatment plant has to be treated to a high level.

It should be noted that the model provides daily average values for concentrations but does not adequately simulate the diurnal variations that will occur. The results of stream sampling in October 1992 indicate that the diurnal variation in DO is on the order of 1.5 mg/L. For a particular set of model conditions, if the ***average*** DO level is equal to the DO standard of 90 percent of saturation, then the ***minimum*** DO level will fall below the standard due to the diurnal variation.

APPLICABLE DISSOLVED OXYGEN CRITERIA

Based on information from the Oregon Department of Fish and Wildlife, Rickreall Creek is being considered by DEQ as salmonid producing. Therefore, the 95 percent of saturation criterion for dissolved oxygen should be applied during times of salmonid spawning, incubation, and rearing (typically during the winter); the 90 percent of saturation criterion should be applied at other times.

AVAILABLE DATA

Three limited data sets were available for use in the model: extended mixing-zone sampling conducted during low-flow conditions (August 1989); downstream water quality sampling conducted during high flows (April 1992); and additional low-flow sampling (October 1992).

MODEL PARAMETERS

Title Data

Conductivity and total dissolved solids were modelled as conservative tracers. The following were also modelled: temperature, dissolved oxygen, BOD (as ultimate CBOD), algae, phosphorus, ammonia-nitrogen, nitrite-nitrogen, and dissolved phosphorus. Fecal coliform was not modelled.

Program Control Data

Hydraulics were modelled as trapezoidal cross-sections and as power functions. This is discussed in more detail in the section on hydraulics data. It should be noted that the model is only capable of simulating steady-state conditions; the assumption of steady state is not valid for the high-flow conditions observed in April. However, the relative influence of the discharge appears to be reasonably explained using the steady-state assumption.

Global Algal, Nitrogen, Phosphorus, and Light Parameters

These parameters and constants apply to all reaches and represent the kinetics of the algal growth, nutrient, and light interactions. Suggested or default parameters were used.

Temperature Correction Factors (theta values)

Several of the processes represented in QUAL2E are affected by temperature. Default values for the various temperature correction factors were used.

Reach Identification

Several reaches were identified both above and below the discharge from Dallas. Reaches were defined by changes in slope as determined from USGS quadrangle 15-minute (1:24,000) series maps. Each river mile where a contour interval appeared to cross the creek was identified as a separate reach. The slope for each reach was obtained by dividing the drop by the reach length. Additional reaches were identified for the area immediately below the Dallas STP, as well as for the tributary slough at river mile 5 and the section of the creek immediately below the slough.

Hydraulics Data

There are two options available in QUAL2E for modelling stream hydraulics. In the first option, velocity and depth are modelled according to a set of power functions. In the second option, each reach is represented as a trapezoidal channel. Initial evaluation of the low-flow and high-flow conditions used the trapezoidal option. Although the trapezoidal cross-sections represented streamflow for conditions similar to those measured, they appeared questionable at substantially different flows. Power functions were used to interpolate to alternative flow conditions.

Two sets of data — one at low flow and one at high flow — were used to estimate stream velocity, depth, and width. Different stream profiles and Manning's roughness coefficients were used for the high-flow and low-flow conditions. For the measured flows, the cross-sectional area and wetted perimeter could be calculated. Slopes were estimated from USGS quadrangle maps. By rearrangement of the Manning's equation, the roughness coefficient could be calculated from the slope and cross-sectional profiles. For reaches where flow was not measured, the closest cross-section and roughness coefficients were applied.

Under high-flow conditions (100 cfs), the channel geometry was generally "U" shaped. Roughness coefficients of approximately 0.04 were calculated. Under low-flow conditions (5 cfs), more complex trapezoids were identified. Roughness coefficients on the order of 0.6 to 1.0 were calculated. These coefficients are much higher than typical stream coefficients of near 0.03.

Under low-flow conditions, Rickreall Creek does not conform to the open-channel flow for which Manning's equation applies; the creek may act more like a series of impoundments behind weirs, pools, and riffles. In such cases, the Manning's roughness coefficient simply becomes an empirical value used to relate observed velocity to stream profile.

For a limited number of locations, streamflow hydraulics data are available for both high- and low-flow conditions. For these locations, stream velocity and depth were empirically related to flow using the power function, velocity = aQ^b. For reaches where flow measurements were not available, the power functions were determined using values estimated from the trapezoidal calculations developed for low- and high-flow conditions.

Temperature and Local Climatology Data

This group of data supplies the air temperature and climatological information for steady-state water temperature simulation. Data obtained from the nearest gauge (at Salem) were entered for the different months simulated by the model. A shading factor of 50 percent was assumed based on discussions with the consultant for the City of Dallas.

Reaction Rate Constants for BOD and Dissolved Oxygen

This data set includes values for the BOD decay-rate coefficient, the BOD settling rate, and the sediment oxygen demand. The method by which the reaeration coefficient will be determined is also defined in this portion of the model input.

A low BOD decay rate of 0.1/day (temperature corrected) was assumed for summer conditions, along with a value of zero for the rate of BOD settling based on the observed effluent quality of near 10 mg/L CBOD or less. These values were assumed to be constant for the various reaches. Under winter conditions and an assumed 20 mg/L of CBOD, a decay rate of 0.15/day (temperature corrected) was used. A higher decay rate may be associated with higher effluent concentration.

The O'Connor and Dobbins formulation (1958) was selected for calculating the reaeration coefficient. This formulation makes use of stream depth and velocity measurements to estimate reaeration. A low value of 0.04 g/ft^2-day was assumed for SOD for most of the stream. Based on the DO levels measured downstream of the Dallas treatment plant, a higher value of 0.2 g/ft^2-day was assigned to the 0.4 miles just below the treatment plant. (For further discussion, see section on ***"Sediment Oxygen Demand"***.)

N and P Coefficients

This data set makes it possible for QUAL2E to simulate the concentration of algae as well as the components of the nitrogen series and the phosphorus series. Except for the value of the rate coefficient for ammonia, default values were used. The rate coefficient for ammonia varied from 1.0 to 5.0 depending upon the reach. A temperature-adjusted rate of 3.0/day, typical of shallow (1- to 3-feet deep) streams was assumed for Rickreall Creek. The high rates may not be significant when ammonia levels in effluent are low (<1.0 mg/L), but will be significant when levels are higher.

Algae and Other Coefficients

Default values or recommended values were used. Sampling results from the fall and spring periods indicate that algal growth is not significant.

DIURNAL VARIATION

An extended mixing-zone survey of Rickreall Creek was conducted by DEQ during three consecutive days in October 1989 using continuous monitors to measure dissolved oxygen, conductance, temperature, and pH. Evaluation of the data indicated that the diurnal range of dissolved oxygen was greater below the STP (3.1 mg/L-day) than above the STP (1.55 mg/L-day). On one of the three days of the survey, the minimum value observed fell below the State's dissolved oxygen criterion of 6.0 mg/L.

Review of the continuous monitoring data collected during October 1992 shows a larger than expected amount of variation between recordings. Although this variability limits our level of confidence in the data, the data were used to describe the diurnal trends in dissolved oxygen. The data, which were smoothed by regression using a modified Fourier series, appeared to follow a sinusoidal pattern for the days sampled (Figure E-1). The regression sine curve was assumed to simulate the actual diurnal variation in dissolved oxygen.

Ambient dissolved oxygen monitoring data used to estimate the influence of the Dallas STP discharge on the receiving water were corrected

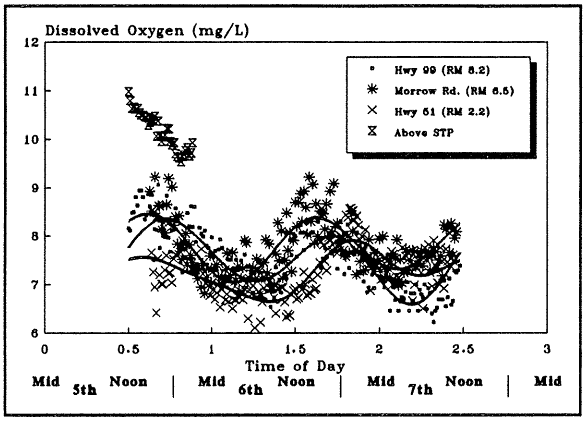

Figure E-1. Observed Levels of Dissolved Oxygen at Selected Locations in Rickreall Creek Near Dallas (October 5-7, 1992).

for daily averaged values using the sine function for the continuous monitor located nearest to the ambient station. Daily averaged dissolved oxygen upstream of the STP was assumed to be 100 percent of saturation.

Streamflow measurements were used for calculating depth, velocity, and reaeration. These data, along with the predictions for diurnal variation, were used to estimate areal dissolved oxygen production using methods described by Di Toro (1981) and Thomann and Mueller (1987). The estimated dissolved oxygen production values based on data from two sampling events (1989 and 1992) are presented in Table E-1. Comparisons of data should be made with caution, however, due to the variability in the continuous-monitor data for 1992 and the occurrence of rainfall during the 1992 survey.

SEDIMENT OXYGEN DEMAND

A sediment oxygen demand component was included in the QUAL2E analysis of the October 1992 data for Rickreall Creek. Calibration of the model to the observed data indicates the rate of SOD increased to 0.20 g/ft^2-day (2.1 g/m^2-day). The increase in the SOD rate was assumed to apply for 0.4 miles below the Dallas STP (Figure E-2).

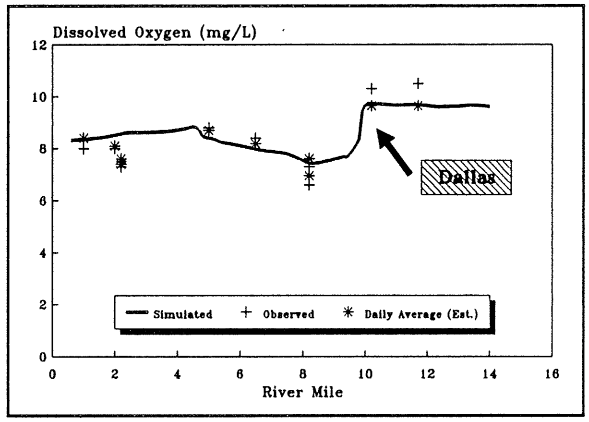

Figure E-2. Observed and Simulated Levels of Dissolved Oxygen in Rickreall Creek Near Dallas (October 5, 1992).

Increased SOD rates below municipal plants have been reported elsewhere (for example, see EPA 1985: Rate Constant Kinetics). In that document, Lam, et al., report SOD rates for a variety of conditions:

SOD (g/m^2):	7.0	spaerolitus
	4.0	municipal sludge below STP
	1.5	"aged" municipal sludge below STP
	1.5	estuarine mud
	0.5	sandy bottoms
	0.07	mineral soils.

Table E-1. Dissolved Oxygen Production Values

Location	1989 Data	1992 Data
Upstream (RM 11)	9.6 mg/L	Data void
Highway 99 (RM 9.9)	12.9 mg/L	5 mg/L
Morrow Rd. (RM 6.5)	Not sampled	5 mg/L
Highway 51 (RM 2.2)	Not sampled	3 mg/L

The SOD rate is entered as a constant into the model; the rate may vary with temperature but is not linked to other variables in the model. The assumed SOD rate incorporates the effect of all benthic production and demand terms. The greater SOD rate determined using the 1992 data may be justified by the significantly lower estimate of benthic dissolved oxygen production.

The inclusion of SOD and temperature in the modelling analysis for data collected during October 1989 results in a decrease in the estimated dissolved oxygen. The increased SOD may provide a better simulation of the diurnal data than the observed ambient dissolved oxygen data (Figure E-3).

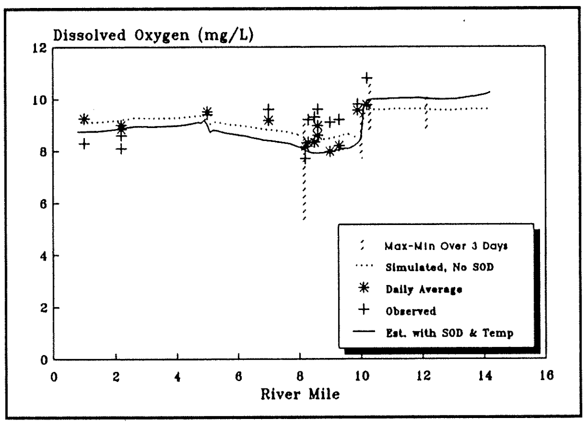

Figure E-3. Observed and Simulated Levels of Dissolved Oxygen in Rickreall Creek Near Dallas (October 5, 1989).

APPLICATION OF MODEL

Figures E-4 and E-5 illustrate the model results for dissolved oxygen based on data from April 1992 (high flows) and October 1989 (low flows).

High Flows

The high-flow data (April) indicate that the discharge from the Dallas STP (RM 8.5) has little influence on instream dissolved oxygen saturation: observed and predicted values were near or above 100 percent of saturation. Increases in ammonia (from 20 to 60 μg/L), dissolved solids (from 50 to 60 mg/L), and bio-

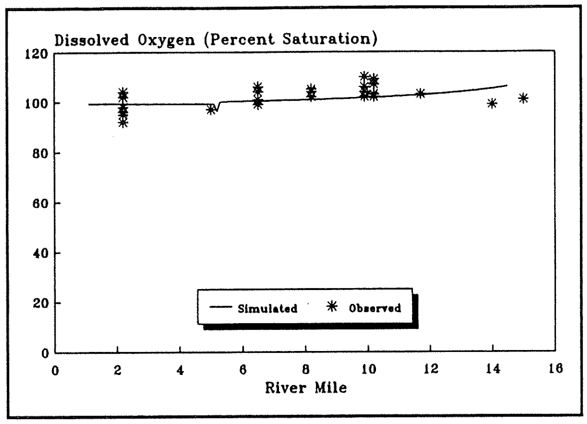

Figure E-4. Observed and Simulated Levels of Dissolved Oxygen in Rickreall Creek Near Dallas (April 1992).

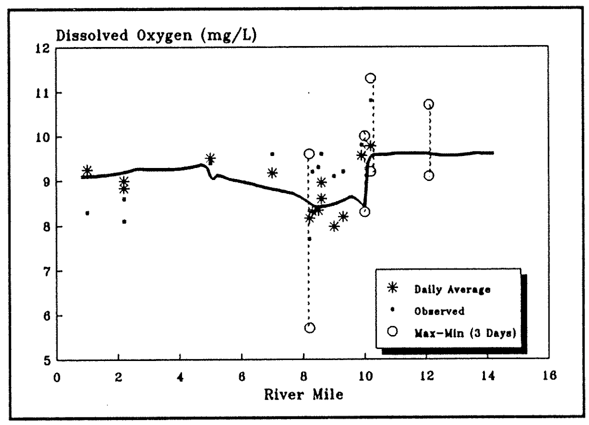

Figure E-5. Observed Levels of Dissolved Oxygen in Rickreall Creek Near Dallas (October 1989).

chemical oxygen demand (from 1 to 1.5 mg/L) were associated with the STP discharge.

Review of sampling data compared with model predictions resulted in underestimating total dissolved solids (TDS) and NH_3 below river mile 4. The increase in the conservative tracer (TDS) and other parameters indicate that additional flow and pollutants may be entering the stream; these were not accounted for in the analysis.

Low Flows

During the October period of low streamflow, discharge from the Dallas STP into Rickreall Creek results in a decrease in the dissolved oxygen concentration. Much of the loss of dissolved oxygen is due to the low dilution ratio and relatively low concentration of oxygen (4 to 6 mg/L) in the effluent.

Diurnal Variation

The observed values need to be corrected for the time of day of sampling so that ***simulated*** daily averages can be compared with ***observed*** daily averages. The diurnal variation measured within several days of the ambient monitoring showed an instream variation of near 1.5 mg/L above the STP and greater than 3.0 mg/L below the STP. In Figure E-5, the circles indicate the variation observed over three days. The lower dissolved oxygen observed in the diurnal data is proportional to the mixing ratio. The relatively good quality of the effluent (low ammonia and BOD) acts to mitigate the potential impact of this discharge on water quality.

INFLUENCE OF DILUTION

Although DEQ does not have continuous data for either streamflow or treatment-plant discharge in Rickreall Creek, these can be estimated using conductivity data. The increase in conductivity between the upstream site (above the STP) and the downstream site (below the STP) provides a measure of the increase in dissolved solids, for which the STP is a dominant source. The observed change in conductivity should be representative of the relative dilution of the effluent discharge provided by the stream (Figure E-6).

For a given sampling time, the concentration of dissolved oxygen at the upstream site is greater than at the downstream site. The difference in the concentration of dissolved oxygen between sites is proportional to the increase in conductivity. However, the dissolved oxygen concentrations are influenced by the time of day the samples were collected (Table E-2). Because the range of diurnal variation is greater downstream than upstream, there will be a greater difference between upstream and downstream samples collected in the morning than in the same locations sampled in the afternoon.

Primary Productivity

The observed increase in diurnal variation below the Dallas STP could be the result of several factors. An increase in photosynthetically active periphyton could increase the diurnal variation in dissolved oxygen; sampling notes indicate an increase in periphyton biomass below the STP. Physical parameters that influence reaeration (such as stream depth and velocity) could also influence the degree of diurnal variation. The changes in dissolved oxygen below the STP may be due to increases in primary production related to the STP discharge. However, the stream appears to have similar levels of production upstream as downstream (see Table E-3).

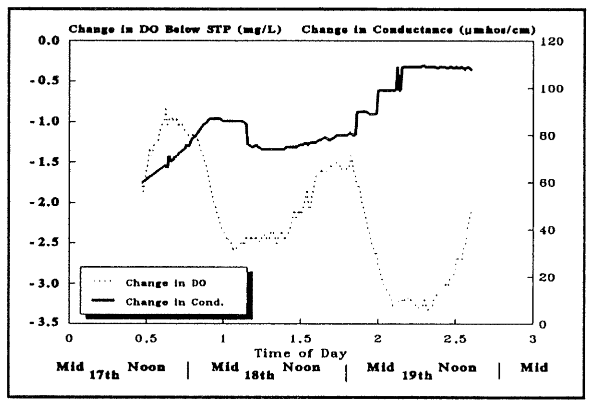

Figure E-6. Changes in Dissolved Oxygen and Changes in Conductance in Rickreall Creek at Highway 99 and Above the Dallas STP (October 17-19, 1989).

Thomann and Mueller (1987), citing Di Toro (1981), develop a simple analytical method relating the observed diurnal variation in dissolved oxygen to reaeration and primary production:

$$P_a = \frac{0.5K_a(1-e^{-K_a t})}{(1-e^{-0.5K_a t})^2}\,\Delta C$$

where delta C is the diurnal change in dissolved oxygen. In this case, the observed change in dissolved oxygen was adjusted for the effect of temperature changes on the saturation levels of oxygen in water. To compare productivity between sites, the calculated production (P_a) was divided by stream depth to represent produc-

Table E-2. Correlation Between Dissolved Oxygen, Conductivity, and Time of Day for Rickreall Creek

Dependent Parameter	Independent Parameter	Correlation Coefficient (r^2)
Change in Dissolved Oxygen (mg/L)	Change in Conductivity (linear)	0.58
Change in Dissolved Oxygen (mg/L)	Time-of-Day (sine)	0.70
Change in Dissolved Oxygen (mg/L)	Change in Conductivity + Time-of-Day	0.96
Change in Conductivity	Time-of-Day (sine)	0.15

tion in units of dissolved oxygen per area of streambed.

Chapra and Di Toro (1991) recommend the following modifications for streams where K_a is less than 5.0/day, such as in Rickreall Creek:

$$\frac{\Delta C}{P_a} = \frac{(1-e^{-0.5K_a})^2}{0.5K_a(1-e^{-K_a})} + 0.0511$$

Results of these applications are presented in Table E-3.

Reaeration

Estimates of reaeration are needed in order to quantify the potential effects of primary production on dissolved oxygen. An assumption inherent in this analysis is that the estimated K_a is representative of the reaeration occurring within the assessed stream reach. Estimates for the reaeration rates vary depending on stream velocity and depth (O'Connor) — Figure E-7.

For the reach below the STP discharge to Highway 99, we have greater detail of the esti-

Table E-3. Estimated Primary Productivity from Diurnal Dissolved Oxygen Measurements: Rickreall Creek, October 1989

Location With Respect to STP	ΔC	K_a	Depth (ft)	Original		Modified	
				P_a	P_a'	P_a	P_a'
Upstream 2 Miles	1.55	3.79	1.07	3.98	12.1	3.52	10.7
Immediately Upstream	1.53	4.77	1.30	4.37	11.1	3.80	9.6
Immediately Downstream	1.36	4.44	1.50	3.75	8.2	3.30	7.2
Hwy 99, 2 Miles Downstream	3.10	2.02	1.54	6.71	14.3	6.04	12.9

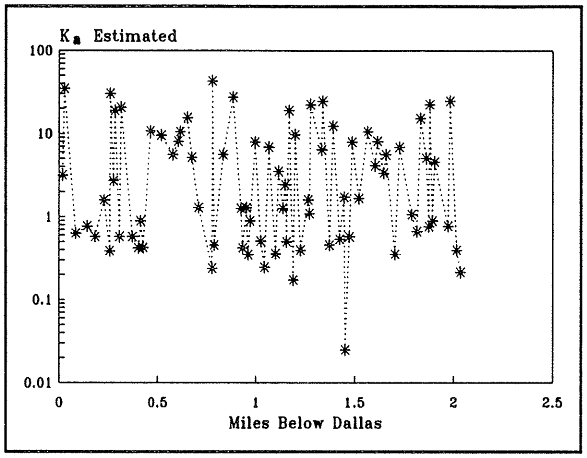

Figure E-7. K_a Estimated (O'Connor and Dobbins, 1958) from Several Estimates of Average Width and Depth for a Measured Flow of 5.8 cfs in Rickreall Creek Below Dallas.

mated cross sections, depth, and velocity. Although more cross-sectional data would provide more detailed estimates of reaeration, the available data indicate significant variation in calculated reaeration rates within a reach.

Various estimates of K_a for the reach from below the STP to Highway 99 include:

Average	6.49
Weighted Average	4.56
$Log_{(10)}$ Average	2.21
$Log_{(10)}$ Weighted Average	1.79
Median	1.67

These estimates of reaeration were calculated at slightly higher measured flows than observed during the October 1989 mixing-zone survey. It appears that the estimated reach reaeration (2.02) is a reasonably accurate representation. We do not have data that will allow refined estimates of reaeration at other locations. Estimates of the benthic production from the diurnal curves is sensitive to estimates of K_a.

Effluent quality may also influence the effect of effluent discharge on receiving-stream water quality. During the mixing-zone study, the effluent quality for ammonia is reported as 0.26 mg/L ammonia, 2.2 mg/L BOD_5, and 6.2 mg/L dissolved oxygen. The resulting low oxygen demand (high effluent quality) reduces the potential impact of the discharge of Rickreall Creek.

SENSITIVITY ANALYSIS

Table E-4 summarizes several model iterations for Rickreall Creek using summer conditions. Table E-5 shows the amount of streamflow that would be required to assimilate the Dallas treatment-plant effluent under a variety of conditions. In all of the simulations, it was assumed that the effluent would contain no more than 5.0 mg/L BOD and no more than 0.5 mg/L ammonia. It should also be noted that an effluent DO concentration of 6.5 mg/L corresponds to 72 percent of saturation at 68°F, while 8.5 mg/L corresponds to 90 percent of saturation.

It appears that achieving a dissolved oxygen criterion of 90 percent of saturation at existing streamflows is improbable for Rickreall Creek. Permit conditions would have to include criteria of 8.30 mg/L or greater dissolved oxygen, 0.25 mg/L or less ammonia, and 5 mg/L or less CBOD. Fairly slow estimated decay rates for ammonia and low or nonexistent sediment oxygen demand would have to be assumed. An assumption of low or nonexistent SOD may be appropriate under observed conditions (see section on ***"Sediment Oxygen Demand"***). To support that assumption, the basin effluent criterion of 10 mg/L or less for total suspended solids was used; this criterion is designed to minimize settling. However, even under these conditions it is not certain that the 90 percent of saturation criterion would be met at the estimated critical low flow (7Q10) of 1.4 cfs (August).

It appears that a streamflow of greater than 40 cfs is needed to assure adequate dilution of discharge under basin effluent standards. Simulated minimum dissolved oxygen was greater than 95 percent of saturation at flows in excess of 70 cfs. These flow conditions may not exist continuously but may occur during winter months. "Winter" limits in discharge permits typically apply between November and April; for the STP permit for Dallas, however, any winter discharge limits which do not include ammonia removal should apply only when flows in Rickreall Creek near Dallas exceed 70 to 120 cfs (weekly average).

Table E-4. Sensitivity Analysis

Sensitivity Analysis — Preliminary Application QUAL2E
July Conditions as Estimated:
Effluent Flow = 1.03 cfs
7Q10 (July) = 1.5 cfs
90Q2 (Average Summer Low Flow) = 5.0 cfs

Q_s cfs	DO_e mg/L	NH_3 mg/L	$CBOD_5$ mg/L	SOD g/ft^2-day	K_n 1/day	DO Min. mg/L	Sat. %
5	6.5	15.00	10	0.04-0.20	3	0.13	1
5	6.5	7.50	10	0.04-0.20	3	3.76	41
5	6.5	0.50	10	0.04-0.20	3	7.12	77
5	8.3	0.50	10	0.04-0.20	3	7.23	79
5	8.3	0.50	10	0.04	3	7.54	82
5	8.3	0.50	10	0.0	3	7.97	86
5	8.3	0.50	5	0.0	3	8.12	88
5	8.3	0.25	5	0.0	3	8.23	89
1.5	8.3	0.25	5	0.0	3	7.35	79
1.5	8.3	0.25	5	0.0	3	8.56	93
10.0	8.3	0.25	5	0.0	1.0	8.64	94
10.0	8.3	0.25	5	0.0	0.50	8.68	94
5.0	8.3	0.25	5	0.0	0.50	8.44	91
1.5	8.3	0.25	5	0.0	0.50	7.80	85

Table E-5. Streamflows Required to Assimilate Dallas STP Effluent Under Varying Conditions

Month	Effluent DO (mg/L)	STP Flow (mgd)	DO Std. (% Sat.)	Streamflow Required (cfs)
July	6.5	2.0	90	25
July	8.2	2.0	90	20
July	6.5	4.5	90	35
July	8.2	4.5	90	25
November	6.5	2.0	95	60
November	8.2	2.0	95	45
November	6.5	4.5	95	70
November	8.2	4.5	95	60

REFERENCES

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APPENDIX F

PERMIT WASTELOAD ALLOCATIONS

WASTELOAD ALLOCATIONS

The Federal Clean Water Act, under Section 303, requires that pollution limits, known as total maximum daily loads (TMDLs), be established on streams that are not achieving water quality standards in either numerical or narrative forms. The TMDLs for Rickreall Creek form the basis for establishing specific wasteload allocations (WLAs) for point sources of pollution. The current TMDL and WLAs for Rickreall Creek impose limits for biochemical oxygen demand, ammonia, and chlorine toxicity (Table F-1). The WLAs are incorporated into the revised permit limits for the City of Dallas (Tables F-2a, b, c). The TMDLs and WLAs are intended to limit introduction of oxygen-demanding pollutants into Rickreall Creek.

The point source discharge from the Dallas sewage treatment plant (STP) has a major influence on the water quality in Rickreall Creek. A total maximum daily load has been prepared to address problems due to low levels of dissolved oxygen and high levels of chlorine and ammonia-nitrogen resulting from the STP discharge. Other parameters of concern which are addressed in the discharge permit for Dallas include temperature, fecal coliform bacteria, total suspended solids, and pH.

NPDES PERMIT

Permit Assumptions

Permit limitations (WLAs) are listed in Schedule A of the NPDES permit for the City of Dallas. These WLAs are specific to the current outfall location and are based on certain assumptions:

- That Rickreall Creek below the current outfall is salmonid-producing (based on information from the Oregon Department of Fish and Wildlife);
- That the current outfall location will remain the same;
- That streamflows will remain the same.

If these assumptions change (i.e., if the stream is found to be non-salmonid-producing; if the City relocates the outfall; if increases in water demand and reservoir storage result in decreased streamflows; if design flows change; if discharge is restricted to Creek flows greater than those used to calculate these WLAs) revisions to the WLAs may be necessary. Future waste discharge limitations prescribed in a new or modified permit will be based upon WLAs appropriate for the location of the outfall and the requirements of the specific receiving stream or proposed treatment plant capabilities, whichever are more stringent.

It is also possible that in the future, WLAs for the Dallas STP will include more stringent numerical effluent limitations for additional water quality parameters, including nutrients (nitrogen and phosphorus compounds), dissolved oxygen, BOD_5, ammonia, TSS, temperature, turbidity, coliform organisms and other bacterial pollution, total dissolved solids, and possibly toxic substances.

The Department has included a paragraph at the top of Schedule A of the permit which states that the WLAs may be revised if new information becomes available. The specific language is as follows:

Note:

"The effluent discharge limitations are derived from wasteload allocations (WLAs) based upon the assumption that

Table F-1. Wasteload and Load Allocations for Rickreall Creek

Season and Flow, Q (cfs), in Rickreall Creek	Source	Ammonia (Monthly Average)				$CBOD_5$ (Monthly Average)			
		Concentration (mg/L)	Flow*, Q (cfs)	WLA (lb/d)	UNBOD (lb/d)	Concentration (mg/L)	Flow*, Q (cfs)	WLA (lb/d)	UCBOD (lb/d)
Summer Q ≥ 90	WLA: STP**	20	3.1	333	1522	10	3.1	170	423
	LA: Background	0.02	90	10	44	2	90	970	2466
	LA: Reserve + NPS	0	0	0	0	2.72	90	1319	3353
Summer Q < 90	WLA: STP**	0	0	0	0	0	0	0	0
	LA: Background	0.2	1.5	0.16	0.73	2	1.5	16	41
	LA: Reserve + NPS	0	0	0	0	2.72	1.5	22	56
Winter Q > 120	WLA: STP**	20	3.1	333	1522	10	3.1	167	505
	LA: Background	0.02	120	13	59	2	120	1294	3924
	LA: Reserve + NPS	0	0	0	0	1.96	120	1268	3845
Winter Q = 45 to 120	WLA: STP**	0.5	3.1	8.3	38.1	5	3.1	83	252
	LA: Background	0.02	45	4.9	22	2	45	485	1471
	LA: Reserve + NPS	0	0	0	0	1.96	45	475	1442
Winter Q < 45	WLA: STP**	0	0	0	0	0	0	0	0
	LA: Background	0.02	13	1.4	6.4	2	13	140	425
	LA: Reserve + NPS	0	0	0	0	1.96	13	137	417

* For WLAs, "flow" refers to STP effluent; for LAs, "flow" refers to streamflow.
** City of Dallas Sewage Treatment Plant.

LEGEND:

STP = Sewage Treatment Plant
WLA = Wasteload Allocation
LA = Load Allocation
NPS = Nonpoint Sources
Summer = May 1 to October 31

cfs = Cubic feet per second
$CBOD_5$ = Five-day Carbonaceous Biochemical Oxygen Demand
UNBOD = Ultimate Nitrogenous Biochemical Oxygen Demand
UCBOD = Ultimate Carbonaceous Biochemical Oxygen Demand
Winter = November 1 to April 30

all Rickreall Creek is salmonid producing downstream of the STP. The dissolved oxygen criteria of 90 percent and 95 percent of saturation, summer and winter, respectively, would apply below the discharge from the point of discharge to the confluence with the Willamette River. Future waste discharge limitations prescribed in a new or modified permit will be based upon the WLAs or proposed treatment plant capabilities, whichever are more stringent.''

Permit Conditions

(See actual permit for additional requirements.)

(1) **May 1 to October 31:**

(a) When monthly-average daily flow in Rickreall Creek is less than 90 cfs: No discharge of wastewater is permitted.

(b) When monthly-average daily flow in Rickreall Creek is 90 cfs or greater, the following effluent discharge limitations shall apply (Table F-2a).

(2) **November 1 to April 30:**

(a) When monthly-average daily flow in Rickreall Creek is 45 cfs or less: No discharge of wastewater is permitted.

(b) When monthly-average daily flow in Rickreall Creek is greater than 45 cfs but does not exceed 120 cfs, the following effluent discharge limitations shall apply (Table F-2b).

(c) When monthly-average daily flow in Rickreall Creek is greater than 120 cfs, the following effluent limitations shall apply (Table F-2c).

Table F-2a. Summer Permit Limits (May 1 to October 31) for Flows ≥ 90 cfs

Parameter	Average Effluent Concentration		Mass Load Limitations (lb/day)*		
	Monthly	Weekly	Monthly Average	Weekly Maximum	Daily
$CBOD_5$	10 mg/L	15 mg/L	170	250	330
TSS	10 mg/L	15 mg/L	170	250	330
FC/100 mL	200	400			

* Mass load limitations are based on an effluent flow of 2.0 mgd and those concentrations as necessary to avoid water quality standards violations in Rickreall Creek.

Table F-2b. Winter Permit Limits (November 1 to April 30) for Flows > 45 cfs

Parameter	Average Effluent Concentration		Mass Load Limitations (lb/day)*		
	Monthly	Weekly	Monthly Average	Weekly Maximum	Daily
$CBOD_5$	5 mg/L	7.5 mg/L	83	130	170
TSS	5 mg/L	7.5 mg/L	83	130	170
NH_3-N	0.5 mg/L	0.75 mg/L	8.3	13	17
FC/100 mL	200	400			
Dissolved Oxygen	Shall not be less than a daily average concentration of 8.2 mg/L.				

* Mass load limitations are based on an effluent flow of 2.0 mgd and those concentrations as necessary to avoid water quality standards violations in Rickreall Creek.

Table F-2c. Winter Permit Limits (November 1 to April 30) for Flows > 120 cfs

Parameter	Average Effluent Concentration		Mass Load Limitations (lb/day)*		
	Monthly	Weekly	Monthly Average	Weekly Maximum	Daily
$CBOD_5$	20 mg/L	25 mg/L	330	500	670
TSS	20 mg/L	25 mg/L	330	500	670
FC/100 mL	200	400			

* Mass load limitations are based on an effluent flow of 2.0 mgd and those concentrations as necessary to avoid water quality standards violations in Rickreall Creek.

(3) **Other Limitations (Year-Round):**

(a) $CBOD_5$ and TSS Percent Removal (on a monthly average concentration basis): Shall not be less than 85 percent.

(b) pH shall not be outside the range of 6.0 to 9.0.

(c) Total Chlorine Residual (effluent) shall not exceed a monthly average concentration of 0.012 mg/L and a daily maximum concentration of 0.03 mg/L.

(d) Temperature:

(i) When the temperature of Rickreall Creek at the point of discharge is 58°F or higher, the effluent temperature shall not cause the temperature of the creek outside the assigned mixing zone to exceed the creek temperature as measured above the point of discharge.

(ii) When the temperature of Rickreall Creek at the point of discharge is less than 58°F, effluent temperature shall be limited so as not to increase the temperature of the creek more than 0.5°F outside the mixing zone specified in this permit.

Dissolved Oxygen

The revised effluent limitations are seasonal, as were the limitations in the previous permit. These effluent limitations are based upon the worst-case flow condition projected for Rickreall Creek, i.e., a 7Q10 flow of 1.5 cfs in July and a 7Q10 flow of 13 cfs in November. Using an EPA-supported, steady-state, water-quality model (QUAL2E), the Department determined discharge limitations for the City of Dallas that would not violate the dissolved oxygen standard in Rickreall Creek.

As previously stated, the Department has assumed that the entire Creek below the existing Dallas outfall is salmonid-producing. This means the dissolved oxygen criteria near Dallas is 95 percent of saturation during periods of spawning, incubation, hatching, and fry stages of salmonid fishes (generally corresponding to the winter discharge period). During the summer non-spawning period, the 90 percent of saturation limitation would apply.

Diurnal Fluctuation in Dissolved Oxygen

In October 1989, the Department inserted a series of continuous monitors into Rickreall Creek both above and below the Dallas outfall. These instruments recorded dissolved oxygen, temperature, and pH for several days. The resulting data indicate that, at least during low-flow, summer conditions, the diurnal fluctuation of dissolved oxygen occurring above the outfall is such that the dissolved oxygen levels are depressed below the 90 percent criterion during portions of the non-daylight hours. The observed DO variation is likely due to temperature change and growth of periphyton (algae that are attached to rocks). Periphyton generates oxygen during the sunlight hours but utilizes oxygen when it is dark, thus creating the diurnal fluctuation.

Discharge Limits

Pursuant to Oregon Administrative Rule (OAR) 340-41-445(3), "where the natural quality parameters of waters of the Willamette River Basin are outside the numerical limits of the assigned water quality standards, the natural water quality shall be the standard." Above the existing outfall, depression of the dissolved oxygen levels below the standard could represent natural conditions or could be the result of human-caused pollutants other than the STP discharge. In either case, however, because the "background" dissolved oxygen level above the outfall is below the numerical limits, no further decrease is allowed. As a result, the wasteload allocation under worst-case conditions is zero. For the summer discharge season, because of the inadequate dilution available, any discharge would measurably reduce levels of dissolved oxygen. Therefore, the Department's proposed, revised effluent limit for the existing system is: no discharge during the summer season except when flows exceed 90 cfs.

If information is provided that shows that portions of Rickreall Creek are not salmonid producing and if the discharge location is moved to a non-salmonid producing section, then modification of the WLAs could be considered.

During the winter period, the Department expects that the effect of periphyton will decrease, in part, because of lower water temperatures in the Creek. As stated above, however, the standard for dissolved oxygen is higher because of the need to protect spawning, incubation, hatching, and fry stages of salmonid fishes. Based on computer-modelling results (using QUAL2E), the Department believes that discharge from the Dallas treatment facility can be permitted during the winter period (November 1 to April 30), provided streamflow is greater than 45 cfs and provided the effluent discharge limitations are met.

Stipulated and Final Order

The revised effluent limits are believed to be sufficient to meet water quality standards for dissolved oxygen. The Department recognizes that the existing sewerage facility for the City of Dallas is not currently capable of meeting the revised limits. The City and the Department have entered into a Stipulated and Final Order (SFO) which includes interim effluent limitations and a time schedule for upgrading the sewage treatment plant.

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