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Snohomish River Estuary Dry Season TMDL Study - Phase II

Water Quality Model Confirmation and Pollutant Loading Capacity Recommendations

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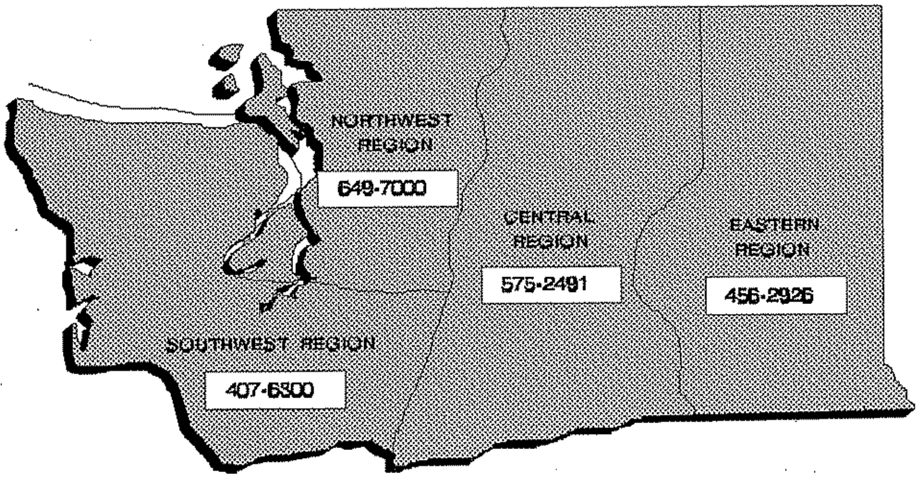

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Snohomish River Estuary Dry Season TMDL Study - Phase II

Water Quality Model Confirmation and Pollutant Loading Capacity Recommendations

by
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Abstract

A water quality modeling study of the Snohomish River Estuary system from Possession Sound to river mile 20 was conducted using an Environmental Protection Agency supported water quality simulation program (WASP5) model to simulate hydrodynamics and water quality. The WASP5 model was developed to assess the capacity of the estuary system to assimilate oxygen consuming pollutants from point and nonpoint sources. The model was calibrated using data collected in August and September 1993 and confirmed (verified) using data collected in August 1996. An interim report summarizing water quality in the study area and the development of the WASP5 model was published in 1995. The present document is the final report for this Total Maximum Daily Load (TMDL) study.

The water quality model predicted that natural conditions in a large portion of the estuary would be below dissolved oxygen standards under critical conditions. The model also predicted that point sources of oxygen-consuming pollutants would cause an exceedence of the 0.2 mg/L deficit allowed by the marine criteria when natural conditions are below the standard (the allowable deficit was also applied to the freshwater portion of the modeled area). The model was used to recommend waste load allocations (WLAs) for the following existing and proposed point sources of carbonaceous biochemical oxygen demand (CBOD) and ammonia BOD: the City of Snohomish Wastewater Treatment Plant (WWTP), Lake Steven's Sewer District WWTP, the City of Marysville WWTP, the City of Everett WWTP, and the proposed Smith Island WWTP. However, the recommended WLAs for ammonia are subject to changes based on mixing zone toxicity limitations that may be established in the future.

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Many Ecology staff have provided valuable help on this project since it began in the spring of 1993. I would like to specifically thank the following: Ed Abbasi, Skip Albertson, Steve Butkus, Randy Coots, Mike Dawda, Lisa Eisner, Karol Erickson, Denis Erickson, Laura Fricke, Joe Jacobson, Will Kendra, Jan Newton, Deborah North, David Palazzi, Paul Pickett, Mary Rumpf, Dan Saul, Keith Seiders, Gerald Shervey, Dave Wright, and all the staff at Manchester Laboratory. In addition, I would like to thank Bill Fox, Cosmopolitan Engineering Group and Robert Waddle and other staff from the city of Everett, Public Works for their comments and help in collecting data. As always I want to acknowledge Barbara Tovrea for her work on word processing and report formatting. Finally, I would like to especially thank Greg Pelletier for assisting in field sampling and providing me with guidance and advice in developing the WASP5 model.

Introduction

Background Information

In June of 1993, the Watershed Assessments Section (WAS) distributed a proposal and quality assurance project plan (QAPP) for conducting a Snohomish River Estuary dry season total maximum daily load (TMDL) study (Cusimano, 1993). The project was requested by staff from Ecology's Northwest Regional Office (NWRO), because of their concern that population growth and development in the estuary watershed may cause adverse effects to water quality. Their major concern was with increased demands on the wastewater treatment plants (WWTPs) permitted to discharge to the river and sloughs.

Although the major focus of the TMDL study is on point sources of pollution, nonpoint sources are considered, but only as loads from tributaries entering the Snohomish River or sloughs. WAS is currently conducting a more detailed water quality assessment of the tributaries and their drainages to the Snohomish River. A final report of the tributary study is scheduled to be completed by September 15, 1997.

The Snohomish River Estuary TMDL study was initiated in the summer of 1993. Figure 1 shows the general location of the study area. Figure 2 shows the study area and the sampling locations, and Figure 3 is a more detailed map of the lower river, sloughs and near shore estuary within the study area. The first sampling survey was conducted on August 16 and 17, 1993. A second sampling survey, originally scheduled to be collected in the summer of 1994, was rescheduled to the summer of 1996 to adjust the project schedule to coincide with Ecology's newly adopted Basin Approach time frame. An interim report (Phase I) was published by Ecology in 1995 (Cusimano, 1995). The Phase I report summarized the 1993 sampling results, and the development and calibration of a water quality analysis simulation program or WASP5 (EPA, 1993) model of the area from Possession Sound to just downstream of the confluence with the Skykomish and Snoqualmie Rivers at River Mile 20.5. An analysis of the 1993 data presented in the Phase I report showed that impacts to the Skykomish River from the WWTPs at Monroe and Sultan would be minimal. In addition, a TMDL for biochemical oxygen demand in the Snoqualmie River was completed in 1994 (Joy, 1994). Therefore, the Skykomish and Snoqualmie Rivers were not included in the modeled area reported in the Phase I document, nor were they sampled during the 1996 survey.

This document is the final report for the TMDL study. The results and recommendations presented here will be used to help set permit limits for discharges to the river and estuary system beginning in 1999. The following topics are summarized:

1. Water quality data collected in 1996;
2. Data collected to improve the accuracy of the calibrated model reported in the Phase I report;

3. Re-calibration of the water quality model developed from data collected in 1993 and reported in the Phase I report;
4. Model verification (confirmation) using 1996 water quality data;
5. Modeling critical conditions; and
6. Waste load and load allocations based on critical condition water quality modeling predictions.

Further background information on problem definition; basin description; historical water quality; wastewater treatment plant descriptive information and effluent quality; 1993 sample collection and field measurement methods, and quality assurance/quality control; and hydrodynamic and water quality modeling development are reported in the QAPP (Cusimano, 1993) and Phase I report titled "Snohomish River Estuary Dry Season TMDL Study - Phase I Water Quality Model Calibration" (Cusimano 1995).

Project Goal and Objectives

The major goal of the Snohomish TMDL study was to develop waste load allocations (WLAs) and load allocations (LAs) for point and nonpoint sources of pollutants based on summer low river flow conditions. The specific objectives based on the project goal were as follows:

- Assess the potential for dissolved oxygen depletion from carbonaceous and nitrogenous biochemical oxygen demand (BOD) from known point sources;
- Identify other water quality variables which may need to be controlled (e.g., metals such as cadmium, copper, and mercury);
- Determine pollutant loading from point and nonpoint sources and background levels; and
- Determine loading capacity and recommend WLAs and LAs based on water quality modeling.

Sample Collection and Field Measurements Methods

An intensive survey was conducted on August 27 and 28, 1996, by four sampling teams to collect water quality samples at all major tributaries, selected river and slough stations, and WWTP effluents. Figure 2 shows the study area for both the 1993 calibration and 1996 confirmation surveys. The 1996 sampling network consisted of a subset of stations sampled during the 1993 survey: 16 stations in the river, sloughs, and estuary; 7 tributary stations; and 4 municipal WWTP effluents. In addition, Ecology's Ambient Monitoring Section (AMS) sampled at 7 stations along a transect from the lower river channel into Possession Sound (Figure 4). The data collection requirements for each of the following study components are discussed below: River, Sloughs, and Tributaries; Lower River and Possession Sound; and WWTP effluents.

The 1996 survey dates were selected to coincide with annual low river flow conditions and a tide sequence such that the low (minus tide) and high (approximately MHHW) occurred during the daylight hours. Appendix A contains graphs of the predicted Tulalip tides for the sampling dates. The Tulalip tides correspond to the WASP5 model seaward boundary. The 1996 survey conditions were similar to those sampled during 1993.

River, Sloughs, and Tributary Sampling:

Table 1 lists the parameters that were measured. Appendix B.1 contains the two day sampling schedules for the three sampling teams that sampled the river, sloughs, and tributaries. All stations were sampled at low tide, and at high tide from station 16 seaward to stations 34 and 35. All samples were collected from the center of the channel. At low tide, a single sample was collected from the surface (approximately 0.2 m below the surface at each station); while at high tide samples were collected from the surface and bottom (approximately one meter from the bottom).

Sampling teams 1 and 2 also collected surface and bottom conductivity measurements at three stations each between the low and high tide sampling periods: stations 21, 20, and 18 were sampled by team one; and stations 32, 31, and 23 by team two. In addition, teams one and two determined the extent of saltwater movement upstream at high tide in Ebey Slough and the mainstem of the river by taking surface and bottom conductivity measurements along a transect which saltwater was expected to reach.

Lower River and Possession Sound Sampling:

In conjunction with WAS, AMS collected vertical profile data with a CTD sensor at a series of stations extending from the lower river into Possession Sound (Figure 4). Parameters measured with the CTD were temperature, salinity, density, dissolved oxygen, fluorescence, and irradiance. The profiles were taken on August 27 and 28. Samples were collected and profiles taken during the later portion of the incoming tide and on the outgoing tide on each of the two days. At each of the seven stations, a CTD profile was done and grab samples taken for dissolved oxygen, salinity, and chlorophyll *a*. At stations E1, E3, and E5 grab samples were collected for dissolved nitrate-nitrite, ammonia, and orthophosphate; at station E1 samples for total nitrogen and phosphorus were also collected. The AMS sampling team and team one both sampled at E7 (station 34).

WWTP Effluent Sampling:

Four WWTPs discharge treated wastewater within the 1996 study area (Figure 2): The City of Snohomish WWTP discharges to the mainstem at river mile (RM) 12, Lake Steven's Sewer District WWTP discharges to Ebey Slough at RM 6.5, the City of Marysville WWTP discharges to Steamboat Slough at RM 3.5, and the City of Everett WWTP discharges at two locations to the mainstem at RM 2.5 and RM 3.5. (Note: all RMs are approximate). Sampling of the WWTPs consisted of 24-hour composites as well as morning and afternoon grab samples of post-chlorination effluent from the five discharges. The type of samples and analyses conducted are listed in Appendix B.2.

Quality Assurance/Quality Control

Analytical procedures and associated precision or reporting limits are listed in Table 1. All samples for laboratory analysis were preserved as specified in Manchester Environmental Laboratory Lab Users Manual (MEL, 1994). Laboratory analyses were performed in accordance with MEL (1994). The data were reported by Ecology's Manchester Laboratory as usable with data qualifiers noted. (See the Phase I report for review of quality assurance/quality control for the data collected during the summer of 1993.)

Salinity/conductivity samples collected by WAS and AMS sampling teams in the lower river and sloughs and Possession Sound, were analyzed using an Autosal® salinometer by the Routine Chemistry Lab at the University of Washington.

Field sampling and measurement procedures used by WAS followed those specified in WAS (1993) for pH (Orion Model 250A meter and Triode™ pH electrode), conductivity (Beckman Model RB-5 and YSI33), dissolved oxygen (Winkler titration), and streamflow (Marsh-McBirney 2000). Temperature was measured using alcohol thermometers and YSI 33 probes. All meters were calibrated and post-calibrated according to manufacturer's instructions.

Field sampling procedures used by AMS followed those specified in Eisner *et al.*, 1994. The protocols include in-house and external CTD sensor calibrations, field-collected sensor verification samples (dissolved oxygen measurements were verified with the Winkler method), replicate samples, and routine cleaning and maintenance schedules. The current calibration coefficients were entered into the configuration file for use in processing the data with Sea-Bird Electronics CTD software. Data quality objectives and additional details on field and laboratory procedures can be found in Eisner *et al.* (1994) and Newton (1995).

Total variation or precision for field measurements and laboratory analysis was assessed by collecting replicate samples for approximately 10% of the total number of laboratory samples per parameter. Ten percent of field measurements for conductivity and dissolved oxygen were also replicated. Replicate precision for field measurements and laboratory analyses, calculated as the root mean square error of the coefficients of variation, are listed in Table 2. Replicate precision was acceptable for all variables given the analytical ranges measured.

Data Assessment Procedures

Data reduction, review, and reporting followed the procedures as outlined in MEL's Laboratory Users Manual (MEL, 1994). The principal investigator ensured that all data were validated before preparing a final project database by reviewing 100 percent of the data for possible errors.

Results and Discussion

Survey Data

The August 1996 and 1993 survey data results are listed in Appendix C. The major purpose of the 1996 survey was to collect data that could be used to confirm the WASP5 water quality model. Overall, the 1996 survey data were consistent with the 1993 survey data. Sampling results for the WWTP effluents are listed in Appendix C.3. (See the Phase I report for a summary of the data results collected during the summer 1993).

Data Collected to Improve Model Accuracy

In the Phase I report, five tasks were identified to be completed before confirming the water quality model results. The five tasks and the actions taken to complete each task are discussed below. In addition, other data and information collected after the Phase I report was published are discussed under number six:

1. Mixing characteristics of the estuary

   The WASP5 model calibration was confirmed by comparing observed and simulated results for the 1993 survey period (Cusimano 1995). However, it was noted in the Phase I report that a number of assumptions related to the mixing characteristics of the estuary with respect to dissolved oxygen, during low river flow, needed to be assessed. Specifically, the high values of sediment oxygen demand (SOD) needed to calibrate the water quality model possibly reflected inaccurate assumptions about the mixing of marine water from Possession Sound with fresh river water in the lower river and sloughs. For example, since the maximum depth of the river and sloughs at high tide are less than 10 meters, the seaward (downstream) boundary concentrations for salinity and dissolved oxygen were assumed to be represented by the average of 0-10 meter profile data from Possession Sound. Because dissolved oxygen concentrations found in the river and sloughs were lower than the profile average concentration used for the downstream boundary, high model segment SOD levels were set during model calibration to adjust the model predicted dissolved oxygen concentrations to those measured.

   In order to better define the mixing characteristics of the estuary during low river flow, CTD profile surveys of temperature, salinity, density, dissolved oxygen, fluorescence, and underwater irradiance were conducted during September 1995 and August 1996. Profiles were taken along a series of stations during low and high tide from the lower river into Possession Sound (Figure 4). Appendix D contains figures depicting contour plots of the 1996 profile data (1995 profiles are similar to the August 28, 1996 profiles). River mile zero on the figures is set at Prieston Point. The results of the profile surveys show that during the flood tide, the lower river is strongly influenced by some portion of the marine water column layer in Possession Sound between 0-16.5 meters. This suggest that water with lower dissolved oxygen concentrations than originally assumed (*i.e.*, deeper water), can affect the dissolved oxygen concentration in the river and sloughs. (See WASP5 Model Re-calibration and Confirmation Sections for a further discussion of downstream boundary conditions.)

2. Model Geometry Characteristics

As reviewed in the Phase I report, an existing hydrodynamic model developed by Stein *et al.* (1991) was updated and used to simulate segment hydrodynamics. All of the model channel widths and depths (junction bottom elevations) were reviewed and modified during the original updating of the hydrodynamic model. River and slough channels were modified based on orthophoto maps and 63 surveyed cross-sections collected by Snohomish County Public Works (Snohomish County, 1989). In addition, the junction bottom elevations in the model segments representing Possession Sound were set at -5 meters MLLW based on the assumption that estuary freshwater and saltwater mixing would be confined to the upper layer of water. Since channel lengths were not reviewed and errors in model geometry can significantly affect model predictions due to differences in hydrodynamic characteristics, it was recommended in the Phase I report to re-evaluate all model geometry.

The hydrodynamic model geometry was reviewed in 1996. Assessing the model geometry was done by overlaying the model physical characteristics on USGS 1:24,000 scale maps, then comparing lengths on corresponding DNR 1:12,000 scale orthophoto maps, and NOAA 1:10,000 scale (for the lower river and Port Gardner) or 1:40,000 scale (for sloughs) navigational charts. Most of the channel lengths only varied 1-3% from the original value, but a few of the channels in Ebey Slough were found to be as much as 35% too long. The major changes made to the channel lengths were the combined reductions in the overall lengths of channels 97, 98, and 99 of 1,550 meters; and an increase in the length of channel 85 of 220 meters. Model channel widths and most junction depths were found to be accurate within 1-2% percent of those used in the model calibration input file listed in Appendix E of the 1995 Phase I report. However, a number of junction depths representing the area seaward of the mouth of Steamboat Slough (e.g., junctions 10, 11, 16, 17, 18, 22, 24, and 31) were reduced from -5 meters to more closely represent their actual depths. Even though some of the areas represented by the model in Possession Sound are exposed at low tide, the hydrodynamic model requires water to be in a channel at all times. Thus, tidal flat segment depths must be deeper than the lowest low tide. Also, in order to maintain model stability at the lowest low tide of approximately -0.4 meter, the minimum depth must be about 0.5 meter.

3. Critical Conditions for Point Sources of Pollution

A set of critical conditions based on defining a critical period of July through October (summer), were listed in the Phase I report. It was noted that critical conditions for point source loads should be reviewed by the permit manager(s) to make sure that critical design flows, concentrations, and loads are consistent with how future permit limits would be derived. The NWRO permit manager, David Wright, has reviewed the critical conditions listed in the Phase I report and provided recommended changes. The most significant changes were increases in the design flows for the Marysville, Lake Steven's, and Snohomish WWTPs. (See Modeling Critical Conditions Table 7 for critical values).

4. Mixing Zone Studies

Another task identified in the Phase I report was to incorporate the results of mixing zone studies for Everett, Marysville, and Lake Steven's WWTPs, with respect to any water quality-based ammonia limits, into final dissolved oxygen model predictions. However, these studies are on-going and final results are not available. Consequently, all critical condition modeling uses effluent ammonia concentrations that could exceed final mixing zone permit limits.

5. 1996 Ambient and Effluent Data

The 1996 water quality survey was conducted on August 27 and 28, 1996. The data collected during the survey, and the 1996 profile data discussed above are used in this report to verify model predictions. However, one of the data tasks not accomplished was to establish discharge specific effluent ultimate CBOD/BOD$_5$ ratios. Effluent BOD samples were collected during the 1996 August survey. Laboratory ultimate CBOD test were also conducted in the summer of 1993 and 1995, but they were not successful. The results of the 1996 ultimate CBOD/BOD$_5$ analyses gave a range of ratios from 1.94 for Marysville's effluent to 5.14 for Lake Steven's effluent. Although the data were considered usable, they were not used because of possible problems with the nitrogen corrections used in the analytical method. Instead, ratios of 1.5 for Everett's mechanical (trickling filter treatment) plant and 2.0 for the other WWTP lagoon systems (secondary treatment) were used (Lund, 1993).

6. Other Data and Information Collected.

The Tulalip Landfill Superfund Site located on Ebey Island just west of Interstate 5 (see Figure 2) was identified as an additional loading source of ammonia, and added to the water quality model at segments 50 and 60 based on an estimated discharge rate of 2,971 lbs/year (EPA, 1996).

During the summer of 1995, the YSI 33 meters used to collect conductivity and salinity data in the river and sloughs were found to have a negative bias between 5-15%, depending on the meter and concentration range measured. During the 1996 confirmation survey, in addition to *in situ* measurements of conductivity/salinity, grab samples were collected and sent to the University of Washington, Marine Chemistry Laboratory, School of Oceanography for salinity analysis. The results were used to develop regression relationships with the YSI 33 meters that were used in both the 1993 and 1996 surveys. The regression corrections were applied to the 1993 conductivity/salinity estimates and used in the model re-calibration. Appendix C.2 contains the 1993 survey data, including the measured and corrected salinity estimates.

WASP5 Model Re-calibration

As reviewed in the Phase I report, the WASP5 sub-programs DYNHYD5 and EUTRO5 were used, respectively, to simulate the hydrodynamics and eutrophication kinetics in the Snohomish River Estuary system. The DYNHYD5 and EUTRO5 model networks extend from an upstream boundary just below the confluence of the Skykomish and Snoqualmie Rivers, to six seaward boundaries in Possession Sound (Figures 5 and 6). A description of the contents of the specific model "Data Groups" for each sub-program are contained in the Phase I report, which includes a review of all parameters, constants, and coefficients used in the model.

The DYNHYD5 program was used to simulate segment hydrodynamics (e.g., velocities, volumes, depths, etc.) under changing tidal conditions and steady state river flow.

The EUTRO5 water quality model was used to simulate simple eutrophication kinetics in the river and estuary system that include interactions of the following variables: ammonia nitrogen, nitrate nitrogen, inorganic phosphorus, phytoplankton carbon, carbonaceous BOD, dissolved oxygen, organic nitrogen, and organic phosphorus.

The EUTRO5 spatial network corresponds to the DYNHYD5 network such that each EUTRO5 segment corresponds exactly to a hydrodynamic volume element, or junction, and each segment interface corresponds exactly to a hydrodynamic link, or channel. The hydrodynamic model has additional junctions outside the EUTRO5 model network. These DYNHYD5 junctions correspond to EUTRO5 boundaries and are denoted in Figure 6 with segment number "0."

The hydrodynamic and water quality models were modified and re-calibrated to the 1993 water quality data based on the information and data collected in 1995 and 1996 (reviewed in the section--Data Collected to Improve Model Accuracy). The first step to recalibrate the model was to reassess the dispersion coefficients that were determined by matching model-predicted salinity values to the August 1993 survey salinity data. The corrected salinity values were used to adjust the dispersion coefficients. (The dispersion coefficients are contained in the EUTRO5 input file listed in Appendix E.)

The second step in re-calibrating the water quality model was to adjust the downstream dissolved oxygen boundary concentrations and model segment SOD values. In the model presented in the Phase I report, dissolved oxygen concentrations at the downstream boundary represented the average of 0-10 meter profile data collected in Possession Sound with a CTD on August 24th, 1993. The transect profiles collected in the summer of 1995 and 1996 showed that the marine water most likely influencing water quality in the main river channel is represented by some portion of the water column between 0.0-16.5 meters in Possession Sound. However, since transect profiles were not collected in 1993 (only two profiles were collected in Possession Sound) it was not possible to identify the specific portion of the water column that moved into the river and sloughs during the 1993 sampling surveys. Instead, the dissolved oxygen (and salinity) data collected at stations 34 and 35 were used to estimate the boundary concentration. The final boundary concentration was set to the best model fit with the water quality model segments corresponding to these sampling stations (*i.e.*, segments 29 and 31).

Overall, most of the contents of the model data groups are the same as those reported in the Phase I report. The major changes in the model were lower dissolved oxygen concentrations at the seaward boundary (from 8.5 to 7.3 mg/L), and the subsequent reduction of SOD in all model segments from a range of 0-9.5 g/m^2-day to 0-4.5 g/m^2-day, with values exceeding 2.8 only in the lower portion of Ebey Slough. (Reference the DYNHYD5 and EUTRO5 Critical Conditions model input files in Appendix E for specific model conditions.)

The model re-calibration was assessed by comparing observed and simulated results for the 1993 survey period. Table 3 lists the root mean square error (RMSE) between the predictions and observations for salinity, dissolved oxygen, and ammonia for both the re-calibrated and the calibrated model reported in the Phase I report. The re-calibrated model RMSEs compare favorably to the values for the original calibration.

WASP5 Model Confirmation

Hydrodynamic Model

The DYNHYD5 model used to confirm the water quality model was identical to the re-calibrated model except for the specific 1993 and 1996 inflows and tides that represent each sampling period.

Water Quality Model

Data from the 1996 survey were used to confirm the re-calibrated EUTRO5 model following the procedures described in the Phase I report. The boundary concentrations and summary of flows and concentrations used to calculate loading are listed in Table 4. Establishing these and other model characteristics used in the verification are discussed below.

River Flow and Tides -- The Snohomish River upstream boundary and Pilchuck River inflows were set at the average flow for the two day survey reported from USGS stations 12150800 and 12155300, respectively. Station 12150800 is located on the Snohomish River near the city of Monroe at about RM 20, and 12155300 is located on the Pilchuck River near the city of Snohomish. Inflows for other tributaries were set at the two day average flow measured by the survey team. WWTP discharges measured during the Class II inspections were also included as inflows. Ground water inflows were set at the same values reported in the Phase I report.

Boundary and Tributary Concentrations -- Upstream (freshwater) boundary concentrations were set at the average concentration measured during the two day August 1996 survey. The downstream (marine) boundary concentrations, except for dissolved oxygen and salinity, were set at the average of the measurements made at station E1. As with the re-calibration, downstream boundary concentrations for dissolved oxygen and salinity were estimated from sampling stations inside the model network, stations E3 and 35, which correspond approximately to the water quality model segments 24 and 31. (See Modeling Critical Conditions for further discussion of downstream boundary concentrations and profile data.)

Effluent Discharge Characteristics -- WWTP effluent water quality variable concentrations were derived by Norm Glenn, WAS, from the effluent survey results summarized in Appendix C.3.

Model Segment Characteristics -- The confirmation EUTRO5 eutrophication kinetic constants listed in Table 5 were the same as those used in the re-calibrated model and listed in the Phase I report (see Phase I report for review on developing rate kinetics). Dispersion coefficients and SOD were also the same as the re-calibrated model. Segment temperatures and initial conditions for all water quality parameters were set based on the average of the 1996 two day survey data.

Model Confirmation Results

As with the re-calibration, model confirmation was assessed by comparing observed and simulated results for the 1996 survey period. Figures 7-13 are representations of salinity and dissolved oxygen at selected segments which compare confirmation survey data against model predictions over the two-day August 1996 sampling period. Changing water depths also are shown on the graphs.

Table 6 lists the overall RMSE between the model estimates and measured values for salinity, dissolved oxygen, chlorophyll *a*, ammonia, and total phosphorus. For comparison, Table 3 lists the RMSE for the calibrated model reported in the Phase I report and the re-calibrated model. The estimate of model variation represented by the RMSE for dissolved oxygen and ammonia demonstrates a good model fit, relative to the ambient data range measured in the modeled system. A "good model fit" was defined in the Phase I report with respect to three qualitative criteria: (1) did the variable concentration increase or decrease as expected? (e.g., dissolved oxygen increases during low tide and decreases during high tide); (2) how did the RMSE compare to other reported model and observed deviations? (e.g., Pelletier (1993, 1994, 1997) reported dissolved oxygen RMSEs for models representing the Puyallup, Spokane, and Colville Rivers of 0.20, 0.38, and 0.4 to 0.8 mg/L, respectively; and ammonia RMSEs for the Spokane and Colville Rivers of 0.01 and 0.01 to 0.05 mg/L, respectively); and (3) how does the RMSE compare to temporal variability and measurement variability? (e.g., *in situ* data suggest that diurnal dissolved oxygen changes upstream of tidal effects were at least 0.2-0.4 mg/L, and the RMSEs for ammonia were close to the reporting limit).

The confirmation model estimates for salinity are less accurate than the re-calibrated model results for values less than 3 ppt. This is likely due to limitations of the DYNHYD5 model. For example, DYNHYD5 treats each segment as a rectangle with a corresponding rectangular cross-section, however, the actual properties of the cross-sections should be a function of depth and resemble a trapezoid. In the Snohomish Model, widths of each channel are set to approximate the channel width at mid-tide. Consequently, the channels in the lower river and sloughs are 20-30% wider (estimated at Langus Park boat launch near Everett's WWTP) than they should be at low tide and low river flow. The model channels allow saltwater to remain in the lower reaches of the river and sloughs at low tide because there is not enough freshwater to displace the saltwater, given that the channel bottoms are below MLLW and the channel widths are set to mid-tide values. The re-calibrated model was more accurate at low salinities because there was significantly more freshwater river flow during the 1993 calibration survey (2,990 cfs) than in the 1996 confirmation survey (1,840 cfs).

In addition to confirming the model with the 1996 WAS survey data, the model was also confirmed by simulating *in situ* continuous monitoring data of salinity and dissolved oxygen at three locations in the lower river, and by simulating the results of a dye study of the city of Everett's WWTP discharge. The continuous monitoring and dye study data were collected by the city of Everett, Public Works.

The continuous monitoring data were collected for 72 hours (beginning at 1600 hours on August 26 and ending on August 29) using three YSI PC6000 probes at the locations shown on Figure 3. Figures 14-16 are plots of the continuous salinity and dissolved oxygen data for August 27 and 28. The grab sample data collected by both the city of Everett and WAS are also plotted. The model results fit the grab sample data well and compare favorably to the timing and changes in the *in situ* data for both salinity and dissolved oxygen. The differences in the *in situ* data, grab sample data, and model estimates are likely due to the following: 1) the model is a vertically averaged value, while the *in situ* measurements are taken near the surface, which may account for the steepness of the changes between high and low tide (i.e., *in situ* data only reflect part of the water column during periods that the water column is partially stratified so changes occur more quickly, while the model provides vertically averaged estimates so changes are more gradual); 2) *in situ* dissolved oxygen measurements appear to have some downward drift over time. Plus, the *in situ* monitors appear to measure salinity high at higher values when compared to the grab sample data.

The dye study was conducted on August 14-18, 1995, to determine the degree of mixing and the steady-state maximum concentration or "reflux" of the WWTP's effluent in the Snohomish River estuary (Cosmopolitan Engineering Group, 1996). Dye was injected into Everett's lagoon and mechanical plant outfalls for 24 hours (one tidal cycle) beginning at 18:00 August 14 and ending at 18:00 on August 15, 1995. Dye was measured in the river for five days, including the initial dye injection period.

Figure 17 shows both the measured dye concentration and the model simulation of the dye concentration versus time at model segment 37. The measured dye concentration represents a ten-minute moving average concentration taken in the river midway between the two outfalls. (Model segment 37 most closely corresponds to the dye study sampling location.) The dye tracking is part of the USGS superposition method for determining the daily maximum accumulation of effluent (Hubbard and Stamper, 1972). The method ascribes, for this situation, that the maximum accumulation of effluent is equal to the initial peak concentration during the first tidal cycle, plus the peak concentrations for every other cycle (Cosmopolitan Engineering Group, 1996).

The graph shows that the model predicted peak dye concentrations are similar to the measured dye concentrations except for the largest measured peak. According to the investigator who conducted the dye study, the differences between the model predicted peak values and the measured values during day one could be due to incomplete mixing of the dye during the injection period (personal communication, William Fox, Cosmopolitan Engineering Group). In addition, the total dye retained within the model segment, as represented by the area under the time-concentration curve, is nearly identical to the dye measured (*i.e.*, 0.00617 fraction-days for the model, and 0.00612 fraction-days for the measured dye).

Overall, the model confirmation studies indicate that the model is a reliable predictor of dissolved oxygen and ammonia concentrations in the river and sloughs, and can be used to assess the impact of BOD loading to these areas. However, because the downstream boundary for dissolved oxygen had to be estimated from data inside the modeled system in both the re-calibration and confirmation, the effective use of the model to predict water quality under critical conditions was limited to the area between one segment seaward of the water quality model segments used to set the downstream boundary dissolved oxygen concentrations, and the upstream boundary. This limits the model use for predicting water quality to the area between segments 28 (possibly segment 24) and 76 in the mainstem of the Snohomish River, and between segments 18 outside the mouth of the sloughs upstream to segment 76.

Waste Load Allocations for BOD and Ammonia

Seasonal Permit Periods

Two seasonal permit periods: summer, low river flow; and winter, high river flow were chosen to regulate dischargers use of the assimilative capacity of the estuary. However, WLAs were only estimated for the summer low river flow season, because the model developed for the estuary is not appropriate to estimate water quality under high river flow conditions. Until an appropriate model is developed, permit limits for the high river flow season should be based on technology and mixing zone limits. The following two seasons were selected:

- July-October (low river flow)
- November-June (high river flow)

Waterbody Classification, Dissolved Oxygen Standard, and Targets for WASP5 Modeling

The Snohomish River from the mouth upstream to the confluence with the Skykomish and Snoqualmie Rivers is currently classified as Freshwater Class A, which requires a dissolved oxygen water quality criterion of 8 mg/L. From the river mouth upstream to the southern tip of Ebey Island a special condition has been established for fecal coliform: fecal coliform organism levels shall neither exceed a geometric mean value of 200 cfu/100 mL nor have more than 10 percent of the samples obtained for calculating the mean value exceeding 400 cfu/100 mL. Inner Everett Harbor northeast of a line bearing 121 degrees true from approximately 47°59'5"N and 122°13'44W (approximately southwest corner of pier--Figure 3) is Marine Class B. Possession Sound (North of Mukilteo) is Marine Class A.

Estuarine systems are transitional environments between saltwater and freshwater habitats. In recognizing this, WAC 173-201A-060(2) states:

> In brackish waters of estuaries, where the fresh and marine water quality criteria differ within the same classification, the criteria shall be interpolated on the basis of salinity; except that the marine water quality criteria shall apply for dissolved oxygen when salinity is one part per thousand ($^{o}/_{oo}$) or greater and fecal coliform organisms when salinity is ten parts per thousand or greater.

In addition to these criteria and salinity conditional modifications, the marine classification in WAC 173-201A allows dissolved oxygen levels to be degraded up to 0.2 mg/L by human-caused activities when natural conditions are near or below 6.0 mg/L.

In the Phase I report, WAS proposed using the vertically-averaged salinity of 1 ‰ at Mean High Water (MHHW = 11.1 feet) during low river flow to define the estuary's upstream boundary as a fixed point, then applying the marine or freshwater criteria upstream or downstream of the defined point. However, for this report the dissolved oxygen criteria based on the WAC language listed above was used, such that criteria were applied based only on the 1 ‰ salinity designation. The vertically-averaged salinity at any time during the tidal cycle was used to define the 1 ‰ condition. Consequently, the marine or freshwater dissolved oxygen criteria apply at different points in the estuary depending on the tidal conditions. The WAC language was chosen over the Phase I report proposed fixed point 1 ‰ salinity boundary because the quasi-dynamic modeling results are easier to interpret with respect to changing fresh and marine criteria, and the WAC language better represents the actual physical and chemical processes occurring in the estuary (*i.e.*, dissolved oxygen concentrations changing due to tidal changes that brings higher salinity, lower dissolved oxygen water into the river and sloughs). In this report, the 0.2 mg/L allowance for marine waters below the criteria was also applied to the freshwater portion of the modeled system.

To estimate allowable BOD loading, the dissolved oxygen standard was assumed to be met if the WASP5 model predicted dissolved oxygen to be greater than the fresh or marine standard based on the salinity requirement discussed above, or if the human-caused depletion was less than 0.2 mg/L when dissolved oxygen was predicted to be below the standard.

Modeling Critical Conditions

Critical conditions were evaluated in the model to estimate the potential effects of current and future waste loading to the estuary. Critical conditions are those possible physical, chemical, and biological characteristics of the receiving water and pollutant loading sources that can increase the adverse effects of a pollutant of concern (e.g., low river flow and increased temperature would increase the effect of a given BOD load). For the Snohomish River Estuary, the critical period was set to July through October (summer) based on a review of ambient data for the drainage by Ehinger (1993) presented in the QAPP. The ambient data showed that the probable combined occurrence of high water temperature, low dissolved oxygen, and low river flow would be restricted to these months.

Table 7 lists estimated critical conditions for the modeled system. The following is a summary of how the critical condition values for river flow (and tides), boundary and tributary concentrations, effluent discharge characteristics, and model segment characteristics were established. The DYNHYD5 and EUTRO5 critical condition input files are contained in Appendix E. The Data Groups and individual model characteristics (e.g., channel depth, dispersion coefficients, etc.) are noted.

River Flow and Tides -- Critical river flows for the period were estimated as the 7-day average low flow with a recurrence interval of once every 20 years (7Q20) (WAS, 1996). Flow distribution estimates and flow statistic calculations for the Snohomish River were made using WQHYDRO (Aroner, 1992). Table 8 displays estimated critical flows listed in the Phase I report for the mainstem of the Snohomish River and its tributaries, including the annual 7Q10 and winter 7Q20 (November through June) statistics for comparison to the summer 7Q20. Derivation of these flows is discussed in the Phase I report.

Although no discharge was observed from the "pumped" tributaries (*i.e.*, French Creek, the Marshland, Deadwater Slough, and Swan Trail Slough) during the August 1993 and 1996 surveys, an estimated discharge was included for the critical condition scenario. The average daily (July-October) pumping rate for French Creek was estimated by Rod Denherder of the U.S. Department of Agriculture, Renton, Washington, from pumping records for 1993 and 1994. Since no records were available for the other pumped waters, an average daily value was estimated from the relative size of these drainages compared to French Creek.

Boundary and Tributary Concentrations

For most water quality variables, critical conditions for the upstream and downstream boundary, July-October period, were based on the 90th percentile (or 10th for chlorophyll) of data from Ecology's ambient stations near the City of Snohomish and near Gedney Island (stations 07A090 and PSS019, respectively). Upstream and downstream boundary temperatures were set at 19.8° and 15.9°C. Tributary critical conditions were set to the highest values (lowest for dissolved oxygen and chlorophyll) of those measured during the August 1993 and 1996 surveys, except for the Pilchuck River, which were based on percentiles of data from Ecology's ambient station on the Pilchuck near the City of Snohomish (07B055). In addition, dissolved oxygen at the upstream boundary was set at saturation, and temperatures for all other tributaries were set at the upstream boundary value of 19.8°C.

The seaward boundary conditions for dissolved oxygen and salinity were based on the most extreme monthly profile data collected from 1990-1996 for the July-October period at PSS019, which corresponded to the profile data collected on September 20, 1993. The dissolved oxygen recorded on this date ranged from 8.3 mg/L at the surface to 5.6 mg/L at 16.5 meters. (The profile depth range of 0-16.5 meters was selected as the maximum depth range that could influence water quality in the river and sloughs, based on the transect profile data collected in 1995 and 1996.) The median of the 10-meter running average profile data from 0 to 16.5 meters was used to set the seaward boundary at 6.0 mg/L for dissolved oxygen and 29.5 ‰ for salinity. A maximum running average depth of 10 meters was selected based on the assumption that no more than 10 meters of the water column would influence water quality in the channeled river and sloughs that have maximum depths <10 meters (see profile contour plots in Appendix D).

Effluent Discharge Characteristics

Effluent critical condition characteristics for flow, ammonia, and $CBOD_5$ were provided by NWRO permit writers responsible for managing NPDES permits. The critical condition flows for the Everett WWTP discharges were set at the summer low flow season permit limits. The flows used for the other WWTPs were set at the maximum monthly values listed in their respective annual permits. All other effluent characteristics were set to the highest value measured during the August 1993 Class II inspections and the August 1996 effluent sampling survey.

Model Segment Characteristics

All model segment characteristics, except temperature, were those established during model calibration and re-calibration. Segment temperatures were based on interpolating the 90th percentile temperatures measured at the following Ecology historical ambient stations located within the model network: PSS005, PSS008, PSS009, PSS015, PSS016, PSS018, PSS020 and 07A090.

Dissolved Oxygen Model Predictions Under Critical Conditions

The cumulative water quality impacts of NPDES permit loading alternatives are reviewed in this section. Alternatives for NPDES discharge limits are based on two possible scenarios: 1) existing discharges to the estuary, and 2) existing and proposed discharges to the estuary.

Alternative Total BOD Discharge Scenarios

Scenario I: Existing Discharges

Figures 18-20 show the results of the dissolved oxygen model predictions for the existing discharges to the system under critical conditions. The graphs represent the predicted minimum and maximum dissolved oxygen concentrations, with and without loading sources (*i.e.*, no point sources of BOD and nonpoint sources set at estimated background conditions--ammonia = 0.005 mg/L and CBOD = 1.2 mg/L) for the mainstem of the Snohomish River, Steamboat Slough, and Ebey Slough. The insert graph in Figure 18 shows how predicted values from the 24-day model run for each model segment were used to construct the dissolved oxygen profiles for the series of segments corresponding to river miles shown on the X-axis. The profile presented in Figure 18 corresponds to the model segments 2 (seaward boundary), 8, 14, 24, plus all the segments representing the mainstem of the river (25, 27-30, 34-48, and 71-75) to the headwaters at segment 76 (Figure 6). The profile in Figure 19 starts at segment 6 (seaward boundary) and includes segments 12, 18, 31, 32, 49, 50, 54-58. Figure 20 also starts at segment 6 and includes segments 12, 18, 31, 33, 59-64, 56, and 65-70. The minimum dissolved oxygen profiles correspond to the time around high slack tide, while the maximum concentrations correspond to ebbing (or low) tide conditions.

The critical time, when dissolved oxygen concentrations are the lowest, is around high slack tide. The dissolved oxygen profiles for the mainstem and sloughs show that the predicted minimum dissolved oxygen values without loading are below the marine criteria for part of the modeled system. At high tide the marine dissolved oxygen criterion of 6.0 mg/L would apply to all of the segments in the lower river and sloughs (i.e., the 1 ‰ marine condition is predicted to reach an upstream point between segments 43 and 46 for all of the high tides during the 24 day model period). In order to compare the magnitude of the difference between both high and low dissolved oxygen concentrations with and without loading, the difference between the maximum dissolved oxygen concentrations with and without loading sources, and the difference between the minimum dissolved oxygen concentrations with and without loading sources (as presented in Figures 18-20) were calculated as the predicted dissolved oxygen deficits for each model segment. Table 9 presents the numeric results for the predicted dissolved oxygen deficits at low ebbing and high slack tide, and the percentage of the total deficit attributable to the specific BOD loading sources for model segments with the largest deficits. For example, Everett's WWTP BOD loading accounts for 77 percent of the projected critical condition oxygen deficit at segment 36 around high slack tide (salinity >1 ‰.).

In order to establish WLAs, the model was run with reduced total BOD loads until all segments below the marine criterion met the 6.0 mg/L criterion at high tide, or caused no more than a 0.2 mg/L deficit. Table 10 shows the results of three different point source load reduction alternatives on the model predicted deficits. The first (I) BOD reduction was made by setting all ammonia point source discharges to 2 mg/L. The results show that this level of treatment would not be adequate to meet the criteria at all segments. The second (II) BOD reduction was made by setting ammonia to 2 mg/L and reducing BOD_5 to 33 mg/L. These results show that this level of treatment would be adequate to meet the criteria at all segments. The third (III) BOD reduction was made by setting ammonia at 5 mg/L and reducing BOD_5 27 mg/L. This level of treatment also allows all the model segments to meet the criteria. Reductions of ammonia to 2 and 5 mg/L correspond to a typical effluent quality after activated sludge/nitrification-denitrification in separate stage and single stage treatment, respectively (Metcalf and Eddy, 1991). The BOD_5 levels needed to attain compliance with the dissolved oxygen criteria are also attainable with these levels of treatment (Metcalf and Eddy, 1991).

It should be noted that segment 57 (located near the midpoint of Steamboat Slough, at the junction with upper Ebey Slough) was found to be the "critical" model segment in the system, or the segment which requires the most load reduction to meet the criteria. Table 9 shows that this segment receives significant loading from all the major sources in the modeled area. It is also important to note that the level of BOD reduction alternatives listed in Table 10 were made equally to all point sources without regard to the percent contributions at any one segment, or the total loading of any one source. Generally, each loading source has its greatest effect on segments near its discharge, however, contributions to many segments are predicted.

It should also be noted that the minimum dissolved oxygen concentration in segment 57 with and without BOD loading was predicted to be 5.61 and 6.05 mg/L, respectively. The allowable 0.2 mg/L deficit was applied to the predicted deficit for this segment such that the final dissolved oxygen with treatment was 5.85 mg/L, which is 0.15 mg/L below the marine criterion. A more strict interpretation of the marine dissolved oxygen criteria would be to allow only a 0.05 mg/L deficit at segment 57. However, the 0.2 mg/L deficit was allowed because the criteria states that natural oxygen levels near or below 6.0 mg/L may be degraded by up to 0.2 mg/L.

Scenario II: Existing and Proposed Discharges

Two new pulp and paper facilities, a de-inking and recycling facility, are being planned for construction on the site of the former Weyerhaeuser bleached Kraft pulp mill in Everett (Figure 3). A cogeneration facility is also planned to be built on the site to supply steam for the de-inking facility. Process wastewater will be generated from the facilities, and the current plan is to send the wastewater to the Smith Island Treatment Plant (SITP) for treatment, then discharge the treated effluent into Steamboat Slough just downstream from the Union Slough junction, into the area represented by water quality model segment 49 (CH2M Hill, 1996).

The treated wastewater is planned to be intermittently discharged through a new outfall diffuser. Based on an analysis of the tidal conditions in Steamboat Slough, the effluent is planned to be discharged twice daily during the ebbing tides starting 30 minutes after high slack and ending 1 hour before low slack for a minimum period of 8 hours per day. The average flow rate for the intermittent discharge is projected to be 32.7 mgd (12.6 as a continuous daily flow) with a BOD_5 concentration of 63 mg/L and total ammonia concentration of 2 mg/L (CH2M Hill, 1996; Per. Comm. Robert York, Environmental Engineer, CH2M Hill). An estimate of the ultimate BOD/BOD_5 ratio of 1.27 was made from data collected to characterize the effluent of Sonoco Products Company waste paperboard mill in Sumner, Washington (Pelletier, 1993).

Figure 21 is an example of the modeled SITP intermittent discharge periods for the first 1.5 days of the tidal sequence used for the critical conditions simulations. Table 11 lists the results of model predicted dissolved oxygen concentrations for load reduction strategy II listed in Table 10, plus the same level of treatment with the SITP BOD loading (IV). The results show that the SITP discharge would cause additional deficits in the segments representing Steamboat Slough (*i.e.*, segments 49, 50, 55, 56, and 57) and just seaward of the slough (*i.e.*, segments 31 and 32), ranging from 0.04-0.07 mg/L. An additional dissolved oxygen deficit of 0.06 mg/L is predicted at the critical model segment 57. In order to meet the allowable 0.2 mg/L deficit at all locations with the SITP BOD loading, all point source dischargers would have to be reduced to 2 mg/L of ammonia and 26 mg/L of BOD_5 (Table 11, V). These ammonia and BOD_5 levels should be attainable for the municipal WWTPs with separate stage activated sludge/nitrification denitrification, however, it is not known whether these levels can be achieved by the proposed new discharge from the SITP.

WLAs and LAs

Table 12 presents the allowable effluent limits or WLAs for BOD_5 and ammonia that meet the dissolved oxygen criteria as the maximum daily average concentrations (in mg/L) and loads (in pounds/day). At this time, **no** allocation has been made for future growth (e.g., new discharges, increased WWTP capacity). Also, if monthly limits are needed, then the statistical procedure described in the EPA Technical Support Document should be used to establish the maximum average monthly limit (EPA, 1991). The maximum average monthly limit calculations need to account for effluent variation and the number of samples per month used to monitor effluent quality. The nonpoint LA is set at existing conditions (*i.e.*, no reductions are proposed for nonpoint sources). Nonpoint source pollutant controls will be addressed in the tributary report scheduled to be completed in September 1997.

Uncertainty and Sensitivity Analysis

The WASP5 (DYNHYD5 and EUTRO5) model used to simulate the Snohomish River Estuary system is a one-dimensional quasi-dynamic model. The DYNHYD5 sub-program provides real time variations in tidal heights and velocities (and channel flows) to the EUTRO5 eutrophication program. Although EUTRO5 averages concentrations of water quality variables vertically and laterally in each segment, it does simulate dynamic changes in a number of state variables. The resultant complexity of the model is such that a complete uncertainty or sensitivity analysis would be a monumental undertaking.. However, because the economic and environmental impact of this project are considerable, a partial but reasonable assessment of model certainty and sensitivity has been conducted.

The calibration and confirmation of the model results reported in this document and the Phase I report using the RMSE of the model predicted and observed values as an estimator of model uncertainty is an acceptable method of assessing model uncertainty (Reckhow *et al.*, 1986). For example, the confirmation of the model suggests that the vertically averaged dissolved oxygen and ammonia concentrations within each model segment can be predicted with an average error of 0.39 and .016 mg/L, respectively. The correlation coefficients for the model and predicted values of salinity, dissolved oxygen and ammonia for the 1993 data were 0.93, 0.94, and 0.78, respectively, and for the 1996 data they were 0.98, 0.93, and 0.72. The RMSEs and correlation coefficients suggest that the model is a good predictor of these parameters in the modeled area.

A complete sensitivity analysis for the model at only a small subset of the segments would require a factorial design which is not possible without analysis software designed to link with the model. Instead, a one variable-at-a-time approach for some of the major input parameters was used to show what the effect would be on dissolved oxygen concentrations from changes to some of the input parameters. Table 13 lists the results for a subset of representative water quality model segments. The values listed in Table 13 are equal to the percent change in the model predicted dissolved oxygen concentration after a 10 percent change in each of the model input parameters listed in the table. For example, a 10 percent change in river flow (upstream boundary input to the model) would cause a 1.9 percent change in dissolved oxygen at low tide, and a 0.9 percent change at high tide at segment 34. The sensitivity analysis indicates that for all segments the model results are most sensitive to temperature, and at high tide the segments in the lower river and sloughs are most sensitive to the downstream (or seaward) boundary dissolved oxygen concentration.

Conclusions and Recommendations

- A one-dimensional quasi-dynamic water quality and quantity model of the Snohomish River Estuary was developed using WASP5. The model was calibrated and confirmed using data collected during August of 1993 and 1996, respectively. An uncertainty analysis of the differences between predicted and observed values for ammonia and dissolved oxygen indicate the model is an acceptable predictor for these variables. The model was developed to evaluate the capacity of the river to assimilate waste loads from point and nonpoint sources of BOD. The model was also developed to recommend WLAs for carbonaceous and nitrogenous BOD that would not violate the dissolved oxygen criteria.
- The WASP5 model of dissolved oxygen under critical conditions indicates that natural conditions in a large portion of the lower river and estuary would be below the Marine Class A dissolved oxygen criteria when salinity in the estuary exceeds 1 ‰. To meet the allowable anthropogenically-caused dissolved oxygen deficit of 0.2 mg/L, WLAs are recommended for the following point sources of ammonia and carbonaceous BOD: the City of Everett WWTP (two discharges), the City of Marysville WWTP, the Lake Steven's Sewer District WWTP, and the City of Snohomish WWTP. In addition, a WLA was determined for a proposed new discharge by Snohomish River Pulp Company. However, accommodating the new discharge would require more restrictive WLAs for all the existing dischargers.
- No reserve for future growth or water quality protection was determined. However, an allocation for a reserve could be considered during the public review period for this TMDL.
- Data analysis presented in the Phase I report showed that under critical conditions, the City of Monroe and Sultan WWTPs discharging to the Skykomish River would only have a small effect on dissolved oxygen concentrations. Permit limits for these discharges were recommended to be based on technology and mixing zone evaluations only. However, these WWTP discharges should be reassessed if increases in population are projected to significantly change the assumed critical effluent flows and concentrations used in the reported analyses.
- Mixing zone analysis should be completed for all permitted discharges to the river estuary system, and the results incorporated into the TMDL study and recommended WLAs.
- Copper was identified as a possible problem pollutant in the Class II inspections reported in the Phase I report. Measurable dissolved and total recoverable copper concentrations were also found in the Snohomish River and Ebey Slough during the 1993 metals screening survey reported in the Phase I report. Measurable concentrations of dissolved and total recoverable copper have also been found by AMS at station 07A090 located in the Snohomish River near the city of Snohomish. It is recommended that a complete review of existing copper data and an intensive survey of the Snohomish River Estuary be conducted to assess if a copper TMDL and associated WLAs and LAs need to be established.

References

Aroner, E.R., 1992. WQHYDRO: Water Quality/Hydrology Graphics/Analysis System. P.O. Box 18149, Portland, OR.

CH2M-HILL, 1996. Upgrade of the Treatment and Effluent Disposal Systems for the Smith Island Treatment Plant. Engineering Report. CH2M-HILL Bellevue, WA.

Cosmopolitan Engineering Group, 1996. Supplemental Mixing Zone Study City of Everett Wastewater Treatment Plant. Cosmopolitan Engineering Group, Tacoma, WA.

Cusimano, R.F., 1993. Snohomish River TMDL Quality Assurance Project Plan. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Cusimano, R.F., 1995. Snohomish River Estuary Dry Season TMDL Study - Phase I: Water Quality Model Calibration. Ecology Report No. 95-338. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Ehinger, W., 1993. Summary of ambient monitoring data collected form the Snohomish River Basin. Ecology internal report, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

EPA, 1991. Technical Support Document for Water Quality-based Toxics Control. Office of Water, U.S. Environmental Protection Agency. EPA/505/2-90-001.

EPA, 1993. WASP5 Model Documentation and User Manual. Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

EPA, 1996. Tulalip Landfill Superfund Site Interim Remedial Action Marysville, Washington. U.S. Environmental Protection Agency, Region X, Seattle, Washington.

Eisner, L.B., C.A. Janzen, S.L. Albertson, S.A. Bell, and J.A. Newton. 1994. 1992 Budd Inlet Seasonal Monitoring Report. Ecology Report No. 94-132. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Hubbard, E.F. and Stamper, W.G., 1972. Movement and Dispersion of Soluble Pollutants in the Northeast Cape Fear Estuary, North Carolina, Geological Survey Water-Supply Paper 1873-E, Washington D.C.

Joy, J., 1994. Snoqualmie River Total Maximum Daily Load Study. Ecology Report No. 94-71. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Lund, Wu-Seng, 1993. Water Quality Modeling Volume III: Applications to Estuaries. CRC Press, Inc. Boca Raton, FL.

MEL, 1994. Manchester Environmental Laboratory. Laboratory User's Manual. Fourth Edition. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Manchester, WA.

Metcalf and Eddy, 1991. Wastewater Engineering: Treatment, Disposal, and Reuse. Third Edition. McGraw-Hill, Inc.

Newton, J., 1995. Whidbey Basin Project Plan: Final Quality Assurance Project Plan. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Pelletier, G.J., 1993. Puyallup River Total Maximum Daily Load for Biochemical Oxygen Demand, Ammonia, and Residual Chlorine. Ecology Report, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Pelletier, G.J., 1994. Dissolved Oxygen in the Spokane River Downstream from Island Empire Paper Company with Recommendations for Waste Load Allocations for Biochemical Oxygen Demand. Ecology Report No. 94-155, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Pelletier, G.J., 1997. Colville River Water Quality: Pollutant Loading Capacity and Recommendations for Total Maximum Daily Loads. Ecology Report No. 96-349, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Reckhow, K.H., J.T. Clements, and R. Dodd, 1986. Statistical goodness-of-fit measures for waste load allocation models. Work Assignment No. 33. EPA Contract No. 68-01-6904. September, 1986.

Snohomish County, 1989. Snohomish River Unsteady Flow Model (FEQ), Results of Model Calibration and Reevaluation of the Five-Year + One Foot Level of Protection. Snohomish County, Department of Public Works, Surface Water Management Division.

Stein, S.M., R.T. Kilgore, and G.K. Young, 1991. Hydrodynamic and Mass Transport Modeling of Everett Harbor. A report prepared by GKY and Associates, Inc., 5411-E Backlick Road Springfield, VI.

WAS, 1993. Field Sampling and Measurement Protocols for the Watershed Assessments Section. Ecology Manual, Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Watershed Assessments Section, Olympia, WA.

WAS, 1996. Total Maximum Daily Load (TMDL) Development Guidelines. Ecology Report #97-315. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Watershed Assessments Section, Olympia, WA.

Figures

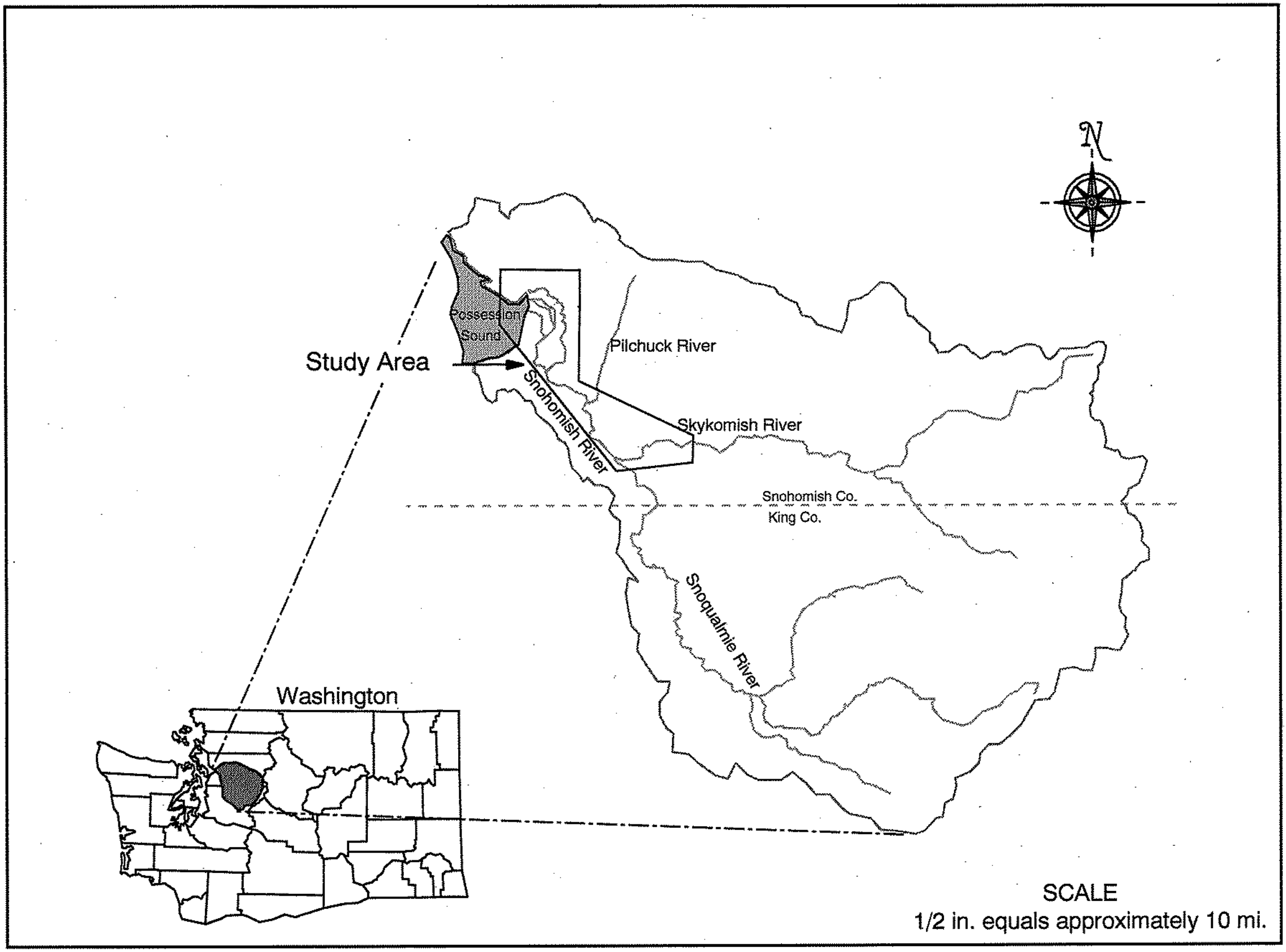


Figure 1. Snohomish River Basin and TMDL study area location map.

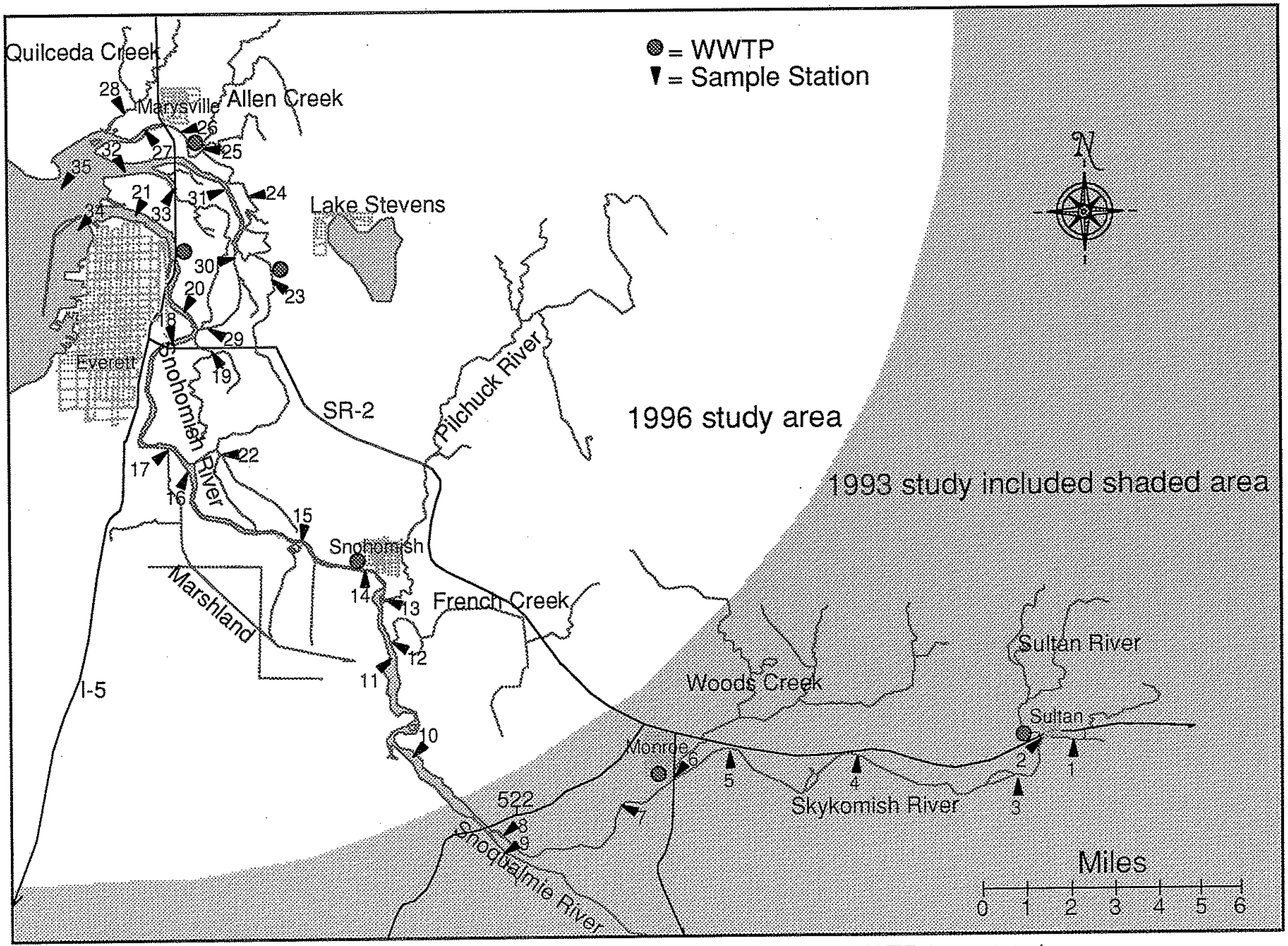


Figure 2. Study area map with sampling stations and wastewater treatment plants (WWTPs) annotated.

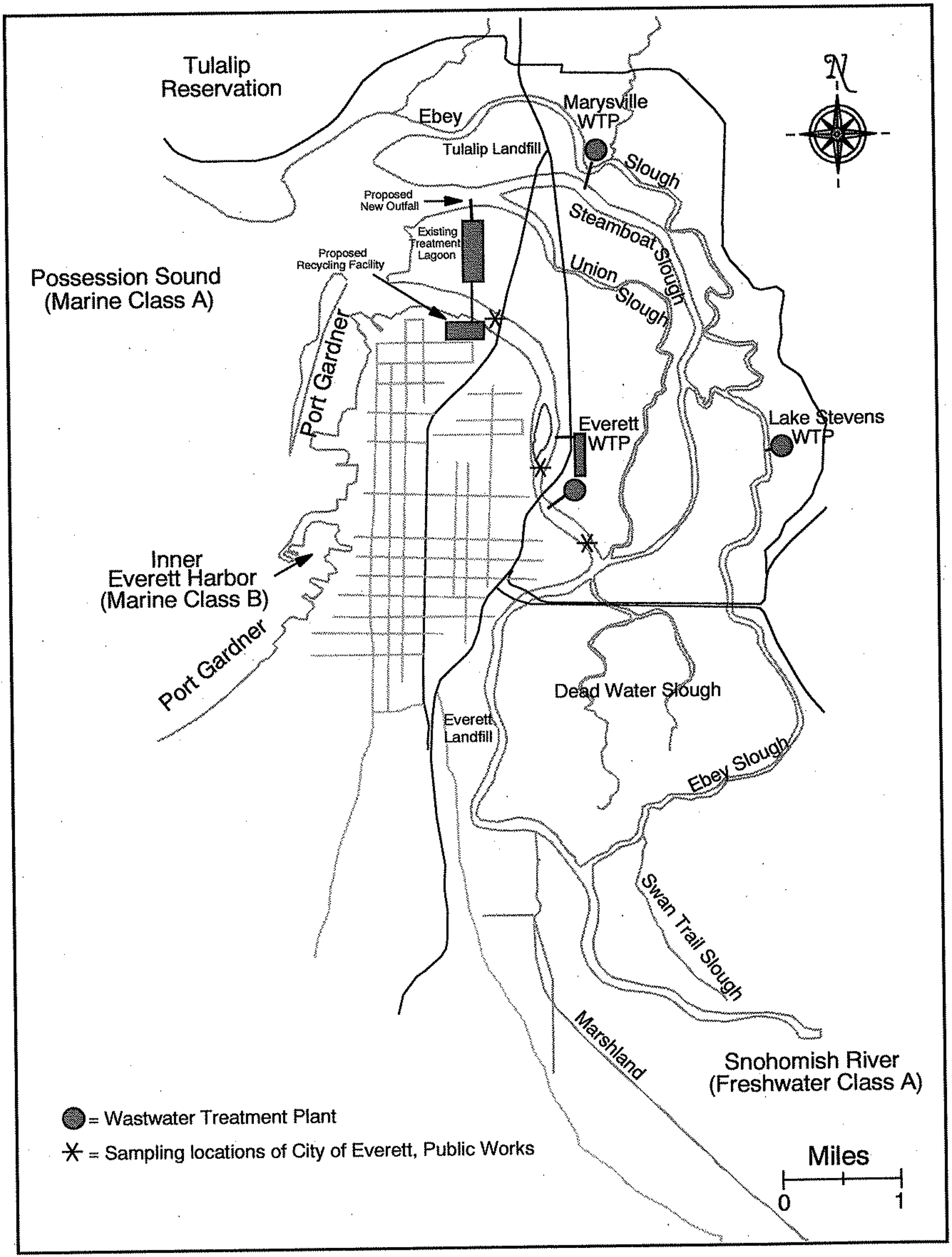


Figure 3. Map of sloughs and near shore estuary within study area.

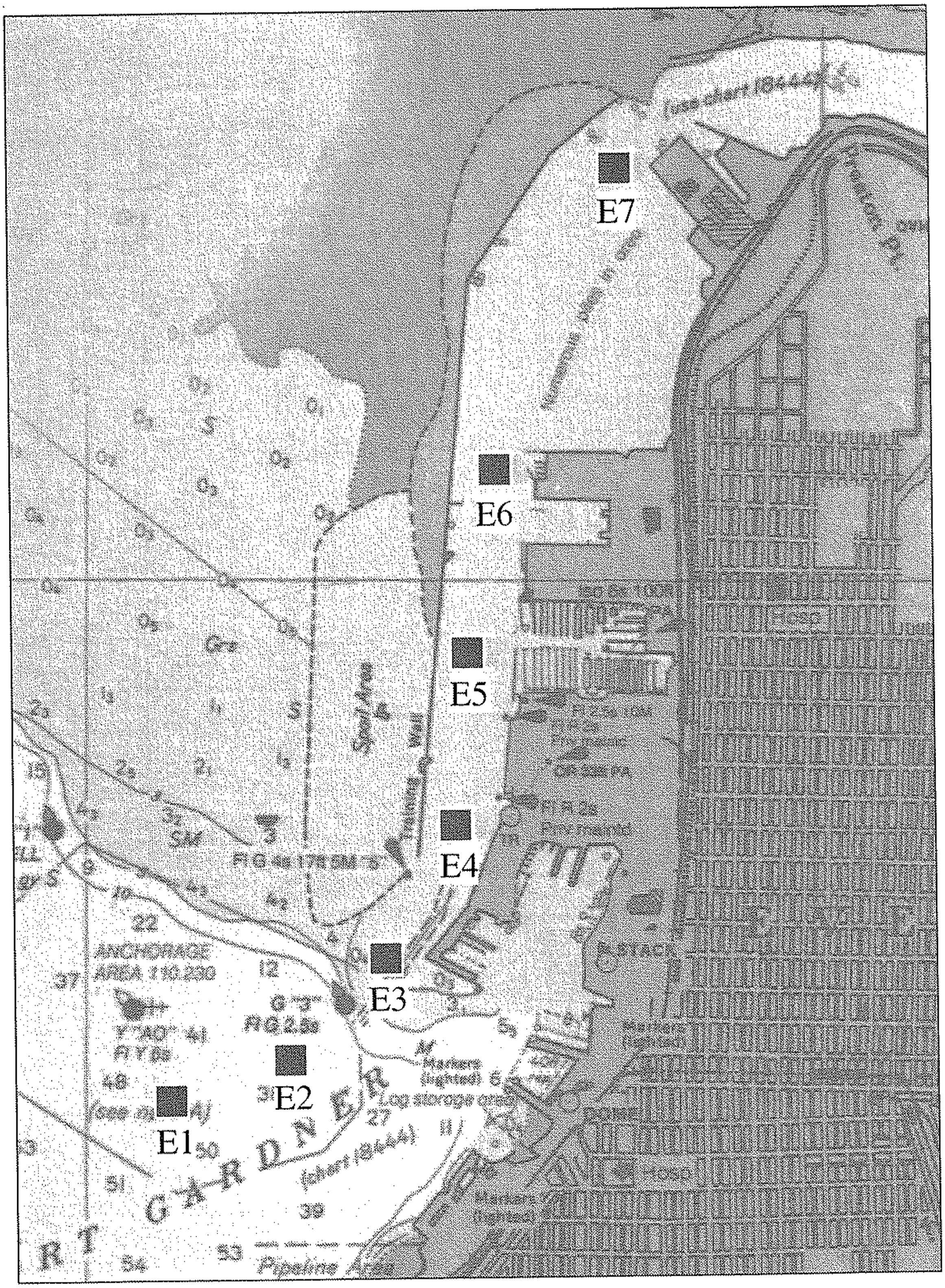


Figure 4. Sampling stations in the lower river and Possession Sound.

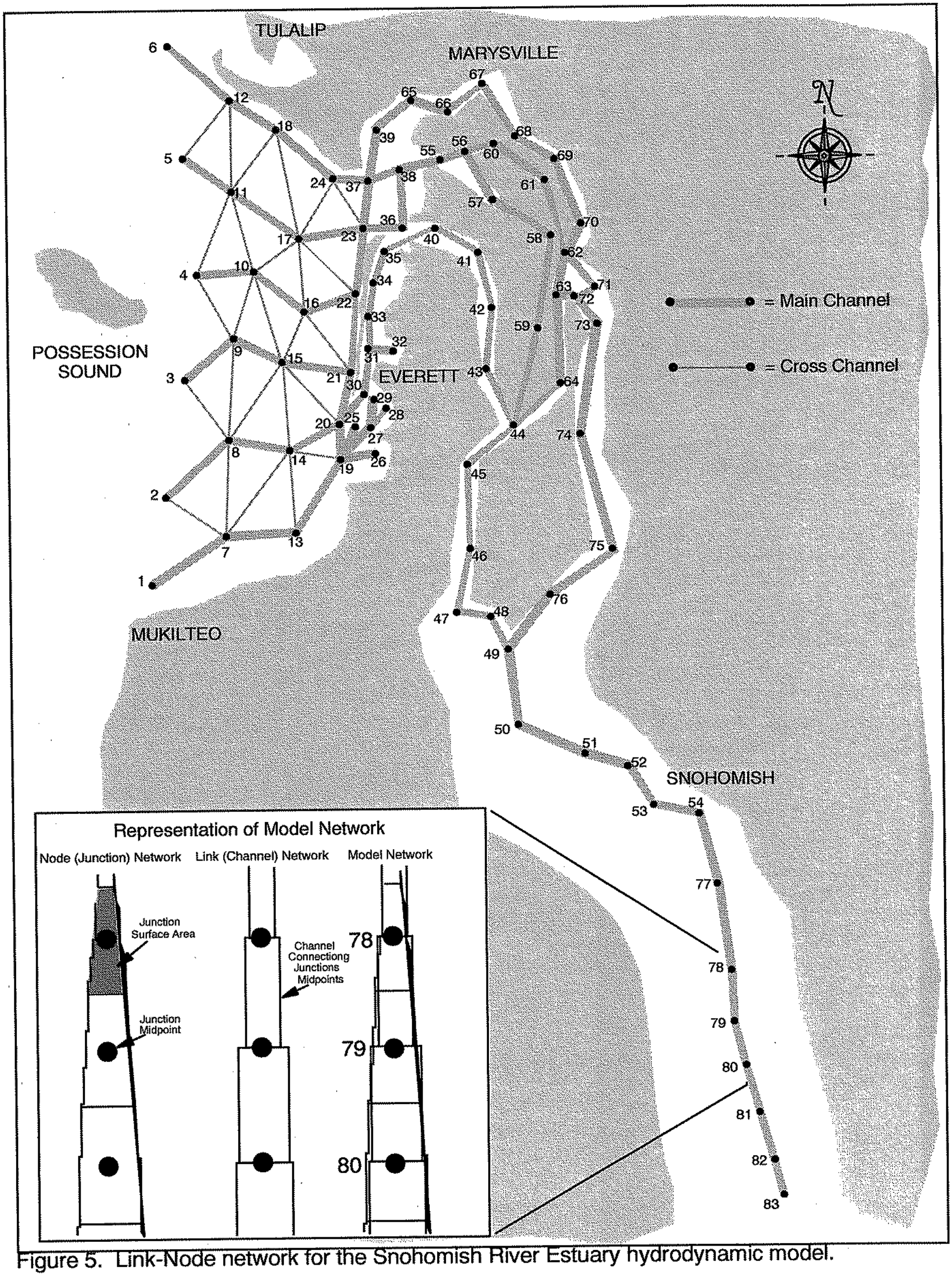


Figure 5. Link-Node network for the Snohomish River Estuary hydrodynamic model.

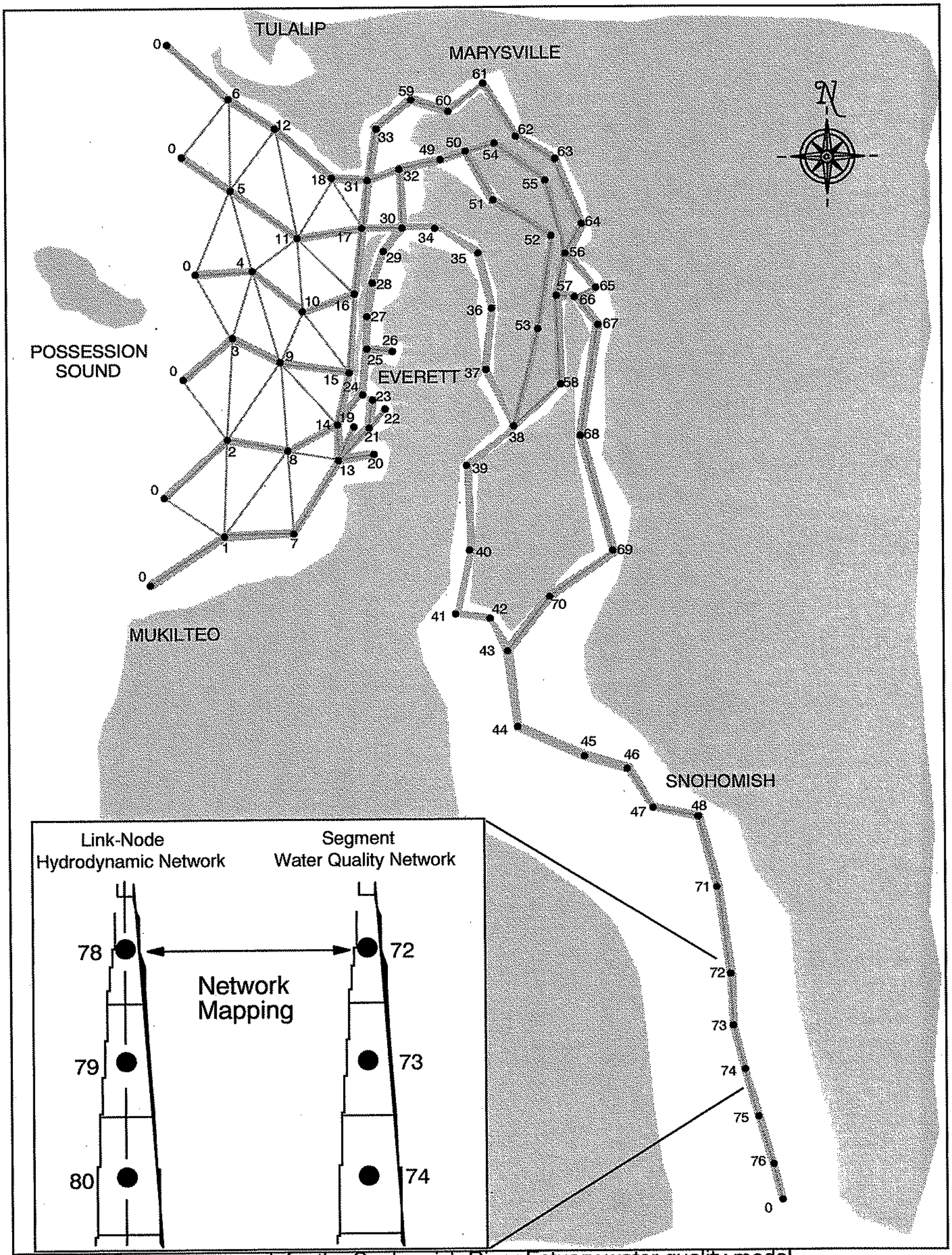


Figure 6. Segment network for the Snohomish River Estuary water quality model.

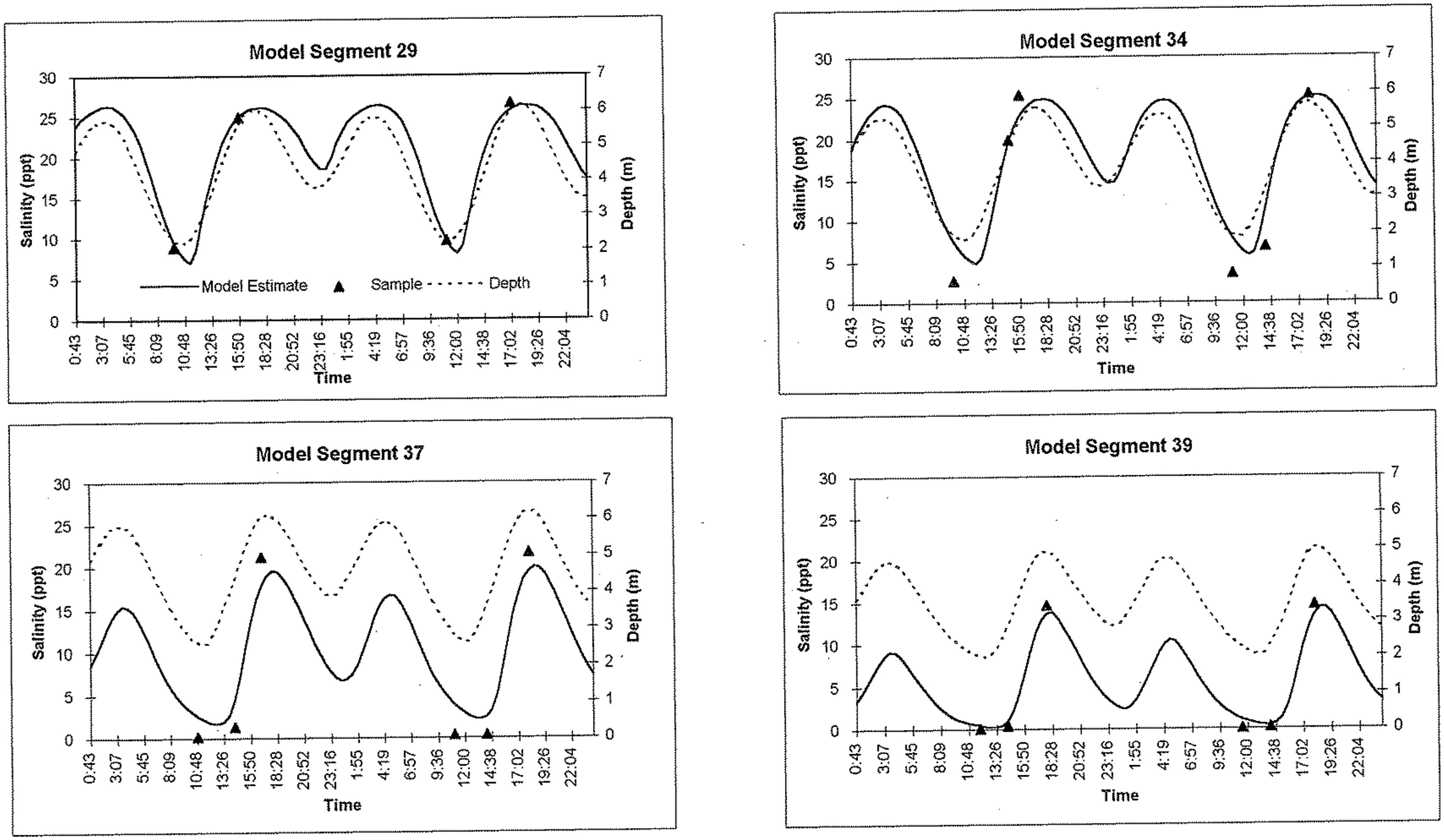


Figure 7. Verification of Eutro5 to predict salinity in the Snohomish River Estuary.

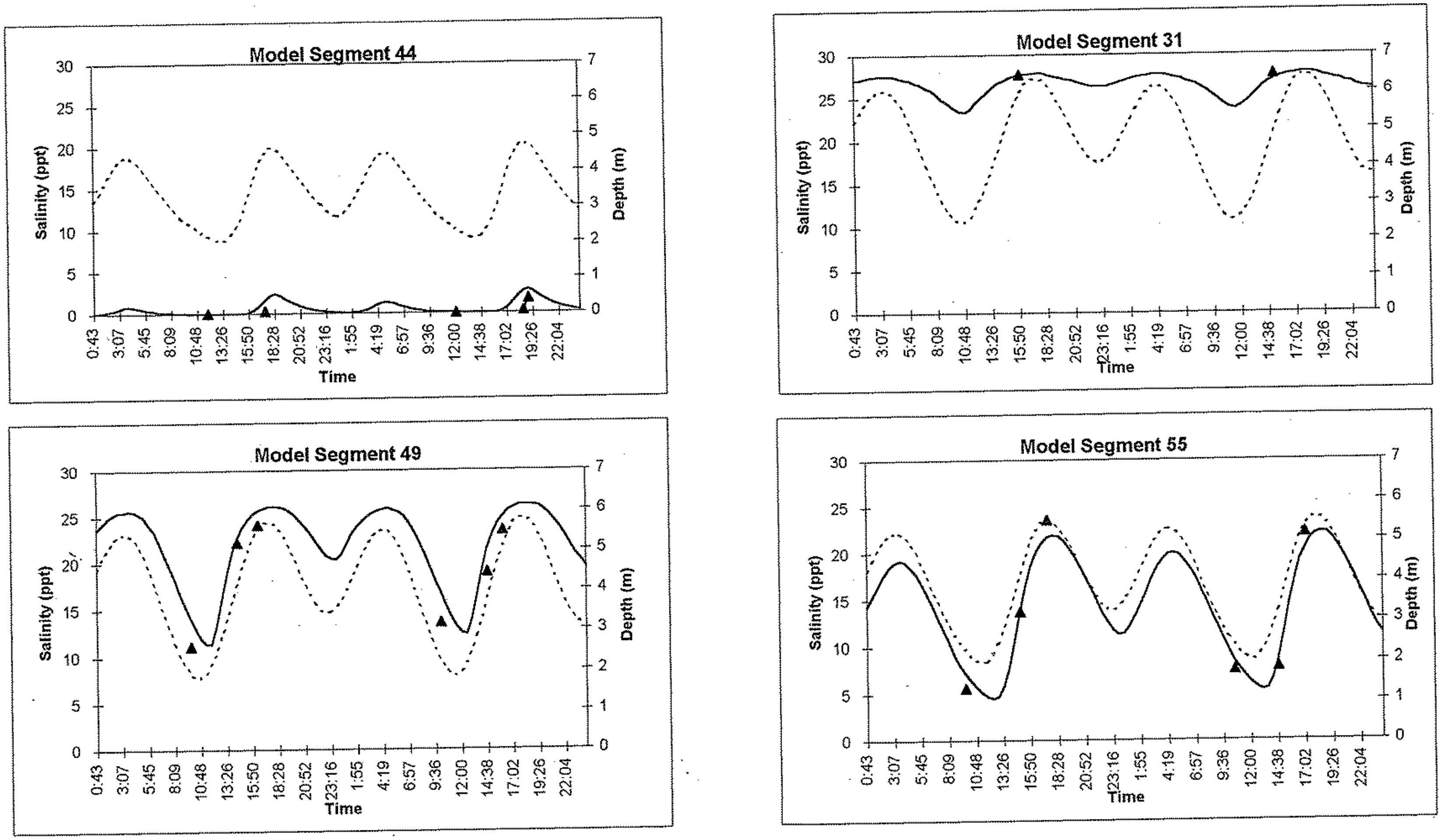


Figure 8. Verification of Eutro5 to predict salinity in the Snohomish River Estuary.

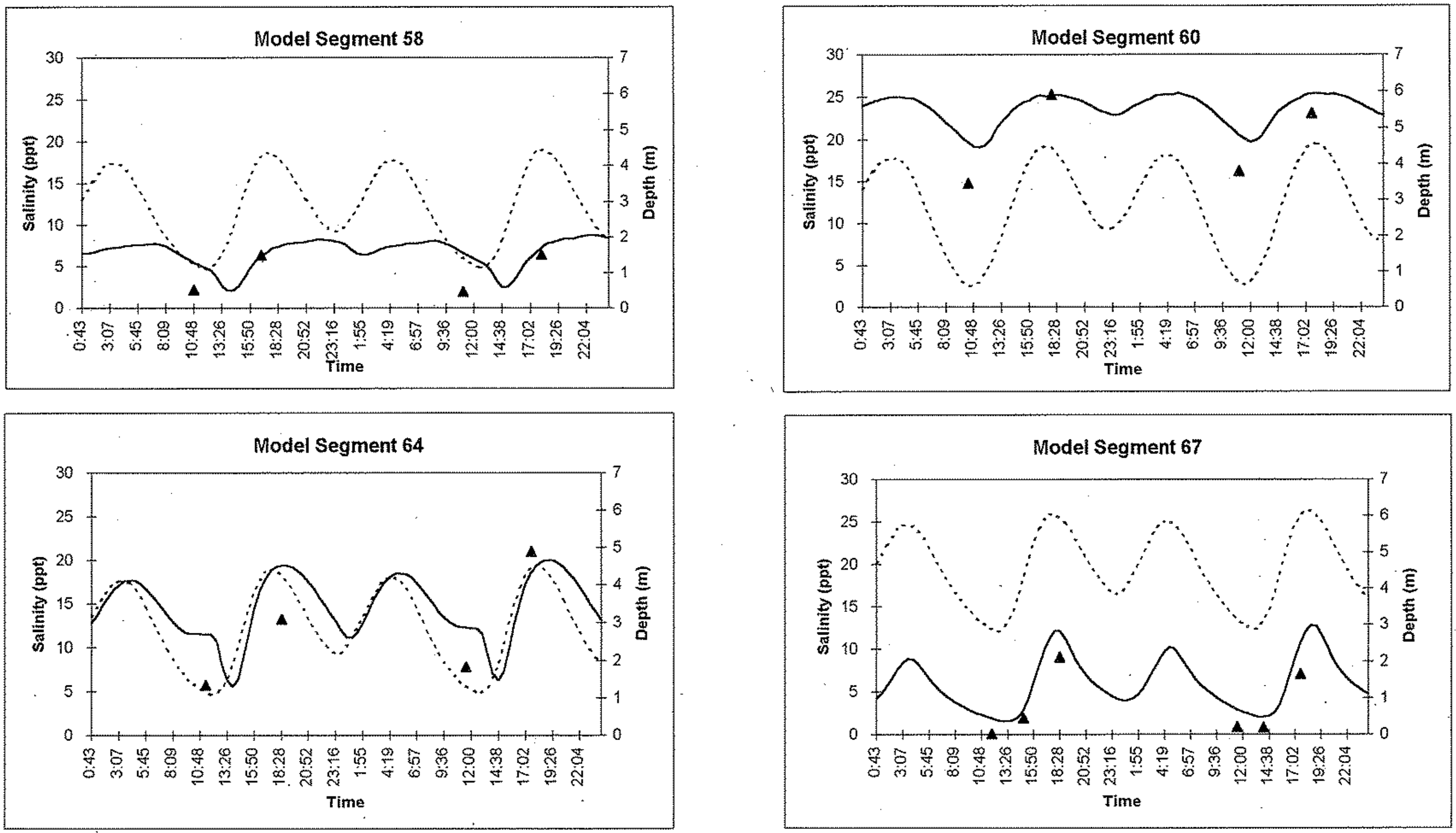


Figure 9. Verification of Eutro5 to predict salinity in the Snohomish River Estuary.

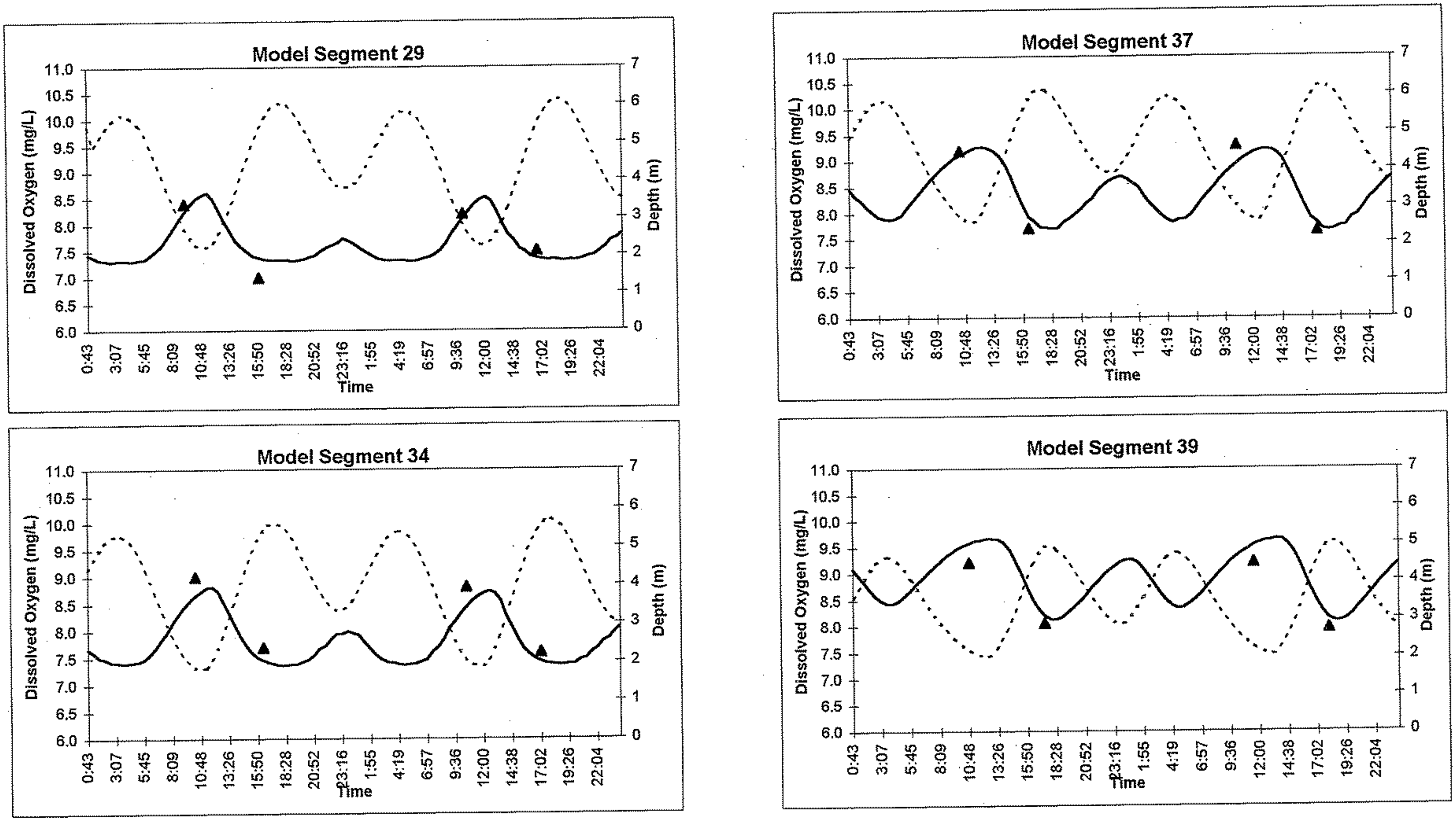


Figure 10. Verification of EUTRO5 to predict dissolved oxygen in the Snohomish River Estuary

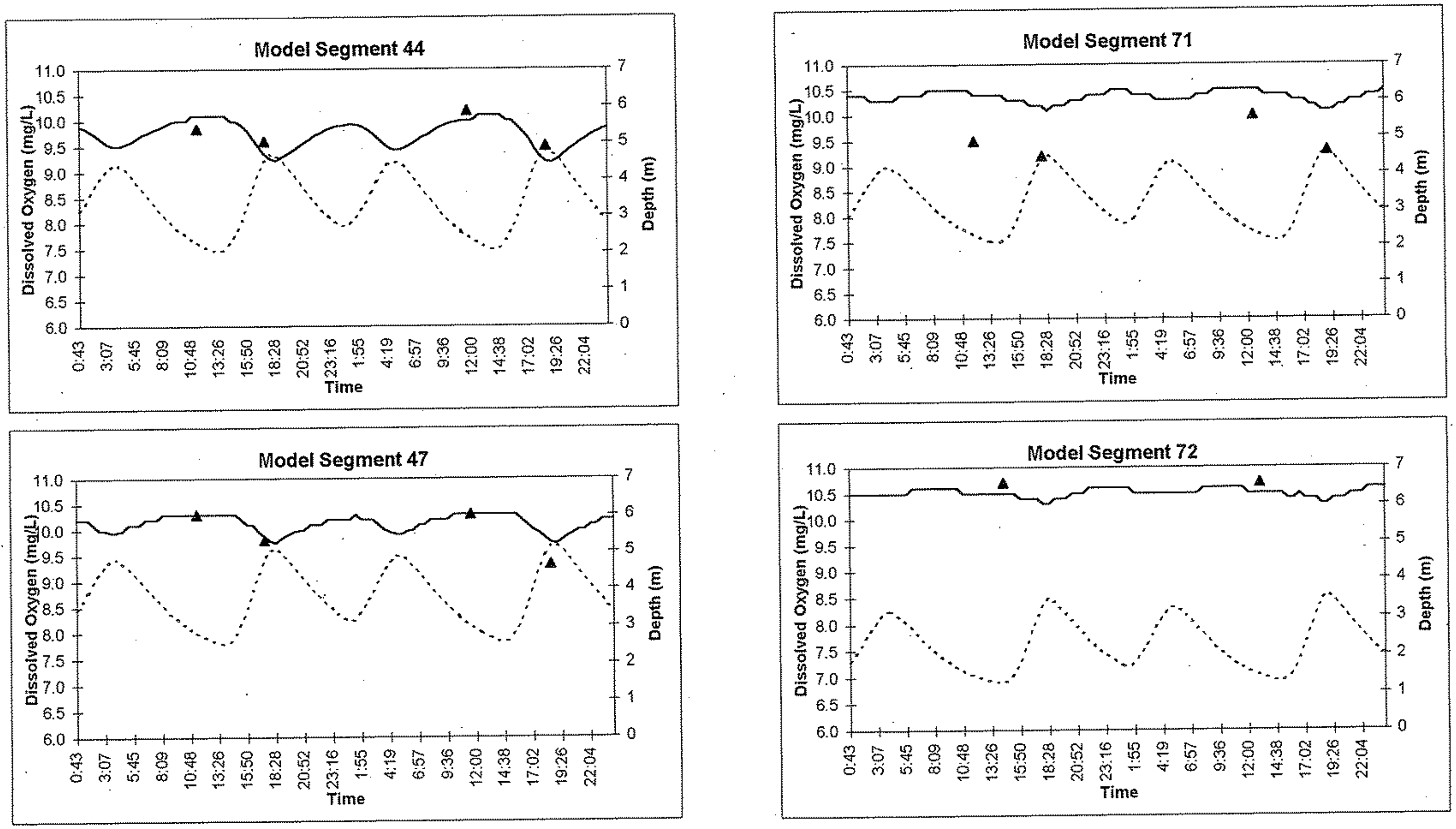


Figure 11. Verification of EUTRO5 to predict dissolved oxygen in the Snohomish River Estuary

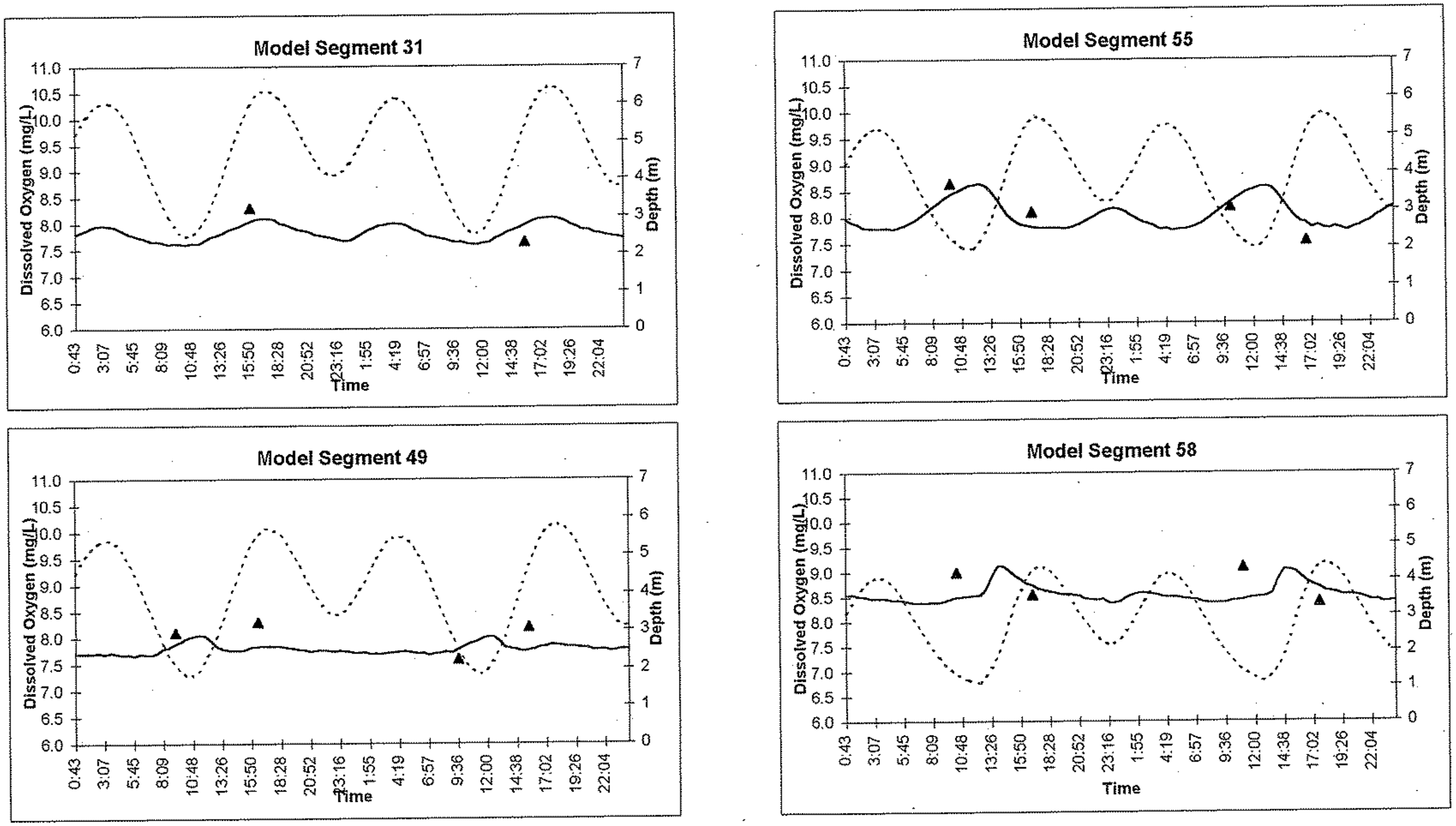


Figure 12. Verification of EUTRO5 to predict dissolved oxygen in the Snohomish River Estuary

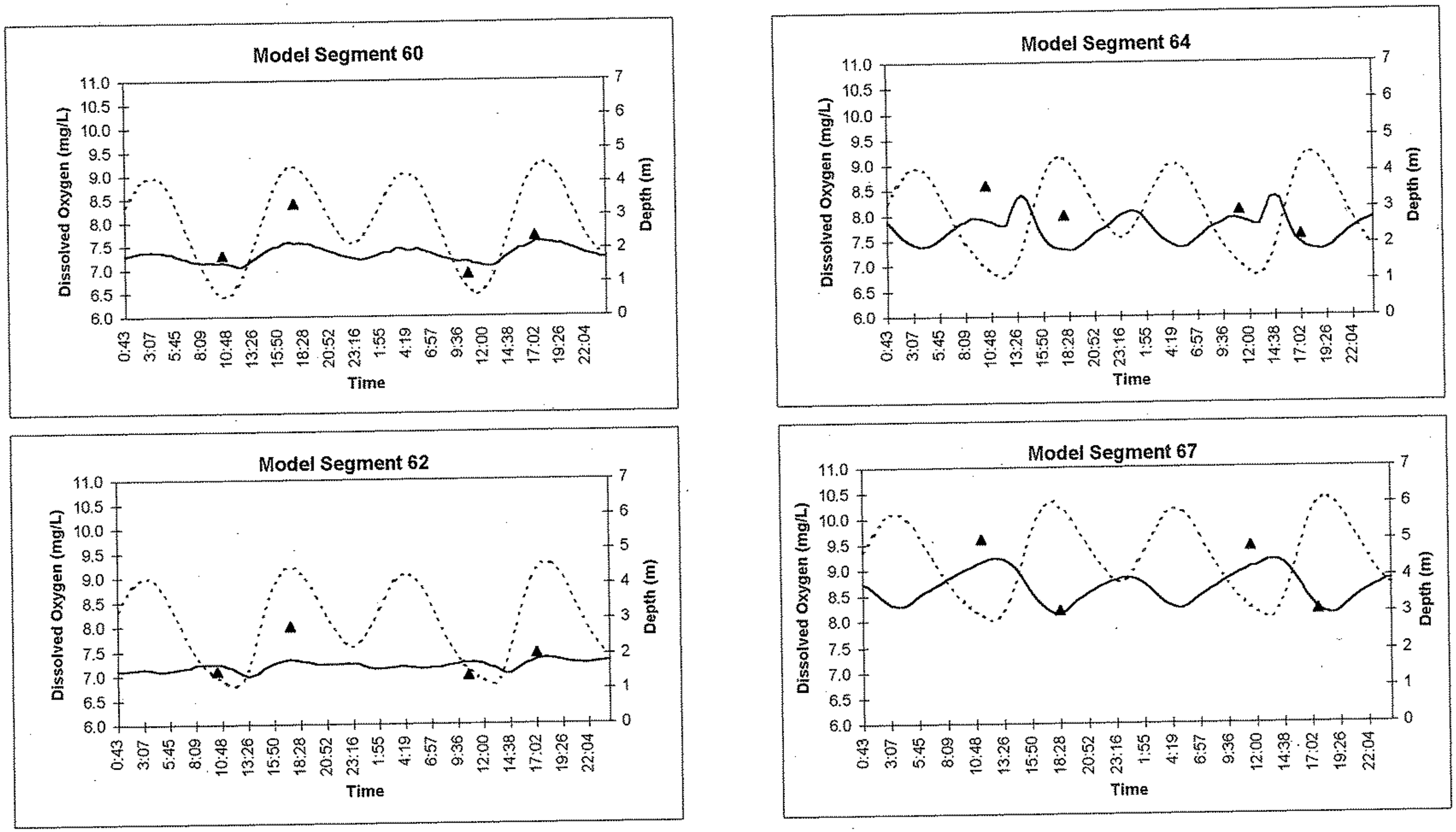
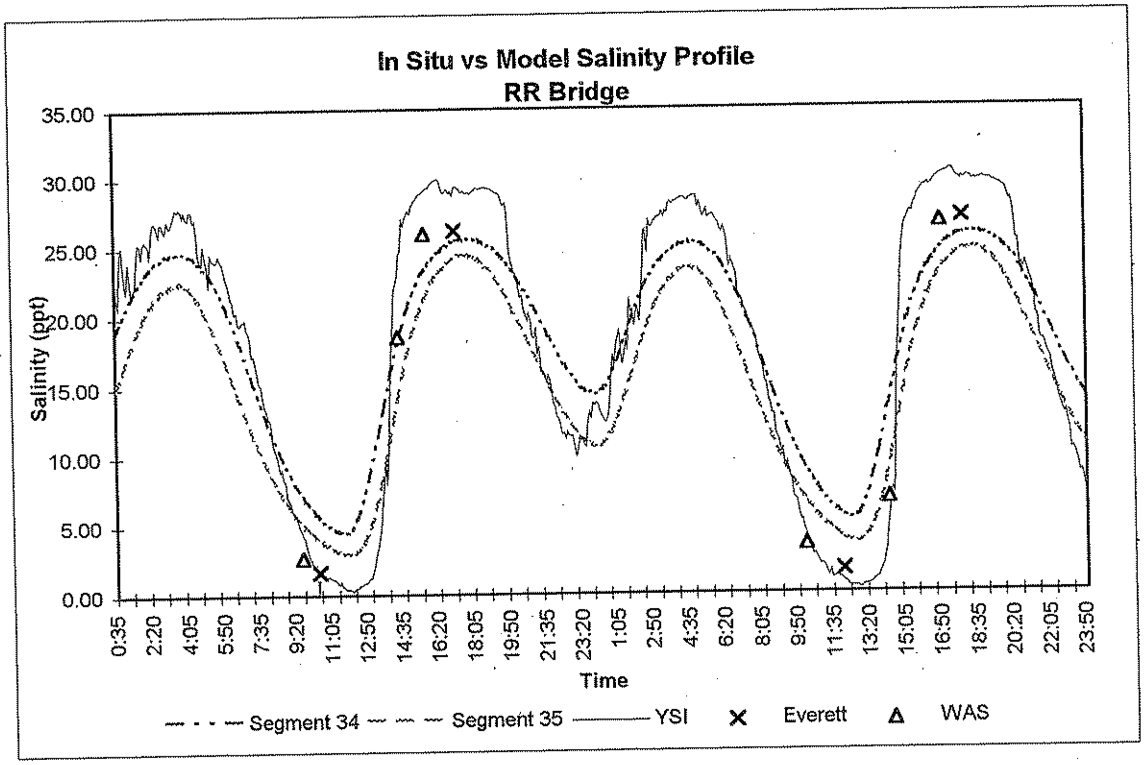


Figure 13. Verification of EUTRO5 to predict dissolved oxygen in the Snohomish River Estuary



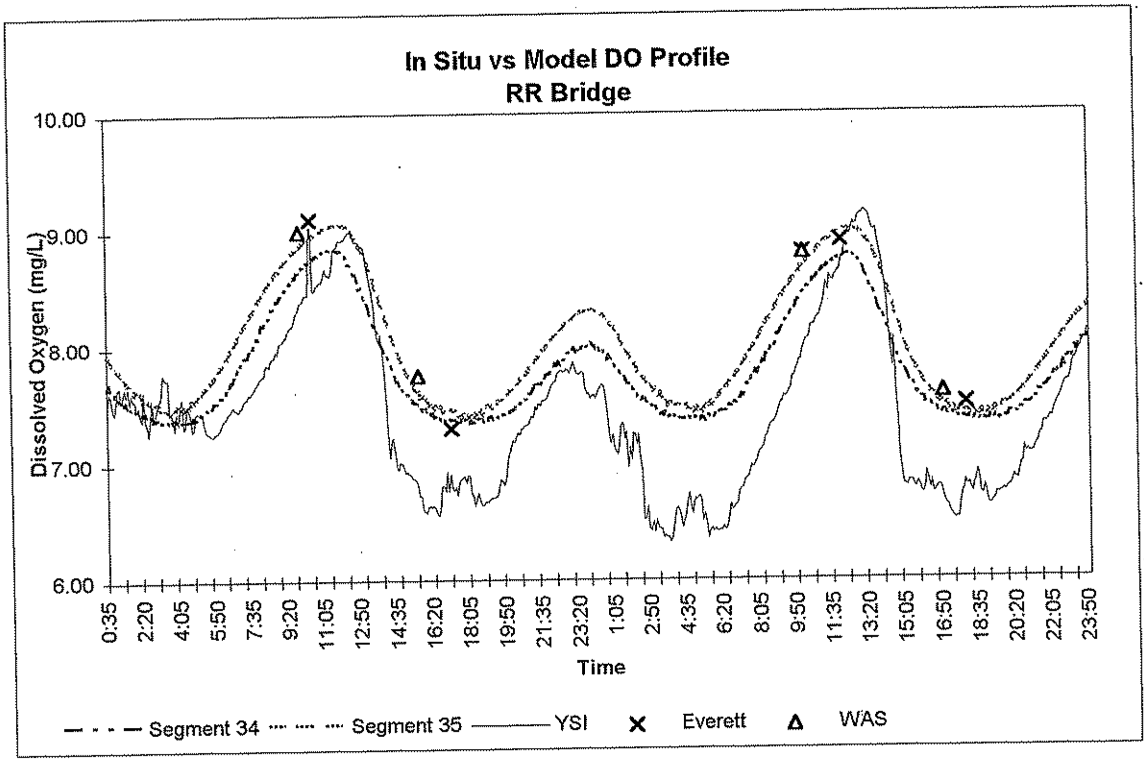
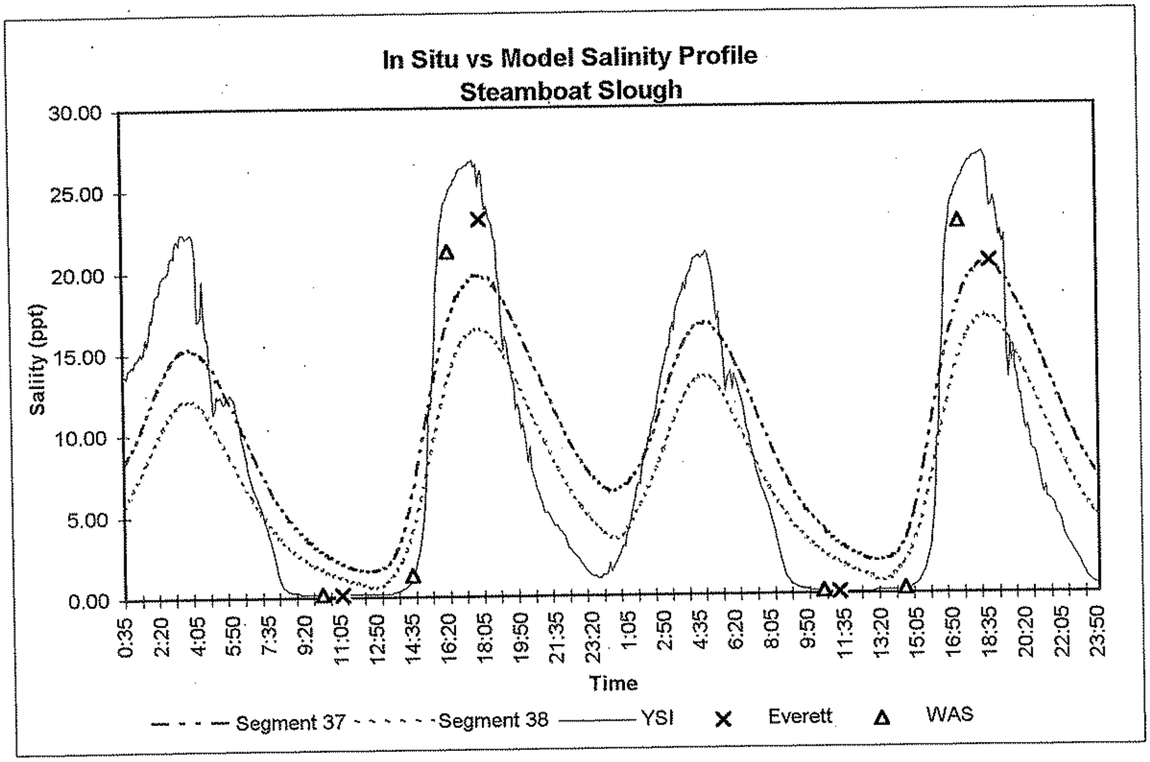


Figure 14. Comparison of EUTRO5 predicted values to continuous *in situ* and grab sample data.



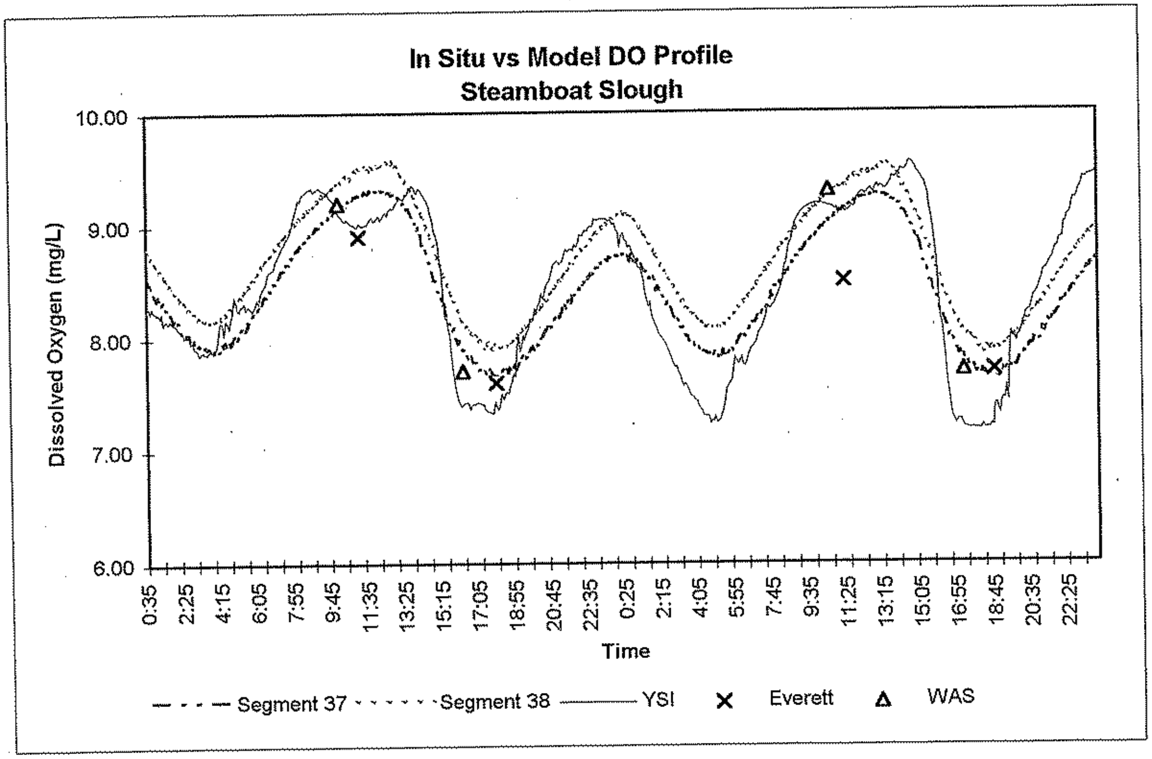


Figure 15. Comparison of EUTRO5 predicted values to continuous *in situ* and grab sample data.

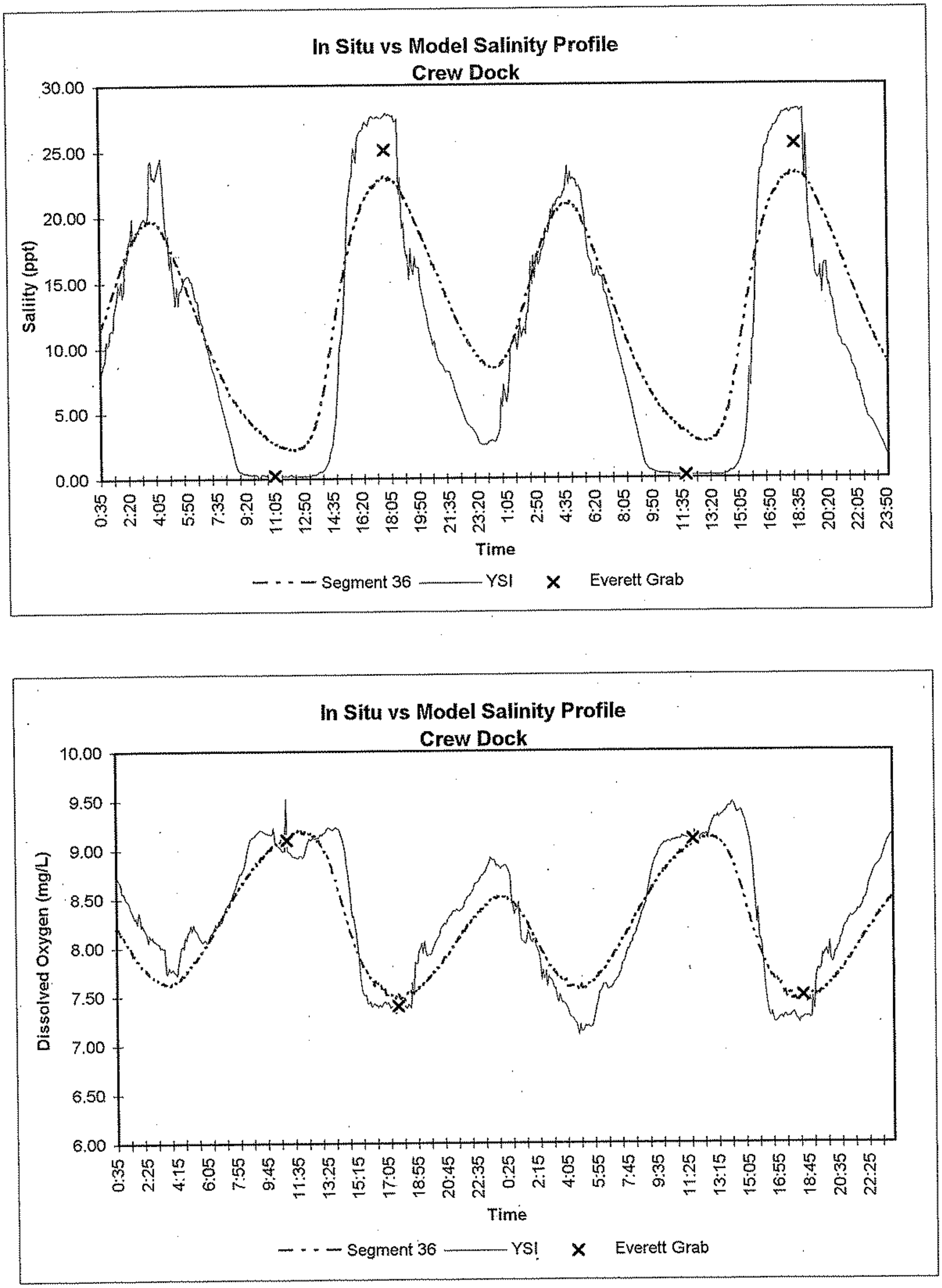


Figure 16. Comparison of EUTRO5 predicted values to continuous *in situ* and grab sample data.

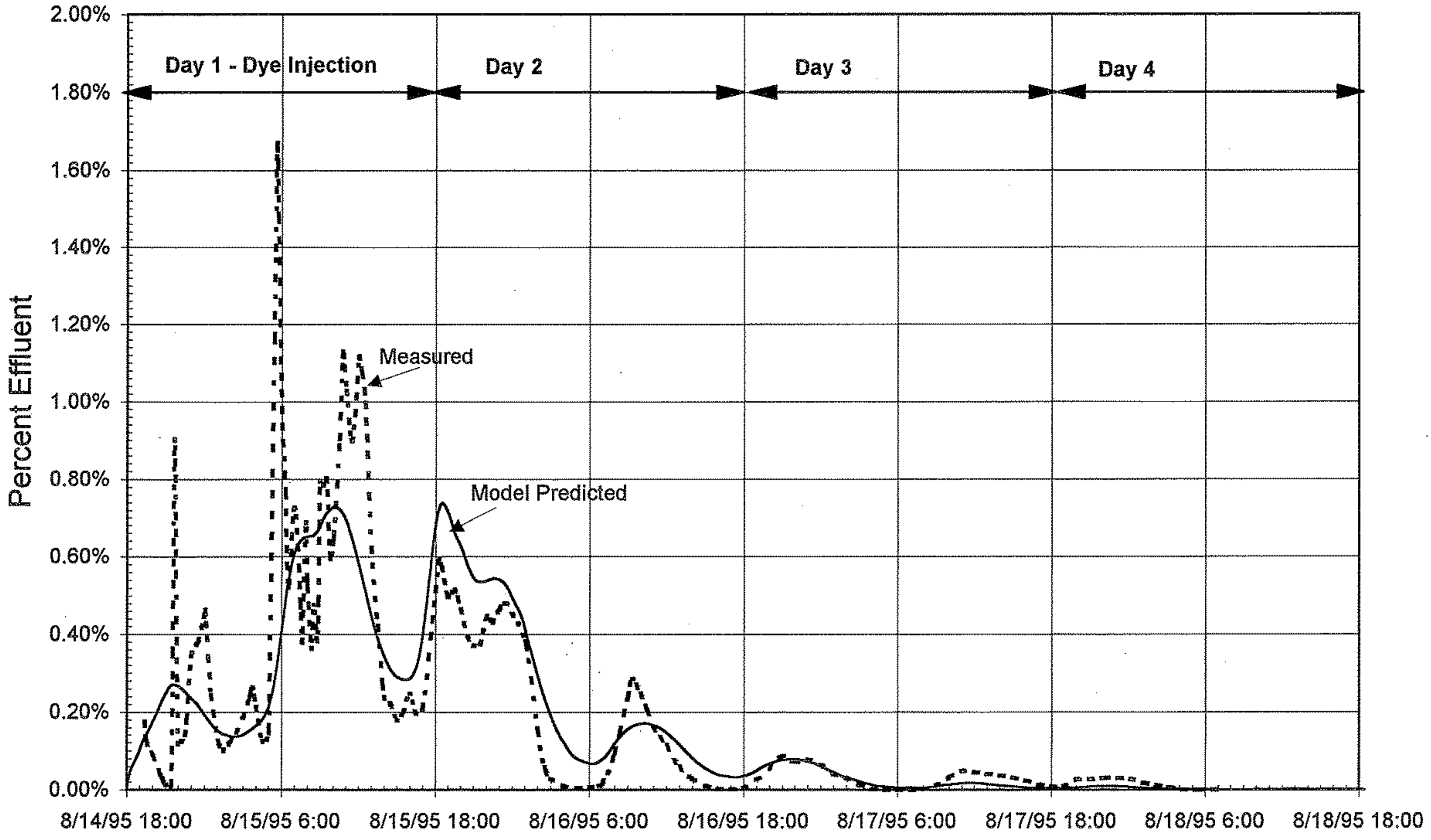


Figure 17. Measured and EUTRO5 model predicted dye concentrations as percent effluent in the Snohomish River near Langus Park.

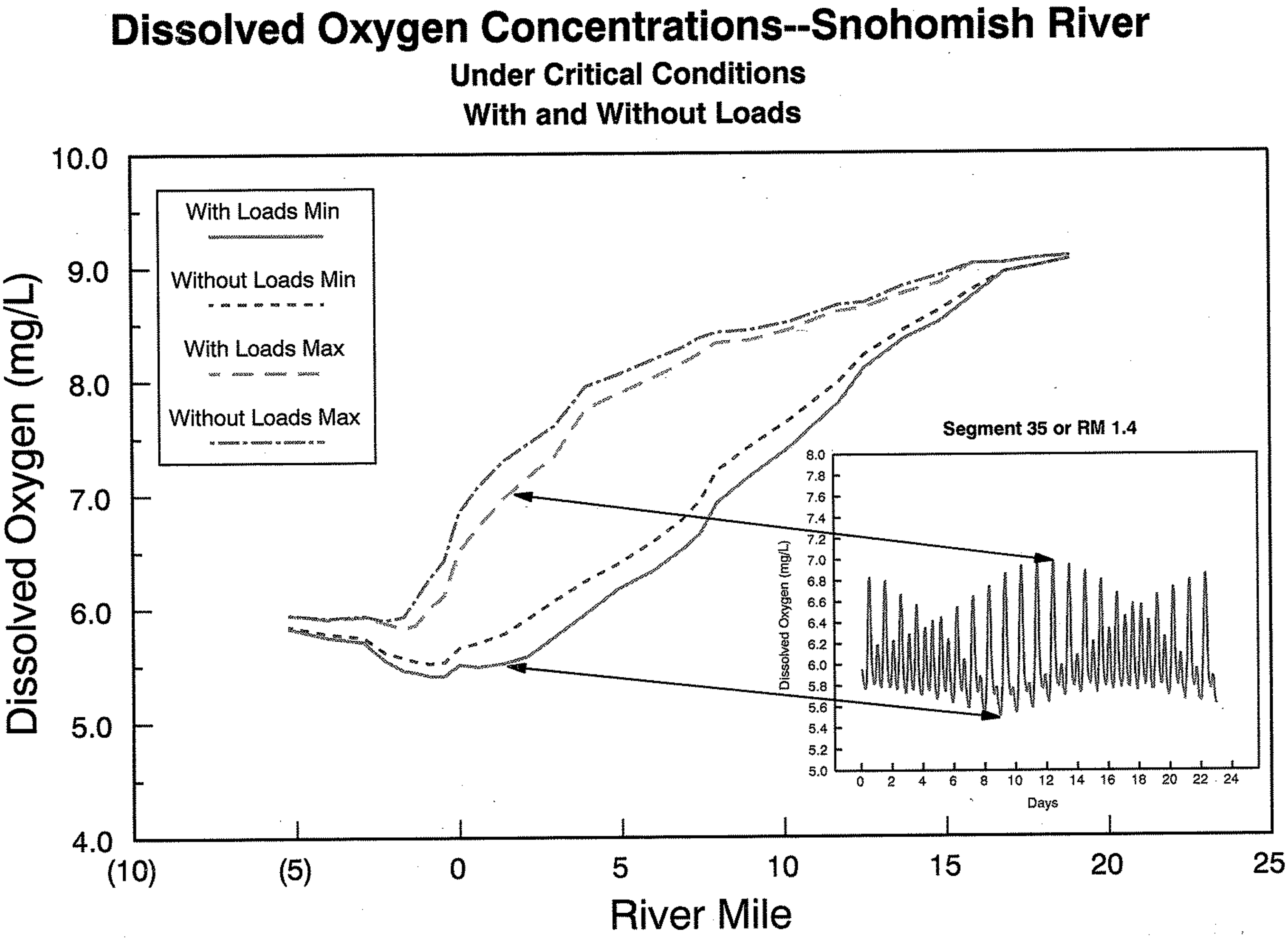


Figure 18. EUTRO5 predicted dissolved oxygen concentrations for the Snohomish River under critical conditions, with and without BOD loads.

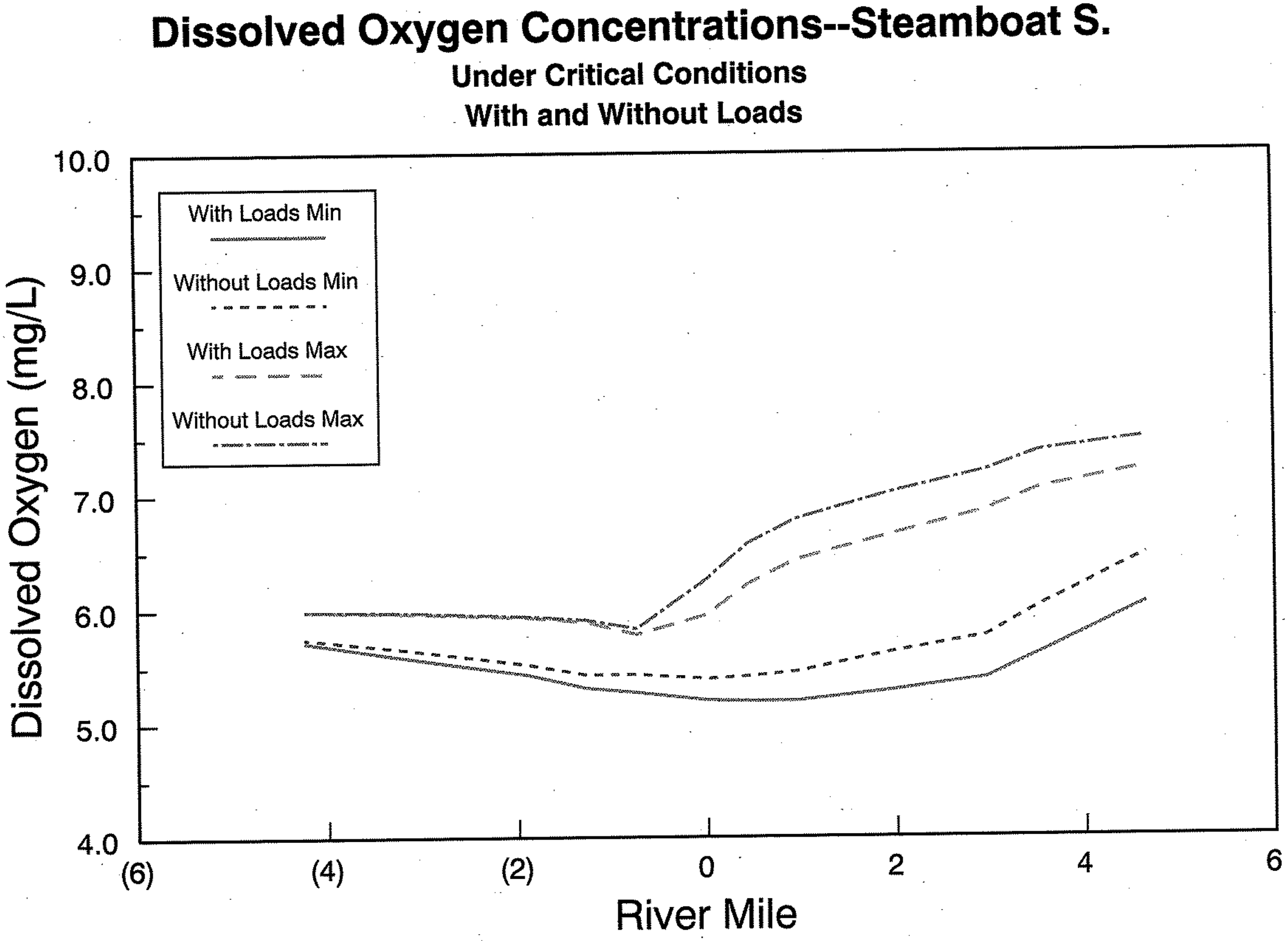


Figure 19. EUTRO5 predicted dissolved oxygen concentrations for Steamboat Slough under critical conditions, with and without BOD loads.

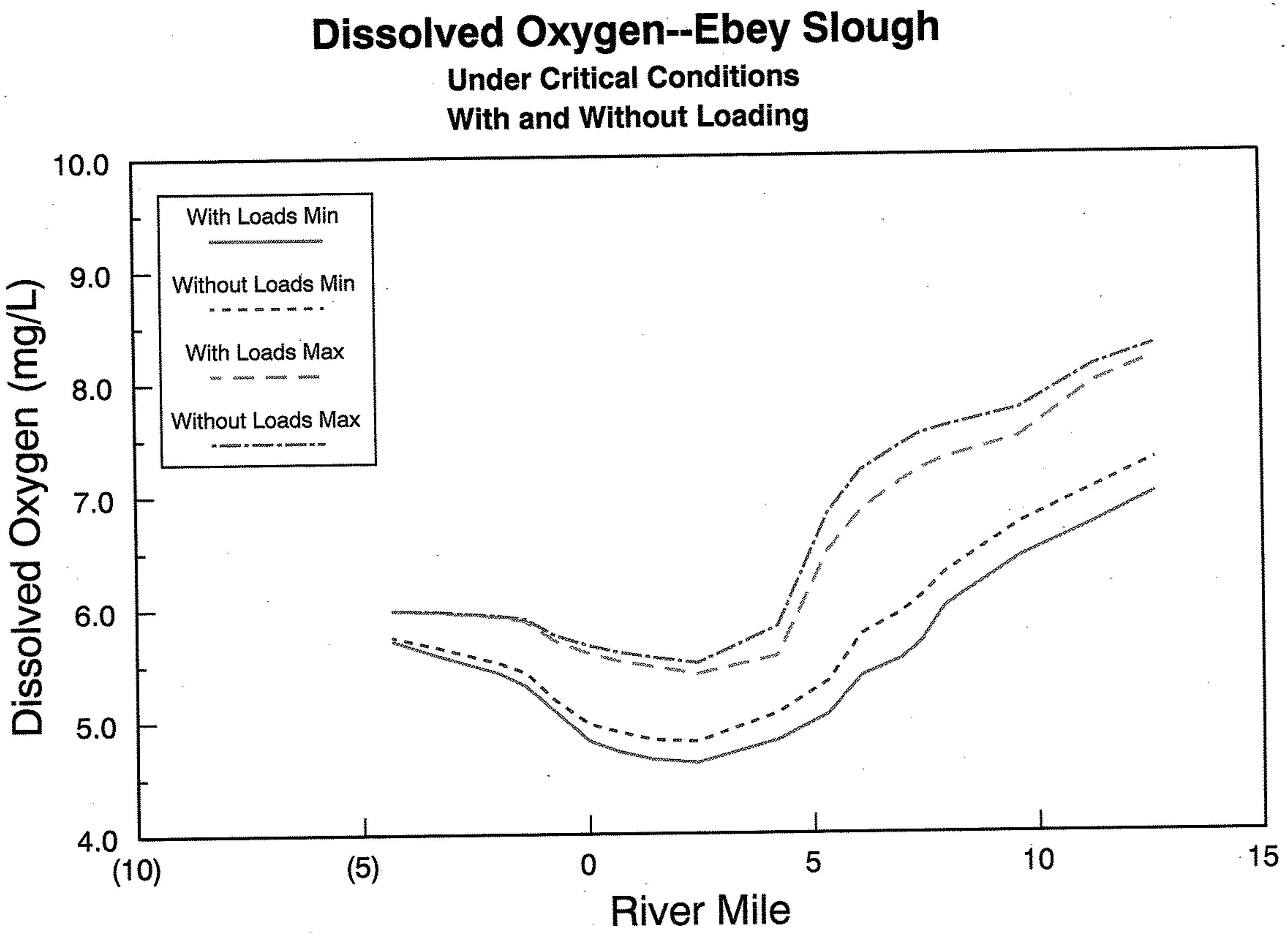


Figure 20. EUTRO5 predicted dissolved oxygen concentrations for Ebey Slough under critical conditions, with and without BOD loads.

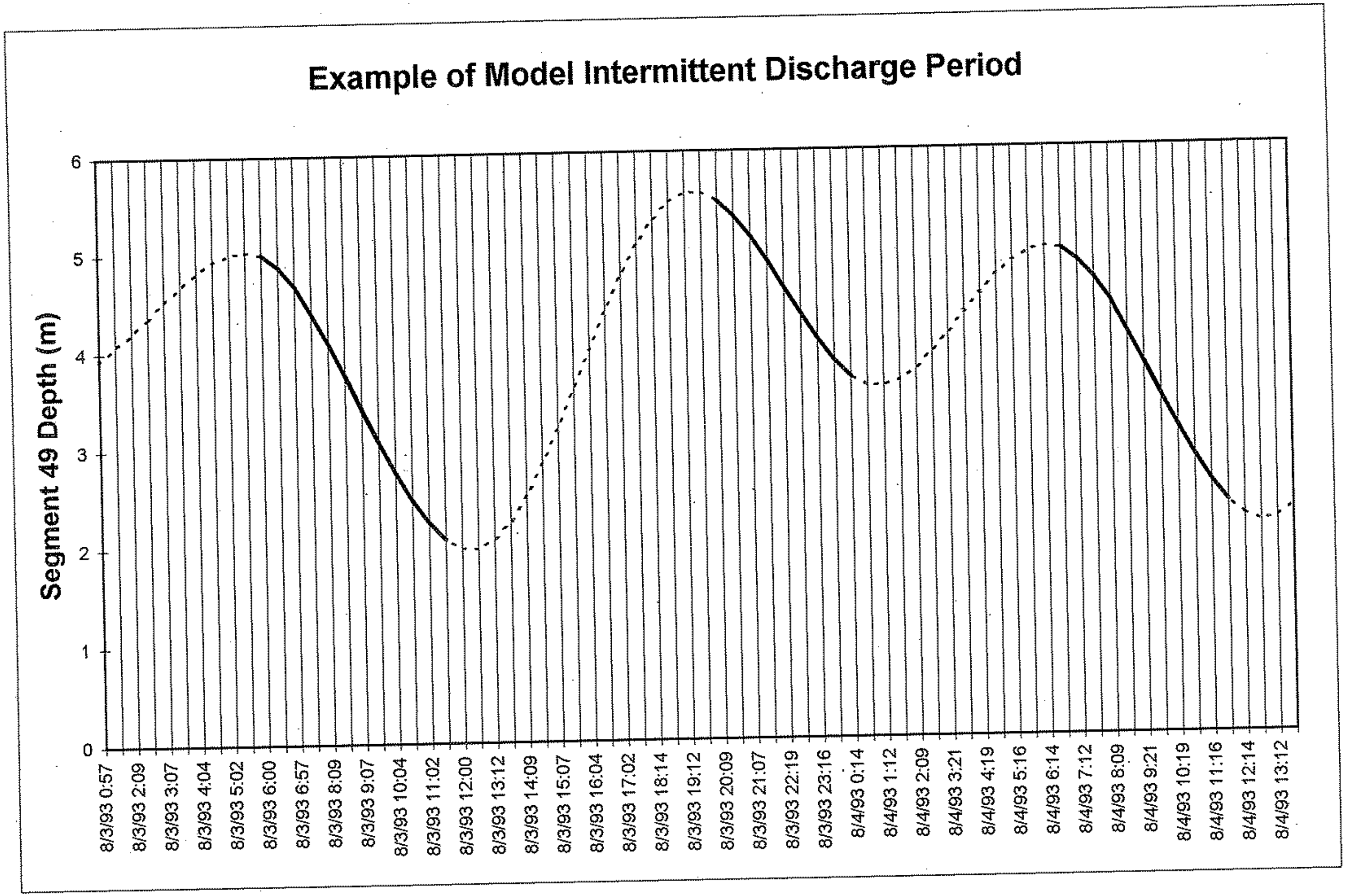


Figure 21. Example of the intermittent discharge periods (solid line on graph) for the Smith Island Treatment Plant.

Tables

Table 1. Summary of field and laboratory measurements of water, target precision or detection limits, and methods.

Parameter (all measurements of water)	Precision Limit (for field measurements) or Reporting Limit (for general chemestry)	Method[1]
Field Measurements		
Velocity	± 0.05 f/s	Current Meter
pH	± 0.1 SU	Field Meter/Electrode
Temperature	± 0.2 °C	Alcohol Thermometer
Dissolved Oxygen	± 0.06 mg/L	Gas Probe/Winkler Titration
Specific Conductivity	± 5% of reading	Field Meter/Conductivity Bridge
General Chemistry		
Salinity[1]		
Ammonia nitrogen	0.01 mg/L	EPA 350.1
Nitrate+nitrite nitrogen	0.01 mg/L	EPA 353.2
Total persulfate nitrogen	0.01 mg/L	SM 4500 NO3-F Modified
Orthophosphate	0.01 mg/L	EPA 365.3
Total phosphorus	0.01 mg/L	EPA 365.3
Chlorophyll *a*	0.05 g/L	SM 10200H(3), Fluorometer
Ultimate Biochemical Oxygen Demand (BOD_{35})	2 mg/L	NCASI

[1] Salinity was analyzed with an Autosal® salinometer by the Routine Chemistry Laboratory at the University of Washington.

EPA=	Environmental Protection Agency
SM=	Standard Methods
NCASI=	National Council of the Paper Indudstry for Air and Stream Improvement, Inc.

Table 2. Field Replicate Precision.

Parameter	Root Mean Square of the Coefficient of Variation (%) of Replicates	
	1993 Data	1996 Data
Conductivity	1.4	1.0
Temperature	0.9	0.8
Dissolved Oxygen	3.7	0.9
pH	1.3	0.7
Total Persulfate Nitrogen	5.4	4.0
Ammonia	14.2	17.4
Nitrite-Nitrate	1.9	6.9
Total Phosphorus	15.5	12.6
Ortho-Phosphorus	3.9	2.7
Turbidity	61.4	
Total Suspended Solids	2.0	
Total Organic Carbon	9.3	
Chlorophyll *a*	29.7	14.1
Phaeophytin *a*	44.4	17.6
Total Hardness	4.3	
Fecal Coliform	45.1	

Table 3. Root mean square error (RMSE) between the recalibrated model predicted (P) and observed (O) values for salinity, dissolved oxygen, chlorophyll *a*, ammonia, and phosphorus (for comparison, values from the Phase I report are presented).

Parameter	n (number of pairs)	RMSE[a] Recalibrated model	RMSE from Phase I report	Range Observed
Salinity (ppt)	38	2.10[b]	2.18	0.0 - 27.3
Dissolved Oxygen (mg/L)	56	0.32	0.23	6.6 - 10.2
Chlorophyll *a* (µg/L)	26	1.50[c]	1.55	1.4 - 7.4
Ammonia (mg/L)	52	0.0185[d]	0.0167	0.005[e] - 0.140
Total Phosphorus (mg/L)	52	0.0050	0.0050	0.005[e] - 0.049

[a] RMSE = $[\sqrt{}\ \Sigma(P_i - O_i)^2/n]$

[b] For salinity values ≤ 3 ppt RMSE is 0.77.

[c] RMSE is 0.66 µg/L excluding two sites in Ebey Slough associated with water quality model segments 60 and 67.

[d] RMSE is 0.0107 mg/L excluding two sites in Ebey Slough associated with water quality model segments 60 and 62.

[e] Minimum value is one-half the detection limit.

Table 4. 1996 confirmation conditions for water quality of upstream and downstream boundaries and pointloads (tributaries and WWTPs).

	Flow (cfs)[a]	Ammonia (mg/L)	Nitrate (mg/L)	Ortho P (mg/L)	Chlorophyll *a* (µg/L)	Non-algal CBODU (mg/L)	Dissolved Oxygen (mg/L)	Organic N (mg/L)	Organic P (mg/L)	Salinity (ppt)
Upstream Boundary	1840	0.005	0.134	0.005	2.8	1.2	9.5	0.047	0.005	0.0
French Creek	0.0[b]	0.135	0.637	0.016	30.0	6.0	8.1	0.223	0.054	0.0
Pilchuck River	80	0.005	0.290	0.005	1.6	1.2	10.3	0.079	0.005	0.0
Snohomish WWTP	0.79	0.460	7.58	4.55	0.0	12.0	8.7	2.38	0.005	0.0
Marshland	0.0[b]	0.117	1.23	0.034	14	5.4	9.2	0.370	0.090	0.0
Deadwater Slough	0.0[b]	0.237	0.226	0.018	15.7	10.8	9.8	0.519	0.080	3.3
Everett WWTP (Mechanical)	9.04	11.4	10.2	4.05	0.0	17.5	4.8	3.00	0.230	0.0
Everett WWTP (Lagoon)	8.22	17.3	0.050	4.76	0.0	20.0	5.4	3.30	0.030	0.0
Swan Trail Slough	0.0[b]	3.83	0.069	0.015	7.0	16.2	1.2	0.546	0.215	0.1
Lake Stevens WWTP	1.92	17.3	0.005	1.07	0.0	12.0	6.1	.005	0.250	0.0
Marysville WWTP	2.02	1.90	3.80	2.39	0.0	30.0	1.7	10.8	2.21	0.0
Allen Creek	0.0[c]	0.010	0.923	0.073	1.4	1.2	1.1	0.133	0.018	0.0
Quilceda Creek	24.0	0.018	1.08	0.056	2.4	1.2	9.5	0.142	0.036	0.6
Tulalip Landfill		8.14[d]								
Downstream Boundary	NA	0.005	0.186	0.035	4.1	2.5	7.2[e]	0.113	0.014	29.3

[a] Flows in model input as m^3/s

[b] Tributaries controlled by pumping stations; were not pumping during survey.

[c] No flow measured during survey.

[d] Value listed as lbs/day based on EPA estimate of 2971 lbs/year (EPA, 1996).

[e] EUTRO5 model boundaries 1-5 set at 7.2; boundary 6 set at 8.0 based on sampling station PS35.

Table 5. Summary of EUTRO5 model constants for eutrophication kinetics.

Model Constant	Description	Units	Value Used	Temperature Correction Coefficient
K12C	Nitrification rate	day^{-1}	0.2	1.085
KNIT	Half-saturation constant for nitrification-oxygen limitation	mg O_2/L	2.0	
K20C	Denitrification rate	day^{-1}	0.09	1.045
KNO3	Half-saturation constant for denitrification oxygen limitation	mg O_2/L	0.1	
K1C	Saturated growth rate of phytoplankton	day^{-1}	1.40	1.066
LGTHTS	Light formulation switch: LGHTS = 1 use Di Toro et al. (1971) formulation.		1	
CCHL	Carbon-to-chlorophyll ratio	mg C/mg chl *a*	75	
IS1	Saturation light intensity for phytoplankton growth.	Ly/day	100	
KMNG1	Nitrogen half-saturation constant for nitrogen for phytoplankton growth, which also affects ammonia preference.	mg N/L	0.03	
KMPG1	Phosphorous half-saturation constant for phytoplankton growth.	mg PO_4-P/L	0.002	
NCRB	Nitrogen-to-carbon ratio in phytoplankton	mg N/L	0.25	
PCRB	Phosphorus-to-carbon ratio in phytoplankton	mg P/L	0.025	
K1RC	Endogenous respiration rate of phytoplankton	day^{-1}	0.092	1.045
K1D	Non-predatory phytoplankton death rate	day^{-1}	0.02	
KDC	CBOD deoxygenation rate	day^{-1}	0.152	1.047
OCRB	Oxygen to carbon ratio in phytoplankton	mg O_2/mg C	2.67	
K71C	Mineralization rate of dissolved organic nitrogen	day^{-1}	0.10	1.047
FON	Fraction of dead and respired phytoplankton nitrogen recycled to organic nitrogen		1.0	
K83C	Mineralization rate of dissolved organic phosphorus	day^{-1}	0.10	1.047
FOP	Fraction of dead and respired phytoplankton phosphorus recycled to organic phosphorus		1.0	

Di Toro et. al. 1971 referenced in the WASP5 users manual.

Table 6. Root mean square error (RMSE) between the confirmation model predicted (P) and observed (O) values for salinity, dissolved oxygen, chlorophyll *a*, ammonia, and phosphorus.

Parameter	n (number of pairs)	RMSE[a] Recalibrated model	Range Observed
Salinity (ppt)	46	3.00[b]	0.0 - 27.7
Dissolved Oxygen (mg/L)	64	0.39	7.0 - 10.7
Chlorophyll *a* (μg/L)	42	4.43	1.5 - 26.3
Ammonia (mg/L)	59	0.0163	0.005[c] - 0.112
Total Phosphorus (mg/L)	59	0.0050	0.005[c] - 0.294

[a] $\mathrm{RMSE} = [\sqrt{\Sigma(P_i - O_i)^2/n}]$

[b] For salinity values ≤ 3 ppt RMSE is 2.4.

[c] Minimum value is one-half the detection limit; only one Total Phosphorus value exceeded 0.072 mg/L.

Table 7. Critical conditions for water quality of upstream and downstream boundaries and pointloads (tributaries and WWTPs).

	Flow (cfs)^a	Ammonia (mg/L)	Nitrate (mg/L)	Ortho P (mg/L)	Chlorophyll *a* (µg/L)	Non-algal CBODU (mg/L)	Dissolved Oxygen (mg/L)	Organic N (mg/L)	Organic P (mg/L)	Salinity (ppt)
Upstream Boundary	1051	0.050	0.340	0.005	1.6	1.2	9.1	0.117	0.020	0.0
French Creek	16.2	0.219	1.08	0.023	1.9	6.0	3.5	0.806	0.059	0.0
Pilchuck River	55.8	0.030	0.400	0.005	1.6	1.2	9.2	0.134	0.020	0.0
Snohomish WWTP	4.34^b	21.0	7.58	4.55	0.0	90.0	8.7^e	12.8	4.55	0.0
Marshland	16.2	0.231	1.23	0.052	14.1	5.4	4.4	0.519	0.135	0.0
Deadwater Slough	5.51	0.752	0.226	0.018	15.7	10.8	9.8	1.28	0.136	0.0
Everett WWTP (Mechanical)	12.4^c	24.0	10.16	4.05	0.0	65.7	4.8^e	4.0	4.05	0.0
Everett WWTP (Lagoon)	16.3^c	26.0	0.950	4.76	0.0	100.0	5.4^e	25.0	4.76	0.0
Swan Trail Slough	1.62	3.83	0.069	0.015	11.7	16.2	1.2	0.470	0.099	0.0
Lake Stevens WWTP	3.72^b	17.3	0.170	2.17	0.0	90.0	6.1^e	4.0	1.07	0.0
Marysville WWTP	9.46^b	21.0	3.94	4.73	0.0	90.0	1.7^e	10.0	2.39	0.0
Allen Creek	0.0^d	0.025	0.923	0.900	1.3	1.2	1.0	0.282	0.025	0.0
Quilceda Creek	4.5	0.023	1.08	0.064	1.6	1.2	7.2	0.219	0.039	0.0
Downstream Boundary	NA	0.095	0.300	0.060	0.9	2.5	6.0	0.126	0.040	29.5

[a] Flows in model input as m^3/s.
[b] Maximum monthly flow listed in current annual permit.
[c] Summer low flow seasonal permit limit.
[d] No flow measured during survey, assumed no flow during critical conditions.
[e] WWTP effluent measured dissolved oxygen concentration during 1996 survey.

Table 8. Critical 7-day average low flows in cfs.

Location	$7Q10_{Annual}$	$7Q20_{Jul-Oct}$	$7Q20_{Nov-Jun}$
Skykomish @ Goldbar	442	401	563
Sultan @ Sultan	40	29	120
Skykomish @ Sultan	580	530	822
Woods Creek @ Monroe	14	13	20
Skykomish @ Monroe	701	653	993
Snoqualmie @ Mouth	436	398	675
Snohomish @ RM 20.4	1137	1051	1668
Pilchuck @ Snohomish	58	56	73
Allen Creek @ Ebey S.	-	0	-
Quelceda Creek	-	4.5	-

Table 9. Contribution of point and nonpoint sour ces of BOD to the total dissolved oxygen (DO) deficit at low (L) ebbing and high (H) slack tide at selected water quality model segments.

Model	DO (mg/L) Deficit[a]	DO (mg/L) Deficit[a]	% Contribution to Dissolved Oxygen Deficit[b]															
			Everett WWTP		Marysville WWTP		Lake Stevens WWTP		Snohomish WWTP		French Creek		Marshland		Deadwater S.		Other[c]	
Seg #	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
34	0.41	0.23	51	71	<5	<5	<5	<5	19	11	9	<5	11	7	<5	<5	<5	<5
36	0.35	0.39	40	77	<5	<5	6	<5	23	10	11	<5	14	5	<5	<5	<5	<5
43	0.11	0.32	<5	37	<5	6	<5	9	33	22	59	9	8	9	<5	<5	<5	7
46	0.08	0.24	<5	27	<5	<5	<5	7	22	28	78	19	<5	14	<5	<5	<5	<5
50	0.38	0.23	21	18	24	45	24	18	18	11	8	<5	5	4	<5	<5	<5	<5
55	0.41	0.36	17	17	17	44	24	22	22	11	7	<5	5	3	<5	<5	8	<5
56	0.39	0.40	18	17	13	37	21	22	28	14	8	<5	6	4	<5	<5	6	<5
57	0.37	0.44	16	18	11	32	19	23	30	16	11	5	8	5	<5	<5	5	<5
58	0.30	0.46	27	48	6	10	10	13	27	18	13	6	10	6	<5	<5	7	<5
64	0.37	0.31	19	19	19	35	21	26	21	13	8	<5	5	3	<5	<5	6	<5
66	0.35	0.42	19	20	11	31	19	25	27	16	14	<5	8	4	<5	<5	<5	<5
68	0.28	0.33	18	21	7	18	14	21	32	21	18	9	7	3	<5	<5	<5	7

[a] Deficit determined as the difference between DO at critical conditions with point and nonpoint sources of BOD, and critical conditions without point sources of BOD and nonpoint sources of BOD set at estimated background conditions (*i.e.*, ammonia = 0.005 mg/L and CBOD = 1.2 mg/L).

[b] Model and rounding error may account for 0.01 mg/L or 5% at a deficit of 0.20 mg/L.

[c] Other contributions are Quilceda Creek, Pilchuck River, organic nitrogen from all sources, rounding and model error.

Table 10. Model predicted changes in dissolved oxygen (DO) concentrations at low (L) ebbing and high (H) slack tide after three (I, II, III) different point source BOD loading reduction alternatives. Dissolved oxygen deficits are calculated as the difference between alternative predicted concentration and the predicted concentration without BOD loading.

	Critical Conditions						I				II				III			
	Without BOD Loads [a]		With BOD Loads[b]				Ammonia set at 2 mg/L				Ammonia set at 2 mg/L, BOD_5 at 33 mg/L				Ammonia set at 5 mg/L, BOD_5 at 27 mg/L			
Model Seg #	DO (mg/L) L	DO (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H
34	7.13	5.72	6.72	5.49	-0.41	-0.23	6.88	5.60	-0.25	-0.12	6.93	5.63	-0.20	-0.09	6.93	5.63	-0.20	-0.09
36	7.50	5.97	7.15	5.58	-0.35	-0.39	7.28	5.76	-0.22	-0.21	7.32	5.82	-0.18	-0.15	7.32	5.82	-0.18	-0.15
43	8.44	7.25	8.33	6.93	-0.11	-0.32	8.36	7.05	-0.08	-0.20	8.36	7.09	-0.08	-0.16	8.36	7.08	-0.08	-0.17
46	8.61	7.86	8.53	7.62	-0.08	-0.24	8.54	7.70	-0.07	-0.16	8.54	7.73	-0.07	-0.13	8.54	7.72	-0.07	-0.14
50	6.60	5.42	6.22	5.19	-0.38	-0.23	6.36	5.29	-0.24	-0.13	6.42	5.33	-0.18	-0.09	6.42	5.33	-0.18	-0.09
55	7.05	5.64	6.64	5.28	-0.41	-0.36	6.79	5.43	-0.26	-0.21	6.85	5.48	-0.20	-0.16	6.84	5.48	-0.21	-0.16
56	7.24	5.79	6.85	5.39	-0.39	-0.40	6.99	5.55	-0.25	-0.24	7.04	5.61	-0.20	-0.18	7.04	5.61	-0.20	-0.18
57	7.41	6.05	7.04	5.61	-0.37	-0.44	7.17	5.78	-0.24	-0.27	7.22	5.85	-0.19	-0.20	7.22	5.85	-0.19	-0.20
58	7.52	6.50	7.22	6.04	-0.30	-0.46	7.32	6.25	-0.20	-0.25	7.36	6.31	-0.16	-0.19	7.36	6.31	-0.16	-0.19
64	6.86	5.36	6.49	5.05	-0.37	-0.31	6.63	5.17	-0.23	-0.19	6.68	5.22	-0.18	-0.14	6.68	5.22	-0.18	-0.14
66	7.56	6.11	7.21	5.69	-0.35	-0.42	7.33	5.87	-0.23	-0.24	7.38	5.94	-0.18	-0.17	7.38	5.94	-0.18	-0.17
68	7.77	6.76	7.49	6.43	-0.28	-0.33	7.58	6.55	-0.19	-0.21	7.62	6.60	-0.15	-0.16	7.61	6.60	-0.16	-0.16

[a] Critical conditions without point sources of BOD and nonpoint sources of BOD set at estimated background conditions.

[b] Critical conditions with point and nonpoint sources of BOD.

Note: Segment 57 is the "critical" segment for the modeled system (i.e., requires the most load reduction to meet the criteria).

Table 11. Model predicted changes in dissolved oxygen (DO) concentrations at low (L) ebbing and high (H) slack tide after point source BOD loading reduction alternatives including the proposed Smith Island Treatment Plant (SITP) discharge. Dissolved oxygen deficits are calculated as the difference between scenario alternative predicted concentration and the predicted concentration without BOD loading.

	Critical Conditions Without BOD Loads[a]		**II** WWTPs Ammonia set at 2 mg/L, BOD₅ at 33 mg/L (same as II in Table 10)				**IV** WWTPs Ammonia set at 2 mg/L, BOD₅ at 33 mg/L; SITP Ammonia set at 2mg/L, BOD5 at 63 mg/L				**V** WWTPs Ammonia set at 2 mg/L, BOD₅ at 26 mg/L; SITP Ammonia set at 2mg/L, BOD5 at 26 mg/L			
Model Seg #	DO (mg/L) L	DO (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H	DO (mg/L) L	DO (mg/L) H	Deficit (mg/L) L	Deficit (mg/L) H
34	7.13	5.72	6.93	5.63	-0.20	-0.09	6.93	5.63	-0.20	-0.09	6.95	5.64	-0.18	-0.08
36	7.50	5.97	7.32	5.82	-0.18	-0.15	7.31	5.81	-0.19	-0.16	7.33	5.84	-0.17	-0.13
43	8.44	7.25	8.36	7.09	-0.08	-0.16	8.36	7.08	-0.08	-0.17	8.37	7.10	-0.07	-0.15
46	8.61	7.86	8.54	7.73	-0.07	-0.13	8.54	7.72	-0.07	-0.14	8.55	7.74	-0.06	-0.12
50	6.60	5.42	6.42	5.33	-0.18	-0.09	6.39	5.26	-0.21	-0.16	6.43	5.31	-0.17	-0.11
55	7.05	5.64	6.85	5.48	-0.20	-0.16	6.82	5.42	-0.23	-0.22	6.86	5.48	-0.19	-0.16
56	7.24	5.79	7.04	5.61	-0.20	-0.18	7.03	5.55	-0.21	-0.24	7.06	5.61	-0.18	-0.18
57	7.41	6.05	7.22	5.85	-0.19	-0.20	7.20	5.79	-0.21	-0.26	7.23	5.85	-0.18	-0.20
58	7.52	6.50	7.36	6.31	-0.16	-0.19	7.35	6.29	-0.17	-0.21	7.37	6.33	-0.15	-0.17
64	6.86	5.36	6.68	5.22	-0.18	-0.14	6.66	5.17	-0.20	-0.19	6.69	5.22	-0.17	-0.14
66	7.56	6.11	7.38	5.94	-0.18	-0.17	7.37	5.89	-0.19	-0.22	7.39	5.95	-0.17	-0.16
68	7.77	6.76	7.62	6.60	-0.15	-0.16	7.61	6.58	-0.16	-0.18	7.63	6.61	-0.14	-0.15
49[b]	6.29	5.40	6.13	5.32	-0.16	-0.08	6.10	5.25	-0.19	-0.15	6.14	5.30	-0.15	-0.10
32[b]	5.83	5.44	5.81	5.37	-0.02	-0.07	5.80	5.32	-0.03	-0.12	5.81	5.36	-0.02	-0.08
31[b]	5.91	5.44	5.90	5.38	-0.01	-0.06	5.90	5.34	-0.01	-0.10	5.90	5.37	-0.01	-0.07

[a] Critical conditions without point sources of BOD and nonpoint sources of BOD set at estimated background conditions.

[b] Model segment 49 receives SITP effluent, segments 31 and 32 are downstream (seaward) of the discharge (see Figure 6).

Note: Segment 57 is the "critical" segment for the modeled system (i.e., requires the most load reduction to meet the criteria).

Table 12. Summary of recommended TMDLs and WLAs for water quality-based permit limit development

	Daily Maximum BOD_5		Daily Maximum Ammonia	
	mg/L	pounds/day	mg/L	pounds/day
1. WLAs without Smith Island Treatment Plant				
Everett Mechanical WWTP	27	1805	5	334
Everett Lagoon WWTP	27	2372	5	439
Marysville WWTP	27	1377	5	255
Lake Steven's Sewer District	27	541	5	100
Snohomish WWTP	27	632	5	117
2. WLAs with Smith Island Treatment Plant				
Everett Mechanical WWTP	26	1738	2	134
Everett Lagoon WWTP	26	2284	2	176
Marysville WWTP	26	1326	2	102
Lake Steven's Sewer District	26	521	2	40
Snohomish WWTP	26	608	2	47
Smith Island Treatment Plant	26	2732	2	210
Background/Nonpoint LA	--	3862[a]	--	133[a]
Total Maximum Daily Load #1	--	10589	--	1378
Total Maximum Daily Load #2	--	9209	--	842

[a] Includes Snohomish River and tributary loads; does not include seaward loads.

Table 13. Results of sensitivity analysis of EUTRO5 model predictions for dissolved oxygen changes at low (L) ebbing and high (H) slack tide..

	Critical Conditions with Loads Dissolved Oxgygen (mg/L)		% change after a 10% change in model input parameters													
			River Flow		Upstream DO		Downstream DO		Nitrification Rate		Segment Temp.		Deoxygenation Rate		SOD	
Model Seg#	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
34	6.72	5.49	1.9	0.9	1.9	0.4	1.5	7.1	0.2	0.2	4.8	3.1	0.6	0.9	1.8	1.5
36	7.15	5.58	1.7	1.4	2.7	0.9	0.6	5.6	0.3	0.4	4.8	4.3	0.4	0.9	1.5	1.8
43	8.33	6.93	0.7	1.6	4.1	2.2	0	1.4	0	0.3	3.4	4.5	0.2	0.4	0.7	1.4
46	8.53	7.62	0.5	1.4	4.6	3.0	0	0.5	0	0.1	2.8	4.2	0.1	0.4	0.5	1.2
50	6.22	5.19	1.6	0.8	1.3	0.4	2.1	6.4	0.2	0.2	4.8	4.1	0.8	1.0	2.4	2.3
55	6.64	5.28	2.0	1.3	2.0	0.8	1.1	5.3	0.3	0.4	5.1	4.6	0.6	1.0	2.3	2.8
56	6.85	5.39	1.9	1.9	2.2	0.7	0.6	4.1	0.3	0.2	5.1	5.2	0.6	1.1	2.0	3.2
57	7.04	5.61	1.4	2.0	2.6	1.3	0.4	3.0	0.3	0.4	5.1	5.5	0.4	0.9	1.9	2.9
58	7.22	6.04	1.7	2.2	2.6	2.2	0.4	1.5	0.3	0.5	5.0	6.1	0.4	0.8	1.7	2.7
64	6.49	5.05	2.0	1.6	1.7	0.6	1.2	4.0	0.2	0.2	5.1	6.5	0.6	1.0	2.3	4.2
66	7.21	5.69	1.9	2.1	2.6	1.2	0.4	2.8	0.1	0.4	4.9	5.6	0.6	0.9	1.8	3.0
68	7.49	6.43	1.5	1.7	2.9	1.9	0.3	1.2	0.1	0.3	4.7	5.4	0.4	0.6	1.5	2.0

Appendix A

Tides for August 27 and 28

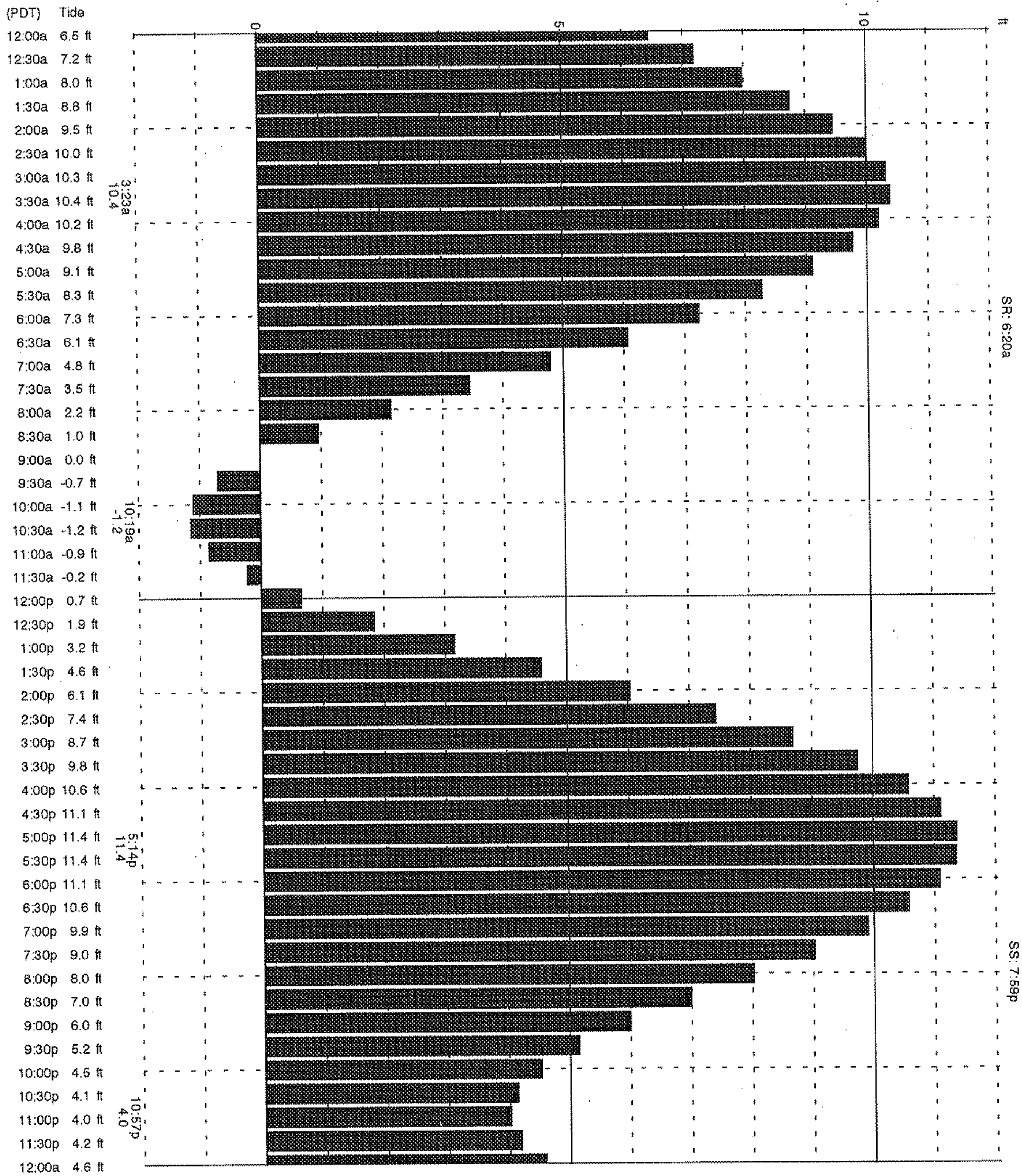
Tides-Tulalip

based on Seattle, Washington (NOAA)
48° 3.90 N 122° 17.30 W

Tuesday, August 27, 1996

Average Tides	
Mean Range:	7.5 ft
MHHW:	11.1 ft
Mean Tide:	6.4 ft

Daily Highs & Lows		
3:23a	10.4 ft	High
10:19a	-1.2 ft	Low
5:14p	11.4 ft	High
10:57p	4.0 ft	Low



Tides-Tulalip

based on Seattle, Washington (NOAA)
48° 3.90 N 122° 17.30 W

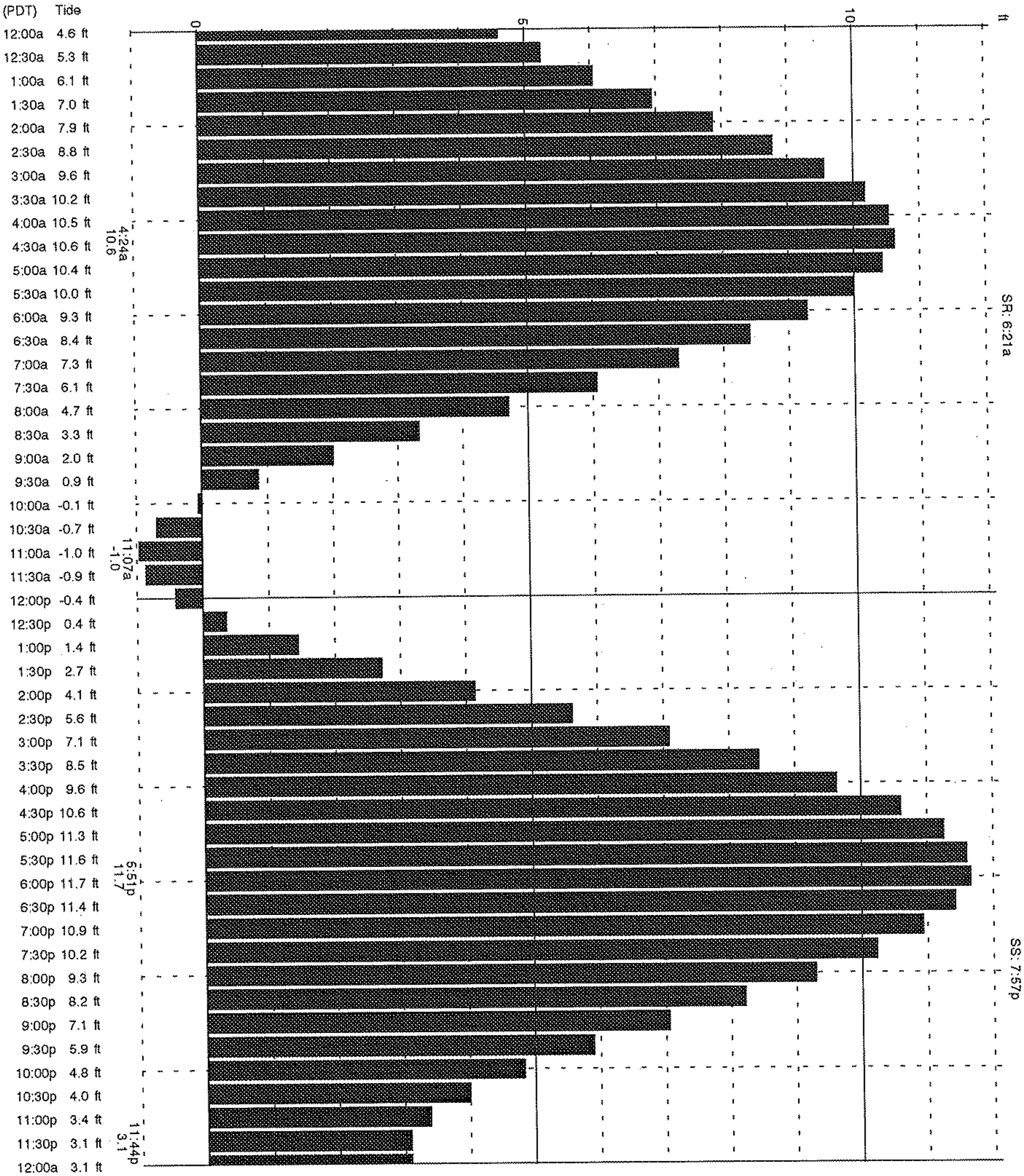
Wednesday, August 28, 1996

Average Tides

Mean Range:	7.5 ft
MHHW:	11.1 ft
Mean Tide:	6.4 ft

Daily Highs & Lows

4:24a	10.6 ft	High
11:07a	-1.0 ft	Low
5:51p	11.7 ft	High
11:44p	3.1 ft	Low



Appendix B

Sampling Schedules

Appendix B.1. Snohomish River TMDL Sampling Schedule

TEAM 1 8/27/96

Site	Location	Station ID	LAB ID	Tide[a]	Sample Depth	Site Depth	Secchi Disc	pH Cond Temp	Salinity	DO	UBOD	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
14	Upriver of Snohomish WTP	SNO14	358600	Low	Surface	X	X	X		X		X	X	X	X	X	X
15	1 mi. below Snohomish WTP	SNO15	358601	Low	Surface	X	X	X		X		X	X	X	X	X	
16	Upriver of Ebey Slough	SNO16	358602	Low	Surface	X	X	X		X		X	X	X	X	X	X
		REP16	358603	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358604	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358605	High	Bottom	X		X	X	X		X	X	X	X	X	
18	By Hwy 2 bridge	SNO18	358606	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358607	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358608	High	Bottom	X		X	X	X		X	X	X	X	X	
20	Upriver of Everett WTP	SNO20	358609	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358610	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358611	High	Bottom	X		X	X	X		X	X	X	X	X	
21	1 mi. downriver Everett WTP	SNO21	358612	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358613	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358614	High	Bottom	X		X	X	X		X	X	X	X	X	
30	Steamboat S. upriver Ebey S. junction	STM30	358615	Low	Surface	X	X	X		X		X	X	X	X	X	
			358616	High	Surface	X	X	X		X		X	X	X	X	X	
			358617	High	Bottom	X		X		X		X	X	X	X	X	
34	Port Gardner	POG34	358618	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358619	High	Surface	X	X	X	X	X	X	X	X	X	X	X	X
			358620	High	Bottom	X		X	X	X		X	X	X	X	X	

[a] Sampled both high and low tide; surface samples at low tide; surface and bottom samples at high tide

TEAM 1 8/28/96

Site	Location	Station ID	LAB ID	Tide[a]	Sample Depth	Site Depth	Secchi Disc	pH Cond Temp	Salinity	DO	UBOD	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
14	Upriver of Snohomish WTP	SNO14	358700	Low	Surface	X	X	X		X		X	X	X	X	X	X
15	1 mi. below Snohomish WTP	SNO15	358701	Low	Surface	X	X	X		X		X	X	X	X	X	
16	Upriver of Ebey Slough	SNO16	358702	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358703	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358704	High	Bottom	X		X	X	X		X	X	X	X	X	
18	By Hwy 2 bridge	SNO18	358705	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358706	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358707	High	Bottom	X		X	X	X		X	X	X	X	X	
20	Upriver of Everett WTP	SNO20	358708	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358709	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358710	High	Bottom	X		X	X	X		X	X	X	X	X	
21	1 mi. downriver Everett WTP	SNO21	358711	Low	Surface	X	X	X		X		X	X	X	X	X	X
		REP21	358712	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358713	High	Surface	X	X	X	X	X		X	X	X	X	X	
			358714	High	Bottom	X		X	X	X		X	X	X	X	X	
30	Steamboat S. upriver Ebey S. junction	STM30	358715	Low	Surface	X	X	X		X		X	X	X	X	X	
			358716	High	Surface	X	X	X		X		X	X	X	X	X	
			358717	High	Bottom	X		X		X		X	X	X	X	X	
34	Port Gardner	POG34	358718	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358719	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358720	High	Bottom	X		X	X	X		X	X	X	X	X	

[a] Sampled both high and low tide; surface samples at low tide; surface and bottom samples at high tide

Appendix B.1. Snohomish River TMDL Sampling Schedule.

TEAM 2 8/27/96

Site	Location	Station ID	LAB ID	Tide[+G]	Sample Depth	Site Depth	Secchi Disc	pH Cond Temp	Salinity	DO	UBOD	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
23	Upriver of Lake Stevens WTP	EBE23	358621	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358622	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358623	High	Bottom	X		X	X	X		X	X	X	X	X	
24	Ebey S. downriver Lake Stevens WTP	EBE24	358624	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358625	High	Surface	X	X	X		X		X	X	X	X	X	X
			358626	High	Bottom	X		X		X		X	X	X	X	X	
26	Downriver Allen Creek	EBE26	358627	Low	Surface	X	X	X		X		X	X	X	X	X	
			358628	High	Surface	X	X	X		X		X	X	X	X	X	
			358629	High	Bottom	X		X		X		X	X	X	X	X	
27	Mouth of Ebey Slough	EBE27	358630	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358631	High	Surface	X	X	X		X		X	X	X	X	X	X
			358632	High	Bottom	X		X		X		X	X	X	X	X	
31	Steamboat S. Upriver Marysville WTP	STM31	358633	Low	Surface	X	X	X		X		X	X	X	X	X	X
		REP	358634	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358635	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358636	High	Bottom	X		X	X	X		X	X	X	X	X	
32	Mouth of Steamboat Slough	STM32	358637	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358638	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358639	High	Bottom	X		X	X	X		X	X	X	X	X	
33	Union Slough at I-5	UNS33	358640	Low	Surface	X	X	X		X		X	X	X	X	X	
			358641	High	Surface	X	X	X		X		X	X	X	X	X	
			358642	High	Bottom	X		X		X		X	X	X	X	X	
35	Possession Sound	PS35	358643	High	Surface	X	X	X	X	X	X	X	X	X	X	X	X
			358644	High	Bottom	X		X	X	X		X	X	X	X	X	

[a] Sampled both high and low tide; surface samples at low tide; surface and bottom samples at high tide.

TEAM 2 8/28/96

Site	Location	Station ID	LAB ID	Tide[a]	Sample Depth	Site Depth	Secchi Disc	pH Cond Temp	Salinity	DO	UBOD	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
23	Upriver of Lake Stevens WTP	EBE23	358721	Low	Surface	X	X	X		X		X	X	X	X	X	X
		REP23	358722	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358723	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358724	High	Bottom	X		X	X	X		X	X	X	X	X	
24	Ebey S. downriver Lake Stevens WTP	EBE24	358725	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358726	High	Surface	X	X	X		X		X	X	X	X	X	X
			358727	High	Bottom	X		X		X		X	X	X	X	X	
26	Downriver Allen Creek	EBE26	358728	Low	Surface	X	X	X		X		X	X	X	X	X	
			358729	High	Surface	X	X	X		X		X	X	X	X	X	
			358730	High	Bottom	X		X		X		X	X	X	X	X	
27	Mouth of Ebey Slough	EBE27	358731	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358732	High	Surface	X	X	X		X		X	X	X	X	X	X
			358733	High	Bottom	X		X		X		X	X	X	X	X	
31	Steamboat S. Upriver Marysville WTP	STM31	358734	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358735	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358736	High	Bottom	X		X	X	X		X	X	X	X	X	
32	Mouth of Steamboat Slough	STM32	358737	Low	Surface	X	X	X		X		X	X	X	X	X	X
			358738	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358739	High	Bottom	X		X	X	X		X	X	X	X	X	
33	Union Slough at I-5	UNS33	358740	Low	Surface	X	X	X		X		X	X	X	X	X	
			358741	High	Surface	X	X	X		X		X	X	X	X	X	
			358742	High	Bottom	X		X		X		X	X	X	X	X	
35	Possession Sound	PS35	358743	High	Surface	X	X	X	X	X		X	X	X	X	X	X
			358744	High	Bottom	X	X	X	X	X		X	X	X	X	X	

[a] Sampled both high and low tide; surface samples at low tide; surface and bottom samples at high tide.

Appendix B.1. Snohomish River TMDL Sampling Schedule.

TEAM 3 8/27/96

Site	Location	Station ID	LAB ID	Flow	Secchi Disc	pH Cond Temp	DO	UBOD	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
10	Downriver of Confluence	SNO10	358645			X	X		X	X	X	X	X	X
11	Upriver of French Creek	SNO11	358646			X	X	X	X	X	X	X	X	X
		REP11	358647			X	X	X	X	X	X	X	X	X
12	French Creek	FRN12	358648	a		X	X	X	X	X	X	X	X	X
13	Pilchuck River	PIL13	358649	X		X	X		X	X	X	X	X	X
17	Marshland	MAR1	358650	a		X	X		X	X	X	X	X	X
19	Deadwater Slough	DED19	358651	a		X	X		X	X	X	X	X	X
22	Swan Trail Slough	STS22	358652	a		X	X		X	X	X	X	X	X
25	Allen Creek	ALL25	358653	X		X	X		X	X	X	X	X	X
28	Quilceda Creek	QIL28	358654	X		X	X		X	X	X	X	X	X

(a) note if water was being pumped.

TEAM 3 8/28/96

Site	Location	Station ID	LAB ID	Flow	Secchi Disc	pH Cond Temp	DO	BOD35	NH3	NO3-NO2	TPN	Ortho-P	TP	Chloro a
10	Downriver of Confluence	SNO10	358745			X	X		X	X	X	X	X	X
11	Upriver of French Creek	SNO11	358746			X	X		X	X	X	X	X	X
12	French Creek	FRN12	358747	a		X	X		X	X	X	X	X	X
13	Pilchuck River	PIL13	358748	X		X	X		X	X	X	X	X	X
17	Marshland	MAR1	358749	a		X	X		X	X	X	X	X	X
		REP17	358750			X	X		X	X	X	X	X	X
19	Deadwater Slough	DED19	358751	a		X	X		X	X	X	X	X	X
22	Swan Trail Slough	STS22	358752	a		X	X		X	X	X	X	X	X
25	Allen Creek	ALL25	358753	X		X	X		X	X	X	X	X	X
28	Quilceda Creek	QIL28	358754	X		X	X		X	X	X	X	X	X

(a) note if water was being pumped.

Appendix B.2. Snohomish River TMDL WWTP effluent Sampling Schedule.

Parameter	Composite Sample	Grab Sample 1	Grab Sample 2
Solids4	X	X	X
Total solids			
Total non-volatile solids			
Total suspended solids			
Total non-volatile suspended solids			
BOD5	X	X	X
UBOD	X		
NH3	X	X	X
N03-N02	X	X	X
TKN	X	X	X
Ortho-P	X	X	X
TP	X	X	X
Temperature	X	X	X
pH	X	X	X
DO		X	X
Chlorine free & combined		X	X

Appendix C

1996 Ecology Survey Data

Appendix C.1. Laboratory data and field measurements for samples collected August 27 and 28, 1996

Date 1996	LAB ID	Station ID	Time (hour)	Tide	Sample Depth (m)	Cond (umho/cm)	Calibrated Sal (o/oo)	Measured Sal (o/oo)	Temp (C°)	DO (mg/L	pH (S.U.)	TPN (mg/L)	NH3 (mg/L)	NO2-NO3 (mg/L)	NO2 (mg/L)	TP (mg/L)	Ortho-P (mg/L)	BOD35 (mg/L)	Chloro a (ug/L)	Pheo a (ug/L)
27-Aug	358600	SNO14	1135	LOW	0.2	54	0.0		18.0	9.6	6.8	0.196	0.01 U	0.131	0.01 U	0.029	0.01 U		2.9	1.7
27-Aug	358601	SNO15	1120	LOW	0.2	63	0.0		18.9	10.3	6.8	0.203	0.01 U	0.133	0.01 U	0.026	0.01 U			
27-Aug	358602	SNO16	1105	LOW	0.2	63	0.0		19.5	9.9	6.8	0.197	0.01 U	0.120	0.01 U	0.030	0.01 U		5.1	1.5
27-Aug	358603	SNO16	1105	LOW	0.2	63	0.0		19.5	9.8	6.8	0.205	0.01 U	0.127	0.01 U	0.033	0.01 U		5.1	1.5
27-Aug	358604	SNO16	1730	HIGH	0.2	324	0.1	0.1	19.5	9.7	7.2	0.252	0.01 U	0.139	0.01 U	0.036	0.01 U		16.7	2.1
27-Aug	358605	SNO16	1735	HIGH	5.2	670	0.4	0.3	19.5	9.5	7.2	0.282	0.023	0.157	0.01 U	0.044	0.014 U			
27-Aug	358606	SNO18	1045	LOW	0.2	83	0.0		19.1	9.2	6.9	0.223	0.01 U	0.133	0.01 U	0.035	0.01 U		13	2.8
27-Aug	358607	SNO18	1700	HIGH	0.2	16500	13.1	12.3	18.0	8.3	7.4	0.376	0.062	0.167	0.01 U	0.065	0.032		6.3	2.5
27-Aug	358608	SNO18	1705	HIGH	4.6	21000	17.2	16.8	17.5	7.8	7.4	0.368	0.064	0.164	0.01 U	0.061	0.035			
27-Aug	358609	SNO20	1010	LOW	0.2	440	0.2		19.5	9.2	7.6	0.241	0.01 U	0.129	0.01 U	0.045	0.01 U		13.3	1.8
27-Aug	358610	SNO20	1615	HIGH	0.2	24000	20.4	20.3	16.5	7.8	7.7	0.380	0.050	0.163	0.01 U	0.059	0.036		5	3.5
27-Aug	358611	SNO20	1616	HIGH	3.1	25500	22.0	21.9	16.0	7.6	7.7	0.390	0.061	0.187	0.01 U	0.070	0.045			
27-Aug	358612	SNO21	940	LOW	0.2	3700	2.7		19.0	9.0	7.5	0.341	0.038	0.171	0.01 U	0.066	0.017		8.9	4.9
27-Aug	358613	SNO21	1540	HIGH	0.2	28000	24.7	25.5	15.5	8.2	7.6	0.269	0.018	0.103	0.01 U	0.060	0.034		3.2	2.3
27-Aug	358614	SNO21	1545	HIGH	3.7	29000	26.1	26.6	14.8	7.3	7.6	0.311	0.013	0.147	0.01 U	0.065	0.037			
27-Aug	358615	STM30	1025	LOW	0.2	3100	2.2		19.5	9.0	7.0	0.255	0.011	0.139	0.01 U	0.036	0.01 U			
27-Aug	358616	STM30	1635	HIGH	0.2	8000	5.8		19.9	8.2	7.3	0.262	0.032	0.128	0.01 U	0.01 U	0.01 U			
27-Aug	358617	STM30	1640	HIGH	4.0	9500	7.0		19.9	8.9	7.3	0.309	0.032	0.130	0.01 U	0.294	0.01 U			
27-Aug	358618	POG34	920	LOW	0.2	11500	8.9		18.1	8.4	7.3	0.405	0.085	0.183	0.01 U	0.049	0.03		3.7	6.6
27-Aug	358619	POG34	1520	HIGH	0.2	26200	23.3	23.6	15.0	7.0	7.6	0.307	0.026	0.206	0.01 U	0.043	0.043	1.9	3.5	2.1
27-Aug	358620	POG34	1530	HIGH	4.3	29000	26.6	28.3	14.0	7.0	7.6	0.317	0.01 U	0.203	0.01 U	0.072	0.042			
27-Aug	358621	EBE23	1103	LOW	0.2	248	0.1		18.5	9.6	7.6	0.233	0.01 U	0.126	0.01 U	0.072	0.01 U		26.3	3.4
27-Aug	358622	EBE23	1811	HIGH	0.2	11800	7.7	7.6	18.8	8.4	7.4	0.273	0.041	0.125	0.01 U	0.058	0.014		2.6	2.9
27-Aug	358623	EBE23	1816	HIGH	5.2	15500	10.4	10.1	18.6	8.0	7.3	0.281	0.045	0.116	0.01 U	0.042	0.018			
27-Aug	358624	EBE24	1041	LOW	0.2	9000	5.7		18.5	8.6	7.5	0.255	0.024	0.119	0.01 U	0.012	0.01 U		4.5	6
27-Aug	358625	EBE24	1755	HIGH	0.2	16500	11.1		19.0	8.6	7.5	0.254	0.035	0.113	0.01 U	0.029	0.012		2.3	3.2
27-Aug	358626	EBE24	1758	HIGH	4.0	21800	15.3		18.6	7.4	7.3	0.242	0.027	0.090	0.01 U	0.043	0.018			
27-Aug	358627	EBE26	1025	LOW	0.2	19300	13.4		18.2	7.1	7.3	0.296	0.034	0.106	0.01 U	0.035	0.013			
27-Aug	358628	EBE26	1740	HIGH	0.2	27100	19.7		18.2	8.0	7.6	0.212	0.017	0.067	0.01 U	0.029	0.022			
27-Aug	358629	EBE26	1745	HIGH	5.8	32000	24.2		17.4	8.0	7.7	0.170	0.011	0.030	0.01 U	0.035	0.024			
27-Aug	358630	EBE27	1012	LOW	0.2	21000	14.8		18.2	7.3	7.5	0.248	0.028	0.067	0.01 U	0.029	0.019		2.5	3.2
27-Aug	358631	EBE27	1715	HIGH	0.2	32900	25.0		17.4	8.3	7.9	0.185	0.01 U	0.022	0.01 U	0.035	0.028		3.9	1.7
27-Aug	358632	EBE27	1730	HIGH	4.8	33500	25.7		17.0	8.5	8.1	0.167	0.01 U	0.012	0.01 U	0.036	0.026			
27-Aug	358633	STM31	938	LOW	0.2	8900	5.7		18.3	8.6	7.2	0.275	0.047	0.122	0.01 U	0.038	0.015		3.9	3.9
27-Aug	358634	STM31	943	LOW	0.2	8700	5.5		18.5	8.7	7.2	0.264	0.039	0.125	0.01 U	0.034	0.014		4.1	5
27-Aug	358635	STM31	1645	HIGH	0.2	31000	23.5	23.6	17.2	8.1	7.7	0.173	0.061	0.022	0.01 U	0.033	0.03		2.8	1.8
27-Aug	358636	STM31	1651	HIGH	4.8	31000	23.6	24.4	17.0	8.1	7.7	0.172	0.016	0.013	0.01 U	0.036	0.032			
27-Aug	358637	STM32	908	LOW	0.2	16200	11.1		18.2	8.1	7.5	0.263	0.040	0.102	0.01 U	0.029	0.023		2.3	3.7
27-Aug	358638	STM32	1614	HIGH	0.2	29500	22.1	20.0	17.3	8.1	7.9	0.232	0.031	0.061	0.01 U	0.042	0.033		2.5	1.8
27-Aug	358639	STM32	1619	HIGH	4.6	33500	26.1	26.4	16.4	8.5	8.0	0.126	0.015	0.01 U	0.01 U	0.032	0.024			
27-Aug	358640	UNS33	926	LOW	0.2	14500	9.8		18.2	7.5	7.2	0.252	0.034	0.082	0.01 U	0.037	0.017			
27-Aug	358641	UNS33	1628	HIGH	0.2	30500	23.2		17.0	8.4	7.7	0.169	0.028	0.013	0.01 U	0.034	0.029			
27-Aug	358642	UNS33	1636	HIGH	2.5	32500	25.1		16.7	8.4	7.8	0.156	0.021	0.011	0.01 U	0.028	0.024			
27-Aug	358643	PS35	1542	HIGH	0.2	33800	27.3	27.7	15.0	8.3	8.1	0.164	0.01 U	0.01 U	0.01 U	0.035	0.017	3.0	6.3	1.3
27-Aug	358644	PS35	1549	HIGH	5.5	33800	27.3	27.7	15.0	8.3	8.1	0.154	0.01 U	0.01 U	0.01 U	0.032	0.016			
27-Aug	358645	SNO10	1450		0.2	60			18.0	11.0	7.8	0.173	0.01 U	0.123	0.01 U	0.01 U	0.01 U		2.3	1.2
27-Aug	358646	SNO10	1505		0.2	60			18.1	11.1	7.8	0.167	0.01 U	0.119	0.01 U	0.01 U	0.01 U		2.8	0.89
27-Aug	358647	SNO11	1415		0.2	62			18.3	10.7	7.6	0.162	0.01 U	0.113	0.01 U	0.01 U	0.01 U	1.2	2.8	0.92
27-Aug	358648	FRN12	1350		0.2	230			19.7	8.2	7.1	1.08	0.197	0.639	0.02	0.059	0.017	6.0	30.7	5.6
27-Aug	358649	PIL13	1315		0.2	102			18.2	10.5	7.8	0.324	0.01 U	0.265	0.01 U	0.01 U	0.01 U		0.71	0.73
27-Aug	358650	MARS17	1210		0.2	241			18.1	11.1	7.6	1.70	0.084	1.15	0.04	0.117	0.035		13.9	13.8
27-Aug	358651	DED19	900		0.2	5490		3.4	18.3	10.0	7.6	0.965	0.180	0.229	0.06	0.084	0.016		13	4.2
27-Aug	358652	STS22	810		0.2	375			17.4	1.1	7.1	4.56	3.960	0.01 U	0.01 U	0.353 J	0.017		8.6	5.1
27-Aug	358653	ALL25	1120		0.2	193			15.6	1.0	6.9	1.040	0.01 U	0.924	0.01 U	0.088	0.077		1.3	0.78
27-Aug	358654	QIL28	1000		0.2	1287		0.8	14.9	8.5	7.4	1.180	0.015	1.05	0.01 U	0.093	0.058		1.8 J	2.7

U The analyte was not detected at or above the reported limit.

J The analyte was positively identified, but the associated numerical result is an estimate.

Appendix C.1. Laboratory data and field measurements for samples collected August 27 and 28, 1996

Date 1996	LAB ID	Station ID	Time (hour)	Tide	Sample Depth (m)	Cond (umho/cm)	Calibrated Sal (o/oo)	Measured Sal (o/oo)	Temp (C°)	DO (mg/L	pH (S.U.)	TPN (mg/L)	NH3 (mg/L)	NO2-NO3 (mg/L)	NO2 (mg/L)	TP (mg/L)	Ortho-P (mg/L)	BOD35 (mg/L)	Chloro a (ug/L)	Pheo a (ug/L)
28-Aug	358700	SNO14	1214	LOW	0.2	59	0.0		18.0	10.0	6.7	0.241	0.01 U	0.180	0.01 U	0.013	0.01 U		3.7	1.9
28-Aug	358701	SNO15	1155	LOW	0.2	59	0.0		18.0	9.3	6.7	0.211	0.01 U	0.170	0.01 U	0.01 U	0.01 U			
28-Aug	358702	SNO16	1142	LOW	0.2	59	0.0		18.8	10.2	6.8	0.189	0.01 U	0.143	0.01 U	0.01	0.01 U		7.2	1
28-Aug	358703	SNO16	1832	HIGH	0.2	324	0.1	0.2	20.0	10.1	7.1	0.246	0.01 U	0.161	0.01 U	0.020	0.01 U		13.9	0.9
28-Aug	358704	SNO16	1825	HIGH	0.2	810	0.4	0.4	20.0	9.5	7.1	0.286	0.031	0.188	0.01 U	0.037	0.01 U			
28-Aug	358705	SNO18	1124	LOW	0.2	92	0.0		18.8	9.5	6.9	0.196	0.01 U	0.155	0.01 U	0.021	0.01 U		6.5	0.9
28-Aug	358706	SNO18	1750	HIGH	0.2	17500	13.7	11.7	19.0	8.2	7.3	0.353	0.058	0.198	0.01 U	0.046	0.032 J		1.5	0.9
28-Aug	358707	SNO18	1756	HIGH	0.2	23000	18.3	17.5	19.0	7.7	7.3	0.371	0.060	0.199	0.01 U	0.055	0.035			
28-Aug	358708	SNO20	1033	LOW	0.2	405	0.2		19.0	9.3	7.5	0.232	0.01 U	0.145	0.01 U	0.031	0.01 U		5.9	1.7
28-Aug	358709	SNO20	1709	HIGH	0.2	26800	22.7	22.8	17.0	7.5	7.6	0.355	0.051	0.198	0.01 U	0.050	0.045		4.9	3.1
28-Aug	358710	SNO20	1715	HIGH	0.2	25000	20.8	22.8	17.4	7.8	7.6	0.417	0.075	0.224	0.01 U	0.063	0.05			
28-Aug	358711	SNO21	1013	LOW	0.2	4750	3.5		19.0	8.8	7.6	0.359	0.080	0.202	0.01 U	0.045	0.022		4.2	4.4
28-Aug	358712	SNO20	1039	LOW	0.2	302	0.1		19.0	9.2	7.5	0.253	0.01 U	0.155	0.01 U	0.029	0.01 U		10.4	2.6
28-Aug	358713	SNO21	1650	HIGH	0.2	30000	25.3	25.9	17.5	8.0	7.7	0.291	0.016	0.165	0.01 U	0.049	0.041		3.8	2.6 J
28-Aug	358714	SNO21	1655	HIGH	0.2	30500	26.7	27.5	16.0	7.2	7.7	0.308	0.01 U	0.212	0.01 U	0.049	0.046			
28-Aug	358715	STM30	1103	LOW	0.2	2800	2.0		19.5	9.1	7.0	0.286	0.012	0.165	0.01 U	0.033	0.01 U			
28-Aug	358716	STM30	1730	HIGH	0.2	8000	5.7		21.1	8.5	7.1	0.291	0.044	0.146	0.01 U	0.036	0.01 U			
28-Aug	358717	STM30	1738	HIGH	0.2	10000	7.2		21.1	8.3	7.1	0.248	0.045	0.138	0.01 U	0.031	0.011			
28-Aug	358718	POG34	955	LOW	0.2	12350	9.7		18.0	8.2	7.6	0.418	0.112	0.204	0.01 U	0.065	0.037		2.2	3.6
28-Aug	358719	POG34	1627	HIGH	0.2	29000	25.6	25.0	15.5	7.9	7.7	0.297	0.034	0.202	0.01 U	0.058	0.043		3.8	2.7
28-Aug	358720	POG34	1632	HIGH	0.2	31000	27.5	28.5	15.5	7.1	7.7	0.316	0.01 U	0.223	0.01 U	0.051	0.049			
28-Aug	358721	EBE23	1115	LOW	0.2	1450	0.9		19.8	9.4	7.8	0.206	0.01 U	0.153	0.01 U	0.021	0.01 U		20.6	4
28-Aug	358722	EBE23	1121	LOW	0.2	1480	0.9		20.2	9.5	7.6	0.224	0.01 U	0.156	0.01 U	0.029	0.01 U		20.6	4
28-Aug	358723	EBE23	1740	HIGH	0.2	11200	7.0	7.1	20.0	8.3	7.5	0.281	0.038	0.139	0.01 U	0.027	0.015		2.9	2.5
28-Aug	358724	EBE23	1746	HIGH	5.5	11400	7.2	7.4	19.9	8.1	7.3	0.303	0.046	0.138	0.01 U	0.032	0.016			
28-Aug	358725	EBE24	1052	LOW	0.2	12000	7.8		19.0	8.1	7.6	0.288	0.043	0.134	0.01 U	0.034	0.015		2.6	3
28-Aug	358726	EBE24	1723	HIGH	0.2	29800	20.9		20.2	7.7	7.5	0.294	0.041	0.104	0.01 U	0.039	0.017		3.8	2.2
28-Aug	358727	EBE24	1728	HIGH	3.1	30000	21.2		19.9	7.5	7.3	0.251	0.035	0.097	0.01 U	0.035	0.02			
28-Aug	358728	EBE26	1040	LOW	0.2	21200	14.8		18.6	7.0	7.5	0.283	0.040	0.102	0.01 U	0.035	0.016			
28-Aug	358729	EBE26	1706	HIGH	0.2	27000	18.8		20.0	7.5	7.5	0.254	0.023	0.090	0.01 U	0.043	0.024			
28-Aug	358730	EBE26	1711	HIGH	6.4	28000	19.7		19.6	7.4	7.6	0.246	0.023	0.088	0.01 U	0.048	0.027			
28-Aug	358731	EBE27	1026	LOW	0.2	22800	16.2		18.3	6.9	7.6	0.273	0.030	0.083	0.01 U	0.037	0.017		1.9	2
28-Aug	358732	EBE27	1650	HIGH	0.2	29300	21.2		18.7	7.7	8.0	0.239	0.023	0.090	0.01 U	0.035	0.031		4.6	2.5
28-Aug	358733	EBE27	1700	HIGH	4.6	33000	24.9		17.6	7.7	7.8	0.210	0.012	0.091	0.01 U	0.044	0.034			
28-Aug	358734	STM31	1001	LOW	0.2	11500	7.5		18.7	8.2	7.5	0.269	0.041	0.135	0.01 U	0.029	0.015		2 J	4.3
28-Aug	358735	STM31	1625	HIGH	0.2	29800	21.7	21.2	18.6	7.5	7.6	0.243	0.024	0.090	0.01 U	0.039	0.03		3.8	3
28-Aug	358736	STM31	1630	HIGH	4.0	30800	22.5	22.3	18.6	7.6	7.6	0.217	0.021	0.087	0.01 U	0.040	0.033			
28-Aug	358737	STM32	935	LOW	0.2	19500	13.6		18.3	7.6	7.7	0.259	0.040	0.108	0.01 U	0.025	0.023		4.3	5.3
28-Aug	358738	STM32	1550	HIGH	0.2	29500	20.9	20.2	19.6	8.6	8.0	0.251	0.026	0.106	0.01 U	0.037	0.033		1.7	1.1
28-Aug	358739	STM32	1559	HIGH	4.6	33800	26.1	26.4	16.8	7.8	7.8	0.209	0.039	0.104	0.01 U	0.041	0.038			
28-Aug	358740	UNS33	950	LOW	0.2	19900	13.9		18.2	7.3	7.5	0.236	0.033	0.097	0.01 U	0.026	0.019			
28-Aug	358741	UNS33	1606	HIGH	0.2	28200	19.2		21.0	7.6	7.5	0.263	0.034	0.100	0.01 U	0.036	0.03			
28-Aug	358742	UNS33	1615	HIGH	2.8	31200	23.4		17.7	7.6	7.8	0.242	0.024	0.101	0.01 U	0.035	0.034			
28-Aug	358743	PS35	1530	HIGH	0.2	33200	25.9	26.9	16.4	7.6	8.3	0.288	0.018	0.115	0.01 U	0.042	0.035		5.6	1
28-Aug	358744	PS35	1538	HIGH	5.2	33100	26.3	26.9	15.6	7.7	8.2	0.250	0.01 U	0.131	0.01 U	0.039	0.038			
28-Aug	358745	SNO10	1215		0.2	59			18.0	11.3	7.5	0.199	0.01 U	0.150	0.01 U	0.01 U	0.01 U		2.2	1.1
28-Aug	358746	SNO11	1240		0.2	60			17.2	10.7	7.6	0.200	0.01 U	0.155	0.01 U	0.01 U	0.01 U		2.8	1
28-Aug	358747	FRN12	1305		0.2	210			19.7	7.9	7.0	1.13	0.073	0.635	0.02	0.081	0.015		29.3	0.5
28-Aug	358748	PIL13	945		0.2	105			16.7	10.0	7.6	0.413	0.01 U	0.314	0.01 U	0.01 U	0.01 U		2.5	2.3
28-Aug	358749	MARS17	900		0.2	255			16.8	8.4	7.3	1.81	0.145	1.30	0.05	0.142	0.034		3.1	1.8
28-Aug	358750	MARS17	845		0.2	258			16.9	8.4	7.3	1.80	0.153	1.30	0.05	0.119	0.032		24.9	11
28-Aug	358751	DED19	820		0.2	5200		3.2	18.7	9.6	7.5	1.11	0.294	0.223	0.05	0.111	0.019		18.3	9.6
28-Aug	358752	STS22	755		0.2	365			17.0	1.3	7.1	4.34	3.700	0.133	0.01 U	0.107	0.013		5.4	3.6
28-Aug	358753	ALL25	1025		0.2	170			15.1	1.1	7.0	1.10	0.015	0.921	0.01 U	0.092	0.068		1.4	0.6
28-Aug	358754	QIL28	1125		0.2	825		0.4	15.9	10.5	7.5	1.31	0.021	1.11	0.01 U	0.090	0.053		3	4.5

U The analyte was not detected at or above the reported limit

J The analyte was positively identified, but the associated numerical result is an estimate.

Appendix C.1. Laboratory data and field measurements for samples collected August 27 and 28, 1996

Date 1996	LAB ID	Station ID	Time (hour)	Tide	Sample Depth (m)	Cond (umho/cm)	Calibrated Sal (o/oo)	Measured Sal (o/oo)	Temp (C°)	DO (mg/L	pH (S.U.)	TPN (mg/L)	NH3 (mg/L)	NO2-NO3 (mg/L)	NO2 (mg/L)	TP (mg/L)	Ortho-P (mg/L)	BOD35 (mg/L)	Chloro a (ug/L)	Pheo a (ug/L)
27-Aug		SNO18	1437		a	24300	19.9		18.0											
27-Aug		SNO20	1431		a	1800	1.3		18.5											
27-Aug		SNO21	1420		a	610	0.4		18.0											
27-Aug		EBE23	1505		a	3070	1.9		19.4											
27-Aug		STM31	1450		a	19700	13.7		18.5											
27-Aug		STM32	1437		a	29300	22.2		17.0											
28-Aug		SNO18	1438		a	425	0.2		19.9											
28-Aug		SNO20	1433		a	520	0.3		20.0											
28-Aug		SNO21	1421		a	9250	6.8		20.0											
28-Aug		EBE23	1424		a	1100	0.8		19.3											
28-Aug		STM31	1440		a	11500	7.8		19.2											
28-Aug		STM32	1450		a	26700	19.0		18.9											
27-Aug	358234	E1	1231	LOW	0.5					9.5		0.148	0.01 U	0.01 U		0.047	0.017		12.9	0.9
27-Aug	358235	E1	1236	LOW	5					6.6		0.335	0.01 U	0.287		0.051	0.058		1.2	0.8
27-Aug	358236	E1	1241	LOW	10					5.6		0.356	0.01 U	0.301		0.066	0.060		0.8	1.0
27-Aug	358241	E1	1803	HIGH	0.5					10.3		0.120	0.01 U	0.01 U		0.028	0.013		11.3	1.1
27-Aug	358242	E1	1808	HIGH	5					10.4		0.125	0.01 U	0.01 U		0.022	0.011		12.6	1.9
27-Aug	358243	E1	1813	HIGH	10					7.6		0.277	0.01 U	0.196		0.041	0.045		5.4	1.3
27-Aug	358232	E3	1130	LOW	0.5					8.1			0.07	0.148			0.035		5.2	2.6
27-Aug	358233	E3	1135	LOW	3					8.0			0.013	0.099			0.035		7.3	1.8
27-Aug	358239	E3	1803	HIGH	0.5					10.8			0.01 U	0.01 U			0.01 U		7.6	1.0
27-Aug	358240	E3	1813	HIGH	5					9.5			0.01 U	0.020			0.020		12.0	1.5
27-Aug	358230	E5	1045	LOW	0.5					7.7			0.083	0.192			0.032		3.9	3.7
27-Aug	358231	E5	1050	LOW	3					8.3			0.084	0.131			0.040		4.6	3.5
27-Aug	358237	E5	1630	HIGH	0.5					9.7			0.01 U	0.025			0.200		10.4	1.4
27-Aug	358238	E5	1635	HIGH	5					8.0			0.01 U	0.158			0.040		6.8	1.3
28-Aug	358250	E1	1142	LOW	0.5					7.6		0.280	0.01 U	0.141		0.060	0.041		6.3	1.5
28-Aug	358249	E1	1147	LOW	5					6.5		0.306	0.01 U	0.212		0.051	0.048		3.5	1.4
28-Aug	358248	E1	1152	LOW	10					6.7		0.305	0.01 U	0.240		0.062	0.058		2.4	1.7
28-Aug	358260	E1	1820	HIGH	0.5					8.5		0.296	0.012	0.139		0.043	0.041		8.2	1.2
28-Aug	358259	E1	1825	HIGH	5					8.1		0.281	0.01 U	0.192		0.049	0.048		4.7	1.4
28-Aug	358258	E1	1830	HIGH	10					7.4		0.352	0.01 U	0.228		0.065	0.054		2.1	0.9
28-Aug	358247	E3	1038	LOW	0.5					7.3			0.103	0.192			0.046		2.9	3.4
28-Aug	358246	E3	1043	LOW	3					7.7			0.01 U	0.164			0.045		5.4	2.0
28-Aug	358257	E3	1706	HIGH	0.5					8.1			0.017	0.123			0.042		7.1	0.6
28-Aug	358256	E3	1711	HIGH	5					7.2			0.01 U	0.206			0.050		5.4	1.3
28-Aug	358245	E5	1009	LOW	0.5					7.9			0.106	0.193			0.049		3.3	3.8
28-Aug	358244	E5	1014	LOW	3					6.8			0.081	0.182			0.046		4.2	6.6
28-Aug	358255	E5	1634	HIGH	0.5					7.3			0.01 U	0.191			0.050		4.3	1.1
28-Aug	358254	E5	1639	HIGH	5					6.4			0.01 U	0.250			0.057		2.5	1.3

a Represent average of profile data

U The analyte was not detected at or above the reported limit

Appendix C.2. Laboratory data and field measurements for samples collected August 16 and 17, 1993.

Date 1993	LAB ID	Station ID	Time (hour)	Tide	Sample Depth (m)	Cond (umhos/cm)	Sal (o/oo)	Calibrated Sal (o/oo)	Temp (C°)	DO (mg/L	pH (S.U.)	TPN (mg/L)	NH3 (mg/L)	NO2-NO3 (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Turb (NTU)	TSS (mg/L	TOC (mg/L)	BOD5 (mg/L)	BOD35 (mg/L)	hloro a (ug/L)	Pheo a (ug/L)	Total Hard (mg/L)	FC (#/100mL)
16-Aug	348401	SKY01	2015	-	0.2	46	0.0	0.0	14.7	9.8	7.6	0.194	0.010 U	0.129	0.010 U	0.010 U	0.5	2	1 U	3 U	-	4.8	1.5	19	78
16-Aug	348402	SUL02	1945	-	0.2	35	0.0	0.0	12.1	11.0	7.8	0.118	0.010 U	0.076	0.010 U	0.010 U	1.0	4	1.1	3 U	-	3.1	1.2	12 J	52
16-Aug	348404	SKY05	1830	-	0.2	42	0.0	0.0	13.5	10.6	7.7	0.129	0.010 U	0.085	0.010 U	0.010 U	1.6	4	1 U	-	-	3.1	2.0	14	190
16-Aug	348405	WOD06	1800	-	0.2	92	0.0	0.0	14.2	9.6	7.8	0.671	0.010 U	0.551	0.021	0.011	1.4	3	3.2	3 U	-	6.8	3.1	39	750
16-Aug	348406	SKY07	1440	-	0.2	48	0.0	0.0	14.0	10.0	7.8	-	-	-	-	-	-	-	-	-	-	-	-	-	160
16-Aug	348407	SNQ09	1700	-	0.2	66	0.0	0.0	15.2	9.7	7.5	0.297	0.010 U	0.225	0.011	0.010 U	1.5	2	1.2	3 U	-	0.7 J	0.6	27	140
16-Aug	348408	SNQ09	1705	-	0.2	66	0.0	0.0	15.2	9.4	7.5	0.297	0.010 U	0.228	0.011	0.010 U	1.6	2	1.0	3 U	-	1.2	0.5	28	100
16-Aug	348409	FRN12	1515	-	0.2	217	0.0	0.0	15.5	2.4	6.8	2.10	0.211	1.13	0.090	0.024	16	3	8.1	3 U	-	2.4	1.1	-	51
16-Aug	348410	PIL13	1430	-	0.2	88	0.0	0.0	14.8	10.0	7.7	0.344	0.010 U	0.249	0.010 U	0.010 U	0.6	1	2.0	3 U	-	2.0	1.3	-	210
16-Aug	348411	MAR17	1330	-	0.2	205	0.0	0.0	15.2	1.7	6.9	1.86	0.311	1.13	0.131	0.055	9.9	3	4.5	3	-	17.4	4.0	-	72
16-Aug	348412	DED19	1140	-	0.2	1100	0.6	0.6	17.7	8.9	7.0	1.90	0.619	0.214	0.129	0.011	24	11	10.2	6	-	104.0	10.9	-	57
16-Aug	348413	STS22	1225	-	0.2	352	0.1	0.1	14.3	2.4	6.7	4.33	3.95	0.010 U	0.056	0.010	80	26	8.8	9	-	11.0	4.6	-	190
16-Aug	348414	ALL25	1007	-	0.2	191	0.0	0.0	14.6	1.0	7.0	1.20	0.025	0.893	0.115	0.090	1.7	1	5.2	3 U	-	1.3	1.0	-	200
16-Aug	348415	QIL28	905	-	0.2	740	0.4	0.4	14.2	7.0	7.5	1.19	0.022	0.958	0.113	0.069	6.6	9	4.9	3 U	-	0.8	0.8	-	810 S
16-Aug	348416	SNQ19	-	-	0.2	-	-		-	-	-	-	-	-	-	0.010 U	-	-	-	-	-	-	-	-	-
16-Aug	348420	EBE23	1235	LOW	0.2	141	0.0	0.0	16.1	9.1	7.7	0.253	0.053	0.186	0.012	0.010 U	2.2	5	1.2	3 U	-	6.8	1.3	21	51 S
16-Aug	348421	EBE23	1745	HIGH	0.2	10300	6.8	7.9	18.2	8.3	7.4	0.367	0.046	0.170	0.033	0.021	2.3	4	1.2	-	-	3.3	2.0	730	-
16-Aug	348422	EBE23	1750	HIGH	5.5	11000	7.3	8.5	18.0	8.1	7.4	0.376	0.05	0.164	0.035	0.015	3.4	8	1.0 U	3 U	-	-	-	-	-
16-Aug	348423	EBE24	1040	LOW	0.2	5400	3.5	4.1	17.0	8.6	7.4	0.294	0.025	0.163	0.033	0.010 U	4.0	14	1.0 U	-	2.0	-	-	-	57
16-Aug	348424	EBE24	1730	HIGH	0.2	12100	7.9	9.3	18.7	8.2	7.4	0.290	0.032	0.158	0.024	0.010 U	2.6	4	1.0 U	-	-	-	-	-	-
16-Aug	348425	EBE24	1735	HIGH	4	18000	12.2	14.1	19.0	6.8	7.4	0.402	0.050	0.135	0.047	0.022	6.8	18	1.0 U	-	-	-	-	-	-
16-Aug	348426	EBE26	1110	LOW	0.2	16800	11.7	13.6	17.5	6.6	7.4	0.346	0.047	0.138	0.041	0.020	4.9	12	1.0 U	-	-	-	-	-	110
16-Aug	348427	EBE26	1710	HIGH	0.2	18000	12.3	14.2	18.6	7.4	7.7	0.367	0.032	0.128	0.037	0.034	3.7	7	1.0 U	-	-	-	-	-	-
16-Aug	348428	EBE26	1715	HIGH	5.2	22200	15.4	17.8	18.6	7.2	7.8	0.272	0.025	0.108	0.046	0.035	4.0	14	1.0 U	-	-	-	-	-	-
16-Aug	348429	EBE27	1125	LOW	0.2	15400	10.6	12.3	17.6	7.0	7.4	0.340	0.052	0.138	0.044	0.023	4.2	11	1.0 U	-	-	4.2	2.5	-	290
16-Aug	348430	EBE27	1650	HIGH	0.2	24800	17.7	20.3	18.0	7.3	7.8	0.262	0.011	0.101	0.043	0.035	2.7	6	1.0 U	-	-	7.4	1.7	-	-
16-Aug	348431	EBE27	1655	HIGH	4.3	27800	20.1	23.0	18.0	7.3	7.9	0.262	0.013	0.096	0.046	0.038	2.4	11	1.0 U	-	-	-	-	-	-
16-Aug	348432	STM31	1005	LOW	0.2	4030	2.6	3.1	16.2	8.3	7.4	0.305	0.037	0.171	0.033	0.014	1.8	26	1.0 U	3 U	-	3.6	2.1	-	51 S
16-Aug	348433	STM31	1010	LOW	0.2	3950	2.5	3.0	16.2	8.8	7.4	0.335	0.040	0.170	0.039	0.014	6.9	25	1.0 U	3 U	-	4.2	4.1	-	73
16-Aug	348434	STM31	1615	HIGH	0.2	23200	16.5	18.9	18.0	7.3	7.8	0.295	0.021	0.107	0.049	0.038	2.0	9	1.0 U	-	-	4.4	1.6	-	-
16-Aug	348435	STM31	1620	HIGH	4	24000	17.4	19.4	18.4	6.9	7.8	0.276	0.020	0.106	0.048	0.040	2.5	10	1.0 U	3 U	-	-	-	-	-
16-Aug	348436	STM32	910	LOW	0.2	12200	8.5	9.9	16.5	7.8	7.5	0.317	0.038	0.145	0.041	0.030	4.2	14	1.0 U	-	2.9	-	-	-	49
16-Aug	348437	STM32	1535	HIGH	0.2	19500	13.6	15.6	18.2	7.3	7.7	0.363	0.03	0.117	0.043	0.036	3.1	9	1.0 U	-	-	-	-	-	-
16-Aug	348438	STM32	1540	HIGH	4	28000	20.2	23.1	18.1	7.1	7.9	0.255	0.021	0.099	0.044	0.034	1.7	8	1.0 U	-	-	-	-	-	-
16-Aug	348439	UNS33	940	LOW	0.2	11000	7.6	8.9	16.5	7.4	7.3	0.336	0.048	0.137	0.033	0.013	2.5	10	1.0 U	3 U	-	-	-	-	100
16-Aug	348440	UNS33	1600	HIGH	0.2	23000	16.3	18.8	18.0	7.4	7.8	0.306	0.025	0.110	0.043	0.031	3.0	12	1.0 U	-	-	-	-	-	-
16-Aug	348441	UNS33	1605	HIGH	2	24200	17.2	19.8	18.0	7.2	7.8	0.291	0.024	0.108	0.041	0.034	3.5	8	1.0 U	-	-	-	-	-	-
16-Aug	348442	IEH35	1510	HIGH	0.2	28700	21.8	25.0	16.0	7.8	7.9	0.238	0.013	0.095	0.040	0.035	1.0	4	1.0 U	-	-	3.5	0.9	-	-
16-Aug	348443	IEH35	1515	HIGH	4.6	29100	22.2	25.4	16.0	7.6	8.0	0.234	0.012	0.100	0.040	0.036	0.8	4	1.0 U	-	-	-	-	-	-
16-Aug	348445	STM31	-	-	-	-	-		-	-	-	-	-	-	-	0.010 U	-	-	-	-	-	-	-	-	-
16-Aug	348450	SNO11	1430	LOW	0.2	45	0.0	0.0	14.5	9.5	7.4	0.251	0.010 U	0.179	0.010 U	0.010 U	1.0	3	1.4	3 U	-	1.6	1.4	21	-
16-Aug	348451	SNO14	1220	LOW	0.2	45	0.0	0.0	14.5	9.2	7.5	0.267	0.010 U	0.185	0.010 U	0.010 U	1.5	5	1.1	3 U	-	1.4	1.6	24	58
16-Aug	348452	SNO15	1205	LOW	0.2	45	0.0	0.0	14.5	9.3	7.5	0.266	0.010 U	0.185	0.010 U	0.010 U	1.0	3	1.0 U	-	-	1.5	1.3	-	150
16-Aug	348453	SNO16	1120	LOW	0.2	48	0.0	0.0	15.0	9.2	7.5	0.276	0.010 U	0.192	0.010 U	0.010 U	2.0	2	1.1	-	0.7	1.3	1.2	23	57
16-Aug	348454	SNO16	1125	LOW	0.2	48	0.0	0.0	15.0	9.3	7.5	0.280	0.010 U	0.193	0.010 U	0.010 U	1.5	2	1.1	-	1.5	1.4	1.2	23	100 S
16-Aug	348455	SNO18	1103	LOW	0.2	60	0.0	0.0	15.0	9.5	7.5	0.273	0.010 U	0.181	0.013	0.010 U	1.6	4	1.0 U	-	-	-	-	23	65
16-Aug	348456	SNO18	1750	HIGH	0.2	5000	3.4	3.3	15.0	8.8	7.6	0.415	0.087	0.193	0.033	0.041	2.5	2	1.0 U	-	-	-	-	598	-
16-Aug	348457	SNO18	1755	HIGH	5	20000	14.9	15.2	15.0	8.2	7.7	0.442	0.095	0.182	0.053	0.039	3.6	7	1.0 U	-	-	-	-	-	-
16-Aug	348458	SNO20	1005	LOW	0.2	450	0.2	0.2	15.0	9.1	7.5	0.282	0.010 U	0.186	0.018	0.010 U	3.3	7	1.1	3 U	-	2.2	1.8	-	88
16-Aug	348459	SNO20	1705	HIGH	0.2	19000	14.2	14.3	15.0	8.4	7.6	0.424	0.090	0.187	0.041	0.029	2.5	3	1.0 U	-	-	2.2	1.4	-	-
16-Aug	348460	SNO20	1710	HIGH	10	29000	23.2	23.6	14.0	7.5	7.9	0.379	0.055	0.170	0.062	0.050	3.2	13	1.0 U	3 U	-	-	-	-	-
16-Aug	348461	SNO21	930	LOW	0.2	5500	3.7	3.6	15.0	8.7	7.4	0.420	0.090	0.192	0.047	0.023	7.8	22	1.0 U	-	0.9	-	-	-	92
16-Aug	348462	SNO21	1630	HIGH	0.2	29500	23.7	24.1	14.0	7.5	7.9	0.350	0.035	0.162	0.053	0.048	2.2	4	1.0 U	-	-	-	-	-	-
16-Aug	348463	SNO21	1645	HIGH	4	31500	25.8	26.2	13.5	7.5	8.0	0.301	0.015	0.174	0.055	0.049	1.9	9	1.0 U	-	-	-	-	-	-
16-Aug	348464	STM30	1035	LOW	0.2	4200	2.8	2.7	15.5	8.6	7.3	0.344	0.049	0.190	0.019	0.012	2.7	3	1.0 U	-	-	-	-	-	160
16-Aug	348465	STM30	1730	HIGH	0.2	4300	2.8	2.7	16.0	9.1	7.5	0.294	0.032	0.176	0.021	0.012	2.4	3	1.0 U	-	-	-	-	-	-
16-Aug	348466	STM30	1735	HIGH	4	11500	8.2	8.2	15.0	8.0	7.5	0.301	0.030	0.174	0.019	0.012	2.5	3	1.0 U	-	-	-	-	-	-
16-Aug	348467	POG34	1555	HIGH	0.2	32500	27.1	27.6	13.0	7.9	7.9	0.367	0.029	0.188	0.054	0.046	1.5	3	1.0 U	-	-	3.9	1.1		67
16-Aug	348468	POG34	1600	HIGH	4.5	32000	26.6	27.1	13.0	7.2	8.0	0.343	0.012	0.184	0.057	0.050	2.0	7	1.0 U	-	-	-	-	-	-
16-Aug	348469	SNO16	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	1.0 U	-	-	-	-	-	-
16-Aug	348470	SNO16	-	-	-	-	-		-	-	-	-	-	-	-	0.010 U	-	-		-	-	-	-	-	-

U The analyte was not detected at or above the reported limit.

S Data Qualifier for Microbiology.

J The analyte was positively identified, but the associated numerical result is an estimate.

Appendix C.2. Laboratory data and field measurements for samples collected August 16 and 17, 1993.

Date 1993	LAB ID	Station ID	Time (hour)	Tide	Sample Depth	Cond (umhos/cm)	Sal (o/oo)	Calibrated Sal (o/oo)	Temp (C°)	DO (mg/L	pH (S.U.)	TPN (mg/L)	NH3 (mg/L)	NO2-NO3 (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Turb (NTU)	TSS (mg/L	TOC (mg/L)	BOD5 (mg/L)	BOD35 (mg/L)	hloro a (ug/L)	Pheo a (ug/L)	Total Hard (mg/L)	FC (#/100mL)
17-Aug	348501	SKY01	1015	-	0.2	55	0.0	0.0	13.7	10.6	7.7	0.209	0.010 U	0.148	0.012	0.010 U	0.8		1.1	3 U	-	3.5	1.5	19	41
17-Aug	348502	SUL02	1100	-	0.2	38	0.0	0.0	12.2	11.3	7.9	0.128	0.010 U	0.08	0.010 U	0.010 U	0.6		1.3	3 U	-	1.7	0.6	11 J	25
17-Aug	348503	SKY03	1040	-	0.2	52	0.0	0.0	14.2	10.5	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	15
17-Aug	348504	SKY05	1135	-	0.2	45	0.0	0.0	14.0	10.7	7.8	0.140	0.010 U	0.091	0.010 U	0.010 U	0.6		1.0	-	-	1.5	1.1	14	20
17-Aug	348504	SKY07	1440	-	0.2	40	0.0	0.0	15.3	10.5	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	46
17-Aug	348505	WOD06	1225	-	0.2	90	0.0	0.0	14.5	11.4	8.0	0.698	0.010 U	0.537	0.028	0.012	1.5	-	3.6	3 U	-	14.3	3.3	38	870
17-Aug	348507	SNQ09	1400	-	0.2	72	0.0	0.0	15.3	9.6	7.6	0.294	0.010 U	0.239	0.014	0.010 U	1.1	-	1.2	3 U	-	1.0	0.6	26	88
17-Aug	348508	FRN12	1505	-	0.2	225	0.0	0.0	17.5	4.5	6.8	2.11	0.226	1.03	0.074	0.022	12	-	10.3	3 U	-	1.4	1.7	-	63
17-Aug	348509	PIL13	1545	-	0.2	89	0.0	0.0	17.7	10.2	7.8	0.355	0.010 U	0.274	0.013	0.010 U	0.7	-	3.0	3 U	-	1.8	1.1	-	92
17-Aug	348510	MAR17	1810	-	0.2	232	0.0	0.0	17.0	7.1	7.1	1.69	0.137	0.912	0.133	0.050	9.0	-	5.8	4	-	11.9	7.1	-	29
17-Aug	348511	MAR17	1815	-	0.2	232	0.0	0.0	17.0	7.0	7.1	1.71	0.165	0.931	0.144	0.048	7.6	-	5.6	5	-	9.6	3.9	-	32
17-Aug	348512	DEO19	1720	-	0.2	1100	0.5	0.5	23.0	15.0	7.0	2.59	0.884	0.203	0.159	0.010 U	33	-	13.9	10	-	105.0	54.6	-	81
17-Aug	348513	STS22	1630	-	0.2	375	0.1	0.1	19.5	2.9	6.9	3.54	2.96	0.01 U	0.157	0.010 U	54	-	9.0	10	-	12.3	2.7	-	96
17-Aug	348515	QIL28	0830	-	0.2	1000	0.6	0.6	14.6	7.3	7.3	1.18	0.024	0.928	0.092	0.058	4.5	-	3.9	3 U	-	2.4	2.7	-	930
17-Aug	348516	MAR17	-	-	0.2	-	-		-	-	-	-	-	-	-	0.010 U	-	-	-	-	-	-	-	-	-
17-Aug	348520	EBE23	1100	LOW	0.2	105	0.0	0.0	16.5	9.2	7.6	0.291	0.010	0.192	0.020	0.010 U	2.6	-	1.3	-	-	5.3	1.7	25	49 S
17-Aug	348521	EBE23	1105	LOW	0.2	107	0.0	0.0	16.8	9.3	7.4	0.283	0.012	0.191	0.016	0.010 U	3.0	-	1.3	-	-	5.2	1.7	27	70 S
17-Aug	348522	EBE23	1705	HIGH	0.2	3420	2.1	2.5	17.7	8.9	7.7	0.311	0.034	0.188	0.028	0.013	4.0	-	1.0 U	-	-	4.2	1.9	420	-
17-Aug	348523	EBE23	1710	HIGH	5.5	3550	2.2	2.6	18.0	8.9	7.7	0.336	0.035	0.189	0.033	0.012	6.8	-	1.0 U	-	-	-	-	-	-
17-Aug	348524	EBE24	1040	LOW	0.2	6100	3.9	4.7	17.3	8.3	7.3	0.324	0.046	0.178	0.023	0.013	5.9	-	1.0 U	-	-	-	-	-	88
17-Aug	348525	EBE24	1650	HIGH	0.2	13400	8.8	10.2	19.2	7.7	7.4	0.495	0.058	0.157	0.077	0.022	6.1	-	1.0 U	-	-	-	-	-	-
17-Aug	348526	EBE24	1655	HIGH	3.7	13600	8.8	10.2	19.8	7.1	7.4	0.413	0.056	0.158	0.043	0.023	13	-	1.0 U	-	-	-	-	-	-
17-Aug	348527	EBE26	1020	LOW	0.2	15900	10.9	12.7	17.8	6.8	7.3	0.388	0.053	0.162	0.030	0.020	5.2	-	1.0 U	-	-	-	-	-	160
17-Aug	348528	EBE26	1630	HIGH	0.2	14100	9.3	10.8	19.2	7.6	7.5	0.389	0.038	0.156	0.035	0.026	6.9	-	1.0 U	-	-	-	-	-	-
17-Aug	348529	EBE26	1635	HIGH	4.3	14700	9.6	11.2	19.5	7.8	7.5	0.360	0.038	0.157	0.042	0.026	9.2	-	1.0 U	-	-	-	-	-	-
17-Aug	348530	EBE27	1000	LOW	0.2	15500	10.7	12.4	17.5	6.8	7.4	0.357	0.047	0.136	0.030	0.024	4.2	-	1.0 U	-	-	3.0	2.5	-	160
17-Aug	348531	EBE27	1615	HIGH	0.2	1900	12.7		19.5	8.3	7.7	0.328	0.032	0.140	0.022	0.030	4.3	-	1.0 U	-	-	3.6	1.9	-	-
17-Aug	348532	EBE27	1620	HIGH	4.3	22800	14.8	17.1	21.2	7.7	7.7	0.346	0.028	0.127	0.041	0.034	6.9	-	1.0 U	-	-	-	-	-	-
17-Aug	348533	STM31	935	LOW	0.2	6200	4.0	4.8	17.0	8.4	7.4	0.354	0.050	0.174	0.032	0.015	5.3	-	1.0 U	-	-	2.8	2.7	-	89
17-Aug	348534	STM31	1540	HIGH	0.2	14500	9.6	11.2	18.9	8.1	7.5	0.363	0.041	0.160	0.031	0.029	4.2	-	1.0 U	-	-	4.2	2.7	-	-
17-Aug	348535	STM31	1545	HIGH	3.7	14900	9.3	10.8	21.8	7.9	7.5	0.372	0.040	0.157	0.039	0.028	5.8	-	1.0 U	-	-	-	-	-	-
17-Aug	348536	STM32	850	LOW	0.2	14600	10.1	11.8	17.1	7.6	7.5	0.326	0.040	0.150	0.032	0.029	3.1	-	1.0 U	-	-	-	-	-	59
17-Aug	348537	STM32	1500	HIGH	0.2	20000	13.5	15.6	19.5	7.6	7.6	0.338	0.037	0.140	0.033	0.029	4.7	-	1.0 U	-	-	-	-	-	-
17-Aug	348538	STM32	1505	HIGH	4.6	24600	16.9	19.4	19.6	8.0	7.8	0.293	0.023	0.121	0.038	0.037	3.2	-	1.0 U	-	-	-	-	-	-
17-Aug	348539	UNS33	910	LOW	0.2	15500	10.8	12.2	18.2	7.3	7.3	0.350	0.048	0.145	0.030	0.020	4.0	-	1.0 U	-	-	-	-	-	60
17-Aug	348540	UNS33	1520	HIGH	0.2	15500	10.1	11.7	19.9	8.2	7.6	0.344	0.041	0.158	0.030	0.026	5.5	-	1.0 U	-	-	-	-	-	-
17-Aug	348541	UNS33	1525	HIGH	0.9	15200	9.6	11.2	21.0	8.0	7.5	0.351	0.038	0.147	0.033	0.026	5.8	-	1.0 U	-	-	-	-	-	-
17-Aug	348542	IEH35	1430	HIGH	0.2	27900	20.1	23.1	18.0	7.9	7.9	0.258	0.019	0.111	0.039	0.038	2.2	-	1.0 U	-	-	2.5	1.0	-	-
17-Aug	348543	IEH35	1435	HIGH	4.8	29500	20.4	23.4	20.0	8.1	8.0	0.252	0.014	0.105	0.033	0.039	1.5	-	1.0 U	-	-	-	-	-	-
17-Aug	348544	STM31	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	1.4	-	-	-	-	-	-
17-Aug	348545	EBE23	-	-	-	-	-		-	-	-	-	-	-	-	0.010 U	-	-	-	-	-	-	-	-	-
17-Aug	348546	SNO11	1230	LOW	0.2	40	0.0	0	14.5	9.9	7.4	0.262	0.010 U	0.180	0.010 U	0.010 U	1.0	-	1.4	3 U	-	2.0	1.4	21	-
17-Aug	348551	SNO14	1155	LOW	0.2	40	-	0	14.5	10.2	7.4	0.261	0.010 U	0.179	0.017	0.010 U	1.2	-	1.1	-	-	2.3	1.8	21	71
17-Aug	348552	SNO15	1140	LOW	0.2	40	-	0	14.5	9.7	7.4	0.271	0.013	0.182	0.012	0.010 U	1.3	-	1.4	-	-	1.6	1.6		150
17-Aug	348553	SNO16	1115	LOW	0.2	45	-	0	15.0	9.1	7.4	0.317	0.010 U	0.186	0.013	0.010 U	1.4	-	1.2	3 U	-	1.6	1.5	22	140 S
17-Aug	348554	SNO18	1050	LOW	0.2	52	-	0	15.0	9.8	7.4	0.255	0.010 U	0.188	0.016	0.010 U	2.3	-	1.3	-	-	-	-	23	130 S
17-Aug	348555	SNO18	1700	HIGH	0.2	5000	3.2	3.1	17.0	8.9	7.5	0.465	0.078	0.201	0.035	0.021	3.3	-	1.0 U	-	-	-	-	620	-
17-Aug	348556	SNO18	1705	HIGH	4.6	10000	6.8	6.8	16.5	8.4	7.6	0.380	0.090	0.197	0.039	0.028	4.6	-	1.0 U	-	-	-	-	-	-
17-Aug	348557	SNO20	1000	LOW	0.2	550	0.3	0.3	15.0	9.2	7.3	0.272	0.018	0.194	0.018	0.010 U	3.4	-	1.3	-	-	2.3	2.1	-	100 S
17-Aug	348558	SNO20	1615	HIGH	0.2	4100	2.6	2.5	17.5	8.8	7.6	0.343	0.079	0.189	0.033	0.019	3.8	-	1.0 U	-	-	2.4	1.8	-	60
17-Aug	348559	SNO20	1630	HIGH	9.5	11000	7.8	7.4	17.0	7.8	7.7	0.437	0.111	0.190	0.054	0.042	6.5	-	1.0 U	-	-	-	-	-	-
17-Aug	348560	SNO21	915	LOW	0.2	9500	6.7	6.6	15.0	8.4	7.6	0.430	0.134	0.189	0.045	0.031	3.8	-	1.0 U	-	-	-	-	-	110
17-Aug	348561	SNO21	920	LOW	0.2	9550	6.7	6.7	15.0	8.2	7.6	0.449	0.146	0.194	0.040	0.029	3.8	-	1.0 U	-	-	-	-	-	75 S
17-Aug	348562	SNO21	1515	HIGH	0.2	25500	19.7	19.9	15.0	7.7	7.9	0.392	0.053	0.191	0.043	0.049	2.0	-	1.0 U	-	-	-	-	-	20
17-Aug	348563	SNO21	1535	HIGH	2.8	28000	21.8	22.1	15.0	7.6	8.0	0.372	0.036	0.188	0.044	0.050	2.8	-	1.0 U	-	-	-	-	-	-
17-Aug	348564	STM30	1030	LOW	0.2	4200	2.8	2.7	15.5	8.7	7.3	0.306	0.055	0.193	0.019	0.010	2.4	-	1.0 U	-	-	-	-	-	69
17-Aug	348565	STM30	1640	HIGH	0.2	3450	2.1	2.1	17.5	9.2	7.4	0.264	0.031	0.184	0.018	0.012	3.4	-	1.0 U	-	-	-	-	-	-
17-Aug	348566	STM30	1645	HIGH	2.8	7500	4.9	4.9	17.0	8.6	7.4	0.322	0.051	0.188	0.024	0.014	4.1	-	1.0 U	-	-	-	-	-	-
17-Aug	348567	POG34	1445	HIGH	0.2	29500	23.4	23.7	14.5	7.7	7.8	0.373	0.067	0.194	0.037	0.045	2.2	-	1.0 U	-	-	-	-	-	12
17-Aug	348568	POG34	1500	HIGH	5.2	30000	23.8	24.2	14.5	7.4	8.0	0.502	0.030	0.192	0.050	0.053	3.0	-	1.0 U	-	-	2.8	1.0	-	-
17-Aug	348570	SNO21	-	-	-	-	-		-	-	-	-	-	-	-	0.013	-	-	1.0 U	-	-	-	-	-	-

U The analyte was not detected at or above the reported limit.

S Data Qualifier for Microbiology.

J The analyte was positively identified, but the associated numerical result is an estimate.

Appendix C.3. Laboratory data and field measurements for samples collected from WWTP effluents.

General Chemistry Results from City of Everett WWTPs, 8/96.

	Location:	EffEV1-E	EffEV1-1	EffEV1-2	EffEV2-E	EffEV2-1	EffEV2-2
	Type:	Comp	Grab	Grab	Comp	Grab	Grab
	Date:	8/27-28	8/27	8/28	8/27-28	8/27	8/28
	Time:	24 hour	pm	am	24 hour	pm	am
Parameter	Lab Log #: 3581	-45	-46	-47	-50	-51	-52
FIELD SAMPLING							
SOLIDS 4 (mg/L)							
TS		337	362	472	414	393	342
TNVS		221	144 J	240	278	251	233
TSS		7	12	6	9	9	12
TNVSS		1	1	2	3	2	1
BOD5 (mg/L)		10 J	14 J	10 J	12 J	14 J	12 J
NH3-N (mg/L)		17.3	17.1	12.2	11.4	10.7	17.6
NO2+NO3-N (mg/L)		0.179	0.229	10.9	11.3	11.8	0.110
NO2 (mg/L)		0.133	0.163	1.27	1.14	1.10	0.083
Total Kjeldahl N (mg/L)		20.6	21.4	15.0	14.4	13.1	22.8
Phosphate - Ortho (mg/L)		4.76	4.70	4.09	4.05	4.13	4.76
Phosphate - Total (mg/L)		4.79	4.60	3.88	4.28	4.25	2.01
FIELD OBSERVATIONS							
Flow (MGD)		5.30			5.83		
Temperature (°C.)		2.5*	22.0	21.1	3.0*	20.7	20.5
pH (s.u.)		7.59	7.60	7.54	6.93	6.90	6.68
D.O. (mg/L)		–	5.4	4.8	–	3.9	3.65

EffEV1 - Effluent to outfall 015; EffEV2 - Effluent to outfall 015a; -E - Ecology sampler.
J means the analyte was positively identified. The associated numerical result is an estimate.
* - Iced composite sample.

General Chemistry Results from Lake Stevens' S.D. WWTP, 8/96.

	Location:	EffLS-E	EffLS-1	EffLS-2
	Type:	Comp	Grab	Grab
	Date:	8/27-28	8/27	8/28
	Time:	24 hour	pm	am
Parameter	Lab Log #: 3581	-35	-36	-37
FIELD SAMPLING				
SOLIDS 4 (mg/L)				
TS		251	258	249
TNVS		134	133	156
TSS		5	4	4
TNVSS		1 U	1 U	1 U
BOD5 (mg/L)		6 J	4 J	4 J
NH3-N (mg/L)		17.3	13.7	12.7
NO2+NO3-N (mg/L)		0.070	0.180	0.282
NO2 (mg/L)		0.089	0.198	0.346
Total Kjeldahl N (mg/L)		17.0	16.0	16.5
Phosphate - Ortho (mg/L)		1.070	0.677	0.618
Phosphate - Total (mg/L)		1.320	0.894	0.848
FIELD OBSERVATIONS				
Flow (MGD)		1.24		
Temperature (°C.)		5.4	19.0	19.3
pH (s.u.)		7.31	7.38	6.99
D.O. (mg/L)		–	6.7	6.1

EffLS - Effluent; -E - Ecology sampler.
-1 - Grab sample taken on 8/27; -2 - Grab sample taken on 8/28.
U means the analyte was not detected at or above the reported result.
J means the analyte was positively identified. The numerical result is an estimate.
* - Iced composite sample.

Appendix C.3. Laboratory data and field measurements for samples collected from WWTP effl

General Chemistry Results from City of Marysville WWTP, 8/96.

	Location:	EffMA-E	EffMA-1	EffMA-2
	Type:	Comp	Grab	Grab
	Date:	8/27-28	8/27	8/28
	Time:	24 hour	pm	am
Parameter	Lab Log #: 3581	-40	-41	-42
FIELD SAMPLING				
SOLIDS 4 (mg/L)				
TS		419	*	459
TNVS		244	*	184
TSS		70	*	49
TNVSS		8	*	5
BOD5 (mg/L)		15 G	*	15 G
NH3-N (mg/L)		1.91	*	2.72
NO2+NO3-N (mg/L)		5.40	*	4.88
NO2 (mg/L)		1.60	*	1.03
Total Kjeldahl N (mg/L)		12.7	*	11.4
Phosphate - Ortho (mg/L)		2.39	*	2.21
Phosphate - Total (mg/L)		4.60	*	3.83
FIELD OBSERVATIONS				
Flow (MGD)		1.3		
Temperature (°C.)		6.2**	*	21.4
pH (s.u.)		7.36	*	7.11
D.O. (mg/L)		—	*	1.65

EffMA - Effluent; -E - Ecology sampler.

-1 - Grab sample taken on 8/27; -2 - Grab sample taken on 8/28.

G means that the value is greater than the result reported due to insufficient dilution of the samples. Result is a calculated estimate.

* - Samples not collected or observations not made.

** - Iced composite sample.

General Chemistry Results from City of Snohomish WWTP, 8/96.

	Location:	EffSN-E	EffSN-1	EffSN-2
	Type:	Comp	Grab	Grab
	Date:	8/27-28	8/27	8/28
	Time:	24 hour	pm	am
Parameter	Lab Log #: 3581	-30	-31	32
FIELD SAMPLING				
SOLIDS 4 (mg/L)				
TS		263	*	279
TNVS		146	*	159
TSS		6	*	5
TNVSS		1	*	1
BOD5 (mg/L)		6 J	*	3 J
NH3-N (mg/L)		0.455	*	0.490
NO2+NO3-N (mg/L)		7.76	*	8.04
NO2 (mg/L)		0.181	*	0.18
Total Kjeldahl N (mg/L)		2.84	*	2.42
Phosphate - Ortho (mg/L)		4.55	*	4.51
Phosphate - Total (mg/L)		4.27	*	4.44
FIELD OBSERVATIONS				
Flow (MGD)		0.51		
Temperature (°C.)		6.4**	*	20.6
pH (s.u.)		7.69	*	7.51
D.O. (mg/L)		—	*	8.7

EffSN - Effluent; -E - Ecology sampler.

-1 - Grab sample taken on 8/27; -2 - Grab sample taken on 8/28.

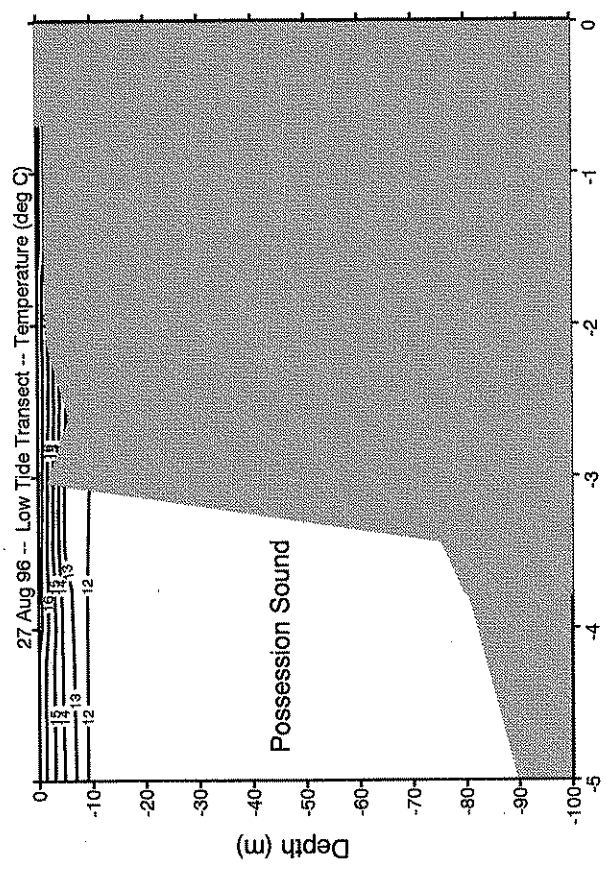
J means the analyte was positively identified. The associated numerical result is an estimate.

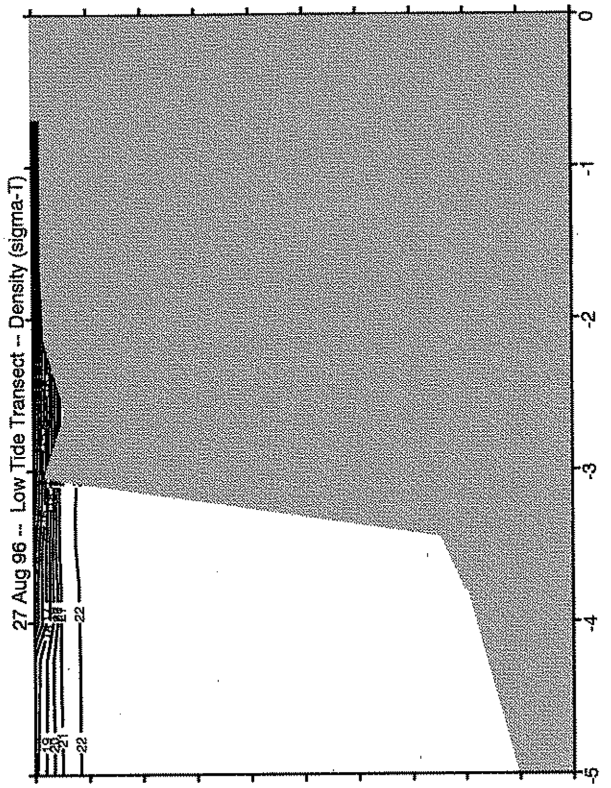
* - Samples not collected or observations not made.

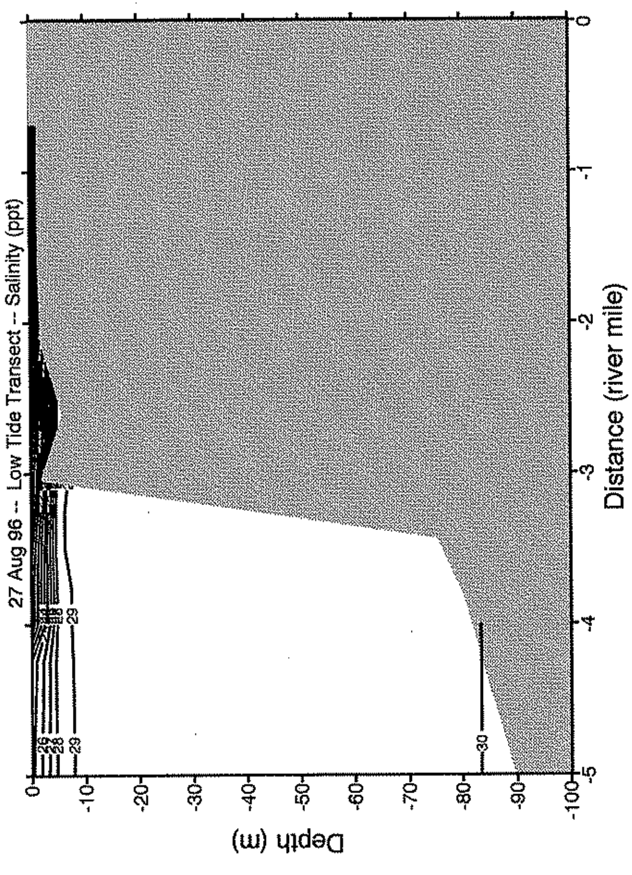
** - Iced composite sample.

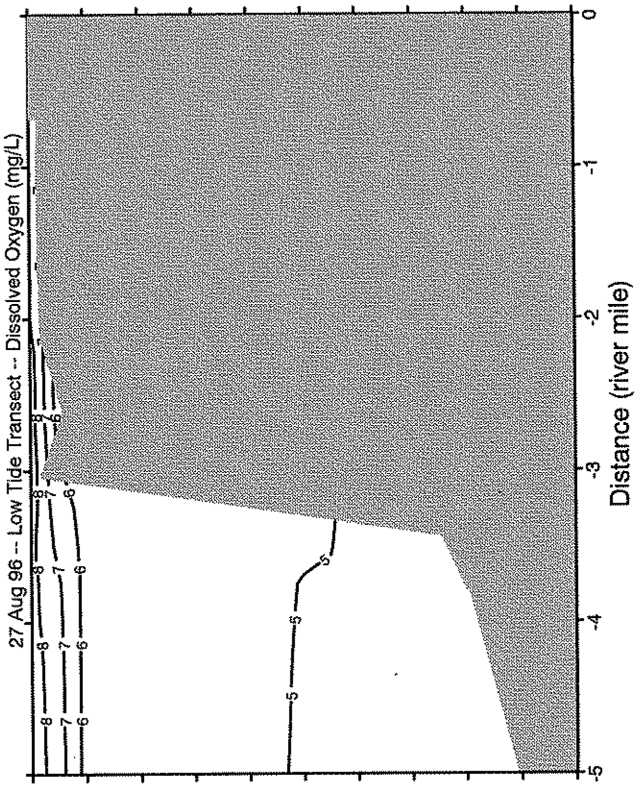
Appendix D

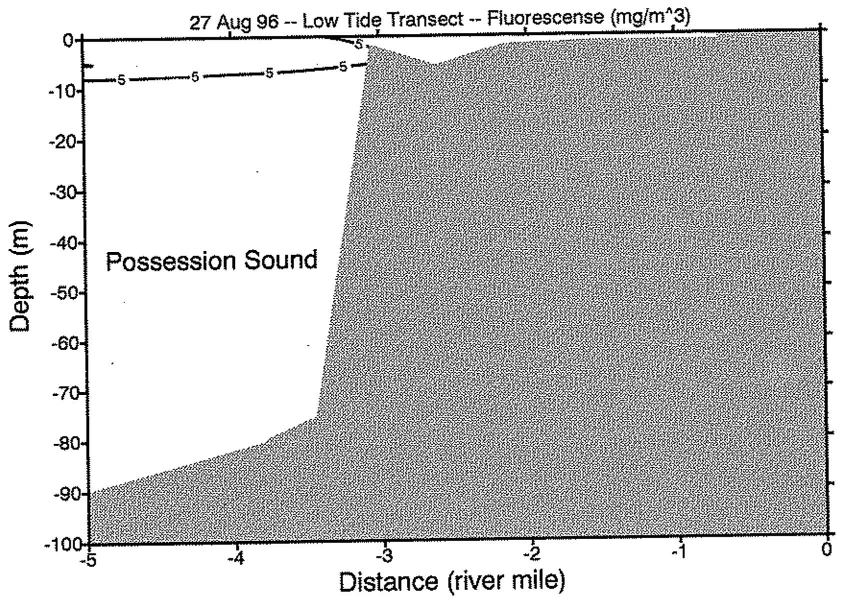
Contour Plots of 1996 Profile Transect Data

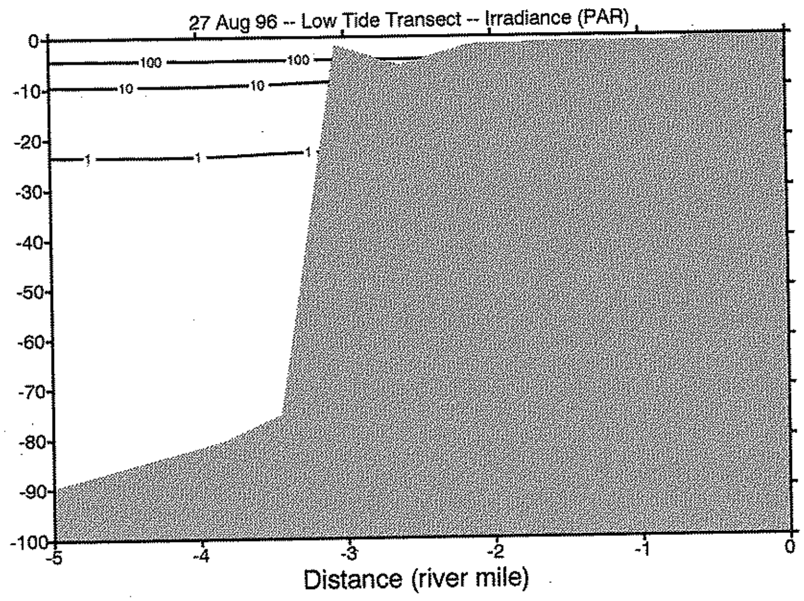

27 Aug 96 -- Low Tide Transect -- Temperature (deg C)


27 Aug 96 -- Low Tide Transect -- Density (sigma-T)

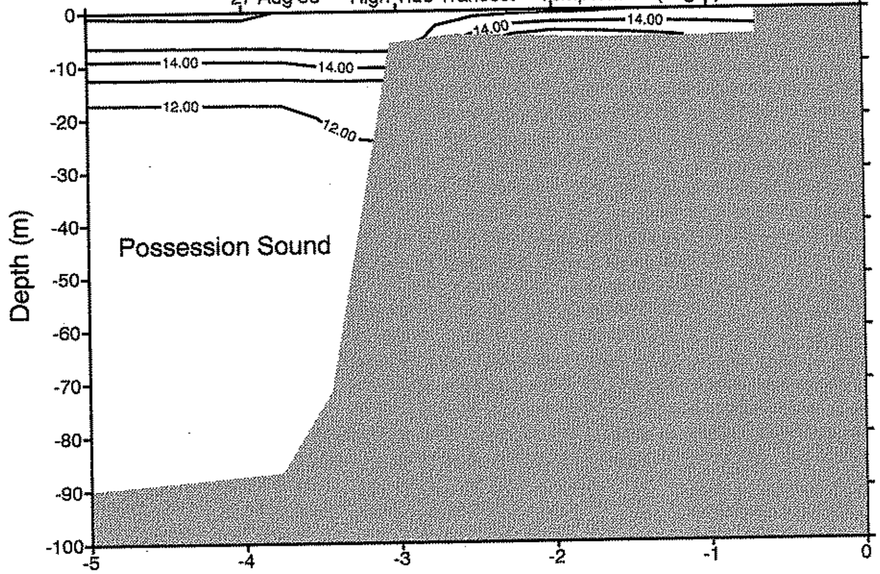

27 Aug 96 -- Low Tide Transect -- Salinity (ppt)


27 Aug 96 -- Low Tide Transect -- Dissolved Oxygen (mg/L)

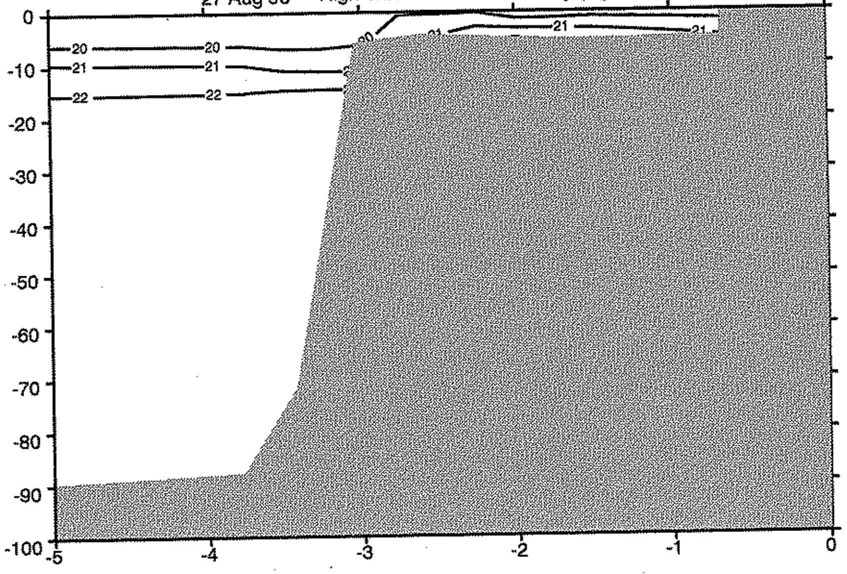

27 Aug 96 -- Low Tide Transect -- Fluorescense (mg/m^3)
Possession Sound
Depth (m)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
5
5
5
5
5
5
-5
-4
-3
-2
-1
0
Distance (river mile)


27 Aug 96 -- Low Tide Transect -- Irradiance (PAR)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
100
100
10
10
1
1
1
-5
-4
-3
-2
-1
0
Distance (river mile)

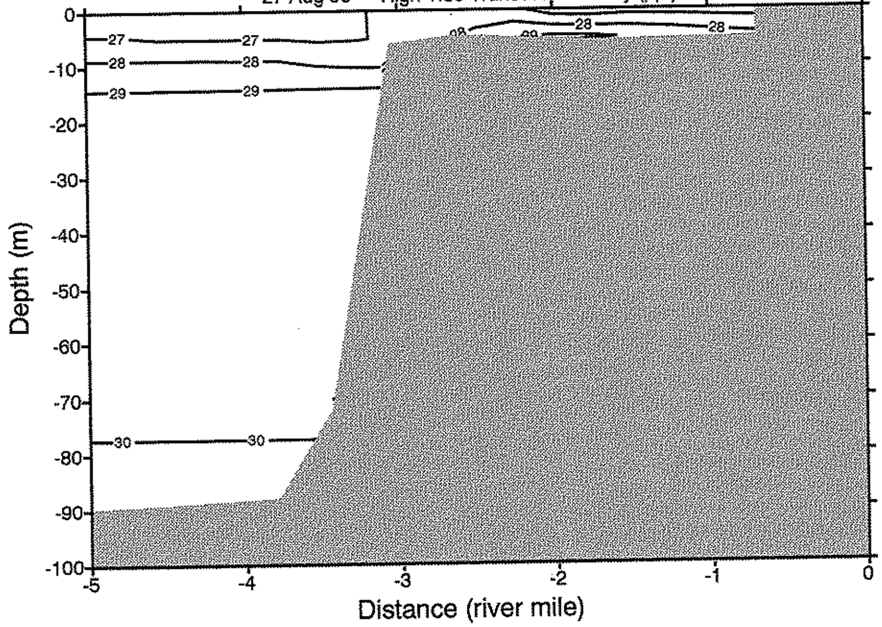
27 Aug 96 -- High Tide Transect -- Temperature (deg C)



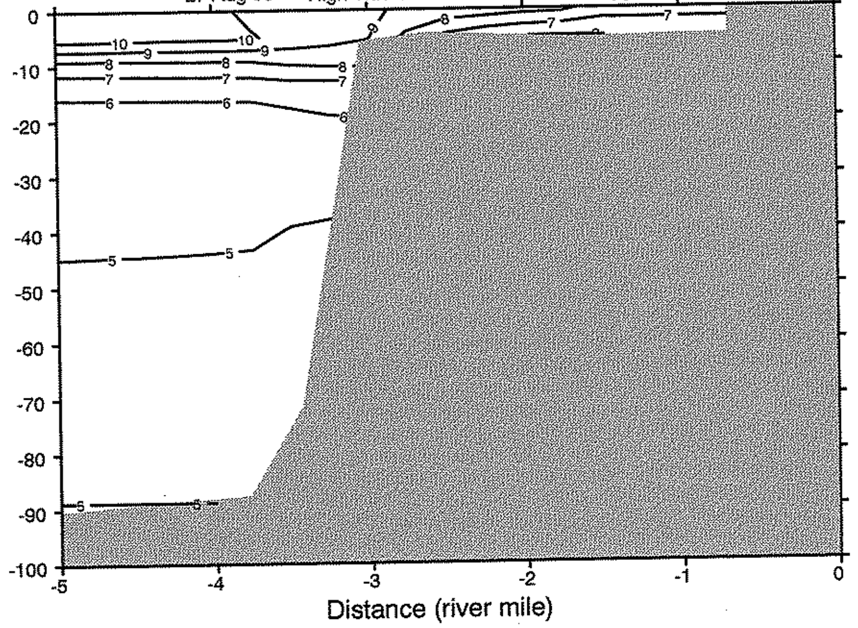
27 Aug 96 -- High Tide Transect -- Density (sigma-T)

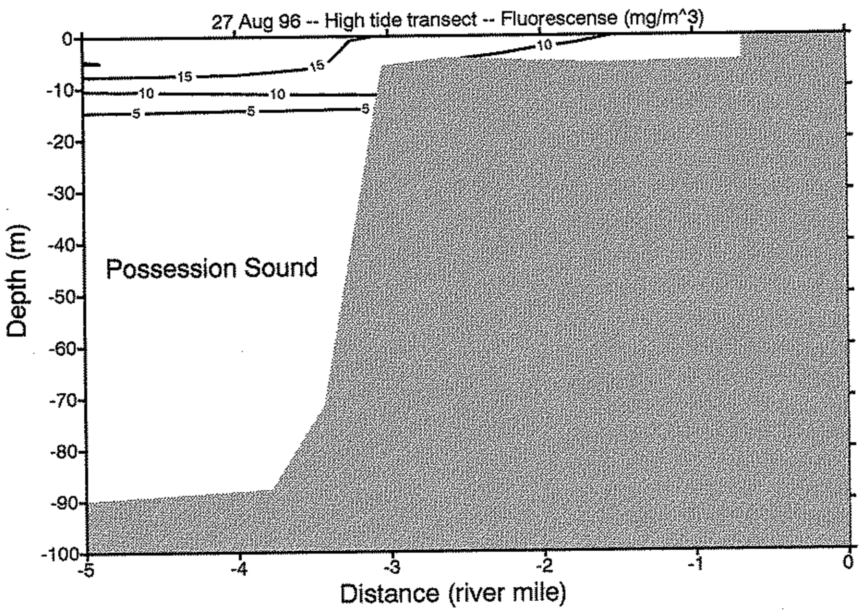


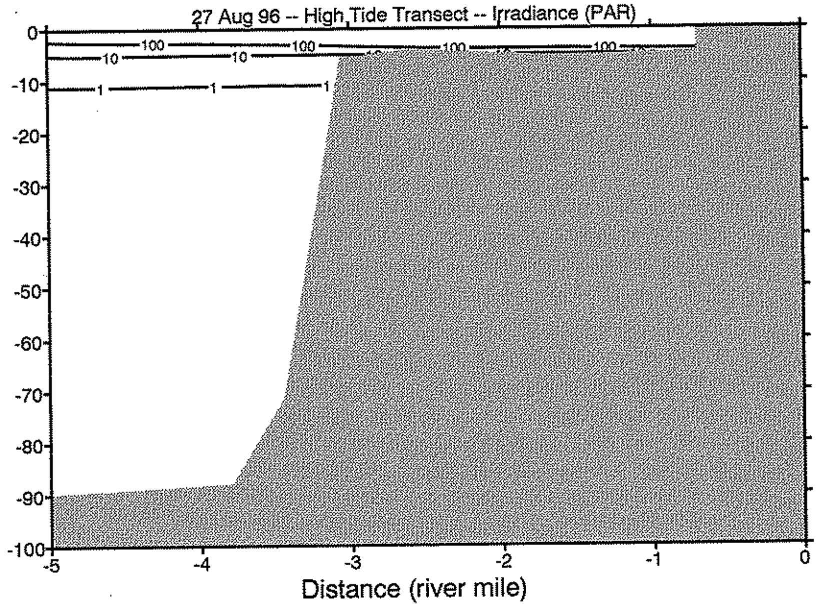
27 Aug 96 -- High Tide Transect -- Salinity (ppt)



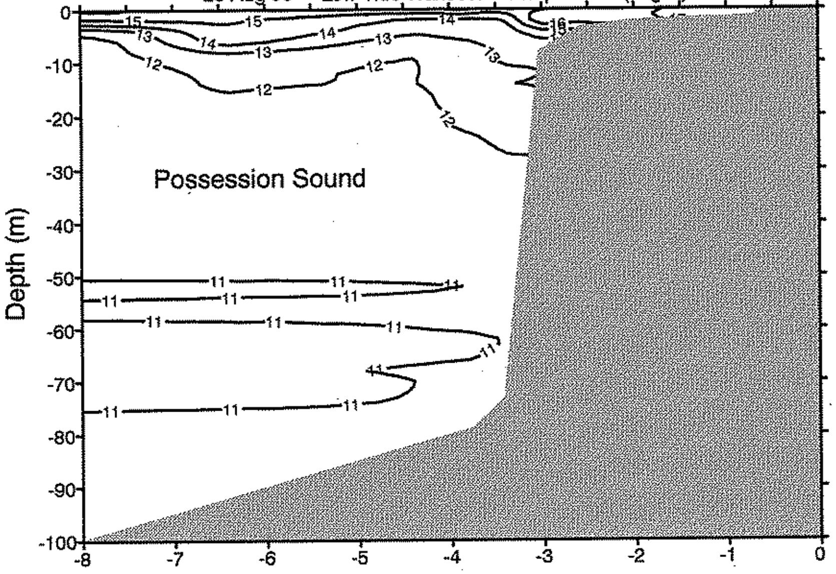
27 Aug 96 -- High Tide Transect -- Dissolved Oxygen (mg/L)



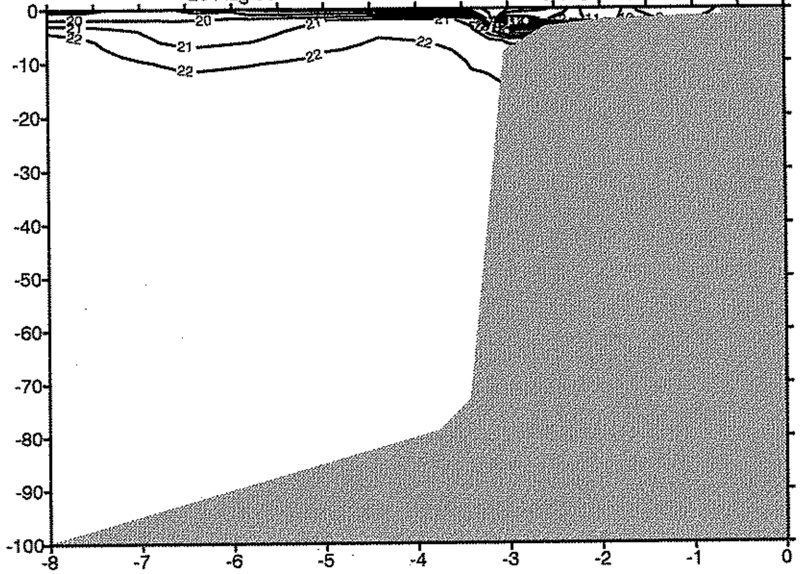

27 Aug 96 -- High tide transect -- Fluorescense (mg/m^3)


27 Aug 96 -- High Tide Transect -- Irradiance (PAR)

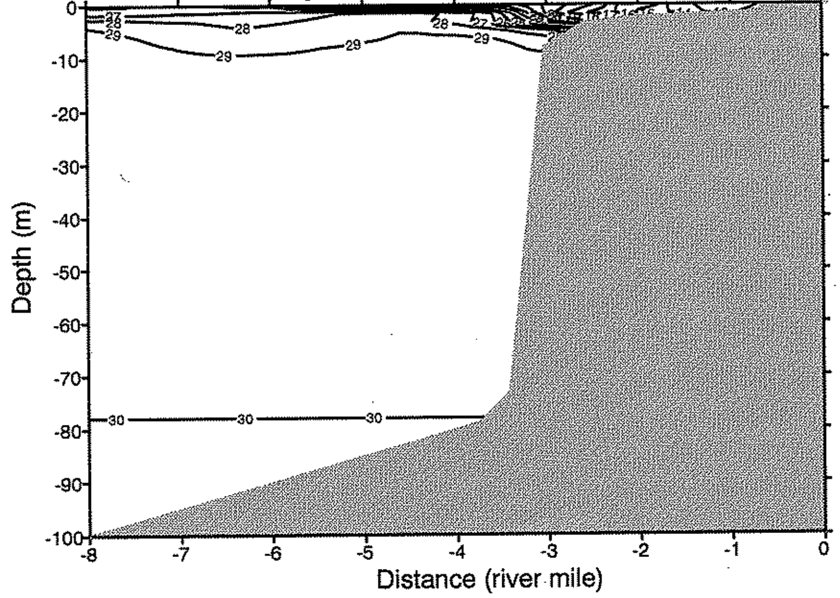
28 Aug 96 -- Low Tide Transect -- Temperature (deg C)



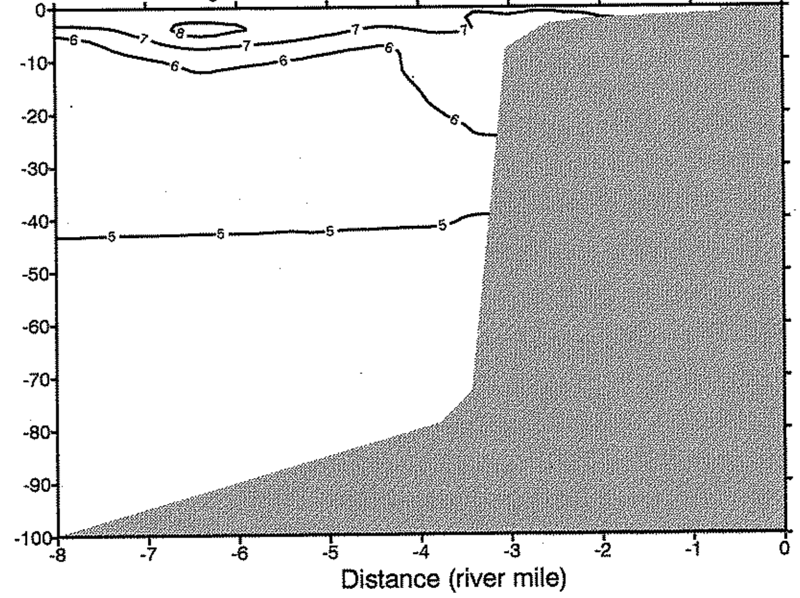
28 Aug 96 -- Low Tide Transect -- Density (sigma-t)

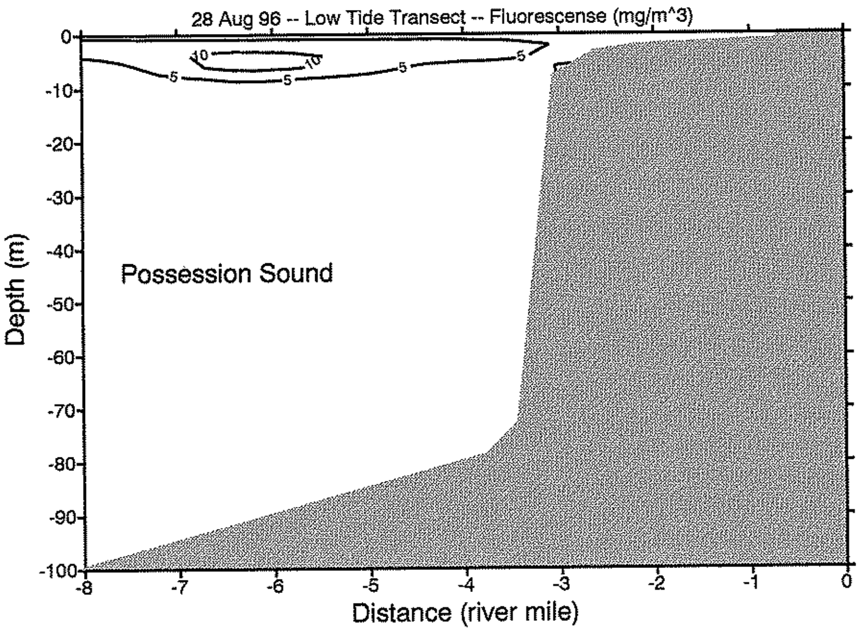


28 Aug 96 -- Low Tide Transect -- Salinity (ppt)

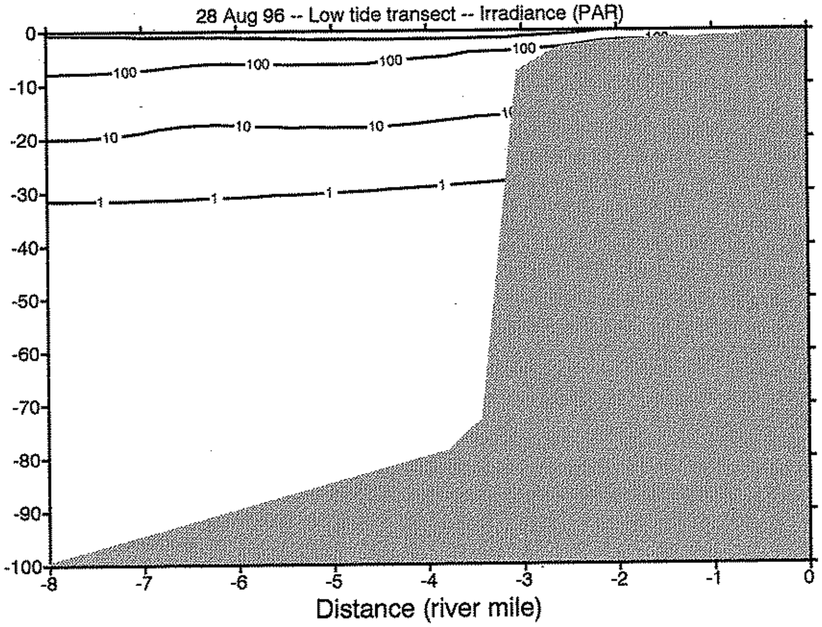


28 Aug 96 -- Low Tide Transect -- Dissolved Oxygen (mg/L)

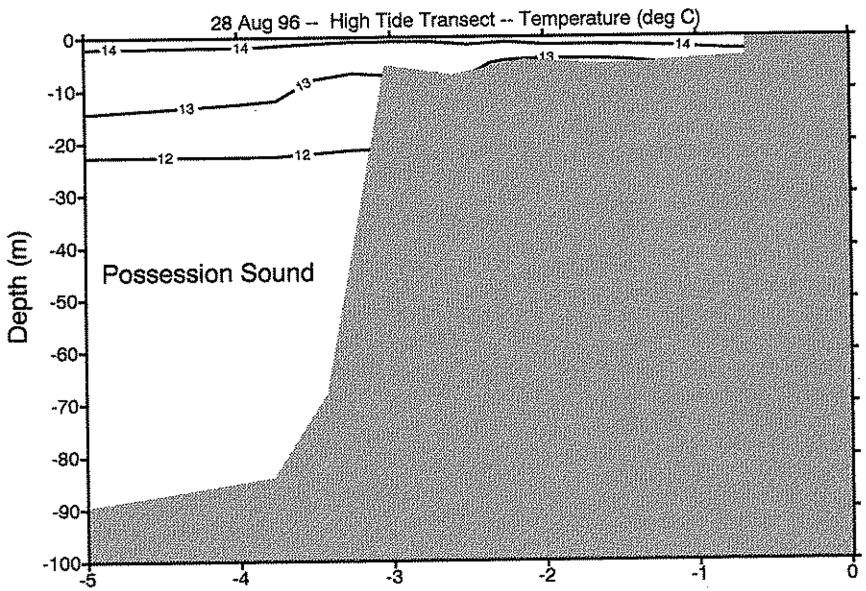


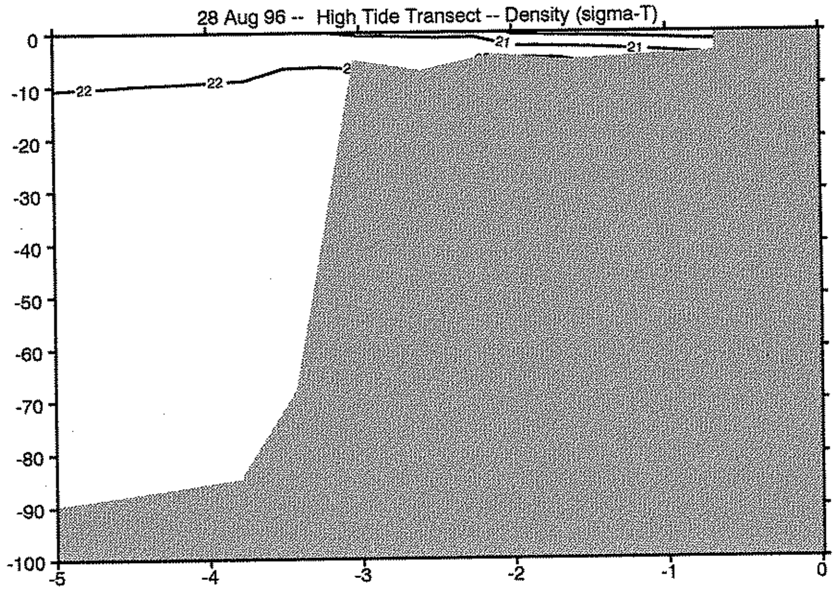


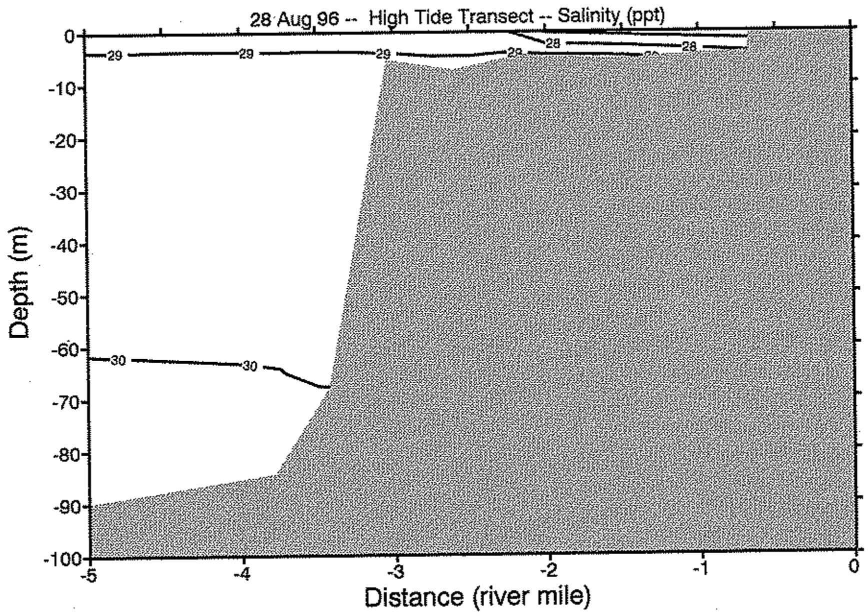
28 Aug 96 -- Low Tide Transect -- Fluorescense (mg/m^3)

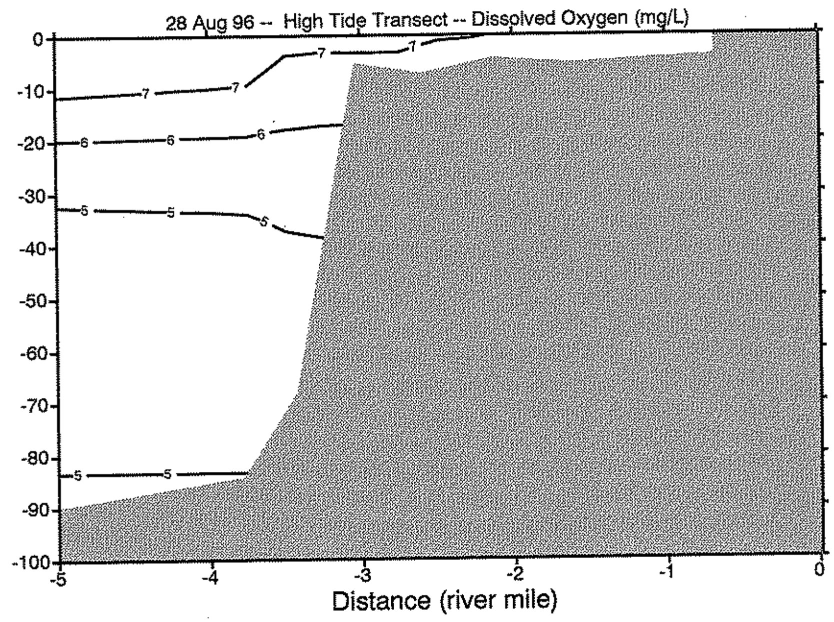


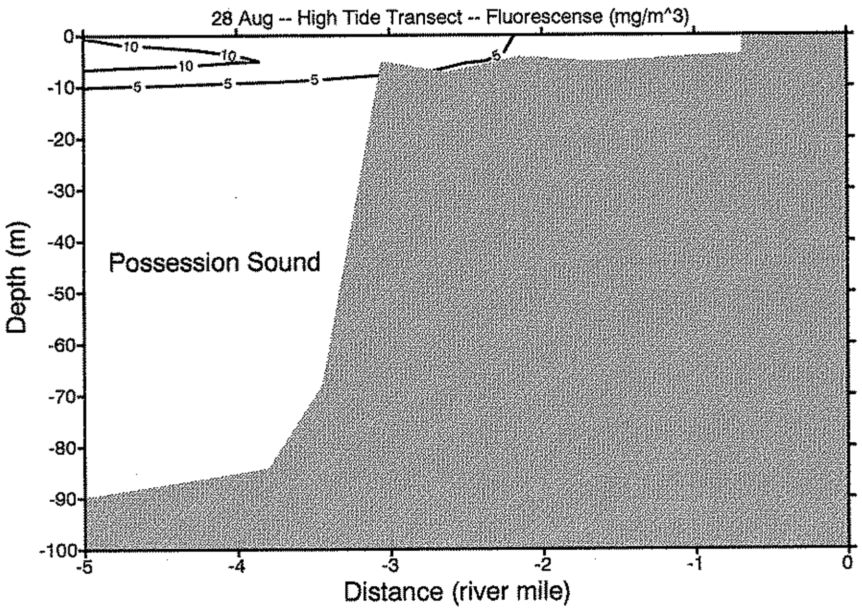
28 Aug 96 -- Low tide transect -- Irradiance (PAR)

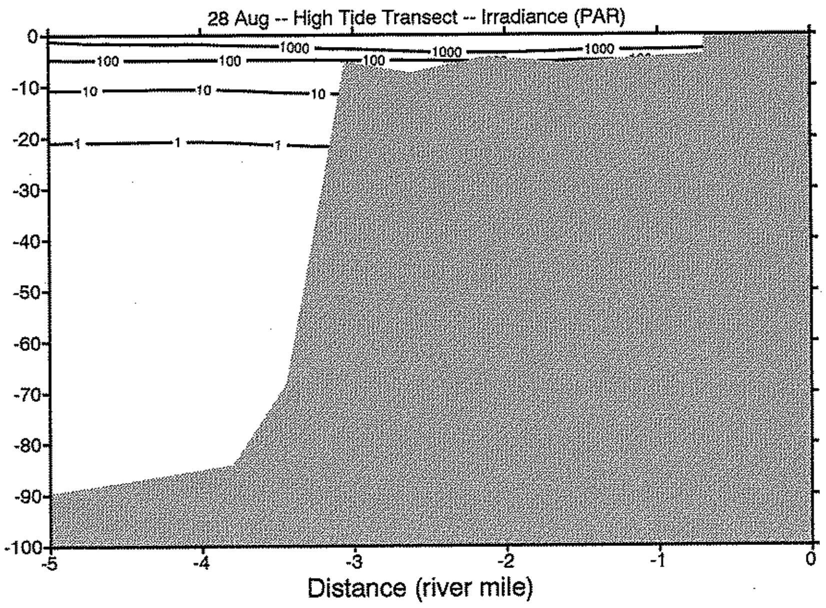

28 Aug 96 -- High Tide Transect -- Temperature (deg C)


28 Aug 96 -- High Tide Transect -- Density (sigma-T)


28 Aug 96 -- High Tide Transect -- Salinity (ppt)


28 Aug 96 -- High Tide Transect -- Dissolved Oxygen (mg/L)


28 Aug -- High Tide Transect -- Fluorescense (mg/m^3)


28 Aug -- High Tide Transect -- Irradiance (PAR)

Appendix E

WASP5 Input Files

DYNHYD5 Input File

Critical Conditions

```
SNOTIDE1.INP,TIME=0 CRITICAL CONDITIONS HYDRODYNAMIC FILE FOR EUTROWASP
ROBERT CUSIMANO, WA.DEPT.OF ECOLOGY, October 25, 1996
**********A: PROGRAM CONTROL DATA*****************************************
   83  115 0000 45.0     5    1 0000 25.0 0000 [Time Step= 45 sec.]
**********B: PRINTOUT CONTROL DATA****************************************
       1.0        1.0    0
   1    6    9   11    15   17
**********C: SUMMARY CONTROL DATA*****************************************
   1    1 0100 25.0     4    2
**********D: JUNCTION DATA************************************************
Junction   Head   Surface       Depth       Channel number entering junction
Number      (m)   Area (m^2)   MLLW (m)
    1     1.6943  2226443.      -5.0     1    0    0    0    0    0    0    0    0
    2     1.6976  2101893.      -5.0     2    3    0    0    0    0    0    0    0
    3     1.7010  1854725.      -5.0     4    5    0    0    0    0    0    0    0
    4     1.7045  1731141.      -5.0     6    7    8    0    0    0    0    0    0
    5     1.7080  1669349.      -5.0     9   10    0    0    0    0    0    0    0
    6     1.7116  2226443.      -5.0    11    0    0    0    0    0    0    0    0
    7     1.6929  2803443.      -5.0     1    2   12   13   14    0    0    0    0
    8     1.6955  3025846.      -5.0     3    4   14   15   16   17    0    0    0
    9     1.6990  2198943.      -5.0     5    6   16   18   19    0    0    0    0
   10     1.7023  2045937.      -5.0     7   19   20   21   31   32    0    0    0
   11     1.7052  2713145.      -5.0     8    9   21   22   33   34    0    0    0
   12     1.7067  2208976.      -5.0    10   11   22   35    0    0    0    0    0
   13     1.6925  1932227.      -5.0    12   23   25    0    0    0    0    0    0
   14     1.6944  2374524.      -5.0    13   15   23   24   26   27    0    0    0
   15     1.6977  2262487.      -5.0    17   18   20   24   28   29   30    0    0
   16     1.7002  1886242.      -0.9    30   31   41   42   43    0    0    0    0
   17     1.7017  2328539.      -0.9    32   33   37   38   39   40   41    0    0
   18     1.7032  1826042.      -3.9    34   35   36   37    0    0    0    0    0
   19     1.6931  1370368.      -2.2    25   26   44   45   48   49    0    0    0
   20     1.6940   999976.      -5.0    27   28   49   50   54    0    0    0    0
   21     1.6964  1320202.      -2.1    29   43   50   51    0    0    0    0    0
   22     1.6984  1375385.      -1.9    40   42   51   52    0    0    0    0    0
   23     1.6975  1367860.      -0.9    39   52   53   61   91    0    0    0    0
   24     1.6976  1293447.      -3.2    36   38   91   92    0    0    0    0    0
   25     1.6928   128676.      -2.1    48    0    0    0    0    0    0    0    0
   26     1.6930   147822.      -1.9    44    0    0    0    0    0    0    0    0
   27     1.6915   349195.      -1.5    45   46   47    0    0    0    0    0    0
   28     1.6914   115298.      -1.5    46    0    0    0    0    0    0    0    0
   29     1.6914   116719.      -1.5    47    0    0    0    0    0    0    0    0
   30     1.6929   285110.      -5.0    54   55    0    0    0    0    0    0    0
   31     1.6916   330761.      -4.6    55   56   57    0    0    0    0    0    0
   32     1.6915   156769.      -2.4    56    0    0    0    0    0    0    0    0
   33     1.6909   161451.      -3.7    57   58    0    0    0    0    0    0    0
   34     1.6903   352166.      -3.4    58   59    0    0    0    0    0    0    0
   35     1.6902   360108.      -2.4    59   60    0    0    0    0    0    0    0
   36     1.6905   537696.      -1.2    60   61   64  108    0    0    0    0    0
   37     1.6934   663111.      -3.2    53   62   63   92    0    0    0    0    0
   38     1.6890  1067031.      -2.6    62   79  108    0    0    0    0    0    0
   39     1.6893  1336282.      -2.3    63   93    0    0    0    0    0    0    0
   40     1.6867   336079.      -2.4    64   65    0    0    0    0    0    0    0
   41     1.6814   188683.      -2.4    65   66    0    0    0    0    0    0    0
   42     1.6782   182003.      -2.2    66   67    0    0    0    0    0    0    0
   43     1.6761   186832.      -3.7    67   68    0    0    0    0    0    0    0
   44     1.6814   249220.      -0.5    68   69   84   90    0    0    0    0    0
   45     1.7724   182976.      -1.6    69   70    0    0    0    0    0    0    0
   46     1.8112   156024.      -1.6    70   71    0    0    0    0    0    0    0
   47     1.8498   111288.      -1.6    71   72    0    0    0    0    0    0    0
   48     1.8646    91403.      -1.2    72   73    0    0    0    0    0    0    0
   49     1.8845   121938.      -0.5    73   74  107    0    0    0    0    0    0
   50     2.0382   174131.      -1.2    74   75    0    0    0    0    0    0    0
   51     2.1236   167059.      -1.2    75   76    0    0    0    0    0    0    0
   52     2.1573   113393.      -1.4    76   77    0    0    0    0    0    0    0
   53     2.2189    97025.      -1.0    77   78    0    0    0    0    0    0    0
   54     2.2615   176054.      -2.0    78  109    0    0    0    0    0    0    0
   55     1.6849   449458.      -1.8    79   80    0    0    0    0    0    0    0
   56     1.6802   203386.      -2.0    80   81   85    0    0    0    0    0    0
   57     1.6753    73188.      -0.5    81   82    0    0    0    0    0    0    0
```

```
   58   1.6553    61591.       -0.5   82   83    0     0     0     0     0     0     0
   59   1.6490    58953.       -0.5   83   84    0     0     0     0     0     0     0
   60   1.6755   209072.       -2.1   85   86    0     0     0     0     0     0     0
   61   1.6664   213638.       -1.9   86   87    0     0     0     0     0     0     0
   62   1.6589   181067.       -1.7   87   88   99   100     0     0     0     0     0
   63   1.6607   114302.       -1.7   88   89  102     0     0     0     0     0     0
   64   1.6675    82867.       -0.4   89   90    0     0     0     0     0     0     0
   65   1.6849   476240.       -1.2   93   94    0     0     0     0     0     0     0
   66   1.6831   280913.       -0.7   94   95    0     0     0     0     0     0     0
   67   1.6707   110083.       -0.7   95   96    0     0     0     0     0     0     0
   68   1.6613   148623.       -1.1   96   97    0     0     0     0     0     0     0
   69   1.6463   128584.       -0.9   97   98    0     0     0     0     0     0     0
   70   1.6506    77249.       -0.5   98   99    0     0     0     0     0     0     0
   71   1.6593    48980.       -0.5  100  101    0     0     0     0     0     0     0
   72   1.6622    57857.       -2.0  101  102  103     0     0     0     0     0     0
   73   1.6637   115385.       -2.1  103  104    0     0     0     0     0     0     0
   74   1.6781   173080.       -3.1  104  105    0     0     0     0     0     0     0
   75   1.7043   150098.       -1.1  105  106    0     0     0     0     0     0     0
   76   1.8204   116614.       -1.0  106  107    0     0     0     0     0     0     0
   77   2.3168   193875.       -0.7  109  110    0     0     0     0     0     0     0
   78   2.3827   203587.        0.5  110  111    0     0     0     0     0     0     0
   79   2.8786   204176.        1.5  111  112    0     0     0     0     0     0     0
   80   3.3530   192477.        1.7  112  113    0     0     0     0     0     0     0
   81   3.9414   180116.        2.4  113  114    0     0     0     0     0     0     0
   82   5.1500   187842.        4.3  114  115    0     0     0     0     0     0     0
   83   6.2099    92928.        4.5  115    0    0     0     0     0     0     0     0
*********E: CHANNEL DATA*************************************************
Channel  Length     Width      Depth   Direction  Mannings Initial    Connecting
Number    (m)        (m)        (m)     Degrees      N     Velocity   Junction
   1     2306.     1931.       6.69       64.     0.010   0.03860    1     7
   2     2113.        1.       6.70      114.     0.010   0.05980    2     7
   3     2177.     1931.       6.70       56.     0.010   0.05280    2     8
   4     1985.        1.       6.70      134.     0.010   0.03420    3     8
   5     1921.     1931.       6.70       59.     0.010   0.04430    3     9
   6     1921.        1.       6.70      140.     0.010  -0.02310    4     9
   7     1793.     1931.       6.70       88.     0.010   0.01080    4    10
   8     2306.        1.       6.70       29.     0.010   0.02940    4    11
   9     1729.     1931.       6.71      115.     0.010   0.02330    5    11
  10     2049.        1.       6.71       47.     0.010   0.07410    5    12
  11     2306.     1931.       6.71      122.     0.010   0.03530    6    12
  12     2177.     1448.       6.69       88.     0.010   0.03050    7    13
  13     2817.        1.       6.69       45.     0.010   0.03210    7    14
  14     2049.        1.       6.69        3.     0.010   0.01110    7     8
  15     1921.     1448.       6.69       97.     0.010   0.04610    8    14
  16     2306.        1.       6.70        4.     0.010  -0.02410    8     9
  17     2497.        1.       6.70       42.     0.010  -0.01340    8    15
  18     1601.     1448.       6.70      111.     0.010   0.04030    9    15
  19     1601.        1.       6.70       20.     0.010   0.04450    9    10
  20     2177.        1.       6.70      155.     0.010   0.01220   10    15
  21     1985.        1.       6.70      338.     0.010   0.05260   10    11
  22     2049.        1.       6.71      358.     0.010   0.05370   11    12
  23     1921.        1.       6.69      354.     0.010  -0.00316   13    14
  24     2177.        1.       6.70      354.     0.010  -0.06020   14    15
  25     2306.     1042.       3.69       40.     0.010   0.02700   13    19
  26     1665.        1.       3.69       96.     0.010   0.07110   14    19
  27     1793.     1042.       6.69       70.     0.010   0.04500   14    20
  28     2306.      100.       2.69      128.     0.010   0.10900   15    20
  29     2049.     1042.       2.80       96.     0.021   0.03740   15    21
  30     1409.        1.       2.60       30.     0.024   0.14200   15    16
  31     1857.     1448.       2.60      119.     0.028   0.00063   10    16
  32     1665.        1.       2.60       59.     0.032   0.15300   10    17
  33     2369.     1448.       2.60      116.     0.032   0.01140   11    17
  34     2049.        1.       3.60       44.     0.037   0.13400   11    18
  35     1601.     1448.       5.60      113.     0.037   0.02880   12    18
  36     2177.     1042.       4.90      122.     0.035   0.02460   18    24
  37     2562.        1.       2.60      344.     0.037   0.08770   17    18
  38     1793.        1.       2.60       39.     0.034   0.15600   17    24
  39     2049.     1042.       2.60       82.     0.037  -0.00512   17    23
  40     2049.        1.       2.60      125.     0.037  -0.08040   17    22
  41     1665.        1.       2.60      353.     0.032   0.12600   16    17
  42     1729.     1042.       2.60       75.     0.032  -0.01460   16    22
  43     2049.        1.       2.60      133.     0.028  -0.08840   16    21
  44     1089.      402.       3.19       80.     0.010   0.00343   19    26
  45     1217.      163.       3.19       53.     0.010   0.03330   19    27
  46      768.      392.       3.19       43.     0.017   0.00276   27    28
  47      768.      312.       3.19        8.     0.017   0.00353   27    29
  48      896.      141.       3.69       32.     0.010   0.00851   19    25
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 49     768.      758.     3.69     360.     0.010   0.01250   19   20
 50    1216.      758.     6.70      14.     0.021   0.06190   20   21
 51    1857.      758.     3.80       4.     0.029   0.09840   21   22
 52    1537.      758.     2.60       9.     0.037   0.08750   22   23
 53    1089.      440.     2.59       8.     0.037   0.12600   23   37
 54    1025.      497.     6.70      44.     0.022   0.00256   20   30
 55     931.      343.     6.29       7.     0.022  -0.00442   30   31
 56     643.      398.     4.19      97.     0.026   0.00474   31   32
 57     653.      348.     6.34     360.     0.024  -0.02160   31   33
 58     686.      403.     5.24       9.     0.026  -0.02940   33   34
 59     730.      475.     4.09      25.     0.026  -0.01860   34   35
 60     781.      322.     3.49      46.     0.024  -0.10100   35   36
 61    1114.      326.     2.59      90.     0.037   0.06040   23   36
 62     951.      719.     2.49      76.     0.042   0.04090   37   38
 63    1062.      690.     2.49      11.     0.027   0.07150   37   39
 64     905.      322.     3.49      90.     0.027  -0.05680   36   40
 65    1251.      142.     4.08     112.     0.035  -0.15700   40   41
 66    1145.      169.     3.98     161.     0.035  -0.14900   41   42
 67    1383.      133.     4.63     186.     0.035  -0.15900   42   43
 68    1526.      121.     3.63     147.     0.038  -0.23800   43   44
 69    1571.      102.     2.63     240.     0.037  -0.39600   44   45
 70    1781.      103.     3.39     176.     0.036  -0.31800   45   46
 71    1425.       93.     3.43     194.     0.034  -0.37000   46   47
 72     930.      101.     3.26      93.     0.031  -0.31600   47   48
 73     894.      104.     2.52     140.     0.031  -0.32500   48   49
 74    1622.      105.     2.61     169.     0.031  -0.56700   49   50
 75    1995.       96.     3.28     107.     0.031  -0.46700   50   51
 76    1308.      109.     3.44     101.     0.031  -0.37000   51   52
 77    1144.       74.     3.39     136.     0.032  -0.52900   52   53
 78    1253.       87.     3.74      98.     0.034  -0.39200   53   54
 79    1201.      620.     2.79      82.     0.048   0.01630   38   55
 80     708.      217.     3.58      75.     0.055   0.00254   55   56
 81    1333.       68.     2.93     142.     0.052   0.02200   56   57
 82    2005.       27.     2.17     114.     0.052   0.00355   57   58
 83    2220.       31.     2.15     191.     0.052  -0.04270   58   59
 84    2416.       21.     2.02      18.     0.052   0.11700   59   44
 85     828.      195.     3.73      79.     0.055  -0.01970   56   60
 86    1629.      158.     3.67     117.     0.055  -0.04520   60   61
 87    1588.      107.     3.46     159.     0.046  -0.10000   61   62
 88     883.       78.     2.86     195.     0.036  -0.19200   62   63
 89    1897.       49.     2.21     175.     0.036  -0.05930   63   64
 90    1637.       49.     1.97      55.     0.036   0.08520   64   44
 91    1284.        1.     3.59     319.     0.036   0.16100   24   23
 92     978.      763.     3.10      91.     0.033   0.02630   24   37
 93    1200.      392.     2.49      57.     0.034   0.04960   39   65
 94    1039.      464.     2.63     106.     0.034   0.01820   65   66
 95    1235.       65.     2.38      58.     0.034   0.03880   66   67
 96    1599.       87.     2.57     139.     0.036  -0.00240   67   68
 97    1868.       55.     2.65     113.     0.036  -0.06510   68   69
 98    1619.       55.     2.35     149.     0.036  -0.12300   69   70
 99    1201.       46.     2.75      34.     0.036   0.15000   70   62
100    1425.       46.     2.76     129.     0.036  -0.15600   62   71
101     726.       46.     2.91     248.     0.036  -0.15700   71   72
102     994.       61.     3.01      94.     0.036  -0.15700   63   72
103     819.       70.     3.71     126.     0.036  -0.18800   72   73
104    2710.       64.     4.27     192.     0.036  -0.23200   73   74
105    2683.       64.     3.79     157.     0.036  -0.25700   74   75
106    2180.       59.     2.56     240.     0.036  -0.39200   75   76
107    1773.       59.     2.55      45.     0.036   0.28100   76   49
108    1301.        1.     2.49     353.     0.052   0.06100   36   38
109    2012.       86.     3.14     158.     0.041  -0.33100   54   77
110    1768.      121.     1.95     167.     0.045  -0.29000   77   78
111    1609.      121.     1.63     167.     0.052  -0.47000   78   79
112    1609.      133.     1.52     167.     0.052  -0.43300   79   80
113    1609.      106.     1.60     240.     0.052  -0.50300   80   81
114    1609.      118.     1.20     140.     0.052  -0.59900   81   82
115    1609.      115.     1.28     140.     0.052  -0.57600   82   83
**********F: CONSTANT INFLOW DATA******************************************
  20
    Junction  Inflow
    Number    (m³)
       83     -29.8   [Upstream Boundary Inflow]
       82     -0.03
       81     -0.03
       80     -0.03
       79     -0.03
       78     -0.76   [French Creek Inflow]
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       77      -1.65  [Pilchuk River Inflow]
       73      -0.05
       65      -0.13
       60      -0.19
       54      -0.07
       53      -0.01
       52      -0.01
       51      -0.01
       50      -0.01
       49      -0.01
       48      -0.46
       44      -0.16
       43      -0.35
       42      -0.46
         *variable inflow data*
   0
**********G: SEAWARD BOUNDARY DATA****************************************
   6
   3    1  100    20     0     0     0  1.0
Junction Time     Head  Junction Time     Head  Junction  Time     Head  Junction  Time     Head
         (hr)      (m)            (hr)     (m)            (hr)      (m)            (hr)      (m)
   1    0000    1.6943     1     538    2.8651     1    1219   -0.1829     1    1930    3.4138
   2     103    1.4326     2     624    2.8042     2    1251    0.0000     2    1953    3.3833
   3     138    1.2497     3     710    2.7432     3    1326    0.2743     3    2016    3.3223
   4     214    1.0668     4     758    2.6518     4    1402    0.5486     4    2041    3.2614
   5     256    0.9144     5     852    2.5603     5    1440    0.8839     5    2108    3.1699
   6     337    0.7620     6     951    2.4689     6    1519    1.2192     6    2138    3.1090
   7     426    0.6096     7    1101    2.4079     7    1605    1.5850     7    2213    3.0175
   8     519    0.4877     8    1227    2.4079     8    1703    1.8898     8    2254    2.9261
   9     617    0.3658     9    1403    2.4994     9    1813    2.1336     9    2339    2.8651
  10     715    0.1829    10    1519    2.7127    10    1932    2.2555    11      32    2.8346
  11     810    0.0000    11    1607    2.8956    11    2047    2.2250    12     130    2.8346
  12     901   -0.1829    12    1649    3.0785    12    2142    2.1031    13     233    2.8956
  13     949   -0.3353    13    1718    3.2614    13    2231    1.8898    14     328    2.9870
  14    1033   -0.3962    14    1746    3.3833    14    2313    1.6154    15     428    3.0785
  15    1115   -0.3962    15    1815    3.4747    15    2355    1.2497    16     524    3.1394
  16    1157   -0.2743    16    1844    3.5662    17      36    0.8839    17     622    3.1699
  17    1239    0.0305    17    1914    3.6271    18     123    0.5486    18     722    3.1394
  18    1325    0.3048    18    1950    3.6271    19     211    0.2438    19     825    3.0481
  19    1410    0.7315    19    2025    3.5662    20     300    0.0611    20     931    2.9261
  20    1500    1.1582    20    2107    3.4747    21     356   -0.0611    21    1050    2.8042
  21    1554    1.5545    21    2152    3.3223    22     500   -0.0914    22    1217    2.7737
  22    1701    1.8898    22    2244    3.1394    23     607   -0.0914    23    1349    2.8346
  23    1827    2.0726    23    2349    2.9871    24     716   -0.0914    24    1502    2.9871
  24    1958    2.0726    25     102    2.8346    25     821   -0.0914    25    1601    3.1091
  25    2114    1.9507    26     214    2.8042    26     917   -0.0915    26    1644    3.2309
   3    2  100    20     0     0     0  1.0
   1    0000    1.6976     1     537    2.8651     1    1218   -0.1829     1    1929    3.4138
   2     102    1.4326     2     623    2.8042     2    1250    0.0000     2    1952    3.3833
   3     137    1.2497     3     709    2.7432     3    1325    0.2743     3    2015    3.3223
   4     213    1.0668     4     757    2.6518     4    1401    0.5486     4    2040    3.2614
   5     255    0.9144     5     851    2.5603     5    1439    0.8839     5    2107    3.1699
   6     336    0.7620     6     950    2.4689     6    1518    1.2192     6    2137    3.1090
   7     425    0.6096     7    1100    2.4079     7    1604    1.5850     7    2212    3.0175
   8     518    0.4877     8    1226    2.4079     8    1702    1.8898     8    2253    2.9261
   9     616    0.3658     9    1402    2.4994     9    1812    2.1336     9    2338    2.8651
  10     714    0.1829    10    1518    2.7127    10    1931    2.2555    11      31    2.8346
  11     809    0.0000    11    1606    2.8956    11    2046    2.2250    12     129    2.8346
  12     900   -0.1829    12    1648    3.0785    12    2141    2.1031    13     232    2.8956
  13     948   -0.3353    13    1717    3.2614    13    2230    1.8898    14     327    2.9870
  14    1032   -0.3962    14    1745    3.3833    14    2312    1.6154    15     427    3.0785
  15    1114   -0.3962    15    1814    3.4747    15    2354    1.2497    16     523    3.1394
  16    1156   -0.2743    16    1843    3.5662    17      35    0.8839    17     621    3.1699
  17    1238    0.0305    17    1913    3.6271    18     122    0.5486    18     721    3.1394
  18    1324    0.3048    18    1949    3.6271    19     210    0.2438    19     824    3.0481
  19    1409    0.7315    19    2024    3.5662    20     259    0.0611    20     930    2.9261
  20    1459    1.1582    20    2106    3.4747    21     355   -0.0611    21    1049    2.8042
  21    1553    1.5545    21    2151    3.3223    22     459   -0.0914    22    1216    2.7737
  22    1700    1.8898    22    2243    3.1394    23     606   -0.0914    23    1348    2.8346
  23    1826    2.0726    23    2348    2.9871    24     715   -0.0914    24    1501    2.9871
  24    1957    2.0726    25     101    2.8346    25     820   -0.0914    25    1600    3.1091
  25    2113    1.9507    26     213    2.8042    26     916   -0.0915    26    1643    3.2309
   3    3  100    20     0     0     0  1.0
   1    0000    1.7010     1     536    2.8651     1    1217   -0.1829     1    1928    3.4138
   2     101    1.4326     2     622    2.8042     2    1249    0.0000     2    1951    3.3833
   3     136    1.2497     3     708    2.7432     3    1324    0.2743     3    2014    3.3223
   4     212    1.0668     4     756    2.6518     4    1400    0.5486     4    2039    3.2614
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  5    254    0.9144    5    850    2.5603    5   1438    0.8839    5   2106    3.1699
  6    335    0.7620    6    949    2.4689    6   1517    1.2192    6   2136    3.1090
  7    424    0.6096    7   1059    2.4079    7   1603    1.5850    7   2211    3.0175
  8    517    0.4877    8   1225    2.4079    8   1701    1.8898    8   2252    2.9261
  9    615    0.3658    9   1401    2.4994    9   1811    2.1336    9   2337    2.8651
 10    713    0.1829   10   1517    2.7127   10   1930    2.2555   11     30    2.8346
 11    808    0.0000   11   1605    2.8956   11   2045    2.2250   12    128    2.8346
 12    859   -0.1829   12   1647    3.0785   12   2140    2.1031   13    231    2.8956
 13    947   -0.3353   13   1716    3.2614   13   2229    1.8898   14    326    2.9870
 14   1031   -0.3962   14   1744    3.3833   14   2311    1.6154   15    426    3.0785
 15   1113   -0.3962   15   1813    3.4747   15   2353    1.2497   16    522    3.1394
 16   1155   -0.2743   16   1842    3.5662   17     34    0.8839   17    620    3.1699
 17   1237    0.0305   17   1912    3.6271   18    121    0.5486   18    720    3.1394
 18   1323    0.3048   18   1948    3.6271   19    209    0.2438   19    823    3.0481
 19   1408    0.7315   19   2023    3.5662   20    258    0.0611   20    929    2.9261
 20   1458    1.1582   20   2105    3.4747   21    354   -0.0611   21   1048    2.8042
 21   1552    1.5545   21   2150    3.3223   22    458   -0.0914   22   1215    2.7737
 22   1659    1.8898   22   2242    3.1394   23    605   -0.0914   23   1347    2.8346
 23   1825    2.0726   23   2347    2.9871   24    714   -0.0914   24   1500    2.9871
 24   1956    2.0726   25    100    2.8346   25    819   -0.0914   25   1559    3.1091
 25   2112    1.9507   26    212    2.8042   26    915   -0.0915   26   1642    3.2309
  3    4  100    20     0      0      0  1.0
  1   0000    1.7045    1    535    2.8651    1   1216   -0.1829    1   1927    3.4138
  2    100    1.4326    2    621    2.8042    2   1248    0.0000    2   1950    3.3833
  3    135    1.2497    3    707    2.7432    3   1323    0.2743    3   2013    3.3223
  4    211    1.0668    4    755    2.6518    4   1359    0.5486    4   2038    3.2614
  5    253    0.9144    5    849    2.5603    5   1437    0.8839    5   2105    3.1699
  6    334    0.7620    6    948    2.4689    6   1516    1.2192    6   2135    3.1090
  7    423    0.6096    7   1058    2.4079    7   1602    1.5850    7   2210    3.0175
  8    516    0.4877    8   1224    2.4079    8   1700    1.8898    8   2251    2.9261
  9    614    0.3658    9   1400    2.4994    9   1810    2.1336    9   2336    2.8651
 10    712    0.1829   10   1516    2.7127   10   1929    2.2555   11     29    2.8346
 11    807    0.0000   11   1604    2.8956   11   2044    2.2250   12    127    2.8346
 12    858   -0.1829   12   1646    3.0785   12   2139    2.1031   13    230    2.8956
 13    946   -0.3353   13   1715    3.2614   13   2228    1.8898   14    325    2.9870
 14   1030   -0.3962   14   1743    3.3833   14   2310    1.6154   15    425    3.0785
 15   1112   -0.3962   15   1812    3.4747   15   2352    1.2497   16    521    3.1394
 16   1154   -0.2743   16   1841    3.5662   17     33    0.8839   17    619    3.1699
 17   1236    0.0305   17   1911    3.6271   18    120    0.5486   18    719    3.1394
 18   1322    0.3048   18   1947    3.6271   19    208    0.2438   19    822    3.0481
 19   1407    0.7315   19   2022    3.5662   20    257    0.0611   20    928    2.9261
 20   1457    1.1582   20   2104    3.4747   21    353   -0.0611   21   1047    2.8042
 21   1551    1.5545   21   2149    3.3223   22    457   -0.0914   22   1214    2.7737
 22   1658    1.8898   22   2241    3.1394   23    604   -0.0914   23   1346    2.8346
 23   1824    2.0726   23   2346    2.9871   24    713   -0.0914   24   1459    2.9871
 24   1955    2.0726   25     59    2.8346   25    818   -0.0914   25   1558    3.1091
 25   2111    1.9507   26    211    2.8042   26    914   -0.0915   26   1641    3.2309
  3    5  100    20     0      0      0  1.0
  1   0000    1.7080    1    534    2.8651    1   1215   -0.1829    1   1926    3.4138
  2     59    1.4326    2    620    2.8042    2   1247    0.0000    2   1949    3.3833
  3    134    1.2497    3    706    2.7432    3   1322    0.2743    3   2012    3.3223
  4    210    1.0668    4    754    2.6518    4   1358    0.5486    4   2037    3.2614
  5    252    0.9144    5    848    2.5603    5   1436    0.8839    5   2104    3.1699
  6    333    0.7620    6    947    2.4689    6   1515    1.2192    6   2134    3.1090
  7    422    0.6096    7   1057    2.4079    7   1601    1.5850    7   2209    3.0175
  8    515    0.4877    8   1223    2.4079    8   1659    1.8898    8   2250    2.9261
  9    613    0.3658    9   1359    2.4994    9   1809    2.1336    9   2335    2.8651
 10    711    0.1829   10   1515    2.7127   10   1928    2.2555   11     28    2.8346
 11    806    0.0000   11   1603    2.8956   11   2043    2.2250   12    126    2.8346
 12    857   -0.1829   12   1645    3.0785   12   2138    2.1031   13    229    2.8956
 13    945   -0.3353   13   1714    3.2614   13   2227    1.8898   14    324    2.9870
 14   1029   -0.3962   14   1742    3.3833   14   2309    1.6154   15    424    3.0785
 15   1111   -0.3962   15   1811    3.4747   15   2351    1.2497   16    520    3.1394
 16   1153   -0.2743   16   1840    3.5662   17     32    0.8839   17    618    3.1699
 17   1235    0.0305   17   1910    3.6271   18    119    0.5486   18    718    3.1394
 18   1321    0.3048   18   1946    3.6271   19    207    0.2438   19    821    3.0481
 19   1406    0.7315   19   2021    3.5662   20    256    0.0611   20    927    2.9261
 20   1456    1.1582   20   2103    3.4747   21    352   -0.0611   21   1046    2.8042
 21   1550    1.5545   21   2148    3.3223   22    456   -0.0914   22   1213    2.7737
 22   1657    1.8898   22   2240    3.1394   23    603   -0.0914   23   1345    2.8346
 23   1823    2.0726   23   2345    2.9871   24    712   -0.0914   24   1458    2.9871
 24   1954    2.0726   25     58    2.8346   25    817   -0.0914   25   1557    3.1091
 25   2110    1.9507   26    210    2.8042   26    913   -0.0915   26   1640    3.2309
  3    6  100    20     0      0      0  1.0
  1   0000    1.7116    1    533    2.8651    1   1214   -0.1829    1   1925    3.4138
  2     58    1.4326    2    619    2.8042    2   1246    0.0000    2   1948    3.3833
  3    133    1.2497    3    705    2.7432    3   1321    0.2743    3   2011    3.3223
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    4     209    1.0668    4     753    2.6518    4     1357    0.5486    4     2036    3.2614
    5     251    0.9144    5     847    2.5603    5     1435    0.8839    5     2103    3.1699
    6     332    0.7620    6     946    2.4689    6     1514    1.2192    6     2133    3.1090
    7     421    0.6096    7    1056    2.4079    7     1600    1.5850    7     2208    3.0175
    8     514    0.4877    8    1222    2.4079    8     1658    1.8898    8     2249    2.9261
    9     612    0.3658    9    1358    2.4994    9     1808    2.1336    9     2334    2.8651
   10     710    0.1829   10    1514    2.7127   10     1927    2.2555   11       27    2.8346
   11     805    0.0000   11    1602    2.8956   11     2042    2.2250   12      125    2.8346
   12     856   -0.1829   12    1644    3.0785   12     2137    2.1031   13      228    2.8956
   13     944   -0.3353   13    1713    3.2614   13     2226    1.8898   14      323    2.9870
   14    1028   -0.3962   14    1741    3.3833   14     2308    1.6154   15      423    3.0785
   15    1110   -0.3962   15    1810    3.4747   15     2350    1.2497   16      519    3.1394
   16    1152   -0.2743   16    1839    3.5662   17       31    0.8839   17      617    3.1699
   17    1234    0.0305   17    1909    3.6271   18      118    0.5486   18      717    3.1394
   18    1320    0.3048   18    1945    3.6271   19      206    0.2438   19      820    3.0481
   19    1405    0.7315   19    2020    3.5662   20      255    0.0611   20      926    2.9261
   20    1455    1.1582   20    2102    3.4747   21      351   -0.0611   21     1045    2.8042
   21    1549    1.5545   21    2147    3.3223   22      455   -0.0914   22     1212    2.7737
   22    1656    1.8898   22    2239    3.1394   23      602   -0.0914   23     1344    2.8346
   23    1822    2.0726   23    2344    2.9871   24      711   -0.0914   24     1457    2.9871
   24    1953    2.0726   25      57    2.8346   25      816   -0.0914   25     1556    3.1091
   25    2109    1.9507   26     209    2.8042   26      912   -0.0915   26     1639    3.2309
**********H: WIND DATA******************************
    0
**********I: EVAPORATION OR GEOMETRY DATA***********
    0
**********J: JUNCTION GEOMETRY DATA*****************
    0
**********K: CHANNEL GEOMETRY DATA******************
    0
**********L: MAP TO WASP5***************************
Junction  EUTRO5 Segment
Number    Number
    0          83
    1           0
    2           0
    3           0
    4           0
    5           0
    6           0
    7           1
    8           2
    9           3
   10           4
   11           5
   12           6
   13           7
   14           8
   15           9
   16          10
   17          11
   18          12
   19          13
   20          14
   21          15
   22          16
   23          17
   24          18
   25          19
   26          20
   27          21
   28          22
   29          23
   30          24
   31          25
   32          26
   33          27
   34          28
   35          29
   36          30
   37          31
   38          32
   39          33
   40          34
   41          35
   42          36
   43          37
```

```
44          38
45          39
46          40
47          41
48          42
49          43
50          44
51          45
52          46
53          47
54          48
55          49
56          50
57          51
58          52
59          53
60          54
61          55
62          56
63          57
64          58
65          59
66          60
67          61
68          62
69          63
70          64
71          65
72          66
73          67
74          68
75          69
76          70
77          71
78          72
79          73
80          74
81          75
82          76
83           0
```

EUTRO5 Input File

```
SNOFIN1.INP: TIME=0 CRITICAL CONDITIONS WATER QUALITY INPUT FILE (TETRA TECH VERSION)
******ROBERT CUSIMANO, WA. DEPT. OF ECOLOGY, March 4, 1997*************
 NOSE NOSY ICFL MFLA JMAS NEGS INTY ADFA ZDAY HHMM TFLG ***A: MODEL OPTIONS***
   80    9    0    0    1    0    0 0.00  1.0 0100    0
   14   24   29   30   34   44
    1
     0.021      24.0
    2
       7.0        7.0      0.021      24.0
    0    0    0    0    0    0    0    0
    1    0                                                 *******B: EXCHANGES***
    6     1.000     1.000
   42
  Exchange     Length   Segment
    Area        (m)      Pair
    13903      2306     0    1      <<<Possession Sound>>>
    13903      2177     0    2
    13903      1921     0    3
    13903      1793     0    4
    13903      1729     0    5
    13903      2306     0    6
        6      1970     1    2
    10425      1947     1    7
        6      2509     1    8
        6      2096     2    3
    10425      1682     2    8
        6      2194     2    9
        6      1450     3    4
    10425      1432     3    9
        6      1765     4    5
        6      2007     4    9
    10425      1647     4   10
        6      1437     4   11
        6      1869     5    6
    10425      2123     5   11
        6      1810     5   12
    10425      1434     6   12
        6      1715     7    8
     9502      1986     7   13
        6      1828     8    9
        6      1477     8   13
     7502      1548     8   14
        6      1230     9   10
        6      2092     9   14
     7502      1940     9   15
     7502      1971    12   18
     5458       708    13   14
     1015       803    13   19
     1524      1014    13   20
     1181      1056    13   21
     5458      1115    14   15
     5458      1621    15   16
     2830       642    21   22
     2246       651    21   23
     3578       937    14   24
     2470       931    24   25
     2265       643    25   26
    2
  Dispersion          Dispersion
 Value (m2/sec)     Value (m2/sec)
    120.00      0.0    120.00       365.
   12
        6      1507    10   11
        6      1812    10   15
     7502      1474    10   16
        6      2320    11   12
        6      1969    11   16
     7502      1847    11   17
        6      1572    11   18
     5458      1391    16   17
     1584       961    17   31
        6      1284    17   18
```

```
    2457       879   31   32
    2370      1062   31   33
  2
   40.00       0.0     40.00      365.
 10
    2040      1201   32   49    <<<Lower Steamboat Slough>>>
     779       750   49   50
     198      1333   50   51
     743       828   50   54
     659      1629   54   55
    1176      1200   33   59
    1444      1114   17   30    <<<Lower Snohomish River>>>
    1069       765   29   30
       6      1195   30   32
    1444       925   30   34
  2
    5.00       0.0      5.00      365.
  4
    2032       637   25   27     <<<Lower Snohomish River>>>
    1910       670   27   28
    2061       750   28   29
    4043       978   18   31     <<<Mouth to Sloughs>>>
  2
   80.00       0.0     80.00      365.
 21
      68      2005   51   52    <<<Union and Lower Ebey Slough>>>
      77      2220   52   53
     423      1588   55   56
     262       922   56   57
     124      1201   64   56
     214      1425   56   65
     132      1797   57   58
     257       831   57   66
     121      1597   58   38
      56      2416   53   38
     231      1773   43   70
    1067      1039   59   60    <<<Upper Ebey Slough>>>
     142      1235   60   61
     192      1599   61   62
     121      2868   62   63
     121      1819   63   64
     133       750   65   66
     335       819   66   67
     243      2710   67   68
     275      2683   68   69
     211      2180   69   70
  2
    1.00       0.0      1.00      365.
 21
     460      1271   34   35
     533      1165   35   36
     626      1403   36   37
     500      1546   37   38    <<<Middle Snohomish River>>>
     372      1551   38   39
     400      1761   39   40
     365      1405   40   41
     380       910   41   42
     314       874   42   43
     326      1622   43   44    <<<Upper Snohomish River>>>
     362      1995   44   45
     429      1308   45   46
     288      1144   46   47
     372      1253   47   48
     398      2012   48   71
     350      1768   71   72
     181      1609   72   73
     200      1609   73   74
     159      1609   74   75
     130      1609   75   76
     139      1609    0   76
  2
    1.00       0.0      1.00      365.
  0    0    0    0    0    0    0    0
```

2 0 1.0

1.0000 1.0000

*********C: VOLUMES***

Segment Number	**Bottom Segment**		**Segment Volume (m^3)**			**Average Depth**	
1	77	1	2.58E+07	0	0	7.2	0
2	77	1	2.37E+07	0	0	7.2	0
3	77	1	2.03E+07	0	0	7.2	0
4	77	1	2.09E+07	0	0	7.2	0
5	77	1	2.32E+07	0	0	7.2	0
6	77	1	2.28E+07	0	0	7.2	0
7	77	1	2.00E+07	0	0	7.2	0
8	77	1	1.67E+07	0	0	7.2	0
9	77	1	1.61E+07	0	0	7.2	0
10	77	1	1.62E+07	0	0	7.2	0
11	77	1	2.01E+07	0	0	7.2	0
12	77	1	1.66E+07	0	0	7.2	0
13	77	1	1.32E+07	0	0	7.2	0
14	77	1	1.38E+07	0	0	7.2	0
15	77	1	1.61E+07	0	0	7.2	0
16	77	1	1.58E+07	0	0	7.2	0
17	77	1	7.07E+06	0	0	3.4	0
18	77	1	1.09E+07	0	0	7.2	0
19	77	1	4.09E+05	0	0	7.2	0
20	77	1	1.42E+06	0	0	7.2	0
21	77	1	2.40E+06	0	0	7.2	0
22	77	1	9.81E+05	0	0	7.2	0
23	77	1	7.77E+05	0	0	7.2	0
24	77	1	2.54E+06	0	0	6.8	0
25	77	1	2.44E+06	0	0	6.8	0
26	77	1	5.31E+05	0	0	4.6	0
27	77	1	1.08E+06	0	0	4.9	0
28	77	1	1.96E+06	0	0	4.6	0
29	77	1	1.83E+06	0	0	4.6	0
30	78	1	1.76E+06	0	0	3.4	0
31	79	1	4.38E+06	0	0	3.4	0
32	79	1	3.02E+06	0	0	4.0	0
33	79	1	1.47E+06	0	0	2.4	0
34	78	1	7.37E+05	0	0	3.2	0
35	78	1	7.81E+05	0	0	4.6	0
36	78	1	4.91E+05	0	0	2.7	0
37	78	1	1.10E+06	0	0	5.9	0
38	78	1	5.48E+05	0	0	2.2	0
39	78	1	6.95E+05	0	0	3.8	0
40	78	1	5.93E+05	0	0	3.8	0
41	78	1	4.23E+05	0	0	3.8	0
42	78	1	3.11E+05	0	0	3.4	0
43	80	1	2.80E+05	0	0	2.3	0
44	80	1	6.17E+05	0	0	3.4	0
45	80	1	5.69E+05	0	0	3.4	0
46	80	1	4.09E+05	0	0	3.6	0
47	80	1	3.11E+05	0	0	3.2	0
48	80	1	5.95E+05	0	0	4.2	0
49	79	1	1.80E+06	0	0	4.0	0
50	79	1	8.53E+05	0	0	2.2	0
51	79	1	1.96E+05	0	0	2.7	0
52	79	1	1.65E+05	0	0	2.7	0
53	79	1	1.59E+05	0	0	2.7	0
54	79	1	8.99E+05	0	0	4.3	0
55	79	1	8.75E+05	0	0	4.1	0
56	79	1	7.07E+05	0	0	3.9	0
57	79	1	3.31E+05	0	0	2.9	0
58	79	1	2.14E+05	0	0	2.6	0
59	79	1	1.62E+06	0	0	3.4	0
60	79	1	8.15E+05	0	0	2.9	0
61	79	1	3.19E+05	0	0	2.9	0
62	79	1	4.91E+05	0	0	3.3	0
63	79	1	3.99E+05	0	0	3.1	0
64	79	1	2.09E+05	0	0	2.7	0
65	79	1	1.33E+05	0	0	2.7	0
66	79	1	2.43E+05	0	0	4.2	0
67	79	1	5.01E+05	0	0	4.3	0
68	79	1	9.09E+05	0	0	5.3	0
69	79	1	4.93E+05	0	0	3.3	0
70	79	1	3.85E+05	0	0	2.7	0
71	80	1	7.55E+05	0	0	3.9	0
72	80	1	5.29E+05	0	0	2.6	0
73	80	1	3.47E+05	0	0	1.7	0

```
     74        80        1  3.47E+05        0        0      1.8        0
     75        80        1  3.07E+05        0        0      1.7        0
     76        80        1  3.19E+05        0        0      1.7        0
     77         0        3  1.00E+08        0        0      0.1        0
     78         0        3  1.00E+08        0        0      0.1        0
     79         0        3  1.00E+08        0        0      0.1        0
     80         0        3  1.00E+08        0        0      0.1        0
 3    1FINTIDE1.HYD                                 ***********D: FLOWS***
 0    0    0    0    0    0    0    0    0
      7    +    *    +    *    +                       ******E: BOUNDARIES***
    1.0       1.0                    (System 1--Ammonia)
 1    2
Ammonia     Starting  Ammonia   Ending [same for other "system variables]
 (mg/L)       Day      (mg/L)    Day
   .095        0.       .095     365.0
 2    2
   .095        0.       .095     365.0
 3    2
   .095        0.       .095     365.0
 4    2
   .095        0.       .095     365.0
 5    2
   .095        0.       .095     365.0
 6    2
   .095        0.       .095     365.0
76    2
   .050        0.       .050     365.0
      7    +    *    +    *    +                       ******E: BOUNDARIES***
    1.0       1.0                    (System 2--Nitrate)
 1    2
   .300        0.       .300     365.0
 2    2
   .300        0.       .300     365.0
 3    2
   .300        0.       .300     365.0
 4    2
   .300        0.       .300     365.0
 5    2
   .300        0.       .300     365.0
 6    2
   .300        0.       .300     365.0
76    2
   .160        0.       .160     365.0
      7    +    *    +    *    +                       ******E: BOUNDARIES***
    1.0       1.0                    (System 3--Inorg Phos)
 1    2
   .060        0.       .060     365.0
 2    2
   .060        0.       .060     365.0
 3    2
   .060        0.       .060     365.0
 4    2
   .060        0.       .060     365.0
 5    2
   .060        0.       .060     365.0
 6    2
   .060        0.       .060     365.0
76    2
   .005        0.       .005     365.0
      7    +    *    +    *    +                       ******E: BOUNDARIES***
    1.0       1.0                    (System 4--Chlorophyl-a)
 1    2
    0.9        0.        0.9     365.0
 2    2
    0.9        0.        0.9     365.0
 3    2
    0.9        0.        0.9     365.0
 4    2
    0.9        0.        0.9     365.0
 5    2
    0.9        0.        0.9     365.0
 6    2
    0.9        0.        0.9     365.0
76    2
    1.6        0.        1.6     365.0
      7    +    *    +    *    +                       ******E: BOUNDARIES***
    1.0       1.0                    (System 5--CBOD)
```

```
  1    2
     2.5        0.        2.5      365.0
  2    2
     2.5        0.        2.5      365.0
  3    2
     2.5        0.        2.5      365.0
  4    2
     2.5        0.        2.5      365.0
  5    2
     2.5        0.        2.5      365.0
  6    2
     2.5        0.        2.5      365.0
 76    2
     1.2        0.        1.2      365.0
       7    +    *    +    *    +                 ******E: BOUNDARIES***
     1.0      1.0                  (System 6--DO)
  1    2
     6.0        0.        6.0      365.0
  2    2
     6.0        0.        6.0      365.0
  3    2
     6.0        0.        6.0      365.0
  4    2
     6.0        0.        6.0      365.0
  5    2
     6.0        0.        6.0      365.0
  6    2
     6.0        0.        6.0      365.0
 76    2
     9.1        0.        9.1      365.0
       7    +    *    +    *    +                 ******E: BOUNDARIES***
     1.0      1.0                  (System 7--Org Nitrogen)
  1    2
    .126        0.       .126      365.0
  2    2
    .126        0.       .126      365.0
  3    2
    .126        0.       .126      365.0
  4    2
    .126        0.       .126      365.0
  5    2
    .126        0.       .126      365.0
  6    2
    .126        0.       .126      365.0
 76    2
    .117        0.       .117      365.0
       7    +    *    +    *    +                 ******E: BOUNDARIES***
     1.0      1.0                  (System 8--Org Phos)
  1    2
    .040        0.       .040      365.0
  2    2
    .040        0.       .040      365.0
  3    2
    .040        0.       .040      365.0
  4    2
    .040        0.       .040      365.0
  5    2
    .040        0.       .040      365.0
  6    2
    .040        0.       .040      365.0
 76    2
    .020        0.       .020      365.0
       7    +    *    +    *    +                 ******E: BOUNDARIES***
     1.0      1.0                  (System 9--Salinity)
  1    2
    29.5        0.       29.5      365.0
  2    2
    29.5        0.       29.5     365.0
  3    2
    29.5        0.       29.5      365.0
  4    2
    29.5        0.       29.5      365.0
  5    2
    29.5        0.       29.5      365.0
  6    2
    29.5        0.       29.5      365.0
 76    2
```

```
    0.0       0.        0.0      365.0
     13     +    *     +           *****F: WASTE LOADS (System 1 - Ammonia)
   1.00     0.4535  [lbs/day to kilograms/day conversion factor]
72     2                                  (French Creek)
 Ammonia    Starting  Ammonia    Ending
(lbs/day)     day    (lbs/day)    day
   19.2       0.0      19.2      365.0
71     2                                  (Pilchuck River)
   9.02       0.0      9.02      365.0
48     2                                  (Snohomsih WTP)
  491.2       0.0     491.2      365.0
42     2                                  (Marshland)
   20.2       0.0      20.2      365.0
38     2                                  (Deadwater Slough)
   22.2       0.0      22.2      365.0
60     2                                  (Tulalip Landfill--Ebey)
   4.07       0.0      4.07      365.0
50     2                                  (Tulalip Landfill--Steamboat)
   4.07       0.0      4.07      365.0
70     2                                  (Swan Trail Slough)
   33.4       0.0      33.4      365.0
67     2                                  (Lake Stevens WTP)
  346.9       0.0     346.9      365.0
54     2                                  (Marysville WTP)
 1070.8       0.0    1070.8      365.0
37     2                                  (Everett Mech WTP)
 1737.7       0.0    1737.7      365.0
36     2                                  (Everett Lagoon WTP)
 2108.6       0.0    2108.6      365.0
59     2                                  (Quilceda Creek)
   0.56       0.0      0.56      365.0
     11     +    *     +           *****F: WASTE LOADS (System 2 - Nitrate)
   1.00     0.4535
72     2                                  (French Creek)
   94.6       0.0      94.6      365.0
71     2                                  (Pilchuck River)
  120.3       0.0     120.3      365.0
48     2                                  (Snohomsih WTP)
  177.3       0.0     177.3      365.0
42     2                                  (Marshland)
  107.4       0.0     107.4      365.0
38     2                                  (Deadwater Slough)
    6.2       0.0       6.2      365.0
70     2                                  (Swan Trail Slough)
   0.06       0.0      0.06      365.0
67     2                                  (Lake Stevens WTP)
    3.4       0.0       3.4      365.0
54     2                                  (Marysville WTP)
  200.9       0.0     200.9      365.0
37     2                                  (Everett Mech WTP)
  679.1       0.0     679.1      365.0
36     2                                  (Everett Lagoon WTP)
   83.5       0.0      83.5      365.0
59     2                                  (Quilceda Creek)
   26.2       0.0      26.2      365.0
     11     +    *     +           *****F: WASTE LOADS (System 3 - Inorg Phos)
   1.00     0.4535
72     2                                  (French Creek)
    2.0       0.0       2.0      365.0
71     2                                  (Pilchuck River)
    1.5       0.0       1.5      365.0
48     2                                  (Snohomsih WTP)
  106.4       0.0     106.4      365.0
42     2                                  (Marshland)
    4.6       0.0       4.6      365.0
38     2                                  (Deadwater Slough)
   0.53       0.0      0.53      365.0
70     2                                  (Swan Trail Slough)
   0.13       0.0      0.13      365.0
67     2                                  (Lake Stevens WTP)
   43.5       0.0      43.5      365.0
54     2                                  (Marysville WTP)
  241.2       0.0     241.2      365.0
37     2                                  (Everett Mech WTP)
  270.7       0.0     270.7      365.0
36     2                                  (Everett Lagoon WTP)
  418.2       0.0     418.2      365.0
```

```
59     2                                 (Quilceda Creek)
   1.6        0.0        1.6      365.0
    11     +     *     +            *****F: WASTE LOADS (System 4 - Chloropyl)
  1.00     0.4535
72     2                                 (French Creek)
   2.6        0.0        2.6      365.0
71     2                                 (Pilchuck River)
  0.57        0.0       0.57      365.0
48     2                                 (Snohomsih WTP)
   0.0        0.0        0.0      365.0
42     2                                 (Marshland)
   1.3        0.0        1.3      365.0
38     2                                 (Deadwater Slough)
   3.1        0.0        3.1      365.0
70     2                                 (Swan Trail Slough)
   0.1        0.0        0.1      365.0
67     2                                 (Lake Stevens WTP)
   0.0        0.0        0.0      365.0
54     2                                 (Marysville WTP)
   0.0        0.0        0.0      365.0
37     2                                 (Everett Mech WTP)
   0.0        0.0        0.0      365.0
36     2                                 (Everett Lagoon WTP)
   0.0        0.0        0.0      365.0
59     2                                 (Quilceda Creek)
  0.06        0.0       0.06      365.0
    11     +     *     +            *****F: WASTE LOADS (System 5 - CBOD)
  1.00     0.4535
72     2                                 (French Creek)
 523.9        0.0      523.9      365.0
71     2                                 (Pilchuck River)
 360.9        0.0      360.9      365.0
48     2                                 (Snohomsih WTP)
2105.3        0.0     2105.3      365.0
42     2                                 (Marshland)
 471.5        0.0      471.5      365.0
38     2                                 (Deadwater Slough)
 320.7        0.0      320.7      365.0
70     2                                 (Swan Trail Slough)
 141.5        0.0      141.5      365.0
67     2                                 (Lake Stevens WTP)
1804.6        0.0     1804.6      365.0
54     2                                 (Marysville WTP)
4589.0        0.0     4589.0      365.0
37     2                                 (Everett Mech WTP)
4391.1        0.0     4391.1      365.0
36     2                                 (Everett Lagoon WTP)
8785.7        0.0     8785.7      365.0
59     2                                 (Quilceda Creek)
  65.6        0.0       65.6      365.0
    11     +     *     +            *****F: WASTE LOADS (System 6 - DO)
  1.00     0.4535
72     2                                 (French Creek)
 305.6        0.0      305.6      365.0
71     2                                 (Pilchuck River)
2767.0        0.0     2767.0      365.0
48     2                                 (Snohomsih WTP)
 203.5        0.0      203.5      365.0
42     2                                 (Marshland)
 384.2        0.0      384.2      365.0
38     2                                 (Deadwater Slough)
 291.0        0.0      291.0      365.0
70     2                                 (Swan Trail Slough)
  10.5        0.0       10.5      365.0
67     2                                 (Lake Stevens WTP)
 122.3        0.0      122.3      365.0
54     2                                 (Marysville WTP)
  86.7        0.0       86.7      365.0
37     2                                 (Everett Mech WTP)
 320.8        0.0      320.8      365.0
36     2                                 (Everett Lagoon WTP)
 474.4        0.0      474.4      365.0
59     2                                 (Quilceda Creek)
 174.6        0.0      174.6      365.0
    11     +     *     +            *****F: WASTE LOADS (System 7 - Org N)
  1.00     0.4535
72     2                                 (French Creek)
```

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    70.4        0.0       70.4      365.0
71     2                                 (Pilchuck River)
    40.3        0.0       40.3      365.0
48     2                                 (Snohomsih WTP)
   299.4        0.0      299.4      365.0
42     2                                 (Marshland)
    45.4        0.0       45.4      365.0
38     2                                 (Deadwater Slough)
    38.0        0.0       38.0      365.0
70     2                                 (Swan Trail Slough)
     4.1        0.0        4.1      365.0
67     2                                 (Lake Stevens WTP)
    80.2        0.0       80.2      365.0
54     2                                 (Marysville WTP)
   550.7        0.0      550.7      365.0
37     2                                 (Everett Mech WTP)
   267.2        0.0      267.2      365.0
36     2                                 (Everett Lagoon WTP)
  2196.4        0.0     2196.4      365.0
59     2                                 (Quilceda Creek)
     5.3        0.0        5.3      365.0
      11    +     *     +           *****F: WASTE LOADS (System 8 - Org P)
    1.00    0.4535
72     2                                 (French Creek)
     5.2        0.0        5.2      365.0
71     2                                 (Pilchuck River)
     6.0        0.0        6.0      365.0
48     2                                 (Snohomsih WTP)
   106.4        0.0      106.4      365.0
42     2                                 (Marshland)
    11.8        0.0       11.8      365.0
38     2                                 (Deadwater Slough)
     4.0        0.0        4.0      365.0
70     2                                 (Swan Trail Slough)
     0.9        0.0        0.9      365.0
67     2                                 (Lake Stevens WTP)
    21.5        0.0       21.5      365.0
54     2                                 (Marysville WTP)
   121.7        0.0      121.7      365.0
37     2                                 (Everett Mech WTP)
   270.7        0.0      270.7      365.0
36     2                                 (Everett Lagoon WTP)
   418.2        0.0      418.2      365.0
59     2                                 (Quilceda Creek)
     0.9        0.0        0.9      365.0
      11    +     *     +           *****F: WASTE LOADS (System 9 - Salinity)
  1.00    0.4535
72     2                                 (French Creek)
     0.0        0.0        0.0      365.0
71     2                                 (Pilchuck River)
     0.0        0.0        0.0      365.0
48     2                                 (Snohomsih WTP)
     0.0        0.0        0.0      365.0
42     2                                 (Marshland)
     0.0        0.0        0.0      365.0
38     2                                 (Deadwater Slough)
     0.0        0.0        0.0      365.0
70     2                                 (Swan Trail Slough)
     0.0        0.0        0.0      365.0
67     2                                 (Lake Stevens WTP)
     0.0        0.0        0.0      365.0
54     2                                 (Marysville WTP)
     0.0        0.0        0.0      365.0
37     2                                 (Everett Mech WTP)
     0.0        0.0        0.0      365.0
36     2                                 (Everett Lagoon WTP)
     0.0        0.0        0.0      365.0
59     2                                 (Quilceda Creek)
     0.0        0.0        0.0      365.0
       0    +     *     +     *     +    (System F.2 - NPS loads)
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          5     +     *     +     *     +                  ******G: PARAMETERS***
SAL       2      1.0 TMPSG     3        1.0 KESG      5       1.0 SOD1D     9       1.0
SODAT    12      1.0

 Segment
 Number
    1
                Average                    Temperature     Light Extinction        Sediment Oxygen
                Salinity                                      Coefficient              Demand
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
               Segment Temperature
              Corection Coefficient
SODAT    12      1.08
    2
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    3
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    4
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    5
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    6
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    7
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    8
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
    9
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   10
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   11
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   12
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   13
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   14
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   15
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   16
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   17
SAL       2      25.8 TMPSG    3        15.9 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   18
SAL       2      25.8 TMPSG    3        19.1 KESG     5       0.85 SOD1D     9       0.0
SODAT    12      1.08
   19
SAL       2      25.8 TMPSG    3        19.1 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   20
SAL       2      24.3 TMPSG    3        19.1 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   21
SAL       2      24.3 TMPSG    3        19.1 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   22
SAL       2      24.3 TMPSG    3        19.1 KESG     5       0.85 SOD1D     9       1.5
SODAT    12      1.08
   23
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SAL       2      24.3 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       1.5
SODAT    12       1.08
  24
SAL       2      24.3 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  25
SAL       2      24.3 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  26
SAL       2      24.3 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  27
SAL       2      23.4 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  28
SAL       2      23.4 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  29
SAL       2      23.2 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  30
SAL       2      23.2 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  31
SAL       2      23.0 TMPSG     3      19.2 KESG     5     0.85 SOD1D     9       1.5
SODAT    12       1.08
  32
SAL       2      21.1 TMPSG     3      19.2 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  33
SAL       2      21.1 TMPSG     3      19.2 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  34
SAL       2      12.0 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  35
SAL       2      10.2 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  36
SAL       2       8.2 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  37
SAL       2       6.5 TMPSG     3      19.1 KESG     5     0.85 SOD1D     9       2.8
SODAT    12       1.08
  38
SAL       2       0.0 TMPSG     3      19.4 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  39
SAL       2       0.0 TMPSG     3      19.4 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  40
SAL       2       0.0 TMPSG     3      19.4 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  41
SAL       2       0.0 TMPSG     3      19.4 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  42
SAL       2       0.0 TMPSG     3      19.4 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  43
SAL       2       0.0 TMPSG     3      19.8 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  44
SAL       2       0.0 TMPSG     3      19.8 KESG     5     0.85 SOD1D     9       2.4
SODAT    12       1.08
  45
SAL       2       0.0 TMPSG     3      19.8 KESG     5     1.51 SOD1D     9       2.4
SODAT    12       1.08
  46
SAL       2       0.0 TMPSG     3      19.8 KESG     5     1.51 SOD1D     9       2.4
SODAT    12       1.08
  47
SAL       2       0.0 TMPSG     3      19.8 KESG     5     1.51 SOD1D     9       2.4
SODAT    12       1.08
  48
SAL       2       0.0 TMPSG     3      19.8 KESG     5     1.51 SOD1D     9       2.4
SODAT    12       1.08
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  49
SAL      2     14.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  50
SAL      2     12.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  51
SAL      2     10.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       3.5
SODAT   12      1.08
  52
SAL      2      8.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       3.5
SODAT   12      1.08
  53
SAL      2      6.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       3.5
SODAT   12      1.08
  54
SAL      2      9.7 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  55
SAL      2      9.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  56
SAL      2      2.0 TMPSG    3      19.3 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  57
SAL      2      1.0 TMPSG    3      19.8 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  58
SAL      2      0.5 TMPSG    3      19.8 KESG     5      0.69 SOD1D     9       2.8
SODAT   12      1.08
  59
SAL      2     16.0 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       2.8
SODAT   12      1.08
  60
SAL      2     13.5 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       2.8
SODAT   12      1.08
  61
SAL      2     11.8 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       4.5
SODAT   12      1.08
  62
SAL      2      6.0 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       4.5
SODAT   12      1.08
  63
SAL      2      5.5 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       2.8
SODAT   12      1.08
  64
SAL      2      1.0 TMPSG    3      19.3 KESG     5      1.20 SOD1D     9       2.8
SODAT   12      1.08
  65
SAL      2      1.0 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.8
SODAT   12      1.08
  66
SAL      2      1.0 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.8
SODAT   12      1.08
  67
SAL      2      1.0 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.4
SODAT   12      1.08
  68
SAL      2      0.3 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.4
SODAT   12      1.08
  69
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.4
SODAT   12      1.08
  70
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.10 SOD1D     9       2.4
SODAT   12      1.08
  71
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.51 SOD1D     9       1.5
SODAT   12      1.08
  72
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.51 SOD1D     9       0.5
SODAT   12      1.08
  73
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.51 SOD1D     9       0.5
SODAT   12      1.08
  74
SAL      2      0.0 TMPSG    3      19.8 KESG     5      1.51 SOD1D     9       0.5
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SODAT   12      1.08
   75
SAL      2      0.0 TMPSG    3      19.8 KESG    5      1.51 SOD1D    9      0.5
SODAT   12      1.08
   76
SAL      2      0.0 TMPSG    3      19.8 KESG    5      1.51 SOD1D    9      0.5
SODAT   12      1.08
   77
SAL      2      0.0 TMPSG    3      19.8 KESG    5     10.0 SOD1D    9      0.1
SODAT   12      1.08
   78
SAL      2      0.0 TMPSG    3      19.8 KESG    5     10.0 SOD1D    9      0.1
SODAT   12      1.08
   79
SAL      2      0.0 TMPSG    3      19.8 KESG    5     10.0 SOD1D    9      0.1
SODAT   12      1.08
   80
SAL      2      0.0 TMPSG    3      19.8 KESG    5     10.0 SOD1D    9      0.1
SODAT   12      1.08
     +    *    +    *    +    *    +                    *******H: CONSTANTS***
    GLOBAL          0
AMMONIA-N           1
nitrif              3
      K12C         11      0.20      K12T        12      1.085
      KNIT         13       2.0
NITRATE-N           1
denitrif            3
      K20C         21      0.09      K20T        22      1.045
      KNO3         23       0.1
O-PO4               0
PHYTO-C             4
growth              2
       K1C         41      1.40       K1T        42      1.066
light               5
     LGHTS         43       1.0     PHIMX        44      720.0
       XKC         45    0.0170      CCHL        46       75.0
       IS1         47      100.
nutrients           4
     KMNG1         48     0.030     KMPG1        49      0.002
      NCRB         58     0.250      PCRB        57      0.025
death               3
      K1RC         50     0.092      K1RT        51      1.045
       K1D         52      0.10
CBOD                1
deoxygen            2
       KDC         71     0.152       KDT        72      1.047
DO                  1
ratio               1
      OCRB         81      2.67
ORGANIC-N           1
mineralize          3
      K71C         91      0.10      K71T        92      1.047
       FON         95       1.0
ORGANIC-P           1
mineralize          3
      K83C        100      0.10      K83T       101      1.047
       FOP        104       1.0
SALINITY            0
          8         *    +    *    +                     **I: TIME FUNCTIONS***
  ITOT    2    5
       392.       0.0      392.     365.0
     F    2    6
       0.58       0.0      0.58     365.0
  WIND    2    7
        0.0       0.0       0.0     365.0
 TFNH4    2   13
        0.0       0.0       0.0     365.0
 TFPO4    2   14
        0.0       0.0       0.0     365.0
   ZOO    2   19
        0.0       0.0       0.0     365.0
 AIRTM    2   21
       22.0       0.0      22.0     365.0
 XICEV    2   22
        1.0       0.0       1.0     365.0
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YSTEM-1 (AMMONIA)                          3  0.0       50.0 ***J: INITIAL CONDS***
Segment Ammonia           Segment Ammonia           Segment Ammonia  [same for other "initial conditions"]
Number    (mg/L)          Number    (mg/L)          Number    (mg/L)
   1 0.942E-01      1.0     2 0.940E-01      1.0     3 0.947E-01       1.0
   4 0.949E-01      1.0     5 0.942E-01      1.0     6 0.944E-01       1.0
   7 0.941E-01      1.0     8 0.949E-01      1.0     9 0.947E-01       1.0
  10 0.942E-01      1.0    11 0.942E-01      1.0    12 0.940E-01       1.0
  13 0.942E-01      1.0    14 0.941E-01      1.0    15 0.944E-01       1.0
  16 0.949E-01      1.0    17 0.949E-01      1.0    18 0.944E-01       1.0
  19 0.949E-01      1.0    20 0.940E-01      1.0    21 0.942E-01       1.0
  22 0.942E-01      1.0    23 0.942E-01      1.0    24 0.945E-01       1.0
  25 0.944E-01      1.0    26 0.946E-01      1.0    27 0.944E-01       1.0
  28 0.101E+00      1.0    29 0.111E+00      1.0    30 0.155E+00       1.0
  31 0.629E-01      1.0    32 0.760E-01      1.0    33 0.540E-01       1.0
  34 0.199E+00      1.0    35 0.266E+00      1.0    36 0.248E+00       1.0
  37 0.209E+00      1.0    38 0.182E+00      1.0    39 0.139E+00       1.0
  40 0.761E-01      1.0    41 0.594E-01      1.0    42 0.597E-01       1.0
  43 0.521E-01      1.0    44 0.389E-01      1.0    45 0.448E-01       1.0
  46 0.446E-01      1.0    47 0.415E-01      1.0    48 0.366E-01       1.0
  49 0.951E-01      1.0    50 0.114E+00      1.0    51 0.867E-01       1.0
  52 0.969E-01      1.0    53 0.118E+00      1.0    54 0.138E+00       1.0
  55 0.115E+00      1.0    56 0.146E+00      1.0    57 0.148E+00       1.0
  58 0.153E+00      1.0    59 0.505E-01      1.0    60 0.487E-01       1.0
  61 0.439E-01      1.0    62 0.473E-01      1.0    63 0.670E-01       1.0
  64 0.118E+00      1.0    65 0.150E+00      1.0    66 0.146E+00       1.0
  67 0.145E+00      1.0    68 0.841E-01      1.0    69 0.758E-01       1.0
  70 0.676E-01      1.0    71 0.450E-01      1.0    72 0.734E-01       1.0
  73 0.452E-01      1.0    74 0.450E-01      1.0    75 0.469E-01       1.0
  76 0.450E-01      1.0    77 0.459E-01      1.0    78 0.419E-01       1.0
  79 0.459E-01      1.0    80 0.459E-01      1.0
SYSTEM-2 (NITRATE)                         3  0.0       50.0 ***J: INITIAL CONDS***
   1 0.256E+00      1.0     2 0.255E+00      1.0     3 0.255E+00       1.0
   4 0.256E+00      1.0     5 0.255E+00      1.0     6 0.254E+00       1.0
   7 0.256E+00      1.0     8 0.256E+00      1.0     9 0.256E+00       1.0
  10 0.257E+00      1.0    11 0.256E+00      1.0    12 0.254E+00       1.0
  13 0.256E+00      1.0    14 0.256E+00      1.0    15 0.256E+00       1.0
  16 0.257E+00      1.0    17 0.256E+00      1.0    18 0.252E+00       1.0
  19 0.257E+00      1.0    20 0.257E+00      1.0    21 0.257E+00       1.0
  22 0.257E+00      1.0    23 0.257E+00      1.0    24 0.257E+00       1.0
  25 0.257E+00      1.0    26 0.256E+00      1.0    27 0.257E+00       1.0
  28 0.257E+00      1.0    29 0.256E+00      1.0    30 0.257E+00       1.0
  31 0.252E+00      1.0    32 0.249E+00      1.0    33 0.246E+00       1.0
  34 0.259E+00      1.0    35 0.253E+00      1.0    36 0.243E+00       1.0
  37 0.230E+00      1.0    38 0.203E+00      1.0    39 0.183E+00       1.0
  40 0.165E+00      1.0    41 0.162E+00      1.0    42 0.163E+00       1.0
  43 0.160E+00      1.0    44 0.157E+00      1.0    45 0.158E+00       1.0
  46 0.157E+00      1.0    47 0.159E+00      1.0    48 0.158E+00       1.0
  49 0.246E+00      1.0    50 0.242E+00      1.0    51 0.232E+00       1.0
  52 0.221E+00      1.0    53 0.216E+00      1.0    54 0.240E+00       1.0
  55 0.224E+00      1.0    56 0.216E+00      1.0    57 0.207E+00       1.0
  58 0.209E+00      1.0    59 0.240E+00      1.0    60 0.237E+00       1.0
  61 0.225E+00      1.0    62 0.221E+00      1.0    63 0.213E+00       1.0
  64 0.218E+00      1.0    65 0.206E+00      1.0    66 0.202E+00       1.0
  67 0.195E+00      1.0    68 0.177E+00      1.0    69 0.168E+00       1.0
  70 0.165E+00      1.0    71 0.158E+00      1.0    72 0.155E+00       1.0
  73 0.159E+00      1.0    74 0.159E+00      1.0    75 0.159E+00       1.0
  76 0.160E+00      1.0    77 0.160E+00      1.0    78 0.160E+00       1.0
  79 0.160E+00      1.0    80 0.160E+00      1.0
SYSTEM-3 (INORGANIC PHOSPHORUS)            3  0.0       50.0 ***J: INITIAL CONDS***
   1 0.593E-01      1.0     2 0.592E-01      1.0     3 0.590E-01       1.0
   4 0.592E-01      1.0     5 0.592E-01      1.0     6 0.599E-01       1.0
   7 0.596E-01      1.0     8 0.595E-01      1.0     9 0.594E-01       1.0
  10 0.596E-01      1.0    11 0.599E-01      1.0    12 0.591E-01       1.0
  13 0.599E-01      1.0    14 0.599E-01      1.0    15 0.597E-01       1.0
  16 0.599E-01      1.0    17 0.593E-01      1.0    18 0.592E-01       1.0
  19 0.599E-01      1.0    20 0.599E-01      1.0    21 0.590E-01       1.0
  22 0.511E-01      1.0    23 0.511E-01      1.0    24 0.596E-01       1.0
  25 0.526E-01      1.0    26 0.524E-01      1.0    27 0.538E-01       1.0
  28 0.554E-01      1.0    29 0.566E-01      1.0    30 0.625E-01       1.0
  31 0.505E-01      1.0    32 0.514E-01      1.0    33 0.490E-01       1.0
  34 0.682E-01      1.0    35 0.733E-01      1.0    36 0.669E-01       1.0
  37 0.546E-01      1.0    38 0.401E-01      1.0    39 0.269E-01       1.0
  40 0.126E-01      1.0    41 0.957E-02      1.0    42 0.987E-02       1.0
  43 0.796E-02      1.0    44 0.531E-02      1.0    45 0.659E-02       1.0
  46 0.644E-02      1.0    47 0.640E-02      1.0    48 0.612E-02       1.0
  49 0.525E-01      1.0    50 0.526E-01      1.0    51 0.448E-01       1.0
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   52 0.400E-01      1.0   53 0.394E-01        1.0   54 0.538E-01       1.0
   55 0.425E-01      1.0   56 0.398E-01        1.0   57 0.354E-01       1.0
   58 0.392E-01      1.0   59 0.477E-01        1.0   60 0.471E-01       1.0
   61 0.447E-01      1.0   62 0.435E-01        1.0   63 0.404E-01       1.0
   64 0.408E-01      1.0   65 0.343E-01        1.0   66 0.323E-01       1.0
   67 0.295E-01      1.0   68 0.168E-01        1.0   69 0.134E-01       1.0
   70 0.116E-01      1.0   71 0.404E-02        1.0   72 0.502E-02       1.0
   73 0.490E-02      1.0   74 0.497E-02        1.0   75 0.489E-02       1.0
   76 0.506E-02      1.0   77 0.500E-02        1.0   78 0.500E-02       1.0
   79 0.500E-02      1.0   80 0.500E-02        1.0
SYSTEM 4 (CHLOROPHYL a)                      3  0.0      50.0 ***J: INITIAL CONDS***
    1       0.90     1.0   2         0.90    1.0   3        0.90      1.0
    4       0.90     1.0   5         0.90    1.0   6        0.90      1.0
    7       0.96     1.0   8         0.80    1.0   9        0.83      1.0
   10       0.87     1.0  11         0.85    1.0  12        0.85      1.0
   13       0.81     1.0  14         0.88    1.0  15        0.83      1.0
   16       0.84     1.0  17         0.88    1.0  18        0.82      1.0
   19       0.82     1.0  20         0.81    1.0  21        0.82      1.0
   22       0.83     1.0  23         0.83    1.0  24        0.84      1.0
   25       0.81     1.0  26         0.81    1.0  27        0.84      1.0
   28       0.86     1.0  29         0.85    1.0  30        0.89      1.0
   31       0.85     1.0  32         0.81    1.0  33        0.81      1.0
   34       0.88     1.0  35         0.85    1.0  36        0.85      1.0
   37       0.86     1.0  38         0.80    1.0  39        0.83      1.0
   40       0.89     1.0  41         0.87    1.0  42        0.83      1.0
   43       0.90     1.0  44         1.00    1.0  45        1.00      1.0
   46       1.00     1.0  47         1.00    1.0  48        1.00      1.0
   49       0.87     1.0  50         0.84    1.0  51        0.87      1.0
   52       0.85     1.0  53         0.81    1.0  54        0.87      1.0
   55       0.98     1.0  56         0.81    1.0  57        0.82      1.0
   58       0.80     1.0  59         0.84    1.0  60        0.84      1.0
   61       0.87     1.0  62         0.86    1.0  63        0.89      1.0
   64       0.89     1.0  65         0.85    1.0  66        0.89      1.0
   67       0.88     1.0  68         0.81    1.0  69        0.83      1.0
   70       1.47     1.0  71         1.20    1.0  72        1.50      1.0
   73       1.40     1.0  74         1.40    1.0  75        1.50      1.0
   76       1.50     1.0  77         1.50    1.0  78        1.60      1.0
   79       1.60     1.0  80         1.60    1.0
SYSTEM-5 (CBOD)                              3  0.0      50.0 ***J: INITIAL CONDS***
    1 0.242E+01      1.0    2 0.243E+01      1.0    3 0.246E+01       1.0
    4 0.248E+01      1.0    5 0.244E+01      1.0    6 0.249E+01       1.0
    7 0.245E+01      1.0    8 0.249E+01      1.0    9 0.240E+01       1.0
   10 0.246E+01      1.0   11 0.241E+01      1.0   12 0.240E+01       1.0
   13 0.248E+01      1.0   14 0.248E+01      1.0   15 0.237E+01       1.0
   16 0.245E+01      1.0   17 0.241E+01      1.0   18 0.220E+01       1.0
   19 0.245E+01      1.0   20 0.247E+01      1.0   21 0.246E+01       1.0
   22 0.246E+01      1.0   23 0.225E+01      1.0   24 0.232E+01       1.0
   25 0.242E+01      1.0   26 0.222E+01      1.0   27 0.242E+01       1.0
   28 0.243E+01      1.0   29 0.221E+01      1.0   30 0.243E+01       1.0
   31 0.244E+01      1.0   32 0.239E+01      1.0   33 0.240E+01       1.0
   34 0.125E+01      1.0   35 0.140E+01      1.0   36 0.235E+01       1.0
   37 0.121E+01      1.0   38 0.113E+01      1.0   39 0.201E+01       1.0
   40 0.139E+01      1.0   41 0.133E+01      1.0   42 0.149E+01       1.0
   43 0.146E+01      1.0   44 0.126E+01      1.0   45 0.185E+01       1.0
   46 0.113E+01      1.0   47 0.127E+01      1.0   48 0.118E+01       1.0
   49 0.236E+01      1.0   50 0.221E+01      1.0   51 0.238E+01       1.0
   52 0.242E+01      1.0   53 0.224E+01      1.0   54 0.207E+01       1.0
   55 0.247E+01      1.0   56 0.224E+01      1.0   57 0.203E+01       1.0
   58 0.246E+01      1.0   59 0.248E+01      1.0   60 0.238E+01       1.0
   61 0.243E+01      1.0   62 0.222E+01      1.0   63 0.267E+01       1.0
   64 0.242E+01      1.0   65 0.223E+01      1.0   66 0.221E+01       1.0
   67 0.200E+01      1.0   68 0.246E+01      1.0   69 0.222E+01       1.0
   70 0.236E+01      1.0   71 0.182E+01      1.0   72 0.222E+01       1.0
   73 0.169E+01      1.0   74 0.179E+01      1.0   75 0.226E+01       1.0
   76 0.120E+01      1.0   77 0.128E+01      1.0   78 0.228E+01       1.0
   79 0.118E+01      1.0   80 0.128E+01      1.0
SYSTEM-6 (DO)                                3  0.0      50.0 ***J: INITIAL CONDS***
    1 0.600E+01      1.0    2 0.600E+01      1.0    3 0.600E+01       1.0
    4 0.600E+01      1.0    5 0.600E+01      1.0    6 0.600E+01       1.0
    7 0.595E+01      1.0    8 0.591E+01      1.0    9 0.592E+01       1.0
   10 0.596E+01      1.0   11 0.597E+01      1.0   12 0.593E+01       1.0
   13 0.591E+01      1.0   14 0.591E+01      1.0   15 0.593E+01       1.0
   16 0.594E+01      1.0   17 0.593E+01      1.0   18 0.598E+01       1.0
   19 0.598E+01      1.0   20 0.598E+01      1.0   21 0.597E+01       1.0
   22 0.586E+01      1.0   23 0.596E+01      1.0   24 0.598E+01       1.0
   25 0.581E+01      1.0   26 0.571E+01      1.0   27 0.581E+01       1.0
   28 0.583E+01      1.0   29 0.571E+01      1.0   30 0.581E+01       1.0
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  31 0.582E+01        1.0   32 0.591E+01        1.0   33 0.582E+01        1.0
  34 0.586E+01        1.0   35 0.595E+01        1.0   36 0.623E+01        1.0
  37 0.584E+01        1.0   38 0.594E+01        1.0   39 0.683E+01        1.0
  40 0.685E+01        1.0   41 0.742E+01        1.0   42 0.742E+01        1.0
  43 0.714E+01        1.0   44 0.754E+01        1.0   45 0.771E+01        1.0
  46 0.781E+01        1.0   47 0.837E+01        1.0   48 0.857E+01        1.0
  49 0.689E+01        1.0   50 0.608E+01        1.0   51 0.615E+01        1.0
  52 0.682E+01        1.0   53 0.629E+01        1.0   54 0.613E+01        1.0
  55 0.686E+01        1.0   56 0.654E+01        1.0   57 0.674E+01        1.0
  58 0.685E+01        1.0   59 0.640E+01        1.0   60 0.625E+01        1.0
  61 0.587E+01        1.0   62 0.584E+01        1.0   63 0.593E+01        1.0
  64 0.684E+01        1.0   65 0.682E+01        1.0   66 0.688E+01        1.0
  67 0.682E+01        1.0   68 0.738E+01        1.0   69 0.750E+01        1.0
  70 0.685E+01        1.0   71 0.826E+01        1.0   72 0.863E+01        1.0
  73 0.913E+01        1.0   74 0.910E+01        1.0   75 0.910E+01        1.0
  76 0.910E+01        1.0   77 0.910E+01        1.0   78 0.910E+01        1.0
  79 0.910E+01        1.0   80 0.910E+01        1.0
SYSTEM-7 (ORGANIC NITROGEN)                      3  0.0       50.0 ***J: INITIAL CONDS***
   1 0.126E+00        1.0    2 0.126E+00        1.0    3 0.125E+00        1.0
   4 0.126E+00        1.0    5 0.126E+00        1.0    6 0.125E+00        1.0
   7 0.126E+00        1.0    8 0.125E+00        1.0    9 0.125E+00        1.0
  10 0.126E+00        1.0   11 0.128E+00        1.0   12 0.126E+00        1.0
  13 0.126E+00        1.0   14 0.127E+00        1.0   15 0.126E+00        1.0
  16 0.127E+00        1.0   17 0.131E+00        1.0   18 0.128E+00        1.0
  19 0.126E+00        1.0   20 0.126E+00        1.0   21 0.125E+00        1.0
  22 0.126E+00        1.0   23 0.126E+00        1.0   24 0.131E+00        1.0
  25 0.138E+00        1.0   26 0.138E+00        1.0   27 0.146E+00        1.0
  28 0.156E+00        1.0   29 0.163E+00        1.0   30 0.193E+00        1.0
  31 0.130E+00        1.0   32 0.138E+00        1.0   33 0.130E+00        1.0
  34 0.220E+00        1.0   35 0.244E+00        1.0   36 0.241E+00        1.0
  37 0.181E+00        1.0   38 0.201E+00        1.0   39 0.126E+00        1.0
  40 0.106E+00        1.0   41 0.844E-01        1.0   42 0.910E-01        1.0
  43 0.834E-01        1.0   44 0.758E-01        1.0   45 0.796E-01        1.0
  46 0.793E-01        1.0   47 0.786E-01        1.0   48 0.766E-01        1.0
  49 0.144E+00        1.0   50 0.150E+00        1.0   51 0.146E+00        1.0
  52 0.153E+00        1.0   53 0.164E+00        1.0   54 0.156E+00        1.0
  55 0.150E+00        1.0   56 0.149E+00        1.0   57 0.143E+00        1.0
  58 0.160E+00        1.0   59 0.133E+00        1.0   60 0.134E+00        1.0
  61 0.139E+00        1.0   62 0.141E+00        1.0   63 0.147E+00        1.0
  64 0.149E+00        1.0   65 0.141E+00        1.0   66 0.137E+00        1.0
  67 0.133E+00        1.0   68 0.110E+00        1.0   69 0.999E-01        1.0
  70 0.943E-01        1.0   71 0.602E-01        1.0   72 0.671E-01        1.0
  73 0.664E-01        1.0   74 0.666E-01        1.0   75 0.660E-01        1.0
  76 0.673E-01        1.0   77 0.620E-01        1.0   78 0.620E-01        1.0
  79 0.620E-01        1.0   80 0.620E-01        1.0
SYSTEM-8 (ORGANIC PHOSPHORUS)                    3  0.0       50.0 ***J: INITIAL CONDS***
   1 0.398E-01        1.0    2 0.398E-01        1.0    3 0.398E-01        1.0
   4 0.399E-01        1.0    5 0.398E-01        1.0    6 0.397E-01        1.0
   7 0.391E-01        1.0    8 0.393E-01        1.0    9 0.396E-01        1.0
  10 0.395E-01        1.0   11 0.394E-01        1.0   12 0.393E-01        1.0
  13 0.390E-01        1.0   14 0.391E-01        1.0   15 0.392E-01        1.0
  16 0.394E-01        1.0   17 0.392E-01        1.0   18 0.390E-01        1.0
  19 0.390E-01        1.0   20 0.390E-01        1.0   21 0.387E-01        1.0
  22 0.387E-01        1.0   23 0.387E-01        1.0   24 0.389E-01        1.0
  25 0.387E-01        1.0   26 0.386E-01        1.0   27 0.386E-01        1.0
  28 0.386E-01        1.0   29 0.386E-01        1.0   30 0.389E-01        1.0
  31 0.389E-01        1.0   32 0.285E-01        1.0   33 0.386E-01        1.0
  34 0.291E-01        1.0   35 0.286E-01        1.0   36 0.274E-01        1.0
  37 0.153E-01        1.0   38 0.116E-01        1.0   39 0.269E-02        1.0
  40 0.124E-01        1.0   41 0.292E-01        1.0   42 0.285E-02        1.0
  43 0.154E-01        1.0   44 0.212E-01        1.0   45 0.133E-02        1.0
  46 0.128E-01        1.0   47 0.222E-01        1.0   48 0.104E-02        1.0
  49 0.180E-01        1.0   50 0.174E-01        1.0   51 0.165E-01        1.0
  52 0.149E-01        1.0   53 0.138E-01        1.0   54 0.170E-01        1.0
  55 0.154E-01        1.0   56 0.139E-01        1.0   57 0.129E-01        1.0
  58 0.129E-01        1.0   59 0.183E-01        1.0   60 0.183E-01        1.0
  61 0.180E-01        1.0   62 0.177E-01        1.0   63 0.166E-01        1.0
  64 0.150E-01        1.0   65 0.126E-01        1.0   66 0.121E-01        1.0
  67 0.114E-01        1.0   68 0.198E-01        1.0   69 0.180E-01        1.0
  70 0.221E-01        1.0   71 0.156E-01        1.0   72 0.199E-01        1.0
  73 0.299E-01        1.0   74 0.198E-01        1.0   75 0.192E-01        1.0
  76 0.203E-01        1.0   77 0.200E-01        1.0   78 0.200E-01        1.0
  79 0.200E-01        1.0   80 0.200E-01        1.0
SYSTEM-9 (SALINITY)                              3  0.0       50.0 ***J: INITIAL CONDS***
   1 0.298E+02        1.0    2 0.298E+02        1.0    3 0.298E+02        1.0
   4 0.298E+02        1.0    5 0.298E+02        1.0    6 0.298E+02        1.0
   7 0.296E+02        1.0    8 0.297E+02        1.0    9 0.292E+02        1.0
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10 0.291E+02         1.0   11 0.295E+02         1.0   12 0.293E+02         1.0
13 0.294E+02         1.0   14 0.293E+02         1.0   15 0.297E+02         1.0
16 0.298E+02         1.0   17 0.291E+02         1.0   18 0.291E+02         1.0
19 0.295E+02         1.0   20 0.265E+02         1.0   21 0.283E+02         1.0
22 0.294E+02         1.0   23 0.264E+02         1.0   24 0.286E+02         1.0
25 0.292E+02         1.0   26 0.271E+02         1.0   27 0.273E+02         1.0
28 0.294E+02         1.0   29 0.277E+02         1.0   30 0.263E+02         1.0
31 0.247E+02         1.0   32 0.215E+02         1.0   33 0.238E+02         1.0
34 0.161E+02         1.0   35 0.705E+01         1.0   36 0.669E+01         1.0
37 0.316E+01         1.0   38 0.100E-24         1.0   39 0.366E+00         1.0
40 0.100E-24         1.0   41 0.673E-01         1.0   42 0.188E-01         1.0
43 0.100E-24         1.0   44 0.409E-05         1.0   45 0.640E-05         1.0
46 0.426E-05         1.0   47 0.162E-05         1.0   48 0.169E-05         1.0
49 0.168E+02         1.0   50 0.128E+02         1.0   51 0.114E+02         1.0
52 0.637E+01         1.0   53 0.484E+01         1.0   54 0.992E+01         1.0
55 0.555E+01         1.0   56 0.272E+01         1.0   57 0.197E+01         1.0
58 0.481E+01         1.0   59 0.215E+02         1.0   60 0.206E+02         1.0
61 0.167E+02         1.0   62 0.147E+02         1.0   63 0.860E+01         1.0
64 0.481E+01         1.0   65 0.150E+01         1.0   66 0.132E+01         1.0
67 0.920E+00         1.0   68 0.100E-24         1.0   69 0.123E+00         1.0
70 0.132E-01         1.0   71 0.100E-24         1.0   72 0.100E-24         1.0
73 0.100E-24         1.0   74 0.100E-24         1.0   75 0.100E-24         1.0
76 0.100E-24         1.0   77 0.100E-24         1.0   78 0.100E-24         1.0
79 0.100E-24         1.0   80 0.100E-24         1.0□
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