WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Snohomish River Estuary Total Maximum Daily Load

SUPPLEMENT

August 1999

Printed on Recycled Paper

Introduction

This Supplement contains additional background and clarifying information in support of the Snohomish River Estuary Total Daily Load Submittal Report, August 1999, **Publication Number 99-57-WQ.**

Included here-in are a series of letters, memoranda, and data analyses that support the public outreach and technical conclusions contained within the Submittal Report. This information provides the references and elaborates on the history and responsiveness summary discussed within the report.

DEPARTMENT OF ECOLOGY

July 14, 1999

TO: John Glynn, Laura Fricke, and David Wright
Water Quality Program, NWRO

THROUGH: Karol Erickson
Environmental Assessment Program, Watershed Studies Unit

FROM: Bob Cusimano
Watershed Studies Unit

SUBJECT: Snohomish River Estuary Dry Season TMDL Study Project History and Responsiveness Summary

Attached is a set of correspondence and technical documents summarizing the history of significant decisions, comments, and responses concerning the Snohomish River Estuary Dry Season TMDL Study. The materials document the development of the project from its beginning in 1992 to the present, and provide responses to outstanding comments on the project.

cc: Will Kendra

Snohomish River Estuary Dry Season TMDL Study
Project History and Responsiveness Summary

The Snohomish River Estuary Dry Season total maximum daily load (TMDL) study was initiated by the Department of Ecology (Ecology) in the fall of 1992. The project was requested by Ecology's Northwest Regional Office (NWRO) because of concern that population growth and development in the estuary watershed may adversely effect water quality. Their major concern was with increased demands on the wastewater treatment plants (WWTPs) permitted to discharge to the river and sloughs. In the study area, the City of Everett, Marysville, Snohomish, Monroe, and Sultan and the Lake Stevens Sewer District have permitted WWTP discharges. The following is a brief history of the project and responses to review comments as the study progressed:

- NWRO requested the project in 1992.

- A Quality Assurance Project Plan (QAPP) was completed in June 1993 (Cusimano, 1993). The plan summarized the historical information for the estuary and identified specific objectives. Historical data showed that dissolved oxygen in the lower river and sloughs could drop below 6 mg/L. Dissolved oxygen concentrations are inversely related to increase salinity due to marine water flooding into the lower river and sloughs during high tide. A number of waterbody segments in the study area were on the 1992, 1994, and 1996 303(d) list for dissolved oxygen (WA-07-0010, -1010, -1011, and -1050). The combination of low dissolved oxygen in the estuary and the potential for increased WWTP discharges led to the major objective identified in the QAPP: "Assess the potential for dissolved oxygen depletion from carbonaceous and nitrogenous biochemical oxygen demand (BOD) from known point sources."

  The project objectives were met by a combination of collecting field data and developing a hydrodynamic and water quality model of the estuary.

- Field sampling was initiated in August/September 1993. The field sampling was designed to collect data that could be used to calibrate an Environmental Protection Agency supported computer model called "Water Quality Simulation Program (WASP5)."

- A second field sampling survey was scheduled for the summer of 1994. However it 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) and distributed to the Public Works, Conservation District, Snohomish County Surface Water Management, Tulalip Tribe, Industries, and consultant staff that might be most affected and interested in the results of the study. The phase I report summarized the 1993 sampling results, and the development and calibration of a WASP5 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 BOD in the Snoqualimie 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 in the 1996 survey.

- In February 1996, the City of Everett, Public Works submitted a list of general and specific comments on the Phase I report (Attachment 1). Ecology provided a response to the comments on May 7, 1996 (Attachment 2). One of the major comments was that the model should be calibrated to a dye tracer study that the City conducted in the lower mainstem of the river on August 14-18, 1995. Comparing the dye tracer study with model predictions was included in the 1996-work plan for the project. The City of Everett participated in the 1996 summer sampling by collecting grab sample and continuous *in situ* data for salinity, and dissolved oxygen at three sampling stations in the lower river.

- The second sampling survey was conducted on August 27-28, 1996. These survey data were used to confirm the ability of the calibrated model to predict water quality in the estuary.

- On October 2, 1996, the City of Everett's consultant, Bill Fox, Cosmopolitan Engineering Group, submitted a follow-up set of comments on the development of the model (Attachment 3). The major comment was that the model should be calibrated to the 1995 dye study and continuous salinity and dissolved oxygen data from August 28, 1996.

- In October 1996, Ecology's Industrial Program notified the lead investigator on the TMDL study that Weyerhaeuser Paper Company was proposing to upgrade the treatment and disposal system for the Smith Island Treatment Plant (SITP) to accommodate two new pulp and paper facilities. The new facilities would be located at the old Weyerhaeuser bleached Kraft pulp mill in Everett would route their process wastewater to SITP for treatment, then discharge the treated effluent into Steamboat Slough. In November 1996, the Weyerhaeuser Plant Manager was notified that the new permit (if issued) could be limited by the TMDL (Attachment 4).

- In February 1997, Vernice Santee, Environmental Review and Sediment Section, notified the Weyerhaeuser site development manager, that their application for a Section 401 Water Quality Certification for the proposed outfall construction and plant operation was being held in abeyance by the state, pending resolution of the impacts of the new facilities' discharge with respect to the TMDL (Attachment 5).

- The Snohomish River Estuary Dry Season TMDL Study – Phase II report was published by Ecology in June 1997. The report summarized the results of the water quality model confirmation and pollutant loading capacity recommendations. The confirmation results included comparison of the model predictions with the 1995 dye study results and the continuous salinity and dissolved oxygen data collected by the City of Everett. Comparison of the model predictions with the Everett data provided additional confirmation of the model. Under design conditions, the model predicted that point sources of oxygen-consuming pollutants would cause an exceedence of the 0.2 mg/L deficit allowed by the marine water quality criteria when natural conditions are below the standard (the allowable deficit was also applied to the freshwater portion of the modeled area). Waste load allocations were proposed for the following point sources of carbonaceous BOD and ammonia BOD: the City of Snohomish WWTP, Lake Steven's Sewer District WWTP, City of Marysville WWTP, City of Everett WWTP, and for the proposed Smith Island WWTP. As with the Phase I report, the Phase II report was distributed to the Public Works, Conservation District, Snohomish County Surface Water Management, Tulalip Tribe, Industries, and consultant staff that might be most affected and interested in the results of the study.

- The Snohomish River Regional Water Authority (RWA) submitted a change application, and draft Plan of Use to Ecology in December 1996 to transfer the Weyerhaeuser Everett Kraft Mill water right to the RWA. In October 1997, Ecology staff from the Watershed Studies Unit met with representatives of the RWA to review the proposed water withdrawal use and its treatment in the TMDL process. The water right was not included in the TMDL analysis presented in the 1997 report, because the Weyerhaeuser plant stopped manufacturing at the end of April 1992 and the water right was not being used during the TMDL study period. Subsequent to the October 1997 meeting, a number of additional meetings and discussions were held both within Ecology (including Water Quality and Water Resources Program staff) and between Ecology and RWA representatives to determine how the water withdrawal would be treated in the TMDL. A draft technical TMDL addendum was prepared and distributed for review in January 1998. The addendum reviewed the water withdrawal issue with respect to the proposed BOD TMDL and recommended that the actual historic Weyerhaeuser water use for the TMDL period should be included as part of the background conditions for establishing allocations (Attachment 6). As of today, Ecology's Water Resource Program has not made a determination on the validity and quantification of the water right change application by the RWA.

- In May 1998, Ecology's NWRO and Environmental Assessments Program (EAP) made an interim decision to include the perfected withdrawal rate as part of the background water quality condition for the Snohomish TMDL.

- A public meeting was held February 9, 1998, at the Snohomish County Administration Building to discuss the TMDL study and answer questions from the public. Written comments and suggestions were directed to Laura Fricke at the Department of Ecology.

- Written comments on the Phase II report were received following the public meeting from EPA and the newly formed Snohomish Regional Water Quality Association (SRWQA) (Attachment 7 and 8). A response to the general comments from the SRWQA was sent to the SRWQA in June 1998 (Attachment 9). The SRWQA's comments included a request to conduct additional studies "to improve the model and study allocation alternatives before implementing WLAs." Through discussions with the SRWQA, it was agreed that Ecology would allow more data to be collected during the summer of 1998 to either confirm or reject the concerns the SRWQA raised in their comment letter. It was decided to wait to respond to EPA comments until the SRWQA completed and presented the 1998 summer findings. Responses to the SRWQA specific comments and EPA comments are included in this summary (Attachment 10 and 11, respectively).

- In November 1998, the Watershed Studies Unit and the RWA developed a procedure for using the TMDL model to mitigate the impact of the water withdrawal on dissolved oxygen concentrations in the estuary (Attachment 12). The analysis assumes that the historical use for the TMDL period will be treated as "background." However, the maximum sustained water withdrawal rate would be conditioned by the critical conditions predicted by the TMDL model with respect to river flow and tidal periods. Currently, the Water Resources Program has not made a final determination on the validity and quantity of the Weyerhaeuser water right that could be transferred to the RWA. Although the Water Quality Program agrees with the general approach outlined in Attachment 12, a final decision on how to treat the water right with respect to the TMDL can not be made until the Water Resource Program makes a final determination about the RWAs change application.

- The SRWQA and Ecology met in January 1999 to review the results of their summer sampling. The SRWQA's efforts focused on collecting data in Steamboat Slough and testing the model simulations relative to the City of Marysville and Weyerhaeuser effluent discharges by conducting dye tracer studies and collecting current measurements and density profiles during August and September 1998. Daily effluent monitoring data for carbonaceous BOD and ammonia were also collected from all of the dischargers during August and September 1998. The SRWQA's dye studies and field-sampling survey data results supported the accuracy of the model to predict the impact of the effluent discharges on dissolved oxygen in the estuary. Graphs showing both the measured dye concentrations and the model simulations versus time for model segments 49, 55, and 56 are presented in Attachment 13. (See the Phase II report Figure 17 for the comparison of the model predictions for the 1995 dye study for the Everett discharges to the lower part of the river.)

- During the January 1999 meeting, the SRWQA requested that Ecology delay putting wasteload allocations in the pending NPDES permits based on the TMDL in order to allow the dischargers time to plan and collect more water quality and effluent data during the next five year permit period that starts July 1999. After reviewing the summer 1998 data, Ecology notified the SRWQA that The Department had decided to proceed with preparing draft permits based on the TMDL (Attachment 14).

- Ecology has revised the proposed allocations listed in the Phase II report based on the comments and data collected by the SRWQA. The changes are discussed in the enclosed Technical Addendum Number 2.

Attachment 1

PUBLIC WORKS

EVERETT

February 9, 1996

Robert F. Cusimano
Washington Department of Ecology
EILS Program
Watershed Assessments Section
P.O. Box 47600
Olympia, WA 98504-7600

RE: Snohomish River Estuary Dry Season TMDL-Phase I Document Comments

Dear Mr. Cusimano:

The enclosed comments and recommendations are forwarded to you as the City of Everett's response to the Snohomish River Estuary Dry Season TMDL Study-Phase I document completed in July of 1995. In order to provide both a regulatory and technical overview of the Phase I document, comments were solicited from several water quality professionals. The comments below are the result of that solicitation. The responses are segregated into general comments, and specific comments and recommendations.

Please note that the City of Everett is very interested in taking a more active role in all future studies on the lower Snohomish River. We feel that our participation in any water quality related project on the estuary would enhance our understanding and acceptance of the project. Therefore, after your review of our comments, I would like to schedule a meeting with you to discuss future TMDL work on the lower Snohomish. I can be reached at (206) 259-8820.

Sincerely,

Robert Waddle

Enclosures (2)

CITY OF EVERETT • 3200 Cedar St. • Everett, WA 98201 • (206) 259-8819 • Fax (206) 259-8881

General Comments

1. The Phase I document focuses specifically on suspected D.O. depletions due to carbonaceous and nitrogenous loadings. In the proposed 1996 Section 303(d) list, the recommendation is to de-list the lower Snohomish for D.O. since the excursions are due to natural sources. What impact, if any, will this action have on further TMDL work (Phase II)?

2. The City concurs with the selection of WASP5 for TMDL modeling. However, we believe that Ecology must consider two layers in the water column. The estuary is clearly stratified, particularly at 7Q20 low river flow conditions. Stratification strongly influences the hydrodynamics of the estuary.

   We believe that conceptually the model is mis-representing the actual exchanges of water that occur in the estuarine portion of the Snohomish River in that:

   - The model treats each parameter as an average value for each segment.
   - Each parameter represents an average over the water column.
   - The model does not distinguish the distribution over the water column.
   - The model does not account for the effects on the circulation that density stratification will impose.

   Therefore, the model hydrodynamics are driven by tidal and river forces only, without considering added exchange rates associated with the two layered system that is especially characteristic of salt-wedge type estuaries such as the lower Snohomish River. The model will sense an upstream flow associated with a rising tide, a downstream flow associated with a falling tide, and a downstream flow associated with the freshwater inputs. In terms of a net outflow from the estuary, the un-layered model will show only a net outward flow equal to the river flow.

   The problem with this representation is that in the estuarine region, there is a net inflow at depth of salt water. Therefore the surface must display a net outflow equal to the net freshwater input from the upstream side and the net saltwater inflow from Port Gardner. The outflow is a mix of fresh and salt water.

   Failing to account for these two net inputs, the model holds Everett's effluent within the modeled estuary longer than actually occurs in the real world. This allows Everett's CBOD and ammonia to exert more of an effect on the D.O. levels in the model than really occurs.

3. The hydrodynamic model should be calibrated to the conditions observed on August 14-18, 1995. A 24-hour tracer discharge between nodes 42 and 43 should be

simulated. The model would be calibrated to the conservative tracer concentration vs. time as shown in Figure 9 (attached).

4. In spite of the inaccuracies of the model, the modeling indicates that the lower river and sloughs to the north are incorrectly classified as class A waters.

   The modeling shows dissolved oxygen levels below 6 mg/L when there are no BOD or ammonia loadings. The information should be used by Ecology's water quality standards section to reclassify these water bodies to reflect their actual conditions. The appropriate classification, based on both the dissolved oxygen modeling and the historical dissolved oxygen data as well appears to be class B for the Snohomish Estuary and Steamboat Slough, and class C for Ebey Slough.

5. The Phase I document concentrates on point source loadings. What work is planned to effectively incorporate non-point source loading into the TMDL equation? Even though this loading in not easily quantifiable, the TMDL study must account for and control non-point sources as well as point sources.

Specific Comments

1. (Pg.5, third paragraph): During metals sample collection, it is unclear whether or not the samplers followed "clean" sampling protocols. If clean protocols were used, please define or reference.

   Everett developed an extensive database on total and dissolved metals for the lower Snohomish. A copy of these data were forwarded to you on November 21, 1995. These data show that the metals of concern (cadmium, copper, lead, mercury, silver and zinc) are, without exception, below the water quality standards (dissolved and total) when clean sampling techniques are used.

2. (Pg. 7, third paragraph): The reporting limits stated here and in Appendix B.2 are surprisingly low for a marine matrix. This is not a major point, but we would be interested in the specifics of the analytical methods used to achieve these limits.

3. (Pg. 7, third paragraph, last sentence): This states that "Copper loading to the estuary may need to be controlled because it was also identified as a pollutant of concern in the Class II inspections for WWTPs discharging to the lower river and sloughs..."

   This sentence needs to be reconsidered in view of the pending change to the marine copper criteria (and the indefensibility of the existing criteria). The EPA has proposed revisions of the marine copper criteria based on new data. The availability of the new data make the old criteria invalid. The change in the criteria may be sufficient that copper will not be a concern.

4. (Pg. 10, Data Group D): The bathymetry and channel geometry at the seaward boundary appear to be over-simplified. Most of the seaward nodes are depicted as a depth of -5.0 m MLLW, however:
   - The Snohomish Delta is not well represented. Nodes 10, 11, 16, 17, 21 and 22 (and the interconnecting reaches) are on tideflats with a MLLW depth of about 0.0, but are represented as -5.0 m MLLW in the model.
   - Nodes 12, 18 and 24 are also modeled at 5.0 m MLLW. This path is actually a channel from Steamboat and Ebey Sloughs at a depth of about -1 m MLLW.
   - Nodes 26 through 29 at -5 m MLLW are probably adequate.
   - Nodes 1, 2, 7, 8, 13, 14, 19 and 20 and interconnecting reaches are all significantly greater depth than -5 m MLLW. This may not be a shortcoming of the model, but should be tested.
   - Node 36 is listed at -1.2 m MLLW, while nodes 35 and 40 are -2.4 m MLLW. We suspect that these mainstem channel nodes should all be the same, at -2.4 m MLLW.

   The net effect of the geometry coded into the model is, we suspect, to allow too much tidal exchange and salinity intrusion into Steamboat and Ebey Sloughs relative to the mainstem. Whereas the mainstem is relatively open (*i.e.* deep) at the seawater boundary, the sloughs are actually restricted by the broad tideflats, which is not reflected in the model.

5. (Pg. 13, Data Group B): Dispersion coefficients varied widely (0 to 120 m^2 /sec) in order to calibrate the model salinity to observed data. We would not expect dispersion to vary to this degree. Zero is not realistic for a dispersion coefficient. 120 m^2/sec is well within literature values for linear estuaries (Table 7.2 in *Mixing in Inland and Coastal Waters,* Fischer, 1979). A two layer model and/or more accurate channel geometry may result in more consistent dispersion coefficients.

6. (pg. 20, paragraph on Boundary and Tributary Concentrations): This states that a 10 m vertically averaged dissolved oxygen value was used for the most extreme condition at station PSS019 from 1990-94. We do not believe that is representative of the dissolved oxygen in the source water. We suspect it will be higher than the actual marine source water because there will be a net outflow at the surface and a net inflow at depth. Therefore, the 10 m measurement will be more representative of the dissolved oxygen in the marine water that enters the estuary.

   It is also worth noting here that the calibration of the model used average values for the surface to approximately 5 meters for the marine water boundary station of POG34, in spite of the sample plan calling for measuring at 10 meters at high tide (see comments re pages A-1, B-1 and B-2).

7. (pg. 21, second paragraph): This states that the "dissolved oxygen profiles for the mainstream and sloughs show that the predicted minimum dissolved oxygen values **without loading** are below both the freshwater and marine criteria for most of the system."

   It would be a correct and logical conclusion to state here that if these predicted values, occurring without loading, are correct, then it makes the case for reclassifying the waters from Class A to Class B, and that such reclassification does not represent a degradation of the waters, but a correction of a past error in the classification that is now possible with the availability of better data and analyses.

8. (pg. 21, second paragraph): This paragraph proclaims that an oxygen deficit of greater than the allowable 0.2 mg/L results and that 89% of the deficit is predicted to be caused by BOD loading from Everett. We believe that the water replacement rates in the estuarine area may be greater than the model portrayed, for the reasons given in general comments. If this is correct, then the model will have overstated the effects of ammonia and CBOD on the dissolved oxygen in the area.

9. (pg. 23, Recommendation #1): We concur with the report recommendation on page 23 to conduct detailed CTD profile surveys of the lower Snohomish River. We suggest that Ecology review and use as guidance *Determination of Mass Balance and Entrainment in the Stratified Duwamish River Estuary, King County, Washington* (USGS Water Supply Paper 1873-F, by J.D. Stoner, 1972). The data necessary to support horizontal and vertical advective flux terms in a two-layer hydrodynamic model would be developed as follows:

   The profiles would be obtained at 30 to 60 minute intervals, at 3 to 6 locations in the estuary, over complete tide cycles (24.8 hrs). The profiles need not be simultaneous, due to the difficulty of occupying multiple stations. However, concurrent velocity profiling at each station is required.

   If these recommendations are accepted by Ecology, Everett has the following recommendations regarding study protocol. The first is that profiling be conducted with a SeaBird Model SBE-19 or equal. Ecology's instrument (Hydrolab) is not precise or reliable enough to support this analysis. The second recommendation is that the study not be conducted until the river gage at Monroe is below 1,500 cfs or so. The calibration data in your model as well as data collected by Everett in 1993 and 1995 have been at flows significantly higher than critical conditions. The value of collecting additional data at high river flows (>1500 cfs) is questionable.

10. (Pg. 23, Recommendation #2): One of the author's recommendations is that channel geometry in the model be re-evaluated. We concur (see specific comment #4). After this is done, We would be interested in the split of <u>net</u> flows among the various channels (mainstem, Ebey and Steamboat) under various river flow conditions (1,100 and 3,300 cfs).

11. (Pg. 23, Recommendation #3): We concur with this recommendation. Projected mixing-zone based permit limits for ammonia should be used in the model for point source loads, rather than historic effluent data. Further, we recommend that a dynamic wasteload allocation be performed rather than steady-state to more accurately establish these point loads. Specifically, a continuous simulation model could be implemented for all point sources to determine a realistic worst-case combination of river discharge, effluent flows, and effluent ammonia and CBOD concentrations. These would then be used as steady-state loadings for the WASP5 model. This work has already been completed by Everett and will be submitted to Ecology as part of our final mixing zone study report.

12. (pg. 26, last bullet item): The conclusion that copper loading may need to be controlled through the development of a TMDL is not supported by the evidence. The comparison for copper in Class II inspections was only a comparison to an overly conservative permit limit that was appealed and stayed. The stayed permit limit was based on a waste load allocation computed without TMDL considerations, based on inaccurate background estimates, insufficient allowable mixing, and an indefensible marine copper standard that EPA is now in the process of correcting. Better information, available now, suggest that permit limits for copper will not be necessary for Everett as there is no potential to exceed.

13. (Pg. 25, Second bullet): We concur with the use of 1 o/oo salinity for delineating between fresh and marine water quality criteria. However, we do not agree with the delineation of water quality classification on pages 16 - 18 of the report, as shown on Figure 3. The TMDL proposes to establish the line between fresh and marine criteria at approximately mile 5.5 on the mainstem, based on modeled salinity results at an annual average low flow of 6,577 cfs. There is no regulatory or physical basis for using this river flow rate to establish the criteria for water quality protection during low flow conditions.

    This TMDL is seeking to protect water quality during the 7Q20 low river flow condition of 1,051 cfs. Therefore, the location of the line separating marine and fresh water criteria should also be established at the same low flow condition. The marine criteria should apply from possession Sound up to approximately mile 12, including all the mainstem and sloughs. Fresh water criteria would apply above mile 12.

    Figure 14 illustrates the incompatibility of the criteria and model results. The dotted line showing the D.O. standard, based on 6,577 cfs river flow, is specified by an absence of saline water above mile 5.5. However, the model runs are based on 1,051 cfs river flow. Modeled D.O. concentrations upstream of mile 5.5 are clearly an artifact of intrusion of low D.O. saline waters beyond that point.

14. (Pg. 36-37, Figures 4-5): It would have been useful if the reach (or channel) numbers between nodes of the DYNHYD and EUTRO5 models (Figures 4 and 5) had been labeled.

15. (Pg. 38-40, Figures 6-8): The calibration results in Figures 6 through 8 are not particularly compelling because salinity is depth averaged in both the observed data and the model predictions. Widely varying dispersion coefficients were used to artificially calibrate the model to salinity. This masks the advective and dispersive processes that occur in the waterway. A two-layer hydrodynamic model is necessary to replicate the horizontal and vertical flux of sea water in the estuary.

16. (pg. 45, Figure 13): The marine criteria should extend to river mile 12 for the simulation based on this figure.

17. (pg. 46, Figure 14): The profile that shows the lower levels ("deficits") of dissolved oxygen associated with high tide shows no difference between the "without loads" and "with loads" condition between river miles 5 and 14. However, deficits are presented for all the profile between river miles 0 through 15 on the profile that is actually associated with the low tide. It is unclear what happens to the high tide oxygen deficit.

    The figure incorrectly assigns a low water profile to a high water mark on the insert graph. It also incorrectly assigns a high water profile to a low water mark on the insert graph.

    This figure makes the case for reclassifying the estuarine reach of the Snohomish River as Marine Class B water based on the dissolved oxygen levels, particularly when the "Without Loads" modeling shows that values are less than 6.0 mg/L.

18. (pg. 47, Figure 15): This figure makes the case for reclassifying Steamboat Slough as Marine Class B water based on the dissolved oxygen levels, particularly when the "Without Loads" modeling shows that values are less than 6.0 mg/L.

    Also note that the "With Load" scenario appears to result in less than a 0.2 mg/L change when the D.O. is less than 6.0 mg/L.

19. (pg. 48, Figure 16): This figure makes the case for reclassifying Ebey Slough as Marine Class C water based on the dissolved oxygen, particularly when the "Without Loads" modeling shows that values are less than 5.0 mg/L. Also, where should the transition to freshwater Class A appear? The 1 o/oo salinity intrusion up Ebey Slough will be comparable to and perhaps even greater than that for the Snohomish River.

    Also note that the "With Load" scenario appears to result in less than a 0.2 mg/L change when the D.O. is less than 6.0 mg/L.

20. (pg. 52, Table 2 and pg. 55, Table 5): These tables list dissolved oxygen levels for the different waste water treatment effluents as assumed to be 6.0 mg/L. Is there any information that suggests any other values? Also, each of these tables list Deadwater Slough as having a very high dissolved oxygen levels of 12.0, yet page 26 proposes additional studies to find the causes of low dissolved oxygen in Deadwater Slough.

Table 2 also lists Non-algal CBODU data used in the model calibration. It is not clear where the values for Everett's north and south effluent came from. Specifically the CBODU for the north outfall (lagoon) is almost four times that of the south outfall (TFSC). Historically, both effluents are much closer in CBOD than the data presented here.

21. (pg. 53, Table 3): Table 3 lists model constants for eutrophication kinetics of 0.02 per day for "Non-predatory phytoplankton death rate". We think that a constant of very close to 1.0 is more appropriate for the freshwater phytoplankton, given that freshwater phytoplankton (and zooplankton) entering salt water will die because they are not tolerant of saline conditions.

22. (pp. A-1, B-1 and B-2): This table shows that Team 1 was supposed to sample the surface and 10 meters at Port Gardner station POG34 on 8/16/93 and 8/17/93, but in the actual data on pages B-1 and B-2 show that they sampled 4.5 meters instead of 10 meters deep on 8/16, and 5.2 meters instead of 10 meters on 8/17. This probably results in a higher dissolved oxygen attributed to the marine source waters than was actually present.

23. (pg. C-1 to C-2, Norm Glenn memo re Class II Inspection): See attached letter to Norm Glenn dated October 9, 1995.

24. (pg. C-6, Table 2): The double asterisk at the bottom notes that the Temperature sample was an "iced composite sample". This does not make sense.

25. (Pg. D-1, D:JUNCTION data): The reach between nodes 25 and 30 in DYNHYD (shown on Figure 4) appears to be missing from the code.

G:\DATA\ROBERT\FILES\NPDES\TMDL_MZ\TMDLCOM4.DOC

Attachment 2

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

P.O. Box 47600 • Olympia, Washington 98504-7600

(206) 407-6000 • TDD Only (Hearing Impaired) (206) 407-6006

May 7, 1996

Robert Waddle
City of Everett
3200 Cedar Street
Everett, Washington 98201

Dear Mr. Waddle:

Thank you for your comments on the Snohomish River Estuary Dry Season TMDL-Phase I report. They are very constructive, and will help improve the project. Your comments highlight two important topics that need to be resolved before the project is completed: (1) the classification of the lower river and sloughs, and (2) the appropriateness of the model used to predict water quality in the Snohomish River Estuary. The classification question will have to be addressed by Ecology's Water Quality Program. We (Ecology's Watershed Assessments Section) will pursue an independent review of the model to help resolve the second question. In addition, it would be helpful to meet to discuss future work and possibly resolve some of the modeling issues raised in your review.

Please note that the Phase I Calibration Report is an interim report. The report was designed to initiate appropriate discussions between Ecology and those affected by the TMDL, or other interested persons. No regulatory actions or permits will be initiated based on the interim report. The list of recommendations on pages 23-24 were included because we realized additional data were needed to improve the accuracy of the model before it could be finalized. The model will be recalibrated based on data and information collected since the August 1993 surveys. The recalibrated model will likely have changes that substantially affect the ultimate model predictions. Responses to your general and specific comments are listed below:

General Comments 1-5:

1. It is our understanding that the Water Quality Program will not de-list the lower river based on the Phase I estimate that dissolved oxygen levels may be degraded by human-caused activities. In addition to addressing 303(d) listed segments in the drainage, the TMDL was initiated because of concern that increased growth in the area could lead to increased discharges to the river.

2. Ecology recommends using EPA-supported models, and WASP5 is one of the few generalized EPA-supported models that can be used to link water quality and hydrodynamics, including tide changes. Ideally, the modeling would be dynamic in time and dimension. However, the hydrodynamic subroutine which includes tide dynamics cannot be used with a two-layered water quality segment network. This limitation negates the possibility of developing a dynamically stratified hydrodynamic model. Notwithstanding this limitation, we believe the modeling presented in the Phase I report accurately represents the potential far-field effects of pollutant loading to the channelized portions of the river estuary system.

   Your major criticism is that "the model holds Everett's effluent within the modeled estuary longer than actually occurs in the real world." You believe that the model misrepresents the actual exchanges of water that occur in the estuarine portion of the Snohomish River, because it does not treat the segments as stratified.

   In order to respond to your comment it is first helpful to separate the modeled system's hydrodynamics into two major regions: the bay, and the tidally-affected lower river and sloughs. The bay is a fully developed estuarine region, where the two-layered circulation you describe is likely correct. But in the river and sloughs, stratification does not appear to be significant under low river flow conditions. The following are some supporting reasons why we believe the vertically-averaged model accurately represents the system under low river flow conditions:

   - The river (and sloughs) are probably stratified during incoming tides most of the year, but the field data collected during the 1993 survey and a survey conducted in September 1995 suggest that it is not stratified under low river flow conditions (e.g., 7Q20). Generally, we would expect that the lower the river flow, the more likely tidal mixing will occur (i.e., under low river flow, tidal flow will be significantly greater than fresh water flow, which should increase mixing). In addition, frictional mixing during an incoming tide and low river flow probably occurs throughout the lower river and sloughs, because they are relatively shallow.

   - During the 1993 calibration survey and the September 1995 survey, the difference between top and bottom salinity was found to only be 0.5-3 ppt at stations POG34 and SNO21 (about an hour before high slack tide). Stations SNO20 and SNO18 had greater differences between top and bottom salinities, but they were still found to be partially tidally mixed. In addition, the difference between surface and bottom dissolved oxygen concentrations was usually less than 0.6 mg/L for all the sampling stations in the lower river (with the exception of Station 20, which is located in the deepest segment of the river). This also suggests mixing of salt and fresh water throughout the lower river.

- The results of two conductivity surveys conducted to find the upstream 1 ppt saltwater boundary showed the system to be partially- to well-mixed upstream of the I-2 bridge during the incoming high tide.
- In the later part of the incoming high tide period, complete tidal reversals were observed at most of the sampling stations in the lower river and sloughs. A estuary/river is considered one-dimensional when it is subjected to tidal reversals.
- The major purpose of model segments associated with the bay is to establish boundary conditions well outside the area of interest (i.e., the lower river and sloughs). We do not consider more detailed modeling of the bay necessary unless significant water quality changes are predicted in the bay segments by the model. Stratification in the bay supports the assumption that the river and sloughs are most likely mixing with the surface 8-10 meters at low tide, and are most likely affected by the surface waters at high tide (see response to specific comment #6).

3. The model has been calibrated to salinity, which is an appropriate chemical tracer given the complexity and extent of the model network. However, using the segment specific dye tracer study results to check/recalibrate the accuracy of the model with respect to the amount of Everett's WWTP effluent that is recirculated, is a good suggestion that we will pursue. (We did not receive Figure 9, nor have we received the results of the August 1995 mixing study.)

4. A discussion of the classification of the estuary is appropriate and will be an important part of the project. However, the Water Quality Program, not our program, determines the classification of water bodies. In the report, we are making a recommendation to the Water Quality Program (our client) that the system be reclassified. As an interested group, you can best propose changes to the classification of the Snohomish River and sloughs through the Water Quality Standards Triennial Review process.

   Currently, the river is classified by regulation as Freshwater Class A (from the river's mouth upstream). The Phase I report discusses a recommendation for reclassification based on our interpretation of the upstream extent of the estuary. As discussed on pages 16-18 of the report, the proposed classification scheme for the estuary is based on protecting habitat that would likely be supported (i.e., either established saltwater-tolerant or freshwater biota habitat). After publication of our report, Everett (1995) completed an estuary wetland integration plan based on plant habitat analysis. The boundaries proposed in the Phase I report appear to closely represent established wetland saltwater and freshwater plant communities inventoried by Everett.

   It should be noted that strict application of the Freshwater Class A dissolved oxygen criterion in the Snohomish River would require that dissolved oxygen levels not be degraded by human activity below natural conditions in the Snohomish River (i.e., natural conditions become the criteria when they are below the criteria). This would require the elimination of all point and nonpoint sources of pollution to the river. As an alternative to this restrictive interpretation of the water quality standards, we have proposed three major changes: (1) reclassify the lower river to Marine Class A; (2) allow natural dissolved oxygen levels to be degraded up to 0.2 mg/L by human-caused activities in the marine waters; and (3) allow natural dissolved oxygen levels to be degraded up to 0.2 mg/L by human-caused activities in the freshwater portion of the Snohomish River, where natural conditions are projected to be below the freshwater criterion.

5. The tributaries to the Snohomish River account for most of the nonpoint loading to the system at low river flow or dry season conditions. The system is also somewhat buffered from direct inputs of nonpoint pollution during dry conditions, because most of the river and sloughs are diked. Drainage from most of the agricultural area in the river basin is concentrated in French Creek, Marshland, and Deadwater Slough drainages. Load allocations for all of the tributaries will be included in the final TMDL report.

Responses to Specific Comments

1. We generally followed the major elements identified by EPA (1995a and 1995b) for sample collection and analysis. Ecology's Laboratory Manual describes ultra-trace metals determination procedures (Kammin 1994).

2. Please contact Bill Kammin, Manchester Environmental Laboratory, 360-871-8801 for information about metals reporting limits.

3. The statement in the report about copper as a pollutant of concern in the lower river and sloughs is based on Class II inspection reports and the results of the two metals surveys listed in Appendix B.2. The recommendation on page 26 is that copper <u>may need</u> to be controlled through the development of a TMDL. Plus, we base our water quality studies and interpretations on existing criteria, not possible future criteria.

   We still believe that copper is a pollutant of concern in the lower river and sloughs, and the next step should be to evaluate existing data (including the metals data collected by Everett), and possibly conduct a more complete study of the sources and ambient concentrations of copper throughout the lower river and sloughs. A further discussion of this issue will be included in the final TMDL report.

4. The channel geometry in the model from the entry to the river at the breakwater and from the mouth of the sloughs to the boundary in Possession Sound is simplified. Some of the reasons for the simplification are listed on pages 10 and 11 in the report. Additional reasons for the simplification are listed below:

- Even though some channels are exposed at low tide, much of the area shown as exposed tide flat on the NOAA charts of the Everett Harbor area were not exposed at low tide during our surveys (when minus tides occurred). We also found the water depths outside Steamboat and Ebey Sloughs to be extremely variable at low tide, but there is a relatively deep water channel that connects the sloughs to Possession Sound.

- 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 in the model tide sequence of approximately -0.4 meter. Also, in order to maintain model stability at the lowest low tide, the minimum depth must be about 0.5 meter.

- The major purpose of the modeling is to predict water quality in the mainstem of the river and sloughs, and not in Possession Sound. The purpose of the seaward network is to set boundary conditions well outside the area of interest.

We don't agree that the model allows too much tidal exchange into Steamboat and Ebey Sloughs relative to the mainstem, because there is a well defined deep channel that connects the sloughs to Possession Sound, and only the geometry of node 37 controls the exchange of water in and out of the sloughs. Plus, salinity in the lower portion of the sloughs can be greater than 20 ppt during incoming high tides, which suggest that exchanges with the marine system are high. We do agree that some of the channels bottom depths should be less than -5 meters and we will change them based on data collected during the summer of 1996.

Setting the depth to -5 meter MLLW in Possession Sound from the main river channel to the boundary (node 35 to the boundaries at nodes 1 and 2) is appropriate, because the surface of Possession Sound is the water mass most likely to mix with the water discharging from the sloughs and river at low tide.

5. As cited on page 9 of the report, Stein et al. (1991) developed a DYNHYD4 hydrodynamic model of the system, which we updated to DYNHYD5. They also developed a TOXI4 mass transport model. The dispersion coefficients from the TOXI4 model were used as initial settings in the EUTRO5 model and adjusted to fit observed conditions. The original estimated dispersion coefficients ranged from 3 to 150 m^2/sec. In our model, dispersion ranged from 0 to 120 m^2/sec. A nominal value of 1 m^2/sec should have been used instead of 0, but the range is reasonable if the differences in transport in rivers versus estuaries, and the model treatment of mass transport are considered.

You comment that "We would not expect dispersion to vary to this degree." Given the change from a freshwater river to tidally-affected, channelized river and sloughs, and then to a more open marine water bay, it seems reasonable that dispersion should vary widely throughout the modeled system. Estimates of dispersion are usually model- and condition-dependent, and in the mixing area of fresh and marine water, dispersion coefficients can only be estimated based on calibrating to field data (as was done). The range of dispersion indicates the difference between the importance of advective versus diffusive transport processes at different points in the modeled system. Also, the hydrodynamic and water quality model time scales are very short (one and six minutes, respectively), and overall smaller dispersion coefficients are needed than if the model had larger time steps.

6. During the August 1995 survey, we found that the water moving into the main river channel during high tide had a similar signature (temperature, salinity, and density) as the water mass between the depths of 3-10 meters of the deep water just outside of Port Gardner. This suggests that we will need to redefine the seaward boundary conditions to represent values between 3 and 10 meters instead of 0 and 10 meters. We will be trying to better define the seaward boundary conditions and water mass movements into the main river channel this summer.

   Bottom samples at POG34 were taken at approximately 0.5-1.0 meter from the bottom.

7. Again, the Water Quality program will have to determine if any reclassification of the system is justified.

8. Again, as explained earlier, we believe the model assumptions accurately represent the river and sloughs at low river flow.

9. As discussed in the response to general comment #2, we do not believe data need to be collected to support a two-layered model for low river flow conditions. We used YSI (temperature, salinity, and conductivity) meters to collect profile data during the 1993 surveys. We used a SeaBird CTD and YSI meters to collect profile data during the August 1995 survey discussed above. Hydrolab (DataSonde) meters were not used to collect profile data during the surveys. They were used during the summer of 1993 to collect continuous diurnal data from different locations in the river and sloughs at one depth. Sampling during summer low river flow is appropriate for calibrating and verifying model results, however targeting a specific low river flow for sampling is not needed, nor is it a realistic approach, in light of the fact that the 7Q20 is only expected to occur once every 20 years.

10. As stated in the report, channel geometry will be re-evaluated. We will provide channel flows estimated by the model for the mainstem, Ebey Slough, and Steamboat Slough in the final report.

11. Regional Permit Managers will be asked to provide critical condition estimates for the different point sources. If recommended by the Permit Manager, we will use estimates provided by your mixing zone study for steady state loading in the WASP5 model.

However, although we generally support using continuous simulations for developing WLAs, it is unclear whether it will improve the final critical loading estimate, or even be possible using WASP5 given all the data permutations that would be required for continuous simulation.

The major problem with continuous simulation in the Snohomish River Estuary WASP5 model is collecting and combining data on dynamic effluent discharge, river flow, and other conditions with dynamic tidal ranges. Since the preverified model suggests that the tides control the critical conditions and critical loading occurs during slack water around neap tides, it is particularly difficult to imagine a dynamic simulation that could be modeled within the confines of the WASP5 tidal boundary data limits. Even if a continuous simulation of the system is possible in WASP5, the benefit of such a model run to the dischargers is questionable because the dissolved oxygen criteria is "not to exceed" and does not have a frequency of violation associated with it. The combination of peak discharge concentrations (which will be higher than the critical effluent discharge conditions used in the Phase I model) and slack water around neap tide will always be the critical period.

If you have a proposal for developing a continuous simulation WASP5 model we will be glad to consider it, but it is our current position that the psuedodynamic model developed for the Phase I report is a reasonable simulation of the potential effects of loading to the system.

12. Discussed in response #3.

13. Classification of the waterbody is a separate issue from the design or critical conditions used to estimate adverse impacts on water quality that could affect aquatic biota and existing or characteristic water uses. We believe that the rationale for the proposed delineation is sound and is generally supported by established plant communities. However, a final determination of the classification issues will have to be made by the Water Quality Program.

14. I began to create a channel/node map, but it had too many numbers and seemed to be confusing, so it was never completed. We will include more complete link/node and segment channel maps for the final report.

15. Discussed previously.

16. Discussed previously.

17-19.
There are a number of reasons why the oxygen deficit profiles are different between low and high tide and location. First, the profiles represented in Figures 14-16 are not an instantaneous snapshot. They show an envelope of the lowest and highest

dissolved oxygen concentrations through a set of segments over the entire model run of 23 days. Consequently it is difficult to make relational statements about the figures, but the major causes of differences are due to a combination of changing velocities, depth, and segment volumes and their effects on rearation and BOD dilution; plus the distance from the major discharge points (especially at neap high slack tide when the maximum deficit occurs at or near slack water).

Your comment about Figure 14 and the relationship between the insert and the graph is somewhat unclear (maybe the graph is a little too confusing). The insert on Figure 14 is Days versus Dissolved Oxygen for segment 35 at river mile 1.4, and is used as an example of how the graph was built. Dissolved oxygen concentrations at most sampling stations on the river and sloughs were found to be inversely related to tide, so the graph is correct with respect to assigning concentrations. Interpretation of Figures 14-16 is discussed on pages 20-21.

As discussed on page 21, the pre-verified model predicted that only segments 35 and 36 would exceed the allowable 0.2 mg/L deficit.

20. Dissolved oxygen levels in most effluents are less than the assumed 6 mg/L used in the calibration data set. We will be collecting effluent dissolved oxygen during the verification survey.

Although Deadwater Slough did not have low dissolved oxygen values during the time it was sampled, we suspect that this eutrophic system could experience diurnal low dissolved oxygen minimums. The text should have referred to studying "dissolved oxygen" not "low dissolved oxygen."

The CBOD5 value was estimated by Norm Glenn from the Class II inspection data. The ultimate CBOD value was calculated as the CBOD5 value multiplied by 1.46. The inspection BOD5 sample data did show a significant difference between the outfalls. In 1995 we measured ultimate BOD at all of the major discharges to the lower river and sloughs in order to get better estimates of the ultimate CBOD. These data will be used to recalibrate the model.

21. As mentioned on the top of page 15, we calibrated the model to chlorophyll *a* by setting the saturated growth rate to best fit the chlorophyll data. The death rate was set to a literature value. Phytoplankton samples were collected as part of the 1993 survey. As expected, the species composition is extremely varied within the river/estuary system. However, the model is limited to estimating only overall population kinetics, which means that spatial changes in kinetics cannot be specifically represented. As you point out, the death rate is probably very high in the transition zone between fresh and saltwater, but this zone does not represent the total modeled area. Increasing the death rate would require increasing the growth rate in order to

match chlorophyll data, which would misrepresent the actual kinetics of the different populations in the modeled system.

22. As discussed in response #6, bottom samples at POG34 (and at all stations where bottom samples were collected) were taken at approximately 0.5-1.0 meter from the bottom.

23. Norm Glenn responded to your letter.

24. The annotation means that measurements were taken from the composite sample, which has ice packed around it to keep the sample cool.

25. Figure 4 is incorrect; Nodes 25 and 30 are not connected. The main channel is from 20, 30, 31 etc.

Thank you again for your comments. If you have any questions, please feel free to call me at (360) 407-6688.

Sincerely,

Bob Cusimano
Watershed Assessments Section

BC:blt
Enclosure

cc: Laura Fricke
John Glynn
Will Kendra
Dave Wright

References:

EPA, 1995a. Guidance on the documentation and evaluation of trace metals data collected for Clean Water Act compliance monitoring. EPA 821-B-95-002. U.S. Environmental Protection Agency. Office of Water. Washington, DC

EPA, 1995b. Sampling ambient water for trace metals at EPA water quality criteria levels. EPA 821-R-95-034. U.S. Environmental Protection Agency. Office of Water. Washington, DC

Everett, 1995. Snohomish Estuary Wetland Integration Plan. City of Everett, Department of Planning and Community Development. Everett, Washington.

Kammin, B 1994. Manchester Environmental Laboratory. Laboratory Users Manual. Fourth Edition. January, 1994. Environmental Investigations and Laboratory Services Program. Washington State Department of Ecology. Olympia, Washington.

Attachment 3

MEMORANDUM

To: Bob Cusimano, Ecology

From: Bill Fox, Cosmopolitan Engineering Group

Date: October 2, 1996

Re: Snohomish Estuary TMDL

Bob, I wanted to get back to you with any concerns or suggestions for the completion of the TMDL model, now that the data collection phase is complete. As discussed on the phone, I am in general agreement as to the modeling approach you have taken. In order to bring to conclusion any outstanding issues, and reiterate previous concerns, the following paragraphs respond to selected issues raised in Everett's February 9, 1996 letter, and your response dated May 7, 1996:

General Comments

2. I still do not necessarily concur that the mainstem is unstratified, as you state. I believe their is a classic two-layer estuarine pattern that enhances net circulation. **However**, I do understand the limitations of the hydrodynamic model, and concur with the modeling approach. The hydrodynamics of a two-layer system will be adequately represented (artificially) if the model is well calibrated to salinity. I assume the principal calibration knobs will be geometry and dispersion.

3. I continue to recommend that the dye study conducted in 1995 be used for the calibration. I was impressed at the fit you obtained with the draft model, and assume you will use the dye study again for the final model calibration, along with the salinity data Everett obtained during your intensive field study August 28, 1996.

Specific Comments

3. You indicated in your response that Ecology will evaluate the potential for a copper WLA further in the final TMDL. We urge Ecology to use the most recent EPA guidelines and precedence in evaluating copper criteria and impacts. We also urge you to consider the ambient data obtained by the City of Everett in the last few years in the mainstem, which in recent meetings you and/or Norm seemed to be unaware of. You can get this data from Dave Wright at NWRO, or Robert Waddle at Everett (206)259-8820.

4. My comments on the channel geometry still stand. I understand that you will be re-evaluating geometry as part of the final. I do concur with your reasons why the model must be simplified (model stability). As stated above, I will be satisfied if the model calibrates to the dye study and Everett's salinity measurements, in the mainstem.

5. I would like to see a sensitivity analysis for the dispersion coefficient in the mainstem.

6. I concur with your response to this comment.

7.

8.

9. Redundant, see above.

10. Redundant, see above.

11. We have not received any response from Dave Wright regarding the mixing zone-based ammonia limit. Please confirm this limit with me or Robert Waddle before proceeding with your final modeling. Also, I think you misinterpreted this comment. The continuous simulation (in our mixing zone study report) would be used to establish mixing zone-based limits, which would then be used as steady-state values in the TMDL model.

12. Comment stands, see above.

13. In the final TMDL model runs, please plot salinity with dissolved oxygen on the same figure. We will argue that any time salinity exceeds 1 ppt, marine criteria apply, not an arbitrary fixed boundary. The location of the boundary between salt and fresh water is transient in the estuary, so should be the dissolved oxygen criteria. If the salinity exceeds 1 ppt, the dissolved oxygen standard is 6 mg/L, regardless of location. Please advise us if the Water Quality Program advises you on this matter, prior to completing the draft TMDL.

In conclusion, I am encouraged by your modeling efforts thus far, and your plan for completing the task. My principal concern will be that the model is calibrated to the 1995 dye study and <u>continuous</u> salinity and dissolved oxygen data on August 28, 1996 in the mainstem. Please contact Robert Waddle to acquire the 1996 field data.

Please call if you have questions.

cc: Robert Waddle

Attachment 4

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

P.O. Box 47600 • Olympia, Washington 98504-7600
(360) 407-6000 • TDD Only (Hearing Impaired) (360) 407-6006

November 13, 1996

Mr. Harold Ruppert
Weyerhaeuser Paper Company
101 East Marine View Drive
Everett, Washington 98201

RE: SEPA

Dear Mr. Ruppert:

This letter confirms my telephone conversation with you held on November 12, 1996. As we discussed, Ecology made a Determination of Non-Significance (DNS) on the proposed outfall construction project. This determination was made last July.

I also want to reiterate that Ecology is requiring SEPA be addressed on the new permit to be issued for both projects (i.e., Snohomish River deink facility and the Domtar Soda mill facility). As part of that submittal, (once DOMTAR has made the decision to proceed), an updated NPDES application will be required. I look forward to working with you once that decision to proceed has been made. If the treatment system is sold to Snohomish River Pulp Company prior to issuing the permit, the same process as described above will be required. Thank you for your efforts on this project.

As I also mentioned to you during my telephone call, Ecology is developing a Total Mass Daily Loading (TMDL) for the Snohomish delta area. This TMDL could impact the final limitations in the new permit. If you should have any questions, please call me at (360) 407-6934.

Sincerely,

Marc E Crooks

Marc E. Crooks, P.E.
Pulp & Paper Mill Specialist

cc: Merley McCall, Ecology
Mike Palko, Ecology
Bob Cusimano, Ecology

Attachment 5

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. Box 47600 • Olympia, Washington 98504-7600
(360) 407-6000 • TDD Only (Hearing Impaired) (360) 407-6006

February 12, 1997

Mr. Michael D. Elmer
SRPC Associates
10500 NE 8th Street
Bellevue WA 98004

RE: Status Letter for Corps Reference No. 96-2-00882, Nationwide Permit #12 for Snohomish River Pulp and Paper Company -- Install an effluent pipeline and outfall diffuser structure. The proposal is located in Steamboat Slough, Snohomish River estuary near Everett, Snohomish County, Washington.

Dear Ms. Walters:

I am writing to let you know that I received substantial comments from Mr. John Glynn, with Ecology's Water Quality Program, during the 20-day public notice. Mr. Glynn requested that the Section 401 Water Quality Certification not be issued until he has had an opportunity to evaluate the projected load from the facility with the Total Maximum Daily Load (TMDL) model of the lower Snohomish River. Until Ecology can do this, we do not know whether this discharge, or the cumulative impacts of this discharge and others in the estuary, will meet state water quality standards.

For this reason, I am unable to certify that construction and operation of this facility is consistent with state aquatic regulations and the Coastal Zone Management Act at this time. The draft report should be available for review around mid April, and the final report should be available by the end of June. During the draft review period, Ecology should have a better idea of the project's possible impacts to water quality in the Snohomish River.

Approval of this project is being held in abeyance by the state pending resolution of the issue identified above. Please call me at (360) 407-6926 if you have any questions.

Sincerely,

M Vernice Santee

M. Vernice Santee
Environmental Review and Sediment Section

cc: Natasha Walters, CH2M HILL
Evan Lewis, COE
John Glynn, Ecology
Bob Cusimano, Ecology
Marc Crooks, Ecology

DRAFT January 12, 1998

Attachment 6

Snohomish River Estuary Dry Season TMDL Study - Phase II

Technical Addendum
Number 1

by
Robert F. Cusimano

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Watershed Assessments Section
Post Office Box 47600
Olympia, Washington 98504-7600

January 1998

Background

In June 1997 a final report was published by Ecology entitled, "Snohomish River Estuary Dry Season TMDL Study – Phase II" (Cusimano, 1997). The report discussed the development of a water quality model that was used to recommend waste load allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources of carbonaceous biochemical oxygen demand (CBOD) and ammonia BOD discharging to the Snohomish River and Sloughs.

Currently, the Snohomish River Regional Water Authority (RWA) is in the process of submitting SEPA documentation for a proposed water right transfer from Weyerhaeuser Company to the RWA. The certified water right is for an instantaneous withdrawal rate of 56 cfs (36 mgd). The intake for the withdrawal is located in the upper reach of Ebey Slough, which is in the proposed TMDL area (Figure 1). The water right was not included in the original TMDL analysis, because it was not being used during the summer 1993-1996 study period (the Weyerhaeuser plant stopped manufacturing at the end of April 1992). However, if the water right will be used in the future it should be included in the TMDL analysis. This Addendum was prepared to assess the effect of the use of the water right relative to the proposed BOD TMDLs and associated WLAs and LAs.

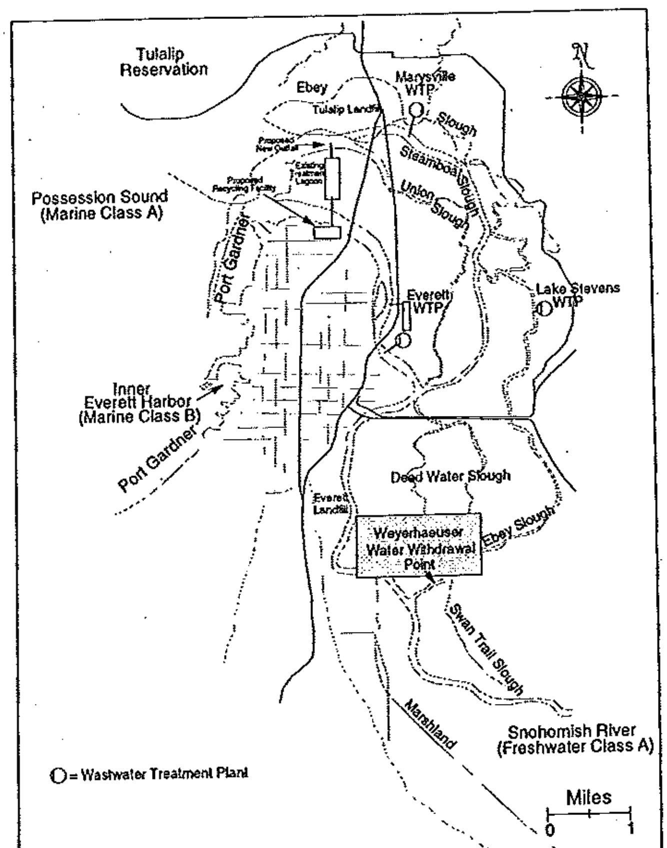

Figure 1. Map of sloughs and near shore estuary within TMDL study area.

The following analysis is prefaced by the fact that water withdrawals and water quality are regulated by separate sets of laws and policies, which are administered by separate programs in Ecology (the Water Resources and Water Quality Programs). Consequently, it is unclear how the exercise of the legal Weyhaeuser water right should be treated in the Snohomish BOD TMDL analysis. For example: (1) should the existing, perfected Weyhaeuser water right be included as a discrete effect on water quality in the TMDL analysis, and possibly restricted as part of the TMDL (i.e., treated like a pollutant), (2) if the water right can not be regulated under the TMDL, how should the withdrawal be treated in the technical analysis to determine WLAs and LAs, and (3) how should all the other water rights in the drainage basin upstream of the boundary condition (i.e., upstream of river mile 20) be treated? These questions raise additional legal and policy questions that can only be addressed by the joint efforts of Water Resources and Water Quality Programs.

The objectives for this analysis are to discuss how other water rights are incorporated in the Snohomish CBOD and ammonia TMDLs, assess the possible effect of the Weyhaeuser water right on water quality, and make a recommendation for treating the Weyhaeuser water right in the TMDL analysis.

Weyhaeuser Water Right and Water Quality TMDLs

In any basin, there are usually water rights that are not being used, or only partially used. It is generally not possible to assess all of the active and inactive water rights in a basin. However, historic water withdrawals are included in the 7Q10 low flow statistic used as part of the critical design conditions for TMDL analysis. The critical low flow is considered "background conditions." Background conditions are defined in Chapter 173-201A WAC as, " *the biological, chemical, and physical conditions of a water body, outside the area of influence of the discharge under consideration*." This should not be confused with "natural conditions," which is defined in the WAC as "surface *water quality that was present before any human-caused pollution*."

In part, Ecology's usual practice has been to rely on minimum flow calculations to protect water quality, and has not tried to separate water consumption in low flow analyses for TMDLs. Water consumption usually affects TMDL analyses by lowering the flows used to assess water quality under critical conditions, thereby reducing a waterbody's assimilative capacity and ability to dilute pollutants. This is an important distinction, because the Snohomish TMDL analysis was prepared to assess the impact of BOD loading under critical conditions, and was not conducted to be a "flow" TMDL.

In the Phase II report, critical conditions were evaluated in the model to estimate the potential effects of current and future BOD loading to the estuary system. Critical conditions were defined as those possible physical, chemical, and biological characteristics of the receiving water and pollutant loading sources that could increase the adverse effects of BOD containing substances. As part of the critical conditions, a seasonal critical river flow for the TMDL period (July-October), equal to the probability of a 7Q10 low flow, was calculated and input in the model as part of the upstream (background) boundary conditions. The background flow was based on daily records from the USGS station located at about river mile 20. As noted above, the calculated low flow background condition includes historic water withdrawals in the upper basin.

The Weyhaeuser water right is in the modeled area, but downstream of the gauge station used to calculate the upstream boundary flow. In order to be consistent with the treatment of the other water withdrawals in the drainage basin, the actual historic Weyhaeuser water withdrawal for the TMDL period should be included as part of the background conditions for establishing BOD WLAs and LAs. Representatives of the RWA determined that the daily average Weyhaeuser historic withdrawal was 25.7 mgd for the TMDL period. As a potential new human impact on water quality, the difference between the authorized right of 36 mgd and the historic use of 25.7 should be evaluated separately, and possibly subject to restrictions. However, it is unclear what restrictions should be recommended.

Modeling Critical Conditions with the Weyhaeuser Historic Water Use

In order to establish the WLAs listed in the Phase II report, the model was run with reduced point source loads of total BOD until all model segments caused no more than a 0.2 mg/L dissolved oxygen deficit. The deficits were calculated for each model segment, as the difference between model results for the estimated background conditions and alternative BOD loading scenarios. Table 1 lists predicted dissolved oxygen concentrations with and without the proposed water withdrawal for representative model segments under background conditions and for the exercise of the full water right of 36 mgd. The model results show that including the historic water withdrawal lowers the dissolved oxygen concentration by as much as 0.21 mg/L in model segment 57. The results for the full water right show that the predicted dissolved oxygen concentration at segment 57 would be lowered 0.24 mg/L, or an additional 0.03 mg/L.

Including the historic water withdrawal as part of the background critical conditions will not change the proposed WLAs listed in the Phase II report, however, it does lower the background conditions. The effect of withdrawing the full water right on the TMDLs will depend on how Water Resources and Water Quality choose to treat the withdrawal. The full water right could be restricted based on a minimum river flow requirement that would mitigate the effect of the withdrawal on dissolved oxygen, or the impact could be mitigated by reducing the proposed BOD TMDL loads. For example, the full water right could be used until the river reaches a minimum river flow of approximately 1350 cfs (at the river mile 20 USGS gauge). At this river flow, with the additional 10.3 mgd withdrawal, model predicted dissolved oxygen concentrations would be greater than or equal to those estimated for the TMDL background conditions. Alternatively, the impact of the full water right could be mitigated by reducing the proposed WLAs for CBOD by 7 mg/L.

Table 1. Model predicted maximum (MAX) and minimum (MIN) dissolved oxygen concentrations (mg/L) with and without the Weyerhaeuser water withdrawal under background conditions (i.e., without point source BOD loads and nonpoint sources set at estimated background conditions).

Model Segments	No withdrawal		25.7 mgd withdrawal				36 mgd withdrawal			
	Max	Min	Max	Min	Deficit	Deficit	Max	Min	Deficit	Deficit
Segment 34	7.13	5.72	7.03	5.68	0.10	0.04	7.01	5.68	0.12	0.04
Segment 36	7.50	5.97	7.42	5.91	0.08	0.06	7.40	5.89	0.10	0.08
Segment 43	8.44	7.25	8.43	7.15	0.01	0.10	8.42	7.12	0.02	0.13
Segment 46	8.61	7.86	8.61	7.81	0.00	0.05	8.61	7.79	0.00	0.07
Segment 50	6.60	5.42	6.41	5.34	0.19	0.08	6.37	5.32	0.23	0.10
Segment 55	7.05	5.64	6.83	5.48	0.22	0.16	6.79	5.45	0.26	0.19
Segment 56	7.24	5.79	7.05	5.61	0.19	0.18	7.01	5.58	0.23	0.21
Segment 57	7.41	6.05	7.22	5.84	0.19	0.21	7.18	5.81	0.23	0.24
Segment 58	7.52	6.50	7.47	6.36	0.05	0.14	7.47	6.33	0.05	0.17
Segment 64	6.86	5.36	6.65	5.20	0.21	0.16	6.62	5.17	0.24	0.19
Segment 66	7.56	6.11	7.39	5.93	0.17	0.18	7.35	5.89	0.21	0.22
Segment 68	7.77	6.76	7.66	6.61	0.11	0.15	7.63	6.58	0.14	0.18

Conclusions and Recommendations

The Snohomish River Estuary Dry Season TMDL Study was completed in June 1997. However, the TMDL analysis did not include a Weyerhaeuser Company water right to withdraw up to 36 mgd from the upper part of Ebey Slough. The Snohomish River Regional Water Authority (RWA) is in the process of requesting a transfer of the Weyerhaeuser Company water right to the RWA.

Including the water right in the TMDL analysis has the effect of lowering the model estimated dissolved oxygen concentrations in the estuary by as much as 0.24 mg/L.

It is recommended that the historic use of the water right of 25.7 mgd be included in the TMDL analysis as part of the background conditions. It is also recommended that the

Water Resources and Water Quality Programs determine how to mitigate the impact of the full water right of 36 mgd on water quality at low river flows (i.e., the impact of the 10.3 mgd that has not been used historically).

Two alternative approaches for mitigating the impact of the full water right are proposed: (1) set a minimum river flow requirement of approximately 1350 cfs (at the river mile 20 USGS gauge), or (2) reduce the proposed WLAs for CBOD by 7 mg/L.

There are other possible treatments of the water withdrawal: (1) include the total effect of the water right in the TMDL as a WLA, and (2) condition the total withdrawal with a minimum flow requirement (e.g., use minimum flows established by the Snohomish River Basin Instream Resources Protection Program for the gauge at river mile 20).

Reference:

Cusimano, R.F. 1997. Snohomish River Estuary Dry Season TMDL Study – Phase II: Water Quality Model Confirmation and Pollutant Loading Capacity Recommendations. Publication No. 97-325. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program, Olympia, WA.

Attachment 7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

MAR 11 1998

Reply to
Attn. of: OW-134

Will Kendra
Washington Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

Re: Snohomish River Estuary Dry Season TMDL Study - Phase II; Water Quality Assessment of Tributaries to the Snohomish River and Nonpoint Source Pollution TMDL Study

Dear Mr. Kendra:

The U.S. Environmental Protection Agency, Region 10 (EPA) has reviewed the referenced studies and recognizes the substantial effort the Washington Department of Ecology (Ecology) has made in developing the technical documents to support the Snohomish River Total Maximum Daily Load (TMDL) Study. We find the modeling appropriate and technically sound, and the documentation thorough. However, EPA has identified the following issues which need further clarification. We are also attaching EPA's previously submitted comments and ask that Ecology address them as well.

- Although the study area is one of the fastest growing regions in the state, there is no provision for growth in the waste load allocations (WLAs) and load allocations (LAs). Local jurisdictions are planning for substantial growth of population and industrial capacity. The city of Everett will need to expand its wastewater treatment plant (WTP) capacity. The city of Lake Stevens has limited reserve capacity and Marysville is considering expansion from 6 to 12 mgd. The existing NPDES permits do not meet the proposed WLAs in the study. Weyerhaeuser has a "right" to a WTP discharge from Smith Island (but the mill is now closed). How will growth be addressed in the TMDL allocations? What process will Ecology use to allocate WLAs?

- The WTP from the Tulalip Indian Reservation discharges to Mission Bay. Ecology reported there is no known influence that the WTP is having on DO in the Snohomish estuary. In its analysis, did Ecology consider the potential DO impact from industrial/residential growth on the reservation? Was the issue of growth discussed with the Tribe?

- The analysis for the loading capacity does not appear to include a margin of safety. A margin of safety is mandatory especially for a TMDL derived from modeling studies and in an area experiencing rapid growth. Please describe how Ecology has applied, or intends to apply, a margin of safety in this TMDL?

- The state's dissolved oxygen water quality standard for marine waters allows for a 0.2 mg/l depression due to human-caused activities when natural conditions are near or below 6 mg/l. For this TMDL study, EPA is not convinced that the evidence supports the conclusion that existing DO concentrations are depressed to near or below 6 mg/l by natural conditions. There are substantial inputs of oxygen demanding pollutant loadings from human sources, both above the confluence of the Skykomish and Snoqualmie Rivers and in the Snohomish estuary study area. We believe there may be a confusion of "background" with "natural condition," and that the measured DO levels do not reflect natural conditions. Please provide additional information to support Ecology's conclusion that the reduced DO levels in the study are due to non-anthropogenic causes. Note: It may be helpful to refer to the Snoqualmie River TMDL, specifically the sources of pollution and the load allocations primarily for the nonpoint sources.

- The nonpoint source study of tributaries does not include description of control measures. (Although as yet uncompleted management plans are referenced.) When allocating portions of the loading capacity to both point and nonpoint sources of pollution, there must be reasonable assurance that the measures to achieve the necessary LAs will be implemented in order to give relief to the point sources via their WLAs. As part of the TMDL study, a summary implementation plan, identifying both point and non-point source control measures, needs to be provided.

- The NPS study objectives imply that all parameters affecting impairment (and 303(d) listing) are to be addressed. And yet, the study conclusion and results focus only on fecal coliform. Does Ecology intend to address all parameters at this time?

Again, we wish to state our appreciation of the effort that has gone into these studies. We continue to be ready to work with Ecology to resolve remaining issues and concerns. Should you have questions regarding these comments, please contact Alan Henning at (206) 553-8293.

Sincerely,

for Tim Hamlin
Manager, Water Quality Unit

Enclosure

cc: Bob Cusimano

e-mailed to Ecology 5/29/97

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

Reply To
Attn Of: OEA-095

MEMORANDUM

SUBJECT: Snohomish Estuary Dry Season TMDL Study - Phase II

FROM: Rob Pedersen
OEA, Risk Evaluation Unit

TO: Alan Henning
OW, Water Quality Unit

The following comments for Washington State Department of Ecology's Snohomish River Estuary Dry Season TMDL Study - Phase II Final Report are based on information from the 16 May 1997 meeting at Ecology's Northwest Regional Office (NWRO) and a general review of the Phase I and Phase II documents.

Ecology's modeling and proposed TMDL represent a thorough effort. From a policy standpoint, there are a few issues for EPA to consider as the Snohomish River estuary TMDL process continues. The issues are key drivers in how this proposed TMDL or a revised TMDL will be implemented. Most of these concerns were also touched on during the meeting at Ecology's NWRO (these items are discussed in more detail later in the memo):

- The TMDL has no reserve for growth; the Everett/south Snohomish County is one of the fastest growing areas of the state.
- Interpretation of the dissolved oxygen (DO) water quality standard. A defensive strategy will be needed for using 'when natural background DO conditions are near or below 6 mg/l, then a 0.2 mg/l depression due to human-caused activities may be allowed'; and, applying this interpretation to freshwater, as well as marine water versus the Marine Class A absolute requirement of 6.0 mg/l. There may also be

antidegradation issues.

From a technical standpoint, Ecology's interpretation and application of the DO standard to this modeling may make sense. However, the 0.2 mg/l DO allowance is for marine waters with existing DO concentrations depressed to near or below 6 mg/l from natural conditions. DO levels in the lower Snohomish River cannot be considered to be caused by natural conditions because of the current oxygen demanding pollutant loading from human sources. Modeled, "natural" conditions are used to prepare TMDL alternatives. The modeling effort estimates what the DO concentration is without any BOD loading, i.e. the model determines a baseline as if there is no "human BOD" input. Nonpoint sources of human-generated BOD loads or loads from say, the Snoqualmie River are deemed insignificant sources. I'm concerned that utilizing the 0.2 mg/l allowance as a basis for the Snohomish River estuary modeling is a problematic interpretation of WAC 173-201A. Also, even though the model seems to be an accurate predictor, some interests may not believe the predicted natural DO concentrations are "really natural".

- Nonpoint pollution, apparently a minor contributor of oxygen demanding materials is not considered in detail.

- Copper is mentioned as a possible problem pollutant for a potential TMDL (p. 28). Perhaps stating that all other water quality standards are met, except for copper and DO, would be informative; or some general statement regarding all other toxics and nutrients.

When I first started reading the reports I assumed the study would include major tributaries such as the Skykomish and Snoqualmie Rivers. To help an outside reader - not previously involved with the project, to quickly see the bounds of the modeling effort for the TMDL, an additional sentence or two in the Introduction (paragraph 3, page 6) would help. The title clearly states the TMDL is for the Snohomish estuary. However, Figure 2, in addition to tables and figures of sampling stations and model segment numbers, give the impression of perhaps a greater geographic application of the modeling effort. Helpful information up front would delineate the 1996 study area from the actual bounds of the proposed TMDL. For example:

- The upstream boundary for this study is near, but below the confluence of the Snoqualmie River; this location at approximately RM 18.5 represents the upstream boundary of tidal influence to the Snohomish River.

- Considering the WASP5 modeling for the TMDL, the upstream limits for model accuracy is to segment 76 (Figure 5) which is many miles below the upstream boundary of the study area. This 'model accurate' area of the estuary includes the significant sources of oxygen demanding materials (e.g., ammonia, BOD) for waste load allocations.

Regarding the two major rivers that form the Snohomish River, other helpful introduction-type information might mention that the Snoqualmie River has a Phased TMDL that primarily allocates loads to nonpoint sources. Also, that Snoqualmie River loading is incorporated in the Snohomish Estuary study through data collection efforts below the confluence of the Snoqualmie and Skykomish Rivers (e.g., at station 10, Figure 2). I understand from the 16 May meeting that the lower Skykomish River was not included in this study for technical reasons regarding estuary modeling constraints, but the explanation in paragraph 3, page 6 is simpler and more to the point.

No reserve for growth. The project objectives make it clear that a TMDL reserve for growth is not included. This should be resolved with the statement on page 21 that critical conditions were modeled considering future waste loading versus the statements on pages 26 and 28 that no allocation was made for future growth (perhaps the page 21 comment refers to the proposed Smith Island industrial discharge.)

Local jurisdictions are planning for population/industrial growth that is expected to continue at a dizzying pace. Everett will need to expand its wastewater treatment plant (WTP) capacity, Lake Stevens still has some capacity, and Marysville is considering expansion from 6 to 12 mgd. The existing NPDES permits do not meet the proposed WLAs in the TMDL. Additionally, Weyerhaeuser has a WTP discharge "right" from Smith Island (water quality segment number 49, page 25), but the mill is closed. Two new pulp and paper facilities and a recycling/deinking plant are planned; the TMDL considers this possibility under one scenario (Table 11) but there is no room under the TMDL's proposed WLAs for the Smith Island facility. The Tulalip Indian Reservation discharges to Mission Bay; theoretically, depending on growth and level of wastewater treatment, there could be an impact on near shore marine DO levels. Currently there is no known influence on DO in the Snohomish estuary due to WTP effluent from the Tulalip Reservation.

Further complications are possible in terms of TMDL reserve for growth. The city of Everett holds a significant water right to pump from Ebby Slough. Although the water right is not currently used, if withdrawal occurs after a TMDL is implemented, then the lack of available dilution may cause water quality standards to be violated and the system would not be in compliance with the TMDL.

Timing of discharges from some of the municipal wastewater treatment plant (WTP) discharges may be controlled, at least somewhat, on a seasonal discharge basis and Everett might consider diverting their WTP discharge to Puget Sound. In fact, a more regional solution to WTP discharge diversion through a deep-water marine outfall (instead of each jurisdiction making independent plans), makes a lot of sense. Apparently this sort of plan was discussed in the past and may not be a foreign idea.

I suspect that the TMDL will need to provide for growth in the Everett area in order to pass muster during the public process. Also, if the lower Skykomish River area experiences significant development, and if there are significant changes in the Snoqualmie River drainage regarding growth or in the ability to control nonpoint source pollution, then the TMDL may not be on track since it deals with current conditions for the Snohomish Estuary. Obviously, as with any TMDL, post-implementation monitoring is an important component.

Water quality standards for DO. The Snohomish River is classified as freshwater Class A (requires a minimum DO concentration of 8 mg/l) in the Washington Administrative Code (WAC) for the whole river including the estuary and sloughs. The WAC allows for the application of the marine classification (Class A, 6 mg/l) where salinity is 1 ppt or greater (WAC 173-201A-060(2); also, see pages 20-21 and 24 of the Phase II document). The practical problem for modeling (and regulating discharge times, monitoring, etc.) with this latter DO standard approach is due to the tidal effect of moving the 1 ppt salinity zone up- and down- stream; hence, one could have a DO standard moving 10 miles upstream with the tides.

A DO water quality standard "option" used for the TMDL (see page 21) is a contingency in the WAC (173-201A) that allows a human-caused 0.2 mg/l depression in marine water DO when the background, natural DO level, is near or below 6 mg/l. The model also applies the 0.2 mg/l allowance to the freshwater portion (salinity less than 1 ppt) of the modeled system when instream DO is near or below 6 mg/l. One can see potential conflict with various interest groups depending on the DO standard interpretation they prefer or whether they believe the modeled background DO concentrations really represent natural conditions.

The modeling work for predictive changes in DO in the Snohomish River estuary is very dependent on the application of this 0.2 mg/l allowance, and a better definition of what constitutes "meeting the standard" is probably needed. For example, various point source loading scenarios with reductions in BOD and at different ammonia concentrations (during critical conditions) are analyzed in the Phase II report for effectiveness by using the 0.2 mg/l allowance (e.g., see Table 10). Regardless of how much pollutant load reduction is required for any given water quality segment of the model (Alternative II and III in Table 10 are deemed to meet the standard), then more explanation is needed for predicted DO concentrations such as 5.22 mg/l or 5.33 mg/l in Table 10. These DO concentrations are considered to be in compliance with the standard because the values are depressed less than 0.2 mg/l from the predicted "natural" DO concentration (i.e., DO levels in the estuary without any point source BOD loading to the system). But, one could argue that you are allowing too much DO depression in this TMDL because the background, baseline DO concentrations estimated for the various model segments start out lower than true natural conditions. Nonpoint and upstream BOD loads, however small, might support such a claim. If the allowance can be applied for marine waters with DO levels currently near or below 6 mg/l, then the allowance can be applied to any natural DO concentration, no matter how depressed that natural level is. For the proposed TMDL to move into the public review process, I believe a better defense is need for: the use of this "allowance caveat"; applying the allowance to freshwater; and, that the predicted DO concentrations without BOD loads in Table 10 represent natural conditions.

Assume for the moment that it is legitimate to apply this 0.2 mg/l allowance to the Snohomish River. Another possible source of controversy is how the allowable 0.2 mg/l DO standard is applied in the model. For example consider, segment 57 (page 25 and Figure 5) which was found to be the "critical" model segment in the system, or the segment which requires the most load reduction to meet the standard. The allowance is applied to "predicted natural" values near 6 mg/l in this segment (see Table 10 or 11). The allowable 0.2 mg/l deficit is applied to the predicted deficit so that the final DO with point source loads is 5.85 mg/l or 0.15 mg/l below the marine standard (DO depressed from 6.05 to 5.85 mg/l is "OK" by this approach). A more stringent argument would say you only have 0.05 mg/l to "give away" through additional DO depression (i.e., going from 6.05 mg/l DO to the marine Class A standard of 6.0 mg/l, not 5.85 mg/l). See page 25, Tables 10 and 11.

Also, consider a river segment with a DO concentration above 6.0 mg/l. That is, at a concentration not deemed to be "near" 6.0 mg/l (say, 6.5 mg/l) so that the 0.2 mg/l allowance does not apply, and that the proposed TMDL allows to depress to 6 mg/l. Could an antidegradation argument be defended - one that would obviate the proposed TMDL?

Application of the 0.2 mg/l allowance for DO depression may open up technical criticisms from another perspective. Page 27 discusses uncertainty and sensitivity analysis. The confirmation of the model suggests that the vertically averaged DO and ammonia concentrations within each model segment can be predicted with an average error of 0.39 and 0.016 mg/l, respectively. Model verification suggests that the model is a good predictor of DO and ammonia in the modeled area. However accurate the model is, one still must consider precision of the model. A predicted DO error of 0.39 mg/l applied to a "modeled predicted value - with 0.2 mg/l allowance" means that the "true value" could actually be nearly three times lower than predicted or about three time greater than predicted (i.e., adding to or subtracting from the 0.2 mg/l allowance the maximum error range of 0.39 mg/l). Table 10 shows predicted DO concentrations for other model segments for various critical conditions and advanced treatment options. Applying the 0.39 mg/l DO error to predicted figures in this table gives one an idea how interest groups could pick at some assumptions behind the modeling effort.

Nonpoint sources. As explained in the Phase I and II documents, nonpoint sources of oxygen demanding materials are considered insignificant contributors to DO deficits in the lower river. Ecology is currently conducting a more detailed water quality assessment of the tributaries and their drainages to the Snohomish River; the report for this study is due by mid-September 1997. If significant nonpoint source pollutant loads are characterized by this study, and/or if growth is expected in any of the subbasins, then the proposed TMDL must be modified to include the LAs and adjusted WLAs.

I'd like to reiterate encouragement for Ecology's NWRO to seek a regional solution by way of wastewater diversion to Puget Sound. With the ensuing growth over the next 10-20 years, only lower WLAs and permit limits can be expected for oxygen demanding pollutants; perhaps even more stringent seasonal discharge limits. Even if only the city of Everett diverts its WTP effluent to marine disposal, the DO problem in the lower river would improve greatly. As pointed out on page 24 of the Phase II document, Everett's WTP BOD loading accounts for 77 percent of the projected critical condition oxygen deficit at segment 36 around high slack tide (salinity >1 ppt).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

31 July 1997

Reply To
Attn Of: OEA-095

MEMORANDUM

SUBJECT: Supplemental nonpoint source pollution information for the Snohomish Estuary Dry Season TMDL Study - Phase II

FROM: Rob Pedersen
OEA, Risk Evaluation Unit

TO: Alan Henning
OW, Water Quality Unit

I appreciate the opportunity to see Ecolgy's report on nonpoint source pollution to the Snohomish River via several tributaries and marshland (Water Quality Assessment of Tributaries to the Snohomish River and Nonpoint source Pollution TMDL Study by Bob Cusimano, 2 July 1997; received 24 July 1997). It's great to see cooperative efforts (county and state) to combat significant nonpoint pollution sources. Although the report only deals with TMDL development for fecal coliform (FC) bacteria, the document does provide information on other nonpoint pollutant concerns such as nutrients.

One potential issue in the Snohomish Estuary TMDL (Phase II Final Report) for dissolved oxygen water quality standard violations, is the prediction of natural background conditions (without pollutant loads). Predicted background dissolved oxygen (DO) concentrations are the basis for modeling the required biochemical oxygen demand (BOD) load reductions necessary to meet water quality standards during critical flow/tidal conditions.

For the Snohomish Estuary TMDL, apparently some nonpoint sources are considered insignificant, some sources are characterized, and others have not been included in the modeling (e.g., Table 9 includes French Creek, the Marshland, Deadwater Slough, and Other). The nonpoint source data report provides insight on studies and plans for FC bacteria reduction in the watershed; BOD loads are not the focus of the nonpoint pollution data report/ FC TMDL. For its intended purpose. the nonpoint pollution report is a good summary. Regarding the DO TMDL for the estuary. it's hard to have a good appreciation of relative loading of oxygen demanding material from the various sources discussed in the nonpoint pollution report (some such information could probably be gleaned from the data appendices to the nonpoint source report).

So, the question is "are all significant nonpoint source loads removed from the model when predicting background-natural DO conditions in the estuary?" Also, what nonpoint pollution sources are important for modeling. French Creek (located upstream of the Pilchuck River) is a part of the model but the Pilchuck River is not included; is this because the Pilchuck River does not have a DO problem (Table 1 of the nonpoint report)? Taking a different tack, could one argue that all these sources upstream of say, the city of Snohomish are included in the model through downstream data collection at mainstem Snohomish River sites? What about problematic downstream tributaries, proximal to the estuary. that are not in the model such as Quilceda and Allen Creeks? Are these lower tributaries too dry during critical Snohomish Estuary modeling conditions to be significant?

Well, far be it from me to second guess this point since I have not been sampling in the field and analyzing data. I'm sure that Ecology. through Bob Cusimano's thorough efforts has incorporated the necessary components in the Snohomish Estuary TMDL. However, as an outside observer, looking at reports, the above questions arise. I'm also told of storm drains and runoff from this-or-that "eastside" development (Darrell Williams, Tulalip Tribe; 3 July, 1997). Being an "outsider" is why I suggested in my earlier memo that a short paragraph in the Snohomish Estuary TMDL document could help by summarizing just what nonpoint and/or tributary pollution sources are insignificant, why specific sources are included, and how the model and WLAs/LAs may be modified based on future monitoring efforts.

The nonpoint source pollution document also states that control measures for the FC TMDL would probably have beneficial effects regarding other pollutants that exceed water quality standards. Nonpoint pollution control measures that reduce nutrient loading to the mainstem Snohomish River could certainly be a help for the Snohomish Estuary TMDL, especially if there is a secondary BOD load to the system. This could be due to nonpoint source nutrients enhancing algal growth in the slower moving sections of the lower river, followed by a BOD load from algal die-off and consequent water column DO reduction.

Attachment 8

Snohomish Regional Water Quality Association
C/O
City of Everett
3200 Cedar Street
Everett, WA 98201

RECEIVED

MAY 0 8 1998

DEPT. OF ECOLOGY

April 30, 1998

Laura Fricke
Washington Department of Ecology
Northwest Regional Office
3190 160th Avenue S.E.
Bellevue, WA 98008-5452

RE: Comments on the Snohomish River Estuary Dry Season TMDL Study-Phase II

Dear Ms. Fricke:

The official comments and recommendations from the Snohomish Regional Water Quality Association (SRWQA) on Ecology's *Snohomish River Estuary Dry Season TMDL Study-Phase II* report (TMDL report) are enclosed.

The creation of the SRWQA resulted from its members' review of the TMDL report. The SRWQA members include Weyerhaeuser Everett, Lake Stevens Sewer District and the cities of Everett, Marysville and Snohomish. Enclosure 2 is a copy of the draft "Memorandum of Agreement" that officially forms the SRWQA.

SRWQA members do not accept the WLAs proposed in the TMDL report due to perceived problems with the model's ability to accurately simulate the flushing effects in the stratified portion of the Snohomish River Estuary. We believe that further refinement of the WASP5 model is needed before implementing any WLAs which might result from the final TMDL. To this end, the affected dischargers have worked together to develop the comments and proposal described below. We appreciate the effort Ecology will need to make in order to review our comments, and thank you in advance for your consideration.

In Enclosure 1, the SRWQA proposes additional work to improve the model and study allocation alternatives before implementing WLAs on the lower Snohomish River Estuary. The SRWQA considers this additional work, which may include field studies and additional model runs, critical to their full understanding and ultimate acceptance of a final TMDL report.

Given the impacts of El Niño and the likelihood of a dry summer, the SRWQA feels that August and September of 1998 will prove to be the optimum time to collect additional data for refining the WASP5 model. Therefore, it is imperative that Ecology review the comments and work proposal and be prepared to meet with the SRWQA by June 1, 1998. This meeting would be used to facilitate the development of a scope of work to be completed jointly by the SRWQA and Ecology during the low flow season of 1998.

The goal of the SRWQA is to maintain and improve the water quality in the Snohomish River Estuary and provide cost effective services to the customers served by the SRWQA members. We look forward to working directly with Ecology to accomplish these goals through the implementation of a technically sound and scientifically defensible TMDL.

To schedule a meeting between Ecology and the SRWQA, or if you require clarification on the comments or proposed studies, please call Robert Waddle at (425) 257-8230.

Respectfully,

Clair Olivers
City of Everett

Ken Winckler
City of Marysville

Mick Monken
City of Snohomish

Harold Ruppert
Weyerhaeuser Everett

Darwin Smith
Lake Stevens Sewer District

Enclosures (2)

DRAFT

Memorandum of Agreement
SNOHOMISH RIVER ESTUARY DRY SEASON TMDL STUDY AND WASTELOAD ALLOCATIONS

I. Parties

This agreement is entered by and between the City of Everett ("Everett"), the City of Marysville ("Marysville"), the Lake Stevens Sewer District ("Lake Stevens"), the City of Snohomish ("Snohomish"), the Snohomish River Regional Water Authority ("RWA") and the Weyerhaeuser Company ("Weyerhaeuser") (collectively referred to as the "Snohomish River Water Quality Association" - "SRWQA" or "participants").

II. Background

In 1997 the Washington State Department of Ecology ("Ecology") published the Snohomish River Estuary Dry Season TMDL Study-Phase II. This study reviewed total maximum daily loading (TMDL) in the lower Snohomish and predicted that large portions of the estuary would be below dissolved oxygen standards under critical dry flow conditions. The water quality model used in the study was also used to develop and recommend wasteload allocations (WLAs) for the following point sources of carbonaceous biochemical oxygen demand (CBOD) and ammonia: the Everett Wastewater Treatment Plant (WWTP), the Snohomish WWTP, the Marysville WWTP, Lake Stevens' WWTP and the proposed Smith Island WWTP.

Wasteload allocations were based on permitted flows for each facility. A reserve for future growth was not considered. Upon initial review of the TMDL study and proposed WLAs, the participants determined that treatment for the removal of ammonia might be required for each of the mentioned discharges. The cost implications for such a scenario would be in the range of $100 million. Additionally, the participants determined that Ecology's wasteload allocations might not be practical, nor in the best interests of the region.

During discussions with Ecology staff, it was made clear to the participants that Ecology was in favor of a regional approach for addressing the TMDL study and WLAs. Subsequently, the participants decided to organize formally for the purposes of addressing the TMDL study and associated WLAs. Thus, the participants agree that a "Memorandum of Agreement" ("MOA") is appropriate at this time, to enable the participants to address the TMDL study and develop alternate WLAs for consideration by Ecology.

III. Statement of Purpose

Due to the significance Ecology's recommended WLAs have for the region, the participants held preliminary discussions concerning the feasibility of developing a regional response to the TMDL study and associated WLAs. It is the belief of the participants that a regional approach will provide the most cost effective and practical alternatives for addressing the TMDL study. In general, this agreement will provide the basis for more effective regional wastewater treatment planning.

DRAFT

This document provides the framework for agreement as to technical work necessary to establish a regional approach to WLAs and responses to Ecology's proposed regulations and foreseeable technical work but is not limited to:

1) Field monitoring studies and model verification, specifically to test the effect of existing or proposed outfall locations on dissolved oxygen (D.O.) at critical locations.

2) These studies could include tracer studies and extensive monitoring during low river flows.

3) Dynamic modeling may be considered.

4) The WASP5 model may be modified.

5) Further investigation of the affects of the salt wedge near the mouth of the river needs to be investigated.

6) Studies may be conducted to confirm specific kinetic rate constants, dispersion coefficients, etc.

7) Testing for UBOD/BOD5 ratio at each WWTP may be conducted.

8) Legal services re effluent trading and/or related legal matters of concern to the SRWQA.

IV. Technical Guidance Committee

Each participant to this agreement shall designate an authorized member (plus authorized alternate members) to the Snohomish River TMDL Technical Guidance Committee (TGC). The TGC shall keep minutes of its meetings. Attendance of three or more designated members shall constitute a quorum. The TGC shall establish the scope of work for all technical studies to be performed under this agreement. The TGC shall convene a panel of experts for the purpose of reviewing all existing information relative to the Snohomish River TMDL, such as reports and data, and making recommendations to the TGC with regards to the development of the aforementioned scope of work. The TGC shall make recommendations regarding the selection of the consultant to perform the technical studies defined in the scope of work. It is agreed that technical services will be procured by Everett, provided that the Committee shall review all technical proposals and designate all technical service providers.

V. Technical Services Costs

Costs for technical and legal services designated to be performed by the Technical Guidance Committee shall be shared among participants. Everett shall bill each participant for its share of technical services costs by technical service providers. Payment shall be due to Everett thirty days after submittal of a bill for reimbursement. Interest on late payments shall be 1% per month. This agreement contemplates payment for technical and legal service providers only. Costs to be shared by participants shall not include any staff time or material and equipment use by Everett or other participants. Participants agree that their cost-share-liability shall be based on a two part formula: 50% of the cost share will be based on flow, the remaining 50% shall be negotiated based on information provided in the final TMDL study, final wasteload allocations and/or other elements as determined by the participants. The flow based cost share will be determined by each participant's flows for the months of July, August, September and October of 1996 and 1997. The RWA cost share shall be based on information to be published in the final TMDL study relative to impacts on the receiving water due to withdrawls of water from the river for RWA purposes.

VI. Legal Relationship

Each participant shall be responsible for acts of its officers and employees. Everett agrees that technical services agreements will include provision for third party liability insurance for all service providers.

VII. Technical Data and Information

All participants agree to share, at no cost to participants, all data and information related to this agreement that is subject to public disclosure. Technical service providers shall agree that all data and information developed under funding provided by participants shall be available at no cost to all participants.

VIII. Withdrawal

Any participant may withdraw at any time but will be subject to its share of costs incurred for thirty days after written notice of withdrawal to all other participants.

IX. Venue

Any litigation arising out of or in connection with this agreement shall be conducted in Snohomish County.

X. Notice

Notice to members of the Technical Guidance Committee shall be addressed to members designated by participants.

Notice to participants shall be as follows:

To Everett ______________________

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To Marysville ______________________

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To Lake Stevens ______________________

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To Snohomish ______________________

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To Weyerhaeuser ______________________

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To RWA ______________________

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Snohomish River Estuary Dry Season TMDL Study - Phase II
Regional Comments

Prepared jointly by City of Everett, City of Marysville, City of Snohomish, Lake Stevens Sewer District, Snohomish Regional Water Authority, and Weyerhaeuser Everett

GENERAL COMMENTS

1) The Model needs to be run using conditions that are actually representative of the receiving water.

The modeling effort associated with the Snohomish River Estuary TMDL determined that dissolved oxygen (D.O.) might be depressed below the applicable standard by human non-point and point sources more than the allowable 0.2 mg/L. This determination was based upon the assumption that the following conservative conditions will all occur simultaneously:

- Low river flow conditions (summer flows) that occur over a seven day consecutive period only once every 20 years (an extremely dry season).
- Tributaries (non-point contributions) to the river contribute loadings to the lower basin even though most tributary flows are zero under extreme dry season 7Q20 conditions.
- Only at or near high slack tide for a several hour duration.
- Only under maximum high spring tide conditions.
- Assumes dischargers are releasing treated effluents at their maximum month permitted design flows during extreme dry season conditions, even though effluent flows are actually lower during these periods.

The regional commenters feel that the possibility of these events occurring simultaneously is small. Ecology should conduct a probability analysis to determine the likelihood of occurrence for each condition, individually and simultaneously.

2. The Phase II report did not indicate frequency or duration of the D.O. depression. Ecology should not only quantify the D.O. depression but also determine the frequency and duration, in order to assess the impact and set priority on listings and public expenditures.

The model did not:

- Identify the duration of the predicted D.O. depression. That is, would this depression occur for only an instant, a minute, a few hours, or longer?

- Assess the real effects of this very rare and transient D.O. depression.
- Provide for any future growth in the entire lower Snohomish Basin. Loadings used in the model are permit limitations for the current permit cycle. The model should consider projected loadings for a reasonable period so that dischargers can effectively plan for any necessary WWTP upgrades.

3. **The waste load allocations proposed in the Phase II report excluded input from the stakeholders in the region. Financial implications to ratepayers are significant. Ecology needs to work with regional dischargers to determine the impact and develop needed waste load allocations.**

As a result of this evaluation, Ecology has proposed waste load allocations for CBOD and ammonia on the River and apportioned them between the point source dischargers. Based on the results of Ecology's limited modeling effort, we believe this to be a drastic measure with significant financial implications for the citizens and ratepayers. As such, we urge Ecology to give serious consideration to our proposal (later herein) to (1) confirm and /or improve the model's ability to predict the impacts of the point sources of CBOD on the D.O. depression, (2) establish CBOD and ammonia wasteload allocations through a cooperative regional approach including the affected local governments, (3) identify methods of enforcement through NPDES permits that will ensure compliance with the TMDL model, and (4) establish a reasonable compliance schedule.

4. **Implementation of a TMDL, waste load allocation and listing on the 303(d) list appears to be based upon anticipated population growth. The dischargers on the lower Snohomish River estuary must have objective and reasonable criteria to set targets and make major expenditures. Ecology's listing criteria of 10% of sample results or 10% percent of the time exceedance is apparently not being used. The duration of the D.O. depression and the percent of time are currently not known and must be determined to assess impact.**

Ecology should clarify their process for determining when to conduct a TMDL on a water body. The introduction of the TMDL document states that the NWRO staff requested the TMDL on the Snohomish River due to population growth and development. To our knowledge, the regulated community does not have the ability to foresee their receiving waters being subject to a TMDL outside of the 303(d) listing process. Also, if the 303(d) is a priority listing of receiving waters in need of a TMDL study, what does the requesting of a TMDL on a non-listed water body imply about the validity of the 303(d) list?

We understand that the lower Snohomish River was originally placed on the 303(d) list in 1992 and again in 1998 for low D.O. based on available ambient monitoring data. In late 1997 Everett provided comments to Ecology on the listing of the lower Snohomish River for low D.O. and on the ambient monitoring data. A copy of these comments is provided as Appendix C. Our comments were based on the 303(d) listing criteria outlined in Section 3 of the Water Quality Program Policy 1-11 item A.1 that reads:

ten percent or more of the measurements with a minimum of at least two measurements are beyond the numeric state surface water quality criteria within the most recent five year period that data has been collected (Emphasis added).

The intent of including the 10% exceedance for conventional pollutants in the 303(d) listing criteria was to use the same threshold defined in EPA's guidance for Section 305(b) reports to identify the level necessary **"to fully support designated uses."** Most other states are using the 10% threshold, and EPA approved this change in Washington's 303(d) listing criteria. Clearly, this change was intended to help us all to prioritize and target our resources to the most significant problems.

The data provided in our comments show that the 10% exceedance criteria for the ambient data was not met. Therefore, the lower Snohomish River should not be listed based on the ambient D.O data under item A.1.

However, with the modeling results from the Phase II report, we understand that the lower Snohomish River may be placed on the 303(d) list under the criteria described in Section 3 of the Water Quality Program Policy 1-11. Item A.8 in the policy states that

a modeling analysis of an existing or proposed activity shows that standards will likely not be met within the next two years.

Note that the criteria outlined in item A.1 calls for an exceedance of the criteria ten percent or more of the time based on real data, while criteria A.8 may be based on any exceedance, no matter how brief, based on modeling. We believe there is a serious incongruity between these criteria, and we see the effects of it if Ecology pursues implementation of this TMDL.

Additionally, consider Figure 1 (Appendix D) that shows the D.O. extremes for low and high tide under worst case conditions, for the no waste load scenario and the existing waste load scenario. The modeling shows that a small decrease in D.O. occurs when the present waste load scenario is compared to the no waste load scenario. The modeling also shows that a tremendous variation will occur at any given site as this water mass (saltwater) moves in and out. If the data were averaged over the day, we would not even be considering the situation to be a "problem."

Now with Figure 1 separate the no waste load image from the waste load image as in Figures 2 and 3, respectively. Then offset and superimpose as shown in Figure 4. This shows that the dissolved oxygen regime under either condition is quite similar, but offset by perhaps a mile. Remember that the extremes are temporary conditions and that on the rise or the fall of the tide, the conditions at any given location will change accordingly [redacted]

We believe that if one considers the modeling results in the context of the historical water quality data, Ecology has observed a small and infrequent change in the level of D.O. Does such an occurrence truly have a significant effect when it occurs in a dynamic system subject to natural widespread variation, such as the Snohomish Estuary? And if so, should Ecology not provide better evidence to support that conclusion? Item A.8 as a listing criteria, does not address these questions. Based on our analysis, we suspect that the theoretical dissolved oxygen depression may in fact not represent a significant impact on the estuary. Nevertheless, we share the concerns of Ecology. Therefore, we want to further evaluate the dissolved oxygen question before committing public resources to implement WLAs proposed entirely on the basis of the modeling work done to date.

In summary, we need to understand the magnitude of the depressed oxygen situation predicted by the model. That is, are we observing a dissolved oxygen depression that exists less than 10% of the time? If so, how much less? The available data show a less than 10% of the time exceedance, and modeling itself also suggests a substantially less than 10% of the time exceedance. Where is the distinction between a dissolved oxygen problem and no problem? Ecology has chosen 10% exceedance as a basis for prioritizing TMDL studies. Why was this criteria pre-empted by a modeled prediction that also indicates a less than 10% oxygen depression? We believe that much more work needs to be done prior to making WLA decisions. Of course, the affected dischargers desire to discuss this issue in more detail with Ecology.

5. **The City of Everett's comments on the Phase I report dated February 9, 1996, question the potential effect of density stratification in the lower portion of the estuary. Everett argued that a two-layer model may be necessary to simulate conditions where and when stratification occurs. Ecology responded that the estuary is well mixed vertically, and that a two-layer model is not possible with WASP5/DYNHYD5.**

Appendix D data in the Phase II report demonstrate that the lower mainstem is stratified at low and high tides. Data collected by the City of Everett in 1993 and 1995 demonstrated that the salt wedge extends as far upstream as the Everett WWTP outfalls for brief periods during high tides. After adjustments to the model in Phase II, Ecology demonstrated that net transport of the Everett WWTP effluents are adequately simulated (Figure 17 in the Phase I report).

We concur that most of the estuary is well mixed, and transport processes at those locations are adequately simulated in the model. However, the data collected by Ecology confirms that there is significant density stratification in the river's estuarine seaward sections that is not accounted for in the model. This could be significant to the dischargers located in the density stratified areas. Additional monitoring in the lower estuary should be performed to assess two-layer hydrodynamics. If confirmed, we would be willing to work with Ecology to construct a model that accounts for stratification.

The lower end of Steamboat Slough is density stratified. This is evident from Ecology's salinity data at Station STM32 at 1615 on August 27, 1996, 1555 on August 28, 1996, 1540 on August 16, 1993 and 1500 on August 17, 1993. Density profiles obtained for the City of Marysville's approved mixing zone study from Steamboat Slough near the Marysville outfall confirm this stratification (profiles from the Marysville mixing zone study provided in Appendix B). We suspect that the model may be overly conservative in relation to discharges from the Smith Island Treatment Plant and possibly the Marysville WWTP. Due to the two-layer circulation in the lower Steamboat Slough, the effluents from these two facilities may not be held within the estuary as long as the vertically-averaged model indicates. This should be tested, since the modeling shows these two discharges have significant impacts at the critical Segment 57, and therefore the TMDL.

Due to stratified flow from density difference between salt and fresh water, the model may not fit actual dilution and movement of wastewater in the Lower Snohomish River and sloughs. Consequently, the impact of discharged BOD on the dissolved oxygen profile in segment 57 may be over estimated. The model needs revision or recalibration before it can be used to list the water body or determine waste load allocations.

Additionally, several different discharge scenarios for the Weyerhaeuser Smith Island Treatment Plant were tried using the model to determine ways to minimize the impact on the Snohomish River. Four discharge patterns of note were:

1) Discharge 24 hours per day;
2) Discharge 10 hours per day on ebb tide;
3) Discharge 5 hours per day at twice the flow rate on ebb tide; and
4) Discharge 10 hours per day starting 2.4 hours before slack high tide.

Segment 57 is approximately 3.5 miles up river from the modeled discharge point. The difference in D.O. depletion between 24 hour discharge and controlled discharge on segment 57 was minimal. Discharge during ebb tide was required during mill operation and served to remove the discharge from the river. The model showed very little benefit to discharge during ebb tide contrary to observations. Appendix A provides more specific information.

Additional general comments as submitted by the City of Marysville are provided in Appendix B.

SPECIFIC COMMENTS

1. Pg 1, para 1- This TMDL was conducted as requested by the NWRO not because of a valid 303 (d) listing of the lower Snohomish River for low dissolved oxygen. See general comment 4 above

2. Pg 6, para 4- We concur with the conclusions in this section that the low D.O. observed in the lower estuary at high tide is principally caused by low D.O. marine water from Possession Sound, rather than excessively high sediment oxygen demand as proposed in the Phase I TMDL report.

3. Pg 7, para 4- We recognize the requirements of the WASP/DYNHYD5 model geometry in the Possession Sound delta (model depths must be entered greater than actual), and further that the current model is unable to simulate vertically stratified conditions. The effect of these modifications is to lengthen the apparent residence time of water in the estuarine portion of the river. We still contend (as before in comments dated February 9, 1996 on the Phase I report) that these limitations are significant to the dischargers located on the lower end of the estuary, relative to their projected impacts on upstream D.O. and

setting of wasteload allocations. We propose meeting with Ecology to investigate modeling alternatives.

4. Pg 7, para 4- WWTP design flows were used to assess critical conditions and establish proposed WLAs. WLAs should not be based on current treatment plant design flows, but on future dry weather treatment plant flows that are based on growth management planning-mandated population projections for sewered areas.

   The existing permit for the Everett WWTP applies low flow summer loading limits during the months of August and September only. The critical period for low flows in the Phase II document is defined as July through October. Everett's historical data show that plant flows are 47% higher in October than the average flows for July through September. This trend is associated with high rainfall (combined sewer storm flow) and therefore higher river flows. Combined sewer plants like Everett will have difficulty meeting low flow load limits under high flow conditions as the rainfall increases when in reality the low flow load limit does not apply.

5. Pg 8, para 2- Everett completed a mixing zone study on their two outfalls and submitted it to WDOE in April of 1996. Therefore, Everett's data was available at the time of the study.

6. Pg 8, para 3- Ultimate CBOD to BOD_5 ratios are extremely critical to the final wasteload allocations. The results obtained in the 1996 tests are not valid due to the reasons cited. The selected values for the lagoons are higher than EPA's recommended default value of 1.5 (Revised Section 301(h) Technical Support Document, EPA 430/9-82-011). We insist that accurate tests be performed on each of the regulated WWTP effluents before $CBOD_5$ WLAs are established.

7. Pg 8, para 4- Since the Tulalip landfill is a Superfund site, we presume it will be remediated in the future. Therefore, there should not be an allocation for this source.

8. Pg 11, para 4- The reported RMSE for D.O. is 0.39 mg/L, suggesting a 95 percent confidence interval of approximately 1.6 mg/L. While we agree that the general temporal and spatial trends in D.O. relative to tidal changes are simulated in this model, this model error is far greater than the implied precision of the model to predict D.O. changes from wastewater inputs of less than 0.2 mg/L. The Phase II report does not provide any data or discussion of the model's accuracy in predicting the D.O. changes in response to wastewater loadings.

9. Pg 12, para 6- We concur that the model adequately simulated the dye tracer study conducted by the City of Everett in August 1995. We believe that it would be appropriate to perform similar trace studies for other point source discharges in the model study area. This would confirm whether the model hydrodynamics are adequately simulating the fate and transport of each effluent plume.

10. Pg 14, para 1- Seasonal permits have some value in recognizing that the critical low summer flows only occur during July through October. However, Ecology must

recognize that significant storms can also occur during this period (especially October), which increase both river and wastewater flows and loadings. Effluent limitations should be based on actual river flows rather than a seasonal basis, since the assumed river flow is integral to the TMDL and WLAs.

11. Pg 15, para 2 - We concur with the application of the salinity criteria from WAC 173-201A-060(2) to determine freshwater or marine water quality standards for D.O.

12. Pg 16, para 2- No flow was observed from the pumped tributaries during the study period in August 1996 when the Snohomish River flow was 1840 cfs (Table 4). However these tributaries were assigned critical condition flows equal to their annual average daily flows. These assigned flows represent significant increases over the observed flows of zero (Table 7). This assignment is counterintuitive given that river flow during the study was 75% greater than the 7Q20 critical condition used in the model (1840 cfs -vs- 1051 cfs). The 7Q20 represents drought conditions in the basin and the tributaries would be subject to the same drought. Therefore, critical flows for French Creek, Marshland, Deadwater Slough and Swan Trail Slough should be set to 0.0 cfs. Note that even if Ecology insists that these tributaries sometimes have flow, this also relates to the 10% issue in the 303(d) guidance (General Comment #4).

13. Pg 16, para 4 - The downstream ammonia boundary condition of 0.095 mg/L is quite high for Puget Sound. A value of 0.02 mg/L would be more in line with upper end concentrations in Puget Sound.

14. Pg 17, para 1- For a summer low flow TMDL, modeling should be completed using actual observed combinations of river flow, tributary wasteloads, and effluent flows and loadings.

    Observed discharge and river flow data for July through October 1996 and 1997 are presented in Figure 5 (Appendix D). This aggregate BOD loading plot accurately represents the current WWTP loading conditions to the Lower Snohomish Estuary. It effectively demonstrates that current BOD loading to the Estuary is significantly below the modeled critical condition.

    Everett's average summer time flow is 13 MGD (excluding October flows). Everett's flow in the TMDL model was set at a 18.5 MGD (8-TFSC and 10.5-Lagoon). In order for Everett to discharge this volume during 7Q20 conditions (no storm flow), water stored in the lagoons must be pumped. The net lagoon in-flow would be -4.5 MGD. At this pumping rate the lagoons would be pumped dry in less than two months. Flows and BOD loadings from the other WWTPs in the Snohomish River Estuary are similarly below the "critical condition".

    This scenario indicates that the timeline for implementing the WLAs in the Phase II document is actually well in the future (e.g., Everett's service population increases by 35%) and there is no need to establish wasteload allocations at this time.

15. Pg 17, para 4- The CBOD loads shown in Table 12 indicate that the 1.2 mg/L CBOD value is really an Ultimate CBOD value. Also, the background ammonia concentration is listed as 0.005 mg/L, yet Table 7 and Appendix E list background ammonia as 0.050 mg/L. Which is correct? Are they the same in the background conditions and TMDL alternatives?

16. Pg 20, para 1 - The recommended WLAs unnecessarily assign $CBOD_5$ and ammonia limits both in lbs/day and mg/L. The model is entirely a mass based model, and there should be no need for concentration limits, other than $CBOD_5$ AKART limits and mixing zone limits for ammonia.

17. Pg 20, para 1 - Other TMDLs have been based on weekly rather than daily BOD_5 loads. Given that the BOD_5 is exerted over 5 days, and ultimate BOD is even longer, weekly limits seem appropriate. Ecology would need to demonstrate that the compliance with the standard is sensitive to significant daily fluctuations to justify daily limits.

18. Pg 20, para 1 - Ecology should not move to adopt the WLAs in Table 12. The WWTP dischargers demand that they be given the opportunity to establish WLAs in a cooperative regional approach to achieve the water quality objectives in the most cost effective manner possible. Many treatment and discharge options should be explored to achieve this goal. The WLAs will be based on the final WASP5 model version that has been agreed upon by all parties affected by the TMDL.

19. Pg 21, para 2 - As discussed previously, we agree that the model is a good predictor of D.O. in the study area. However, there is no confirmation of the WASP5 model's ability to predict responses to changes in wastewater loadings, other than the tracer studies performed on the Everett plant.

20. Pg 22, para 6- Everett has conducted extensive metals sampling on the lower Snohomish River. This study, approved by WDOE, used clean sampling techniques to determine ambient concentrations for several metals. These data clearly indicate that both total and dissolved concentration of copper are well below the water quality standard and typically below analytical detection limits for graphite furnace techniques (< 1 µg/L). These data were submitted to WDOE (Robert Cusimano) on November 21, 1995.

21. Figure 6- The segment map should include the WWTP's discharge locations.

22. Figures 18-20- Captions indicate with and without BOD loads. We assume that this BOD includes NBOD.

23. Table 7- See comment #12 above.

24. Table 12- Daily Maximum BOD_5 should read Daily Maximum $CBOD_5$ according to the abstract on page v.

25. Table 12- Total Maximum Daily Load #2 should be 13,071 lbs/day for $CBOD_5$, not 9,209 lbs/day as listed.

26. Table 12- Please provide a breakdown of the background/nonpoint loadings for $CBOD_5$ and ammonia, including the UBOD/BOD_5 ratios. Please confirm whether these loadings are the same as used in the background conditions (if not, what was changed).

27. Table 12- It appears there is an error in the background/nonpoint LA for ammonia, Appendix E and Table 7 suggest an ammonia concentration at the upstream model boundary of 0.050 mg/L. At the 7Q20 flow of 1,051 cfs, this corresponds to an ammonia loading of 280 lbs/day, which exceeds the tabulated ammonia LA.

PROPOSAL FOR REGIONAL SOLUTION FOR THE TMDL ISSUE

Costs to upgrade treatment plants in the Snohomish River Estuary to comply with the recommended WLAs are estimated to exceed $100 million. In light of the severe financial implications of these costs on ratepayers, Ecology must provide a compliance schedule that will allow adequate planning, design and phased construction. The schedule must include adequate time for the affected WWTP operators to assure themselves that the TMDL model and results are appropriate. A minimum compliance schedule of 10 years to achieve the TMDL limits must be provided, roughly outlined as follows:

Years 1-3: Model verification and regional wastewater planning
Years 4-6: Financing and facilities design
Years 7-10: Construction and startup

During this ten year period, the dischargers of the region must have the ability to benefit from feedback on continued monitoring and changes in the basin. The ten year timeline for compliance must be viewed as a dynamic one that allows the dischargers to meet the limitations of the Snohomish River in a scientifically defensible and economically realistic manner.

The cities of Everett, Marysville and Snohomish, the Lake Stevens Sewer District, Snohomish County and Weyerhaeuser propose the following TMDL implementation approach. A three-year regional wastewater facilities planning study would be conducted by the parties listed above. The study would be funded through an interlocal agreement or a regional wastewater authority comprised of these parties. The study scope and schedule would be specified by Ecology in the next round of NPDES permits issued to the WWTPs, or through a separate order to the regional body. The scope of the regional facilities planning study would be developed cooperatively with Ecology staff. Specific activities that would be included in this three-year scope may include the following:

Monitoring/Modeling

- Field monitoring studies may be conducted to verify the TMDL model, specifically to test the effect of existing or proposed outfall locations on D.O. at critical locations.

- These studies could include tracer studies, density stratification, currents and D.O. monitoring during low river flows.
- Studies may be conducted to confirm site specific kinetic rate constants, dispersion coefficients, etc.
- Testing for the UBOD/ BOD_5 ratio at each WWTP may be conducted.
- The WASP5 model may be modified (and documented) if warranted by the results of these studies. Alternate models may also be considered.
- Dynamic modeling (continuous simulation and Monte Carlo) may be considered.

WLA Alternatives

- Regional alternatives for WLAs will be developed that satisfy the final TMDL model, or as modified and approved by Ecology.
- Alternatives will be established for a 20 to 30 year planning horizon that include growth in the basin.
- Alternatives investigated for each WWTP will include various combinations of treatment plant improvements, outfall relocation, storage with discharge on outgoing tides, and effluent reuse during critical water quality periods.

Implementation Options

- The regional facilities plan will investigate and propose options for implementation of the TMDL through NPDES permits, including ammonia/BOD exchange, watershed effluent trading, aggregate limits, and flow-based limits.
- All options will be based on meeting the D.O. standard as determined by the results from the agreed-upon TMDL model.

Appendix A

Specific Comments from Weyerhaeuser

Prepared by Harold Ruppert, Weyerhaeuser Everett

Model Inadequacy

To determine the relative impact of the Smith Island Treatment Plant (SITP) discharge on Segment 57 and to explore ways to decrease the impact on the critical segment the WASP5/DYNHYD5 model was run with four different discharge patterns.

Historically, during kraft mill operation, the discharge from the SITP occurred only on ebb tide. At the request of upstream and downstream users the Pulp Mill staff restricted the discharge between 10 and 4 foot tides during the ebb tide. Shutting the discharge gate at a 4 foot tide elevation during ebb tide was sufficient to alleviate complaints from both up stream and down stream at Priest Point. This demonstrated, in a qualitative way, the efficiency of the tide cycle to move discharged effluent out of the estuary. Hoping to quantify this benefit the following model runs were performed.

The four scenarios of discharge were:

1) Discharge continuously for 24 hours.
2) Discharge 10 hours per day on ebb tide. Opening at slack high tide and closing at approximately slack low tide.
3) Discharge 10 hours per day beginning at 2.4 hours (0.1 day) before high slack tide and closing at approximately 2.4 hours before low slack tide.
4) Discharge at twice the rate for five hours per day opening the gate at high slack tide and closing approximately 2.5 hours later on each discharge.

Each of the modeled patterns used the following similar assumptions:

Flow: 12.6 MGD from SITP
Ammonia: 2 mg/L NH4
CBOD: 7912 lbs per day total.
Background non-point loads included in runs.
Point source discharges not included to improve sensitivity.

We chose to look at the results in two ways; average D.O. depletion and maximum D.O. depletion, and to look at Segments 55 and 57. Segment 57 because it is the critical segment used in the Phase II report and Segment 55 because the SITP discharge impacts this segment most. The results of these model runs are provided in the following table.

Discharge Scenario	River Segment Number	Average Oxygen Depletion	Maximum Oxygen Depletion
1	55	.059	.09
2	55	.042	.07
3	55	.042	.07
4	55	.053	.08
1	57	.045	.08
2	57	.032	.06
3	57	.031	.07
4	57	.039	.07

In comparing the oxygen depletions at Segments 55 and 57 there is a small magnitude of change between discharging 24 hours per day and discharging 5 hours per day from the SITP on ebb tide. The model does not appear to predict what would logically happen when discharging on the ebb tide. It does not predict what has been visually apparent over many years of operation of the former Pulp Mill. The model does not serve as a tool to find the best discharge schedule. Given this, it is our opinion the model requires further refinement before it can be used to predict impact upon the lower Snohomish River Estuary. It appears premature for Ecology to use model results to place the lower Snohomish River on the 303(d) list due to oxygen deficiency and set waste load allocations.

Appendix B

Specific Comments From Marysville

Prepared by Jones & Stokes Associates

1) **Timescale used in the model may not be appropriate.** Jones & Stokes Associates extracted a time series of dissolved oxygen deficits predicted by the existing conditions scenario model (snofin1) for model segment 57 (Figure 1). As can be seen in the graphic, the predicted dissolved oxygen deficit decreases through time in the model. There could be two explanations for this effect.

   a) The model uses a number of equations to simulate the consumption and production of oxygen. The high oxygen deficits in the first few days of the model run may be start-up transients during which the biological equations expressing oxygen gain have not yet stabilized. Consequently, as the model is run for longer durations, oxygen generation, once it stabilizes, may result in lower oxygen deficits associated with WWTP and non-point source inputs.

   b) Alternatively, the reduction in oxygen deficits through time may be due to differences in mixing associated with spring versus neap tide cycles. Spring tides may afford more mixing than neap tides.

   To answer this question, Jones & Stokes Associates recommends that the model be rerun for a longer duration. If the deficits used by Ecology are actually the result of start-up transients, then predicted oxygen deficits and consequent loading limitations would be in error. In order to evaluate whether this effect is caused by model start-up and stabilization, or differential mixing associated with tides, the model should be run for a period which at least spans a second neap tidal cycle, approximately 35 days. If by the end of the second neap tide period, the oxygen deficits do not return to the high levels cited in the Phase II report, the conclusion would be that the model had not stabilized, and the deficits used in the Phase II report were not properly calculated.

   Jones & Stokes Associates attempted to run the model for 35 days, but the model became unstable after 22 days, possibly due to inadequate array sizes in the program. Modification of the array sizes in the source code could allow running the model for longer durations..

2) **Model predicted current speeds in Steamboat Slough are not consistent with observed current speeds.** In 1990, Jones & Stokes Associates continuously measured tides in Steamboat Slough for a one month period (late June to late July), and conducted several drogue studies. The monitoring indicated that ebb tide current velocities can exceed 100 cm/sec compared to maximum ebb tide velocities of 60 cm/sec predicted by the model (see Figures 2 and 3). By using the 60 cm/sec velocity assumption, the model underestimates the amount of oxygen consuming pollutants exiting the downstream

model boundary during the ebb tide, particularly those discharged from the Marysville outfall.

Tidal characteristics in Steamboat Slough are complex. In the study conducted by Jones & Stokes Associates, it was determined that most of the tidal energy in Steamboat Slough is contained in five harmonic tidal constituents (see Table 1). In contrast, the TMDL model uses only two tidal constituents. The inclusion of the additional tidal constituents would allow a model to use currents much more in line with those observed.

The inclusion of these additional constituents to a model is probably more important for Steamboat and Ebey Sloughs than for the main river channel. The overtides are a result of the extensive shoal waters present in the approaches to Steamboat and Ebey Sloughs, as well as the interaction between differences in the arrival times of the tide wave at the junction of Ebey and Steamboat Sloughs. These time differences are the result of different channel depths and lengths. Because Steamboat Slough is the shorter of the two channels, the inflowing tide arrives at the upstream junction of the two sloughs before the tide can travel up Ebey Slough to the junction. During the first hour, the flood tide produces a seagoing flow in Ebey Slough (field observations by Jones & Stokes Associates - Oestman and Larsen). The end results of these interactions are tidal phases in the currents that can only be modeled with a program that allows for overtides.

3) **Dissolved oxygen concentrations in the receiving water for the no-loading scenario may be over predicted.** Under the no-loading scenario, Ecology eliminated the BOD loading from the WWTPs. However, the model input files (snono10.inp) still contained loading of oxygen from the WWTPs (dissolved oxygen in the effluent). Jones & Stokes Associates are not sure why effluent oxygen was not eliminated from the input files. When Jones & Stokes Associates eliminated this source of oxygen, oxygen levels in the estuary decreased by 0.04 mg/l. Ecology should run the no-load scenario without oxygen inputs from the WWTPs or document why effluent oxygen should be retained in the model.

Jones & Stokes Associates also compared the calibration model Ecology used as part of the Phase I study (snocal1) to the baseline model used by Ecology in the Phase II study (snono10). Based on figures and tables in the Phase I report, the calibration model predictions agreed well with dissolved oxygen values Ecology observed in the estuary. However, the preverification model in Phase I (Figure 16 in the Phase I report) and the Phase II baseline model (Figure 20 in the Phase II report) do not appear to agree with the calibration model; these two latter models predict lower dissolved oxygen under the no-load condition compared to the calibration model. The no-load models should predict higher dissolved oxygen in the estuary than those observed by Ecology or predicted by the calibration model because the no-load models do not include WWTP inputs. The calibration model predictions and the observations are already affected by the present loading from WWTPs.

There is no discussion in the TMDL to document what changes were made, or how the observations/calibration model predictions relate to the maximum dissolved oxygen deficits predicted by the preverification and Phase II no-load models. It is extremely important that baseline oxygen levels in the estuary be reasonably defined in establishing the baseline model because it is from these values that TMDL limits will be derived. It seems logical that a baseline model which presumably has no WWTP loadings should have a higher base level of dissolved oxygen than the field observations. The field observations have been taken with the present loadings of the WWTPs into the estuary.

4) **BOD loadings used for the proposed discharges scenario are unclear.** It is unclear in the Phase II report how loadings from WWTPs were estimated for the proposed discharges scenario (sitpalt5). WWTP loadings for the proposed discharge scenario (sitpalt5) are lower than those used for the existing discharge scenarios (snofin1). For instance, Marysville's ammonia and CBODU loadings are 1,071 lbs/day and 4,589 lbs/day, respectively for the existing scenario and 102 lbs/day and 2,651 lbs/day, respectively, for the proposed discharge scenario respectively. Ecology does not document why these loadings are different.

5) **A data entry error is present in the proposed discharges scenario input file.** In reviewing input files, a data entry error was found in the input file for the proposed discharges scenario (sitpalt5.inp). The file reads pairs of data denoting the time and loading for the proposed facilities at Smith Island. On the second to last line of the input file in the far right-hand column, the time should read 13.41, not 12.41. Although this is a small error, all input files should be reverified for accuracy.

Other Issues

1) **Mixing coefficient in the model requires adjustments that may affect the outcome of the modeling effort.** Bob Cusimano noted that he was considering changing the "advective factor" in the "Simulation Control Parameters" record of the EUTRO5 input file. This would affect the results of the model, and likely any consequent loading limitations.

Table 1. Tidal Constituents Estimated for Steamboat Slough in 1990

I	Tide Name	Amplitude[1]	Ranking	Phase
1	M2	1.36338	1	127.796
2	K1	1.31470	2	159.729
3	S2	.29205	4	196.563
4	2SM2	.05123		54.748
5	2N2	.01768		244.554
6	M3	.03924		253.867
7	M4	.07392	5	184.775
8	01	.65133	3	148.823
9	001	.11117		7.683[2]
10	MS4	.05950		208.918
11	S4	.01299		290.207
12	S6	.00473		4.576
13	M6	.00252		328.112
14	M8	.00325		31.027
15	2Q1	.01837		242.039
16	MF	.11297		20.359[3]

[1] amplitudes are in pounds per square inch
[2] tide influenced by river flow
[3] monthly tide is impossible to evaluate accurately because of river flow fluctuations

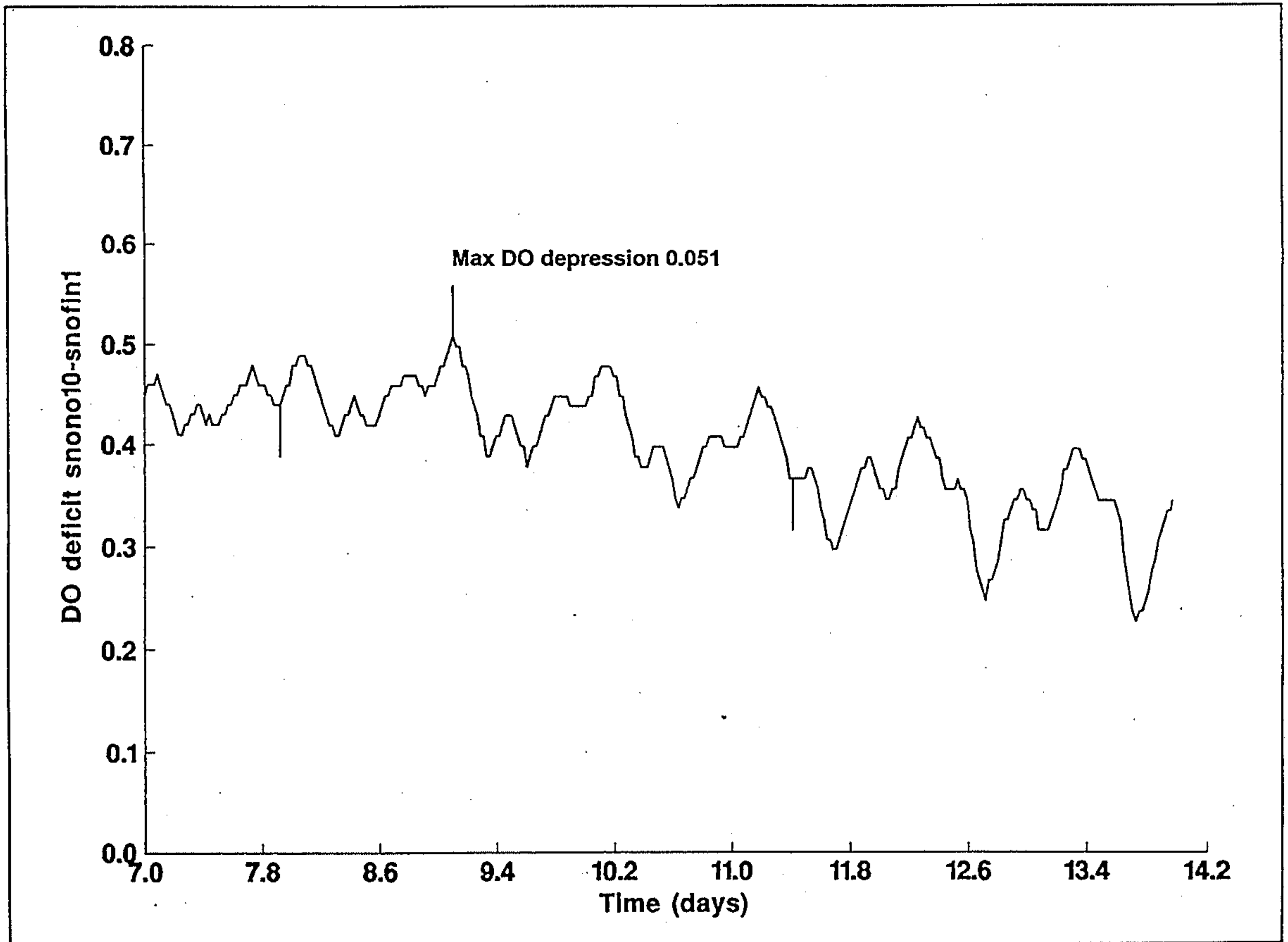


Figure 1. Oxygen Deficits Predicted by the TMDL Model (snofin1) for Segment 57 as a Function of Time

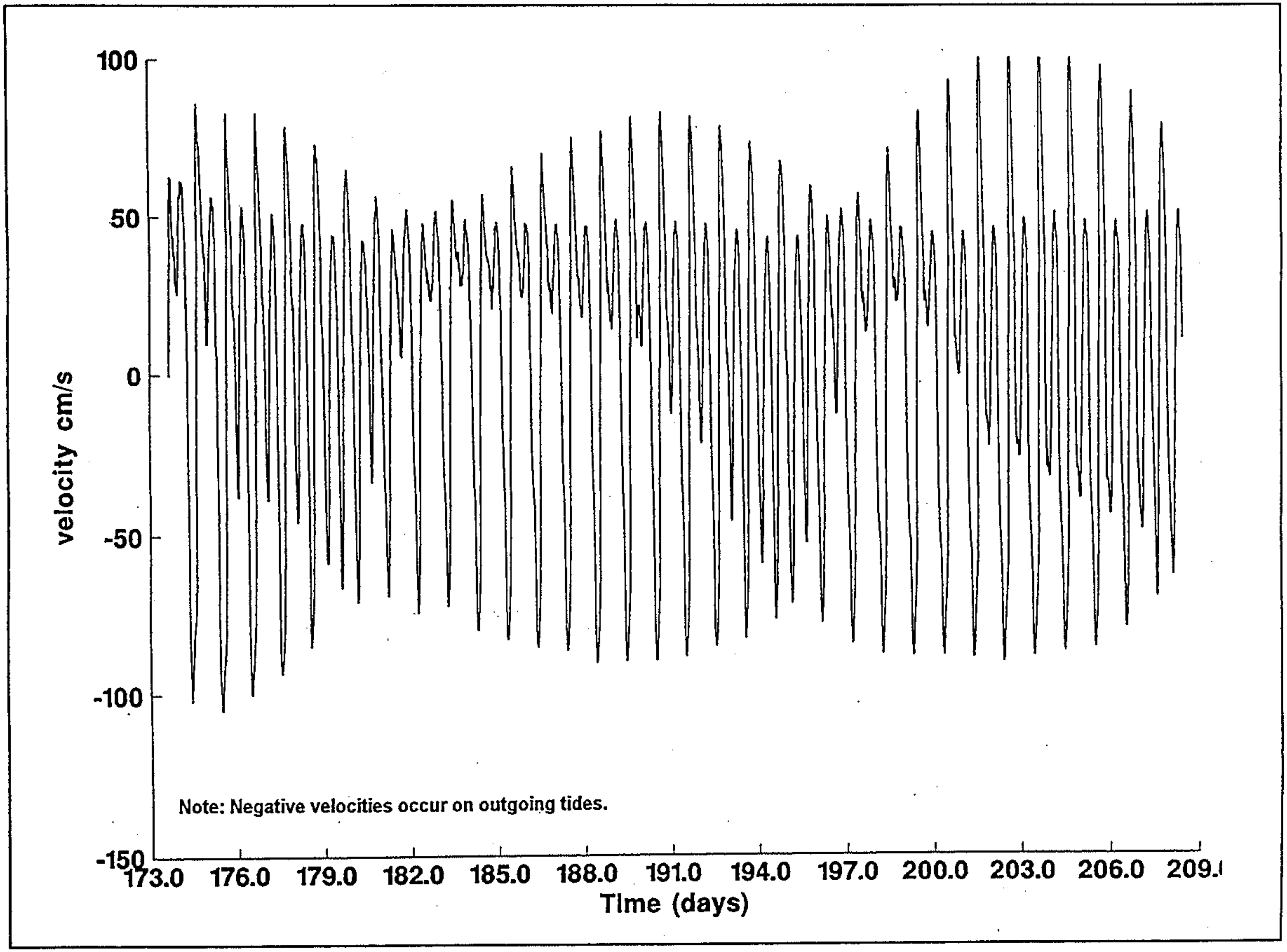


Figure 2. Observed Current Velocities in Steamboat Slough, Mid-June through Mid-July 1990

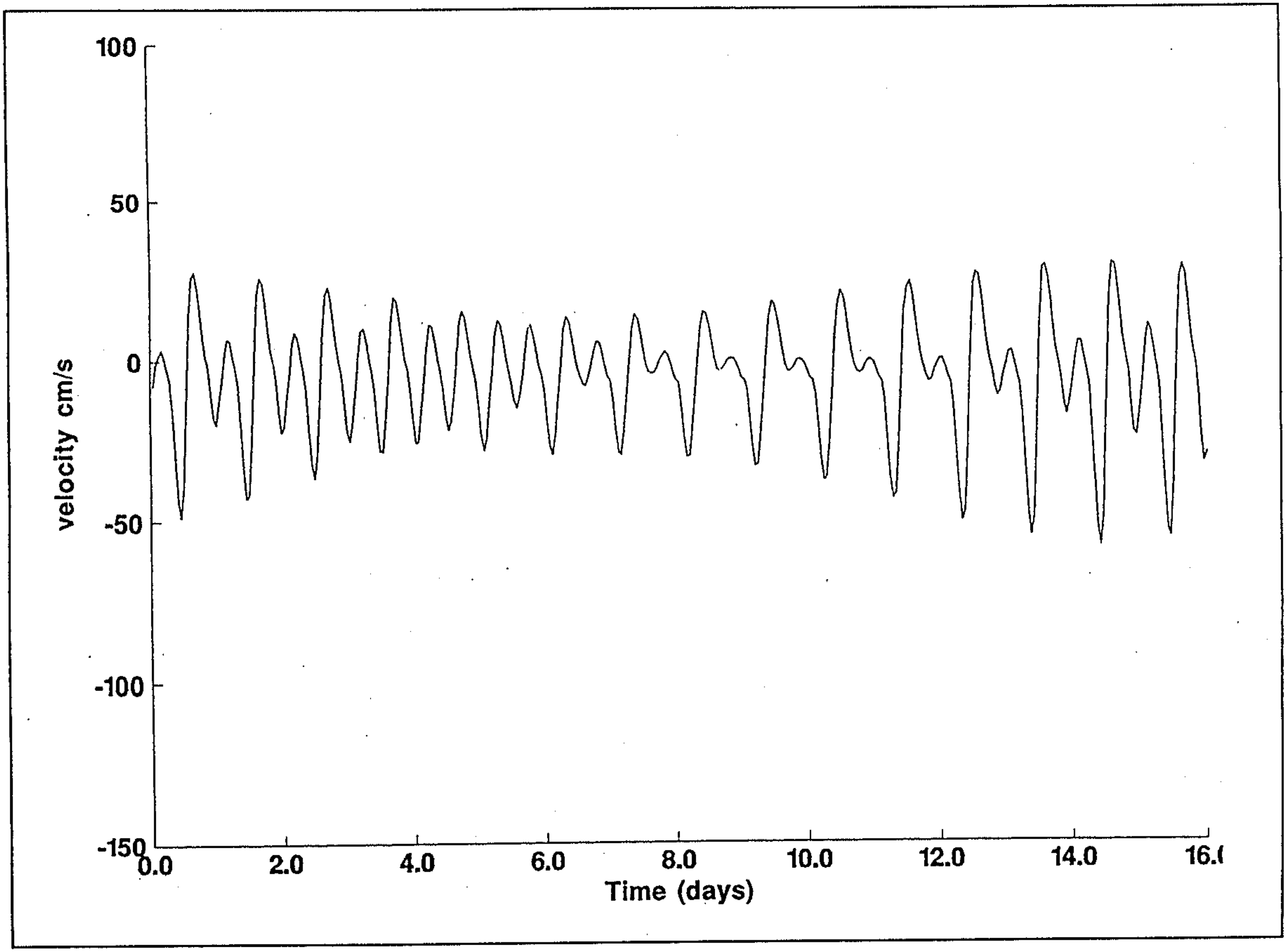
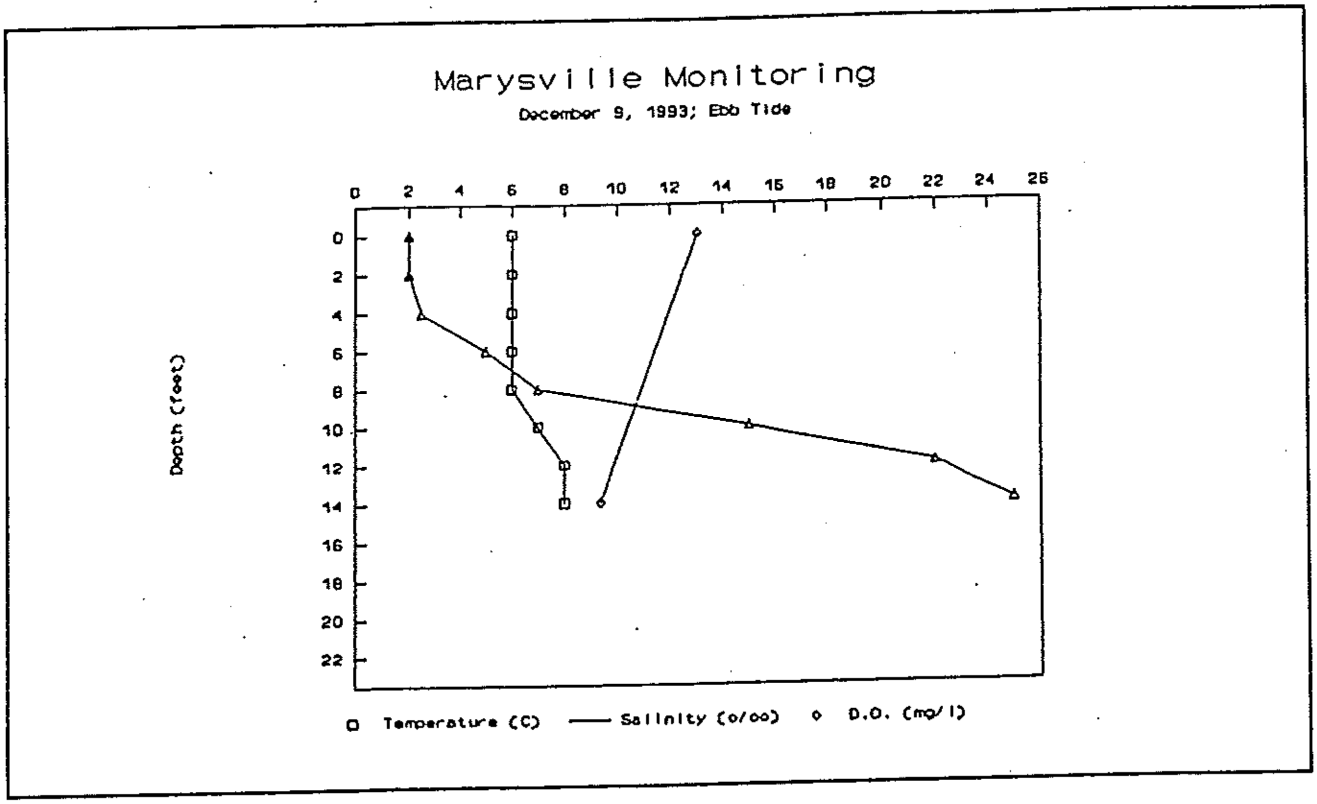


Figure 3. Current Velocities Predicted by the TMDL Hydrodynamic Model for Steamboat Slough (Link Node 60)



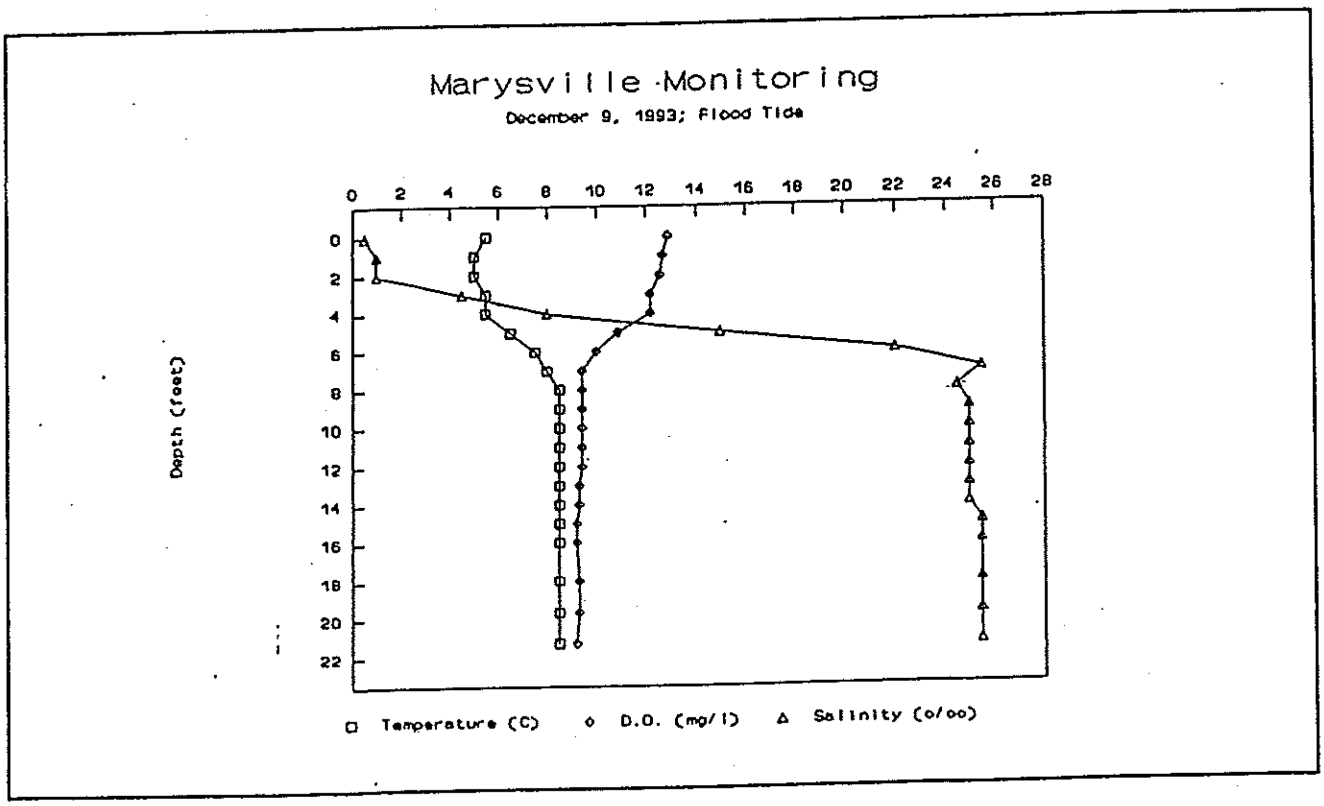
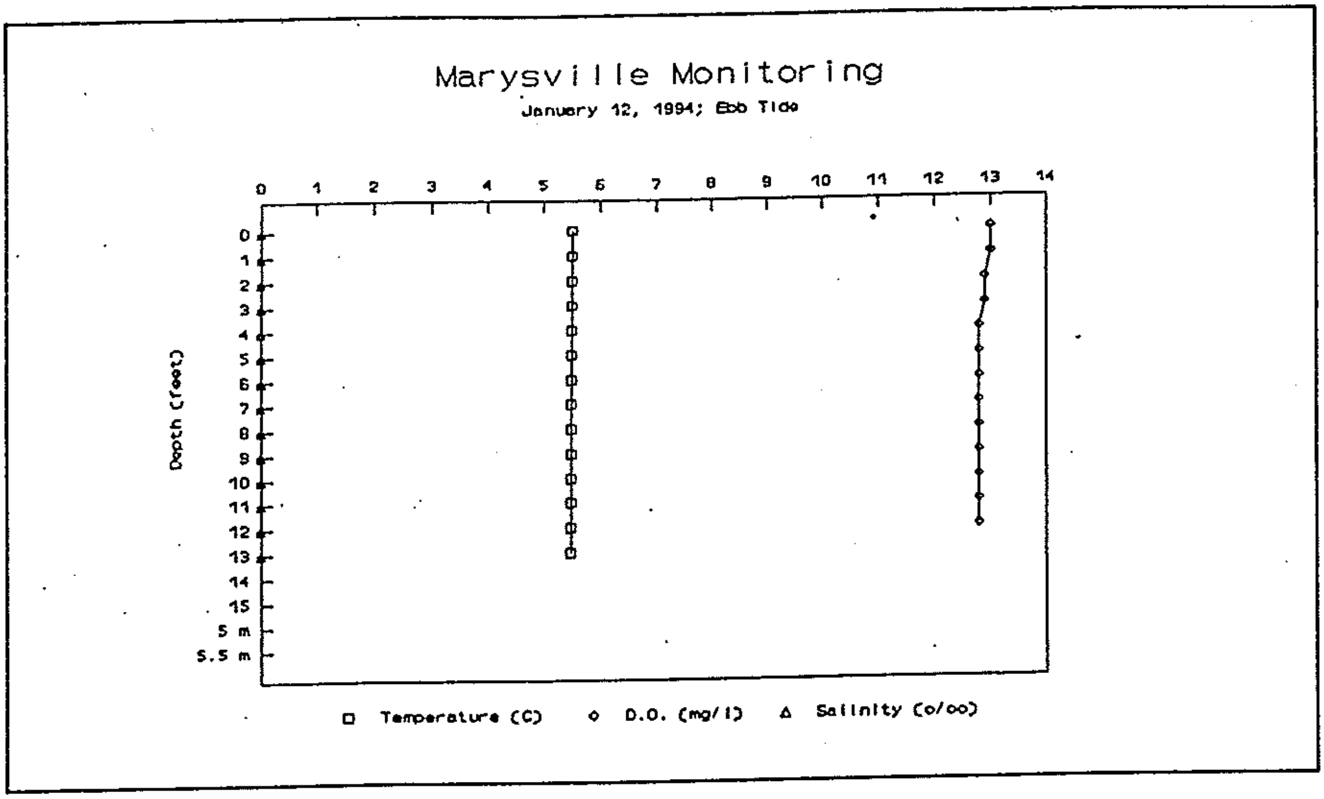


Figure 4. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, December 1993



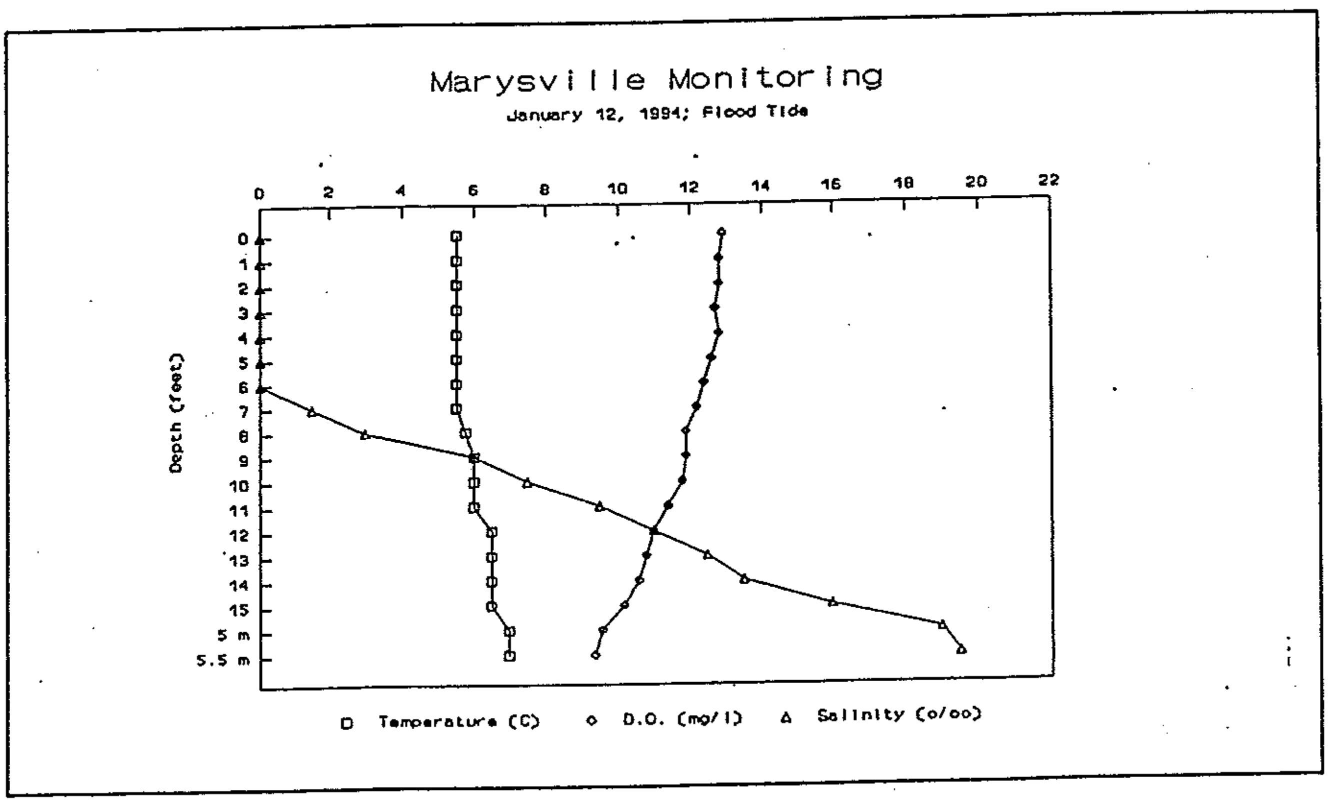
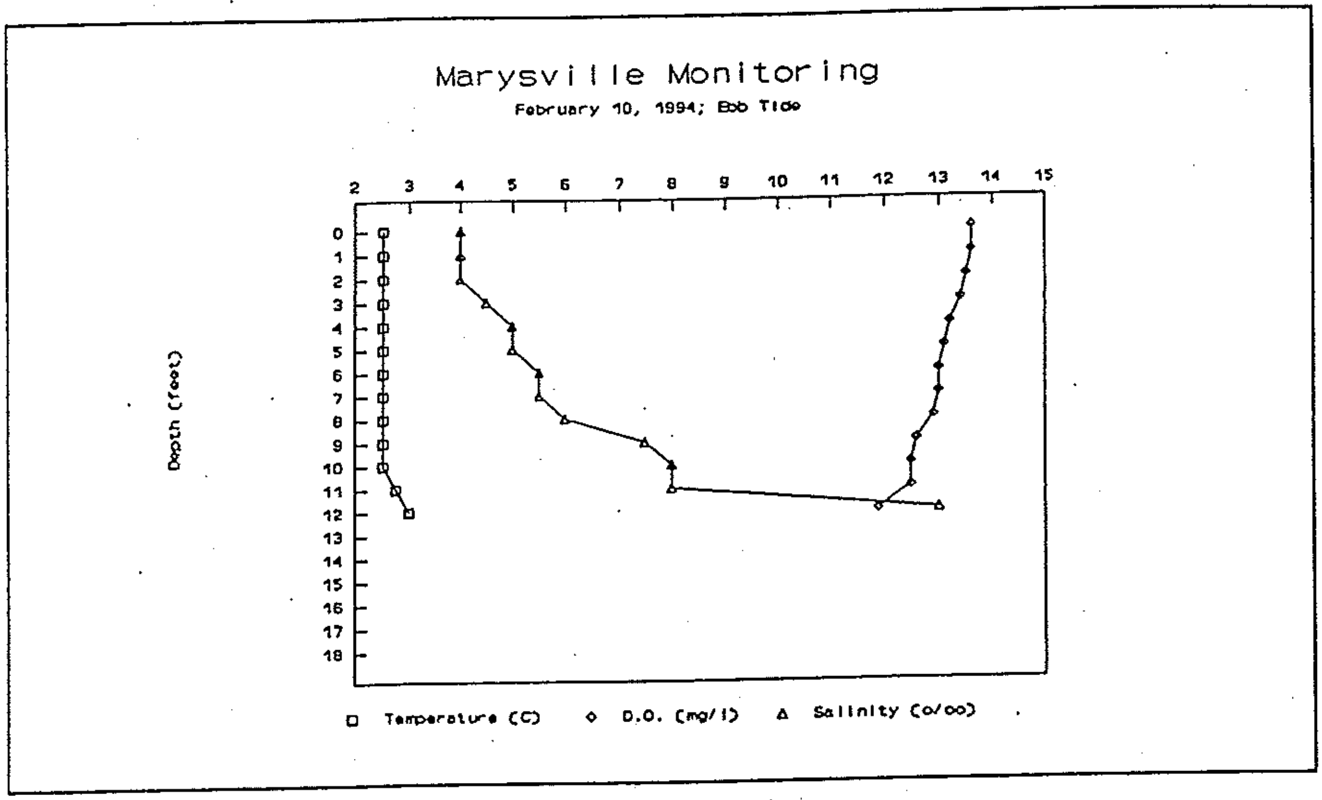


Figure 5. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, January 1994



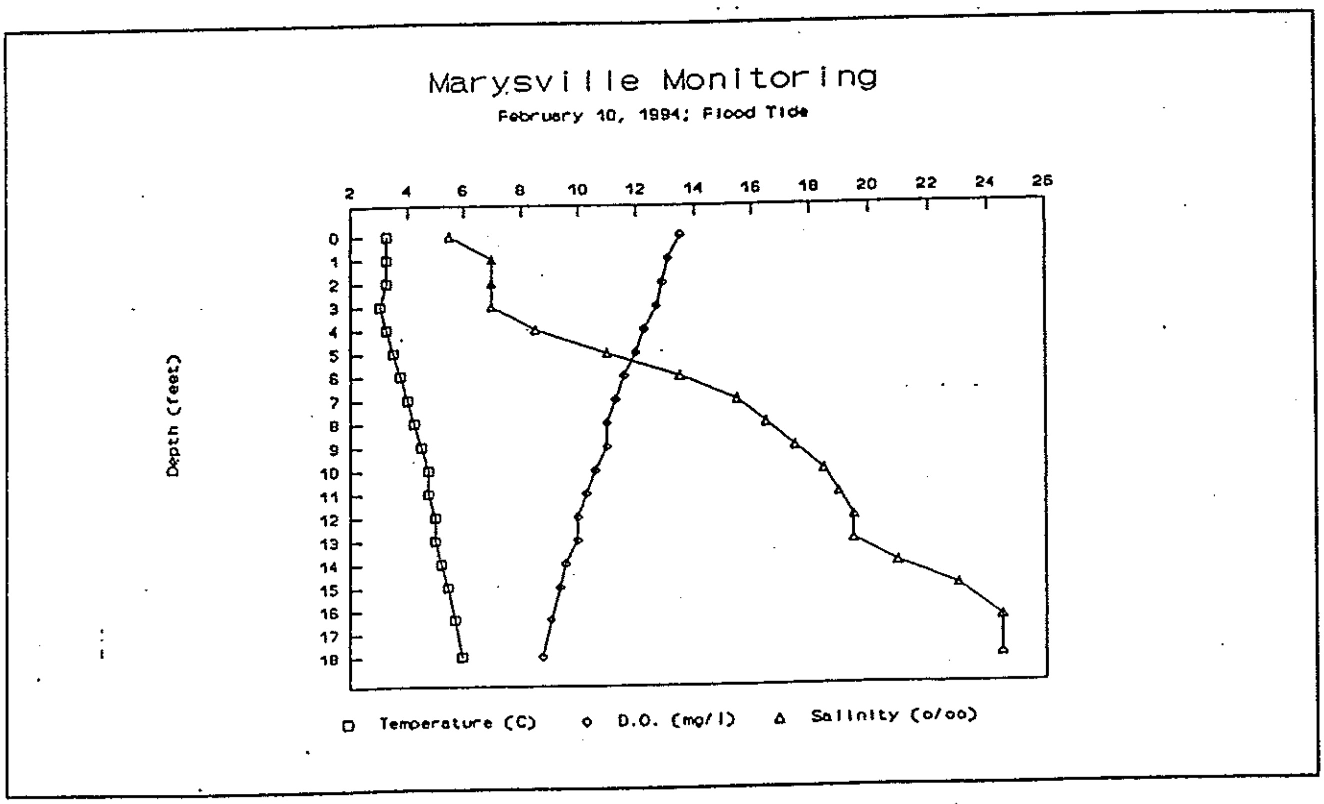
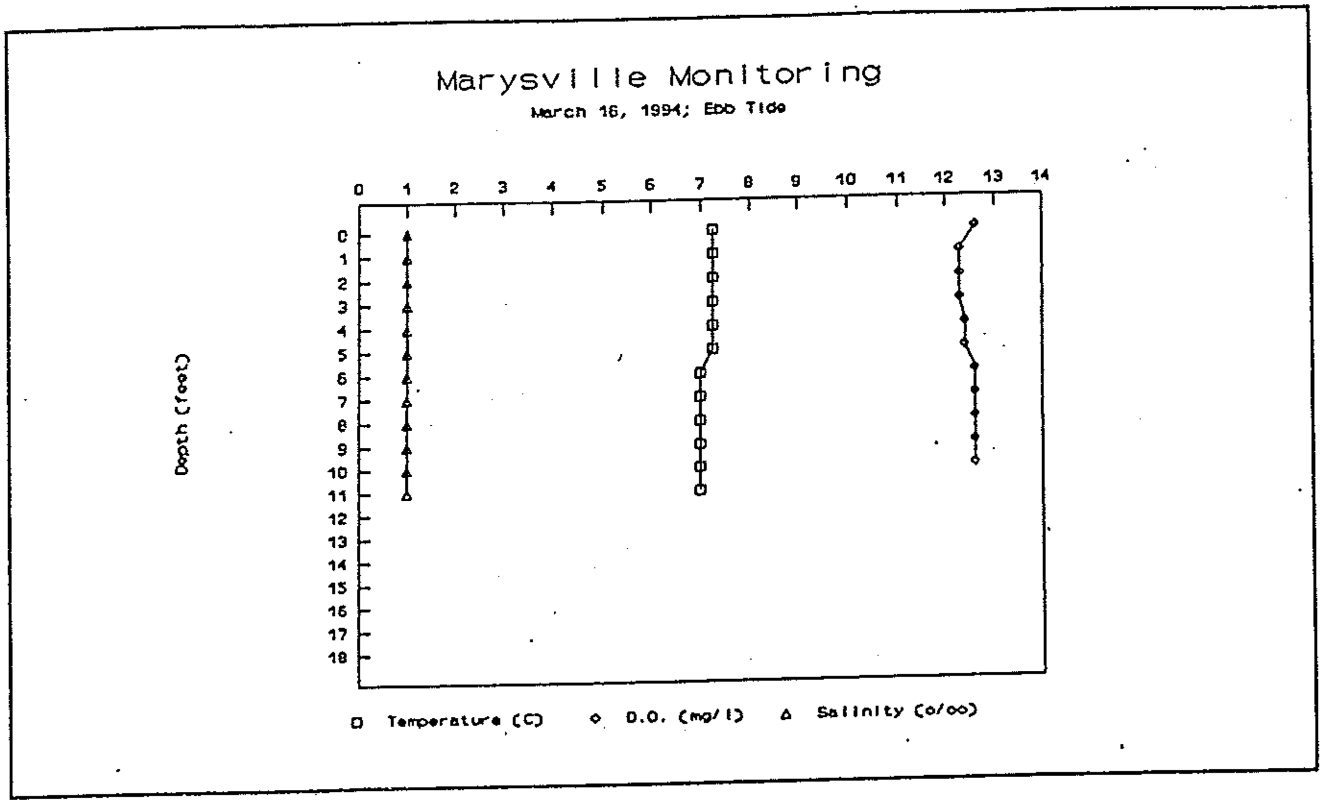


Figure 6. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, February 1994



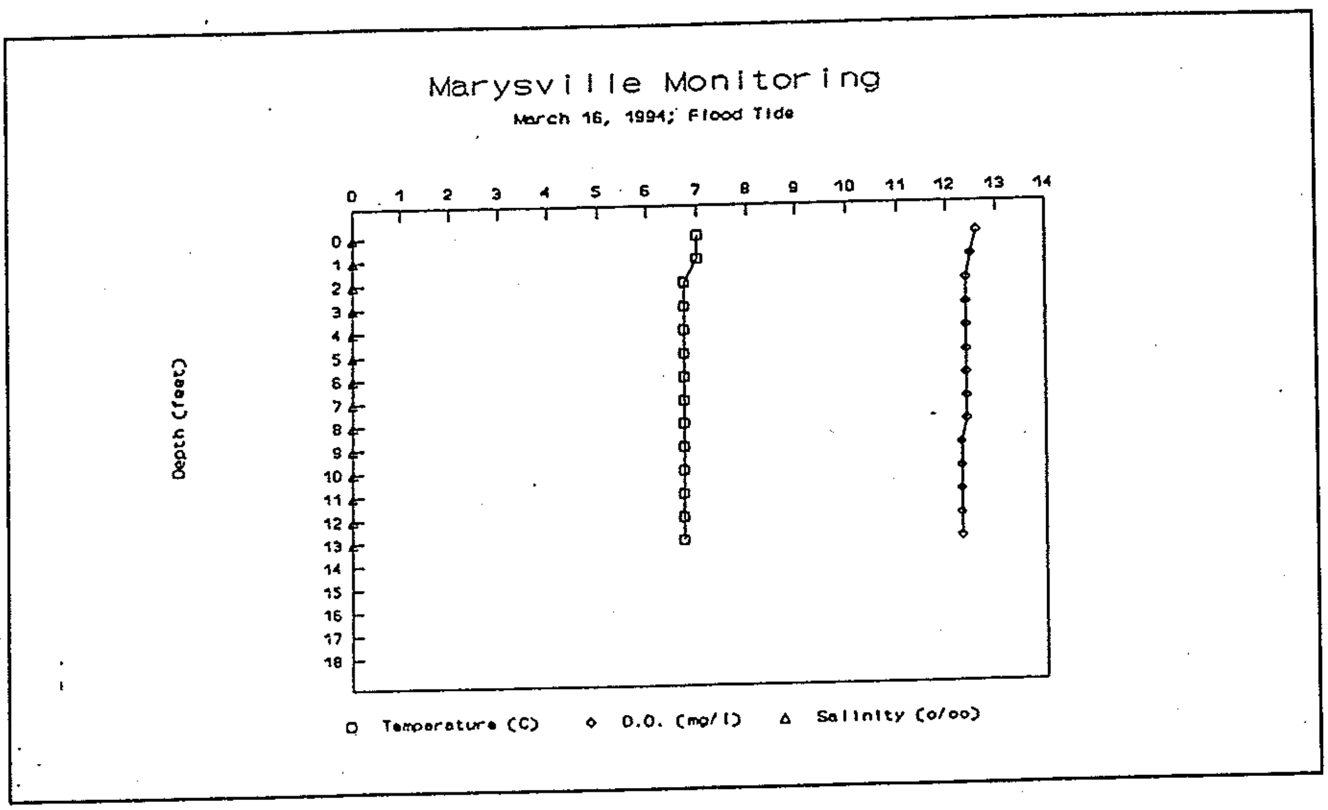
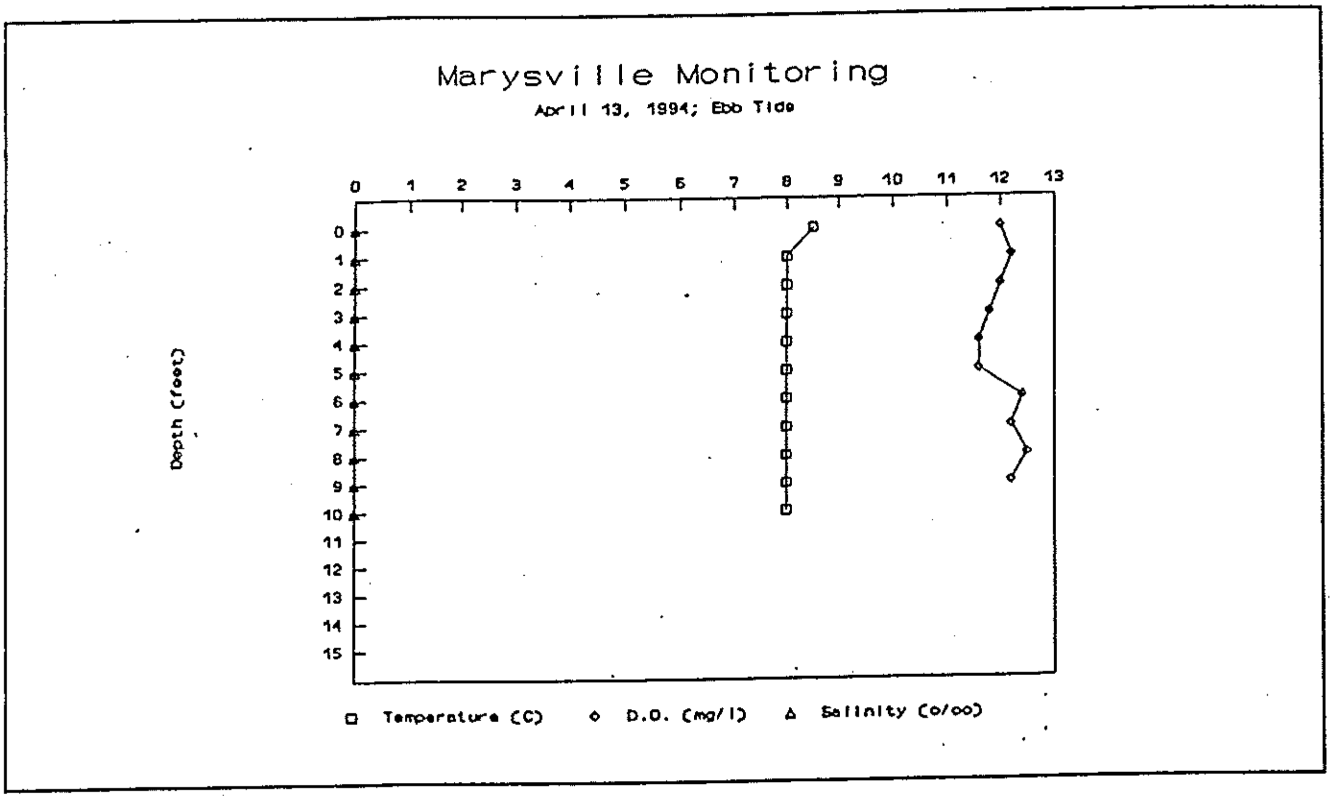


Figure 7. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, March 1994



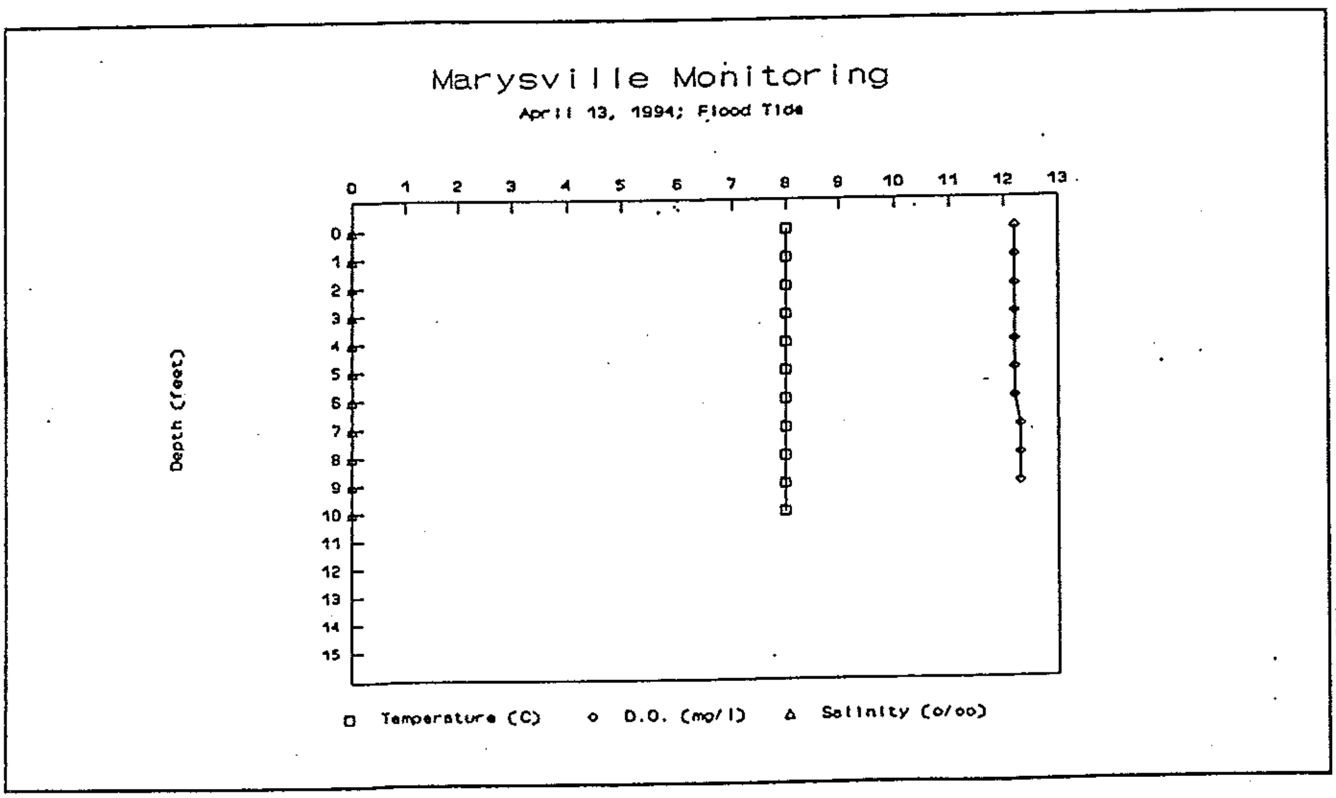
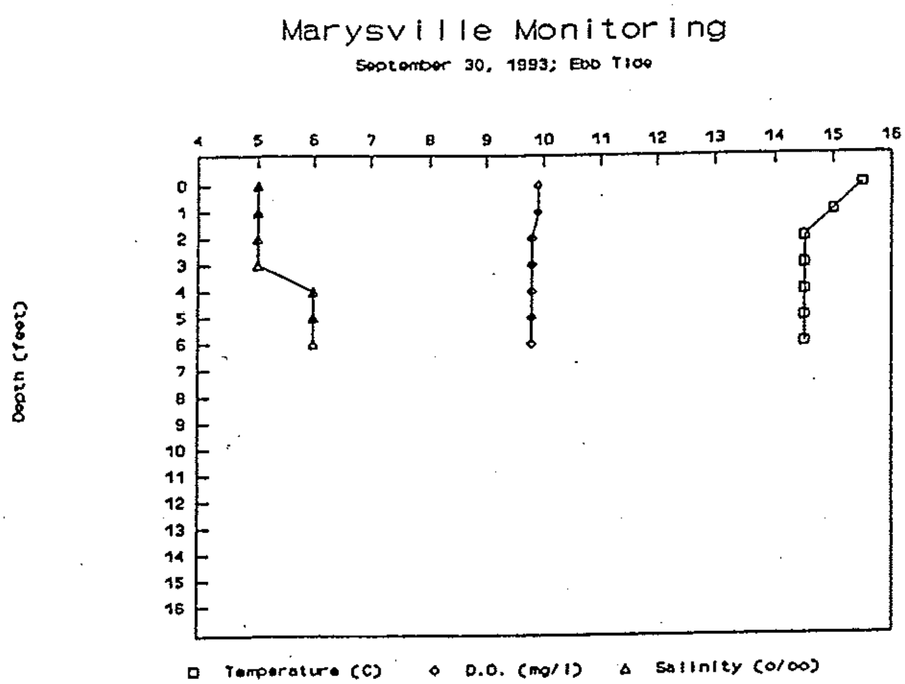
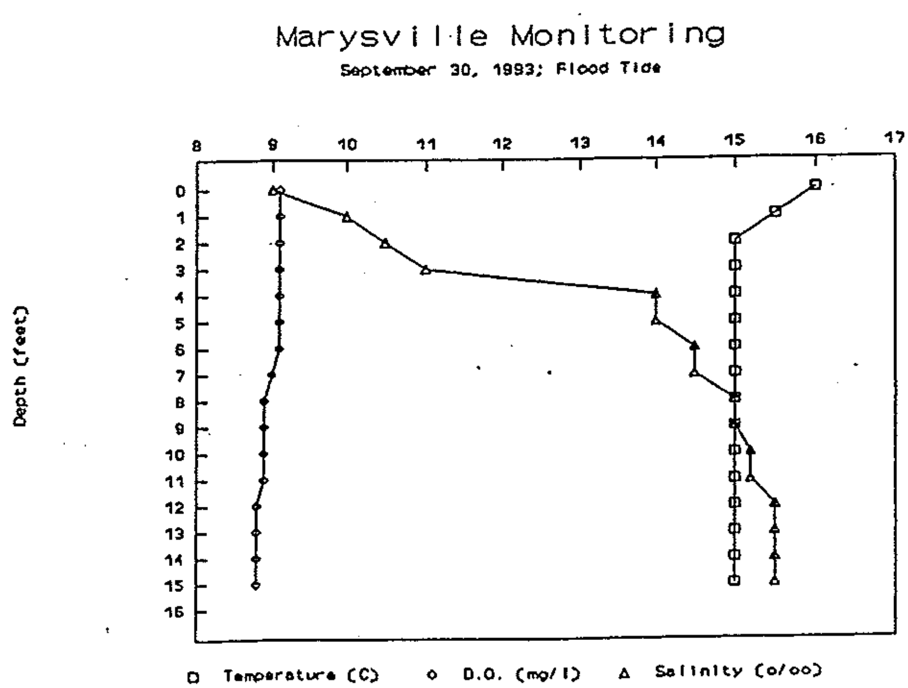
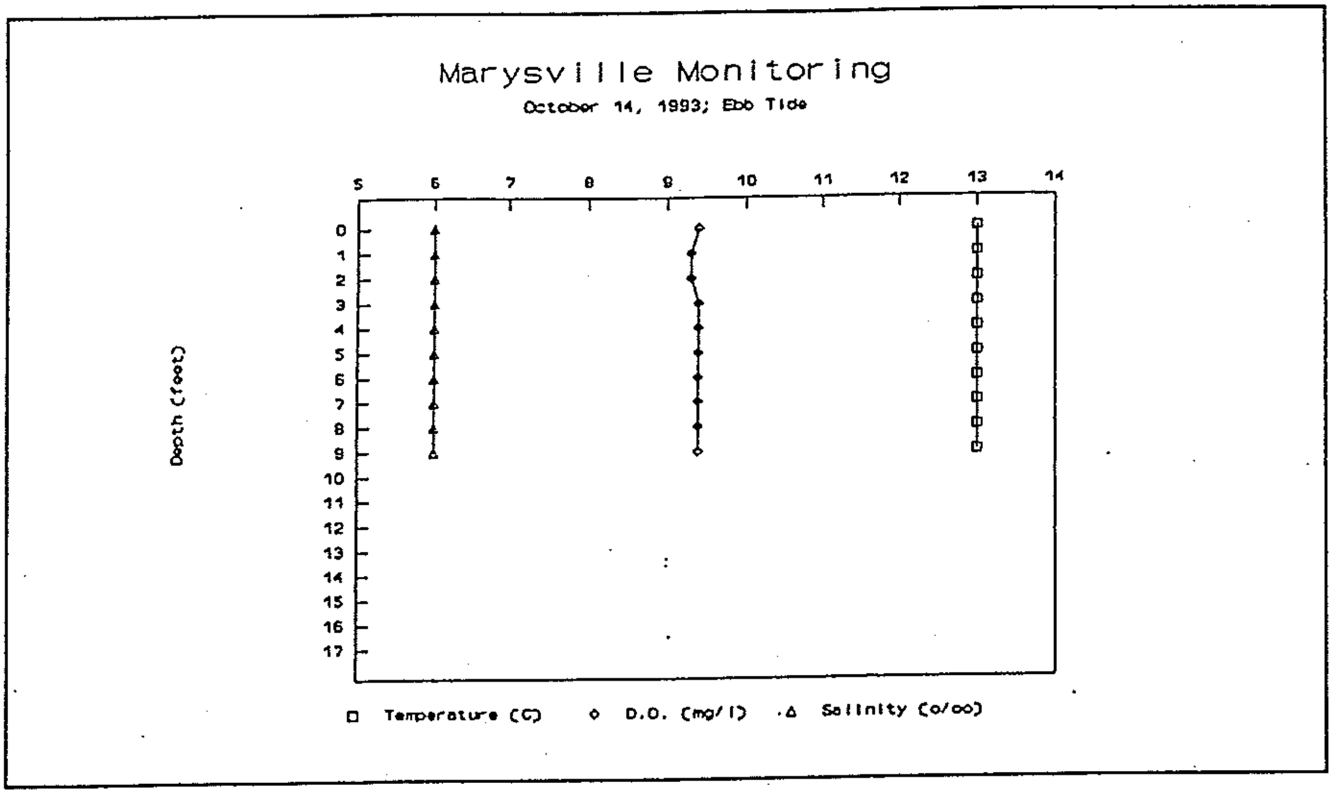


Figure 8. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, April 1994





igure 1. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, September 1993



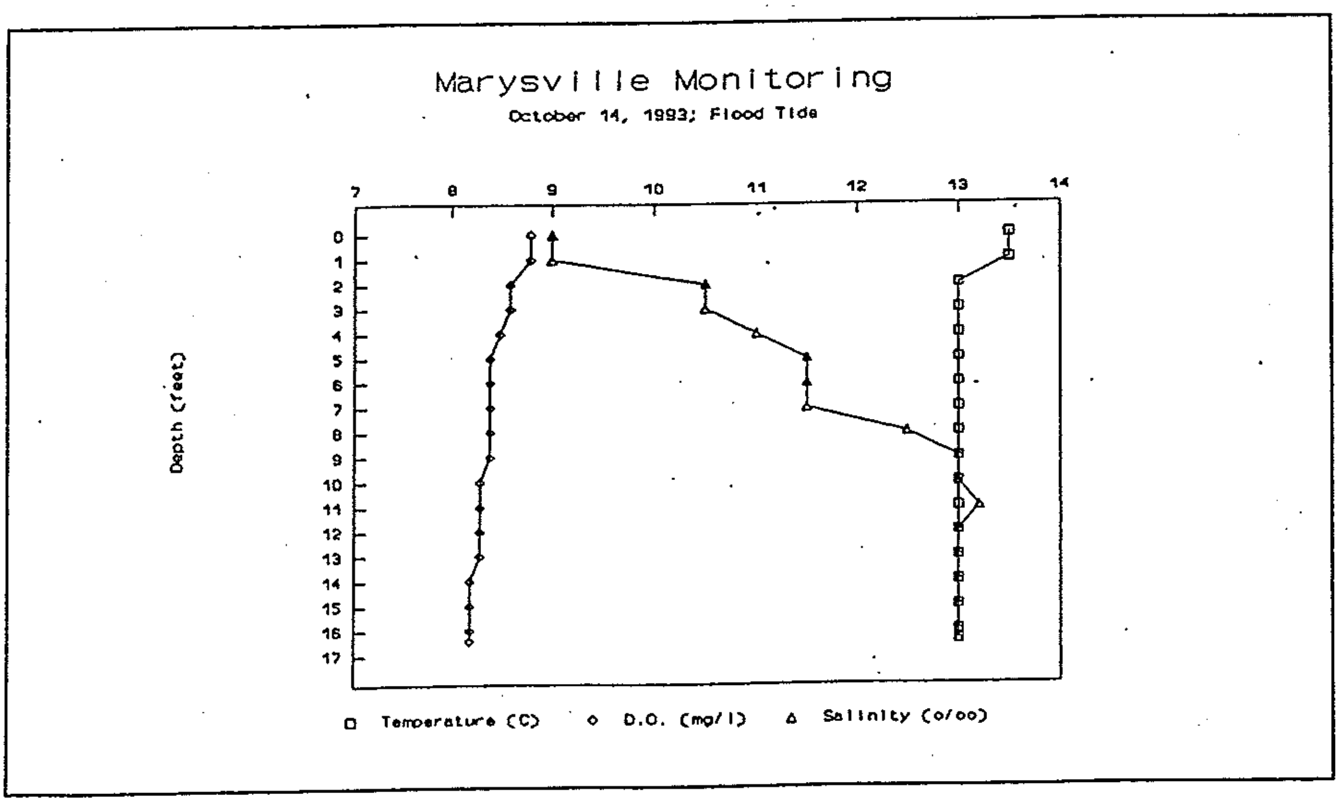
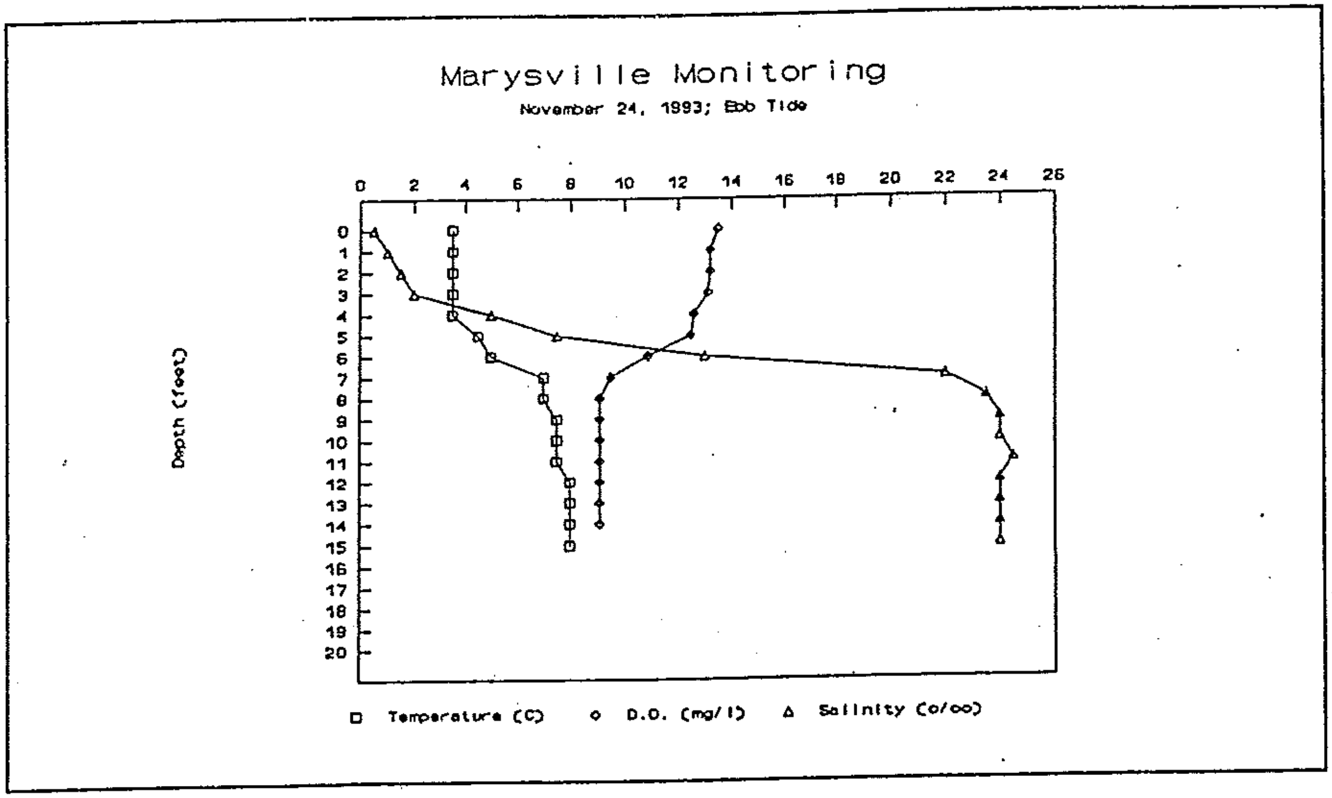


Figure 2. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, October 1993



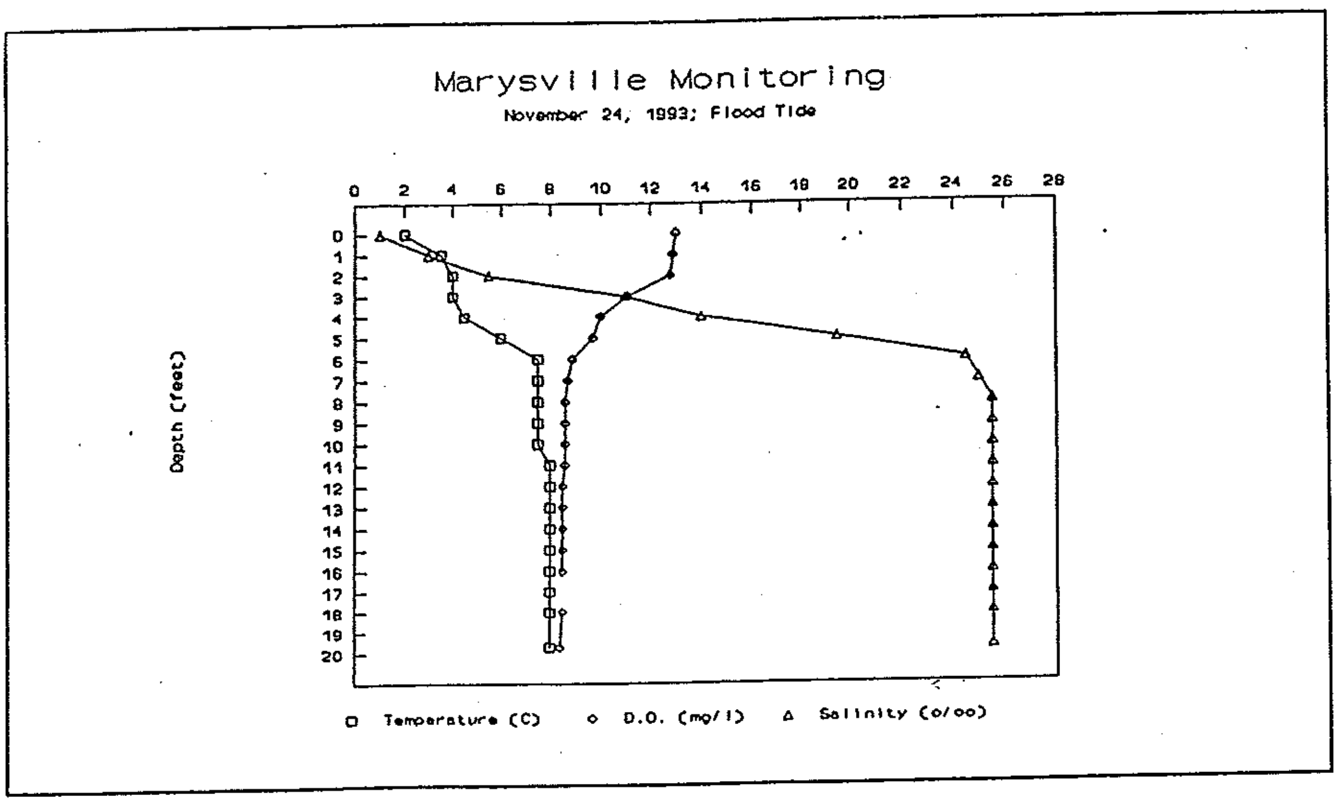
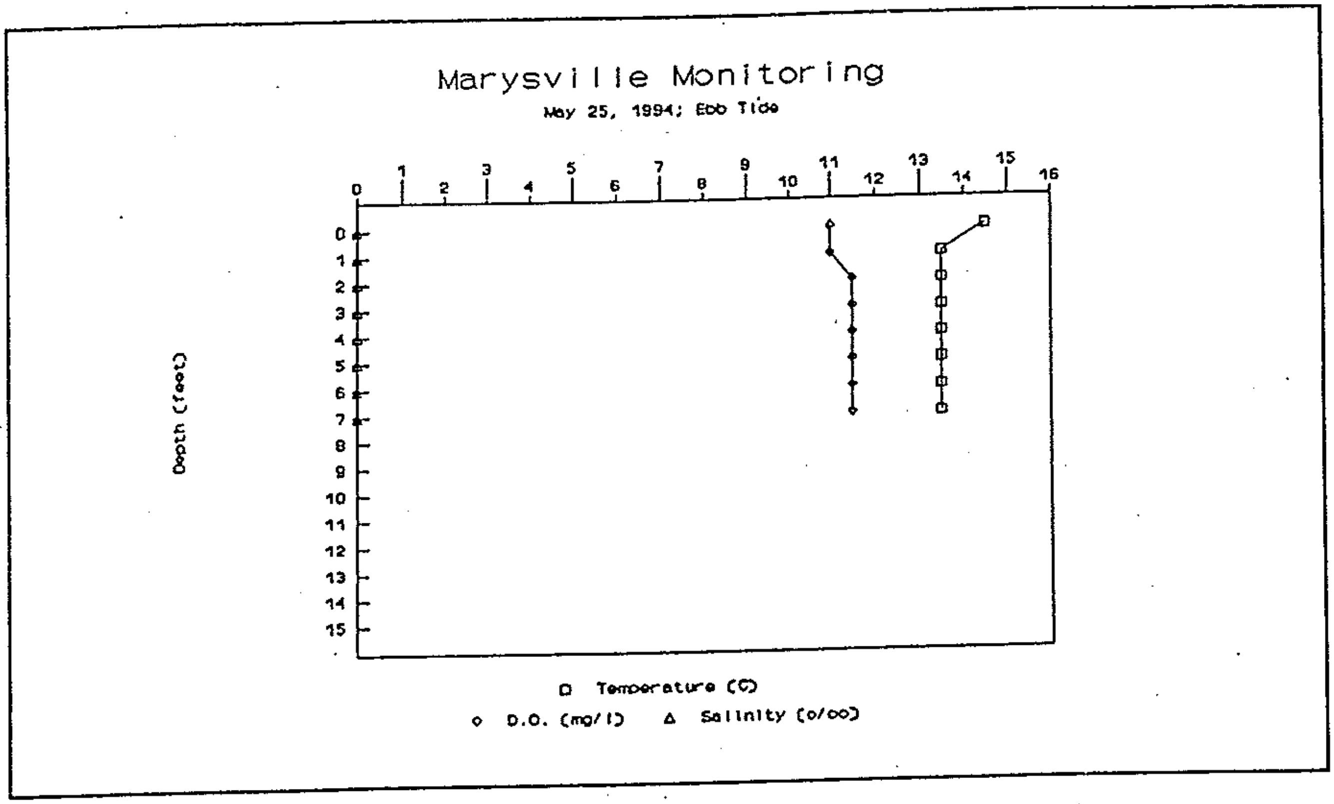


Figure 3. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles November 1993



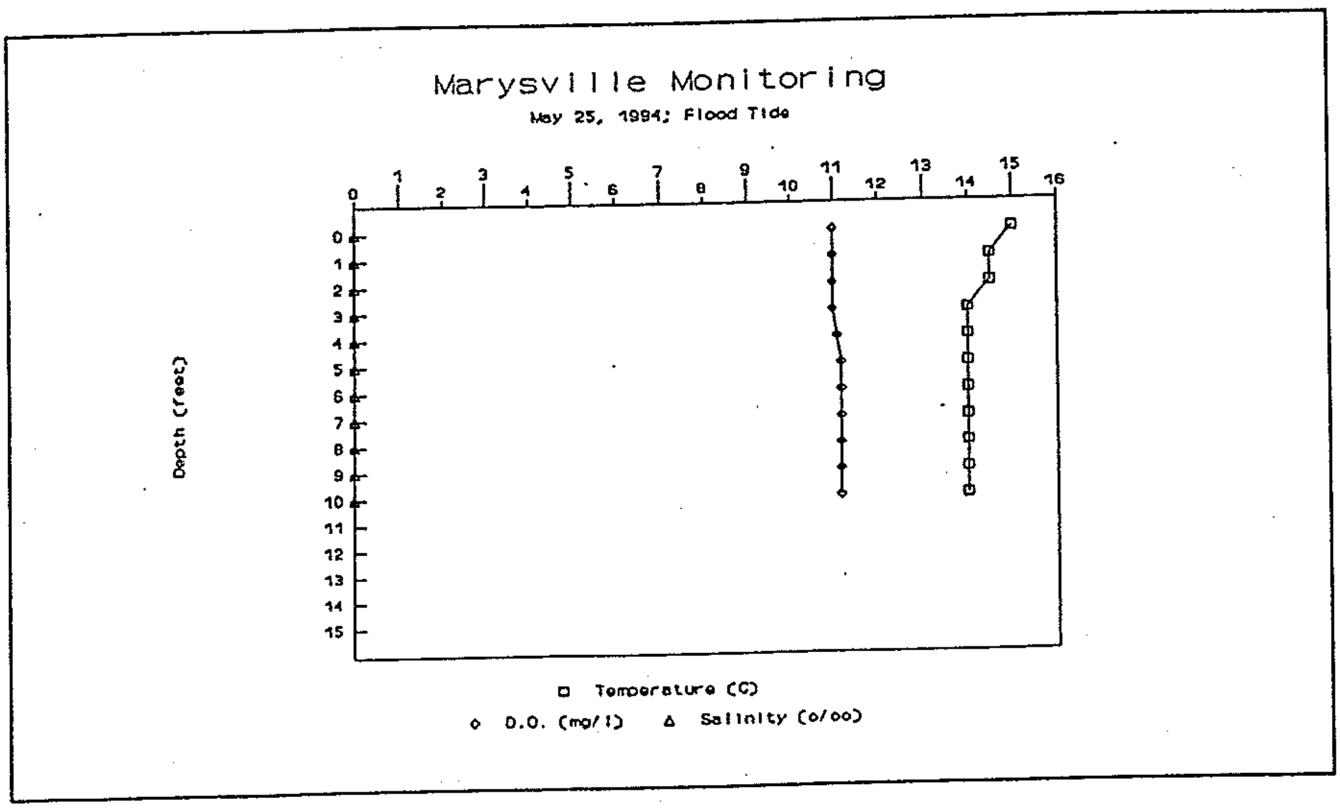
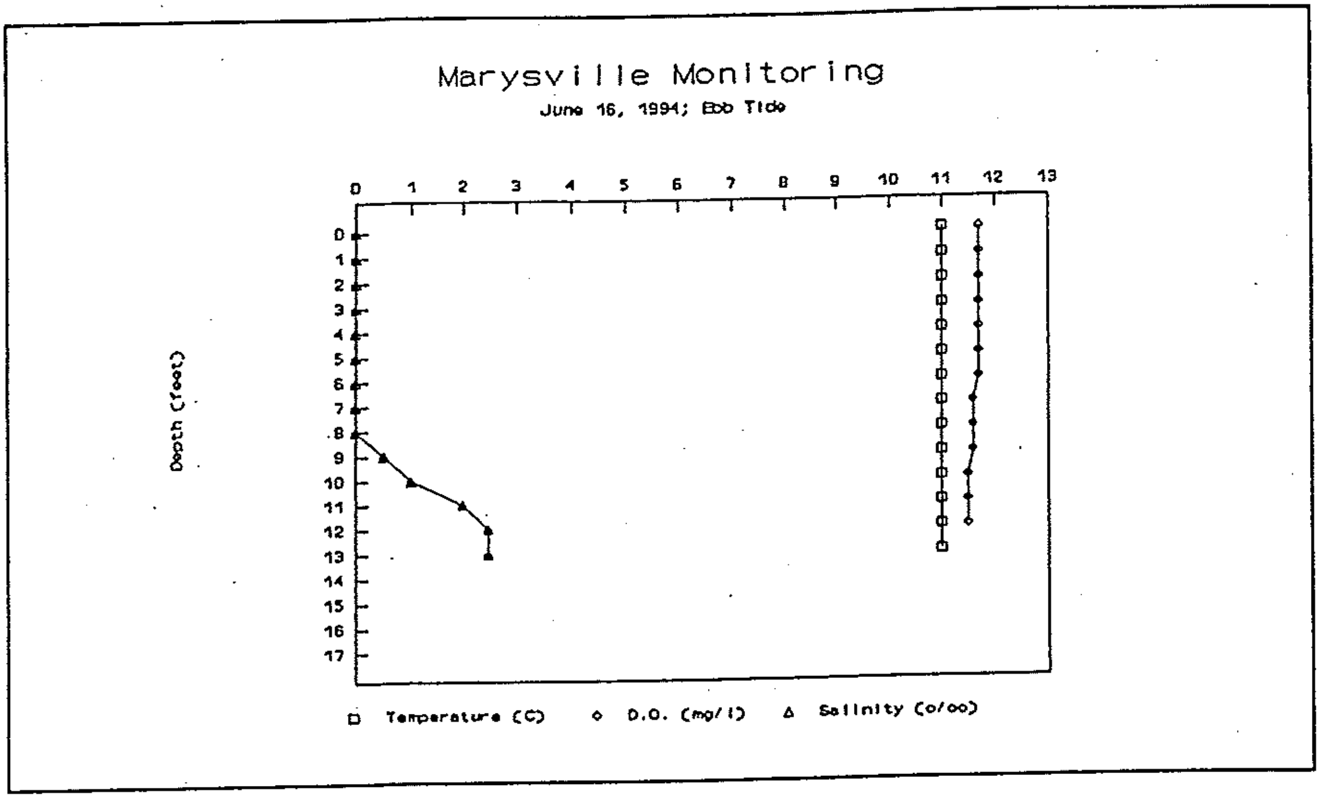


Figure 9. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, May 1994



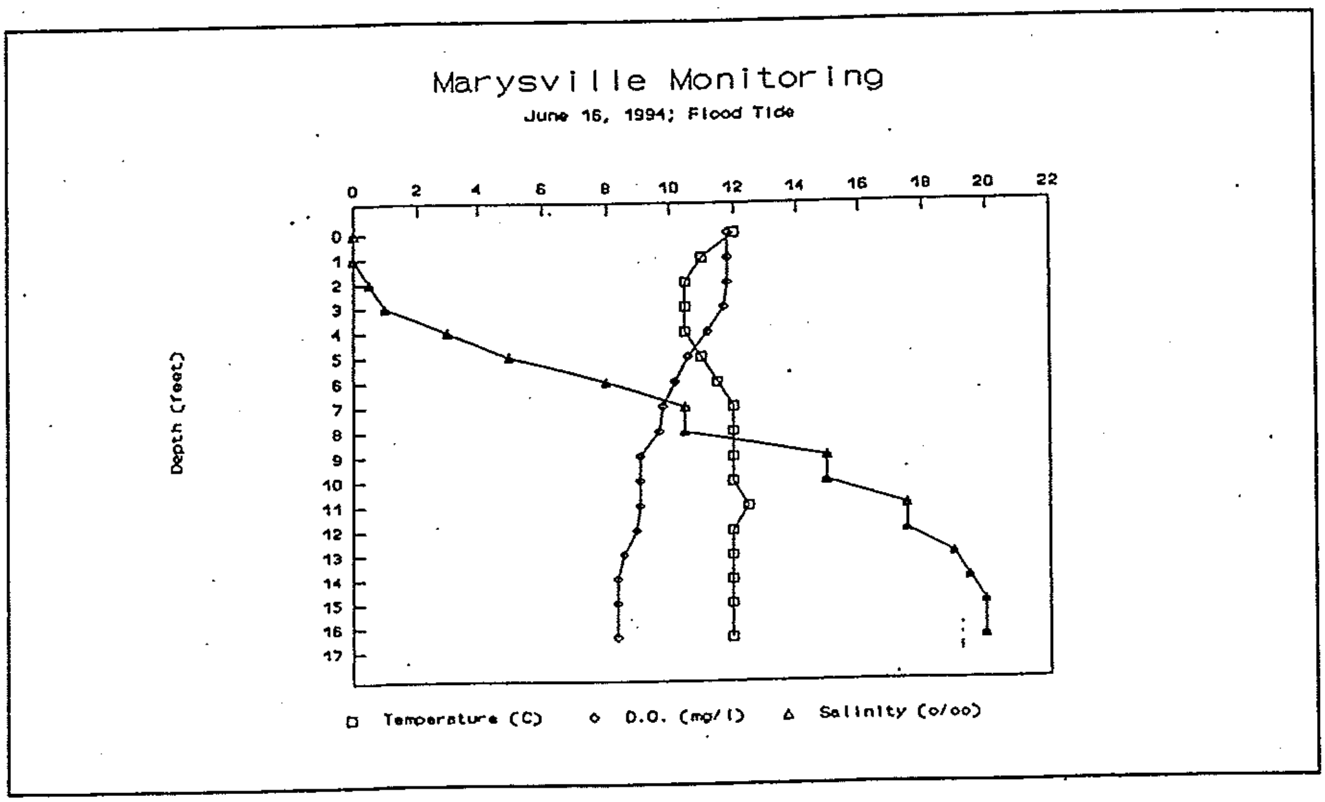
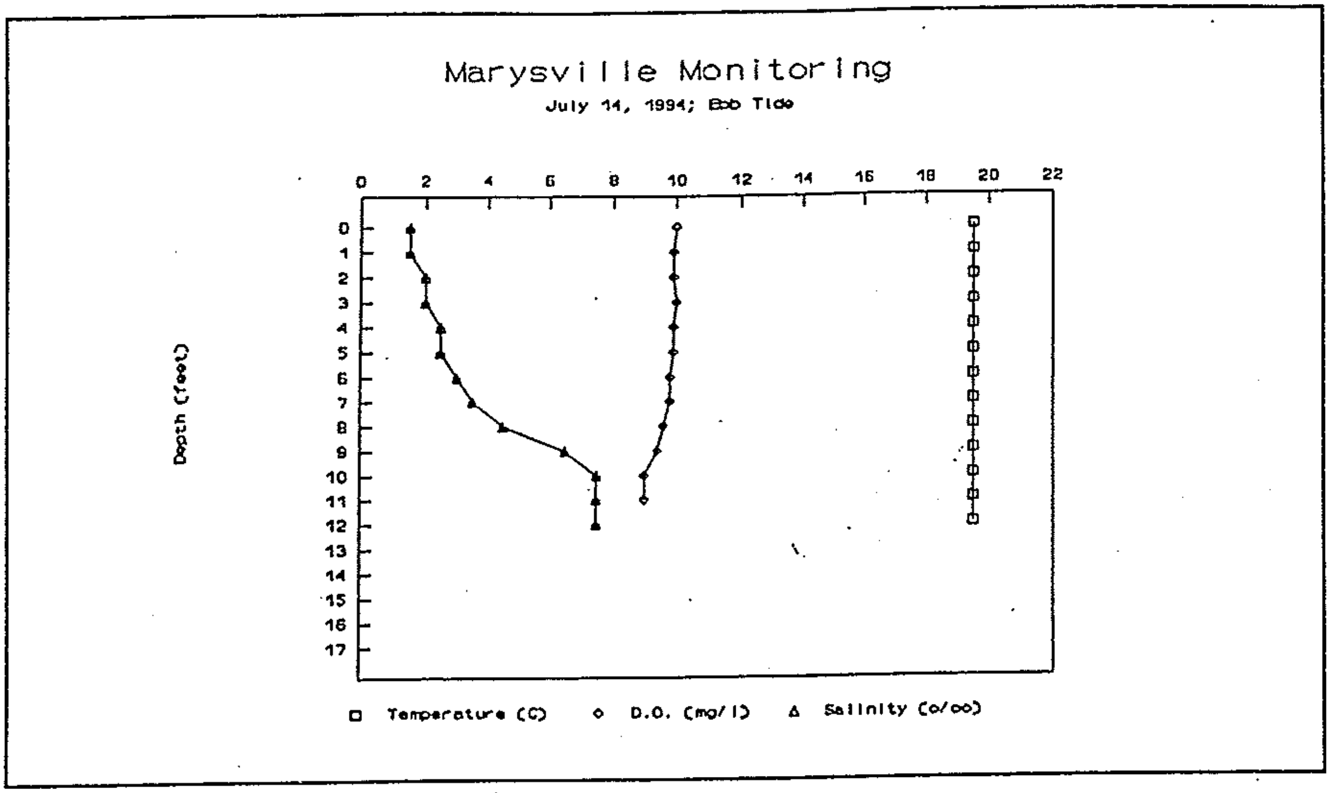


Figure 10. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, June 1994



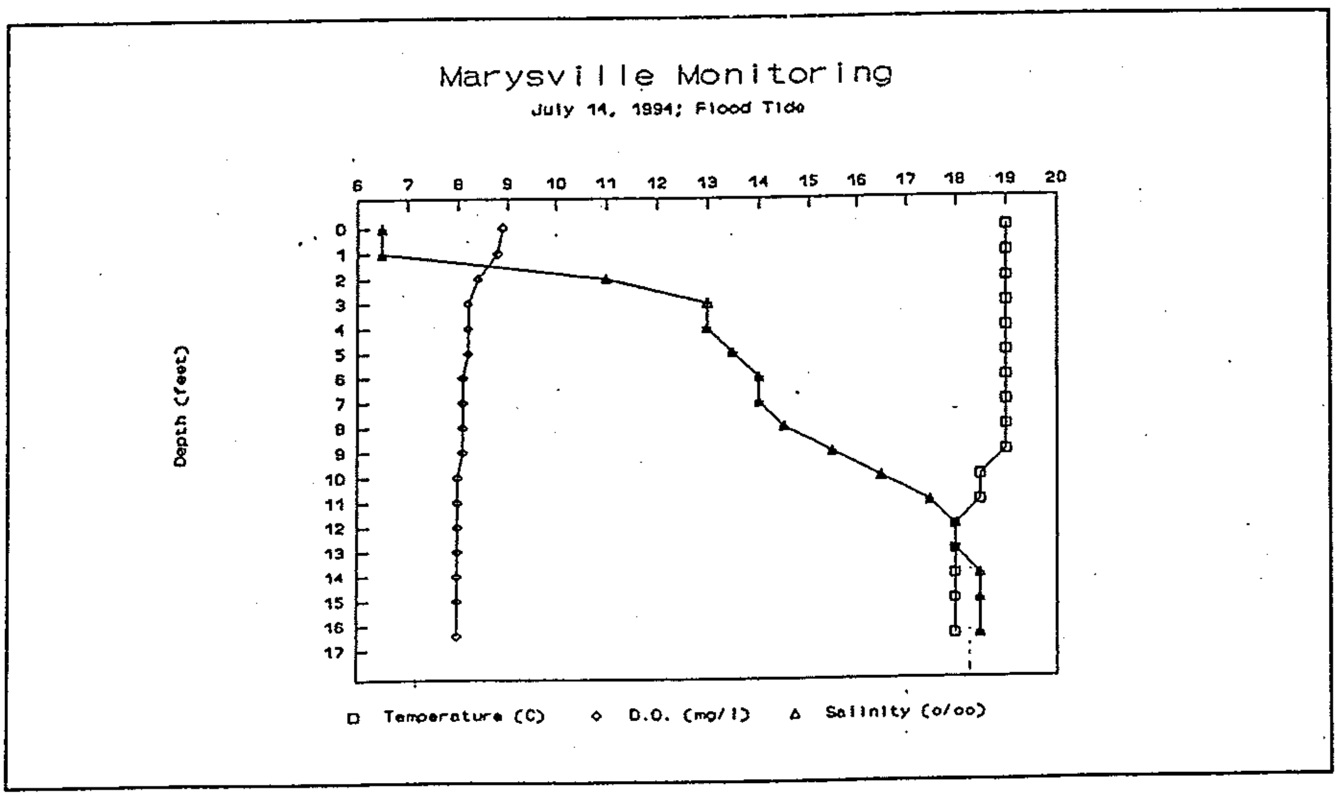
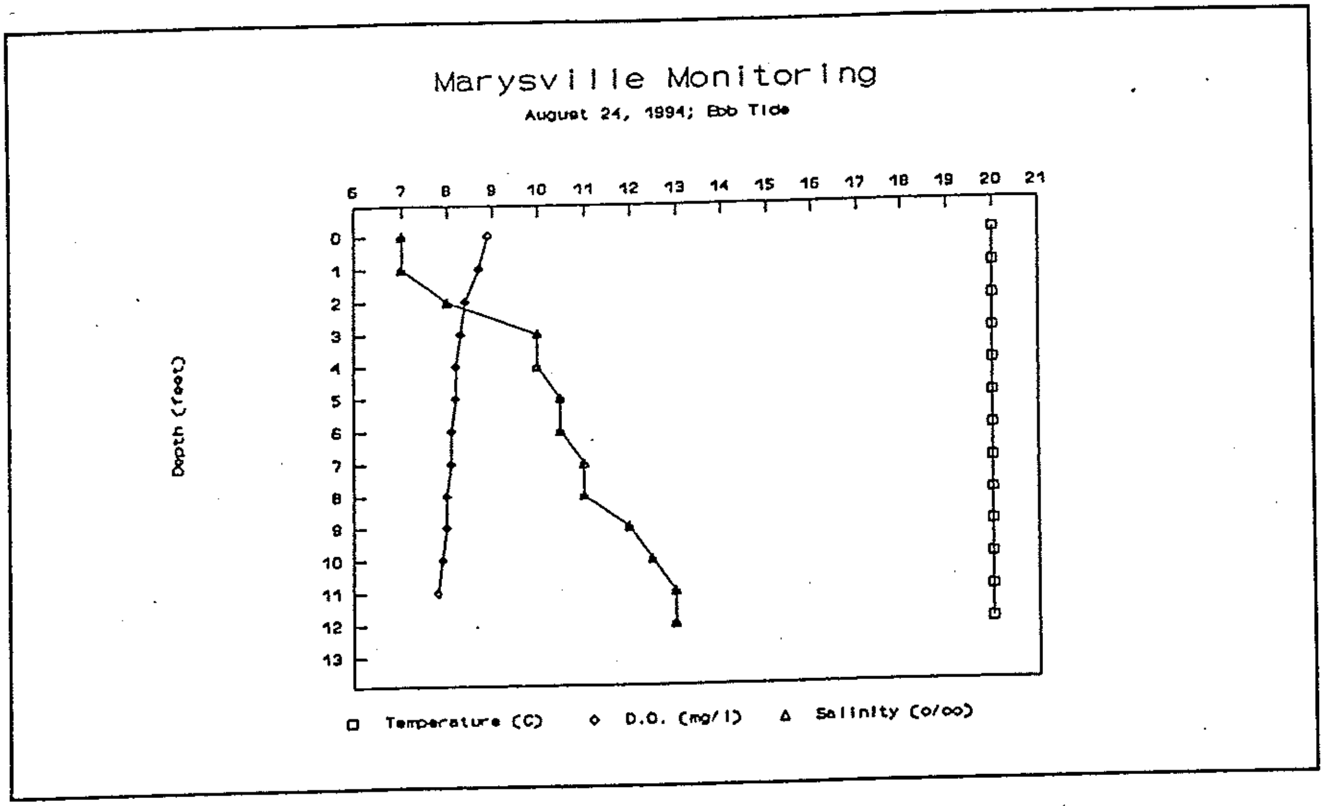


Figure 11. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, July 1994



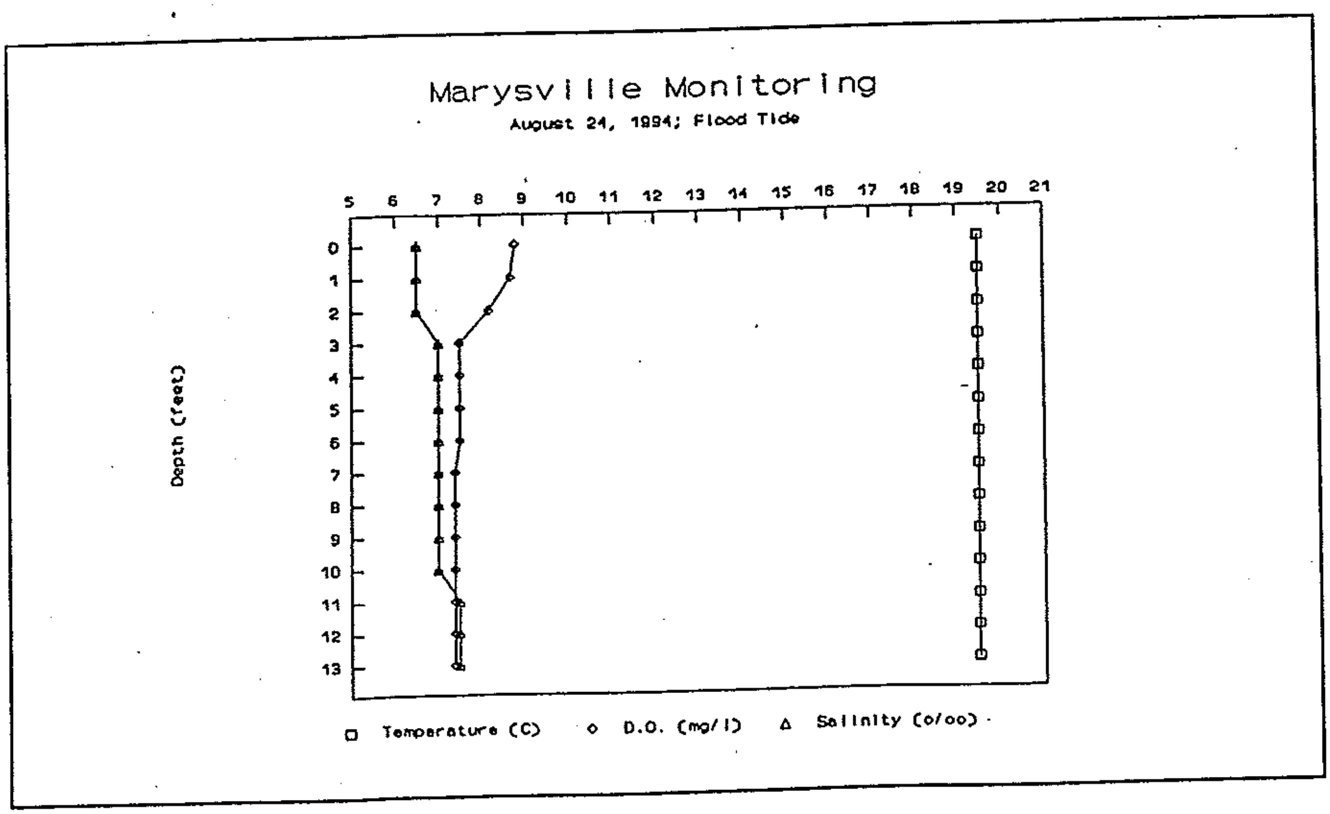


Figure 12. Steamboat Slough Temperature, Salinity, and Dissolved Oxygen Profiles, August 1994

Appendix C

PUBLIC WORKS

EVERETT

October 31, 1997

Steve Butkus
Washington Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

Subject: Comments on the proposed 303(d) listings

Dear Steve:

Concerning the placement of the Snohomish River estuary on the 303(d) list, the City of Everett asked Eugene Collias to review and comment on this matter. I have enclosed his report, copies of Everett's D.O. data and QC protocols, pages from the Department of Ecology's (DOE) TMDL study showing locations for stations in the estuary, and DOE's 1993 and 1996 data.

We appreciate Ecology's efforts on the Snohomish River TMDL study as well as the cooperation extended to the City during this process. Consequently, we hope you will find Eugene's comments to be of value. Please feel free to contact me at (425) 257-8230.

Sincerely,

Robert Waddle
Process Analyst

ENVIRONMENTAL LABORATORY
CITY OF EVERETT • 3200 Cedar Street • Everett, WA 98201 • (425) 257-8230 • Fax (425) 257-8228

Report of Eugene E Collias to the City of Everett

Concerning the placement of the Snohomish River estuary on the 303(d) list

Review of water quality standards

I have reviewed the water quality standards for Puget Sound established by the Washington State Department of Ecology (DOE) and published in Chapter 173-201A of the Washington State Administrative Code (WAC). According to this publication, the Snohomish River Estuary is classified as Class A Marine Waters. This classification states *that the dissolved oxygen (DO) shall exceed 6.0 mg/L. (But) when natural conditions, such as upwelling occur, causing the dissolved oxygen levels may be degraded by up to 0.2 mg/L by human-caused activities.* A literal interpretation of this wording is that any DO observation greater than 5.8 mg/L meets the standard, and those less than 5.8 mg/L will meet the standard provided that the natural DO level at that time was less than 6.0 mg/L and human-caused activities did not depress the DO by more than 0.2 mg/L.

Review of the proposed 303(d) list

I have received the proposed 303(d) list for the Snohomish River (segment WA-07-010). The segment is listed for dissolved oxygen. The basis for this listing stated *there were four excursions beyond the criterion at (Department of) Ecology ambient monitoring station PSS015 between 1985 and 1987.* In addition, a mathematical model study by the DOE (Cusimano, 1995) indicated *that upstream wastewater discharges likely contribute to the low dissolved oxygen levels measured. (Emphasis added.)*

Review of the Water Quality Program Policy 1-11

This policy concerns the Assessment of Water Quality for the Section 303(d) list required by the Clean Water Act (40 CFR 130.2(j)). Section 3 of this policy identifies criteria required for a 303(d) listing. Specifically for DO, item A.1 states that *ten percent or more of the measurement with a minimum of at least two measurements are beyond the numeric state surface water quality criteria within the most recent five year period that data have been collected. (Emphasis added.).*

In addition, item A.8 states : *A modeling analysis of an existing or proposed activity shows that standards will likely not be met within the next two years.* It must be noted that no specific frequency or duration of human-caused activities resulting in a DO violation is mentioned or specified. This raises a question concerning the use of any mathematical model for placement of a water body on the 303(d) list.

Review of available data

I have reviewed the available data for the following stations

Station Name	Station Number	Years of record	Sampled by
Snohomish River	Site 1	1995 and 1996	City of Everettt
Snohomish River	Site 2	1995 and 1996	City of Everettt
Snohomish River	Site 3	1995 and 1996	City of Everettt
Snohomish River	SN020	1993 and 1996	DOE
Snohomish River	SN021	1993 and 1996	DOE
Snohomish River at Hwy. 99	PSS015	1973-1987	DOE
Gedney Island, East of	PSS019	1980-1996	DOE
Puget Sound at West Point	PSB003	1976-1996	DOE
Admiralty Inlet	ADM001	1975-1996	DOE

An examination of the data for the Snohomish River Estuary at Station PSS015 indicated only **three** samples over a 23 year period where the DO was below 6 mg/L - the standard imposed by the DOE for Class A marine waters. Of these values, only two were below 5.8 mg/L. These three values are presented in the following table:

Date	DO (mg/L)	Salinity
9 Oct 1974	5.9	28.0
10 Aug 1987	2.7	2.0
15 Sept 1987	5.7	27.0

The low DO observed on 10 August 1987 is suspect. If this low DO is associated with human-caused activity, the associated nutrient data should be high. This is not the case.

According to the WQPP 1-11, the data to be examined for depressed DO is to have been acquired during the last five year period for which data have been collected. Data at station PSS015 were obtained in 1986, 1987, 1993, 1995 and 1996 on a total of 26 days. Days where more than one sample was obtained at this station were counted as only one day. Since only two days of "low" DO were noted during this five year period, the percentage of low DO was 7.7% considerably less than the 10% value in WQPP 1-11.

Other data from other stations in Puget Sound and sampled by DOE (Admiralty Inlet, Possession Sound, and off Gedney Island), indicate that low DO may occur naturally especially in late summer (August and September) when the influence of coastal upwelling is observed throughout Puget Sound. Upwelled oceanic water entering the Straits of Juan de Fuca is low in DO which eventually results in a lowering of DO throughout all of Puget Sound. This phenomenon is evident and well documented in the historical data obtained between 1951 and 1962 (Collias, 1974).

Gedney Island station

The proposed 303(d) list identified other Puget Sound stations with more than 10% of the samples having low DO. These are stations off West Point, in Admiralty Inlet, in Saratoga Passage and east of Gedney Island. The first three stations were excluded because the lower DO is attributed to natural conditions and was not related to human-caused activities.

Data from the station east of Gedney Island (DOE station PSS019) showed DO concentrations of less than 6.00 mg/L for 28 out of 343 times over a period of 15 years for a percentage of 8.2. All of these samples were taken from a depth of 10 meters or greater. For the five year period of 1991 through 1995, 14 out of 168 samples (8.3%) had a DO of less than 6.0 mg/L and all of these 14 samples were at depths of 10 or 30 meters. These observed values of DO less than 6 mg/L are consistent with natural causes that affect the waters of Port Susan and Possession Sound especially the water below 5 meters.

TMDL Study

The results of the mathematical modeling used for the TMDL Study of the Snohomish River Estuary Dry Season (Cusimano, 1997) indicated that it is possible to have DO values of less than 6 mg/L for very short periods of time during a tide cycle. These depressions were derived for assumptions concerning oxygen utilization incorporated into the mathematical model. Also, the *average* daily values of DO were not given. From an examination of the figure presented on page 46, the *average* DO is considerably higher than 6 mg/L. Field data obtained in August 1993 and in August 1996, do not support the computed DO values below 6 mg/L.

Conclusion

After an extensive review of the available data obtained in the Snohomish River Estuary and adjacent waters, it is my opinion that on only rare conditions (substantially less than ten percent of the times) will the DO be depressed below 6.0 mg/L These excursions will be very brief in duration lasting only a few hours. The data do not support any five year period including the most recent, where greater than ten percent of the observations were less than 6 mg/L. But, the mathematical model indicated that DO levels of less than 6.0 mg/L might occur for short duration's. The question arises which criteria shall a 303(d) listing be based - upon actual observed data or from results of a mathematical model.

From this review, it is my opinion that the Snohomish River estuary from the mouth to river mile 8.5 should be *excluded* from the 303(d) list for dissolved oxygen.

In addition, placing the Gedney Station (PSS019) for dissolved oxygen on the 303(d) list is not warranted as the observed low DO values are due to natural causes rather than human-related activities.

Bibliography

Collias, Eugene E., Noel McGary and Clifford A. Barnes
1974. Atlas of Physical and Chemical Properties of Puget Sound and its Approaches Washington Sea Grant Publication, University of Washington Press.

Cusimano, Robert F.
1995. Snohomish River Estuary Dry Season TMDL Study - Phase I Washington State Department of Ecology Publication No. 95-338.

Cusimano, Robert F.
1997. Snohomish River Estuary Dry Season TMDL Study - Phase II Washington State Department of Ecology Publication No. 97-325.

Personal qualifications (also see attached biography)

I have over 45 years experience as a descriptive physical oceanographer. My major studies have been In Puget Sound and adjacent waters. From 1949 through 1980, I was responsible for over 70% of the physical and chemical data collected in Puget Sound.

This report was prepared on 28 October 1997 by

Eugene E. Collias, Oceanographer

Appendix D

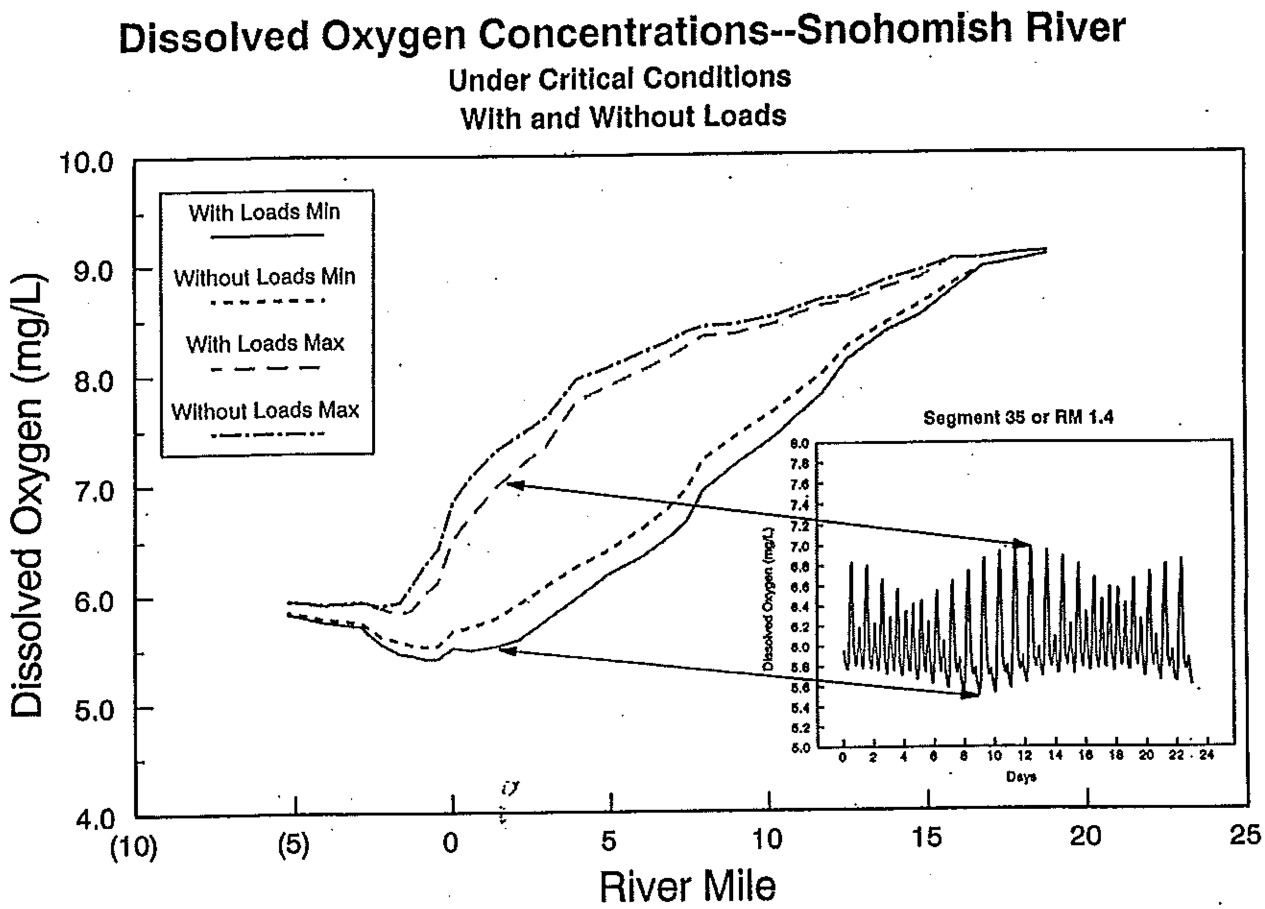


Figure 1. Model output from Figure 18 in Phase II TMDL

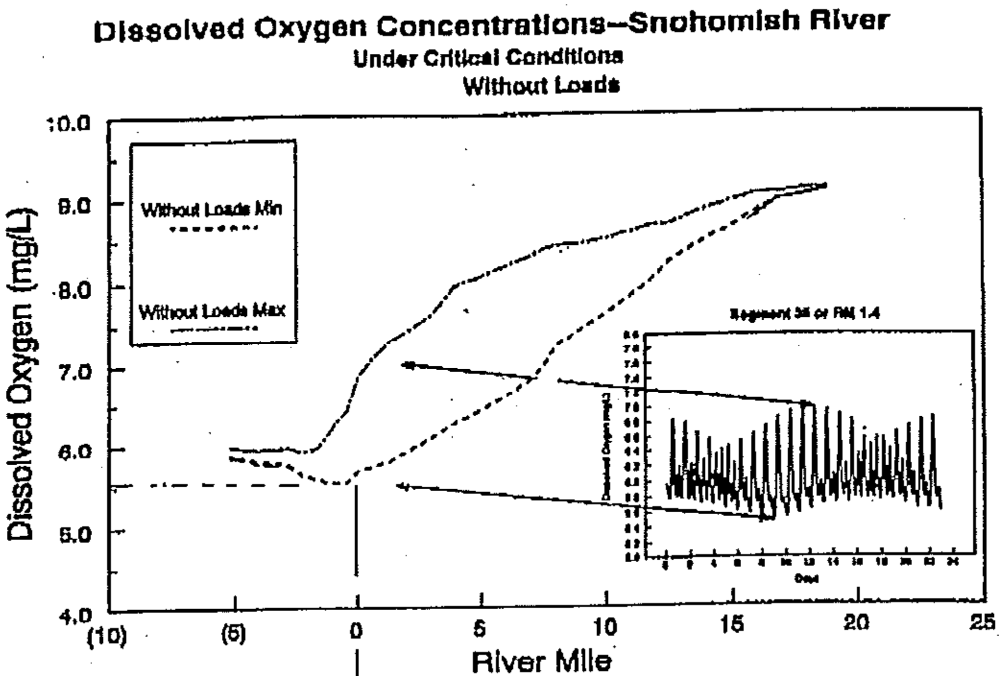


Figure 18. EUTRO5 predicted dissolved oxygen concentrations for the Snohomish River under critical conditions, with and without BOD loads.

Figure 2. Same as Figure 1, but only showing without loads.

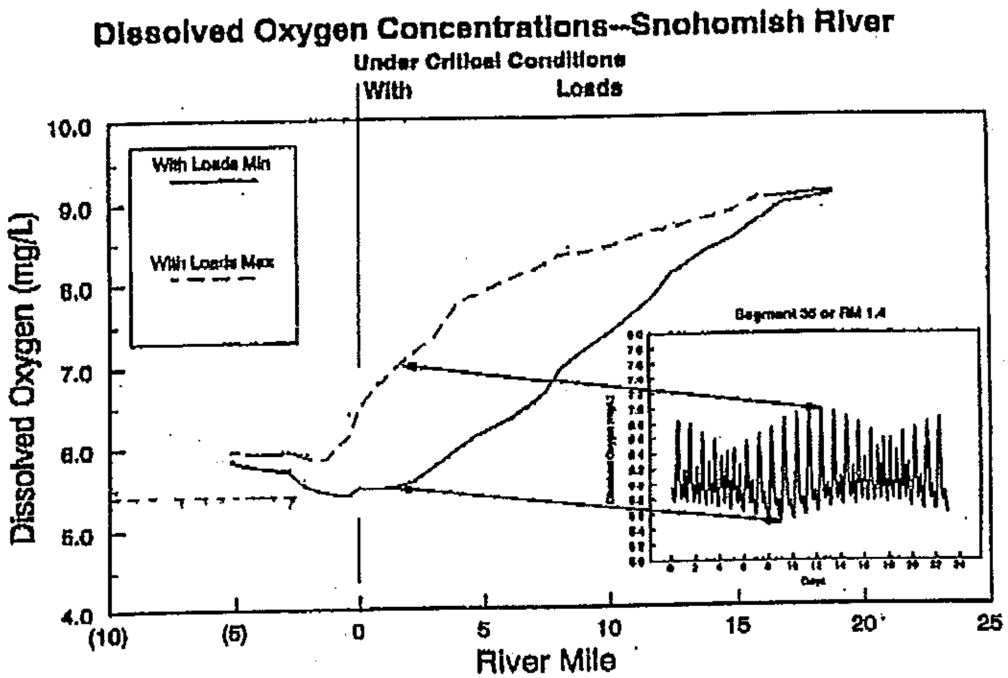


Figure 18. EUTRO5 predicted dissolved oxygen concentrations for the Snohomish River under critical conditions, with and without BOD loads.

Figure 3. Same as Figure 1, but only showing with loads.

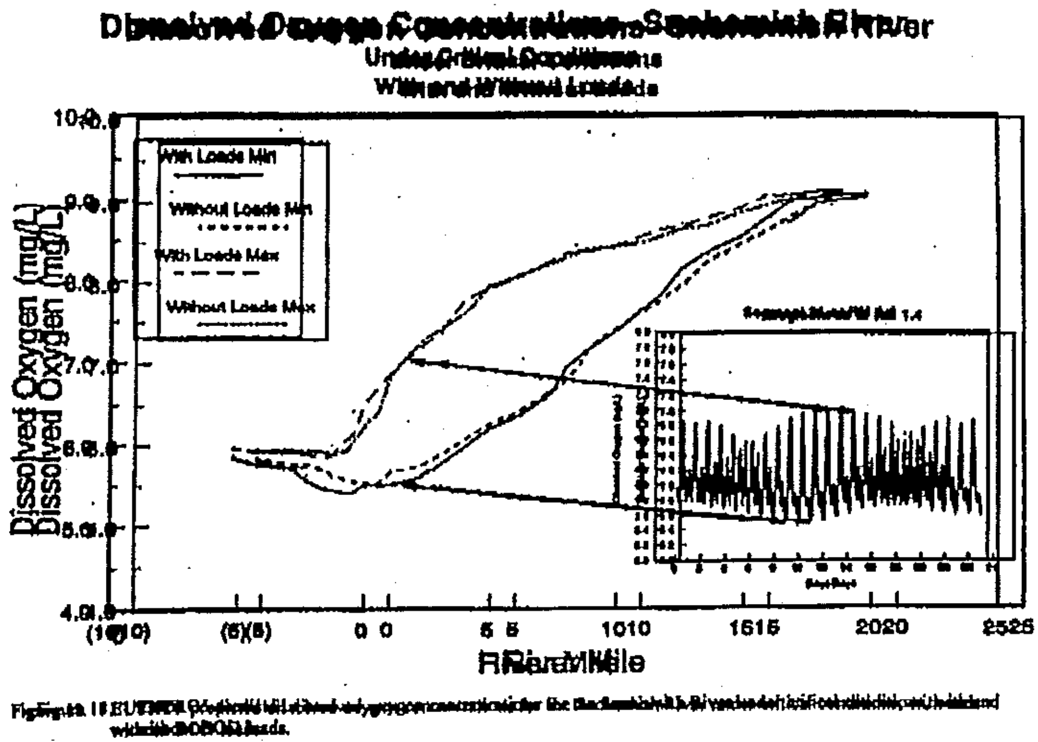
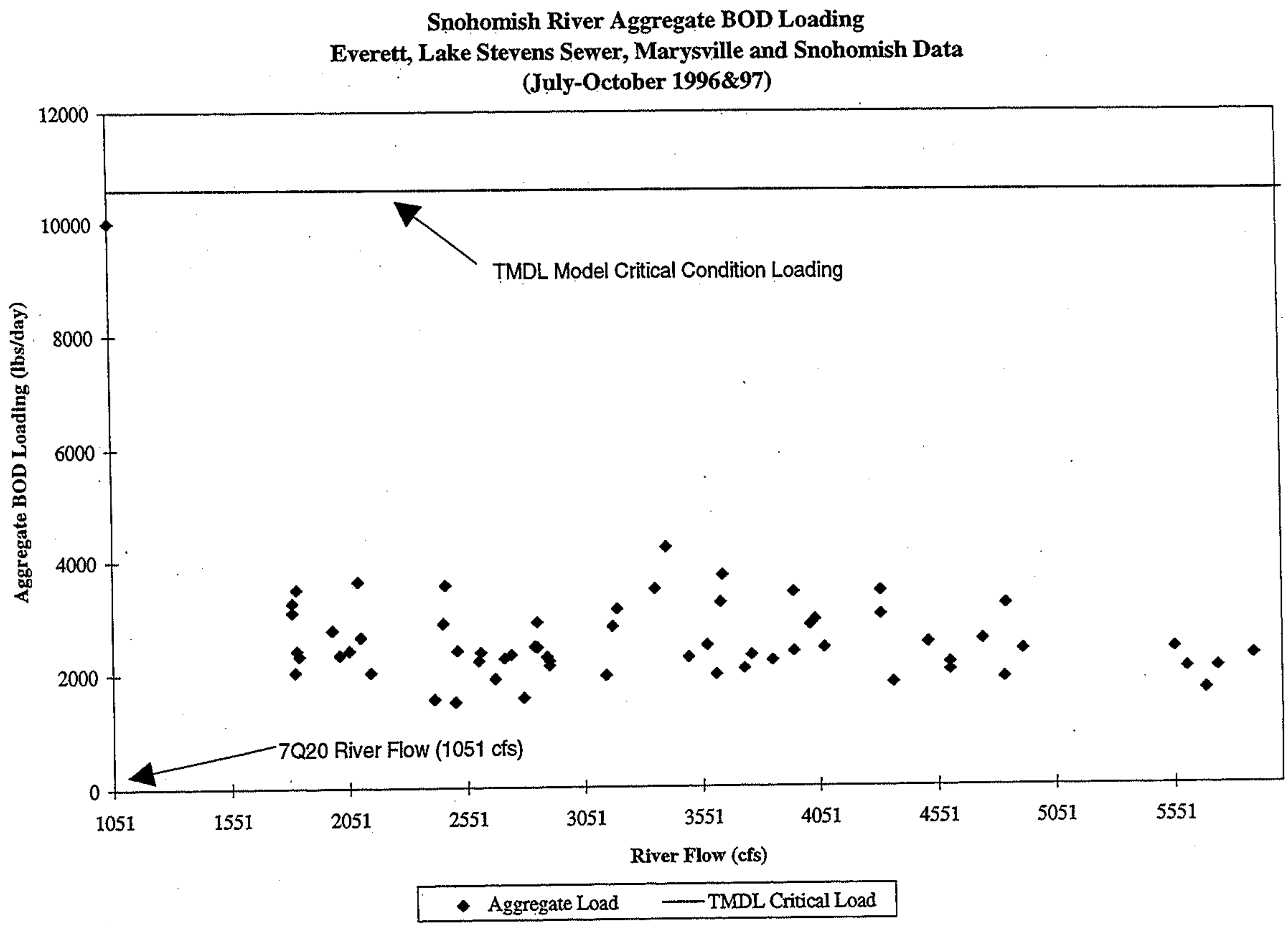


Figure 4. Same as Figure 1, but with about a one mile offset between the without loads and the with loads condition.

Figure 5


Snohomish River Aggregate BOD Loading
Everett, Lake Stevens Sewer, Marysville and Snohomish Data
(July-October 1996&97)
Aggregate BOD Loading (lbs/day)
12000
10000
8000
6000
4000
2000
0
TMDL Model Critical Condition Loading
7Q20 River Flow (1051 cfs)
1051
1551
2051
2551
3051
3551
4051
4551
5051
5551
River Flow (cfs)
Aggregate Load
TMDL Critical Load

Attachment 9

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (425) 649-7000

June 8, 1998

Snohomish Regional Water Quality Association
C/O Clair Olivers, City of Everett
3200 Cedar Street
Everett, WA 98201

Dear Mr. Olivers:

This letter is in response to the comments from the Snohomish Regional Water Quality Association (SRWQA) on Ecology's Snohomish River TMDL Report. Detailed responses to the specific comments are not included; only the general comments are addressed at this time. We would be willing to meet with the SRWQA in the near future to discuss the steps needed to develop revised waste load allocations (WLAs).

The Department of Ecology is responsible for setting water quality standards and issuing waste discharge permits to assure compliance with those standards. State law and regulations prohibit the Department from issuing permits which authorize any violation of state water quality standards. Based on the best information available, the existing wastewater permits for the cities of Everett, Marysville, and Snohomish, Lake Stevens Sewer District, and the Weyerhaeuser Smith Island Treatment Plant, in combination, authorize the discharge of oxygen depleting pollutants at levels which would cause a violation of the standard for dissolved oxygen in the Snohomish River at critical low flow conditions. All of the municipal permits will need to be renewed during the next year. The Department is obligated to incorporate limitations in the new permits that ensure compliance with the dissolved oxygen standards. Compliance schedules of a reasonable duration to allow any necessary upgrades of facilities will be included in the permits.

Overall, the SRWQA's comments contend that: (1) the TMDL is too restrictive, and (2) the model accuracy at some locations is questionable. We disagree with both these contentions.

In general, we believe your comments ignore the poor historical conditions of the estuary with respect to past pollution and Ecology's goal to protect water quality from potential future pollution. For example, in 1941 it was documented by the State of Washington Water Pollution Control Commission that "considerable area of surface water is at times uninhabitable for salmon" because of low dissolved oxygen due to pollution (Townsend *et.al.*, 1941). Dissolved oxygen concentrations below 6.0 mg/L were measured in the lower Snohomish River, Steamboat Slough, and Ebey Slough (Townsend *et.al.*, 1941). In 1951 the Water Pollution Control Commission reported the "existence of a definite barrier to the normal migration of salmon in the lower estuary of the Snohomish River at its entrance into Port Gardner Bay" (Orlob *et.al*, 1951). The historical data from 1949 showed median dissolved oxygen concentrations near the mouth of the river to be less than 3 mg/L (Orlob *et.al*, 1951). After mitigating some of the major sources of BOD to the river, the median dissolved oxygen values measured between 1967-1970 near the mouth of the river were reported to be around 6.0 mg/L (Driscoll 1978). Obviously, this demonstrates that BOD loading to the estuary and low dissolved oxygen have been a problem in the past. In addition, the physical attributes of the estuary that contributed to dissolved oxygen problems in the past are still affecting the system today.

Orlob *et.al.* (1951) attributed the formation and persistence of a pollution barrier to the effective migration of salmon through the Snohomish River channel to the following factors: (1) concentration of oxygen-consuming organic matter carried in the waters of the Snohomish River and Port Gardner Bay; (2) action of the tides which restricts the river discharge and tends to carry the harbor water into the confined river channel; (3) high water temperatures, occurring coincident with minimum stream flows in the late summer, decrease oxygen solubility and increased deoxygenation rates; (4) minimal wind action (because of the protected river channel) which affect the ability of polluted waters to restore oxygen deficits by reaeration; and (5) minimum flows which permit greatest salt water intrusions occur during the months of August and September. This list of factors identified in 1951 can be applied to support the rationale for the proposed BOD TMDL for the estuary today.

We also believe your comments fail to take into consideration the spatial scale of the computer model and the water quality management question being asked. The computer model represents over 40 miles of river and slough channels, plus part of Possession Sound. The model is not designed (nor can it be expected) to represent near-field conditions, but rather represent the far-field possible impacts of the collective loading of point and nonpoint sources of BOD. We believe the model has been appropriately calibrated and confirmed to answer this water quality management question. Further, we believe your comments raising concerns about the accuracy of the model in Steamboat Slough are inconsistent with the water quality analysis conducted and reported by Jones and Stokes Associates in 1991. The 1991 Jones and Stokes report included an estimate of the impact of the Marysville discharge on dissolved oxygen in Steamboat Slough. The report states, "There are very few large (up to 0.88 mg/L) peaks in DO deficit.... There are numerous smaller peaks (0.1 to 0.3 mg/L) which arise because of the strong semidiurnal character of the tides." Table 5-13 of the report projects the maximum upstream DO deficit at 6.7 and 10.25 mgd to be 0.49 and 0.79 mg/L, respectively. These estimates are significantly higher than those estimated for the Marysville discharge by our WASP model using an estimated discharge of 6.1 mgd. We believe it is unreasonable for the regional commentors to state concerns that the model is overly conservative and question the function and parameterization of the WASP5 model, when the model parameters and results are less conservative than those estimated by the commentors' own consultants.

Responses to your general comments are listed below:

1. EPA guidance requires that all TMDLs have a margin of safety (MOS). In developing TMDLs, Ecology has had a policy of building in an inherent MOS through the use of conservative assumptions representing critical conditions. If non critical conditions are modeled, then a specific MOS would have to be allocated based on model uncertainty and public debate. The water quality standards specify that critical conditions include a river flow equal to the probability of an annual 7-day low flow recurring 1 out of 10 years (7Q10) (WAC 173-201A WAC). The equivalent return period for a semiannual time interval is 7Q20. All of the critical conditions (except tide) in the Snohomish TMDL were set to maintain an inherent MOS following Ecology's TMDL development guidelines (Ecology, 1996).

   In addition, we do not believe the critical river flow is overly conservative because during our review of the river flow record from 1963-1995, we found that the 7-day low flows for the years after 1980 were lower than the years before 1980, which suggest that summer base flows may be decreasing. Also, there are large unused or underused municipal water rights in the basin that may be more fully exercised as population and development increase. Neither of these water quantity issues was included in the critical river flow calculation.

   The TMDL must address nonpoint sources of pollution. We set the flows for those tributaries controlled by pump stations at the average daily discharge for the TMDL period as estimated by Rod Denherder of the U.S. Department of Agriculture, from the pumping records for 1993 at French Creek. Although these values could be improved by incorporating more years of data, we believe they represent a minimum contribution of the controlled tributaries (only 16.2 cfs for French Creek and the Marshland and 5.5 cfs for Deadwater Slough). One of our concerns is that during summer freshets, French Creek and the Marshland can be pumped at rates of over 100 cfs. It would be unreasonable not to include a minimum flow from these tributaries in the TMDL, especially because the water quality of these systems is very poor. Other tributaries were set at estimated critical flows (no flow was included for Allen Creek and only 4.5 cfs for Quilceda).

   Currently, there is no guidance for establishing critical tides. However, we do not believe the tide sequence used in the modeling is conservative. In fact, it may be one of the least conservative tide sequences, because the spring/neap tide sequence used in the modeling provides for more flushing than may be provided by less extreme tide sequences. (The critical period is around neap tide conditions, and not the spring tide conditions noted in your comment.) The issue of frequency or duration of the dissolved oxygen violations is discussed in our response to your general comment #2.

We used the existing permitted design flows for the discharges for two reasons: (1) the dischargers are permitted to discharge at those levels, and (2) growth is continuing in the areas served by the dischargers. One outcome from the TMDL may be to set permitted summer flow limits for those dischargers currently operating under only annual limits.

The SRWQA commenters should note that there are a number of conditions set in the model that are very favorable to the dischargers. For example, the upstream boundary condition for dissolved oxygen entering the system was set at saturation, and the upstream and seaward ammonia boundary conditions were not changed between the loading and nonloading scenarios to determine the WLAs. It would not be unreasonable to alter both these assumptions to be more conservative (i.e., include a diurnal dissolved oxygen estimate at the upstream boundary, and assume that the difference between the 90th and 10th percentile ammonia boundary concentrations should be part of the nonpoint loading to the system).

2. The dissolved oxygen water quality standards have been set to protect organisms from encountering any levels of oxygen that might be detrimental to their health. The dissolved oxygen standards are zero-tolerance and expressed as a minimum. As such, the standards do not specify an allowable frequency or duration for violations. The dissolved oxygen issues in the Snohomish Estuary revolve around the influence of the tide and low dissolved oxygen marine water moving into the lower river and sloughs. The WASP model simulates the effects of the tides in the system, and the hourly changes in dissolved oxygen concentrations. In order to be consistent with the water quality standards, the critical condition modeling predicted dissolved oxygen concentrations were treated as violations if they did not meet the criteria. Applying a daily average value to the estuary would not be representative of the environmental conditions in the estuary.

   Ecology collected monthly ambient data from the mainstem river by the HWY 99 bridge and from Ebey Slough near Marysville from 8/73 to 11/87. Both stations had violations of the marine 6.0 mg/L dissolved oxygen standard. Since the data were from surface samples collected without consideration of tide, it is our concern that the number and frequency of dissolved oxygen violations may be much greater than suggested by these data. Technically, as an absolute minimum criteria, the dissolved oxygen violations in the lower Snohomish suggest that there is no assimilative capacity in the estuary for biochemical oxygen demanding substances.

   It is unclear to us what you mean about "Assess the real effects of this very rare and transient dissolved oxygen depression." As stated above, violations of the criteria have been measured in the past. However, in the proposed TMDL we are allowing a degradation of dissolved oxygen of 0.2 mg/L below the criteria under critical conditions. An appropriate alternative interpretation of the criteria would be to set the natural conditions in the estuary as the dissolved oxygen criteria and not allow any discharges to the system. It is our view that allowing the 0.2 mg/L human caused degradation is a very reasonable approach to managing pollutant discharges to the estuary and cannot be considered overly protective or conservative.

Providing for future growth in the basin is a concern of Ecology. However, any allocation for future growth should be determined through the public process. Because the department believes there is no excess capacity in the river during critical low flow conditions, this allocation would have to be subtracted from the allocations for existing discharges. The allocation for the Smith Island Treatment Plant is essentially for future industrial development since there is no current discharge from that site. We would gladly consider a recommendation for how to include a "future growth" component in the TMDL from the SRWQA.

3. The waste load allocations (WLAs) in the Phase II report are only recommended as a starting point for setting the final WLAs. The public process is where actual WLAs are set through public debate and negotiations. We were expecting your review comments to include alternative WLA strategies.

   We understand the significant financial implications of the TMDL to the citizens and ratepayers in the region. However, we are mandated to protect the water quality of the estuary and Puget Sound. We believe that through the TMDL we are asking for reasonable limits for the type and amount (or location) of effluent being discharged to the estuary given available technology, especially since similar requirements have been placed on other communities (e.g., Renton, Lacey-Olympia-Tumwater-Thurston County Wastewater Treatment Plants)

   Generally, we agree with your list of actions that need to be undertaken. However, we believe that the water quality model has been calibrated and confirmed and is currently adequate to function as a tool for managing CBOD and ammonia discharges to the estuary. We will consider modifications to the model, such as using projected dry season flows from the treatment plants and the proposed deep water outfall, to recalculate the WLAs. However, we do not believe additional monitoring is needed.

4. The Clean Water Act allows setting of TMDLs for non listed waters (CWA section 303 (d)(3)). EPA guidance also encourages the establishment of "preventative TMDLs." Many of the waters for which Ecology has established TMDLs have been preventative. Ecology believes that it is important to protect waters from ever being listed, and preventative TMDLs are one of the tools we use. The public process for the TMDL is not the proper forum to comment on the adequacy or accuracy of the 303(d) list or the interpretation of the water quality standards. Separate public processes for these issues occur every two and three years, respectively. In our May 7, 1996 reply to comments from the City of Everett on the Phase I report (distributed to your members in July 1995) we recommended that "As an interested group, you

can best propose changes to the classification of the Snohomish River and sloughs through the Water Quality Standards Triennial Review process." This is also true for the water quality standards being applied to the estuary. Since the last Triennial Review concluded at the end of 1997, it would have been appropriate and timely for your members to have directed comments on these issues to that process.

As specified in the Phase I and II reports, the Snohomish Estuary TMDL was pursued because of Ecology's concern that population growth and development in the estuary watershed may cause adverse effects to water quality. Specifically, Ecology's concerns about increased demands on the wastewater treatment plants discharging to the estuary were expressed. Based on these concerns, the project was initiated in 1992. The rationale of your general comment 4 seems to be counter to the current reality in the estuary, because some of the SRWQA participants that are raising questions about the appropriateness of the TMDL are also currently proposing to significantly increase their discharges.

We also believe that it is inappropriate to use the historical survey data for dissolved oxygen to assess the frequency of water quality criteria excursions. One of the reasons the historical stations were abandoned was that the randomly collected surface sample data could not be interpreted because of the influences of the tide. Statistically, the historical data set is not homogenous and any analysis of the data to calculate a "frequency" would require stratifying the data into homogeneous strata that might represent the critical times, which is not possible since very few, if any data were collected at or near high slack tide.

5. The profile and dye study data collected by consultants for the City of Everett in August 1995 showed that a "two-layer" model is unnecessary to simulate the hydrodynamics and water quality of the estuary. It is unreasonable to contend that a process that doesn't exist in the mainstem (that has more fresh water than Steamboat Slough), somehow exists in Steamboat Slough. Snohomish County (1974) collected salinity and velocity data throughout the estuary, and did a review of the estuary with respect to vertical variations in salinity, and concluded that the Snohomish Estuary is a "vertically and horizontally homogeneous estuary." They also state that "estuaries with depths of less than 20 feet often lack virtually any stratification and the consequent two-layered circulation patterns," and go on to report that the Snohomish Estuary "....can be reasonably well approximated using the vertically averaged equations of motion (i.e., representing a vertically and horizontally homogeneous estuary)." Further, the report states with respect to modeling that "in many estuaries two-dimensional models are much more desirable than the connected one-dimensional channel models, due to their ability to simulate transverse and circular, eddy type motion. However, in highly channelized, narrow estuaries such as the Snohomish and Stillaquamish, this is not a real advantage since these types of motion are restricted to the very near field...."

In reviewing the performance of the WASP5 model, it is important to consider that we are modeling the 3-dimensional space of more than 40 miles of river and slough channels. We believe that a comment or concern raised about 2-dimensional profile data, collected sometime during a flood tide, from a single point in the modeled system, is at best misleading. As with the profile data collected on the mainstem referenced above, the profile data provided in Appendix B of your comment document suggest that the stratification is temporary and restricted to the nearfield (e.g., the August 24, 1994 flood tide profile shows a mixed condition). In addition, the single flood/ebb flow profiles provide little information with respect to the changing conditions during the whole flood and ebbing periods. In order to support your supposition that a two-layer-hydrodynamic process is replacing water faster than the model predicts, the stratification would have to be permanent and occur in three dimensional space for a distance represented by a minimum of 2 model segments—i.e., transport pollutants through two adjacent segments faster than the vertically averaged model does. During our work on the river we have never observed far-field stratification of the channelized portion of the estuary during low river flow conditions (i.e., river flows less than 3000 cfs).

One area of concern with respect to the WASP5 model predictions is the observed current velocities reported by Jones and Stokes Associates, as shown in Figure 2 (Appendix B of the comment document). We concur that observed cross-sectional average ebbing velocities approaching or exceeding 100 cm/sec would be significantly different than those estimated by the model. However, although we have measured mid-channel velocities of about 100 cm/sec, we have never estimated average cross-section velocities of the magnitude reported by Jones and Stokes Associates anywhere in the estuary. We are unsure what Jones and Stokes are calling "observed" velocities. After reviewing their 1991 report summarizing the work they did to establish the reported velocities, it appears to us that these were not observed velocities, but "estimated" velocities based on applying a "uniform canal theory" to tide gauge measurements, an equation of motion, and an estimated friction coefficient (i.e., a model estimate). In addition, although Jones and Stokes Associates say in their comment #2 that they did drogue studies, they do not clarify that the "observed" maximum ebbing velocity based on their drogue study in 1991 was 45 cm/sec. With our experience in the estuary and measuring velocities in other areas of the Puget Sound it seems unlikely to us that the average velocity through a 2-mile channel (i.e., distance between the tide gauge stations) can approach their maximum estimated velocities for Steamboat Slough. A cross-sectional average velocity of 100 cm/sec would imply that the mid-channel velocities would have to be significantly greater than 100 cm/sec, which also is unlikely. It is more likely that Jones and Stokes made an error in collecting tide gauge data, an error in setting the friction coefficient, or an error in their calculations.

It is not possible for us to comment on the specific model runs that were done by Harold Ruppert (Appendix A) for the Weyerhaeuser Smith Island Treatment Plant

(SITP) without reviewing the specific model input files. However, in order to examine the efficiency of discharging on ebbing tides at the SITP we ran the input file used to get scenario V reported in the Phase II report as (1) a continuous discharge (12.6 mgd), (2) an ebb discharge with the same rate as the continuous discharge (12.6 mgd), and (3) an ebb discharge at a rate that would be equal to the daily rate for a continuous discharge (32.7 mgd). The results show about a 70% reduction in estimated dissolved oxygen deficits between scenario one and two, and a 30% reduction between the first and third. As noted in the Phase II report, we estimated that the model error was 0.01 mg/L, which can be significant when discussing the differences between the small values listed in Harold Ruppert's comment. For example 0.01 mg/L is 17 to 32% of the average oxygen depletion values listed in Mr. Ruppert's comment.

In the last part of your general comment #5 you say that the model showed "very little benefit to discharging during ebb tide contrary to observations." Again we are not sure what you mean by observations, since in Appendix A it is unclear what you "alleviated" or how "This demonstrated, in a qualitative way, the efficiency of the tide cycle to move discharged effluent out of the estuary." In the TMDL we are referring to parts-per-million of CBOD and ammonia throughout the water column, not unsightly plumes of effluent that may dissipate more quickly if you only discharge during an outgoing tide. The model shows that there is a minimum BOD efficiency of 30% using an ebbing tide discharge strategy.

We appreciate your thorough review of the TMDL report. This response was primarily composed by Bob Cusimano, with some assistance from David Wright and myself. We look forward to meeting with the SRWQA to discuss these matters further.

Sincerely,

Laura Fricke, P.E.
Water Quality Program
Northwest Regional Office

LF:ct

References:

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cc: Ken Winckler, City of Marysville
Mick Monken, City of Snohomish
Harold Ruppert, Weyerhaeuser Everett
Darwin Smith, Lake Stevens Sewer District

Attachment 10

Department of Ecology
June 30, 1999

Responses to the specific comments listed in the April 30, 1998 SRWQA comments (Attachment 8):

1. As pointed out in our response to general comment 4 (ref: Attachment 9) the project was undertaken as a "preventative TMDL." However, it should be noted that waterbody segments WA-07-0010, -1010, -1011, and -1050 in the study area were listed for dissolved oxygen on the 1992, 1994 and 1996 303(d) list.

2. No comment.

3. The City of Everett's 1995 dye study and 1996 summer *in situ* and grab sample data collected in the lower part of the river; and the SRWQA's Steamboat Slough 1998 dye studies and *in situ* and grab sample data support the accuracy of the model to predict the impacts of BOD loading to dissolved oxygen in the estuary. The dye studies showed that the continuous discharge from Marysville and the intermittent discharge from Weyerhaeuser are not only refluxed upstream of their respective discharge points, but as predicted by the model, held in the slough for at least four days.

4. See Technical Addendum Number 2 for modifications to the TMDL.

5. See Technical Addendum Number 2.

6. See Technical Addendum Number 2.

7. As a human-caused non-controlled source of ammonia, the landfill must be given an allocation.

8. Your assessment of the RMSE associated with assessing the precision of the model and the model predictions with respect to the 0.2 mg/L change in dissolved oxygen are two different issues. The RMSE, confidence intervals, or other statistical assessment of the reliability of model predictions are used to either "accept" or "reject" the model as a tool to predict water quality. As discussed in the report, we believe the model demonstrates a good model fit. The 0.2 mg/L change applies to the difference between "load" and "no load" BOD model predictions.

   The "accuracy in predicting the dissolved oxygen changes in response to wastewater loading" is determined by the model calibration and confirmation with respect to all of the rate constants and other values input to the model. Normally, uncertainty in model predictions is incorporated into any prediction by using the most conservative estimate of any statistical assessment to compare to a target value. Incorporating uncertainty into the relative difference between the load versus no load model runs would have to be taken out of the 0.2 mg/L allowable difference-i.e, maximum loading would have to be reduced to an amount less than proposed. However, we believe uncertainty has been included in the model calibration and the model can be used reliably to estimate the difference between different loading scenarios.

9. Summer 1998 dye studies conducted by the SRWQA for the Marysville and Weyerhaeuser discharges provided additional confirmation of the model predictions.

10. See Technical Addendum Number 2.

11. No comment.

12. The pump stations are "triggered" by water levels upstream of the pumps. See response number one in Attachment 9.

13. The ammonia concentration represents the 90th percentile of the ambient data collected from Ecology's ambient station PSS019. Using the 90th percentile concentration is consistent with published Ecology TMDL guidelines (Ecology, 1996).

14. See Technical Addendum Number 2.

15. The upstream ammonia boundary was set to have the model meet the 90th percentile of the ammonia concentration data collected at ambient station 07A090 (0.05 mg/L) in order to have the model predict critical conditions for the modeled area. However, the background concentration was determined to be 0.005 mg/L or half of the reporting limits for ammonia. Because the ambient sampling station is well inside the modeled area, the upstream boundary ammonia concentration was not changed between the load and no load scenarios and was not included in the allocations. In Technical Addendum Number 2, the model upstream boundary concentration of 0.05 mg/L is reported as background.

16. The concentration values were included in Table 12 were included to provide the permit manager information about the concentration associated with the calculated pounds-per-day limit.

17. The model is based on daily values.

18. See Attachment 12 and Attachment 13 (and Technical Addendum Number 2).

19. Again, the summer 1998 dye studies and other data collected by the SRWQA provided additional confirmation of the model predictions.

20. Ecology collected metals metals data bimonthly at ambient station 07A090 from October 1995 through August 1997. No violations of the copper criteria were found. These data together with the Everett metals data suggest that at this time a copper TMDL is not needed for the estuary.

21. The model segments that receive the discharges are as follows:
    Everett Lagoon into segment 36
    Everett Mechanical Plant into segment 37
    Marysville into segment 54
    Lake Stevens into segment 67
    Snohomish into segment 48

22. BOD as used in the report includes both carbonaceous and nitrogenous BOD unless specified as CBOD or ammonia.

23. No comment.

24. Correct, the values in Table 12 should be $CBOD_5$ (see Technical Addendum Number 2 for modifications to Table 12).

25. Correct, the Total Maximum Daily Load #2 should be 13,071 lbs/day.

26. River and tributary loading of CBOD and ammonia were determined from the survey data collected during 1993 and 1996. The ratios of ultimate and five day CBOD were set to 1.8 for French Creek, Marshland, Swain Trail Slough, and Deadwater Slough; and 2.35 for the mainstem river upstream boundary, Pilchuck River, and Quilceda Creek. For example, for the critical conditions with loading (reference Table 7 in the Phase II report) the Marshland is listed as having an ultimate CBOD of 5.4 which is 1.8*3.0 mg/L. As pointed out on page 17 of the Phase II report, the no load scenario was established by setting point source loads to zero and nonpoint source loads to estimated background conditions, i.e., ammonia = 0.005 mg/L and CBOD = 1.2 mg/L. Therefore, the nonpoint source loads receive an allocation equal to the difference between the critical conditions with and without loading as defined by the estimated background conditions.

    The upstream and downstream boundary conditions for CBOD and ammonia were set to the same values for with and without loading scenarios--i.e., the model boundaries were treated as background conditions.

27. Same as response #15.

Response to proposal for a Regional Solution for the TMDL Issue

- See response #3 in Attachment 9 and Attachment 14 letter to the SRWQA.

Responses to specific comments from Weyerhaeuser listed in Appendix A:

- See response to general comments #5 in Attachment 9. In addition we believe the summer 1998 dye studies and other data collected by the SRWQA provided additional confirmation of the model predictions for the Weyerhaeuser discharge.

Responses to specific comments from Marysville listed in Appendix B:

1. The maximum run time for the model with six ocean boundaries is 23 days. We have tested the model through different neap and spring tides and it appears to stabilize within the first

day. However, because the initial conditions of the model run with loading are the same as those for the without loading run, the start-up transients take a few days to be removed. The start-up problem could be eliminated by setting the initial conditions in model run with loads to those provided in the re-start file after a few day spin-up. In order to minimize questions about the differences between the model runs, we keep the initial conditions the same for all of the model runs. We have not pursued modifying the code to allow longer model runs.

As discussed in the report, the maximum dissolved oxygen deficits occur during neap tide periods. In the SNOFIN1 model run the neap period is between day 7 and 10, which corresponds to the largest deficits in your Figure 1.

2. See response to general comments #5 in Attachment 9.

3. In order to quantify only the effect of BOD loading, the quantity and dissolved oxygen concentration of the effluent was not changed between model scenarios. The Phase II report discusses the differences between the Phase I calibrated model and the re-calibrated model.

4. Again, the Phase II report discusses the alternative scenarios presented in Table 10 and 11.

5. All data files have been reviewed for errors. However, some errors may exist because for each model scenario the input files for the water quality and hydrodynamic submodels contain 80 columns and 1600 rows of data. The time error identified has been corrected, but does not affect the results presented in Table 11.

Responses to report of Eugene E. Collias to the City of Everett listed in Appendix C:

- Comments on the 303(d) listing of the lower Snohomish River and slough segments for dissolved oxygen and the purpose of the TMDL have been responded to in Attachment 2 and 9, and in response #1 above. The proposed TMDL and related modeling used in the analyses presented in the Phase II report are based on a set of critical conditions (i.e., those possible physical, chemical, and biological characteristics of the receiving water and pollutant loading sources that can increase the adverse effects of a given pollutant). The critical conditions were set to represent the critical period of July-October. Implicit in the critical conditions is a margin of safety relative to protecting water quality during this period, which includes possible "unknown" adverse conditions that may occur at any time during the critical period. Most of the historical data have not been collected during the critical time of around high or low slack tide, but rather during intermediate tidal conditions which does not provide a clear assessment of the salt and freshwater mixing conditions in the estuary. To date, an appropriate data set to assess criteria excursions in the lower river and sloughs has not been collected.

  As reviewed in Attachment 9, historically, there have been problems with low dissolved oxygen caused by effluent discharges to the lower river. The rationale and application of the 0.2 mg/L allowable human-caused deficit is also discussed in Attachment 9.

Attachment 11

Department of Ecology
June 30, 1999

Responses to EPA comments from Tim Hamlin and Rob Pedersen (Attachment 7):

- Growth is being accounted for in the TMDL by setting summer design flows for the WWTPs. Improving treatment processes will create any additional capacity needed in the future. In addition, no new discharges will be permitted in the study area. See Technical Addendum Number 2 for WLA and LA allocations.

- In the Phase II report it was noted that the effective use of the model was to predict water quality in the area between segments 24 or 28 and 76 in the mainstem of the Snohomish River, and between segments 18 outside the mouth of the sloughs upstream to segment 76—i.e, in the channeled river and sloughs. Because Mission Bay is outside the study area, it is not included directly in the model. Plus it is my understanding that the proposed new Tulalip outfall will be into deep water. Again, a deep-water outfall is outside the effective modeled area. Industrial/residential areas on the reservation were not considered part of the study area.

- See response #1 in Attachment 9.

- In establishing allocations, the dissolved oxygen standard was interpreted to allow a 0.2 mg/L deficit due to human causes when natural conditions were near or below the criterion for both marine and freshwater. This allowance is currently in WAC 173-201A for marine waters. When dissolved oxygen concentrations are depressed to near or below 6 mg/L in the estuary it is due to upwelling of marine water with "naturally" low dissolved oxygen concentrations. The main issue in the TMDL is the marine water quality violations that might occur under critical conditions during high slack tide. In setting the seaward boundaries we used the most extreme monthly profile data collected from 1990-1996 for the July-October period at PSS019. As pointed out in Attachment 8 by Eugene E. Collias in the report to the City of Everett "....Other data from other stations in Puget Sound and sampled by Ecology (Admiralty Inlet, Possession Sound, and of Gedney Island), indicate that low dissolved oxygen may occur naturally especially in late summer (August and September)...." He goes on to say "....These observed values of dissolved oxygen less than 6 mg/L are consistent with natural causes that affect the waters of Port Susan and Possession Sound especially the water below 5 meters." We concur with this part of his analysis of dissolved oxygen concentrations in the Snohomish Estuary, and we believe the seaward boundary in our critical conditions model scenarios represents "natural" conditions for dissolved oxygen concentrations.

  The upstream boundary was established from the data collected below the confluence of the Skykomish and Snoqualmie Rivers. The boundary concentrations for ammonia and CBOD represent half the reporting limit or 0.005 mg/L for ammonia, and the average of the CBOD measured values or 1.2 mg/L (the average was used because the reporting limits for the standard BOD test are 2.0 to 3.0 mg/L, and all of the ultimate CBOD uncensored data values for the upper part of the river were less than the standard reporting values). In the Snoqualmie TMDL, the upstream boundary for ammonia and CBOD were set to 0.005 and 1.0 mg/L, respectively. These values represent half the reporting limits. The upstream boundary for the Snoqualmie study was about 47 river miles upstream of the confluence with the Snohomish. Using the 1993 survey data from the Skykomish River, the concentrations for ammonia and CBOD for the Skykomish upstream of the City of Sultan, or about 16 miles upstream of the confluence with the Snohomish, would be 0.005 mg/L and 1.5 mg/L, respectively. The upstream boundaries for the data collected on the Snoqualmie, Skykomish and Snohomish Rivers show that the point and nonpoint sources of BOD loading in the upper watershed are not conserved in the watershed—i.e., the oxygen demanding pollutant loading from human sources in the Skykomish and Snoqualmie Rivers are not likely influencing dissolved oxygen concentrations in the Snohomish River. All of these concentrations could be considered "background" because "natural" levels are not know, but given the low concentrations measured (or estimated) they likely represent natural levels for major rivers in Western Washington.

- In the Snohomish BOD TMDL Phase II report, a combined LA is set for French Creek, the Pilchuck River, the Marshland, and Quelceda Creek and "Background." Although individual LAs were not listed in the report, they are listed in Technical Addendum Number 2. However, at this time there is no plan to mitigate the nonpoint sources of BOD pollution through implementing "BOD" controls.

- The nonpoint source pollution TMDL established for the Snohomish River tributaries focuses on controlling fecal coliform. As noted in the tributary TMDL report (Ecology Publication Number 97-334), it is likely that targeting fecal coliform for control will help manage other nonpoint pollution issues as control measures are implemented in the subbasins. As you know, nonpoint pollution is diffuse and not readily separated into different control strategies for different pollutants. We are assuming that as nonpoint controls are implemented for fecal coliform they will help control other pollutants. We are also assuming that controls will be phased-in over a number of years, and that follow-up monitoring will have to be done to determine whether water quality is improving in the subbasins. For example, we are currently requiring that dairy farmers in the subbasins implement best management practices that should lead to improved water quality.

Response to Rob Pedersen comment about allowing 0.2 mg/L deficit due to human-causes when natural conditions were below the water quality criteria for both marine and freshwater.

- Allowing the 0.2 mg/L deficit is currently in WAC 173-201A for marine waters. Although there is no specific provision in the water quality standards that allows this deficit for freshwater, the Environmental Assessment Program has proposed its use under certain conditions defined in "Total Maximum Daily Load Development Guidelines" Publication Number 97-315 as follows:

The WQS (water quality standards) regulations specify that if natural conditions fall below a criteria, then the antidegredation policy applies, which states that whenever the natural conditions of said waters are of lower quality than the criteria assigned, the natural conditions are defined as surface water quality that was present before any human-caused pollution.

Water quality modeling or other analysis may determine that natural conditions are below criteria in a water body subject to a TMDL study. However, it will probably not be possible to determine specific numeric criteria that represent natural conditions, since the true water quality that occurred before human impacts would be very difficult to determine. Therefore, a more practical approach to use in this situation is to require that no significant degradation of dissolved oxygen be allowed below the estimate of natural conditions found by modeling or other analysis.

Significant degradation of dissolved oxygen may be interpreted as zero degradation or 0.2 mg/L degradation.

The guidelines define these two options as follows:

1. Allow zero degradation. An allowance of zero degradation would apply where the amount of loading that causes a reduction in dissolved oxygen is very low, and any capacity is only provided by the degradation allowance. In this case, keeping loading to zero would allow a margin of safety for the protection of the waterbody.

2. Allow 0.2 mg/L degradation. An allowance of 0.2 mg/L would apply where a large loading can be added to a waterbody with small levels of degradation. A value of 0.2 mg/L has been used in previous studies and this corresponds to the degradation allowed by the WQS in marine waters.

We believe the second option applies to the Snohomish Estuary. We also believe that allowing the 0.2 mg/L in both the marine and freshwater portions of the Snohomish Estuary is consistent with past studies conducted by Ecology and the Environmental Protection Agency.

Attachment 12

ASSOCIATED EARTH SCIENCES, INC

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November 6, 1998
Project No. KB98046A

Mr. Tom Mortimer
1325 Fourth Avenue, Suite 940
Seattle, Washington 98101

Subject: Description of the
Total Maximum Daily Load (TMDL) Model Use
Snohomish River Regional Water Authority (RWA)

Dear Tom:

The following description of the TMDL model use as an impact avoidance tool by the RWA is attached. This description reflects cooperative agreement between Bob Cusimano (Washington Department of Ecology), Bill Fox (Cosmopolitan Engineering), and me. We recommend that the attached be used to explain how the TMDL model would be employed to mitigate dissolved oxygen (DO) impacts and be incorporated into Ecology's Report of Examination for review by the RWA and Ecology.

USE OF THE TMDL MODEL AS A MITIGATION TOOL BY THE SNOHOMISH RIVER REGIONAL WATER AUTHORITY

<u>DEFINITIONS</u>

For the purposes of this description, the following definitions are made:

- The maximum sustained withdrawal allowable by the RWA is defined as "**A**". [This definition does not supercede an annual withdrawal volume limit.]
- The minimum sustained withdrawal allowable by the RWA, or that amount defined as "historic background," is defined as "**B**".
- Ecology's currently approved TMDL model (at any time in the future), is defined as the "**TMDL Model.**"

PURPOSE

The steps below define a process to implement a mitigation commitment by the RWA. The result will be to avoid contributing to cumulative, human-caused DO reductions equal to or greater than 0.2 mg/l when background DO falls below the state water quality standard. These steps would be taken once annually and produce the following:

- An "Annual Operations Table" setting out allowable withdrawal rates during the 4 months of TMDL concern (July through October) as a function of date and river flows;
- TMDL model output that technically justifies the Annual Operations Table; and
- Documentation of TMDL model simulation results, river flows, and withdrawals that would be available to Ecology for review upon request.

IMPLEMENTATION STEPS

1. The TMDL model, including the point and nonpoint source discharges of biochemical oxygen demanding substances (BOD), would be run to determine the minimum river flow (as measured at Monroe) under which the least favorable tidal sequence, at the location of maximum DO effect, failed to violate the DO criterion of 0.18 mg/l depression below state standards (the 0.2 mg/l DO depression in the state standard plus a 10 percent safety factor).

   > *For example, with the model configuration used by the RWA for SEPA and by Mr. Cusimano for the Phase II TMDL Study, the most sensitive location was Segment 57, and the threshold river flow at which the worst-case tides begin to violate the DO criterion with "A" set to 10.3 mgd was 1,350 cfs (measured at Monroe).*

   The flow at which tides begin to combine with the RWA withdrawal and the point and nonpoint source discharges of BOD to violate the DO criterion, is hereafter referred to as the "threshold river flow."

2. At flows greater than or equal to the threshold river flow, or any time between November 1st and June 30th, the RWA could withdraw "**A**" at its discretion.

3. At flows less than the threshold river flow, during the July through October period of TMDL concern, the RWA may need to reduce withdrawals to avoid water quality impact at certain tide and river flow combinations. To determine when withdrawal reductions below "**A**" are required, the RWA will use tide tables (adjusted for the withdrawal location) as input to the TMDL model at the 7Q20 flow (referenced to Monroe) to define the tidal periods when "**A**" would cause violation of the cumulative DO criterion of 0.18 mg/l depression below state standards at a 7Q20 river flow. The TMDL model would

simulate the July through October period. The RWA would always have the right to withdraw "**B**".

> *After 2 years of results, Ecology and the RWA would reevaluate the need to simulate the entire July through October period to compile the Annual Operations Table for subsequent years.*

The output for 7Q20 would be represented in the format of Figure H-12 in the Plan of Use, Appendix H. The period when withdrawal at less than "**A**" is required to avoid a greater than 0.18 mg/l DO reduction is defined as the entire period of successive tidal peak DO reductions greater than 0.18 mg/l. See Figure 1 for an example.

The dates when withdrawal at less than "**A**" is required at a flow between the threshold and 7Q20 flow would be entered on the Annual Operations Table. See Figure 2 for an example.

4. At the RWA's discretion, it may run the TMDL model at one or more flows in addition to the 7Q20 and the threshold river flows, to determine the tidal periods which violate the cumulative DO criterion at those flows. Definition of the tidal periods requiring reduction of RWA withdrawal would always be set by a simulated flow equal to, or lower than, that which actually occurs. Alternatively, the RWA could choose to reduce withdrawal to "**B**" at any flow below the threshold river flow.

5. At the RWA's discretion, it may run the TMDL model at one or more withdrawal rates between "**A**" and "**B**" to establish a graduated reduction in flows. These different withdrawal rates would need to be run at a simulated flow(s) equal to, or lower than, that which actually occurs if a graduated reduction withdrawal is to occur.

6. To determine flows which actually occur, RWA will obtain flows from U.S. Geological Survey (USGS) telemetry at Monroe and calculate a 24-hour running average. That average, at a pre-determined time set by RWA each day, would define the actual river flow for the next 24-hour period.

7. The RWA would store records of the following:

   (A) Model run DO results in a format similar to Figure 1;
   (B) The Annual Operational Tables for each year;
   (C) Records of the 24-hour running average Snohomish River flows at Monroe used to establish actual flows for each day; and
   (D) Records of withdrawals from Ebey Slough.

8. The RWA would make all flow, withdrawal, and model records in 7(A-D) available to Ecology, and explain the rationale for any schedule of withdrawals during low flow conditions at Ecology's request.

9. Model runs to produce records 7(A) and 7(B) above would be prepared annually and submitted to Ecology by June 1st of each year.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Andrew C. Kindig, Ph.D.
Sr. Associate Biologist/Water Quality

pc: Bob Cusimano, Washington Department of Ecology
Bill Fox, Cosmopolitan Engineering

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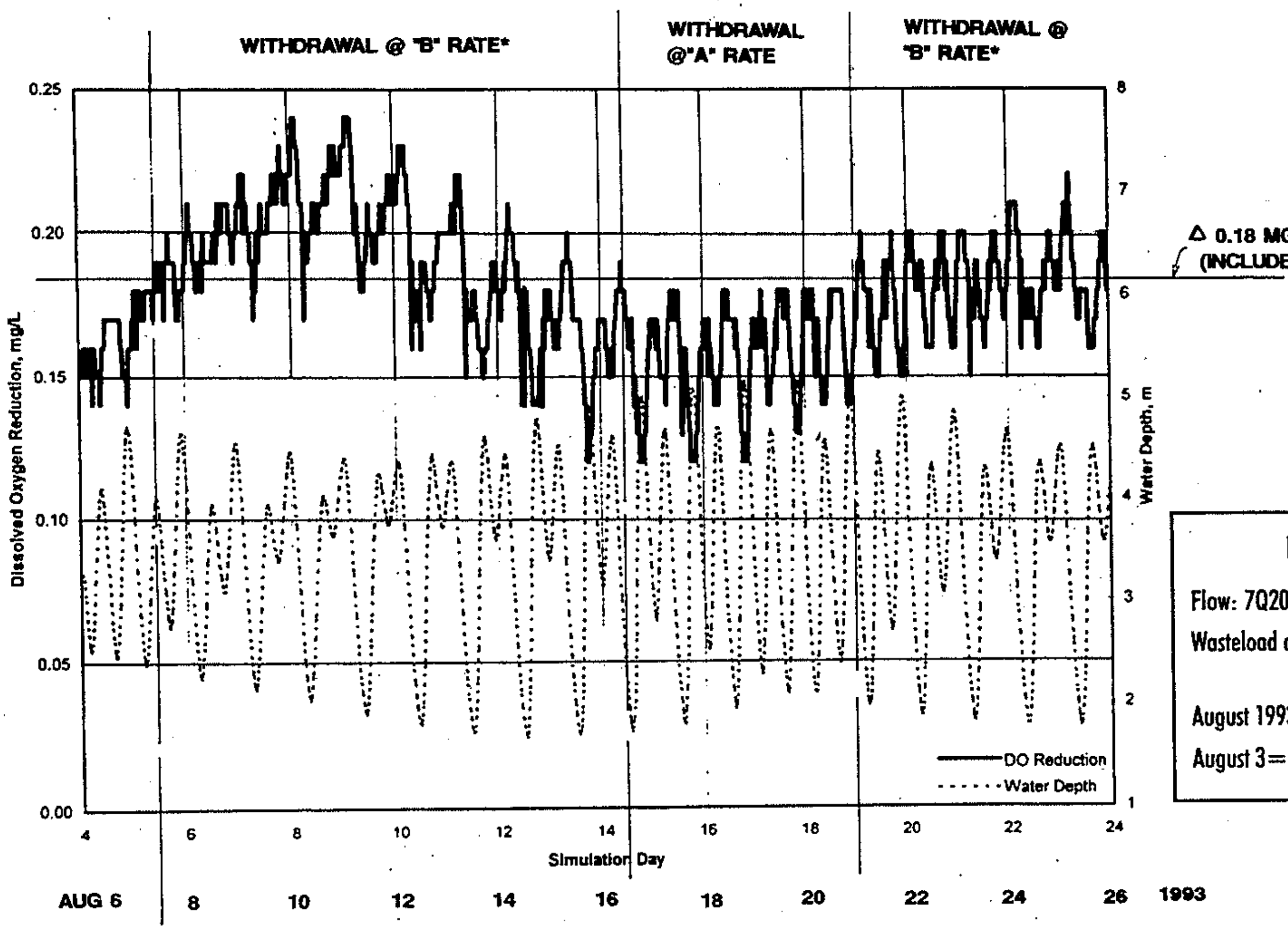
11/1/98 ld - WP8



PARAMETERS

Flow: 7Q20 (1050 cfs at Monroe)

Wasteload concentration: ammonia 5 mg/L
BOD 27 mg/L

August 1993 tides

August 3= Simulation day 1

REFERENCE: SNOHOMISH RIVER REGIONAL WATER AUTHORITY "REVISED & AMENDED PLAN OF USE TECHNICAL MEMORANDUM (APPENDICES H-L), WEYERHAEUSER TIMBER COMPANY WATER RIGHT NO. S1-16617C", JANUARY 30, 1998, VOL. 2.

*GRADUATED WITHDRAWAL REDUCTION FROM "A" DOWN TO "B" IS ALLOWED IF SUPPORTED BY SIMULATION RUNS AND 0.18 MG/L DO CRITERION.

ASSOCIATED EARTH SCIENCES, INC

EXAMPLE OF MODEL RUN OUTPUT

SNOHOMISH RIVER REGIONAL WATER AUTHORITY

EVERETT, WASHINGTON

FIGURE 1

DATE 11/98

PROJ. NO. KB98046A

derrelloga\dnm\8.5x11h base

Snohomish River Regional Water Authority
Figure 2. Annual Operational Table (Example for 1993 from POU Figure H-12)

Date	Threshold Flow 1,350 cfs*	Simulated Flow	Simulated Flow	7Q20 Flow 1,050 cfs	Simulated Flow
1-Jul-93	Rate "A"				
2-Jul-93	Rate "A"				
31-Jul-93	Rate "A"				
1-Aug-93	Rate "A"				
2-Aug-93	Rate "A"				
3-Aug-93	Rate "A"				
4-Aug-93	Rate "A"				
5-Aug-93	Rate "A"				
6-Aug-93	Rate "A"			Rate "A"	
7-Aug-93	Rate "A"			Rate "B"	
8-Aug-93	Rate "A"			Rate "B"	
9-Aug-93	Rate "A"			Rate "B"	
10-Aug-93	Rate "A"			Rate "B"	
11-Aug-93	Rate "A"			Rate "B"	
12-Aug-93	Rate "A"			Rate "B"	
13-Aug-93	Rate "A"			Rate "B"	
14-Aug-93	Rate "A"			Rate "B"	
15-Aug-93	Rate "A"			Rate "B"	
16-Aug-93	Rate "A"			Rate "B"	
17-Aug-93	Rate "A"			Rate "A"	
18-Aug-93	Rate "A"			Rate "A"	
19-Aug-93	Rate "A"			Rate "A"	
20-Aug-93	Rate "A"			Rate "A"	
21-Aug-93	Rate "A"			Rate "A"	
22-Aug-93	Rate "A"			Rate "B"	
23-Aug-93	Rate "A"			Rate "B"	
24-Aug-93	Rate "A"			Rate "B"	
25-Aug-93	Rate "A"			Rate "B"	
26-Aug-93	Rate "A"			Rate "B"	
27-Aug-93	Rate "A"				
28-Aug-93	Rate "A"				
29-Aug-93	Rate "A"				
30-Aug-93	Rate "A"				
31-Aug-93	Rate "A"				
1-Sep-93	Rate "A"				
2-Sep-93	Rate "A"				
3-Sep-93	Rate "A"				
4-Sep-93	Rate "A"				
5-Sep-93	Rate "A"				
6-Sep-93	Rate "A"				
7-Sep-93	Rate "A"				
8-Sep-93	Rate "A"				
9-Sep-93	Rate "A"				
10-Sep-93	Rate "A"				
11-Sep-93	Rate "A"				
12-Sep-93	Rate "A"				
13-Sep-93	Rate "A"				
14-Sep-93	Rate "A"				
31-Oct-93	Rate "A"				

* As established for flow at Monroe in this example for 1993 described in the POU.

RWA May run as many flow simulations as it likes to create as many columns as it likes. Only the Threshold and 7Q20 flow simulations are required.

For illustration, some dates in July are missing. All dates in the July 1 through October 31 period would be in final table.

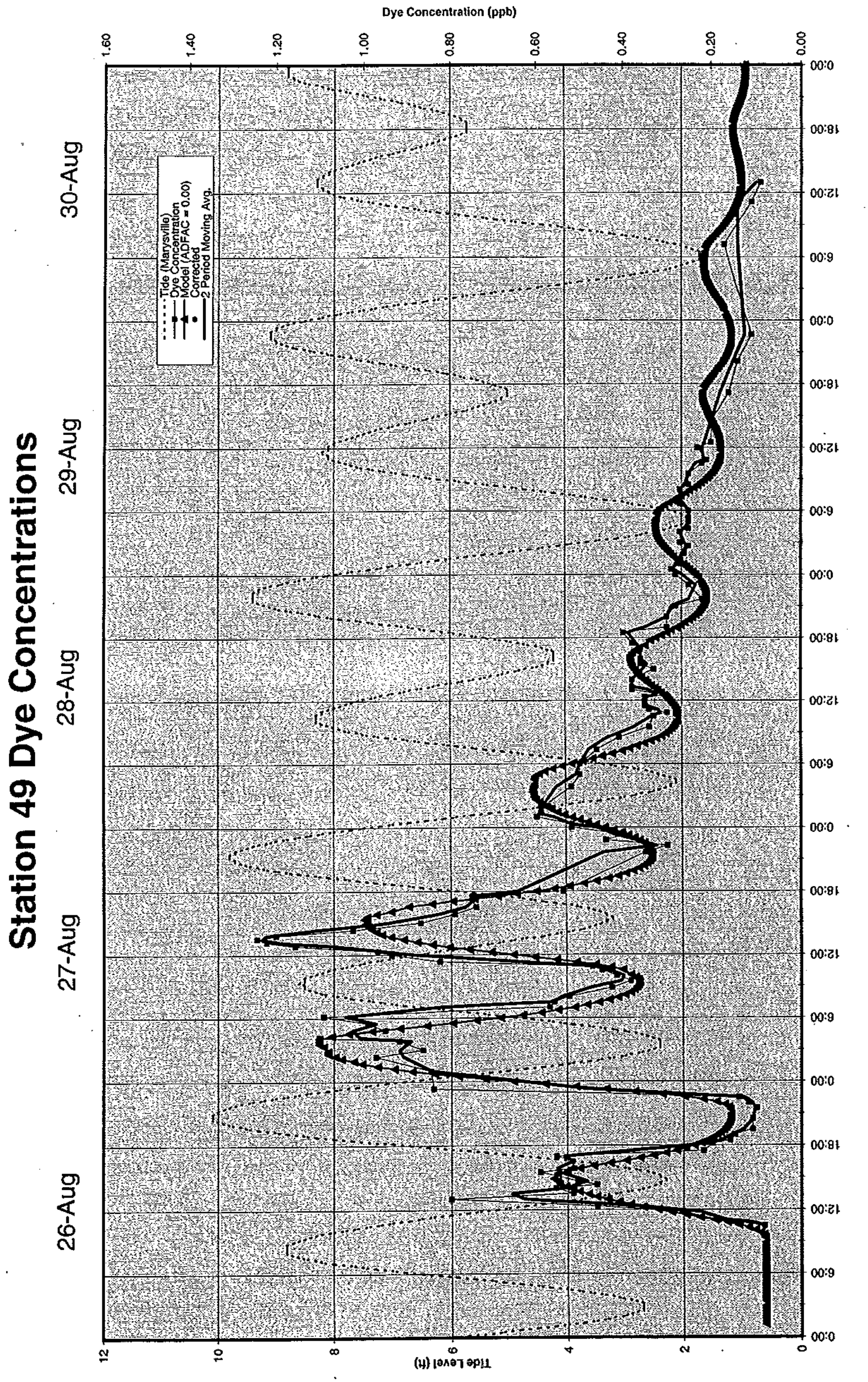
Blank columns and rows to be filled in by simulation TMDL model results

Portion of Table Simulated in Fig. 1 (boxed portion)

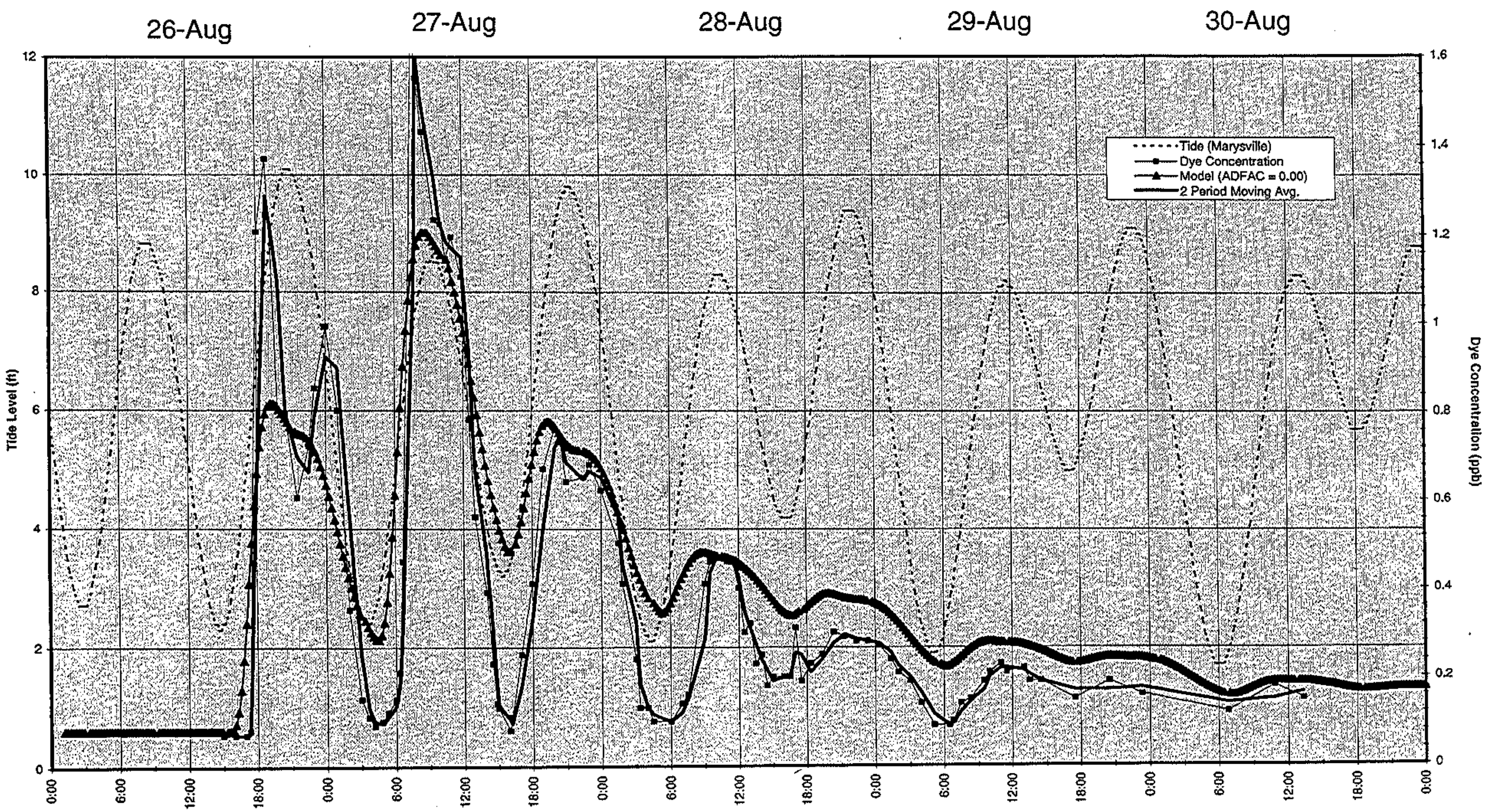
For illustration, some dates in September/October are missing. All of the July 1 through October 31 period would be in final table.

file: ACK c:/RWA/Figure2.xls

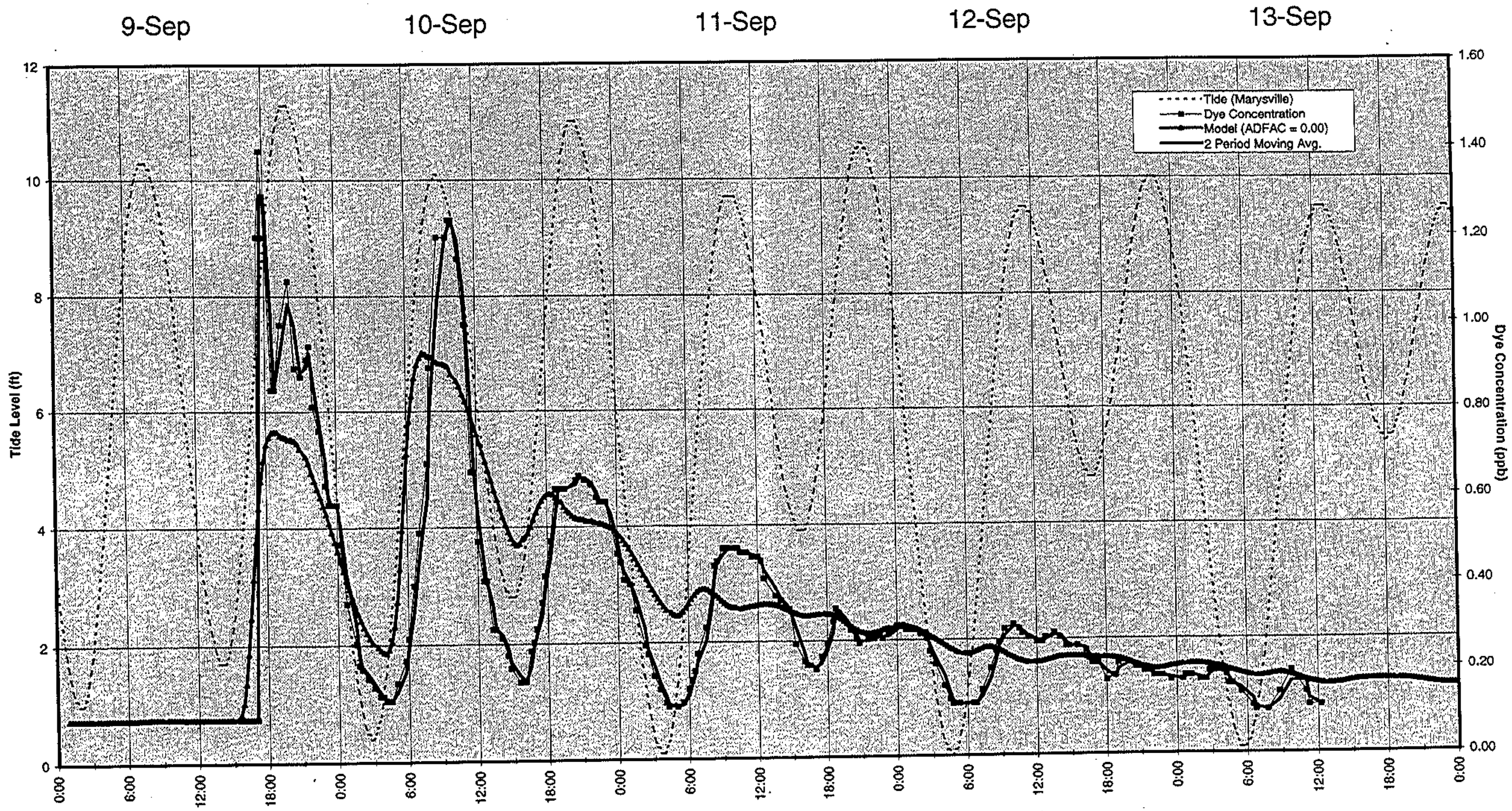
Attachment 13



Station 56 Dye Concentrations



Station 55 Dye Concentrations



Attachment 14

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (425) 649-7000

April 26, 1999

Mr. Robert Waddle
Snohomish Regional Water Quality Association (SRWQA)
City of Everett
3200 Cedar Street
Everett, WA 98201

Dear Mr. Waddle:

NPDES permits are scheduled to be completed for your respective facilities by July 1999. In 1993 the Department began conducting an assessment of the Snohomish River Estuary with respect to the system's ability to assimilate pollutants that exert an oxygen demand (i.e. both carbonaceous and nitrogenous pollutants from point and nonpoint sources). The Department reports summarizing the work were published in 1995 and 1997. These reports were completed to provide us with the technical basis for setting total daily maximum loads (TMDLs) for two pollutants: carbonaceous biochemical oxygen demand (CBOD) and ammonia. Our goal has been to include the report-recommended discharge limits in the 1999 permits. Although these reports and the public process have been completed for over a year, the Department delayed action on the proposed TMDL in order to allow the SRWQA time to collect more data which could be used to "test" the water quality and hydrodynamic model used to establish allocation limits for the TMDL and to allow the SRWQA to submit an alternative TMDL Waste Load Allocation proposal.

At our January 21, 1999, meeting you presented the results of your August-September 1998 data collection efforts and how the TMDL model estimates compared to the ambient data you collected. The results supported the accuracy of the model and its use as a water quality management tool. However, you suggested that we not proceed with issuing draft permits based on the TMDL. The request to delay implementing the TMDL was based on your assessment of the August-September 1998 data that suggests the dischargers do not have a reasonable potential to violate the TMDL at the existing discharge levels (i.e. CBOD and ammonia loading during the August-September 1998 study period). Although the Department agreed with the general approach used in your assessment, we believe that many more years of data would have to be collected in order to use the "dynamic" approach you proposed as an alternative to the Ecology steady-state guidance used to establish the TMDL allocations. Therefore, the Department does not believe there is enough information to justify delaying implementing the TMDL allocations. To the contrary, we found that incorporating nonpoint sources and the actual distribution characteristics of the effluent data you collected in the model during the critical tide sequence for the August-September 1998 study period suggests that current pollutant loading to the estuary could cause the water quality standards to be violated.

The Department has decided to proceed with preparing draft permits based on the TMDL. However, we are proposing to modify the critical conditions for determining allocations using the data you collected as follows:

- Effluent discharge concentrations of ultimate CBOD and ammonia will be equal to the 95th percentile of the August-September 1998 effluent monitoring data.
- Effluent flows will equal the summer design flows for the City of Everett and the summer flows estimated by Marysville, Lake Stevens, and Snohomish.

The Department has made the decision to proceed with implementing the TMDL because:
(1) the potential for point and nonpoint source loads to violate the TMDL limits exists,
(2) the development of the proposed TMDL has followed Ecology's guidelines and WAC specifications,
(3) Ecology's and SRWQA's data collection efforts confirm the accuracy of the model used to establish the TMDL and allocations for the estuary, and
(4) Implementation of the TMDL is consistent with the Draft State Salmon Strategy.

The Department is willing to consider adaptive management proposals within the framework of the NPDES permits to insure water quality standards can be maintained. The permits must contain design levels of discharge as required by regulation. I would encourage the SRWQA members to begin evaluating allocation proposals and WWTP upgrade and expansion options to accommodate growth anticipated by the GMA which will be handled by the WWTPs. The TMDL model is an excellent tool for evaluating these potential solutions.

Sincerely,

David E. Wright

David E. Wright, P.E.
Senior Water Quality Engineer

DW/bas

cc: Terry Williams, The Tulalip Tribes
Joni Earl, Snohomish County Executive Office
Peter Hahn, Snohomish County Public Works

Snohomish River Estuary Dry Season TMDL Study - Phase II

Technical Addendum
Number 2

By
Robert F. Cusimano

Washington State Department of Ecology
Environmental Assessments Program
Watershed Ecology Section
Post Office Box 47600
Olympia, Washington 98504-7600

July 1999

Modifications to the Snohomish River Estuary Dry Season TMDL Study.

Abstract

Waste load allocations (WLAs) for carbonaceous biochemical oxygen demand and ammonia proposed in the Snohomish River Estuary Dry Season TMDL Study – Phase II report (Cusimano, 1997) were revised based on new data collected by the Snohomish Regional Water Quality Authority (SRWQA) during the summer of 1998.

Introduction

This technical addendum documents the revision of recommended waste load allocations (WLAs) for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) and ammonia for the Snohomish River Estuary (Cusimano, 1997). The revisions were based on effluent water quality data collected by the SRWQA during August-September 1998 (Appendix A). The amount of discharge was also modified based on SRWQA estimates of the maximum summer flows for each wastewater treatment plant (WWTP). Please reference the Phase II report for more information on the water quality modeling used to establish the WLAs reported in this document.

Critical Conditions

The critical conditions used to evaluate the potential effects of current and future waste loading to the Snohomish River Estuary were the same as those listed in the Phase II report for the critical period, river flow (i.e., 7Q20), boundary conditions, and tributary and model segment characteristics (Cusimano, 1997). However, effluent discharge characteristics for the WWTPs were modified for flow, and ultimate carbonaceous biochemical oxygen demand (UCBOD) and ammonia concentrations. Concentrations of other effluent water quality variables (e.g., nitrate, dissolved oxygen, etc.) were the same as those listed in the Phase II report. Table 1 lists the WWTP modified effluent characteristics used as critical conditions for this assessment.

Table 1. Waste Water Treatment Plant (WWTP) summer flows and ultimate carbonaceous biochemical oxygen demand (UCBOD) and ammonia concentrations and loads based on effluent data collected from August through September 1998. Values represent the 95th percentile of the effluent concentrations measured during this period.

WWTP	Summer Flow (MGD)	UCBOD (mg/L)	UCBOD (lbs./day)	Ammonia (mg/L)	Ammonia (lbs./day)
Everett North	10.5	40.0	3336	22.8	1904
Everett South	8.0	14.8	988	15.6	1041
Marysville	4.03	86.0	2891	12.0	403
Lake Stevens	2.12	19.6	347	22.4	396
Snohomish	1.15	19.4	186	10.3	99

Dissolved Oxygen Predictions under Critical Conditions

Figure 1 shows the results of the dissolved oxygen model predictions for the existing discharges to the system under the modified critical conditions. Figure 2 shows the water quality model segment network for the estuary. The graphs in Figure 1 represent the predicted difference between the concentration of dissolved oxygen without and with loading sources for model segments 36, 55, and 57 (i.e., without loads = no point sources of BOD and nonpoint sources set at estimated background conditions of ammonia at 0.05 mg/L and UCBOD at 1.2 mg/L). These critical segments represent the areas in the mainstem river by the Everett discharge, in lower Steamboat Slough by the Marysville discharge, and in upper Steamboat Slough where the impact from all loading was found to be the greatest.

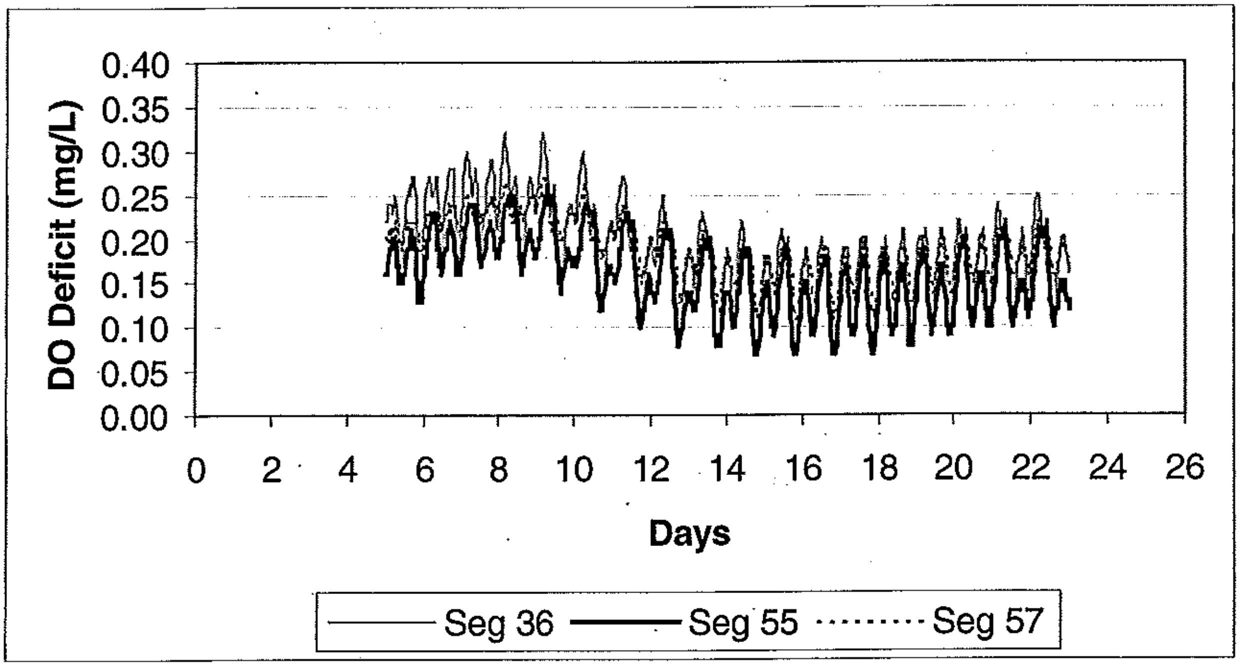


Figure 1. Dissolved oxygen deficit for critical model segments as the difference between model runs with no loads and all point and nonpoint loads.

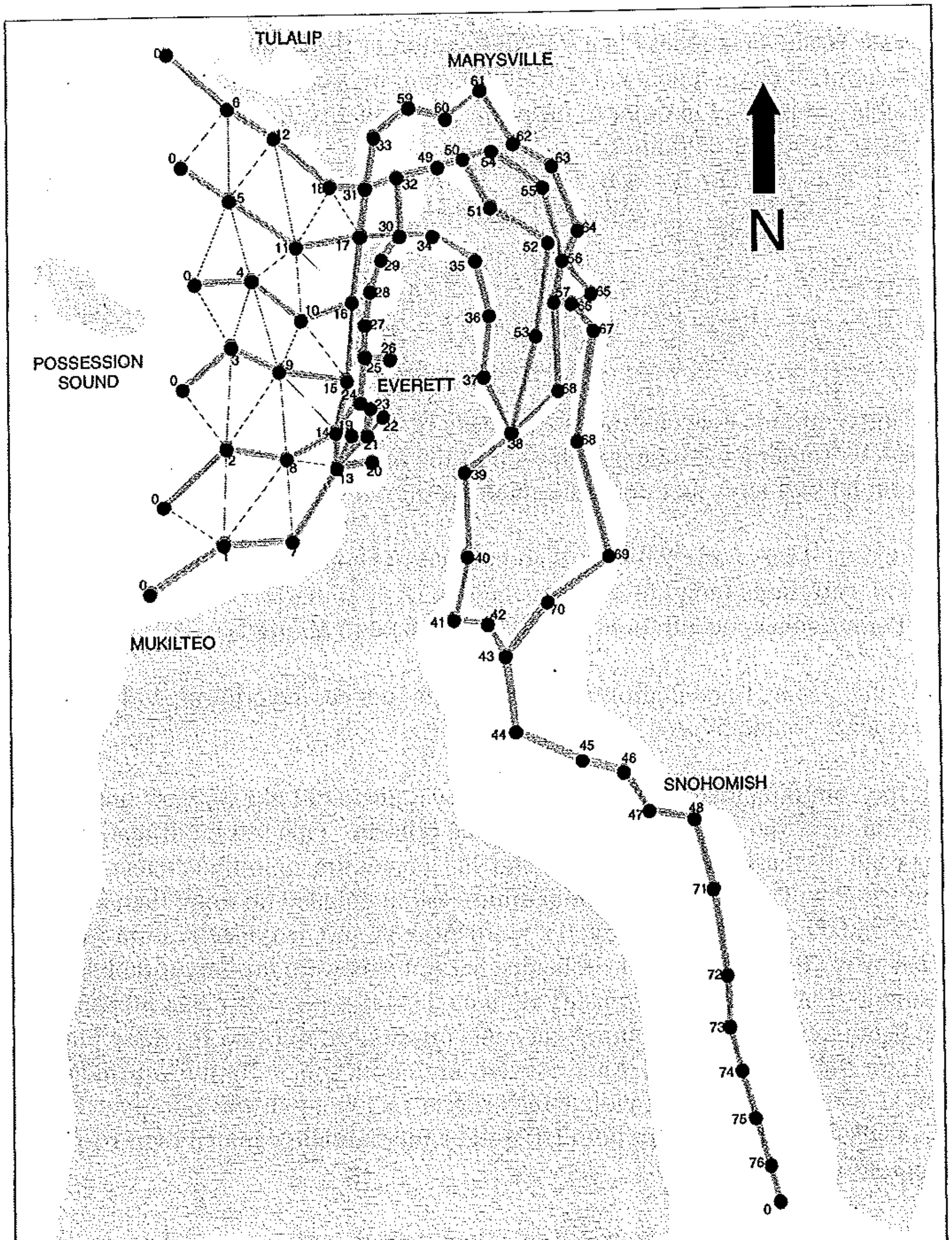


Figure 2. Segment network for the Snohomish River Estuary water quality model.

In order to meet the water quality criteria in the estuary at these model segments (i.e., human caused dissolved oxygen deficit not to exceed 0.20 mg/L when either the marine or fresh water criteria would apply), all of the point source loads were modified as listed in Table 2.

Table 2. Waste Water Treatment Plant (WWTP) summer flows and ultimate carbonaceous biochemical oxygen demand (UCBOD), ammonia concentrations and the pounds discharged per day in order to meet the water quality criteria allowable dissolved oxygen deficit of 0.20 mg/L.

WWTP	Summer Flow (MGD)	UCBOD (mg/L)	UCBOD (lbs./day)	Ammonia (mg/L)	Ammonia (lbs./day)
Everett North	10.5	40.0	3336	10.0	876
Everett South	8.0	14.8	988	10.0	667
Marysville	4.03	40.0	1344	12.0	403
Lake Stevens	2.12	19.6	347	16.0	283
Snohomish	1.15	19.4	186	10.3	99

The UCBOD and ammonia concentrations and loads in Table 2 were established through an iterative process by running the model with each of the following changes until the maximum deficit at the critical segments met the water quality criteria:

1. Assumed that the Marysville WWTP (lagoon system) should be able to achieve the same UCBOD concentrations found in Everett's lagoon of 40.0 mg/L.
2. All WWTP ammonia concentrations were first reduced to 10 mg/L.

The combined changes of 1 and 2 allowed all segments to meet the criteria, with additional capacity at segments 55 and 57.

3. Increased the ammonia loads at Snohomish, Marysville, and Lake Stevens until the maximum deficit at the critical segments met the criteria. This last modification was made by setting each discharge to the lowest of the 95th percentile ammonia concentrations for each plant listed in Table 1, until the maximum deficit equaled no more than 0.20 mg/L at segment 55 and 57. For example, the 95th percentile ammonia concentration for the City of Snohomish WWTP was 10.3 mg/L. The discharge loads were initially established using this concentration. Since additional capacity remained, Marysville and Lake Stevens loads were increased using the next highest ammonia concentration established for these plants—i.e., 12.0 mg/L for Marysville. Then, Lake Stevens ammonia concentration was increased until the deficit at segment 57 did not violate the criteria. Snohomish was not given an additional allocation because their limits for both UCBOD and ammonia equaled their respective 95% tile concentrations and loads.

The concentrations and loads presented in Table 2 are based on the August-September 1998 performance of the major point sources in the Snohomish River Estuary as established above.

Revised WLAs and LAs

Table 3 is a summary of the UCBOD and ammonia loads used in model runs to establish WLAs and LAs. Figure 4 is a pie chart representing the TMDL, WLAs, LAs, and Background. The downstream or seaward loading is not included. Table 4 presents the allowable effluent limits or WLAs for $CBOD_5$ and ammonia that meet the dissolved oxygen criteria as the maximum daily average loads (in pounds/day). No allocation has been made for future growth (e.g., new discharges, and increased WWTP capacity). The nonpoint LAs shown in Figure 3 are equal to the estimated critical conditions minus Background (i.e., no reductions are proposed for nonpoint sources). The revised WLAs for $CBOD_5$ were estimated from the UCBOD in Table 2 using the ratio of UCBOD/BOD_5 listed in the Phase II report of 2.0.

Table 3. Ammonia and UCBOD loads used in modeling critical conditions to establish TMDL allocations.

Loading Source	Ammonia (lbs./day)			UCBOD (lbs./day)		
	A	B	C	A	B	C
Upstream Boundary	283	283	283	6798	6798	6798
French Creek	0.4	19.2	19.2	105	524	524
Pilchuck River	1.5	9.02	9.02	361	361	361
Marshland	0.4	20.2	20.2	105	472	472
Deadwater Slough	0.1	22.2	22.2	35.6	321	321
Swan Trail Slough	0.04	33.4	33.4	10.4	142	142
Quilceda Creek	0.12	0.56	0.56	29.1	65.6	65.6
Tulalip Landfill—Ebey	0	4.07	4.07	0	0	0
Tulalip Landfill—Steamboat	0	4.07	4.07	0	0	0
Snohomish WWTP	0	99	99	0	186	186
Lake Stevens WWTP	0	396	283	0	347	347
Marysville WWTP	0,	403	403	0	2891	1344
Everett WWTP North	0	1904	876	0	3336	3336
Everett WWTP South	0	1041	667	0	988	988
Totals	286	4239	2724	7444	16430	14883

A = No point source loads; nonpoint sources set to estimated background conditions.
B = With point and nonpoint source loads for critical conditions.
C = Point and nonpoint source loads needed to meet dissolved oxygen criteria.

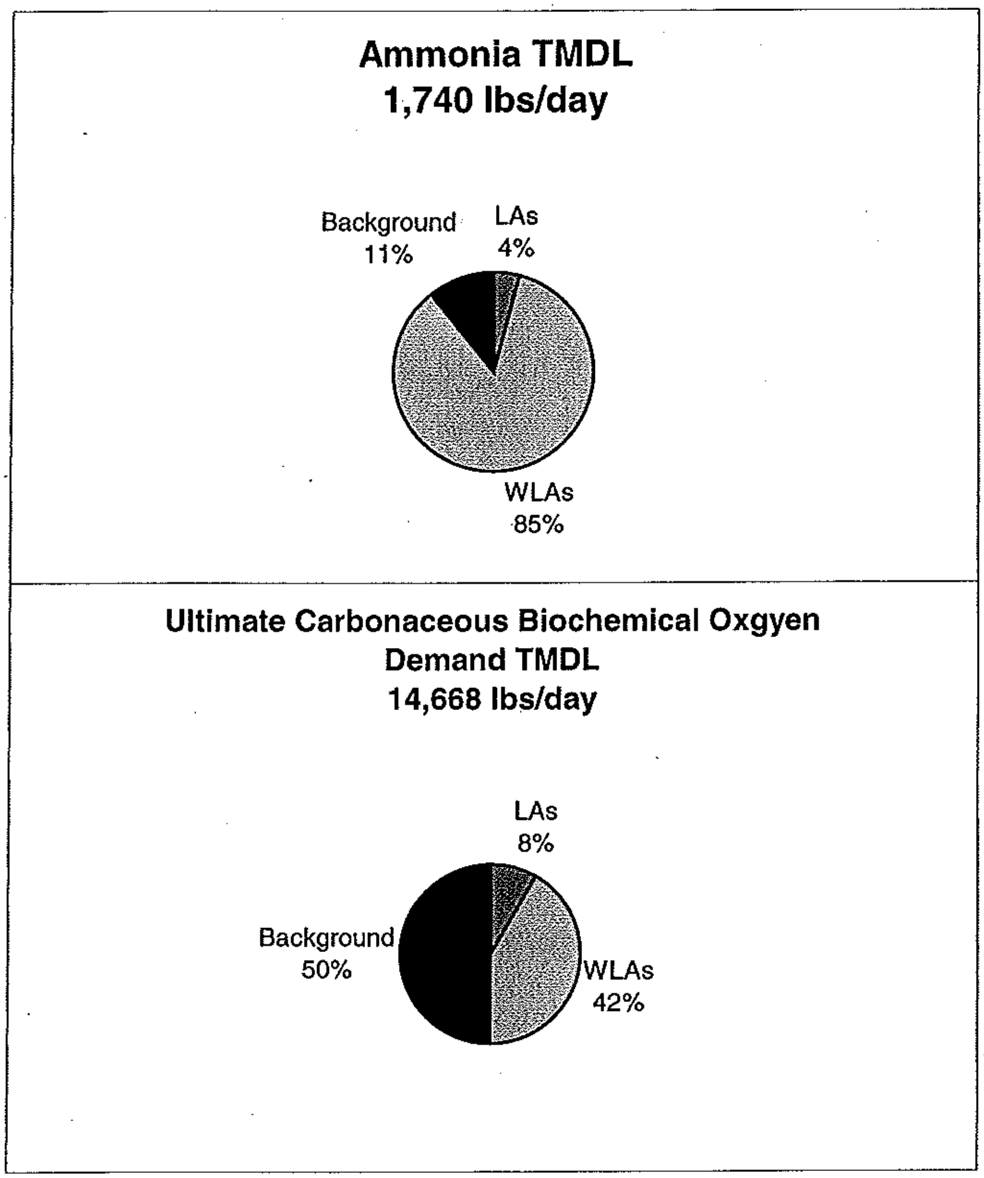


Figure 3. Pie chart showing WLAs, LAs, and Background as a percentage of the Snohomish River Estuary TMDLs for ammonia and ultimate carbonaceous biochemical oxygen demand.

Table 4. Summary of the revised WLAs for water quality-based permit limit development, and the WLAs listed in the Phase II report. LAs are listed in Table 3.

Loading Source	Revised WLAs (lbs./day)		Phase II WLAs (lbs./day)	
	Daily Maximum Ammonia	Daily Maximum $CBOD_5$	Daily Maximum Ammonia	Daily Maximum $CBOD_5$
Snohomish WWTP	99	93	117	632
Lake Stevens WWTP	283	174	100	541
Marysville WWTP	403	672	255	1377
Everett WWTP North	876	1668	439	2372
Everett WWTP South	667	494	334	1805

References:

Cusimano, R.F. 1997. Snohomish River Estuary Dry Season TMDL Study – Phase II: Water Quality Model Confirmation and Pollutant Loading Capacity Recommendations. Ecology Report No.97-325. Washington State Department of Ecology, Environmental Assessments Program, Olympia, WA.

1998 Snohomish River TMDL Study: Discharge Characteristics

	Everett - Final Effluent South					Everett - Final Effluent North					City of Snohomish		
Date	Flow (MGD)	CBOD (mg/L)	CBOD (lbs/day)	Ammonia (mg/L)	Ammonia (lbs/day)	Flow (MGD)	CBOD (mg/L)	CBOD (lbs/day)	Ammonia (mg/L)	Ammonia (lbs/day)	Flow (MGD)	CBOD (mg/L)	CBOD (lbs/day)
02-Aug-98	3.5	6.2	360.9		0.0	7.7	13.0	1674.0		0.0	0.56	7.3	68.2
03-Aug-98	3.5	7.3	423.7		0.0	10.6	16.0	2818.3		0.0	0.65	5.9	64.0
04-Aug-98	4.3	6.6	475.6	7.55	272.2	9.6	14.0	2239.5		0.0	0.62	6.2	64.1
05-Aug-98	4.7	5.9	460.6	8.97	349.9	9.1	15.0	2274.3	19.59	1484.8	0.62	5.2	53.8
06-Aug-98	4.7	5.6	437.1	10.60	413.7	8.3	16.0	2225.8	19.06	1325.7	0.61	6.5	66.1
07-Aug-98	4.7	4.1	319.4	11.23	437.5	7.7	17.0	2186.2	18.93	1217.0	0.64	6.3	67.3
08-Aug-98	4.7	4.3	337.8	12.00	471.4	7.1	18.0	2131.7	18.72	1108.4	0.67	5.5	61.5
09-Aug-98	4.5	4.2	316.7	12.17	458.7	7.2	14.0	1681.3	18.41	1105.7	0.60	5.3	53.0
10-Aug-98	4.4	4.3	317.0	12.27	452.2	7.4	12.0	1489.2	18.53	1149.5	0.64	6.8	72.6
11-Aug-98	4.0	3.8	251.0	12.13	400.7	6.7	12.0	1349.1	18.43	1035.8	0.68	7.5	85.1
12-Aug-98	4.5	4.2	314.6	13.46	504.1	6.8	13.0	1476.7	18.89	1072.6	0.68	7.9	89.6
13-Aug-98	4.5	4.0	300.9	12.99	488.4	7.0	13.0	1515.7	19.84	1156.5	0.69	7.3	84.0
14-Aug-98	4.6	4.3	329.9	12.67	486.1	10.0	8.4	1402.5	20.51	1712.2	0.71	7.8	92.4
15-Aug-98	4.6	6.1	470.1	12.85	495.0	7.0	11.0	1280.7	20.99	1221.8	0.54	8.9	80.2
16-Aug-98	4.6	5.8	447.0	9.83	378.6	6.1	14.0	1419.8	21.43	1086.7	0.69	8.8	101.3
17-Aug-98	4.7	5.5	426.6	9.67	374.9	6.7	14.0	1552.9	21.41	1187.1	0.69	6.7	77.1
18-Aug-98	5.2	5.5	479.8	10.03	437.3	5.5	14.0	1279.7	21.71	992.0	0.58	5.9	57.1
19-Aug-98	5.3	7.5	664.3	11.50	509.2	8.4	20.0	2788.9	21.73	1515.3	0.55	8.3	76.1
20-Aug-98	5.1	5.7	488.7	12.62	541.1	6.6	20.0	2191.8	21.20	1161.8	0.59	6.0	59.0
21-Aug-98	5.2	4.0	344.9	13.28	572.6	6.4	17.0	1806.3	20.67	1098.1	0.56	6.4	59.8
22-Aug-98	5.1	3.5	298.9	14.00	597.9	6.4	12.0	1285.0	21.17	1133.4	0.56	5.2	48.6
23-Aug-98	5.2	4.0	344.9	13.80	595.2	5.7	11.0	1045.8	21.12	1003.8	0.55	4.4	40.4
24-Aug-98	5.1	4.1	351.5	14.11	604.8	7.0	11.0	1282.5	21.78	1269.8	0.51	12.0	102.1
25-Aug-98	4.0	5.2	346.1	14.97	498.1	6.5	12.0	1301.0	22.30	1208.7	0.56	5.6	52.3
26-Aug-98	4.4	3.0	217.7	16.63	603.3	7.3	10.0	1209.3	22.81	1379.1	0.59	5.6	55.1
27-Aug-98	4.3	5.4	387.3	15.37	551.3	6.8	11.0	1240.3	23.02	1297.9	0.53	6.1	53.9
28-Aug-98	4.2	4.7	332.4	16.44	581.3	6.6	13.0	1433.3	23.24	1280.9	0.54	5.5	49.5
29-Aug-98	4.2	7.0	495.1	16.27	575.4	6.6	14.0	1543.6	22.96	1265.7	0.55	4.8	44.0
30-Aug-98	0.1	3.7	5.6		0.0	6.5	16.0	1734.7	22.59	1224.4	0.55	5.1	46.8
31-Aug-98	0.1	7.1	8.3		0.0	8.0	12.0	1609.3	21.76	1458.8	0.64	4.0	42.7
01-Sep-98	0.0	5.1	0.0		0.0	8.3	12.0	1665.3	21.67	1503.6	0.55	5.1	46.8
02-Sep-98	5.4	3.5	315.8	11.56	521.6	9.3	11.0	1700.9	21.01	1624.3	0.56	4.6	43.0
03-Sep-98	5.2	6.6	575.8	12.74	555.7	8.1	18.0	2444.0	20.69	1404.7	0.50	9.9	82.6
04-Sep-98	5.2	5.4	472.0	13.93	608.6	7.3	14.0	1702.4	20.06	1219.4	0.51	7.8	66.4
05-Sep-98	5.2	3.3	287.3	14.69	639.4	6.2	13.0	1348.7	19.52	1012.4	0.49	5.2	42.5
06-Sep-98	5.2	7.4	635.7	14.62	628.0	5.7	12.0	1142.9	19.19	913.7	0.57	5.5	52.3
07-Sep-98	5.3	3.6	317.1	14.66	645.7	5.0	8.0	667.2	18.79	783.6	0.60	4.0	40.0
08-Sep-98		6.4	0.0	12.46	0.0	6.0	9.7	970.8	18.31	916.4	0.58	3.8	36.8
09-Sep-98	4.5	5.9	439.9	12.59	469.3	7.0	10.0	1167.6	18.96	1106.9	0.55	5.1	46.8
10-Sep-98	4.4	5.0	367.8	12.25	450.6	8.0	10.0	1334.4	18.56	1238.5	0.51	5.0	42.5
11-Sep-98	4.5	5.3	393.4	13.07	485.0	8.6	13.0	1862.7	18.24	1306.4	0.56	4.8	44.8
12-Sep-98	4.4	5.0	369.5	13.79	509.3	8.2	12.0	1643.3	18.74	1283.2	0.53	5.6	49.5
13-Sep-98	4.4	5.2	384.2	13.62	503.2	8.0	12.0	1601.3	18.77	1252.6	0.56	4.9	45.8
14-Sep-98	4.5	4.2	317.4	13.97	527.8	8.1	10.0	1342.7	18.81	1263.0	0.60	4.0	40.0
15-Sep-98	4.5	3.9	291.4	14.49	541.2	7.5	11.0	1383.4	18.87	1186.7	0.53	4.8	42.4
16-Sep-98	4.5	4.3	320.6	14.44	538.3	8.1	11.0	1477.0	18.90	1268.9	0.49	5.3	43.3
17-Sep-98	4.5	4.7	352.8	14.99	562.6	7.6	8.8	1121.4	18.37	1170.3	0.52	4.6	39.9
18-Sep-98	4.5	4.9	365.3	13.53	504.5	7.5	12.0	1495.2	19.09	1189.4	1.20	7.4	148.1
19-Sep-98	4.6	4.0	304.9	14.57	555.2	7.0	9.1	1064.0	18.95	1108.1	0.77	5.2	66.8
20-Sep-98	4.5	3.4	255.8	12.22	459.6	6.6	9.6	1056.8	18.98	1044.6	0.59	5.2	51.2
21-Sep-98	4.5	4.5	337.0	12.81	479.6	7.3	9.7	1179.5	19.08	1160.2	0.67	4.0	44.7
22-Sep-98	4.4	5.3	386.3	13.92	507.3	7.5	12.0	1505.2	18.72	1173.9	0.66	5.1	56.1
23-Sep-98	4.5	4.0	297.6	14.11	524.9	8.1	9.3	1255.0	18.52	1249.6	0.66	3.2	35.2
24-Sep-98	4.5	5.0	378.6	15.09	571.5	9.0	14.0	2101.7	17.89	1342.5	0.57	5.6	53.2
25-Sep-98	4.5	3.4	255.8	12.01	451.7	11.0	9.7	1779.8	18.82	1726.3	0.64	4.5	48.0
26-Sep-98	4.5	5.5	414.7	10.81	407.3	10.0	14.0	2335.2	18.37	1531.9	0.89	6.3	93.5
27-Sep-98	4.5	5.7	429.7	11.59	436.9	11.0	16.0	2935.7	17.79	1632.0	0.60	6.3	63.1
28-Sep-98	4.5	8.0	603.1	12.76	481.1	10.0	20.0	3336.0	17.28	1441.0	0.71	11.0	130.3
29-Sep-98	3.3	8.1	439.1	13.71	371.7	10.3	20.0	3436.1	16.68	1432.8	0.52	9.7	84.1
30-Sep-98	2.4	4.7	188.9	13.98	281.0	18.3	15.0	4583.7	17.01	2599.2	0.55	4.7	43.1
01-Oct-98	2.5	4.0	168.8	13.76	290.3	18.1	12.0	3618.9	17.10	2578.5	0.61	3.7	37.6
mean	**4.3**	**5.0**	**351.2**	**13.0**	**445.2**	**8.0**	**13.0**	**1749.6**	**19.7**	**1226.5**	**0.6**	**6.0**	**61.1**
stdev	**1.1**	**1.2**	**134.4**	**1.8**	**170.0**	**2.3**	**3.0**	**718.2**	**1.7**	**415.6**	**0.1**	**1.8**	**22.6**
95%tile	**5.2**	**7.4**	**575.8**	**15.6**	**608.6**	**11.0**	**20.0**	**3336.0**	**22.8**	**1712.2**	**0.7**	**9.7**	**101.3**
UCBOD		**14.8**	**1151.5**				**40.0**	**6672.0**				**19.4**	**202.6**

	City of Snohomish		Lake Stevens Sewer District					City of Marysville				
Date	Ammonia (mg/L)	Ammonia (lbs/day)	Flow (MGD)	CBOD (mg/L)	CBOD (lbs/day)	Ammonia (mg/L)	Ammonia (lbs/day)	Flow (MGD)	CBOD (mg/L)	CBOD (lbs/day)	Ammonia (mg/L)	Ammonia (lbs/day)
02-Aug-98	3.01	14.1	1.67	5.3	147.9	22.27	310.7	4.00	25.0	1668.0	14.19	473.3
03-Aug-98	2.71	14.7	1.60	7.7	205.8	21.62	288.9	2.69	24.0	1076.9	13.76	308.8
04-Aug-98	2.43	12.6	1.53	3.7	94.1	21.63	275.1	3.91	24.0	1565.3	12.92	421.4
05-Aug-98	2.20	11.4	1.52	3.3	83.6	21.53	272.8	3.96	22.0	1453.2	11.49	379.4
06-Aug-98	2.00	10.2	1.56	2.9	75.3	22.54	292.7	3.86	25.0	1609.6	8.31	267.4
07-Aug-98	1.65	8.8	1.47	4.1	100.2	22.45	274.3	3.82	38.0	2421.3	5.28	168.2
08-Aug-98	1.33	7.4	1.55	3.7	95.5	21.96	283.3	3.78	15.0	945.8	1.94	61.3
09-Aug-98	0.84	4.2	1.65	6.1	167.6	22.08	303.2	3.73	19.0	1182.1	0.52	16.1
10-Aug-98	0.48	2.6	1.60	9.2	244.8	21.90	291.3	3.85	25.0	1605.5	0.46	14.9
11-Aug-98	0.31	1.8	1.55	7.2	185.5	20.62	265.7	3.18	44.0	2333.9	0.91	24.1
12-Aug-98	0.29	1.7	1.55	7.3	188.4	21.10	272.3	2.65	24.0	1060.8	2.56	56.6
13-Aug-98	0.37	2.1	1.57	7.0	183.2	22.04	288.4	2.74	44.0	2010.9	4.28	97.9
14-Aug-98	0.58	3.4	1.49	5.0	124.1	20.63	256.1	2.69	24.0	1076.9	6.60	148.1
15-Aug-98	0.83	3.8	1.56	4.6	119.6	20.16	262.1	2.69	22.0	987.1	7.71	172.9
16-Aug-98	1.24	7.1	1.74	4.7	136.6	20.39	296.4	2.67	43.0	1915.0	8.45	188.2
17-Aug-98	1.78	10.2	1.64	8.6	235.7	20.49	280.8	2.68	29.0	1296.4	7.70	172.2
18-Aug-98	2.29	11.1	1.54	5.9	151.7	20.13	258.7	2.69	20.0	897.4	8.08	181.4
19-Aug-98	2.83	13.0	1.54	7.8	200.6	21.38	274.9	3.86	29.0	1867.2	8.45	272.0
20-Aug-98	3.40	16.7	1.55	6.8	175.8	21.77	281.4	4.09	21.0	1432.6	9.51	324.4
21-Aug-98	4.02	18.8	1.47	25.0	614.2	22.35	274.6	4.03	6.7	450.4	10.25	344.3
22-Aug-98	4.71	22.0	1.55	6.4	165.8	21.78	282.1	3.98	22.0	1460.5	10.10	335.3
23-Aug-98	5.44	25.0	1.68	5.7	159.5	20.57	287.9	3.85	19.0	1220.1	10.18	326.8
24-Aug-98	6.12	26.0	1.60	10.0	266.9	17.55	234.1	3.33	19.0	1055.3	10.12	281.1
25-Aug-98	6.89	32.2	1.58	5.3	139.3	18.36	241.3	2.83	20.0	944.1	10.63	250.8
26-Aug-98	7.56	37.2	1.58	5.5	145.0	19.68	259.5	2.97	20.0	990.8	10.90	269.9
27-Aug-98	8.33	36.8	1.54	5.4	139.0	20.24	260.4	2.38	20.0	794.0	9.73	193.2
28-Aug-98	8.94	40.3	1.48	2.9	71.5	21.23	261.7	2.75	16.0	733.9	10.02	229.9
29-Aug-98	9.59	44.0	1.56	4.0	104.2	21.86	284.8	2.75	17.0	779.8	9.88	226.7
30-Aug-98	9.92	45.5	1.74	6.2	179.5	21.95	317.7	2.83	21.0	991.3	8.89	209.9
31-Aug-98	10.11	54.0	1.62	9.8	265.3	22.02	298.1	2.84	16.0	757.9	8.54	202.3
01-Sep-98	10.33	47.4	1.56	7.1	184.3	21.74	282.1	2.76	17.0	782.6	8.19	188.5
02-Sep-98	10.45	48.8	1.57	6.7	174.9	21.94	286.4	3.36	17.0	952.8	10.64	298.0
03-Sep-98	10.56	44.0	1.56	2.2	57.4	22.77	297.1	4.03	16.0	1075.5	11.99	403.0
04-Sep-98	10.33	44.0	1.48	2.2	54.1	22.29	274.2	3.99	16.0	1064.9	11.64	387.3
05-Sep-98	9.94	40.6	1.49	2.0	49.8	21.88	272.6	3.99	18.0	1198.0	11.12	370.1
06-Sep-98	9.63	45.8	1.45	2.3	55.5	22.01	265.6	3.95	14.0	922.4	10.28	338.7
07-Sep-98	8.93	44.7	1.76	7.1	208.0	22.40	328.0	3.91	12.4	808.7	9.20	300.0
08-Sep-98	8.72	42.2	1.61	6.3	168.7	21.20	283.8	3.86	21.0	1352.1	6.57	211.4
09-Sep-98	7.86	36.1	1.53	4.4	112.0	20.94	266.5	3.62	15.0	905.7	4.59	138.6
10-Sep-98	7.28	31.0	1.55	1.6	41.3	21.54	278.0	3.60	15.0	900.7	2.10	62.9
11-Sep-98	6.87	32.1	1.49	10.0	249.2	21.23	264.5	3.05	22.0	1119.2	0.93	23.6
12-Sep-98	6.18	27.3	1.60	6.0	159.8	21.33	284.1	2.68	49.0	2190.4	0.53	11.9
13-Sep-98	5.63	26.3	1.70	7.2	204.3	20.42	289.6	2.66	22.0	976.1	0.09	2.0
14-Sep-98	5.40	27.0	1.59	3.9	103.6	19.98	265.3	2.86	32.0	1526.6	0.31	7.4
15-Sep-98	5.15	22.8	1.57	2.8	73.5	19.24	252.6	2.92	16.0	779.3	0.15	3.6
16-Sep-98	5.12	20.9	1.54	3.1	79.6	19.74	253.4	2.81	19.0	890.5	0.09	2.0
17-Sep-98	4.62	20.0	1.59	1.6	42.5	20.77	275.6	2.86	33.0	1574.3	0.10	2.4
18-Sep-98	7.27	72.7	1.41	1.8	42.3	20.79	244.1	2.33	21.0	816.2	0.03	0.5
19-Sep-98	4.28	27.5	1.59	1.6	42.4	21.84	289.1	1.98	15.0	495.4	0.14	2.3
20-Sep-98	4.02	19.8	1.75	3.1	90.6	20.77	303.6	2.11	22.0	774.3	0.03	0.6
21-Sep-98	3.79	21.2	1.61	5.6	150.2	19.42	260.5	2.29	17.0	649.4	0.12	2.2
22-Sep-98	3.40	18.7	1.50	4.0	100.1	18.51	231.6	3.91	16.0	1043.5	0.06	2.1
23-Sep-98	3.25	17.9	1.53	4.5	114.8	19.12	244.0	3.98	17.0	1128.6	0.10	3.3
24-Sep-98	3.14	14.9	1.57	3.5	91.8	19.59	256.9	3.89	13.0	843.5	0.31	10.1
25-Sep-98	3.10	16.6	1.50	2.6	65.0	19.46	243.2	4.99	17.0	1415.0	0.78	32.6
26-Sep-98	3.11	23.1	1.60	7.4	196.9	19.54	259.9	5.07	19.0	1606.8	0.72	30.4
27-Sep-98	3.09	15.5	1.80	1.2	36.0	18.58	278.8	5.00	14.0	1167.6	1.07	44.7
28-Sep-98	3.19	18.9	1.59	3.3	87.5	18.32	242.8	4.93	34.0	2795.9	2.21	90.8
29-Sep-98	3.28	14.2	1.55	4.5	116.6	19.33	250.3	3.49	15.0	873.2	2.47	71.8
30-Sep-98	3.45	15.8	1.48	3.7	91.1	20.10	247.4	4.72	18.0	1417.1	3.18	125.0
01-Oct-98	3.63	18.4	1.64	2.6	71.2	20.40	279.2	3.6	21.2	1273.0	4.28	128.5
mean	**4.9**	**23.8**	**1.6**	**5.3**	**139.0**	**20.8**	**273.5**	**3.4**	**21.8**	**1211.5**	**5.7**	**162.5**
stdev	**3.2**	**15.4**	**0.1**	**3.4**	**87.2**	**1.2**	**20.3**	**0.8**	**8.3**	**473.7**	**4.6**	**138.5**
95%tile	**10.3**	**47.4**	**1.7**	**9.8**	**249.2**	**22.4**	**303.6**	**4.9**	**43.0**	**2190.4**	**12.0**	**387.3**
UCBOD				**19.6**	**498.4**				**86.0**	**4380.8**		