Presumpscot River
Supplemental Report to Waste Load Allocation
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Executive Summary

1. This report is a follow up of an earlier effort (Presumpscot River Waste Load Allocation, Nov 1995) as a result of a work plan of action items in the S.D. Warren Co. relicensing process and additional information requests from USEPA. The action items are a series of steps with deadlines that will bring the Presumpscot River into compliance with water quality standards. The Waste Load Allocation and this report will be submitted to USEPA as a TMDL for the Presumpscot River watershed.

2. The accuracy of the water quality model was retested with 42 additional verification runs of 1994 and 1995 data from the continuous four parameter monitor at the Smelt Hill dam. The model output of dissolved oxygen was compared to the monitor dissolved oxygen in these runs. All of the assumptions of the original model were found to be accurate with the exception of the diurnal dissolved oxygen adjustment of the lower Presumpscot which was adjusted from 0.0 to 0.4 ppm.

3. BOD5 loads from S D Warren Co. of 4200 and 2400 lb/day for a daily maximum and monthly average, respectively (65% reduction) will be necessary to attain riverine and estuarine dissolved oxygen standards in the summer period (June 1 to Sept 30) at 10 year low flow conditions with no flow augmentation from Sebago Lake.

4. Flow augmentation from Sebago Lake and summer BOD5 loads from S D Warren of 6780 and 3565 lb/day for a daily maximum and monthly average, respectively (45% reduction) are the chosen alternatives to comply with dissolved oxygen standards. The water quality model was used to derive a final temperature based flow augmentation (QVT) curve for the Presumpscot River which will result in compliance of dissolved oxygen standards (see next page) in the lower Presumpscot River and estuary.

5. Both the water quality model and actual data taken in 1993 indicate that minor non attainment of class B dissolved oxygen standards (0.2 to 0.3 ppm under standards) occurs in the upper Presumpscot River at the Little Falls, Mallison Falls, and Saccarappa dam impoundments. Additional data collection in the early morning hours (before 8 AM) is recommended to confirm non attainment.

6. To assure adequate water levels in Sebago Lake in extreme drought conditions, minimum flow from Sebago Lake should be reduced to 250 cfs during emergency low lake level conditions. Emergency low lake level conditions are defined as follows: When the level of Sebago Lake is one foot below its allowable target range (see Sebago Lake management plan, appendix) between May 1 and November 1 and flow releases from Sebago Lake have been greater than 270 cfs for at least four weeks in order to maintain the water quality in the river as required by the flow augmentation QVT curve. Reduced point source loadings from S D Warren Co. that are necessary to meet dissolved oxygen standards under this flow cap are presented as a function of river temperature and daily maximum loads in the chart following the QVT curve.

7. Federal regulations (40CFR125.3) require that before flow augmentation may be considered as an alternative, a demonstration must be made that flow augmentation is the preferred environmental and economic alternative to achieve standards after consideration of other alternatives such as advanced treatment. It is believed that the public participation process involving stakeholders that developed the Sebago Lake level management plan satisfies this requirement. It has been assumed for state licensing that the required level of treatment for S D Warren Co. with no flow augmentation (see recommendation #3) would result in undue economic hardship, although no cost estimates for this have been made and no significant environmental benefits could be gained. Thus the chosen alternative is preferred over others.

8. Current TSS loading from S D Warren Co. is considered to be the cause of noncompliance of class C aquatic life standards and, from an aesthetic stand point, impairment of designated uses of fishing and swimming. To address compliance of aquatic life standards, TSS limits for S D Warren Co. of 5500 and

12700 lb/day for a monthly average and daily maximum, respectively, from May 1 to Sept 30 should be required as the starting point in a phased approach to licensing. TSS limits in the nonsummer should be limited to past demonstrated performance or 9950 and 22850 lb/day for a monthly average and daily maximum, respectively. The licensing should be conditioned to annual summer monitoring to assure compliance of aquatic life standards, and be subjected to annual reductions in TSS should monitoring continue to show noncompliance of aquatic life standards. Licensing should require that a study plan should be submitted to the DEP for approval to assure macroinvertebrate monitoring is consistent with DEP methods and protocol.

9. A temporary 6.5 mile mixing zone was established in January of 1996 to comply with emergency legislation that required facility specific solutions for dischargers unable to comply with the temperature regulation. It is recommended that ambient continuous temperature monitoring be implemented in a number of locations with the goal of greatly reducing the size of this mixing zone.

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Introduction

The Presumpscot River Load Allocation (Nov. 1995) utilized temperature based flow augmentation from Sebago Lake (i.e., discharge more flow from the lake as water temperatures increase) to maintain acceptable dissolved oxygen levels in the river under summer low flow conditions. Licensed BOD5 loads were used as inputs to the water quality model in the development of these curves. The flow regulation recommended by the report was used voluntarily by the S. D. Warren Co. (SDW) in 1995. The summer of 1995 was a year in which extreme drought conditions were experienced statewide. As a result of the very low lake levels experienced in that summer, and the overall non attainment status of the river, it became evident that additional measures were necessary. A work plan of action items (see appendix) was developed in the waste discharge relicensing process of SDW that sets deadlines for a series of additional measures to bring the river into compliance with water quality standards .

This supplemental report to the Presumpscot River Waste Load Allocation is primarily a result of specific action items of the work plan and tests the accuracy of the model with additional verification runs in which the model dissolved oxygen is compared to the continuous four parameter monitor at the Smelt Hill dam. In addition, this report is intended to provide additional information that USEPA requested in a preliminary assessment of the adequacy of the Waste Load Allocation Report for fulfillment as a Total Maximum Daily Load (TMDL). The Waste Load Allocation is occasionally referenced but not discussed. For a detailed discussion of the prior modeling effort, one should refer to the Presumpscot River Waste Load Allocation (Nov 95). Both this report and the Waste Load Allocation will be submitted to EPA as a TMDL for the Presumpscot River.

Action item 4 of the work plan instructs SDW to submit a proposal for technology based seasonal reductions of BOD discharged to the river. The reduced BOD load to the river will lessen flow passage requirements from Sebago Lake. The following seasonal reduction (June 1 to Sept 30) resulted for BOD5:

	Current	Proposed
BOD5 Daily Maximum (lb/day)	12000	6780
BOD5 Monthly Average (lb/day)	6500	3565

Action item 6 of the work plan instructs the Department to develop new temperature based flow regulation (QVT) curves jointly with SDW to maintain the Presumpscot River at acceptable dissolved oxygen levels. These curves are developed with the DEP model of the Presumpscot River based upon the reduced loadings proposed by SDW.

Action item 8 of the work plan requires the DEP to establish a minimum flow for the Presumpscot River under emergency low lake levels at Sebago Lake and effluent limits under this flow cap. This flow cap agreed to by S D Warren and the DEP is 250 cfs from Sebago Lake. Both the flow cap and the associated effluent reductions under the flow cap are actions above and beyond the QVT curves to be used in extreme drought years when emergency low lake levels are experienced. The goal of the proposed flow management plan is to use the water volume in the lake to maintain adequate water quality in the Presumpscot River, but at the same time minimizing the use of this water to the maximum extent possible while still maintaining adequate lake levels.

The 1995 data at the four parameter monitor at the Smelt Hill dam resulted in ideal data to retest the accuracy of the model, i.e. additional verification runs. This data together with the 1994 data resulted in 42 additional model runs. This analysis goes above and beyond what is typically done for a waste load allocation, and results in a very high quality model for the Presumpscot River. In general, all of the original assumptions used in the modeling analysis of the Waste Load Allocation were found to be accurate, with the exception of the diurnal dissolved oxygen adjustment that was used in the lower Presumpscot River. The original model had no diurnal adjustment here, but the new analysis indicates that an adjustment of 0.4 ppm is necessary and should be subtracted from the model results to obtain the daily minimum dissolved oxygen.

Model Verification Based Upon 1994 and 1995 Four Parameter Monitor Data

A limitation to the original model calibration to the 1993 data was described in the Waste Load Allocation (p 22):

"The major disadvantage to the data sets collected in 1993 is that minimal point source loading was occurring during the surveys and hence the dissolved oxygen deficit at the sag point was not large. A larger deficit would have resulted in greater model sensitivity to parameter rate changes and a better calibration. In addition to the calibration and verification data sets, the four parameter monitor could serve as additional model verification in the future. The dissolved oxygen at the monitor could be observed during a higher loading condition in the future and the model rechecked and adjusted, if it is appropriate."

The four parameter monitor at the Smelt Hill dam is located at the river's dissolved oxygen sag point which is the location where the lowest dissolved oxygen occurs. Continuous data at a river's sag point is best mechanism for checking compliance with dissolved oxygen standards. If standards are met here, then they should be met everywhere. Model verification to continuous data at this location has the advantage of utilization of longer term averages of 7 and 30 days than what was used in the 1993 data (three days). The river is much more likely to be in an equilibrium or steady state condition over a period of several days. An important assumption in the Qual2e model is the assumption of steady state conditions throughout the system. The 1993 data has the advantage of more spatial coverage, i.e. many sample locations.

The 1995 data was ideal data to further verify the model. SDW BOD5 discharged to the river, contrary to the 1993 data sets which was taken under 20% loading conditions, reached 60% of licensed values which is similar to the proposed seasonal licensed BOD5. The flow conditions in the watershed reached levels more extreme than a 10 year low flow. In some of the runs, river flow losses actually occurred from Sebago Lake to Westbrook. As a result, larger dissolved oxygen deficits resulted in the river than what occurred in 1993. The dissolved oxygen levels in the river in 1995 in some cases approached the minimum values allowed under state law. This data represent conditions similar to the design criteria, i.e. licensed load, dissolved oxygen just barely meeting standards and are good to test the model's reliability under the worst case design runs in the development of the QVT curves. The 1994 data were used to a lesser extent to further test the reliability of the model under less extreme conditions.

The following data were used in the Smelt Hill dam monitor verification runs:

Flow - Flow gages at Sebago Lake and Westbrook as reported by USGS
Temperature and Dissolved Oxygen - The continuous data at the four parameter monitor
Point Source Loads - As reported on DMR's by SDW and PWD, Westbrook

The model verification runs were made as 30 day, 7 day and 2 day average conditions. A spreadsheet was set up to calculate the values used as inputs to the model. In addition a spreadsheet was set up to calculate a flow balance for each data set, based upon the two flow gages and drainage area proportions. Both of the spreadsheets are in the appendix to this report. The following number of runs were made:

1995 30 day average	11 runs
1995 7 day average	8 runs
1995 2 day average	10 runs
1994 30 day average	4 runs
1994 7 day average	4 runs
1994 2 day average	5 runs
Total	42 runs

The upstream boundary conditions, had to be assumed for each run at conditions used for the design model runs, (dissolved oxygen at 93% of saturation; CBODu and NBODu at 3.4 and 1.1 ppm, respectively; and temperature of upper Presumpscot at $1^{o}C$ less than the monitor temperature). All of the other calibrated parameter rates, i.e. BOD decay rate, reaeration rate, SOD rate, were held constant to the prior calibrated rates of the 1993 data. In addition, the same five day to ultimate BOD factors determined for the various effluents were used as determined in the Waste Load Allocation. For most effluents, this was a straight average, but for SDW, a function was derived based upon the BOD5 concentration (figure 3a of the WLA report is repeated on the next page for convenience).

The five day to ultimate BOD factor for SDW's effluent as a function based upon five day BOD concentration is considered to be another questionable portion of the model. The BODu/BOD5 for the higher BOD5 concentrations (lower end of curve) had to be derived based upon a mix of primary and secondary effluent, due primarily to the lack of BODu data at the higher BOD5 concentrations. To compensate for this data deficiency, model calibration was used to check the BODu/BOD5 function The verification runs were initially run utilizing both the function derived values and a straight average of 5.33 when computing SDW's ultimate BOD input. This resulted in different BODu inputs for SDW's effluent, and the different model output values for dissolved oxygen could then be compared to the monitor values. When the straight average of 5.33 for SDW's effluent BODu/BOD5 was used to derive the ultimate BOD model input, the model dissolved oxygen was slightly lower than the monitor dissolved oxygen, when considered collectively, by a value of 0.07 to 0.23 ppm. When the function derived BODu/BOD5 for SDW's effluent was used to derive the ultimate BOD model input, the model prediction of the monitor dissolved oxygen was high, when considered collectively, but was within .01 to .06 ppm. For this reason the function derived BODu/BOD5 for SDW's effluent is considered to be the better of the two options for characterizing SDW's ultimate BOD inputs.

The 42 verification runs are summarized in table 1. The model dissolved oxygen and monitor dissolved oxygen are compared both individually as a difference and collectively as an average difference and average deviation. The average difference considers the sign (+ or -) and is hence an indication of the model being high or low collectively in its estimate of dissolved oxygen. The average deviation pays no attention to sign and hence is an estimate of the model precision. The average deviation of all of the model runs when compared to the monitor values, collectively, was within 0.2 ppm. When considered individually, in 27 of the 42 runs (64%), the model dissolved oxygen came within 0.2 ppm of monitor values and in 37 of the 42 runs (88%) the model dissolved oxygen came within 0.3 ppm of the monitor dissolved oxygen. This is considered to be a satisfactory verification of the model. It is likely that other factors such as the accuracy of the monitor data and the assumptions for upstream boundary conditions are also limiting the accuracy of the model verification, rather than the model, itself. The model and monitor dissolved oxygen for the 42 runs are also compared as time series plots in figures 1,2,3, and 4.

The model values in table 1 represent a long term average dissolved oxygen of 2, 7, or 30 days. Even though the model prediction of average dissolved oxygen levels is considered adequate, it became evident that the diurnal adjustment of 0.0 ppm in the lower Presumpscot River was not adequate to characterize daily minimum dissolved oxygen. The diurnal adjustment (daily average D.O. - daily minimum D.O.) at the continuous four parameter averaged over the entire summers of 1994 and 1995 resulted in diurnal adjustments of 0.39 and 0.43 ppm, respectively. A value of 0.4 ppm is subsequently being used as the diurnal adjustment for the lower Presumpscot and the adjustment in the rest of the river remains unchanged (figure 5).

Model Projections at Design Conditions

The model runs at design conditions are simulations at worst case conditions of high water temperature, low river flow, and maximum licensed loading from all point sources. The design condition is when D.O. readings are likely to be lowest and is something that occurs infrequently (once in ten years). The model predictions are subsequently compared to dissolved oxygen standards specified by state law to check compliance with water quality standards. There are two separate tests which must be made; assessment of minimum dissolved oxygen standards and assessment of monthly average standards. The 7Q10 flow is used in the assessment of the former and the 30Q10 flow of the latter. These values are difficult to determine on a regulated river, in particular, on one such as the Presumpscot, where flow regulation in the future may be quite different than historical flow regulation. Low flow values of 300 and 330 cfs for a 7Q10 and 30Q10, respectively at Westbrook were used in this analysis. In a meeting in February of 1998, S D Warren and the DEP agreed to these values for regulatory purposes. After adjusting flow for intervening drainage from Westbrook to Sebago Lake (contributions from tributary

Figure 3a
S D Warren Effluent Data

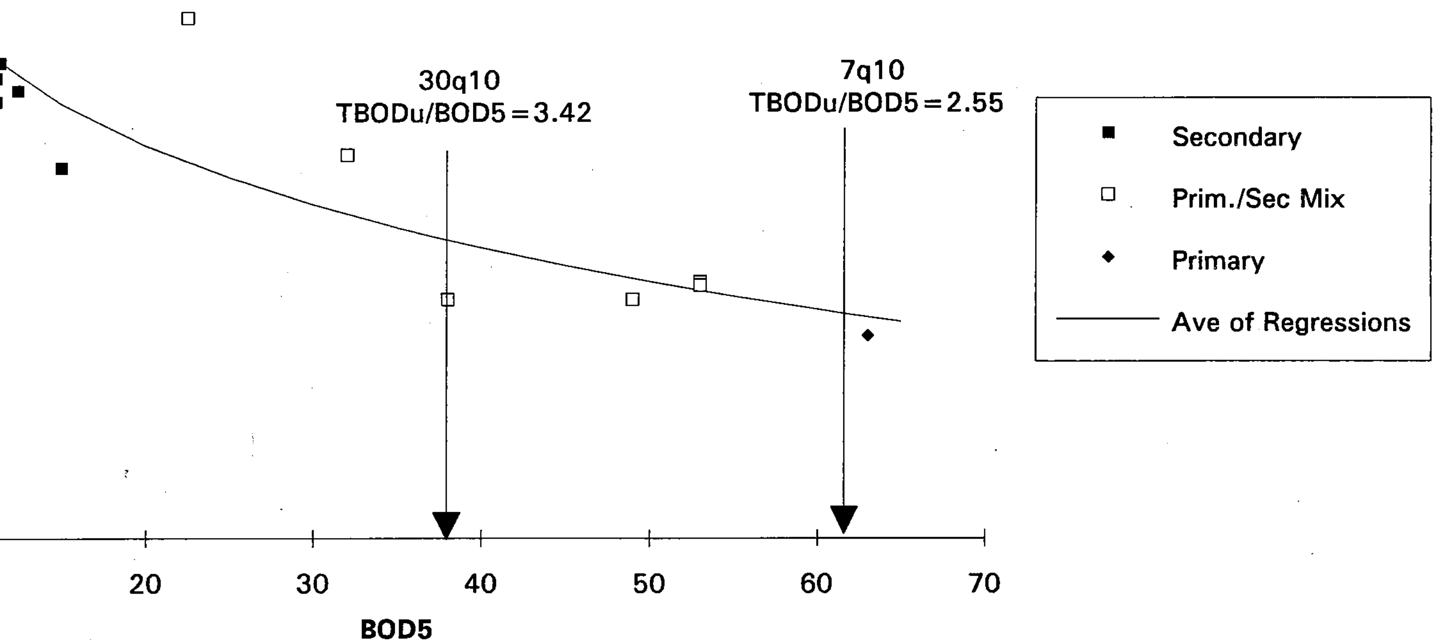


Table 1 Summary of Additional Model Verification Runs

1995 30 Day

Date 1995	Monitor D.O. mg/l	Model DO mg/l	D.O. Diff mg/l
18-Jul	6.72	6.91	0.19
25-Jul	6.76	6.9	0.14
1-Aug	6.86	6.97	0.11
8-Aug	7.16	7.01	-0.15
17-Aug	7.22	6.96	-0.26
25-Aug	7.02	6.82	-0.2
2-Sep	6.85	6.72	-0.13
9-Sep	6.56	6.75	0.19
17-Sep	6.74	6.91	0.17
24-Sep	6.94	7.15	0.21
30-Sep	7.28	7.36	0.08
		Ave	0.032
		Ave Dev	0.158

1995 7 day

Date 1995	Monitor D.O. mg/l	Model DO mg/l	D.O. Diff mg/l
11-Jul	6.37	6.56	0.19
17-Jul	6.7	6.74	0.04
6-Aug	7.37	6.87	-0.5
20-Aug	6.34	6.6	0.26
28-Aug	6.13	6.52	0.39
4-Sep	7.21	7.12	-0.09
22-Sep	7.26	7.44	0.18
27-Sep	7.63	7.69	0.06
		Ave	0.066
		Ave Dev	0.189

1995 2 day

Date 1995	Monitor D.O. mg/l	Model DO mg/l	D.O. Diff mg/l
8-Jul	6.2	6.41	0.21
17-Jul	6.25	6.58	0.33
26-Jul	6.8	6.76	-0.04
3-Aug	7.1	6.72	-0.38
15-Aug	6.3	6.56	0.26
24-Aug	6.65	6.38	-0.27
25-Aug	6.2	6.34	0.14
5-Sep	7.1	6.87	-0.23
16-Sep	7.15	7.12	-0.03
26-Sep	8	7.92	-0.08
		Ave	-0.009
		Ave Dev	0.195

1995 D.O. Diff

Ave	0.027
Ave Dev	0.185

1994 Data

Date 1994	Monitor D.O. mg/l	Model DO mg/l	D.O. Diff mg/l
30 Day			
31-Jul	7.05	6.91	-0.14
13-Aug	6.63	6.7	0.07
20-Aug	6.74	6.74	0
30-Aug	6.84	6.91	0.07
7 Day			
24-Jul	6.99	6.57	-0.42
7-Aug	6.86	6.89	0.03
15-Aug	6.11	6.65	0.54
31-Aug	7.13	7.11	-0.02
2 Day			
24-Jul	6.4	6.28	-0.12
3-Aug	6.7	6.76	0.06
14-Aug	6.35	6.65	0.3
22-Aug	7.55	7.3	-0.25
31-Aug	6.85	7.01	0.16

1994 D.O. Diff

Ave	0.022
Ave Dev	0.166

Figure 1
Model Verification Runs
1995 30 Day Average Data

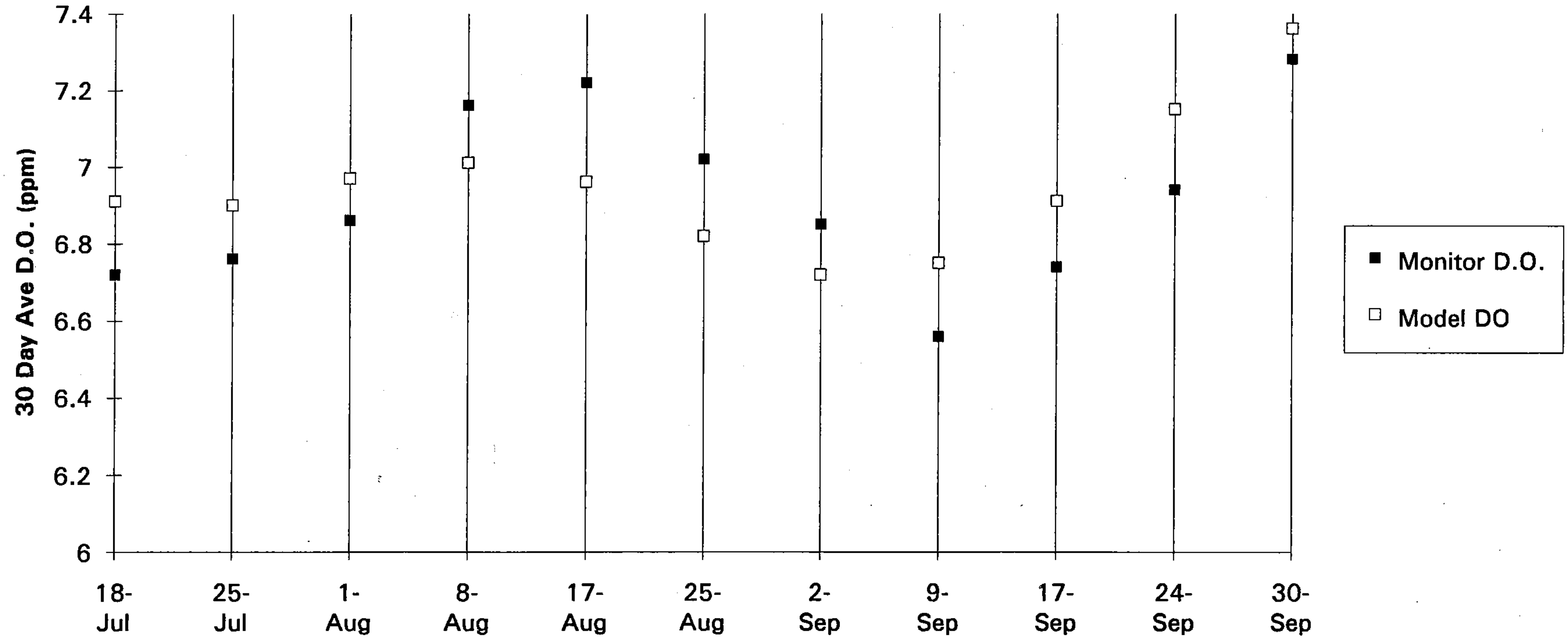


Figure 2
Model Verification Runs
1995 7 Day Average Data

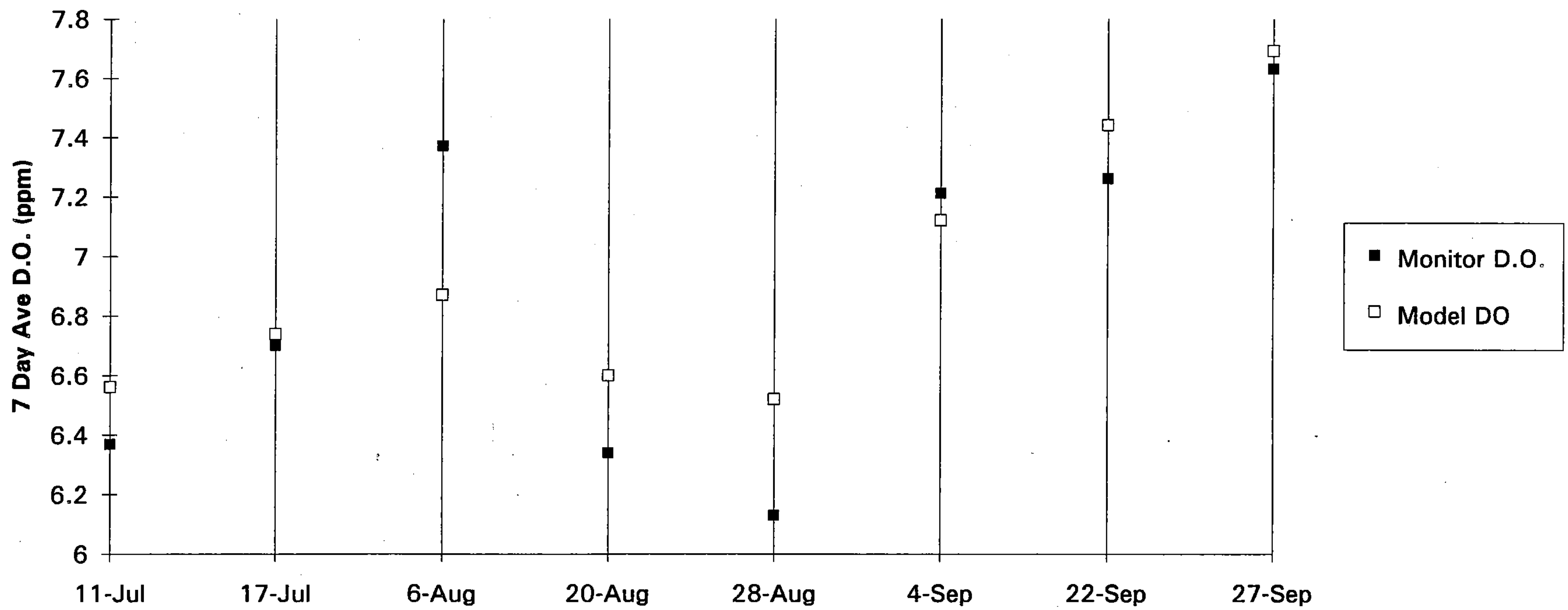


Figure 3
Model Verification Runs
1995 2 Day Average Data

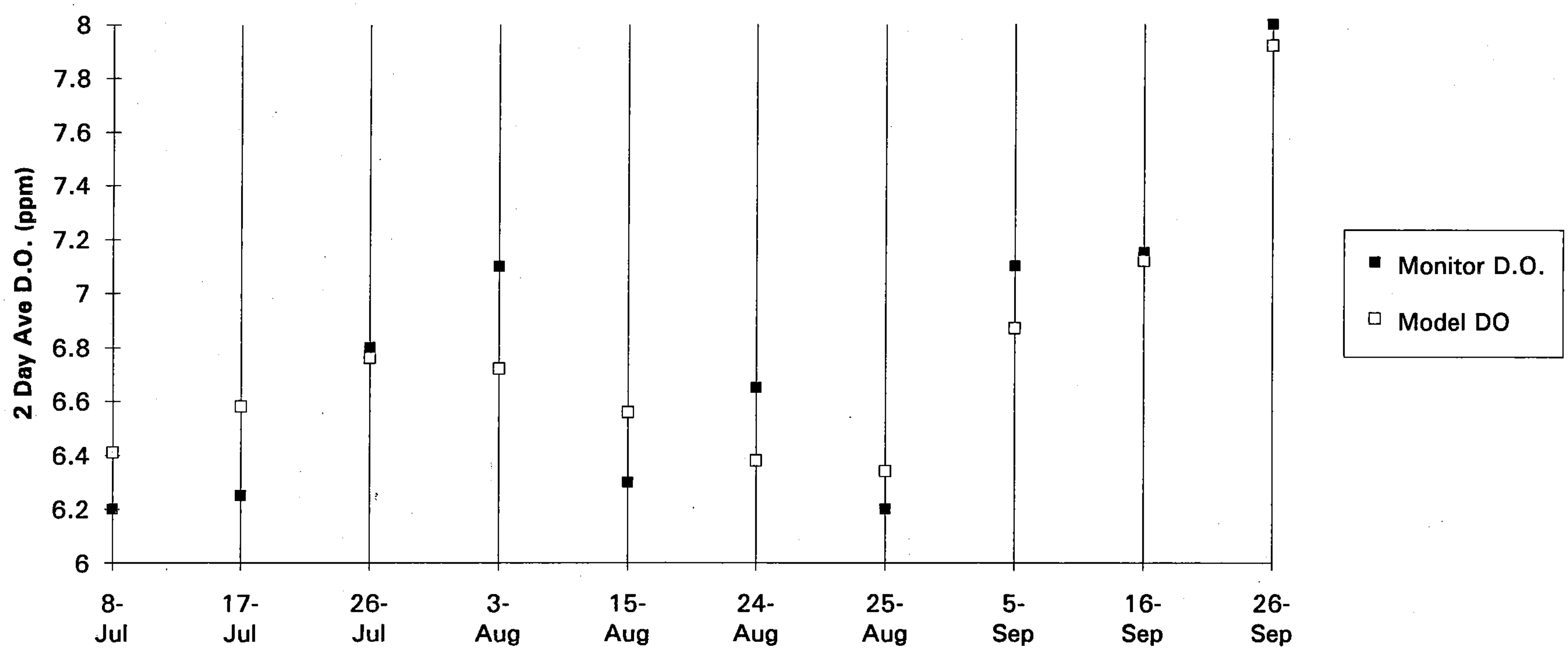


Figure 4
Model Verification Runs
1994 30, 7, and 2 Day Average Data

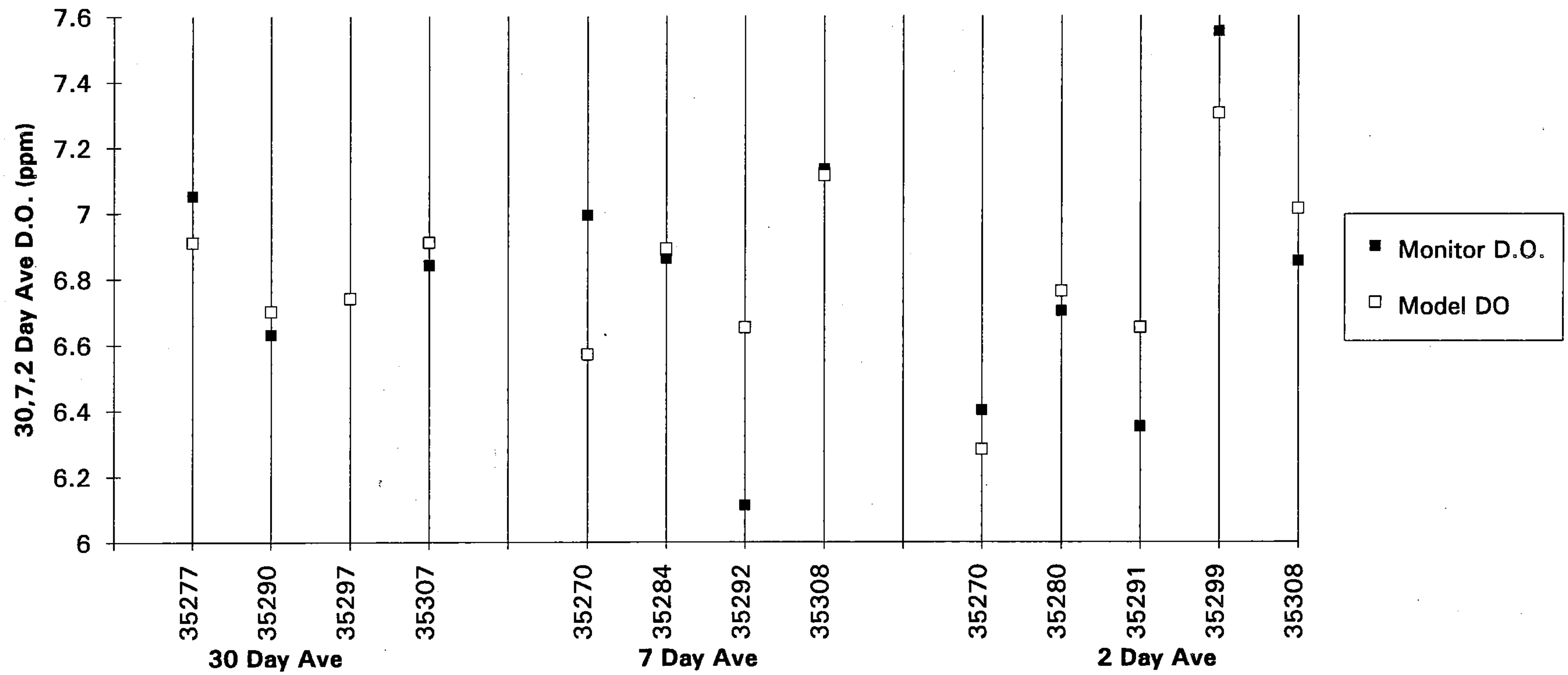
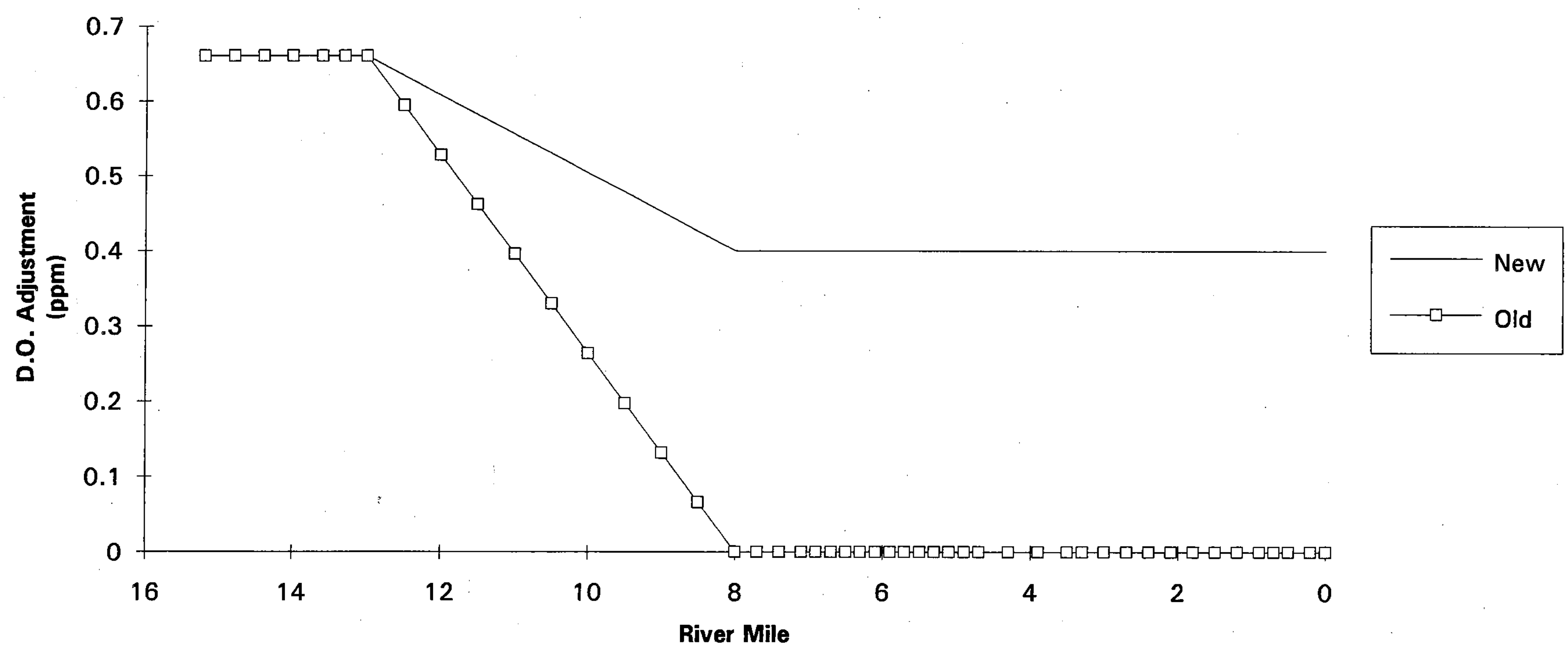


Figure 5
Diurnal Adjustment of Model to Obtain the Daily Minimum Dissolved Oxygen



standards would occur for 1.3 miles and the dissolved oxygen would reach a daily minimum of 4.6 ppm above the Smelt Hill dam (figure 6). A daily maximum BOD5 of 4200 lb/day is necessary to meet both class C and SC standards (figure 6).

The model simulation at 30q10 at current BOD5 loading conditions indicates that about 2 miles of the river would not meet the monthly average dissolved oxygen standard of 6.5 ppm, but would be within 0.6 ppm of attainment (figure 7). With the proposed loading reductions, the model simulation estimates that about 1.2 miles of the river would not meet the monthly average dissolved oxygen standard of 6.5 ppm, but would be within 0.25 ppm of attainment (figure 7). A monthly average BOD5 of 2400 lb/day is necessary to meet monthly average dissolved oxygen standards. (figure 7).

The model runs at 270 cfs (7Q10) also indicate that about 8 miles of the Upper Presumpscot, including the Little Falls, Mallison Falls, and Saccarappa dam impoundments fail to meet minimum class B criteria, but are within 0.2 ppm of attaining standards in the first two impoundments and 0.35 ppm in the last impoundment. This is not a surprising finding since minor non attainment occurred in the 1993 data in two of these three impoundments, and marginal compliance was also often observed. It is surprising that the data taken in what most would consider relatively pristine waters would have moderately depressed dissolved oxygen. Since a diurnal trend was evident here, the source of the dissolved oxygen depression is believed to be respiration from bottom attached algae (which was also observed in these impoundments).

It is unclear if the 1993 data was an anomaly and/or if the proposed Sebago Lake management plan will improve water quality enough to meet standards. EPA has suggested in a letter (Steve Silva, USEPA, letter to Dave Courtemanch, MDEP, June 1996) that a TMDL be developed here to bring the river into compliance with D.O. standards. It is felt that the non attainment here is based upon limited data (unlike the lower Presumpscot which has a continuous monitor) and both the data and model indicate that the non attainment is minor and within measurement error. The large amount of effort required for a TMDL here is not warranted at this time. The upper Presumpscot should be closely watched in the future, since existing data may indicate the beginning of water quality problems from non point sources of pollution. Additional data collection in the early morning hours (before 8 AM) is recommended and if non attainment continues to occur, a TMDL should be implemented for non point sources.

When compliance with class SC estuarine dissolved oxygen standards of 70% of saturation are checked, the model estimates that with current BOD loading from SDW, about 1.6 miles of the estuary would not meet standards at low tide and 0.8 miles would not meet standards at high tide. Although the length of the estuary in non attainment with standards is not significantly different when comparing the model dissolved oxygen at current and proposed loading conditions, the estuary comes closer to attaining standards with the reduced loads. At low tide, the estuary is within 0.2 ppm of attaining standards at proposed loading conditions, compared with 0.5 ppm of attaining standards at current loading conditions (figure 8). At high tide, the estuary is within 0.5 of attaining standards at proposed loading conditions compared with 0.8 ppm of attaining standards at current loading conditions (figure 9).

In summary, although the proposed reduced loadings from SDW improve dissolved oxygen, some non attainment of standards is still possible and additional measures are necessary. Both flow augmentation from Sebago Lake and the proposed 45% reduction in summer BOD5 from S D Warren are the alternatives agreed to by S D Warren and DEP to comply with dissolved oxygen standards. The water quality model was used to derive a final temperature based flow augmentation (QVT) curve for the

Figure 6
Model Run at Design Conditions in Consideration of Minimum Riverine Dissolved Oxygen Standards No Flow Augmentation

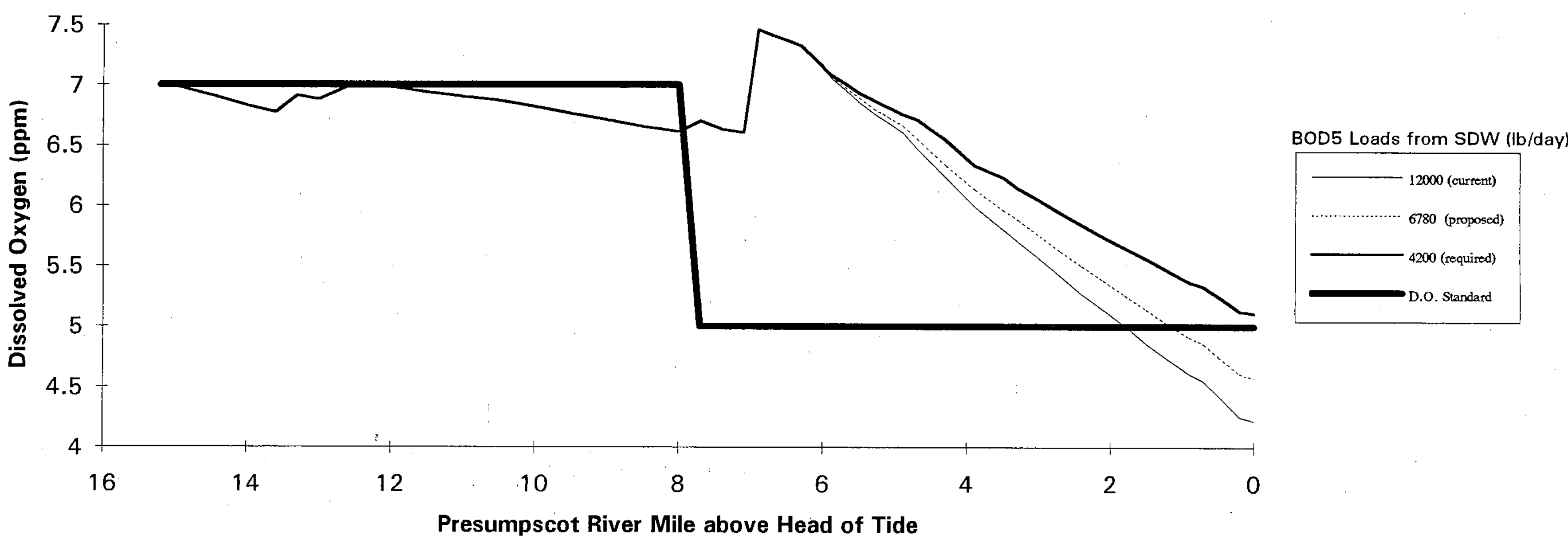


Figure 7
Model Run at Design Conditions in Consideration of 30 Day Average Riverine Dissolved Oxygen Standards
No Flow Augmentation

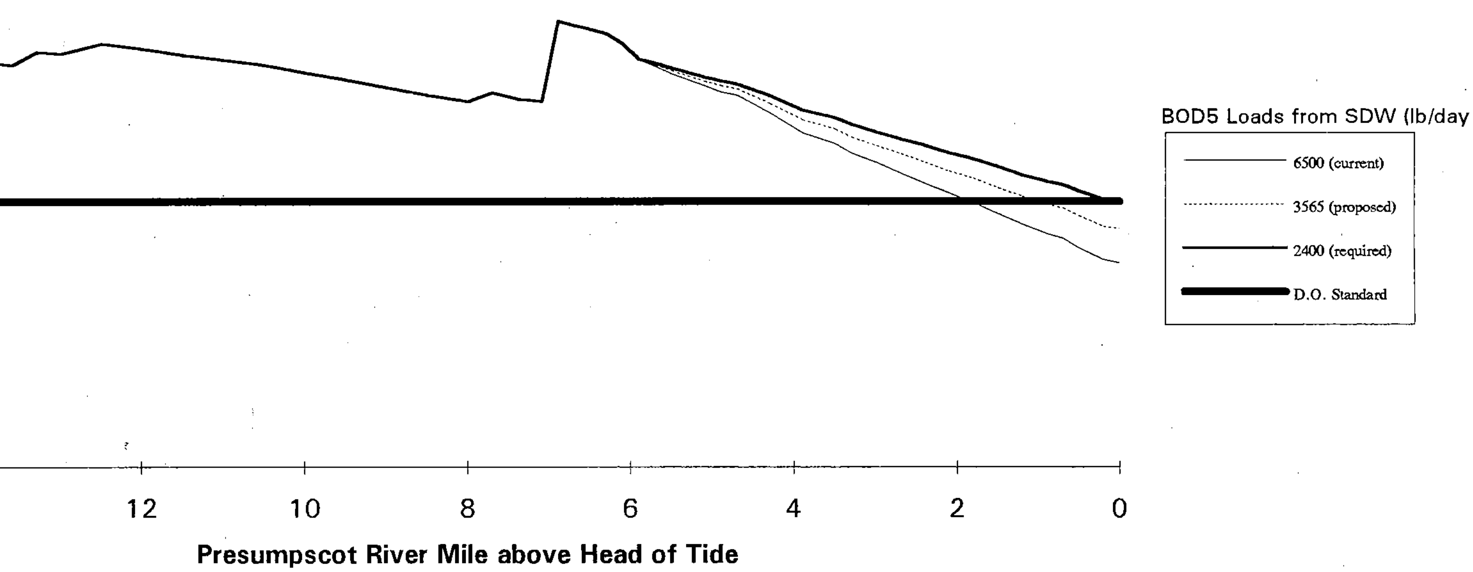


Figure 8
Model Run at Design Conditions in Consideration of Minimum Estuarine Dissolved Oxygen Standards at Low Tide
No Flow Augmentation

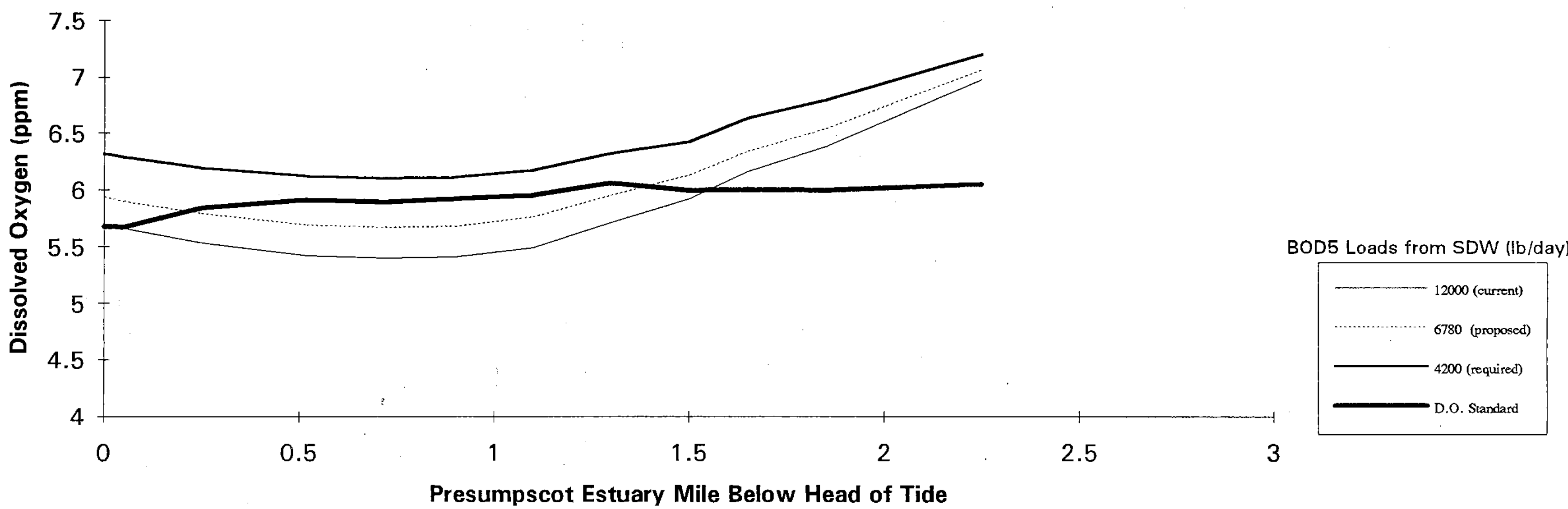
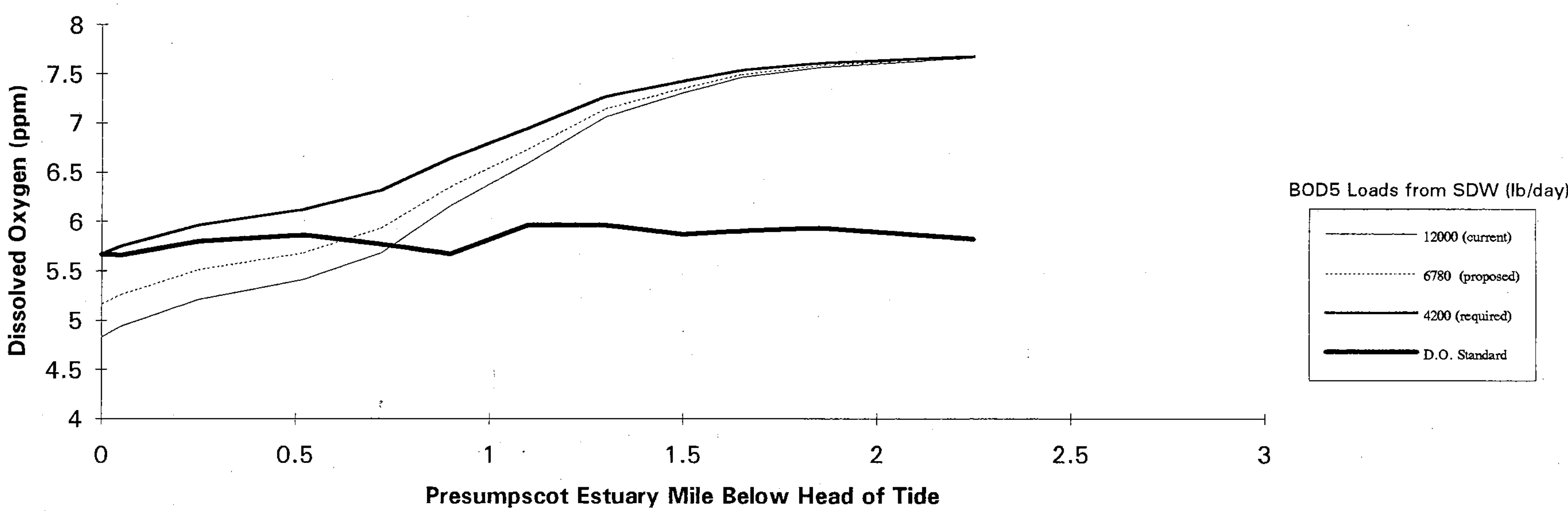


Figure 9
Model Run at Design Conditions in Consideration of Minimum Estuarine Dissolved Oxygen Standards at High Tide No Flow Augmentation



Westbrook was proposed by SDW as a guaranteed minimum flow The minimum flows guaranteed by S D Warren Co. and agreed upon in a meeting in February of 1998 are 300 cfs for a 1Q10 and 7Q10 and 330 cfs for a 30Q10 at Westbrook. When adjusted downward for intervening drainage area in-between Sebago Lake and Westbrook, 7Q10 and 30Q10 flows of 270 and 300 respectively result at Sebago Lake. These flows or greater would be passed from Sebago Lake at all times, except when the flow cap is being implemented during emergency low lake level situations in extreme drought conditions.

The model runs presented in this analysis initially assume no minimum guaranteed flow. The model runs are made with all inputs constant except the temperature and boundary dissolved oxygen (93% of saturation assumed) which are changed for each run and then held constant. The flow is then varied in a trial and error process until dissolved oxygen standards are met. The runs are then plotted collectively in a flow vs temperature format (figure 10).

The final QVT curve is one in which all dissolved oxygen standards are met in the lower Presumpscot River and estuary (figure 11 and table 2) including minimum class C (5 ppm and 60% of saturation), minimum class SC (70% of saturation), and monthly average C (6.5 ppm). In the final curve, a minimum instantaneous flow of 270 cfs and 30 day average minimum flow of 300 cfs from Sebago Lake are used when developing the curves.

A dissolved oxygen saturation value of 68% of saturation for a daily average was used as the target dissolved oxygen level above the Smelt Hill dam which assures compliance of dissolved oxygen standards everywhere in the lower Presumpscot River and estuary. This threshold level of D.O. was determined in the final Waste Load Allocation Report (Nov 1995, p41). Note that temperature ceilings of 26^{o} C and 30^{o} C were used in this analysis for the 30 day average and daily average, respectively. These upper limits of temperature were derived from 16 years of record at the Smelt Hill dam continuous monitor.

Table 2 Final QVT Curve

Temp	Req. Flow (cfs) Sebago L	
	Min. C and SC	Ave C
16	270	300
18	270	300
20	270	300
22	270	300
24	300	340
26	330	445
28	380	
30	470	

Implementation of the QVT curve requires tracking of the running 30 day average for both flow (from Sebago Lake) and temperature (at the Smelt Hill dam continuous monitor). In addition, the daily average flow and mid day temperature at the same locations must be tracked. Each analysis is done individually and then the higher from each of the two curves is utilized. It is recommended that the actual regulation of flow be implemented so that a buffer of safety is maintained, i.e. the actual flow is slightly above the required flow.

Figure 10
Required Flow to Meet Presumpscot River Dissolved Oxygen Standards

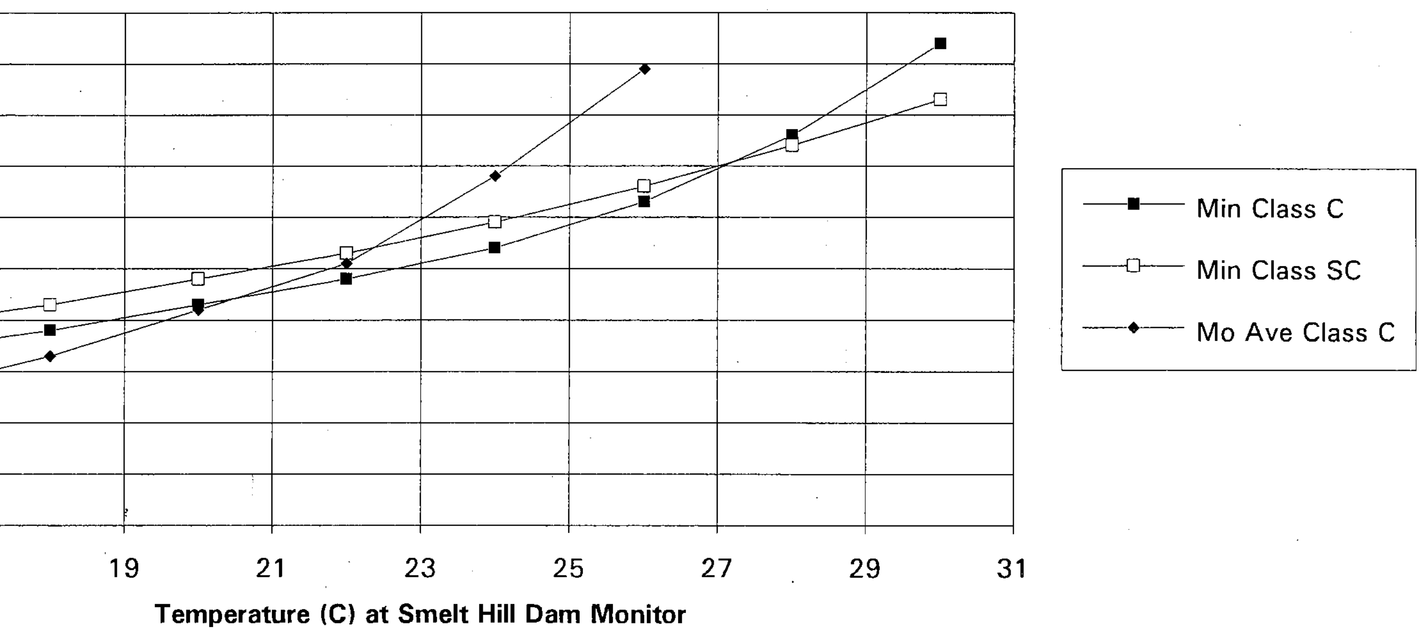
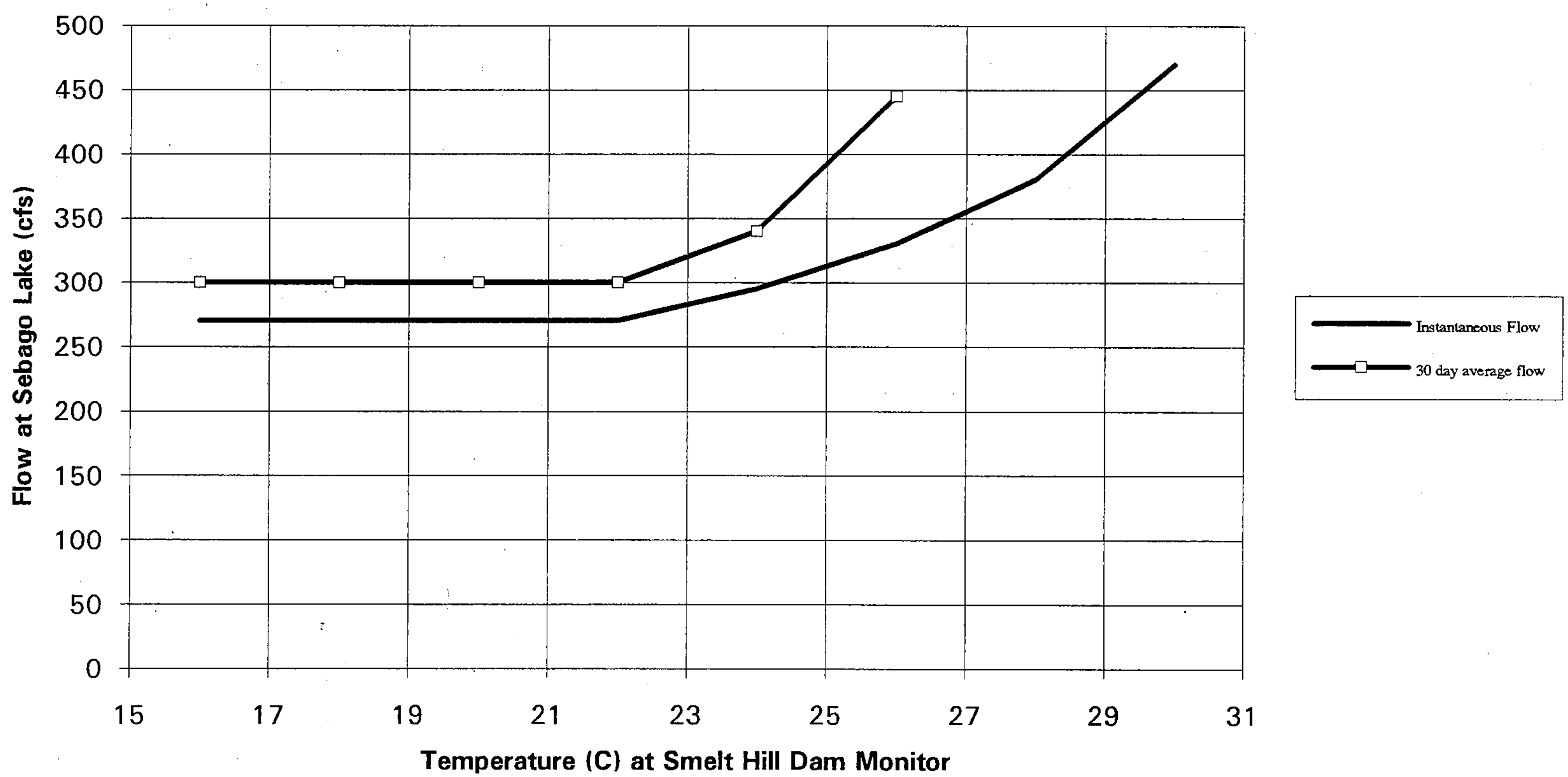


Figure 11
Final Temperature Based Flow Regulation Curve
For Presumpscot River*



*Developed in Jan of 1998 using SDW proposed license BOD5 of 6780 and 3565 lb/day, respectively for a daily maximum and monthly average. River design flows at Westbrook are 7q10 of 300 cfs and 30Q10 of 330 cfs, respectively. Instantaneous flow curve results in compliance of minimum class C (5 ppm and 60% saturation) and SC (70% saturation) D.O. standards. The 30 day average flow curve results in compliance of the 30 day average D.O. standard (6.5 ppm). Temperatures of 26 C and 30C assumed ceilings for daily and 30 day average river temperatures, respectively.

buffer.

About 350 cfs would be required for the 30 day curve but 400 cfs is needed for daily requirements, so 400 cfs should be passed that week. Since flow in the river will probably not be adjusted daily, it is important to maintain some buffer in the river for future uncertainty, i.e. changes in weather.

Federal regulations require a MOS in TMDL development. An acceptable MOS could be rounding up required flows from the QVT curve to the nearest 50 cfs. Some margin of safety is also realized due to the fact that the intervening drainage adjustment of 30 cfs from Sebago Lake to Westbrook is based upon 10 year low flow conditions. Most of the time, the intervening flow will probably exceed this value resulting in more flow at Westbrook than deduced by this analysis. The Royal River gage could be used as a check to estimate flow from intervening drainage. If flow here greatly exceeds the 30 cfs an adequate buffer would be maintained.

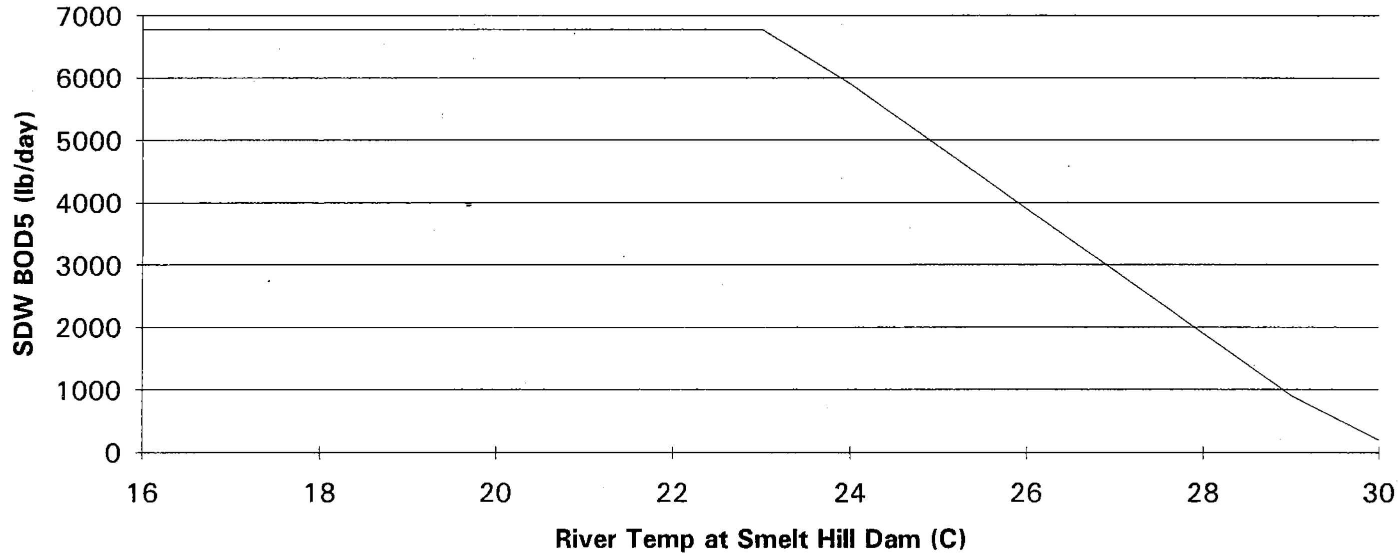
An important point to mention is that a buffer of .1 to .2 ppm for dissolved oxygen is automatically maintained in the lower Presumpscot, since 68% of saturation as a daily average is used to derive the QVT curve (the 68% of saturation above the Smelt Hill Dam results in attainment of SC D.O. standards in the estuary). Due to damage in the 1996 flood, the Smelt Hill dam is not used for hydropower currently. Therefore a MOS is automatically provided in the estuary, since dam reaeration is now provided for 100% of the flow spilling over the Smelt Hill dam. With this spillage, dissolved oxygen levels are actually significantly better in the estuary than model projections which assume hydropower is still intact with no spillage. If the dam is refurbished in the future, spillage could be required in low flow situations to maintain this MOS.

Federal regulations (40CFR125.3) require that before flow augmentation may be considered as an alternative, a demonstration must be made that flow augmentation is the preferred environmental and economic alternative to achieve standards after consideration of other alternatives such as advanced treatment. It is believed that the public participation process involving stakeholders that developed the Sebago Lake level management plan satisfies this requirement. This plan will become final when it is approved by FERC, but in the interim S D Warren has agreed to follow the management plan voluntarily. It has been assumed for state licensing that the required level of treatment for S D Warren Co. with no flow augmentation (2400 and 4200 lb/day BOD5 for monthly average and daily maximum, respectively) would result in undue economic hardship, although no cost estimates for this have been made. Thus a no flow augmentation alternative is not the preferred economic alternative. The Sebago Lake flow management plan represents a balance amongst competing uses and it is concluded that it is unlikely that significant environmental benefits could be gained without flow augmentation.

Flow Cap Runs

To assure adequate water levels in Sebago Lake in extreme drought conditions, a minimum flow of 250 cfs from Sebago Lake is required during emergency low lake level conditions. Emergency low lake level conditions are defined as follows: When the level of Sebago Lake is one foot below its allowable target range (see Sebago Lake management plan, appendix) between May 1 and November 1 and flow releases from Sebago Lake have been greater than 270 cfs for at least four weeks in order to maintain the water quality in the river as required by the flow augmentation QVT curve.

Figure 12
Allowable BOD5 Discharge for SDW
During Emergency Low Sebago Lake Levels
Flow = 250 cfs



Temp(C)	SDW BOD5 (lb/day)
22	6780
23	6780
24	5900
25	4900
26	3900
27	2900
28	1900
29	900
30	200

It is assumed in this analysis that emergency low lake levels would be encountered less than 30 days each summer. Therefore the required BOD reductions from S D Warren Co. are only daily maximum values and no reduction in monthly average limit is required. The allowable BOD5 is illustrated in both graph and tabular format as a function of river temperature (figure 12). This analysis shows that as long as the daily average river temperature above the Smelt Hill dam is less than 23 ^{o}C, no further BOD reduction from the 6780 lb/day is necessary. Above 23 ^{o}C, about 1000 lb/day less of BOD5 should be discharged for each ^{o}C rise.

Assessment of Aquatic Life Standards and Required TSS Reductions

The lower Presumpscot River has historically been plagued with high total suspended solids (TSS) as a result of TSS discharged from the S D Warren Co. outfall. Considering the high strength of SDW's waste and low dilution of waste water to river (9.2:1 at 7Q10 flow) when compared to other paper mills in the state, it is not surprising that the DEP staff considers the lower Presumpscot as the worst stretch river in the state, when considering TSS impacts. As a result, designated uses of fishing and swimming are clearly impaired due to poor aesthetic conditions on 6.5 miles of the lower Presumpscot River.

Macroinvertebrate data collected by Maine DEP in 1995 and 1996 below the mill outfall has revealed the lower Presumpscot does not attain class C aquatic life standards. However macroinvertebrate data taken about 1500 feet above the mill outfall in 1996 and preliminary data taken above the mill outfall in both the Gambo and Little Falls impoundments in 1997 indicate attainment of class C aquatic life standards. Since no toxic problems were apparent and dissolved oxygen levels were adequate in these years, it is presumed that the TSS discharged from SDW is the cause of the non attainment of aquatic life standards and reductions in TSS are necessary.

The assumption that reduced TSS levels will result in a positive community response of macroinvertebrates is supported by work undertaken by the DEP and International Paper Co. on the Androscoggin River. Below IP's discharge, aquatic life standards were similarly not met in impoundments below their discharge in 1995, a low flow year. In 1996 increased dilution of IP's discharge was gained from a wetter summer than normal and in addition, the mill experimented with polymer addition that resulted in significant TSS reductions. The river below the mill responded positively to this, and attainment of aquatic life standards resulted that summer.

S D Warren has recently made improvements to their treatment to address the TSS issue on the Presumpscot River. Action item #5 of the licensing work plan required SDW to submit a copy of their final secondary clarifier study and a proposal for TSS limits as a result of improvements to their treatment. S D Warren proposed a 15% cut in discharge from their past demonstrated performance (PDP). Action item #9 of the licensing work plan required DEP staff to determine whether or not the reduction of TSS proposed by SDW would be adequate to meet aquatic life standards below the mill discharge. The DEP staff determined that the 15% reduction would not be adequate and reductions of 45% from PDP or more would be necessary. The reasons for this determination are explained below.

While it is difficult to determine appropriate TSS limits based upon aesthetics, a methodology has been developed to determine limits based upon aquatic life considerations. It is assumed that the required TSS reductions to meet aquatic life standards will also result in improved aesthetic conditions and an overall attainment of standards. This methodology uses aquatic life assessment analysis (attainment / non attainment); river flow during macroinvertebrate colonization period (when rock baskets were in the river), and mill discharge of TSS during colonization period. For example in 1995 when SDW was discharging 7454 lb/day of TSS and river flow conditions were 25% higher than 10 year low flow conditions, aquatic life data showed non attainment of standards. Hence it can be concluded that limits would definitely have to be lower than 7454 lb/day. Since IP discharges to similar habitat as SDW, the Androscoggin River data was also used in this analysis. In summary, the methodology is as follows: