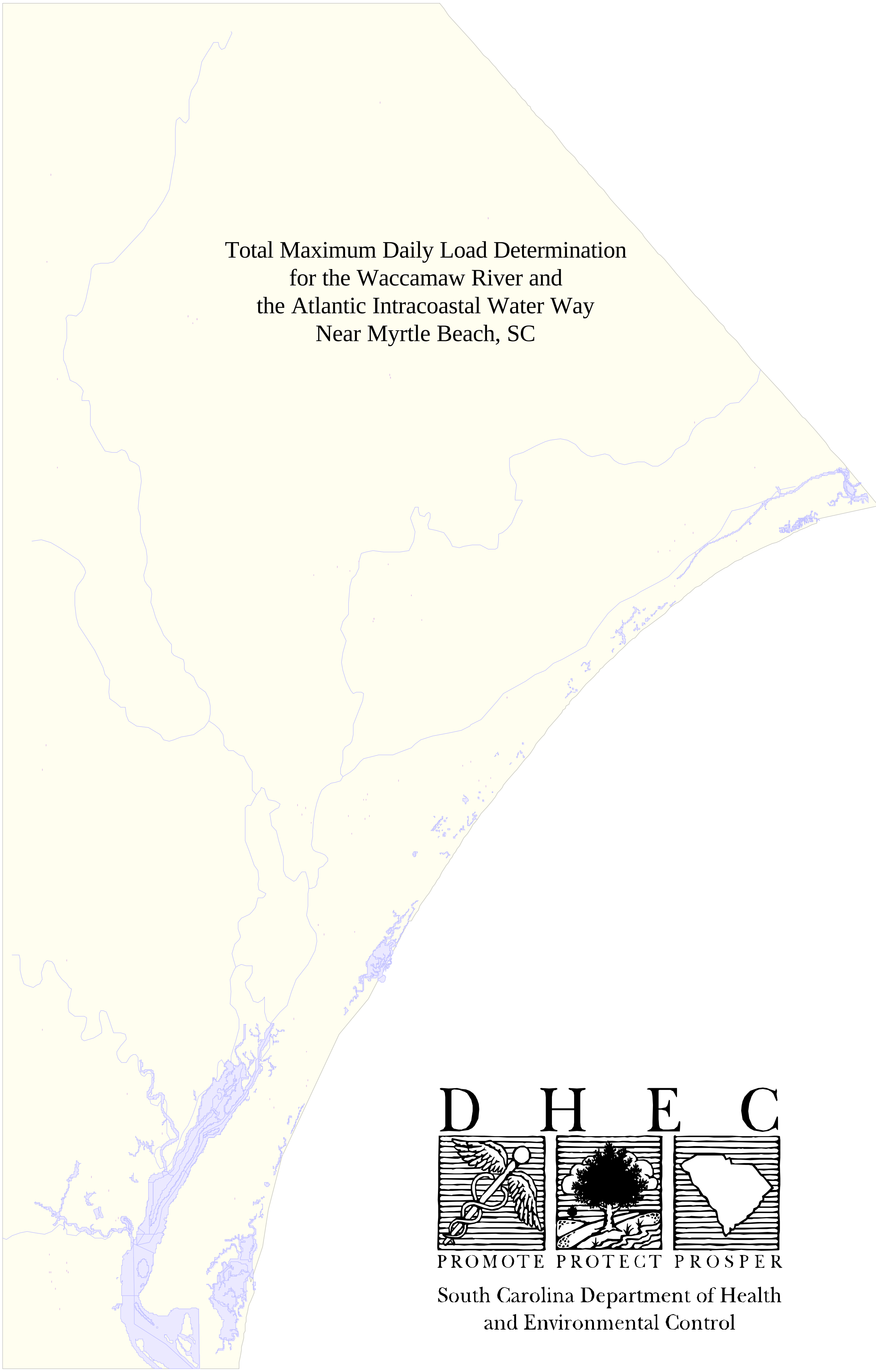
Total Maximum Daily Load Determination for the Waccamaw River and the Atlantic Intracoastal Water Way Near Myrtle Beach, SC



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South Carolina Department of Health
and Environmental Control

INDEX

State of South Carolina Administrative Record
TMDL Submittal for Waccamaw River and Atlantic Intracoastal Waterway
Biochemical Oxygen Demand

BASIS FOR 303(d) LISTING

Introduction:

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for their water bodies that are not meeting designated uses under technology-based controls for pollution. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and instream water quality conditions, so that the states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

Problem Definition:

Waterbodies Impaired:	Waccamaw River & Atlantic Intracoastal Waterway Watersheds 03040206-140, 03040206-150 and 03040207-030
Water Quality Standard Being Violated:	Dissolved Oxygen
Pollutant of Concern:	Biochemical Oxygen Demand (Carbonaceous and Nitrogenous)
Water Classification:	Freshwater

Atlantic Intracoastal Waterway and the Waccamaw River are classified freshwater with the Waccamaw River having a site specific criteria for dissolved oxygen (DO). Waters of this class are to be:

> "Freshwater suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. Suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. Suitable also for industrial and agricultural uses."(R.61-68)

Dissolved Oxygen Criteria:

Waccamaw River:	A minimum DO concentration of 4 mg/l.
Atlantic Intracoastal Waterway:	Daily average DO concentration of 5 mg/l with a minimum of 4 mg/l.

The Waccamaw River and the AIWW are tidally influenced fresh waters located along the northern coastal region of the state. The referenced portion of the AIWW is the man made canal from Little River to Waccamaw River. Net flow through this section is northward and enters the Atlantic Ocean through Little River. The referenced portion of the Waccamaw River runs from Conway, SC to south of the convergence with the AIWW. The predominate direction of flow for this section is southward towards Winyah Bay, although a portion of the Waccamaw enters the AIWW and flows north. Low velocities and low re-aeration are found throughout this system. These waterbodies, located in watersheds 03040206-140, 03040206-150 and 03040207-030, are listed as Primary Priority Waterbodies on the 1996 303(d) list and the 1998 South Carolina Waters of Concern for violations of DO. South Carolina Department of Health and Environmental Control (SCDHEC) has data from seven ambient STORET monitoring stations on the Intracoastal Waterway and Waccamaw River, MD-088, MD-085, MD-127, MD-087, MD-125, MD-089, MD-091 that document periods in the late summer during which DO concentrations fail to meet numeric standards. These periods are considered naturally occurring phenomenon. Antidegradation rules of South Carolina Regulation 61-68 allow a maximum DO deficit of 0.1 mg/l from point sources (“0.1 rule”) under these conditions. The “0.1 rule” will be the standard applicable in the development of these TMDLs.

TMDL TECHNICAL BASIS

Target Identification:

Antidegradation rules of South Carolina Regulation 61-68 state:

> “4. Certain natural conditions maycause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained. The Department shall allow a dissolved oxygen depression in these low dissolved oxygen waterbodies as prescribed below:
>
> > a. Under these conditions the quality of the surface waters shall not be cummulatively lowered more then 0.1 mg/l for dissolved oxygen from point sources and other activities .....”

This rule’s focus is the cummulative 0.1 mg/l point source impact on DO and will be the standard applicable in the development of these TMDLs.

Point Sources by Area in Waccamaw/ AIWW Watershed:

The four areas where point source TMDLs are being established are: the Conway area of the Waccamaw River; the North Myrtle Beach area of the AIWW; the area at the confluence of the AIWW and the Waccamaw River near Bucksport; and the southern area of the Waccamaw River, north of Hagley Landing. The pollutant of concern is biochemical oxygen demand, both carbonaceous and nitrogenous, which is expressed in ultimate oxygen demand (UOD). The TMDLs will be expressed in terms of UOD, based on the water bodies’ assimilative capacity for oxygen-demanding substances.

Permitted Dischargers in Areas of Concern

		Current Permit Limits		
Location	Dischargers	NPDES Permit #	Q (MGD)	UOD (#/d)
Conway	City of Conway GSW&SA Central Total	SC0021733 SC0040410	3.2 1.2 4.4	522 1,351 **1,873**
Bucksport	GSW&SA Bucksport	SC0040886	0.2	**228**
Hagley	GSW&SA Schwartz Plant Myrtle Beach WWTP GCW&SD Murrells Inlet GCW&SD Pawley's Area Total	SC0037753 SC0039039 SC0040959 SC0039951	12 17 1 2.75 32.75	7,871 13,507 567 2,275 **24,220**
North Myrtle Beach	NMB Ocean Drive NMB Crescent Beach GSW&SA Vereen Plant Total	SC0022152 SC0022161 SC0041696	3.4 2.1 2.5 8.0	685 743 481 **1,908**

TMDL Development:

The Branched Lagrangian Transport Model (BLTM), a dynamic, one dimensional water quality model, was applied by the United States Geological Survey (USGS) for the Waccamaw Regional Planning and Development Council (WRP&DC). BLTM utilizes hydrodynamic data generated by USGS's BRANCH model. These models were submitted to SC Department of Health and Environmental Control (SCDHEC) in the fall of 1995 for use in determining the assimilative capacity for oxygen demanding substances of the Waccamaw/AIWW system.

The BRANCH/BLTM model developed by USGS for the Waccamaw River and AIWW has undergone internal USGS review as well as external review by SCDHEC and Jordan, Jones & Goulding, Inc.. These entities have confirmed the model's calibration and verification. Information concerning development, calibration and verification of BRANCH/BLTM can be found in the USGS Water-Resources Investigations Report 95-4111 titled *Assimilative Capacity of the Waccamaw River and the Atlantic Intracoastal Waterway near Myrtle Beach, South Carolina 1989-92.*

As a result of public comment, a second review of the model was conducted. This included an external review of the Department's application of dynamic models by both the U.S. Environmental Protection Agency (EPA) and Tetra Tech, Inc. (an EPA contractor). This review offered specific recommendations for selection of critical conditions (App. A) which were followed by SCDHEC.

BRANCH/BLTM, as with some other water quality models, handles point sources as loads without adding the corresponding flow to the hydrodynamic portion of the model. This approach was changed by USGS in order to utilize the model for evaluation of water withdrawal impacts on the system's assimilative capacity. The BRANCH/BLTM model specific for the Waccamaw / Atlantic Intracoastal Waterway was re-schematized (Fig.1) and re-configured to accomplish this. The drinking water withdrawal on the AIWW was entered into the model as the difference between permitted and June through July 1994 average withdrawal. Other drinking water withdrawals were entered as permitted withdrawals. AIW1.CTL (App. B) contains discharge flow and drinking water withdrawal information. An internal boundary (an artifact from original model development) was also removed.

Critical conditions for wasteload allocation application were determined using data from USGS water quality stations and SCDHEC STORET stations for the month of July from 1988 to 1998. For all water quality parameters except DO, the 75th percentile was considered as being representative of critical conditions. For DO, the 25th percentile was considered as being representative of critical conditions. Values greater than plus or minus two standard deviations of the mean of the raw data were considered anomalies and discarded. Because the data used for critical conditions were actual water quality measurements, loads attributable to non-point and natural sources are indirectly included. Meteorological effects were derived from National Oceanic and Atmospheric Administration data. Average wind speed and average monthly maximum and minimum temperatures were determined for July 1990. Flow conditions for the model runs were actual stage data (June 1 - July 15, 1994) as required by the model. Sensitivity analysis shows changes in boundary conditions have little impact when predicting the relative difference between model predicted instream DO with and without the dischargers' contributions. Boundary conditions for the critical condition model run are listed in Table 1. Model input files may be found in Appendix B.

Wasteload allocation models typically used throughout the state, for non-tidal rivers, are developed using a stream flow representing the lowest seven day average with a ten year recurrence (7Q10). A 7Q10 low flow is not applicable for the Waccamaw / AIWW system due to it's complexity and tidal influence. There are four boundaries: two fresh water boundaries, representing four large river systems each with headwaters in different geographical regions, and two tidally influenced boundaries. In an effort to identify a critical flow period analogous to a 7Q10, USGS supplied analysis of seven day mean stream flow, daily average specific conductance and daily average minimum specific conductance for various stations near the model's boundaries.

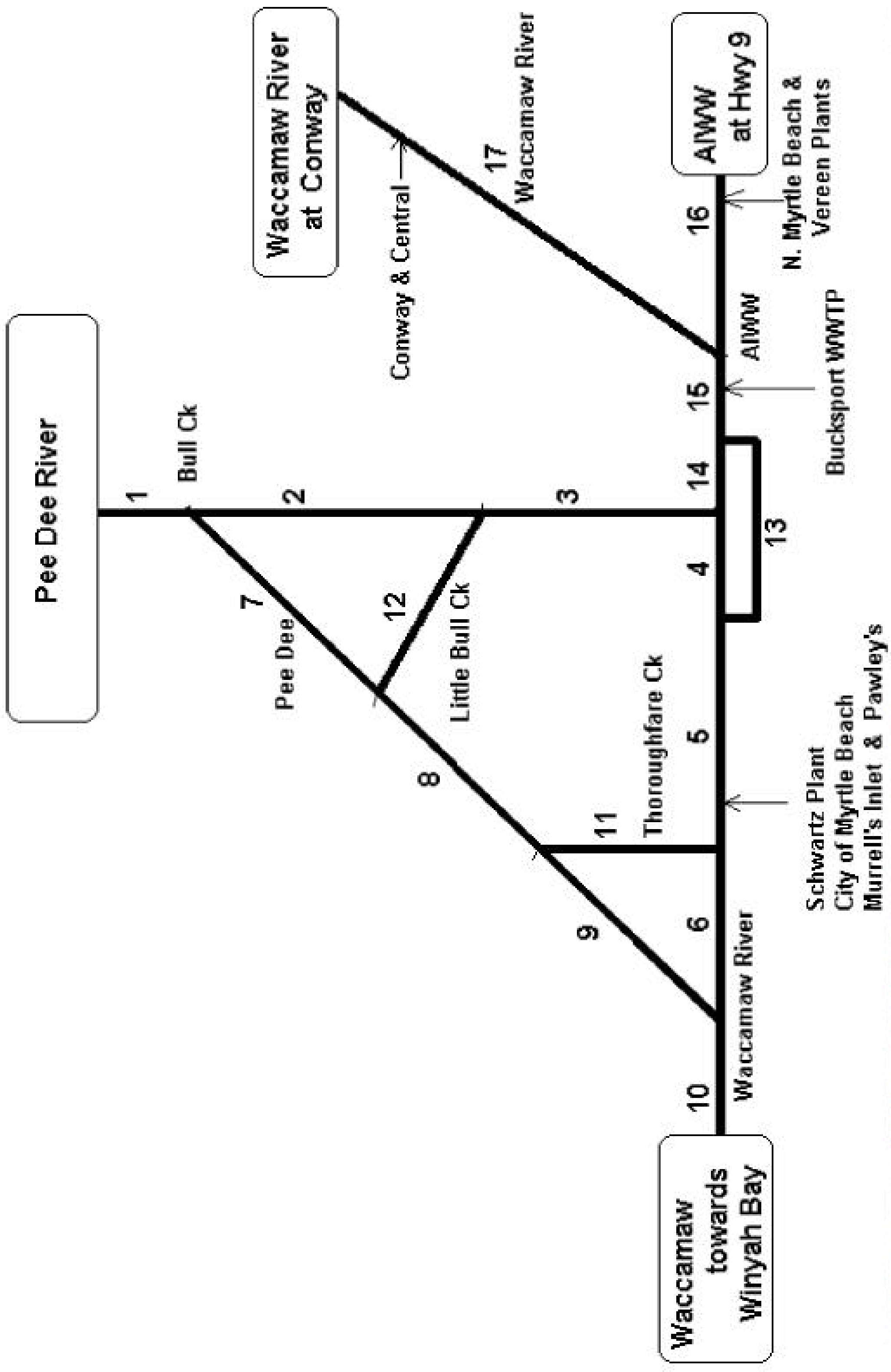
Pee Dee River
Waccamaw River at Conway
AIWW at Hwy 9
Waccamaw towards Winyah Bay
Bull Ck
Pee Dee
Little Bull Ck
Thoroughfare Ck
Waccamaw River
AIWW
Conway & Central
N. Myrtle Beach & Vereen Plants
Bucksport WWTP
Schwartz Plant
City of Myrtle Beach
Murrell's Inlet & Pawley's
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Figure 1- Current Model Schematization

Review of supplied data identified numerous periods with low freshwater flow in the Waccamaw River as well as periods of high specific conductance at the tidally influenced boundaries throughout the period of record. To maintain continuity, to apply a watershed approach, and to reduce human error within the permitting process, one specific flow period, rather than different flow periods for each general area of the model, was selected to be the representative low flow critical condition. The chosen flow period was June 1 - July 15, 1994. This selection was based on the period's low variability in flow, best approximation of a critical low flow with a ten year recurrence and lack of bias towards any specific region within the model.

Table 1 - Boundary Conditions for the Critical Condition Model Run with concentrations in mg/l

Location	**Temperature**	**Ammonia**	**NO_3**	**BOD_5**	**DO**
Pee Dee River	28 ^{0}C	0.06	0.23	2.3	5.0
Waccamaw River -at Conway	30 ^{0}C	0.07	0.22	1.3	4.5
Waccamaw River -at Hagley River	28 ^{0}C	0.09	0.36	1.2	5.0
AIWW -at Hwy 9	30 ^{0}C	0.10	0.39	2.3	4.5

Antidegradation rules of South Carolina Regulation 61-68 allow a maximum DO deficit of 0.1 mg/l attributable to point sources ("0.1 rule") where waters do not meet the numeric DO standard due to natural conditions. The "0.1 rule" was applied to determine the point source TMDL for oxygen consuming constituents. The "background" condition was identified by removing the permitted dischargers from the critical condition model and used as a baseline. The second step was to run each area's permitted loadings separately, and identify the corresponding areas of impact. The third step was to reduce the area loadings, until a change of 0.1 mg/l below the "background" DO was identified. The loadings were then run concurrently and adjusted to compensate for interaction between areas. The dischargers' impacts were determined as the difference between the "background" run's and the "load" run's twenty-four hour daily averages as required by R.61-68. Appendix C contains five graphs representing the predicted instream DO with and without the discharges at a given point in time. These graphs illustrate the dynamic nature of discharges' impact on the system. Table 2 lists the current NPDES permit limits and corresponding loads by area. Table 3 lists the identified TMDL UOD load by area.

Table 2 - Current limits for Waccamaw/ AIWW permits

		Current Permit Limits		
Location	Dischargers	Limits (BOD/NH3/DO)	Q (MGD)	UOD (#/d)
Conway	City of Conway GSW&SA Central Total	10/1/6 *	3.2 1.2 4.4	522 1,351 **1,873**
Bucksport	GSW&SA Bucksport	30/--/1	0.2	**228**
Hagley	GSW&SA Schwartz Plant Myrtle Beach WWTP GCW&SD Murrells Inlet GCW&SD Pawley's Area Total	* 30/11/4 * *	12 17 1 2.75 32.75	7,871 13,507 567 2,275 **24,220**
North Myrtle Beach	NMB Ocean Drive NMB Crescent Beach GSW&SA Vereen Plant Total	10/2/6 10/6/6 *	3.4 2.1 2.5 8.0	685 743 481 **1,908**

*Currently limited by UOD load

Table 3 - Proposed TMDLs for Waccamaw/ AIWW System with effluent DO of 6 mg/l

Location	**Dischargers**	**UOD (#/d)**
Conway	City of Conway GSW&SA Central **Total**	303 #/d
Bucksport	GSW&SA Bucksport	84 #/d
Hagley	GSW&SA Schwartz Plant Myrtle Beach WWTP GCW&SD Murrells Inlet GCW&SD Pawley's Area **Total**	8,643 #/d

Location	Dischargers	UOD (#/d)
North Myrtle Beach	NMB Ocean Drive NMB Crescent Beach GSW&SA Vereen Plant **Total**	1,638 #/d

References

Butcher, Jonathan B., 1998. "Review of South Carolina Dynamic Modeling Applications for Dissolved Oxygen." Unpublished paper

Chapra, Steven C., 1997. Surface Water Quality Modeling. McGraw-Hill, New York, New York.

South Carolina Department of Health and Environmental Control. 1998. "Water Classifications and Standards." Regulation 61-68.

South Carolina Department of Health and Environmental Control. 1997. "Watershed Water Quality Management Strategy - Pee Dee Basin." Technical Report No. 001-97.

Thomann, Robert V., 1972. Systems Analysis and Water Quality Management. McGraw-Hill, New York, New York.

Thomann, Robert V., and John A. Mueller, 1987. Principles of Surface Water Quality Modeling and Control. Harper Collins, New York, New York.

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-001.

Untied States Geological Survey. 1991. Low-Flow Frequency and Flow Duration of Selected South Carolina Stream through 1987. Water-Resources Investigations Report 91-4170.

United States Geological Survey. 1995. Assimilative Capacity of the Waccamaw River and The Atlantic Intracoastal Waterway near Myrtle Beach, South Carolina, 1989-92. Water-Resources Investigations Report 95-4111.

Appendix A

EPA/Tetra Tech, Inc. Report

EPA SWAT Team Modeling Assistance

Review of South Carolina Dynamic Modeling Applications for Dissolved Oxygen

Jonathan B. Butcher, Ph.D., P.H.
Tetra Tech, Inc.
May 6, 1998

1. Summary

Through the EPA SWAT program, the South Carolina Department of Health and Environmental Control (DHEC) requested a review of their application of dynamic modeling to wasteload allocation development for biochemical oxygen demand (BOD) and ammonia loading in terms of their impacts on dissolved oxygen (DO). This report is based on a review of two draft wasteload allocation model applications to the Waccamaw River/Intracoastal Waterway system and to the Cooper/Wando River system.

DHEC specifically requested an assessment of (1) the appropriateness of using dynamic models to determine wasteload allocations, (2) the methodology used to determine critical conditions, (3) the averaging period used to evaluate model output for compliance with standards, and (4) the methodology used to determine permit limits from model output. In general these applications are of high quality and relevant to establishing appropriate wasteload allocations. The following summarizes the results of the review:

- Dynamic models of the type used by DHEC are appropriate for wasteload allocations in tidal systems.
- Critical conditions used in the existing wasteload allocation applications might be overly stringent. Additional analysis of critical conditions for determination of wasteload allocations might hold excursions of the DO standard to an acceptably low frequency.
- Consideration might be given to the use of a fixed daily period (rather than running a twenty-four hour average) for evaluation of the daily average instead of 7-day average concentrations. In addition, evaluation of dynamic model output both in terms of instantaneous concentrations (for compliance with the instantaneous DO standard) and daily average concentrations (for compliance with the daily average standard) would coordinate with the state water quality standards.
- A statistical method can be used to evaluate the consistency of permit limits with the wasteload allocations.

2. Relevant Standards

In wasteload allocations, models are applied to determine and predict attainment of water quality standards. Therefore, appropriate model application and interpretation of model output is consistent with the applicable state standards. South Carolina standards are summarized in this section.

DO Standards

Dynamic models of the DO balance are proposed by DHEC for analysis of waterbodies in which steady state and tidally averaged models may lead to an incomplete or incorrect evaluation of the impacts of loads of oxygen demanding waste. This includes estuarine and tidally-influenced freshwater rivers, as well as rivers controlled by hydroelectric power plants. The most relevant South Carolina water use classifications in which dynamic models are likely to be applied for wasteload allocations are Freshwaters ("freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment..."), Class SA ("tidal saltwaters suitable for primary and secondary contact recreation"), and Class SB ("tidal saltwaters suitable for primary and secondary contact recreation, crabbing and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption"). Within Freshwaters and Class SA waters, the following quality standard is established for DO: "Daily average not less than 5.0 mg/l with a low of 4.0 mg/l." Within Class SB waters the standard for DO oxygen is "not less than 4.0 mg/l."

Applicability of Standards

These standards are not applied under extreme low flow conditions. The general statement on applicability at C(2)(a) and (b) states:

> (a) With the exception of human health criteria...the numeric standards...are applicable to any flowing waters when the flow rate is equal to or greater than the minimum seven day average flow rate that occurs with an average frequency of once in ten years (7Q10).
> (b) The Department will consider flows other than 7Q10 where appropriate to protect classified and existing uses.

In addition, South Carolina's antidegradation statement at D(4) provides for water bodies in which the DO concentration will naturally contravene the standards (the "point one" rule):

> Under certain conditions, the quality of some free flowing surface waters and lakes... does not meet numeric standards for dissolved oxygen due to natural conditions, even though classified uses in these waters are achieved. Under these conditions, the quality of the free flowing surface waters or lakes...shall not be cumulatively lowered more than 0.10

mg/l for dissolved oxygen from impacts by point sources and other activities, unless a site-specific standard is established.

Comments

The regulations state that 4 mg/l is an instantaneous minimum standard for DO and the 5 mg/l standard (applicable to Freshwaters and Class SA waters) is defined as a daily average.

The applicability statement recognizes that appropriate DO standards are likely to be contravened under rare conditions of extreme low dilution. The intent of the standard is not to ensure that instantaneous DO concentrations less than 4 mg/l (and daily average concentrations less than 5 mg/l) *never* occur; rather, it is to ensure that excursions of the standard are held to an acceptably low frequency. In flowing streams this goal is achieved by specifying that the standards are applicable only when flow is equal to or greater than the 7Q10 flow; it is expected that a low (but non-zero) frequency of excursions will occur during those infrequent time periods when flow is less than 7Q10.

The 7Q10 flow is established as a cutoff value of flow rate for applicability of the standards. Even though this flow rate is estimated as a 7-day average, no averaging period for applicability of the standard is necessarily implied by use of the 7Q10 calculation. For instance, analysis of historical flow records might establish that the 7Q10 flow for a given river is 100 cfs. Instantaneous standards (e.g., 4 mg/l DO) should then be achieved whenever the instantaneous flow is greater than 100 cfs. Two interpretations appear possible for daily average standards (e.g., 5 mg/l DO): (1) the standard should be achieved as a daily average whenever the daily average flow is greater than 100 cfs; or (2) the standard should be achieved as the daily average of all times in which the instantaneous flow is greater than 100 cfs. These two interpretations can yield different results when continuous observations or model predictions of DO are available. The first alternative is more stringent, as DO concentrations at flows less than 7Q10 may be included in a daily average, as long as the daily average flow is greater than or equal to the 7Q10 flow. For instance, consider a river with a 7Q10 of 100 cfs and 24-hour period in which 12 hours of flow are at 50 cfs and a DO of 3 mg/l and 12 hours of flow are at 150 cfs and a DO of 5 mg/l. The daily average flow is equal to the 7Q10 flow. The first interpretation of applicability yields a daily average DO concentration of 4 mg/l. The second interpretation, which allows exclusion of the 12 hour period with flow less than 7Q10, yields a daily average concentration of 5 mg/l for purposes of application of the standard. The issue is not, however, relevant to the "critical condition" model applications submitted by DHEC as long as boundary flows are held at appropriate design conditions.

The "point one" rule in the antidegradation statement does not contain a specific note as to applicable flow conditions. However, since the "point one" rule refers to conditions in which standards are not achieved, and standards are only applicable at flows greater than or equal to the

7Q10 flow, the "point one" rule also can be inferred to be applicable at flows greater than or equal to the 7Q10 flow.

The applicability clause is written for uni-directional flowing streams in which the 7Q10 flow is readily determined. In tidal systems, 7Q10 may not be readily measured, and the interpretation is much less clear. The intent of the standards appears clear, however, that allocations for these types of waterbodies should be designed to restrict excursions of the DO standard to an acceptably low frequency, rather than prohibiting excursions under all extreme low dilution conditions. Potential minimum dilution design conditions for tidal systems are discussed further in Section 5.

3. Use of Dynamic Models for Wasteload Allocations

Applicability of Dynamic Models to DO Analysis in Tidal Systems

In wasteload allocations, models are applied to determine and predict attainment of water quality standards. Therefore, appropriate model application and interpretation of model output should be consistent with the applicable state standards. Traditionally, most wasteload allocations have relied on steady state modeling at design conditions representative of a rare event with a specified probability of occurrence. Where appropriate, steady state models are recommended for wasteload allocations because they are simpler to apply and easier to interpret. In certain situations, however, steady state modeling does not provide an accurate estimate of the probability of excursions of a standard resulting from a wasteload allocation. The steady state approach yields only the probability of standard excursions at design conditions, and does not yield the full distribution of environmental outcomes. This is appropriate when a design condition associated with an acceptable low probability of excursion of the standard is identifiable—for instance, when an effluent discharges oxygen-demanding waste into a uni-directional flowing stream, such that impact on DO is at a maximum when dilution capacity is lowest, temperature-dependent oxygen saturation is lowest, and temperature-dependent reaction rates are highest. To determine design or critical conditions, a suitably rare combination of low dilution flow, high water temperature, and other relevant factors is selected. A steady state wasteload allocation at such design conditions then ensures that excursions of the standard will not occur at more common higher flow and lower temperature combinations. If, however, a design condition is not identifiable, steady state wasteload allocations under a particular set of conditions cannot ensure a specific low frequency of excursions of the standard under other conditions. Use of steady state models also does not explicitly consider the effects of correlation between dilution capacity and variable effluent loads. For instance, precipitation-driven nonpoint loads are associated with higher instream dilution flows, and analysis at steady state 7Q10 design conditions can lead to overly-stringent results.

For tidal waterbodies, flow is not uni-directional, but changes in magnitude and oscillates with the tidal cycle. It is still possible to define critical, minimum dilution conditions within a tidal system (see Section 4); however, a steady state analysis at the minimum dilution condition is not sufficient to provide an accurate time course prediction of DO concentrations, because DO will depend on the extent of mixing of oxygen-demanding waste in the period leading up to the minimum dilution condition, and critical DO concentrations may not coincide in time with minimum dilution.

In contrast to a steady state analysis, dynamic modeling approaches attempt to reproduce the actual time series or distribution of instream concentrations and explicitly include the effects of variability in dilution capacity and effluent load over time. A full dynamic modeling analysis can predict the entire effluent concentration frequency distribution, thus allowing wasteload allocations to be set to produce an expected frequency of excursions of the standard.

Steady state analyses are still useful for tidal systems, particularly for initial scoping analyses. They are particularly useful for approximating concentrations averaged over a tidal cycle. For DO problems a steady state analysis cannot, however, provide accurate estimates of intra-tidal instantaneous concentrations. South Carolina water quality standards specify both daily average and instantaneous DO concentrations. Thus, a dynamic, intra-tidal modeling analysis is appropriate for accurate determination of a wasteload allocation.

DHEC Dynamic Model Applications

For two waterbodies—the Waccamaw/Intracoastal Waterway and the Cooper River—DHEC, in conjunction with USGS, has conducted dynamic DO modeling using the BRANCH/BLTM model (Drewes and Conrads 1995, Conrads and Smith 1997). BRANCH/BLTM is a USGS one-dimensional, unsteady-flow model coupled with an unsteady water-quality transport model which is applicable to tidal systems lacking significant stratification. Both models have a credible record of application by USGS and others. DO and nutrient kinetics of the BLTM model are the same as those included in EPA's QUAL2E model.

A technical review of model application was not specifically requested for this SWAT response; however, a cursory review of the model set-up and calibration did not uncover any unreasonable assumptions. Synoptic water quality data available for calibration were, however, limited. The Waccamaw/Intracoastal Waterway model was calibrated to data for April 10-25, 1990, while the Cooper/Wando model was calibrated to data for August 23-25, 1993 and validated on data from May 4-5, 1993. For the Waccamaw/Intracoastal Waterway system, USGS developed assimilative capacity curves that show assimilative capacity conditional on seven-day average influent streamflows. For the Cooper/Wando model, the primary freshwater input is controlled by Pinopolis Dam, and USGS reported simulations for several different assumptions of flow over this dam.

One significant difference between the Cooper and Waccamaw models is that the Cooper model includes algae in the simulation, while the Waccamaw model does not. This is typically a difficult issue for DO wasteload allocation modeling. Algae can have a significant effect on the DO balance, but are difficult to represent accurately in dynamic models. Under many conditions algae lead to a net increase in DO; however, at a saltwater/freshwater interface the die-off of freshwater algae can sometimes result in a high oxygen demand. It is often necessary to include algae in a DO model to obtain calibration to synoptic data, unless the effect of algae on the DO balance can be shown to be insignificant. Inclusion of algae in a wasteload allocation model is a different matter. While algae may increase DO during calibration observations, algal populations are highly variable, and may not always mitigate effects of oxygen-demanding waste. An available option to account for the effects of algae but still ensure the highest possible accuracy, is to calibrate and validate the model including the algal component, but then run the model with and without algae, using the more stringent result for the wasteload allocation.

4. Interpretation of Dynamic Modeling Output: Averaging Periods

DHEC extended the USGS model applications for the Waccamaw and Cooper Rivers by adjusting the calibrated, validated BRANCH model to a critical conditions model. First, assumptions were made for design conditions of flow and other relevant parameters (see Section 5 for a review of design condition assumptions). For the Waccamaw, the analysis was based on examination of the June to September flow records for the year of calibration, with the most critical month selected for each permitted facility (September for some, July for others). For the Cooper river the model uses an observed late summer month of flow conditions, except that some synthesized flows are used for the dam. The last two weeks of the simulation period is at dam releases equal to the limiting flow specified in the dam operation agreement (personal communication from Nancy Sullins, SC DHEC, 1/12/98). In both water bodies the DO standards are not expected to be attained due to natural conditions at low flow conditions, so the "point one" rule is applied to analysis of wasteload allocations. DHEC then applied the model as follows:

> DHEC has chosen to run the BRANCH/BLTM model for six weeks, two weeks for model warm up and four weeks of the critical month. First, a no load run is made without discharger inputs. Then the model is run with the dischargers permitted loads included. The outputs are compared, time step by time step, and twenty-four hour running averages of the differences between the two scenarios are determined. Adjustments are made in the "with load" scenario to determine the maximum loading that will not result in any twenty-four hour period having an average deficit greater than 0.1 mg/l. The load associated with this 0.1 mg/l change is then identified as the maximum allowable load for that reach of the water body. A twenty-four hour running average was chosen with the thought that any averaging period longer than twenty-four hours would reduce the variability of the predicted dissolved oxygen. This softening of the curve reduces the

effectiveness of the model to predict periods which may cause stress to the biological community.

The DHEC analysis of attainment of standards is based on running twenty-four hour averages calculated from a critical low flow month, with other design conditions held constant. Instantaneous predictions were not used to assess attainment.

Examination of issues surrounding the averaging period was included in review of the analysis. The water quality standards express an instantaneous DO standard (4 mg/l) and a "daily average" DO standard (5 mg/l). Therefore, for waters which would attain the standards under natural conditions, it would be appropriate to compare both each instantaneous prediction and the twenty-four hour averages in model output to the appropriate standard.

Similarly, in naturally non-attaining waters where the "point one" rule applies, both instantaneous and daily average values are appropriate for measurement to compare to the water quality standards. For any point in time when the instantaneous DO under natural conditions would be less than 4 mg/l the wasteload allocations allows no more than an 0.1 mg/l lowering of instantaneous concentration, and for any day in which the average DO under natural conditions would be less than 5 mg/l the wasteload allocations allows no more than an 0.1 mg/l lowering of the twenty-four hour average concentration.

Options for calculation of the twenty-four averages include use of a running average, or use of a discrete average concentration over a specified diurnal cycle (e.g., sunrise to sunrise). The two methods do not necessarily provide the same result under dynamic conditions, and the running average would be more stringent, as it can "seek out" and combine adjacent parts of two days in which concentration is abnormally low. However, the use of running twenty-four hour averages may overestimate the accuracy of the model. In general, DO models should be better at predicting the average over a diurnal cycle than instantaneous concentrations. Therefore, it might be more appropriate to evaluate daily averages on a fixed (rather than running) twenty-four hour period.

According to DHEC, "There has been concern expressed by the regulated community that the twenty-four hour running average is overly conservative and a seven day average is more appropriate for tidally influenced systems." The South Carolina standards refer to the twenty-four hour average and minimum concentrations and not a 7-day average. The fact that the flow regime under which the standard is applicable is based on the 7Q10 flow is not relevant to the standard averaging period. Finally, it should be noted that the appropriate interpretation of dynamic model output is dependent on how the design conditions are specified. These issues are addressed in the following section.

5. Design Conditions for Dynamic Modeling

Dynamic versus Quasi-Dynamic State Applications

For tidal systems, dynamic modeling of DO is recommended to capture complex patterns induced by tidal mixing, particularly for prediction of instantaneous DO concentrations. DHEC adopted a dynamic modeling framework primarily because appropriate design conditions for flow in tidal systems were not readily identifiable. Model calibration to synoptic data also implicitly includes the effects of variability in nonpoint and background pollutant loads, although this is not explicitly addressed in the wasteload allocation applications.

As noted above, a full dynamic modeling analysis can predict the entire effluent concentration frequency distribution, thus allowing wasteload allocations to be set to produce an expected frequency of excursions of the standard. A full dynamic analysis, however, requires a substantial level of effort and data. For instance, if recurrence intervals of 10 or 20 years are desired, at least 30 years of continuous simulation is needed to provide a sufficient record to estimate the probability of such rare events (USEPA 1991).

While DHEC has employed a dynamic model, the wasteload allocation procedure is not a full dynamic analysis; sufficient flow data are not available to undertake long-term simulation. Instead, DHEC has used the dynamic model to represent internal flow and mixing processes, and to implicitly determine critical flow conditions. The wasteload allocation analysis was then performed with other critical conditions, such as temperature, held constant. This may be termed a quasi-dynamic model application. Although based on dynamic flows, it is still essentially a design condition analysis.

This section reviews the various components of the quasi-dynamic design condition specification.

Approximate Minimum Dilution Design Conditions for Tidal Systems

In typical steady state wasteload allocation modeling, a design low flow such as the 7Q10 is used. This design flow has a low dilution capacity for effluents, and is used to implicitly establish an acceptable frequency of excursions of the standard associated with a wasteload allocation for a steady source. Within tidal systems, the concept of 7Q10 flow does not directly apply, although a 7Q10 flow of freshwater influent to the tidal system can be estimated. More importantly, dilution capacity of a tidal system is a function of both the inflow of fresh water and tidal flushing.

DHEC has adopted a quasi-dynamic modeling approach to represent tidally-driven mass fluxes and intratidal variability of concentrations within the waterbody. Boundary conditions are held constant in the quasi-dynamic application. Because simulation is not undertaken for the long period of time necessary to establish actual average excursion frequencies, it is important to ensure that the simulation design conditions represent a suitable level of criticality in dilution capacity. A steady-state analysis would be sufficient to establish wasteload allocations. Although more than one option might be appropriate, an example approach for tidal systems is to use an analysis based on a minimum dilution level which is analogous to the 7Q10 flow used for steady state wasteload allocations in streams. USEPA (1991, p.74) makes the following recommendation for estimating critical dilution conditions for toxics in estuaries:

> In estuaries without stratification, the critical dilution condition includes a combination of low-water slack at spring tide for the estuary and design low flow for riverine inflow. In estuaries with stratification, a site-specific analysis of a period of minimum stratification and a period of maximum stratification, both at low-water slack, should be made to determine which one results in the lowest dilution... Recommendations for a critical design period for coastal bays are the same as for stratified estuaries.

This approach is most applicable to acute or instantaneous standards for toxics in which intra-tidal variability must be considered and maximum impact is expected at the point of discharge of an effluent. For BOD/DO problems, reactions and transport within the system must also be considered and maximum DO deficit may not coincide in time with minimum dilution; it would be advisable to examine a combination of design low flow (7Q10) in riverine inflow with both spring and neap tidal ranges, which determine the maximum and minimum values of tidal mixing. With this approach, it would be helpful to examine instantaneous DO concentrations and daily average conditions over a full lunar cycle.

Physical and Chemical Components of Design Conditions

A number of factors other than flow or dilution capacity affect the impact of BOD loads on DO concentrations. Most notable among these is temperature: higher temperatures decrease the saturation concentration of oxygen in water, and increase reaction rates which deplete DO. The DO balance is also affected by wind-driven reaeration and influent (freshwater or tidal) concentrations of DO, BOD, and nutrients (which affect algal growth and thus DO). Design conditions for DO/BOD analysis should specify a variety of other physical and chemical factors in addition to flow. This is done automatically in a full dynamic simulation; in the quasi-dynamic approach, fixed boundary values of these supplementary parameters are specified externally. While using a dynamic simulation of flows, DHEC has specified additional critical conditions as steady state at the boundaries using the following rule:

> In-stream water temperature, DO, NH_3-N, NO_2, NO_3, PO_4, and BOD_5 critical values are determined by identifying the 95th percentile of all parameters except for DO, where the 5th percentile was identified, for the given month from STORET station monthly

sampling data located within the model's domain. These percentiles were chosen with the thought that since a 7Q10 critical flow period approximates a 95th percentile the other parameters should approach the same criticality.

The 7Q10 critical flow does not specifically represent a "95th percentile." The 7Q10 is calculated as a minimum annual 7-day average which recurs once every ten years on average—so, on average, one or more 7-day flows at least this low will be seen in one out of ten years (10% of years). The 7Q10 is based on annual minima, and is not simply related to the actual frequency of 7-day flows. In the terminology of USEPA (1986), the 7Q10 is a hydrologically-based recurrence interval, whereas the actual recurrence of all low dilution flows (not just annual minima) is called a "biologically-based" recurrence interval. Further, the South Carolina standards are based on 1-day or instantaneous flows, not 7-day flows, even though the 7Q10 is used to establish the critical flow. Based on the analysis in USEPA (1986), the 1-day biologically-based dilution flow with a 3-year recurrence interval averages approximately 90% of the 7Q10 flow. Therefore, a 1-day flow at the 7Q10 value should occur in *at least* one out of three years, only 0.09% of days.

A second concern is that if a 95th (or other) percentile level is desired, this is not properly obtained by taking the 95th percentile value of each of seven observed parameters, unless the distributions of these parameters are perfectly correlated. For example, assume that each of the parameters is independent. For each parameter, a value equal to or greater than the 95th percentile occurs 5% of the time. The probability of all seven parameters exceeding the 95th percentile at the same time (if independently distributed) would be $0.05^7 = 7.81 \times 10^{-10}$, or the 99.9999999th percentile. Even for three parameters (e.g., temperature, DO, and BOD, as required for the Waccamaw model), the probability of all parameters exceeding the 95th percentile (if independently distributed) is equal to the 99.9875th percentile. Although, some of these parameters will be strongly correlated (e.g., the nitrogen series), increasing the probability of co-occurrence. Others, however, (such as temperature and BOD_5) may be negatively correlated, which decreases the probability of co-occurrence. Further, the analysis assumes that the 95th percentile of these parameters is uncorrelated to the occurrence of minimum flow, whereas nonpoint washoff processes may result in a positive relationship between flow and pollutant concentrations, and perhaps a negative correlation between flow and temperature.

Determining appropriate critical conditions for multiple parameters is a difficult issue. It is possible, however, that choosing the 95th percentile (5th percentile for DO) of each of these parameters could lead to an analysis which is more stringent than is intended. Indeed, if analysis with the 7Q10 dilution flow is assumed to implicitly establish an allowed frequency of excursion of the standard, selection of extreme values for other design conditions would result in holding the allocations to a lower allowed frequency of excursions than is implied in the regulation. Unfortunately, the fact that the distributions are likely to be non-normal and correlated means that an analysis with the other design conditions simply set to monthly mean values may underestimate the actual frequency of excursions.

There are various approaches which can be taken here. One is to impose a protective, but more conservative assumption. For instance, the State of North Carolina sets each of these auxiliary design parameters at the outer edge of the interquartile range (75th or 25th percentile) of the observed summer distribution in a wasteload allocation. This is essentially an *ad hoc* compromise designed to avoid highly stringent results while retaining a (likely) conservative approach. This percentile was selected based on non-parametric analysis which suggested it provided a good representation of the actual frequency of excursions of standards (personal communication from Trevor Clements, former Chief, Technical Support Branch, Water Quality Section, NC Division of Environmental Management, now with Tetra Tech, 1/13/98).

A more rigorous alternative to specifying steady design boundary conditions is to undertake a multivariate analysis. This is the approach used in EPA's (1988, 1991) DESCON model. While DESCON is not directly applicable to tidal systems, the general approach is relevant. DESCON estimates design conditions based on maintaining a specified desired limit on the frequency of water quality excursions in a receiving water. DESCON considers the effects that daily fluctuations in stream flow and other water quality conditions have on the capability of a receiving water to accept pollutant loadings, while explicitly accounting for the correlation present among design variables. The general approach is as follows (USEPA 1991):

1. A long-term record of observed stream flows and pertinent water quality data are assembled or synthesized.

2. The maximum allowable pollutant load that the receiving water can accept without causing a water quality excursion is computed for each day of this record.

3. This synthesized record of allowable loads is searched for the critical load, i.e., the load whose frequency of not being exceeded matches the desired water quality excursion frequency.

4. Design conditions are then derived from receiving water conditions realized during the period of record when the computed allowable load was closest to the critical load.

Unfortunately, this type of approach would be difficult to implement for the complicated tidal flow patterns of the Waccamaw and Cooper Rivers. Further, available data might not be sufficient to support such an approach. Therefore, a simpler *ad hoc* approach (such as choosing 75th percentile values) is a more viable option.

However, a full long-term dynamic simulation would avoid these issues by directly representing the interactions between all parameters.

Based on the discussion on the previous pages, the following options for additional design or critical condition analysis are provided:

- Set upstream uncontrolled freshwater inflows to 7Q10 flows, consistent with state regulations to represent minimum dilution design conditions while keeping a dynamic seaward boundary condition. For Pinopolis Dam, set overflows to minimum specified in operational agreement.
- Select seaward tidal boundary conditions to represent the range of spring to neap tides. This is probably best done by simulating a lunar month (from first quarter to subsequent first quarter) with the addition of a sufficient model spin-up period.
- Set seaward boundary temperature and constituent concentrations to 75th percentile values (25th percentile for DO).
- Set freshwater inflow temperature and concentration to *either* median observed at low flow conditions, *or* 75th percentile values for summer months.
- Test sensitivity of model to boundary conditions.

6. Permit Limits

The procedure set out by DHEC yields wasteload allocations to result in compliance with the "point one" antidegradation rule. Appropriate statistical methods are discussed in EPA's (1991) TSD for Toxics. This approach to statistically-based permit limits is included as a point of discussion. It is not often applied to DO/BOD problems, but does represent a way to obtain sophisticated and accurate permit limits appropriate to dynamic model output. Other options are available that are appropriate for determining permit limits.

References

Conrads, P.A. and P.A. Smith. 1997. Simulation of Temperature, Nutrients, Biochemical Oxygen Demand, and Dissolved Oxygen in the Cooper and Wando Rivers near Charleston, South Carolina. Water-Resources Investigations Report 97-4151. U.S. Geological Survey, Columbia, SC.

Drewes, P.A. and P.A. Conrads. 1995. Assimilative Capacity of the Waccamaw River and the Atlantic Intracoastal Waterway near Myrtle Beach, South Carolina, 1989-92. Water-Resources Investigations Report 95-4111. US Geological Survey, Columbia, SC.

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

USEPA. 1988. Technical Guidance on Supplementary Stream Design Conditions for Steady State Modeling. (Technical Guidance Manual for Performing Wasteload Allocations, Book 6, Chapter 2). Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, DC. Unpublished; available from Exposure Assessment Branch, Office of Science and Technology, U.S. Environmental Protection Agency, Washington, DC.

USEPA. 1986. Technical Guidance Manual for Performing Wasteload Allocation. Book VI: Design Conditions; Chapter 1: Stream Design Flow for Steady-state Modeling. EPA 440/4-87-004. Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, DC.

Appendix B

Input Files for BRANCH/BLTM Models

QUAL2E KINETIC TERMS

VARIABLE	RECOMMENDED RANGE	MODELED RANGE	DESCRIPTION
A1	3.01	0.10	Free convection - wind
B1	1.13	0.10	Mass transfer coefficient - wind
ALPHA0	10.0-100.0	67.0	Ratio of Chl-a to algal biomass
ALPHA1	0.07-0.09	0.09	N fraction of algal biomass
ALPHA2	0.01-0.02	0.012	P fraction of algal biomass
ALPHA3	1.40-1.80	1.60	O_2 production per unit of algal growth
ALPHA4	1.60-2.30	2.10	O_2 uptake per unit of algae expired
ALPHA5	3.00-4.00	3.90	O_2 uptake per unit of NH_3 oxidized
ALPHA6	1.00-1.14	1.09	O_2 uptake per unit of NO_2 oxidized
GROMAX	1.00-3.00	1.00	Maximum specific growth rate
IRGO	option 1,2	2	Growth rate option
RSPRT	0.05-0.50	0.20	Algal respiration rate
LFO	option 1,2	1	
CKL	0.02-0.10	0.03	Light half-saturation rate for algea
CKN	0.01-0.30	0.30	N half-saturation rate for algea
CKP	0.001-0.05	0.003	P half-saturation rate for algea
SHAD0	variable	0.100	Light extinction coefficient for algea
SHAD1	0.002-0.02	0.000	Linear self shading
SHAD2	0.0165	0.000	Non-linear self shading
PN	0.00-1.00	0.080	Algal preference factor for NH_3
K2O	options 1-8	1	Reaeration option
NO2L	0.00-1.00	0.000	Nitrate loss factor
ALGSET	0.50-6.00	1.6	Settling rate for algae
BET3	0.02-0.40	0.00	Hydrolysis rate of ON -->NH_3
SIG4	0.001-0.10	0.001	Organic N settling rate
BET1	0.1-1.00	0.07-0.23	Biological oxidation rate of NH_3 -->NO_2
SIG3	variable	-0.99 - 1.5	Benthos source rate for NH_3
BET2	0.2 - 2.0	0.6	Biological oxidation rate of NO_2 -->NO_3
BET4	0.01-0.70	0.00	Decay rate of organic P to dissolved P
SIG5	0.001-0.10	0.0	Organic P settling rate
SIG2	variable	0.0	Benthos source rate for dissolved P
CK1	0.02-3.40	0.09	Carbonaceous BOD decay rate

CK3	-0.36-0.36	-0.13- -0.01	Carbonaceous sink rate for BOD
CK4	variable	1.0-1.75	Benthos oxygen consumption rate
CK2	0.0 -100.0	0.07-0.11	Reaeration rate
CB	variable	0.00	

<u>QUAL2E.IN</u>

```
AIW Nutrient Model June 1 94 to July 15 94 Up-dated PRODUCTION RUN NRS 4/26/99
Wind function =  A1  +  B1 V [mm/(day kpa)], Wind speed V in m/s
                0.10   0.10
ALPH0   ALPH1   ALPH2   ALPH3   ALPH4  ALPH5  ALPH6 GROMAX IGRO RSPRT
 67.0   0.090   0.012    1.60    2.10   3.90   1.09   1.00   2   0.20
 LFO  CKL    CKN     CKP    SHAD0   SHAD1  SHAD2    PN    K2O  NO2L
  1  0.030  0.300   0.003    0.100  0.000   0.000  0.080   1   0.000
  Br  Gr  ALGSET  BET3    SIG4     BET1      SIG3       BET2      BET4
  1    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  1    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    4    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    5    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    6    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    7    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    8    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  2    9    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  3    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  3    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  4    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  4    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    4    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    5    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  5    6    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  6    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  6    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  6    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    4    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    5    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  7    6    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  8    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  8    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  8    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  8    4    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    1    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    2    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    3    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    4    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    5    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    6    1.6   .00    0.001     0.07     -0.99       0.6        0.0
  9    7    1.6   .00    0.001     0.07     -0.99       0.6        0.0
```

10	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
10	2	1.6	.00	0.001	0.07	-0.99	0.6	0.0
11	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
11	2	1.6	.00	0.001	0.07	-0.99	0.6	0.0
11	3	1.6	.00	0.001	0.07	-0.99	0.6	0.0
11	4	1.6	.00	0.001	0.07	-0.99	0.6	0.0
12	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
12	2	1.6	.00	0.001	0.07	-0.99	0.6	0.0
13	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
13	2	1.6	.00	0.001	0.07	-0.99	0.6	0.0
14	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
15	1	1.6	.00	0.001	0.07	-0.99	0.6	0.0
15	2	1.6	.00	0.001	0.07	-0.99	0.6	0.0
15	3	1.6	.00	0.001	0.23	1.50	0.6	0.0
15	4	1.6	.00	0.001	0.23	1.50	0.6	0.0
15	5	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	1	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	2	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	3	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	4	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	5	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	6	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	7	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	8	1.6	.00	0.001	0.23	1.50	0.6	0.0
16	9	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	10	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	11	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	12	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	13	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	14	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	15	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	16	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	17	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	18	1.6	.00	0.001	0.12	0.30	0.6	0.0
16	19	1.6	.00	0.001	0.12	0.30	0.6	0.0
17	1	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	2	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	3	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	4	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	5	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	6	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	7	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	8	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	9	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	10	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	11	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	12	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	13	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	14	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	15	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	16	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	17	1.6	.00	0.001	0.23	1.50	0.6	0.0
17	18	1.6	.00	0.001	0.23	1.50	0.6	0.0

Br	Gr	SIG5	SIG2	CK1	CK3	CK4	CK2	CB
1	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
1	2	0.0	0.0	0.09	-0.01	1.50	0.07	0.00
2	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00

2	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	5	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	6	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	7	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	8	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
2	9	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
3	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
3	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
4	1	0.0	0.0	0.09	-0.10	1.00	0.07	0.00
4	2	0.0	0.0	0.09	-0.10	1.00	0.07	0.00
5	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
5	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
5	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
5	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
5	5	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
5	6	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
6	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
6	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
6	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	5	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
7	6	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
8	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
8	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
8	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
8	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	5	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	6	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
9	7	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
10	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
10	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
11	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
11	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
11	3	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
11	4	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
12	1	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
12	2	0.0	0.0	0.09	-0.01	1.00	0.07	0.00
13	1	0.0	0.0	0.09	-0.12	1.00	0.07	0.00
13	2	0.0	0.0	0.09	-0.12	1.00	0.07	0.00
14	1	0.0	0.0	0.09	-0.12	1.25	0.07	0.00
15	1	0.0	0.0	0.09	-0.12	1.75	0.07	0.00
15	2	0.0	0.0	0.09	-0.12	1.75	0.07	0.00
15	3	0.0	0.0	0.09	-0.12	1.75	0.07	0.00
15	4	0.0	0.0	0.09	-0.07	1.75	0.07	0.00
15	5	0.0	0.0	0.09	-0.07	1.75	0.07	0.00
16	1	0.0	0.0	0.09	-0.13	1.75	0.07	0.00
16	2	0.0	0.0	0.09	-0.13	1.75	0.07	0.00
16	3	0.0	0.0	0.09	-0.12	1.75	0.11	0.00
16	4	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	5	0.0	0.0	0.09	-0.11	1.75	0.11	0.00

16	6	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	7	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	8	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	9	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	10	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	11	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	12	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	13	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	14	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	15	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	16	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	17	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	18	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
16	19	0.0	0.0	0.09	-0.11	1.75	0.11	0.00
17	1	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	2	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	3	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	4	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	5	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	6	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	7	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	8	0.0	0.0	0.09	-0.01	1.75	0.08	0.00
17	9	0.0	0.0	0.09	-0.03	1.75	0.08	0.00
17	10	0.0	0.0	0.09	-0.03	1.75	0.08	0.00
17	11	0.0	0.0	0.09	-0.05	1.75	0.08	0.00
17	12	0.0	0.0	0.09	-0.05	1.75	0.08	0.00
17	13	0.0	0.0	0.09	-0.07	1.75	0.08	0.00
17	14	0.0	0.0	0.09	-0.07	1.75	0.08	0.00
17	15	0.0	0.0	0.09	-0.09	1.75	0.08	0.00
17	16	0.0	0.0	0.09	-0.11	1.75	0.08	0.00
17	17	0.0	0.0	0.09	-0.11	1.75	0.08	0.00
17	18	0.0	0.0	0.09	-0.11	1.75	0.08	0.00

time	eq tem	wind	rad
1.00	15.460	1.300	0.000
2.00	15.600	1.300	0.000
3.00	16.420	1.300	0.000
4.00	17.880	1.300	0.000
5.00	19.880	1.300	0.000
6.00	22.820	1.300	0.000
7.00	26.590	1.300	0.390
8.00	30.420	1.300	0.730
9.00	33.990	1.300	1.040
10.00	37.030	1.300	1.310
11.00	39.290	1.300	1.510
12.00	40.570	1.300	1.620
13.00	40.780	1.300	1.650
14.00	39.910	1.300	1.580
15.00	38.010	1.300	1.420
16.00	35.250	1.300	1.190
17.00	32.350	1.300	0.900
18.00	29.620	1.300	0.580
19.00	26.750	1.300	0.160
20.00	23.930	1.300	0.000
21.00	21.300	1.300	0.000
22.00	19.020	1.300	0.000
23.00	17.220	1.300	0.000
24.00	16.010	1.300	0.000
25.00	15.460	1.300	0.000

26.00	15.600	1.300	0.000
27.00	16.420	1.300	0.000
28.00	17.880	1.300	0.000
29.00	19.880	1.300	0.000
30.00	22.820	1.300	0.000
31.00	26.590	1.300	0.400
32.00	30.420	1.300	0.730
33.00	33.990	1.300	1.040
34.00	37.030	1.300	1.310
35.00	39.290	1.300	1.510
36.00	40.570	1.300	1.620
37.00	40.780	1.300	1.650
38.00	39.910	1.300	1.580
39.00	38.010	1.300	1.420
40.00	35.250	1.300	1.190
41.00	32.350	1.300	0.900
42.00	29.620	1.300	0.580
43.00	26.750	1.300	0.160
44.00	23.930	1.300	0.000
45.00	21.300	1.300	0.000
46.00	19.020	1.300	0.000
47.00	17.220	1.300	0.000
48.00	16.010	1.300	0.000
49.00	15.460	1.300	0.000
50.00	15.600	1.300	0.000
51.00	16.420	1.300	0.000
52.00	17.880	1.300	0.000
53.00	19.880	1.300	0.000
54.00	22.820	1.300	0.000
55.00	26.590	1.300	0.400
56.00	30.420	1.300	0.730
57.00	33.990	1.300	1.040
58.00	37.030	1.300	1.310
59.00	39.290	1.300	1.510
60.00	40.570	1.300	1.620
61.00	40.780	1.300	1.650
62.00	39.910	1.300	1.580
63.00	38.010	1.300	1.420
64.00	35.250	1.300	1.190
65.00	32.350	1.300	0.900
66.00	29.620	1.300	0.580
67.00	26.750	1.300	0.170
68.00	23.930	1.300	0.000
69.00	21.300	1.300	0.000
70.00	19.020	1.300	0.000
71.00	17.220	1.300	0.000
72.00	16.010	1.300	0.000
73.00	15.460	1.300	0.000
74.00	15.600	1.300	0.000
75.00	16.420	1.300	0.000
76.00	17.880	1.300	0.000
77.00	19.880	1.300	0.000
78.00	22.820	1.300	0.000
79.00	26.590	1.300	0.400
80.00	30.420	1.300	0.730
81.00	33.990	1.300	1.040
82.00	37.030	1.300	1.310
83.00	39.290	1.300	1.510

84.00	40.570	1.300	1.620
85.00	40.780	1.300	1.650
86.00	39.910	1.300	1.580
87.00	38.010	1.300	1.420
88.00	35.250	1.300	1.190
89.00	32.350	1.300	0.900
90.00	29.620	1.300	0.580
91.00	26.750	1.300	0.170
92.00	23.930	1.300	0.000
93.00	21.300	1.300	0.000
94.00	19.020	1.300	0.000
95.00	17.220	1.300	0.000
96.00	16.010	1.300	0.000
1.00	15.460	1.300	0.000
2.00	15.600	1.300	0.000
3.00	16.420	1.300	0.000
4.00	17.880	1.300	0.000
5.00	19.880	1.300	0.000
6.00	22.820	1.300	0.000
7.00	26.590	1.300	0.390
8.00	30.420	1.300	0.730
9.00	33.990	1.300	1.040
10.00	37.030	1.300	1.310
11.00	39.290	1.300	1.510
12.00	40.570	1.300	1.620
13.00	40.780	1.300	1.650
14.00	39.910	1.300	1.580
15.00	38.010	1.300	1.420
16.00	35.250	1.300	1.190
17.00	32.350	1.300	0.900
18.00	29.620	1.300	0.580
19.00	26.750	1.300	0.160
20.00	23.930	1.300	0.000
21.00	21.300	1.300	0.000
22.00	19.020	1.300	0.000
23.00	17.220	1.300	0.000
24.00	16.010	1.300	0.000
25.00	15.460	1.300	0.000
26.00	15.600	1.300	0.000
27.00	16.420	1.300	0.000
28.00	17.880	1.300	0.000
29.00	19.880	1.300	0.000
30.00	22.820	1.300	0.000
31.00	26.590	1.300	0.400
32.00	30.420	1.300	0.730
33.00	33.990	1.300	1.040
34.00	37.030	1.300	1.310
35.00	39.290	1.300	1.510
36.00	40.570	1.300	1.620
37.00	40.780	1.300	1.650
38.00	39.910	1.300	1.580
39.00	38.010	1.300	1.420
40.00	35.250	1.300	1.190
41.00	32.350	1.300	0.900
42.00	29.620	1.300	0.580
43.00	26.750	1.300	0.160
44.00	23.930	1.300	0.000
45.00	21.300	1.300	0.000

46.00	19.020	1.300	0.000
47.00	17.220	1.300	0.000
48.00	16.010	1.300	0.000
49.00	15.460	1.300	0.000
50.00	15.600	1.300	0.000
51.00	16.420	1.300	0.000
52.00	17.880	1.300	0.000
53.00	19.880	1.300	0.000
54.00	22.820	1.300	0.000
55.00	26.590	1.300	0.400
56.00	30.420	1.300	0.730
57.00	33.990	1.300	1.040
58.00	37.030	1.300	1.310
59.00	39.290	1.300	1.510
60.00	40.570	1.300	1.620
61.00	40.780	1.300	1.650
62.00	39.910	1.300	1.580
63.00	38.010	1.300	1.420
64.00	35.250	1.300	1.190
65.00	32.350	1.300	0.900
66.00	29.620	1.300	0.580
67.00	26.750	1.300	0.170
68.00	23.930	1.300	0.000
69.00	21.300	1.300	0.000
70.00	19.020	1.300	0.000
71.00	17.220	1.300	0.000
72.00	16.010	1.300	0.000
73.00	15.460	1.300	0.000
74.00	15.600	1.300	0.000
75.00	16.420	1.300	0.000
76.00	17.880	1.300	0.000
77.00	19.880	1.300	0.000
78.00	22.820	1.300	0.000
79.00	26.590	1.300	0.400
80.00	30.420	1.300	0.730
81.00	33.990	1.300	1.040
82.00	37.030	1.300	1.310
83.00	39.290	1.300	1.510
84.00	40.570	1.300	1.620
85.00	40.780	1.300	1.650
86.00	39.910	1.300	1.580
87.00	38.010	1.300	1.420
88.00	35.250	1.300	1.190
89.00	32.350	1.300	0.900
90.00	29.620	1.300	0.580
91.00	26.750	1.300	0.170
92.00	23.930	1.300	0.000
93.00	21.300	1.300	0.000
94.00	19.020	1.300	0.000
95.00	17.220	1.300	0.000
96.00	16.010	1.300	0.000
97.00	15.460	1.300	0.000
98.00	15.600	1.300	0.000
99.00	16.420	1.300	0.000
100.00	17.880	1.300	0.000
101.00	19.880	1.300	0.000
102.00	22.820	1.300	0.000
103.00	26.590	1.300	0.400

104.00	30.420	1.300	0.730
105.00	33.990	1.300	1.040
106.00	37.030	1.300	1.310
107.00	39.290	1.300	1.510
108.00	40.570	1.300	1.620
109.00	40.780	1.300	1.650
110.00	39.910	1.300	1.580
111.00	38.010	1.300	1.420
112.00	35.250	1.300	1.190
113.00	32.350	1.300	0.900
114.00	29.620	1.300	0.580
115.00	26.750	1.300	0.170
116.00	23.930	1.300	0.000
117.00	21.300	1.300	0.000
118.00	19.020	1.300	0.000
119.00	17.220	1.300	0.000
120.00	16.010	1.300	0.000
121.00	15.460	1.300	0.000
122.00	15.600	1.300	0.000
123.00	16.420	1.300	0.000
124.00	17.880	1.300	0.000
125.00	19.880	1.300	0.000
126.00	22.820	1.300	0.000
127.00	26.590	1.300	0.400
128.00	30.420	1.300	0.730
129.00	33.990	1.300	1.040
130.00	37.030	1.300	1.310
131.00	39.290	1.300	1.510
132.00	40.570	1.300	1.620
133.00	40.780	1.300	1.650
134.00	39.910	1.300	1.580
135.00	38.010	1.300	1.420
136.00	35.250	1.300	1.190
137.00	32.350	1.300	0.900
138.00	29.620	1.300	0.580
139.00	26.750	1.300	0.170
140.00	23.930	1.300	0.000
141.00	21.300	1.300	0.000
142.00	19.020	1.300	0.000
143.00	17.220	1.300	0.000
144.00	16.010	1.300	0.000
145.00	15.460	1.300	0.000
146.00	15.600	1.300	0.000
147.00	16.420	1.300	0.000
148.00	17.880	1.300	0.000
149.00	19.880	1.300	0.000
150.00	22.820	1.300	0.000
151.00	26.590	1.300	0.400
152.00	30.420	1.300	0.730
153.00	33.990	1.300	1.040
154.00	37.030	1.300	1.310
155.00	39.290	1.300	1.510
156.00	40.570	1.300	1.620
157.00	40.780	1.300	1.650
158.00	39.910	1.300	1.580
159.00	38.010	1.300	1.420
160.00	35.250	1.300	1.190
161.00	32.350	1.300	0.900

162.00	29.620	1.300	0.580
163.00	26.750	1.300	0.160
164.00	23.930	1.300	0.000
165.00	21.300	1.300	0.000
166.00	19.020	1.300	0.000
167.00	17.220	1.300	0.000
168.00	16.010	1.300	0.000
169.00	15.460	1.300	0.000
170.00	15.600	1.300	0.000
171.00	16.420	1.300	0.000
172.00	17.880	1.300	0.000
173.00	19.880	1.300	0.000
174.00	22.820	1.300	0.000
175.00	26.590	1.300	0.400
176.00	30.420	1.300	0.730
177.00	33.990	1.300	1.040
178.00	37.030	1.300	1.310
179.00	39.290	1.300	1.510
180.00	40.570	1.300	1.620
181.00	40.780	1.300	1.650
182.00	39.910	1.300	1.580
183.00	38.010	1.300	1.420
184.00	35.250	1.300	1.190
185.00	32.350	1.300	0.900
186.00	29.620	1.300	0.580
187.00	26.750	1.300	0.160
188.00	23.930	1.300	0.000
189.00	21.300	1.300	0.000
190.00	19.020	1.300	0.000
191.00	17.220	1.300	0.000
192.00	16.010	1.300	0.000
193.00	15.460	1.300	0.000
194.00	15.600	1.300	0.000
195.00	16.420	1.300	0.000
196.00	17.880	1.300	0.000
197.00	19.880	1.300	0.000
198.00	22.820	1.300	0.000
199.00	26.590	1.300	0.390
200.00	30.420	1.300	0.730
201.00	33.990	1.300	1.040
202.00	37.030	1.300	1.310
203.00	39.290	1.300	1.510
204.00	40.570	1.300	1.620
205.00	40.780	1.300	1.650
206.00	39.910	1.300	1.580
207.00	38.010	1.300	1.420
208.00	35.250	1.300	1.190
209.00	32.350	1.300	0.900
210.00	29.620	1.300	0.580
211.00	26.750	1.300	0.160
212.00	23.930	1.300	0.000
213.00	21.300	1.300	0.000
214.00	19.020	1.300	0.000
215.00	17.220	1.300	0.000
216.00	16.010	1.300	0.000
217.00	15.460	1.300	0.000
218.00	15.600	1.300	0.000
219.00	16.420	1.300	0.000

220.00	17.880	1.300	0.000
221.00	19.880	1.300	0.000
222.00	22.820	1.300	0.000
223.00	26.590	1.300	0.390
224.00	30.420	1.300	0.730
225.00	33.990	1.300	1.040
226.00	37.030	1.300	1.310
227.00	39.290	1.300	1.510
228.00	40.570	1.300	1.620
229.00	40.780	1.300	1.650
230.00	39.910	1.300	1.580
231.00	38.010	1.300	1.420
232.00	35.250	1.300	1.190
233.00	32.350	1.300	0.900
234.00	29.620	1.300	0.580
235.00	26.750	1.300	0.160
236.00	23.930	1.300	0.000
237.00	21.300	1.300	0.000
238.00	19.020	1.300	0.000
239.00	17.220	1.300	0.000
240.00	16.010	1.300	0.000
241.00	15.460	1.300	0.000
242.00	15.600	1.300	0.000
243.00	16.420	1.300	0.000
244.00	17.880	1.300	0.000
245.00	19.880	1.300	0.000
246.00	22.820	1.300	0.000
247.00	26.590	1.300	0.390
248.00	30.420	1.300	0.730
249.00	33.990	1.300	1.040
250.00	37.030	1.300	1.310
251.00	39.290	1.300	1.500
252.00	40.570	1.300	1.620
253.00	40.780	1.300	1.650
254.00	39.910	1.300	1.580
255.00	38.010	1.300	1.420
256.00	35.250	1.300	1.190
257.00	32.350	1.300	0.900
258.00	29.620	1.300	0.580
259.00	26.750	1.300	0.160
260.00	23.930	1.300	0.000
261.00	21.300	1.300	0.000
262.00	19.020	1.300	0.000
263.00	17.220	1.300	0.000
264.00	16.010	1.300	0.000
265.00	15.460	1.300	0.000
266.00	15.600	1.300	0.000
267.00	16.420	1.300	0.000
268.00	17.880	1.300	0.000
269.00	19.880	1.300	0.000
270.00	22.820	1.300	0.000
271.00	26.590	1.300	0.390
272.00	30.420	1.300	0.730
273.00	33.990	1.300	1.040
274.00	37.030	1.300	1.310
275.00	39.290	1.300	1.500
276.00	40.570	1.300	1.620
277.00	40.780	1.300	1.650

278.00	39.910	1.300	1.580
279.00	38.010	1.300	1.420
280.00	35.250	1.300	1.190
281.00	32.350	1.300	0.900
282.00	29.620	1.300	0.580
283.00	26.750	1.300	0.160
284.00	23.930	1.300	0.000
285.00	21.300	1.300	0.000
286.00	19.020	1.300	0.000
287.00	17.220	1.300	0.000
288.00	16.010	1.300	0.000
289.00	15.460	1.300	0.000
290.00	15.600	1.300	0.000
291.00	16.420	1.300	0.000
292.00	17.880	1.300	0.000
293.00	19.880	1.300	0.000
294.00	22.820	1.300	0.000
295.00	26.590	1.300	0.390
296.00	30.420	1.300	0.730
297.00	33.990	1.300	1.040
298.00	37.030	1.300	1.300
299.00	39.290	1.300	1.500
300.00	40.570	1.300	1.620
301.00	40.780	1.300	1.650
302.00	39.910	1.300	1.580
303.00	38.010	1.300	1.420
304.00	35.250	1.300	1.190
305.00	32.350	1.300	0.900
306.00	29.620	1.300	0.580
307.00	26.750	1.300	0.160
308.00	23.930	1.300	0.000
309.00	21.300	1.300	0.000
310.00	19.020	1.300	0.000
311.00	17.220	1.300	0.000
312.00	16.010	1.300	0.000
313.00	15.460	1.300	0.000
314.00	15.600	1.300	0.000
315.00	16.420	1.300	0.000
316.00	17.880	1.300	0.000
317.00	19.880	1.300	0.000
318.00	22.820	1.300	0.000
319.00	26.590	1.300	0.390
320.00	30.420	1.300	0.730
321.00	33.990	1.300	1.040
322.00	37.030	1.300	1.300
323.00	39.290	1.300	1.500
324.00	40.570	1.300	1.620
325.00	40.780	1.300	1.650
326.00	39.910	1.300	1.580
327.00	38.010	1.300	1.420
328.00	35.250	1.300	1.190
329.00	32.350	1.300	0.900
330.00	29.620	1.300	0.580
331.00	26.750	1.300	0.160
332.00	23.930	1.300	0.000
333.00	21.300	1.300	0.000
334.00	19.020	1.300	0.000
335.00	17.220	1.300	0.000

336.00	16.010	1.300	0.000
337.00	15.460	1.300	0.000
338.00	15.600	1.300	0.000
339.00	16.420	1.300	0.000
340.00	17.880	1.300	0.000
341.00	19.880	1.300	0.000
342.00	22.820	1.300	0.000
343.00	26.590	1.300	0.390
344.00	30.420	1.300	0.730
345.00	33.990	1.300	1.040
346.00	37.030	1.300	1.300
347.00	39.290	1.300	1.500
348.00	40.570	1.300	1.620
349.00	40.780	1.300	1.650
350.00	39.910	1.300	1.580
351.00	38.010	1.300	1.420
352.00	35.250	1.300	1.190
353.00	32.320	1.300	0.900
354.00	29.530	1.300	0.580
355.00	26.600	1.300	0.160
356.00	23.710	1.300	0.000
357.00	21.020	1.300	0.000
358.00	18.690	1.300	0.000
359.00	16.860	1.300	0.000
360.00	15.620	1.300	0.000
361.00	15.060	1.300	0.000
362.00	15.200	1.300	0.000
363.00	16.040	1.300	0.000
364.00	17.530	1.300	0.000
365.00	19.580	1.300	0.000
366.00	22.580	1.300	0.000
367.00	26.430	1.300	0.390
368.00	30.350	1.300	0.730
369.00	34.000	1.300	1.040
370.00	37.110	1.300	1.300
371.00	39.410	1.300	1.500
372.00	40.720	1.300	1.620
373.00	40.940	1.300	1.650
374.00	40.040	1.300	1.580
375.00	38.110	1.300	1.420
376.00	35.280	1.300	1.190
377.00	32.350	1.300	0.900
378.00	29.620	1.300	0.580
379.00	26.750	1.300	0.160
380.00	23.930	1.300	0.000
381.00	21.300	1.300	0.000
382.00	19.020	1.300	0.000
383.00	17.220	1.300	0.000
384.00	16.010	1.300	0.000
385.00	15.460	1.300	0.000
386.00	15.600	1.300	0.000
387.00	16.420	1.300	0.000
388.00	17.880	1.300	0.000
389.00	19.880	1.300	0.000
390.00	22.820	1.300	0.000
391.00	26.590	1.300	0.380
392.00	30.420	1.300	0.730
393.00	33.990	1.300	1.040

394.00	37.030	1.300	1.300
395.00	39.290	1.300	1.500
396.00	40.570	1.300	1.620
397.00	40.780	1.300	1.640
398.00	39.910	1.300	1.580
399.00	38.010	1.300	1.420
400.00	35.250	1.300	1.190
401.00	32.350	1.300	0.900
402.00	29.620	1.300	0.580
403.00	26.750	1.300	0.160
404.00	23.930	1.300	0.000
405.00	21.300	1.300	0.000
406.00	19.020	1.300	0.000
407.00	17.220	1.300	0.000
408.00	16.010	1.300	0.000
409.00	15.460	1.300	0.000
410.00	15.600	1.300	0.000
411.00	16.420	1.300	0.000
412.00	17.880	1.300	0.000
413.00	19.880	1.300	0.000
414.00	22.820	1.300	0.000
415.00	26.590	1.300	0.380
416.00	30.420	1.300	0.730
417.00	33.990	1.300	1.040
418.00	37.030	1.300	1.300
419.00	39.290	1.300	1.500
420.00	40.570	1.300	1.620
421.00	40.780	1.300	1.640
422.00	39.910	1.300	1.580
423.00	38.010	1.300	1.420
424.00	35.250	1.300	1.180
425.00	32.350	1.300	0.900
426.00	29.620	1.300	0.570
427.00	26.750	1.300	0.150
428.00	23.930	1.300	0.000
429.00	21.300	1.300	0.000
430.00	19.020	1.300	0.000
431.00	17.220	1.300	0.000
432.00	16.010	1.300	0.000
433.00	15.460	1.300	0.000
434.00	15.600	1.300	0.000
435.00	16.420	1.300	0.000
436.00	17.880	1.300	0.000
437.00	19.880	1.300	0.000
438.00	22.820	1.300	0.000
439.00	26.590	1.300	0.380
440.00	30.420	1.300	0.730
441.00	33.990	1.300	1.030
442.00	37.030	1.300	1.300
443.00	39.290	1.300	1.500
444.00	40.570	1.300	1.620
445.00	40.780	1.300	1.640
446.00	39.910	1.300	1.570
447.00	38.010	1.300	1.420
448.00	35.250	1.300	1.180
449.00	32.350	1.300	0.890
450.00	29.620	1.300	0.570
451.00	26.750	1.300	0.150

452.00	23.930	1.300	0.000
453.00	21.300	1.300	0.000
454.00	19.020	1.300	0.000
455.00	17.220	1.300	0.000
456.00	16.010	1.300	0.000
457.00	15.460	1.300	0.000
458.00	15.600	1.300	0.000
459.00	16.420	1.300	0.000
460.00	17.880	1.300	0.000
461.00	19.880	1.300	0.000
462.00	22.820	1.300	0.000
463.00	26.590	1.300	0.380
464.00	30.420	1.300	0.720
465.00	33.990	1.300	1.030
466.00	37.030	1.300	1.300
467.00	39.290	1.300	1.500
468.00	40.570	1.300	1.620
469.00	40.780	1.300	1.640
470.00	39.910	1.300	1.570
471.00	38.010	1.300	1.420
472.00	35.250	1.300	1.180
473.00	32.350	1.300	0.890
474.00	29.620	1.300	0.570
475.00	26.750	1.300	0.150
476.00	23.930	1.300	0.000
477.00	21.300	1.300	0.000
478.00	19.020	1.300	0.000
479.00	17.220	1.300	0.000
480.00	16.010	1.300	0.000
481.00	15.460	1.300	0.000
482.00	15.600	1.300	0.000
483.00	16.420	1.300	0.000
484.00	17.880	1.300	0.000
485.00	19.880	1.300	0.000
486.00	22.820	1.300	0.000
487.00	26.590	1.300	0.370
488.00	30.420	1.300	0.720
489.00	33.990	1.300	1.030
490.00	37.030	1.300	1.300
491.00	39.290	1.300	1.500
492.00	40.570	1.300	1.620
493.00	40.780	1.300	1.640
494.00	39.910	1.300	1.570
495.00	38.010	1.300	1.420
496.00	35.250	1.300	1.180
497.00	32.350	1.300	0.890
498.00	29.620	1.300	0.570
499.00	26.750	1.300	0.150
500.00	23.930	1.300	0.000
501.00	21.300	1.300	0.000
502.00	19.020	1.300	0.000
503.00	17.220	1.300	0.000
504.00	16.010	1.300	0.000
505.00	15.460	1.300	0.000
506.00	15.600	1.300	0.000
507.00	16.420	1.300	0.000
508.00	17.880	1.300	0.000
509.00	19.880	1.300	0.000

510.00	22.820	1.300	0.000
511.00	26.590	1.300	0.370
512.00	30.420	1.300	0.720
513.00	33.990	1.300	1.030
514.00	37.030	1.300	1.300
515.00	39.290	1.300	1.500
516.00	40.570	1.300	1.620
517.00	40.780	1.300	1.640
518.00	39.910	1.300	1.570
519.00	38.010	1.300	1.410
520.00	35.250	1.300	1.180
521.00	32.350	1.300	0.890
522.00	29.620	1.300	0.570
523.00	26.750	1.300	0.150
524.00	23.930	1.300	0.000
525.00	21.300	1.300	0.000
526.00	19.020	1.300	0.000
527.00	17.220	1.300	0.000
528.00	16.010	1.300	0.000
529.00	15.460	1.300	0.000
530.00	15.600	1.300	0.000
531.00	16.420	1.300	0.000
532.00	17.880	1.300	0.000
533.00	19.880	1.300	0.000
534.00	22.820	1.300	0.000
535.00	26.590	1.300	0.370
536.00	30.420	1.300	0.720
537.00	33.990	1.300	1.030
538.00	37.030	1.300	1.300
539.00	39.290	1.300	1.500
540.00	40.570	1.300	1.620
541.00	40.780	1.300	1.640
542.00	39.910	1.300	1.570
543.00	38.010	1.300	1.410
544.00	35.250	1.300	1.180
545.00	32.350	1.300	0.890
546.00	29.620	1.300	0.570
547.00	26.750	1.300	0.140
548.00	23.930	1.300	0.000
549.00	21.300	1.300	0.000
550.00	19.020	1.300	0.000
551.00	17.220	1.300	0.000
552.00	16.010	1.300	0.000
553.00	15.460	1.300	0.000
554.00	15.600	1.300	0.000
555.00	16.420	1.300	0.000
556.00	17.880	1.300	0.000
557.00	19.880	1.300	0.000
558.00	22.820	1.300	0.000
559.00	26.590	1.300	0.370
560.00	30.420	1.300	0.720
561.00	33.990	1.300	1.030
562.00	37.030	1.300	1.300
563.00	39.290	1.300	1.500
564.00	40.570	1.300	1.610
565.00	40.780	1.300	1.640
566.00	39.910	1.300	1.570
567.00	38.010	1.300	1.410

568.00	35.250	1.300	1.180
569.00	32.350	1.300	0.890
570.00	29.620	1.300	0.570
571.00	26.750	1.300	0.140
572.00	23.930	1.300	0.000
573.00	21.300	1.300	0.000
574.00	19.020	1.300	0.000
575.00	17.220	1.300	0.000
576.00	16.010	1.300	0.000
577.00	15.460	1.300	0.000
578.00	15.600	1.300	0.000
579.00	16.420	1.300	0.000
580.00	17.880	1.300	0.000
581.00	19.880	1.300	0.000
582.00	22.820	1.300	0.000
583.00	26.590	1.300	0.360
584.00	30.420	1.300	0.720
585.00	33.990	1.300	1.030
586.00	37.030	1.300	1.300
587.00	39.290	1.300	1.500
588.00	40.570	1.300	1.610
589.00	40.780	1.300	1.640
590.00	39.910	1.300	1.570
591.00	38.010	1.300	1.410
592.00	35.250	1.300	1.180
593.00	32.350	1.300	0.890
594.00	29.620	1.300	0.560
595.00	26.750	1.300	0.140
596.00	23.930	1.300	0.000
597.00	21.300	1.300	0.000
598.00	19.020	1.300	0.000
599.00	17.220	1.300	0.000
600.00	16.010	1.300	0.000
601.00	15.460	1.300	0.000
602.00	15.600	1.300	0.000
603.00	16.420	1.300	0.000
604.00	17.880	1.300	0.000
605.00	19.880	1.300	0.000
606.00	22.820	1.300	0.000
607.00	26.590	1.300	0.360
608.00	30.420	1.300	0.720
609.00	33.990	1.300	1.030
610.00	37.030	1.300	1.290
611.00	39.290	1.300	1.500
612.00	40.570	1.300	1.610
613.00	40.780	1.300	1.640
614.00	39.910	1.300	1.570
615.00	38.010	1.300	1.410
616.00	35.250	1.300	1.180
617.00	32.350	1.300	0.890
618.00	29.620	1.300	0.560
619.00	26.750	1.300	0.140
620.00	23.930	1.300	0.000
621.00	21.300	1.300	0.000
622.00	19.020	1.300	0.000
623.00	17.220	1.300	0.000
624.00	16.010	1.300	0.000
625.00	15.460	1.300	0.000

626.00	15.600	1.300	0.000
627.00	16.420	1.300	0.000
628.00	17.880	1.300	0.000
629.00	19.880	1.300	0.000
630.00	22.820	1.300	0.000
631.00	26.590	1.300	0.350
632.00	30.420	1.300	0.710
633.00	33.990	1.300	1.020
634.00	37.030	1.300	1.290
635.00	39.290	1.300	1.490
636.00	40.570	1.300	1.610
637.00	40.780	1.300	1.640
638.00	39.910	1.300	1.570
639.00	38.010	1.300	1.410
640.00	35.250	1.300	1.170
641.00	32.350	1.300	0.880
642.00	29.620	1.300	0.560
643.00	26.750	1.300	0.130
644.00	23.930	1.300	0.000
645.00	21.300	1.300	0.000
646.00	19.020	1.300	0.000
647.00	17.220	1.300	0.000
648.00	16.010	1.300	0.000
649.00	15.460	1.300	0.000
650.00	15.600	1.300	0.000
651.00	16.420	1.300	0.000
652.00	17.880	1.300	0.000
653.00	19.880	1.300	0.000
654.00	22.820	1.300	0.000
655.00	26.590	1.300	0.350
656.00	30.420	1.300	0.710
657.00	33.990	1.300	1.020
658.00	37.030	1.300	1.290
659.00	39.290	1.300	1.490
660.00	40.570	1.300	1.610
661.00	40.780	1.300	1.640
662.00	39.910	1.300	1.570
663.00	38.010	1.300	1.410
664.00	35.250	1.300	1.170
665.00	32.350	1.300	0.880
666.00	29.620	1.300	0.560
667.00	26.750	1.300	0.130
668.00	23.930	1.300	0.000
669.00	21.300	1.300	0.000
670.00	19.020	1.300	0.000
671.00	17.220	1.300	0.000
672.00	16.010	1.300	0.000
673.00	15.460	1.300	0.000
674.00	15.600	1.300	0.000
675.00	16.420	1.300	0.000
676.00	17.880	1.300	0.000
677.00	19.880	1.300	0.000
678.00	22.820	1.300	0.000
679.00	26.590	1.300	0.350
680.00	30.420	1.300	0.710
681.00	33.990	1.300	1.020
682.00	37.030	1.300	1.290
683.00	39.290	1.300	1.490

684.00	40.570	1.300	1.610
685.00	40.780	1.300	1.640
686.00	39.910	1.300	1.570
687.00	38.010	1.300	1.410
688.00	35.250	1.300	1.170
689.00	32.350	1.300	0.880
690.00	29.620	1.300	0.560
691.00	26.750	1.300	0.130
692.00	23.930	1.300	0.000
693.00	21.300	1.300	0.000
694.00	19.020	1.300	0.000
695.00	17.220	1.300	0.000
696.00	16.010	1.300	0.000
697.00	15.460	1.300	0.000
698.00	15.600	1.300	0.000
699.00	16.420	1.300	0.000
700.00	17.880	1.300	0.000
701.00	19.880	1.300	0.000
702.00	22.820	1.300	0.000
703.00	26.590	1.300	0.340
704.00	30.420	1.300	0.710
705.00	33.990	1.300	1.020
706.00	37.030	1.300	1.290
707.00	39.290	1.300	1.490
708.00	40.570	1.300	1.610
709.00	40.780	1.300	1.640
710.00	39.910	1.300	1.570
711.00	38.010	1.300	1.410
712.00	35.250	1.300	1.170
713.00	32.350	1.300	0.880
714.00	29.620	1.300	0.550
715.00	26.750	1.300	0.130
716.00	23.930	1.300	0.000
717.00	21.300	1.300	0.000
718.00	19.020	1.300	0.000
719.00	17.220	1.300	0.000
720.00	16.010	1.300	0.000
721.00	15.460	1.300	0.000
722.00	15.600	1.300	0.000
723.00	16.420	1.300	0.000
724.00	17.880	1.300	0.000
725.00	19.880	1.300	0.000
726.00	22.820	1.300	0.000
727.00	26.590	1.300	0.340
728.00	30.420	1.300	0.710
729.00	33.990	1.300	1.020
730.00	37.030	1.300	1.290
731.00	39.290	1.300	1.490
732.00	40.570	1.300	1.610
733.00	40.780	1.300	1.630
734.00	39.910	1.300	1.560
735.00	38.010	1.300	1.400
736.00	35.250	1.300	1.170
737.00	32.350	1.300	0.880
738.00	29.620	1.300	0.550
739.00	26.750	1.300	0.120
740.00	23.930	1.300	0.000
741.00	21.300	1.300	0.000

742.00	19.020	1.300	0.000
743.00	17.220	1.300	0.000
744.00	16.010	1.300	0.000
745.00	15.460	1.300	0.000
746.00	15.600	1.300	0.000
747.00	16.420	1.300	0.000
748.00	17.880	1.300	0.000
749.00	19.880	1.300	0.000
750.00	22.820	1.300	0.000
751.00	26.590	1.300	0.340
752.00	30.420	1.300	0.700
753.00	33.990	1.300	1.020
754.00	37.030	1.300	1.290
755.00	39.290	1.300	1.490
756.00	40.570	1.300	1.610
757.00	40.780	1.300	1.630
758.00	39.910	1.300	1.560
759.00	38.010	1.300	1.400
760.00	35.250	1.300	1.170
761.00	32.350	1.300	0.870
762.00	29.620	1.300	0.550
763.00	26.750	1.300	0.120
764.00	23.930	1.300	0.000
765.00	21.300	1.300	0.000
766.00	19.020	1.300	0.000
767.00	17.220	1.300	0.000
768.00	16.010	1.300	0.000
769.00	15.460	1.300	0.000
770.00	15.600	1.300	0.000
771.00	16.420	1.300	0.000
772.00	17.880	1.300	0.000
773.00	19.880	1.300	0.000
774.00	22.820	1.300	0.000
775.00	26.590	1.300	0.330
776.00	30.420	1.300	0.700
777.00	33.990	1.300	1.010
778.00	37.030	1.300	1.280
779.00	39.290	1.300	1.490
780.00	40.570	1.300	1.610
781.00	40.780	1.300	1.630
782.00	39.910	1.300	1.560
783.00	38.010	1.300	1.400
784.00	35.250	1.300	1.170
785.00	32.350	1.300	0.870
786.00	29.620	1.300	0.550
787.00	26.750	1.300	0.120
788.00	23.930	1.300	0.000
789.00	21.300	1.300	0.000
790.00	19.020	1.300	0.000
791.00	17.220	1.300	0.000
792.00	16.010	1.300	0.000
793.00	15.460	1.300	0.000
794.00	15.600	1.300	0.000
795.00	16.420	1.300	0.000
796.00	17.880	1.300	0.000
797.00	19.880	1.300	0.000
798.00	22.820	1.300	0.000
799.00	26.590	1.300	0.330

800.00	30.420	1.300	0.700
801.00	33.990	1.300	1.010
802.00	37.030	1.300	1.280
803.00	39.290	1.300	1.490
804.00	40.570	1.300	1.610
805.00	40.780	1.300	1.630
806.00	39.910	1.300	1.560
807.00	38.010	1.300	1.400
808.00	35.250	1.300	1.160
809.00	32.350	1.300	0.870
810.00	29.620	1.300	0.540
811.00	26.750	1.300	0.110
812.00	23.930	1.300	0.000
813.00	21.300	1.300	0.000
814.00	19.020	1.300	0.000
815.00	17.220	1.300	0.000
816.00	16.010	1.300	0.000
817.00	15.460	1.300	0.000
818.00	15.600	1.300	0.000
819.00	16.420	1.300	0.000
820.00	17.880	1.300	0.000
821.00	19.880	1.300	0.000
822.00	22.820	1.300	0.000
823.00	26.590	1.300	0.320
824.00	30.420	1.300	0.700
825.00	33.990	1.300	1.010
826.00	37.030	1.300	1.280
827.00	39.290	1.300	1.480
828.00	40.570	1.300	1.600
829.00	40.780	1.300	1.630
830.00	39.910	1.300	1.560
831.00	38.010	1.300	1.400
832.00	35.250	1.300	1.160
833.00	32.350	1.300	0.870
834.00	29.620	1.300	0.540
835.00	26.750	1.300	0.110
836.00	23.930	1.300	0.000
837.00	21.300	1.300	0.000
838.00	19.020	1.300	0.000
839.00	17.220	1.300	0.000
840.00	16.010	1.300	0.000
841.00	15.460	1.300	0.000
842.00	15.600	1.300	0.000
843.00	16.420	1.300	0.000
844.00	17.880	1.300	0.000
845.00	19.880	1.300	0.000
846.00	22.820	1.300	0.000
847.00	26.590	1.300	0.320
848.00	30.420	1.300	0.690
849.00	33.990	1.300	1.010
850.00	37.030	1.300	1.280
851.00	39.290	1.300	1.480
852.00	40.570	1.300	1.600
853.00	40.780	1.300	1.630
854.00	39.910	1.300	1.560
855.00	38.010	1.300	1.400
856.00	35.250	1.300	1.160
857.00	32.350	1.300	0.870

858.00	29.620	1.300	0.540
859.00	26.750	1.300	0.110
860.00	23.930	1.300	0.000
861.00	21.300	1.300	0.000
862.00	19.020	1.300	0.000
863.00	17.220	1.300	0.000
864.00	16.010	1.300	0.000
865.00	15.460	1.300	0.000
866.00	15.600	1.300	0.000
867.00	16.420	1.300	0.000
868.00	17.880	1.300	0.000
869.00	19.880	1.300	0.000
870.00	22.820	1.300	0.000
871.00	26.590	1.300	0.310
872.00	30.420	1.300	0.690
873.00	33.990	1.300	1.010
874.00	37.030	1.300	1.280
875.00	39.290	1.300	1.480
876.00	40.570	1.300	1.600
877.00	40.780	1.300	1.630
878.00	39.910	1.300	1.560
879.00	38.010	1.300	1.400
880.00	35.250	1.300	1.160
881.00	32.350	1.300	0.860
882.00	29.620	1.300	0.540
883.00	26.750	1.300	0.100
884.00	23.930	1.300	0.000
885.00	21.300	1.300	0.000
886.00	19.020	1.300	0.000
887.00	17.220	1.300	0.000
888.00	16.010	1.300	0.000
889.00	15.460	1.300	0.000
890.00	15.600	1.300	0.000
891.00	16.420	1.300	0.000
892.00	17.880	1.300	0.000
893.00	19.880	1.300	0.000
894.00	22.820	1.300	0.000
895.00	26.590	1.300	0.310
896.00	30.420	1.300	0.690
897.00	33.990	1.300	1.000
898.00	37.030	1.300	1.280
899.00	39.290	1.300	1.480
900.00	40.570	1.300	1.600
901.00	40.780	1.300	1.630
902.00	39.910	1.300	1.560
903.00	38.010	1.300	1.390
904.00	35.250	1.300	1.160
905.00	32.350	1.300	0.860
906.00	29.620	1.300	0.530
907.00	26.750	1.300	0.100
908.00	23.930	1.300	0.000
909.00	21.300	1.300	0.000
910.00	19.020	1.300	0.000
911.00	17.220	1.300	0.000
912.00	16.010	1.300	0.000
913.00	15.460	1.300	0.000
914.00	15.600	1.300	0.000
915.00	16.420	1.300	0.000

916.00	17.880	1.300	0.000
917.00	19.880	1.300	0.000
918.00	22.820	1.300	0.000
919.00	26.590	1.300	0.300
920.00	30.420	1.300	0.690
921.00	33.990	1.300	1.000
922.00	37.030	1.300	1.270
923.00	39.290	1.300	1.480
924.00	40.570	1.300	1.600
925.00	40.780	1.300	1.620
926.00	39.910	1.300	1.550
927.00	38.010	1.300	1.390
928.00	35.250	1.300	1.150
929.00	32.350	1.300	0.860
930.00	29.620	1.300	0.530
931.00	26.750	1.300	0.100
932.00	23.930	1.300	0.000
933.00	21.300	1.300	0.000
934.00	19.020	1.300	0.000
935.00	17.220	1.300	0.000
936.00	16.010	1.300	0.000
937.00	15.460	1.300	0.000
938.00	15.600	1.300	0.000
939.00	16.420	1.300	0.000
940.00	17.880	1.300	0.000
941.00	19.880	1.300	0.000
942.00	22.820	1.300	0.000
943.00	26.590	1.300	0.300
944.00	30.420	1.300	0.680
945.00	33.990	1.300	1.000
946.00	37.030	1.300	1.270
947.00	39.290	1.300	1.480
948.00	40.570	1.300	1.600
949.00	40.780	1.300	1.620
950.00	39.910	1.300	1.550
951.00	38.010	1.300	1.390
952.00	35.250	1.300	1.150
953.00	32.350	1.300	0.860
954.00	29.620	1.300	0.530
955.00	26.750	1.300	0.090
956.00	23.930	1.300	0.000
957.00	21.300	1.300	0.000
958.00	19.020	1.300	0.000
959.00	17.220	1.300	0.000
960.00	16.010	1.300	0.000
961.00	15.460	1.300	0.000
962.00	15.600	1.300	0.000
963.00	16.420	1.300	0.000
964.00	17.880	1.300	0.000
965.00	19.880	1.300	0.000
966.00	22.820	1.300	0.000
967.00	26.590	1.300	0.290
968.00	30.420	1.300	0.680
969.00	33.990	1.300	1.000
970.00	37.030	1.300	1.270
971.00	39.290	1.300	1.480
972.00	40.570	1.300	1.600
973.00	40.780	1.300	1.620

974.00	39.910	1.300	1.550
975.00	38.010	1.300	1.390
976.00	35.250	1.300	1.150
977.00	32.350	1.300	0.850
978.00	29.620	1.300	0.520
979.00	26.750	1.300	0.090
980.00	23.930	1.300	0.000
981.00	21.300	1.300	0.000
982.00	19.020	1.300	0.000
983.00	17.220	1.300	0.000
984.00	16.010	1.300	0.000
985.00	15.460	1.300	0.000
986.00	15.600	1.300	0.000
987.00	16.420	1.300	0.000
988.00	17.880	1.300	0.000
989.00	19.880	1.300	0.000
990.00	22.820	1.300	0.000
991.00	26.590	1.300	0.290
992.00	30.420	1.300	0.680
993.00	33.990	1.300	1.000
994.00	37.030	1.300	1.270
995.00	39.290	1.300	1.470
996.00	40.570	1.300	1.590
997.00	40.780	1.300	1.620
998.00	39.910	1.300	1.550
999.00	38.010	1.300	1.390
1000.00	35.250	1.300	1.150
1001.00	32.350	1.300	0.850
1002.00	29.620	1.300	0.520
1003.00	26.750	1.300	0.090
1004.00	23.930	1.300	0.000
1005.00	21.300	1.300	0.000
1006.00	19.020	1.300	0.000
1007.00	17.220	1.300	0.000
1008.00	16.010	1.300	0.000
1009.00	15.460	1.300	0.000
1010.00	15.600	1.300	0.000
1011.00	16.420	1.300	0.000
1012.00	17.880	1.300	0.000
1013.00	19.880	1.300	0.000
1014.00	22.820	1.300	0.000
1015.00	26.590	1.300	0.280
1016.00	30.420	1.300	0.680
1017.00	33.990	1.300	0.990
1018.00	37.030	1.300	1.270
1019.00	39.290	1.300	1.470
1020.00	40.570	1.300	1.590
1021.00	40.780	1.300	1.620
1022.00	39.910	1.300	1.550
1023.00	38.010	1.300	1.390
1024.00	35.250	1.300	1.150
1025.00	32.350	1.300	0.850
1026.00	29.620	1.300	0.520
1027.00	26.750	1.300	0.080
1028.00	23.930	1.300	0.000
1029.00	21.300	1.300	0.000
1030.00	19.020	1.300	0.000
1031.00	17.220	1.300	0.000

1032.00	16.010	1.300	0.000
1033.00	15.460	1.300	0.000
1034.00	15.600	1.300	0.000
1035.00	16.420	1.300	0.000
1036.00	17.880	1.300	0.000
1037.00	19.880	1.300	0.000
1038.00	22.820	1.300	0.000
1039.00	26.590	1.300	0.280
1040.00	30.420	1.300	0.670
1041.00	33.990	1.300	0.990
1042.00	37.030	1.300	1.260
1043.00	39.290	1.300	1.470
1044.00	40.570	1.300	1.590
1045.00	40.780	1.300	1.620
1046.00	39.910	1.300	1.550
1047.00	38.010	1.300	1.380
1048.00	35.250	1.300	1.140
1049.00	32.350	1.300	0.850
1050.00	29.620	1.300	0.520
1051.00	26.750	1.300	0.080
1052.00	23.930	1.300	0.000
1053.00	21.300	1.300	0.000
1054.00	19.020	1.300	0.000
1055.00	17.220	1.300	0.000
1056.00	16.010	1.300	0.000
1057.00	15.460	1.300	0.000
1058.00	15.600	1.300	0.000
1059.00	16.420	1.300	0.000
1060.00	17.880	1.300	0.000
1061.00	19.880	1.300	0.000
1062.00	22.820	1.300	0.000
1063.00	26.590	1.300	0.270
1064.00	30.420	1.300	0.670
1065.00	33.990	1.300	0.990
1066.00	37.030	1.300	1.260
1067.00	39.290	1.300	1.470
1068.00	40.570	1.300	1.590
1069.00	40.780	1.300	1.620
1070.00	39.910	1.300	1.540
1071.00	38.010	1.300	1.380
1072.00	35.250	1.300	1.140
1073.00	32.350	1.300	0.840
1074.00	29.620	1.300	0.510
1075.00	26.750	1.300	0.080
1076.00	23.930	1.300	0.000
1077.00	21.300	1.300	0.000
1078.00	19.020	1.300	0.000
1079.00	17.220	1.300	0.000
1080.00	16.010	1.300	0.000
1081.00	15.460	1.300	0.000
1082.00	15.600	1.300	0.000
1083.00	16.420	1.300	0.000
1084.00	17.880	1.300	0.000
1085.00	19.880	1.300	0.000
1086.00	22.820	1.300	0.000
1087.00	26.590	1.300	0.270
1088.00	30.420	1.300	0.670
1089.00	33.990	1.300	0.980

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   1090.00 37.030  1.300  1.260
   1091.00 39.290  1.300  1.470
   1092.00 40.570  1.300  1.590
   1093.00 40.780  1.300  1.610
   1094.00 39.910  1.300  1.540
   1095.00 38.010  1.300  1.380
   1096.00 35.250  1.300  1.140
   1097.00 32.320  1.300  0.840
   1098.00 29.530  1.300  0.510
   1099.00 26.600  1.300  0.070
   1100.00 23.710  1.300  0.000
   1101.00 21.020  1.300  0.000
   1102.00 18.690  1.300  0.000
   1103.00 16.860  1.300  0.000
   1104.00 15.620  1.300  0.000
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BLTM.IN

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TMDL.IN   With loads 6.01.94 to 7.15.94  TMDL RUN 4/26/99 NRS 75% conditions
HEADER 1        17     10   1200      8      2      1      1      0      1
HEADER 2      1.00   0.00
LABEL            1   T           1
LABEL            2   A           2
LABEL            3   NH3         3
LABEL            4   N02         4
LABEL            5   N03         5
LABEL            6   P           6
LABEL            7   BOD         7
LABEL            8   DO          8
BRANCH   1       3     14        1      2
 GRID    1  0.000       0   0.03  27.90   0.00   0.06   0.00   0.23   0.00   3.45
              5.05
 GRID    2  1.030       0   0.03  28.00   0.00   0.06   0.00   0.23   0.00   3.45
              5.00
 GRID    3  2.390       0
BRANCH   2      10      1      3      2
 GRID    1  0.000       0   0.03  28.00   0.00   0.06   0.00   0.24   0.00   3.30
              5.00
 GRID    2  0.580       0   0.03  28.00   0.00   0.06   0.00   0.24   0.00   3.30
              5.00
 GRID    3  1.340       0   0.03  28.00   0.00   0.06   0.00   0.24   0.00   3.30
              5.00
 GRID    4  2.110       0   0.03  28.00   0.00   0.06   0.00   0.25   0.00   3.30
              5.00
 GRID    5  3.300       0   0.03  28.00   0.00   0.06   0.00   0.25   0.00   3.15
              4.95
 GRID    6  4.480       0   0.03  28.00   0.00   0.06   0.00   0.25   0.00   3.15
              4.95
 GRID    7  5.380       0   0.03  28.00   0.00   0.06   0.00   0.26   0.00   3.00
              4.95
 GRID    8  6.280       0   0.03  28.00   0.00   0.06   0.00   0.26   0.00   2.63
              4.95
 GRID    9  7.180       0   0.03  28.00   0.00   .065   0.00   0.27   0.00   2.25
              4.90
 GRID   10  8.080       0
BRANCH   3       3      3      4      2
 GRID    1  0.000       0   0.03  28.00   0.00   .065   0.00   0.28   0.00   1.88
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               4.90
  GRID     2  0.950      0   0.03  28.00    0.00    0.07    0.00    0.28    0.00    1.80
               4.90
  GRID     3  2.250      0
 BRANCH    4      3      4      5      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.07    0.00    0.28    0.00    1.70
               4.85
  GRID     2  0.800      0   0.03  28.00    0.00    0.07    0.00    0.28    0.00    1.69
               4.85
  GRID     3  1.600      0
 BRANCH    5      7      5      7      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.07    0.00    0.28    0.00    1.69
               4.90
  GRID     2  1.850      0   0.03  28.00    0.00    0.07    0.00    0.29    0.00    1.68
               4.90
  GRID     3  2.940      0   0.03  28.00    0.00    0.08    0.00    0.29    0.00    1.68
               4.90
  GRID     4  4.140      0   0.03  28.00    0.00    0.08    0.00    0.30    0.00    1.70
               4.95
  GRID     5  5.340      0   0.03  28.00    0.00    0.08    0.00    0.30    0.00    1.71
               5.00
  GRID     6  6.650      0   0.03  28.00    0.00    0.08    0.00    0.31    0.00    1.73
               5.00
  GRID     7  7.960      0
 BRANCH    6      4      7      8      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.08    0.00    0.32    0.00    1.75
               5.00
  GRID     2  1.850      0   0.03  28.00    0.00    0.09    0.00    0.34    0.00    1.76
               5.00
  GRID     3  2.780      0   0.03  28.00    0.00    0.09    0.00    0.35    0.00    1.77
               5.00
  GRID     4  3.700      0
 BRANCH    7      7      1      2      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.06    0.00    0.23    0.00    3.38
               5.00
  GRID     2  1.320      0   0.03  28.00    0.00    0.06    0.00    0.23    0.00    3.38
               5.00
  GRID     3  2.350      0   0.03  28.00    0.00    0.06    0.00    0.23    0.00    3.30
               5.00
  GRID     4  3.280      0   0.03  28.00    0.00    0.06    0.00    0.24    0.00    3.30
               5.00
  GRID     5  4.250      0   0.03  28.00    0.00    0.06    0.00    0.24    0.00    3.15
               5.00
  GRID     6  5.280      0   0.03  28.00    0.00    0.06    0.00    0.25    0.00    3.15
               5.00
  GRID     7  6.320      0
 BRANCH    8      5      2      6      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.06    0.00    0.26    0.00    3.00
               5.00
  GRID     2  1.110      0   0.03  28.00    0.00    0.06    0.00    0.27    0.00    2.85
               5.00
  GRID     3  2.230      0   0.03  28.00    0.00    0.07    0.00    0.28    0.00    2.85
               5.00
  GRID     4  3.550      0   0.03  28.00    0.00    0.07    0.00    0.29    0.00    2.70
               5.00
  GRID     5  4.970      0
 BRANCH    9      8      6      8      2
  GRID     1  0.000      0   0.03  28.00    0.00    0.07    0.00    0.31    0.00    2.40
```

```
              5.00
  GRID    2  0.700       0   0.03  28.00   0.00   0.07   0.00   0.32   0.00   2.25
              5.00
  GRID    3  1.680       0   0.03  28.00   0.00   0.08   0.00   0.33   0.00   2.25
              5.00
  GRID    4  2.650       0   0.03  28.00   0.00   0.08   0.00   0.34   0.00   2.10
              5.00
  GRID    5  4.060       0   0.03  28.00   0.00   0.08   0.00   0.34   0.00   2.10
              5.00
  GRID    6  5.030       0   0.03  28.00   0.00   0.08   0.00   0.35   0.00   1.95
              5.00
  GRID    7  7.220       0   0.03  28.00   0.00   0.08   0.00   0.36   0.00   1.95
              5.00
  GRID    8  7.450       0
 BRANCH  10      3       8     13      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.09   0.00   0.36   0.00   1.80
              5.00
  GRID    2  0.750       0   0.03  28.00   0.00   0.09   0.00   0.36   0.00   1.80
              5.00
  GRID    3  1.500       0
 BRANCH  11      5       6      7      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.08   0.00   0.29   0.00   2.25
              5.00
  GRID    2  0.200       0   0.03  28.00   0.00   0.08   0.00   0.29   0.00   2.25
              5.00
  GRID    3  1.300       0   0.03  28.00   0.00   0.08   0.00   0.29   0.00   2.25
              5.00
  GRID    4  3.550       0   0.03  28.00   0.00   0.07   0.00   0.29   0.00   2.25
              5.00
  GRID    5  5.700       0
 BRANCH  12      3       2      3      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.06   0.00   0.26   0.00   2.25
              4.90
  GRID    2  0.860       0   0.03  28.00   0.00   0.06   0.00   0.26   0.00   2.25
              4.90
  GRID    3  2.200       0
 BRANCH  13      3       9      5      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.07   0.00   0.28   0.00   1.69
              4.85
  GRID    2  1.350       0   0.03  28.00   0.00   0.07   0.00   0.28   0.00   1.69
              4.85
  GRID    3  2.700       0
 BRANCH  14      2       4      9      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.07   0.00   0.28   0.00   1.69
              4.65
  GRID    2  0.650       0
 BRANCH  15      6       9     10      2
  GRID    1  0.000       0   0.03  28.00   0.00   0.06   0.00   0.27   0.00   1.65
              4.50
  GRID    2  1.190       0   0.03  27.90   0.00   0.06   0.00   0.25   0.00   1.65
              4.30
  GRID    3  3.480       0   0.03  27.90   0.00   0.05   0.00   0.23   0.00   1.58
              4.10
  GRID    4  4.670       0   0.03  27.90   0.00   0.05   0.00   0.23   0.00   1.58
              4.00
  GRID    5  5.860       0   0.03  28.00   0.00   0.05   0.00   0.22   0.00   1.65
              3.90
  GRID    6  6.960       0
```

```
BRANCH  16     20      10      12      2
 GRID    1  0.000       0   0.03  28.00   0.00   0.05   0.00   0.22   0.00   1.65
             3.80
 GRID    2  1.060       0   0.03  28.00   0.00   0.05   0.00   0.22   0.00   1.65
             3.70
 GRID    3  2.000       0   0.03  28.10   0.00   0.06   0.00   0.22   0.00   1.65
             3.60
 GRID    4  3.810       0   0.03  28.50   0.00   0.07   0.00   0.21   0.00   1.73
             3.90
 GRID    5  4.750       1   0.03  29.00   0.00   0.07   0.00   0.21   0.00   1.80
             4.20
 GRID    6  6.130       0   0.03  29.00   0.00   0.07   0.00   0.20   0.00   1.80
             4.40
 GRID    7  7.520       0   0.03  29.00   0.00   0.07   0.00   0.19   0.00   1.80
             4.60
 GRID    8  9.030       0   0.03  29.00   0.00   0.06   0.00   0.18   0.00   1.80
             4.80
 GRID    9 10.550       0   0.03  29.00   0.00   0.06   0.00   0.18   0.00   1.95
             4.90
 GRID   10 12.060       0   0.03  29.00   0.00   0.07   0.00   0.22   0.00   2.10
             5.00
 GRID   11 13.580       0   0.03  29.00   0.00   0.07   0.00   0.24   0.00   2.25
             5.20
 GRID   12 14.530       0   0.03  29.50   0.00   0.07   0.00   0.26   0.00   2.40
             5.40
 GRID   13 15.680       0   0.03  30.00   0.00   0.08   0.00   0.28   0.00   2.55
             5.50
 GRID   14 16.860       0   0.03  30.00   0.00   0.08   0.00   0.30   0.00   2.70
             5.60
 GRID   15 18.060       0   0.03  30.00   0.00   0.08   0.00   0.32   0.00   2.85
             5.70
 GRID   16 20.710       0   0.03  30.00   0.00   0.09   0.00   0.34   0.00   3.00
             5.80
 GRID   17 24.690       0   0.03  30.00   0.00   0.09   0.00   0.36   0.00   3.15
             6.00
 GRID   18 26.770       0   0.03  30.00   0.00   0.10   0.00   0.38   0.00   3.30
             6.00
 GRID   19 28.660       0   0.03  30.00   0.00   0.10   0.00   0.39   0.00   3.50
             6.00
 GRID   20 29.880       0
BRANCH  17     19      11      10      2
 GRID    1  0.000       0   0.03  30.00   0.00   0.07   0.00   0.22   0.00   2.00
             4.45
 GRID    2  0.570       0   0.03  30.00   0.00   0.07   0.00   0.22   0.00   2.03
             4.45
 GRID    3  1.140       0   0.03  30.00   0.00   .065   0.00   0.21   0.00   2.07
             4.50
 GRID    4  2.200       0   0.03  30.00   0.00   .065   0.00   0.21   0.00   2.09
             4.50
 GRID    5  3.690       0   0.03  29.60   0.00   0.06   0.00   0.20   0.00   2.07
             4.50
 GRID    6  4.580       0   0.03  29.40   0.00   0.06   0.00   0.20   0.00   2.03
             4.40
 GRID    7  5.460       0   0.03  29.00   0.00   0.06   0.00   0.20   0.00   1.97
             4.40
 GRID    8  6.340       0   0.03  28.80   0.00   0.06   0.00   0.20   0.00   1.94
             4.30
 GRID    9  6.750       0   0.03  28.60   0.00   0.06   0.00   0.20   0.00   1.89
```

```
             4.30
 GRID   10  7.710      0   0.03  28.40   0.00   0.06   0.00   0.20   0.00   1.86
             4.20
 GRID   11  8.670      0   0.03  28.20   0.00   0.06   0.00   0.20   0.00   1.80
             4.20
 GRID   12  9.640      0   0.03  28.00   0.00   0.06   0.00   0.20   0.00   1.77
             4.10
 GRID   13 10.470      0   0.03  27.80   0.00   0.06   0.00   0.20   0.00   1.74
             4.10
 GRID   14 11.330      0   0.03  27.70   0.00   0.06   0.00   0.20   0.00   1.71
             4.00
 GRID   15 12.030      0   0.03  27.90   0.00   0.06   0.00   0.21   0.00   1.65
             4.00
 GRID   16 12.820      0   0.03  28.00   0.00   0.06   0.00   0.21   0.00   1.65
             3.90
 GRID   17 13.430      0   0.03  28.00   0.00   0.05   0.00   0.22   0.00   1.65
             3.80
 GRID   18 13.670      0   0.03  28.00   0.00   0.05   0.00   0.22   0.00   1.65
             3.70
 GRID   19 14.670      0
TIME     1      8
 B  1 G  1  27.90   0.00   0.06   0.00   0.23   0.00   3.45   5.05
 B 17 G  1  30.00   0.00   0.07   0.00   0.22   0.00   2.00   4.45
 B 16 G 20  30.00   0.00   0.10   0.00   0.39   0.00   3.50   4.50
 B 10 G  3  28.00   0.00   0.09   0.00   0.36   0.00   1.80   5.00
 B 17 G  5  30.00   0.00   0.50   0.00   0.00   0.00   6.00   6.00
 B 16 G 17  29.00   0.00   1.00   0.00   0.00   0.00  20.00   6.00
 B 15 G  4  27.90   0.00   5.00   0.00   0.00   0.00  30.00   6.00
 B  5 G  2  28.00   0.00   2.00   0.00   0.00   0.00  25.00   6.00
```

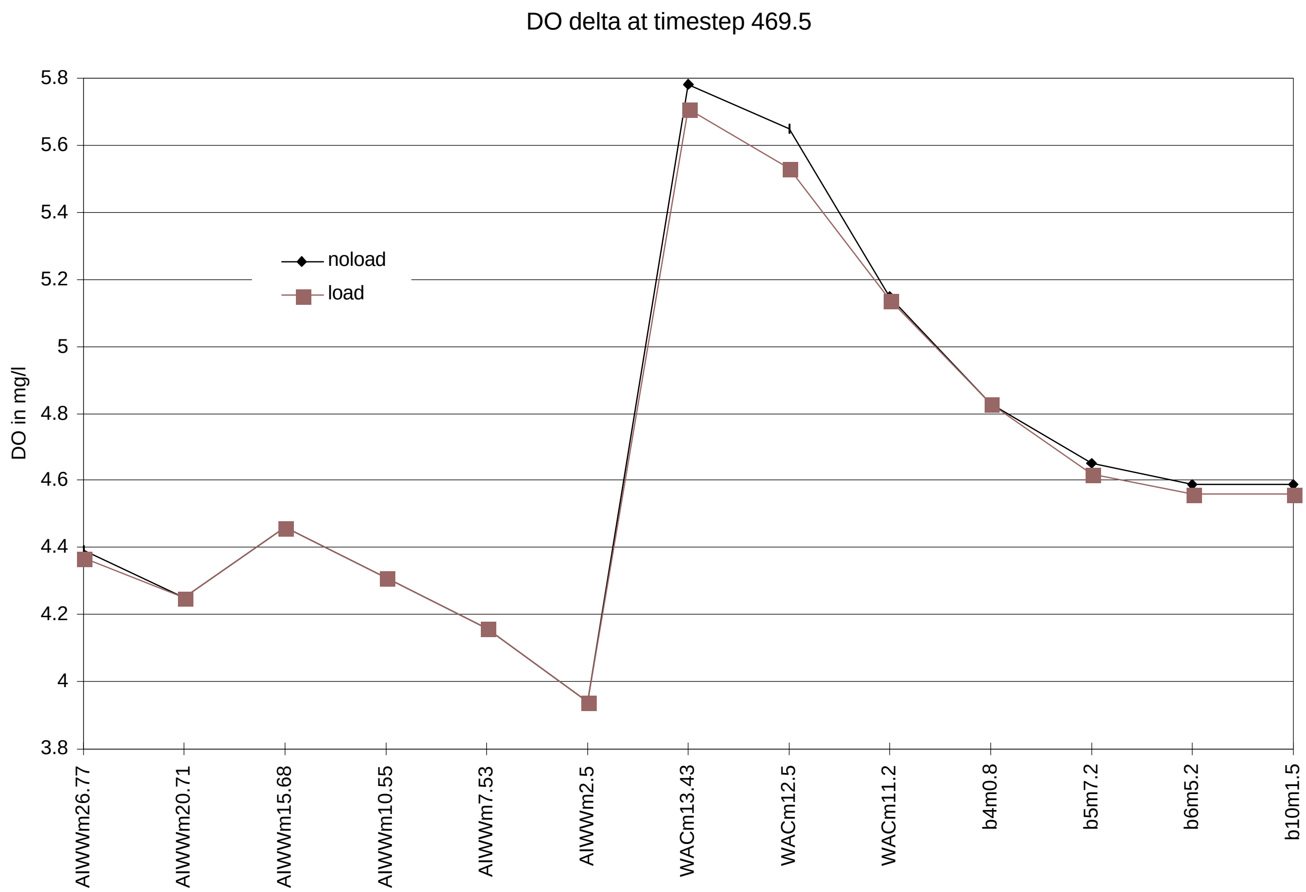
<u>AIW1.CTL</u>

```
BRANCH MODEL OF AIWW NETWORK FROM HWY 9 TO 501 TO 701 TO HAGLEY. Sullins w/ withdrawals
EN2421 4   0EN10950000001 0 0  15100 10000.050 1.00.0026196171001010170.00210001
1.00.00000.0000.0000.00  15       0.0  0.00  0.000.002338 0.00068.000    0.0000
    0.0     0.0   -40.3     0.0     0.0    46.9     0.0    -6.2     0.0     0.0
    0.3     6.8     0.0     0.0     0.0   -17.6    12.4     0.0     0.0     0.0
    0.0     0.0     0.0     0.0

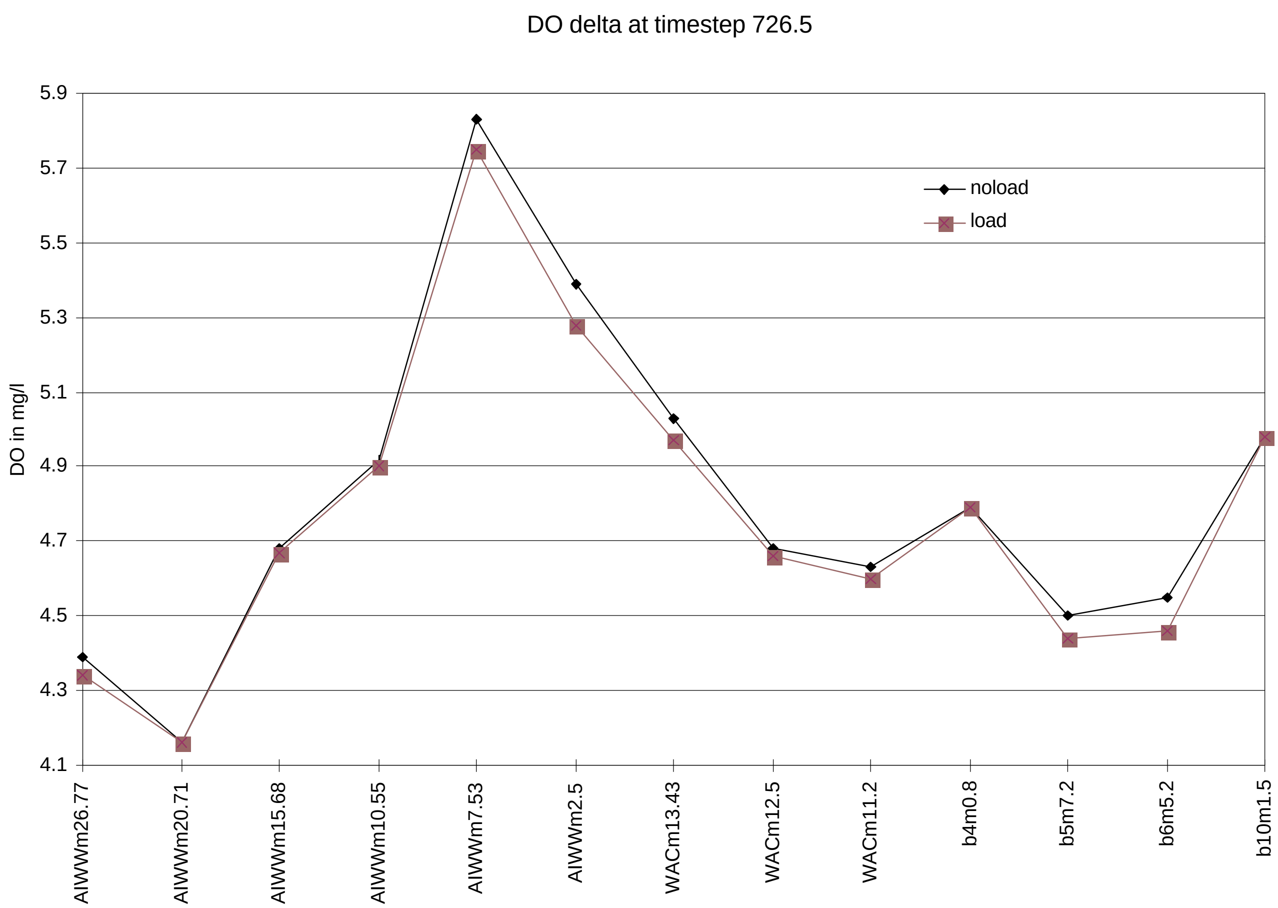
 Z18     02110705 FROM= 94.06.01 24:00 TO=  94.07.15 24:00     96  -2.16      I2
 Z21     02135190                                                96 - 1.33
 Z19     02110777                                                96 -11.72
 Z20     02110815                                                96 -13.95
```

Appendix C

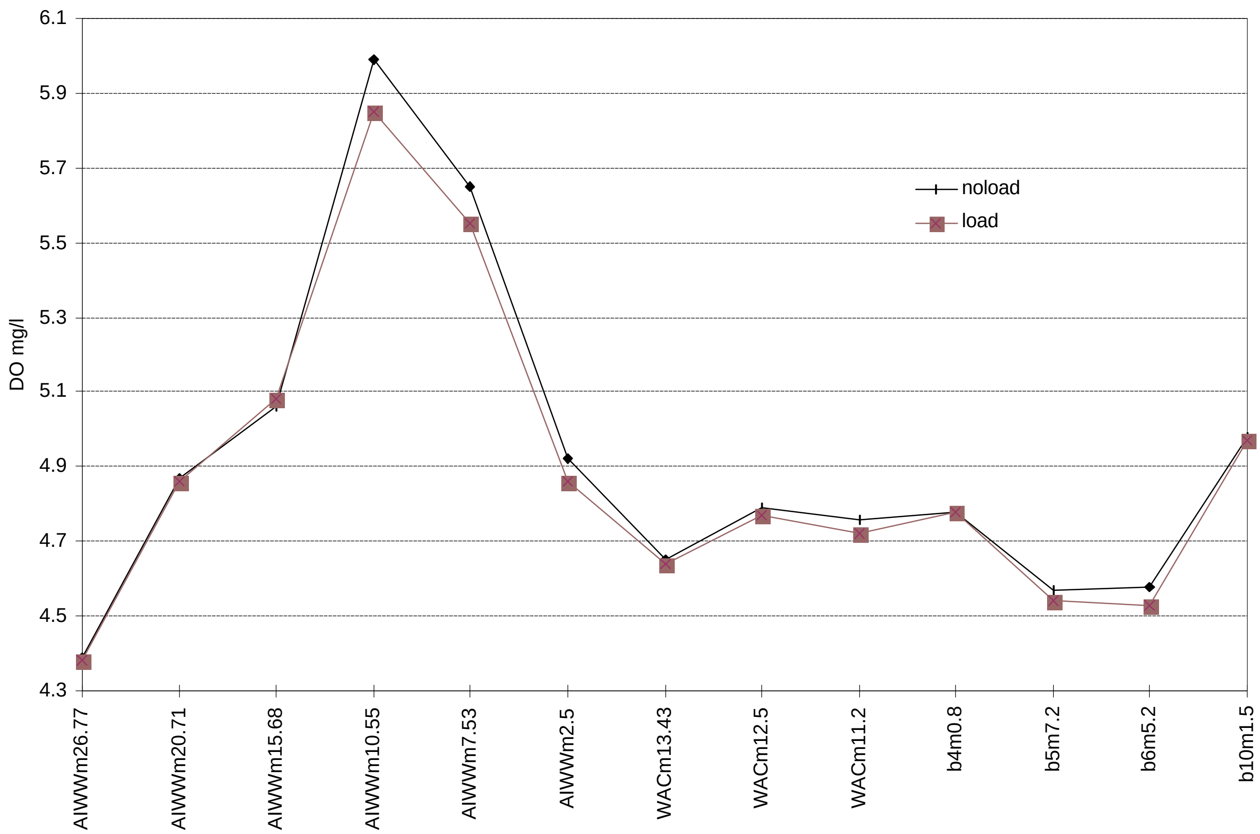
Model Predicted Spatially Evaluated Instream DO
at
Five Different Time Periods

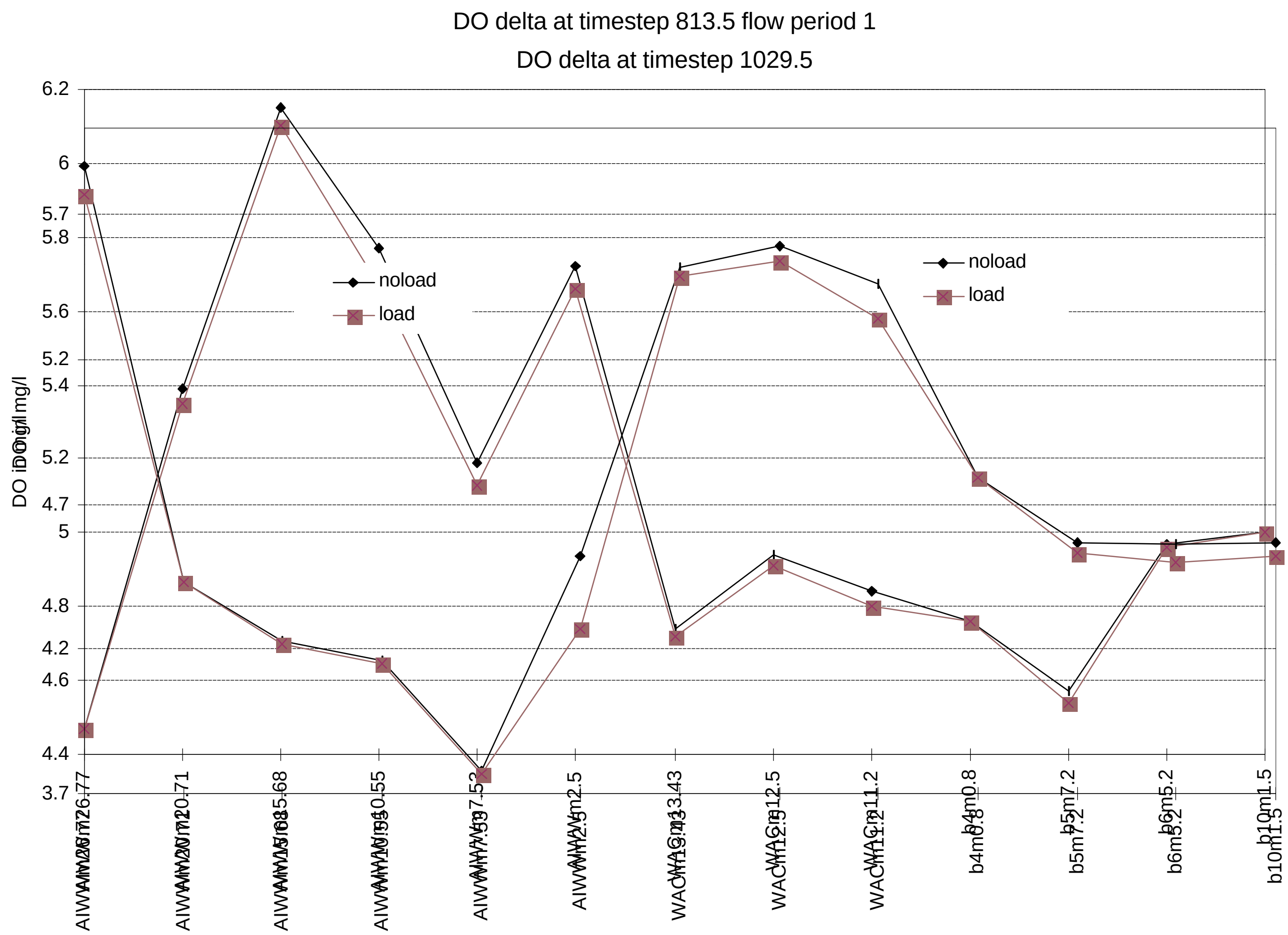


DO delta at timestep 469.5
DO in mg/l
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
noload
load
AIWWm26.77
AIWWm20.71
AIWWm15.68
AIWWm10.55
AIWWm7.53
AIWWm2.5
WACm13.43
WACm12.5
WACm11.2
b4m0.8
b5m7.2
b6m5.2
b10m1.5


DO delta at timestep 726.5
DO in mg/l
5.9
5.7
5.5
5.3
5.1
4.9
4.7
4.5
4.3
4.1
noload
load
AIWWm26.77
AIWWm20.71
AIWWm15.68
AIWWm10.55
AIWWm7.53
AIWWm2.5
WACm13.43
WACm12.5
WACm11.2
b4m0.8
b5m7.2
b6m5.2
b10m1.5

DO delta at timestep 765.5




DO delta at timestep 813.5 flow period 1
DO delta at timestep 1029.5
noload
load
noload
load
AIWWm26.77
AIWWm20.71
AIWWm15.68
AIWWm10.55
AIWWm7.53
AIWWm2.5
WACm13.43
WACm12.5
WACm11.2
b4m0.8
b5m7.2
b6m5.2
b10m1.5

Appendix D

Public Notices

NOTICE OF AVAILABILITY OF PROPOSED TMDL
FOR WATERS AND POLLUTANTS OF CONCERN IN SC

The South Carolina Department of Health and Environmental Control (DHEC) has developed a proposed total maximum daily load (TMDL) for biochemical oxygen demand for the Waccamaw River and the Atlantic Intracoastal Waterway in South Carolina and is proposing to establish this as a final TMDL. This TMDL has been developed in accordance with Section 303(d) of the Clean Water Act.

Persons wishing to offer comments or new data regarding the proposed TMDL may submit data and comments in writing no later than June 18, 1999 to Nancy Sullins, DHEC, Bureau of Water, 2600 Bull Street, Columbia, SC 29201. For more information, please contact Ms. Sullins at (803) 898-4244 or visit our website at www.state.sc.us/dhec/eqpubnot.htm.

May 17, 1999

PUBLIC NOTICE

NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD
FOR WATERS AND POLLUTANTS OF CONCERN IN THE STATE OF SOUTH CAROLINA

May 17, 1999

Section 303(d)(1)(C) of the Clean Water Act (CWA), 33 U.S.C. §1313(d)(1)(C), and EPA's implementing regulation, 40 C.F.R. §130.7(c)(1), require the establishment of total maximum daily loads (TMDLs) for waters identified as impaired pursuant to §303(d)(1)(A) of the CWA. Each of these TMDLs is to be established at a level necessary to implement applicable water quality standards with seasonal variations and a margin of safety, accounting for lack of knowledge concerning the relationship between effluent limitations and water quality. At this time, the South Carolina Department of Health and Environmental Control (SC DHEC) has developed a proposed TMDL for the Waccamaw River and the Atlantic Intracoastal Waterway, §303(d)(1)(A) waters in watershed units
03040206-140, 03040206-150 and 03040207-030 in Horry and Georgetown Counties, South Carolina. The pollutant of concern is biochemical oxygen demand, (carbonaceous and nitrogenous), the combination of which is expressed as ultimate oxygen demand (UOD). The TMDL suggests reductions in UOD as great as 64% to meet the dissolved oxygen standard. SC DHEC is proposing to establish this as a final TMDL.

Persons wishing to comment on the proposed TMDL or to offer new data regarding the proposed TMDL are invited to submit the same in writing no later than June 18, 1999 to the South Carolina Department of Health and Environmental Control, Bureau of Water, 2600 Bull Street, Columbia, South Carolina 29201, ATTN.: Ms. Nancy Sullins. Ms. Sullins' telephone number is 803- 898-4244. Her E-Mail is sullinnr @columb32.dhec.state.sc.us.

The proposed TMDL and the administrative record, including technical information, data, and analysis supporting the proposed TMDL, may be reviewed and copied at 2600 Bull Street, Columbia, South Carolina between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday. Copies can be obtained by contacting Ms. Brenda Williams at the above address, by calling her at 803-898-4173 or by e-mail at williabb @ columb32.dhec.state.sc.us. Copies will be provided at a minimal cost per page.

Following review and consideration of comments, the proposed TMDL will be sent to EPA for approval shortly after June 25, 1999.

Please bring the foregoing to the attention of persons whom you believe will be interested in this matter.

Appendix E

State of South Carolina 303(d) List for 1998