DEPARTMENT OF ECOLOGY

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Eastern Regional Office

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EILS Program, Watershed Assessments Section

SUBJECT: BOD Loading from Quincy Industrial Wastewater Treatment System

INTRODUCTION

This memo presents the results of a modeling analysis of dissolved oxygen (DO) in the receiving water for effluent from the City of Quincy's Industrial Wastewater Treatment System (Quincy WTP). The City of Quincy operates an NPDES-permitted industrial wastewater treatment system to accommodate two local vegetable processing plants. The Quincy WTP discharges to irrigation wasteways within the Bureau of Reclamation's Columbia Basin Project (wasteways DW237, W645W, and W645). Dissolved oxygen in the receiving water is influenced by discharge of biochemical oxygen demand (BOD), including demand from oxidation of ammonia and nitrite (NBOD) and carbonaceous BOD (CBOD). Allowable BOD loading was also found to be significantly related to effluent DO.

Dissolved oxygen was modeled using the QUAL2E model developed by the U.S. Environmental Protection Agency (Brown and Barnwell, 1987). Calibration and verification of the QUAL2E model was accomplished using data from four surveys collected by CH_2M-Hill during 1991 and 1992 (CH_2M-Hill, 1992). The QUAL2E model represented conditions significantly better than the Streeter-Phelps model used by CH_2M-Hill (Paulson, 1992). Waste Load Allocations (WLAs) for 5-day BOD (BOD_5) are proposed in this memo based on use of the QUAL2E model to assess compliance with DO standards.

QUAL2E MODEL CALIBRATION AND VERIFICATION

Model Structure and Approach

QUAL2E is a one-dimensional, steady-state numerical model capable of simulating a variety of conservative and non-conservative water quality parameters. QUAL2E was calibrated to the Quincy receiving water to simulate dissolved oxygen, biochemical oxygen demand, and ammonia at steady-state conditions. The major constituent interactions modeled in the Quincy receiving water system are shown in Figure 1.

The receiving water system was divided into seven reaches for QUAL2E modeling. A schematic of reaches and loading sources is presented in Table 1 using model notation documented in Brown and Barnwell (1987). The location of CH_2M-Hill sampling stations during 1991 and 1992 is also shown in Table 1. Each reach was divided into computational elements with a length of 0.1 mile, which were assumed to have uniform steady-state concentrations of modeled constituents.

The model was calibrated using data collected during the third sampling survey by CH_2M-Hill, which occurred on October 22, 1991. Kinetic coefficients calibrated to the October 22 survey were then applied to the other three CH_2M-Hill surveys for model verification. Comparison of the results of the model fit to the four surveys tested the validity of the model over a wide range of seasonal conditions. After calibration and verification, the model was run at selected reasonable worst-case design conditions to determine the amount of CBOD loading that would meet DO standards.

Relationship Between BOD_5 and Ultimate CBOD

QUAL2E models CBOD as ultimate carbonaceous BOD (CBODU). CBODU was estimated from measured 5-day BOD (BOD_5) by the following relationship at the typical BOD decay rate (Brown and Barnwell, 1987; EPA, 1985a):

$$BOD_5 = 0.68 * CBODU.$$

Velocity, Temperature, and Incremental Inflows

Sampling data collected by CH_2M-Hill were used to directly calculate velocity, temperature, and incremental inflows in QUAL2E reaches (Table 2). Nonpoint sources such as drains and groundwater inflows were accounted for using QUAL2E's incremental inflows, which were assumed to occur uniformly over the entire length of the QUAL2E reaches. The largest drain inputs between CH_2M-Hill stations 2-UP/2-DN and 5-UP/5-DN were represented by QUAL2E pointloads instead of incremental inflows (see next section). Incremental inflow rates between CH_2M-Hill stations 1-UP/1.5, 1.5/2-UP, 2-DN/3, 3/4, and 4/5-UP were estimated based on differences in flows between the CH_2M-Hill stations.

Concentrations of dissolved oxygen, CBOD, organic-N, ammonia-N, and nitrite-N were assumed to be represented by the flow-weighted average concentrations that were measured or estimated from three locations: 1) CH2M-Hill station 1-UP; 2) the drains discharging between CH2M-Hill stations 2-UP and 2-DOWN; and 3) the drains discharging between stations 5-UP and 5-DOWN. Loading and concentrations from drains between stations 2-UP/2-DOWN and 5-UP/5-DOWN were estimated based on flow and loading differences between upstream and downstream stations. The resulting estimates of flows and flow-weighted average concentrations for incremental inflows are presented in Table 2.

Headwater and Pointload Inputs

QUAL2E refers to loading from sources at the upstream end of the model network as headwater loads. Headwater loads in the Quincy receiving water model were estimated by data from CH_2M-Hill station 1-UP. Direct discharges to the model system are referred to as pointloads. Three loading sources were included as QUAL2E pointloads: 1) the Quincy WTP; 2) the drains discharging between CH_2M-Hill stations 2-UP and 2-DOWN; and 3) the drains discharging between CH_2M-Hill stations 5-UP and 5-DOWN. Other drains and groundwater inputs were included as incremental inflows (see previous section). The WTP load was estimated based on measured loading during the CH_2M-Hill study. Loading from the two drain pointloads was estimated based on differences in flow and loading between upstream and downstream stations 2-UP/2-DN and 5-UP/5-DN. The estimated headwater and pointload inputs for the QUAL2E model are presented in Table 3.

Kinetic Coefficients for Dissolved Oxygen and Nitrogen Cycle Simulation

A total of seven constants and kinetic coefficients were selected during model calibration to simulate the dissolved oxygen and nitrogen cycles shown in Figure 1. Table 4 shows the calibration coefficients selected to fit observed conditions during the October 22, 1991 survey. The coefficients shown in Table 4 were also applied to the other three CH_2M-Hill sampling events to test the performance of the model under the range of seasonal conditions. Full printouts of the final calibration and verification input files for the four CH_2M-Hill survey dates are presented in Appendix A.

The coefficients α_5 and α_6 represent the oxygen uptake per unit of ammonia and nitrite oxidized. The values selected represent the stoichiometric amounts of oxygen required as recommended by EPA (1985b).

The rate constants for biological oxidation of nitrite to nitrate (β_2) and hydrolysis of organic-N to ammonia (β_3) were specified from typical reported values (EPA, 1985b) and not varied during model calibration. The value of β_2 was selected from near the high end of reported values to approximate a single-stage process of nitrification controlled by the rate of oxidation of ammonia to nitrate (β_1), which typically is slower than β_2.

The reaeration rate (K_2) was estimated as 3 day^{-1} (at 20 degrees C and base e), which is the same value assumed by CH_2M-Hill in their Streeter-Phelps model. The selected reaeration rate is typical of the mid-range of reported values in streams with similar depth, velocity, and flow (NCASI, 1990). The reaeration rate was not varied during model calibration.

The ammonia oxidation (β_1) and CBOD decay (K_1) rate constants were varied during model calibration to achieve the selected best fit to the observed data. The final selected values (Table 4) are within the range of typical values reported in similar streams (EPA, 1985b).

Temperature Correction of Coefficients

Reaction coefficients in Table 4 (except α_5 and α_6) are reported at 20 degrees C using base e of the natural logarithms. The QUAL2E model allows correction of actual reaction rates from the rate at 20 degrees C to the ambient temperature of the receiving water during simulations. The temperature corrections used were commonly accepted values from the scientific literature (EPA, 1985b; EPA, 1991a) using the formula:

$$X_T = X_{20}\,\theta^{(T-20)}$$

where

X_T = the value of the coefficient at the local temperature (T in degrees C)

X_{20} = the value of the coefficient at the standard temperature of 20 degrees C

θ = an empirical constant from literature for each reaction coefficient.

The values used for the empirical constants for temperature correction were as follows:

QUAL2E Coefficient (Table 4)	θ
β_1	1.080
β_2	1.047
β_3	1.047
K_1	1.047
K_2	1.024

Comparison of Observed and Modeled Dissolved Oxygen

The simulated DO using QUAL2E is compared with observed and modeled values by CH_2M-Hill in Figure 2. The QUAL2E input files for the four CH2M-Hill sampling events are presented in Appendix A. The QUAL2E model was found to significantly improve the prediction accuracy compared with the Streeter-Phelps model used by CH_2M-Hill. The uncertainty of model prediction was estimated by the root-mean-squared-error (RMSE), which is a commonly used measure of model error (Reckhow, *et al.*, 1986). The RMSE is a measure of the difference between model predictions and measured values. The QUAL2E model had an overall RMSE for DO of 0.7 mg/L compared with 1.4 mg/L for the CH_2M-Hill model. For the most critical summer event (October 22, 1991) the QUAL2E model fit the observed data with a RMSE of 0.4 mg/L compared with 2.8 mg/L for the CH_2M-Hill model.

The CH_2M-Hill model was least accurate during the most critical summer sampling event (Figure 2), probably because dilution of low DO inputs from nonpoint sources was not represented. The QUAL2E model fit was least accurate during the January 21, 1992, sampling event, probably because CBOD measurements of input loads did not represent average loads accurately. The QUAL2E model was considered acceptable for evaluating waste load allocations (WLAs) of BOD from the Quincy WTP based on the accuracy of the model over a wide range of seasonal conditions.

WASTE LOAD ALLOCATIONS FOR BOD

Waste Load Allocations (WLAs) for BOD were estimated as the maximum amount of loading from the Quincy WTP which would meet the water quality standard for DO in the receiving water under an assumed set of critical conditions. Separate WLAs were estimated for the summer (April-October) and winter (November-March) conditions. The seasonal periods were chosen based on the irrigation season of April-October (Merrill, 1993).

Dissolved Oxygen Standard and Targets for QUAL2E Modeling

The receiving water for the Quincy WTP effluent is Class AA according to Chapter 173-201A WAC. The Water Quality Program's Eastern Regional Office has determined that a DO standard of 8 mg/L is appropriate to meet beneficial uses of the receiving water (Merrill, 1993). Concentrations of DO less than 8 mg/L were observed by CH_2M-Hill in the receiving water downstream from the effluent discharge during summer. Concentrations were well above 8 mg/L during critical winter conditions.

For the purpose of estimating allowable BOD loading from the Quincy WTP during summer when receiving water DO is less than 8 mg/L, the DO standard was assumed to be met if the WTP was predicted to cause an insignificant depletion of DO. Insignificant depletion was defined as less than a 0.2 mg/L depletion using the QUAL2E model, which is within the magnitude of measurement and modeling uncertainties. This definition was assumed to be consistent with the antidegradation requirements of WAC 173-201A-070, which specify that when natural conditions are of a lower quality than the criteria assigned, the natural conditions constitute the water quality criteria. DO depletion of no more than 0.2 mg/L below background conditions is assumed to be small enough to prevent interference with existing beneficial uses. Defining insignificant DO depletion as no more than 0.2 mg/L also has precedent in the marine DO standards of WAC 173-201A and has been approved in NPDES permits to protect Washington's freshwater standards (e.g., EPA Permit No. ID-000116-3; Potlatch Corporation, Lewiston, Idaho; discharge to the Snake River at the state line).

For the winter season when receiving water DO was well above 8 mg/L, the DO standard was assumed to be met if the Quincy WTP did not cause predicted downstream DO to decrease below a 24-hour average of 8.5 mg/L. An in-stream target of 8 mg/L was not considered to be appropriate for the QUAL2E model result because the model prediction is a 24-hour average and the DO standard is an instantaneous minimum. Using an in-stream DO target of 8.5 mg/L allows a safety factor to account for expected diurnal variability and uncertainty and is consistent with EILS guidelines and EPA technical guidance for WLA modeling (EPA, 1980).

Critical Effluent Flow Rates

The actual wastewater flows are presently not precisely known (Merrill, 1993). The average monthly flow is estimated to be 5 cfs (3.23 mgd). Effluent flows during the four CH_2M-Hill surveys ranged from 1.3 to 2.7 mgd. Effluent flows for WLAs should be representative of reasonable extreme conditions, which would be higher than average flows. For evaluation of WLAs for BOD, effluent flows were estimated to be 4 mgd, which is assumed to represent potential high flows based on available data.

Effluent Ammonia Limits

Ammonia from the Quincy WTP is part of the total BOD load. Ammonia is used to estimate NBOD in the QUAL2E model. The amount of ammonia loading for estimating WLAs for BOD was determined based on likely ammonia limits required to meet toxicity criteria for un-ionized ammonia at the mixing zone boundary. WLAs for ammonia were estimated assuming that 25% of the receiving water flow would be allowed for dilution to comply with the un-ionized ammonia standard (Chapter 173-201A-100 WAC). Temperature and pH measured by CH_2M-Hill downstream from the effluent outfall (station 1-DN) were used to estimate ammonia criteria. The most limiting ammonia criteria are represented by the July 30, 1991 sampling for the summer period and the February 20, 1991 sampling for the winter period (Table 5).

WLAs for ammonia were estimated from effluent dilution, ammonia criteria, and upstream ammonia concentrations (Table 6). Effluent dilution factors and ammonia WLAs were estimated in Table 6 as follows:

$$DF_{chronic} = (Q_{wtp} + 0.25 * Q_{up}) / Q_{wtp}$$

$$DF_{acute} = (Q_{wtp} + 0.025 * Q_{up}) / Q_{wtp}$$

$$WLA_{chronic} = (WQS_{chronic} * DF_{chronic}) - (C_{up} * (DF_{chronic} - 1))$$

$$WLA_{acute} = (WQS_{acute} * DF_{acute}) - (C_{up} * (DF_{acute} - 1))$$

where:

$DF_{chronic}$ = dilution factor at the chronic mixing zone boundary

DF_{acute} = dilution factor at the acute mixing zone boundary

$WLA_{chronic}$ = chronic WLA for effluent total ammonia-N

WLA_{acute} = acute WLA for effluent total ammonia-N

Q_{up} = flow upstream from Quincy WTP (CH2M-Hill station 1-UP)

Q_{wtp} = Quincy WTP flow

$WQS_{chronic}$ = chronic water quality standard for total ammonia

WQS_{acute} = acute water quality standard for total ammonia

C_{up} = ammonia concentration upstream from Quincy WTP (station 1-UP)

The calculation of water quality-based effluent limits for ammonia (Table 6) is based on the procedure in EPA's Technical Support Document for Water Quality-based Toxics Control (EPA, 1991b) and Ecology's Permit Writer's Manual (Ecology, 1993). For estimating WLAs for BOD, effluent ammonia-N was estimated to be 1.88 mg/L during summer and 2.44 mg/L during winter. The WLA for BOD was not sensitive to different ammonia WLAs in the range of limiting values presented in Table 6.

Effluent Dissolved Oxygen

The DO concentration in effluent from the Quincy WTP was found to significantly affect the DO in the receiving water near the point of discharge because of relatively low dilution. The WLA for BOD was related to the effluent DO. The WLA for BOD increases as the effluent DO increases. A permit limit for effluent DO is recommended to meet water quality standards for DO at the boundary of the mixing zone, and to determine an appropriate WLA for BOD.

Table 7 presents calculations of minimum allowable effluent dissolved oxygen concentrations to meet a receiving water standard of 8 mg/L. Effluent DO measured by CH_2M-Hill is likely to be less than the estimated minimum required based on February 20 and October 22, 1991 data. Assuming that 100% of the upstream flow will be allowed for meeting the DO standard at the mixing zone boundary, minimum effluent DO should not be less than 7.3 mg/L during the summer and 6.8 mg/L during the winter seasons. If the effluent is restricted to using no more than 25% of the upstream flow to meet the DO standard at the mixing zone boundary, then effluent DO should not be less than 7.8 mg/L during summer or less than 7.7 mg/L during winter.

Critical Conditions in the Receiving Water for WLA Modeling of DO

When a steady-state water quality model such as QUAL2E is used to derive a WLA, the pollutant loading is introduced into the model under a given set of assumed water quality conditions (e.g., receiving water flows, temperature, background, and nonpoint source loading). A trial-and-error procedure was used to find a WLA for BOD that produced an in-stream DO concentration that just satisfied the water quality standard for DO (EPA, 1983). The receiving water conditions that were used in WLA modeling are called critical conditions.

Data characterizing the receiving water are limited to the four surveys conducted by CH_2M-Hill during 1991 and 1992. The October 22, 1991 survey exhibited the lowest DO and effluent dilution. Therefore, the October survey was assumed to represent the worst observed case for receiving water conditions and background causes of low DO during summer. The February 20, 1991, survey conditions were the most critical for the winter season.

It is possible that receiving water conditions more restrictive than those observed by CH_2M-Hill could occur. For example, a worse summer condition would occur if the higher temperatures measured in July 1991 occurred when flows and nonpoint loadings were similar to October 1991. However, it is also possible that these conditions would not occur together. The receiving water conditions are influenced by irrigation practices which maintain higher instream flows during summer than fall and winter. The critical conditions for summer appear to be likely at the end of the irrigation season when instream flows and temperatures decline. Therefore, the October 1991 conditions may be typical of critical summer conditions. Further receiving water sampling would probably be required during the July through October period to confirm the possibility of conditions being more critical than those observed by CH_2M-Hill during the summer of 1991.

Effluent DO less than 8 mg/L was found to severely limit the amount of BOD that could be discharged and still meet the water quality standard. For example, if effluent DO is 7.5 mg/L or less, then no BOD loading would be permissible at the critical conditions for summer. For the purpose of estimating WLAs for BOD, effluent DO was assumed to be limited to no less than 8 mg/L. Higher minimum effluent DO's of 8.5 and 9 mg/L were also evaluated to determine the sensitivity of WLAs for BOD to effluent DO.

QUAL2E Model Results for WLAs

The QUAL2E model was used to determine WLAs for BOD loading from the Quincy WTP. Various concentrations of effluent CBODU and DO were input to the model until the combination which just satisfied the DO standard was found. Three effluent DO concentrations were evaluated: 8, 8.5, and 9 mg/L. WLAs for BOD at each effluent DO concentration were found by trial. The QUAL2E model results and effluent WLAs represent 24-hour average concentrations of BOD which should not be exceeded.

The QUAL2E input files used for WLA modeling are the same as those presented in Appendix A for October 22, 1993 (summer critical condition) and February 20, 1991 (winter critical condition) with the following exceptions:

- Summer WLA: Quincy effluent flow of 4 mgd and effluent ammonia-N concentration of 1.88 mg/L were used. Quincy effluent DO of 8, 8.5 and 9 mg/L were used and CBODU concentrations that resulted in compliance with the DO standard were found by trial for each effluent DO. The DO standard for summer was assumed to be met if the model result showed no more than 0.2 mg/L depletion of DO from background conditions when receiving water DO was less than 8 mg/L.

Background conditions of receiving water DO were defined as the receiving water DO that would result if there was no discharge from the Quincy WTP. Background conditions for summer were determined by running the October 22, 1993 QUAL2E input file (Appendix A) with effluent discharge from the Quincy WTP set to zero. The resulting background DO is shown in Figure 3 in comparison with survey conditions and WLA predictions.

- Winter WLA: Quincy effluent flow of 4 mgd and effluent ammonia-N concentration of 2.44 mg/L were used. Quincy effluent DO of 8, 8.5 and 9 mg/L were used and CBODU concentrations that resulted in compliance with the DO standard were found by trial. The DO standard for winter was assumed to be met if the model result showed no less than 8.5 mg/L of DO at any point in the receiving water model network.

WLAs for 5-day BOD (BOD_5) were estimated from CBODU using the relationship described in the model calibration section. The following WLAs for BOD_5 were found by the trial procedure using the QUAL2E model:

Summer WLAs (April-October)			
Minimum 1-day average DO (mg/L)	8.0	8.5	9.0
Maximum 1-day average BOD_5 (mg/L)	95.2	126	143
Maximum 1-day average BOD_5 (lbs/d)	3,180	4,200	4,770
Winter WLAs (November-March)			
Minimum 1-day average DO (mg/L)	8.0	8.5	9.0
Maximum 1-day average BOD_5 (mg/L)	136	163	177
Maximum 1-day average BOD_5 (lbs/d)	4,540	5,450	5,900

Recommended Implementation of WLAs in NPDES Permit Limits

The WLAs presented in the previous section are recommended as maximum 1-day average concentrations and loads for BOD and minimum 1-day average concentrations for DO. Since the DO standard is a single value that is to be exceeded at all times, the WLAs would be protective of the standard if only a daily maximum limit for BOD_5 is included in the permit. If the Regional Office decides to also include a maximum average monthly limit in the permit, the statistical procedure described in Box 5-2 of EPAs Technical Support Document would be appropriate (EPA, 1991b). The maximum average monthly limit, if included, would vary depending on the variability of effluent BOD concentrations.

The statistical procedure described by EPA (1991b) was used to calculate a multiplier which can be applied to the maximum 1-day average WLAs to estimate maximum average monthly limits. The following formula relates maximum average monthly limits (AML) to the WLA:

$$AML = WLA * \exp[0.5\sigma^2 - 2.326\sigma] * \exp[1.645\sigma_n - 0.5\sigma_n^2]$$

where:

σ^2 $= \ln(CV^2 + 1)$

CV = long-term coefficient of variation of effluent BOD_5
= (standard deviation/mean)

σ_n^2 $= \ln((CV^2/n) + 1)$

n = number of samples per month for compliance monitoring.

For the 12-month period of December, 1992 through November, 1993, the mean and standard deviation of 94 observations of BOD_5 were 25.7 and 26.1 mg/L, respectively (Merrill, 1993). Therefore, the coefficient of variation was 1.02. The maximum average monthly limit (AML), assuming 20 samples per month for future compliance monitoring can be estimated from the formula above as follows based on historical CV:

$$AML = 0.283 * WLA.$$

If the variability of effluent BOD_5 concentrations can be decreased through operational changes or new treatment processes, then the AML could be increased depending on the new CV. A new multiplier to estimate the AML from the WLA can be calculated using the above equations if the effluent CV changes.

The permit limits should specify minimum effluent DO concentrations and maximum effluent BOD_5 concentrations and loads. Each of the combinations of effluent DO and BOD WLAs presented in the previous section are equally protective of the DO standard. The Regional Office can include the range of combinations in the permit or select a single combination, depending on whichever is most appropriate considering design of the wastewater treatment facility.

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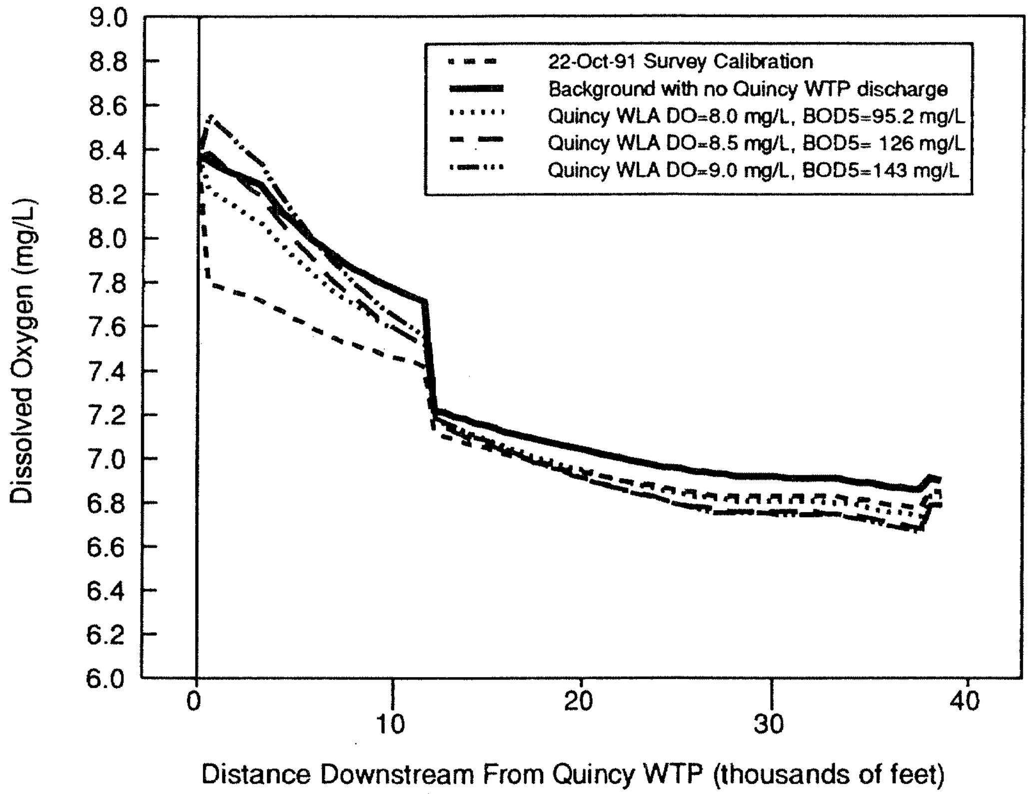

Figure 3. Comparison of receiving water DO during the October 22, 1991 survey with background and WLA predictions for summer based on October 22.

Table 1. Schematic of QUAL2E reaches and computational elements.

Spreadsheet QUINQUAL.WK1

Revised: 26-Jan-94 QUAL2E Compu-tational Element	Up-stream Boundary Distance From WTP (mi)	Down-stream Boundary Distance From WTP (mi)	Down-stream Boundary Distance From WTP (ft)	CH2M-Hill Station Repre-sented	QUAL2E Point Load to Element	QUAL2E Reach Number	QUAL2E Reach Element Number	QUAL2E DATA4 Flag (1=headwater 2=standard 6=pointload element type per Brown and Barnwell, 1987)
1	-0.1	0.0	0	1-UP		1	1	1
2	0.0	0.1	528	1-DN	QuincyWTP	1	2	6
3	0.1	0.2	1,056			1	3	2
4	0.2	0.3	1,584			1	4	2
5	0.3	0.4	2,112			1	5	2
6	0.4	0.5	2,640			1	6	2
7	0.5	0.6	3,168			1	7	2
8	0.6	0.7	3,696	1.5		2	1	2
9	0.7	0.8	4,224			2	2	2
10	0.8	0.9	4,752			2	3	2
11	0.9	1.0	5,280			2	4	2
12	1.0	1.1	5,808			2	5	2
13	1.1	1.2	6,336			2	6	2
14	1.2	1.3	6,864			2	7	2
15	1.3	1.4	7,392			2	8	2
16	1.4	1.5	7,920			2	9	2
17	1.5	1.6	8,448			2	10	2
18	1.6	1.7	8,976			2	11	2
19	1.7	1.8	9,504			2	12	2
20	1.8	1.9	10,032			2	13	2
21	1.9	2.0	10,560			2	14	2
22	2.0	2.1	11,088			2	15	2
23	2.1	2.2	11,616	2-UP		2	16	2
24	2.2	2.3	12,144	2-DN	Drain	3	1	6
25	2.3	2.4	12,672			3	2	2
26	2.4	2.5	13,200			3	3	2
27	2.5	2.6	13,728			3	4	2
28	2.6	2.7	14,256			3	5	2
29	2.7	2.8	14,784			3	6	2
30	2.8	2.9	15,312			3	7	6
31	2.9	3.0	15,840			3	8	2
32	3.0	3.1	16,368			3	9	2
33	3.1	3.2	16,896			3	10	2
34	3.2	3.3	17,424			3	11	2
35	3.3	3.4	17,952			3	12	2
36	3.4	3.5	18,480			3	13	2
37	3.5	3.6	19,008			3	14	2
38	3.6	3.7	19,536			3	15	2
39	3.7	3.8	20,064			3	16	2
40	3.8	3.9	20,592			3	17	2
41	3.9	4.0	21,120			3	18	2
42	4.0	4.1	21,648			3	19	2
43	4.1	4.2	22,176			4	1	6
44	4.2	4.3	22,704			4	2	2
45	4.3	4.4	23,232			4	3	2
46	4.4	4.5	23,760			4	4	2
47	4.5	4.6	24,288			4	5	2
48	4.6	4.7	24,816			4	6	2
49	4.7	4.8	25,344			4	7	2
50	4.8	4.9	25,872			4	8	2
51	4.9	5.0	26,400			4	9	2
52	5.0	5.1	26,928			4	10	2
53	5.1	5.2	27,456	3		5	1	2
54	5.2	5.3	27,984			5	2	2
55	5.3	5.4	28,512			5	3	2
56	5.4	5.5	29,040			5	4	2
57	5.5	5.6	29,568			5	5	2
58	5.6	5.7	30,096			5	6	2
59	5.7	5.8	30,624			5	7	2
60	5.8	5.9	31,152			5	8	2
61	5.9	6.0	31,680			5	9	2
62	6.0	6.1	32,208			5	10	2
63	6.1	6.2	32,736			5	11	2
64	6.2	6.3	33,264			5	12	2
65	6.3	6.4	33,792	4		6	1	2
66	6.4	6.5	34,320			6	2	2
67	6.5	6.6	34,848			6	3	2
68	6.6	6.7	35,376			6	4	2
69	6.7	6.8	35,904			6	5	2
70	6.8	6.9	36,432	5-UP		7	1	2
71	6.9	7.0	36,960			7	2	2
72	7.0	7.1	37,488			7	3	2
73	7.1	7.2	38,016		Drain	7	4	6
74	7.2	7.3	38,544	5-DN		7	5	2

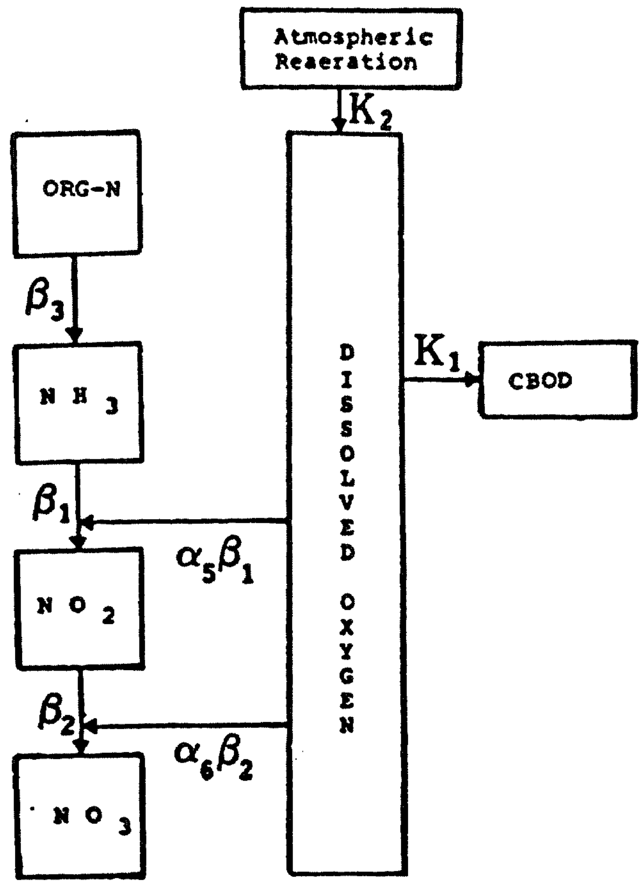

Figure 1. Major constituent interactions modeled in the receiving water for the Quincy Industrial Wastewater Treatment System using QUAL2E.

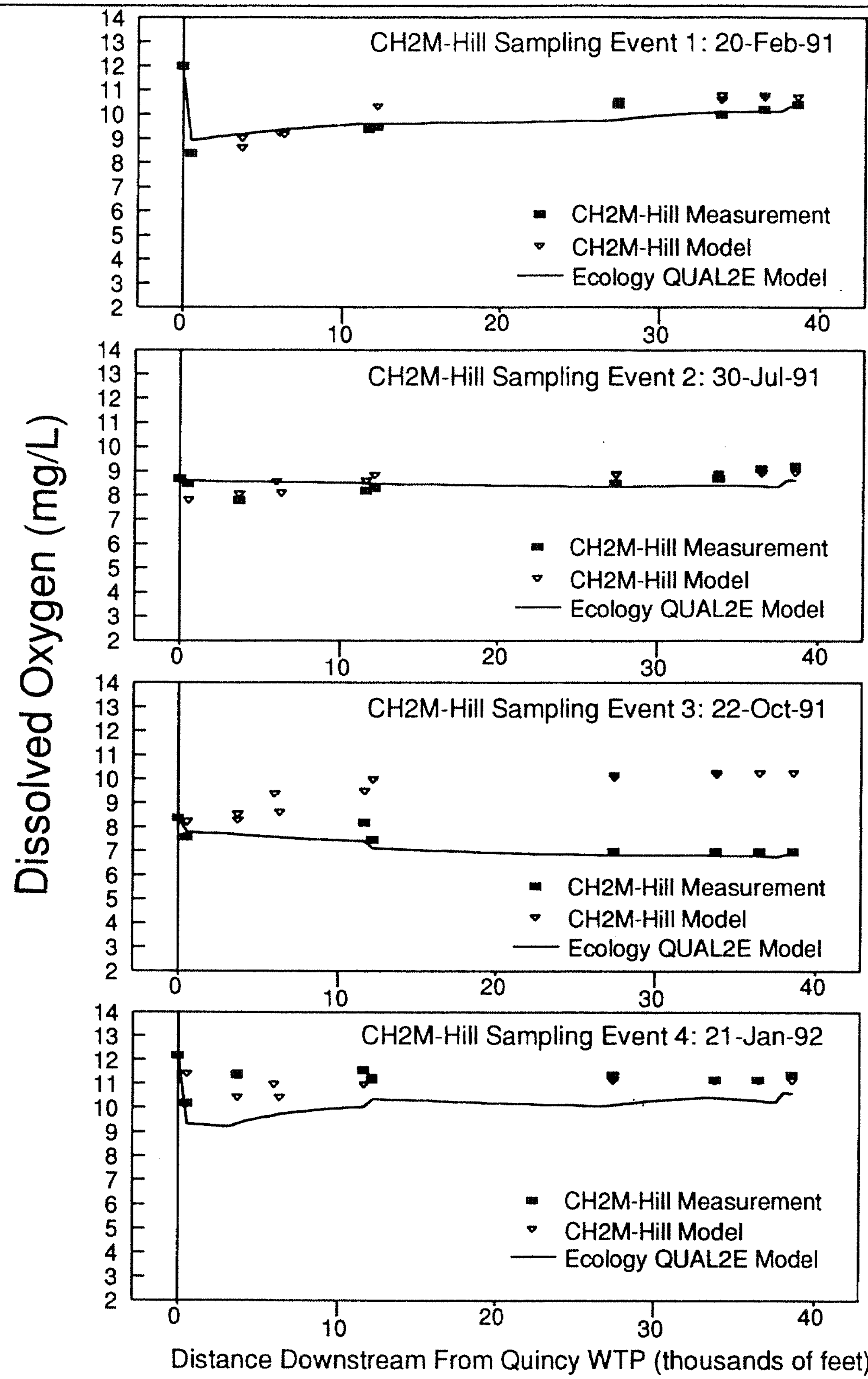

Figure 2: Comparison of measured dissolved oxygen, CH2M-Hill model results, and Ecology QUAL2E model results for Quincy WTP receiving water.

Table 2: QUAL2E reach input data summaries for Data Groups 5, 7, 8, and 8A.
Lotus File QUINCY1.WK1\tab1
Revised: 28-Dec-93

Sampling Date	QUAL2E Reach	Velocity (fps)	Temperature (deg F)	Incremental Inflow (cfs)	Incremental Inflow Diss. Oxygen (mg/L)	Incremental Inflow Ultimate CBOD (mg/L)	Incremental Inflow Organic-N (mg/L as Org-N)	Incremental Inflow Ammonia-N (mg/L as NH3-N)	Incremental Inflow Nitrite-N (mg/L as NO2-N)
20-Feb-91	1	1.38	45.4	1.073	10.5	5.54	2.608	0.186	0.002
20-Feb-91	2	1.38	45.4	2.627	10.5	5.54	2.608	0.186	0.002
20-Feb-91	3	1.54	51.2	1.365	10.5	5.54	2.608	0.186	0.002
20-Feb-91	4	1.54	51.2	0.735	10.5	5.54	2.608	0.186	0.002
20-Feb-91	5	1.94	51.5	14.500	10.5	5.54	2.608	0.186	0.002
20-Feb-91	6	1.79	51.6	2.200	10.5	5.54	2.608	0.186	0.002
20-Feb-91	7	1.52	52.1	0.000	10.5	5.54	2.608	0.186	0.002
30-Jul-91	1	3.00	71.2	-2.900	--	--	--	--	--
30-Jul-91	2	2.15	70.3	18.700	9.02	35.2	4.405	0.310	0.056
30-Jul-91	3	2.65	68.0	28.275	9.02	35.2	4.405	0.310	0.056
30-Jul-91	4	2.65	68.0	15.225	9.02	35.2	4.405	0.310	0.056
30-Jul-91	5	2.95	68.5	49.000	9.02	35.2	4.405	0.310	0.056
30-Jul-91	6	2.50	68.9	19.000	9.02	35.2	4.405	0.310	0.056
30-Jul-91	7	2.40	68.9	0.000	9.02	35.2	4.405	0.310	0.056
22-Oct-91	1	2.65	55.4	2.000	7.10	57.2	0.786	0.132	0.033
22-Oct-91	2	1.90	55.4	13.000	7.10	57.2	0.786	0.132	0.033
22-Oct-91	3	1.95	56.3	16.900	7.10	57.2	0.786	0.132	0.033
22-Oct-91	4	1.95	56.3	9.100	7.10	57.2	0.786	0.132	0.033
22-Oct-91	5	2.25	56.3	31.000	7.10	57.2	0.786	0.132	0.033
22-Oct-91	6	2.00	56.3	-5.000	--	--	--	--	--
22-Oct-91	7	2.00	56.3	0.000	7.10	57.2	0.786	0.132	0.033
21-Jan-92	1	1.50	40.6	0.000	11.5	81.8	5.017	0.000	0.000
21-Jan-92	2	1.30	43.7	6.300	11.5	81.8	5.017	0.000	0.000
21-Jan-92	3	2.05	48.2	2.665	11.5	81.8	5.017	0.000	0.000
21-Jan-92	4	2.05	48.2	1.435	11.5	81.8	5.017	0.000	0.000
21-Jan-92	5	2.65	48.7	15.500	11.5	81.8	5.017	0.000	0.000
21-Jan-92	6	1.80	49.6	1.500	11.5	81.8	5.017	0.000	0.000
21-Jan-92	7	1.35	50.0	0.000	11.5	81.8	5.017	0.000	0.000

Table 3: QUAL2E input data summary for data groups 10, 10A, 11, and 11A
Lotus File QUINCY1.WK1/tab2
Revised: 28-Dec-93

	Flow (cfs)	Diss. Oxygen (mg/L)	Ultimate CBOD (mg/L)	Organic-N (mg/L as Org-N)	Ammonia-N (mg/L as NH3-N)	Nitrite-N (mg/L as NO2-N)
Sampling Event 1: 20-Feb-91						
Headwater (CH2M-Hill station 1-UP):	1.8	12.0	2.94	2.700	0.100	0.010
Pointloads:						
Quincy WTP:	2.2	6.20	46.8	10.600	10.600	1.100
Drains between stations 2-UP and 2-DOWN:	10.6	9.57	2.19	1.747	0.756	0.090
Drains between stations 5-UP and 5-DOWN:	13.4	10.95	8.54	3.277	0.000	0.000
Sampling Event 1: 30-Jul-91						
Headwater (CH2M-Hill station 1-UP):	26.4	8.70	16.6	2.100	0.500	0.050
Pointloads:						
Quincy WTP:	5.9	8.40	29.9	16.900	1.500	2.400
Drains between stations 2-UP and 2-DOWN:	39.4	8.42	28.1	4.444	0.200	0.098
Drains between stations 5-UP and 5-DOWN:	71.0	9.48	46.1	5.241	0.300	0.036
Sampling Event 3: 22-Oct-91						
Headwater (CH2M-Hill station 1-UP):	11.0	8.40	13.7	1.200	0.040	0.020
Pointloads:						
Quincy WTP:	4.0	6.20	78.7	6.400	5.100	1.700
Drains between stations 2-UP and 2-DOWN:	33.0	6.86	100	0.818	0.227	0.094
Drains between stations 5-UP and 5-DOWN:	65.0	7.00	42.6	0.700	0.100	0.005
Sampling Event 4: 21-Jan-92						
Headwater (CH2M-Hill station 1-UP):	1.9	12.2	17.6	4.390	0.040	0.100
Pointloads:						
Quincy WTP:	3.5	7.80	124	8.990	8.100	0.420
Drains between stations 2-UP and 2-DOWN:	10.4	10.75	23.9	3.258	0.545	0.033
Drains between stations 5-UP and 5-DOWN:	15.1	11.97	130	6.308	0.000	0.000

Table 4. Summary of QUAL2E model coefficients for dissolved oxygen modeling.

QUAL2E Coefficient (Figure 1)	Description	Units (1)	Value Used
α_5	O_2 uptake per unit NH_3 oxidized	mg O/mg N	3.43
α_6	O_2 uptake per unit NO_2 oxidized	mg O/mg N	1.14
β_1	rate constant for biological oxidation of NH_3 to NO_2	day^{-1}	0.5
β_2	rate constant for biological oxidation of NO_2 to NO_3	day^{-1}	3
β_3	rate constant for hydrolysis of organic N to NH_3	day^{-1}	0.1
K_1	CBOD decay rate constant	day^{-1}	0.23
K_2	reaeration rate constant	day^{-1}	3

1) base e at 20 degrees C for first-order rate constants β_1, β_2, β_3, K_1, and K_2.

Table 5: Calculation of ammonia criteria in the mixing zone of Quincy WTP for CH2M-Hill Sampling dates.
Based on EPA Gold Book (EPA 440/5-86-001).

Lotus File NH3NCRIT.WK1/tab1 Revised 28-Dec-93

CH2M-Hill Sampling Event Date:	20-Feb-91	30-Jul-91	22-Oct-91	21-Jan-92
INPUT				
1. Temperature (deg C; 0<T<30) at station 1-DOWN:	6.0	21.5	12.5	4.5
2. pH (6.5<pH<9.0) at station 1-DOWN:	7.9	7.9	7.1	7.6
3. Acute TCAP (Salmonids present- 20; absent- 25):	20	20	20	20
4. Chronic TCAP (Salmonids present- 15; absent- 20):	15	15	15	15
OUTPUT				
1. Intermediate Calculations:				
Acute FT:	2.63	1.00	1.68	2.92
Chronic FT:	2.63	1.41	1.68	2.92
FPH:	1.05	1.05	2.40	1.30
RATIO:	16	16	32	19
pKa:	9.87	9.35	9.65	9.92
Fraction Of Total Ammonia Present As Un-ionized:	1.0654%	3.3995%	0.2840%	0.4756%
2. Un-ionized Ammonia Criteria:				
Acute (1-hour) Un-ionized Ammonia Criterion (ug/L as NH3-N):	77.2	203.0	53.1	56.1
Chronic (4-day) Un-ionized Ammonia Criterion (ug/L as NH3-N):	14.8	27.6	5.1	9.3
3. Total Ammonia Criteria:				
Acute Total Ammonia Criterion (ug/L as NH3-N):	7,243	5,971	18,704	11,804
Chronic Total Ammonia Criterion (ug/L as NH3-N):	1,393	813	1,804	1,961

Table 6: **Calculation of permit limits for ammonia from CH2M-Hill data assuming WTP design flow of 3.23 and 4 mgd and 25% of receiving stream for chronic and 2.5% for acute mixing zones. (see text for explanation of critical effluent flow rates).**

(based on EPA/505/2-90-001 Box 5-2).

Lotus File NH3NCRIT.WK1/tab2 Revised 28-Dec-93

Design Flow Assumption:	Quincy WTP Design Flow of 3.23 mgd:					Quincy WTP Design Flow of 4 mgd:				
CH2M-Hill Sampling Event Date for Criteria and Background Conditions:	20-Feb-91	30-Jul-91	22-Oct-91	21-Jan-92	worst of 30-Jul and 22-Oct-91 combined	20-Feb-91	30-Jul-91	22-Oct-91	21-Jan-92	worst of 30-Jul and 22-Oct-91 combined
INPUT										
1. Water Quality Standards (mg/L of total NH3-N)										
Acute (one-hour) Criteria (station 1-DOWN):	7.243	5.971	18.704	11.804	5.971	7.243	5.971	18.704	11.804	5.971
Chronic (n-day) Criteria (station 1-DOWN):	1.393	0.813	1.804	1.961	0.813	1.393	0.813	1.804	1.961	0.813
2. Upstream Receiving Water Concentration of ammonia-N (mg/L of total NH3-N)										
Upstream Concentration for Acute Condition (station 1-UP):	0.100	0.500	0.040	0.040	0.500	0.100	0.500	0.040	0.040	0.500
Upstream Concentration for Chronic Condition (station 1-UP):	0.100	0.500	0.040	0.040	0.500	0.100	0.500	0.040	0.040	0.500
3. Dilution Factors (1/(Effluent Volume Fraction))										
Upstream Flow (cfs)	1.8	26.4	11	1.9	11	1.8	26.4	11	1.9	11
Effluent Design Flow (cfs)	5.0	5.0	5.0	5.0	5.0	6.2	6.2	6.2	6.2	6.2
Acute Receiving Water Dilution Factor at 7Q10:	1.009	1.132	1.055	1.010	1.055	1.007	1.107	1.044	1.008	1.044
Chronic Receiving Water Dilution Factor at 7Q10:	1.090	2.321	1.550	1.095	1.550	1.073	2.066	1.444	1.077	1.444
4. Coefficient of Variation for Effluent Concentration (use 0.6 if data are not available):	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
5. Number of days (n1) for chronic average (usually four or seven; four is recommended):	4	4	4	4	4	4	4	4	4	4
6. Number of samples (n2) required per month for monitoring:	4	4	4	4	4	4	4	4	4	4
OUTPUT										
1. Z Statistics										
LTA Derivation (99%tile):	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
Daily Maximum Permit Limit (99%tile):	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326	2.326
Monthly Average Permit Limit (95%tile):	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
2. Calculated Waste Load Allocations (WLA's)										
Acute (one-hour) WLA:	7.307	6.693	19.731	11.916	6.272	7.295	6.554	19.533	11.894	6.214
Chronic (n1-day) WLA:	1.509	1.226	2.775	2.143	0.985	1.487	1.146	2.588	2.108	0.952
3. Derivation of LTAs using April 1990 TSD (Box 5-2 Step 2 & 3)										
Sigma^2:	0.3075	0.3075	0.3075	0.3075	0.3075	0.3075	0.3075	0.3075	0.3075	0.3075
Sigma^2-n1:	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862
LTA for Acute (1-hour) WLA:	2.346	2.149	6.335	3.826	2.014	2.342	2.104	6.272	3.819	1.995
LTA for Chronic (n1-day) WLA:	0.796	0.647	1.464	1.130	0.520	0.784	0.605	1.365	1.112	0.502
Most Limiting LTA (minimum of acute and chronic):	0.796	0.647	1.464	1.130	0.520	0.784	0.605	1.365	1.112	0.502
4. Derivation of Permit Limits From Limiting LTA (Box 5-2 Step 4)										
Sigma^2-n2:	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862	0.0862
Daily Maximum Permit Limit (mg/L of total NH3-N):	2.48	2.01	4.56	3.52	1.62	2.44	1.88	4.25	3.46	1.56
Monthly Average Permit Limit (mg/L of total NH3-N):	1.24	1.00	2.27	1.75	0.81	1.22	0.94	2.12	1.73	0.78
Daily Maximum Permit Limit (lbs/day of total NH3-N):	66.8	54.3	122.9	94.9	43.6	81.5	62.9	141.9	115.6	52.2
Monthly Average Permit Limit (lbs/day of total NH3-N):	33.3	27.1	61.2	47.3	21.7	40.6	31.3	70.7	57.6	26.0

Table 7. Minimum allowable effluent dissolved oxygen for Quincy WTP to meet a receiving water standard of 8 mg/L.
EFFDO.WK1 Revised: 29-Dec-93

CH2M-Hill Sampling Event	CH2M-Hill Survey Conditions					Critical Conditions		
Date	Station 1-Up Flow (cfs)	Station 1-Up DO (mg/L)	Quincy WTP Effluent Temp-erature (deg C)	Quincy WTP Effluent DO (mg/L)	Quincy WTP Effluent Saturation DO (1) (mg/L)	Quincy WTP Design Flow (cfs)	Minimum Allowable Effluent DO assuming complete mix (2) (mg/L)	Minimum Allowable Effluent DO allowing 25% of upstream flow (3) (mg/L)
Quincy WTP Design Flow of 3.23 mgd:								
20-Feb-91	1.8	12	4	6.2	12.5	5.0	6.6	7.6
30-Jul-91	26.4	8.7	22	8.4	8.4	5.0	4.3	7.1
22-Oct-91	11	8.4	12	6.2	10.3	5.0	7.1	7.8
21-Jan-92	1.9	12.2	2.5	7.8	13.0	5.0	6.4	7.6
Quincy WTP Design Flow of 4 mgd:								
20-Feb-91	1.8	12	4	6.2	12.5	6.2	6.8	7.7
30-Jul-91	26.4	8.7	22	8.4	8.4	6.2	5.0	7.3
22-Oct-91	11	8.4	12	6.2	10.3	6.2	7.3	7.8
21-Jan-92	1.9	12.2	2.5	7.8	13.0	6.2	6.7	7.7

1) Saturation concentration of dissolved oxygen in effluent in equilibrium with air with correction for local elevation of 1250 ft.

2) Minimum allowable effluent DO allowing complete mix of effluent with 100% of upstream flow =
((Qup + Qwtp) * 8 - (Qup * DOup))/ Qwtp

3) Minimum allowable effluent DO allowing mix of effluent with 25% of upstream flow =
((0.25*Qup + Qwtp) * 8 - (0.25*Qup * DOup))/ Qwtp

APPENDIX A

QUAL2E Input Files for Calibration
and Verification Predictions of
CH_2M-Hill Sampling Data

EVENT1N.IN
11/12/93

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TITLE01          QUINCY INDUSTRIAL WTP RECEIVIENG WATER MODEL
TITLE02          CALIBRATION TO CH2M-HILL EVENT 1, 20-FEB-91 INCL NH3N
TITLE03   NO     CONSERVATIVE MINERAL I
TITLE04   NO     CONSERVATIVE MINERAL II
TITLE05   NO     CONSERVATIVE MINERAL III
TITLE06   NO     TEMPERATURE
TITLE07  YES     BIOCHEMICAL OXYGEN DEMAND
TITLE08   NO     ALGAE AS CHL-A IN UG/L
TITLE09   NO     PHOSPHORUS CYCLE AS P IN MG/L
TITLE10            (ORGANIC-P, DISSOLVED-P)
TITLE11  YES     NITROGEN CYCLE AS N IN MG/L
TITLE12            (ORGANIC-N, AMMONIA-N, NITRITE-N, NITRITE-N)
TITLE13  YES     DISSOLVED OXYGEN IN MG/L
TITLE14   NO     FECAL COLIFORMS IN NO./100 ML
TITLE15   NO     ARBITRARY NON-CONSERVATIVE NH3N    MG/L
ENDTITLE
LIST DATA INPUT
WRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
DISCHARGE COEFFICIENTS
NO PRINT SOLAR/LCD DATA
NO PLOT DO AND BOD
FIXED DNSTM COND (YES=1)=   0.00000        5D-ULT BOD CONV K COEF  =   0.00000
INPUT METRIC (YES=1)    =   0.00000        OUTPUT METRIC (YES=1)   =   0.00000
NUMBER OF REACHES       =   7.00000        NUMBER OF JUNCTIONS     =   0.00000
NUM OF HEADWATERS       =   1.00000        NUMBER OF POINT LOADS   =   3.00000
TIME STEP (HOURS)       =                  LNTH  COMP  ELEMENT (DX)=   0.10000
MAXIMUM ITERATIONS      =  30.00000        TIME INC. FOR RPT2 (HRS)=
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)= 3.4300  O UPTAKE BY NO2 OXID(MG O/MG N)= 1.1400
O PROD  BY ALGAE (MG O/MG A)   = 1.6000  O UPTAKE BY ALGAE (MG O/MG A)  = 2.0000
N CONTENT OF ALGAE (MG N/MG A) = 0.0800  P CONTENT OF ALGAE (MG P/MG A) = 0.0110
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.3000  ALGAE RESPIRATION RATE (1/DAY) = 0.1200
N HALF SATURATION CONST (MG/L) = 0.0200  P HALF SATURATION CONST  (MG/L)= 0.0050
LIN ALG EXCO (1/FT)/(UGCHLA/L) = 0.0130  NLINCO (1/FT)/(UGCHLA/L)**(2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 1.0000  LIGHT SAT'N COEFF (BTU/FT2/MIN)= 0.0920
DAILY AVERAGING OPTION (LAVOPT)=      2  LIGHT AVERAGING FACTOR (AFACT) = 1.0000
NUMBER OF DAYLIGHT HOURS (DLH) = 14.000  TOTAL DAILY SOLR RAD (BTU/FT2) = 1800.0
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000  ALGAL PREF FOR NH3-N (PREFN)   = 0.9000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500  NITRIFICATION INHIBITION COEF  = 0.6000
ENDATA1A
THETA    NH3 DECA    1.080
ENDATA1B
STREAM REACH      1.RCH= W645W 1-UP/1.5     FROM       0.1     TO        -0.6
STREAM REACH      2.RCH= W645W 1.5/2-UP     FROM      -0.6     TO        -2.2
STREAM REACH      3.RCH= W645W 2-UP/DRAIN   FROM      -2.2     TO        -4.1
STREAM REACH      4.RCH= W645W DRAIN/3      FROM      -4.1     TO        -5.1
STREAM REACH      5.RCH= W645W 3/4          FROM      -5.1     TO        -6.3
STREAM REACH      6.RCH= W645W 4/5-UP       FROM      -6.3     TO        -6.8
STREAM REACH      7.RCH= W645W 5-UP/5-DN    FROM      -6.8     TO        -7.3
ENDATA2
ENDATA3
FLAG FIELD RCH=   1.         7          1 6 2 2 2 2 2
FLAG FIELD RCH=   2.        16          2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   3.        19          6 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   4.        10          2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   5.        12          2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   6.         5          2 2 2 2 2
FLAG FIELD RCH=   7.         5          2 2 2 6 2
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ENDATA4
HYDRAULICS RCH=   1.              1.380             1.000
HYDRAULICS RCH=   2.              1.380             1.000
HYDRAULICS RCH=   3.              1.540             2.000
HYDRAULICS RCH=   4.              1.540             2.000
HYDRAULICS RCH=   5.              1.940             2.000
HYDRAULICS RCH=   6.              1.790             2.000
HYDRAULICS RCH=   7.              1.520             2.000
ENDATA5
ENDATA5A
REACT COEF RCH=   1.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   2.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   3.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   4.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   5.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   6.   0.23   0.00   0.00   1   3.00
REACT COEF RCH=   7.   0.23   0.00   0.00   1   3.00
ENDATA6
N AND P COEF   RCH=   1.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   2.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   3.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   4.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   5.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   6.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   7.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
ENDATA6A
ALG/OTHER COEF RCH=   1.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   2.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   3.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   4.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   5.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   6.     0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=   7.     0.   0.00   0.00   0.00    0.0    0.0    0.
ENDATA6B
INITIAL COND-1 RCH=   1.   45.4
INITIAL COND-1 RCH=   2.   45.4
INITIAL COND-1 RCH=   3.   51.2
INITIAL COND-1 RCH=   4.   51.2
INITIAL COND-1 RCH=   5.   51.5
INITIAL COND-1 RCH=   6.   51.6
INITIAL COND-1 RCH=   7.   52.1
ENDATA7
INITIAL COND-2 RCH=   1.
INITIAL COND-2 RCH=   2.
INITIAL COND-2 RCH=   3.
INITIAL COND-2 RCH=   4.
INITIAL COND-2 RCH=   5.
INITIAL COND-2 RCH=   6.
INITIAL COND-2 RCH=   7.
ENDATA7A
INCR INFLOW-1   RCH=   1.  1.073          10.5  5.54
INCR INFLOW-1   RCH=   2.  2.627          10.5  5.54
INCR INFLOW-1   RCH=   3.  1.365          10.5  5.54
INCR INFLOW-1   RCH=   4.  0.735          10.5  5.54
INCR INFLOW-1   RCH=   5. 14.500          10.5  5.54
INCR INFLOW-1   RCH=   6.  2.200          10.5  5.54
INCR INFLOW-1   RCH=   7.  0.000          10.5  5.54
ENDATA8
INCR INFLOW-2   RCH=   1.          2.608  0.186  0.002
INCR INFLOW-2   RCH=   2.          2.608  0.186  0.002
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INCR INFLOW-2  RCH=   3.          2.608  0.186  0.002
INCR INFLOW-2  RCH=   4.          2.608  0.186  0.002
INCR INFLOW-2  RCH=   5.          2.608  0.186  0.002
INCR INFLOW-2  RCH=   6.          2.608  0.186  0.002
INCR INFLOW-2  RCH=   7.          2.608  0.186  0.002
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1.  1-UP               1.800        12.0  2.94
ENDATA10
HEADWTR-2  HDW=   1.                    2.700 0.100 0.010
ENDATA10A
POINTLD-1 PTL=   1. QUINCY WTP          2.200         6.20  46.8
POINTLD-1 PTL=   2. DRAIN 2U/D         10.600         9.57  2.19
POINTLD-1 PTL=   3. DRAIN 5U/D         13.400        10.95  8.54
ENDATA11
POINTLD-2  PTL=   1.                    10.60 10.60 1.100
POINTLD-2  PTL=   2.                    1.747 0.756 0.090
POINTLD-2  PTL=   3.                    3.277 0.000 0.000
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
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EVENT2N.IN
12/13/93

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TITLE01           QUINCY INDUSTRIAL WTP RECEIVIENG WATER MODEL
TITLE02           CALIBRATION TO CH2M-HILL EVENT 2, 30-JUL-91 W/NBOD .5/D
TITLE03   NO      CONSERVATIVE MINERAL I
TITLE04   NO      CONSERVATIVE MINERAL II
TITLE05   NO      CONSERVATIVE MINERAL III
TITLE06   NO      TEMPERATURE
TITLE07  YES      BIOCHEMICAL OXYGEN DEMAND
TITLE08   NO      ALGAE AS CHL-A IN UG/L
TITLE09   NO      PHOSPHORUS CYCLE AS P IN MG/L
TITLE10             (ORGANIC-P, DISSOLVED-P)
TITLE11  YES      NITROGEN CYCLE AS N IN MG/L
TITLE12             (ORGANIC-N, AMMONIA-N, NITRITE-N, NITRITE-N)
TITLE13  YES      DISSOLVED OXYGEN IN MG/L
TITLE14   NO      FECAL COLIFORMS IN NO./100 ML
TITLE15   NO      ARBITRARY NON-CONSERVATIVE NH3N    MG/L
ENDTITLE
LIST DATA INPUT
WRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
DISCHARGE COEFFICIENTS
NO PRINT SOLAR/LCD DATA
NO PLOT DO AND BOD
FIXED DNSTM COND (YES=1)=   0.00000      5D-ULT BOD CONV K COEF  =   0.00000
INPUT METRIC (YES=1)     =   0.00000      OUTPUT METRIC (YES=1)   =   0.00000
NUMBER OF REACHES        =   7.00000      NUMBER OF JUNCTIONS     =   0.00000
NUM OF HEADWATERS        =   1.00000      NUMBER OF POINT LOADS   =   3.00000
TIME STEP (HOURS)        =                LNTH  COMP  ELEMENT (DX)=   0.10000
MAXIMUM ITERATIONS       =  30.00000      TIME INC. FOR RPT2 (HRS)=
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)= 3.4300  O UPTAKE BY NO2 OXID(MG O/MG N)= 1.1400
O PROD  BY ALGAE (MG O/MG A)   = 1.6000  O UPTAKE BY ALGAE (MG O/MG A)   = 2.0000
N CONTENT OF ALGAE (MG N/MG A) = 0.0800  P CONTENT OF ALGAE (MG P/MG A) = 0.0110
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.3000  ALGAE RESPIRATION RATE (1/DAY) = 0.1200
N HALF SATURATION CONST (MG/L) = 0.0200  P HALF SATURATION CONST  (MG/L)= 0.0050
LIN ALG EXCO (1/FT)/(UGCHLA/L) = 0.0130  NLINCO (1/FT)/(UGCHLA/L)**(2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 1.0000  LIGHT SAT'N COEFF (BTU/FT2/MIN)= 0.0920
DAILY AVERAGING OPTION (LAVOPT)=      2  LIGHT AVERAGING FACTOR (AFACT) = 1.0000
NUMBER OF DAYLIGHT HOURS (DLH) = 14.000  TOTAL DAILY SOLR RAD (BTU/FT2) = 1800.0
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000  ALGAL PREF FOR NH3-N (PREFN)   = 0.9000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500  NITRIFICATION INHIBITION COEF  = 0.6000
ENDATA1A
THETA    NH3 DECA    1.080
ENDATA1B
STREAM REACH     1.RCH= W645W 1-UP/1.5     FROM        0.1     TO        -0.6
STREAM REACH     2.RCH= W645W 1.5/2-UP     FROM       -0.6     TO        -2.2
STREAM REACH     3.RCH= W645W 2-UP/DRAIN   FROM       -2.2     TO        -4.1
STREAM REACH     4.RCH= W645W DRAIN/3      FROM       -4.1     TO        -5.1
STREAM REACH     5.RCH= W645W 3/4          FROM       -5.1     TO        -6.3
STREAM REACH     6.RCH= W645W 4/5-UP       FROM       -6.3     TO        -6.8
STREAM REACH     7.RCH= W645W 5-UP/5-DN    FROM       -6.8     TO        -7.3
ENDATA2
ENDATA3
FLAG FIELD RCH=  1.       7       1 6 2 2 2 2 2
FLAG FIELD RCH=  2.      16       2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  3.      19       6 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  4.      10       2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  5.      12       2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  6.       5       2 2 2 2 2
FLAG FIELD RCH=  7.       5       2 2 2 6 2
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ENDATA4
HYDRAULICS RCH=   1.              3.000              1.000
HYDRAULICS RCH=   2.              2.150              1.000
HYDRAULICS RCH=   3.              2.650              2.000
HYDRAULICS RCH=   4.              2.650              2.000
HYDRAULICS RCH=   5.              2.950              2.000
HYDRAULICS RCH=   6.              2.500              2.000
HYDRAULICS RCH=   7.              2.400              2.000
ENDATA5
ENDATA5A
REACT COEF RCH=   1.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   2.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   3.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   4.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   5.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   6.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   7.    0.23    0.00    0.00   1    3.00
ENDATA6
N AND P COEF    RCH=   1.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   2.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   3.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   4.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   5.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   6.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF    RCH=   7.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
ENDATA6A
ALG/OTHER COEF RCH=    1.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    2.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    3.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    4.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    5.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    6.      0.   0.00   0.00   0.00    0.0    0.0    0.
ALG/OTHER COEF RCH=    7.      0.   0.00   0.00   0.00    0.0    0.0    0.
ENDATA6B
INITIAL COND-1 RCH=   1.   71.2
INITIAL COND-1 RCH=   2.   70.3
INITIAL COND-1 RCH=   3.   68.0
INITIAL COND-1 RCH=   4.   68.0
INITIAL COND-1 RCH=   5.   68.5
INITIAL COND-1 RCH=   6.   68.9
INITIAL COND-1 RCH=   7.   68.9
ENDATA7
INITIAL COND-2 RCH=   1.
INITIAL COND-2 RCH=   2.
INITIAL COND-2 RCH=   3.
INITIAL COND-2 RCH=   4.
INITIAL COND-2 RCH=   5.
INITIAL COND-2 RCH=   6.
INITIAL COND-2 RCH=   7.
ENDATA7A
INCR INFLOW-1   RCH=   1. -2.900         9.02  35.2
INCR INFLOW-1   RCH=   2. 18.700         9.02  35.2
INCR INFLOW-1   RCH=   3. 28.275         9.02  35.2
INCR INFLOW-1   RCH=   4. 15.225         9.02  35.2
INCR INFLOW-1   RCH=   5. 49.000         9.02  35.2
INCR INFLOW-1   RCH=   6. 19.000         9.02  35.2
INCR INFLOW-1   RCH=   7.  0.000         9.02  35.2
ENDATA8
INCR INFLOW-2   RCH=   1.          4.405  0.310  0.056
INCR INFLOW-2   RCH=   2.          4.405  0.310  0.056
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INCR INFLOW-2  RCH=   3.         4.405  0.310  0.056
INCR INFLOW-2  RCH=   4.         4.405  0.310  0.056
INCR INFLOW-2  RCH=   5.         4.405  0.310  0.056
INCR INFLOW-2  RCH=   6.         4.405  0.310  0.056
INCR INFLOW-2  RCH=   7.         4.405  0.310  0.056
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1.  1-UP              26.40         8.70  16.6
ENDATA10
HEADWTR-2  HDW=   1.                   2.100 0.500 0.050
ENDATA10A
POINTLD-1 PTL=   1. QUINCY WTP         5.900         8.40  29.9
POINTLD-1 PTL=   2. DRAIN 2U/D        39.400         8.42  28.1
POINTLD-1 PTL=   3. DRAIN 5U/D        71.000         9.48  46.1
ENDATA11
POINTLD-2  PTL=   1.                   16.90 1.500 2.400
POINTLD-2  PTL=   2.                   4.444 0.200 0.098
POINTLD-2  PTL=   3.                   5.241 0.300 0.036
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
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EVENT3N.IN
12/14/93

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TITLE01              QUINCY INDUSTRIAL WTP RECEIVIENG WATER MODEL
TITLE02              CALIBRATION TO CH2M-HILL EVENT 3, 22-OCT-91 W/ NBOD
TITLE03    NO        CONSERVATIVE MINERAL I
TITLE04    NO        CONSERVATIVE MINERAL II
TITLE05    NO        CONSERVATIVE MINERAL III
TITLE06    NO        TEMPERATURE
TITLE07   YES        BIOCHEMICAL OXYGEN DEMAND
TITLE08    NO        ALGAE AS CHL-A IN UG/L
TITLE09    NO        PHOSPHORUS CYCLE AS P IN MG/L
TITLE10                (ORGANIC-P, DISSOLVED-P)
TITLE11   YES        NITROGEN CYCLE AS N IN MG/L
TITLE12                (ORGANIC-N, AMMONIA-N, NITRITE-N, NITRITE-N)
TITLE13   YES        DISSOLVED OXYGEN IN MG/L
TITLE14    NO        FECAL COLIFORMS IN NO./100 ML
TITLE15    NO        ARBITRARY NON-CONSERVATIVE NH3N    MG/L
ENDTITLE
LIST DATA INPUT
WRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
DISCHARGE COEFFICIENTS
NO PRINT SOLAR/LCD DATA
NO PLOT DO AND BOD
FIXED DNSTM COND (YES=1)=   0.00000        5D-ULT BOD CONV K COEF  =   0.00000
INPUT METRIC (YES=1)    =   0.00000        OUTPUT METRIC (YES=1)   =   0.00000
NUMBER OF REACHES       =   7.00000        NUMBER OF JUNCTIONS     =   0.00000
NUM OF HEADWATERS       =   1.00000        NUMBER OF POINT LOADS   =   3.00000
TIME STEP (HOURS)       =                  LNTH  COMP  ELEMENT (DX)=   0.10000
MAXIMUM ITERATIONS      =  30.00000        TIME INC. FOR RPT2 (HRS)=
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)= 3.4300  O UPTAKE BY NO2 OXID(MG O/MG N)= 1.1400
O PROD  BY ALGAE (MG O/MG A)   = 1.6000  O UPTAKE BY ALGAE (MG O/MG A)  = 2.0000
N CONTENT OF ALGAE (MG N/MG A) = 0.0800  P CONTENT OF ALGAE (MG P/MG A) = 0.0110
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.3000  ALGAE RESPIRATION RATE (1/DAY) = 0.1200
N HALF SATURATION CONST (MG/L) = 0.0200  P HALF SATURATION CONST  (MG/L)= 0.0050
LIN ALG EXCO (1/FT)/(UGCHLA/L) = 0.0130  NLINCO (1/FT)/(UGCHLA/L)**(2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 1.0000  LIGHT SAT'N COEFF (BTU/FT2/MIN)= 0.0920
DAILY AVERAGING OPTION (LAVOPT)=      2  LIGHT AVERAGING FACTOR (AFACT) = 1.0000
NUMBER OF DAYLIGHT HOURS (DLH) = 14.000  TOTAL DAILY SOLR RAD (BTU/FT2) = 1800.0
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000  ALGAL PREF FOR NH3-N (PREFN)   = 0.9000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500  NITRIFICATION INHIBITION COEF  = 0.6000
ENDATA1A
THETA    NH3 DECA    1.080
ENDATA1B
STREAM REACH     1.RCH= W645W 1-UP/1.5    FROM      0.1    TO        -0.6
STREAM REACH     2.RCH= W645W 1.5/2-UP    FROM     -0.6    TO        -2.2
STREAM REACH     3.RCH= W645W 2-UP/DRAIN  FROM     -2.2    TO        -4.1
STREAM REACH     4.RCH= W645W DRAIN/3     FROM     -4.1    TO        -5.1
STREAM REACH     5.RCH= W645W 3/4         FROM     -5.1    TO        -6.3
STREAM REACH     6.RCH= W645W 4/5-UP      FROM     -6.3    TO        -6.8
STREAM REACH     7.RCH= W645W 5-UP/5-DN   FROM     -6.8    TO        -7.3
ENDATA2
ENDATA3
FLAG FIELD RCH=  1.      7      1 6 2 2 2 2 2
FLAG FIELD RCH=  2.     16      2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  3.     19      6 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  4.     10      2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  5.     12      2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=  6.      5      2 2 2 2 2
FLAG FIELD RCH=  7.      5      2 2 2 6 2
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ENDATA4
HYDRAULICS RCH=   1.              2.650            1.000
HYDRAULICS RCH=   2.              1.900            1.000
HYDRAULICS RCH=   3.              1.950            2.000
HYDRAULICS RCH=   4.              1.950            2.000
HYDRAULICS RCH=   5.              2.250            2.000
HYDRAULICS RCH=   6.              2.000            2.000
HYDRAULICS RCH=   7.              2.000            2.000
ENDATA5
ENDATA5A
REACT COEF RCH=   1.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   2.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   3.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   4.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   5.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   6.    0.23   0.00   0.00   1    3.00
REACT COEF RCH=   7.    0.23   0.00   0.00   1    3.00
ENDATA6
N AND P COEF   RCH=   1.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   2.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   3.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   4.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   5.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   6.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   7.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
ENDATA6A
ALG/OTHER COEF RCH=   1.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   2.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   3.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   4.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   5.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   6.     0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   7.     0.   0.00   0.00   0.00    0.0    0.0     0.
ENDATA6B
INITIAL COND-1 RCH=   1.   55.4
INITIAL COND-1 RCH=   2.   55.4
INITIAL COND-1 RCH=   3.   56.3
INITIAL COND-1 RCH=   4.   56.3
INITIAL COND-1 RCH=   5.   56.3
INITIAL COND-1 RCH=   6.   56.3
INITIAL COND-1 RCH=   7.   56.3
ENDATA7
INITIAL COND-2 RCH=   1.
INITIAL COND-2 RCH=   2.
INITIAL COND-2 RCH=   3.
INITIAL COND-2 RCH=   4.
INITIAL COND-2 RCH=   5.
INITIAL COND-2 RCH=   6.
INITIAL COND-2 RCH=   7.
ENDATA7A
INCR INFLOW-1  RCH=   1.  2.000        7.10  57.2
INCR INFLOW-1  RCH=   2. 13.000        7.10  57.2
INCR INFLOW-1  RCH=   3. 16.900        7.10  57.2
INCR INFLOW-1  RCH=   4.  9.100        7.10  57.2
INCR INFLOW-1  RCH=   5. 31.000        7.10  57.2
INCR INFLOW-1  RCH=   6. -5.000        7.10  57.2
INCR INFLOW-1  RCH=   7.  0.000        7.10  57.2
ENDATA8
INCR INFLOW-2  RCH=   1.          0.786  0.132  0.033
INCR INFLOW-2  RCH=   2.          0.786  0.132  0.033
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INCR INFLOW-2  RCH=   3.          0.786  0.132  0.033
INCR INFLOW-2  RCH=   4.          0.786  0.132  0.033
INCR INFLOW-2  RCH=   5.          0.786  0.132  0.033
INCR INFLOW-2  RCH=   6.          0.786  0.132  0.033
INCR INFLOW-2  RCH=   7.          0.786  0.132  0.033
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1.  1-UP               11.00        8.40  13.7
ENDATA10
HEADWTR-2  HDW=   1.                    1.200 0.040 0.020
ENDATA10A
POINTLD-1 PTL=   1. QUINCY WTP          4.000        6.20  78.7
POINTLD-1 PTL=   2. DRAIN 2U/D         33.000        6.86  100.
POINTLD-1 PTL=   3. DRAIN 5U/D         65.000        7.00  42.6
ENDATA11
POINTLD-2  PTL=   1.                    6.400 5.100 1.700
POINTLD-2  PTL=   2.                    0.818 0.227 0.094
POINTLD-2  PTL=   3.                    0.700 0.100 0.005
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
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EVENT4N.IN
12/13/93

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TITLE01             QUINCY INDUSTRIAL WTP RECEIVIENG WATER MODEL
TITLE02             CALIBRATION TO CH2M-HILL EVENT 4, 21-JAN-92 W/NBOD .5/D
TITLE03   NO        CONSERVATIVE MINERAL I
TITLE04   NO        CONSERVATIVE MINERAL II
TITLE05   NO        CONSERVATIVE MINERAL III
TITLE06   NO        TEMPERATURE
TITLE07   YES       BIOCHEMICAL OXYGEN DEMAND
TITLE08   NO        ALGAE AS CHL-A IN UG/L
TITLE09   NO        PHOSPHORUS CYCLE AS P IN MG/L
TITLE10               (ORGANIC-P, DISSOLVED-P)
TITLE11   YES       NITROGEN CYCLE AS N IN MG/L
TITLE12               (ORGANIC-N, AMMONIA-N, NITRITE-N, NITRITE-N)
TITLE13   YES       DISSOLVED OXYGEN IN MG/L
TITLE14   NO        FECAL COLIFORMS IN NO./100 ML
TITLE15   NO        ARBITRARY NON-CONSERVATIVE NH3N    MG/L
ENDTITLE
LIST DATA INPUT
WRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
DISCHARGE COEFFICIENTS
NO PRINT SOLAR/LCD DATA
NO PLOT DO AND BOD
FIXED DNSTM COND (YES=1)=   0.00000       5D-ULT BOD CONV K COEF  =   0.00000
INPUT METRIC (YES=1)    =   0.00000       OUTPUT METRIC (YES=1)   =   0.00000
NUMBER OF REACHES       =   7.00000       NUMBER OF JUNCTIONS     =   0.00000
NUM OF HEADWATERS       =   1.00000       NUMBER OF POINT LOADS   =   3.00000
TIME STEP (HOURS)       =                 LNTH  COMP  ELEMENT (DX)=   0.10000
MAXIMUM ITERATIONS      =  30.00000       TIME INC. FOR RPT2 (HRS)=
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)= 3.4300  O UPTAKE BY NO2 OXID(MG O/MG N)= 1.1400
O PROD  BY ALGAE (MG O/MG A)   = 1.6000  O UPTAKE BY ALGAE (MG O/MG A)   = 2.0000
N CONTENT OF ALGAE (MG N/MG A) = 0.0800  P CONTENT OF ALGAE (MG P/MG A) = 0.0110
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.3000  ALGAE RESPIRATION RATE (1/DAY) = 0.1200
N HALF SATURATION CONST (MG/L) = 0.0200  P HALF SATURATION CONST  (MG/L)= 0.0050
LIN ALG EXCO (1/FT)/(UGCHLA/L) = 0.0130  NLINCO (1/FT)/(UGCHLA/L)**(2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 1.0000  LIGHT SAT'N COEFF (BTU/FT2/MIN)= 0.0920
DAILY AVERAGING OPTION (LAVOPT)=      2  LIGHT AVERAGING FACTOR (AFACT) = 1.0000
NUMBER OF DAYLIGHT HOURS (DLH) = 14.000  TOTAL DAILY SOLR RAD (BTU/FT2) = 1800.0
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000  ALGAL PREF FOR NH3-N (PREFN)   = 0.9000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500  NITRIFICATION INHIBITION COEF  = 0.6000
ENDATA1A
THETA    NH3 DECA    1.080
ENDATA1B
STREAM REACH      1.RCH= W645W 1-UP/1.5     FROM        0.1     TO        -0.6
STREAM REACH      2.RCH= W645W 1.5/2-UP     FROM       -0.6     TO        -2.2
STREAM REACH      3.RCH= W645W 2-UP/DRAIN   FROM       -2.2     TO        -4.1
STREAM REACH      4.RCH= W645W DRAIN/3      FROM       -4.1     TO        -5.1
STREAM REACH      5.RCH= W645W 3/4          FROM       -5.1     TO        -6.3
STREAM REACH      6.RCH= W645W 4/5-UP       FROM       -6.3     TO        -6.8
STREAM REACH      7.RCH= W645W 5-UP/5-DN    FROM       -6.8     TO        -7.3
ENDATA2
ENDATA3
FLAG FIELD RCH=   1.        7        1 6 2 2 2 2 2
FLAG FIELD RCH=   2.       16        2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   3.       19        6 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   4.       10        2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   5.       12        2 2 2 2 2 2 2 2 2 2 2 2
FLAG FIELD RCH=   6.        5        2 2 2 2 2
FLAG FIELD RCH=   7.        5        2 2 2 6 2
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ENDATA4
HYDRAULICS RCH=   1.            1.500           1.000
HYDRAULICS RCH=   2.            1.300           1.000
HYDRAULICS RCH=   3.            2.050           2.000
HYDRAULICS RCH=   4.            2.050           2.000
HYDRAULICS RCH=   5.            2.650           2.000
HYDRAULICS RCH=   6.            1.800           2.000
HYDRAULICS RCH=   7.            1.350           2.000
ENDATA5
ENDATA5A
REACT COEF RCH=   1.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   2.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   3.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   4.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   5.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   6.    0.23    0.00    0.00   1    3.00
REACT COEF RCH=   7.    0.23    0.00    0.00   1    3.00
ENDATA6
N AND P COEF   RCH=   1.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   2.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   3.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   4.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   5.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   6.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
N AND P COEF   RCH=   7.   0.10  0.000   0.50   0.00   3.00   0.00   0.00   0.00
ENDATA6A
ALG/OTHER COEF RCH=   1.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   2.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   3.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   4.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   5.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   6.      0.   0.00   0.00   0.00    0.0    0.0     0.
ALG/OTHER COEF RCH=   7.      0.   0.00   0.00   0.00    0.0    0.0     0.
ENDATA6B
INITIAL COND-1 RCH=   1.   40.6
INITIAL COND-1 RCH=   2.   43.7
INITIAL COND-1 RCH=   3.   48.2
INITIAL COND-1 RCH=   4.   48.2
INITIAL COND-1 RCH=   5.   48.7
INITIAL COND-1 RCH=   6.   49.6
INITIAL COND-1 RCH=   7.   50.0
ENDATA7
INITIAL COND-2 RCH=   1.
INITIAL COND-2 RCH=   2.
INITIAL COND-2 RCH=   3.
INITIAL COND-2 RCH=   4.
INITIAL COND-2 RCH=   5.
INITIAL COND-2 RCH=   6.
INITIAL COND-2 RCH=   7.
ENDATA7A
INCR INFLOW-1  RCH=   1.  0.000         11.5  81.8
INCR INFLOW-1  RCH=   2.  6.300         11.5  81.8
INCR INFLOW-1  RCH=   3.  2.665         11.5  81.8
INCR INFLOW-1  RCH=   4.  1.435         11.5  81.8
INCR INFLOW-1  RCH=   5. 15.500         11.5  81.8
INCR INFLOW-1  RCH=   6.  1.500         11.5  81.8
INCR INFLOW-1  RCH=   7.  0.000         11.5  81.8
ENDATA8
INCR INFLOW-2  RCH=   1.          5.017  0.000  0.000
INCR INFLOW-2  RCH=   2.          5.017  0.000  0.000
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INCR INFLOW-2  RCH=   3.          5.017  0.000  0.000
INCR INFLOW-2  RCH=   4.          5.017  0.000  0.000
INCR INFLOW-2  RCH=   5.          5.017  0.000  0.000
INCR INFLOW-2  RCH=   6.          5.017  0.000  0.000
INCR INFLOW-2  RCH=   7.          5.017  0.000  0.000
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1.  1-UP             1.900          12.2  17.6
ENDATA10
HEADWTR-2  HDW=   1.                  4.390 0.040 0.100
ENDATA10A
POINTLD-1 PTL=   1. QUINCY WTP        3.500          7.80  124.
POINTLD-1 PTL=   2. DRAIN 2U/D       10.400         10.75  23.9
POINTLD-1 PTL=   3. DRAIN 5U/D       15.100         11.97  130.
ENDATA11
POINTLD-2  PTL=   1.                  8.990 8.100 0.420
POINTLD-2  PTL=   2.                  3.258 0.545 0.033
POINTLD-2  PTL=   3.                  6.308 0.000 0.000
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
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