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STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504-6811 • (206) 753-2353

MEMORANDUM

February 4, 1985

To: Carl Nuechterlein, ERO

Through: Lynn Singleton and Dick Cunningham

From: Joe Joy

Subeject: Dissolved Oxygen Simulations for Mill Creek Using 1983-84 Walla Walla STP Effluent Data

I have completed the dissolved oxygen simulations for Mill Creek using the Walla Walla STP effluent data you provided in your August 1984 request (Nuechterlein, 1984). Eight simulations were made using the MILL3, dissolved oxygen model (Singleton, 1981). The variables used in the simulations, and selected downstream dissolved oxygen results are presented in Table 1 (attached).

The MILL3 model structure was kept the same as in our previous work (Singleton and Joy, 1982). The model requires the following upstream and effluent variables to produce simulations:

- flow
- dissolved oxygen (D.O.)
- temperature
- ammonia nitrogen (NH_3-N)
- five-day biochemical oxygen demand (BOD_5)

The upstream variables in these simulations were taken directly from Singleton and Joy (1982); i.e., one-in-ten-year monthly low-flow values; and D.O., NH_3-N, temperature, and BOD_5 values based on intensive survey and historical ambient monitoring station results. Walla Walla STP effluent variables were taken from the 1983-1984 data you had sent us. Maximum monthly effluent NH_3-N and BOD_5 values, and average monthly flow and influent temperature values were used in the simulations. Effluent D.O. values were taken from Singleton and Joy (1982) simulations.

Simulations were run for the five months, December through April, when discharge is permitted into Mill Creek (NPDES, 1983). In addition, simulations for the months of May, October, and November were run. Effluent discharge to Mill Creek is not currently permitted during these three months. The current permit was modified to eliminate October and November from the effluent discharge season.

The D.O. model simulation results are shown in the last four columns of Table 1. These columns display:

- initial D.O. concentration in discharge mixing zone at r.m. 5.4
- lowest D.O. concentration and its river mile location
- maximum D.O. decline; i.e., the difference between the lowest D.O. concentration and the upstream D.O. concentration
- final Mill Creek D.O. concentration (r.m. 0.2) before its confluence with the Walla Walla River

The model results suggest downstream D.O. concentrations for the permitted months met the Class B criterion of 6.5 mg/L in 1983 and 1984. For example, the greatest downstream D.O. loss (4.7 mg/L) may have occurred in December if flows were as low as the monthly one-in-ten-year flow. Simulations of the other four permitted months under extreme conditions suggested only minor D.O. losses downstream.

This is in contrast to predictions made for May, October, and November. Had effluent been discharged, severe D.O. deficits would likely have occurred.

Of course, as stated in Singleton and Joy (1982), these simulations have limitations. For example, the simulations do not address the impact of STP effluent from irrigation return flows. Neither do they address diel oxygen patterns nor impacts from in-stream biological systems. However, since worst-case effluent variables were chosen, D.O. in Mill Creek probably met the Class B criterion during the 1983-1984 discharge season.

In conclusion, the MILL3 model simulations suggest the current permit for the Walla Walla STP protects Mill Creek against D.O. depletion under one-in-ten-year low-flow conditions. Diverting October and November effluent to the irrigation systems as directed in the NPDES permit seems justified.

JJ:cp

Attachments

References

Neuchterlein, C., 1984. "Walla Walla STP - NH_3-N data." Memorandum to Dick Cunningham, Wash. St. Dept. of Ecology, Olympia, WA, August 22, 1984.

NPDES 1983. City of Walla Walla National Pollutant Discharge Elimination System Waste Discharge Permit. Permit No. WA-002462-7. Issued 2/14/83; Expires 2/14/88. Washington State Dept. of Ecology, Olympia, WA. 12 pp.

Singleton, L., 1981. MILL3, a dissolved oxygen model for Singleton and Joy, 1982, Water Quality Investigations Section, Washington State Dept. of Ecology, Olympia, WA.

Singleton, L. and J. Joy, 1982. "Mill Creek Receiving Water Study." Memorandum to Carl Nuechterlein, Eastern Regional Office, Washington State Dept. of Ecology, Spokane, WA, May 5, 1982. 25 pp.

Table 1. Variables used in the dissolved oxygen model, MILL3 for upstream and Walla Walla STP effluent conditions. Also selected MILL3 dissolved oxygen simulation results.

		Upstream Parameters					Effluent Parameters*				Model Results			
Month	Flow** (cfs)	D.O. (mg/L)	Temp. (°C)	NH_3 (mg/L)	BOD_5 (mg/L)	Flow (cfs)	D.O. (mg/L)	Temp. (°C)	NH_3 (mg/L)	BOD_5 (mg/L)	D.O. at r.m. 5.4 (mg/L)	Lowest D.O. at (r.m.) (mg/L)	Max. D.O. Decline (mg/L)	D.O. at r.m. 0.2 (mg/L)
Dec.	19.1	12.4	5.8	0	2	8.4	8.1	13.3	4.1	19	11.1	7.7(1.4)	4.7	7.8
Jan.	57.7	13.2	2.3	0	2	9.1	7.8	13.3	4.1	19	12.5	11.2(1.4)	2.0	11.2
Feb.	49.4	13.6	4.6	0	2	9.2	8.4	12.2	3.2	20	12.8	11.2(0.2)	2.4	11.2
Mar.	72.4	12.6	5.9	0	2	9.4	7.8	13.9	4.2	26	12.1	10.8(0.2)	1.8	10.8
Apr.	55.1	13.3	6.2	0	2	9.0	7.4	16.1	2.4	19	12.5	11.3(0.2)	2.0	11.3
May†	4.9	12.0	7.5	0	2	7.8	7.0	20	2.4	10	8.9	5.1(2.2)	6.9	5.5
Oct†	0.1	12.0	10.9	0	2	6.9	7.2	18	5.8	18	7.3	0 (4.6)	12.0	0
Nov†	1.0	12.4	6.8	0	2	8.5	7.4	22	3.8	24	7.9	0 (3.4)	12.4	0

*Maximum monthly NH_3-N, temperature, and BOD_5 values and average monthly flows and temperatures used from Walla Walla STP data (Nuechterlein, 1984).

**One-in-ten-year monthly low flow.

†Discharge directly into Mill Creek not permitted during these months (NPDES, 1983).

MEMORANDUM

CHECK
INFORMATON ____
FOR ACTION ____
PERMIT ____
OTHER ____

TO: Dick Cunningham

FROM: Carl Nuechterlein

SUBJECT: Walla Walla STP - NH_3N Data

DATE: August 22, 1984

State of Washington Department of Ecology

In 1981, your staff conducted a receiving water study on Mill Creek and the impact the Walla Walla STP was having. This was conducted by Lynn Singleton and Joe Joy.

Part of the recommendations section dealt with the nitrification efficiency of the new plant and the possibility of establishing a NH_3N limit. Based on this study, we established a new discharge period and required Walla Walla to begin Nitrogen monitoring.

Now that we have a full year's monitoring information, I am requesting that your staff review this information and determine what impact the effluent is having using the dissolved oxygen model. I have attached a copy of the monitoring results from May, 1983, to April, 1984.

Please let me know if you can conduct this analysis and if any other information is required. Thank you.

CJN:adw

Enclosures

ECY 010-4

Eastern Washington Regional Office East 103 Indiana Avenue Spokane, Washington 99207 Telephone (509) 456-2926

SEPTEMBER	9.9			4.3		
	9.8	4.1	6.5	4.1	7.6	3.4
		5.3	7.6		.8	1.1
	11.3	4.7	2.4	4.2	7.6	1.1
	12.1	3.8	7.6	5.3	6.4	1.4
AVERAGE	10.775	4.475	6.025	4.475	5.6	1.75
OCTOBER	9.5	4.7	4.4	8.2	7.6	1.4
	7.9	4.7	2.9	6.6	6.8	1.1
	9.3			6.4		
	9.1	2.9	2.4	4.4	7.2	1.1
	8.1	3.5	.42	3.2	8.1	1.9
AVERAGE	8.78	3.95	2.53	5.76	7.425	1.375
NOVEMBER	7.2	4.1	2.9	2.4	7.6	.42
	8.4	5.3	.42	3.8	6.8	1.4
	9.6	7.2	5.5	3.5	6.8	1.2
	7.4	6.4	1.4	2.8	10.1	1.4
		5.6	2.4		9.2	2.9
AVERAGE	8.15	5.72	2.524	3.125	8.1	1.464
TOT. AV.	7.897143	5.203571	4.183429	2.941905	8.062143	1.160571

APRIL	7.3	3.5	2.4	2.3	9.2	2.4
	7.1	6.4	4.9	2.4	9.2	3.9
	7.4	8.1	4.9	2.1	10.4	3.4
	9.5	4.4	4.9	1.5	6.4	1.9
AVERAGE	7.825	5.6	4.275	2.075	8.8	2.9
TOT. AV.	7.2838	5.322	4.55	2.873	8.362	3.395
YR. AV.	7.641583	5.252917	4.336167	2.913194	8.187083	2.091583

WALLA WALLA WASTEWATER TREATMENT PLANT

NITROGEN DATA

MAY 1983 - APRIL 1984

MAY 1983 - NOVEMBER 1983 (IRRIGATION)

MONTH	INF NH3 PPM	INF NO3 PPM	INF NO2 PPM	EFF NH3 PPM	EFF NO3 PPM	EFF NO2 PPM
MAY		4.1	1.1		8.8	.4
		4.7	4.4		10.1	.4
	6.2	6.4	8.7	2.4	9.2	3.4
	6.1	3.8	4.9	2.2	8.1	.4
AVERAGE	6.15	4.75	4.775	2.3	9.05	1.15
JUNE		4.4	3.4		9.6	.4
	6.1	6.4	3.4	1.6	12.5	.4
	5.9	2.9	2.4	1.9	9.2	.4
	7.3	6.1	4.4	1.6	11.2	1.1
		7.6	4.1		10.4	1.9
AVERAGE	6.433333	5.48	3.54	1.7	10.58	.84
JULY	7.7	3.8	2.4	1.1	8.8	.4
	6.8	3.2	4.4	1.2	11.2	1.4
	6.3	7.6	2.4	1.4	6.4	.4
	8.1	7.6	5.4	2.7	7.2	1.1
AVERAGE	7.225	5.55	3.65	1.6	8.4	.825
AUGUST		6.4	11.6		6.8	.4
	7.8	6.3	9.4	1.6	6.7	1.1
	8.7	5.3	4.4	1.5	7.2	.4
	6.8	8.1	1.4	1.8	7.6	.3
		6.4	4.4		8.1	1.4
AVERAGE	7.766667	6.5	6.24	1.633333	7.28	.72

DECEMBER 1983 - APRIL 1984 (DISCHARGE)

MONTH	INF NH3 PPM	INF NO3 PPM	INF NO2 PPM	EFF NH3 PPM	EFF NO3 PPM	EFF NO2 PPM
DECEMBER	9.1			2.7		
	7.4	6.1	1.4	2.7	7.2	2.9
	7.8	5.7	6.1	3.2	9.6	2.9
	7.8	6.4	3.4	4.1	12.1	4.9
	7.2	4.7	6.1	4.1	6.8	4.9
AVERAGE	7.86	5.725	4.25	3.36	8.925	3.9
JANUARY	6.4	4.4	5.5	2.6	6.4	4.4
	6.3	5.3	6.1	3.8	8.1	1.9
	9.4	6.8	5.5	4.1	9.2	4.9
	8.2	6.1	3.4	3.3	7.6	1.9
AVERAGE	7.575	5.65	5.125	3.45	7.825	3.275
FEBRUARY	9.7	4.1	4.4	2.6	8.8	3.4
	7.1	4.7	4.4	3.1	8.4	4.4
	7.4	8.1	3.4	3.2	9.2	2.9
	7.1	6.8	4.9	3.1	2.6	3.4
		5.1	4.9		8.8	3.4
AVERAGE	7.825	5.76	4.4	3	7.56	3.5
MARCH	7.3			1.8		
	7.2	5.6	7.1	4.2	8.8	3.9
	6.8	2.9	3.4	3.1	7.6	3.4
	5.2	3.8	4.4	2.1	8.8	2.9
	.17	3.2	3.9	1.2	9.6	3.4
AVERAGE	5.334	3.875	4.7	2.48	8.7	3.4

WALLA WALLA WASTEWATER TREATMENT PLANT

NITROGEN DATA

MAY 1983 - APRIL 1984

MAY 1983 - NOVEMBER 1983 (IRRIGATION)

MONTH	INF NH3 PPM	INF NO3 PPM	INF NO2 PPM	EFF NH3 PPM	EFF NO3 PPM	EFF NO2 PPM
MAY		4.1	1.1		8.8	.4
		4.7	4.4		10.1	.4
	6.2	6.4	8.7	2.4	9.2	3.4
	6.1	3.8	4.9	2.2	8.1	.4
AVERAGE	6.15	4.75	4.775	2.3	9.05	1.15
JUNE		4.4	3.4		9.6	.4
	6.1	6.4	3.4	1.6	12.5	.4
	5.9	2.9	2.4	1.9	9.2	.4
	7.3	6.1	4.4	1.6	11.2	1.1
		7.6	4.1		10.4	1.9
AVERAGE	6.433333	5.48	3.54	1.7	10.58	.84
JULY	7.7	3.8	2.4	1.1	8.8	.4
	6.8	3.2	4.4	1.2	11.2	1.4
	6.3	7.6	2.4	1.4	6.4	.4
	8.1	7.6	5.4	2.7	7.2	1.1
AVERAGE	7.225	5.55	3.65	1.6	8.4	.825
AUGUST		6.4	11.6		6.8	.4
	7.8	6.3	9.4	1.6	6.7	1.1
	8.7	5.3	4.4	1.5	7.2	.4
	6.8	8.1	1.4	1.8	7.6	.3
		6.4	4.4		8.1	1.4
AVERAGE	7.766667	6.5	6.24	1.633333	7.28	.72

DECEMBER 1983 - APRIL 1984

MONTH	INF NH3 PPM	INF NO3 PPM	INF NO2 PPM
DECEMBER	9.1		
	7.4	6.1	1.4
	7.8	5.7	6.1
	7.8	6.4	3.4
	7.2	4.7	6.1
AVERAGE	7.86	5.725	4.25
JANUARY	6.4	4.4	5.5
	6.3	5.3	6.1
	9.4	6.8	5.5
	8.2	6.1	3.4
AVERAGE	7.575	5.65	5.125
FEBRUARY	9.7	4.1	4.4
	7.1	4.7	4.4
	7.4	8.1	3.4
	7.1	6.8	4.9
		5.1	4.9
AVERAGE	7.825	5.76	4.4
MARCH	7.3		
	7.2	5.6	7.1
	6.8	2.9	3.4
	5.2	3.8	4.4
	.17	3.2	3.9
AVERAGE	5.334	3.875	4.7

| N || O || P || Q |

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(DISCHARGE)

EFF NH3 PPM	EFF N03 PPM	EFF N02 PPM
2.7		
2.7	7.2	2.9
3.2	9.6	2.9
4.1	12.1	4.9
4.1	6.8	4.9
3.36	8.925	3.9
2.6	6.4	4.4
3.8	8.1	1.9
4.1	9.2	4.9
3.3	7.6	1.9
3.45	7.825	3.275
2.6	8.8	3.4
3.1	8.4	4.4
3.2	9.2	2.9
3.1	2.6	3.4
	8.8	3.4
3	7.56	3.5
1.8		
4.2	8.8	3.9
3.1	7.6	3.4
2.1	8.8	2.9
1.2	9.6	3.4
2.48	8.7	3.4

SEPTEMBER	9.9			4.3		
	9.8	4.1	6.5	4.1	7.6	3.4
		5.3	7.6		.8	1.1
	11.3	4.7	2.4	4.2	7.6	1.1
	12.1	3.8	7.6	5.3	6.4	1.4
AVERAGE	10.775	4.475	6.025	4.475	5.6	1.75
OCTOBER	9.5	4.7	4.4	8.2	7.6	1.4
	7.9	4.7	2.9	6.6	6.8	1.1
	9.3			6.4		
	9.1	2.9	2.4	4.4	7.2	1.1
	8.1	3.5	.42	3.2	8.1	1.9
AVERAGE	8.78	3.95	2.53	5.76	7.425	1.375
NOVEMBER	7.2	4.1	2.9	2.4	7.6	.42
	8.4	5.3	.42	3.8	6.8	1.4
	9.6	7.2	5.5	3.5	6.8	1.2
	7.4	6.4	1.4	2.8	10.1	1.4
		5.6	2.4		9.2	2.9
AVERAGE	8.15	5.72	2.524	3.125	8.1	1.464
TOT. AV.	7.897143	5.203571	4.183429	2.941905	8.062143	1.160571

APRIL	7.3	3.5	2.
	7.1	6.4	4.
	7.4	8.1	4.
	9.5	4.4	4.
AVERAGE	7.825	5.6	4.
TOT. AV.	7.2838	5.322	4.
YR. AV.	7.641583	5.252917	4.