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STATE OF WASHINGTON
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Governor

DEPARTMENT OF ECOLOGY
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MEMORANDUM

September 23, 1977

To: John Hodgson, Central Office

From: Dan Kruger

Re: Twisp STP Efficiency Survey - Receiving Water Quality Survey

On 29 August 1977, Dale Tucker and I initiated a 72 hour efficiency survey on the new sewage treatment facilities located in Twisp, Washington (Okanogan County). The treatment plant consists of an oxidation ditch, secondary clarifier, sludge drying beds and a chlorine contact chamber. Two Manning S-4000 sequential samplers were used in obtaining 24 hour composite samples of both the influent and effluent. The influent sampler was positioned at the inlet to the oxidation ditch with the effluent compositor stationed at the end of the chlorine contact chamber.

In conjunction with the plant efficiency study a survey of the receiving waters, above and below the STP outfall was to be conducted. The receiving water survey was deemed important due to the unusually low flow conditions experienced in the Methow River Valley as well as throughout the state. It was felt that any significant detrimental effects on the Methow River by the Twisp STP in fecal coliform contamination, decrease in dissolved oxygen (D.O.) concentrations due to BOD (biological oxygen demand) loading, alteration in pH and/or other chemical and physical parameters would be seen during low dilution ratios in the river.

Flow Calculations

The first task in the STP efficiency survey was to determine the accuracy of the flow measuring and recording instruments. According to the plant's specifications the end of the chlorine contact chamber is equipped with a 30° v-notch weir, an instantaneous flow meter and a totalizer gage. I was unable to locate a discharge formula for the plant's weir in our hydraulic manuals. I performed a regression analysis (power curve fit) on known degree v-notch weirs (22 1/2°, 45°, 60°, 90°) to derive a discharge formula for the 30° v-notch

weir (Equation 1). The coefficient of determination or goodness of fit was extremely good ($r^2 = 0.996$):

$$Q = 0.673\ H^{2.48}$$

(Equation 1)

where: Q = discharge in cfs
H = height in feet over weir

The formula obtained from plant's consulting engineers (Equation 2) is very similar to the one I calculated:

$$Q = 0.685\ H^{2.48}$$

(Equation 2)

where: Q = discharge in cfs
H = height in feet over weir

The following data is the instantaneous flow measurement for the treatment plant in MGD (cfs X 0.646) using equations 1 and 2 and the dail reading from the flow meter.

Date	Equation 1	Equation 2	Meter
8/29	0.095	0.097	0.088
8/30	0.136	0.138	0.125
8/31	0.159	0.162	0.155
9/1	0.104	0.106	0.099

Comparison between the values derived from equation 1 and the plant flow meter shows a 5.7% (average) higher discharge leaving the plant than what is actually recorded. According to our section's sanitary engineer, if the plant is within a $\pm$ 10% error the instruments are working satisfactorily. The daily totalizer reading will be used in subsequent calculations of plant loading and efficiency. The totalizer readings (MGD) for 8/30, 8/31 and 9/1 were 0.067, 0.068, and 0.064, respectively.

Discharge of the Methow River was obtained at the USGS gaging station (GS 12449500) at Twisp. Flow on 9/1/77 was 166 cfs. Using this figure as a mean value for river flow and 0.10 cfs (0.066 MGD) for the treatment plant discharge, the dilution ratio of river to effluent approaches 1660 times.

Receiving-Water Quality

Four sampling stations were established on the Methow River, one above and three below the STP outfall. Station 1 was located approximately 250 feet downstream from the East Methow River

Bridge south of Twisp, and 1/2 mile above the STP outfall. Mean depth of this reach, as well as all river stations, was about 2 feet. Station 2 was established about 10 feet downstream from the STP submerged outfall, directly in the plume as defined by rodamine-B dye. The river was dredged at the outfall site to produce a large basin 10 to 15 feet in diameter and 4 to 6 feet in depth. River velocity at this station was the fastest we encountered during the survey (3 to 5 ft/sec.). Station 3 was located approximately 100 feet downstream from station 2 in the plume using surface currents as the determining factor. Station 4 was established 1/4 mile downstream from the STP outfall.

At each station the following field parameters were taken; dissolved oxygen, conductivity and temperature. Concurrently, samples were collected, iced and shipped to the DOE laboratory in Olympia for detailed analysis. Turbidity, total and fecal coliform bacteria, nitrate, nitrite, ammonia, total kjeldahl, orthophosphate and total phosphate were determined according to Standard Methods (14 Edition).

Results of the 72 hour survey show little if no effect of the Twisp STP effluent on the Methow River. Field and laboratory sample analysis above and below the STP outfall showed only minimal random variation. It appears that even during drought conditions sufficient volume in the Methow River exists to adequately dilute the sewage effluent.

Treatment Plant Efficiency

Retention time in the chlorine contact chamber was determined by adding rodamine-B dye at the headworks of the chlorine contact chamber and waiting until a red color became visible at the outfall pipe. For the first traces of the dye to reach the river took only 8 minutes. However, for all the dye to be eliminated from the chlorine contact chamber took up to 6 hours. Examination of the fecal coliform data indicates no problem in disinfection. We checked for residual chlorine using the Hach DPD kit and found concentrations in the final effluent to be on an average of 2.3 to 2.4 mg/l. In the receiving waters at stations 2 and 3 the chlorine residual was ND (none detected) to 0.2 mg/l.

During the survey the plant operated well within the limits established in their NPDES waste discharge permit (Table 1). Table 2 gives the percent efficiency of the treatment plant for each day of the 72 hour survey. The overall mean for each parameter is presented in Table 3. According to the O & M for the plant it is designed to achieve an 85% in BOD_5 and suspended solids. For the survey the plant had an 89.5% BOD_5 reduction and a suspended solids reduction of 91.0%. The plant appears to be run efficiently and seems to have no major operational problems.

DK:ee

Table 1. Daily loading rates for the Twisp sewage treatment plant in permit required analyses and the corresponding effluent limitations according to NPDES waste discharge permit #WA 002337-0.

		Effluent		Effluent Limitations	
Parameter	Date	Conc (mg/l)	lbs/day	Monthly Average	Weekly Average
BOD_5	8/30	< 20	< 11.1	30 mg/l, 30 lbs/day	45 mg/l, 45 lbs/day
	8/31	7	4.0		
	9/1	21	11.3		
TSS	8/30	12	6.7	30 mg/l, 35 lbs/day	45 mg/l, 53 lbs/day
	8/31	12	6.9		
	9/1	No data	No data		
Fecal Coliform (colonies/100 mls)	8/30	5		200/100 mls	400/100 mls
	8/31	8			
	9/1	10			
pH	8/30	7.8		Not outside the range of 6.5 to 8.5	
	8/31	7.8			
	9/1	7.6			
Plant Flow (MGD)	8/30	0.067		0.170 MGD	
	8/31	0.068			
	9/1	0.064			

Table 2. Percent reduction or increase in the following parameters for each day of the survey at the Twisp STP.

	8/30/77		8/31/77		9/1/77	
Parameter	% Reduction	% Increase	% Reduction	% Increase	% Reduction	% Increase
BOD	84.1	--	94.6	--	89.8	--
TSS	91.4	--	90.6	--	No data	No data
TS	36.5	--	37.7	--	No data	No data
COD	79.7	--	81.1	--	89.7	--
NO_3	0	0	0	0	0	0
NO_2	0	0	0	0	0	0
NH_3	46.2	--	36.4	--	40.7	--
TIN*	46.1	--	36.3	--	40.5	--
TKj	44.3	--	66.2**	--	39.7	--
$O\text{-}PO_4$	--	48.4	--	28.1	--	53.1
TP	10.6	--	1.1	--	5.9	--

* Total inorganic nitrogen

** Data is suspect because the concentration of NH_3 was greater than Kjeldahl (organic nitrogen + ammonia)

Table 3. Mean percent reduction or increase in the following parameters for the 72 hour survey at the Twisp STP.

Parameter	% Reduction	% Increase
BOD	89.5	- -
TSS	91.0	- -
TS	37.1	- -
COD	83.5	- -
NO_3	0	0
NO_2	0	0
NH_3	41.1	- -
TIN*	41.0	- -
TKj	42.0	- -
$O\text{-}PO_4$	- -	43.2
T-P	5.9	- -

* Total inorganic nitrogen