Publication No. 84-e47

WA-57-9010

JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
7272 Cleanwater Lane, LU-11 • Olympia, Washington 98504 • (206) 753-2353

MEMORANDUM
March 13, 1984

To: Roger Ray and Jim Prudente

From: Marc Heffner

Subject: Liberty Lake Sewer District Sewage Treatment Plant Class II Inspection, August 30-31, 1983

Introduction

On August 30-31, 1983 a Class II inspection was held at the Liberty Lake Sewer District (LLSD) Sewage Treatment Plant (STP) (Figure 1). The inspection was conducted in conjunction with a receiving water study in the Spokane River. Results of the receiving water study will be presented in a separate memorandum (Bailey and Singleton, 1984).

The LLSD STP is an activated sludge plant (Figure 2). The process train includes two equalization basins, two aeration basins, two secondary clarifiers, and two chlorination/dechlorination facilities. Two aerobic digesters and a series of sludge drying beds treat the sludge before final disposal. The plant as it presently exists is rated at 1 MGD. To date, flows to the plant have been low enough so that duplicated units are operated one at a time. Also, sludge concentrations in the aerobic digester had not yet increased to the point where wasting to the drying beds had been necessary. Discharge from the plant to the Spokane River is limited by National Pollutant Discharge Elimination System (NPDES) permit #WA-004514-4.

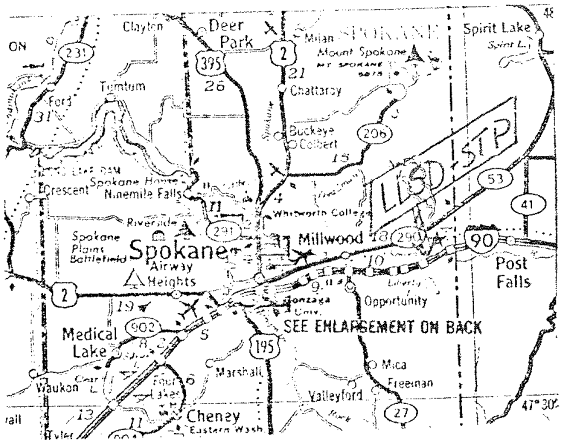
The inspection was conducted primarily for two purposes:

1. To review LLSD laboratory testing and NPDES permit compliance; and

2. To estimate loads to the Spokane River from the LLSD STP for the time period corresponding to the receiving water study.

Participating in the inspection were Bill Yake and Marc Heffner (Washington State Department of Ecology [WDOE], Water Quality Investigations Section), Roger Ray and Jim Prudente (WDOE, Eastern Regional Office), and Gary Fletcher, Dan Grog, and John Yake (LLSD STP operators).

FIGURE 1 - LLSD-STP LOCATION - LLSD, AUGUST 1983



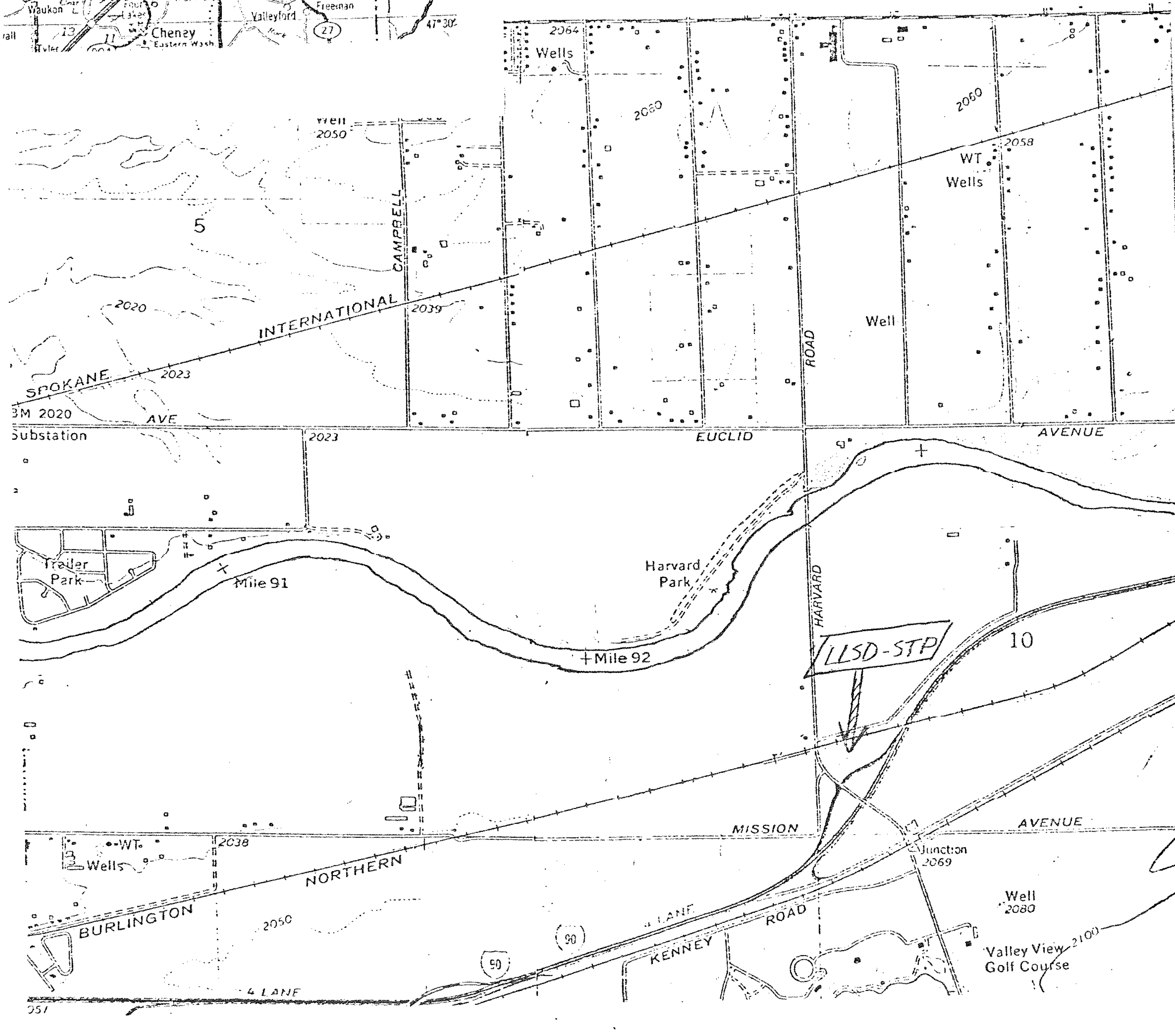
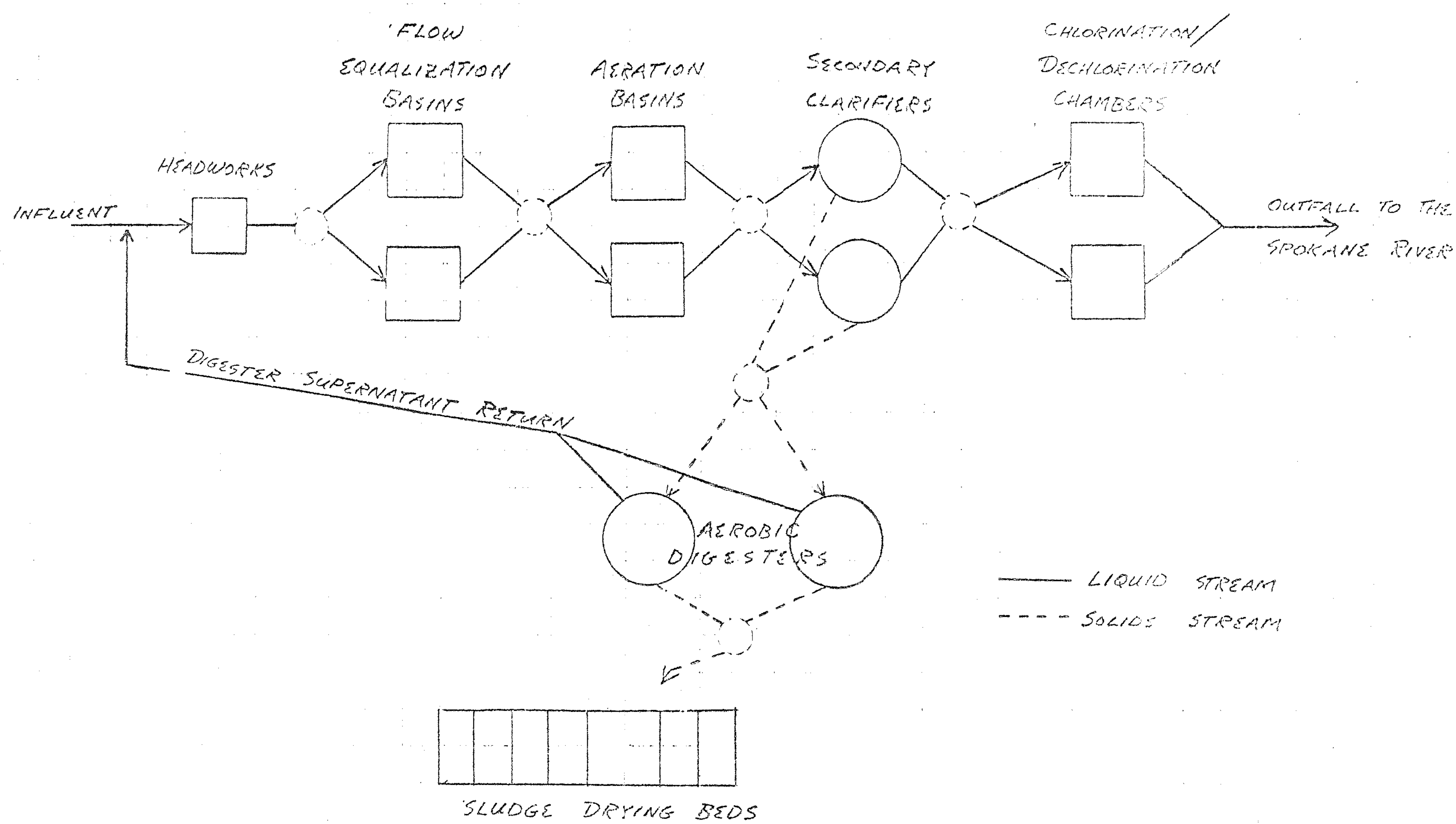


FIGURE 2 - LLSD - STP FLOW SCHEME - LLSD, AUGUST 1983.



Memo to Roger Ray and Jim Prudente
Liberty Lake Sewer District STP Class II Inspection, August 30-31, 1983

Procedures

Influent and dechlorinated effluent composite samples were collected by both WDOE and LLSD during the inspection. WDOE samplers were set to collect approximately 220 mLs of sample every 30 minutes. LLSD samplers collected approximately 200 mLs of sample hourly. Sampling intervals were approximately 1030-1030 for the influent and approximately 1100-1100 for the effluent. Samples were split for analysis by both the LLSD and WDOE laboratories. WDOE and LLSD laboratory analytical results for conventional parameters are presented in Table 1.

In addition to composite sampling, grab samples were collected for field and laboratory analysis (Table 2). Grab samples included simultaneous grab samples of the effluent by LLSD and WDOE for fecal coliform analysis.

Influent, equalization basin effluent, and plant effluent flows were measured by in-plant meters (Table 3). Independent WDOE flow measurements were not made at the plant.

The LLSD had not yet had to waste sludge from the aerobic digester. A sludge sample from the sludge blanket in the aerobic digester was taken for metals and percent solids analysis. The sample was taken after the aerators had been shut off and supernatant was being decanted and returned to the plant. Metals analysis was also run on the influent and effluent composite samples and a sample of digester supernatant (Table 4).

Table 1. Composite sample conventional parameter results - LLSD, August 1983.

Sample	Sampler	Laboratory	BOD_5 (mg/L)	Inhibited BOD_5 (mg/L)	COD (mg/L)	Solids (mg/L)				pH (S.U.)	Cond. (µmhos/cm)	Turbidity (NTU)	Nutrients (mg/L)					Alkalinity (mg/L)	Chloride (mg/L)
						TS	TNVS	TSS	TNVSS				NH_3-N	NO_2-N	NO_3-N	Dis-O-PO_4-P	Total PO_4-P		
Influent	LLSD	WDOE	94		200	380	200	110	10	7.4	480	70	16	<.10	<.10	6.1	7.4	170	35
		LLSD	87					129									9.9		
	WDOE	WDOE	100		220	420	200	140	14	7.5	488	75	18	<.10	<.10	5.9	7.7	170	35
		LLSD	123					126									8.7		
Effluent	LLSD	WDOE	2.8 est		19	310	190	7	<1	7.3	412	9	.04	.10	16	6.6	6.7	34	38
		LLSD	2.2					4									7.3		
	WDOE	WDOE	2.8 est	2.6 est	19	320	220	8	<1	6.6	420	3	.04	.10	17	6.7	6.7	34	39
		LLSD	2.6					4.5									8.0		

est = Estimated.

Table 2. Grab sample results - LLSD, August 1983.

Sample	Date	Time	Field Analysis: Temp. (°C)	Cond. (μmhos/cm)	pH (S.U.)	D.O. (mg/L)	Total Chlorine Residual (mg/L)	WDOE Laboratory Analysis: F. Coliform (col/100 mL)	TSS (mg/L)	TVSS (mg/L)
Influent	8/30	1035	21.0	500	7.4					
		1435	21.5	490	7.5					
	8/31	0835	20.0	390	7.3					
		Comp	11.5	525	7.3					
Effluent*	8/30	1100	21.5	435	6.1					
		1500	22.2	395	6.2					
		1525					.3† <0.1	<1		
	8/31	0920	21.1	430	6.1	4.2	<0.1	20		
		1045						2 (est)		
		Comp	9.5	440	6.6					
Activated Sludge	8/30								1500	1100
Check for pH drop through plant										
Effluent	8/31	0835		390	7.3					
Equalization basin		0845		380	7.2					
Aeration basin		0855		440	6.2					
Secondary clarifier		0900		370	6.3					
Chlorine contact chamber Head end		0910		335	6.2					
Discharge†		0915		425	6.2					
Effluent*		0920		430	6.1					

†Sample taken prior to dechlorination.
*Sample taken after dechlorination unless otherwise noted.
(est) = Estimated.

Table 3. Flows during Class II inspection - LLSD, August 1983.

Date	Time	Influent Meter: Totalizer*	Influent Meter: Flow for Interval (MGD)	Equalization Basin Effluent Meter: Totalizer*	Equalization Basin Effluent Meter: Flow for Interval (MGD)	Effluent Meter: Totalizer*	Effluent Meter: Flow for Interval (MGD)
8/30	1040	116847		86201		90487	
			.39		.32		.35
	1640	116945		86282		90575	
			.25		.32		.31
8/31	0830	117111		86494		90780	
			.41		.27		.32
	0950	117134		86509		90799	
			.43		.29		.34
	1110	117158		86525		90818	
Average Flow for Composite Sampling Period			.30		.32		.32

*Totalizer readings in 1,000-gallon units.

Table 4. Metals results* - LLSD, August 1983.

Sample	Sampler	Cd Total	Cd Dis.	Cr Total	Cr Dis.	Cu Total	Cu Dis.	Pb Total	Pb Dis.	Ni Total	Ni Dis.	Zn Total	Zn Dis.	Al Total	Ag Total
		(μg/L)													
Influent	WDOE	2	<2	<10	<10	110	40	<50	<50	50	<50	140	37	<500	1.9
	LLSD	2	<2	<10	<10	70	30	<50	<50	70	50	100	40	<500	1.2
Effluent	WDOE	1	0.8	<10	<10	40	20	2	<1	<50	<50	90	85	<500	<.1
	LLSD	<2	<2	<10	<10	40	20	<50	<50	50	<50	100	85	<500	<.1
Digester Supernatant	WDOE grab	4		<50		80		3		50		97		<500	<.1
		(mg/Kg)													
Digester Sludge	WDOE grab	6.5		39		1700		170		16		1500			

***Analysis by WDOE laboratory.**

Discussion

Influent flow to the LLSD STP was relatively weak, with a BOD_5 concentration of approximately 100 mg/L and a suspended solids (TSS) concentration of approximately 125 mg/L (Table 1). Plant effluent concentrations are compared to NPDES permit concentrations in Table 5. Excellent BOD_5 and TSS removal (greater than 94 percent) were achieved as these parameters easily met permit limits. With the exception of the pH, other parameters met permit limits. The three grab sample pH values all fell below the 6.5 lower limit (6.1, 6.2, 6.1).

Table 5. Comparison of Class II inspection data to NPDES permit limits - LLSD, August 1983.

Parameter	WDOE Composites: WDOE Analysis	WDOE Composites: LLSD Analysis	LLSD Composites: WDOE Analysis	LLSD Composites: LLSD Analysis	NPDES Permit Limits: Monthly	NPDES Permit Limits: Weekly	NPDES Permit Limits: Daily
BOD_5 (mg/L)	2.8 est	2.6	2.8 est	2.2	30	45	
(lbs/day)*	7.5	6.9	7.5	5.9	250	375	
% Removal	97%	98%	97%	97%	85%		
TSS (mg/L)	8	4.5	7	4	30	45	
(lbs/day)*	21.4	12.0	18.7	10.7	250	375	
% Removal	94%	96%	94%	97%	85%		
F. Coli. (col/100 mL)	<1, 20, 2 est			3	200	400	
Cl Resid. (mg/L)	<.1						.22**
pH (S.U.)	6.1. 6.2. 6.1						6.5 ≤ pH ≤ 8.5
Flow (MGD)	.32						1.0

*Based on a flow of .32 MGD.

**Calculated based on the permit limit of "Total residual chlorine in the final effluent will be regulated to a value that will result in a calculated instream concentration of less than .002 mg/L. The volume of river water to be used in this calculation is 15 percent of the flow recorded at USGS Gauging Station No. 12419500. At no time shall total residual chlorine concentration in the final effluent be in excess of that necessary to reliably achieve the fecal coliform limitation." Flow at gage #12419500 was ≈370 cfs during the inspection (Smith, 1983).

est = Estimated.

In addition to BOD and TSS removal, nitrification was also taking place in the plant. As noted in Table 6, virtually all the influent NH_3-N was oxidized to NO_3-N during the treatment process. The corresponding destruction of alkalinity associated with nitrification (see Table 6) was probably responsible for the inability of the plant to meet NPDES pH limits. Grab samples also indicated that the pH drop occurred in the aeration basins (Table 2). EPA secondary treatment standards (EPA, 1982) call for setting permit limits within the range of $6.0 \le pH \le 9.0$ with provision for more liberal limits when chemical additions either at the plant or due to industrial activities are not responsible for variations outside these limits. Based on both the limited influence of the LLSD discharge on the Spokane River pH (Bailey, 1984), and the EPA guidance, relaxation of the 6.5 lower limit for pH appears appropriate for the present plant operational mode.

Table 6. Ammonia/alkalinity removal summary - LLSD, August 1983.

	WDOE Composites*			LLSD Composites*		
	Influent	Effluent	Change	Influent	Effluent	Change
NH_3-N (mg/l)	18	.04	-18	16	.04	-16
NO_3-N (mg/L)	<.10	17	+17	<.10	16	+16
Alkalinity (mg/L)	170	34	-136	170	34	-136
Expected alkalinity drop	18 x 7.14† = 129 mg/L			16 x 7.14† = 114 mg/L		

*WDOE sample analysis.

†In theory, 7.14 mg/L of alkalinity are destroyed for every 1 mg/L of NH_3-N oxidized (EPA, 1975).

As loads to the plant increase, it may become necessary to run inhibited BOD_5 tests to more accurately characterize effluent strength. Nitrification was almost complete for the existing load; thus results of the BOD_5 test (2.8 est mg/L) and the inhibited BOD_5 test (2.6 est mg/L) run by WDOE on the WDOE composite were almost identical. When loads are such that partial nitrification is taking place, the difference between inhibited and uninhibited BOD_5 tests may become substantial.

Fecal coliform counts (<1/100 mL; 2 est/100 mL; 20/100 mL) were well below the NPDES permit limits (200/100 mL monthly average). The operators mentioned that a goal of zero coliforms in the effluent had been set by the LLSD board. This goal is acceptable, although it is more stringent and may result in more chemical consumption (Cl_2 and SO_2) than required.

Metals in the influent and effluent (Table 4) were present in concentrations within ranges that appeared fairly "normal", although Cu concentrations were somewhat elevated. Table 7 compares sludge metals concentrations to concentrations found in previous Class II inspections at activated sludge plants. Concentrations in sludge are comparable with the previously collected data except for Cu which was found at higher concentrations.

Table 7. Sludge metals - LLSD, August 1983.

	LLSD Sludge (mg/Kg)*	Previous Surveys[†] Range (mg/Kg)*	Previous Surveys[†] Geometric Mean (mg/Kg)*	Previous Surveys[†] Number of Samples
Cd	6.5	<.1 - 25	6.9	16
Cr	39	37 - 230	81	16
Cu	1700	75 - 1100	326	16
Pb	170	34 - 600	238	16
Ni	16	<.1 - 51	18	12
Zn	1500	165 - 3370	1200	16

*Dry-weight basis.

[†]Data collected during previous WDOE Class II inspections at activated sludge plants.

Laboratory Discussion

Results of split samples analyzed by WDOE and LLSD are shown on Table 8. LLSD and WDOE composite samples and analytical results compare closely for BOD_5, TSS, and fecal coliforms. LLSD total phosphate-phosphorus results were slightly higher than WDOE, but here too the comparisons were generally acceptable.

Table 8. Comparison of WDOE and LLSD laboratory results - LLSD, August, 1983.

Sample	Sampler	BOD_5 (mg/L) WDOE Analysis	BOD_5 (mg/L) LLSD Analysis	TSS (mg/L) WDOE Analysis	TSS (mg/L) LLSD Analysis	Total-PO_4-P (mg/L) WDOE Analysis	Total-PO_4-P (mg/L) LLSD Analysis	Fecal Coliform (col/100 mL) WDOE Analysis	Fecal Coliform (col/100 mL) LLSD Analysis
Influent	LLSD	94	87	110	129	7.4	9.9		
	WDOE	100	123	140	126	7.7	8.7		
Effluent	LLSD	2.8 est	2.2	7	4	6.7	7.3		
	WDOE	2.8 est	2.6	8	4.5	6.7	8.0		
Effluent	Grab							2 est	3

Est - estimated.

Laboratory analytical responsibilities are shared equally by the three LLSD operators. Each operator spends two consecutive weeks in the lab, then four weeks with other duties, on a rotating basis. Lab procedures were reviewed with all three operators as a group.

As might be surmised by the close agreement between WDOE and LLSD lab results, lab procedures at LLSD closely followed accepted techniques. Specific comments and recommendations included:

BOD_5 Test

1. The distilled water used for making dilution water should be adequately aged (1 to 2 weeks in the dark in cotton-plugged containers).

2. Whenever the sample pH is <6.5 or >8.0, the pH should be adjusted to 7 prior to starting the test (WDOE, 1988, p. 11).

TSS Test

Samples should occasionally be redried and reweighed to assure that the drying time is adequate.

Fecal Coliform Test

A phosphate buffer should be used for rinses done as part of the test procedure (WDOE, 1977A).

Total Phosphorus Test

1. Glassware for phosphate testing is used only for the phosphate test. LLSD routinely acid rinses this glassware prior to their weekly test. Monthly acid rinses should be adequate provided that the glassware is thoroughly rinsed with distilled water after each phosphate test. Glassware should be left full of distilled water during storage periods.

2. The test procedure being used (sulfuric acid/nitric acid digestion with the vanadate-molybdate reagent detection method) appears adequate for measurement of phosphorus at present influent and effluent concentrations. When flows increase to the point that phosphorus removal is required, per section S5e of the NPDES permit, the accuracy of the test at the reduced phosphorus concentrations should be re-evaluated.

Memo to Roger Ray and Jim Prudente
Liberty Lake Sewer District STP Class II Inspection, August 30-31, 1983

Conclusions

LLSD STP appeared to be a well-operated plant that is substantially underloaded, both organically and hydraulically. The plant provides more thorough treatment than the permit requires except for failure to meet the lower pH limit of 6.5. Consumption of alkalinity associated with nitrification is probably responsible for this violation. As noted in the text, allowance for a lower pH minimum appears appropriate at the present plant loading.

LLSD laboratory techniques were generally quite good, with results comparing closely to WDOE laboratory results. Specific recommendations are included in the Results and Discussion section.

MH:cp