CHAPTER 2. EFFLUENT QUALITY

Dr. Sumitra Roy Burman and Aden N. Leonard

I. INTRODUCTION

The goal of the Terminal Island Treatment Plant (TITP) effluent monitoring program is to characterize the physical and chemical properties of treated wastewater discharged from the plant. The effluent data, in conjunction with the receiving water monitoring data, are used to assess the impact of the effluent discharge on the Los Angeles Harbor.

TITP has been a full secondary treatment facility with biosolids handling capability since 1977. The plant was upgraded to include a filtration system, which became operational in December 1996. Since 1997, essentially all of TITP effluent discharged to the Harbor has been filtered secondary-treated wastewater. Construction of an Advanced Wastewater Treatment Facility (AWTF) at TITP began in 1999 and was essentially completed in October 2001. The AWTF is designed to treat TITP's filtered secondary effluent further for the plant's water reclamation project. The treatment process at AWTF consists of micro filtration, reverse osmosis (RO), lime stabilization, chlorination and dechlorination. During the last quarter of 2001, about 5 MGD of effluent discharged to the ocean also received micro filtration and RO treatment at AWTF. Biosolids produced during wastewater treatment at TITP are anaerobically digested and dewatered. The resultant biosolids are 100% beneficially reused.

The AWTF underwent testing in the second half of 2001 to determine if the reclaimed water passes the Department of Health Services' requirements for water quality. After meeting these requirements, approximately 5 MGD of RO water produced by AWTF will be transported daily via pipeline and injected into the ground under separate waste discharge requirements at the Dominguez Gap Barrier Project to control salt-water intrusion beyond this area.

The plant has a dry weather design capacity of 30 million gallons per day (MGD) and receives wastewater from San Pedro and neighboring cities (CLA, EMD 1994). Approximately 60% of the wastewater is from the industrial and commercial sector, while the remaining 40% is domestic. The domestic sewage sources include the cities of Wilmington, San Pedro, and Harbor City. The major industrial sources include the seafood processing, petroleum, and metal finishing industries. Other non-domestic sources include docking and storage facilities around the Los Angeles Harbor and the United States Coast Guard facility.

In 2001, TITP discharged an average of 15.2 MGD of filtered secondary-treated wastewater into the outer Los Angeles Harbor. Table 2-1 lists the constituents measured in the effluent under the current TITP NPDES effluent monitoring program. The concentrations of major wastewater constituents in the effluent discharged in 2001 were compared with the current NPDES permit limits. The original discharge limits, along with their interim provision, are based on the California Bays and Estuaries Policy discharge criteria and on TITP performance from 1987 to 1991. The permit has been in effect since March of 1993. Under an order from the Regional Water Quality Control Board, TITP completed a filtration facility for its effluent in mid-

December 1996. Since then, more stringent permit limits have been applied to the filtered wastewater effluent.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Representative TITP effluent samples were collected from the effluent pumping plant wet-well. Raw sewage influent to the plant comes from four forcemains: Fries Avenue, Terminal Way, San Pedro, and Navy. Representative raw influent samples were collected after a convergence point of all the four influent sewers. Twenty-four hour composite samples for both the raw influent and wet-well effluent were collected using automatic samplers that collect samples every two hours. The samples were then composited by laboratory personnel based on the flow on the sampling date. Grab samples were collected manually by plant operators or laboratory technicians for analysis (see Table 2-1). These samples were taken during the expected peak flow.

Samples for oil and grease and organic analyses were collected in glass bottles. All other samples were collected in plastic bottles. The grab samples for VOCs were collected with no headspace in amber glass bottles with Teflon-coated screw caps. Samples were preserved and stored as detailed in Standard Methods (APHA 1992).

B. LABORATORY ANALYSIS

All samples were analyzed according to the Environmental Laboratory Accreditation Program (ELAP) approved procedures. Specific methods used for individual analyte measurements are listed in Table 2-1. When the result of an analysis for a constituent was below the Method Detection Limit (MDL) of the constituent, a value of zero was used in the calculation of the average value of the constituent.

To control discharge of toxic chemicals to the environment, the Federal Clean Water Act mandates a national policy that "the discharge of toxic pollutants in toxic amounts be prohibited". The EPA, as authorized by the Clean Water Act, implements this policy through the use of "whole effluent testing" for toxicity using the sensitive life stage of aquatic organisms exposed to wastewater effluent. Acute toxicity tests were performed using fathead minnows.

Chronic toxicity tests are conducted using the most sensitive species, which is determined by annual screening tests of three species: sporophytes of the giant kelp (*Macrocystis*), larvae of the red abalone (*Haliotis*), and larvae of the silverside (*Menidia*). The most sensitive species determined for TITP in 2000 was the red abalone (*Haliotis*). The annual screening in May – July 2001 resulted in the continued use of the red abalone larvae for the remainder of the year.

Table 2-1. Constituents measured in the 2001 effluent monitoring program.

Constituent	Units of Analysis	Frequency of Analysis	Sample Type	Method*
Total Waste Flow	MGD	continuous	recorder/totalizer	
Total chlorine residue	mg/L	continuous	--	4500-CL C
Turbidity	NTU	continuous	--	2130B
pH	pH units	weekly	grab	4600-H+
Temperature	°F	weekly	grab	
Settleable solids	ml/L	weekly	grab	2540F
Suspended solids	mg/L	weekly	24-hr composite	2540D
BOD_5 @20°C	mg/L	weekly	24-hr composite	5210B
Oil & Grease	mg/L	weekly	grab	EPA 1664
Toxicity (acute)**	TUa	monthly	grab	**
Toxicity (chronic)**	TU_c	monthly	24-hr composite	**
Ammonia-Nitrogen	mg/L	monthly	24-hr composite	4500-NH3-B&E
Cyanide	µg/L	monthly	grab	EPA 335.2
Arsenic	µg/L	monthly	24-hour composite	3030G, 3114B
Cadmium	µg/L	quarterly	24-hour composite	3030H, 3120B
Chlordane	pg/L	quarterly	24-hour composite	EPA 608
Chloroform	µg/L	quarterly	24-hour composite	
Chromium (hexavalent)	µg/L	quarterly	24-hour composite	3500-Cr D
Copper	µg/L	quarterly	24-hour composite	3030H, 3120B
Lead	µg/L	quarterly	24-hour composite	3030H, 3113B
Mercury	ng/L	quarterly	24-hour composite	3030G, 3112B
Nickel	µg/L	quarterly	24-hour composite	3030H, 3120B
Selenium	µg/L	quarterly	24-hour composite	3030G, 3114B
Silver	µg/L	quarterly	24-hour composite	3030H, 3113B
Zinc	µg/L	quarterly	24-hour composite	3030H, 3120B
Aldrin	pg/L	quarterly	24-hour composite	EPA 608
Benzene	µg/L	quarterly	24-hour composite	EPA 8260
DDT's	pg/L	quarterly	24-hour composite	EPA 608
1,2-dichlorobenzene	mg/L	quarterly	24-hour composite	EPA 8260
1,3-dichlorobenzene	µg/L	quarterly	24-hour composite	EPA 8260
1,4-dichlorobenzene	µg/L	quarterly	24-hour composite	EPA 8260
Dichloromethane	µg/L	quarterly	24-hour composite	EPA 8260
Dieldrin	pg/L	quarterly	24-hour composite	EPA 608
Endosulfan	ng/L	quarterly	24-hour composite	EPA 608
Endrin	ng/L	quarterly	24-hour composite	EPA 608
Fluoranthene	µg/L	quarterly	24-hour composite	EPA 8260
Halomethanes	µg/L	quarterly	24-hour composite	EPA 8260
Heptachlor	ng/L	quarterly	24-hour composite	EPA 608
Heptachlor epoxide	ng/L	quarterly	24-hour composite	EPA 608
Hexachlorobenzene	pg/L	quarterly	24-hour composite	EPA 8260
HCH - Alpha	pg/L	quarterly	24-hour composite	EPA 608
HCH - Beta	ng/L	quarterly	24-hour composite	EPA 608
HCH - Gamma	ng/L	quarterly	24-hour composite	EPA 608
PAH's	pg/L	quarterly	24-hour composite	EPA 625
PCB's	g/L	quarterly	24-hour composite	EPA 608
Pentachlorophenol	g/L	quarterly	24-hour composite	EPA 625
TCDD equivalents	ng/L	quarterly	24-hour composite	EPA 625
Toluene	ng/L	quarterly	24-hour composite	EPA 8260
Toxaphene	ng/L	quarterly	24-hour composite	EPA 608
Tributyltin	ng/L	quarterly	24-hour composite	
2,4,6-trichlorophenol	ng/L	quarterly	24-hour composite	EPA 625
Radioactivity	ng/L	semi-annually	24-hour composite	7110

* All methods are from Standard Methods, 18th Edition, 1992 (APHA, 1992) unless otherwise specified.
**Acute toxicity is measured as described under EPA (1985). Chronic toxicity is measured using EPA methods 600/4-87/028 (Weber et al., 1988) and Marine Bioassay Project, 90-10WQ (Anderson et al., 1990).

III. RESULTS AND DISCUSSION

The main objectives in the treatment of wastewater are the removal of suspended and floatable materials and the treatment of biodegradable organics (Metcalf and Eddy 1979). The discharge of materials with high total suspended solids (TSS), biochemical oxygen demand (BOD), and oil and grease (O&G) can cause degradation of the receiving environment through eutrophication and introduction of toxic materials (Morel and Schiff 1983).

TITP's current effluent discharge limits for major wastewater constituents, as well as the 2001 effluent average and the number of permit exceedances are listed in Table 2-2. The 2001 averages for all the major wastewater constituents were much lower than the discharge permit limits. For example, the 30-day average concentration and mass emission limits for BOD are 15 mg/L and 3750 lbs/day, respectively, while the 2001 effluent quality averages were only 1.4 mg/L and 178 lbs/day. Similarly, while the discharge limits for 30-day averages were 15 mg/L, 10 mg/L, 15 mg/L, and 0.1 ml/L for suspended solids, O&G, settleable solids, and ammonia, the effluent quality averages were 1.1 mg/L, 1.2 mg/L, 0.6 mg/L, and <0.03 ml/L, respectively.

The Terminal Island Treatment Plant is permitted to conduct both acute and chronic toxicity tests. For 2001, the TITP effluent met both monthly acute toxicity test limits of 70% survival for a single test and 90% average for three consecutive tests. Since November 1998, routine acute toxicity tests for TITP have been pH-adjusted to accurately reflect the pH of the final effluent and to counteract the pH drift that invariably occurs during a static, non-renewal, and acute toxicity test.

The monthly chronic toxicity test limit is based on a TUc=1.0. This is equivalent to a no effect concentration of 100% effluent. Due to procedural difficulties, the highest possible concentration of effluent to test is 60%. Therefore, no effect at the highest concentration tested (60%) is not considered a violation. In 2001, the plant experienced six permit exceedances, all from non-compliance with chronic toxicity test results using the *Haliotis rufescens* (red abalone) larval development test. The chronic limit (TUc =1.0) was not met during the months of February, May, June, September, October, and November. The February and September tests both had TUc's of 3.3 and the months of May, June, October, and November had TU_c's of 2.5. The causes of the exceedances using the red abalone *Haliotus rufescens* have were not determined.

Table 2-2. The NPDES effluent limits and annual averages of major effluent constituents in 2001.

CONSTITUENT	UNITS	LIMITS 30-DAY AVERAGE	7-DAY AVERAGE	DAILY MAXIMUM	2001 ANNUAL AVERAGE	# of EXCEED-ANCES
BOD_5 @20°C	mg/L	15	30	40	1.4	0
	lbs/day	3750	7500	10000	178	0
	mg/L	15% INF. ---	---	---	---	0
	lbs/day	15% INF. ---	---	---	---	0
Suspended Solids	mg/L	15	30	40	1.1	0
	lbs/day	3750	7500	10000	139	0
	mg/L	15% INF. ---	---	---	---	0
	lbs/day	15% INF. ---	---	---	---	0
Oil and Grease	mg/L	10	---	15	1.2	0
	lbs/day	2500	---	3750	152	0
Settleable Solids	ml/L	0.1	---	0.3	<0.03	0
Residual Chlorine	mg/L	---	---	0.1	<0.05	0
Ammonia-N	mg/L	15	---	45	0.6	0
	lbs/day	3750	---	11250	76	0
pH	pH unit	6 - 9			7.3	0
Temperature	°F	---	---	100	78	0
Turbidity	NTU	---	---	2*	0.5	0
				5NTU**		0

* Daily average

**Turbidity shall not exceed 5 NTU for more than 5% of the time (72 minutes) during any 24-hour period.

TITP faces several unique challenges that are uncommon to many municipal wastewater treatment plants. These challenges include the following factors:

1) High fluctuation in daily flow. A typical ratio of the peak flow to low flow at TITP is about 4:1, while at most other treatment plants, this ratio is below 3:1.

2) High percentage of industrial waste and an elevated salinity caused by seawater infiltration into the sewer line.

3) Short distance from major dischargers to the plant (e.g., the U.S. Naval Shipyard and some fish canneries). Discharge from some industrial sources arrives at the plant within minutes; therefore, very little or no degradation occurs before the influent arrives at the plant.

4) High effluent volumes are from a few dischargers (e.g., the TOSCO Refinery discharges approximately 4-5 MGD to TITP or about 25% of the total influent flow). When the Tosco plant stops discharging, TITP experiences a sudden drop in influent flow, causing irregularity in both concentration and retention time in the plant's aeration basin.

Tables 2-3 through 2-5 list the effluent discharge limits for non-carcinogens, carcinogens and marine aquatic life toxicants, the 2001 annual effluent averages, and the maximum 30-day averages detected in any month. Pollutants under these groups include heavy metals, pesticides, and some common solvents used in industries. Among the organic constituents tested, only chloroform, halomethanes, and hexachlorocyclohexane (gamma-) were detected. The inorganic constituents detected were arsenic, cyanide, copper, mercury, silver, selenium, tributyltin and zinc. There were no permit exceedances for these constituents.

Table 2-3. The NPDES permit limits and the 2001 annual averages and maximum 30-day averages for non-carcinogens and carcinogens.

CONSTITUENT	UNITS	LIMITS 30-DAY AVERAGE	2001 EFFLUENT 30 DAY AVERAGE	2001 EFFLUENT 30 DAY MAX
NON-CARCINOGENS				
1,2-DICHLOROBENZENE	mg/L	18	ND	ND
	lbs/day	4504	NC	
1,3-DICHLOROBENZENE	µg/L	2600	ND	ND
	lbs/day	651	NC	
FLUORANTHENE	ug/l	42	ND	ND
	lbs/day	10.5	NC	
TOLUENE	mg/L	300	ND	ND
	lbs/day	74700	NC	
TRIBUTYLTIN	ng/L	5.0	1.6	4.3
	lbs/day	0.001251	0.0002	0.0005
CARCINOGENS				
ALDRIN	pg/L	140	ND	ND
	lbs/day	0.000035	NC	
BENZENE	µg/L	21	ND	ND
	lbs/day	5.2	NC	
CHLOROFORM	µg/L	480	0.32	0.6
	lbs/day	120	0.041	0.067
DICHLOROMETHANE	µg/L	1600	ND	ND
	lbs/day	400	NC	NC
1,4-DICHLOROBENZENE	µg/L	64	ND	ND
	lbs/day	16	NC	
HALOMETHANES	µg/L	480	<1.90	<2.22
	lbs/day	120	0.24	
HEPTACHLOR EPOXIDE	ng/L	0.07	ND	ND
	lbs/day	0.000017	NC	
HEXACHLOROBENZENE	pg/L	690	ND	ND
	lbs/day	0.00017	NC	
HEXACHLOROCYCLOHEXANE				
ALPHA	ng/L	13	ND	ND
	lbs/day	0.0032	NC	
BETA	ng/L	46	ND	ND
	lbs/day	0.011	NC	
PAH's	ng/L	31	ND	ND
	lbs/day	0.0077	NC	
TCDD equivalents	pg/L	0.014	ND	ND
	lbs/day	3.5×10^{-9}	NC	
2,4,6-TRICHLOROPHENOL	µg/L	1.0	ND	ND
	lbs/day	0.25	NC	

ND = NOT DETECTED, NC = NOT CALCULABLE

Table 2-4. The NPDES effluent permit limits with 2001's annual averages and maximum 30-day averages.

CONSTITUENT	UNITS	LIMIT 30-DAY AVG	LIMIT DAILY AVG	LIMIT INST.* MAX	2001 EFFLUENT 30-DAY AVERAGE	2001 EFFLUENT 30-DAY MAX
ARSENIC	µg/L	10	20	30	3	5.9
	lbs/day	2.5	5.0	---	0.4	0.75
CADMIUM	µg/L	---	9.3	43	ND	ND
	lbs/day	---	2.33	---	NC	
CHROMIUM (VI)	µg/L	---	50	1100	ND	ND
	lbs/day	---	12.5	---	NC	
CYANIDE	µg/L	30	300	---	<4	6
	lbs/day	7.5	75	---	<0.5	0.8
LEAD	µg/L	---	5.6	140	ND	ND
	lbs/day	---	1.40	---	NC	
NICKEL	µg/L	---	8.3	75	ND	ND
	lbs/day	---	2.08	---	NC	
SELENIUM	µg/L	---	71	300	10	21.7
	lbs/day	---	17.76	---	1.27	2.82
DDT	pg/L	600	1000	---	ND	ND
	lbs/day	1.5×10^{-4}	2.5×10^{-4}	---	NC	
DIELDRIN	pg/L	140	1900	---	ND	ND
	lbs/day	3.5×10^{-5}	4.75×10^{-4}	---	NC	
ENDOSULFAN	ng/L	---	8.7	34	ND	ND
	lbs/day	---	2.18×10^{-3}	---	NC	
ENDRIN	ng/L	---	2.3	37	ND	ND
	lbs/day	---	5.76×10^{-4}	---	NC	
HEPTACHLOR	ng/L	0.17	3.6	---	ND	ND
	lbs/day	4.25×10^{-5}	9.0×10^{-4}	---	NC	
HEXACHLOROCYCLO-HEXANE, GAMMA	ng/L	62	160	---	8	20
	lbs/day	0.0155	0.040	---	0.0010	0.0020
PCBs	pg/L	70	30000	---	ND	ND
	lbs/day	1.75×10^{-5}	7.5×10^{-3}	---	NC	
PENTACHLOROPHENOL	µg/L	---	7.9	13	ND	ND
	lbs/day	---	1.98	---	NC	
TOXAPHENE	ng/L	---	0.02	210	ND	ND
	lbs/day	---	5×10^{-6}	---	NC	
CHLORDANE	pg/L	81	4000	---	ND	ND
	lbs/day	2.03×10^{-5}	1.0×10^{-3}	---	NC	

ND =NOT DETECTED, NC = NOT CALCULABLE
* Instantaneous

Table 2-5. Interim limitations (Objectives for Protection of Marine Aquatic Life) in effluent.

		LIMITS			2001 EFFLUENT	
CONSTITUENT	UNITS	30-DAY AVERAGE	DAILY MAX	INST.* MAX	30 DAY AVERAGE	30-DAY MAX
COPPER	µg/L	27	---	---	<10	17.1
	lbs/day	6.75	---	---	<1.3	2.2
MERCURY	ng/L	450	---	2100	<300	300
	lbs/day	0.1125	---	---	<0.04	0.04
SILVER	µg/L	3.7	---	---	<0.6	1.7
	lbs/day	0.925	---	---	0.08	0.22
ZINC	µg/L	151	---	---	26	56.9
	lbs/day	37.75	---	---	3.3	7.2

* Instantaneous

Table 2-6 lists the 2001 monthly averages for most of the major wastewater constituents. The 2001 average percent removals ranged from 98% for ammonia, 95% for oil and grease, 99% for BOD, to almost complete removal of both suspended and settleable solids.

Table 2-6. 2001 monthly averages for major wastewater constituents.

	FLOW	TEMP	TURB	pH		TSS		5-d BOD		OIL & GREASE		SETT. SOLID		AMMONIA-N	
	INF	EFF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF
2001	MGD	°F	NTU			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L	ml/L	mg/L	mg/L
JAN	17.1	72	0.5	7.6	7.1	251	1	235	2	37	2	11.5	<0.03	34.8	0.2
FEB	17.4	72	0.5	7.5	7.0	235	1	249	2	59	2	13.4	<0.03	38.4	2.4
MAR	16.5	74	0.6	7.5	7.1	267	1	270	2	38	2	11.9	<0.03	41.5	1.9
APR	14.5	75	0.5	7.5	7.0	254	1	260	2	40	1	12.8	<0.03	33.1	0.1
MAY	15.1	77	0.5	7.4	7.1	224	2	252	1	39	3	13.5	<0.03	33.9	0.2
JUN	14.6	80	0.6	7.7	7.4	164	2	213	2	34	1	12.1	<0.03	26.9	1.5
JUL	14.5	81	0.4	7.5	7.4	170	1	208	1	39	1	12.7	<0.03	25.4	0.3
AUG	14.7	83	0.5	7.1	7.5	199	1	244	1	32	2	16.9	<0.03	26.9	0.2
SEP	15.0	83	0.5	7.3	7.5	196	1	242	1	34	1	14.8	<0.03	26.7	0.1
OCT	14.4	81	0.6	7.2	7.4	215	1	294	1	39	3	15.4	<0.03	25.3	0.1
NOV	13.9	79	0.6	7.3	7.4	219	1	274	1	43	<3	14.6	<0.03	29.4	<0.1
DEC	14.5	75	0.4	7.5	7.4	195	1	266	1	39	<3	13.0	<0.03	25.5	0.2
*MAX	18	85	1.0	8.2	7.7	592	3	513	6	105	10	75	<0.03	74.2	9.2
*MIN	13.3	66	0.1	6.6	6.6	60	<1	96	<1	17	<1	3.5	<0.03	17.1	<0.1
MEAN	15.2	78	0.5	7.4	7.3	216	1	237	1	39	2	13.6	<0.03	30.6	0.6
%REMOVAL							99.5		99.4		95		100		98

* Daily maximum or minimum results for 2001

Table 2-7 lists the annual averages from 1991 to 2001 for major wastewater constituents. The data shows that the quality of TITP effluent has continued to improve each year since 1994. Prior to 1994, most of the exceedances at TITP were associated with a high level of settleable solids caused by occasional bulking in the aeration tanks. At that time, after excessive bulking occurred, there were several successive days of high settleable solids before the biological aeration process could be brought under control. In recent years, quick identification and control of bulking conditions has led to fewer process upsets. The gradual decline in influent metal concentration over the years is mainly attributed to an effective pretreatment program used to control industrial discharge. The control of influent metals has led to a large number of below-detection-limit results in the final effluent.

Table 2-7. Annual average of major wastewater constituents from 1991 to 2001.

	Flow	Total	Turb.	pH		Susp. Solids		BOD-5		Oil & Grease		Sett. Solids		Ammonia-N	
	INF	# of Permit	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF	INF	EFF
Year	MGD	Exceedances	NTU			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ml/L	ml/L	mg/L	mg/L
1991	17.8	23	3.1	7.7	7.0	219	9	244	4	65	2.1	15.0	0.09	29.3	1.4
1992	17.0	26	3.5	7.7	6.9	198	10	253	6	72	2.2	14.0	0.15	30.5	0.7
1993	17.2	24	3.1	7.6	6.8	193	11	244	5	54	2.9	13.8	0.32	29.5	0.3
1994	16.1	0	2.9	7.6	7.3	199	7	221	5	54	3.4	16.0	0.03	32.3	0.4
1995	16.9	0	2.5	7.6	7.3	195	6	194	3	48	3.3	14.1	<0.03	28.5	<0.3
1996	15.9	0	1.2	7.6	7.2	187	5	201	3	49	2.2	12.6	0.03	28.5	0.4
1997	16.3	2	1.0	7.6	7.4	185	2	193	2	48	2.0	12.5	<0.03	28.5	1.8
1998	16.6	4	1.0	7.4	7.3	195	1	192	4	43	1.0	15.3	<0.03	29.7	6.2
1999	15.1	5	<0.5	7.5	7.4	234	2	251	3	41	1.0	16.0	<0.03	32.6	3.4
2000	15.9	3	0.5	7.5	7.3	227	1	237	2	40	2.0	15.9	<0.03	33.7	1.6
2001	15.2	6	0.5	7.4	7.3	216	1.1	251	1.4	39	1.20	13.6	<0.03	30.6	0.6

	As		Cr		Cu		Pb		Hg		Se		Ag		Zn	
	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff
µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
1991	6	5	12	2	70	8	4	<2	0.5	0.1	24	17	4.8	0.5	250	75
1992	4	3	6	3	58	<5	3	<2	0.8	1.0	18	11	1.9	1.0	1210	116
1993	8	4	10	2	59	6	<2	<2	0.7	<0.2	22	12	2.2	<0.4	222	50
1994	4	3	10	<4	47	7	<2	<2	<0.2	<0.2	46	25	1.9	<0.4	115	44
1995	4	4	<5	<4	41	<10*	<6	<4	<0.3	<0.3	20	14	2.0	<0.4	118	47
1996	4	2	4	<4	50	<10	6	<3	<0.3	<0.3	20	14	1.8	<0.4	154	44
1997	4	3	<4	<4	32	<10	4	<3	<0.3	<0.3	29	19	0.9	<0.4	86	25
1998	3	1	<4	<4	40	<10	3	<3	<0.3	<0.3	25	12	0.8	<0.4	103	8
1999	3	2	<4	<4	26	<10	<3	<3	<0.3	<0.3	22	14	0.7	<0.4	107	34
2000	4	3	4	3	33	<10	<3	<3	<0.3	<0.3	26	10	0.5	<0.4	103	27
2001	3	3	<10**	<10**	39	<10	<5**	<5**	<0.3	<0.3	21	10	1.0	<0.6**	127	26

* MDL changed in 1995
** MDL changed in 2001

The removal efficiency of metals through the treatment process is related to the chemical and physical characteristics of the individual metal. In general, higher removal efficiencies are found in metals that are less soluble in wastewater and have greater tendencies to associate with particles present in wastewater. This group of metals includes zinc and copper, which have high removal efficiencies (Table 2-7). The removal efficiencies of chromium, lead, and mercury cannot be determined because both the influent and effluent are below the detection limit. The arsenic concentration in the effluent was approximately the same as in the influent.

IV. CONCLUSION

Continuous efforts to upgrade the plant have resulted in excellent effluent quality in the year 2001. The improvement in effluent quality over the years can be attributed mainly to the following:

1) aggressive industrial pretreatment enforcement,
2) activated sludge selector system,
3) intensive process control program, and
4) capital improvements, such as the addition of a tertiary filtration system.

In October 2001, the construction of AWTF for TITP's wastewater reclamation project was completed. During 2001, continued efforts were made to improve treatment plant processes, and control pollutant sources in wastewater treated at TITP to produce high quality AWTF product water that would meet the regulatory standards for reclaimed water use. In the near future, approximately 5 MGD of the AWTF-treated effluent is planned for ground water injection. This is the first phase of a multi-phase project to reclaim the total plant flow by the year 2020.

V. LITERATURE CITED

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