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**INVESTIGATION AND SUMMARY REPORT
FOR THE WASTEWATER TREATMENT PLANT
COMPLIANCE EVALUATION**

BEALE AIR FORCE BASE

Final

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LIST OF ACRONYMS

ACC	Air Combat Command
AFB	Air Force Base
Ag	silver
BDCM	bromodichloromethane
BEHP	bis(2-ethylhexyl)phthalate
BMP	best management practice
BOD	biochemical oxygen demand
CBU	continuous backwash upflow
CCB	chlorine contact basin
CCD	Customer Concept Design
CDO	Cease and Desist Order
Cl	chlorine
COC	contaminant of concern
Cu	copper
CVRWQCB	Central Valley Regional Water Quality Control Board
DBCM	dibromochloromethane
DBP	disinfection byproduct
dN	denitrification
DS	disinfected secondary
E&E	Ecology & Environment, Inc.
EPA	United States Environmental Protection Agency
EVAP	evaporation and treatment system
FPI	fluorescent penetrant inspection
gpd	gallons per day
gpm	gallons per minute
HDPE	high density polyethylene
Hg	mercury
HQ	Headquarter
HRT	hydraulic retention time
LBD	land-based discharge
LI	Langlier Index
MBAS	methylene-blue active substances
MCL	maximum contaminant level
MG	million gallons
mg/L	milligrams per liter

LIST OF ACRONYMS (Continued)

MGD	million gallons per day
MIPE	mobile image processing equipment
MPN	most probable number
NDI	non-destructive inspection
NH ₃ -N	ammonia (as nitrogen)
NO ₂ -N	nitrite as nitrogen
NO ₃ -N	nitrate as nitrogen
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OCF	oxidation, coagulation, and filtration
OVS	oil/water separator
PAB	post aeration base
ppb	parts per billion
RFP	request for proposal
RO	reverse osmosis
RSS	return secondary sludge
SO ₂	sulfur dioxide
TDS	total dissolved solids
THM	trihalomethane
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons as diesel
TPH-G	total petroleum hydrocarbons as gasoline
TSS	total suspended solids
URS	URS Group, Inc.
USAF	United States Air Force
UV	ultraviolet
WDR	waste discharge requirement
WTP	water treatment plant
WWTP	wastewater treatment plant
µg/L	micrograms per liter

1.0 INTRODUCTION

URS Group, Inc. (URS) is contracted by Headquarter Air Combat Command (HQ ACC) to conduct a limited field investigation, implement point source treatment technologies, and design wastewater treatment plant (WWTP) upgrades in order to bring Beal Air Force Base's (AFB) wastewater discharges into full compliance with current and anticipated future water quality regulatory permits, and particularly with the more stringent National Pollutant Discharge Elimination System (NPDES) permit requirements that will become effective 1 April 2009. This Investigation Summary and Recommendation Report (report) summarizes the document and data reviews, on-site investigations, and engineering analyses. Recommendations for two proposed pretreatment systems are provided including installation schematics and cost estimates for point-source pretreatment.

This report includes the following sections:

- **Section 2.0 – Regulatory Summary.** This section summarizes the compliance evaluation performed using WWTP data, identifies contaminants of concern (COCs), and discusses regulatory considerations.
- **Section 3.0 – BMP Status and Recommendations.** The inspection summaries for the implementation or improvement of best management practices (BMPs) are provided in this section along with recommendations to address potential point sources.
- **Section 4.0 – Pretreatment Recommendations.** This section discusses recommendations for pretreatment system installation and coordination activities for the drinking water system and the mobile image processing equipment (MIPE).
- **Section 5.0 – Wastewater Treatment Plant Recommendations.** This section provides a preliminary summary of activities to date and upcoming work on WWTP modifications.

Supplemental information is provided in the following appendices:

- **Appendix A.** NPDES compliance data for 2006 and early 2007 are graphically provided. A table showing Title 22 water reuse criteria is also provided.
- **Appendix B.** Summaries of analytical data received to date.
- **Appendix C.** Calculations performed to evaluate corrosion potential in the drinking water system are provided, based on water quality sampling performed in May 2007.
- **Appendix D.** Contains cost data.

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2.0 REGULATORY SUMMARY

Discharges from the WWTP to surface waters and/or to land are currently subject to the following regulatory permits, which are administered by the Central Valley Regional Water Quality Control Board (CVRWQCB) to ensure that water quality standards are achieved:

- Discharges to the golf course and to Hutchinson Creek are regulated pursuant to Waste Discharge Requirements (WDRs) for the United States Air Force (USAF), Beale AFB, WWTP, Yuba County; NPDES No. CA0110299; Order #R5-2004-0045 (NPDES-WDRs). The current term permit expires 1 April 2009; the base must submit a Report of Waste Discharge 180 days prior to the expiration date in order to renew the permit.
- Discharges to Pond 4 and the 40-acre irrigation field are regulated pursuant to WDRs for the USAF, Beale AFB, Land-Based Discharge (LBD) to Pond and Irrigation Field, Order #5-01-087 (LBD-WDRs). This permit has no specified expiration date.

Both permits incorporate effluent limitations that are based on Title 22 water reuse requirements. Title 22 criteria provide treatment requirements, total coliform, and turbidity limits aimed at ensuring that human health is protected where reclaimed water is used for various purposes. For irrigation applications in which human contact with reclaimed water is minimal, criteria are less restrictive than for irrigation applications in which humans may come into physical contact with reclaimed water (i.e., restricted access vs. unrestricted access areas). Title 22 requirements associated with each of the above permits are shown in Appendix A.

There has been a history (1999–2002) of noncompliance with the NPDES permit due to exceedances of effluent limitations for methylene-blue active substances (MBAS), copper, mercury, total petroleum hydrocarbons as diesel (TPH-D), and total cyanide (EarthTech, 2006), and the CVRWQCB issued Cease and Desist Order (CDO) R5-2004-0046 on 23 April 2004, for violation of NPDES effluent limitations for MBAS, iron, oil and grease, total petroleum hydrocarbons (TPH), aluminum, nitrate, and nitrite. The CDO provided that full compliance with the permit effluent limits must be achieved by 1 April 2009 (when the NPDES-WDRs are up for renewal), or further regulatory enforcement action would be considered.

Since the 1990s, Beale AFB has been investigating options for bringing WWTP discharges into compliance with all permits; options include WWTP upgrades as well as water management and discharge strategies. Because the NPDES permit generally has very restrictive effluent limitations compared to the LBD-WDRs (see Table 2-1), the current goal is to move toward 100% land based discharge with no effluent discharges being directed to Hutchinson Creek. This would allow the base to terminate coverage under the NPDES-WDRs and retain only the LBD-WDRs. Termination of the NPDES-WDRs is also supported by the fact that over the past five years or so, only one discharge to the creek has occurred. The base's preferred approach is to achieve compliance in two phases. Phase I includes the following goals:

- Separate Site 13 treated groundwater from WWTP treated effluent, and use it to water the golf course and main base. Site 13 water does not meet the Title 22 definition of “recycled water,” and is, therefore, not subject to Title 22 water reuse requirements.
- Create additional water storage capacity to ensure that discharges to the creek will not occur.

- Continue to use treated WWTP effluent for restricted access irrigation, pursuant to applicable Title 22 requirements and effluent limitations in the LBD-WDRs.
- Make any WWTP improvements that are necessary to comply with existing LBD-WDRs.

To maximize the number of discharge options available for treated effluent, Phase II of the current plan is to implement WWTP upgrades, over time, that will allow effluent discharges to meet Title 22 criteria for unrestricted access water reuse (see Appendix A).

The following section provides a compliance evaluation of the NPDES-WDRs and LBD-WDRs.

2.1 Preliminary Findings

Exceedances of Effluent Limitations

NPDES-WDRs. Monitoring data were analyzed for WWTP effluent samples collected between January 2006 and April 2007. Because discharges are not currently occurring to Hutchinson Creek, the monitoring frequency for many constituents has not been consistent with monitoring requirements specified in the permit (however, the current monitoring frequency has apparently been approved by the staff of the CVRWQCB). Nevertheless, sufficient data exist to suggest that while effluent limitations specified in the current term permit are generally being met, there are a number of constituents *frequently* present in wastewater effluent at concentrations that could cause or contribute to exceedances of the NPDES final effluent limitations that will become effective beginning 1 April 2009. These pollutants of concern include:

- Total suspended solids (TSS);
- bis(2-Ethylhexyl)phthalate (BEHP);
- Total copper;
- TPH; and
- Nitrate (as nitrogen [NO₃-N]).

(See Table A-1 and Figures A-1 through A-17 in Appendix A.)

Several other constituents were *occasionally* present at concentrations that would exceed the 2009 NPDES permit effluent limitations; these include:

- Total coliform;
- Biochemical oxygen demand (BOD);
- MBAS;
- Total mercury; and
- Total residual chlorine.

There was only one exceedance of the weekly average BOD effluent limitation between January 2006 and April 2007 out of 55 weekly samples (Figure A-1); there was also one exceedance of the monthly average effluent limitation for MBAS (Figure A-11), total mercury (Figure A-7),

and total residual chlorine (Figure A-14) during this time period. BOD and MBAS are not considered to pose a substantial compliance problem; compliance with effluent limits for total mercury and total residual chlorine is more uncertain (see discussion below).

Compliance Uncertainties. It is unknown whether the 2009 NPDES permit effluent limitations for some constituents are currently being achieved, either because insufficient data were available with which to evaluate compliance or because current laboratory method detection limits and/or reporting limits are higher than the effluent limitations. *No data* were available for:

- Oil and grease;
- Total aluminum;
- Nitrite-N; and
- Total iron.

Note that oil and grease, total aluminum, nitrite-N, and total iron were included as pollutants of concern in the CDO issued to the base.

Laboratory results currently report any constituent concentrations that are below reporting limits as non-detects (see Table 2-1). In Appendix A, non-detects are shown graphically at concentrations equal to the reporting limits. Reporting limits are greater than the 2009 permit effluent limitations for total mercury, total copper, total cyanide, TPH constituents, and residual chlorine. Because concentrations that have been reported as not detected (below reporting limit) may actually exceed the effluent limitation, it is not possible to evaluate compliance unless sample concentrations exceed reporting limits (e.g., TPH). In the case of copper, reporting limits for dissolved copper were lower than for total copper (Figures A-8 and A-9), and dissolved copper concentrations regularly exceeded 2009 permit effluent limitations for total copper (assuming the limitation at a hardness of 100 milligrams per liter [mg/L]). Thus, total copper concentrations would also fail to meet the 2009 effluent limitations.

LBD-WDRs. Pollutant constituents are present in recent WWTP discharges (January 2006–April 2007) at concentrations that exceed or threaten to exceed effluent limitations specified in the LBD-WDRs (Table 2-1). These pollutant constituents include:

- Total mercury (Figure A-7);
- Total coliform (Figure A-4);
- TPH (Figure A-12); and
- Total dissolved solids (TDS) (Figure A-15).

While there was one sample in July 2006 that exceeded the mercury effluent limitation, a duplicate sample was below the 0.2 micrograms per liter ($\mu\text{g/L}$) reporting limit (also the effluent limit). All other samples were below the reporting limit; therefore, compliance with the mercury permit limitation is likely not problematic. Both the NPDES-WDRs and LBD-WDRs prohibit discharges from causing a statistically significant increase in nutrients or salts in underlying groundwater, and nutrient loading is not to exceed crop demand. There is some indication that $\text{NO}_3\text{-N}$ may increase in groundwater underlying Pond 4, over time, although the very limited

monitoring well data are inconclusive. Additional evaluation of the Pond 4 impacts is necessary to address this potential impact. If and when Site 13 water is separated from WWTP effluent, nitrogen concentrations in the treated effluent discharges may increase and become more problematic; additionally, agronomic rates of application would need to be recalculated.

2.2 Recommended Tasks for Achieving Regulatory Compliance

As the base moves toward 100% land based discharge, it is important to achieve full compliance with LBD-WDRs. Besides meeting numeric effluent limitations, other permit requirements that must be achieved include the following:

- Assure discharge of reclaimed water is at agronomic rates;
- Assure groundwater mounding does not occur beneath Pond 4;
- Construct tailwater return system, or other system approved by the CVRWQCB, to ensure that discharges do not migrate off site into Hutchinson Creek; and
- Develop an engineering plan and comply with other administrative requirements, including monitoring and reporting requirements, that are specified in the LBD-WDRs.

The current LBD-WDRs provide a total coliform effluent limitation for discharges to Pond 4 that reflect the Title 22 water reuse criterion for irrigation of unrestricted access areas. It is recommended that negotiations occur with the CVRWQCB to have the LBD-WDRs modified to reflect “restricted access” instead of “unrestricted access” in Title 22 requirements. Consistent with the definition of restricted access, Pond 4 must not be used recreationally.

In addition, it is recommended that discussions occur with the CVRWQCB to modify the permit limit for total dissolved solids (TDS). Review of recent a CVRWQCB guidance document related to TDS suggests that the permit limit may reasonably be modified upward and still meet applicable water quality objectives. (TDS is further discussed in Section 5.)

If it becomes necessary for the base to continue to rely on the NPDES-WDRs, the following tasks are recommended to ensure discharges comply with effluent limitations:

- The contract laboratory should report analytical data to the method detection limit (not reporting limit) and reporting limits (and preferably detection limits) should be lower than the 2009 permit effluent limitations.
- All pollutant constituents included in the NPDES permit as well as the LBD-WDRs should be included in monitoring.
- A strategy should be developed for addressing any pollutant constituents in the WWTP effluent that occur at concentrations that cannot be reduced, even after treatment, to levels that are below permit limitations. For example, evaluate and document the regulatory basis and “reasonable potential” for constituents identified as requiring effluent limitations by the CVRWQCB (in particular, for BEHP), if necessary.
- The feasibility and benefits of implementing alternative water management strategies should be further explored (e.g., isolating Site 13 water for irrigation of the main base and golf course).

- Other opportunities to use reclaimed water in applications that are consistent with Title 22 water reuse requirements should be explored.

Table 2-1. Summary of Compliance with Water Quality Regulatory Permits

Constituent	Units	RL	MCL	Effluent Concentration Avg – Max	2004 NPDES- WDRs	2009 NPDES- WDRs	2009 NPDES- WDRs	LBD- WDRs	LBD-WDRs	Compliance Time Period
					Hutchinson Creek and Golf Course	Hutchinson Creek and Golf Course	Number of Exceedances/ Number of Samples 2006-2007	Pond 4 and 40-acre Irrigation Field	Number of Exceedances/ Number of Samples 2006-2007	
MBAS	µg/L	100	500	290–590	500 1,000	500 1,000	1/16			Monthly average Daily maximum
BOD	mg/L	3.0		6–16	30 45 60	10 15 20	1/55	30	0	Monthly average Weekly average Daily Average
TSS	mg/L	5.0		12–17	30 45 60	10 15 20	6/48 (2006 only)			Monthly average Weekly average Daily average
Total Settleable Solids	mL/L/hr	0.10						0.1		30-day average
NH ₃ -N	mg/L	0.10		0.2–0.4	1.5	1.5	0/15			Monthly average, assuming 72°F and pH 8.0
NO ₃ -N	mg/L	2.0	10	11–13	10	10	1/3			6-month average Monthly average
NO ₂ -N	mg/L		1		1	1				6-month average Monthly average
Turbidity	NTU			6–13		2.0				Daily average
Total Aluminum	µg/L		200		71	71				Monthly average
Total Iron	µg/L		300		300	300				Monthly average

Table 2-1. (Continued)

Constituent	Units	RL	MCL	Effluent Concentration Avg – Max	2004 NPDES- WDRs	2009 NPDES- WDRs	2009 NPDES- WDRs	LBD- WDRs	LBD-WDRs	Compliance Time Period
					Hutchinson Creek and Golf Course	Hutchinson Creek and Golf Course	Number of Exceedances/ Number of Samples 2006-2007	Pond 4 and 40-acre Irrigation Field	Number of Exceedances/ Number of Samples 2006-2007	
Total Mercury	µg/L	0.20	2	<0.2–0.4		0.05	1/16	0.2	1/16	Monthly average Daily average
Total Cyanide	µg/L	5	150	<5	0.5 37	0.1 9.6	Unknown	56	0	Monthly average Daily average
Boron	µg/L	100		118–190				250	0	30-day average
TDS	mg/L	10	500	369–480				350	9/12	30-day average
Total Barium	µg/L	100	1,000	<100				300	0	30-day average
Total Cadmium	µg/L	1	5	<1	5	2.02 (assuming hardness = 100 mg/L)	0	1.3	0	30-day average Daily average
Total Copper	µg/L	10	1,000	10–12	40	5.8	1/15	20	0	Daily average Monthly average
Dissolved Copper	µg/L	5				14	9/15 (based on dissolved Cu data)			Daily maximum (NPDES-WDRs assumes hardness of 100 mg/L)
BEHP	µg/L	1.0		2.2–3.7	53	1.8 5.4	8/15			Monthly average Daily maximum
Oil and grease	mg/L				10 15	10 15				Monthly average Daily maximum
TPH	µg/L	50		140–320	5	5	6/12 (2006 only)	<50	6/12 (2006 only)	Monthly Average

Table 2-1. (Continued)

Constituent	Units	RL	MCL	Effluent Concentration Avg – Max	2004	2009	2009 NPDES- WDRs	LBD- WDRs	LBD-WDRs	Compliance Time Period	
					NPDES- WDRs	NPDES- WDRs					Number of Exceedances/ Number of Samples 2006-2007
Total Coliform	MPN/10 0 mL	2.0		2 -8	23	2.2 (creek) 23 (golf course)	5/95 (2006 only)	2.2 (Pond 4)	5/95 (2006 only)	7-day median Instantaneous maximum Daily maximum	
Cl Residual	mg/L	0.10		0.01	0.01 0.02	0.01 0.02	1/48			4-day average 1-hour average	
THMs											
DBCM	µg/L			1.0	1.1	0.41				Monthly average Daily maximum	
BDCM	µg/L			2.1	4.1	0.56				Monthly average Daily maximum	
Minimum Treatment				DS		OCF		OCF			
BDCM	= bromodichloromethane					NH ₃ -N	= ammonia as nitrogen				
BEHP	= bis(2-ethylhexyl)phthalate					NO ₂ -N	= nitrite as nitrogen				
BOD	= biochemical oxygen demand					NO ₃ -N	= nitrate as nitrogen				
Cl	= chlorine					NPDES	= National Pollutant Discharge Elimination System				
Cu	= copper					NTU	= nephelometric turbidity unit				
DBCM	= dibromochloromethane					OCF	= oxidation, coagulation, and filtration				
DS	= disinfected secondary					RL	= reporting limit				
L	= liter					TDS	= total dissolved solids				
LBD	= land-based discharge					THM	= trihalomethane				
MBAS	= methylene-blue active substances					TPH	= total petroleum hydrocarbons				
mg/L	= milligrams per liter					TSS	= total suspended solids				
mL	= milliliter					WDR	= waste discharge requirement				
MPN	= most probable number					µg/L	= micrograms per liter				

3.0 BMP STATUS AND RECOMMENDATIONS

The work plan identified a number of potential pretreatment systems with discharges to the sanitary sewer that have the potential to affect the effluent discharge limits at the WWTP. URS inspected the following sites to assess the implementation of or improvement of existing BMPs:

- Building 1072 Washrack – TPH and metals.
- Hospital Clinic – mercury.
- Building 1075 NDI Laboratory – TPH and metals.
- Building 2496, 9th Transportation Maintenance Facility – TPH and metals.

Findings for each of these systems are in this section.

3.1 Building 1072 Washrack

Summary of Existing Conditions

The wash water from the Building 1072 aircraft wash rack is a potential source of TPH and metals. The wash water from the wash rack drains to two below ground sumps, where it is consolidated, and then pumped into an aboveground oil/water separator (OWS), OWS-I. Previous investigations have determined that OWS-I has not been fully functional for a number of years. There is not enough oil and grease coming from the wash water at this site to be skimmed off the surface of the water and the wash water appears milky, indicating the presence of surfactants in the detergent used to wash down aircrafts. Recent analytical data provided by EarthTech are summarized in Appendix B, Table B-1 (EarthTech, 2007). The data indicate the presence of TPH, oil and grease, MBAS, cadmium, copper, and TDS in OWS-I wash water collected during the wash down of a KC-135 tanker air craft and a U2. TPH and oil and grease were present, but the primary concern with the system was the elevated total cadmium and copper concentrations:

- TPH-D: 8.3 to 55 mg/L.
- TPH as gasoline (TPH-G): 1.7 to 21 mg/L.
- Oil and grease: 16 to 120 mg/L.
- Cadmium: 20.4 to 42 µg/L as total cadmium; 9.1 to 13.2 µg/L as dissolved cadmium.
- Copper: 155 to 407 µg/L as total copper; 34.8 to 48.8 µg/L as dissolved copper.
- MBAS: 3.1 to 4 mg/L.
- TDS: 170 to 320 mg/L.

The flow rate of the wash water generated at the wash rack was not measured, however, the *Industrial Wastewater Pretreatment Study Phase II Report, Beale AFB*, dated April 1997 (Ecology and Environment, Inc. [E&E], 1997) estimates the maximum daily flow at 1,050 gallons per day (gpd).

Potential Impacts to the WWTP

While total cadmium and total copper concentrations in WWTP effluent do not exceed current permit limitations, total copper concentrations exceed the NPDES permit final effluent limitation that will become effective 1 April 2009 (5.8 µg/L, based on hardness of 100 mg/L) (see Figure A-8). Based on a total cadmium concentration of 40 parts per billion (ppb) and a total copper concentration of 400 ppb in the wash water, Table 3-1 summarizes the estimated contribution of OWS-I on cadmium and copper concentrations entering the WWTP and the estimated percentage of cadmium and copper contributing to the WWTP effluent limits for the NPDES permit (2009) for various flow scenarios. The worst-case scenario is for an OWS-I flow rate of 1,500 gpd, combined with the minimum flow rate at the WWTP of 0.4 million gallons per day (MGD).

The LBD-WDR concentrations for copper are 20 µg/L for the 30-day average, and 45 µg/L for the daily maximum. For cadmium, the LBD-WDR concentrations are 1.30 µg/L for the 30-day average, and 5.0 µg/L for the daily maximum. Therefore, as with the NPDES limits, the OWS-I contribution to cadmium concentrations will be minimal. However, since the LBD-WDR limits for copper are significantly higher than the NPDES limits (20 to 45 µg/L versus 5.08 µg/L), the maximum contribution from the OWS-I to copper concentrations will only be 7.5 percent.

Recommendations

The performance of OWS-I is currently being evaluated under a separate contract with EarthTech. Based on conversations with Air Force representatives at the site on 7 June 2007, the existing OWS will likely be removed from service and all wash water will flow through a grit chamber to collect solids where metals are expected to concentrate and release the water directly to the sanitary sewer. Pretreatment of the Building 1072 wash rack wash water for cadmium or copper removal is not recommended at this time. Cadmium is not a current concern at the WWTP. If implementation of planned copper mitigation measures, such as injection of corrosion inhibitors at the water treatment plant (WTP) and modifications to the WWTP, do not reduce the copper concentrations in the WWTP effluent to acceptable levels, or if cadmium has the potential to exceed the WWTP effluent limits, pretreatment of the OWS-I water may be warranted in the future.

The current BMPs and recommendations for their improvement are summarized below for the Building 1072 wash rack:

<u>Current BMPs</u>	<u>Status/Recommendations</u>
<ul style="list-style-type: none"> Regular inspection and maintenance of OWS-I should be performed. Remove debris from the inlet grates to the washwater sumps. 	<ul style="list-style-type: none"> OSW-I is not functional and no separation of oil from water is apparent. The Air Force indicated that the OWS will be taken out of service. This BMP is not currently (but should be) implemented. It appears that debris collects and is pushed through the grates into the sumps. In addition, the grate of the northern sump has been modified to let all material pass into the sump. To prevent this material from being pumped into the OWS-I and eventually into the sewer, the debris should be separated via gravity and/or filtration, and the debris that collects in the sumps should be cleaned out regularly.

<u>Current BMPs</u>	<u>Status/Recommendations</u>
<ul style="list-style-type: none">• The detergents currently used are Penair HD-1 and ECO-Safety Kleen.• No current BMP exists for pretreatment of the metals in the wash rack wash water.	<ul style="list-style-type: none">• Consider replacing current detergent with a steam cleaning system or a high pressure water system that uses less detergent and water.• Depending on impacts to the WWTP, recommend implementing a pretreatment system for the washwater to remove metals prior to sewer discharge (e.g., solids removal via gravity and/or filtration).

3.2 Hospital Clinic

Summary of Existing Conditions

The hospital clinic was originally identified as a potential source of mercury. At this time, two actions have been implemented to abate mercury:

- A new pretreatment system and the associated plumbing from the dental sinks were installed sometime around 2003. This resulted in a reduction in the amount of amalgam that could get into the plumbing system.
- Piping under the hospital clinic was replaced sometime around February 2006. This was where elemental mercury from thermometers and/or manometers was found.

Flushing of lines from the clinic to the WWTP has not been done. Beale AFB plans to send out an request for proposal (RFP) to perform this work some time in 2008.

Potential Impacts to the WWTP

Based on conversations with clinic personnel, a substantial amount of work has been undertaken over the past few years to reduce or eliminate mercury discharges from the clinic into the sanitary sewer collection system, including:

- In 2003, a new pretreatment system was installed at the dental clinic that recovers the mercury amalgam collected from the suction lines plumbed to each dentist chair; new suction lines were also installed for each chair. This treatment system replaces a gravity separation system that was not very effective in removing mercury. While this upgrade included replacing piping to the dentist chairs, the piping leading from the original and the new treatment systems to the sanitary sewer connection could not be replaced because it runs below the building through the concrete floor. It is possible that residual amalgam could remain at low points in this line.
- In February 2006, VWI was contracted to remove and replace piping in the crawl space of the original hospital clinic. Piping that was replaced included water, steam, and sanitary sewer lines. The hospital addition was built on a slab, so no piping under the addition was replaced. During the work, elemental mercury, likely from thermometers and/or manometers used in the laboratory, was discovered and removed from one of the lines. AMI Group was the company contracted to provide environmental services and Cal Inc. was the company contracted to provide the mercury removal services.

Based on the above information, it is believed that the current mercury impacts to the WWTP originating from the clinic are minimal, though some residual mercury may still be present in the piping below the building and in the sanitary sewer lines between the clinic and the WWTP.

Recommendations

The base is scheduled to issue an RFP sometime in the next two years to flush and clean out the traps associated with the sanitary sewer line between the Clinic and the WWTP to ensure the elimination of any residual mercury. As discussed in Section 2.0, in order to comply with the 2009 NPDES-WDRs, laboratory detection limits for mercury should be lower than 0.05 µg/L.

3.3 Building 1075 Non-Destructive Inspection Laboratory

Summary of Existing Conditions

The Non-Destructive Inspection (NDI) Laboratory, located in Building 1075, was identified as a potential source of metals and TPH. The lab has an existing pre-treatment system to destroy petroleum hydrocarbons found in the rinsewater generated by their fluorescent penetrant inspection (FPI) operations. The system is an EcoPure 250R system, by Environmental Compliance, Inc. As shown in the flow schematic for the treatment system provided on Figure 3-1, rinsewater from the lab goes to a holding tank. From there, the water is pumped in 15-gallon batches into the EcoPure cabinet for treatment of petroleum hydrocarbons, through an activated carbon unit for polishing, then to the sanitary sewer. The system can process up to 250 gallons in a 12-hour period. This system is not intended to treat metals, but because the flow rate from this system is expected to be less than 1,000 gallons per month, the metals are not expected to cause a problem at the WWTP.

Based on conversations with the vendor for the EcoPure system and a review of the operations and maintenance information available at the NDI Laboratory, the treatment system is capable of accepting rinsewater with a TPH concentration of 1,000 mg/L. The EcoPure system incorporates a recirculation system to treat the rinsewater with ozone to reduce TPH to a concentration less than 100 mg/L. The activated carbon should then reduce the TPH concentration to less than 10 mg/L before the water is discharged to the sanitary sewer.

Potential Impacts to the WWTP

Base personnel provided the analytical results for a sample collected from discharge from the carbon adsorption unit in February 2007. The results are summarized below:

Barium:	94 µg/L.
Zinc:	29 µg/L.
Mercury:	1.1 µg/L.
TPH-D:	44 mg/L.
Benzoic Acid:	12,000 mg/L.

System records indicate that the activated carbon unit was last replaced in September 2006. The carbon is currently being changed out every 12 months. The flow rate of the system is unknown but is believed to be less than 1,000 gallons per month. Carbon replacement costs for a 55-gallon drum size vessel varies depending on the destination of the drum. This is based on the waste characterization (i.e., RCRA hazardous, California hazardous, or non-hazardous). Carbon canisters at the facility are returned to the supplier's facility and the carbon is tested there. When

the carbon is found to be non-hazardous, it is regenerated at the supplier facility. If the carbon is classified as a hazardous waste, it is transported to a hazardous waste facility in Nevada for disposal. The cost for disposal of a non-hazardous 55-gallon drum of spent carbon from Beale AFB ranges between \$250 to \$300 per drum, including transportation costs. The additional cost related to the disposal of spent activated carbon as hazardous waste ranges between \$500 to \$600 per drum, also including transportation costs. The spent carbon is expected to be classified as non-hazardous waste.

Recommendations

The treatment system is operating as intended, but periodic monitoring is recommended to assure continued compliance. The operations and maintenance information for this system is available in the laboratory, is still valid, and should continue to be referenced by personnel. The manual, however, does not provide monitoring recommendations. Based on our observations of the system, the following monitoring program should be implemented to provide operators with information that can be used to maintain the system:

- Sampling should be performed as part of the normal operations and maintenance of the system to monitor the condition of the system. The data should be tabulated to provide a history of system operations. The first few sets of data should be provided to the system vendor for recommendations and interpretation. As operators gain experience interpreting the data, they will be able to determine whether or not vendor intervention would be required.
- The outlet concentration from the current carbon unit already exceeds its target outlet concentration and should be replaced. The sampling program can be used to evaluate a more appropriate change-out schedule.
- A second activated carbon unit might be warranted based on the rate at which the current unit exceeded its capacity, but is not critical.
- The number of gallons of rinsewater generated per week or per month should be estimated.

In a typical sampling program associated with a treatment system, samples should be collected at a higher frequency at the beginning of the program. Samples will be collected at a lower frequency as operators become more familiar with the system and at a higher frequency when, for trouble shooting purposes, the system does not appear to be functioning properly.

As a starting point, a monthly sampling frequency is recommended. Samples should be analyzed for extractable TPH by United States Environmental Protection Agency (EPA) Method SW8015M. Once the first set of activated carbon units meets its criteria for change-out and is replaced, the sampling frequency can be reduced so that there are perhaps three sampling events per change-out. The following sample locations are recommended:

- S-1 = Inlet to the EcoPure cabinet;
- S-2 = Outlet from the EcoPure cabinet;
- S-3 = Midtrain of the activated carbon units; and
- S-4 = Outlet from the activated carbon units.

Sample location S-3 is a recommended sample location only if a second carbon unit is installed.

In addition to the monitoring program, the current BMPs and recommendations for their improvement for the NDI laboratory are summarized below:

Current BMPs

- Follow the operation and maintenance requirements for the EcoPure 250R pretreatment system.

Status/Recommendations

- Perform system testing to determine the correct carbon changeout frequency. A sampling plan is provided in Table 3-2.
- If influent concentrations at S-1 are below 100 µg/L, determine whether the treatment system can be reduced to carbon only.
- Consult with Environmental Compliance if monitoring data indicates the need for system modifications.

3.4 Building 2496, 9th Transportation Maintenance Facility

Summary of Existing Conditions

Building 2496 houses the 9th Transportation Maintenance Facility where vehicle maintenance is performed. Wash water from vehicle washing, including engine washing, collects in floor drains and flows by gravity to a collection sump and a closed-loop treatment system designed to remove oil and grease, fuels, and solids from the wash water. This system replaced OWS-M and was designed so that the treated wash water could be re-used in the shop to wash vehicles and engines. Based on conversations with the operators, however, the “closed-loop” treatment system has not been functional for over three years; the odor associated with the treated water was so bad that they had to evacuate the building after it was used. Since the treatment system is not functional, vehicle and engine washing operations are completed less frequently than before the treatment system was installed; when washing is conducted, the wash water remains in the floor trenches until sufficient water in the sump and drains evaporates to allow more room for wash water. The operators also employ other methods for equipment washing that minimize the amount of water generated, such as using dry adsorbents and discharging spilled water in the drive-through vehicle washing facility located in the parking lot.

The drive-through vehicle washing facility, located in the parking lot to the east of Building 2496 also has a water recycling system. It includes a grit chamber followed by an OWS that is used to collect the wash water prior to discharge to the sanitary sewer. The OWS for this system does not receive large volumes of oil and grease or fuels. However, it also does not function properly; the oil collection chamber is full of water, indicating that there is an improper setting on the oil recovery system.

Potential Impacts to the WWTP

Since the “closed-loop” system is not connected to the sewer collection system, there are no impacts to the WWTP from this facility.

Impacts to the WWTP from the vehicle wash facility located in the parking lot are unknown at this time, but based on conversations with the operators, the system is used infrequently and the washing activities typically do not generate substantial amounts of oil and grease or fuels.

Recommendations

No further action is recommended for the pretreatment “closed-loop” system. These current systems, however, do not appear to be effective. They will be evaluated during follow-on OWS contracts. It is recommended that BMPs be identified and a maintenance contract be implemented under these follow-on contracts.

Effluent from the vehicle wash facility located in the parking lot should be reviewed after the formal inspection of the OWS is completed under the separate project. No BMPs are recommended for this facility at this time, since it does not appear to have any substantial impacts on the WWTP and repairs to the system will be performed under a maintenance contract.

Table 3-1. OWS-I Cadmium and Copper Contributions to WWTP Effluent Concentrations

OWS-I Effluent Concentration (µg/L)		OWS-I Effluent Flow Rate (gpd)	WWTP Influent Flow Rate (MGD) ^a	WWTP Influent Concentration Contribution from OWS-I (µg/L)		Contribution based on the WWTP Effluent Limit from OWS-I (%)	
				Cadmium	Copper	Cadmium (Based on NPDES Limit of 2.02 µg/L)	Copper (Based on NPDES Limit of 5.8 µg/L)
40	400	500	0.4	0.050	0.50	2.5%	8.6%
			0.7	0.029	0.29	1.4%	4.9%
			1.2	0.017	0.17	0.8%	2.9%
		1,000	0.4	0.100	1.00	5.0%	17.2%
			0.7	0.057	0.57	2.8%	9.9%
			1.2	0.033	0.33	1.7%	5.7%
		1,500	0.4	0.150	1.50	7.4%	25.9%
			0.7	0.086	0.86	4.2%	14.8%
			1.2	0.050	0.50	2.5%	8.6%

^a The 0.4 MGD, 0.7 MGD, and 1.2 MGD values represent the minimum, average, and maximum flows observed at the WWTP from January 2006 to April 2007. Note that these flow rates do not include the Site 13 water.

gpd = gallons per day
 MGD = million gallons per day
 NPDES = National Pollutant Discharge Elimination System
 OWS = oil/water separator
 WWTP = wastewater treatment plant
 µg/L = micrograms per liter

**Table 3-2. Monitoring Program for
Building 1075 NDI Laboratory Treatment System**

Parameter: Flowrate

Data collection and documentation:	<p>Two options for collecting flowrate data are identified: The first is to conduct manual monitoring; the second is to install a flow totalizer. Because the flowrates are relatively low, a per day or per week flowrate would be appropriate.</p> <ul style="list-style-type: none"> • Manual monitoring method. Manual monitoring of flowrates can be performed by shutting the valve at the bottom of the effluent tank. Record the date and time when the valve is shut. When the tank is one-half to three-quarters full, the volume of water in the tank should be estimated, the date and time recorded, and the valve reopened. This should be repeated regularly (weekly to monthly). Data and calculated flowrates should be recorded. • Totalizer monitoring method. If a totalizer is installed, record the date, time, and totalizer reading on a daily to weekly basis. Average flowrates daily and weekly can then be calculated and recorded.
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Parameter: Constituent Concentrations

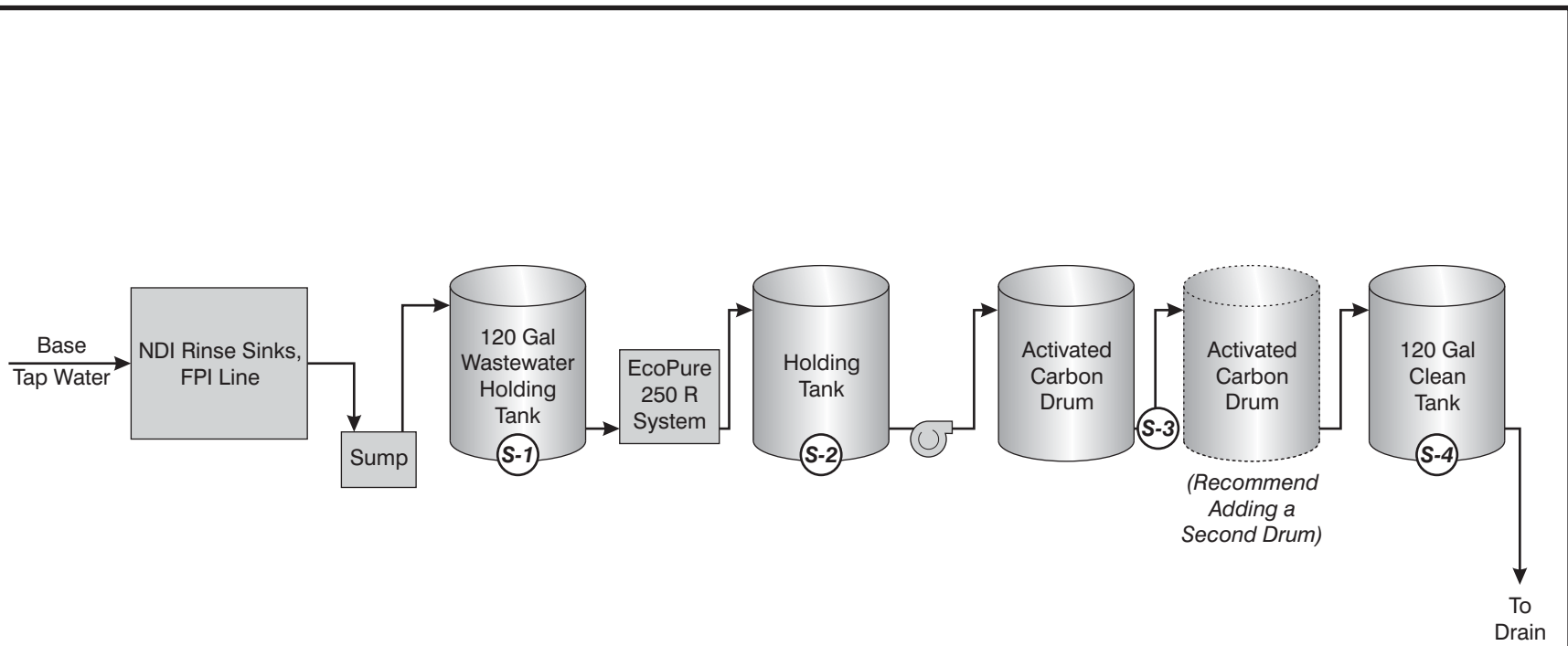
Data collection and documentation:	<p>Collect water samples at the following locations periodically (at least monthly) to monitor the condition of the system.</p> <ul style="list-style-type: none"> • S-1 = Inlet to the EcoPure cabinet; • S-2 = Outlet from the EcoPure cabinet; • S-3 = Midtrain of the activated carbon units; and • S-4 = Outlet from the activated carbon units. <p>Note that S-3 will only exist if two activated carbon units are used. Otherwise this sample location should be disregarded.</p>
Sample analyses:	<p>Submit samples collected from S-1, S-2, S-3, and S-4 to a certified analytical laboratory for extractable TPH analysis by EPA Method SW8015M. Request a detection limit of 1 mg/L.</p>
Sampling frequency:	<p>Starting point: sample monthly.</p>
Sample frequency modifications:	<p>The TPH should be less than 1,000 mg/L at S-1. If this concentration is consistently below this limit for one year, reduce sampling frequency to every other month after one year. If the TPH exceeds this concentration, contact Environmental Compliance Systems for recommendations.</p> <p>The TPH should be less than 100 mg/L at S-2. If this concentration is consistently below this limit after one year, reduce sampling frequency to every other month. If the TPH exceeds this concentration, contact Environmental Compliance Systems for recommendations.</p> <p>The TPH at S-3 and S-4 should be less than 10 mg/L.</p> <ul style="list-style-type: none"> • Case I: One carbon unit. Sample port S-4 is the outlet from the carbon unit. When TPH at S-4 is detected above 1 mg/L, sample more frequently (every one to two weeks to try to have the changeout occur before the S-4 concentration exceeds 10 mg/L) until concentrations rise to 5 mg/L. At that time, request a carbon changeout. • Case II: Two carbon units. Sample port S-3 is the outlet of the first carbon unit. If TPH is above 5 mg/L, sample more frequently (every one to two weeks) until concentrations rise to 40 mg/L. At that time, request a carbon changeout. It is best if the carbon changeout occurs before the S-3 concentration exceeds 50 mg/L. Sample port S-4 can continue to be sampled monthly unless its concentration exceeds 5 mg/L, at which time, the sampling frequency shall be increased to every one to two weeks and there will likely be the need to changeout both carbon units. If concentrations at sample port S-4 remain low, after the changeout of the lead vessel, move the second (lag) vessel into the #1 (lead) position, and place the new vessel into the #2 (lag) position.

Table 3-2. (Continued)

Notes:

1. Sampling should be performed as part of the normal operations and maintenance of the system to monitor the condition of the system. The data should be tabulated to provide a history of system operations. The first few sets of data should be provided to the system vendor for recommendations and interpretation. As operators gain experience interpreting the data, they will be able to determine whether or not vendor intervention would be required.
2. The monitoring data can be used to evaluate an appropriate change-out schedule for the activated carbon unit. Assuming only one carbon vessel is in place, watch for the presence of TPH at S-4.
 - A second activated carbon unit might be warranted based on the speed at which the current unit exceeded its capacity, but is not critical.
 - The number of gallons of rinsewater generated per week or per month should be estimated.
3. In a typical sampling program associated with a treatment system, samples should be collected at a higher frequency at the beginning of the program. Samples will be collected at a lower frequency as operators become more familiar with the system and at a higher frequency when for trouble shooting purposes, the system does not appear to be functioning properly.

***Disclaimer:** This monitoring plan is provided to augment the O&M manual for the EcoPure 250R system by Environmental Compliance, Inc. to help operators gather the data necessary to understand how the system is operating. This is not a substitute for the O&M manual.*



Recommended Initial Sampling Program:

(S-1) - Treatment System Inlet:

- Sample monthly for TPH extractable analysis by EPA method 8015M
 - Concentration should be <1000 mg/L TPH

(S-2) - EcoPure Outlet:

- Sample monthly for TPH extractable analysis by EPA method 8015M
 - Concentration should be <100 mg/L TPH

(S-3) - Activated Carbon Midtrain:

- Sample monthly for TPH extractable analysis by EPA method 8015M
 - Concentration should be <10 mg/L TPH

(S-4) - Activated Carbon Outlet:

- Sample monthly for TPH extractable analysis by EPA method 8015M
 - Concentration should be <10 mg/L TPH

Beale06-07-TPH-pretreat-sys.cdr - VMIG 06/20/07 SAC

Figure 3-1. NDI Laboratory TPH Pretreatment System, Beale AFB Wastewater Treatment Plant Compliance Evaluation

4.0 PRETREATMENT RECOMMENDATIONS

Of the point sources identified in the work plan, the WTP and the MIPE have been identified as pretreatment candidates. The copper concentrations in drinking water are well below the drinking water standard of 1,300 µg/L. However, due to the slightly corrosive nature of the drinking water and the presence of copper piping within the distribution system, the drinking water distribution system has been identified as a contributor to the copper discharged to the WWTP.

The MIPE historically used a closed loop system to treat their waste. However, a less costly and more efficient technology is desired that would enable them to meet their mission requirements without significantly impacting the discharge limits at the WWTP. A discussion of the current conditions and recommendations for a pretreatment system for each of these systems is presented below.

4.1 Corrosion Inhibition

Summary of Existing Conditions

The water distribution system at Beale AFB has been identified as one source of copper that may lead to an exceedance of the NPDES permit final effluent limitation for total copper that will become effective 1 April 2009 (5.8 µg/L, assuming a hardness of 100 mg/L). It should be noted that the NPDES permit limits are based on concentrations at which adverse effects to the most sensitive beneficial uses could potentially occur. For discharges to Hutchinson Creek, copper limits are based on concentrations that are toxic to aquatic life. On the other hand, according to the LBD-WDRs, the copper 30-day effluent limitation for discharges to Pond #4 is based on established basewide background concentrations; the daily maximum effluent limitation is based on the narrative toxicity, chemical constituent, and taste and odor water quality objectives specified in the Basin Plan. A 2003 investigation conducted by the base reported copper concentrations as high as 400 µg/L in the water in the Military Family Housing area where copper pipe is used (9CES/CC, 2003). The sources of copper contamination were evaluated to determine possible ways to reduce total copper in the water and wastewater systems.

The WWTP treats groundwater from nine extraction wells for manganese and iron, then chlorinates and fluoridates the water before distributing it out to the different areas of the base. Plant flow rates compiled from plant data sheets for the period of January 2006 through April 2007 ranged from 0.7 to 3.1 MGD with an average flow rate of 1.4 MGD; the maximum flow rates occur during the summer months.

One inlet sample and one outlet sample were collected at the WTP in May 2007. The analytical results are summarized and compared to the base quarterly monitoring compliance results for 2006 and 2007 in Table B-2 in Appendix B. The water quality parameters were used to evaluate the Langlier Index (LI), a measure of expected corrosivity for the water. The calculations for the LI are provided in Appendix C.

Potential Impacts to the WWTP

The LI indicates that the water at the base is corrosive in nature and that design and installation of a corrosion inhibition system is warranted to reduce copper corrosion in the water distribution system and to reduce the copper loading on the WWTP. The copper concentrations in the

drinking water are well below the drinking water standard of 1,000 µg/L. However, due to the slightly corrosive nature of the drinking water and the presence of copper piping within the distribution system, concentrations of copper in the drinking water distribution system have been detected at concentrations approximately two orders of magnitude above the effluent limitation identified in the 2009 NPDES permit. It is, therefore, considered to be a contributor to the WWTP copper effluent concentrations.

Because the NPDES-WDRs effluent limitation for total copper will be reduced in 2009 from a daily average limit of 40 µg/L to a monthly average limit of 5.8 µg/L (and a daily maximum limit of 14 µg/L, based on a hardness of 100 mg/L), addition of a corrosion inhibitor alone will not likely ensure that the WWTP will meet the new limit. Nevertheless, it is expected to reduce corrosion of the copper piping in the drinking water distribution system, which will reduce the copper loading at the WWTP.

Recommendations

The historical and recent sampling data have been provided to a number of vendors with a request for their recommendations for corrosion inhibitors, chemical dosing rate, and considerations of effectiveness. Discussions with vendors and in-house professionals are still in progress. At this time, methods of corrosion inhibition being evaluated include injection of a polyphosphate/orthophosphate corrosion inhibitor formulation at concentrations less than 5 mg/L at the WTP. Although additional copper concentration reductions can be attained by raising the pH of the drinking water, pH adjustment is not being considered at this time since the pH of the water at the WTP already fluctuates between 7.0 and 8.1.

Installation of the injection system is recommended at the inlet to the 3 million gallon (MG) tank. The system was originally to be installed at the WTP, adjacent to and following the fluoride injection system. However, there were concerns that the corrosion inhibitor would clog the filters during backwashing. The corrosion inhibition system will be installed in an 8-foot by 6-foot shed on a concrete pad with a 4-inch berm for secondary containment. The shed will also have room for the metering pump. The anticipated injection rate is expected to be less than 12 gpd.

After installation and initial setup of the system, the following additional testing and sampling is recommended:

- Continue to collect water samples from each potable well to confirm all current well total copper concentrations (sampling to be conducted by Bioenvironmental Engineering).
- Slowly increase the chemical injection rate over a period of six weeks while testing the residual orthophosphate concentrations in the drinking water distribution and sanitary sewer systems. The process should be allowed to equilibrate before increasing the dose. Sampling for phosphates should be conducted at the 3 MG tank and other sample points in the distribution system to evaluate the residual orthophosphate concentrations in the distribution system.
- Sampling for copper will be conducted monthly for six months following the start of injection. Based on discussions with the vendors, reductions in copper corrosion impacts will not be representative for approximately 90 days. Sampling should be conducted at various points in the drinking water distribution system, the sanitary sewer, and the WWTP inlet.

Anticipated sampling locations include Military Family Housing, the Cantonment Area, the Flightline, the sanitary sewer line, and the WWTP inlet.

Estimated Cost

The cost to install a phosphate corrosion inhibition system is approximately \$30,000.

4.2 MIPE

Summary of Existing Condition

The MIPE, located at C and 10th Street, produces wastewater streams containing metals, organics, and TDS. Currently, the film developing process produces approximately 5,000 gallons of rinsewater and 500 gallons of photoprocessing wastewater per mission. The wastewater is treated for silver at the MIPE; the wastewater and rinsewater are then combined and transported to the evaporation and treatment system (EVAP), located in Building 2145, where it is then treated to remove metals and TDS. The EVAP pretreatment system uses evaporation followed by reverse osmosis (RO). The treated water is sampled and discharged to the sanitary sewer system if it meets the WWTP discharge limits.

URS evaluated the possibility of segregating the rinsewater and discharging it directly to the sanitary sewer. Sample results for the rinsewater at the MIPE are summarized in Table B-3 in Appendix B. This table includes the results of one sample collected by URS and three samples collected by Beale AFB. The analytical data indicate that the concentrations of boron, copper, mercury, and TDS in the MIPE rinsewater exceed the WWTP NPDES permit discharge limits. Silver does not currently have a permit limit, but the silver concentration in the rinsewater ranges from 280 to 810 µg/L. Although this is below the hazardous waste threshold (5 mg/L), it exceeds water quality criteria for protection of aquatic life that serve as the basis for discharge criteria developed for Hutchinson Creek. If the MIPE were to begin discharging rinsewater directly to the WWTP without pretreatment, it is likely that the RWQCB would develop a discharge limit for silver. We estimated a potential discharge standard of 4.1 µg/L by applying aquatic toxicity criteria and a hardness of 100 mg/L. Long-term discharge to Hutchinson Creek would likely require some level of pretreatment to reduce the silver concentrations. Standards for discharge to land would probably default to the maximum contaminant level (MCL) (100 µg/L).

Sample results for the development process wastewater and the treated post-RO water that is discharged to the sanitary sewer were summarized and provided in the work plan and are not repeated in this document. These results indicate that the EVAP pretreatment system is capable of meeting the WWTP discharge requirements prior to release to the sanitary sewer.

Pretreatment Objectives

Although the EVAP pretreatment system currently meets the WWTP discharge requirements, the logistics of collecting, transporting, and treating the photo processing wastewater and rinsewater to meet the discharge requirements for the sanitary sewer challenge the ability of MIPE personnel to meet their mission requirements. The Air Force would like to be able to treat the rinsewater at the MIPE to eliminate or reduce the frequency of transporting it to the EVAP.

The primary COCs for the MIPE rinsewater are silver, copper, mercury, and TDS. The pretreatment system for MIPE operations was originally a closed-loop system, so pretreatment standards were not established. The base is presently using the WWTP discharge limits as target pretreat-

ment limits for discharge to the sanitary sewer. Future pretreatment objectives for the MIPE would require pretreatment to reduce concentrations of constituents in the water to levels that will not impact the ability of the WWTP to meet the final NPDES effluent limitations that will become effective 1 April 2009, if the option of discharging to Hutchinson Creek is retained.

Potential Impacts to the WWTP

To evaluate potential impacts from the discharge of untreated rinsewater from the MIPE area, URS estimated constituent concentrations that would occur in the influent to the WWTP (see Table 4-1). These calculations use the following assumptions:

- The maximum concentrations of copper, silver, mercury, and TDS from the data summarized in Table B-3 are present in the rinsewater.
- Dilution of the rinsewater is assumed based on the minimum, maximum, and average WWTP flow rates from 2006 to 2007.
- The rinsewater from one mission (5,000 gallons) is metered to the sanitary sewer over 12 hours. This metering occurs during the hours of 0500 to 2100 when the WWTP receives most of the water it treats in a day.
- The calculations do not account for any removal of constituents at the WWTP through sludge thickening or other mechanisms.

Based on these calculations, copper and mercury from the rinsewater might contribute to 2009 permit limit exceedances under the minimum plant flow scenario. Silver concentration estimates for the WWTP influent range from 4.8 to 14.7 $\mu\text{g/L}$, suggesting a challenge in meeting potential future discharge limits for silver. To ensure that both concentration and mass-based discharge limitations for silver are consistently achieved, some level of treatment, besides dilution alone, is recommended. Pretreatment for silver will likely result in some level of reduction in the concentrations of copper and mercury as well.

Pretreatment Recommendations

To maintain the long-term flexibility of being able to discharge to Hutchinson Creek, it is recommended that the silver concentration discharged to the sanitary sewer system be maintained below 100 $\mu\text{g/L}$. Ideally, pretreatment to remove silver and other metals should not be maintenance intensive, to avoid encumbering the MIPE staff. Selection of pretreatment equipment for polishing has significant uncertainty due to the sensitivity of metals removal to the presence of other constituents in the rinsewater. Use of a chelating resin that would be disposed of when spent, and ion exchange with off-site regeneration, were investigated as low maintenance methods effective for selective metals removal. Reverse osmosis and regenerable type ion exchange are more labor intensive and costly due to the requirement of handling the reject water (for RO systems), which can be as high as 70%, and regeneration chemicals and processes (for ion exchange), which can pose safety hazards and may be labor intensive to operate. The evaluation summary of the technologies considered is presented in Table 4-2 with preliminary costs. Backup cost data can be found in Appendix D.

The chelating resin process would require off-site disposal of spent media and would either be placed in a vessel smaller than 25 gallons, or be housed in cylinders similar to those used for water softening systems. URS will obtain rinsewater samples and coordinate with the vendors to

test the chelating resin and ion exchange resin with off-site regeneration. We will make a final selection of the system to be used based on the test results.

The pretreatment equipment can be set up on an existing 20-foot by 20-foot concrete pad located within the fenced boundary of the MIPE. The pad is located in the southeast corner of the fenced in area and directly adjacent to a sanitary sewer manhole. The proposed plan is to direct water from the three 5,000-gallon rinsewater storage tanks to a pretreatment system followed by discharge to the sanitary sewer. Figure 4-1 shows the proposed layout of equipment. Figure 4-2 is a process flow diagram showing the piping, valves, treatment components, and miscellaneous equipment required to conduct the pretreatment testing. The approach for this pretreatment plan has been discussed with MIPE operations personnel. The MIPE personnel are prepared to assist in the installation and operation of the pretreatment system. Additionally, MIPE personnel will complete electrical power connections for the pump and flow meters and piping from the existing storage tanks to the pretreatment system and the discharge manhole.

The pretreatment system design and operation criteria and associated proposed sampling requirements are presented below:

Design Flow Rate (All Phases): 5 to 8 gallons per minute (gpm) (this simulates draining one 5,000-gallon tank over a 12-hour period)

Pretreatment Equipment: 1-inch piping, valves, pump, and flow meter as shown on the process drawing
500-gallon storage tanks (high density polyethylene [HDPE] or polyethylene)
Pre-filtration equipment (filter and granular activated carbon, size to be determined, based on resin selected, and non regenerable ion exchange resin)

Sampling Analytes: Copper (Cu), total
Silver (Ag), total
Mercury (Hg), total

Table 4-1. MIPE Photochemistry Rinsewater Dilution-Only Contributions to the WWTP Effluent Concentrations^a

Analytes	Rinsewater Maximum Concentration	Discharge Target at the WWTP		WWTP Flow Data - January 2006–April 2007 (MGD) ^b			WWTP Flow Data - January 2006–April 2007 (MGD) ^b		
				Minimum	Maximum	Average	Minimum	Maximum	Average
				0.4	1.2	0.7	0.4	1.2	0.7
				Constituent Concentration Impacts Assuming Dilution with Water from the WWTP under Situations of Minimum, Maximum, and Average Flowrates			Constituent Concentration Impacts (Percent of the Discharge Limit)		
Boron (µg/L)	37,000	250	WDRs	67.08	21.73	36.40	26.8%	8.7%	14.6%
Copper (µg/L)	210	5.8	NPDES	3.81	1.23	2.07	65.6%	21.3%	35.6%
Silver (µg/L)	810	4.1	No limit ^c	14.68	4.76	7.97	358.2%	116.0%	194.4%
Mercury (µg/L)	1.1	0.05	NPDES	0.02	0.01	0.01	39.9%	12.9%	21.6%
Total Dissolved Solids (mg/L)	430	350	LBD	7.80	2.52	4.23	2.2%	0.7%	1.2%

^a Concentrations were calculated assuming no removal of these constituents by WWTP processes.

^b No Minimum, maximum, and average flow rates are based on monthly averages and do not include Site 13 flows.

^c No limit has been identified for silver in the NPDES WDRs. The limit of 4.1 µg/L was assigned as a worst-case scenario using the CTR water quality criteria for protection of aquatic life, assuming a hardness of 100 mg/L and using a conversion factor to derive total concentration from dissolved criteria.

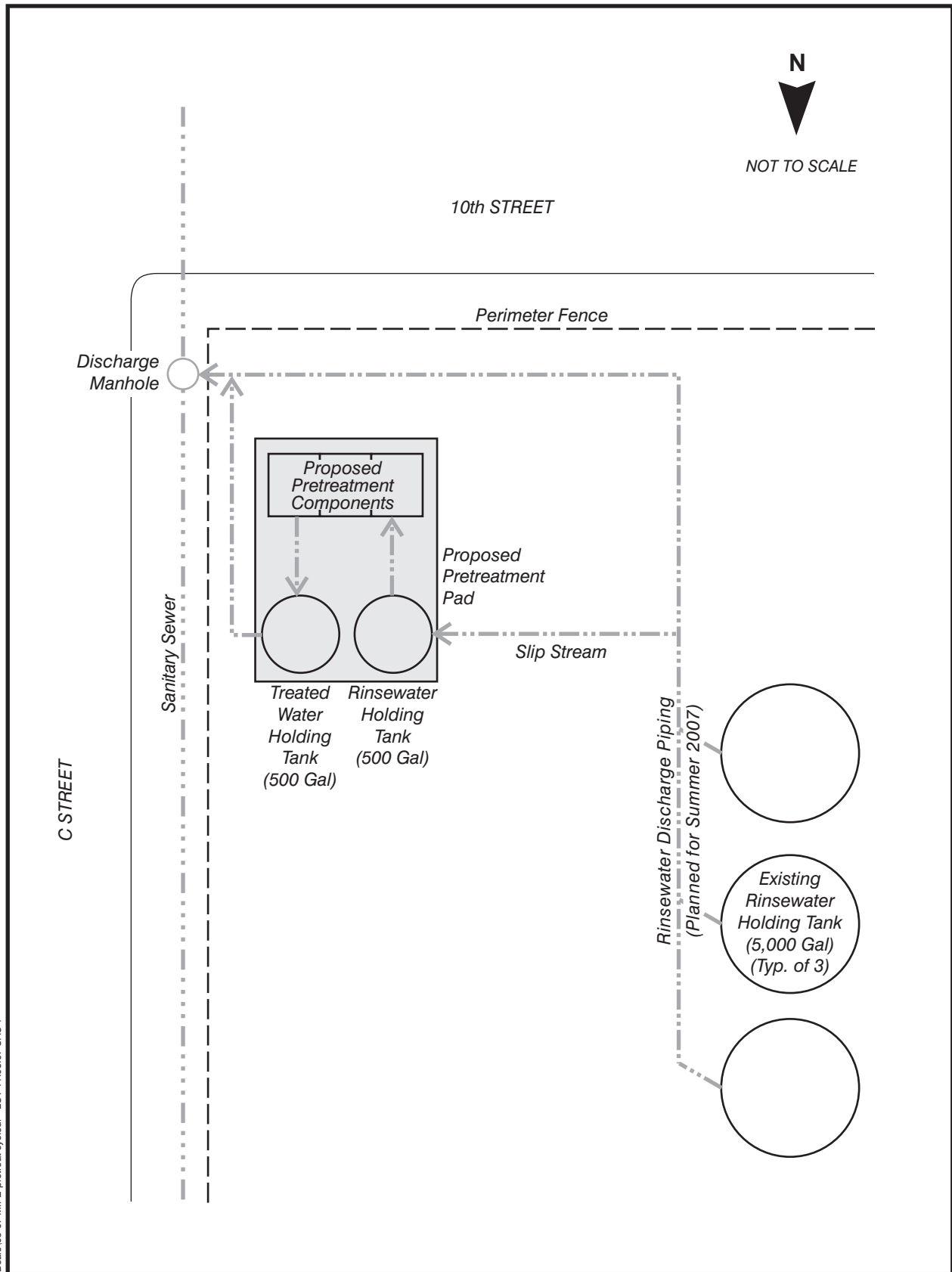
CTR = California Toxics Rule
 LBD = lead-based disposal
 MIPE = mobile image processing equipment
 WWTP = wastewater treatment plant
 MGD = million gallons per day
 mg/L = milligrams per liter
 NPDES = National Pollutant Discharge Elimination System
 WDR = waste discharge requirement
 WWTP = wastewater treatment plant
 µg/L = micrograms per liter

Table 4-2. Benefit Analysis for Potential MIPE Pretreatment Technologies

Technology Considered	Benefits	Problems	Recommendation	Estimated Capital and Chemical Costs
Regenerable Ion Exchange	Effective selective metals removal	Labor intensive operation Requires organics and solids removal prior to treatment On-site regeneration requires chemical handling operations	Not recommended	No cost provided
Chelating Resin	Effective selective metals removal No prefiltration or organics removal required	May release dithiocarbamates or amines into the water Changeout of resin that will likely be a California hazardous waste is required periodically	Consider for implementation Bench-scale testing prior to purchase	\$9K
Reverse Osmosis	Effective metals and TDS removal	Requires organics and solids removal prior to treatment Rejected water will need to be treated at the EVAP Labor intensive operation High power consumption	Not recommended	\$50K
Ion Exchange Resin with Off-Site Regeneration	Effective selective metals removal Minimal labor requirements for operation Requires no hazardous chemicals handling	Requires organics and solids removal prior to treatment	Recommended for consideration after testing of the chelating resin	\$30K

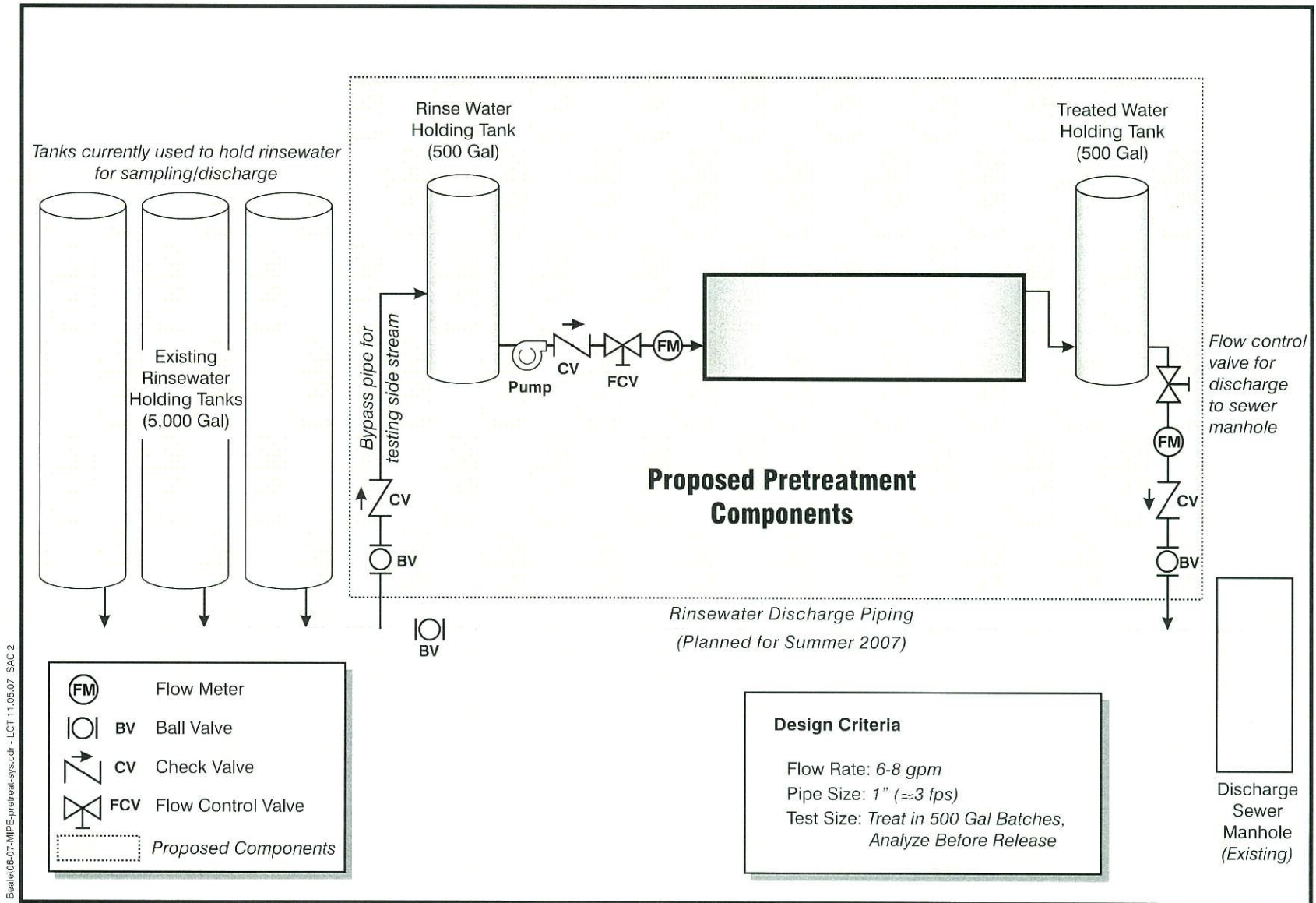
EVAP = evaporation and treatment system
 MIPE = mobile image processing equipment
 TDS = total dissolved solids

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Beale\06-07-MIPE-pretreat-sys.cdr - LCT 11.05.07 SAC 1

**Figure 4-1. MIPE Pretreatment System, Proposed Equipment Layout
Beale AFB Wastewater Treatment Plant Compliance Evaluation**



**Figure 4-2. MIPE Pretreatment System, Proposed Process Diagram
Beale AFB Wastewater Treatment Plant Compliance Evaluation**

5.0 WWTP TREATMENT RECOMMENDATIONS

5.1 Background

The existing Beale AFB WWTP (shown on Figure 5-1) is an under-loaded conventional rock trickling filter plant, which treats a very dilute (low strength) wastewater of primarily domestic origin. Because of light organic loadings, the facility already achieves future ammonia (ammonia [as nitrogen] [NH₃-N]) limitations for discharge to Hutchinson Creek (Table 2-1). Effluent ammonia concentrations generally average from 0.2 to 0.3 mg/L as NH₃-N, while future discharge limits are estimated at 1.5 mg/L or greater (depending upon water pH and temperature).

Pollutant discharge limitations vary depending on whether the discharge is to Hutchinson Creek, or to spray irrigation fields or the golf course (i.e., discharges to Hutchinson Creek and the golf course are regulated under the NPDES-WDRs and discharges to Pond 4 and the 40-acre irrigation field are regulated under the LBD-WDRs; effluent limitations differ for each permit). In the future, the base may choose to expand their use of recycled water for irrigation of unrestricted access areas. Table 2-1 presents a comparison of existing plant effluent (average and maximum) concentrations compared to key pollutants that appear to be limiting.

5.2 Past Performance

Perhaps the most critical parameter that requires additional removal is NO₃-N. Current and future discharges to Hutchinson Creek are limited to 10 mg/L NO₃-N. Although disposal of effluent by land application (irrigation/golf/recycled water) has no specific nitrate limitation, application rates are limited to crop uptake and/or to be controlled so that no adverse impact to groundwater occurs. Therefore, under any discharge scenario, denitrification (dN) (or the removal of NO₃) to less than 7 mg/L NO₃-N is desirable. A goal of 7 mg/L NO₃-N has been chosen by URS because 10 mg/L (limit to Hutchinson Creek and EPA drinking water criteria) would not allow for the presence of organic and ammonia nitrogen in the effluent.

Additional key pollutants to control are associated with a number of disinfection or chlorine related issues. Existing disinfection processes include the on-site generation of sodium hypochlorite from a salt solution. Contact time is provided by a chlorine contact basin (CCB) with three channels. Chlorine dosage averages 11 mg/L and may be as high as 24 mg/L. Limited data on the treated effluent indicate that the presence of free chlorine (rather than chloramines) is resulting in the production of undesirable disinfection byproducts (DBPs). Principal among the DBPs are trihalomethanes (THMs). The 2009 NPDES permit effluent limitations for THMs to Hutchinson Creek will include 0.41 µg/L (monthly average) for dibromochloromethane (DBCM) and 0.56 µg/L (monthly average) for bromodichloromethane (BDCM). Based on concentrations detected at the CCB (Table 5-1), it appears that the existing Beale AFB WWTP effluent exceeds future THM limits by several times future requirements.

Dechlorination is accomplished by generating a sulfur dioxide (SO₂) solution on site and adding the SO₂ solution to the edge of the post-aeration basin (PAB). The dechlorination system is relatively new and has experienced problems with sulfur fumes and concerns over operator safety. The existing dechlorination system is shut down while waiting for replacement equipment that will address operator safety.

Although mixing of SO₂ in the PAB is poor, the combination of SO₂ reducing agent, algae production, sunlight degradation, and hydraulic retention time (HRT) result in measured chlorine residuals in the PAB effluent of less than 0.1 mg/L (0.1 mg/L is the present reporting limit). Chlorine residual discharge limitations to Hutchinson Creek are 0.01 mg/L (as a 4-day average). Lower detection/reporting limits are needed to evaluate compliance with the residual chlorine effluent limitation.

Minimum levels of treatment are required depending upon the disposal option. Discharges to areas with restricted human access require disinfected secondary (DS) effluent. Future discharge to Hutchinson Creek or the production of recycled water will require a minimum of oxidation, coagulation, and filtration (OCF) or equivalent treatment prior to discharge. (Note that the current LBD-WDRs require a higher level of treatment for discharges to Pond 4; Section 2 of this report discusses the recommendation to pursue modification of the LBD-WDRs to reflect the less stringent Title 22 criteria for use of recycled water in restricted access areas.)

A TDS limit of 350 mg/L (30-day average) has been established for land application options. Regulatory negotiation is required to address TDS because the average TDS concentration in drinking water is greater than 300 mg/L. In several of the wastewater treatment steps, TDS is added, so that naturally high background TDS makes compliance impossible with standard technology.

Turbidity requirements of 2.0 nephelometric turbidity unit (NTU) for discharge to Hutchinson Creek or for certain land applications of recycled water, will not be achievable without additional treatment. The ability to predict achievable turbidity values is difficult without full-scale facilities in place. The use of solids contact or tertiary treatment technology will undoubtedly reduce turbidity. However, we are unable to predict whether a 2 NTU can be achieved without chemical addition.

Finally, a monthly average effluent concentration of 10 mg/L or less of TSS and BOD is required for future discharge to Hutchinson Creek. Conventional tertiary treatment (which includes effluent filtration) should be able to easily achieve the required effluent TSS/BOD limit.

5.3 June 2007 Sampling

Sampling and laboratory analysis are still ongoing (at the time of this investigation and summary report). Contract laboratories have submitted partial information for samples collected in June 2007 (Tables B-4, B-5, and B-6 in Appendix B). Table 5-1 provides available laboratory information on key pollutants sampled in May and June 2007 that may affect the Beale AFB WWTP upgrade. The following are observations and comments on the preliminary laboratory results.

TSS: As expected, testing at the CCB indicated that effluent TSS was below the future permit limit of 10 mg/L. In fact, future effluent TSS concentration is expected to be below the permit limit most of the time. However, effluent filtration is required to consistently achieve both the effluent TSS limit and to assure good removal of metals and other particulates that could otherwise cause compliance problems. For comparison, the historic results (2007 to 2007) are provided in Figure A-5.

NH₃-N: Testing confirmed that the Beale AFB WWTP has a fully nitrified (ammonia has been converted to nitrate) treated effluent. Since the plant is already nitrifying, no further action is

required to comply with future ammonia standards. For comparison, the historic results (2006 to 2007) are provided on Figure A-17.

NO₃-N: Testing of NO₃-N showed high concentrations at both the chlorine contact basin and post-aeration basin. Interestingly, there appears to be a significant amount of denitrification occurring in Pond 4. Recent sampling results do not change URS' current thinking as to the appropriate treatment technology for the WWTP upgrade. However, obtaining information on NO₃-N concentration is important in predicting use of a carbon source such as methanol (used for denitrification), and for sizing biological reactors/recycle flows. For comparison, the historic results (2006 to 2007) are provided on Figure A-13.

TDS: Sampling of TDS confirms that background levels are at or near permit limits. Recent testing reaffirms the need to discuss TDS with environmental professionals having regulatory oversight of the Beale AFB WWTP. For comparison, the historic results (2006 to 2007) are provided on Figure A-15.

Copper: The concentration of copper appears to be high relative to future permit limits. However, additional adsorption of copper will likely occur with treatment plant improvements. These improvements, along with steps to add corrosion inhibitors at the WTP are expected to reduce copper to acceptable levels. For comparison, the historic results (2006 to 2007) are provided on Figure A-8 and A-9.

BEHP or phthalate: The analytical reporting level of BEHP has historically been slightly above the future NPDES discharge limit. Several samples exceeded the reporting level and, therefore, the 2009 NPDES effluent limitation. Future tertiary treatment (filtration, chemical addition, or solids contact) should provide added removal of BEHP from the wastewater treatment plant effluent. In the future, analytical laboratories should be sought that can achieve detection limits that allow for evaluation of permit compliance (see discussion in Section 2). Historic results (2006 to 2007) are provided on Figure A-6.

THMs: DBCM and BDCM both exceeded the 2009 NPDES permit effluent limitation. The recent sampling confirms that DBPs need to be addressed in the current upgrade of the Beale AFB WWTP.

5.4 Current Direction

Compliance Strategy

The current strategy of the base is to move toward 100% LBD and, ideally, terminate the NPDES-WDRs that authorizes discharges to Hutchinson Creek and the golf course.

As part of this strategy, the TDS effluent limit for LBD of 350 mg/L must be increased. Testing in 2007 at the Beale AFB WTP indicates that TDS of the drinking water is near or exceeds 300 mg/L. With background levels of TDS being near the limitation for LBD, extreme treatment measures, such as reverse osmosis, would be necessary to lower the effluent TDS. The current strategy is to negotiate an achievable TDS limit. If a higher TDS limit (such as 600 mg/L versus 350 mg/L) cannot be negotiated, then LBD may no longer be a viable option.

IMPORTANT:
Present TDS limits for land-based disposal are unachievable without extreme measures.

With the exception of TDS, conventional or normally applied advance treatment technologies (coagulation/filtration) will be able to address all of the issues associated with requirements for discharge either to land based disposal, Hutchinson Creek, or reuse through a future recycled water system. For example, nitrate concerns can be addressed through biological denitrification. Additional COCs (turbidity, copper, BEPH, TPH, total coliform, chlorine (Cl) residual, THMs) will be addressed through a combination of improved secondary treatment and/or tertiary treatment.

WWTP Upgrade

A goal at the early phase of this WWTP upgrade was to keep the total capital cost under \$3 million. Therefore, only necessary improvements to the WWTP were considered. The WWTP project will include adding or improving denitrification, filtration, and disinfection.

More thorough details on the treatment alternatives greater than presently available will be developed and presented in the Customer Concept Design (CCD). The CCD will contain life cycle cost for the primary alternatives along with the initial design/specification for the apparent best alternative for upgrading the Beale AFB WWTP. Phasing and details of the treatment alternatives will be developed in the CCD. At this stage of study, the following options are being considered to achieve both the required discharge limits and meet the established project goals.

Denitrification

A denitrification process will be added to the existing WWTP treatment scheme. This additional treatment will allow total nitrogen values to be reduced within ranges necessary to prevent adverse impact to groundwater.

Option 1 – Solids Contact: The existing CCB will be converted to a solids contact basin with provisions for methanol (or other carbon source) addition as illustrated on Figure 5-2. Methanol will undoubtedly be required because of the low strength wastewater and highly oxidative state of the trickling filter underflow. A return secondary sludge (RSS) submersible pump station will be added to return settled biological solids to the new solids contact basin (converted existing CCB). Floating mixers will be installed in each of the three existing chambers. The conversion to solids contact will be relatively low-cost since the existing CCB is in a good location and is of adequate size.

A portion of the secondary effluent will be split off and pumped to effluent filters. Both filtered effluent and unfiltered effluent to be discharged to the LBD system will be disinfected. A description of disinfection alternatives will be described later in this section.

The solids contact alternative splits off a portion of effluent and treats a relatively modest portion of the flow in a tertiary (effluent filtration/new disinfection) system designed to achieve the production of recycled water that meets the California Title 22 regulations or meets future discharge requirements to Hutchinson Creek.

The advantage of the Solids Contact Option is that denitrification is separated from filtration, resulting in a less complicated system than combining both nitrate removal and filtration in the same unit. Another advantage of solids contact is that the effluent filters may be low cost, disk filters rather than deep bed units, which may be more expensive.

Option 2 – Denitrification Effluent Filter: The denitrification effluent filter alternative combines methanol addition with the use of deep bed continuous backwash upflow (CBU) filters as

illustrated on Figure 5-3. Because both denitrification and filtration are combined in the same unit, a more conservative hydraulic loading is used on the filters than would otherwise be required. A computerized control package will be included to control the amount of methanol so that overdosing does not occur. The addition of methanol is necessary to provide an anoxic (no free oxygen) state and environment that will cause bacteria to remove nitrate. It will also be necessary to re-aerate denitrified effluent after filtration but prior to discharge.

An advantage of the denitrification Effluent Filter Alternative is that the existing CCB will now be available for a reuse water storage basin. A disadvantage is that a majority of the secondary effluent must be treated by the denitrification filter. Since LBD is still the primary means of effluent discharge, peak flows will bypass the tertiary treatment system so that unit sizes may be reduced. Since the land application systems are preceded by more than 100 days of hydraulic storage, the combined effluent will meet permit requirements.

Filtration

An effluent limitation of 10 mg/L BOD/TSS cannot be reliably achieved unless effluent filtration is available. When secondary effluent turbidity exceeds 5 to 7 NTUs, it may be necessary to precede the filters with chemical addition to achieve a final effluent turbidity of less than 2 NTUs.

There are numerous types of filters available to remove suspended solids and reduce turbidity. Currently, commonly selected filters at WWTPs are often either granular media or cloth (disk) filters. Membrane (microfiltration) filtration similar to that used in treating drinking water is also available, but tends to be more costly than other types of filter units.

Two of the more popular filter devices for producing recycled water are the CBU filter and the fuzzy filter (hereafter referred to as high-rate filters). High rate filters can be loaded hydraulically (5 gpm/square foot) at about two times higher than the rate of filters with reduced media depth or with filters that have limited solids carrying capacity. A benefit of the CBU type high-rate filters is that denitrification may be incorporated and its high solids carrying capacity may be a benefit when the chemical addition is incorporated into the filtration scheme.

Numerous other filters exist but may have limitations for treating effluent high in turbidity. Both traveling bridge filters and cloth (disk) filters have been successfully used to filter secondary effluents, which have low influent turbidity. The advantage of these low rate (2 gpm/square foot) filters is that they can be procured at a modest cost. However, unless turbidity in the trickling filter effluent is reduced by addition of the solids contact reactor, rate filters may not achieve the required 2 NTUs for recycled water used for irrigation of unrestricted access areas or for discharge to Hutchinson Creek.

Disinfection

Upgrading the disinfection system at the Beale AFB WWTP is most likely to be accomplished by the following:

- Chlorination/dechlorination;
- Ultraviolet (UV) radiation; and
- A combination of UV radiation and chlorination/dechlorination.

One option to upgrade the disinfection system would be to construct a new disinfection system for chlorination/dechlorination. The new chlorination/dechlorination system would continue to use the existing equipment for generating hypochlorite but would consist of a new basin, dechlorination system, and new monitoring/control. Alternative means of dechlorination may be implemented. The new chlorine contact basin would be divided into channels with geometry and hydraulic retention best suited for achieving low total coliform and minimizing the required chlorine dose. Both dechlorination and the compliance sampling for other pollutants would be moved to the end of the chlorine contact basin (rather than at the PAB). The formation of DBPs will be controlled by avoiding the production of free chlorine. Ammonia will be added to the hypochlorite solution forming a chloramine solution. Chloramines do not lead to the formation of THMs or other related DBPs.

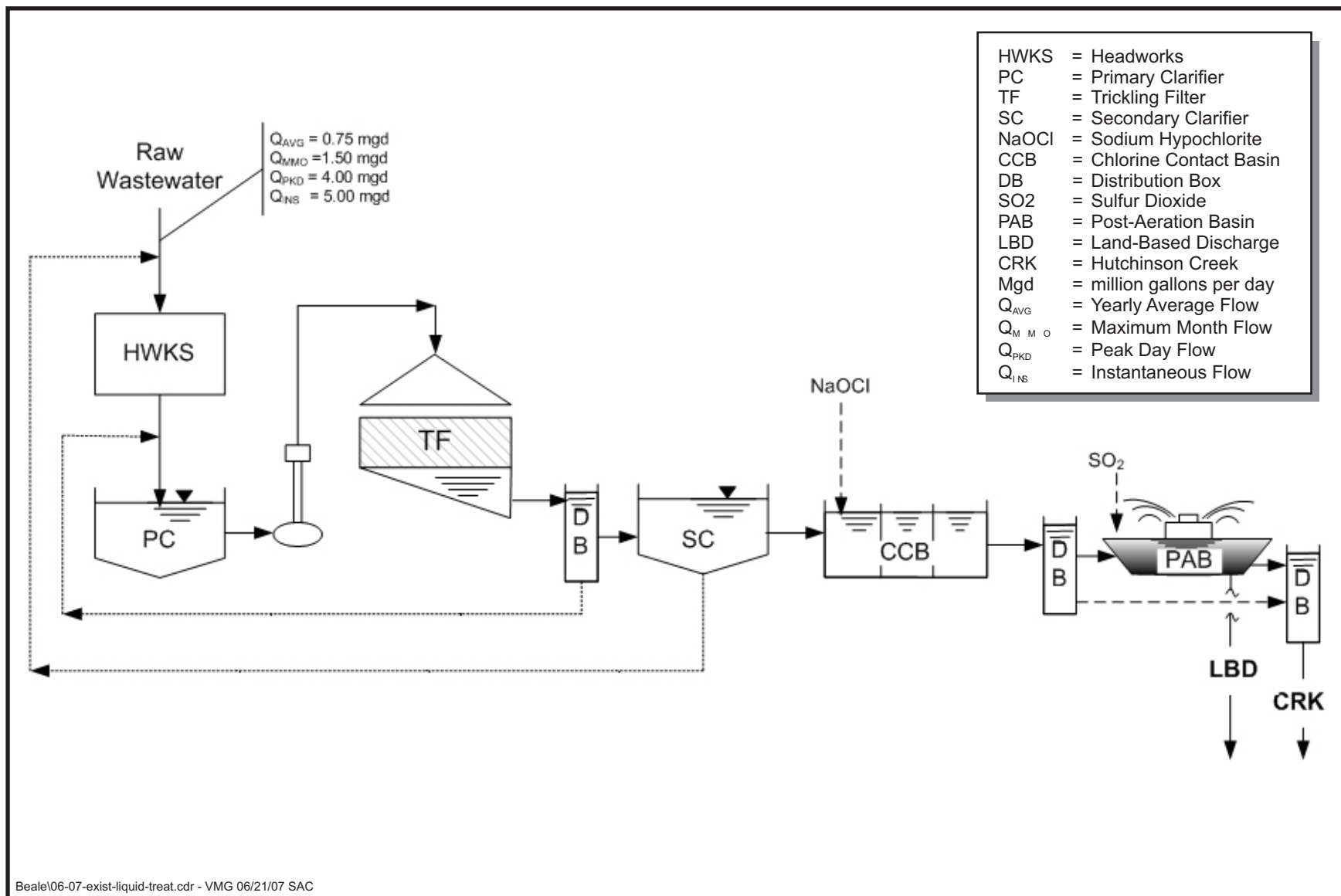
Another option would be to convert to a UV radiation system. Converting to UV would lower effluent TDS and also eliminate issues associated with disinfection byproducts. However, capital cost for a UV system is likely to be relatively high in order to reliably achieve the discharge limitation for total coliform of 2.2 most probable number (MPN)/100 mL. Additionally, regulations by the California Department of Health Services require that UV equipment producing recycled water be subjected to rigorous on-site validation tests. This will add validation expenses to equipment cost. UV validation testing and full equipment redundancy required for producing recycled water would not be required for discharge to Hutchinson Creek.

Another possibility is to use a combination of UV radiation and conventional chlorination/dechlorination. With this scenario (Figure 5-2 and Figure 5-3) UV equipment would be utilized to disinfect the Title 22 recycle water or for discharge to Hutchinson Creek. A parallel system using conventional chlorination/dechlorination will disinfect flow discharged to the land-based disposal systems not involving recycled water. The combined disinfection approach complicates monitoring and control. However, a combined system may result in reduced overall capital cost since disinfection needs can be tailor made to the disposal option.

Table 5-1. Preliminary Comparison – Future Limits to June 2007 Testing

Item	Units	Future Limit	Wastewater			Treated Effluent				
			Plant Influent	Primary Clarifier Effluent	SC	CCB	PAB	Pond 4	Site 13 Effluent	
TSS	mg/L	10				4			<2.5	
NH ₃ -N	mg/L	1.5				0.237			0.125	
NO ₃ -N	mg/L	10	<0.006			12.7	7.5	0.9	5.9	
Turbidity	NTU	2.0	16	9.6	3.1	4.6	16	6.2	0.85	
TDS	mg/L	350 (LBD)		306	296	498			300	
Copper	µg/L	7.5	20			10	<0.05	8	0.9	
BEHP (phthalate)	µg/L	1.8				<2.5			<2.5	
TPH	µg/L	<50	5,500			260	450		<12	
THMs										
DBCM	mg/L	0.41				6.57				
BDCM	mg/L	0.56				16.2				
BDCM	=	bromodichloromethane		NTU	=	nephelometric turbidity unit				
BEHP	=	bis(2-ethylhexyl)phthalate		PAB	=	Post-Aeration Basin				
CCB	=	Chlorine Contact Basin		SC	=	secondary clarifier				
DBCM	=	dibromochloromethane		TDS	=	total dissolved solids				
LBD	=	land-based discharge		THM	=	trihalomethane				
mg/L	=	milligrams per liter		TPH	=	total petroleum hydrocarbons				
NH ₃ -N	=	ammonia (as nitrogen)		TSS	=	total suspended solids				
NO ₃ -N	=	nitrate (as nitrogen)		µg/L	=	micrograms per liter				

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**Figure 5-1. Existing Liquid Treatment Processes,
Beale AFB Wastewater Treatment Plant Compliance Evaluation**

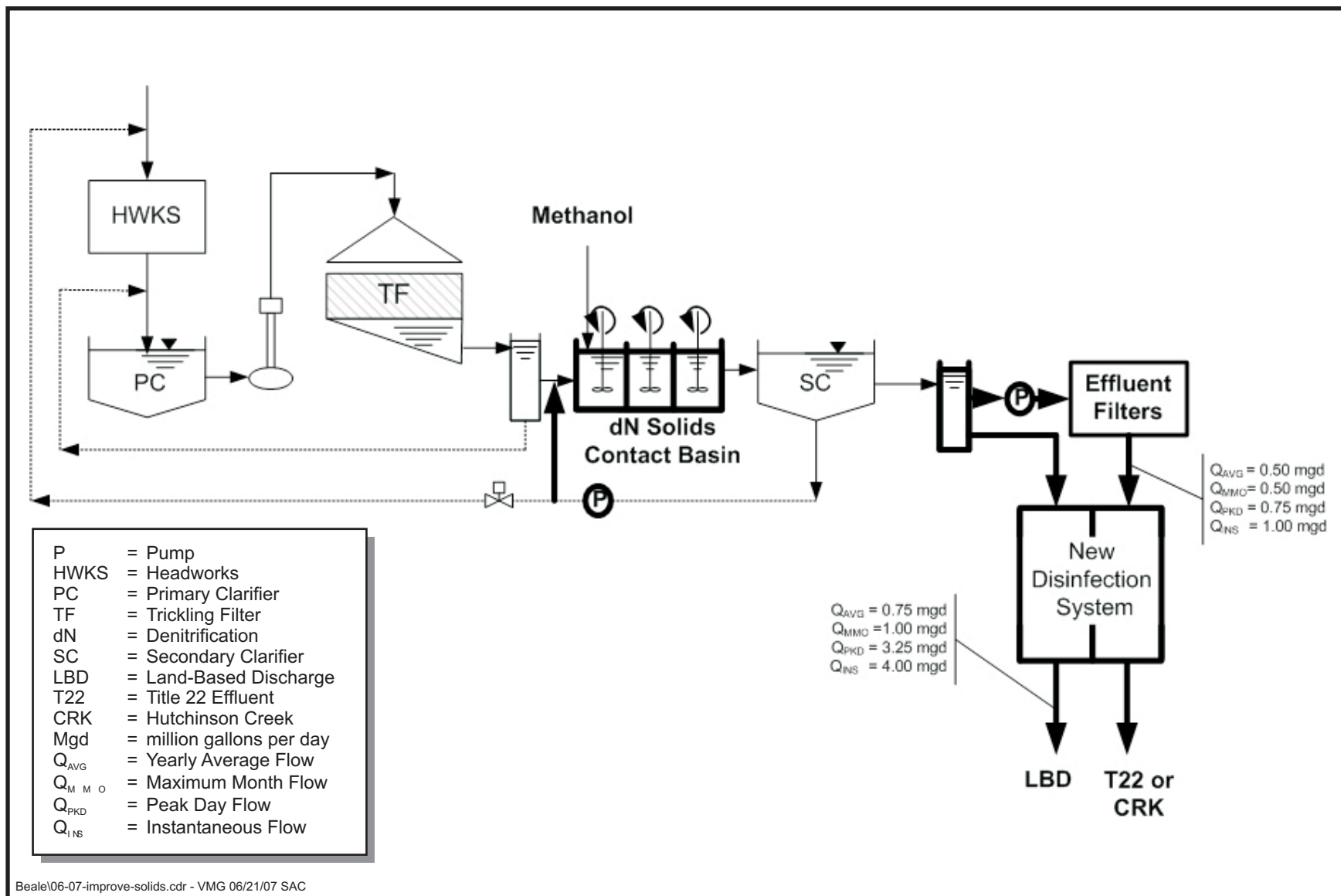


Figure 5-2. WWTP Improvements with Solids Contact, Beale AFB Wastewater Treatment Plant Compliance Evaluation

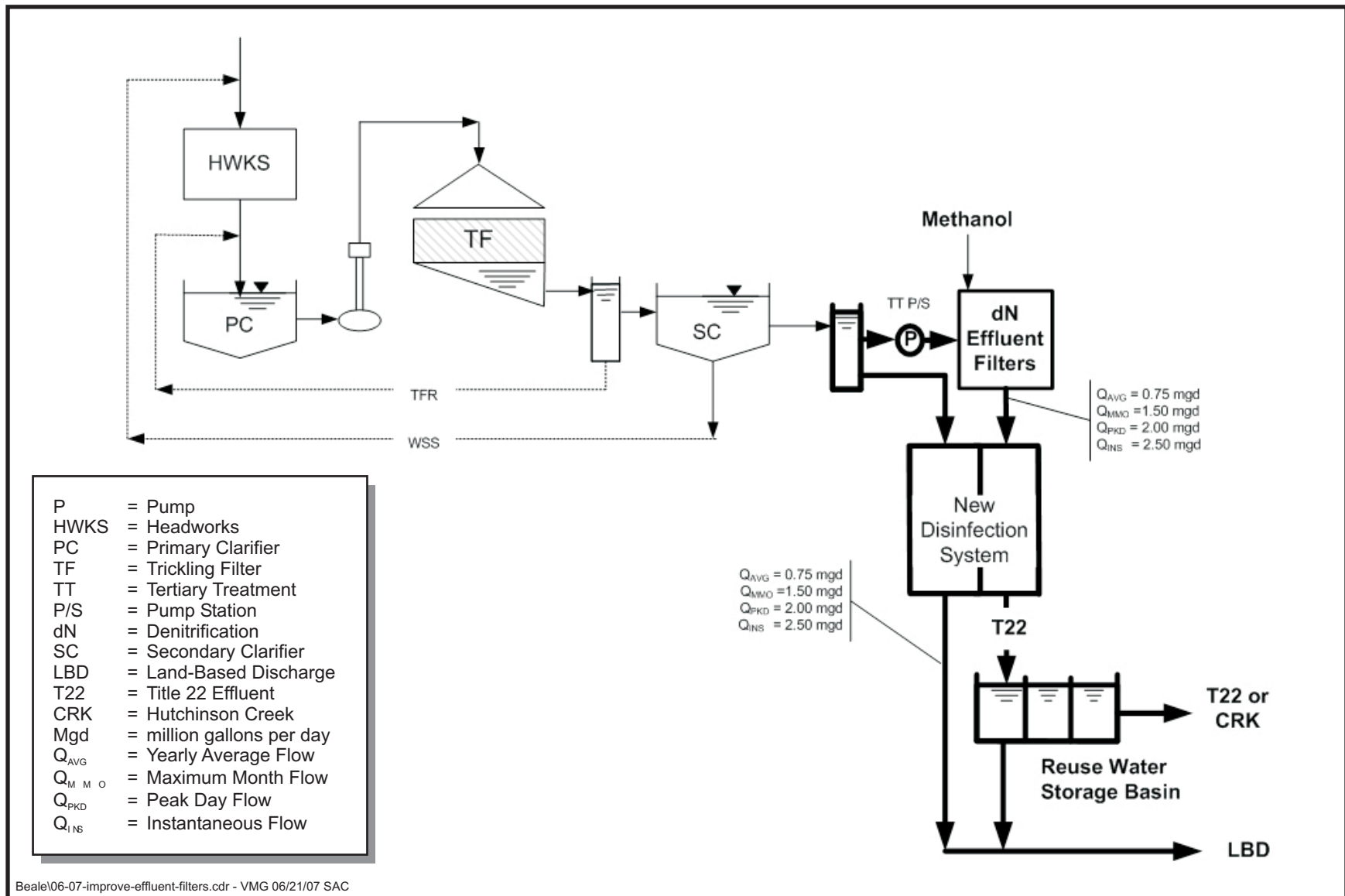


Figure 5-3. WWTP Improvements with Denitrification Effluent Filters, Beale AFB Wastewater Treatment Plant Compliance Evaluation

6.0 WORKS CITED

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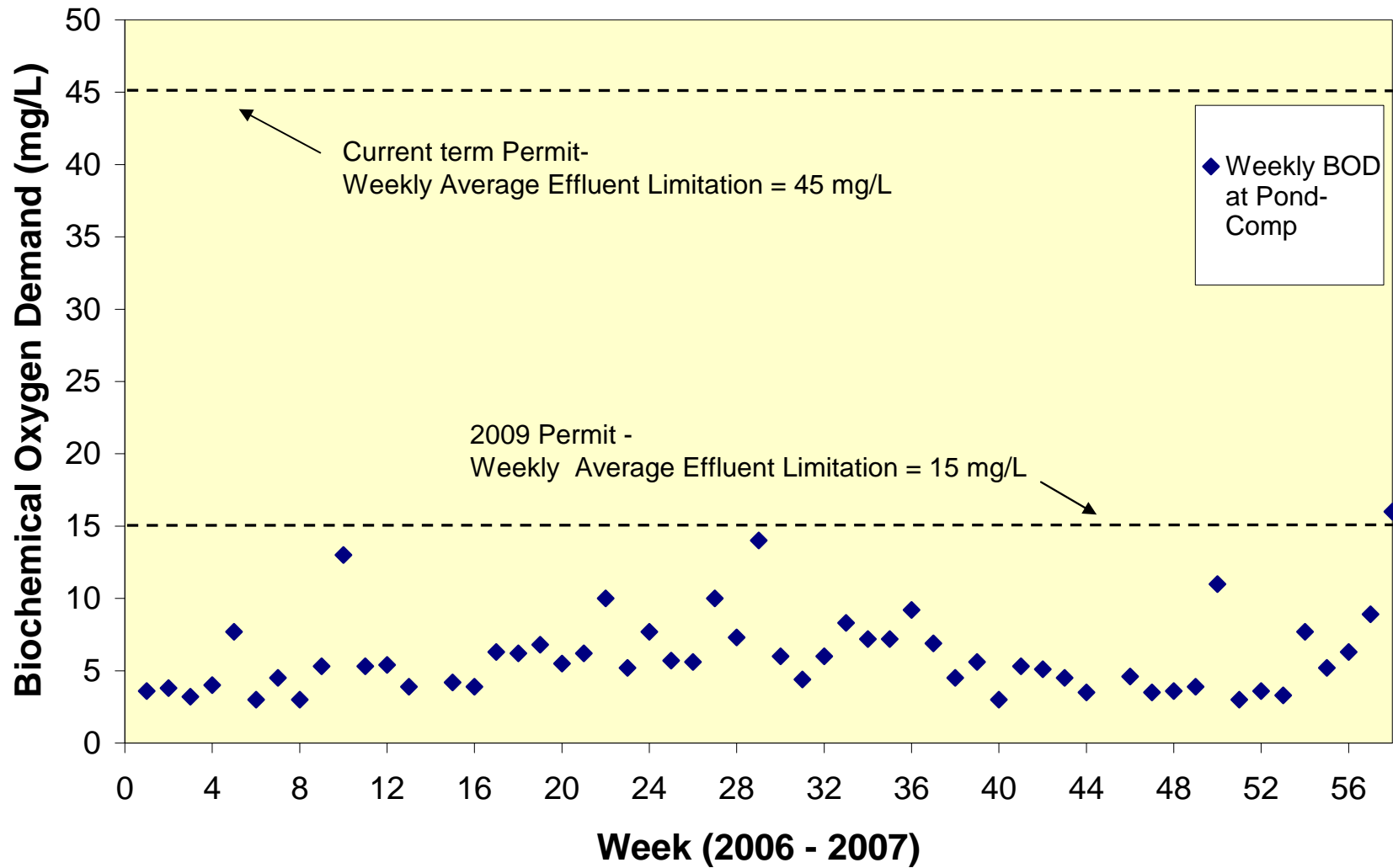
E&E and Jacobs Engineering Group, Inc., 1996. *Industrial Wastewater Pretreatment Study Phase II Report, Beale AFB*. April.

APPENDIX A
NPDES Compliance Data
(2006 to 2007)

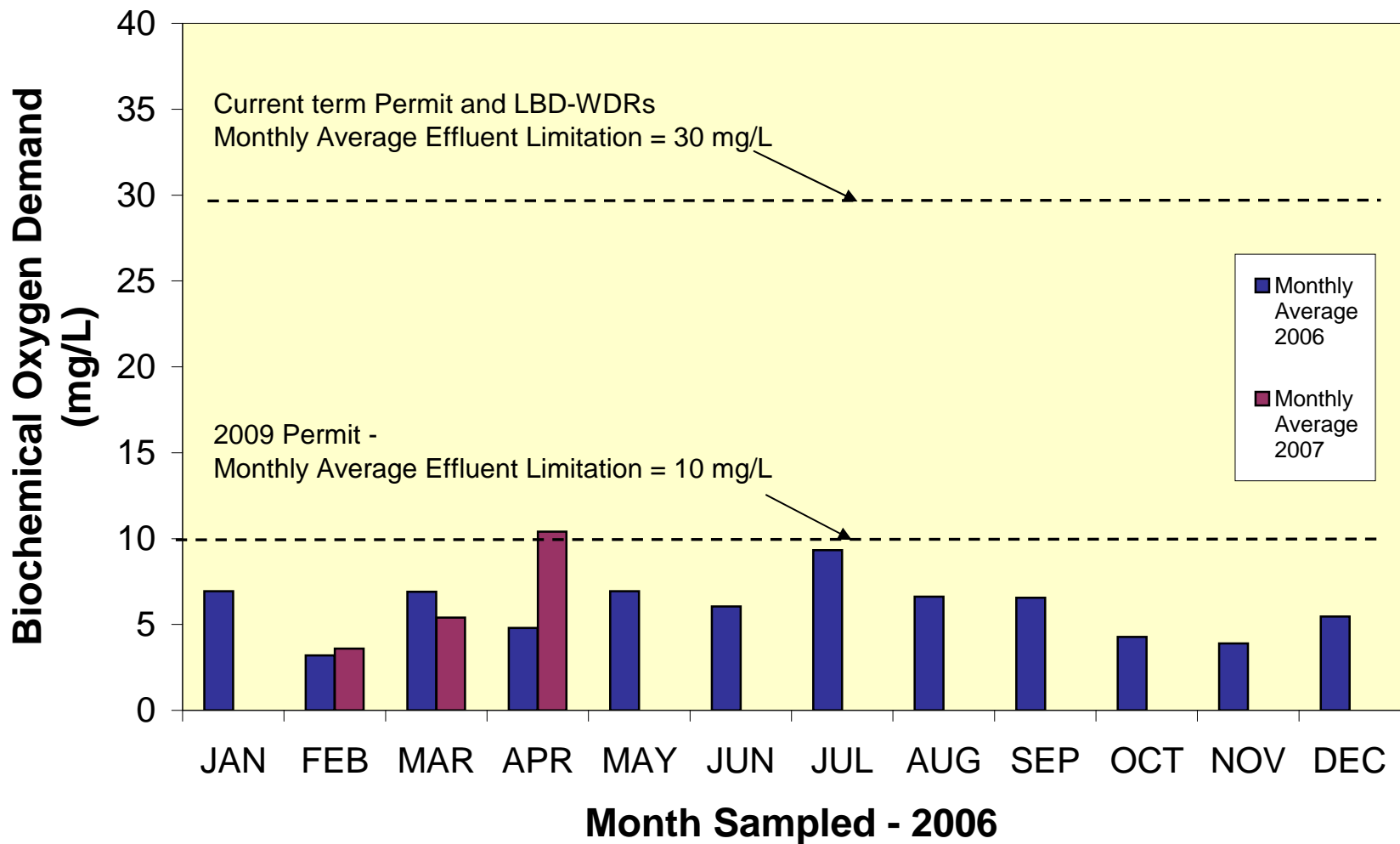
Table A-1. Title 22 Requirements for WWTP Discharges at BAFB

Discharge Application	Applicable Title 22 Land Use Category	Title 22² Criteria	2009 NPDES Permit and LBD WDRs Effluent Limitations
Hutchinson Creek ¹	Unrestricted Access Uses	<p>§60304(a) Recycled water used for the surface irrigation of the following shall be a disinfected tertiary recycled water, except that for filtration pursuant to Section 60301.320(a) coagulation need not be used as part of the treatment process provided that the filter effluent turbidity does not exceed 2 NTU, the turbidity of the influent to the filters is continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes:</p> <ol style="list-style-type: none"> (1) Food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop; (2) Parks and playgrounds; (3) School yards; (4) Residential landscaping; (5) Unrestricted access golf courses, and (6) Any other irrigation use not specified in this section and not prohibited by other sections of the California Code of Regulations. 	<p>2009 NPDES Permit Requirements: Total coliform: 2.2 MPN/100 ml 7-day median</p> <p>23 MPN/100 ml Instantaneous maximum</p> <p>Turbidity: 2.0 NTU daily average 5.0 NTU daily maximum³</p> <p>NPDES Permit requires that “wastewater shall be oxidized, coagulated and filtered, or equivalent treatment provided, by 1 April 2009.”</p> <p><i>For comparison, the current term permit requirements are:</i> <i>Total coliform:</i> <i>23 MPN/100 ml monthly median</i></p> <p><i>230 MPN/100 ml daily maximum</i></p> <p><i>Turbidity:</i> <i>No requirement</i></p>

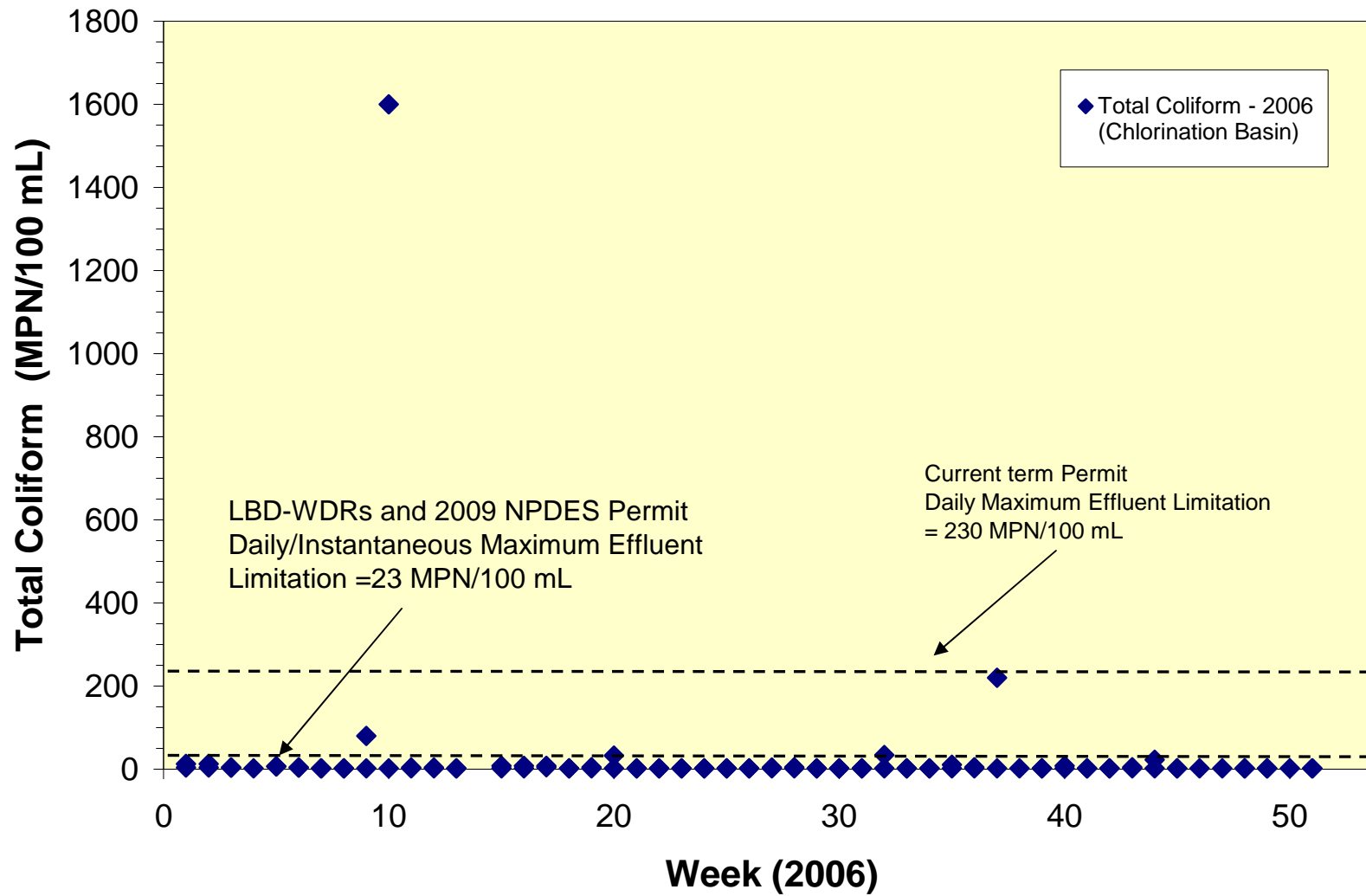
**FIGURE A-1. Weekly Biochemical Oxygen Demand
(2006 - 2007)**



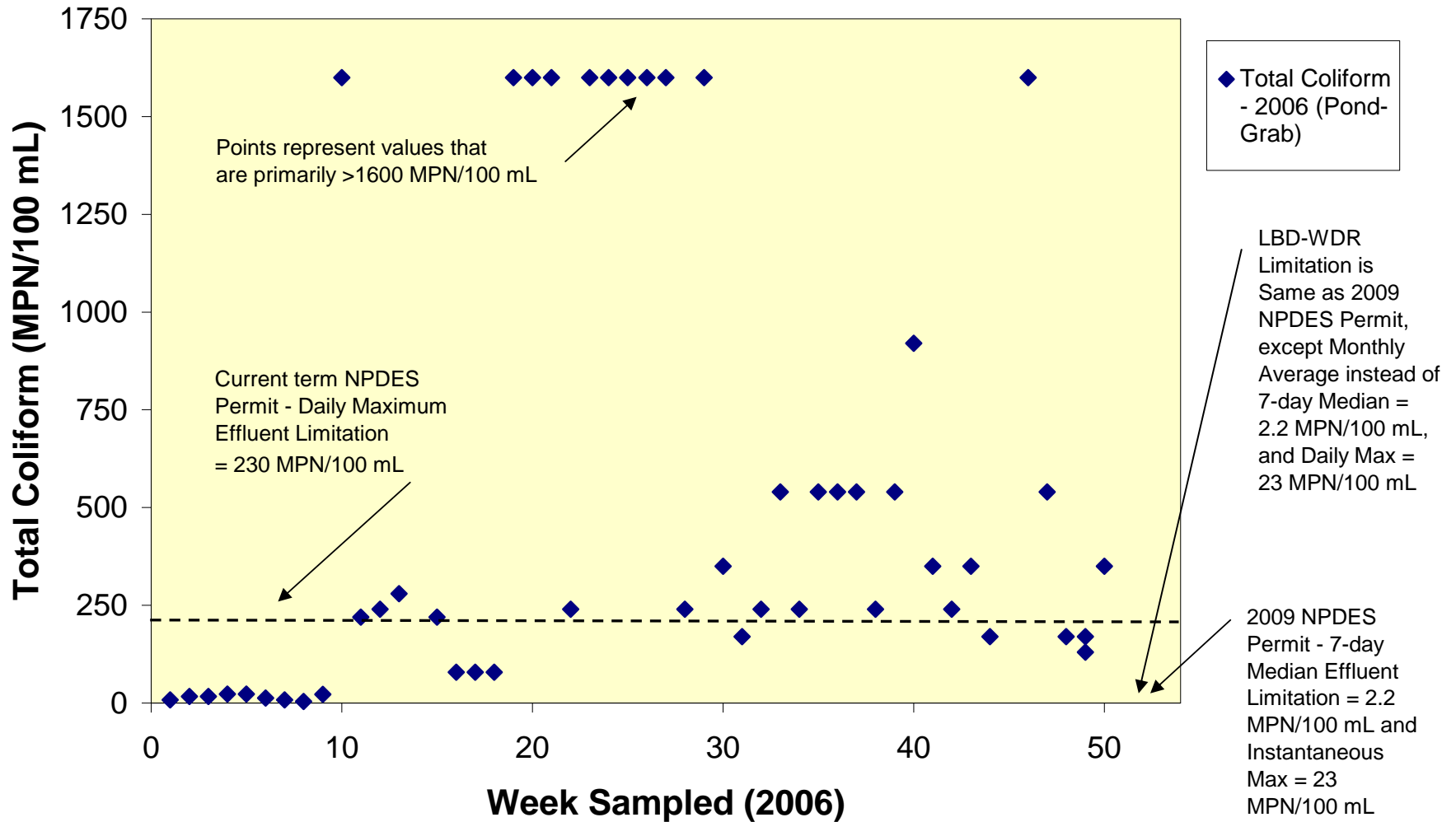
**FIGURE A-2. Monthly Biochemical Oxygen Demand
(2006 - 2007) Pond Composite Samples**



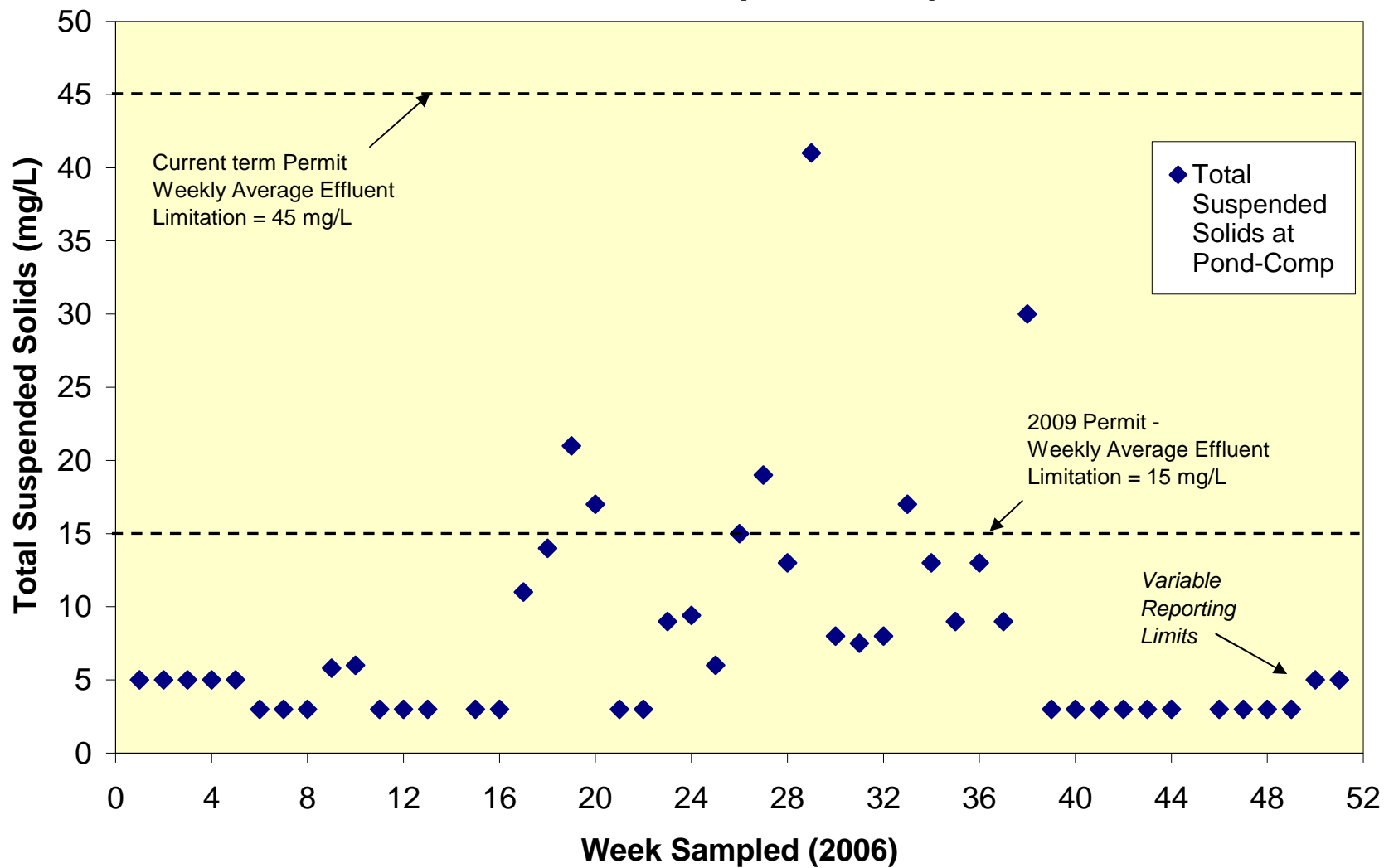
**FIGURE A-3. Weekly Total Coliform at
WWTP Chlorine Contact Basin - 2006**



**FIGURE A-4. Weekly Total Coliform Results - 2006
WWTP Pond Grab Samples**



**FIGURE A-5. Weekly Total Suspended Solids - 2006
WWTP Pond Composite Samples**



**FIGURE A-6. Monthly Bis(2-Ethylhexyl) Phthalate Concentrations
(2006 - 2007)**

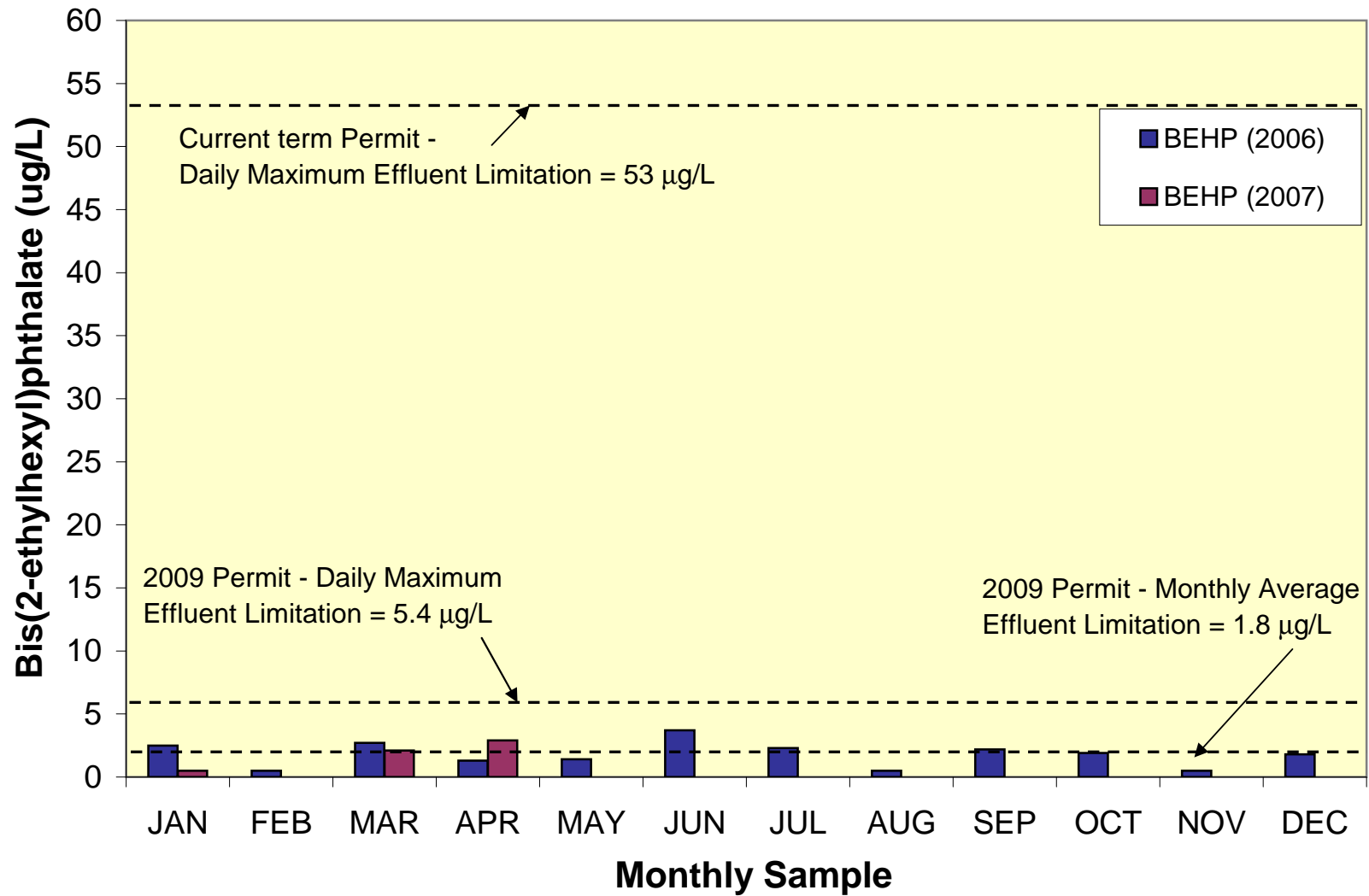


FIGURE A-7. Monthly Total Mercury Concentrations (2006 - 2007)

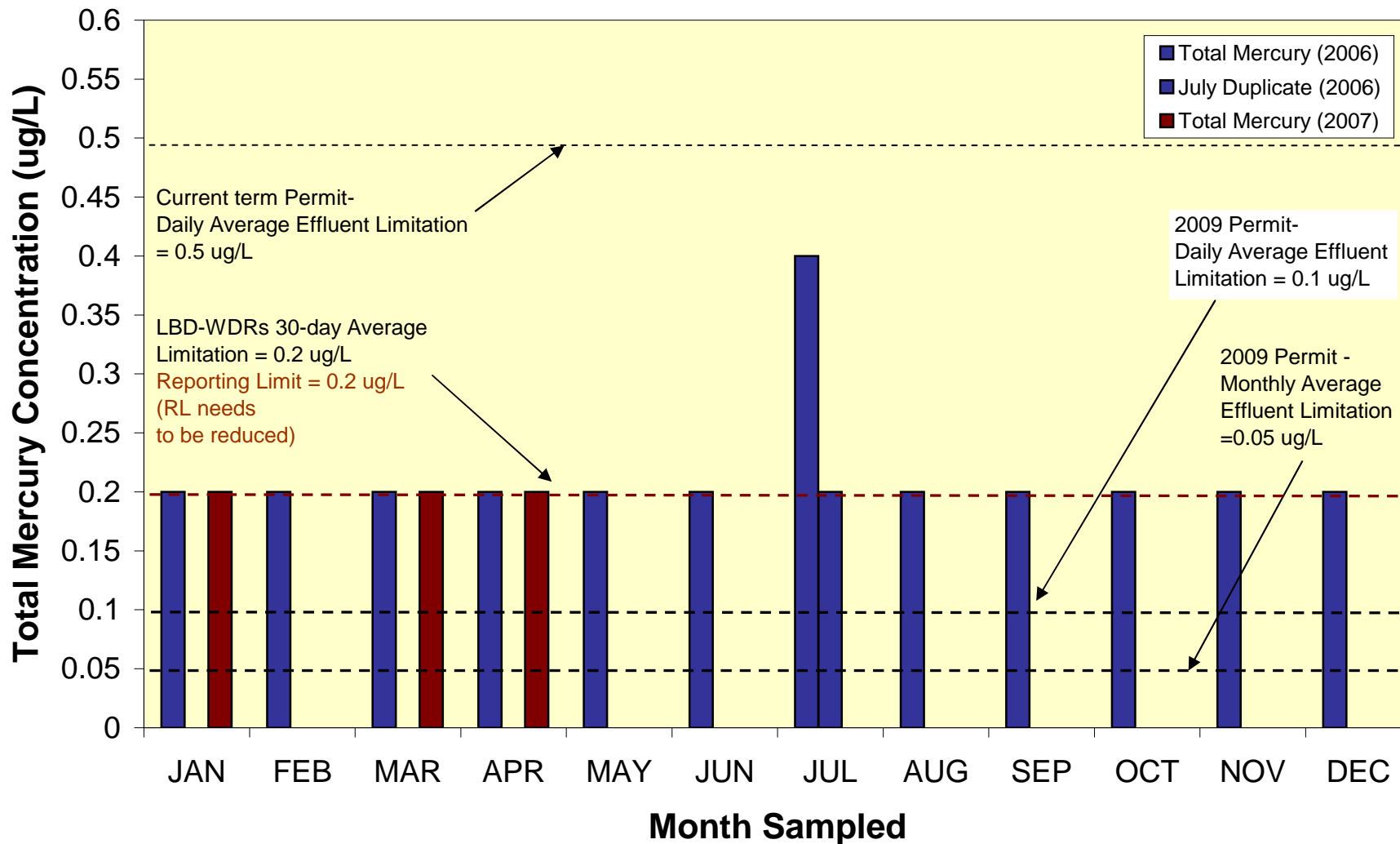
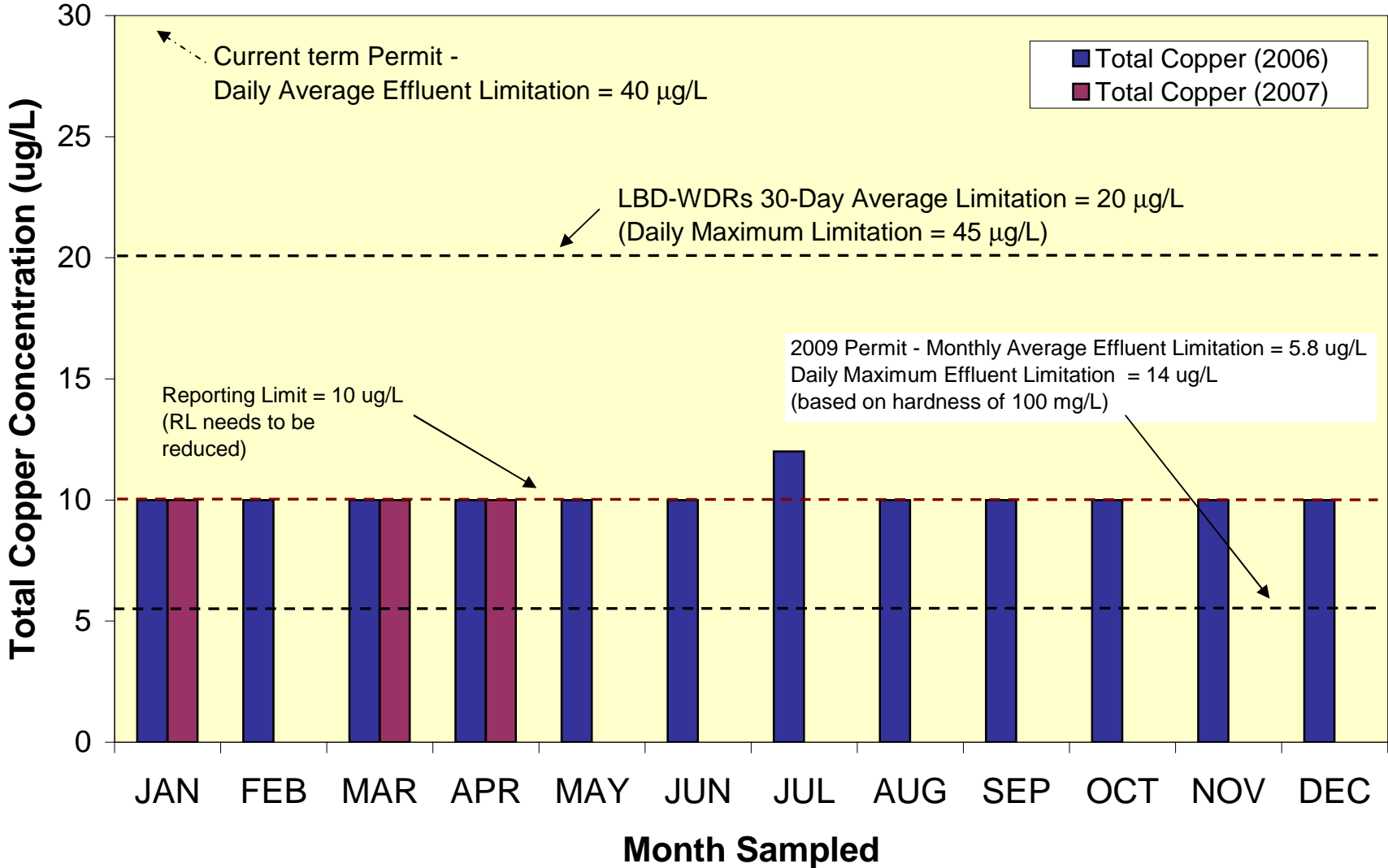


FIGURE A-8. Monthly Total Copper Concentrations (2006 - 2007)



**FIGURE A-9. Monthly Dissolved Copper Concentrations
(2006 - 2007)**

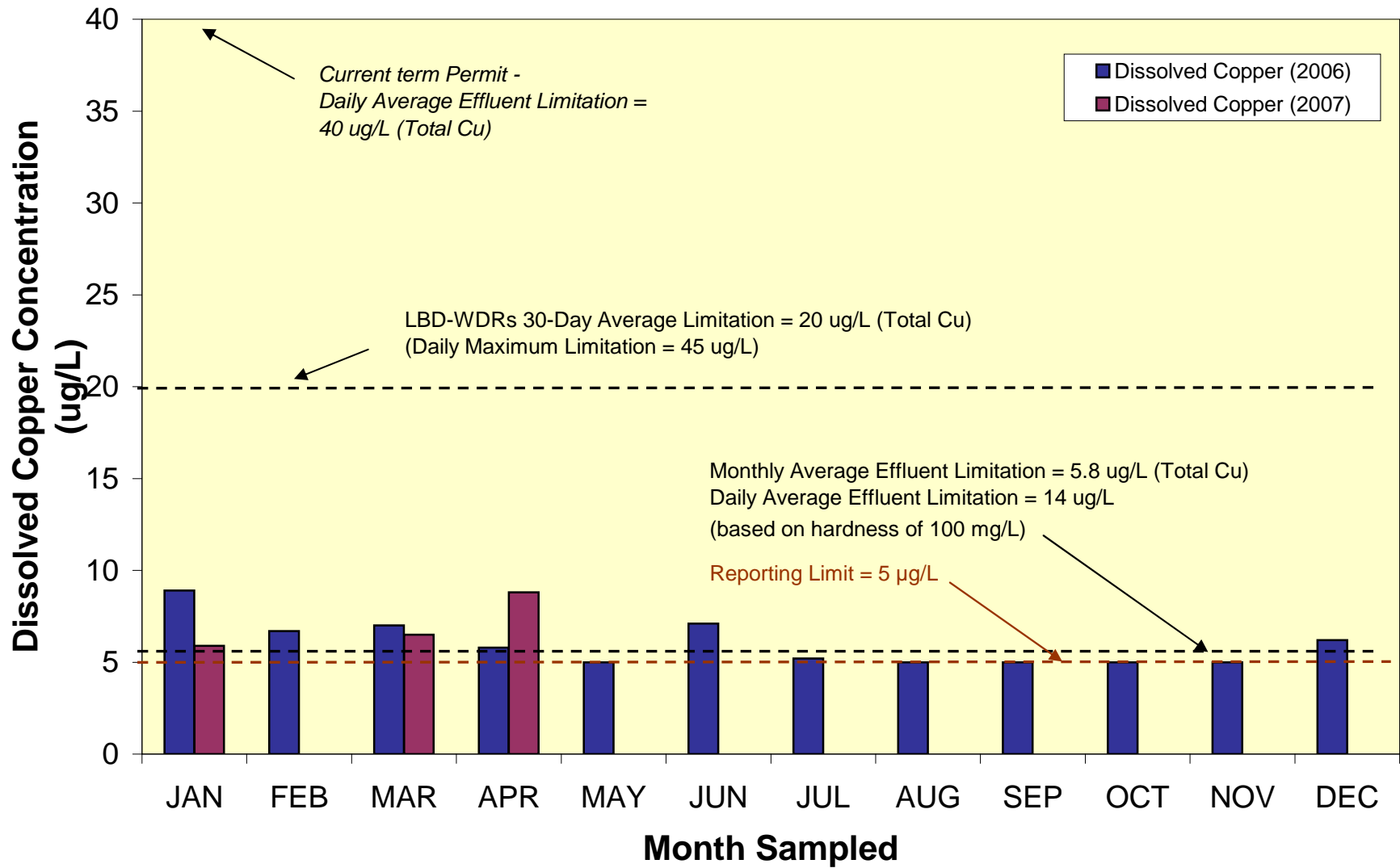


FIGURE A-10. Monthly Total Cyanide Concentrations (2006 - 2007)

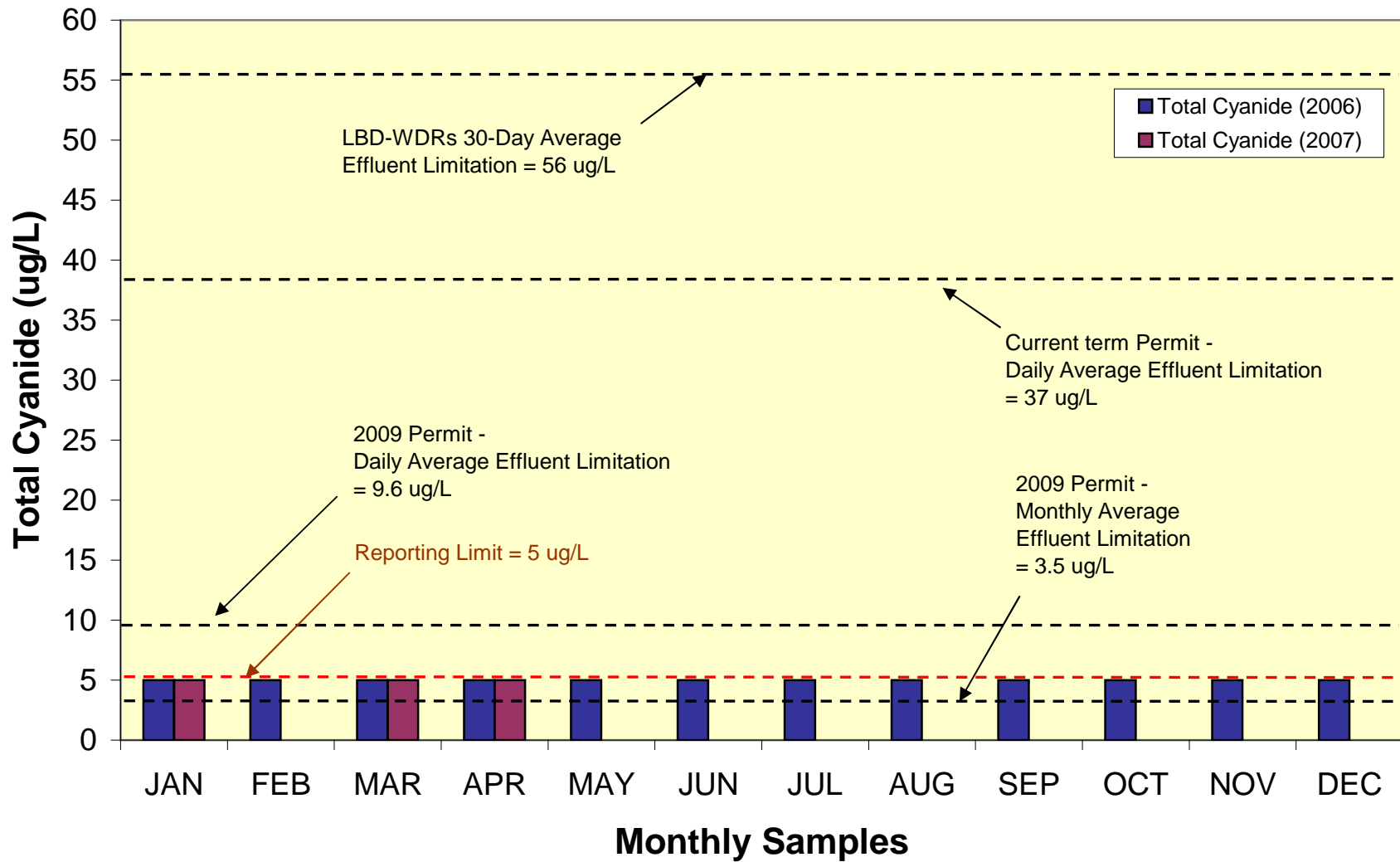


FIGURE A-11. Monthly MBAS Concentrations (2006 - 2007)

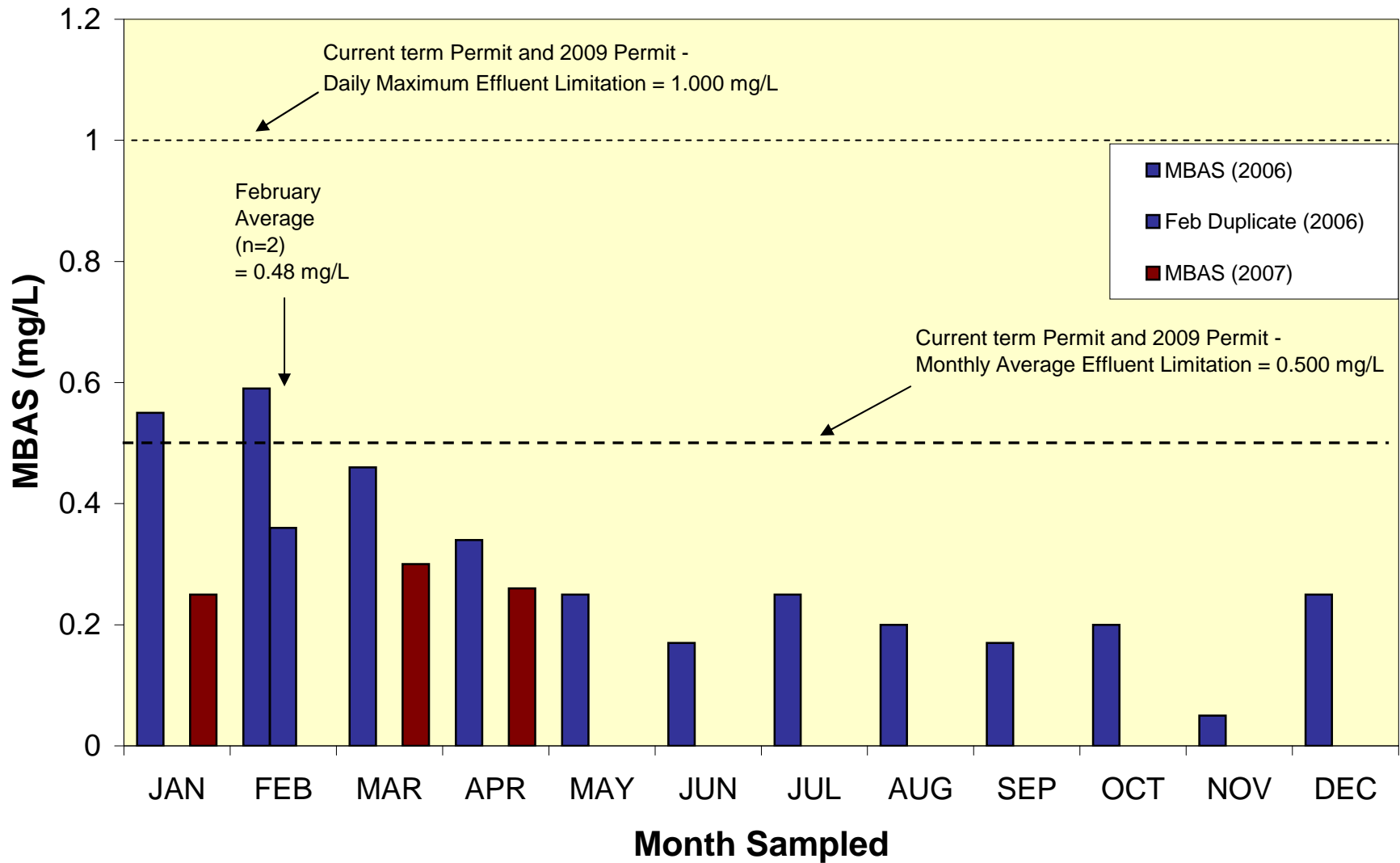


FIGURE A-12. Monthly TPH Concentrations (2006 - 2007)

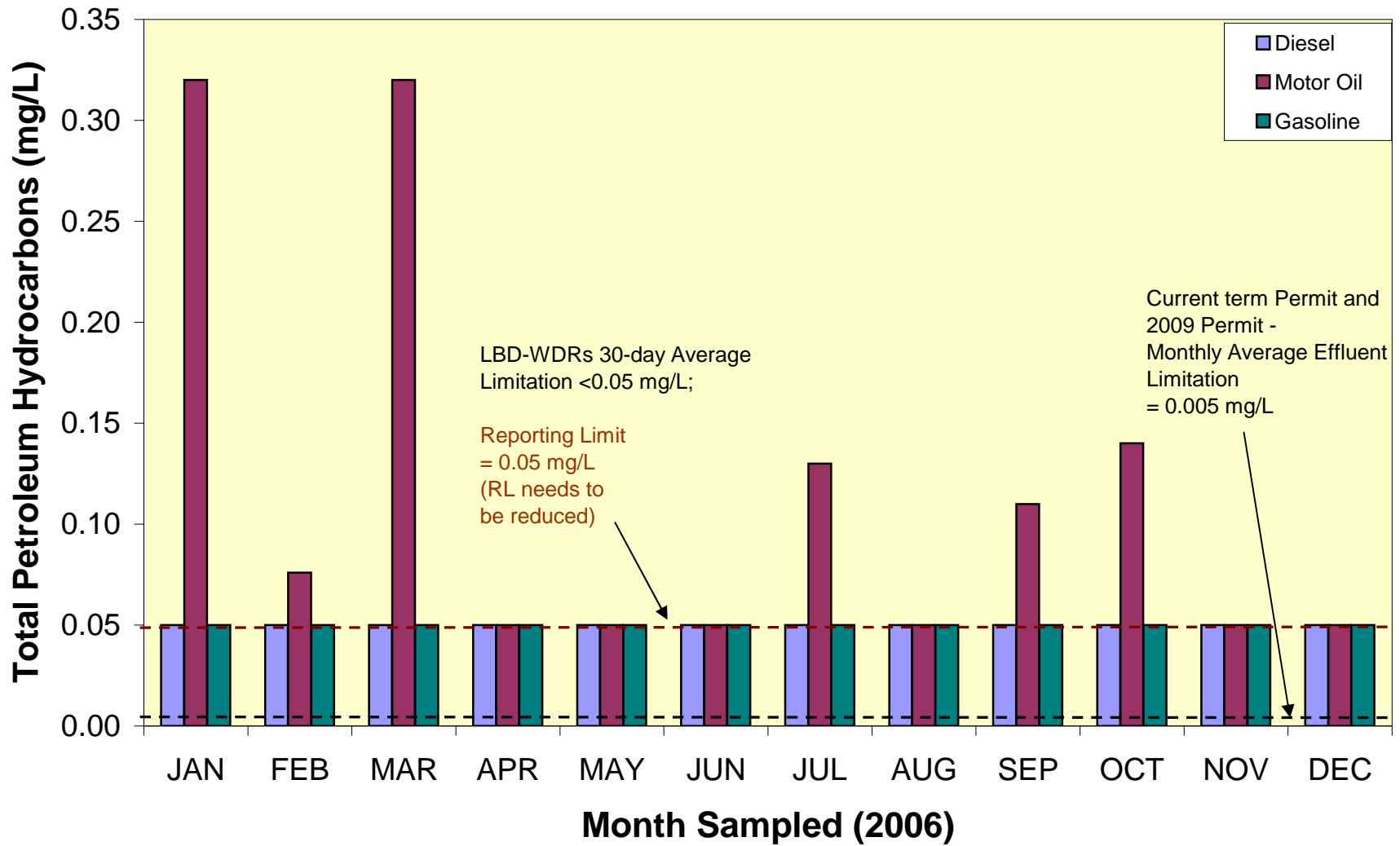


FIGURE A-13. Quarterly Nitrate Concentrations (2006 - 2007)

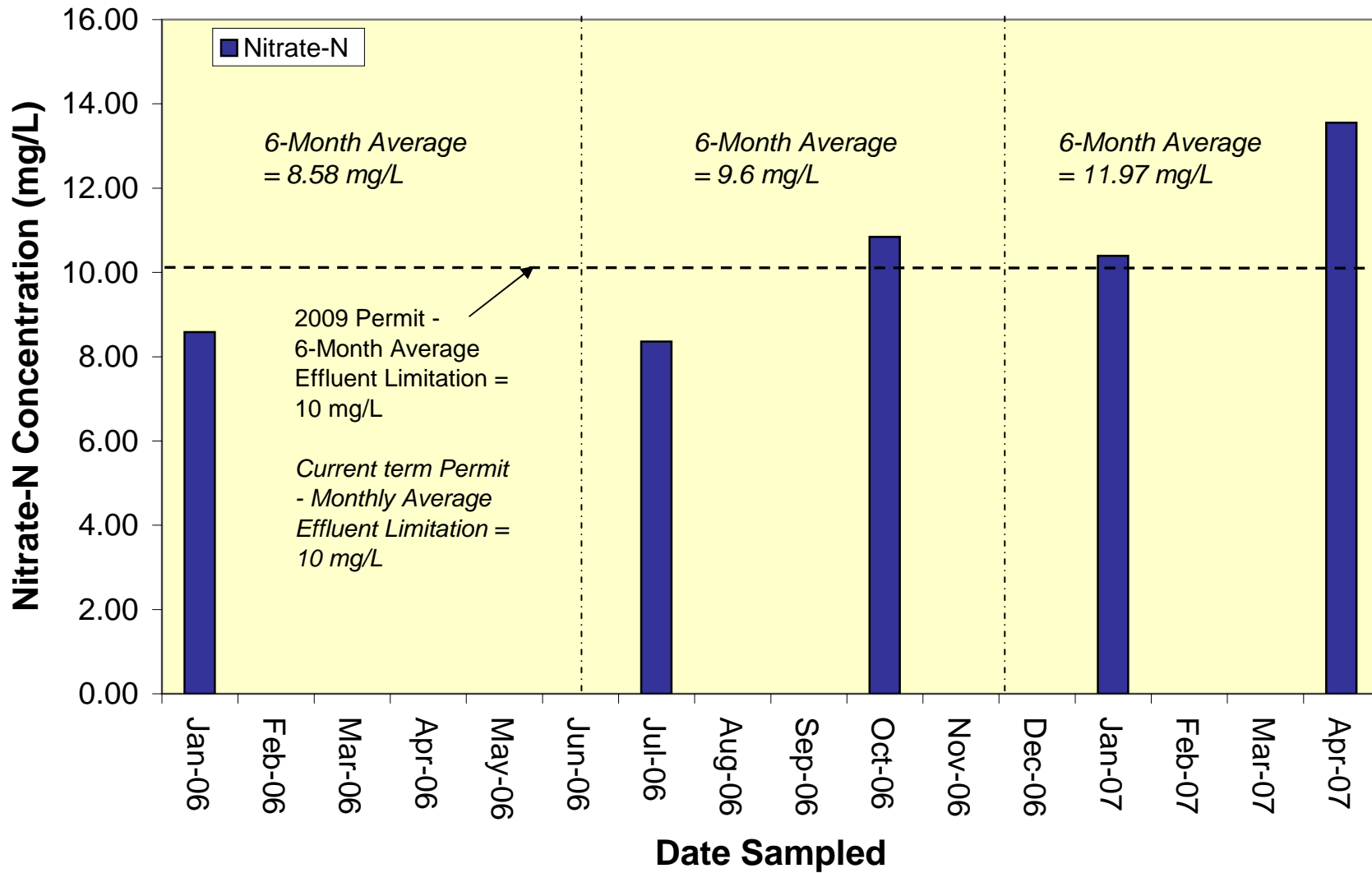


FIGURE A-14. Weekly Residual Chlorine Concentrations - 2006

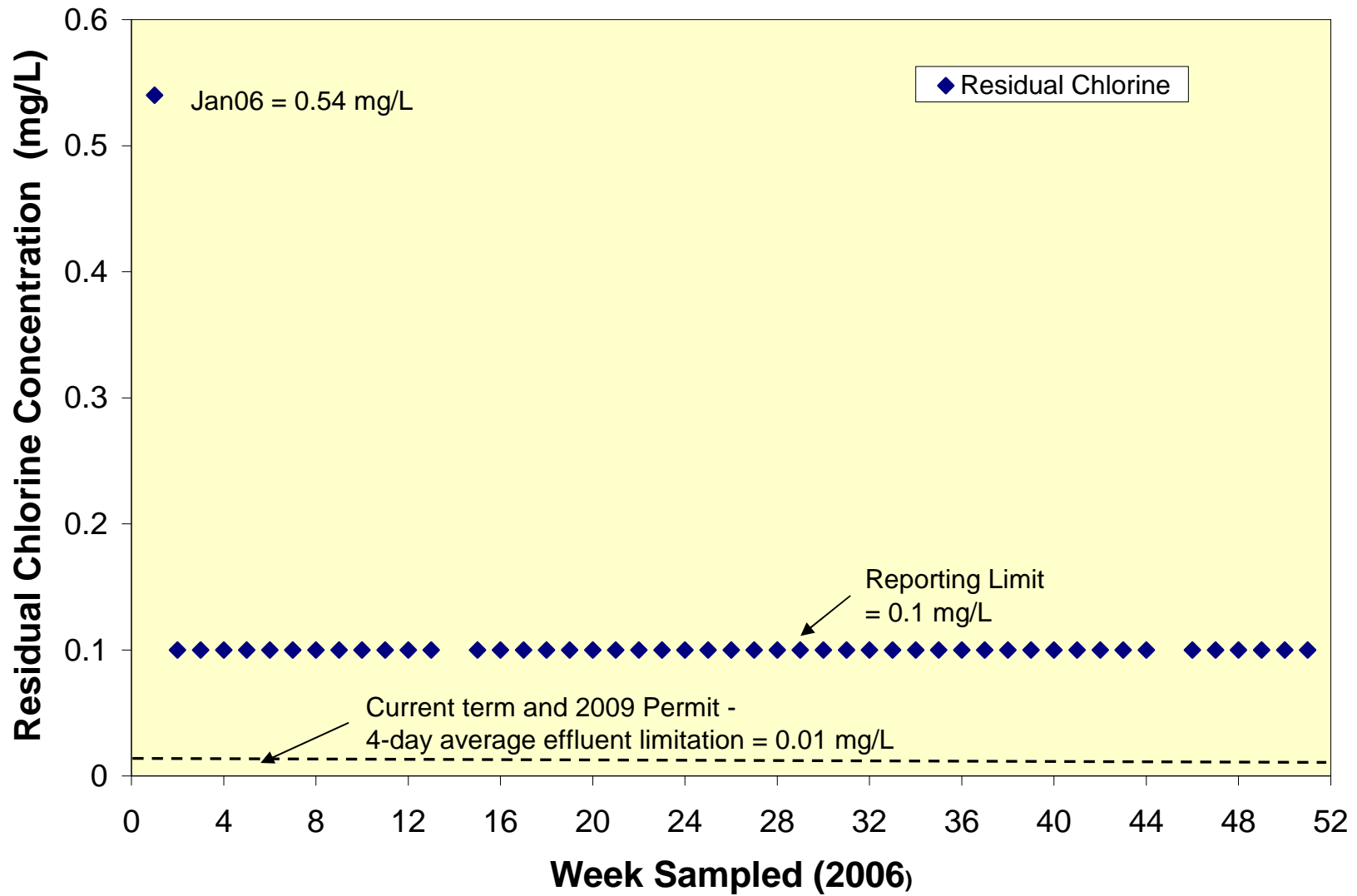


FIGURE A-15. Monthly Average Total Dissolved Solid Concentrations - 2006

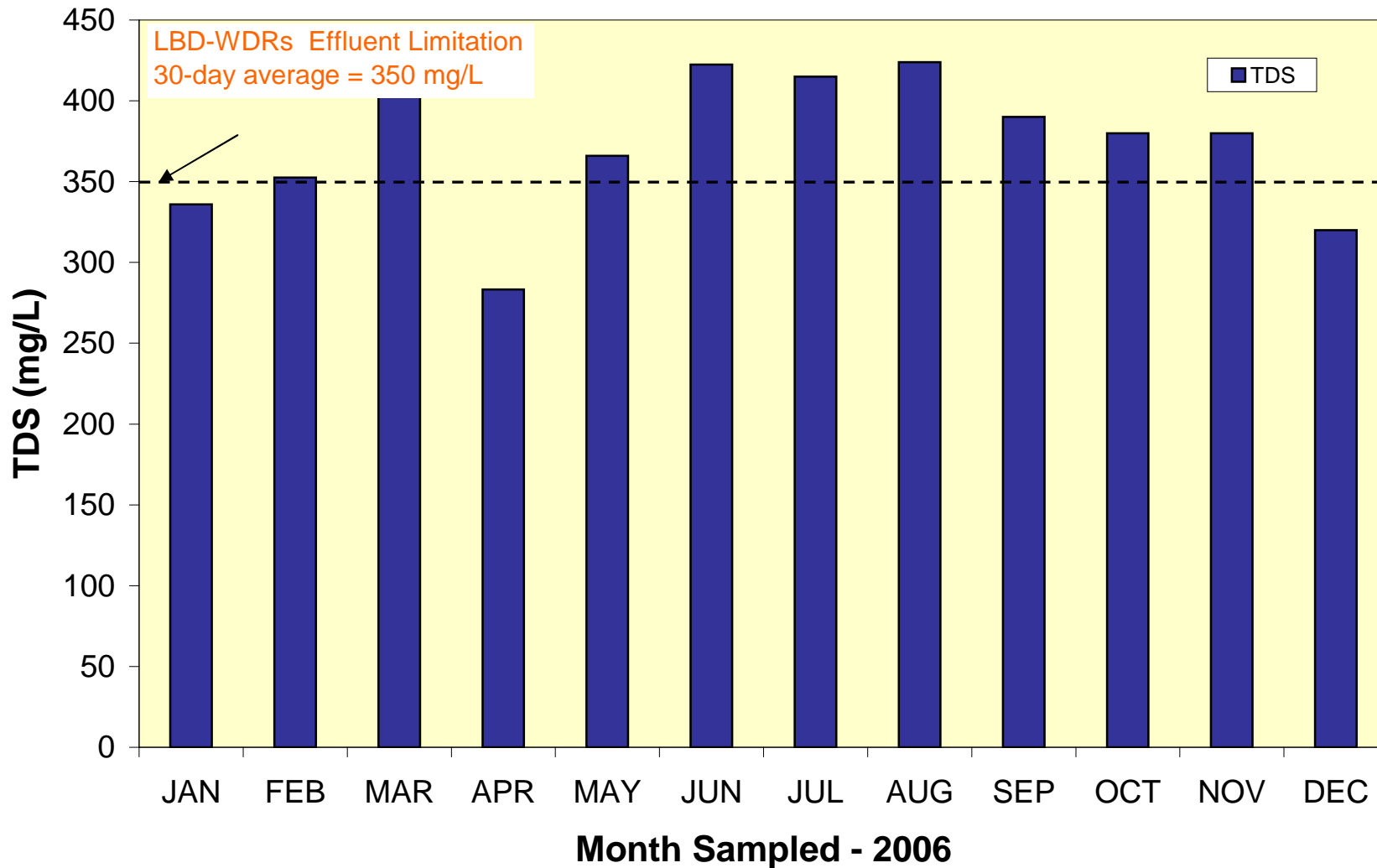


FIGURE A-16. Monthly Boron Concentrations (2006 - 2007)

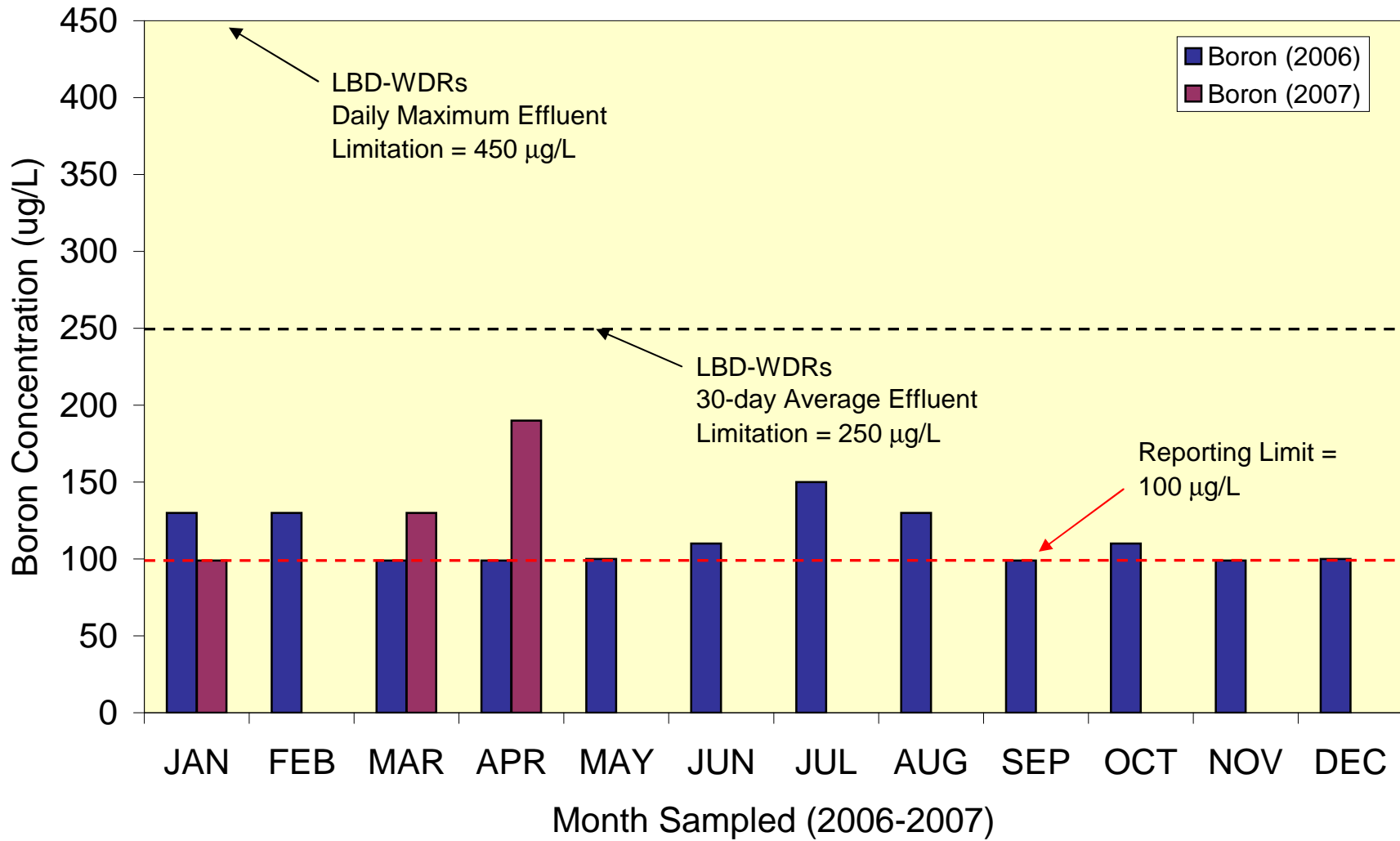
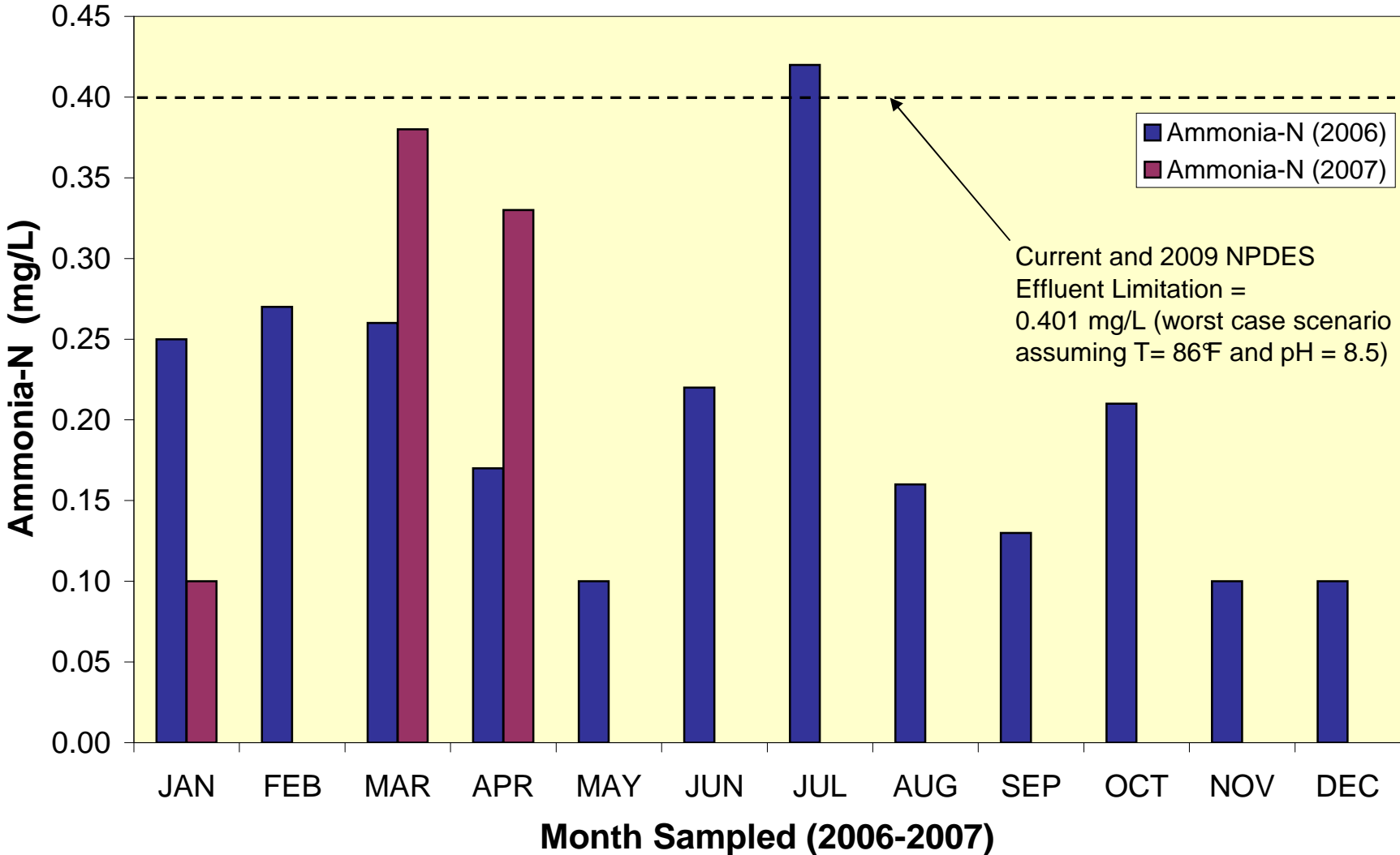


FIGURE A-17. Monthly Ammonia-N Concentrations (2006 - 2007)



APPENDIX B
Investigation Data Summaries

Table B-1. Bldg 1072 Wash Rack - Summary of Analytical Results for OWS-I

Analyte	Unit	2007 OWS-I Influent Samples		
		03/29/07	04/10/07	04/10/07
Total Cadmium	ug/L	20.4	42	41.9
Dissolved Cadmium	ug/L	9.1	13.2	14.5
Total Copper	ug/L	155	407	409
Dissolved Copper	ug/L	48.8	34.8	38.9
Total Mercury	ug/L	<0.018	<0.018	<0.018
Dissolved Mercury	ug/L	<0.018	<0.018	<0.018
Cyanide	mg/L	<0.0012	<0.0013	<0.0014
MBAS	mg/L	4	3.1	2.8
Oil and Grease	mg/L	16	120	77
TPH - Diesel	mg/L	8.3	55	47
TPH - Motor Oil	mg/L			
TPH - Gas	mg/L	1.7	21	18
TPH	mg/L			
TDS	mg/L	170	320	320
TSS	mg/L	17	10	19

Reference: Conversations and email from Earth Tech (Earth Tech, 2007)

TABLE B-2. WATER TREATMENT PLANT COMPLIANCE EVALUATION RESULTS AND 2006-2007 QUARTERLY MONITORING RESULTS

WWTP Compliance Evaluation Monitoring Results	Units	WTPINF001NS	WTPEFF001NS	Beale Quarterly Monitoring Results for 2006 - 2007	Sample ID Sample Date	DW (drinking water) sample results. Samples were collected at the 3Mgal reservoir				
		Inlet Sample Results	WTP Effluent Sample Results			GN060045 1/17/2006	GN060672 7/11/2006	GP060914 10/24/2006	GN070045 1/16/2007	GP070275 4/17/2007
Parameter		5/21/2007	5/21/2007	Parameter	Units					
Aluminum	ug/L	<1.6 UJ	<1.6 UJ	Calcium	mg/L	33	34	24	21	26
Cadmium	ug/L	<0.020	<0.020	Magnesium	mg/L	19	17	14	12	14
Copper	ug/L	0.6	4.4	Potassium	mg/L	2.5	2.4	2.3	2.3	2.4
Mercury	ug/L	<0.0050	<0.0050	Sodium	mg/L	41	33	25	23	28
Boron	mg/L	0.068 J	0.063 J	Total Alkalinity	mg/L	110	110	130	89	97
Calcium	mg/L	39	37	Bicarbonate (as CaCO3)	mg/L	110	110	130	89	97
Manganese	mg/L	0.067	0.19	Carbonate (as CaCO3)	mg/L	<5	<5	<5	<5	<5
Alkalinity, Total (as Ca CO3)	mg/L	NA	120	Hydroxide (as CaCO3)	mg/L	<5	<5	<5	<5	<5
Alkalinity, Bicarbonate (as Ca CO3)	mg/L	NA	120	Chloride	mg/L	79	70	42	33	45
Alkalinity, Carbonate (as Ca CO3)	mg/L	NA	<1.3	Fluoride	mg/L	0.77	0.90	0.83	0.69	0.91
Alkalinity, Hydroxide	mg/L	NA	<1.3	Hardness (as CaCO3)	mg/L	160	160	120	100	120
Chloride	mg/L	NA	85	Methylene Blue Active Substances	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate (as NO3)	mg/L	0.084 J	0.073J	Nitrate (as NO3)	mg/L	2.3	<2.0	<2.0	<2.0	<2.0
Nitrite (as N)	mg/L	<0.0020	0.012J	Nitrate (as N)	mg/L	0.52	<0.45	<0.45	<0.45	<0.45
Sulfate	mg/L	NA	9.6	Sulfate as SO4	mg/L	5.3	4.1	1.5	3.8	5.2
TDS	mg/L	NA	310	TDS	mg/L	310	320	200	200	220
pH	pH unit	6.86	7.25	pH	pH unit	7.69	7.78	7.47	7.53	7.57
Temperature	OC	19.9	21.3	Specific Conductance	umhos/cm	460	440	320	300	340
Specific Conductance	uS/cm	486	489							
Turbidity	NTU	4.5	1.2							

Notes:

The WTP Influent sample (WTPINF001) point is located at the inlet to the aerator.

The WTP Effluent sample (WTPEFF001) point is located after the fluoride injection point. The quarterly monitoring sample point is at the 3MGal reservoir.

When the WTPEFF sample was collected on 5/21/07, the WTP lab readings for pH did not agree with field parameter readings. Its pH was 7.9

Based on daily WTP readings, the pH fluctuates from 7.0 to 8.1

J = Analyte concentration considered estimated value because one or more quality control specifications were not met.

UJ = The analyte was not detected above the detection limit. The reporting limit for this analyte is estimated.

Table B-3. MIPE Summary of Analytical Data - Baseline Sampling

Samples Collected by URS for WWTP Compliance Evaluation				Samples Collected by Beale AFB Personnel			
Analytes	Units	Rinsewater (5,000-gal tank sample) (Tank 3, while accepting rinsewater)		Analytes	Rinsewater (5,000-gal tank sample)		
		MIPER-NS (not filtered) 5/31/2007	MIPER-NF (field filtered) 5/31/2007		(Tank 1) 1st mission GN070122 2/12/2007	(Tank 2) 2nd mission GN070123 2/15/2007	(Tank 3) 3rd mission GN070124 2/22/2007
Solids							
TSS	mg/L	5					
TDS	mg/L	430		TDS	NA	310	NA
Anions							
Aluminum	ug/L	10 J	9 J	Arsenic	<5	<5	<5
Antimony	ug/L	0.6	0.5	Antimony	<50	<50	<50
Barium	ug/L	87	87	Barium	49	<20	69
Beryllium	ug/L	<0.07	<0.35	Beryllium	<5	<5	<5
Cadmium	ug/L	<0.040	<0.040	Cadmium	<10	<10	<10
Calcium	mg/L	26	26	Chromium	<20	<20	<20
Chromium	ug/L	2	1	Cobalt	<20	<20	<20
Cobalt	ug/L	0.06 J	0.07 J	Copper (total)	180	190	210
Copper	ug/L	190	160	Copper (dissolved)	160	150	180
Iron	ug/L	50	50 J	Lead	<5	<5	<5
Lead	ug/L	0.7	0.5				
Magnesium	mg/L	15	15				
Manganese	mg/L	0.003 J	0.003 J	Mercury	0.7	1.1	0.69
Mercury	ug/L	0.19	0.14	Molybdenum	<20	<20	<20
Molybdenum	ug/L	0.7	0.7	Nickel	<20	<20	<20
Nickel	ug/L	1	1				
Potassium	mg/L	4.2	4.2	Selenium	<5	<5	<5
Selenium	ug/L	<0.98	1 J	Silver	280	490	810
Silver	ug/L	610	500	Thallium	<10	<10	<10
Sodium	mg/L	42	43	Vanadium	<20	<20	<20
Strontium	ug/L			Zinc	43	25	32
Vanadium	ug/L	6	5				
Zinc	ug/L	27	30				
Tin	ug/L	<0.11	<0.11				
Anions							
Bicarbonate (as Ca CO3)	mg/L	29.9 J					
Carbonate (as Ca CO3)	mg/L	<40					
Chloride	mg/L	60					
Fluoride	mg/L	3.8					
Hydroxide (as Ca CO3)	mg/L	<20					
Nitrate (as NO3)	mg/L	0.72 J					
Nitrite (as N)	mg/L	<0.002					
Phosphorus, total	mg/L	0.137					
Sulfate	mg/L	16					
Other							
Ammonia (as N)	mg/L	57.7		Boron	NA	NA	NA
Boron	mg/L	3.7	3.8				
Silica (as SiO2)	mg/L	59	59	COD	NA	140	NA
COD	mg/L	117					
Alkalinity, total	mg/L	29.9 J		Cyanide (total)	NA	NA	NA
MBAS	mg/L	0.97					
Cyanide	ug/L	1.3 J					
Hardness	mg/L	120					
Field Parameters							
pH		7.54		pH	NA	7.85	NA
Color		yellow					
Conductivity	uS/cm	975					
Temperature	OC	32.1					
Turbidity	NTU	2.3					

Table B-3. MIPE Summary of Analytical Data - Baseline Sampling

Samples Collected by URS for WWTP Compliance Evaluation				Samples Collected by Beale AFB Personnel			
Analytes	Units	Rinsewater (5,000-gal tank sample) (Tank 3, while accepting rinsewater)		Analytes	Rinsewater (5,000-gal tank sample)		
		MIPER-NS (not filtered) 5/31/2007	MIPER-NF (field filtered) 5/31/2007		(Tank 1) 1st mission GN070122 2/12/2007	(Tank 2) 2nd mission GN070123 2/15/2007	(Tank 3) 3rd mission GN070124 2/22/2007
Organics							
TOC	mg/L	16.9					
TPH-D	ug/L	890					
Oil and Grease	mg/L	13.4					
VOC by 8260							
Acetone	ug/L	4.71 J					
Bromodichloromethane	ug/L	2.62					
Bromoform	ug/L	5.77					
Chloroform	ug/L	1.09					
Dibromochloromethane	ug/L	5.02					
Methylene chloride	ug/L	1.04					
Tetrachloroethene	ug/L	0.327 J					
Semi-Volatiles (8270)							
bis(2EH)phthalate	ug/L	<12.5					

Samples of the rinsewater from the photo developing process at the MIPE were collected from one of the (3) 5,000-gallon holding tanks.

J = Analyte concentration considered estimated value because one or more quality control specifications were not met.

TABLE B-4. BEALE WWTP - HEADWORKS AND CLARIFIER - BASELINE SAMPLING

Analytes	Units	Headworks to the WWTP		Primary Clarifier Effluent		Secondary Clarifier Effluent
		WWTPINF-NS 6/1/2007 6/5/2007		WWTPPCEFF-NS 6/5/2007	grab sample	Field Parameters Only
				composite		grab sample
TSS	mg/L	29.4		9.5	NA	NA
TDS	mg/L	334		NA	NA	NA
anions:						
Aluminum	mg/L	0.1		NA	NA	NA
Barium	mg/L	0.11		NA	NA	NA
Cadmium	ug/L	0.05 J		NA	NA	NA
Copper	ug/L	20		NA	NA	NA
Iron	mg/L	0.36		NA	NA	NA
Mercury	ug/L	0.083		NA	NA	NA
Silver	ug/L	0.07 J		NA	NA	NA
Zinc	mg/L	0.04		NA	NA	NA
Anions						
Chloride	mg/L	78		NA	NA	NA
Nitrate (as NO3)	mg/L	<0.0060		NA	NA	NA
Nitrite (as N)	mg/L	<0.0020		NA	NA	NA
Phosphorus (total)	mg/L	3.22 J				
Others:						
BOD	mg/L	53.8		19.3	NA	NA
TKN	mg/L	24.6 J		NA	NA	NA
Ammonia (as N)	mg/L	19.1 J		4.11	NA	NA
Boron	mg/L	0.13		NA	NA	NA
Silica	mg/L	NA		NA	NA	NA
COD	mg/L	106 J		NA	NA	NA
Alkalinity, total	mg/L	206		NA	NA	NA
Hardness	mg/L	210		NA	NA	NA
MBAS	mg/L	3.43		NA	NA	NA
Cyanide	ug/L	2.2 J		NA	NA	NA
Field Parameters		6/1/2007				
Color						
pH		6.96		6.79	6.72	7.18
Conductivity	uS/cm	656		607	618	585
TDS	ppm	---		306	ppm	293
Temperature	oC	25.1		10.4	18.4	21.9
Turbidity	NTU	16		9.6	7.8	3.1
Organics						
TOC	mg/L	NA		NA	NA	NA
TPH - D	ug/L	5500		NA	NA	NA
TPH-G	ug/L	<17		NA	NA	NA
Oil and Grease	mg/L	3.54 J		NA	NA	NA
VOC by 8260				NA	NA	NA
Acetone	ug/L	12.2 J				
Bromodichloromethane	ug/L	0.665 J				
Bromoform	ug/L	<0.5 UJ				
Chloroform	ug/L	1.44 J				
Chloromethane	ug/L	<0.25 UJ				
Dibromochloromethane	ug/L	<0.25 UJ				
Methylene Chloride	ug/L	0.658 J				
1,4-Dichlorobenzene	ug/L	0.815 J				
Tetrachloroethene	ug/L	0.438 J				
Toluene	ug/L	5.59 J				
Semi-Volatiles (8270)						
bis(2EH)phthalate	ug/L	6.52 J			NA	NA
4-chloroaniline	ug/L	<5 UJ				
4-methylphenol (p-Cresol)	ug/L	30.5 J				
Phenol	ug/L	5.56 J				

J = Analyte concentration considered estimated value because one or more quality control specifications were not met.
 UJ = The analyte was not detected above the detection limit. The reporting limit for this analyte is estimated.

TABLE B-5. BEALE WWTP - EFFLUENT STREAMS - BASELINE SAMPLING RESULTS

Analytes	Units	Chlorine Contact Tank Effluent (same as the effluent from the WWTP/Inlet to the Aeration Pond) (this is where they collect the coliform sample)			WWTP - post-aeration pond effluent	Pond 4 Effluent Sample
		Effluent from the Site 13 GWTP GWTP13EFF-NS 5/31/2007	WWTPCB-NS 6/1/2007	WWTPCB-FD 6/1/2007	APEFF-NS 5/31/2007 6/1/2007	Pond4EFF-NS 6/5/2007
TSS	mg/L	<2.50	4.0 J	3.0 J	112 J	13
TDS	mg/L	300	498	518	340 J	338
Hardness	mg/L	130	140	140	140	
Cations:						
Aluminum	ug/L	<0.6	50	50 J	70	NA
Barium	ug/L	20	60	60	50	NA
Cadmium	ug/L	<0.040	<0.040	<0.040	<0.040	NA
Copper	ug/L	0.9	10	<0.05	8	NA
Iron	mg/L	0.007 J	0.11	0.11	0.14	NA
Mercury	ug/L	<0.005	0.0098 J	0.0074 J	<0.005	NA
Silver	ug/L	0.04 J	<0.030	<0.030	0.04 J	NA
Zinc	ug/L	1.0 J	10	<0.70	20	NA
Anions						
Chloride	mg/L	26	120	130	74	NA
Nitrate (as NO3)	mg/L	26	56	56	33	4.1
Nitrate (as N) (calculation)	mg/L	5.9	12.7	12.7	7.5	0.9
Nitrite (as N)	mg/L	<0.0020	0.003 J	0.002 J	0.055	0.21 J-
Phosphorus, total	mg/L	0.11	2.87	2.86	2.68 J	NA
Others:						
BOD	mg/L	<1.0	6.23	6	14.9	NA
TKN	mg/L	<0.050	2.12	2.23	7	NA
Ammonia (as N)	mg/L	0.125 J	0.237 J	0.285 J	0.259 J	NA
Boron	mg/L		0.22	0.21	0.12	NA
COD	mg/L	<10	37.4	33.3	105 J	NA
Alkalinity, total	mg/L	84.1	33.5	33.9	105 J	NA
MBAS	mg/L	<0.05	0.5	0.459	0.225	NA
Cyanide	ug/L	<0.80	<0.8	<0.8	2.2 J	NA
Field Parameters						
Color		clear/colorless	clear/colorless			colorless/some visible solids
pH		7.71	7.69		8.8	9.42
Conductivity	uS/cm	381	714		504	510
Temperature	oC	22.1	24.7		28	22.8
Turbidity	NTU	0.85	4.6		16	6.2
Organics						
TPH - D	ug/L	<12	260	260	450	NA
TPH-G	ug/L	<17	<17	<17	<17	NA
Oil and Grease	mg/L	<2.5	<2.53	<2.55 J	4.55 J	NA
VOC by 8260						
Acetone	ug/L	NA	8.52 J	8.14 J	7.48 J	NA
Bromodichloromethane	ug/L	NA	16.2	16.1	9.85 J	NA
Bromoform	ug/L	NA	1.97	1.99	<0.5 J	NA
Chloroform	ug/L	NA	17.9	17.7	19.1 J	NA
Chloromethane	ug/L	NA	0.271 J	<0.250	<0.25 UJ	NA
Dibromochloromethane	ug/L	NA	6.57	6.39	3.82 J	NA
Methylene Chloride	ug/L	NA	0.867 J	0.581 J	<0.25 UJ	NA
Semi-Volatiles (8270)						
bis(2EH)phthalate	ug/L	<2.5	<2.5	<2.5 UJ	<5 J	NA
4-chloroaniline	ug/L	<2.5	2.79 J	4.3 J	<5 J	NA'

J = Analyte concentration considered estimated value because one or more quality control specifications were not met.

J- = Result is estimated, potentially biased low.

UJ = The analyte was not detected above the detection limit. The reporting limit for this analyte is estimated.

TABLE B-6. BEALE WWTP - ANAEROBIC DIGESTERS - BASELINE SAMPLING

Analytes	Units	Primary Anaerobic Digester (solids) (5-ft)	Primary Anaerobic Digester (solids) (10-ft)	Primary Anaerobic Digester (solids) (15-ft)	Primary Anaerobic Digester (solids) (25-ft)	Secondary Anaerobic Digester (solids) (10-ft)	Secondary Anaerobic Digester (solids) (25-ft)
		WWTPSAD105-NS 6/1/2007	WWTPSAD110-NS 6/1/2007	WWTPSAD115-NS 6/1/2007	WWTPSAD125-NS 6/1/2007	WWTPSAD210-NS 6/1/2007	WWTPSAD225-NS 6/1/2007
Solids							
Total Suspended Solids	mg/L	775 J	610 J	700 J		31.5 J	
Volatile Suspended Solids	mg/L	570 J	470 J	520 J		29.2 J	
Total Volatile Solids	mg/kg				616,000 J		621,000 J
Total Solids	mg/kg				47,000 J		41,000 J
Metals:							
aluminum	mg/kg						510
barium	mg/kg						49
cadmium	mg/kg						0.32
chromium	mg/kg						2.8
copper	mg/kg						32
iron	mg/kg						650
lead	mg/kg						2.5
mercury	mg/kg						0.21
nickel	mg/kg						1
silver	mg/kg						0.5 J
zinc	mg/kg						67
Others:							
Boron	mg/kg						2.1 J
cyanide	mg/kg						<0.08

J = Analyte concentration considered estimated value because one or more quality control specifications were not met.

APPENDIX C

Langlier Index Corrosion Analysis

Corrosion for Windows
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Beale AFB WTP Corrosion Analysis @ pH = 7.25

Input Parameters

pH 7.25
Alkalinity 120.
Calcium 95.
Temperature in deg C 21.3
TDS 310.
Chlorides 85.
Sulfates 9.6

Results of Calculations

CCPP -15.8
Langelier Index -0.738
DIC, mg/L as C 31.97
DIC, mg/L as CaCO3 266.31
Acidity, mg/L as CaCO3 119.9
ALK: Cl-/SO4- Ratio 0.92

Equilibrium pH 7.6715
pHs - pH at saturation 7.988

Term0 -4.978E-04
Term1 + Term2 -4.977E-04
Temperature, Deg K 294.3
Calcium, Moles/Liter 9.500E-04
Alkalinity, Equivalents/Liter 2.398E-03
Hydrogen ion, Moles/Liter 5.623E-08
Hydroxide ion, Moles/Liter 1.778E-07
Chlorides, CaCO3 equivalent 120.02
Sulfates, CaCO3 equivalent 10.
Alkalinity, Moles/Liter 1.200E-03

Ksp - CaCO3 Solubility Constant 3.99E-09
Kw - Dissociation Constant for Water 6.87E-15
K1 - 1st Carbonic Dissociation Constant 4.22E-07
K2 - 2st Carbonic Dissociation Constant 4.08E-11

Ksp' - Adjusted for IS and Act. Coeff. 8.41E-09
Kw' - Adjusted for IS and Act. Coeff. 8.22E-15
K1' - Adjusted for IS and Act. Coeff. 5.05E-07
K2' - Adjusted for IS and Act. Coeff. 5.93E-11

Equilibrium Alkalinity, mg/Liter as CaCO3 135.8
Req 3.58E+02
Peq 1.08E+00
Teq 1.01E+00
Seq -3.65E-07
Pi 1.22E+00
Si -9.00E-08

Ti 1.00E+00
 Initial Acidity 2.93E-03
 Equilibrium Alk 2.71E-03
 Term1 2.22E-03
 Term2 2.71E-03
 Equilibrium H+ Concentration 2.13E-08

 Ionic Strength 7.75E-03
 Dielectric Constant of Water 79.623
 Absolute Constant 5.07E-01
 Activity Coefficient, Monovalent 3.87E-02
 Activity Coefficient, Divalent 1.62E-01
 Unity Activity Coefficient -7.75E-04

 pKsp - CaCO3 Solubility Constant 8.3992
 pKw - Dissociation Constant for Water 14.1632
 pK1 - 1st Carbonic Dissociation Constant 6.3743
 pK2 - 2st Carbonic Dissociation Constant 10.3892

 pKsp' - Adjusted for IS and Act. Coeff. 8.0754
 pKw' - Adjusted for IS and Act. Coeff. 14.0850
 pK1' - Adjusted for IS and Act. Coeff. 6.2968
 pK2' - Adjusted for IS and Act. Coeff. 10.2273

 pCa 3.022
 pAlk 2.620

 Dissolved inorganic carbonate, Moles/Liter 2.66E-03
 Total acidity, Moles/Liter 2.40E-03

Negative CCPP values indicate corrosive water. Increase the water pH until the CCPP value falls within the recommended range.

The Alk:Cl-/SO4-2 ratio is below the recommended level (5.0). It may be necessary to reduce the chlorides and/or sulfates in the water to prevent corrosion.

The DIC concentration is above the recommended range (2.0 - 15.0). Decrease the water alkalinity until the DIC concentration is within the recommended range.

The Langelier Index is below the recommended range (-0.2 to 0.2). Increase the water pH near the pHs value given until LI is within the recommended range.

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Beale AFB WTP Corrosion Analysis @ pH = 7.90

Input Parameters

pH 7.90
Alkalinity 120.
Calcium 95.
Temperature in deg C 21.3
TDS 310.
Chlorides 85.
Sulfates 9.6

Results of Calculations

CCPP 1.62
Langelier Index -0.088
DIC, mg/L as C 29.37
DIC, mg/L as CaCO3 244.64
Acidity, mg/L as CaCO3 119.4
ALK: Cl-/SO4- Ratio 0.92

Equilibrium pH 7.8045
pHs - pH at saturation 7.988

Term0 -4.978E-04
Term1 + Term2 -4.980E-04
Temperature, Deg K 294.3
Calcium, Moles/Liter 9.500E-04
Alkalinity, Equivalents/Liter 2.398E-03
Hydrogen ion, Moles/Liter 1.259E-08
Hydroxide ion, Moles/Liter 7.943E-07
Chlorides, CaCO3 equivalent 120.02
Sulfates, CaCO3 equivalent 10.
Alkalinity, Moles/Liter 1.200E-03

Ksp - CaCO3 Solubility Constant 3.99E-09
Kw - Dissociation Constant for Water 6.87E-15
K1 - 1st Carbonic Dissociation Constant 4.22E-07
K2 - 2st Carbonic Dissociation Constant 4.08E-11

Ksp' - Adjusted for IS and Act. Coeff. 8.41E-09
Kw' - Adjusted for IS and Act. Coeff. 8.22E-15
K1' - Adjusted for IS and Act. Coeff. 5.05E-07
K2' - Adjusted for IS and Act. Coeff. 5.93E-11

Equilibrium Alkalinity, mg/Liter as CaCO3 118.38
Req 2.63E+02
Peq 1.06E+00
Teq 1.01E+00
Seq -5.09E-07
Pi 1.05E+00
Si -6.41E-07

Ti 1.01E+00
 Initial Acidity 2.49E-03
 Equilibrium Alk 2.37E-03
 Term1 1.87E-03
 Term2 2.37E-03
 Equilibrium H+ Concentration 1.57E-08

 Ionic Strength 7.75E-03
 Dielectric Constant of Water 79.623
 Absolute Constant 5.07E-01
 Activity Coefficient, Monovalent 3.87E-02
 Activity Coefficient, Divalent 1.62E-01
 Unity Activity Coefficient -7.75E-04

 pKsp - CaCO3 Solubility Constant 8.3992
 pKw - Dissociation Constant for Water 14.1632
 pK1 - 1st Carbonic Dissociation Constant 6.3743
 pK2 - 2st Carbonic Dissociation Constant 10.3892

 pKsp' - Adjusted for IS and Act. Coeff. 8.0754
 pKw' - Adjusted for IS and Act. Coeff. 14.0850
 pK1' - Adjusted for IS and Act. Coeff. 6.2968
 pK2' - Adjusted for IS and Act. Coeff. 10.2273

 pCa 3.022
 pAlk 2.620

 Dissolved inorganic carbonate, Moles/Liter 2.45E-03
 Total acidity, Moles/Liter 2.39E-03

The CCPP value calculated is below the recommended range (4.0 - 10.0). Increase the water pH slightly until the CCPP value falls within the recommended range for your treatment processes.

The Alk:Cl-/SO4-2 ratio is below the recommended level (5.0). It may be necessary to reduce the chlorides and/or sulfates in the water to prevent corrosion.

The DIC concentration is above the recommended range (2.0 - 15.0). Decrease the water alkalinity until the DIC concentration is within the recommended range.