9-17-2010

An evaluation of water treatment technologies piloted at LANL to improve cooling tower water efficiency.

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LA-UR-01-1802
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An Evaluation of Water Treatment Technologies Piloted at LANL to Improve Cooling Tower Water Efficiency

by

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A Professional Project Report Submitted in Partial Fulfillment of the Requirements

For the Degree of

Master of Water Resources
Water Resources Program
The University of New Mexico
Albuquerque, New Mexico

February 23, 2001

Los Alamos
NATIONAL LABORATORY

Committee Approval

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ACKNOWLEGEMENTS

There are many people I would like to thank during all phases of this paper. First I would to thank my committee members at UNM, Professor Michael Campana, Director, Water Resources Program, and Professor Bruce Thomson, Committee Chair, Civil Engineering Department, who supported me through their patience, advice, and support throughout the field project trial and throughout the production of my professional paper. My deepest gratitude goes out to the LANL committee members Bryan Carlson, Water Conservation Project, Lead Engineer, and Pete Worland of LANL's Radioactive Liquid Waste Treatment Facility, who have given much needed advice, guidance, information sources, and have provided their expertise to me in many areas. My most sincere appreciation must be expressed to the Water Conservation Project Manager, D'Ann Bretzke, who allowed me to join the project team, to use this topic as my Master's project, and who has always believed in me and has given me her support and guidance through many difficult tribulations encountered during the course of this project. I would like to thank my manager, Tom Starke, Program Manager, Environmental Stewardship Office for supporting me through his understanding and allowing me time to work on this project. Thank you Phil Sena for allowing me to attend all meetings for the Phase II of this project and for providing me invaluable information and information sources. Thank you Mike Ebbers for providing me with engineering cost estimates for construction and infrastructure. I would like to thank Barry Charles and Dan Erickson from Mission Research Corporation who provided a wonderful facility to demonstrate the field project, who provided engineering support to the project team, and who helped me collect and run sample analysis whenever I was frazzled. Finally, I would like to thank Howard

Granzow, LANL Construction Procurement Specialist, for reviewing this paper and providing needed guidance so that I could complete and present this paper to my committee members.

ABSTRACT

This paper presents an evaluation of three technologies piloted at Los Alamos National Laboratory (LANL) for improving cooling tower water efficiency. High silica content (average of 88 mg/L) in LANL source water requires frequent blow down in cooling tower systems to avoid accumulation of silica scale on heat transfer surfaces. At concentrations above 150 mg/L, silica scaling on heat transfer surfaces can occur to the extent scale causes a reduction in cooling effectiveness and can lead to system shutdown. The pilot project evaluated two chemical treatment processes and two silica removal processes for a period of 4 months in a full-scale pilot. The chemical treatment processes were not successful in meeting reliability standards while meeting the 75 percent efficiency goal (~350 mg/L) silica while the filtration technologies demonstrated over 90 percent efficiency, where efficiency is defined as the percent of expected vendor process water usage to current LANL water usage in cooling tower systems. This paper discusses the results of the field test and evaluates performance, reliability, and regulatory compliance, of the processes and presents an evaluation for full implementation options.

ACRONYMS

AA	Atomic Adsorption
AF	acre-feet equal to 325,829 gallons
AFY	acre-feet per year
CCF	Central Computing Facility
COC	cycles of concentration (calculated as makeup/blow down)
DATS	Deposit Accumulation Test System
ESO	Environmental Stewardship Office
EA	Environmental Assessment
FY	fiscal year
HX	heat exchanger
ICP	Inductively Coupled Plasma emission spectroscopy
LDCC	Laboratory Data Communication Center
LEDA	Low-Energy Demonstration Accelerator
LANL	Los Alamos National Laboratory
Laboratory	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
LAC	Los Alamos County
mg/L	milligrams per liter
Mils/yr	1/1000 of an inch per year
MIOX	mixed oxidant
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
ORP	oxidation-reduction potential
RCRA	Resource Conservation and Recovery Act
RO	reverse osmosis
SCC	Strategic Computing Complex
SWEIS	Site Wide Environmental Impact Statement
SWSC	Sanitary Wastewater System Consolidation
TCLP	Toxic Characteristic Leaching Procedure
TDS	total dissolved solids
TSS	total suspended solids
XRD	X-Ray Diffraction
RFP	Request for Proposal

1.0 INTRODUCTION

From 1943 through 1998, water rights and the supply systems in the town of Los Alamos were owned and operated by the Department of Energy (DOE). By owning and operating the water supply and distribution systems, LANL had some flexibility in supplying water to its facilities, as mission needs changed. On September 8, 1998, the DOE leased their entire 5541.3 acre-feet per year (AFY) water rights holdings and most of the water production and distribution systems to the Los Alamos County (LAC). The ultimate intent for DOE was to transfer 70 percent of the water rights (3879 AFY) to the County for community needs, and lease the remaining 30 percent (1662 acre-feet/year) back from LAC for LANL use.

Although the Laboratory may purchase water in excess of the 30 percent agreement from LAC, the County cannot guarantee large increases in supply. This limit on water supply has prompted the Laboratory to investigate possible conservation measures to meet current and future water demands. In addition to addressing operational needs, the Laboratory and the DOE have a strong commitment to become a responsible steward for this natural resource (DOE/EIS-0238, 1998a).

The average 20-year potable water demand rate at LANL has been 1534 acre-feet per year (AFY). This is approximately 28 percent of the total LAC water right, which is very close to the 30 percent earmarked for the Laboratory's use. In addition to current usage, the Laboratory has planned new needs that have the potential of increasing potable water usage to 2147 AFY, nearly 39 percent of the total LAC water right, by Fiscal Year (FY) 2005.

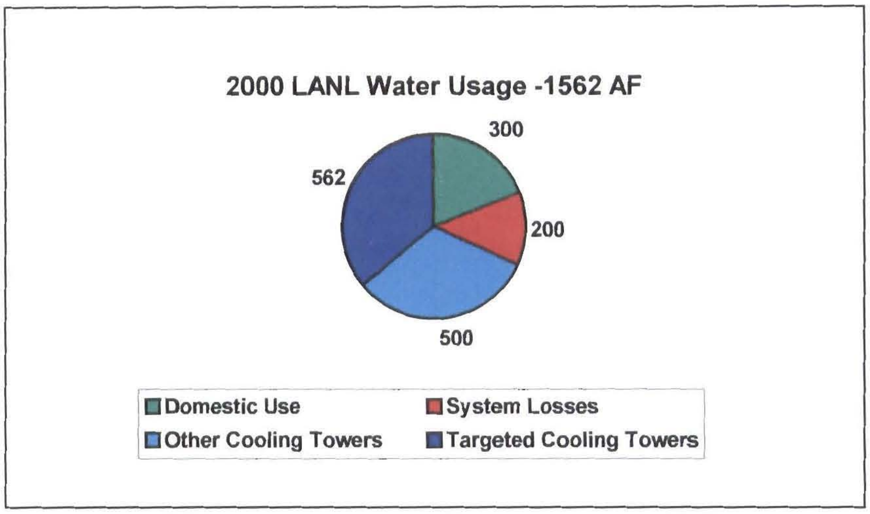

Figure 1: ***LANL Water Demand in 2000.***

At present, the Laboratory uses approximately 300 AFY for domestic use and approximately 200 AFY are lost from the system (Figure 1). The remaining 1062 AFY is used in evaporative cooling towers. The cooling towers targeted for water conservation measures as described in this project are the largest cooling tower units at the Laboratory and have a constant heat load due to year round facility cooling needs (e.g. Power Plant operations and computer centers) and are the largest users of water where their current use is 562 AFY. LANL has projected that these cooling towers will increase their water demand to 1104 AFY in FY 2005, which will surpass the 1662 AFY goal that LANL has committed to stay within in the Laboratory's 1998 Site Wide Environmental Impact Statement (SWEIS).

LANL completed a scoping study in 1998 to evaluate their evaporative cooling tower systems and to determine if conservation efforts could decrease water usage. The study concluded that high silica content (88 mg/L) limited the cooling towers to 2 cycles of

concentration (COC), where COC is defined as the increase in dissolved solids in a cooling tower basin due to evaporative losses.

$$COC = Makeup/\ Blow\ down \qquad \textbf{(Eq. 1)}$$

Where, Makeup = Water added to the system to replace water lost via evaporation, drift, and blow down.

Blow down = The discharge of a portion of the circulating water to remove suspended and dissolved solids.

The reason that cooling towers are operated at 2 COC is because silica in the makeup water averages 88 mg/L and at concentration levels above 150 mg/L, silica will polymerize, precipitate, and deposit onto heat exchanger surfaces (Wohlberg et al,1999). Scaling on heat transfer surfaces reduces efficiency, thus increasing energy costs to run the system. It also increases the frequency of cleaning of the heat transfer surfaces and related equipment, which requires down time for the programmatic functions that the cooling tower systems support.

The maintenance costs for fouled heat transfer surfaces can be quite significant and the time and cooling capacity lost because of down time poses an unacceptable level of risk for facilities. Because silica is the limiting factor in cooling tower operations, facility management teams have chosen to run evaporative cooling systems at 2 COCs to minimize silica scaling.

In September 1999, LANL released a Request for Proposals (RFP H7272RFP9-8S)) to demonstrate technologies and processes to control silica scaling, while at the same time, increasing water conservation at cooling towers from present water use efficiencies of 50 percent (2 COC) to the targeted efficiency of 75 percent (4 COC). The RFP was

$$Efficiency = (Makeup\text{-}Blow\ down)/\ Makeup \qquad \textbf{(Eq. 2)}$$

structured as a two-part solicitation and performance procurement. The first phase of the project would require selected vendors to demonstrate their technologies on cooling

towers during a large-scale demonstration pilot, where vendor processes, water efficiencies, reliability, and feasibility could be evaluated. The second phase of the proposal was structured to be in the form of a fixed price procurement for implementation of the chosen technologies/processes.

This paper discusses the field performance, possible full implementation options for each process/technology, and an evaluation methodology developed by the author to rank and score each implementation option.

2.0 COOLING TOWER WATER DEMAND

Evaporative cooling is the primary source of building and process equipment cooling at LANL. Cooling towers are located throughout the 43 square miles of LANL facilities. The largest cooling towers at LANL provide cooling for the Low-Energy Demonstration Accelerator (LEDA), the Laboratory Data Communication Center (LDCC), the Los Alamos Neutron Science Center (LANSCE), the new Strategic Computing Complex (SCC), and the LANL Power Plant. These cooling towers use approximately 562 AFY of the 1062 AFY of water used in evaporative cooling.

In addition to being the largest users of cooling water, these towers are clustered relatively close to one another. The LANSCE and LEDA towers are located at Technical Area (TA) 53. The CCF, LDCC, SCC and Power Plant towers are located at TA 3. Because of their locality and high water use, LANL targeted water conservation measures to be implemented at these cooling towers in the second phase of the 1998 RFP. The remaining towers at LANL are distributed throughout the Laboratory at various facilities and were not the immediate focus of this RFP.

Table 1: ***Projected LANL Water Consumption with Current 50 % Efficiency (Potable Water only).***

Cooling Tower	**Estimated Water Consumption (AFY) by FY with 50% Water Efficiency (or 2 Cycles of Concentration)**					
	FY-2000	**FY-2001**	**FY-2002**	**FY-2003**	**FY-2004**	**FY-2005**
LANSCE	213	340	340	340	340	340
LEDA	64	64	64	64	64	64
CCF & LDCC	85	85	85	85	85	85
SCC	0	0	145	188	365	365
Power Plant	200	250	250	250	250	250
Other (other cooling towers (outside RFP, and all other uses)	955	965	974	984	994	1004
Total	1517	1704	1858	1911	2098	2108

Table 1 lists the current and projected water usage at the targeted cooling towers and shows the expected increase in water usage for these towers over the next five years. This table represents water usage at the present rate of 50 percent efficiency at the targeted cooling towers by use of potable feed water only, and includes a 1.1 percent increase in domestic demand at the Laboratory per year. By FY-2005, total water usage for the Laboratory is forecasted to be 2108 AFY where this total is approximately 500 acre-feet over the 1662 AFY earmarked for the Laboratory. The LAC may be able to provide this additional water demand, but the Laboratory would be limited in new missions that have not been realized to this point and they may need to provide financial assistance to the LAC to upgrade supply and distribution facilities.

By increasing the efficiency of the targeted cooling towers to the LANL goal of 75 percent, water usage can be dramatically decreased (Table 2), and the Laboratory can remain within its water usage goal of 1662 AFY.

Table 2: ***Estimated LANL Water Usage with 75% Efficiency at Targeted Cooling Towers.***

Cooling Tower	**Estimated Water Consumption (AFY) with 75% Efficiency by FY (or 4 Cycles of Concentration)**					
	FY-2000	**FY-2001**	**FY-2002**	**FY-2003**	**FY-2004**	**FY-2005**
LANSCE	142	227	227	227	227	227
LEDA	43	43	43	43	43	43
CCF & LDCC	57	57	57	57	57	57
SCC	0	0	97	125	243	243
Power Plant	133	167	167	167	167	167
Sanitary Water Reuse	0	-160	-264	-300	-300	-300
Other (other cooling towers (outside RFP) & all other uses)	955	965	974	984	994	1004
Total	1330	1299	1301	1303	1431	1441

Table 2 also includes a phased implementation of 300 AFY of LANL sanitary reuse water. To date, treated sanitary effluent is not fully utilized and facility management teams are hesitant to use this source of water in their cooling towers because of water

quality issues (e.g. increased silica concentrations, high TDS, high phosphates, etc.). By demonstrating the effective reuse of this source of water, the Laboratory could realize an immediate gain in water conservation. At present, approximately 30 percent of this water is used at the Power Plant when it is operating and the remainder of the water is discharged to a permitted outfall.

Table 2 shows that by increasing the cooling tower water use efficiency to 75 percent and by reusing the treated sanitary waste water, it is possible to maintain water usage well within the Laboratory's current water allocation and still allow for further expansion of activities that require additional water use. Phase I of the Cooling Tower Water Conservation Project was developed to achieve this objective.

3.0 SILICA BACKGROUND

High silica levels are found in groundwater supplies from rock formations containing high contents of volcanic deposits, including volcanic glasses. High silica content is not a common problem found in groundwater and does not pose a problem unless the water is needed for industrial uses where the concentration of the silica will be increased over 150 mg/L. Silica concentrations in LAC water are relatively high (88 mg/L).

The high silica content in LAC is not a water quality problem for the community where most water is used for domestic purposes. However, it is a problem in cooling towers, where evaporation concentrates silica to levels that can cause scaling. The following sections explain why Los Alamos has high silica content in its water, what factors contribute to silica solubility, and what observations were made during the Project field testing in relation to silica.

3.1 Geo-Chemical Characteristics

The Laboratory is situated in north-central New Mexico approximately 25 miles northwest of Santa Fe and 60 miles north-northeast of Albuquerque. The LANL facility encompasses approximately 43 square miles of land and is situated on the Pajarito Plateau. The Pajarito Plateau is (Figure 2) found at the southern end of the north-to-south oriented Jemez Mountains on the eastern side of the range. The Pajarito Plateau is a series of finger-like mesas that run east-to-west and were deposited approximately 1.2 to 1.6 million years ago during several major volcanic eruptions. The Plateau was formed from ash fall (Bandelier Tuff) and is more than

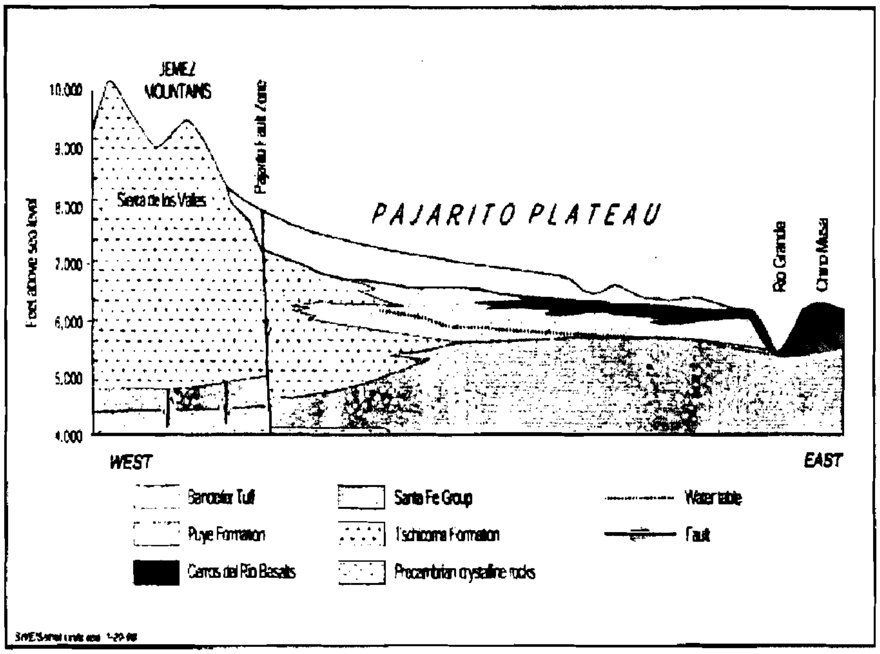

Figure 2: ***Los Alamos Aquifer Rock Formations (Source: Purtymun, 1984).***

1,000 feet thick against the eastern portion of the Jemez Mountains, and thins to 260 feet in the western portion (LA-13633-ENV, 1998). Annual precipitation in the Los Alamos region ranges from 30 inches along the crest of the mountains, to 10 inches along the Rio Grande. The average annual precipitation on the plateau is about 18 inches, and 70 percent of this occurs in July and August (Purtymun, 1984).

The main aquifer in the LAC region extends from the Rio Grande westward beneath the Pajarito Plateau and is estimated to be over 6000 feet thick (Purtymun, 1984) at the westernmost portion of the Plateau that abuts the Jemez Mountains. The main aquifer is the source of all potable water in the Los Alamos area (LA-13633-ENV, 1998).

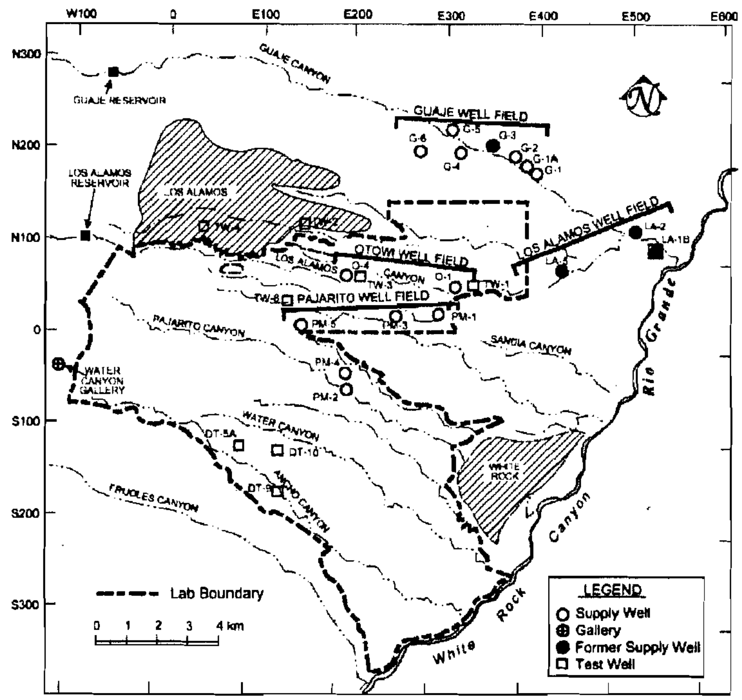

Figure 10: ***Los Alamos Potable Water Production Wells (Source Ref 4).***

The lithology of rocks yielding water to the production wells at LANL in large part, determines the chemical characteristic of the water. Silica concentrations from production wells that support the Laboratory range from 50 to 88 mg/L. The majority of water supplied to the Laboratory is from the Pajarito (PM1-5 in Figure 3) well field located in the south central portion of the Laboratory. Rocks yielding water to the Pajarito well field are from the Tesuque and Puye Formations.

The Tesuque Formation is composed of siltstone and sandstone with sporadic lenses of clay or pebbly conglomerate where basalt flows are often interbedded in the sediments (USGS, 1967). The Puye Formation is made up of quartzite debris where the upper unit of the formation is cemented conglomerate composed of volcanic debris, mainly rhyolite, quartz latite, and latite (USGS, 1967). In general, the rock in

the Puye Formation can be classified as being composed principally of silica and aluminum. Both the Puye and Tesuque Formation are contributors of silica in Laboratory well water (Langmuir, 1997). The Tesuque Formation has the potential to contribute the highest concentrations of silica.

3.2 Silica Solubility Characteristics

Silica in the water from production wells at LANL is, for the most part, present as monomeric orthosilicic acid $Si(OH)_4$ (Worland, 1997),. To a much lesser extent colloidal forms are present (Wohlberg and Buchholz, 1975 and Worland, 1997). Silica solubility depends on the form of the source material, the temperature of the water, the pH, the overall silica concentration in solution, and the presence of other ionic minerals in the water supply. As silica concentrations increase due to evaporation in a cooling tower, it polymerizes into insoluble colloidal and amorphous forms that plate out on heat transfer surfaces.

Silica precipitants can appear in many different forms and is influenced by a variety of variables (Freeman and Majerle, 1995 and Worland, 1997). The following section provides the reader with an overview of the complicated subject of silica solubility.

3.2.1 Theoretical Characteristics of Silica Solubility

The potential for silica to precipitate from solution does not solely depend on its saturation state. Other factors such as co-precipitation with other minerals, colloidal silica suspension, biological activity (Gill, 1998), solution pH, particle hydration, particle size, and temperature also play a major role. The influence of these factors is not well known and contributes to the problem of silica scale deposit control. $Si(OH)_4$ is the most common form of soluble silica found in LANL well water

Amorphous silica is the most common form of silica scale to form from LANL well water and its solubility is discussed herewith.

Table 3 provides silica solubility given pH, temperature, and particle size. Silica solubility increases with temperature. Silica scaling on heat transfer

Table 3: ***Amorphous Silica Solubility In Water.***

Variable	Solubility (mg/L)	Source
Temperature (°C)		
0	30	Gill, 1998
25	80-120	
50	200-220	
100	380-430	
150	620	
200	810-900	
pH at 25°C		
0-5	120	Worland, 1997
6-8	120	
9	138	
9.5	180	
10	310	
10.8	876	
11	2,020	
12	20,500	
Particle Size (nm) – at 25-50°C and pH 8		
2	Extremely soluble	Gill, 1998
3	130	
4	120	
5	110	
6	100	
8	80	
10	60	

surfaces, under most conditions, occurs in the form of amorphous silica regardless of the original source material (Chan, 1988). Silica scaling is found in this form because the kinetics of amorphous silica precipitation is faster at temperatures below 300°C than other forms such as quartz crystallization (Chan, 1988). Particle size inversely correlates with solubility and as particle size increases the solubility decreases. Silica is most insoluble below pH 8 and its solubility increases exponentially above pH 9 (Worland, 1997). At pH values above 8.5 and in the presence of hydrous polyvalent metal ions such as magnesium, iron, and

copper, orthosilicic acid can combine with the metal ions in solution to form neutral and negatively charged colloids (Wohlberg and Buchholz, 1975). The order of decreasing effect of a cation on amorphous silica solubility is (Chan, 1988):

$$Mg^{2+} > Ca^{2+} > Sr^{2+} > Li^{+} > Na^{+} > K^{+} \qquad \textbf{(Eq. 3)}$$

Sessile microorganisms in biofilm may also entrap colloidal silica and cause deposition as scale.

The unpredictability of silica solubility has given the water treatment industry a challenge above other types of mineral scaling and has resulted in much interest within the industry to develop a process to control silica scaling.

3.3 Silica Solubility Observations

Observations made during the pilot demonstration project on silica solubility correlate well with the literature reports of scaling and control. The data presented in this section are based on analytical data derived from field-testing using a molybdate reactive silica test and total silica concentration were determined by Inductively Coupled Plasma (ICP) Emission Spectroscopy in formal laboratory analytical analysis.

Two types of makeup source water were used during the field pilot, potable water supplied from the LAC water system, and treated wastewater from LANL's Sanitary

Table 4: ***LANL Water Chemistry***

Analyte	Unit	Potable Water	Reuse Water
Calcium	mg/L $CaC0_3$	33	40
Magnesium	mg/L $CaC0_3$	16	38
'P' Alkalinity	mg/L $CaC0_3$	5.0	4.0
'M' Alkalinity	mg/L $CaC0_3$	132	149
Sodium	Na	13	94
Potassium	K	2.7	---
Chloride	Cl	4.5	92
Sulfate	mg/L $S0_4$	4.0	11
Silica	mg/L $Si0_2$	88	103
Nitrate	mg/L $N0_3$	0.34	---
Phosphate	mg/L $P0_4$	0.12	15
Aluminum	Al	0.25	---
pH	units	8.3	8.2
Conductance	µS/cm	163	630
TDS*	mg/L	108	429
TSS	mg/L	---	18.2
Arsenic	mg/L As	0.005	0.006
Lead	mg/L Pb	0.018	0.017
Mercury	mg/L Hg	0.00026	0.000156
Copper	mg/L Cu	0.017	0.0145
Selenium	mg/L Se	0.0045	0.014
Zinc	mg/L Zn	0.07	0.0126
Iron	mg/L Fe	---	0.33

Wastewater System (SWS) treatment plant. The groundwater and sanitary reuse water supply were analyzed on a daily basis for silica levels, pH, conductivity, calcium and magnesium levels, alkalinity, and other contaminants as deemed necessary. Table 4 provides an average concentration of the constituents observed in both sources of water.

Figures 4 and 5 present the potable water and reuse water silica observations made in relation to pH levels during the pilot tests. pH levels in the water supply measured between 7.3 to 8.3 during the potable pilot field trial. The variance in pH was due to changes in supply wells where the first half of the potable water trial was

demonstrated on water supplied from LAC well Otowi 2 and the second half was demonstrated on water supplied from LAC well Otowi 4 (See Figure 3 for well locations).

As presented in Table 3, silica solubility in the pH ranges associated with the potable water trial could have been as high as 120 mg/L. The average soluble (molybdate reactive) silica level in the potable water trial (see Figure 4) was 70.8 mg/L, the lowest value was 52 mg/L and the highest value was 90 mg/L. The total

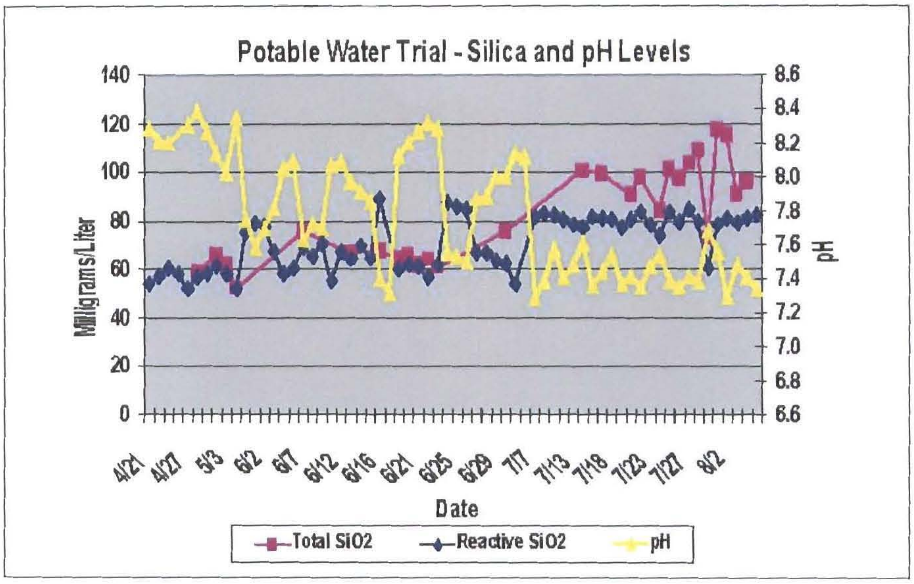

Figure 4: ***Potable Silica and pH Values.***

silica average was 82.3 mg/L where the lowest value was 51 mg/L and the highest value was 118 mg/L. The difference between total and molybdate reactive silica averaged between 10 to 15 percent during the pilots where reactive silica (soluble) was the dominant species.

Small changes in silica solubility can be observed in Figure 4. When the potable makeup water pH varied between 7.3 to 8.0, soluble silica levels tended to be lower

and a greater discrepancy between total and reactive silica levels was found. When pH levels were between 8.4 and 8.2, the difference between total and reactive silica was much less.

The pH values during the treated sanitary reuse water demonstration did not vary as much as during the potable water trial where pH remained between 8.0 to 8.4

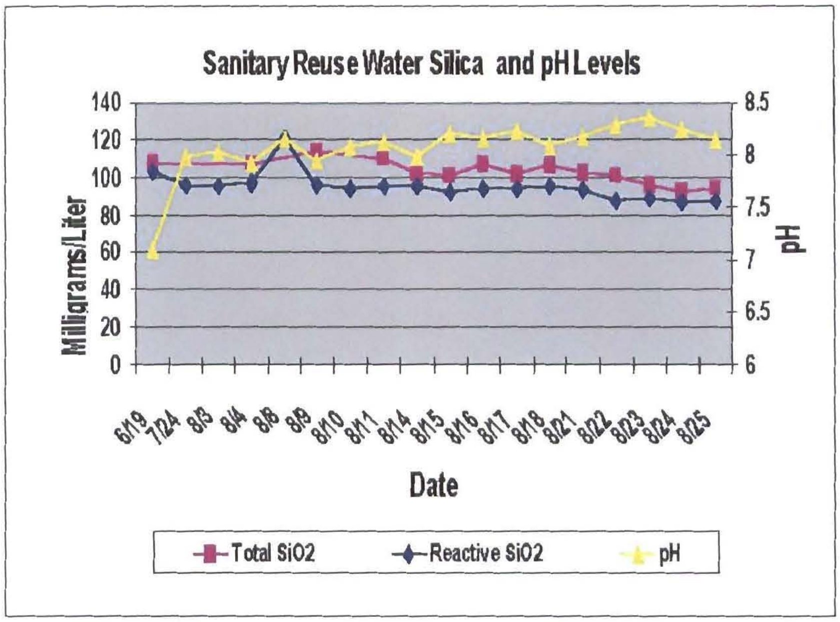

Figure 5: ***Sanitary Reuse Trial Silica and pH Values.***

during the entire reuse trial. The differences between total and reactive silica levels were more stable and averaged 104 and 95 mg/L respectively. The highest total silica value recorded was 115 mg/L and the highest reactive silica value recorded was 103 mg/L. As seen in Figure 5, the differences between total and reactive silica closely track one another where the differences between soluble and insoluble silica show little difference (approximately 10 mg/L). This shows that at the higher pH, soluble silica is more prevalent than insoluble silica when the total silica levels were below 120 mg/L.

3.4 Other Types of Scaling

Calcium, and magnesium, in conjunction with carbonates, phosphates, and sulfates can also contribute to scaling problems. As discussed previously, co-precipitation of silica often is observed with calcium and magnesium. However, these elements alone can cause scaling if not managed. Analysis of the LANL water showed that the potable water supply during the demonstration averaged 49 mg/L total hardness, where 0 to 50 mg/L would be considered soft water. Table 4 lists the average concentrations of these elements found in both sources of water piloted.

Calcium carbonate scaling: At ambient temperature conditions, the tendency of water to form calcium carbonate scale depends on the calcium hardness (CaH), total alkalinity (M Alk), TDS, and pH. Many indices to predict scaling have been developed over the years including the Langelier Saturation Index, the Ryznar Stability Index, and the Practical/Puckorius Scale Index. The Practical/Puckorius Scale Index (PSI), corrects for non-carbonate sources of alkalinity and the pH value is replaced by a function of the total alkalinity to give (Cavano, 1997):

$$PSI = 18.38 - 2\log_{10}(CaH) - 3.465\log_{10}(MAlk) \qquad \textbf{(Eq. 4)}$$

This equation provides an approximation of the potential for scaling conditions. Using the values given in Table 4 for LANL water chemistry, the PSI value is approximately 8.0 for potable water and 7.6 for sanitary reuse water. The values are compared with the scaling conditions in Table 5.

Table 5: *Scaling Conditions* (Cavano, 1997)

LSI	RIS or PSI	SCALING CONDITIONS
3.0	3.0	Extremely Severe Scaling
2.0	4.0	Very Severe Scaling
1.0	5.0	Severe Scaling
0.5	5.5	Moderate Scaling
0.2	5.8	Slight Scaling
0.0	6.0	Stable Water
-0.2	6.5	Very Slight Dissolving
-0.5	7.0	Slight Dissolving
-1.0	8.0	Moderate Dissolving
-2.0	9.0	Strongly Dissolving
-3.0	10.0	Very Strongly Dissolving

Because the potable and reuse water were 8.0 and 7.6 respectively, calcium scaling did not appear to be a major concern.

Phosphate scaling: The high phosphate levels (15 ppm) in the sanitary reuse water were a blessing and a concern. Because polyphosphates are used to control calcium carbonate scaling, there presence would reduce scaling. However, phosphate levels must be controlled at levels between 10-40 mg/L, where the reuse water averaged levels of 15 mg/L as makeup water supplied to the cooling tower. Phosphate will precipitate on heat transfer surfaces as calcium phosphate. Calcium phosphate has a low solubility at pH values above 7.0 and at elevated temperatures. Therefore, the conditions for calcium phosphate scaling during the testing of the sanitary reuse water were prevalent. This problem was addressed by adjusting processes to account for high phosphate by limiting COC's to 2 so as not to exceed 30 mg/L phosphate.

Magnesium scaling: Magnesium hydroxides begin to form scale at pH values above 10 and at high temperatures. Magnesium scaling was not expected to be a problem

because of the low levels of magnesium in the source water and because pH levels in the cooling towers were controlled between 7.5-8.5.

Sulfate scaling: Sulfate can scale on heat transfer surfaces as calcium sulfate. Calcium sulfate is considerably more soluble than calcium carbonate, where it will deposit when the concentration of calcium and sulfate ions in the water exceeds the solubility product of calcium sulfate. However this type of scaling is generally a concern with high sulfate and high calcium makeup water. The alkalinity, sulfate, and calcium levels in both sources of water were low enough that this type of scaling was not considered a major concern.

4.0 PILOT TEST DESCRIPTION

The field project was managed by LANL representatives. To expedite pilot field testing, LANL performed the field project off-site at a private contractor facility within LAC which provided the field testing site, engineering support, and technical assistance.

The Laboratory received 11 proposals in response to the LANL RFP. A 9-person committee with members who have experience in cooling tower operations and water management, reviewed and evaluated each of the proposals. The proposals were scored on technical merit, water efficiency, prior experience, and cost. Proposals with the highest overall score were funded for the first phase. Four vendors were selected for the

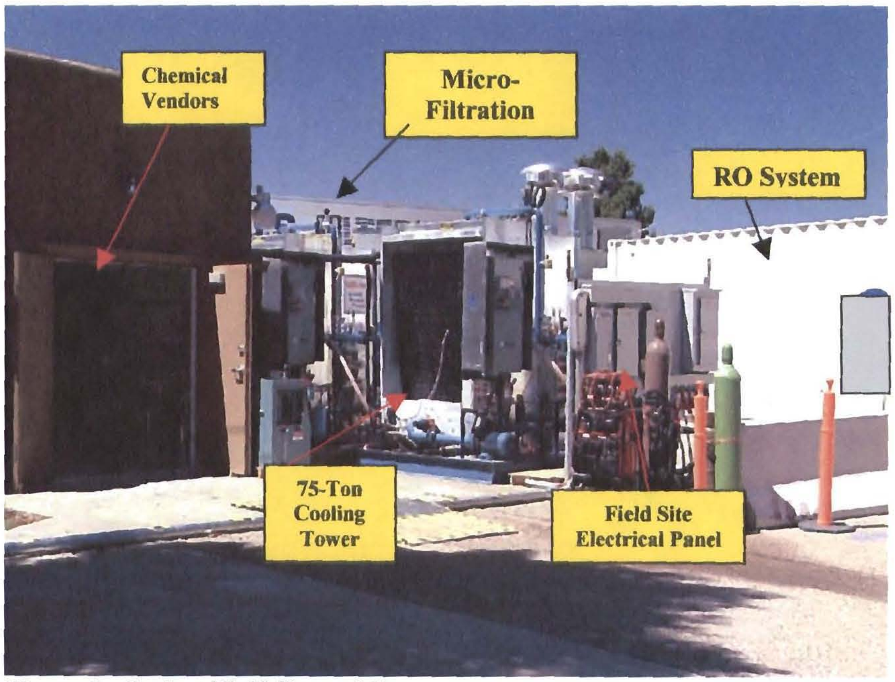

Figure 6: ***Project Field Site and Setup.***

first phase of the project (field testing) where two of the vendor approaches were chemical management and two vendor approaches were silica removal processes.

During the pilot testing, LANL provided the vendors (Figure 6) with 75-ton cooling towers to demonstrate their technologies as described in their phase I proposals. The field pilots were originally scheduled to run for 90 working days so that each vendor would demonstrate their silica control technologies for 45 days on the two sources of feed water. The demonstration started on April 28, 2000, but field testing operations were interrupted (from May 5 through June 7) because of a major forest fire (Cerro Grande Fire) in close proximity of the field testing site. Due to time lost during the fire, vendors requested more demonstration time for the potable water trial. The demonstration schedules were adjusted to allow the chemical vendors to test 50 days on potable water and 18 days on sanitary reuse water. The silica removal vendors tested for 26 days on potable and 25 days (RO) and 11 days (micro-filtration) on the reuse water. The following section describes the purpose and scope of the field trial.

4.1 Pilot Purpose and Field Testing

The purpose of the field trial was to collect operational data during a full-scale pilot test in order to evaluate treatment processes (as stated in the vendors phase I proposals) to achieve a water efficiency goal of 75 percent while pilot testing on potable and sanitary reuse water. The purpose of pilot testing sanitary reuse water was to prove its feasibility as a makeup water source at LANL.

4.2 Scope of Pilot Test

The technical scope of the field project was for the selected vendors to operate full-scale mobile cooling towers at a 75 percent efficiency level or better with the

objective of demonstrating water conservation in cooling tower systems. This efficiency level had to be maintained while controlling water chemistry to ensure that the vendor process would not foul heat transfer surfaces, and any discharges associated with vendor processes regulated by Federal, and State permits would comply with the permitted standards. In addition, operating parameters such as corrosion and micro-biocide control had to be addressed and shown to be adequate.

4.3 Field Pilot Test Plan

LANL provided field demonstration equipment (cooling towers, heat exchangers, and boiler to provide a constant heat load) to allow vendors to prove their performance. The two chemical vendors required the cooling towers to run with a constant heat load 24-hours per day, seven days per week. The micro-filtration silica removal process required a cooling tower to demonstrate the effectiveness of the process but required a constant heat load only during periods of water treatment. The RO silica removal process did not require a cooling tower because the process could be evaluated by monitoring the quality of the treated water. Detailed operating logs were maintained by LANL personnel and by the demonstrating vendors. Information required for notation included shutdown periods, equipment problems and resolution, vendor process anomalies and resolution, chemical usage and dose levels, and cleaning operations.

To evaluate each process, the field plan concentrated on data collection in the following categories: efficiencies achieved, reliability, regulatory compliance, wastes generated, and operations and maintenance issues experienced during the field trial.

A data acquisition system (DAS) was used to collect flow data in and out of the cooling towers (makeup and blow down water), temperature data in and out of the boiler and in and out of the hot and cold side of the cooling tower HXs, and to data on copper and mild steel corrosion rates within the cooling tower basin. These data were automatically recorded every 10 minutes.

Water chemistry of the source water, as well as the chemistry of each treatment process was monitored on a daily basis. A wet chemistry laboratory was set up at the field testing site to provide daily field analysis. Samples were also sent to a LANL analytical laboratory to provide verification of field analysis and a baseline for the project. Daily field analysis was done for silica, calcium, magnesium, and analytes included in Federal and State permits (See Appendix 3 and 4). The field laboratory also provided analytical support for vendor operational parameters.

Solid wastes produced as a result of vendor operations were collected and a composite sample was analyzed by an independent laboratory for hazardous metals. This information was needed so that the disposal path and costs for solid waste disposal could be established.

Visual inspections were performed on heat exchangers four times during the pilot testing. If scale was present, a photograph was taken for documentation, and samples were taken for X-ray Diffraction analysis (XRD) (after two inspections). After each inspection, a cleaning of the heat exchanger was performed before the cooling towers were put back on-line so that LANL personnel could establish a new vendor baseline.

4.4 Description of Technologies Pilot Tested

In order to keep the demonstration vendors identity anonymous in this report, the participating companies are referred to as vendor A, B, C, and D. This anonymity is necessary to maintain confidentiality, as the second phase of the procurement has not been awarded. The evaluation methodology used in this report is not the approach that LANL used during their review process.

4.4.1 Chemical Treatment Approach

Vendors A and B are water treatment chemical companies that have been providing chemicals and treatment plans for industrial process water for many years. The general approach for chemical management was to allow the COCs to increase to where the silica concentrations were approximately 350 mg/L, and scaling was kept in check by the addition of anti-scaling polymers. Control systems were used to control the amount of polymer being added and to set blow down rates. Daily water chemistry monitoring was performed to validate the level of silica concentration, to ensure regulatory compliance, and to ensure that corrosion and microbial growth were kept at reasonable values. The chemical vendors' expressed concern early in the selection process that they would not be able to achieve the 75 percent efficiency goal for the sanitary reuse water because of the high levels of phosphates and high levels of total dissolved solids (generally 450 mg/L).

LANL required all vendors to test both types of makeup water sources regardless of vendor concerns. However, LANL agreed that during the reuse

water trial, both chemical treatment vendors could limit their COCs in the cooling towers to address the water quality concerns. The amount of time required for testing this source water was also reduced because LANL did not believe that the chemical vendors would face technical problems reaching 2 COCs with this source water and saw no reason to pilot the 6 weeks originally planned. Therefore, the chemical vendors' demonstration periods were adjusted to 7 weeks on the potable source water and 3 weeks on the reuse source water.

4.4.1.1 Vendor A Approach – Chemical Treatment

Vendor A's approach to limiting silica scale on the heat exchanger surfaces was to condition the silica by use of a new water treatment polymer specifically designed for high silica waters. This polymer acts to interfere with the silica polymerization mechanism, thereby maintaining silica as a dispersed colloid that is suspended in the cooling water and thereby kept from being deposited on heat transfer surfaces. After reaching the targeted 350

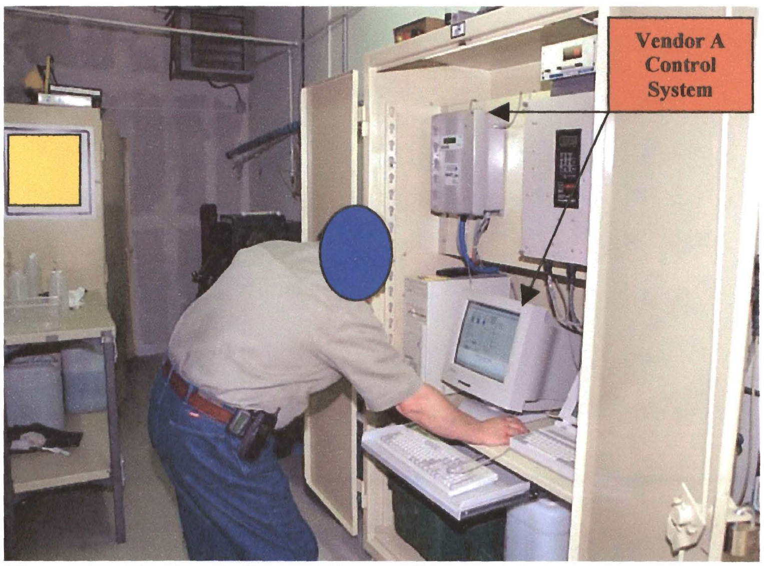

Figure 7: ***Vendor A Control System Set-up.***

mg/L silica concentration, a portion of the treated water was blown down from the cooling tower basin, makeup water was added along with scale polymer.

The chemical feed and control system consisted of a control and data logging system (Figure 7) that could monitor key parameters such as conductivity, pH, oxidation/reduction potential, makeup and blow down water meter rates, chemical tank levels, and water temperatures. The chemical addition and blow down cycle for Vendor A was configured so that the COC was set from the conductivity of the water within the cooling tower basin. Later, Vendor A added a conductivity controller to the makeup water stream to better control the COCs. Because silica scaling is pH dependent, the pH was controlled at or above 8.2 during most of the trial. The control system logged process parameters hourly and the system could be remotely tracked and controlled.

In addition to the control/data logging system, Vendor A installed a deposit accumulation test system (DATs) so that changes in heat transfer over time could be monitored and to provide a measure of fouling.

Water chemistry analysis for Vendor A was performed on a daily basis by both LANL and vendor personnel to track silica concentrations, and other parameters. In addition to field-testing, Vendor A process water samples were sent for formal analysis and validation to the LANL laboratory on a regular schedule.

Vendor A tested their process for 56 days on potable water and 18 days on sanitary reuse water. Vendor A's HX surfaces were visually inspected 4 times during the field pilot where evidence of scaling was documented, and a sample was taken for XRD analysis after two inspections

4.4.1.2 Vendor B Approach – Chemical Treatment

Vendor B's approach for silica scale control was to use a new silica scale polymer that inhibits the polymerization of soluble silica, keeping the silica soluble and avoiding colloid formation. The chemical feed system (Figure 8) had a molecule tracing capability that allowed Vendor B to tightly control its chemical levels in the tower basin and thus its dosage. Vendor B's control system included the chemical tracing controller and automatic chemical feed systems, pH, and conductivity meters. The cooling tower COCs were first controlled by an upper limit of conductivity in the cooling tower basin water,

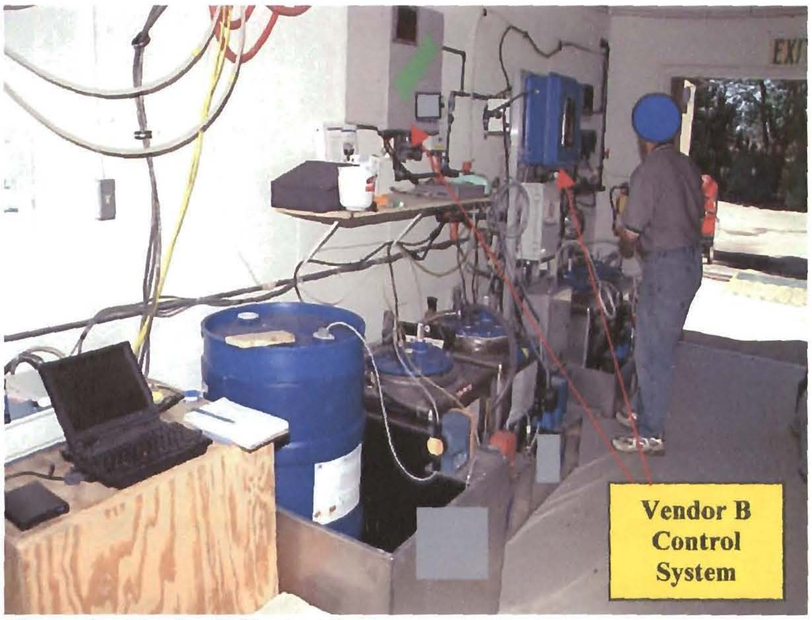

Figure 8: ***Vendor B Control System.***

and later modified to include a conductivity meter on the makeup water where a "conductivity cycle" algorithm was then included as part of their overall control system.

Vendor B also had an on-line monitoring system that tracked parameters such as pH, and conductivity so that vendor personnel could monitor, modify, and optimize the system remotely.

Water chemistry analysis for Vendor B was performed on a daily basis by LANL personnel to track silica concentrations, and other parameters of interest. In addition to field-testing, laboratory testing was performed on a regular schedule. Vendor B pilot tested for 54 days on potable water and 18 days on sanitary reuse water. The HX from the Vendor B process was visually inspected 4 times during the field pilot where its condition was documented and samples were taken for XRD analysis.

4.4.2 Filtration Treatment Approach

Vendors C and D had different approaches to silica control during the field project. One technology was a chemical precipitation and micro-filtration approach (Vendor C) that treated the blow down water coming from the cooling tower and then returned the treated water to the cooling tower basin as part of the makeup stream. Vendor D's approach was to treat makeup water through reverse osmosis with advanced pretreatment of the makeup water. However, the goal for both vendors was to decrease the silica concentration within the cooling tower basin so that maximum COCs could be achieved without scaling.

4.4.2.1 Vendor C Approach – Silica Precipitation and Filtration

Vendor C demonstrated a silica removal process using magnesium, under pH control, to co-precipitate silica from water. Vendor C's demonstration

Figure 9: ***Vendor C Equipment Trailer.***

focused their field trial efforts on the treatment of blow down water so that the cooling tower would concentrate the silica and the vendor could proportionally add less chemicals to their reaction tank (Figure 9) for co-precipitation of silica. After precipitation, the process stream was sent to a bank of micro filters (0.1 micron), where the particulates were filtered from the process stream and then sent to a neutralization tank for pH adjustment before being returned to the cooling tower.

By constantly removing the silica from the blow down and returning the treated blow down to the cooling tower, Vendor C could maintain silica levels in the cooling tower well below levels that cause HX scaling. Either potable or reuse water was provided to the cooling tower to offset evaporative losses.

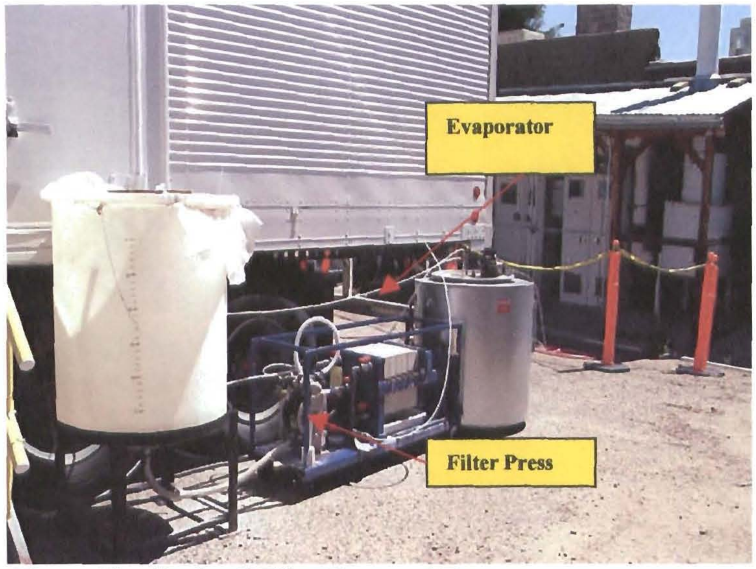

Figure 10: ***Vendor C Filter Press and Evaporator.***

Because the Vendor C treatment process continually added TDS to the treated water, a small side stream was sent to a reverse osmosis (RO) unit to control the build-up of TDS.

The reject stream from the RO unit was sent to a small evaporator (Figure 10) where it was dried for analysis and disposal. The solids that were retained by the micro filter were routed to a sludge holding tank and dewatered by a filter press. The filtrate stream from the filter press was returned to the treatment plant head works for reprocessing. The dewatered filter cake solids were stored for analysis and disposal. The process was demonstrated as a zero liquid discharge system where the only wastes produced were solid wastes. Figure 11 provides a simplified flow diagram of the Vendor C process.

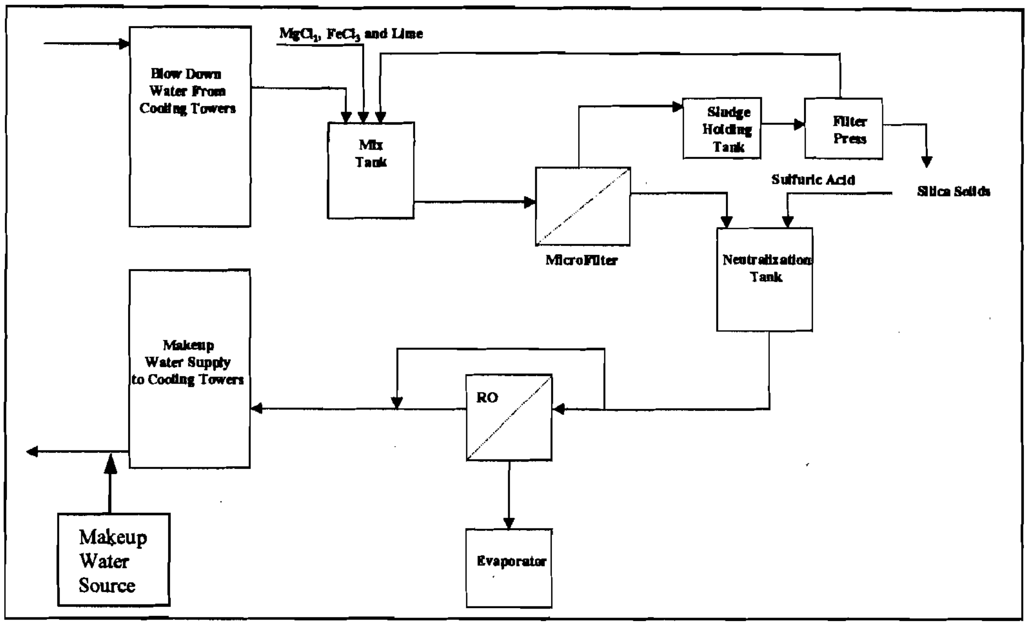

Figure 11: ***Vendor C Process Flow Diagram.***

Vendor C's goal was to consistently produce a filtered stream with approximately 20 mg/L silica concentration and to maintain the cooling tower silica level in the cooling tower basin at 120 mg/L. An interesting technical issue that Vendor C had to address was to compensate for variability of silica levels in the potable makeup source water while maintaining the silica levels in the cooling tower basin at 120 mg/L (and below 150 mg/L). The results that pertain to this question will be addressed in the Vendor C Pilot Results Section.

Vendor C addressed regulatory compliance issues by demonstrating a zero liquid discharge system. Therefore, the only regulatory issue that needed to be addressed was the disposal path for the solids. All solids produced from the filter press and from the evaporator bottoms were sampled and analyzed

for hazardous metals such as selenium, arsenic, and mercury to characterize the waste. Composite samples were taken after the potable water trial and after the sanitary reuse trial.

Water chemistry field analysis was performed on a daily basis, during operational periods, for silica levels in the cooling tower basin. Formal laboratory analysis was also performed on a routine basis.

Analysis of other operational parameters were run for Vendor C for several different points within their treatment process. Vendor C tested their performance 26 days on potable water and 11 days on sanitary reuse water. The cooling tower HX was visually inspected 4 times during the field pilot where its condition was documented.

4.4.2.2 Vendor D Approach – Reverse Osmosis

Vendor D achieved silica removal by using an RO system with an advanced water pretreatment process. The process included removal of all divalent metal ions, removal of calcium and magnesium hardness through a weak acid cation resin where alkalinity is converted to carbon dioxide, the water is then de-carbonated through a forced-draft air stripper where it would lose its natural buffering capacity, and then the water was pH adjusted to 10 and fed into the RO system (Bradley, 2000). The RO membrane used for the pilot was a standard brackish water element (Figure 12) used for commercial applications.

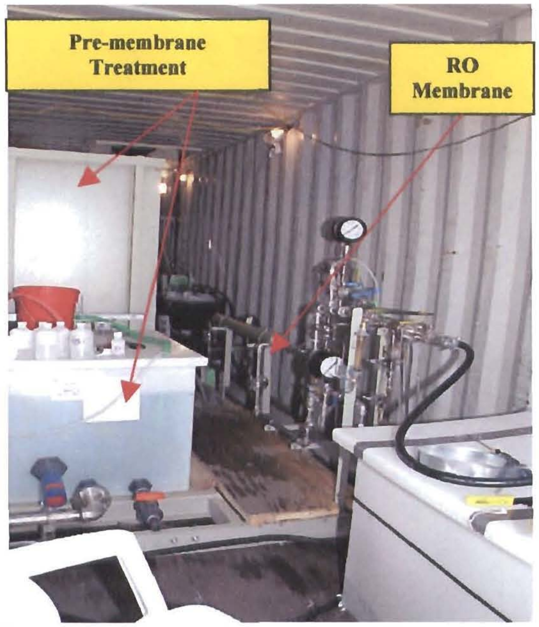

Figure 12: ***Vendor D Treatment Equipment Trailer.***

Vendor D's process was specifically designed to increase silica solubility by an order of magnitude where very high recovery rates (RO reject at silica concentrations of 1500 mg/L or greater) can be achieved without scaling. Figure 13 shows a simplified flow diagram of Vendor D's pilot demonstration plant. Vendor D's goal was to produce a permeate stream with a consistent

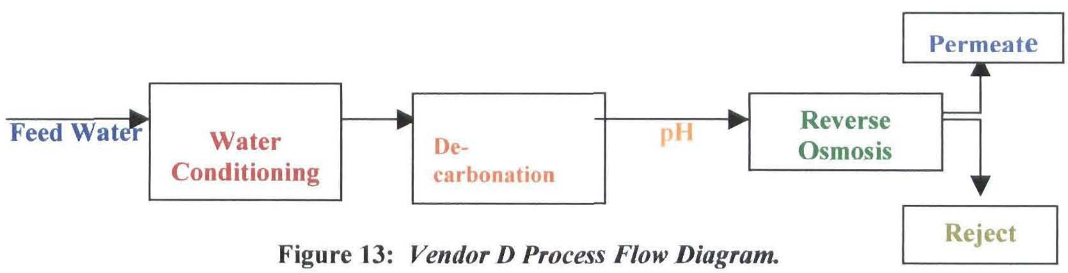

Figure 13: ***Vendor D Process Flow Diagram.***

silica level (approximately 1-2 mg/L) while concurrently increasing the overall recovery rate to efficiencies above 90 percent.

Vendor D focused their field trial efforts on the treatment of makeup water. Because Vendor D removed silica from the makeup water, a cooling

tower was not deemed necessary to evaluate their pilot test results. Therefore, HX and corrosion data were not collected and will not be discussed.

By treating makeup water, the variability of silica in the feed water was stabilized (~1 mg/L), where the permeate water supplied to the cooling towers would no longer be constrained by silica as its limiting factor. Because Vendor D's pre-treatment process removed hardness and alkalinity, other types of scaling were not a concern. The system was not demonstrated as a zero liquid discharge system, however the vendor dried composite samples of the RO reject collected during both the potable and reuse trial for solid waste analysis.

Because the vendor claimed that the RO reject stream could be discharged into permitted outfalls at lower recovery rates (approximately 75% recovery for potable and 50% recovery for sanitary reuse), the RO reject waste stream was sampled on a daily basis for NPDES and Groundwater permit parameters. However, the vendor did not maintain the system at the above recovery rates because they wanted to demonstrate maximum recovery rates as a best water conservation option.

Field analysis of the permeate stream was also performed on a daily basis for silica concentration levels. LANL laboratory analysis was performed on permeate and reject streams on a semi-regular basis. Vendor D piloted 26 days on potable water and 25 days on sanitary reuse water.

5.0 DATA COLLECTION

The data collection methods used during the field trial were chemical analysis of makeup and vendor process water, flow measurements of makeup and blow down water, temperature measurements for heat transfer coefficient estimations, corrosion measurements, visual inspections, TCLP metal analysis for solid waste determination, XRD analysis, and operations and maintenance (O&M) logs kept by both LANL and the vendors on daily operations and maintenance activities. The following sections describe the data collection methods and how the data was used in the process evaluation.

5.1 Water Chemistry Methods

Field samples were collected and analyzed daily on the makeup water and on the vendor process water (Figure 14) using a HACH DR4000 Spectrophotometer. The

Figure 14: ***HACH DR4000 Visual/UV Spectrophotometer.***

major analytes of interest were silica levels and LANL NPDES and Groundwater Permit water quality parameters. The vendors also had analytes of interest that they

requested be analyzed for daily operational adjustments. In addition to field sampling and analysis, samples were collected for formal laboratory analysis where the method used was analyte specific (ICP for cations, AA for sodium, IC for anions, and standard filtrate methods for total suspended solids and total dissolved solids). Table 6 lists the field and laboratory analyses and methods.

Table 6: ***Laboratory and Field - Water Chemistry Analysis Methods***

Analyte (ppm unless otherwise stated)	LANL Lab	Field	NPDES or Groundwater Standard	Method
pH		X	Yes	Field measurement made with meter
Conductivity		X	No	Field measurement made with meter
TDS	X	X	Yes	TDS based on conductivity field measurement
Silica (Reactive/Total)	X	X	No	Field: silicomolybdate complex with reactive silica; Lab: Inductively Coupled Plasma (ICP) for Total Si
Iron	X	X	Yes	Field: Complex with trace iron using ferrozine reagent.
Sodium	X		No	Lab: Atomic Adsorption
Arsenic	X*		Yes	Lab: ICP
Selenium	X*		Yes	Lab: ICP
Mercury	X*		Yes	Lab:
Magnesium as $CaCO_3$	X	X	No	Field: Colormetric, Lab: ICP
Calcium as $CaCO_3$	X	X	No	Field: Colormetric, Lab: ICP
Free and Total Chlorine		X	Yes	Field: N,N-diethyl-p-phenylenediamine indicator
Phosphate	X	X	Yes	Field: Phosphomolybdate Complex
Nitrate	X	X	Yes	Field: UV nitrate direct screening method, Lab: IC
Chlorides	X	X	Yes	Field: Ferric thyocyanate complex, Lab: IC
Sulfates	X	X	Yes	Field: Barium sulfate precipitant, Lab: IC
Fluoride	X		Yes	Lab: ICP
TSS	X	X	Yes	Field & Lab: Filtration
% Solids	X	X	No	Field & Lab: Dry to remove moisture
Alkalinity		X	No	Field: Titration
Turbidity		X	No	Field: Turbidimeter (90° to the incident light beam)
Ammonia		X	No	Field: Nessler Reagent
Color		X	No	Field: Color transmittance

- ***Analyzed in ppb**

Field samples were analyzed on a daily basis and recorded in a laboratory field book where the values were later transferred to an Excel spreadsheet along with the formal laboratory chemical numbers for data analysis.

The silica data for the chemical vendors were used to determine the efficiency level achieved by the chemical vendors where 350 mg/L silica was considered 4 COC or 75 percent efficiency. The silica analysis for Vendor C and Vendor D was used to determine how efficient their systems functioned in removing silica from their process streams. For Vendor D, silica data were used to determine the recovery rate, by evaluating the concentration in the reject stream to the silica concentration in the feed water. Vendor C's cooling tower performance was monitored by reviewing the silica concentrations in their cooling tower basin to ensure that it was maintained below their goal of 120 mg/L.

Data collected for NPDES and Groundwater permit parameters were compiled in a table where weekly averages were established and later compared with the LANL permits for regulatory compliance verification.

5.2 Cooling Tower Operational Data

Each cooling tower had flow elements (FE) to monitor HX flows, makeup and blow down water flows; temperature elements (TE) to monitor HX temperatures; and corrosion elements (CE) to monitor copper and mild steel corrosion rates. The instrumentation had local readouts (Figure 15) and data points were recorded by a data acquisition system every 10 minutes during the entire pilot testing (Figure 16).

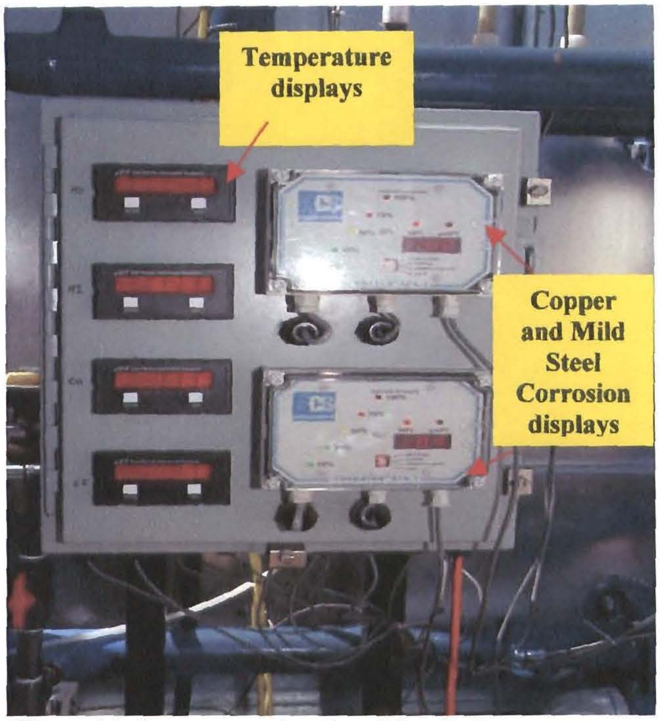

Figure 15: Instrumentation Local Readout.

The data points were downloaded into Excel spreadsheets after the completion of the trial for analysis. Corrosion rates used to evaluate vendor data for mild steel and copper were: <1 mils/yr. was considered an excellent corrosion rate, <3 mils/yr. was considered good, <5 mils/yr. was considered fair, and >5 mils/yr. was considered excessive. HX heat transfer coefficients were graphically compiled to determine at what points in the trial fouling of HX were evident. Flow measurements of makeup and blow down water were compiled to determine the hydraulic cycle of the cooling tower.

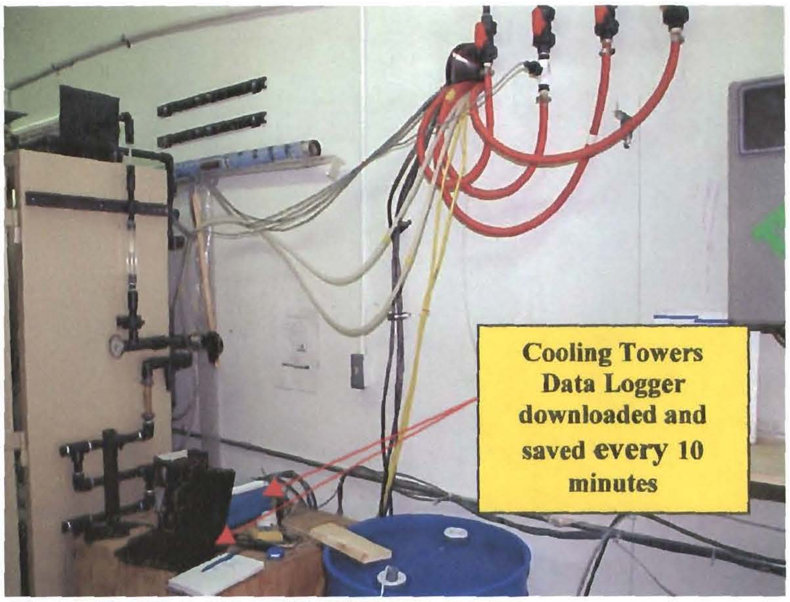

Figure 16: ***Data Acquisition System.***

5.3 Operations and Maintenance Logs

The purpose of the O&M logs was to note periods where the LANL provided equipment was not operational, to record field anomalies such as electrical failures which could effect vendor performance, vendor specific anomalies that effected their performance, and to record problem duration and resolution for both LANL and vendors. These data were considered essential to evaluate vendor reliability during the pilot testing.

The information required to be recorded by the vendors was data such as equipment failures, controller problems, chemical inventory and usage, pressure drops on membrane systems, membrane/filter cleaning and back washing maintenance, and other daily activities that could explain anomalies.

5.4 Solid Wastes

Solid wastes generated from filter press and evaporator operations were collected as they were generated and a composite sample of the solids was collected for each source water (potable and sanitary reuse) and analyzed using the toxic characteristic leaching procedure (TCLP) for hazardous metals (arsenic, selenium, and mercury) levels. Vendor D did not generate a solid waste but air-dried a portion of RO reject from the two source waters for solid waste analysis.

5.5 Visual Inspections

Visual inspections were performed on the cooling towers on a daily basis to note operational issues such as foaming, scale build-up on cooling tower fill material, water turbidity or other anomalies that could be visually recognized as being out of the ordinary. All anomalies were recorded in the LANL project O&M logbook.

Four visual inspections were performed on the cooling tower heat exchangers to check for signs of scaling. After each inspection, a sample of scale build-up was collected and the heat exchangers were cleaned. Photographs were taken of heat exchanger plates 10, 20, 30, and 40 before and after cleaning. Scale deposits from two separate inspection periods were sent to LANL's Geology and Geochemistry group for XRD analysis. The results of the analyses were reviewed to determine speciation and crystalline structure.

6.0 REGULATORY COMPLIANCE ISSUES

In order to implement any of the technologies tested, regulatory compliance issues had to be identified to insure that the technology/process could be implemented at LANL. In addition, the author of this report needed to identify the regulatory issues involved for the second phase of this proposal to properly apply the evaluation criteria. The Laboratory is sensitive to its neighbor's environmental concerns and it was important to identify potential issues that may be associated with each technology. The environmental issues fall into three categories: 1) regulatory compliance with LANL's environmental compliance permits, 2) secondary waste disposal as industrial wastes or hazardous wastes, and 3) implementation of a process at LANL in a reasonable amount of time if there are public perception issues identified during environmental assessment processes.

In order to ensure that the process could meet current LANL permit standards, the process waste streams were monitored during the demonstration project. The hardest of the three environmental issues to evaluate was whether LANL would have adequate time to address public concerns associated with full implementation of a vendor process. The following environmental and regulatory compliance drivers were identified:

- Vendors A, B, and D would be required to meet Clean Water Act NPDES and State of New Mexico Ground and Surface Water Quality Protection Regulations for cooling tower discharges to regulated outfalls while achieving maximum efficiencies;
- LANL's goal for zero environmental compliance incidents could be realized at the targeted cooling outfalls if a zero discharge system was put in place. However, wetlands associated with outfall discharges could decrease in size if the flow was eliminated;
- Wetland impacts might be subject to Endangered Species Act;

- Wetland size reduction issues may prompt negative public response if an Environmental Assessment (EAs) (under the National Environmental Protection Act (NEPA)) is required;
- Vendor D would be limited in their recovery efficiencies if they were to discharge their reject stream because of high concentrations of TDS (>1000 mg/L) and other constituents in their reject stream subject to State and Federal monitoring;
- Siting areas within LANL for a centralized RO plant that would require discharge of effluent are limited and are not viewed as practical. A new NPDES outfall location near the best location for Vendor D would be difficult and time consuming to obtain;
- If the footprint of a centralized plant is large (over 100' x 100') and is sited in an area that is not developed, environmental assessments under the NEPA would need to be completed to address environmental concerns;
- The new construction of the Super Computer Complex EA stated there would be no increase in water usage as a result of facility operations; and
- The New Mexico Health Department is proposing new standards for treated wastewater reuse/human contact. The new standards would require a polishing filter after secondary treatment. The filtration systems that were demonstrated during the pilot project would satisfy this proposed requirement.

The implementation of a chemical treatment process (Vendors A and B) would require focus on monitoring blow down water where this wastewater would be discharged to the environment through a regulated outfall. The Laboratory is required to monitor its effluent on a monthly and quarterly basis to satisfy its NPDES and State of New Mexico Groundwater discharge permit.

Vendor C was tested as a zero liquid discharge system where two centralized plants would be required to collect cooling tower blow down for treatment, where the treated water would be returned to the cooling tower as part of the makeup water stream. The system would be a closed loop where the only wastes generated would be solid wastes.

The Vendor D RO process for makeup water would require one centralized plant in a full implementation option. Vendor D provided the latitude to implement their technology as either zero liquid discharge at the plant or reducing their recovery rates to the point that their RO reject could be discharged to a regulated outfall. Because water conservation efficiency would decrease if the recovery rates were reduced to meet discharge permit standards, this implementation scenario was not considered practical. Maximum water recovery at a centralized plant with no liquid discharge was the only option considered for full implementation. However, because cooling towers would still need to be blown down, a liquid discharge to the outfall would be required. The permeate sent to the cooling towers as makeup water would be devoid of contaminants that would cause NPDES or Groundwater exceedance of the liquid discharge at regulated outfalls at the efficiencies required by the RFP. In fact much higher COCs could be achieved (8+ COC) with RO water before discharge.

7.0 VENDOR PILOT RESULTS

A summary of the performance of each treatment process is described in the following subsections. The summaries document efficiency, reliability, regulatory compliance, and operations and maintenance problems observed during the field pilot test.

7.1 Vendor A – Chemical Treatment Performance Summary

Vendor A had a successful demonstration with respect to operations and maintenance anomalies, and environmental compliance. The vendor was able to achieve an average 75 percent efficiency during most of the potable water trial but was unsuccessful in demonstrating this efficiency level without fouling heat transfer surfaces. The following subsections describe Vendor A's overall performance.

Operation & Maintenance: Vendor A experienced no control system problems during the pilot demonstration. The vendor applied treatment to the test pilot cooling tower 24 hours/day, 7 days/week where a constant heat load was applied to the system. With the exception of two minor chemical injection pump failures, there were no notable problems with the vendor's control system. The system appeared to be user friendly and easy to calibrate. This is an important point if LANL chose to implement this process but required facility teams to operate it.

Because of the variability of the silica levels during the field pilot, Vendor A added a conductivity instrument to monitor makeup water conductivity to better control the cooling tower COC. Using this instrument, the vendor programmed the

control system to adjust cooling tower blow down rates to better maintain silica levels within the cooling tower basin.

The vendor remotely monitored the cooling tower during most of the pilot when vendor personnel would not be on the project site. Vendor A generally came to the project site 7 days a week, 3 hours per day to inspect their tower and controller equipment, and to run samples. The effectiveness of their remote monitoring was impressive. To illustrate, on July 4th, high conductivity (over 2000 μS) makeup water entered their demonstration tower. The vendor immediately contacted LANL project personnel to notify them of the unusual condition. As it turned out, the condition was caused by one of the filtration technologies that had caused a process tank to flow into the pilot field test cooling towers.

Efficiencies Achieved: Total and molybdate reactive silica levels were below the required 75 percent efficiency level (4 cycles of concentration) for the potable water trial (Figure 17) where total silica averaged 282 mg/L and reactive silica averaged 235 mg/L. However, based on information from other researchers (Wohlberg et al, 1999), the true silica levels are higher than what is reported for total silica with ICP emission spectroscopy. The reason for this difference is not well understood and may be attributable to silica supersaturating and depositing as scale. The true silica level used for this evaluation was computed as:

(Blow Down Ca /Makeup Ca)*Makeup Silica **(Eq. 5)**

Silica levels based on the calcium computed silica values were above the 75 percent efficiency level and averaged 352 mg/L during the potable trial. This computed silica level was used to evaluate the efficiency achieved by Vendor A during the demonstration test. Given that the calcium/silica computed value is a reasonable

interpretation of the true silica value, Vendor A averaged the minimum of 75 percent efficiency (or 350 mg/L silica) required by LANL during most of the demonstration on potable water. Silica levels based on hydraulic cycles of concentration (COC) from totalizer measurements on the makeup and blow down lines would have **been a** good comparison to validate the true COC achieved, however, the hydraulic cycle tended to yield a lower value. It is believed that the low values were caused by low makeup water flow periods where the flow to the cooling towers was below the sensitivity of the flow meters. Silica levels based on reactive, total, and computed values are plotted for comparison (Figure 17).

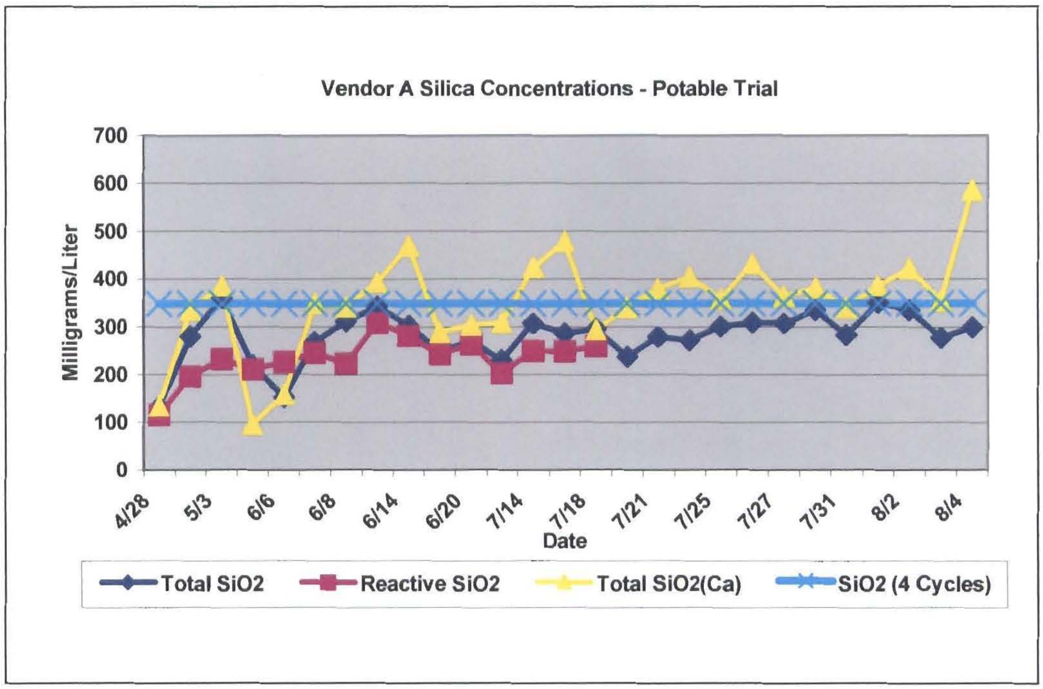

Figure 17: ***Vendor A Silica Levels During the Potable Water Field Trial.***

Vendor A averaged 237 mg/L total silica during the sanitary reuse trial and 221 mg/L on the calculated 'theoretical' silica level (approximately 2.3 COC) where both

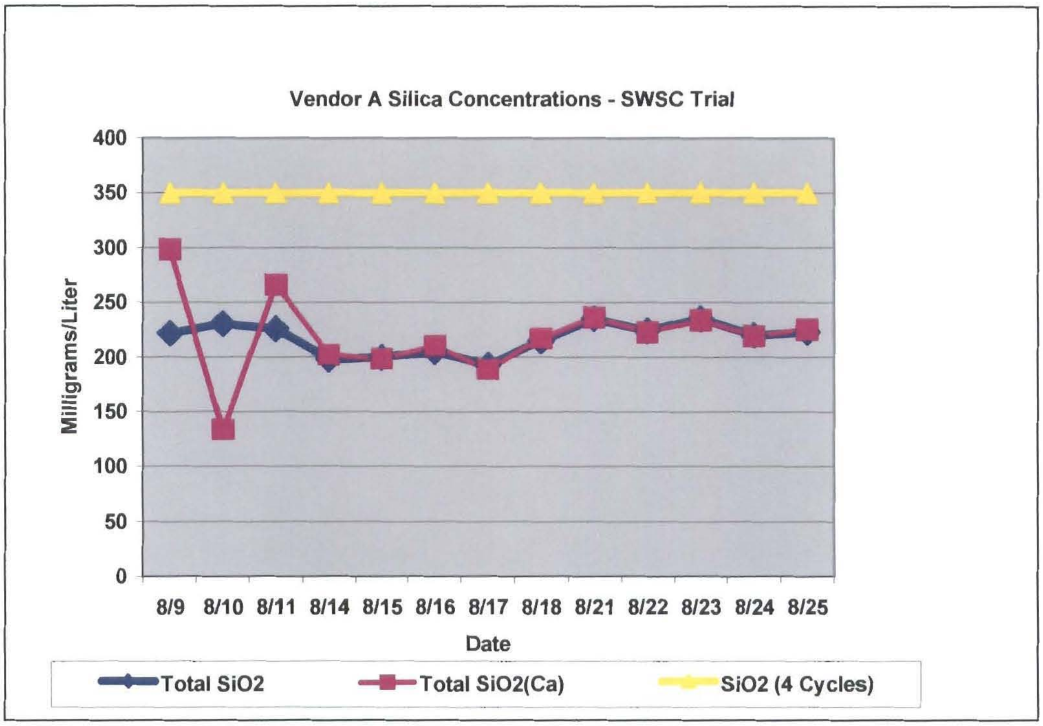

Figure 18: ***Silica Levels achieved during the Sanitary Reuse (SWCS) Trial.***

values during the reuse trial were below the desired 75 percent efficiency goal (Figure 18). The lower efficiencies achieved were due to high TDS concentrations in the reuse water of between 450-500 mg/L, so that the efficiencies could not be achieved without exceeding the 1000 mg/L TDS standard for Groundwater discharge. In addition, phosphate levels averaged 15 mg/L in the reuse water. Calcium phosphate scaling becomes prevalent at phosphate levels above 30 mg/L. Due to these related operational factors, Vendor A chose not to demonstrate their technology at higher silica levels on sanitary reuse water.

Reliability: To evaluate Vendor A's performance, heat transfer coefficients were computed from the logged HX temperature data and corrosion rates were recorded throughout the pilot testing period. The heat transfer coefficient data are presented in Figure 19.

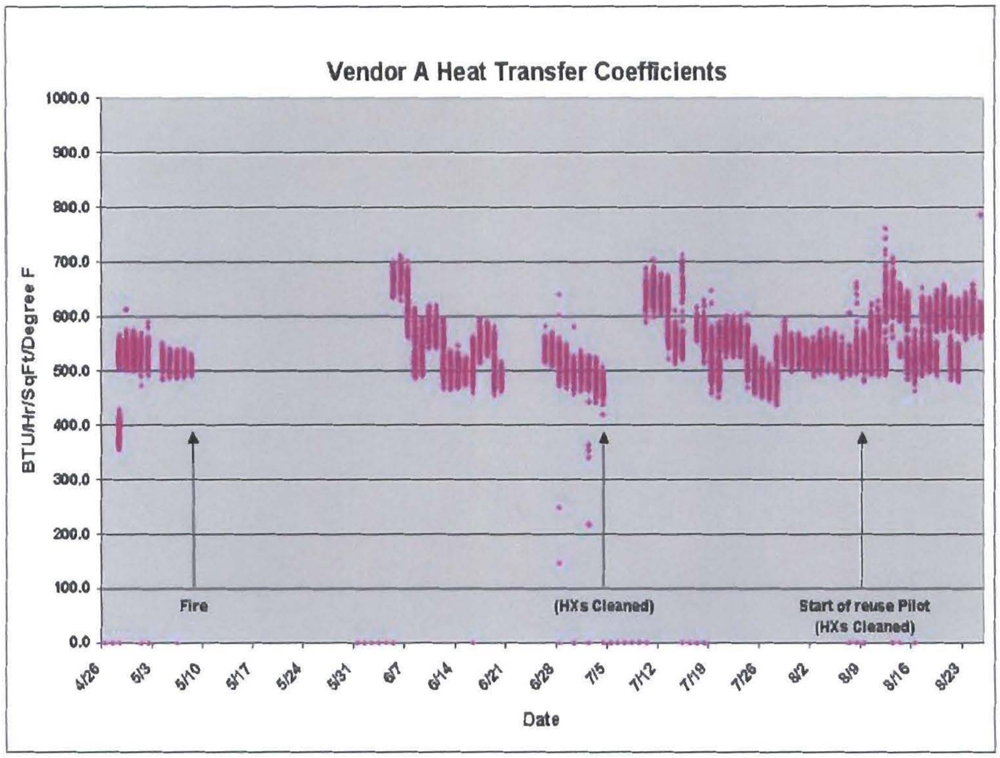

Figure 19: ***Vendor A Heat Exchanger Data During Both Source Water Trials.***

Heat transfer coefficients for Vendor A tended to be higher after each heat exchanger cleaning. However, no strong indication of heat transfer surface scaling was evident from the heat transfer data collected during the trial.

Periodic HX inspections were performed to monitor the presence of silica scaling. The first inspection took place on July 5th. Vendor A's HX plates showed significant beige colored scale which was hard to remove with a fingernail. The level of scaling witnessed was contradictory to the fact that no significant indication of scaling was noted from the heat transfer coefficient data.

Solid samples of the scale were taken from heat transfer surfaces for XRD analysis. The scale analysis for Vendor A showed that over 98 percent by weight of the solid material was amorphous silica and 2 percent by weigh was quartz, gypsum, and calcite. This sample analysis is indicative of the type of scaling found on LANL

Figure 20: ***Vendor A Heat Exchanger First inspection. Plate Showed Significant Scaling on July 5, 2000.***

HXs during normal operations. The results from the XRD are presented in Appendix 2. The HX showed signs of scaling during subsequent inspections performed on July 19th, August 7th, and August 25th, (see Appendix 1 for photos of Vendor A HX inspections). The first inspection on July 5th, had the longest run time before inspection (from May 28, 2000-through-July 5, 2000) and this time variable may explain why this inspection showed the most scaling.

The HX surfaces were cleaned after the July 5th, inspection (Figure 20) and before the start of the reuse water pilot test on August 7th, (See Appendix 1 – Heat Exchanger Photos).

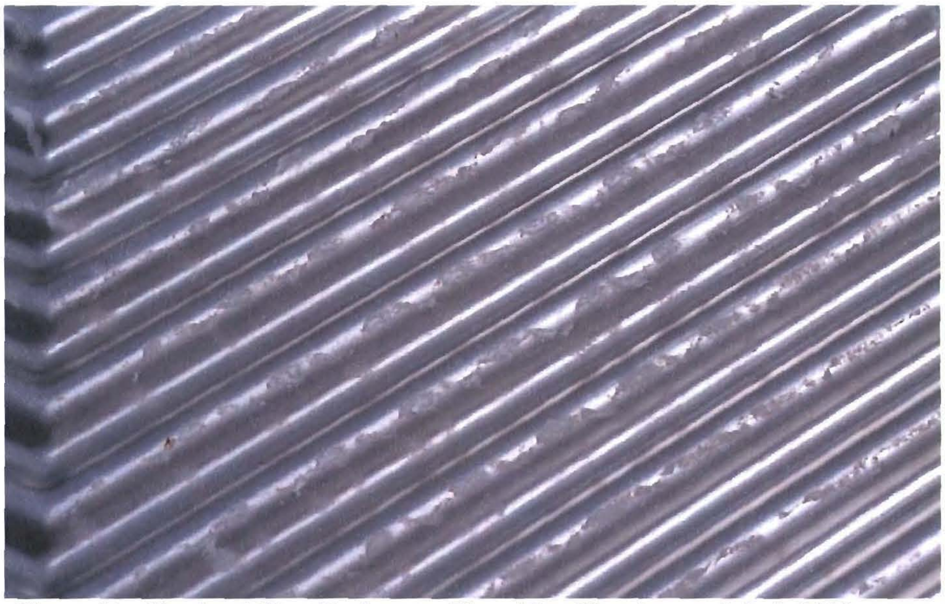

Figure 21: ***Vendor A Heat Exchanger Plate After Cleaning on July 6, 2000.***

XRD analysis on scale deposits after the reuse trial again showed that the majority of scale build-up was amorphous silica. Based on the scaling witnessed on the HX during each inspection, and data collected on the vendor's DATs system (data not available for review), a 75 percent efficiency level could not be maintained on potable water nor can it be achieved on reuse water.

The exact COC that could be achieved without scaling using this technology was not determined during the testing. LANL believes that 3 COC for potable water could be achieved without significant scale buildup and 2 COC could be achieved using reuse water.

Vendor A maintained the iron and copper corrosion rates at less than 1 mil/yr. throughout the testing with the exception of periods when the HXs were either opened or the cooling tower had been placed out of service (Figure 22). These periods were

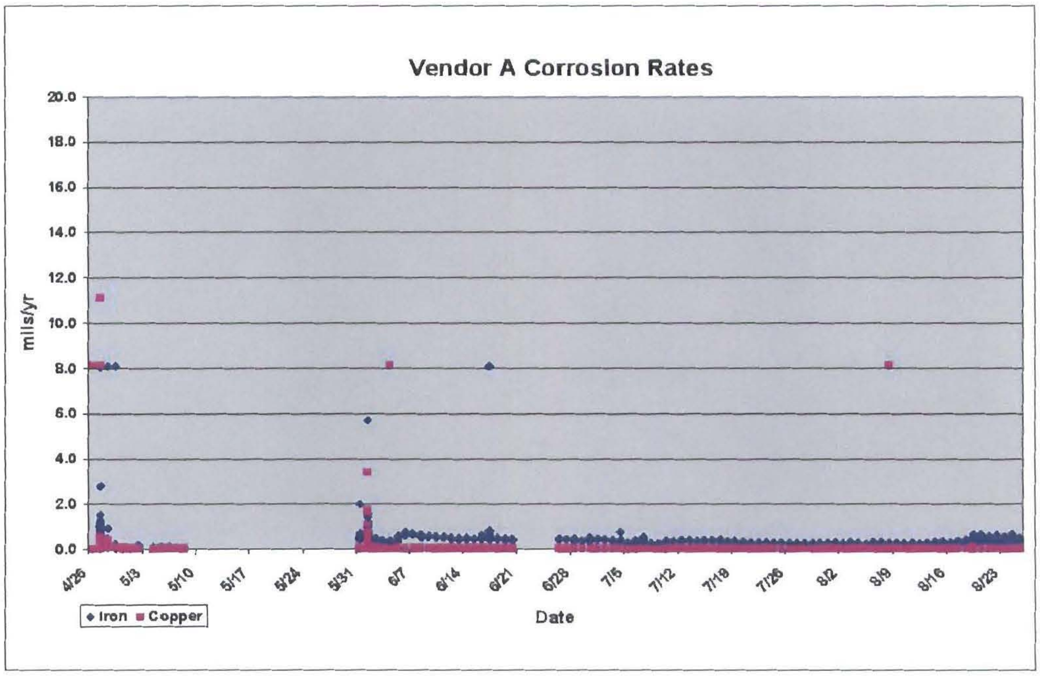

Figure 22: ***Vendor A Iron and Copper Corrosion rates During the Pilot Testing.***

at the start of the pilot, and after the Cerro Grande Fire. The corrosion rate measured during the demonstration of Vendor A is considered excellent by engineering standards.

Regulatory Compliance: Vendor A did not experience excursions of the NPDES Permit standards (see Appendix 3). The Groundwater discharge permit standard for Total Dissolved Solids (TDS) appeared to be slightly elevated during the last week of sanitary reuse trial. The following evaluations summarize the vendor's regulatory performance.

NPDES permit Evaluation - Vendor A controlled the pH of the tower water at 8.5 during the potable trial and 7.9 during the reuse trial where the NPDES discharge standard ranges between 6.0 and 9.0. Mercury, selenium, arsenic, and zinc were non-detectable for most of the potable trial (see Appendix 3 for listing

of LANL NPDES standards and Appendix 4 for Groundwater Standards) and during the reuse trial, arsenic values averaged 0.015 mg/L. Phosphate values during most of the potable trail were non-detect but during the reuse trail averaged 7.7 mg/L. Total residual chlorine during the potable trail and reuse water trial were non-detect. Turbidity measurements were used as a basis to evaluate Total Suspended Solids (TSS) where any turbidity measurement above 10 NTU would be evaluated as a suspect TSS. During the potable trial, turbidity measurements averaged 1.0 NTU. During the reuse trial the turbidity averaged 7.6 NTU. However, the reuse water trucked to the field project site for use by the vendors was averaging 16 NTUs, where the high turbidity in the reuse water was attributed to the extraction point at the sanitary plant. The contractor who trucked the water to the site could only pull the reuse water from a fire hydrant that was never used except during fire hydrant pressure checks. It is believed that the high turbidity was due to biological growth in the line and corrosion particulates that were later discovered to be iron.

Groundwater permit evaluation – The only parameter monitored for groundwater permit compliance was TDS which has a permitted value of 1000 mg/L. During the potable water trial, no TDS excursions were noted. However, during the last week of the sanitary reuse trial, Vendor A appeared to have an elevated TDS average of 1011 mg/L where the high was 1050 mg/L and the low was 967 mg/L.

7.2 Vendor B – Chemical Treatment Performance Summary

Vendor B had a successful demonstration where their testing efforts were supported by individuals from their field and research development offices. Vendor B experienced some operations and maintenance anomalies during the pilot, but was successful in resolving these issues. Environmental compliance was generally good and the vendor was able to reach an average of 75 percent efficiency during most of the potable water trial. However, Vendor B was unsuccessful in demonstrating this efficiency level without fouling heat transfer surfaces. The following subsections describe Vendor B's overall performance during the demonstration.

Operation & Maintenance: Vendor B experienced several problems with both their control and chemical addition systems during the potable water trial. The chemical addition system experienced continual leaks in the concentrated sulfuric acid storage tank (used for tower pH control) during the early weeks of the potable water testing, which caused delays and prompted their hazardous materials team to respond on two separate occasions. Problems with a pH instrument caused a low pH transient within the tower during early testing. During this transient, the control system failed to notify Vendor B staff of the problem. When the problem was discovered, the pH in the cooling tower basin was at a pH value of 3.8 and carbon steel corrosion rates were in excess of 20 mils/yr. Problems with calibrating their pH controller continued for several weeks until the controller was replaced.

Vendor B experienced foaming where the re-circulation water entered the top of the cooling tower and appeared to be caused the addition of excessive chemicals. The foaming problem was addressed by adding a de-foaming agent that corrected the

problem. LANL staff observed that a considerable level of salt on the unwetted tower packing material accumulated on the Vendor B cooling tower. This may have been due to Vendor B's cooling tower being more exposed to windy conditions than the other cooling towers which were somewhat protected by a building wall on the cooling tower fill side.

As the pilot tests proceeded and the variability of the silica levels in the makeup water increased, Vendor B added an instrument to monitor makeup water conductivity. Using this value, Vendor B programmed their control system to compute cooling tower blow down COCs to maintain silica levels at acceptable values in the cooling tower basin. However, the problems noted during the pilot (calibrating their control system, pH excursion, and a continual leak in the sulfuric acid tank) led field personnel to believe that Vendor B's control and chemical containment systems were less user friendly that Vendor A's systems.

Efficiencies Achieved: Vendor B maintained their cooling tower silica levels at an average of 384 mg/L during potable water pilot tests where the total silica level average was 290 mg/L and the reactive silica was 225 mg/L (Figure 23). The computed silica values are based on calcium levels in the makeup and cooling tower water and are estimated to be the true cooling tower basin silica values as compared to field analysis and ICP analysis. Based on a reasonable interpretation of the computed silica values given the computed silica level, Vendor B met the minimum requirement of 75 percent efficiency for this source water.

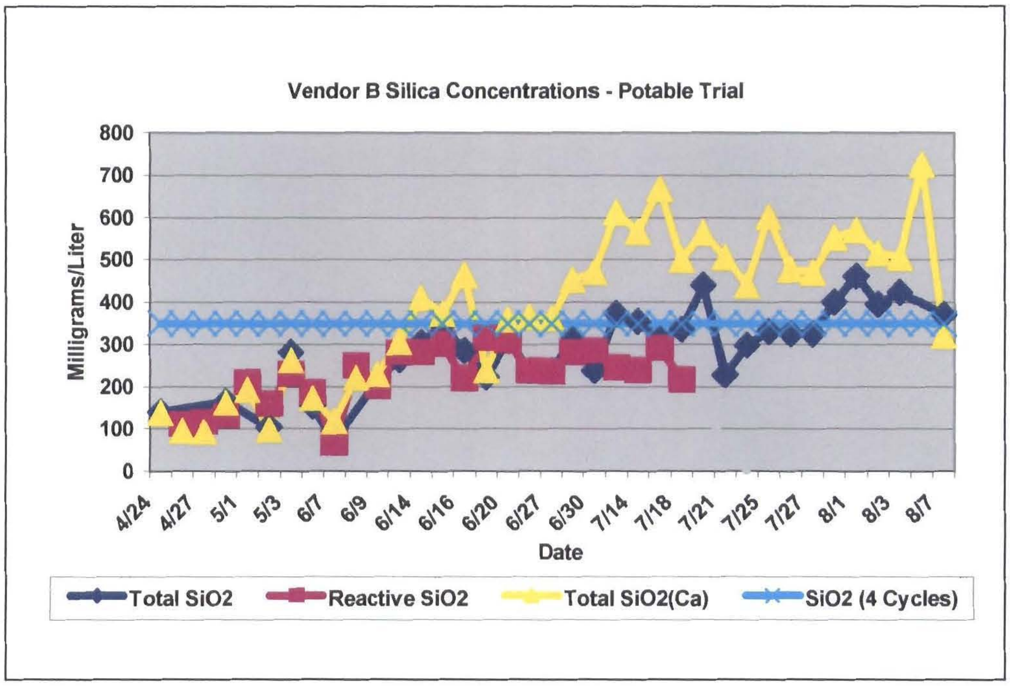

Figure 23: ***Vendor B Silica Levels During the Potable Water Field Trial.***

During the reuse water trial (Figure 24), Vendor B was faced with the same limitations as Vendor A due to high TDS and phosphate.

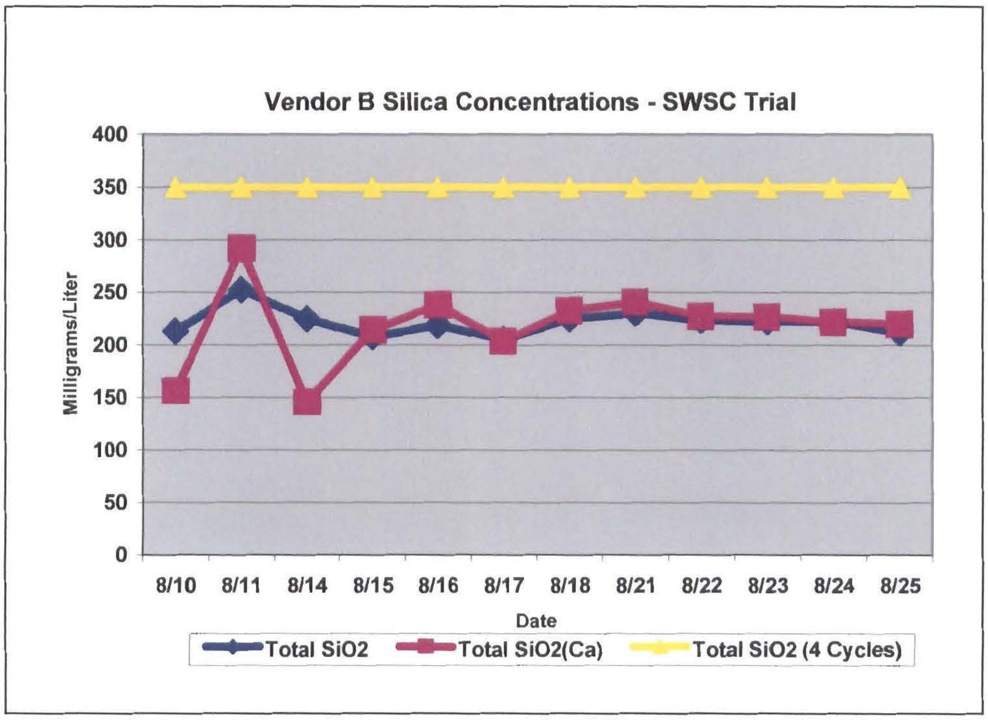

Figure 24: ***Vendor B Silica Values During the Sanitary Reuse Water Trial.***

Therefore, Vendor B chose to operate their cooling tower at a COCs that would ensure they would meet regulatory compliance and favorable conditions that would not induce scaling. Vendor B averaged a computed silica level of 219 mg/L and a total silica level of 222 mg/L or approximately 2.2 COC.

Reliability: Heat transfer coefficients for the cooling tower HX are presented in Figure 25. Figure 25 indicates that directly after cleanings, the heat transfer coefficients improved slightly, but no appreciable difference can be derived from these data and there is no indication that scaling occurred on the Vendor B HX plates.

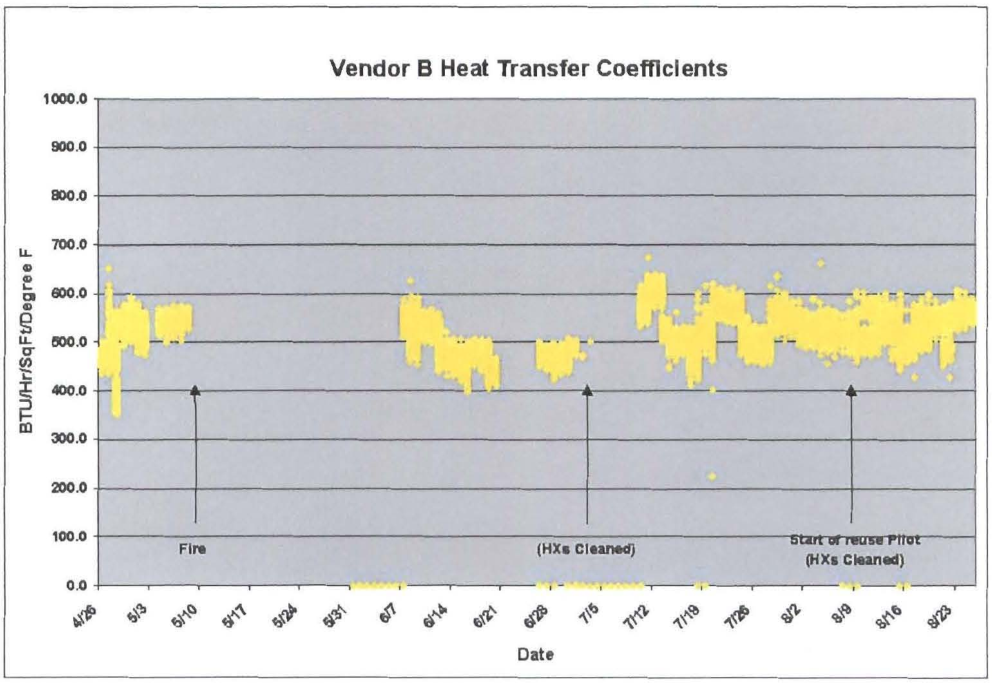

Figure 25: ***Vendor B Heat Transfer Coefficients During Field Trial Test.***

Periodic HX inspections were performed of HX plate surfaces. As can be seen in Figure 26, a significant amount of scaling was deposited and documented during the first inspection of July 5th.

Figure 26: ***Scale on Vendor B Heat Exchanger Plate During First Inspection.***

The scale deposited on Vendor B's heat exchanger plates was opaque and moderately easy to move with a fingernail. Samples were taken for XRD analysis where analysis showed that the solid was 90 percent amorphous silica with 10 percent by weight of gypsum. The soft nature of the scale may be due to a large quantity by weight of gypsum in the scale (See Appendix 2 for XRD analysis).

Figure 27: ***Vendor B Heat Exchanger Plate After First Cleaning.***

The HXs for Vendor B also showed signs of scaling during HX inspection performed on July 19th, August 7th, and August 25th (See Appendix 1). The scaling was most significant during the first inspection, where subsequent inspections showed less scaling. The HX was cleaned after the July 5th inspection (Figure 27), the July 19th inspection, and before the start of the reuse water trial on August 7th (See Appendix 1 for inspection photos).

XRD analysis of deposited scale was also taken after the sanitary reuse trial on August 25th. The results show that the scale was mainly amorphous silica with no other phases detected.

Although Vendor B appeared to be able to meet 75 percent efficiency during the potable trial based on the silica concentration data, the vendor was unable to successfully achieve this efficiency level without depositing significant amounts of scale on the heat transfer surfaces. Therefore, a 75 percent efficiency level using this technology cannot be maintained.

It is reasonable to assume that this vendor could achieve a lower efficiency level (approximately 67 percent efficiency or 3 COC) for potable water where reliability would be increased. The sanitary reuse water as a makeup source would produce a 50 percent efficiency or 2 COC.

Vendor B maintained iron and copper corrosion rates at or below 2 mils/yr. for most of the pilot (Figure 28). However, high corrosion rates were observed during the low pH incident at the start of the potable pilot, after the Cerro Grande fire, and

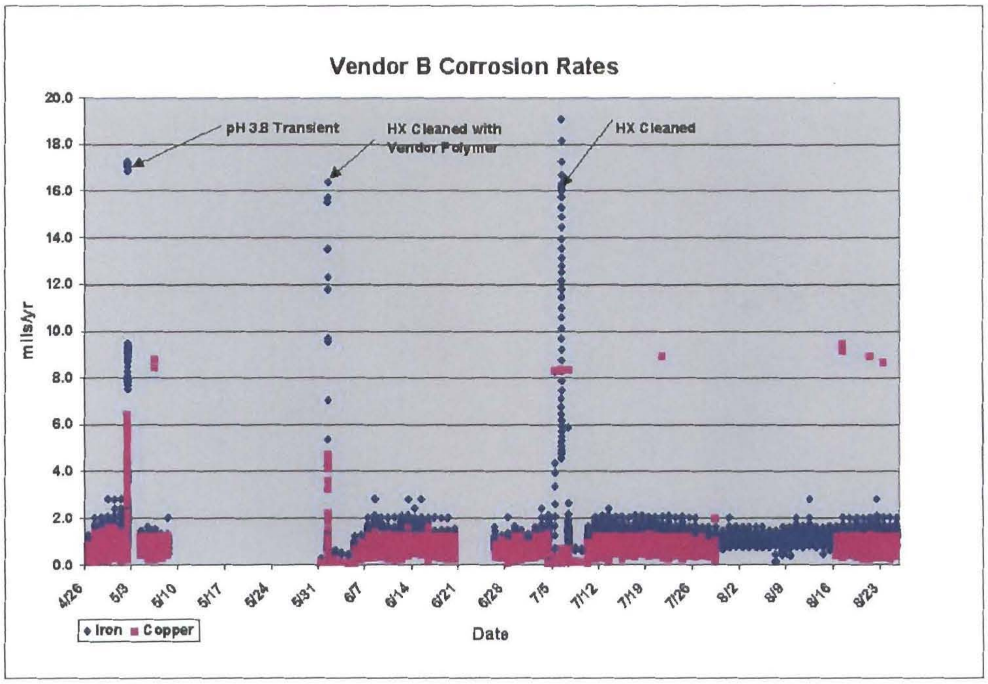

Figure 28: ***Vendor B Corrosion Rates during the Potable and Reuse Field Pilot.***

after the first inspection. Except for the low pH incident, the high corrosion rates may be attributable to exposure to air of the corrator electrodes during HX cleanings.

<u>**Regulatory Compliance:**</u> Vendor B experienced some excursions to the standards enumerated in the LANL NPDES and Groundwater permits. The following summaries explain these excursions.

NPDES permit Evaluation – Vendor B controlled the pH in the cooling tower basin between 8.7 to 7.1 (weekly average) during the entire pilot project. However, when Vendor B lost their pH controller at the beginning of the potable water trial, the pH dropped to 3.8 (NPDES permit standard for discharge range pH 6-9); which constituted a violation of the standard. Arsenic, selenium, mercury and zinc were either below detection or below the regulatory limits (see Appendix 3 for NPDES standards monitored). Phosphate values during most of the potable trial were between 1.9 to 2.3 mg/L (weekly averages), which is also

below the regulatory standard of 30 mg/L. During the sanitary reuse trial, phosphate values were between 12.5 to 9.9 mg/L. Total residual chlorine during the potable and reuse trial was not calculable because the vendor used a bromine-based biocide, which was not detectable by the free chlorine method used during the pilot. However it can be assumed that since they were not adding chlorine, no excursions for total residual chlorine occurred. Turbidity measurements were used as an indication of TSS where any turbidity measurement above 10 NTU would be evaluated as a possible concern. During the potable trail, turbidity ranged between 17. to 1.1 NTU. Although not confirmed, it is believed that Vendor B may have exceeded or come close to exceeding the 40 mg/L TSS limit.

During the reuse trial, the source water was delivered with high turbidity as mentioned in the NPDES section for Vendor A. Therefore, the monitoring of turbidity during the reuse trial could not be used as an indication of TSS. Weekly turbidity averages for Vendor B during this portion of the trial were between 23 to 34 NTU.

Groundwater permit evaluation – During the potable water trial, TDS excursions were noted on June 12th with lab analysis of TDS level of 1149 mg/L, on June 16th where the conductivity meter showed a TDS of 1254 mg/L, on July 3rd where the conductivity meter showed a TDS of 1079 mg/L, and on July 18th where the conductivity meter showed a TDS of 1179 mg/L. During the reuse water trial, no excursions in TDS were noted for Vendor B.

7.3 Vendor C – Silica Precipitation and Filtration Performance Summary

Vendor C was able to remove silica in the cooling tower blow down to their targeted goal of 20 to 25 mg/L during the potable and sanitary reuse trial. Once the water was treated, it was routed to a process water holding tank and was fed to the cooling tower basin as makeup water. Untreated potable or sanitary reuse water was added to the cooling tower basin to makeup for evaporative losses. Vendor C's goal was to keep silica levels in the basin as approximately 120 mg/L. The variability in the silica levels in the potable water made this a difficult task. The following summary provides a narrative of this vendor's performance and reliability.

Operation and Maintenance: Vendor C's treatment plant experienced maintenance and control problems throughout the field pilot. Several incidences of equipment failures (pumps, mixers, and electrical equipment) occurred that limited treatment process time.

Efficiencies Achieved: Vendor C's water treatment performance during both the potable and sanitary reuse water trials showed that silica levels in the cooling tower basin were generally kept below 150 mg/L. (Note: silica levels calculated from calcium levels were not deemed necessary to evaluate Vendor C). During the first few weeks of the potable water trial, Vendor C's treatment process consistently removed the silica to an average of 25 mg/L regardless of the silica levels in the cooling tower blow down returned to the plant for treatment. The total silica level in the cooling

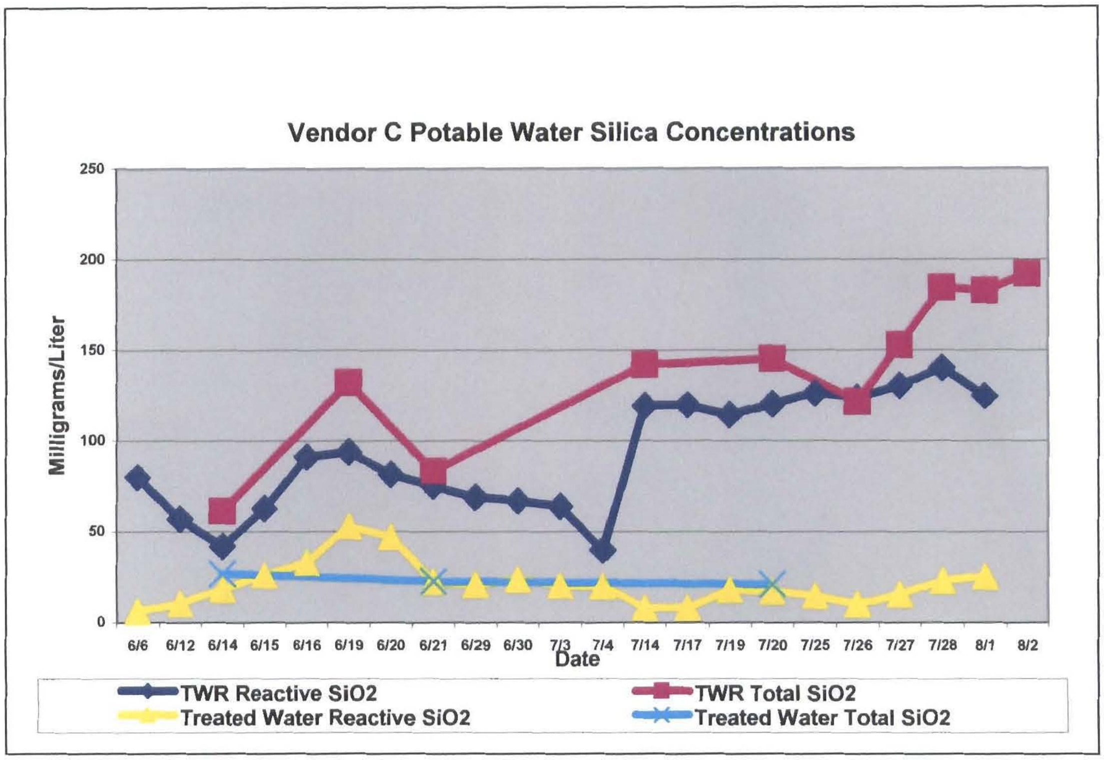

Figure 29: ***Vendor C Silica Removal Performance during the Potable Water Trial.***

tower basin averaged 93 mg/L from June 6th through July 4th, well below the 150 mg/L silica where scaling would become a problem (Figure 29). From July 14 through August 2, Vendor C increased the level of silica removal at their treatment plant where the treated blow down water had silica levels that averaged 16 mg/L. However, even though the silica level in the treated water returned to the cooling towers was lower, the tower basin water averaged 152 mg/L with spikes of 192 mg/L, 185 mg/L and 183 mg/L during this period. The reason for the increase in silica levels in the tower basin water was because of high silica levels in the potable feed water (between 85 to 118 mg/L total silica. The treated recycle flow from the treatment plant to the cooling tower accounted for approximately 40 percent of the makeup flow. Even though Vendor C increased the amount of silica being removed

during the treatment process, the tower basin silica average was higher than vendor C expected and at times exceeded the 150 mg/L-silica level.

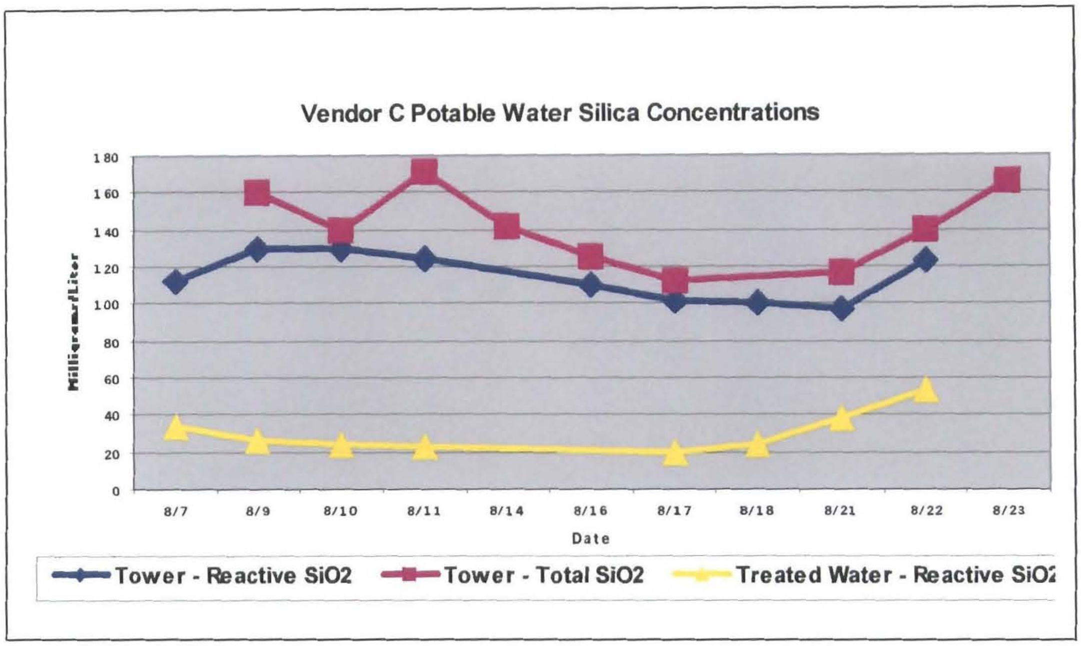

Figure 30: ***Vendor C Silica Removal Performance during the Sanitary Reuse Water Trial.***

During the treated sanitary reuse trial, the silica in the treated blow down water averaged 30 mg/L and the cooling tower basin water averaged 142 mg/L with spikes of over 160 mg/L silica (Figure 30). The sanitary reuse water had less variability in the silica levels and averaged 104 mg/L. This improved Vendor C's process control considerably because the silica level in the makeup water supplied to the tower was more stable. Unfortunately, Vendor C continued to experience equipment failures with seal problems related to their micro-filtration pumping system that was not resolved before the end of the pilot.

The presence of colloidal iron in the reuse water, resulting from corrosion and biological growth caused fouling problems with their micro-filtration system.

The problems experienced by Vendor C during the reuse phase of the project allowed Vendor C to test for only 11 days on this source of water, where they were

able to operate 26 days during the potable demonstration. Vendor C's process does not rely upon conserving water by adjusting the tower blow down to increase the cycles of concentration. Most of the blow down water is treated and reused, thus increasing efficiency of water use in cooling towers to 99 percent.

Reliability: Vendor C chose to treat the blow down water and return it to the cooling tower. This approach required Vendor C to demonstrate that this approach could control the process well enough to maintain the cooling tower silica levels below the values that may cause HX scaling. During the potable water trial Vendor C experienced excursions from the targeted goal of maintaining the cooling tower basin water at or below 150 mg/L silica. Vendor C's heat transfer coefficients were monitored on the cooling tower HX. No strong indication of scaling was evident from the heat transfer data collected during the field trial (Figure 31).

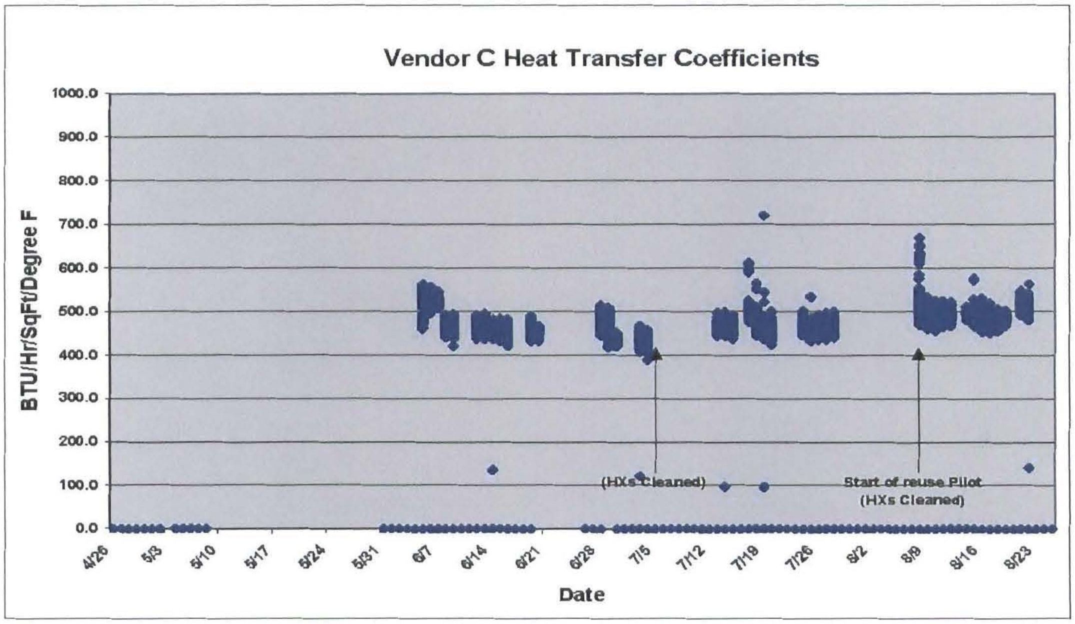

Figure 31: ***Vendor C Heat Exchanger Coefficients during the Field Trial.***

The HX surfaces were inspected three times during the testing of Vendor C's process. Fouling was noted during the inspection performed at the end of the potable water trial on August 2nd (Figure 32). During this inspection, a small amount of

Figure 32: ***Scaling on Vendor C Heat Exchanger Plate.***

beige colored soft material had adhered to the HX surfaces. The field team was unable to determine whether the material was indicative of the early stages of fouling or if this was residue material from a seal failure of the micro-filtration re-circulating pump. The heat exchanger for Vendor C was inspected after this backflow incident and was found to be clean with no evidence of scaling. However, precipitate may not have been thoroughly flushed from their cooling tower system after the incident. The scaling may have been indicative of a small heat transfer coefficient spike recorded between July 6 and July 16 (Figure 33). A solid sample of this scale was not collected for XRD analysis for characterization and therefore the origins of this material cannot be positively identified.

Figure 33: ***Vendor C Heat Exchanger Plate After Cleaning.***

The heat exchanger plates were cleaned after the August 2nd inspection (Figure 33) and the cooling tower was put back into service. The July 5th and August 21st inspections did not detect scale build-up and therefore the heat exchanger plates were not cleaned.

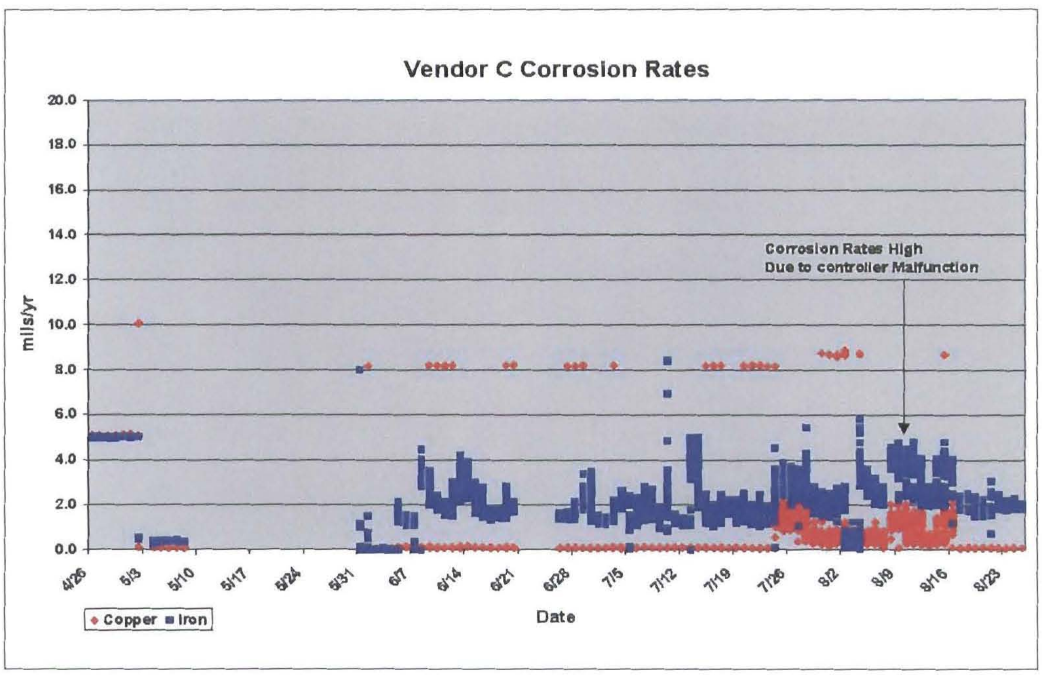

Figure 34: ***Vendor C Corrosion Rates During Field Pilot.***

The data collected for copper and iron corrosion rates were higher than those noted for the other vendors. Iron corrosion rates ranged between 3 to 5 mils/yr. (Figure 34) throughout the pilot testing. Copper corrosion rates were generally less than 1 mil/yr. with periodic spikes as high as 8 mils/yr. These spikes were attributed to the manual addition of biocides to the system by the Vendor C field staff. A period of high corrosion rate activity was noted between July 28th and August 18th. This excursion was caused by instrumentation interface problems with the Vendor C cooling tower control system, which was never installed to be fully operable. The high iron corrosion rates for Vendor C were attributable to high sodium chloride levels present in the cooling tower water as a result of the vendor's silica removal process.

In conclusion, an automated system was not put in place to manage cooling tower blow down levels to ensure that silica values were maintained below 150 mg/L. Although the vendor demonstrated that their process was effective for silica removal and performed well from a chemical point of view, the vendor's ability to control the cooling tower water chemistry was not adequately demonstrated.

Regulatory Compliance: Vendor C operated their treatment process as a zero liquid discharge system throughout the testing. Liquid discharge to a regulated outfall would not be required, therefore analysis of NPDES and Groundwater permit criteria was not performed. However, Vendor C produced solid wastes as a result of their process where the type of solid waste is a regulatory concern for LANL because of storage and disposal concerns. The types of solid waste generated from

Figure 35: ***Vendor C Dewatered Filter Cake.***

Vendor C's process were filter cake (Figure 35) from the micro-filtration process (30 percent water by weight) and evaporator bottoms from the RO reject stream. Both types of solids were sampled as a composite sample after the potable water and after the sanitary reuse trial. A total of four samples (2 evaporator bottoms and 2 filter cake samples) were sent to an independent laboratory for TCLP analysis of metals (Appendix 5). All four samples showed that the solids were not a hazardous waste and could be stored and disposed of as an industrial waste. The estimated yearly solid waste volume for treatment of 360 acre-feet per year of reuse and potable water would be approximately 334 cubic yards/year.

7.4 Vendor D – Silica Reverse Osmosis (RO) Filtration Performance Summary

Vendor D was able to consistently produce a permeate stream with silica concentration of 1 mg/L silica while at the same time demonstrating that their reject stream could be concentrated to 90+ percent. This showed that the water recovery using Vendor D's technology could be maximized in full-scale implementation. Because of the proprietary nature of the vendors pretreatment process, the following evaluation will focus on the vendor's capability to produce a low silica permeate stream without fouling the treatment plant's membranes.

Operation and Maintenance: Vendor D experienced no major operational problems throughout the pilot testing. Their treatment system performed flawlessly except for a minor problem with a pump. However, during the sanitary reuse trial, Vendor D experienced some difficulty with their RO system due to the presence of colloidal iron material. This material fouled their pre-filter unit and required Vendor D to clean their membrane once during the reuse trial. After the pre-filter was replaced and the material was rinsed from the RO membrane, performance returned to normal.

The membrane flux observed during the potable water trial indicated that no signs of membrane fouling occurred during the potable trial. The membrane flux remained within the range of 24 to 31 gallon/feet^2/day where the permeate stream was consistently produced at 0.4 to 0.5 gallon/minute while at the same time the silica concentration in the reject stream increased from a starting point of 158 mg/L to an end point 1442 mg/L reactive silica (Figure 36).

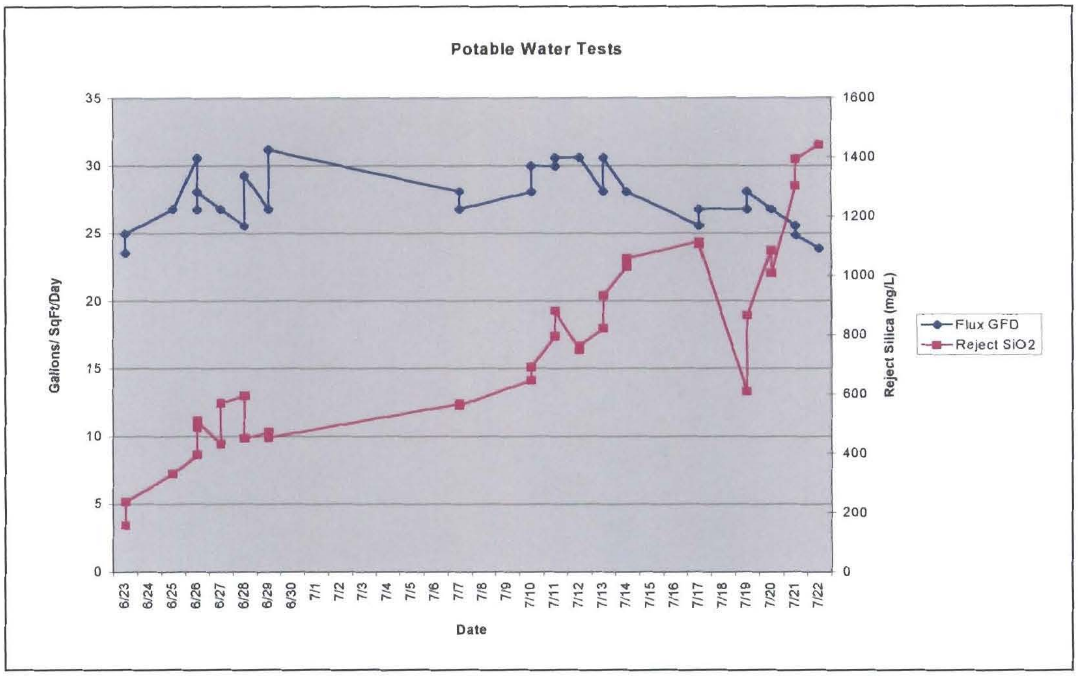

Figure 36: ***Vendor D Membrane Flux During the Potable Water Trial.***

The fluxes observed during the sanitary reuse trial were generally good with the exception of a period of high turbidity water where membrane cleaning was required. As mentioned earlier, the turbidity in the reuse water was attributed to corrosion in stagnant water is not a normal state of this water (generally 1 NTU). The membrane flux remained within the range of 20 to 28 gallon/ feet^2/day, the permeate stream ranged between 0.3 to 0.5 gallon/minute, and the silica concentration in the reject stream increased from a starting point of 122 mg/L to an end point 1070 mg/L reactive silica (Figure 37).

On August 8th the membrane flux dropped to 17.5 gallon/ feet^2/day and the permeate dropped to 0.28 gallons/minute, where upon Vendor D cleaned the membrane element and replaced the systems pre-filter.

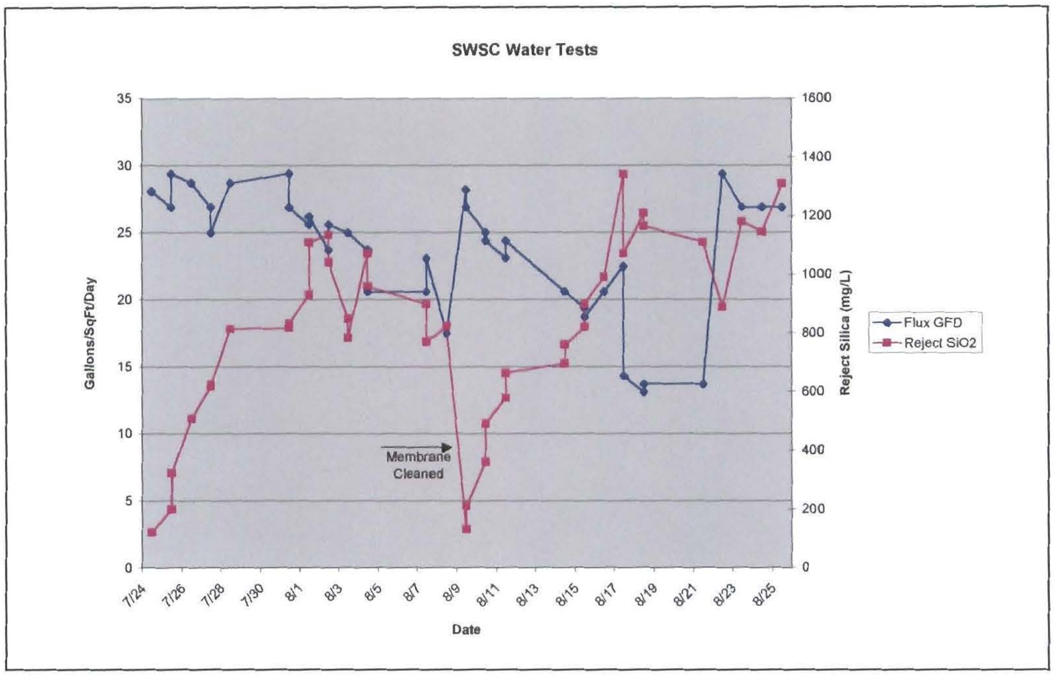

Figure 37: ***Vendor D Membrane Flux During the Sanitary Reuse Trial.***

<u>Efficiencies Achieved:</u> Vendor D's water treatment performance during the potable and sanitary reuse water trials are depicted in Figures 38 and 39. The important

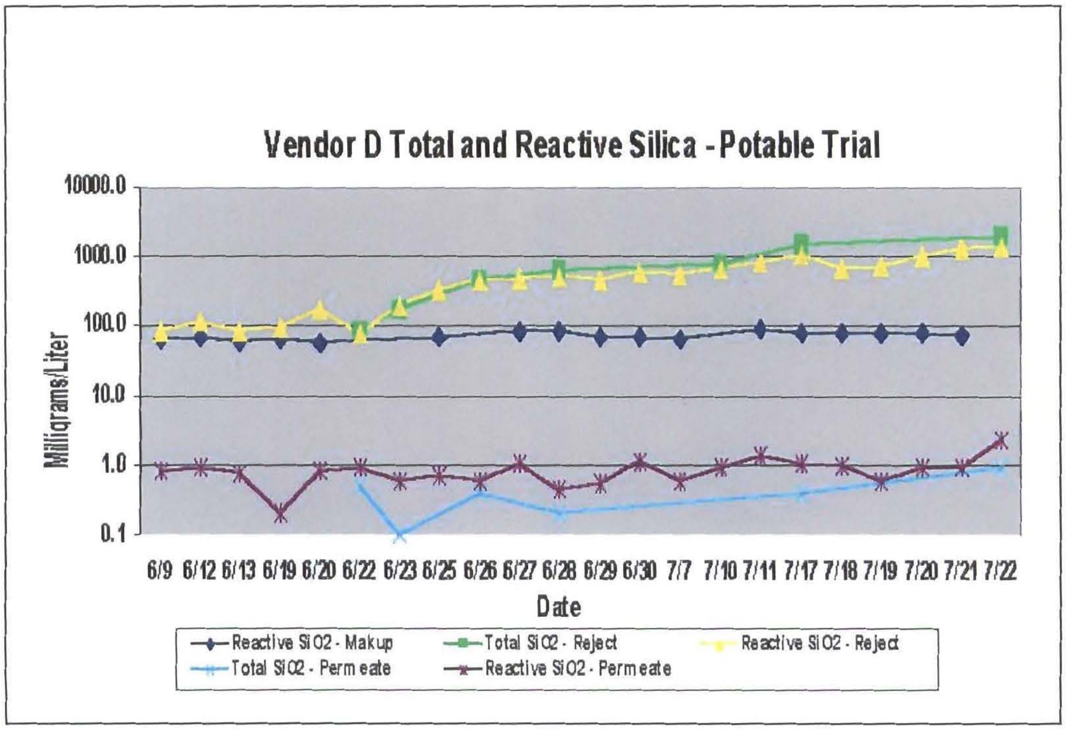

Figure 38: ***Vendor D Silica Concentrations of Permeate and Reject Streams During the Potable Water Trial.***

factors to consider in evaluating Vendor D efficiencies are the silica levels in the permeate and reject streams.

During the potable water trial, the silica concentration in the permeate stream averaged approximately 0.9 mg/L reactive silica and 0.4 mg/L total silica. The silica concentration in the feed water coming into the plant for treatment averaged 73 mg/L reactive silica and the reject stream averaged 548 mg/L reactive silica and 799 mg/L total silica. Concentration of silica in the reject stream ranged from 86 to 1917 mg/L total silica and 85 to 1443 mg/L reactive silica. Based on the average feed water silica concentrations and reject water silica concentrations, the average recovery during the potable testing was approximately 91 percent.

Figure 38 indicates that the total silica and reactive silica closely mirror each other showing that Vendor D was successful in increasing the solubility of silica as part of their pretreatment process.

During the sanitary reuse water trial, the silica concentration in the permeate stream averaged approximately 1.1 mg/L reactive silica. The silica concentration in the reuse feed water entering the treatment process averaged 93 mg/L reactive silica. The silica concentrations in the reject stream averaged 816 mg/L reactive silica. Concentration of silica in the reject stream ranged from 122 mg/L at the beginning of the testing to a high of 1310 mg/L reactive silica (Figure 39). Based on the average

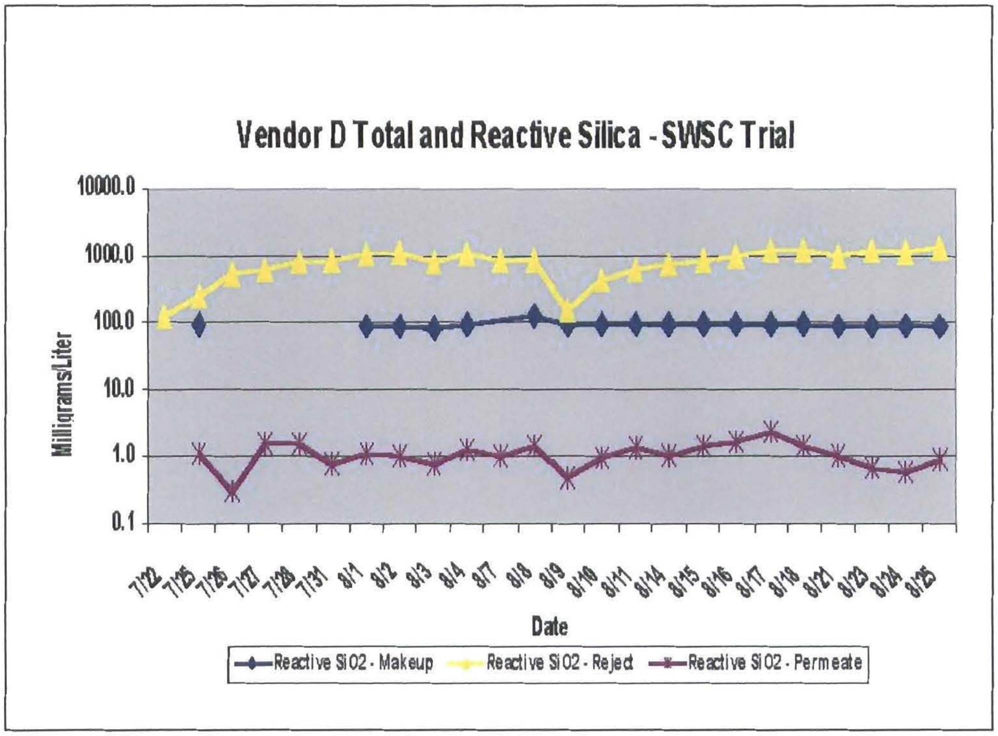

Figure 39: ***Vendor D Silica Concentrations for Permeate and Reject Streams During the Sanitary Reuse Water Trial.***

of feed water silica concentrations and reject silica concentrations, the average recovery during the potable testing was approximately 89 percent.

Based on the recoveries achieved on the feed water and based on the silica concentrations in the permeate stream provided to the cooling towers as makeup water, this process could provide efficiencies of 90+ percent using either potable or sanitary reuse water as its feed source. This efficiency is well above the 75 percent efficiency goal desired during the demonstration pilot.

Reliability: Vendor D was not connected to a cooling tower and therefore exchanger data were not collected. Given the values collected on the permeate stream, silica scaling would be not be an issue with of this technology. The level of softening required for this process is proprietary and will not be presented. However the values

are low enough that calcium carbonate or magnesium hydroxide scaling would not occur.

Corrosion data were not collected and the aggressiveness of this type of water in a cooling tower system or in the piping infrastructure at LANL was not evaluated. This is an important parameter that is missing in the evaluation of this vendor and needs to be addressed if LANL were to implement this technology in a full-scale plant. Secondary waste from softening would need to be evaluated for full implementation. In addition, zero discharge from the process was not demonstrated and therefore the reliability of this type of system was not evaluated.

An evaporator/crystallizer has been proposed by Vendor D to solidify the RO reject to provide zero discharge. However, because of the high silica content in the reject stream, scaling may become problematic when dried in a crystallizer and therefore this type of equipment may not be practical. Because a crystallizer was not tested during the field trail, the reliability and effectiveness of this type of a unit can not be adequately evaluated in this paper.

Except for the indications of membrane fouling during a short period associated with the sanitary reuse trial, the treatment plant did not suffer other problems associated to its reliability.

Regulatory Compliance: Vendor D submitted composite samples for TCLP metal analysis for their reject streams for both the potable and sanitary reuse trials. However, they did not pilot a zero liquid discharge system during the pilot. The following regulatory compliance summary will evaluate their performance for both a

zero liquid discharge plant and a plant that will discharge their reject stream to an NPDES regulated outfall.

NPDES Compliance - Vendor D showed no excursions from the NPDES parameters in its permeate stream for both the potable and sanitary reuse water. However, the pH in the permeate steam ranged from 9.3 to 11.3. LANL did not require the vendor to adjust the permeate stream although in a full-scale plant pH would need to be adjusted before distribution. The reject stream during the potable trial showed no excursions from the NPDES parameters during the potable trial except for pH. Vendor D did not neutralize their reject stream before analysis. However, before discharge to the Los Alamos County sanitary collection system, Vendor D adjusted the pH to meet the regulatory limits. If Vendor D discharged their reject stream to a regulated outfall, they would be required to adjust pH.

During the sanitary reuse trial, data on NPDES parameters were not submitted for laboratory analysis on permeate and reject streams. However, field analysis was performed on a regular basis for phosphates, and turbidity. The permeate stream measured turbidity between 0.1 to 0.35 NTU. The reject stream measured turbidity at ranges between 3.5 to 6.6 NTU. Phosphate analysis for the permeate stream measured between 0.04 and 0.1 mg/L. The reject stream measured between 28.1 and 90.9 mg/L where the phosphate level continued to increase as the reject stream became more concentrated. The sanitary reuse water averages approximately 5 mg/L as phosphorus. Field data indicates that Vendor D could not concentrate their reject stream more than four times before exceeding the

NPDES discharge standard if the reject stream was routed to an outfall. This would allow approximately a 75 percent recovery for this source of water.

Groundwater permit – For both the potable and sanitary field trials, the TDS for the permeate stream was between 10 to 70 mg/L. Concentrating the TDS during cooling tower operations would not be a limiting factor. The highest value obtained for this stream during the pilot (70 mg/L) would allow approximately 13 COC before discharge. However, this is assuming that no other TDS is being added to the tower, which is impractical since other chemicals would be added for microbiological and corrosion control, however these additions would be low concentrations. The reject stream would need to meet the 1000 mg/L TDS limit for discharge to the environment. Vendor D has indicated in their final report that a 75% recovery could be achieved for potable water where the reject stream would meet the groundwater limit and 50 percent recovery could be achieved for sanitary reuse water to meet the discharge requirements.

Solid Waste Requirements – Portions of the RO reject were collected and dried for both potable and sanitary reuse water. The dried samples were analyzed for metals where the results indicated that this waste was not hazardous. The total estimated volume of dried RO reject would be approximately 167 cubic yards per year when processing 500 acre-feet of water per year.

8.0 VENDOR IMPLEMENTATION OPTIONS

All vendors were successful in achieving the minimum requirement of four cycles of concentration during the pilot field demonstrations. However, vendor successes must be qualified based on all data recorded during the testing. The chemical treatment vendors averaged a 75 percent efficiency level stated in the statement of work, but did not adequately meet performance standards in relation to equipment fouling of heat transfer surfaces. Although they did not meet the 75% efficiency level reliably (scale on heat transfer surfaces), their technologies can conserve water over current rates at LANL and will not be excluded from consideration in this report for full implementation. Based on the information gathered, it is believed that chemical treatment could be implemented at targeted cooling towers at a lower efficiency level than required/established in the LANL RFP.

Both of the filtration technologies were successful in demonstrating silica removed from makeup or blow down water during the potable and sanitary reuse trials.

One of the goals of the demonstration project was to show that the approximately 300 AFY of sanitary reuse water produced at the LANL sanitary wastewater treatment plant could be successfully utilized for cooling towers. The water savings in Table 7 assumes full implementation of this water and estimates total water savings and potable water savings per technology in FY 2002 and 2005.

8.1 Chemical Vendor Options

Table 7 estimates what the annual water consumption and water savings could be with the different process implementation options for FY 2002 and 2005, where water consumption, savings and potable water savings are compared against LANLs

Table 7: ***Estimated Water Consumption and Savings at Targeted Cooling Towers for FY 02 & 05.***

	Water Consumption Projections for Targeted Cooling Towers (in Acre-Feet/Year) per Technical Area			
	FY-2002		FY-2005	
	TA-3	TA-53	TA-3	TA-53
Baseline Projection – 50% Efficiency using potable water				
Total Consumption	491	404	797	404
50% Efficiency using potable and reuse water	300 reuse 191 potable	404 potable	300 reuse 497 potable	404 potable
Total Consumption	491	404	797	404
Total Savings	300	---	300	---
Efficiency Goal – 75% Efficiency using potable and reuse water	300 reuse 27 potable	270 potable	300 reuse 231 potable	270 potable
Total Consumption	327	270	531	270
Potable Savings	164	134	266	134
Total Savings	464	134	566	134
Chemical Treatment – Vendor A and B				
50% Efficiency reuse	300	---	300	---
67.5% Efficiency potable	141	299	.368	299
Total Consumption	441	299	668	299
Potable Savings	31	105	429	105
Total Savings	331	105	729	105
Silica Removal - Filtration - Vendor C (2 plants) 90% Efficiency using Potable & Sanitary Reuse	All reuse	All potable	Blend	All potable
Total Consumption	273	224	443	224
Potable Savings	191	180	354	180
Total Savings	518	180	654	180
Silica Removal – Filtration- Vendor D (1 plant) 90% Efficiency using Potable & Sanitary Reuse Blend	Blend	Blend	Blend	Blend
Total Consumption	273	224	443	224
Potable Savings	191	180	354	180
Total Savings	518	180	654	180

present efficiency of 50 percent (or 2 COC) and the under utilization of the sanitary reuse water.

Even though the chemical treatment processes could not reliably achieve 4 COC, they could meet a concentration level of 3.0 COC (67.5 percent efficiency) for potable water and 2.0 COC (50 percent efficiency) for sanitary reuse water without significant scaling and therefore have not been excluded for consideration in a LANL full implementation. By implementation of a piloted chemical vendor technology capable of meeting the above COCs, the FY02 estimated total water use at LANL would be 1540 AFY and in FY05 1767 AFY (Table 7). The FY05 reflects an increase of 105 AFY over the present leased water right earmarked for LANL. However, at present water usage rates where cooling towers only achieve a 2 COC, LANL would use approximately 2000 AFY in FY05 or approximately 340 AFY over the 1662 AFY established as a goal in the LANL SWEIS.

The TA-3 targeted cooling towers (Power Plant, SCC, LDCC, and CCF) have the infrastructure in place to fully utilize the sanitary reuse water. If a chemical treatment process was chosen in Phase II, cooling towers fed reuse water would need to be managed differently than those fed potable water. To fully utilize the reuse water, the cooling towers at TA-3 using this water as a source of makeup would need to be identified and cooling towers using potable water as makeup would need to be identified. This identification is important so that controllers and treatment programs are developed given the makeup water source. By full utilization of reuse water, LANL would immediately realize a 300 AFY savings in potable water use.

Two COC could be achieved with reuse water. Even though this a lower COC than stated in the RFP, the full utilization of reuse water would allow LANL to stay within the 1662 AFY of leased water rights out to FY-2005. Chemical treatment may not meet the long-term goals of water conservation, and could limit future missions at LANL, however, this approach is a lower cost technology and full implementation could be realized within a matter of months. The following options that could be considered at LANL are applicable to both chemical vendors:

Vendor A. Option 1: Contract one of the two chemical vendors to place controllers on all targeted cooling towers. The vendors would supply treatment plans for both reuse water and potable water, and water treatment chemicals from them. The current facility cooling tower operators would manage the treatment program.

Vendor A Option 2: Contract one of the two chemical vendors to place controllers on targeted cooling towers, supply the chemicals, and manage cooling towers a daily to weekly basis. This option would allow the chemical vendors to amend treatment plans as conditions change.

At this time, LANL does not standardize cooling tower operations from facility to facility. By formalizing water treatment, cooling tower operations could be uniformly applied at the targeted cooling towers, and later, throughout the laboratory. This would improve water conservation throughout the Laboratory and could decrease chemical costs by enabling bulk purchases.

By contracting outside management of the treatment programs, tight controls on water treatment programs could be maintained. Applying chemical management at

even 3 cycles of concentration places this technology at its limits of effectiveness and close monitoring would be essential to its success at the laboratory.

8.2 Filtration Vendor Options

Vendor C and D would require centralized plant(s) to treat water for the targeted cooling towers. The following summaries outline the infrastructure and land considerations for implementation of filtration plant(s) at LANL.

Land Availability: Open land available for development at the Laboratory is limited due to the local topography, planned siting of other proposed facilities at LANL, and environmental concerns in undeveloped areas. For example, most of the undeveloped canyon areas within LANL are considered critical habitat for local wildlife.

Infrastructure: A distribution system is in place to supply all of the TA-3 targeted cooling towers with sanitary reuse water. The reuse water is supplied from the sanitary plant (TA-46) by an 8-inch plastic water pipe to a 500,000-gallon holding tank where the water could be distributed to the Power Plant, LDCC, CCF, and SCC. At this time, most of the reuse water is discharged to an NPDES outfall at TA-3. The pumping facility at the sanitary plant can accommodate 600 gallons/minute. Currently, the sanitary plant pumps reuse water to the TA-3 reuse tank 6 to 8 hours a day (season dependent), 7 days a week. TA-53 is approximately 1.2 miles east of the reuse tank at TA-3. A reuse water line was partially run from TA-3 to TA-53 in the early 1990's. However, the line was not completed and the line has not been inspected for several years. Assuming that the line is still serviceable, approximately 9000 feet of water pipe would need to be installed to connect the TA-53 cooling towers to the water from a treatment plant.

The options discussed for Vendor D will assume that the TA-53 line will be completed and one centralized plant could be built to supply all targeted cooling towers with treated water. The Vendor D data in Table 8.1 assumes a zero liquid discharge plant. This assumption is the best value business case for full implementation of an RO technology at LANL and is the best water savings scenario as well. The estimated costs to complete the distribution line to TA-53 and the costs to provide a zero discharge system will be included in the evaluation for this vendor.

Vendor C must collect blow down water, therefore to achieve full implementation at the targeted cooling towers, this technology will require two centralized plants at locations where blow down can be collected from the targeted cooling towers.

Three siting locations for centralized plant(s) to implement Vendors C and D have been identified at TA-3, TA-53, and TA-46. The following options outline the Vendor C and D filtration options that could be considered at LANL:

Vendor C Option: Two zero discharge plants at TA-3 and TA-53 to treat blow down. The Vendor C plants would not require additional space outside of the estimated 100'x100' footprint. The siting of a TA-3 plant has been tentatively identified at LANL's old sanitary wastewater treatment plant. This siting location is within ¼ mile of the power plant where the reuse line could be connected to the plant for distribution of the treated blow down water. This site has not been identified for future development at LANL. It is now designated as a solid waste management unit (SWMU) and would require extensive demolition because the old treatment plant tankage and associated equipment would need to be removed. Infrastructure costs to install blow down collection lines and treated water distribution lines have been tentatively estimated. Lift stations to distribute the treated water would need to be put in place because of elevation changes at TA-3. Due to sitting limitations within TA-3, locating a plant closer to the reuse line and closer to a point of blow down collection is not possible.

At TA-53, a plant site has not been formally identified; however there does not appear to be limitations on space availability close to the targeted cooling towers. At TA-3 and 53, lines to collect blow down water and to distribute treated water would need to be installed. Lift stations to either collect or distribute the blow down or treated water would need to be put in place because of elevation changes at TA-53. The targeted cooling towers at TA-53 are located close to one another and the infrastructure costs should not be significant.

Vendor C has estimated that 4 FTE would be required to operate two plants at TA-3 and TA-53. Vendor C has estimated that to provide two plants at LANL, delivery and installation of the plant equipment would require approximately 1 year. Time and cost estimates provided to LANL by Vendor C do not include plant construction costs or infrastructure costs. LANL has contracted an engineering firm to develop LANL infrastructure and constructions costs but this study has not been completed. However, a construction engineer has developed tentative cost estimates for TA-3, TA-53, and TA-46 plant sitings and will be the cost estimate basis (Appendix 6) used in the following evaluation sections of this report.

Vendor D Option: Locate a centralized treatment plant at TA-46 to treat makeup. The plant would be developed as a zero liquid discharge plant where the RO reject stream would be diverted to crystallizer or some other alternative to achieve zero liquid discharge. The permeate stream would be sent to the 500,000 gallon reuse pond located at TA-46 for distribution to the 500,000 gallon reuse tank at TA-3 and then distribution to the targeted cooling towers. The LANL siting committee has reviewed the TA-46 site and has stated that development at this proposed site is desirable. There are two possible open areas at TA-46 where the plant could be located and no demolition would be required. An added

advantage to placing a plant at TA-46 is that after the targeted cooling towers at TA-3 and TA-46 are connected to the treated water, other LANL facilities along the reuse line corridor could be supplied with this source of treated water.

A centralized plant could be located at the TA-3 site considered in the Vendor C option. Infrastructure costs and demolition costs to prepare the site may be significant and will not be considered as a separate option in this paper. Other disadvantages to development of the TA-3 site would be that LANL would lose the use of the 500,000-gallon reuse pond at TA-46 as a source of storage. Additionally, the TA-46 treatment plant has qualified water and wastewater operators and is manned 8 hours a day, 7 days a week. If the treatment plant were located at TA-3, LANL would lose some of the advantages associated with having a facility that was already manned with qualified personnel on a daily basis.

A centralized plant at TA-53 was not considered for Vendor D because the infrastructure and energy costs for this siting would be prohibitive. Two centralized plants at TA-3 and TA-53 were also not considered because of cost considerations.

Vendor D did not estimate the man-hours associated with operation of a centralized plant. LANL has estimated that 2 FTE would be required. However, the man-hours associated with daily operations and maintenance would depend on the type of zero liquid discharge system that would be utilized and volume of water treated. Vendor D has estimated that to provide a fully installed plant at LANL, they would require approximately 1 year for development, delivery and installation of the plant equipment. Time and cost estimates provided to LANL do not include plant construction costs or infrastructure costs and have been tentatively developed by a

LANL construction estimator. Vendor D has indicated that they offer process plant modular units that may have the potential to greatly reduce construction costs.

9.0 EVALUATION PROCESS

This section describes matrices developed to provide a mechanism for performing an objective evaluation of each vendor and to evaluate the implementation options considered per vendor. The comparison matrix includes evaluation criteria that have been assigned weighting factors that were used to evaluate the implementation options.

9.1 Evaluation Criteria for Water Treatment Technologies

The following evaluation criteria are based on the needs stated in the contracts statement of work, experience gathered during the field pilot project, the immediate needs at LANL, siting considerations, environmental compliance considerations, and the information provided by LANL personnel and the vendors. Table 8 presents the weighting factors that were identified by the writer and were be used to evaluate each option.

Table 8: ***Water Treatment Technologies Evaluation Criteria and Weighting Factors.***

Criterion	Weighting Factor
Water Conservation Efficiency	15
Regulatory Compliance	10
Delivery	10
Turn-Key System Cost	8
Operational Cost	10
LANL Construction/Infrastructure Cost	10
Size/Location	10
Operability	10
Previous Experience	2
Maintenance	5
Secondary Waste Production	5
Project Risks: Environmental, Safety, and Health	5
TOTAL	**100**

Water conservation was given the highest weighting factor. The second highest weighting considered whether the technologies could successfully operate at LANL given the regulatory compliance framework. The third highest weighting factors considered were the vendor costs of a fully installed treatment plant, annual operational costs, ease of operation, and secondary wastes generated as a result of the technology. The lowest weightings were given to criteria that were considered to realize a lower yearly dollar expenditure by LANL.

Each vendor option was evaluated with respect to each criterion. A raw score of 0 to 5, with 5 being the best, was assigned. The raw score was then multiplied by the weighting factor to obtain the weighted score. The highest overall weighted score identified the preferred alternative. The evaluation methodology is specific to this paper and was not the method used by the Laboratory to evaluate the technologies demonstrated during the field project.

9.1.1 Water Conservation Efficiency

Water conservation is a long-term solution for the Laboratory to meet current and future needs, and to decrease the impact LANL operations has on the environment. Cooling towers at the Laboratory are the single largest users of water. Increased cooling tower efficiency is needed to permit LANL to meet its long-term water conservation goal. .

Raw Score	Description
5	Greater than 90% efficiency
4	80-89% efficiency
3	70-79% efficiency
2	60-69% efficiency
1	55-59% efficiency
0	Current Baseline of 50% efficiency

9.1.2 Regulatory Compliance

The vendors were required to prove their ability to operate within the Laboratory's regulatory compliance framework. Specifically, the process could not cause an excursion of the LANL NPDES or Groundwater permits. The raw score reflects the vendors' regulatory compliance during the field pilot project.

Raw Score	Description
5	Within regulatory compliance at all times
4	N/A
3	N/A
2	1 exceedance
1	2 exceedances
0	Greater than 2 exceedances

9.1.3 Delivery

The rapid installation of an operating system is a critical criterion because LANL is close to exceeding its allotment of 1662 acre-feet/year of water rights that it leases from the County. The average water usage at the Laboratory has been 1500 acre-feet/year. The delivery rankings are based on the need for LANL to provide water conservation. They are based on the delivery information provided by the vendors for a reasonable duration for procurement, design, fabrication, installation and startup.

Raw Score	Description
5	Less than 3 months
4	4 to 6 months
3	6 to 12 months
2	12 to 14 months
1	greater than 14 months
0	N/A

9.1.4 Installed System Cost

A return on investment was not the most important factor in determining which vendor or vendors will be chosen for the second phase of the contract.

However fiscal implications are very important and are reflected in the raw score. The data used to evaluate this criterion are based on estimates supplied by the vendors, where the actual estimates are considered proprietary information.

Raw Score	Description
5	Installed system less than $500,000
4	Installed system less $1,500,000
3	installed system less $2,500,000
2	installed system less $3,500,000
1	installed system less $4,500,000
0	installed system greater than $4,500,000

9.1.5 Operational Costs

Annual operations costs include the cost of water treatment and the man-hours required to operate the plant. Maintenance costs are included as a separate criterion and the rationale for this decision will be discussed in the maintenance sub-section. This criterion received a high weighting factor because these costs obviously must be incurred by the Laboratory on a yearly basis. The cost data used to evaluate the implementation options were supplied by the vendors.

Raw Score	Description
5	Annual operational costs less than $450,000
4	Annual operational costs less than $650,000
3	Annual operational costs less than $850,000
2	Annual operational costs less than $950,000
1	N/A
0	Yearly operational costs greater than $950,000

9.1.6 Construction and Infrastructure Costs

Construction and infrastructure costs to support an installed system are limited to the budget allotted. The data used to evaluate this criterion are based from best engineering estimates. The project is now in the process of conducting an

engineering evaluation to determine these costs. However, these data will not be available until mid to late February 2001.

Raw Score	Description
5	No Construction or infrastructure costs
4	Construction and infrastructure costs less than $500,000
3	Construction and infrastructure costs less than $1,000,000
2	Construction and infrastructure costs less than $1,500,000
1	N/A
0	Construction and infrastructure costs greater than 1,500,000

9.1.7 Size/Location

This criterion relates to the process equipment/plant footprint and the siting locations available for treatment system(s). Vendors A and B will require little room for their controller system and chemicals. Vendors C and D will require formal siting of one or several plants in centralized locations. Given that available siting locations at LANL are limited, a high weighting was assigned to this criterion and the raw scores reflect the limitations of land availability faced by LANL.

Raw Score	Description
5	No siting requirements will be needed
4	Fits within existing facility footprint with minimal modifications
3	N/A
2	Fits within existing facility footprint with significant modifications
1	Requires siting at two facilities with minimal modifications
0	Requires siting at two facilities with significant modifications

9.1.8 Operability

Operability refers to the ability of a process to function without expenditures of resources. Options that can operate passively without extensive intervention by operations personnel would be preferred over options that require constant operator attention or complex automation. Likewise, processes that minimize the

use of resources such as energy and chemicals and which are easy to maintain on a daily basis would be preferred over energy intensive options with significant operational personnel intervention.

Raw Score	Description
5	Passive option with minimal resource consumption; requires minimal operator intervention.
4	Passive option with minimal resource consumption; requires moderate operator intervention.
3	More complicated option with minimal to moderate resource consumption; requires minimal operator intervention.
2	More complicated option with minimal to moderate resource consumption; requires moderate operator intervention.
1	Highly complicated option with minimal to moderate resource consumption; requires moderate operator intervention.
0	Highly complicated option with moderate to high resource consumption; requires significant operator intervention.

9.1.9 Previous Experience

Proven technologies are more desirable for incorporation into production-scale facilities than technologies or vendors with little experience. This criterion applies a higher raw score to established and proven technologies, or technologies that have been demonstrated on a similar scale. This criterion relies heavily on previous experience of the vendors under similar conditions as found at LANL and relies little on the experience gained during the demonstration pilot

Raw Score	Description
5	Demonstrated on similar "silica" water conditions and application and at same scale in multiple applications.
4	Demonstrated on similar "silica" water conditions and application and at same scale in several applications.
3	Demonstrated on similar "silica" water conditions and application, but at different scale.
2	Demonstrated at pilot or laboratory level only.
1	Development level only.
0	Works on paper.

9.1.10 Maintenance

Maintenance activities refer to off-normal activities where the technology option requires system adjustments to the vendor equipment or to facility equipment such as cooling tower heat exchanges that are resultant of activities from the vendor system process. The options associated with Vendors A and B might require cooling tower cleanings of the basin, cooling tower fill, and heat exchangers as a end result of upsets due to their chemical treatment plans or as a result of controller failures. Vendors C and D plant system equipment may require extensive maintenance due to equipment failures. The raw scores are based on the potential for maintenance requirements, their ease of maintenance as observed during the pilot test, and from other general data available on vendor technology systems, and if the system process itself has the potential to require significant maintenance, where minimal maintenance is defined as <3 hours/week, moderate is defined as < 6 hours/week, and high is defined as > 6 hours/week.

Raw Score	Description
5	Option would require minimal routine and/or non-routine maintenance to system process equipment or to associated facility equipment where maintenance could not effect facility operations.
4	Option would require minimal routine and/or non-routine maintenance to system process equipment or to associated facility equipment where maintenance would have minimal impact on facility operations.
3	Option would require moderate routine and/or non-routine maintenance to system process equipment with minimal impact to facility equipment and facility operations.
2	Option would require moderate routine and/or non-routine maintenance to system process equipment with minimal impact to facility equipment and a moderate impact to facility operations.
1	Option with high maintenance requirements for routine and/or non-routine system process equipment with minimal impact to facility equipment and a moderate impact to facility operations.
0	Option with high maintenance requirements for routine and/or non-routine system process equipment with high impact to facility equipment and facility operations.

9.1.11 Secondary Waste Production

The final waste form from a treatment process must either meet the appropriate requirements for discharge to a permitted outfall, or in the case of a solid waste, whether a hazardous waste is generated. Some wastes may have additional desirable characteristics, such as ease of handling, and small volumes. Chemical treatment options will produce a liquid secondary waste that would discharge to a regulated outfall where the volume of waste produced would be large. Filtration technologies have the potential to decrease or eliminate the liquid discharges but would produce solid wastes that may require additional handling. Raw scores for this criterion reflect the comparative quality, ease of handling, and volume of the final waste forms.

Raw Score	Description
5	Small volume, no additional treatment, and easily handled.
4	Moderate volume, no additional treatment, and easily handled.
3	Small volume, waste requires minimal additional treatment.
2	Moderate volume, waste requires minimal additional treatment.
1	Large volume, waste requires minimal additional treatment.
0	Moderate to large volume, waste requires significant treatment.

9.1.12 Project Risks - Environmental, Safety, and Health

There are many intangible factors other than those presented which could affect the decision making process. These factors are primarily related to overall project risk, and in and of themselves, may not discriminate between alternatives. However when these factors are considered collectively, they may affect the decision making process. The factors considered include the following:

- ***Accident scenarios*** - Highly complex processes that require extensive maintenance could increase the potential of workers to accident scenarios or to hazardous chemicals. Risk can also relate to the potential for releases to the environment of wastes that do not meet regulatory standards due to system upsets or equipment failures. Use of hazardous chemicals such as acids, bases, or corrosives increase the risk to worker safety or to accidental spills.
- ***Flexibility*** - An important consideration is the ability of the option to maintain regulatory compliance during upset conditions and maintain safety conditions in facility operations. This could be addressed in the ease of applying redundant systems within the process, the ability to alter treatment processes due to changes in feed water conditions into the cooling tower itself or into the treatment plant, and changes by LANL for production of treated water or ease of changing the treatment capacity of the plant, where the ease of transition and operations would be highly desirable.
- ***Implementability*** – Some options may be more difficult to implement than others due to factors such as EAs that must be performed due to negative public perception where the process of adequately addressing these concerns could take years. This type of delay could have negative effects on an implementation option where the negative effects would be seen in integration of plant design, procurement of system, construction of system or construction of the infrastructure needed, and installation and start-up delays/costs. For example zero liquid discharge may have a negative public perception issue due to less discharge into canyons where critical habitat areas could be the end consequence. However, it could also have a positive effect where no waste would be discharged to the environment due to the option implementation. Integration of all phases from design to startup must be considered when choosing a process and an option. The project risk criterion rationale and raw scores were established with the above factors taken into consideration.

Raw Score	Description
5	Low risk – simple process, no potential for off-normal discharges to the environment, public perception expected to be positive, ease of integration is expected in all phases.
4	Low risk – more complex process, no potential for off-normal discharges to the environment, public perception expected to be positive, environmental impacts expected to be positive, ease of integration is expected in all phases, accident scenario is expected to be low.
3	Low to Moderate risk – simple process, low risk for off-normal discharges to the environment, public perception expected to be positive, ease of integration is expected in all phases.
2	Moderate risk – more complex process, low or higher risk of off-normal discharge to the environment, some public relations effort needed, environmental impacts may have negative response associated with it, ease of integration is expected in all phases.
1	N/A.
0	High risk - more complex process, low or high risk of off-normal discharge to the environment, public perception is expected to be negative, environmental impacts will have negative response associated with it, ease of integration is not expected.

The options outlined in Section 8, and the criterion, weighting factors, and raw scores outlined in this section were used to evaluate each option, where each option received an overall raw score and ranking as compared to the other vendor options given the same criteria.

10.0 SUMMARY OF EVALUATION

The options evaluated below encompass the full implementation of all targeted cooling towers addressed in the LANL RFP. The scoring of each option is summarized in the Chemical Vendor and Filtration Vendor subsection tables with a brief description of the scoring. High total scores indicate options that are more desirable for full scale implementation.

10.1 Chemical Vendor Option Evaluations

The full implementation of a chemical treatment water management program at all targeted cooling towers is the first option evaluated. This option would require the vendor to place control systems, chemical delivery systems, and supply chemicals and programs to the targeted cooling towers.

It should be pointed out that the first option summarized would continue the current practice at LANL where facility management staff are responsible for applying water treatment programs within their facilities. They would be using a new silica polymer, but it is unclear that this factor would change present operational practices of achieving 2 COCs. The second option is identical to the first except vendor personnel would apply the water treatment programs to the cooling towers instead of facility management staff.

Both Vendor A and B have similar programs for controlling scale deposit on cooling tower surfaces and showed similar performance. Vendor A showed the best overall chemical treatment program where their reliability and environmental risks appeared to be better. Preliminary cost information for operational costs provided by Vendor A and B also show Vendor A to be the best value procurement for the

Laboratory. Because the technologies are similar and because Vendor A's overall results and costs appear to be more favorable, the following summary evaluation matrix will present the Vendor A data as the best management case.

The summary evaluation matrix (Table 9) shows that chemical management applied by vendor personnel scored higher than a chemical management program applied by facility management personnel.

Table 9: ***Evaluation Matrix for Water Conservation by Chemical Treatment.***

		Vendor A: Option 1 – Facility Teams Applying Chemical Management		**Vendor A: Option 2 – Water Professionals Applying Chemical Management**	
Criteria	**Weight**	**Raw Score**	**Weighted Score**	**Raw Score**	**Weighted Score**
Efficiency	15	0	0	1	15
Regulatory Compliance	10	5	50	5	50
Delivery	10	5	50	5	50
Turn-Key Costs	8	5	40	5	40
Operational Costs	10	0	0	0	0
Construction/Infrastructure Costs	10	5	50	5	50
Size/Location	10	5	50	5	50
Operability	10	4	40	5	50
Previous Experience	2	4	8	5	10
Maintenance	5	2	10	4	20
Secondary Waste	5	2	10	2	10
ESH risk	5	2	10	3	15
TOTAL	**100**		**318**		**360**

Vendor A (option 2) scored higher for efficiency because vendor personnel would be more experienced at responding to changes in water quality conditions and where experience in responding to these changes would achieve an overall higher efficiency level. Facility management personnel would be more inclined to find a consistent level of blow down for cooling towers to ensure ease of daily operations, which is the current approach of operational teams.

Regulatory compliance scored the same for both Vendor A options but the rationale had different reasons for this scoring. For Vendor A (option 1), facility personnel would set their blow down at a safe level that would be consistent to meet permit standards and may not perform daily or weekly operational samples, where the vendor's goal would be for maximum water efficiency and permit compliance. With Vendor A (option 2), vendor personnel would be under contract to develop a daily operational sampling program and controller system check to ensure they are maximizing water efficiency and at the same time maintaining regulatory compliance.

Delivery and costs for an installed system scored high for both Vendor A options because control systems and treatment chemicals to implement this type of program are off-the-shelf items and would not require time for fabrication, assembly, and testing of specialized equipment. The costs for an installed system are low for the same reason in that the equipment is not specialized.

Operational costs include yearly chemical costs and man-hour costs and both Vendor A options scored low for this criterion. It is anticipated that the man-hours dedicated to water treatment by facility management in Vendor A option 1 would be less than Vendor A option 2 because they would not be dedicating personnel to perform daily testing and adjustments, however the cost of chemicals would increase because they would be blowing down more often and would need to add more chemicals. Vendor personnel scored low in this category due to increased man-hours to apply a comprehensive water treatment program at each targeted cooling tower.

Both Vendor A options scored high for size/location and LANL construction/ infrastructure costs. Process, based on chemical control, will require little space for

system equipment and will not incur major construction costs. All of the targeted cooling towers already have some type of control system and chemical storage space associated with chemical management. It is assumed that these systems will only require upgrades and the chemical storage/delivery system space requirements will not change or will not change significantly.

Both Vendor A options scored high for operability where Option 2 scored slightly higher. This is due to vendor personnel having direct experience with their control systems and chemical treatment programs. Facility management staff also have experience with cooling tower water treatment, but would need to be trained on the new water treatment plans and learn how to operate the vendor supplied control system. Vendor A has experience in applying their treatment plan to large cooling tower systems across the United States as well as having specific experience in applying their treatment plan on major cooling tower systems at LANL. Therefore, Vendor A Option 2 scored higher than Option 1.

Vendor A Option 2 received a higher score than Option 1 in the maintenance criterion because vendor personnel have much more experience working with their chemical control system than facility personnel. This criterion also relates to other maintenance activities to the cooling towers and their associated heat exchangers. Option 2 would have vendor personnel sampling and adjusting the system on a daily basis, where Option 1 would be left to run for days, and possibly weeks without facility personnel running checks on the system, taking operational samples, and making appropriate adjustments to the system. Therefore, by having a water treatment professional looking at the system on a daily basis, it is believed that

changes to the system that could cause harm to the cooling tower system would be addressed much earlier and corrective actions could be taken before the system was impacted to the point of having system shutdowns.

The secondary waste criterion was scored low for both Vendor A options and is based entirely on the volume of waste discharged to the environment. The cooling towers would continue to blow down their systems to a regulated outfall, where little change to the total volume of discharge is expected with the application of this technology. The waste discharged is liquid wastewater where the discharge stream must meet the NPDES and Groundwater permit standards. If the waste does not meet the NPDES parameter and this discrepancy is caught before discharge, typical problems such as a high TSS, high chlorine, pH outside the 6-9 range, and some cases of high TDS, can be treated by LANL personnel.

Vendor A Option 2 scored slightly higher for the program risks criterion. Chemical management is currently applied for scale, corrosion, and microbial control and public perception problems will not be an issue. Both options would also be easy to implement, where Option 2 would be slightly easier because there would be minimal or no LANL personnel training involved. However, both options have a median to low score for this criterion because of the risk of accidents. Specifically, because this technology will require that moderate levels of liquid discharge to the environment be released on a daily basis, an upset condition is possible where the discharge does not meet one or more of the LANL permit standards. Option 2 scored slightly higher because vendor personnel would be taking operational samples daily and therefore would be more cognizant of upset conditions.

Overall Vendor A option 1 had an overall score of 318 and option 2 had an overall score of 360 after applying the criterion, weighting factors, and criterion raw scores.

10.2 Filtration Vendor Turn-Key System Options

The evaluation table summary below scores main treatment plant(s) for full implementation of options considered for Vendor C and D. These options would require the construction of a treatment plant(s), the placement of infrastructure for plant connections for collection and distribution of feed water and treated water. These options will also require the procurement of Vendor C or D plant equipment and installation.

The first option will consider the Vendor C option of two plants at TA-3 and TA-53. The second option will consider a centralized plant offered by Vendor D at TA-46. The approach for Vendor C and D is to supply treated water to cooling tower to allow the cooling towers to operate without the concern of silica scaling on cooling tower heat transfer surfaces. Vendor D did not demonstrate a zero liquid discharge system but has quoted prices for a crystallizer unit where the price of this unit would be approximately $1,000,000. The cost for the crystallizer unit will be incorporated into the plant equipment costs and be used as the basis to fully evaluate Vendor D's implementation technology. The RO process could be implemented at LANL as a closed loop system where the cooling tower blow down could be routed to the sanitary plant collection system after a maximum number of cycles. This closed loop configuration will be the basis of the evaluation for this option.

The summary evaluation below (Table 10) shows that an RO process option scored higher than the micro filtration option. This is mainly due to the costs associated with the required construction of two plants for Vendor C. The author has used the costs provided by the Vendors as the basis for the cost information. In phase II of this project, the costs for Vendor C and D may be different than the preliminary numbers provided in previous vendor documentation.

Table 10: ***Evaluation Matrix for Water Conservation by Filtration.***

		Vendor C: Micro Filtration Option		**Vendor D – RO Option**	
Criteria	**Weight**	**Raw Score**	**Weighted Score**	**Raw Score**	**Weighted Score**
Efficiency	15	5	75	5	75
Regulatory Compliance	10	5	50	5	50
Delivery	10	2	20	3	30
Turn-Key Costs	8	0	0	3	24
Operational Costs	10	4	40	5	50
Construction/Infrastructure Costs	10	0	0	3	30
Size/Location	10	0	0	2	20
Operability	10	1	10	3	30
Previous Experience	2	3	6	5	10
Maintenance	5	1	5	3	15
Secondary Waste	5	4	20	2	10
ESH risk	5	2	10	2	10
TOTAL	**100**		**236**		**354**

Vendors C and D scored equally high for efficiency and regulatory compliance because both technologies can provide an efficiency level of 90 percent or higher and because they did not exceed regulatory compliance parameters during the testing for their solid waste and/or liquid waste.

Vendor D scored slightly higher in the delivery criterion because they have the capability of building and delivering skid mounted RO filter bank units in trailers where this approach could decrease the time needed for plant equipment installation, plant construction, and provides for ease of expansion. Vendor C scored slightly

lower because of the projected need of 12+ months to develop and fabricate plant equipment. The plant equipment would then need to be installed, and the capacity of the plant would be fixed.

Vendor D scored higher for fully installed system costs. This is mainly due to the costs associated with building two plants and due to the complexity of Vendor C's filtration equipment.

Vendor D's operational costs were slightly lower than Vendor C's where the price differential is mostly attributable to the man power required in running two plants versus one, and the complexity of a full scale Vendor C treatment plant.

Vendor D scored much higher in the construction/infrastructure criterion and for size/location. The differences in the scoring are mainly attributable to the cost in building two plants and the space requirements for two plants. The plant sitting at TA-3 would require considerable resources to decommission, demolish, and prepare this site for a new plant. Additionally, the TA-3 site would require significant infrastructure costs to run lines to collect the blow down from the targeted cooling towers, to run lines to deliver the treated water to cooling tower sites, and to place a pumping station for delivery of the treated water. Vendor D also scored higher in the operability criterion and this is attributable to the complexity of a Vendor C plant. However, Vendor D did not test a zero discharge system and the cost, operability, maintenance, and time constraints for a zero discharge system may change this evaluation to favor a Vendor C implementation option. For example, if Vendor D were to install a crystallizer as their means of achieving zero discharge, this unit would vastly increase costs, reliability, and operability of a Vendor D. plant.

Vendor D scored higher in experience. Both Vendor C and D demonstrated that their treatment processes are effective in removing silica from water during the pilot demonstration. However, Vendor D has more experience in treating high silica water in similar applications and has designed and built several large-scale plants using this technology. Vendor C has extensive experience in water treatment and filtration and in precipitating silica, however Vendor C has less experience in applying their process in the application tested at LANL.

Vendor D scored higher in the maintenance criterion. This scoring was based on the experience gained during the field pilot and ease of plant operations observed during the testing. Vendor C experienced many maintenance issues during testing that culminated in much less total run time during the field demonstration than Vendor D. Vendor D experienced no down time except that which was experienced when their membrane fouled when the plant was treating the sanitary reuse water that had turbidity.

Vendor C scored higher in the secondary waste criterion. This is attributable to ease of their zero discharge system where their filtration waste stream was sent to a filter press. Vendor D did not adequately demonstrate a zero liquid discharge system for their RO reject and therefore received a lower score.

Both Vendor C and D scored low for project risk where risk is defined as the risk of the project being delayed past the scheduled completion period. LANL can not begin final design until all environmental issues have been resolved. Time delays are anticipated with a Vendor C or D implementation to address EA issues during public comments where it is believed that comments will be tied to wetland destruction

and/or reduction with implementing a zero discharge plant. Zero liquid discharge is highly favored by many regulatory officials because of the reduction and elimination of wastes released to the environment. However not everyone agrees that this is a preferred approach because of the effects that removing the waste (wastewater) may have on wildlife and to wetlands that depend on this water for survival. Specifically, cooling tower blow down from the TA-3 site discharges into Sandia Canyon where this flow accounts for most of the flow within the canyon. Sandia Canyon has a 6-acre wetland associated with it where one acre of the wetland is naturally occurring, and where the other 5 acres are attributable to Laboratory operations. The LANL Ecology Group has recently completed a study and (Sandia Wetland Evaluation Draft report, 2001) which found that if the waste water flow to this canyon were to be decreased by 35 percent or more, there would be a detrimental effect on the wetland in the canyon.

Vendor D, using an RO process, scored (354) higher than Vendor C (236) for a filtration option. This higher score is attributable to the two plants identified as being needed by the vendor in a micro filtration implementation option.

Vendor A chemical management option 2 scored higher than Vendor D filtration option. This is also attributable to the high implementation costs associated with a centralized filtration plant as opposed to chemical management at each targeted cooling tower.

11.0 PROJECT CONCLUSION

The field testing was successful in demonstrating that water conservation can be achieved at cooling towers by managing water quality either through chemical management to keep silica suspended or by the removal of silica from the makeup water source. The level of water conservation the Laboratory needs to achieve to support on-going missions, planned missions, and missions yet to be identified must now be determined by Laboratory management.

The chemical management vendors were unable to demonstrate that their technology can provide a 75 percent efficiency rate without scaling heat transfer surfaces. However, the pilot testing showed that the vendors could provide water conservation above what is now being achieved and at a cost that is much lower than the implementation of a centralized plant. Cooling tower facility operation teams would need to accept a slightly different approach for silica scale control. This would require somewhat of a culture adjustment by facility management because their operational experience has proven to them that blow down must be set to approximately 2 cycles of concentration to avoid scaling. Maintenance costs to clean cooling towers and associated equipment is expensive and can lead to weeks of down time.

The chemical treatment provided by Vendor A- Option 2 gave the highest overall score in the evaluation summary section where the score was 360, and thus was given the number one ranking. It seems somewhat strange that this vendor was unable to meet the minimum efficiency of 75 percent stated in the RFP but yet received the highest overall evaluation score. This result is mainly due to the costs associated with full

implementation of chemical treatment versus silica removal by filtration. However, it must also be stressed that this option will allow LANL to stay within its water budget of 1662 AFY for identified water uses projected out to FY2005.

However, new missions that require significant amounts of water could not be implemented at the Laboratory without additional water conservation efforts, or without without additional water supply. The LAC may be able to supply additional water to the Laboratory, but the Laboratory may need to contribute funds to provide for County expansions of their water plant and delivery system.

Environmental compliance could improve slightly with Vendor A Option 2, but because effluent is released to the environment every day, the risk of environmental exceedance may occur even with a good monitoring program. Therefore, chemical management will still have some level of risk for NPDES and Groundwater non-conformances.

The filtration technologies can provide water conservation well above the 75 percent efficiency goal, but the costs associated with a treatment plant are not trivial and have the potential to have other environmental issues associated with it in regards to wetlands issues and secondary wastes. The RO process scored 354 overall and was the second highest ranking for full implementation at LANL. The reason that this option scored lower than chemical management - option 2, is mainly due to the cost of building a treatment plant and needed infrastructure, size/location requirements, delivery time schedules.

If LANL were to choose a silica removal option in full implementation, the Laboratory would be taking the first step in ensuring that future water needs would be

met and would provide a strong foundation as stewards of this resource. The Laboratory must now decide what water conservation approach it will take to address present and future demand, and to address its role as a steward of this natural resource. The real decision at this point is whether to choose to meet immediate needs by implementing a low cost chemical treatment approach to address the silica problems associated with cooling towers, or install a more expensive long-term silica removal filtration plant where maximum water conservation could be achieved at cooling towers.

13.0 REFERENCES

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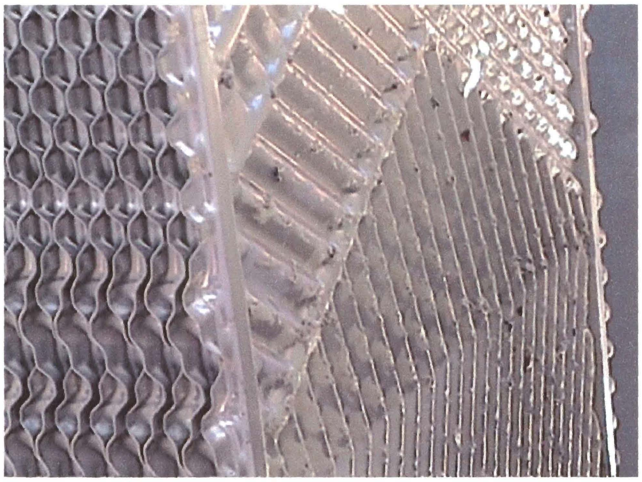
Appendix 1

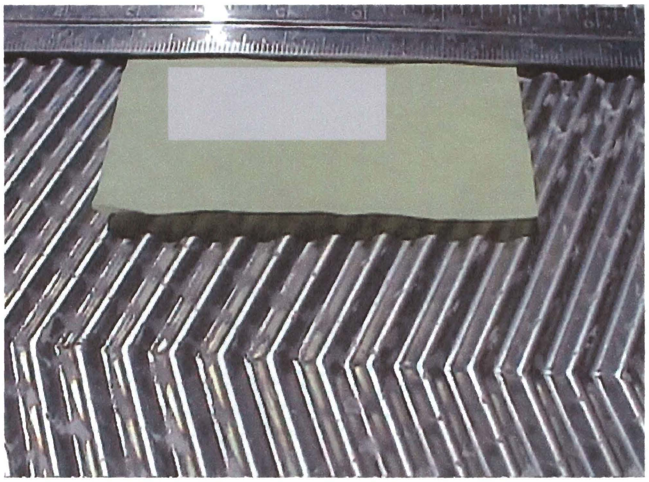
Heat Exchanger Inspection Photographs

APPENDIX 1
Heat Exchanger Photos

Vendor A

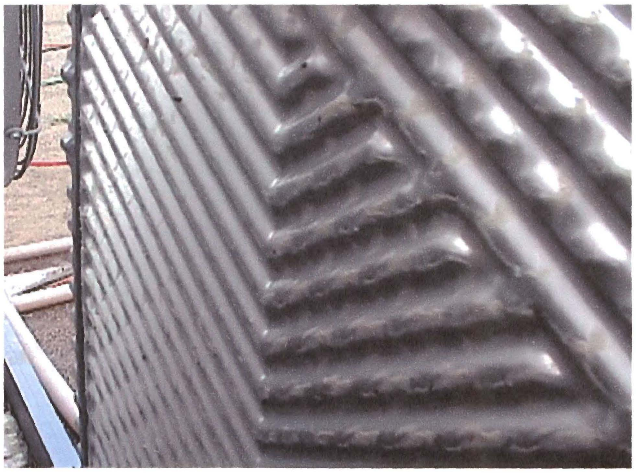


Vendor A 7/5/00, Before Cleaning

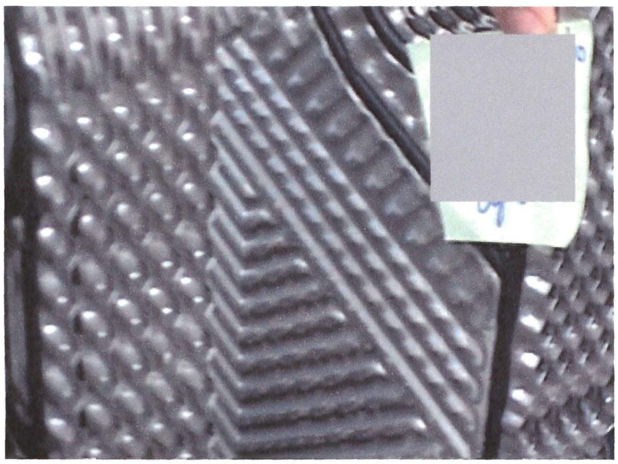


Vendor A 7/6/00, After Cleaning

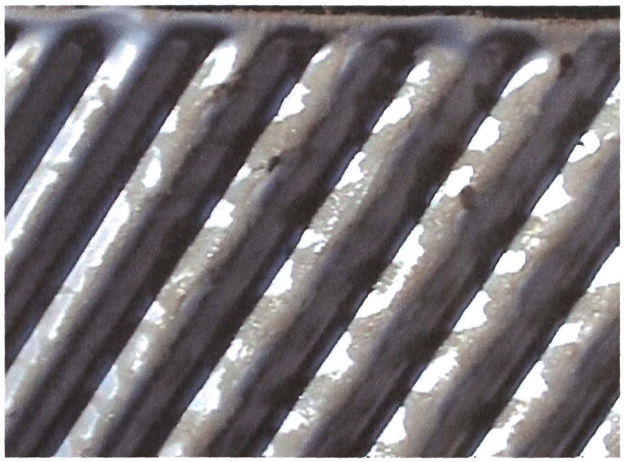
Vendor A 7/19/00



Vendor A 8/7/00, End of Potable Trial



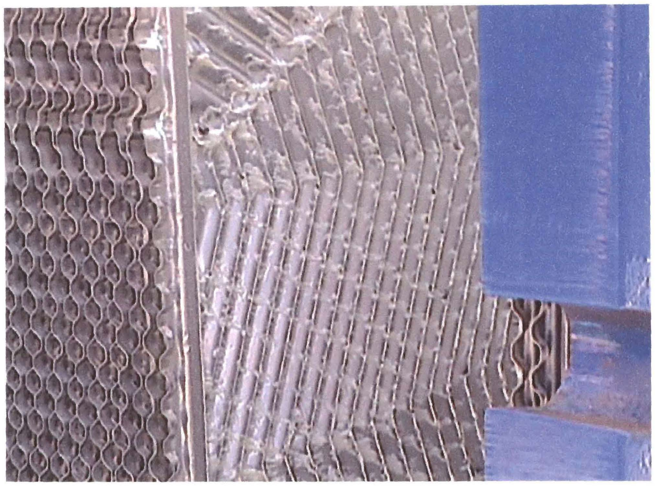
Vendor A 8/7/00, After Cleaning



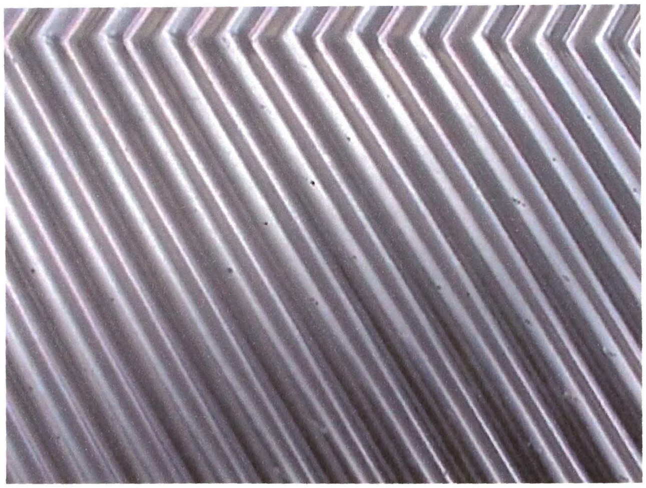
Vendor A 8/25/00, END of SWSC Trial

APPENDIX 1
Heat Exchanger Photos

Vendor B



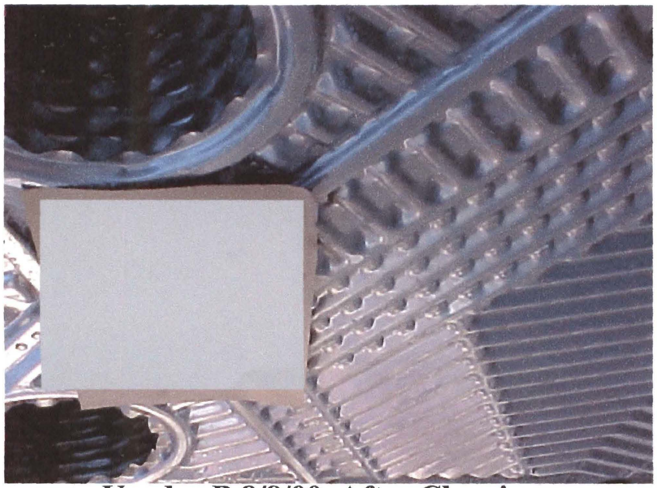
Vendor B 7/5/00, Before Cleaning



Vendor B 7/6/00, After Cleaning

Vendor B 7/19/00

Vendor B 8/7/00, End of Potable Trial

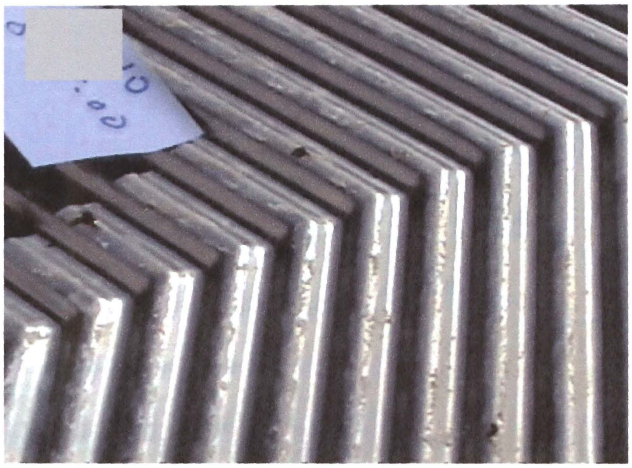


Vendor B 8/8/00, After Cleaning

Vendor B 8/15/00, SWSC Trial

APPENDIX 1
Heat Exchanger Photos

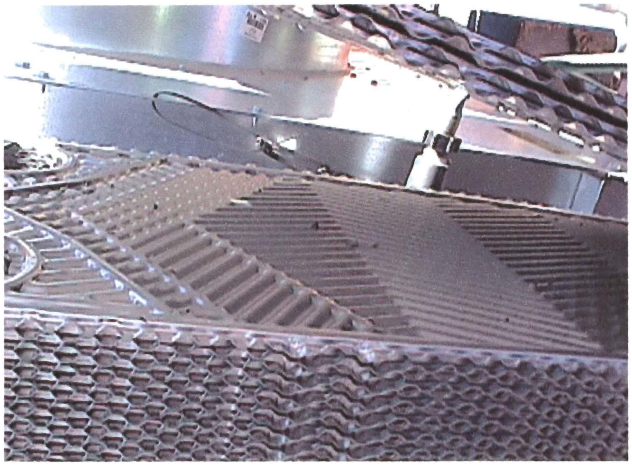
Vendor B



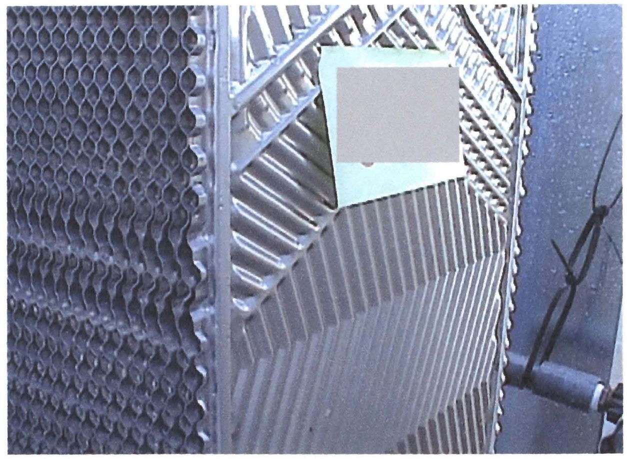
Vendor B 8/25/00, End of SWSC Trial

APPENDIX 1
Heat Exchanger Photos

Vendor C

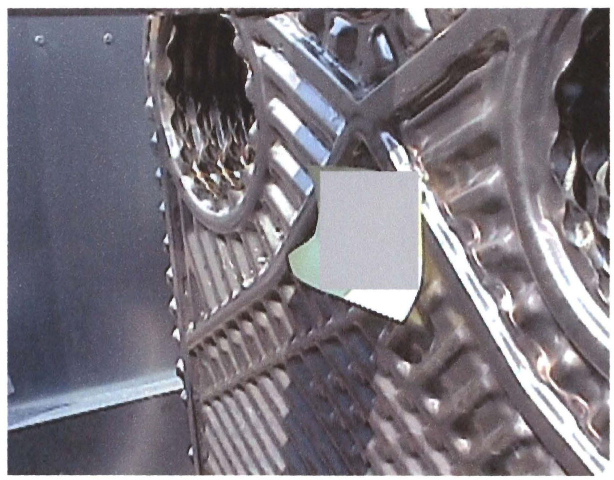


Vendor C, 7/5/00

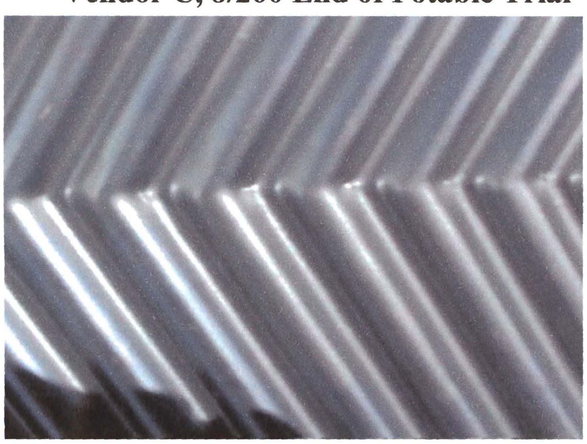


Vendor C, 7/6/00 After Light Rinse

Vendor C, 8/200 End of Potable Trial



Vendor C, 8/2/00 After a Light Rinse



Vendor C, 8/25/00 End of SWSC Trial

Appendix 2

X-Ray Diffraction Analysis

Los Alamos
NATIONAL LABORATORY
memorandum
Geology and Geochemistry (EES-1)

To/MS: Patricia Vardaro, E-ESO, J568
From/MS: Steve J. Chipera, EES-1, D469
Phone/Fax: 7-1110/5-3285
E-mail: chipera@lanl.gov
Symbol: EES-1-SJC-TFS-CFW
Date: September 6th, 2000

Subject: XRD Results for the 5 Water-Precipitate Samples Submitted

The following are X-ray diffraction results for the 5 water-precipitate samples that you had submitted for analysis. I have appended the results for the latest two samples ([redacted]8/25/00 Sample and [redacted]-Hx 8/25/00 Sample) to those that I had transmitted to you previously.

Vendor A HX, 7/5/00 sample

Mainly amorphous (amorphous silica?) with <2 weight percent of gypsum ($CaSO_4 \bullet 2H_2O$), quartz (SiO_2), and possibly calcite ($CaCO_3$).

Vendor A, 8/25/00 10AM sample

Mainly amorphous (amorphous silica?). No other phases were detected.

Vendor B Scale in C.T. Well, 7/5/00 sample

Mainly amorphous (amorphous silica?) at approximately 90 weight percent with ~10 weight percent of gypsum, a trace of quartz, and a possible trace of calcite.

Vendor B Hx, 8/25/00 10AM sample

Mainly amorphous (amorphous silica?). No other phases were detected.

MKUP to C.T.'s, 7/4/00 sample

Mainly calcite ($CaCO_3$) and what would be best described as a poorly-crystalline or proto-montmorillonite (clay mineral with the approximate chemical composition of $(Na,K,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \bullet nH_2O$), and a trace of aragonite ($CaCO_3$) and brucite ($Mg(OH)_2$).

What makes this sample particularly interesting is that except for the brucite, the pattern is almost identical to that of a sample that we analyzed 10 years ago that was obtained deep within the pacific ocean by the Alvin submersible.

Let me know if there is anything else that I can do for you or if I can answer any questions. Copies of the patterns will be sent to you through the mail and the raw XRD data will be e-mailed to you as an Excel spreadsheet.

SJC:sjc

Appendix 3

LANL NPDES Permit

ENCLOSURE 1

Region 6
1445 Ross Avenue
Dallas, Texas 75202-2733

NPDES Permit No. NM0028355

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended,
(33 U.S.C. 1251 et. seq; the "Act"),

University of California
Management Contractor for Operations
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

and

U.S. Department of Energy
Los Alamos Area Office
Los Alamos, New Mexico 87544

are authorized to discharge from a facility located at Los Alamos,

to receiving waters named Mortandad Canyon, Canada del Buey, Los Alamos Canyon, Sandia Canyon, Ten Site Canyon, Canon de Valle, and Water Canyon, which are unclassified tributaries to the Rio Grande in Waterbody Segment Code No. 20.6.4.114, of the Rio Grande Basin,

in accordance with this cover page and the effluent limitations, monitoring requirements, and other conditions set forth in Parts I [Requirements for NPDES Permits - 36 pages], II [Other Conditions - 4 pages], III [Standard Conditions for NPDES Permits - 8 pages], and IV [Sewage Sludge Requirements - 18 pages] hereof.

This permit supersedes and replaces NPDES Permit No. NM0028355 issued June 24, 1994.

This permit shall become effective on February 1, 2001

This permit and the authorization to discharge shall expire at midnight,
January 31, 2005

Issued on December 29, 2000

Prepared by

for Sam Becker
Acting Director
Water Quality Protection Division (6WQ)

J. Scott Wilson
Environmental Scientist
NPDES Permits Branch (6WQ-P)

PART I - REQUIREMENTS FOR NPDES PERMITS

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

OUTFALL 001
Discharge Type: Continuous
Latitude 35°52'26"N, Longitude 106°19'08"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge Power Plant waste water from cooling towers, boiler blowdown drains, demineralizer backwash, and sanitary re-use to Sandia Canyon, an unclassified tributary of the Rio Grande, in Segment Number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Month	Grab

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
TSS STORET: 00530	****	****	30	100
Total Residual Chlorine STORET: 50060	****	****	11 ug/l	11 ug/l
Total Arsenic (*2) STORET: 01002	****	****	0.296	0.296
Total Chromium (*2) STORET: 01034	****	****	4.36	4.36
Total Copper (*2) STORET: 01042	****	****	1.02	1.02
Total Lead (*2) STORET: 01051	****	****	0.38	0.38

Total Zinc (*2) STORET: 01092	****	****	56.25	56.25
Total Aluminum (*2) STORET: 01105	****	****	5.0	5.0
Total Boron (*2) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*2) STORET: 01037	****	****	1.0	1.0
Total Cadmium (*2) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Mercury (*2) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Selenium (*2) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*2) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*2) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*1)(*2) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Month	Estimate
TSS STORET: 00530	1/Month	Grab
Total Residual Chlorine STORET: 50060	1/Month	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab

Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*1) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the point of discharge from Outfall 001 (Latitude 35°52'26"N, Longitude 106°19'08"W).

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 When accelerator produced.

*2 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements.

OUTFALL 13S

Discharge Type: Continuous
Latitude 35°51'08"N, Longitude 106°16'33"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge treated sanitary waste water to Sandia Canyon or Canada del Buey, unclassified tributaries of the Rio Grande, in Segment Number 20.6.4.114 of the Rio Grande Basin and to outfalls utilizing treated effluent as specified in Outfall 001 and Category 03A (*3).

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Week	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
BOD5 (*6) STORET: 00310	72	108	30	45
TSS (*6) STORET: 00530	72	108	30	45
BOD5 (*7) STORET: 00310	77	116	30	45
TSS (*7) STORET: 00530	77	116	30	45
BOD5 (*8)	79.6	119	30	45

STORET: 00310				
TSS (*9)	79.6	119	30	45
STORET: 00530				
Fecal Coliform Bacteria (*1)	****	****	500 (#/100ml)	500 (#/100ml)
STORET: 74055				
Total Residual Chlorine (*5)	****	****	11 ug/l	11 ug/l
STORET: 50060				
Total Arsenic (*4)	****	****	329 ug/l	329 ug/l
STORET: 01002				
Total Chromium (*4)	****	****	4.63	4.63
STORET: 01034				
Total Copper (*4)	****	****	1.19	1.19
STORET: 01042				
Total Lead (*4)	****	****	449 ug/l	449 ug/l
STORET: 01051				
Total Zinc (*4)	****	****	68.45	68.45
STORET: 01092				
Total Aluminum (*4)	****	****	5.0	5.0
STORET: 01105				
Total Boron (*4)	****	****	5.0	5.0
STORET: 01022				
Total Cobalt (*4)	****	****	1.0	1.0
STORET: 01037				
Total Cadmium (*4)	****	****	50 ug/l	50 ug/l
STORET: 01027				
Total Mercury (*4)	****	****	0.77 ug/l	0.77 ug/l
STORET: 71900				
Total Selenium (*4)	****	****	5.0 ug/l	5.0 ug/l
STORET: 01147				
Total Vanadium (*4)	****	****	100 ug/l	100 ug/l
STORET: 01087				
Radium 226 + Radium 228 (*4)	****	****	30 pCi/l	30 pCi/l
STORET: 11503				
Tritium (*2)(*4)	****	****	20,000 pCi/l	20,000 pCi/l
STORET: 82136				

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	Continuous	Totalizer Record
STORET: 50050		
BOD5	3/Month	24-Hr Composite
STORET: 00310		
TSS	1/Month	24-Hr Composite
STORET: 00530		
Fecal Coliform Bacteria	1/Month	Grab
STORET: 74055		
Total Residual Chlorine (*5)	1/Month	Grab
STORET: 50060		
Total Arsenic	1/Year	Grab

STORET: 01002		
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*2) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at the Parshall Flume following the chlorine contact chamber (Latitude 35°51'08"N, Longitude 106°16'33"W) and prior to discharge to either Canada del Buey at Latitude 35°51'07"N, Longitude 106°16'27"W, or into the effluent reuse line to Sandia Canyon at Latitude 35°52'29"N, Longitude 106°18'38"W, or other outfalls utilizing treated effluent in the Outfall 001 and Category 03A

NO DISCHARGE REPORTING

If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM

There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS

"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Logarithmic mean.

*2 When accelerator produced.

*3 See Part II.G.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

*5 Effluent limitations and monitoring requirements only apply when discharge is made to Canada del Buey.

*6 Beginning the effective date of the permit and lasting until the average discharge rate has increased to 0.3083 MGD through the addition of sanitary waste water from a residential subdivision located in Los Alamos County. LANL shall notify EPA Region 6 and NMED in writing two weeks prior to the addition of residential sanitary waste water to the TA-46 treatment plant.

*7 Beginning after the average discharge rate has increased to 0.3083 MGD through the addition of sanitary waste water from a residential subdivision located in Los Alamos County and lasting until the average discharge rate has increased to 0.3183 MGD through addition of sanitary waste water from the new Research Park offices. The permittee shall notify EPA Region 6 and NMED at least two weeks prior to the addition of the Research Park waste water to the TA-46 treatment plant.

*8 Beginning after the average discharge rate has increased to 0.3183MGD through addition of sanitary waste water from the new Research Park offices and lasting through the expiration date of the permit.

OUTFALL 051 - Radioactive Liquid Waste Treatment Facility (TA-50)
Discharge Type: Intermittent
Latitude 35°51'54"N, Longitude 106°17'52"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge treated radioactive liquid waste to Mortandad Canyon, an unclassified tributary to the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUALITY (UNITS AS STATED) MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	Report	Report

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Week	Grab

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUANTITY/LOADING (LBS/DAY UNLESS STATED) MONTHLY AVG	DAILY MAX	QUALITY/CONCENTRATION (mg/L UNLESS STATED) MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report	Report	****	****
Chemical Oxygen Demand STORET: 00340	****	****	125	125
Total Suspended Solids STORET: 00530	****	****	30	45
Total Cadmium (*4) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*4) STORET: 01034	****	****	1.34	2.68
Total Copper (*4) STORET: 01042	****	****	1.393	1.393
Total Iron (*4) STORET:10145	****	****	****	****
Total Lead (*4) STORET: 01051	****	****	423 ug/l	524 ug/l
Total Mercury (*4) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*4) STORET: 01092	****	****	4.37	8.75
Total Toxic Organics (*2) STORET: 78141	****	****	1.0	1.0

Total Arsenic (*4) STORET: 01002	****	****	368 ug/l	368 ug/l
Total Aluminum (*4) STORET: 01105	****	****	5.0	5.0
Total Boron (*4) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*4) STORET: 01037	****	****	1.0	1.0
Total Selenium (*4) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*4) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*4) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*3)(*4) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l
Total Nickel (*4) STORET: 01067	****	****	Report	Report
Perchlorate STORET: 61209	****	****	Report	Report

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	Continuous	Record
Chemical Oxygen Demand STORET: 00340	1/Week	Grab
Total Suspended Solids STORET: 00530	1/Week	Grab
Total Cadmium STORET: 01027	1/Week	Grab
Total Chromium STORET: 01034	1/Week	Grab
Total Copper STORET: 01042	1/Week	Grab
Total Iron STORET: 10145	1/Week	Grab
Total Lead STORET: 01051	1/Week	Grab
Total Mercury STORET: 71900	1/Week	Grab
Total Zinc STORET: 01092	1/Week	Grab
Total Toxic Organics (*2) STORET: 78141	1/Month	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab

Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*3) STORET: 82136	1/Year	Grab
Total Nickel STORET: 01067	1/Month	Grab
Perchlorate STORET: 61209	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following the final treatment and prior to or at the point of discharge from TA-50-1 treatment plant (Latitude 35°51'58.3"N, Longitude 106°17'48.5"W

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 The pH shall be within the range of 6.0 to 9.0 standard units at all times subject to the following continuous monitoring pH range excursion provisions.

pH RANGE EXCURSION PROVISIONS
Where a permittee continuously measures the pH of wastewater pursuant to a requirement or option in a National Pollutant Discharge Elimination System (NPDES) permit issued pursuant to Section 402 of the Clean Water Act, the permittee shall maintain the pH of such wastewater within the range set forth in the permit, except excursions from the range are permitted, provided:

(a) The total time during which the pH values are outside the required range of pH values shall not exceed 446 minutes in any calendar month; and,

(b) No individual excursion from the range of pH values shall exceed 60 minutes.

For purposes of this section, an "excursion" is an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the permit.

*2 The limits and monitoring for Total Toxic Organics do not include 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), Pesticides, or Polychlorinated biphenyls

*3 When accelerator produced. The permittee shall monitor the influent to the TA-50 treatment plant once per year to determine sources of tritium.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALL 05A055 - High Explosives Waste Water Treatment Plant (TA-16-1508)
Discharge Type: Intermittent
Latitude 35°50'49"N, Longitude 106°19'49"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge treated waste water from the high explosives waste water treatment facility to a tributary to Canon de Valle, an unclassified tributary of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin

Such discharges shall be limited and monitored by the permittee as specified below:

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Chemical Oxygen Demand STORET: 00340	****	****	125	125
Total Suspended Solids STORET: 00530	****	****	30	45
Oil and Grease STORET: 00556	****	****	15	15
Total Toxic Organics (*1) STORET: 78141	****	****	1.0	1.0
Trinitrotoluene STORET: 81360	****	****	0.02	Report
Total RDX STORET: 81364	****	****	200 ug/l	660 ug/l
Total Cadmium (*3) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*3) STORET: 01034	****	****	4.81	4.81
Total Copper (*3) STORET: 01042	****	****	1.329	1.329
Total Lead (*3) STORET: 01051	****	****	501 ug/l	501 ug/l
Total Mercury (*3)	****	****	0.77 ug/l	0.77 ug/l

STORET: 71900				
Total Zinc (*3)	****	****	78.5	78.5
STORET: 01092				
Total Arsenic (*3)	****	****	356 ug/l	356 ug/l
STORET: 01002				
Total Aluminum (*3)	****	****	5.0	5.0
STORET: 01105				
Total Boron (*3)	****	****	5.0	5.0
STORET: 01022				
Total Cobalt (*3)	****	****	1.0	1.0
STORET: 01037				
Total Selenium (*3)	****	****	5.0 ug/l	5.0 ug/l
STORET: 01147				
Total Vanadium (*3)	****	****	100 ug/l	100 ug/l
STORET: 01087				
Radium 226 + Radium 228 (*3)	****	****	30 pCi/l	30 pCi/l
STORET: 11503				
Tritium (*2)(*3)	****	****	20,000 pCi/l	20,000 pCi/l
STORET: 82136				
Perchlorate	****	****	Report	Report
STORET: 61209				

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	1/Quarter	Estimate
STORET: 50050		
Chemical Oxygen Demand	1/Quarter	Grab
STORET: 00340		
Total Suspended Solids	1/Quarter	Grab
STORET: 00530		
Oil and Grease	1/Quarter	Grab
STORET: 00556		
Total Toxic Organics	1/Quarter	Grab
STORET: 78141		
Trinitrotoluene	1/Quarter	Grab
STORET: 81360		
Total RDX	2/Month	Grab
STORET: 81364		
Total Cadmium	1/Year	Grab
STORET: 01027		
Total Chromium	1/Year	Grab
STORET: 01034		
Total Copper	1/Year	Grab
STORET: 01042		
Total Lead	1/Year	Grab
STORET: 01051		
Total Mercury	1/Year	Grab
STORET: 71900		
Total Zinc	1/Year	Grab
STORET: 01092		

Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*2) STORET: 82136	1/Year	Grab
Perchlorate STORET: 61209	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the point of discharge (Latitude 35°50'49"N, Longitude 106°19'49"W).

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 The limits and monitoring for Total Toxic Organics do not include 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), Pesticides, or Polychlorinated biphenyls.

*2 When accelerator produced.

*3 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALL 05A097 High Explosives Waste Water (TA-11-25)
Discharge Type: Intermittent
Latitude 35°50'16.7"N, Longitude 106°19'25"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge waste water from the high explosives testing drop pad to an unclassified tributary to Water Canyon, a tributary of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Chemical Oxygen Demand STORET: 00340	****	****	125	125
Total Suspended Solids STORET: 00530	****	****	30	45
Oil and Grease STORET: 00556	****	****	15	15
Total Toxic Organics (*1) STORET: 78141	****	****	1.0	1.0
Trinitrotoluene STORET: 81360	****	****	0.02	Report
Total RDX STORET: 81364	****	****	200 ug/l	660 ug/l
Total Cadmium (*3) STORET: 01027	****	****	50 ug/l	50 ug/l

Total Chromium (*3) STORET: 01034	****	****	4.7	4.7
Total Copper (*3) STORET: 01042	****	****	1.25	1.25
Total Lead (*3) STORET: 01051	****	****	469 ug/l	469 ug/l
Total Mercury (*3) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*3) STORET: 01092	****	****	72.37	72.37
Total Arsenic (*3) STORET: 01002	****	****	340 ug/l	340 ug/l
Total Aluminum (*3) STORET: 01105	****	****	5.0	5.0
Total Boron (*3) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*3) STORET: 01037	****	****	1.0	1.0
Total Selenium (*3) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*3) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*3) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*2)(*3) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l
Perchlorate STORET: 61209	****	****	Report	Report

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Chemical Oxygen Demand STORET: 00340	1/Quarter	Grab
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Oil and Grease STORET: 00556	1/Quarter	Grab
Total Toxic Organics STORET: 78141	1/Quarter	Grab
Trinitrotoluene STORET: 81360	1/Quarter	Grab
Total RDX STORET: 81364	2/Month	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab

Total Lead STORET: 01051	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*2) STORET: 82136	1/Year	Grab
Perchlorate STORET: 61209	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the discharge point (Latitude 35°50'16.7"N, Longitude 106°19'25"W).

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 The limits and monitoring for Total Toxic Organics do not include 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), Pesticides, or Polychlorinated biphenyls.

*2 When accelerator produced.

*3 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALLS 03A024, 03A130, 03A158, 03A181, 03A185 and 03A199

Discharge Type: Intermittent

Outfall 03A024: Latitude 35°52'19"N, Longitude 106°19'06"W (TA3-187)
Outfall 03A130: Latitude 35°50'20"N, Longitude 106°19'31"W (TA11-30)
Outfall 03A158: Latitude 35°52'30"N, Longitude 106°16'16"W (TA21-209)
Outfall 03A181: Latitude 35°51'50.8"N, Longitude 106°18'03"W (TA55-6)
Outfall 03A185: Latitude 35°50'00"N, Longitude 106°18'04"W (TA15-312)
Outfall 03A199: Latitude 35°52'30"N, Longitude 106°16'16"W (TA3-1837)

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge cooling tower blowdown to Mortandad Canyon (Outfall 03A181), Sandia Canyon (Outfalls 03A024, and 03A199), Water Canyon (Outfall 03A130 and 03A185), and Los Alamos Canyon (Outfall 03A158), unclassified tributaries to the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUALITY (UNITS AS STATED) MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Residual Chlorine (*1)	****	****	200 ug/l	500 ug/l

STORET: 50060				
Total Residual Chlorine (*2)(*4) STORET: 50060	****	****	11 ug/l	11 ug/l
Total Phosphorus STORET:00665	****	****	20	40
Total Cadmium (*4) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*4) STORET: 01034	****	****	4.36	4.36
Total Copper (*4) STORET: 01042	****	****	1.02	1.02
Total Lead (*4) STORET: 01051	****	****	380 ug/l	380 ug/l
Total Mercury (*4) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*4) STORET: 01092	****	****	56.25	56.25
Total Arsenic (*4) STORET: 01002	****	****	296 ug/l	296 ug/l
Total Aluminum (*4) STORET: 01105	****	****	5.0	5.0
Total Boron (*4) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*4) STORET: 01037	****	****	1.0	1.0
Total Selenium (*4) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*4) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*4) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*3)(*4) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Total Residual Chlorine STORET: 50060	1/Quarter	Grab
Total Phosphorous STORET: 00665	1/Quarter	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead	1/Year	Grab

STORET: 01051		
Total Mercury STORET: 71900	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*3) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the point of discharge.

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Requirements for this parameter are effective during the period beginning the effective date of the permit and lasting through one (1) day prior to two (2) years from the effective date of the permit.

*2 Requirements for this parameter are effective during the period beginning two (2) years from the effective date of the permit and lasting through the expiration date of the permit.

*3 When accelerator produced.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALLS 03A027, 03A028, 03A048, and 03A049
Discharge Type: Intermittent
03A027: Latitude 35°52'26"N, Longitude 106°19'07"W (TA3-285)
03A028: Latitude 35°49'58"N, Longitude 106°17'44"W (TA-15-202)
03A048: Latitude 35°52'11"N, Longitude 106°15'43"W (TA-53-62)
03A049: Latitude 35°52'13"N, Longitude 106°15'30"W (TA-53-64)

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge cooling tower blowdown to Sandia Canyon (Outfall 03A027), Water Canyon (Outfall 03A028) and Los Alamos Canyon (Outfalls 03A048 and 03A049), unclassified tributaries to the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUALITY (UNITS AS STATED) MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Residual Chlorine (*1) STORET: 50060	****	****	0.2	0.5
Total Residual Chlorine (*2)(*3) STORET: 50060	****	****	11 ug/l	11 ug/l
Total Phosphorus STORET:00665	****	****	20	40
Total Cadmium (*3) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*3) STORET: 01034	****	****	4.527	4.527

Total Copper (*3) STORET: 01042	****	****	1.123	1.123
Total Lead (*3) STORET: 01051	****	****	421 ug/l	421 ug/l
Total Mercury (*3) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*3) STORET: 01092	****	****	63.47	63.47
Total Arsenic (*3) STORET: 01002	****	****	316 ug/l	316 ug/l
Total Aluminum (*3) STORET: 01105	****	****	5.0	5.0
Total Boron (*3) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*3) STORET: 01037	****	****	1.0	1.0
Total Selenium (*3) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*3) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*3) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*4)(*3) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Total Residual Chlorine STORET: 50060	1/Quarter	Grab
Total Phosphorous STORET: 00665	1/Quarter	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Copper (*5) STORET: 01042	1/Quarter	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab

Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*4) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the discharge point.

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Requirements for this parameter are effective during the period beginning the effective date of the permit and lasting through one (1) day prior to two (2) years from the effective date of the permit.

*2 Requirements for this parameter are effective during the period beginning two (2) years from the effective date of the permit and lasting through the expiration date of the permit.

*3 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements.

*4 When accelerator produced.

*5 At Outfall 03A048 only. At all other outfalls Total Copper is required to be monitored once per year.

OUTFALLS 03A021, 03A022, and 03A113
Discharge Type: Intermittent
Outfall 03A021: Latitude 35°52'40"N, Longitude 106°19'09"W (TA3-29)
Outfall 03A022: Latitude 35°52'14"N, Longitude 106°18'58"W (TA3-2274)
Outfall 03A113: Latitude 35°52'04"N, Longitude 106°15'42"W (TA-53-293, 294, 952, and 1032)

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge cooling tower blowdown to Mortandad Canyon (Outfalls 03A021 and 03A022) and Sandia Canyon (Outfall 03A113), unclassified tributaries of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Residual Chlorine (*1) STORET: 50060	****	****	0.2	0.5
Total Residual Chlorine (*2)(*4) STORET: 50060	****	****	11 ug/l	11 ug/l
Total Phosphorus STORET:00665	****	****	20	40
Total Cadmium (*4) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*4)	****	****	4.7	4.7

STORET: 01034				
Total Copper (*4)	****	****	1.25	1.25
STORET: 01042				
Total Lead (*4)	****	****	469 ug/l	469 ug/l
STORET: 01051				
Total Mercury (*4)	****	****	0.77 ug/l	0.77 ug/l
STORET: 71900				
Total Zinc (*4)	****	****	72.37	72.37
STORET: 01092				
Total Arsenic (*4)	****	****	340 ug/l	340 ug/l
STORET: 01002				
Total Aluminum (*4)	****	****	5.0	5.0
STORET: 01105				
Total Boron (*4)	****	****	5.0	5.0
STORET: 01022				
Total Cobalt (*4)	****	****	1.0	1.0
STORET: 01037				
Total Selenium (*4)	****	****	5.0 ug/l	5.0 ug/l
STORET: 01147				
Total Vanadium (*4)	****	****	100 ug/l	100 ug/l
STORET: 01087				
Radium 226 + Radium 228 (*4)	****	****	30 pCi/l	30 pCi/l
STORET: 11503				
Tritium (*3)	****	****	20,000 pCi/l	20,000 pCi/l
STORET: 82136				

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow	1/Quarter	Estimate
STORET: 50050		
Total Suspended Solids	1/Quarter	Grab
STORET: 00530		
Total Residual Chlorine	1/Quarter	Grab
STORET: 50060		
Total Phosphorous	1/Quarter	Grab
STORET: 00665		
Total Cadmium	1/Year	Grab
STORET: 01027		
Total Chromium	1/Year	Grab
STORET: 01034		
Total Copper	1/Year	Grab
STORET: 01042		
Total Lead	1/Year	Grab
STORET: 01051		
Total Mercury	1/Year	Grab
STORET: 71900		
Total Zinc	1/Year	Grab
STORET: 01092		
Total Arsenic	1/Year	Grab
STORET: 01002		
Total Aluminum	1/Year	Grab

STORET: 01105		
Total Boron	1/Year	Grab
STORET: 01022		
Total Cobalt	1/Year	Grab
STORET: 01037		
Total Selenium	1/Year	Grab
STORET: 01147		
Total Vanadium	1/Year	Grab
STORET: 01087		
Radium 226 + Radium 228	1/Year	Grab
STORET: 11503		
Tritium (*3)	1/Year	Grab
STORET: 82136		

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the point of discharge.

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Requirements for this parameter are effective during the period beginning the effective date of the permit and lasting through one (1) day prior to two (2) years from the effective date of the permit.

*2 Requirements for this parameter are effective during the period beginning two (2) years from the effective date of the permit and lasting through the expiration date of the permit.

*3 When accelerator produced.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALL 03A047 (TA53-60)
Discharge Type: Intermittent
Latitude 35°52'10"N, Longitude 106°15'58"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge cooling tower blowdown to Los Alamos Canyon, an unclassified tributary of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS QUALITY (UNITS AS STATED) MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Residual Chlorine (*1) STORET: 50060	****	****	0.2	0.5
Total Residual Chlorine (*2) (*4) STORET: 50060	****	****	11 ug/l	11 ug/l
Total Phosphorus STORET:00665	****	****	20	40
Total Cadmium (*4) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*4) STORET: 01034	****	****	4.81	4.81
Total Copper (*4) STORET: 01042	****	****	1.329	1.329

Total Lead (*4) STORET: 01051	****	****	501 ug/l	501 ug/l
Total Mercury (*4) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*4) STORET: 01092	****	****	78.5	78.5
Total Arsenic (*4) STORET: 01002	****	****	356 ug/l	356 ug/l
Total Aluminum (*4) STORET: 01105	****	****	5.0	5.0
Total Boron (*4) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*4) STORET: 01037	****	****	1.0	1.0
Total Selenium (*4) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*4) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*4) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*3) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Total Residual Chlorine STORET: 50060	1/Quarter	Grab
Total Phosphorous STORET: 00665	1/Quarter	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab

Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*3) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the discharge point (Latitude 35°52'10"N, Longitude 106°15'58"W).

NO DISCHARGE REPORTING

If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM

There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS

"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Requirements for this parameter are effective during the period beginning the effective date of the permit and lasting through one (1) day prior to two (2) years from the effective date of the permit.

*2 Requirements for this parameter are effective during the period beginning two (2) years from the effective date of the permit and lasting through the expiration date of the permit.

*3 When accelerator produced.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

OUTFALL 03A160 (TA-35-124)
Discharge Type: Intermittent
Latitude 35°51'47"N, Longitude 106°17'45"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge cooling tower blowdown to Ten Site Canyon thence to Mortandad Canyon an unclassified tributary of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow STORET: 50050	Report MGD	Report MGD	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Residual Chlorine (*1) STORET: 50060	****	****	0.2	0.5
Total Residual Chlorine (*2) STORET: 50060	****	****	11 ug/l	11 ug/l
Total Phosphorus STORET:00665	****	****	20	40
Total Cadmium (*3) STORET: 01027	****	****	50 ug/l	50 ug/l
Total Chromium (*3) STORET: 01034	****	****	5.278	5.278
Total Copper (*3) STORET: 01042	****	****	1.775	1.775

Total Lead (*3) STORET: 01051	****	****	658 ug/l	658 ug/l
Total Mercury (*3) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*3) STORET: 01092	****	****	113	113
Total Arsenic (*3) STORET: 01002	****	****	444 ug/l	444 ug/l
Total Aluminum (*3) STORET: 01105	****	****	5.0	5.0
Total Boron (*3) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*3) STORET: 01037	****	****	1.0	1.0
Total Selenium (*3) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*3) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*3) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*3)(*4) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Total Residual Chlorine STORET: 50060	1/Quarter	Grab
Total Phosphorous STORET: 00665	1/Quarter	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab
Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab

Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*1) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): following final treatment and prior to or at the point of discharge (Latitude 35°51'47"N, Longitude 106°17'45"W).

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 Requirements for this parameter are effective during the period beginning the effective date of the permit and lasting through one (1) day prior to two (2) years from the effective date of the permit.

*2 Requirements for this parameter are effective during the period beginning two (2) years from the effective date of the permit and lasting through the expiration date of the permit.

*3 When accelerator produced.

*4 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements.

OUTFALL 02A129 (TA-21-357)
Discharge Type: Intermittent
Latitude 35°52'31"N, Longitude 106°16'29"W

During the period beginning the effective date of the permit and lasting through the expiration date of the permit (unless otherwise noted),

the permittee is authorized to discharge boiler blowdown, water softener waste water, and once through cooling water to Los Alamos Canyon, an unclassified tributary of the Rio Grande, in segment number 20.6.4.114 of the Rio Grande Basin.

Such discharges shall be limited and monitored by the permittee as specified below:

pH RANGE

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS	
	QUALITY (UNITS AS STATED)	
	MINIMUM	MAXIMUM
pH (Standard Units) STORET: 00400	6.0	9.0

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
pH (Standard Units) STORET: 00400	1/Quarter	Grab

CHEMICAL/PHYSICAL/BIOCHEMICAL

PARAMETERS/STORET CODES	DISCHARGE LIMITATIONS/REPORTING REQUIREMENTS			
	QUANTITY/LOADING (LBS/DAY UNLESS STATED)		QUALITY/CONCENTRATION (mg/L UNLESS STATED)	
	MONTHLY AVG	DAILY MAX	MONTHLY AVG	DAILY MAX
Flow (MGD) STORET: 50050	Report	Report	****	****
Total Suspended Solids STORET: 00530	****	****	30	100
Total Iron STORET: 10145	****	****	10	40
Total Copper (*2) STORET: 01042	****	****	1.39	1.39
Total Phosphorus STORET: 00665	****	****	20	40
Sulfite (as SO_3) STORET: 00740	****	****	35	70
Total Chromium (*2) STORET: 01034	****	****	4.85	4.85
Total Cadmium (*2)	****	****	50 ug/l	50 ug/l

STORET 01027				
Total Lead (*2) STORET: 01051	****	****	513 ug/l	513 ug/l
Total Mercury (*2) STORET: 71900	****	****	0.77 ug/l	0.77 ug/l
Total Zinc (*2) STORET: 01092	****	****	81.0	81.0
Total Arsenic (*2) STORET: 01002	****	****	362 ug/l	362 ug/l
Total Aluminum (*2) STORET: 01105	****	****	5.0	5.0
Total Boron (*2) STORET: 01022	****	****	5.0	5.0
Total Cobalt (*2) STORET: 01037	****	****	1.0	1.0
Total Selenium (*2) STORET: 01147	****	****	5.0 ug/l	5.0 ug/l
Total Vanadium (*2) STORET: 01087	****	****	100 ug/l	100 ug/l
Radium 226 + Radium 228 (*2) STORET: 11503	****	****	30 pCi/l	30 pCi/l
Tritium (*1)(*2) STORET: 82136	****	****	20,000 pCi/l	20,000 pCi/l

PARAMETERS/STORET CODES	MONITORING REQUIREMENTS	
	FREQUENCY OF ANALYSIS	SAMPLE TYPE
Flow STORET: 50050	1/Quarter	Estimate
Total Suspended Solids STORET: 00530	1/Quarter	Grab
Total Iron STORET: 10145	1/Quarter	Grab
Total Phosphorous STORET: 00665	1/Quarter	Grab
Sulfite (as SO_3) STORET: 00740	1/Quarter	Grab
Total Cadmium STORET: 01027	1/Year	Grab
Total Chromium STORET: 01034	1/Year	Grab
Total Copper STORET: 01042	1/Year	Grab
Total Lead STORET: 01051	1/Year	Grab
Total Mercury STORET: 71900	1/Year	Grab
Total Zinc STORET: 01092	1/Year	Grab
Total Arsenic STORET: 01002	1/Year	Grab

Total Aluminum STORET: 01105	1/Year	Grab
Total Boron STORET: 01022	1/Year	Grab
Total Cobalt STORET: 01037	1/Year	Grab
Total Selenium STORET: 01147	1/Year	Grab
Total Vanadium STORET: 01087	1/Year	Grab
Radium 226 + Radium 228 STORET: 11503	1/Year	Grab
Tritium (*1) STORET: 82136	1/Year	Grab

SAMPLING LOCATION(S) AND OTHER REQUIREMENTS

SAMPLING LOCATION(S)
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Following final treatment and prior to or at the discharge point.

NO DISCHARGE REPORTING
If there is no discharge event at this outfall during the sampling month, place an "X" in the NO DISCHARGE box located in the upper right corner of the preprinted Discharge Monitoring Report.

FLOATING SOLIDS OR VISIBLE FOAM
There shall be no discharge of floating solids or visible foam in other than trace amounts.

FLOW MEASUREMENTS
"Estimate" flow measurements shall not be subject to the accuracy provisions established at Part III.C.6. The daily flow value may be estimated using best engineering judgment.

FOOTNOTES

*1 When accelerator produced.

*2 If any individual analytical test result is less than the minimum quantification level listed at Part II.A of this permit, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements

B. SCHEDULE OF COMPLIANCE

The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

NONE

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than fourteen (14) days following each schedule date. Any reports of noncompliance shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. REPORTING OF MONITORING RESULTS (MAJOR DISCHARGERS)

Monitoring information shall be on Discharge Monitoring Report Form(s) EPA 3320-1 as specified in Part III.D.4 of this permit and shall be submitted monthly.

1. Reporting periods shall end on the last day of the month.

2. The permittee is required to submit regular monthiy reports as described above postmarked no later than the 15th day of the month following each reporting period.

PART II - OTHER CONDITIONS

A. MINIMUM QUANTIFICATION LEVEL (MQL)

If any individual analytical test result is less than the minimum quantification level listed below, a value of zero (0) may be used for that individual result for the Discharge Monitoring Report (DMR) calculations and reporting requirements.

	MQL (µg/L)
Aluminum	100
Barium	100
Boron	100
Residual Chlorine (Total)	100
Cobalt	50
Nitrate as N	100
Vanadium	50
Antimony (Total)	60
Arsenic (Total)	10
Beryllium (Total)	5
Cadmium (Total)	1
Chromium (Total)	10
Chromium (3+)	10
Chromium (6+)	10
Copper (Total)	10
Lead (Total)	5
Mercury (Total)	0.2
Nickel (Total)	5
Selenium (Total)	5
Silver (Total)	2
Thallium (Total)	10
Zinc (Total)	20
Cyanide (Total)	20
Cyanide (Amenable)	20
Chlordane	0.2

The permittee may develop an effluent specific method detection limit (MDL) in accordance with Appendix B to 40CFR136. For any pollutant for which the permittee determines an effluent specific MDL, the permittee shall send to the EPA Region 6 NPDES Permits Branch (6WQ-P) a report containing QA/QC documentation, analytical results, and calculations necessary to demonstrate that the effluent specific MDL was correctly calculated. An effluent specific minimum quantification level (MQL) shall be determined in accordance with the following calculation:

$$MQL = 3.3 \times MDL$$

Upon written approval by the EPA Region 6 NPDES Permits Branch (6WQ-P), the effluent specific MQL may be utilized by the permittee for all future Discharge Monitoring Report (DMR) calculations and reporting requirements.

B. 24-HOUR ORAL REPORTING: DAILY MAXIMUM LIMITATION VIOLATIONS
Under the provisions of Part III.D.7.b.(3) of this permit, violations of daily maximum limitations for the following pollutants shall be reported orally to EPA Region 6, Compliance and Assurance Division, Water Enforcement Branch (6EN-W), Dallas, Texas and NMED, within 24 hours from the time the permittee becomes aware of the violation followed by a written report in five days.

Arsenic, Aluminum, Boron, Cadmium, Chromium, Cobalt, Copper, Lead, Mercury, Selenium, Radium, Tritium, Vanadium, or Zinc.

C. COMPOSITE SAMPLING (24-HOUR)

1. STANDARD PROVISIONS

Unless otherwise specified in this permit, the term "24-hour composite sample" means a sample consisting of a minimum of three (3) aliquots of effluent collected at regular intervals over a normal 24-hour operating period and combined in proportion to flow or a sample continuously collected in proportion to flow over a normal 24-hour operating period.

2. VOLATILE COMPOUNDS

For the "24-hour composite" sampling of volatile compounds using EPA Methods 601, 602, 603, 624, 1624, or any other 40CFR136 method approved after the effective date of the permit, the permittee shall manually collect four (4) aliquots (grab samples) in clean zero head-space containers at regular intervals during the actual hours of discharge during the 24-hour sampling period using sample collection, preservation, and handling techniques specified in the test method. These aliquots must be combined in the laboratory to represent the composite sample of the discharge. One of the following alternative methods shall be used to composite these aliquots.

a. Each aliquot is poured into a syringe. The plunger is added, and the volume in the syringe is adjusted to 1-1/4 ml. Each aliquot (1-1/4 ml.) is injected into the purging chamber of the purge and trap system. After four (4) injections (total 5 ml.), the chamber is purged. Only one analysis or run is required since the aliquots are combined prior to analysis.

b. Chill the four (4) aliquots to 4 Degrees Centigrade. These aliquots must be of equal volume. Carefully pour the contents of each of the four aliquots into a 250-500 ml. flask which is chilled in a wet ice bath. Stir

the mixture gently with a clean glass rod while in the ice bath. Carefully fill two (2) or more clean 40 ml. zero head-space vials from the flask and dispose of the remainder of the mixture. Analyze one of the aliquots to determine the concentration of the composite sample. The remaining aliquot(s) are replicate composite samples that can be analyzed if desired or necessary.

c. Alternative sample compositing methods may be used following written approval by EPA Region 6.

The individual samples resulting from application of these compositing methods shall be analyzed following the procedures specified for the selected test method. The resulting analysis shall be reported as the daily composite concentration.

As an option to the above compositing methods, the permittee may manually collect four (4) aliquots (grab samples) in clean zero head-space containers at regular intervals during the actual hours of discharge during the 24-hour sampling period using sample collection, preservation, and handling techniques specified in the test method. A separate analysis shall be conducted for each discrete grab sample following the approved test methods. The determination of daily composite concentration shall be the arithmetic average (weighted by flow) of all grab samples collected during the 24-hour sampling period.

D. CYANIDE EFFLUENT TEST PROCEDURES

To comply with the sampling and analysis requirements for total cyanide and cyanide amenable to chlorination, the permittee shall use an approved test procedure at 40CFR136. If the analysis of cyanide amenable to chlorination is subject to matrix interferences, the weak acid dissociable cyanide method (Method 4500 CN I - Standard Methods, latest edition approved in 40CFR136) may be substituted for this parameter. The permittee may use ion chromatographic separation - amperometric detection (IC method) as a substitute for the colorimetric detection steps in any of the above cyanide methods. No other modifications of the above methods are authorized by this provision unless such modifications are approved in writing by the permitting authority.

E. OIL AND GREASE ALTERNATIVE TEST PROCEDURE: INTERIM LIMITED USE APPROVAL

Proposed Method 1664 [Federal Register, Vol. 61, No. 15, January 23, 1996, page 1730] may be used as an oil and grease alternative test procedure for NPDES permit compliance monitoring purposes. This approval shall expire at the time of the publication in the Federal Register of the final rule governing the use of Method 1664. This approval includes all of the analytical options within Method 1664 provided that the equivalency demonstration is performed and all performance specifications are met at each outfall.

F. The University of California (UC) and the U.S. Department of Energy (DOE) are co-permittees for the Los Alamos National Laboratory (LANL) NPDES permit.

EPA may take enforcement actions as appropriate against either UC or DOE or both.

G. Upon receipt of analytical results, any limited parameter found to be out of compliance with this permit shall be resampled for that noncompliant parameter within seven (7) days. This resampling schedule for noncompliant effluent limits shall be repeated until analytical results indicate the limited parameter is in compliance with this permit.

H. This permit may be reopened and modified or revoked and reissued to reflect any applicable changes to the New Mexico Water Quality Standards.

I. TEST METHODS

The following methods may be used for analysis under this permit:

Liquid Scintillation Counting: EPA Method ANC335, R-1

Gamma Spectroscopy: EPA Methods 904.0 and 903.1

Nitroaromatics and Nitramines by High Performance Liquids Chromatography: SW846 Method 8330

Determination of Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry: EPA Method 200.7

Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry: EPA Method 200.8

Determination of Trace Elements by Stabilized Temperature Graphite Furnace Atomic Absorption Spectrometry: EPA Method 200.9

Determination of Inorganic Anions by Ion Chromatography: EPA Method 300.0

Microwave Digestion: EPA Method 200.2

PART III - STANDARD CONDITIONS FOR NPDES PERMITS

A. GENERAL CONDITIONS

1. INTRODUCTION

In accordance with the provisions of 40 CFR Part 122.41, et. seq., this permit incorporates by reference ALL conditions and requirements applicable to NPDES Permits set forth in the Clean Water Act, as amended, (hereinafter known as the "Act") as well as ALL applicable regulations.

2. DUTY TO COMPLY

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

3. TOXIC POLLUTANTS

a. Notwithstanding Part III.A.5, if any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this permit, this permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition.

b. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Act for toxic pollutants within the time provided in the regulations that established those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

4. DUTY TO REAPPLY

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application shall be submitted at least 180 days before the expiration date of this permit. The Director may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date. Continuation of expiring permits shall be governed by regulations promulgated at 40 CFR Part 122.6 and any subsequent amendments.

5. PERMIT FLEXIBILITY

This permit may be modified, revoked and reissued, or terminated for cause in accordance with 40 CFR 122.62-64. The filing of a request for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

6. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege.

7. DUTY TO PROVIDE INFORMATION

The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

8. CRIMINAL AND CIVIL LIABILITY

Except as provided in permit conditions on "Bypassing" and "Upsets", nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Any false or materially misleading representation or concealment of information required to be reported by the provisions of the permit, the Act, or applicable regulations, which avoids or effectively defeats the regulatory purpose of the Permit may subject the Permittee to criminal enforcement pursuant to 18 U.S.C. Section 1001.

9. OIL AND HAZARDOUS SUBSTANCE LIABILITY

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

10. STATE LAWS

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

11. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to

other circumstances, and the remainder of this permit, shall not be affected thereby.

B. PROPER OPERATION AND MAINTENANCE

1. NEED TO HALT OR REDUCE NOT A DEFENSE

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. The permittee is responsible for maintaining adequate safeguards to prevent the discharge of untreated or inadequately treated wastes during electrical power failure either by means of alternate power sources, standby generators or retention of inadequately treated effluent.

2. DUTY TO MITIGATE

The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

3. PROPER OPERATION AND MAINTENANCE

a. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by permittee as efficiently as possible and in a manner which will minimize upsets and discharges of excessive pollutants and will achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of this permit.

b. The permittee shall provide an adequate operating staff which is duly qualified to carry out operation, maintenance and testing functions required to insure compliance with the conditions of this permit.

4. BYPASS OF TREATMENT FACILITIES

a. BYPASS NOT EXCEEDING LIMITATIONS

The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of Parts III.B.4.b. and 4.c.

b. NOTICE

(1) ANTICIPATED BYPASS

If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of the bypass.

(2) UNANTICIPATED BYPASS

The permittee shall, within 24 hours, submit notice of an unanticipated bypass as required in Part III.D.7.

c. PROHIBITION OF BYPASS

(1) Bypass is prohibited, and the Director may take enforcement action against a permittee for bypass, unless:

(a) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(b) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and,

(c) The permittee submitted notices as required by Part III.B.4.b.

(2) The Director may allow an anticipated bypass after considering its adverse effects, if the Director determines that it will meet the three conditions listed at Part III.B.4.c(1).

5. UPSET CONDITIONS

a. EFFECT OF AN UPSET

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of Part III.B.5.b. are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

b. CONDITIONS NECESSARY FOR A DEMONSTRATION OF UPSET

A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated;

(3) The permittee submitted notice of the upset as required by Part III.D.7; and,

(4) The permittee complied with any remedial measures required by Part III.B.2.

c. BURDEN OF PROOF

In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

6. REMOVED SUBSTANCES

Unless otherwise authorized, solids, sewage sludges, filter backwash, or other pollutants removed in the course of treatment or wastewater control shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. PERCENT REMOVAL (PUBLICLY OWNED TREATMENT WORKS)

For publicly owned treatment works, the 30-day average (or Monthly Average) percent removal for Biochemical Oxygen Demand and Total Suspended Solids shall not be less than 85 percent unless otherwise authorized by the permitting authority in accordance with 40 CFR 133.103.

C. MONITORING AND RECORDS

1. INSPECTION AND ENTRY

The permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by the law to:

a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under this permit; and

d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location.

2. REPRESENTATIVE SAMPLING

Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

3. RETENTION OF RECORDS

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report, or application. This period may be extended by request of the Director at any time.

4. RECORD CONTENTS

Records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) and time(s) analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical techniques or methods used; and
f. The results of such analyses.

5. MONITORING PROCEDURES

a. Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit or approved by the Regional Administrator.

b. The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instruments at intervals frequent enough to insure accuracy of measurements and shall maintain appropriate records of such activities.

c. An adequate analytical quality control program, including the analyses of sufficient standards, spikes, and duplicate samples to insure the accuracy of all required analytical results shall be

maintained by the permittee or designated commercial laboratory.

6. FLOW MEASUREMENTS

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to insure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than 10% from true discharge rates throughout the range of expected discharge volumes.

D. REPORTING REQUIREMENTS

1. PLANNED CHANGES

a. INDUSTRIAL PERMITS

The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

(1) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR Part 122.29(b); or,

(2) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements listed at Part III.D.10.a.

b. MUNICIPAL PERMITS

Any change in the facility discharge (including the introduction of any new source or significant discharge or significant changes in the quantity or quality of existing discharges of pollutants) must be reported to the permitting authority. In no case are any new connections, increased flows, or significant changes in influent quality permitted that will cause violation of the effluent limitations specified herein.

2. ANTICIPATED NONCOMPLIANCE

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

3. TRANSFERS

This permit is not transferable to any person except after notice to the Director. The Director may require modification or revocation and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under the Act.

4. DISCHARGE MONITORING REPORTS AND OTHER REPORTS

Monitoring results must be reported on Discharge Monitoring Report (DMR) Form EPA No. 3320-1 in accordance with the "General Instructions" provided on the form. The permittee shall submit the original DMR signed and certified as required by Part III.D.11 and all other reports required by Part III.D. to the EPA at the address below. Duplicate copies of DMR's and all other reports shall be submitted to the appropriate State agency(ies) at the following address(es):

EPA:
Compliance Assurance and Enforcement Division
Water Enforcement Branch (6EN-W)
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue
Dallas, TX 75202-2733

New Mexico:
Program Manager
Surface Water Quality Bureau
New Mexico Environment Department
P.O. Box 26110
1190 Saint Francis Drive
Santa Fe, NM 87502

Oklahoma (Industrial Permits Only):
Director
Oklahoma Department of Environmental Quality
1000 NE 10th Street
Oklahoma City, OK 73117-1212

Louisiana:
Assistant Secretary for Water
Water Pollution Control Division
Louisiana Department of Environmental Quality
P.O. Box 82215
Baton Rouge, LA 70884-2215

5. ADDITIONAL MONITORING BY THE PERMITTEE

If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report (DMR). Such

increased monitoring frequency shall also be indicated on the DMR.

6. AVERAGING OF MEASUREMENTS

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Director in the permit.

7. TWENTY-FOUR HOUR REPORTING

a. The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall be provided within 5 days of the time the permittee becomes aware of the circumstances. The report shall contain the following information:

(1) A description of the noncompliance and its cause;

(2) The period of noncompliance including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and,

(3) Steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. The following shall be included as information which must be reported within 24 hours:

(1) Any unanticipated bypass which exceeds any effluent limitation in the permit;

(2) Any upset which exceeds any effluent limitation in the permit; and,

(3) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Director in Part II (industrial permits only) of the permit to be reported within 24 hours.

c. The Director may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

8. OTHER NONCOMPLIANCE

The permittee shall report all instances of noncompliance not reported under Parts III.D.4 and D.7 and Part I.B (for industrial permits only) at the time monitoring reports are submitted. The reports shall contain the information listed at Part III.D.7.

9. OTHER INFORMATION

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, it shall promptly submit such facts or information.

10. CHANGES IN DISCHARGES OF TOXIC SUBSTANCES

All existing manufacturing, commercial, mining, and silvacultural permittees shall notify the Director as soon as it knows or has reason to believe:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant listed at 40 CFR Part 122, Appendix D, Tables II and III (excluding Total Phenols) which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

(1) One hundred micrograms per liter (100 μg/L);
(2) Two hundred micrograms per liter (200 μg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 μg/L) for 2,4-dinitro-phenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;
(3) Five (5) times the maximum concentration value reported for that pollutant in the permit application; or
(4) The level established by the Director.

b. That any activity has occurred or will occur which would result in any discharge, on a nonroutine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

(1) Five hundred micrograms per liter (500 μg/L);
(2) One milligram per liter (1 mg/L) for antimony;
(3) Ten (10) times the maximum concentration value reported for that pollutant in the permit application; or
(4) The level established by the Director.

11. SIGNATORY REQUIREMENTS

All applications, reports, or information submitted to the Director shall be signed and certified.

a. ALL PERMIT APPLICATIONS shall be signed as follows:

(1) FOR A CORPORATION - by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:

(a) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business

function, or any other person who performs similar policy or decision making functions for the corporation; or,

(b) The manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

(2) FOR A PARTNERSHIP OR SOLE PROPRIETORSHIP - by a general partner or the proprietor, respectively.

(3) FOR A MUNICIPALITY, STATE, FEDERAL, OR OTHER PUBLIC AGENCY - by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:

(a) The chief executive officer of the agency, or

(b) A senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

b. ALL REPORTS required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above;

(2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. A duly authorized representative may thus be either a named individual or an individual occupying a named position; and,

(3) The written authorization is submitted to the Director.

c. CERTIFICATION

Any person signing a document under this section shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

12. AVAILABILITY OF REPORTS

Except for applications, effluent data, permits, and other data specified in 40 CFR 122.7, any information submitted pursuant to this permit may be claimed as confidential by the submitter. If no claim is made at the time of submission, information may be made available to the public without further notice.

E. PENALTIES FOR VIOLATIONS OF PERMIT CONDITIONS

1. CRIMINAL

a. NEGLIGENT VIOLATIONS

The Act provides that any person who negligently violates permit conditions implementing Section 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.

b. KNOWING VIOLATIONS

The Act provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

c. KNOWING ENDANGERMENT

The Act provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 303, 306, 307, 308, 318, or 405 of the Act and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 years, or both.

d. FALSE STATEMENTS

The Act provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly

falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both. (See Section 309.c.4 of the Clean Water Act)

2. CIVIL PENALTIES

The Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a civil penalty not to exceed $27,500 per day for each violation.

3. ADMINISTRATIVE PENALTIES

The Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to an administrative penalty, as follows:

a. CLASS I PENALTY

Not to exceed $11,000 per violation nor shall the maximum amount exceed $27,500.

b. CLASS II PENALTY

Not to exceed $11,000 per day for each day during which the violation continues nor shall the maximum amount exceed $137,500.

F. DEFINITIONS

All definitions contained in Section 502 of the Act shall apply to this permit and are incorporated herein by reference. Unless otherwise specified in this permit, additional definitions of words or phrases used in this permit are as follows:

1. ACT means the Clean Water Act (33 U.S.C. 1251 et. seq.), as amended.

2. ADMINISTRATOR means the Administrator of the U.S. Environmental Protection Agency.

3. APPLICABLE EFFLUENT STANDARDS AND LIMITATIONS means all state and Federal effluent standards and limitations to which a discharge is subject under the Act, including, but not limited to, effluent limitations, standards or performance, toxic effluent standards and prohibitions, and pretreatment standards.

4. APPLICABLE WATER QUALITY STANDARDS means all water quality standards to which a discharge is subject under the Act.

5. BYPASS means the intentional diversion of waste streams from any portion of a treatment facility.

6. DAILY DISCHARGE means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in terms of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the sampling day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the sampling day. "Daily discharge" determination of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the "daily discharge" determination of concentration shall be arithmetic average (weighted by flow value) of all samples collected during that sampling day.

7. DAILY MAXIMUM discharge limitation means the highest allowable "daily discharge" during the calendar month.

8. DIRECTOR means the U.S. Environmental Protection Agency Regional Administrator or an authorized representative.

9. ENVIRONMENTAL PROTECTION AGENCY means the U.S. Environmental Protection Agency.

10. GRAB SAMPLE means an individual sample collected in less than 15 minutes.

11. INDUSTRIAL USER means a nondomestic discharger, as identified in 40 CFR 403, introducing pollutants to a publicly owned treatment works.

12. MONTHLY AVERAGE (also known as DAILY AVERAGE) discharge limitations means the highest allowable average of "daily discharge(s)" over a calendar month, calculated as the sum of all "daily discharge(s)" measured during a calendar month divided by the number of "daily discharge(s)" measured during that month. When the permit establishes daily average concentration effluent limitations or conditions, the daily average concentration means the arithmetic average (weighted by flow) of all "daily discharge(s)" of concentration determined during the calendar month where C = daily concentration, F = daily flow, and n = number of daily samples; daily average discharge =

$$\frac{C_1F_1 + C_2F_2 + \ldots + C_nF_n}{F_1 + F_2 + \ldots + F_n}$$

13. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 318, 402, and 405 of the Act.

14. SEVERE PROPERTY DAMAGE means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

15. SEWAGE SLUDGE means the solids, residues, and precipitates separated from or created in sewage by the unit processes of a publicly owned treatment works. Sewage as used in this definition means any wastes, including wastes from humans, households, commercial establishments, industries, and storm water runoff, that are discharged to or otherwise enter a publicly owned treatment works.

16. TREATMENT WORKS means any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage and industrial wastes of a liquid nature to implement Section 201 of the Act, or necessary to recycle or reuse water at the most economical cost over the estimated life of the works, including intercepting sewers, sewage collection systems, pumping, power and other equipment, and their appurtenances, extension, improvement, remodeling, additions, and alterations thereof.

17. UPSET means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

18. FOR FECAL COLIFORM BACTERIA, a sample consists of one effluent grab portion collected during a 24-hour period at peak loads.

19. The term "MGD" shall mean million gallons per day.

20. The term "mg/L" shall mean milligrams per liter or parts per million (ppm).

21. The term "µg/L" shall mean micrograms per liter or parts per billion (ppb).

22. MUNICIPAL TERMS

a. 7-DAY AVERAGE or WEEKLY AVERAGE, other than for fecal coliform bacteria, is the arithmetic mean of the daily values for all effluent samples collected during a calendar week, calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week. The 7-day average for fecal coliform bacteria is the geometric mean of the values for all effluent samples collected during a calendar week.

b. 30-DAY AVERAGE or MONTHLY AVERAGE, other than for fecal coliform bacteria, is the arithmetic mean of the daily values for all effluent samples collected during a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month. The 30-day average for fecal coliform bacteria is the geometric mean of the values for all effluent samples collected during a calendar month.

c. 24-HOUR COMPOSITE SAMPLE consists of a minimum of 12 effluent portions collected at equal time intervals over the 24-hour period and combined proportional to flow or a sample collected at frequent intervals proportional to flow over the 24-hour period.

d. 12-HOUR COMPOSITE SAMPLE consists of 12 effluent portions collected no closer together than one hour and composited according to flow. The daily sampling intervals shall include the highest flow periods.

e. 6-HOUR COMPOSITE SAMPLE consists of six effluent portions collected no closer together than one hour (with the first portion collected no earlier than 10:00 a.m.) and composited according to flow.

f. 3-HOUR COMPOSITE SAMPLE consists of three effluent portions collected no closer together than one hour (with the first portion collected no earlier than 10:00 a.m.) and composited according to flow.

Appendix 4

State of New Mexico Groundwater Standards

State of New Mexico
ENVIRONMENT DEPARTMENT
Ground Water Quality Bureau
Harold Runnels Building
1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-2918 phone
(505) 827-2965 fax

GARY E. JOHNSON
GOVERNOR

MARK E. WEIDLER
SECRETARY

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

January 7, 1998

Thomas Todd, Area Manager
Los Alamos National Laboratory
Sanitary Wastewater Treatment Plant
528 35th Street
Los Alamos, New Mexico 87544

RE: Discharge Plan Renewal, DP-857, Los Alamos National Laboratory, Sanitary Wastewater Systems Consolidation Plant

Dear Mr. Todd:

Pursuant to Water Quality Control Commission (WQCC) Regulation 3109, the application for discharge plan renewal for DP-857, submitted by G. Thomas Todd for the discharge of 600,000 gallons per day of treated sanitary wastewater from the Los Alamos National Laboratory (LANL), Sanitary Wastewater Systems Consolidation (SWSC) Plant is hereby approved. The facility is located approximately 3 1/2 miles southeast of Los Alamos in Section 26, T19N, R6E, Los Alamos County. In approving this discharge plan, the New Mexico Environment Department (NMED) has determined that the requirements of WQCC Regulation 3109.C have been met.

The approved LANL, SWSC Plant and disposal system is briefly described as follows:

> Up to 600,000 gallons per day of sanitary wastewater from LANL will be treated by extended aeration, clarification, chlorination and dechlorination. Treated effluent will either be discharged to Canada Del Buey, or stored in a synthetically lined impoundment for distribution to TA-3 for cooling water or used on site for landscape irrigation. Sludge is dried on site in synthetically lined drying beds and is disposed of under DP-1052. Ground water below the site is at a depth of approximately 1,000 feet and has a total dissolved solids concentration of approximately 165 milligrams per liter.

The approved discharge plan renewal consists of the materials submitted by LANL dated October, 1997, August 18, 1997, April 10, 1997, July 31, 1995, and November 25, 1997. In addition, the discharge plan includes information and materials submitted as part of the original discharge plan approved on July 20, 1997. The discharge shall be managed in accordance with the approved plan.

However, approval of this discharge plan does not relieve you of your responsibility to comply with any conditions or requirements of the previously approved discharge plan, DP-857, the New Mexico Water Quality Act, WQCC Regulations, any other applicable federal, state and/or local laws and regulations, such as zoning requirements and nuisance ordinances.

SPECIFIC REQUIREMENTS

The terms and conditions of this approval contain specific requirements which are summarized below.

1. Operational Plan - LANL will treat and dispose of domestic wastewater at the SWSC Plant as follows:

   a. Up to 600,000 gallons per day of domestic wastewater will be treated by extended aeration with nitrogen removal, clarification, and chlorination-dechlorination for pathogen reduction..

   b. Treated effluent will be stored in a hypolon lined lagoon for distribution to TA-3 for cooling water, for use on site for landscape irrigation, or discharged directly to Canada Del Buey. NMED will be notified at the time of discharge to Canada Del Buey. Irrigation will be conducted in accordance with the NMEID Policy for the Use of Domestic Wastewater Effluent for Irrigation, December 1985 (copy enclosed).

   c. Treated wastewater distributed to TA-3 will be discharged directly to Sandia Canyon through outfall 01S or used for cooling water and discharged to Sandia Canyon through outfall 001.

   d. Sludge will dried on site and disposed of in accordance with 40 CFR Part 503, and may be land applied according to the terms and conditions of DP-1052.

2. Monitoring Plan - LANL will implement the following monitoring plan for the discharge at the SWSC Plant:

   a. Quarterly Reporting- Due the 30th of January, April, July, and October of each year will include:

1. monthly effluent volumes from the wastewater treatment plant,

2. monthly wastewater volumes discharged through each outfall, and

3. analytical results from samples taken quarterly from the TA-46 reuse wet well, outfalls 001 and 01S to Sandia Canyon, and monitor well CBDO-6 for nitrate as nitrogen (NO_3), total Kjeldahl nitrogen (TKN), chloride (Cl, and total dissolved solids (TDS).

b. Annual Reporting- Due by the 30th of January of each year will include:

1. analytical results from samples taken annually from the TA-46 reuse wet well and monitor well CBDO 6 for:

a. radiochemistry: gross alpha particle activity, radium 226 and 228,

b. metals: silver (Ag), arsenic (As), barium (Ba), cadmium (Cd), cyanide (CN), chromium (Cr), fluoride (Fl), mercury (Hg), lead (Pb), selenium (Se), copper (Cu), iron (Fe), manganese (Mn), sulphate (SO4), and zinc (Zn), and

c. volatile and semivolatile organic compounds: EPA methods 8240 and 8270.

3. Contingency Plan - LANL will implement the following contingency plan:

a. In the event that analysis from the SWSC Reuse Wet Well exceeds a WQCC Regulation 3103 standard, LANL will collect quarterly samples for the exceeded constituent at the SWSC Reuse Wet Well and at NPDES outfall 001 until concentrations of the exceeded constituent are below WQCC Regulation 3103 standards for two consecutive quarters.

b. In the event that two consecutive quarterly analysis from NPDES Outfall 001 exceed a WQCC Regulation 3103 standard, LANL will install a ground water monitor well in Sandia Canyon at a location approved by NMED. The well will be used for quarterly ground water monitoring for NO3, TKN, Cl, TDS, and any other constituent in wastewater exceeding WQCC Regulation 3103 standards at NPDES Outfall 001.

c. In the event that analysis of ground water monitor well samples indicate concentrations exceeding WQCC Regulation 3103 standards, LANL will notify the GWQB and initiate a review of the treatment system within 30 days. If necessary,

to meet ground water standards, plant modifications will be implemented.

d. In the event of an unpermitted spill from any laboratory facility, including the SWSC Plant, NMED will be notified within 24 hours and LANL will submit all required information as required by WQCC Regulation 1203.

4. Closure Plan - LANL will submit a closure plan to NMED at the time of SWSC closure. Until a more detailed plan has been developed, LANL will commit to the following:

   a. permanently plug any influent and effluent piping so that wastewater will no longer enter into or discharge from the SWSC Plant,

   b. remove and dispose of all sanitary sludge in accordance with 40 CFR Part 503,

   c. remove and properly dispose of the synthetic liners in the sludge drying beds and the wastewater holding impoundment,

   d. regrade the sludge drying bed area and effluent holding pond area to achieve positive drainage,

   e. conduct post closure ground water monitoring at a frequency and duration that is approved by the NMED and is appropriate at the time of closure,

   f. restoring ground water quality to below WQCC Regulation 3103 standards should standards be exceeded as a result of LANL, SWSC Plant operations.

GENERAL DISCHARGE PLAN REQUIREMENTS

In addition to any other requirements provided by law, approval of discharge plan, DP-857, is subject to the following general requirements:

Monitoring and Reporting

Monitoring and reporting shall be as specified in the discharge plan and supplements thereto. These requirements are summarized on the attached sheet(s). Any inadvertent omissions from this summary of a discharge plan monitoring or reporting requirement shall not relieve you of responsibility for compliance with that requirement.

Record Keeping

1. The discharger shall maintain at the facility, a written record of ground water and wastewater quality analyses.

The following information shall be recorded and shall be made available to the NMED upon request.

a. The dates, exact place and times of sampling or field measurements.

b. The name and job title of the individuals who performed the sampling or measurements.

c. The dates the analyses were performed.

d. The name and job title of the individuals who performed the analyses.

e. The analytical techniques or methods used.

f. The results of such analyses, and

g. The results of any split sampling, spikes or repeat sampling.

2. The discharger shall maintain a written record of any spills, seeps, and/or leaks of effluent, leachate and/or process fluids not authorized by this discharge plan.

3. The discharger shall maintain a written record of the operation, maintenance and repair of facilities/equipment used to treat, store and/or dispose of wastewater; to measure flow rates; and/or to monitor water quality. This will include repairs, replacement or calibration of any monitoring equipment and repairs or replacement of any equipment used in LANL's waste or wastewater treatment and disposal system.

Inspection and Entry

In accordance with § 74-6-9.B & E NMSA 1978 and WQCC Regulation 3107.D., the discharger shall allow the Secretary or his authorized representative, upon the presentation of credentials, to:

1. Enter at regular business hours or at other reasonable times upon the discharger's premises or where records must be kept under the conditions of this discharge plan.

2. Inspect and copy, during regular business hours or at other reasonable times, any

records required to be kept under the conditions of the discharge plan.

3. Inspect, at regular business hours or at other reasonable times, any facility, equipment (including monitoring and control equipment), practices or operations regulated or required under this discharge plan.

4. Sample or monitor, at reasonable times for the purpose of assuring discharge plan compliance or as otherwise authorized by the New Mexico Water Quality Act, any effluent at any location before or after discharge.

Duty to Provide Information

In accordance with § 74-6-9.B NMSA 1978 and WQCC Regulation 3107.D., the discharger shall furnish to the NMED, within a reasonable time, any relevant information which it may request to determine whether cause exists for modifying, terminating and/or renewing this discharge plan or to determine compliance with this plan. The discharger shall furnish to the NMED, upon request, copies of records required to be kept by this discharge plan.

Spills, Leaks and Other Unauthorized Discharges

This approval authorizes only those discharges specified in the discharge plan. Any unauthorized discharges violate WQCC Regulation 3104, and must be reported to the NMED and remediated as required by WQCC Regulation 1203. This requirement applies to all seeps, spills, and/or leaks discovered from the delivery pipelines, treatment works, and storage impoundments or tanks.

Retention of Records

The discharger shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by this discharge plan, and records of all data used to complete the application for this discharge plan, for a period of at least five years from the date of the sample collection, measurement, report or application. This period may be extended by request of the Secretary at any time.

Enforcement

Failure to grant the Secretary or his authorized representative access to the records required to be kept by this discharge plan or to allow an inspection of the discharge facilities or to the collection of samples is a violation of this discharge plan and the WQCC Regulations. Such violations as well as other violations of the discharge plan, may subject the discharger to a compliance order, a compliance order assessing a civil penalty or an action in district court pursuant to § 74-6-10 NMSA 1978, and/or modification or termination of this discharge plan pursuant to § 74-6-5.L NMSA 1978. Penalties assessed as part of a compliance order shall not

exceed $15,000 per day for violations of the terms of this permit or the requirements of § 74-6-5 NMSA 1978, and shall not exceed $10,000 per day for violations of other sections of the Water Quality Act.

Modifications and/or Amendments

The discharger shall notify NMED, pursuant to WQCC Regs. 3107.C, of any modifications or additions to LANL's SWSC disposal system, including any increase in wastewater flow rate or wastewater storage and disposal management changes to the system as approved under this discharge plan. The discharger shall obtain NMED's approval, as a discharge plan modification, prior to any increase in the quantity or concentration of constituents in the leachate above those approved in this plan. Please note that WQCC Regs. 3109.E and F provide for possible future amendment of the plan.

Other Requirements

Please be advised that the approval of this plan does not relieve LANL of liability should your operation result in actual pollution of surface or ground water which may be actionable under other laws and/or regulations.

RIGHT TO APPEAL

If Mr. Todd is dissatisfied with this action taken by NMED, Mr. Todd may file a petition for hearing before the WQCC. This petition shall be in writing to the Water Quality Control Commission within thirty (30) days of the receipt of this letter. Unless a timely request for hearing is made, the decision of the NMED shall be final.

TRANSFER OF DISCHARGE PLAN

Pursuant to WQCC Regulation 3111, prior to any transfer of ownership, the discharger shall provide the transferee a copy of the discharge plan, including a copy of this approval letter and shall document such to the NMED.

PERIOD OF APPROVAL

Pursuant to WQCC Reg. 3109.G.4., this discharge plan approval is for a period of 5 years. This approval will expire January 7, 2003 and you must submit an application for renewal at least 120 days before that date.

On behalf of the staff of the Ground Water Pollution Prevention Section, I wish to thank you for your cooperation during the discharge plan review.

Sincerely,

Marcy Leavitt, Chief
Ground Water Quality Bureau

ML:PAB/pab

enc: Discharge Plan Summary, DP-857
NMEID Policy for the Use of Domestic Wastewater Effluent for Irrigation, December 1985

xc: James Bearzi, Dist. Manager, NMED Dist. II
SWQB

NMED, GROUND WATER SECTION, DISCHARGE PLAN SUMMARY

Discharge Plan Number..... 857
Date Report Generated..... 29-DEC-97
Staff Reviewer............ PHYLLIS BUSTAMANTE

Legally Responsible Party. TOM TODD AREA MANAGER, DOE 667-5105
Owner..................... LANL WWTP TA-46
528 35TH STREET
LOS ALAMOS NM 87544

Facility.................. LANL WWTP TA-46

Primary Waste Type........ DOMESTIC WASTE INSTITUTIONAL
Treatment................. WWTP TERTIARY
Discharge................. WATERCOURSE
Discharge Location........ 3.5 MILES SE OF LOS ALAMOS

Application Received...... 14-APR-97
Public Notice Published... 11-JUL-97
Discharge Plan Approved... 07-JAN-03
Discharge Plan Expires.... 07-JAN-98

Discharge Volume.. 600000 gpd
Depth to GW....... 1000 feet
TDS............... 165 mg/l

Monitoring Reports due.... 30-JAN 30-APR 30-JUL 30-OCT

Sampling Category	Annual Frequency	No. of Sites	Sampling Description
	4	1	Water levels in CBDO-6
2	4	3	WWTP effluent, and volume discharged through each outfall
3	4	4	Cl AND TDS from TA-46 reuse wet well, outfalls 001 and 01S, and CBDO-6
9	1	2	Ra 226 and 228 from TA-46 reuse wet well and CBDO-6
5	4	4	NO3 and TKN from TA-reuse wet well, outfalls 001 and 01S, and CBDO-6
6	1	2	Volatile and Semivolatile organics from TA-46 reuse wet well, and CBDO-6
4	1	2	Ag, As, Ba, Cd, CN, Cr, F, Hg, Pb, Se, Mn, So4, Zn from TA-46 reuse wet well and CBDO-6

_____ If this space is checked, monitoring requirements are summarized or explained in more detail on the attached sheet. Any inadvertent omission from this summary does not relieve the discharger of responsiblility for compliance with that requirement.

Send All monitoring reports or correspondence to:

PHYLLIS BUSTAMANTE
Ground Water Pollution Prevention Section
Environment Department
P.O. Box 26110
Santa Fe NM 87502
(505) 827-2900

Appendix 5

Metals TCLP Analysis for Solid Wastes

ASSAIGAI ANALYTICAL LABORATORIES, INC.
7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259
3332 Wedgewood Dr., Suite N • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes

B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS LABS
attn: **PATRICIA VARDARO-CHARLES**
MS JJ68
LOS ALAMOS, NM 87544

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS LABS**
Project: **0008385 6E10 JRR1 0000 0000**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Potable Trial
Client Sample ID: **POT "G"** Vendor D Ro Reject — Sample Matrix: **SOLID** — Sample Collected: 08/01/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-01B		**SW846 1311/3010A/6010A ICP TCLP**							
M001002	MW.2000.1319-70	7440-38-2	Arsenic	0.7	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-70	7782-49-2	Selenium	ND	mg / L	1	0.05		09/08/00
0008385-01B		**SW846 1311/7470 CVAA TCLP**							
M001023	MW.2000.1346-45	7439-97-6	Mercury	ND	mg / L	1	0.0002		09/13/00

Sanitary Reuse Trial
Client Sample ID: **SANI "G"** Vendor D Ro Reject — Sample Matrix: **SOLID** — Sample Collected: 08/22/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-02B		**SW846 1311/3010A/6010A ICP TCLP**							
M001002	MW.2000.1319-71	7440-38-2	Arsenic	0.4	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-71	7782-49-2	Selenium	ND	mg / L	1	0.05		09/08/00
0008385-02B		**SW846 1311/7470 CVAA TCLP**							
M001023	MW.2000.1346-46	7439-97-6	Mercury	ND	mg / L	1	0.0002		09/13/00

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS LABS**
Project: **0008385 6E10 JRR1 0000 0000**

Vendor C Potable Evaporator Bottoms

Client Sample ID **C.W. RO REJECT RESIDUE** Sample Matrix **SOLID** Sample Collected 08/28/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-03B		SW846 1311/3010A/6010A ICP TCLP							
M001002	MW.2000.1319-67	7440-38-2	Arsenic	0.4	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-67	7782-49-2	Selenium	ND	mg / L	1	0.05		09/08/00
0008385-03B		SW846 1311/7470 CVAA TCLP							
M001023	MW.2000.1350-9	7439-97-6	Mercury	ND	mg / L	1	0.0002		09/14/00

Vendor C Sanitary Filter Cake

Client Sample ID **TREATED SANITARY CAKE** Sample Matrix **SOLID** Sample Collected 08/29/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-04B		SW846 1311/3010A/6010A ICP TCLP							
M001002	MW.2000.1319-72	7440-38-2	Arsenic	ND	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-72	7782-49-2	Selenium	0.20	mg / L	1	0.05		09/08/00
0008385-04B		SW846 1311/7470 CVAA TCLP							
M001023	MW.2000.1350-10	7439-97-6	Mercury	ND	mg / L	1	0.0002		09/14/00

Vendor C Sanitary Evaporator Bottoms

Client Sample ID **SANITARY RO REJECT RESIDUE** Sample Matrix **SOLID** Sample Collected 08/29/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-05B		SW846 1311/3010A/6010A ICP TCLP							
M001002	MW.2000.1319-73	7440-38-2	Arsenic	0.4	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-73	7782-49-2	Selenium	0.10	mg / L	1	0.05		09/08/00
0008385-05B		SW846 1311/7470 CVAA TCLP							
M001023	MW.2000.1350-11	7439-97-6	Mercury	ND	mg / L	1	0.0002		09/14/00

Vendor C Potable Filter Cake

Client Sample ID **TREATED CITY CAKE COMP** Sample Matrix **SOLID** Sample Collected 08/29/00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0008385-06B		SW846 1311/3010A/6010A ICP TCLP							
M001002	MW.2000.1319-74	7440-38-2	Arsenic	ND	mg / L	1	0.1		09/08/00
M001002	MW.2000.1319-74	7782-49-2	Selenium	0.29	mg / L	1	0.05		09/08/00

Certificate of Analysis

Client: **LOS ALAMOS LABS**

Project **0008385** **6E10 JRR1 0000 0000**

0008386-06B **SW846 1311/7470 CVAA TCLP**

M001023	MW.2000.1350-12	7439-97-6	Mercury	ND	mg / L	1	0.0002	09/14/00

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

memo Insufficient sample amount was provided for fractions 0008385-01,-02, and -05 per TCLP method requirements. The required amount is 100g. 91g was provided for fracton 0008385-01, 95 g for fraction 0008385-02, and 44g was provided for sample 0008385-05. Samples were analyzed at the client's request. Method extraction ratios were followed for applicable sample weights.

Appendix 6

Estimated Plant Treatment Costs

Total Estimated Cost

Los Alamos
NATIONAL LABORATORY
Project Management Division
5-Jan-01
COST ESTIMATE

Vendor C Plant at TA-53 (LANSCE) plus Lift Station

The estimated cost for the Building / Lift Station / Piping / Engineering / Management is:

$1,424,412

Please note that the estimate **does not** include costs for:

- TREATMENT SYSTEM
- SPECIALTIES
- FURNISHINGS

Please note that the estimate **does** include costs for:

- ENGINEERING
- PROJECT MANAGEMENT
- JCNNM SUPPORT
- LABORATORY MARKUPS
- CONTINGENCY AND ESCALATION
- INSPECTION SERVICES
- LIFT STATION

	Costs by Contractor	Costs by LANL	Costs by JCNNM	Costs by A/E or Others
		$10,988		
		$32,963		$263,474
	$210,010			
	$650,745			
	$137,685			
			$36,492	
		$16,794		
		$44,870		$20,392
				$0
	$998,440 Costs by Contractors	$105,615 Costs by LANL	$36,492 Costs by JCNNM	$283,866 Costs by A/E or Others

check total $1,424,412

DESIGN PHASE

1 Design

a. Prelim

b. Fin

2 D

LOS ALAMOS NATIONAL LABORATORY

2 Pro

a.

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Conditions Date 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost				Extended Cost				Total
									Labor	Mat'	Equip	Sub.	Labor	Mat.	Eqpt.	Sub.	
		Superintendent ($65/hr for 60 days plus pickup) - 2 months	400	hr	1.00	1.00	65.00	400	$65		$5.00		$26,000		$2,000		$28,000
		Survey Crew - Layout, Control, Cross Sections	1	lot								$5,000				$5,000	$5,000
		Potholing Crew (Utility Locates by Abasto)	30	ea								$450				$13,500	$13,500
		Toilets / Flagging / Misc Items / Misc Equip (3 months)	1	lot								$500				$500	$500
		Clerk / Scheduler / Estimator / Admin / Safety Personnel - 1/3	160	hr	1.00	1.00	42.00	160	$42.00				$6,720				$6,720
		Training & Safety Meetings (1 hr every two days) - 6 workers	160	hr	1.00	1.00	35.66	160	$35.66				$5,706				$5,706
		Testing Laboratory (Soils, Metals, Concrete, Compaction)	1	lot								$2,500				$2,500	$2,500
		Storm Water Pollution Prevention	160	hr	1.00	1.00	32.00	160	$32.00	$20			$5,120	$3,200			$8,320
		Field Office, Computer, Fax	3	mo								$1,200				$3,600	$3,600
		As-builts	80	hr	1.00	1.00	40.00	80	$40.00	$10			$3,200	$800			$4,000
		Commissioning (does not include cooling tower)	40	hr	1.00	1.00	45.00	40	$45.00	$20			$1,800	$800			$2,600
		SUBTOTAL						1000					$48,546	$4,800	$2,000	$25,100	$80,446

	Subtotal :		$80,446
Overhead :		10.0%	$8,045
	Subtotal :		$88,490
Profit :		10.0%	$8,849
	Subtotal :		$97,339
Performance Bond :		0.4%	$409
	Subtotal :		$97,748
Gross Receipts Tax :		6.1%	$5,963
	TOTAL : Direct Costs plus Markups :		$103,711

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs — Location: Los Alamos National Laboratory
Project Engineer: P. Sena; Estimator(s): M. Ebbers — Division: General Conditions — Date: 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub	Total
1		Clear & Grub Site															
		Remove Approx 0 - 6" diam trees/bushes	8	ea	3.50	1.08	26.58	30	$100.47		$25.00		$804		$200		$1,004
		Remove Topsoil & Store (200' by 200' by 8") (w/20% expansion), includes dump truck	1,100	cy	0.04	1.08	26.58	48	$1.15		$2.50		$1,263		$2,750		$4,013
2		Fine Grade at Site	0.5	acre	24.00	1.08	26.58	13	$688.95		$1,200		$344		$600		$944
3		Asphalt Placement at Bldg (30' by 100')	500	sy	0.03	1.08	26.58	16	$0.83	$5	$0.59		$416	$2,745	$295		$3,456
4		Signage / Striping	1	lot								$300				$300	$300
5		Structural Excavation for lift station & Bldg	1	lot	40.00	1.08	26.58	43	$1,148.26		$400.00		$1,148		$400		$1,548
6		Structural Fill (6" depth under lift & Butler Building) (Crushed stone, max size 3/4")	150	ton	0.02	1.08	26.58	3	$0.60	$16	$0.57		$90	$2,460	$86		$2,636
7		Trench for PVC 6" diam Piping (approx. 4' deep) - 1/2 mile	500	cy	0.15	1.13	26.58	85	$4.51		$3.09		$2,253		$1,545		$3,798
		Backfill for PVC (assume exc mat'l good @ backfill)	500	cy	0.25	1.13	26.58	141	$7.51		$3.34		$3,754		$1,670		$5,424
		Haul-off for Supply and Return (3 mi. R.T.)		cy	0.05	1.08	26.58		$1.35		$2.63						
		Shoring Req & Moves (3 ea sets per month), ea is 40' lg		months	32.00	1.08	26.58		$918.60		$400.00	$12,000					
		Sand Bedding (trucked 10 miles)	55	cy	0.25	1.08	26.58	15	$7.18	$12	$2.13		$395	$660	$117		$1,172
		PVC Piping - 6" diameter, includes elbows, etc	2,640	lf	0.20	1.13	35.66	597	$8.06	$8	$2.00		$21,276	$21,120	$5,280		$47,676
		SUBTOTAL :						990					$31,744	$26,985	$12,943	$300	$71,972

Subtotal :		$71,972
Overhead :	10.0%	$7,197
Subtotal :		$79,169
Profit :	10.0%	$7,917
Subtotal :		$87,086
Performance Bond :	0.4%	$366
Subtotal :		$87,452
Gross Receipts Tax :	6.1%	$5,335
TOTAL : Direct Costs plus Markups :		$92,786

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition: Date: 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
9		Adjust for Utility Crossings (assume 3 crew week for utility interferences)	1	lot	360.00	1.13	35.66	407	$14,506	$5,000	$5,000		$14,506	$5,000	$5,000		$24,506
10		Water Line Installation & Tie-In (assume 8"; (assume Tyton) (PIV Valving Boxes)		lf lot	0.25	1.13	35.66		$10.07	$10 $4,000							
11		Gas Line Installation & Tie-In (1.5"), incl. Valves, boxes, etc		lf	0.11	1.13	35.66		$4.59	$5.82							
12		Trench / Backfill / Compact / Bed for above Gas & Water (assume same trench, water lower than gas) 16" by 4' deep		lf	0.05	1.13	26.58		$1.50	$2	$0.50						
18		Site Lighting, Drainage, Seeding, & Misc	1	lot								$16,000				$16,000	$16,000
		SUBTOTAL:						407					$14,506	$5,000	$5,000	$16,000	$40,506

Subtotal:		$40,506
Overhead:	10.0%	$4,051
Subtotal:		$44,557
Profit:	10.0%	$4,456
Subtotal:		$49,013
Performance Bond:	0.4%	$206
Subtotal:		$49,219
Gross Receipts Tax:	6.1%	$3,002
TOTAL: Direct Costs plus Markups:		$52,221

VI-6

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena Estimator(s): M. Ebbers
Location: Los Alamos National Laboratory
Division: General Condition: Date: 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
		Service Building															
		Floor Slab - 4,900 sf - 5" thick slab, reinf, inserts	4,900	sf								$5.50				$26,950	$26,950
		Epoxy coat at floor	4,900	sf								$2				$9,800	$9,800
		SUBTOTAL														$36,750	$36,750

	Subtotal :		$36,750
Overhead :		10.0%	$3,675
	Subtotal :		$40,425
Profit :		10.0%	$4,043
	Subtotal :		$44,468
Performance Bond :		0.4%	$187
	Subtotal :		$44,654
Gross Receipts Tax :		6.1%	$2,724
	TOTAL: Direct Costs plus Markups :		$47,378

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Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena; Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition
Date: 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
		Service Building (70' by 70' w/16' eave height)															
		Pre-engineered metal bldg - 4,900 sf	4,900	sf								$12.50				$61,250	$61,250
		hollow metal doors	7	ea								$800.00				$5,600	$5,600
		12' by 12' doors	2	ea								$1,160.00				$2,320	$2,320
		gravity ridge ventilators	3	ea								$700				$2,100	$2,100
		rotary vents	4	ea								$300.00				$1,200	$1,200
		louvers fixed	4	ea								$300.00				$1,200	$1,200
		aluminum sash	5	ea								$300.00				$1,500	$1,500
		fiberglass insulation, including ceiling	9,380	sf								$0.75				$7,035	$7,035
		Lift Station by Contractor															
		Pumps (includes standby pump)/ includes install	2	ea								$10,000				$20,000	$20,000
		Electrical Service by JCNNM at Lift Station	1	lot								$15,000				$15,000	$15,000
		Lift Station Structure w/Installation	1	lot								$20,000				$20,000	$20,000
		SUBTOTAL :														$137,205	$137,205

Subtotal :		$137,205
Overhead :		
Subtotal :		$137,205
Profit :		
Subtotal :		$137,205
Performance Bond :	0.4%	$576
Subtotal :		$137,781
Gross Receipts Tax :	6.1%	$8,405
TOTAL : Direct Costs plus Markups :		$146,186
GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$14,619
TOTAL :		**$160,805**

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-53 at LANSCE

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Conditions Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt (12% of labor, if applicable)	Extended Cost Sub.	Total
Building Piping																	
		[illegible] Piping PVC Systems 4" [illegible] pipe fittings & supports	200	lf	0.8	1.08	35.66	173	$31	$10			$6,162	$2,000	$739		$8,901
		Mechanical Square Foot Cost Allowance 4,900 sf - fire protection, single zone, gas heat, electric cooling	4,900	sf								$20.00				$98,000	$98,000
		Electrical Square Foot Cost Allowance 200 amp service, panel, feeds, fluorescent fix, recpt, lights	4,900	sf								$17.00				$83,300	$83,300
		SUBTOTAL :						173					$6,162	$2,000	$739	$181,300	$190,201

	Subtotal :		$190,201
Overhead :		15.0%	$28,530
	Subtotal :		$218,732
Profit :		10.0%	$21,873
	Subtotal :		$240,605
Performance Bond :		0.4%	$1,011
	Subtotal :		$241,615
Gross Receipts Tax :		6.1%	$14,739
	TOTAL : Direct Costs plus Markups :		$256,354
	GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$25,635
	TOTAL :		$281,989

Total Estimated Cost

Los Alamos

NATIONAL LABORATORY

Project Management Division

5-Jan-01

COST ESTIMATE

Vendor C Plant at TA-3 plus Lift Station

The estimated cost for the Building / Lift Station / Piping / Engineering / Management is:

$2,054,126

Please note that the estimate **does not** include costs for:

- TREATMENT SYSTEM
- SPECIALTIES
- FURNISHINGS

Please note that the estimate **does** include costs for:

- ENGINEERING
- PROJECT MANAGEMENT
- JCNNM SUPPORT
- LABORATORY MARKUPS
- CONTINGENCY AND ESCALATION
- INSPECTION SERVICES
- LIFT STATION

TA-3 - Vendor C Plant

[redacted]

TA-3 Vendor C Plant Incl Lift Station

ESTIMATE EFFECTIVE DATE PROJECT ELEMENT	6-Jan-01 ESTIMATED DIRECT COST	Start Date	Finish Date	Duration (mos.)	Midpoint Date	Rate	ESCALATION COST	ESCALATED COST	PROCUREMENT TAX	G&A	SUBTOTAL COST	CONTINGENCY %	CONTINGENCY COST	TOTAL ESTIMATED COST (TEC)	Costs by Contractor	Costs by LANL	Costs by JCNNM	Costs by A/E or Others
		ESCALATION CALCULATION																
A DESIGN PHASE																		
1 Design																		
a Preliminary (Title I) Design by A/E (none required)																		
b Final (Title II) Design by A/E @ 12% Escalation included (includes DEMO Plan)	$182,782	1-May-00	1-Sep-00	4	Jul-00		$0	$196,000	$8,633	$14,929	$219,562	20.0%	$43,612	$263,474				$263,474
2 Design Management by LANL																		
a Final Design (Title II) 80 hours)	$8,000	1-May-00	1-Sep-00	4	Jul-00	0.4%	$32	$8,032	$0	$1,124	$9,156	20.0%	$1,831	$10,988		$10,988		
3 Project Management Costs by LANL (240 hrs)	$24,000	1-May-00	1-Sep-00	4	Jul-00	0.4%	$96	$24,096	$0	$3,373	$27,469	20.0%	$5,494	$32,963		$32,963		
B. CONSTRUCTION PHASE																		
I. DEMOLITION ACTIVITIES																		
a. BY CONSTRUCTION CONTRACTOR																		
1 DEMOLITION ACTIVITIES (4 wks / 200 hr / wk / $75 hr) plus $40k for transformer demo & disp, plus $20k for tipping fees	$120,000	1-Oct-00	1-Dec-01	14	May-01	2.3%	$2,760	$122,760	$4,112	$14,576	$141,448	20.0%	$28,290	$169,738	$169,738			
II. CONSTRUCTION ACTIVITIES																		
a. BY CONSTRUCTION CONTRACTOR																		
1 Site Construction	$149,624	1-Oct-00	1-Dec-01	14	May-01	2.3%	$3,441	$153,065	$5,129	$718	$158,911	25.0%	$39,728	$198,639	$198,639			
2 Building (Fixed Price & Competitive Bid)	$852,433	1-Oct-00	1-Dec-01	14	May-01	2.3%	$19,606	$872,038	$29,213	$4,090	$905,342	25.0%	$226,336	$1,131,677	$1,131,677			
3 General Conditions	$96,491	1-Oct-00	1-Dec-01	14	May-01	2.3%	$2,219	$98,710	$3,307	$463	$102,480	25.0%	$25,620	$128,100	$128,100			
b. BY Treatment Facility Contractor																		
1		1-Oct-00	1-Dec-01	14	May-01	2.3%	$0	$0	$0		$0	20.0%	$0	$0				
d BY JOHNSON CONTROL NORTHERN NEW MEXICO (JCNNM)																		
1 JCNNM Support (200 hrs at $80 hr)	$16,000	1-Oct-00	1-Dec-01	14	May-01	2.3%	$368	$16,368	$37	$14,005	$30,410	20.0%	$6,082	$36,492			$36,492	
e BY LANL																		
1 LANL Standard Equipment (GFE)	$0	1-Oct-00	1-Dec-01	14	May-01	2.3%	$0	$0	$0	$0	$0	20.0%	$0	$0				
III PM / CM / ENGR / INSP DURING CONSTRUCTION																		
a BY LANL and A/E																		
1 Inspection & Design & Project Liaison																		
a. LANL Engineering Services (120 hours)	$12,000	1-Oct-00	1-Dec-01	14	May-01	2.3%	$276	$12,276	$0	$1,719	$13,996	20.0%	$2,799	$16,794		$16,794		
b Inspection Services by A/E (160 hrs)	$16,000	1-Oct-00	1-Dec-01	14	May-01	2.3%	$368	$16,368	$548	$77	$16,993	20.0%	$3,399	$20,392				$20,392
c A/E Design during Construction	$0	1-Oct-00	1-Dec-01	14	May-01	2.3%	$0	$0	$0	$0	$0	20.0%	$0	$0				$0
2 Project & Construction Management (PM/CM) by LANL																		
a LANL PM/CM Activities (320 hrs)	$32,000	1-Oct-00	1-Mar-02	17	Jun-01	2.5%	$800	$32,800	$0	$4,592	$37,392	20.0%	$7,478	$44,870		$44,870		
	$1,509,330			TOTAL COSTS			$29,967	$1,564,514	$48,976	$59,966	$1,653,158		$390,968	$2,054,126				
															$1,628,154 Costs by Contractors	$105,615 Costs by LANL	$36,492 Costs by JCNNM	$283,866 Costs by A/E or Others	

check total $2,054,126

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Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor c Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena ; Estimator(s) . M. Ebbers
Location: Los Alamos National Laboratory
Division: General Conditions
Date 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost: Labor	Unit Cost: Mat'	Unit Cost: Equip	Unit Cost: Sub.	Extended Cost: Labor	Extended Cost: Mat.	Extended Cost: Eqpt.	Extended Cost: Sub.	Total
		Superintendent ($65/hr for 60 days plus pickup) - 3 months	320	hr	1.00	1.00	65.00	320	$65		$5.00		$20,800		$1,600		$22,400
		Survey Crew - Layout, Control, Cross Sections	1	lot								$5,000				$5,000	$5,000
		Potholing Crew (Utility Locates by Abasto)	30	ea								$450				$13,500	$13,500
		Toilets / Flagging / Misc Items / Misc Equip (1 months)	1	lot								$500				$500	$500
		Clerk / Scheduler / Estimator / Admin / Safety Personnel - 1/3	160	hr	1.00	1.00	42.00	160	$42.00				$6,720				$6,720
		Training & Safety Meetings (1 hr every two days) - 6 workers	160	hr	1.00	1.00	35.66	160	$35.66				$5,706				$5,706
		Testing Laboratory (Soils, Metals, Concrete, Compaction)	1	lot								$2,500				$2,500	$2,500
		Storm Water Pollution Prevention	160	hr	1.00	1.00	32.00	160	$32.00	$20			$5,120	$3,200			$8,320
		Field Office, Computer, Fax	3	mo								$1,200				$3,600	$3,600
		As-Builts	80	hr	1.00	1.00	40.00	80	$40.00	$10			$3,200	$800			[illegible]
		Commissioning (does not include cooling tower)	40	hr	1.00	1.00	45.00	40	$45.00	$20			$1,800	$800			[illegible]
		SUBTOTAL :						920					$43,346	$4,800	$1,600	$25,100	$74,846

Subtotal :		$74,846
Overhead :	10.0%	$7,485
Subtotal :		$82,330
Profit :	10.0%	$8,233
Subtotal :		$90,563
Performance Bond :	0.4%	$380
Subtotal :		$90,944
Gross Receipts Tax :	6.1%	$5,548
TOTAL : Direct Costs plus Markups :		$96,491

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor c Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena . Estimator(s) : M. Ebbers
Location: Los Alamos National Laboratory
Division: General Conditions
Date: 1/5/2001

									Unit Cost				Extended Cost				
Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Labor	Mat'	Equip	Sub.	Labor	Mat.	Eqpt.	Sub.	Total
1		Clear & Grub Site															
		Remove Approx 0 - 6" diam trees/bushes	8	ea	3.50	1.08	26.58	30	$100.47		$25.00		$804		$200		$1,004
		Remove Topsoil & Store (200' by 200' by 8")		cy	0.04	1.08	26.58		$1.15		$2.50						
		(w/20% expansion), includes dump truck															
2		Fine Grade at Site	0.5	acre	24.00	1.08	26.58	13	$688.95		$1,200		$344		$600		$944
3		Asphalt Placement at Bldg (50 by 100)	500	sy	0.03	1.08	26.58	16	$0.83	$5	$0.59		$416	$2,745	$295		$3,456
4		Signage / Striping	1	lot								$300				$300	$300
5		Structural Excavation for lift station & Bldg	1	lot	40.00	1.08	26.58	43	$1,148.26		$400.00		$1,148		$400		$1,548
6		Structural Fill (6" depth under lift station)	100	ton	0.02	1.08	26.58	2	$0.60	$16	$0.57		$60	$1,640	$57		$1,757
		(Crushed stone max size 3/4")															
7		Trench for PVC 8" diam Piping (approx. 4' deep) - 1/2 mile	650	cy	0.15	1.13	26.58	110	$4.51		$3.09		$2,928		$2,009		$4,937
		Backfill for PVC (assume exc mat'l good @ backfill)	650	cy	0.25	1.13	26.58	184	$7.51		$3.34		$4,881		$2,171		$7,052
		Haul-off for Supply and Return (3 mi. R.T.)		cy	0.05	1.08	26.58		$1.35		$2.63						
		Shoring Req & Moves (3 ea sets per month), ea is 40' lg		months	32.00	1.08	26.58		$918.60		$400.00	$12,000					
		Sand Bedding (trucked 10 miles)	75	cy	0.25	1.08	26.58	20	$7.18	$12	$2.13		$538	$900	$160		$1,598
		PVC Piping - 8" diameter, includes elbows, etc	2,640	lf	0.20	1.13	35.66	597	$8.06	$10	$2.00		$21,276	$26,400	$5,280		$52,956
		SUBTOTAL :						1015					$32,397	$31,685	$11,171	$300	$75,553

Subtotal :		$75,553
Overhead :	10.0%	$7,555
Subtotal :		$83,108
Profit :	10.0%	$8,311
Subtotal :		$91,419
Performance Bond :	0.4%	$384
Subtotal :		$91,803
Gross Receipts Tax :	6.1%	$5,600
TOTAL : Direct Costs plus Markups :		$97,403

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor c Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena , Estimator(s) : M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub	Total
9		Adjust for Utility Crossings (assume 3 crew week for utility interferences)	1	lot	360.00	1.13	35.66	407	$14,506	$5,000	$5,000		$14,506	$5,000	$5,000		$24,506
10		Water Line Installation & Tie-In (assume 8") (assume Tyton)		lf	0.25	1.13	35.66		$10.07	$10							
		(PIV, Valving, Boxes)		lot						$4,000							
11		Gas Line Installation & Tie-In (1.5"), incl. Valves, boxes, etc		lf	0.11	1.13	35.66		$4.59	$5.82							
12		Trench / Backfill / Compact / Bed for above Gas & Water (assume same trench, water lower than gas) 16" by 4' deep		lf	0.05	1.13	26.58		$1.50	$2	$0.50						
18		Site Lighting, Drainage, Seeding, & Misc	1	lot								$16,000				$16,000	$16,000
		SUBTOTAL :						407					$14,506	$5,000	$5,000	$16,000	$40,506

Subtotal :		$40,506
Overhead :	10.0%	$4,051
Subtotal :		$44,557
Profit :	10.0%	$4,456
Subtotal :		$49,013
Performance Bond :	0.4%	$206
Subtotal :		$49,219
Gross Receipts Tax :	6.1%	$3,002
TOTAL : Direct Costs plus Markups		$52,221

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena, Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition: Date: 1/5/2001

									Unit Cost				Extended Cost				
Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Labor	Mat'	Equip	Sub.	Labor	Mat.	Eqpt.	Sub.	Total
		Service Building															
		Floor Slab - 10,000 sf., 5" thick slab, reinf. inserts	10,000	sf								$5.50				$55,000	$55,000
		Epoxy coat at floor	10,000	sf								$2				$20,000	$20,000
		SUBTOTAL.														$75,000	$75,000

Subtotal :		$75,000
Overhead :	10.0%	$7,500
Subtotal :		$82,500
Profit :	10.0%	$8,250
Subtotal :		$90,750
Performance Bond :	0.4%	$381
Subtotal :		$91,131
Gross Receipts Tax :	6.1%	$5,559
TOTAL : Direct Costs plus Markups :		$96,690

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena ; Estimator(s) : M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition:
Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub	Total
		Service Building (100' by 100' w/16' eave height)															
		Pre-engineered metal bldg - 10,000 sf	10,000	sf								$12.50				$125,000	$125,000
		hollow metal doors	4	ea								$800.00				$3,200	$3,200
		12' by 12' doors	2	ea								$1,160.00				$2,320	$2,320
		gravity ridge ventilators	3	ea								$700				$2,100	$2,100
		rotary vents	4	ea								$300.00				$1,200	$1,200
		louvers fixed	4	ea								$300.00				$1,200	$1,200
		aluminum sash	6	ea								$300.00				$1,800	$1,800
		fiberglass insulation, including ceiling	16,400	sf								$0.75				$12,300	$12,300
		Lift Station by Contractor															
		Pumps (includes standby pump)/ includes instal	2	ea								$16,000				$32,000	$32,000
		Electrical Service by JCNNM at Lift Station	1	lot								$15,000				$15,000	$15,000
		Lift Station Structure w/Installation	1	lot								$20,000				$20,000	$20,000
		SUBTOTAL :														$216,120	$216,120

Subtotal :		$216,120
Overhead :		
Subtotal :		$216,120
Profit :		
Subtotal :		$216,120
Performance Bond :	0.4%	$908
Subtotal :		$217,028
Gross Receipts Tax :	6.1%	$13,239
TOTAL : Direct Costs plus Markups		$230,266
GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$23,027
TOTAL :		**$253,293**

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor C Plant at TA-3 plus Lift Station

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena . Estimator(s) . M. Ebbers

Location: Los Alamos National Laboratory
Division: General Conditions
Date . 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt. (12% of labor, if applicable)	Extended Cost Sub	Total
Building Piping																	
		Building Piping / PVC Systems - 4" at bldg. - pipe, fittings, & supports	200	lf	0.8	1.08	35.66	173	$31	$10			$6,162	$2,000	$739		$8,901
		Mechanical Square Foot Cost Allowance 10000 sf - fire protection, single zone, gas heat, electric cooling	10,000	sf								$18.00				$180,000	$180,000
		Electrical Square Foot Cost Allowance 200 amp service, panel, feeds, fluorescent fix, recpt, lights	10,000	sf								$15.00				$150,000	$150,000
		SUBTOTAL :						173					$6,162	$2,000	$739	$330,000	$338,901

Subtotal :		$338,901
Overhead :	15.0%	$50,835
Subtotal :		$389,737
Profit :	10.0%	$38,974
Subtotal :		$428,710
Performance Bond :	0.4%	$1,801
Subtotal :		$430,511
Gross Receipts Tax :	6.1%	$26,261
TOTAL : Direct Costs plus Markups :		$456,772
GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$45,677
TOTAL :		$502,449

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Total Estimated Cost

Los Alamos
NATIONAL LABORATORY
Project Management Division
5-Jan-01
COST ESTIMATE

TA-46 Vendor D Plant Construction and Infrastructure

The estimated cost for the Building / Piping / Engineering / Management is:

$1,525,004

Please note that the estimate **does not** include costs for:
- TREATMENT SYSTEM
- SPECIALTIES
- FURNISHINGS

Please note that the estimate **does** include costs for:
- ENGINEERING
- PROJECT MANAGEMENT
- JCNNM SUPPORT
- LABORATORY MARKUPS
- CONTINGENCY AND ESCALATION
- INSPECTION SERVICES

General Conditions

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena ; Estimator(s) : M. Ebbers
Location: Los Alamos National Laboratory
Division: General Conditions
Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
		Superintendent ($65/hr for 60 days plus pickup) - 2 months	160	hr	1.00	1.00	65.00	160	$65		$5.00		$10,400		$800		$11,200
		Survey Crew - Layout, Control, Cross Sections	1	lot								$1,200				$1,200	$1,200
		Potholing Crew (Utility Locates by Abasto)	4	ea								$450				$1,800	$1,800
		Toilets / Flagging / Misc Items / Misc Equip (1 months)	1	lot								$500				$500	$500
		Clerk / Scheduler / Estimator / Admin / Safety Personnel - 1/3	80	hr	1.00	1.00	42.00	80	$42.00				$3,360				$3,360
		Training & Safety Meetings (1 hr every two days) - 6 workers	40	hr	1.00	1.00	35.66	40	$35.66				$1,426				$1,426
		Testing Laboratory (Soils, Metals, Concrete, Compaction)	1	lot								$1,500				$1,500	$1,500
		Storm Water Pollution Prevention	80	hr	1.00	1.00	32.00	80	$32.00	$20			$2,560	$1,600			$4,160
		Field Office, Computer, Fax	2	mo								$1,200				$2,400	$2,400
		"As-builts"	40	hr	1.00	1.00	40.00	40	$40.00	$10			$1,600	$400			$2,000
		Commissioning (does not include cooling tower)	16	hr	1.00	1.00	45.00	16	$45.00	$20			$720	$320			$1,040
		SUBTOTAL :						416					$20,066	$2,320	$800	$7,400	$30,586

Subtotal :		$30,586
Overhead :	10.0%	$3,059
Subtotal :		$33,645
Profit :	10.0%	$3,365
Subtotal :		$37,010
Performance Bond :	0.4%	$155
Subtotal :		$37,165
Gross Receipts Tax :	6.1%	$2,267
TOTAL : Direct Costs plus Markups		$39,432

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs — Location: Los Alamos National Laboratory
Project Engineer: P. Sena, Estimator(s): M. Ebbers — Division: General Condition: — Date: 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
1		Clear & Grub Site															
		Remove Approx 10 - 6" diam trees/bushes	10	ea	3.50	1.08	26.58	38	$100.47		$25.00		$1,005		$250		$1,255
		Remove Topsoil & Store (200' by 200' by 8")	1,185	cy	0.04	1.08	26.58	51	$1.15		$2.50		$1,361		$2,963		$4,323
		(w/20% expansion), includes dump truck															
2		Fine Grade at Site	1.0	acre	24.00	1.08	26.58	26	$688.95		$1,200		$689		$1,200		$1,889
3		Asphalt Placement at Bldg (100 by 100)	1,000	sy	0.03	1.08	26.58	31	$0.83	$5	$0.59		$832	$5,490	$590		$6,912
4		Signage / Striping	1	lot								$300				$300	$300
5		Structural Excavation for slab	1	lot	64.00	1.08	26.58	69	$1,837.21		$400.00		$1,837		$400		$2,237
6		Structural Fill (6" depth under fac)	340	ton	0.02	1.08	26.58	8	$0.60	$16	$0.57		$205	$5,576	$194		$5,975
		(Crushed stone, max size 3/4")															
7		Trench for PVC 8" diam Piping (approx. 4' deep) - 140 ft	35	cy	0.08	1.13	26.58	3	$2.40		$3.09		$84		$108		$192
		Backfill for TWS & TWR (assume exc mat'l good @ backfil)	35	cy	0.25	1.13	26.58	10	$7.51		$3.34		$263		$117		$380
		Haul-off for Supply and Return (3 mi. R.T.)		cy	0.05	1.08	26.58		$1.35		$2.63						
		Shoring Req & Moves (3 ea sets per month), ea is 40' lg		months	32.00	1.08	26.58		$918.60		$400.00	$12,000					
		Sand Bedding (trucked 10 miles)	5	cy	0.25	1.08	26.58	1	$7.18	$12	$2.13		$36	$60	$11		$107
		PVC Piping - 8" diameter, includes elbows, etc	150	lf	0.40	1.13	35.66	68	$16.12	$20	$2.00		$2,418	$3,000	$300		$5,718
		SUBTOTAL:						305					$8,730	$14,126	$6,132	$300	$29,288

Subtotal:		$29,288
Overhead:	10.0%	$2,929
Subtotal:		$32,216
Profit:	10.0%	$3,222
Subtotal:		$35,438
Performance Bond:	0.4%	$149
Subtotal:		$35,587
Gross Receipts Tax:	6.1%	$2,171
TOTAL: Direct Costs plus Markups:		$37,758

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena ; Estimator(s) : M. Ebbers

Location: Los Alamos National Laboratory
Division: General Conditions
Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost				Extended Cost				Total
									Labor	Mat'l	Equip	Sub.	Labor	Mat	Eqpt.	Sub.	
9		Adjust for Utility Crossings	1	lot	120.00	1.13	35.66	136	$4,835	$2,000	$1,000		$4,835	$2,000	$1,000		$7,835
		(assume 1 crew week for utility interferences)															
10		Water Line Installation & Tie-In (assume 8") (assume Tyton)		lf	0.25	1.13	35.66		$10.07	$10							
		(PIV, Valving Boxes)		lot						$4,000							
11		Gas Line Installation & Tie-In (1.5"), incl. Valves, boxes, etc		lf	0.11	1.13	35.66		$4.59	$5.82							
12		Trench / Backfill / Compact / Bed for above Gas & Water		lf	0.05	1.13	26.58		$1.50	$2	$0.50						
		(assume same trench, water lower than gas) 16" by 4' deep															
13		Site Lighting, Drainage, Seeding	1	lot								$16,000				$16,000	$16,000
		SUBTOTAL						136					$4,835	$2,000	$1,000	$16,000	$23,835

Subtotal :		$23,835
Overhead :	10.0%	$2,384
Subtotal :		$26,219
Profit :	10.0%	$2,622
Subtotal :		$28,841
Performance Bond :	0.4%	$121
Subtotal :		$28,962
Gross Receipts Tax :	6.1%	$1,767
TOTAL : Direct Costs plus Markups :		$30,729

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title: Estimate for Gross Costs
Project Engineer: P. Sena Estimator(s): M. Ebbers

Location: Los Alamos National Laboratory
Division: General Condition: Date: 1/5/2001

									Unit Cost				Extended Cost				
Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Labor	Mat'l	Equip	Sub.	Labor	Mat.	Eqpt.	Sub.	Total
		Service Building															
		Floor Slab - 10,000 sf., 5" thick slab, reinf. inserts	10,000	sf								$5.50				$55,000	$55,000
		Epoxy coat at floor	10,000	sf								$2				$20,000	$20,000
		SUBTOTAL:														$75,000	$75,000

	Subtotal		$75,000
Overhead:		10.0%	$7,500
	Subtotal:		$82,500
Profit:		10.0%	$8,250
	Subtotal:		$90,750
Performance Bond:		0.4%	$381
	Subtotal:		$91,131
Gross Receipts Tax:		6.1%	$5,559
	TOTAL: Direct Costs plus Markups:		$96,690

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title Estimate for Gross Costs — Location: Los Alamos National Laboratory
Project Engineer: P. Sena · Estimator(s) : M. Ebbers — Division: General Condition: — Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt.	Extended Cost Sub.	Total
		Service Building (100' by 100' w/16' eave height)															
		Pre-engineered metal bldg - 10,000 sf	10,000	sf								$12.50				$125,000	$125,000
		hollow metal doors	4	ea								$800.00				$3,200	$3,200
		12' by 12' doors	2	ea								$1,160.00				$2,320	$2,320
		gravity ridge ventilators	3	ea								$700				$2,100	$2,100
		rotary vents	4	ea								$300.00				$1,200	$1,200
		louvers fixed	4	ea								$300.00				$1,200	$1,200
		aluminum sash	8	ea								$300.00				$2,400	$2,400
		fiberglass insulation, including ceiling	15,600	sf								$0.75				$11,700	$11,700
		SUBTOTAL :														$149,120	$149,120

Subtotal :		$149,120
Overhead :		
Subtotal :		$149,120
Profit :		
Subtotal :		$149,120
Performance Bond :	0.4%	$626
Subtotal :		$149,746
Gross Receipts Tax :	6.1%	$9,135
TOTAL : Direct Costs plus Markups :		$158,881
GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$15,888
TOTAL :		**$174,769**

Los Alamos
NATIONAL LABORATORY
Project Management Division

LOS ALAMOS NATIONAL LABORATORY

Vendor D Plant:Metal Bldg w/Ancillary Piping at TA-46

COST ESTIMATE WORKSHEET

Project Title : Estimate for Gross Costs
Project Engineer : P. Sena ; Estimator(s) : M. Ehbers

Location: Los Alamos National Laboratory
Division: General Conditions   Date : 1/5/2001

Item	ID	DESCRIPTION	Qnty	Unit	MH/ Unit	Labor Fact	Labor Rate	Total MH	Unit Cost Labor	Unit Cost Mat'l	Unit Cost Equip	Unit Cost Sub.	Extended Cost Labor	Extended Cost Mat.	Extended Cost Eqpt. (12% of labor, if applicable)	Extended Cost Sub.	Total
Building Piping																	
		Building Piping / PVC Systems - 4" at bldg - pipe, fittings, & supports	50	lf	1.5	1.08	35.66	81	$58	$10			$2,888	$500	$347		$3,735
		Mechanical Square Foot Cost Allowance 10000 sf - fire protection, single zone, gas heat, electric cooling	10,000	sf								$18.00				$180,000	$180,000
		Electrical Square Foot Cost Allowance 200 amp service, panel, feeds, fluorescent fix, recept, lights	10,000	sf								$15.00				$150,000	$150,000
		SUBTOTAL :						81					$2,888	$500	$347	$330,000	$333,735

Subtotal :		$333,735
Overhead :	15.0%	$50,060
Subtotal :		$383,795
Profit :	10.0%	$38,380
Subtotal :		$422,175
Performance Bond :	0.4%	$1,773
Subtotal :		$423,948
Gross Receipts Tax :	6.1%	$25,861
TOTAL : Direct Costs plus Markups :		$449,809
GENERAL CONTRACTOR'S MARKUP ON SUB - 10%		$44,981
TOTAL :		**$494,790**