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# Arsenic Removal from Drinking Water by Adsorptive Media
# U.S. EPA Demonstration Project at Desert Sands MDWCA, NM
# Final Performance Evaluation Report

by

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Sally Gutierrez, Director
National Risk Management Research Laboratory

## ABSTRACT

This report documents the activities performed and the results obtained for the arsenic removal treatment technology demonstration project at the Desert Sands Mutual Domestic Water Consumers Association (MDWCA) facility in Anthony, NM. The objectives of the project were to evaluate 1) the effectiveness of Severn Trent Services' (STS) Arsenic Package Unit-300 (APU-300) SORB 33™ media in removing arsenic to meet the new arsenic maximum contaminant level (MCL) of 10 µg/L, 2) the reliability of the treatment system, 3) the simplicity of required system operation and maintenance (O&M) and operator skill levels, and 4) the cost-effectiveness of the technology. The project also characterized water in the distribution system and process residuals produced by the treatment system.

SORB 33™ media is an iron-based adsorptive media developed by Bayer AG and marketed by STS. Two media runs were conducted in the performance study, with the first utilizing the granular form of the media (–S) and the second utilizing the pelletized form (–P). According to the vendor, SORB 33™–P is an improved version of the granular form (SORB 33™–S) and has more robust physical integrity. The two forms of media have the same composition, but a different bulk density and media particle size distribution.

The APU-300 system consisted of two 63-in-diameter, 86-in-tall pressure vessels in parallel configuration. Each pressure vessel initially contained 80 $ft^3$ of SORB 33™–S media or 62 $ft^3$ of SORB 33™–P media. The adsorptive media were supported by a gravel underbed. Based on a design flowrate of 320 gal/min (gpm), empty bed contact times (EBCTs) for the system were 3.7 and 2.9 min, for the SORB 33™ –S and –P media, respectively. Hydraulic loading to each vessel based on the design flowrate was 7.4 gpm/$ft^2$.

The first media run operated from January 16, 2004 through July 14, 2005, treating approximately 52,645,000 gal of water based on totalizer readings from each vessel. The APU-300 system operated 6.2 hr/day with an average flowrate of 271 gpm. The second media run operated from July 29, 2005 through August 16, 2006, and treated approximately 46,553,000 gal of water based on totalizer readings from each vessel. The APU-300 system operated 7.8 hr/day with an average flowrate of 251 gpm. The EBCTs ranged from 3.1 to 7.5 min for the first media run, and from 2.5 to 6.2 min for the second.

Breakthrough of total arsenic at concentration above the 10 µg/L target MCL occurred at approximately 40,600 bed volumes (BV) during the first media run, representing approximately 62% of the vendor-estimated working capacity of 66,000 BV. During the second media run, breakthrough of arsenic occurred at approximately 49,500 BV, representing about 58% of the estimated working capacity of 85,200 BV.

During the study, total arsenic concentrations in source water ranged from 18.6 to 30.1 µg/L with As(III) comprising a significant portion of the total soluble arsenic with concentrations ranging from 17.6 to 25.2 µg/L. Prechlorination was effective in oxidizing As(III) to As(V), as evident by the low As(III) concentrations (i.e., averaged 2.0 µg/L) in water sampled immediately after prechlorination. Total and free chlorine residuals measured before and after the adsorption vessels were at the equivalent levels of 0.4 to 0.8 mg/L (as $Cl_2$) and 0.3 to 1.0 mg/L (as $Cl_2$), respectively, indicating little or no chlorine consumption by the SORB 33™ media. Concentrations of iron, manganese, silica, orthophosphate, and other ions in raw water were not high enough to impact arsenic removal by the media.

Backwash wastewater contained soluble arsenic concentrations ranging from 6.4 to 22.2 µg/L, and averaging 13.3 µg/L. The average soluble arsenic concentration was lower than that in raw water, indicating removal of some soluble arsenic by the media during backwash. Soluble iron and soluble

manganese concentrations ranged from <25 to 373 and 1.8 to 27.1 µg/L, respectively. As expected, total arsenic, iron, and manganese concentrations were considerably higher than soluble concentrations, indicating the presence of particulate metals in the backwash wastewater. Particulate As might be associated with either iron particles intercepted by the media beds during the service cycle or the media fines. Based on the total suspended solid (TSS) values, approximately 9.1 lb of suspended solid was produced in 10,000 gal of backwash wastewater from both vessels during each backwash event.

The spent media passed the Toxicity Characteristic Leaching Procedure (TCLP) test for all Resource Conservation and Recovery Act (RCRA) metals, with only barium showing detectable concentrations ranging from 0.61 to 0.76 mg/L. The average arsenic loading on the spent media as analyzed by inductively coupled plasma-mass spectrometry (ICP-MS) was 2.2 mg/g or 0.22% on SORB 33™–S media and 1.6 mg/g or 0.16% on SORB 33™–P media. These loadings compared well with the average adsorptive capacities, i.e., 2.1 and 1.7 mg/g, respectively, as calculated by dividing the area between the influent and effluent breakthrough curves by the amount of dry media in each vessel.

Distribution system water samples were collected to determine any impact of arenic treatment on the lead and copper levels and water chemistry in the distribution system. Comparison of the distribution system sampling results before and after the operation of the APU-300 system showed a decrease in arsenic concentrations (from 22.4 to 28.2 µg/L to 1.8 to 19.0 µg/L) at all three sampling locations. However, the concentrations measured at the distribution system were higher than those in the system effluent. This likely was due to the blending with untreated water produced by a separate well in the distribution system. Neither lead nor copper concentrations at the sample sites appear to have been affected by the operation of the system.

The capital investment cost of $153,000 included $112,000 for equipment, $23,000 for site engineering, and $18,000 for installation. Using the system's rated capacity of 320 gpm, the capital cost was $478/gpm of design capacity and the equipment-only cost was $350/gpm of design capacity. These calculations did not include the cost of a building addition to house the treatment system. The unit annualized capital cost was $0.09/1,000 gal, assuming the system operated 24 hours a day, 7 days a week, at the system design flowrate of 320 gpm for 20 years at 7% interest. The system operated only 7 hr/day on average, producing 40,395,000 gal of water per year. At this reduced usage rate, the unit annualized capital cost increased to $0.37/1,000 gal.

The O&M cost of the APU-300 system was estimated at $0.74/1,000 gal, which included media replacement and disposal, chemical supply, electricity consumption, and labor. Because the incremental costs for chemical supply and electricity were negligible, only media replacement and disposal and O&M labor would impact O&M costs.

The APU-300 system experienced excessive flow restriction, imbalanced flow, and/or elevated pressure differential across the adsorption vessels and the entire system during the first four months of system operation. After extensive on-site and off-site investigations and hydraulic testing, the system was retrofitted in May 2004 and, thus, able to operate according to the original design specifications.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| $\Delta p$ | differential pressure |
| | |
| AAL | American Analytical Laboratories |
| Al | aluminum |
| AM | adsorptive media |
| APU | arsenic package unit |
| As | arsenic |
| | |
| bgs | below ground surface |
| BV | bed volume(s) |
| | |
| C/F | coagulation/filtration |
| Ca | calcium |
| $Cl_2$ | chlorine |
| CRF | capital recovery factor |
| Cu | copper |
| | |
| DO | dissolved oxygen |
| | |
| EBCT | empty bed contact time |
| EPA | U.S. Environmental Protection Agency |
| | |
| F | fluoride |
| Fe | iron |
| FRP | fiberglass reinforced plastic |
| | |
| GFH | granular ferric hydroxide |
| gpd | gallons per day |
| gpm | gallons per minute |
| | |
| HDPE | high-density polyethylene |
| | |
| ICP-MS | inductively coupled plasma-mass spectrometry |
| ID | identification |
| IX | ion exchange |
| | |
| LCR | (EPA) Lead and Copper Rule |
| | |
| MCL | maximum contaminant level |
| MDL | method detection limit |
| MDWCA | Mutual Domestic Water Consumers Association |
| Mg | magnesium |
| mg/L | milligrams per liter |
| μg/L | micrograms per liter |
| Mn | manganese |
| Mo | molybdenum |
| mV | millivolts |

| | |
|---|---|
| Na | sodium |
| NA | not available |
| NaOCl | sodium hypochlorite |
| NMED | New Mexico Environmental Department |
| NTU | nephelometric turbidity unit |
| | |
| O&M | operation and maintenance |
| ORD | Office of Research and Development |
| ORP | oxidation-reduction potential |
| | |
| P&ID | piping and instrumentation diagram |
| Pb | lead |
| PLC | programmable logic controller |
| psi | pounds per square inch |
| $PO_4$ | orthophosphate |
| PVC | polyvinyl chloride |
| | |
| QA | quality assurance |
| QA/QC | quality assurance/quality control |
| QAPP | Quality Assurance Project Plan |
| | |
| RCRA | Resource Conservation and Recovery Act |
| RPD | relative percent difference |
| | |
| Sb | antimony |
| SDWA | Safe Drinking Water Act |
| $SiO_2$ | silica |
| SM | system modification |
| $SO_4$ | sulfate |
| SOC | synthetic organic compound |
| STMGID | South Truckee Meadows General Improvement District |
| STS | Severn Trent Services |
| | |
| TBD | to be determined |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TDS | total dissolved solids |
| TOC | total organic carbon |
| TSS | total suspended solids |
| | |
| V | vanadium |
| VOC | volatile organic compound |
| | |
| WRWC | White Rock Water Company |

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# 1.0 INTRODUCTION

## 1.1 Background

The Safe Drinking Water Act (SDWA) mandates that U.S. Environmental Protection Agency (EPA) identify and regulate drinking water contaminants that may have adverse human health effects and that are known or anticipated to occur in public water supply systems. In 1975 under the SDWA, EPA established a maximum contaminant level (MCL) for arsenic at 0.05 mg/L. Amended in 1996, the SDWA required that EPA develop an arsenic research strategy and publish a proposal to revise the arsenic MCL by January 2000. On January 18, 2001, EPA finalized the arsenic MCL at 0.01 mg/L (EPA, 2001). In order to clarify the implementation of the original rule, EPA revised the rule text on March 25, 2003 to express the MCL as 0.010 mg/L (10 µg/L) (EPA, 2003). The final rule required all community and non-transient, non-community water systems to comply with the new standard by January 23, 2006.

In October 2001, EPA announced an initiative for additional research and development of cost-effective technologies to help small community water systems (<10,000 customers) meet the new arsenic standard, and to provide technical assistance to operators of small systems in order to reduce compliance costs. As part of this Arsenic Rule Implementation Research Program, EPA's Office of Research and Development (ORD) proposed a project to conduct a series of full-scale, on-site demonstrations of arsenic removal technologies, process modifications, and engineering approaches applicable to small systems. Shortly thereafter, an announcement was published in the *Federal Register* requesting water utilities interested in participating in Round 1 of this EPA-sponsored demonstration program to provide information on their water systems. In June 2002, EPA selected 17 out of 115 sites to host the demonstration studies, including the Desert Sands Mutual Domestic Water Consumers Association (MDWCA) water system in Anthony, NM.

In September 2002, EPA solicited proposals from engineering firms and vendors for cost-effective arsenic removal treatment technologies for the 17 host sites. EPA received 70 technical proposals for the 17 host sites, with each site receiving from one to six proposals. In April 2003, an independent technical panel reviewed the proposals and provided its recommendations to EPA on the technologies that it determined were acceptable for the demonstration at each site. Because of funding limitations and other technical reasons, only 12 of the 17 sites were selected for the demonstration project. Using the information provided by the review panel, EPA, in cooperation with the host sites and the drinking water programs of the respective states, selected one technical proposal for each site. Severn Trent Services (STS), using the Bayoxide E33 media developed by Bayer AG, was selected for the Desert Sands MDWCA facility in Anthony, NM. STS has given the E33 media the designation "SORB 33™".

## 1.2 Treatment Technologies for Arsenic Removal

The technologies selected for the 12 Round 1 EPA arsenic removal demonstration host sites include nine adsorptive media systems, one anion exchange system, one coagulation/filtration system, and one process modification with iron addition. Table 1-1 summarizes the locations, technologies, vendors, and key source water quality parameters of the 12 demonstration sites. An overview of the technology selection and system design (Wang et al., 2004) and the associated capital costs for each site (Chen et al., 2004) are provided on the EPA website at http://www.epa.gov/ORD/NRMRL/arsenic/ resource.htm. As of September 2008, all 12 systems were operational, and the performance evaluation of 11 systems was completed.

**Table 1-1. Summary of Round 1 Arsenic Removal Demonstration Sites**

| Demonstration Site | Technology (Media) | Vendor | Design Flowrate (gpm) | Source Water Quality | | |
|---|---|---|---|---|---|---|
| | | | | As (µg/L) | Fe (µg/L) | pH |
| WRWC, NH | AM (G2) | ADI | 70[(a)] | 39 | <25 | 7.7 |
| Rollinsford, NH | AM (E33) | AdEdge | 100 | 36[(b)] | 46 | 8.2 |
| Queen Anne's County, MD | AM (E33) | STS | 300 | 19[(b)] | 270[(c)] | 7.3 |
| Brown City, MI | AM (E33) | STS | 640 | 14[(b)] | 127[(c)] | 7.3 |
| Climax, MN | C/F (Macrolite) | Kinetico | 140 | 39[(b)] | 546[(c)] | 7.4 |
| Lidgerwood, ND | SM | Kinetico | 250 | 146[(b)] | 1,325[(c)] | 7.2 |
| Desert Sands MDWCA, NM | AM (E33) | STS | 320 | 23[(b)] | 39 | 7.7 |
| Nambe Pueblo, NM | AM (E33) | AdEdge | 145 | 33 | <25 | 8.5 |
| Rimrock, AZ | AM (E33) | AdEdge | 90[(a)] | 50 | 170 | 7.2 |
| Valley Vista, AZ | AM (AAFS50/ARM 200) | Kinetico | 37 | 41 | <25 | 7.8 |
| Fruitland, ID | IX (A300E) | Kinetico | 250 | 44 | <25 | 7.4 |
| STMGID, NV | AM (GFH/Kemiron) | Siemens | 350 | 39 | <25 | 7.4 |

AM = adsorptive media; C/F = coagulation/filtration; GFH = granular ferric hydroxide; IX = ion exchange; SM = system modification
MDWCA = Mutual Domestic Water Consumer's Association; STMGID = South Truckee Meadows General Improvement District; WRWC = White Rock Water Company; STS = Severn Trent Services
(a) Design flowrate reduced by 50% due to system reconfiguration from parallel to series operation.
(b) Arsenic exists mostly as As(III).
(c) Iron exists mostly as soluble Fe (II).

## 1.3 Project Objectives

The objective of the Round 1 arsenic demonstration program is to conduct full-scale arsenic treatment technology demonstration studies on the removal of arsenic from drinking water supplies. The specific objectives are to:

- Evaluate the performance of the arsenic removal technologies for use on small systems.
- Determine the required system operation and maintenance (O&M) and operator skill levels.
- Characterize process residuals produced by the technologies.
- Determine the capital and O&M cost of the technologies.

This report summarizes the performance of the STS system at the Desert Sands MDWCA facility from January 16, 2004 through August 17, 2006. The types of data collected included system operation, water quality (both across the treatment train and in the distribution system), residuals, and capital and O&M cost.

## 2.0 SUMMARY AND CONCLUSIONS

Based on the information collected during the 31 months of system operation, the following conclusions were made relating to the overall objectives of the treatment technology demonstration study.

*Performance of the arsenic removal technology for use on small systems:*

- Chlorine was effective in oxidizing As(III) to As(V), reducing soluble As(III) concentrations from 21.7 µg/L (on average) in raw water to 2.0 µg/L (on average).
- SORB33™ media was effective in removing arsenic, but its run length was shorter than projected by the vendor. For the run with the granular form of the SORB33™ media (-S), breakthrough of total arsenic at 10 µg/L occurred at 40,600 bed volumes (BV), representing 62% of the vendor estimated working capacity. For the run with the pelletized form of the media (-P), breakthrough of total arsenic occurred at 49,500 BV, representing 58% of the estimated working capacity.
- As much as 45% media loss was observed during the media run using the granular media (-S). Poor physical integrity of the media might have contributed to the media loss. Sieve analyses indicated disintegration of the granular media during the run. Media loss reduced to 12% during the second media run using the pelletized media (-P). Sieve analyses were not performed for the pelletized media.
- The throughput between consecutive backwash events decreased significantly during the media run using the granular media (-S), from over 2,885 BV after system retrofit to 630 BV at the end of the run. Media attrition of the granular media (-S) during backwash appeared to have caused more frequent backwash.
- Arsenic concentrations in the distribution system were reduced from the predemonstration levels of 22.4–28.2 µg/L to 1.8–19.0 µg/L after the sytem became operational. However, the reduced concentrations were still higher than those in the plant effluent, probably due to the blending of the treated water with untreated water produced by a separate well in the distribution system. Neither lead nor copper concentrations appear to have been affected by operation of the system.

*Required system O&M and operator skill levels:*

- The APU-300 system experienced excessive flow restriction, imbalanced flow, and/or elevated pressure differential across the adsorption vessels and the entire system during the first four months of system operation. After extensive onsite and off-site investigations and hydraulic testing, the system was retrofitted in May 2004. Since then the system was able to operate according to the original design specifications through the end of the demonstration study.
- The skill requirements to operate the treatment system were minimal with a typical daily demand on the operator of 15 to 20 min. Normal operation of the system did not appear to require additional skills beyond those necessary to operate the existing water supply equipment. A Level 3 state-certified operator was required for operation of the water system at MDWCA.

*Characteristics of residuals produced by the technology:*

- Each backwash event produced approximately 10,000 gal of wastewater. Backwash wastewater contained less soluble arsenic than raw water, indicating removal of arsenic by the media during backwashing.
- Approximately 2.2 and 1.6 mg of arsenic was loaded per gram of dry SORB33™-S and SORB33™-P media, respectively; equivalent to approximately 0.22 and 0.16%, respectively,

*Capital and O&M cost of the technology:*

- The unit annualized capital cost was \$0.09/1,000 gal if the system operated at 100% utilization rate. The system's actual unit annualized capital cost was \$0.37/1,000 gal, based on 7 hr/day of system operation and 40,395,000 gal/year of water production. The unit O&M cost was \$0.74/1,000 gal, based on media replacement and disposal, chemical supply, electricity consumption, and labor.

# 3.0 MATERIALS AND METHODS

## 3.1 General Project Approach

Following the predemonstration activities summarized in Table 3-1, the performance evaluation study of the STS treatment system began on January 16, 2004. Table 3-2 summarizes the types of data collected and/or considered as part of the technology evaluation process. The overall performance of the system was evaluated based on its ability to consistently remove arsenic to below the target MCL of 10 µg/L through the collection of water samples across the treatment train. The reliability of the system was evaluated by tracking the unscheduled system downtime and frequency and extent of repair and replacement. The unscheduled downtime and repair information were recorded by the plant operator on a Repair and Maintenance Log Sheet.

The O&M and operator skill requirements were evaluated based on a combination of quantitative data and qualitative considerations, including the need for any pre- and/or post-treatment, level of system automation, extent of preventative maintenance activities, frequency of chemical and/or media handling and inventory, and general knowledge needed for relevant chemical processes and related health and safety practices. The staffing requirements for the system operation were recorded on an Operator Labor Hour Log Sheet.

**Table 3-1. Predemonstration Study Activities and Completion Dates**

| Activity | Date |
|---|---|
| Introductory Meeting Held | August 20, 2003 |
| Request for Quotation Issued to Vendor Issued | August 26, 2003 |
| Vendor Quotation to Battelle Submitted | September 17, 2003 |
| Purchase Order Completed and Signed | October 3, 2003 |
| Letter Report Issued | October 16, 2003 |
| Concrete Pad Poured | October 30, 2003 |
| Engineering Package to NMED Submitted | November 18, 2003 |
| APU-300 Unit Shipped by STS | November 18, 2003 |
| Draft Study Plan Issued | November 26, 2003 |
| APU-300 Unit Delivered to Desert Sands MDWCA | December 1, 2003 |
| System Installation Completed | December 11, 2003 |
| Approval for Construction Granted by NMED | December 22, 2003 |
| Building Construction Began | December 23, 2003 |
| System Shakedown Completed | January 15, 2004 |
| Performance Evaluation Began | January 16, 2004 |
| Final Study Plan Issued | January 19, 2004 |
| Building Construction Completed | January 23, 2004 |

NMED = New Mexico Environmental Department

The quantity of aqueous and solid residuals generated was estimated by tracking the amount of backwash water produced during each backwash cycle and the need to replace the media upon arsenic breakthrough. Backwash wastewater and spent media were sampled and analyzed for chemical characteristics.

**Table 3-2. Evaluation Objectives and Supporting Data Collection Activities**

| Evaluation Objective | Data Collection |
|---|---|
| Performance | -Ability to consistently meet 10 μg/L of arsenic in treated water |
| Reliability | -Unscheduled system downtime<br>-Frequency and extent of repairs including a description of problems, materials and supplies needed, and associated labor and cost |
| System O&M and Operator Skill Requirements | -Pre- and post-treatment requirements<br>-Level of system automation for system operation and data collection<br>-Staffing requirements including number of operators and laborers<br>-Task analysis of preventative maintenance including number, frequency, and complexity of tasks<br>-Chemical handling and inventory requirements<br>-General knowledge needed for relevant chemical processes and health and safety practices |
| Residual Management | -Quantity and characteristics of aqueous and solid residuals generated by system operation |
| System Cost | -Capital cost for equipment, site engineering, and installation<br>-O&M cost for media, chemical consumption, electricity usage, and labor |

The cost of the system was evaluated based on the capital cost per gal/min (gpm) (or gal/day [gpd]) of design capacity and the O&M cost per 1,000 gal of water treated. This task required tracking of the capital cost for the equipment, engineering, and installation, as well as the O&M cost for media replacement and disposal, chemical supply, electricity usage, and labor.

## 3.2 System O&M and Cost Data Collection

The plant operator performed daily, weekly, and monthly system O&M and data collection following the instructions provided by STS and Battelle. On a daily basis, the plant operator recorded system operational data, such as pressure, flowrate, totalizer, and hour meter readings on a Daily System Operation Log Sheet; checked the sodium hypochlorite (NaOCl) drum level; and conducted visual inspections to ensure normal system operations. If any problems occurred, the plant operator contacted the Battelle Study Lead, who determined if STS was contacted for troubleshooting. The plant operator recorded all relevant information on the Repair and Maintenance Log Sheet. Weekly or bi-weekly, the plant operator measured water quality parameters, including temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and residual chlorine, and recorded the data on a Weekly Onsite Water Quality Parameters Log Sheet. Monthly, the plant operator inspected the system control panel to ensure that moisture had not penetrated into the panel (STS, 2004). A monthly backwash of the media was originally recommended by STS; however, since it had been retrofitted in May 2004, the system was backwashed automatically when triggered by an increase in differential pressure ($\Delta p$) across each adsorption vessel. Backwash data were recorded on a Backwash Log Sheet.

The capital cost for the arsenic removal system consisted of the cost for equipment, site engineering, and system installation. The O&M cost consisted of the cost for media replacement and spent media disposal, chemical and electricity consumption, replacement parts, and labor. The NaOCl and electricity consumption was tracked using the Daily System Operation Log Sheet. Labor for various activities, such as the routine system O&M, troubleshooting and repair, and demonstration-related work, were tracked using an Operator Labor Hour Log Sheet. The routine O&M included activities such as completing daily field logs, replenishing the NaOCl solution, ordering inventory, performing regular system inspection, and others as recommended by the vendor. The demonstration-related work, including activities such as performing field measurements, collecting and shipping samples, and communicating with the Battelle Study Lead and the vendor, was recorded, but not used for the cost analysis.

### 3.3 Sample Collection Procedures and Schedules

To evaluate the system performance, samples were collected from the wellhead, treatment plant, and distribution system. Table 3-3 provides the sampling schedules and analytes measured during each sampling event. Figure 3-1 presents a flow diagram of the treatment system along with the analytes and schedules at each sampling location. Specific sampling requirements for analytical methods, sample volumes, containers, preservation, and holding times are presented in Table 4-1 of the EPA-endorsed Quality Assurance Project Plan (QAPP) (Battelle, 2003). The procedure for arsenic speciation is described in Appendix A of the QAPP.

**3.3.1 Source Water.** During the initial visit to the site, source water samples were collected and speciated using an arsenic speciation kit described in Section 3.4.1. The sample tap was flushed for several minutes before sampling; special care was taken to avoid agitation, which could cause unwanted oxidation. Analytes for the source water samples are listed in Table 3-3.

**3.3.2 Treatment Plant Water**. Treatment plant water samples were collected by the plant operator weekly, on a four-week cycle, for on- and off-site analyses. For the first week of each four-week cycle, water samples were collected at the wellhead (IN), after chlorination (AC), and from the combined effluent of Vessels A and B (TT) and analyzed for the monthly treatment plant analyte list shown in Table 3-3. For the second, third, and fourth week of each four-week cycle, water samples were collected at four locations across the treatment train, including IN, AC, after Vessel A (TA), and after Vessel B (TB) and analyzed for the weekly treatment plant analyte list shown in Table 3-3.

Over the course of the demonstration study, several changes were made to the sampling schedule as listed in Table 3-3 including:

- Sampling at IN, AC, TA, and TB was reduced from three times per month to once per month from April 30, 2004, to December 14, 2005, and then increased to twice per month from February 1, to August 2, 2006. No sampling was conducted from December 15, 2005, to January 31, 2006. Since February 1, 2006, the analysis for $SiO_2$, $PO_4$, alkalinity, and turbidity was discontinued, and only total As, Fe, and Mn were measured.
- Monthly speciation sampling at IN, AC, and TT was discontinued after January 4, 2006.
- On-site measurements of pH, temperature, DO, ORP, and $Cl_2$ (free and total) were reduced from weekly to monthly from March 2, 2005, to January 4, 2006, and discontinued thereafter.
- Total P replaced orthophosphate beginning on October 12, 2005 due to ease of analysis.

**3.3.3 Backwash Wastewater.** Grab samples were collected periodically from a tap on the backwash wastewater discharge line by the plant operator from May 2004 through November 2005. Filtered samples using 0.45-µm filters were analyzed for soluble As, Fe, and Mn and non-filtered samples analyzed for pH, total dissolved solids (TDS), and turbidity. Since February 2006, composite samples were collected monthly using a procedure that allowed collection of more representative samples during backwash. Tubing, connected to the tap on the discharge line, directed a portion of backwash wastewater at approximately 1 gpm into a clean, 32-gal container over the duration of the backwash for each vessel. After the content in the container was thoroughly mixed, composite samples were collected and/or filtered on-site with 0.45-µm disc filters. Filtered and non-filtered samples were analyzed for the analytes

**Table 3-3. Sample Collection Schedule and Analyses**

| Sample Type | Sampling Locations[a] | No. of Samples | Frequency | Analytes | Collection Date(s) |
|---|---|---|---|---|---|
| Source Water | IN | 1 | Once (during initial site visit) | On-site: pH<br>Off-site:<br>As (total and soluble), As(III), As(V),<br>Fe (total and soluble),<br>Mn (total and soluble),<br>Al (total and soluble),<br>V (total and soluble),<br>Mo (total and soluble),<br>Sb (total and soluble),<br>Na, Ca, Mg, Cl, F, $SO_4$, sulfide, $SiO_2$, $PO_4$, TOC, and alkalinity | 08/20/03 |
| Treatment Plant Water | IN, AC, TA, TB | 4 | 3 time/month (01/28/04 – 04/07/04); monthly (04/30/04 – 12/14/05); No sampling (12/15/05 – 01/31/06); 2 time/month (02/01/06 – 08/02/06) | On-site[b]: pH, temperature, DO, ORP, $Cl_2$ (free and total)<br><br>Off-site[c]: As (total), Fe (total), and Mn (total), $SiO_2$, $PO_4$[d] alkalinity, and turbidity | 01/28/04, 02/04/04, 02/11/04, 02/25/04, 03/03/04, 03/10/04, 03/24/04, 03/31/04, 04/07/04, 04/30/04, 05/26/04, 06/23/04, 07/21/04, 08/18/04, 09/15/04, 10/13/04, 11/03/04, 12/01/04, 01/05/05, 02/02/05, 03/02/05, 03/30/05, 04/27/05, 05/25/05, 06/07/05, 07/06/05,08/17/05[e], 09/14/05[e], 10/12/05,11/09/05, 12/14/05, 02/01/06, 02/15/06, 03/01/06, 03/15/06, 03/29/06, 04/12/06, 04/26/06, 05/10/06, 05/24/06, 06/07/06, 06/21/06, 07/05/06, 07/19/06, 08/02/06 |
| | IN, AC, TT | 3 | Monthly (01/23/04 – 01/04/06) | On-site[b]: pH, temperature, DO, ORP, $Cl_2$ (free and total)<br><br>Off-site:<br>As (total and soluble), As(III), As(V),<br>Fe (total and soluble),<br>Mn (total and soluble),<br>Ca, Mg, F, $NO_3$, $SO_4$, sulfide, $SiO_2$, alkalinity, and turbidity | 01/23/04, 02/18/04, 03/17/04, 04/14/04, 05/12/04, 06/09/04, 07/07/04, 08/04/04, 09/01/04, 09/29/04, 10/28/04, 11/17/04, 12/15/04, 01/20/05, 02/16/05, 03/16/05, 04/13/05, 05/11/05, 06/22/05, 08/03/05, 08/31/05, 09/28/05, 10/26/05, 11/30/05, 01/04/06 |
| Backwash Wastewater | BW | 2 | Eighteen times | Before 02/01/06: pH, TDS, turbidity, soluble As, Fe, and Mn<br><br>After 02/01/06: pH, TDS, and TSS,<br>As (total and soluble),<br>Fe (total and soluble),<br>Mn (total and soluble) | 05/23/04, 07/13/04, 09/30/04, 11/17/04, 12/06/04, 02/07/05, 06/14/05, 07/07/05, 09/15/05, 10/12/05, 11/09/05, 02/01/06, 03/15/06, 04/11/06, 05/10/06, 06/06/06, 07/18/06, 08/16/06 |

**Table 3-3. Sample Collection Schedule and Analyses (Continued)**

| Sample Type | Sampling Locations[(a)] | No. of Samples | Frequency | Analytes | Collection Date(s) |
|---|---|---|---|---|---|
| Backwash Solids | BW | 1 per vessel | Three times | Total Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, Si, and Zn | 06/06/06, 07/18/06, 08/16/06 |
| Distribution Water | One home (an LCR sampling location) and two non-residences within area served by Well No. 3, according to MDWCA model | 5 (3 first draw and 2 flushed) | Monthly | pH, alkalinity, total As, Cu, Fe, Mn, and Pb | Baseline sampling[(f)]: 12/08/03, 12/11/03, 12/30/03<br><br>Monthly sampling: 02/11/04, 03/10/04, 04/07/04, 05/12/04, 06/23/04, 07/21/04, 08/18/04, 09/15/04, 10/13/04, 11/10/04, 12/08/04, 01/20/05, 02/16/05, 03/16/05, 04/13/05, 05/11/05, 06/22/05, 08/03/05, 09/14/05, 10/12/05, 11/09/05, 12/14/05 |
| Spent Media | From spent media in vessels | 2 to 3 per vessel | Two times (at end of media runs) | TCLP; total Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, Si, and Zn | 07/27/05, 09/11/06 (Vessel B only) |

(a) Abbreviation corresponding to sample locations in Figure 3-1: IN = at wellhead, AC = after chlorination, TA = after Vessel A, TB = after Vessel B, TT = comined effluent, and BW = at backwash wastewater discharge line
(b) Onsite chlorine residual measurements not performed at IN; measurements reduced to monthly from March 2, 2005 to January 4, 2006 and discontinued thereafter.
(c) Since February 1, 2006, only total As, Fe, and Mn measured.
(d) Total P replaced $PO_4$ since October 12, 2005.
(e) Samples collected at IN, AC, and TT.
(f) Three baseline sampling events performed before system startup.

performed for the grab samples plus total suspended solids (TSS) and total As, Fe, and Mn. TDS was discontinued after February 2006.

**3.3.4 Residual Solids.** Residual solids included backwash solids and spent media samples. Backwash solids/water mixtures were collected after solids settled in the 32-gal backwash containers and the supernatant carefully decanted. Due to low solids in the backwash wastewater, solids were collected from multiple backwash events during the last few months of system operation and combined for suffcient sample quantity. The samples were air-dried, acid-digested, and analyzed for Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, Si, and Zn. Insufficient sample existed for Toxicity Characteristic Leaching Procedure (TCLP) tests.

Two spent media samples were collected from each vessel during the first media changeout on July 27, 2005. Spent SORB 33™-S media were removed from the top and bottom of each adsorption vessel using a 5-gal wet/dry shop vacuum that had been thoroughly cleaned and disinfected (Figure 3-2). Using a garden spade, the media from each layer was well-mixed in a clean 5-gal pail prior to being filled in an unpreserved 1-gal wide-mouth high-density polyethylene (HDPE) bottle. One aliquot of each sample was sent for TCLP tests. Another was air dried and acid digested for metal analysis. Three spent media samples were collected from Vessel B only during the second media changeout on September 11, 2006. Spent SORB 33™-P media was removed from the top, middle, and bottom of the media bed using the method similar to that for the previous changeout. A portion of each sample was submitted for TCLP tests. Another portion of each sample was air dried and acid digested for metal analysis.

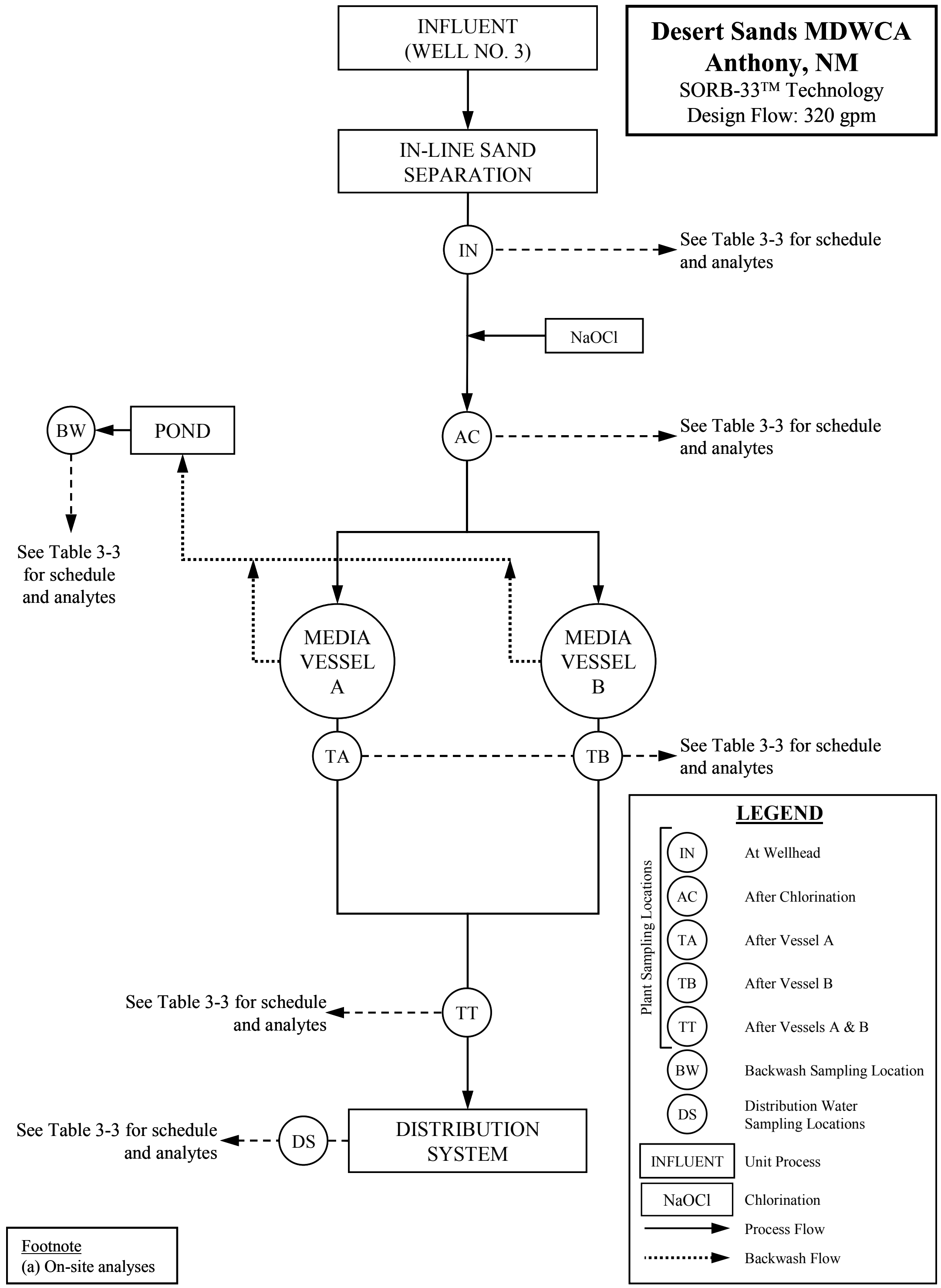



**Figure 3-1. Process Flow Diagram and Sampling Locations**


**Figure 3-2. Apparatus Used for Spent Media Sampling**

**3.3.5 Distribution System Water.** Water samples were collected from the distribution system to determine the impact of the arsenic treatment system on the water chemistry in the distribution system, specifically on lead, copper, and arsenic levels. In December 2003, prior to the startup of the treatment system, three baseline distribution system water samples were collected at three locations within the distribution system. Following system startup, distribution system sampling continued on a monthly basis at the same three locations until December 2005. Baseline and monthly distribution system samples were collected by the plant operator. Samples were collected at his home, which was included in the current Desert Sands MDWCA Lead and Copper Rule (LCR) sampling schedule, as well as two non-LCR sampling taps, with all three locations served by water produced from Well No. 3, as indicated by the Desert Sands MDWCA distribution system model.

The samples were collected at the LCR location following an instruction sheet developed according to the *Lead and Copper Rule Reporting Guidance for Public Water Systems* (EPA, 2002). Sampling at the two non-LCR locations was performed with the first sample taken at the first draw and the second sample taken after flushing the sample tap for several minutes. First draw samples were collected from cold-water faucets that had not been used for at least 6 hr to ensure that stagnant water was sampled. The sampler recorded the date and time of last water use before sampling and the date and time of sample collection for calculating the stagnation time. Analytes for the baseline samples coincided with the monthly distribution system water samples as described in Table 3-3. Arsenic speciation was not performed for the distribution water samples.

## 3.4 Sampling Logistics

All sampling logistics including arsenic speciation kits preparation, sample cooler preparation, and sampling shipping and handling are discussed as follows:

**3.4.1 Preparation of Arsenic Speciation Kits**. The arsenic field speciation method used an anion exchange resin column to separate the soluble arsenic species, As(V) and As(III) (Edwards et al., 1998). Resin columns were prepared in batches at Battelle laboratories according to the procedures detailed in Appendix A of the EPA-endorsed QAPP (Battelle, 2003).

**3.4.2 Preparation of Sampling Coolers.** For each sampling event, a cooler was prepared with the appropriate number and type of sample bottles, disc filters, and/or speciation kits. All sample bottles were new and contained appropriate preservatives. Each sample bottle was affixed with a pre-printed, colored-coded, waterproof label consisting of the sample identification (ID), date and time of sample collection, collector's name, site location, sample destination, analysis required, and preservative. The sample ID consisted of a two-letter code for the specific water facility, sampling date, a two-letter code for a specific sampling location, and a one-letter code designating the arsenic speciation bottle (if necessary). The sampling locations at the treatment plant were color-coded for easy identification. For example, red, orange, yellow, and green were used to designate sampling locations for IN, TA, TB, and TT, respectively. The labeled bottles for each sampling location were placed separately in a ziplock bag (each corresponding to a specific sample location) and packed in the cooler. On a monthly basis, the sample cooler also included bottles for the distribution system sampling.

In addition, all sampling- and shipping-related materials, such as disposable gloves, sampling instructions, chain-of-custody forms, prepaid/pre-addressed FedEx air bills, and bubble wrap, were placed in each cooler. The chain-of-custody forms and air bills were completed except for the operator's signature and the sample dates and times. After preparation, sample coolers were sent to the site via FedEx for the following week's sampling event.

**3.4.3 Sample Shipping and Handling.** After sample collection, samples for off-site analyses were packed carefully in the original coolers with wet ice and shipped to Battelle. Upon receipt, the sample custodian checked sample IDs against the chain-of-custody forms and verified that all samples indicated on the forms were included and intact. Discrepancies noted by the sample custodian were addressed with the plant operator by the Battelle Study Lead. The shipment and receipt of all coolers by Battelle were recorded on a cooler tracking log.

Samples for metal analyses were stored at Battelle's inductively coupled plasma-mass spectrometry (ICP-MS) laboratory. Samples for other water quality analyses were packed in separate coolers and picked up by couriers from American Analytical Laboratories (AAL) in Columbus, OH and TCCI Laboratories in New Lexington, OH, or shipped to DHL Analytical in Round Rock, TX. The chain-of-custody forms remained with the samples from the time of preparation through analysis and final disposition. All samples were archived by the appropriate laboratories for the respective duration of the required hold time and disposed of properly thereafter.

### 3.5 Analytical Procedures

The analytical procedures described in Section 4.0 of the EPA-endorsed QAPP (Battelle, 2003) were followed by Battelle ICP-MS, AAL, DHL, and TCCI Laboratories. Laboratory quality assurance/quality control (QA/QC) of all methods followed the prescribed guidelines. Data quality in terms of precision, accuracy, method detection limit (MDL), and completeness met the criteria established in the QAPP (i.e., 20% relative percent difference [RPD], 80 to 120% percent recovery and 80% completeness). The quality assurance (QA) data associated with each analyte will be presented and evaluated in a QA/QC Summary Report to be prepared under separate cover upon completion of the Arsenic Demonstration Project.

Field measurements of pH, temperature, DO, and ORP were conducted by the plant operator using a WTW Multi 340i handheld meter, which was calibrated for pH and DO prior to use following the procedures provided in the user's manual. The ORP probe also was checked for accuracy by measuring the ORP of the standard solution and comparing it to the expected value. The plant operator collected a water sample in a clean, plastic beaker and placed the WTW probe in the beaker until a stable value was obtained. The plant operator also performed free and total chlorine measurements using Hach chlorine test kits following the user's manual.

# 4.0 RESULTS AND DISCUSSION

## 4.1 Facility Description

Desert Sands MDWCA has been in operation as a non-profit association under the New Mexico Sanitary Projects Act since December 1978. At the time of this demonstration study, the governing board consisted of five members, and the staff members consisted of an office manager (Secretary of the Association), a full-time operator, a part-time customer service clerk, and a part-time contracted operator intern. Desert Sands MDWCA served its customers through an existing supply, storage, and distribution network covering an area of approximately four square miles of unincorporated area in Southern Dona Ana County. The water treatment facility was located approximately 2 miles north of Anthony, NM and serves an area generally situated between Interstate 10 on the east, NM 478 on the west, O'Hara Road on the south, and Ernesto Road on the north.

According to the *40 Year Water Plan* (Desert Sands MDWCA, 2002a) prepared for the water utility in 2002, Desert Sands MDWCA served 1,886 community members. It was projected that population in the Desert Sands MDWCA service area would increase by approximately 5,600 over a 40-yr planning period, assuming a median growth rate of 3.5%. The water production and use have fluctuated over the past several years with the peak production occurring in 1998 at 63,500,000 gal. In 2002, total water production and use were approximately 56,100,000 and 51,400,000 gal, respectively. Water loss percentages ranged from 6.3 to 14.1% during 1998 through 2002, with the lowest and highest loss occurring in 2002 and 1998, respectively.

**4.1.1 Pre-existing System.** The pre-existing system consisted of two production wells (Wells No. 2 and 3) with a combined capacity of 420 gpm, one 99,000-gal and one 240,000-gal storage tank, and approximately 30 miles of distribution piping. Figure 4-1 presents a map of the Desert Sands MDWCA delivery service area.

Prior to the installation of the STS arsenic removal system, the treatment plant consisted of Well No. 3 (located about 20 ft from the pump house), a pump house, and a drainage pond. Well No. 3 was screened from 690 to 740 ft below ground surface (bgs) with the static groundwater table at 45 ±1 ft bgs. The well water was filtered through an in-line sand separator (shown along with Well No. 3 on Figure 4-2) and then fed into the pump house (see piping in the pump house on Figure 4-3). A pressure of 75 pounds per square inch (psi) was maintained through the system. The maximum daily production was approximately 259,000 gpd and the average daily production was 158,000 gpd.

Before entering the distribution system, 0.4 to 0.5 mg/L (as $Cl_2$) of NaOCl was added to the water using a peristaltic pump (Figure 4-4) for a target chlorine residual level of 0.3 mg/L (as $Cl_2$). The two storage tanks are filled with excess water from the distribution system.

**4.1.2 Source Water Quality**. Source water samples were collected from Well No. 3 on August 20, 2003 and subsequently analyzed for the analytes shown in Table 3-3. The results of the source water analyses, along with those provided by the facility to EPA for the demonstration site selection and those independently collected and analyzed by EPA, are presented in Table 4-1.

Total arsenic concentrations in source water ranged from 17.0 to 22.7 μg/L. Based on the August 20, 2003 speciation sampling results, arsenic was present primarily as soluble As(III) (i.e., 96.9% at 21.6 μg/L), with only a small amount existing as soluble As(V) (i.e., 0.7 μg/L ) and particulate As (i.e., 0.4 μg/L). Because As(V) adsorbs better with the SORB 33™ media, it was desirable to oxidize As(III) to As(V) before adsorption.

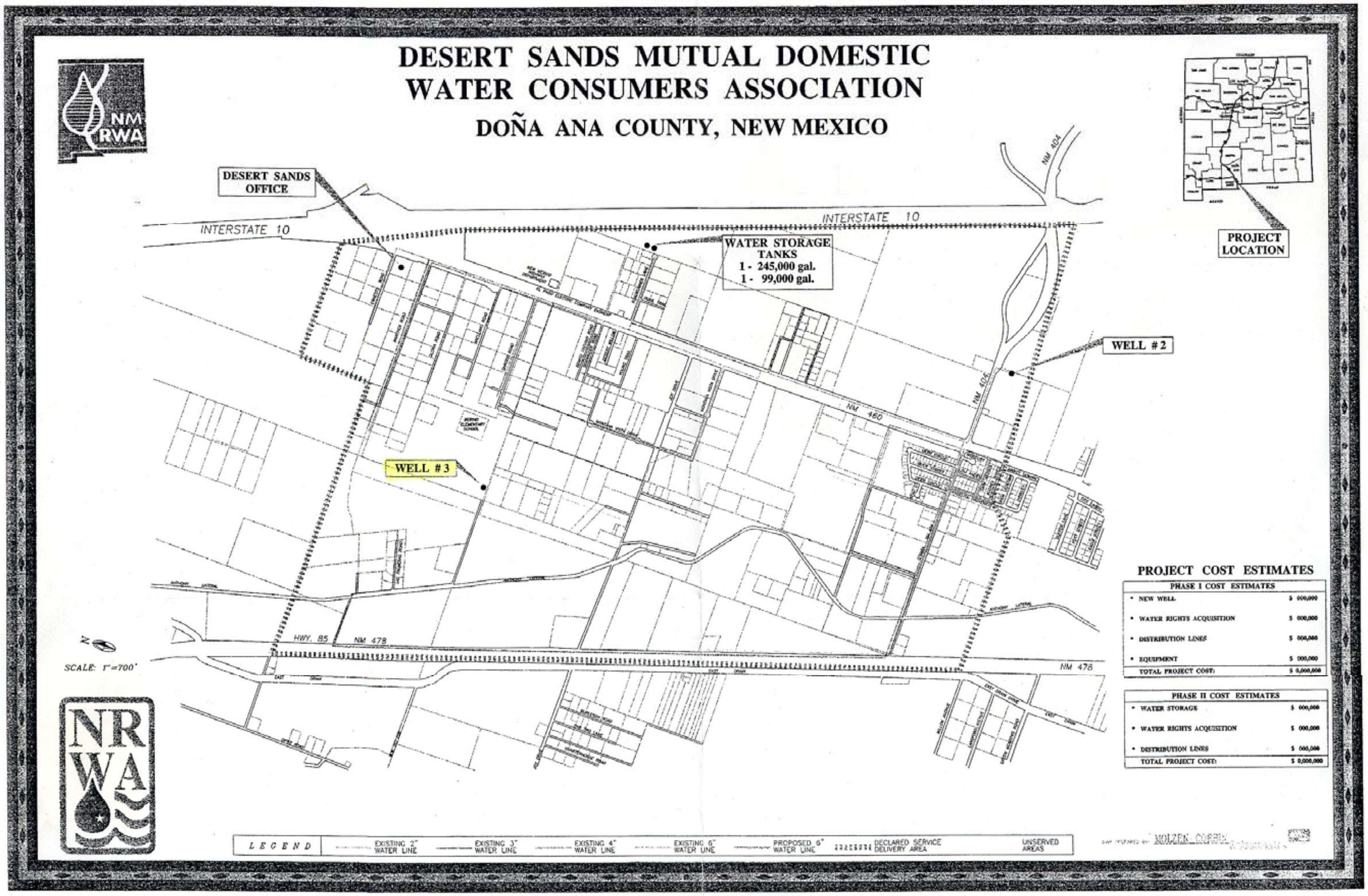



**Figure 4-1. Map of Desert Sands MDWCA Service Area**

**Figure 4-2. Well No. 3 (Left) and In-Line Sand Separator (Center) Adjacent to Pump House (Right) at Desert Sands MDWCA Site**

**Figure 4-3. Piping Inside Pump House at Desert Sands MDWCA Site**

**Figure 4-4. Sodium hypochlorite (NaOCl) Injection System at Desert Sands MDWCA Site**

pH values of source water ranged from 7.6 to 7.7, which was within the range recommended by STS. Therefore, pH adjustment was not recommended.

Iron levels in source water ranged from 38.9 to 73.0 µg/L; manganese levels ranged from 8.9 to 10.0 µg/L. At these levels, the vendor recommended not to pretreat iron and manganese prior to adsorption. Competing anions, such as orthophosphate and silica, were at levels sufficiently low (i.e., <0.065 to 0.1 mg/L and 34.6 to 35.1 mg/L, respectively) to not have a significant effect on arsenic adsorption by SORB 33™ media. Other analytes also were at levels low enough not to exert any impact on arsenic adsorption.

Although sulfide odor has been observed by the operator and by sampling personnel, sulfide was not detected at a detection limit of 0.05 mg/L. Additional samples were collected monthly during the demonstration study and analyzed for sulfide using a detection limit of 0.005 mg/L. The results are discussed in Section 4.4.1.

**4.1.3 Distribution System**. The Desert Sands MDWCA distribution system consists of a looped distribution line supplied by Wells No. 2 and No. 3. After chlorination, water from the two wells was pumped into the distribution system at two different locations, separated by approximately 2 miles. When the water production from the two wells exceeded the consumer demand, the excess flowed under pressure into the two storage tanks (i.e., Tank No. 2 at 75 ft tall by 15 ft in diameter, and Tank No. 3 at 86 ft tall by 22 ft in diameter) connected to the distribution system via 6- and 10-in-diameter polyvinyl chloride (PVC) pipe, respectively. The distribution system was constructed of PVC pipe, measuring approximately 30 miles in total length and varying from 2 to 10-in in diameter. The well pumps were activated by level sensors in the storage tanks, which signaled the pumps to turn on and off when the tank level reached a pre-set low and high level, respectively.

**Table 4-1. Desert Sands MDWCA Well No. 3 Water Quality Data**

| Parameter | Unit | Utility Raw Water Data | EPA Raw Water Data | Battelle Raw Water Data |
|---|---|---|---|---|
| ***Sample Date*** | | NA | 09/24/02 | 08/20/03 |
| pH | – | 7.6 | NA | 7.7 |
| Alkalinity (as $CaCO_3$) | mg/L | 240 | 185 | 188 |
| Hardness (as $CaCO_3$) | mg/L | 152 | NA | 84 |
| Chloride | mg/L | 253 | 161 | 180 |
| Fluoride | mg/L | NA | 0.5 | 1.0 |
| Sulfide | mg/L | NA | NA | <0.05 |
| Sulfate | mg/L | 158 | 180 | 190 |
| Silica (as $SiO_2$) | mg/L | NA | 34.6 | 35.1 |
| Orthophosphate (as P) | mg/L | <0.065 | 0.1 | <0.10 |
| TOC | mg/L | NA | NA | 1.6 |
| As (total) | µg/L | 22.0 | 17.0 | 22.7 |
| As (soluble) | µg/L | NA | NA | 22.3 |
| As (particulate) | µg/L | NA | NS | 0.4 |
| As(III) | µg/L | NA | NA | 21.6 |
| As (V) | µg/L | NA | NA | 0.7 |
| Fe (total) | µg/L | NA | 73.0 | 38.9 |
| Fe (soluble) | µg/L | NA | NA | <30 |
| Al (total) | µg/L | NA | <25 | 27.2 |
| Al (soluble) | µg/L | NA | NA | <10 |
| Mn (total) | µg/L | NA | 8.9 | 10.0 |
| Mn (soluble) | µg/L | NA | NA | 9.0 |
| V (total) | µg/L | NA | NA | 0.5 |
| V (soluble) | µg/L | NA | NA | 0.5 |
| Mo (total) | µg/L | NA | NA | 11.6 |
| Mo (soluble) | µg/L | NA | NA | 11.9 |
| Sb (total) | µg/L | NA | <25 | <0.1 |
| Sb (soluble) | µg/L | NA | NA | <0.1 |
| Na | mg/L | 266 | 225 | 189 |
| Ca | mg/L | 43.0 | 26.3 | 27.2 |
| Mg | mg/L | 11.0 | 3.4 | 3.9 |

NA = not available; TOC = total organic carbon

Water from Wells No. 2 and No. 3 blended within the distribution system and the storage tanks. Desert Sands MDWCA has completed a modeling effort to examine the portions of the system served by the individual wells. The results of this modeling study were used to select distribution system sampling locations from areas that appear to be served by Well No. 3.

Desert Sands MDWCA sampled water periodically from the distribution system for several analytes: once a month for bacteria; once every three years for inorganics (such as heavy metals, cyanide, and F), volatile organic compounds (VOCs), and synthetic organic compounds (SOCs); and once every four years for radionuclides. Under the LCR, samples have been collected from customer taps at 20 locations every three years, with samples most recently collected in 2000. The monitoring results in 2002 (except for the LCR results that were reported in 2000) are summarized in Table 4-2. Desert Sands MDWCA's

**Table 4-2. Desert Sands MDWCA Distribution System Water Quality Data**

| Parameter | Units | Detected Level (Range) |
|---|---|---|
| Arsenic | μg/L | 19 (10.4 to 19.3) |
| Barium | μg/L | 52 (34.1 to 55.2) |
| Cadmium | μg/L | 0.2 (0 to 0.2) |
| Chromium | μg/L | 6 (3.3 to 5.5) |
| Copper[a] | μg/L | 93 (2.8 to 103.5) |
| Nickel | μg/L | 1 (0.54 to 1.2) |
| Lead[a] | μg/L | 6 (0 to 6.9) |
| Selenium | μg/L | 2 (1.1 to 1.6) |
| Thallium | μg/L | 0.12 (0 to 0.12) |

(a) Lead and copper data reported based on result of 20 samples collected on August 29, 2000.

Consumer Confidence Report (2002b) also included results for the contaminants that were monitored every three years for inorganics, VOCs, and SOCs, or four years for radionuclides.

## 4.2 Treatment Process Description

STS' APU systems are designed for arsenic removal for small systems with flowrates greater than 100 gpm. They use Bayoxide® E33 (branded as SORB 33™ by STS), an iron-based adsorptive media developed by Bayer AG, for the removal of arsenic from drinking water supplies. Table 4-3 presents vendor-provided physical and chemical properties of the media. The SORB 33™ media were delivered in a dry crystalline form and listed by NSF International under Standard 61 for use in drinking water applications. The media exist in both granular and pelletized forms, which have similar physical and chemical properties, except that pellets are denser than granules (i.e., 35 vs. 28 lb/ft$^3$). Both granular and pelletized forms of the media were used at the Desert Sands MDWCA facility, with the granule form used in Media Run 1 and pelletized form used in Media Run 2.

STS provided an APU-300 system for the Desert Sands MDWCA site. Since the inception of the performance evaluation study in January 2004, difficulties were encountered in APU-300 system operation, including excessive flow restriction, imbalanced flow, and elevated Δp across the adsorption vessels and entire system. The system was retrofitted in May 2004 and details are described in Section 4.4.1.

Figure 4-5 is a simplified piping and instrumentation diagram (P&ID) of the system after the system retrofit. As shown in Figure 4-5, The APU-300 system consisted of two adsorption vessels, electrically actuated valve tree, and associated piping and instrumentation. Electrically actuated butterfly valves diverted raw water downward through the two adsorption vessels operating in parallel. As water passed through the fixed-bed adsorbers, arsenic concentrations were reduced to below 10 μg/L. When reaching 10-μg/L arsenic breakthrough, the spent media were removed and disposed of after being subjected to the EPA TCLP test. The design features of the APU-300 system are summarized in Table 4-4.

Four key process components are discussed as follows:

- **Intake and In-Line Sand Separation**. Raw water supplied from Well No. 3 passed through the in-line sand separator before it was chlorinated and fed into the APU-300 system.

**Table 4-3. Physical and Chemical Properties of SORB 33™ Media**

| *Physical Properties* | | |
|---|---|---|
| **Parameter** | **SORB 33™-S** | **SORB 33™-P** |
| Matrix | Iron oxide composite | Iron oxide composite |
| Physical Form | Dry granular media | Dry pelletized media |
| Color | Amber | Amber |
| Bulk Density (lb/ft$^3$) | 28.1 | 35.0 |
| BET Surface Area (m$^2$/g) | 142 | - |
| Attrition (%) | 0.3 | 0.3 |
| Moisture Content (%) | <15% (by weight) | <15% (by weight) |
| Particle Size Distribution (U.S. Standard Mesh) | 10 × 35 | 14 × 18 |
| Crystal Size (Å) | 70 | 70 |
| Crystal Phase | $\alpha$ – FeOOH | $\alpha$ – FeOOH |
| *Chemical Analysis* | | |
| **Constituents** | **Weight %** | |
| FeOOH | 90.1 | |
| CaO | 0.27 | |
| $SiO_2$ | 0.06 | |
| MgO | 1.00 | |
| $Na_2O$ | 0.12 | |
| $SO_3$ | 0.13 | |
| $Al_2O_3$ | 0.05 | |
| MnO | 0.23 | |
| $TiO_2$ | 0.11 | |
| $P_2O_5$ | 0.02 | |
| Cl | 0.01 | |

Source: STS

- **Chlorination**. The existing chlorination system was used to chlorinate source water with NaOCl. NaOCl was fed with a peristaltic pump at a location downstream of the in-line sand separator and upstream of the APU-300 treatment system. The peristaltic pump was synchronized with the well pump so that it operated only when the well pump was on. NaOCl dosage was controlled at 0.4 to 0.5 mg/L (as $Cl_2$) for a target chlorine residual level of 0.3 mg/L (as $Cl_2$). Actual dosages were monitored directly by measuring solution consumption rates in the chemical day tank and indirectly by measuring total and free chlorine residual levels at the AC sampling location, installed on a common feed line to the adsorption vessels, and at the TA, TB, and/or TT locations after the adsorption vessels.

- **Arsenic Adsorption**. The APU-300 system was a fixed-bed down-flow adsorption system consisting of two 63-in-diameter, 86-in-tall vertical pressure vessels. The vessels were fiberglass reinforced plastic (FRP) construction, rated for 75 psi working pressure, skid mounted, and piped to a valve rack mounted on a polyurethane coated, welded frame. Each vessel was loaded with approximately 80 ft$^3$ of SORB 33™-S or 62 ft$^3$ of SORB 33™-P media supported by a gravel underbed. Loading of different volumes of media in the adsorption vessels were caused by different densities of the granular and pelletized media since the media were sold by weight rather than by volume. Empty bed contact time (EBCT) for the system was 3.7 and 2.9 min for the SORB 33™-S and SORB 33™-P media beds, respectively, based on a design flowrate of 320 gpm. Hydraulic loading to each vessel was approximately 7.4 gpm/ft$^2$.

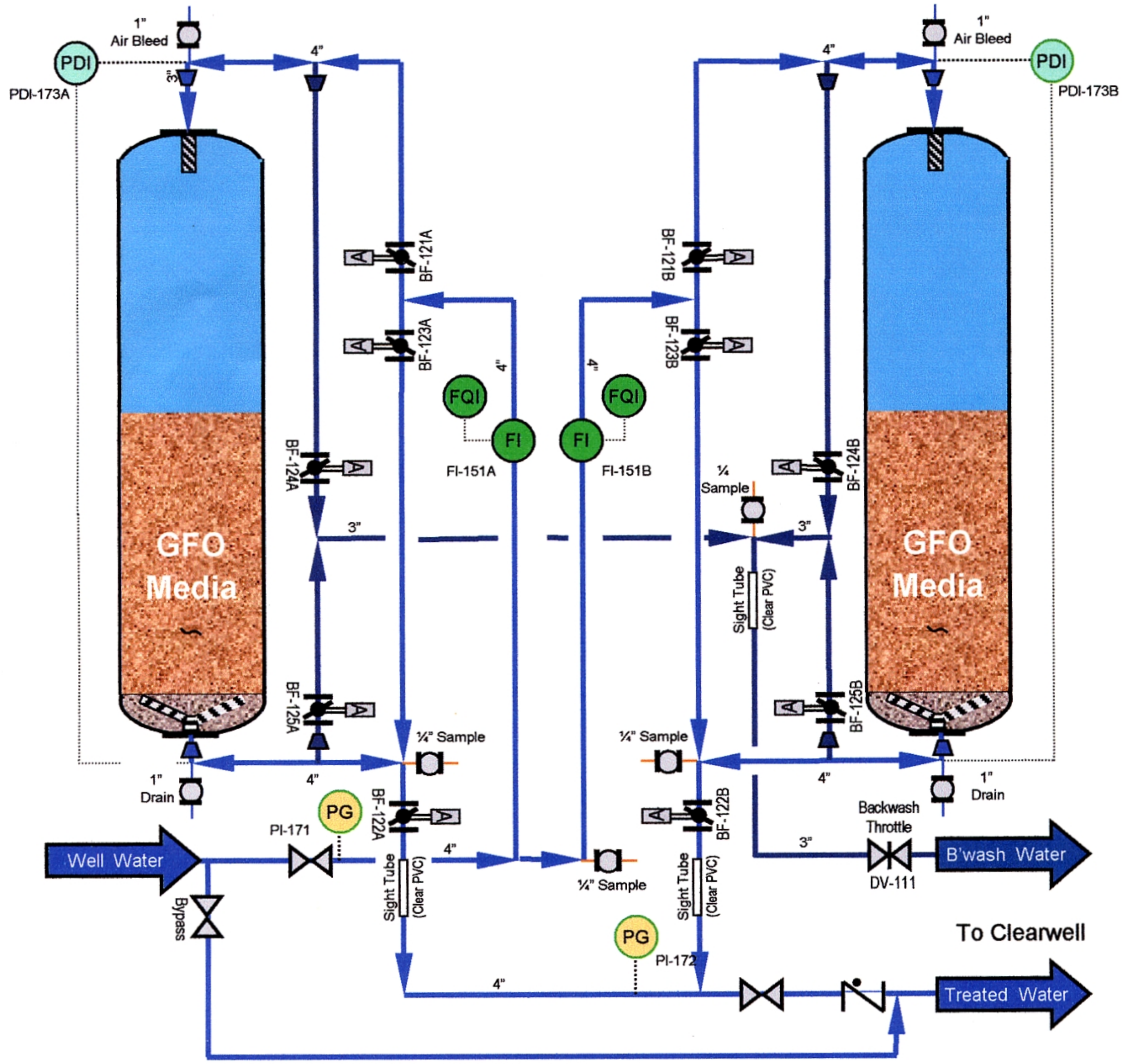



**Figure 4-5. Schematic Diagram of STS APU-300 System after System Retrofit in May 2004**

As illustrated in Figure 4-5, the two adsorption vessels were interconnected with schedule 80 PVC piping and 10 electrically actuated butterfly valves using a valve tree design (Figure 4-6). During normal operation, the feed valves (i.e., BF-121 A and B) and effluent valves (i.e., BF-122 A and B) were opened and the other six valves were closed to divert water downward through the two adsorption vessels. Flow through the two vessels was balanced by throttling the effluent valves, if needed. During backwash, the feed and effluent valves were closed and the backwash feed valves (i.e., BF-123 A and B) and backwash effluent valves (i.e., BF-124 A and B) were opened to divert water upward through the two adsorption vessels. During backwash rinse process, the feed valves (i.e., BF-121 A and B) and rinse valves (i.e., BF-125 A and B) were opened and the other six valves were closed to rinse the media with downward water flow.

**Table 4-4. Design Specifications of APU-300 System**

| Parameter | Value | Remarks |
|---|---|---|
| ***Pretreatment*** | | |
| Sand Separator | NA | Gravity separation |
| NaOCl Dosage (mg/L) | 0.4–0.5 | – |
| ***Adsorption Vessels and Media Beds*** | | |
| Number of Adsorption Vessels | 2 | Parallel configuration |
| Vessel Size (in) | 63 D × 86 H | 21.6 $ft^2$ cross-section |
| Type of Media | SORB 33™ | Run 1: SORB 33™-S (granular)<br>Run 2: SORB 33™-P (pelletized) |
| Media Volume ($ft^3$/vessel) | 80 (SORB 33™-S)<br>62 (SORB 33™-P) | – |
| Media Bed Depth (ft) | 3.7 (SORB 33™-S)<br>2.9 (SORB 33™-P) | – |
| ***Service*** | | |
| Design Flowrate (gpm/vessel) | 160 | 320 gpm total |
| EBCT (min) | 3.7 (SORB 33™-S)<br>2.9 (SORB 33™-P) | Based on design flowrate |
| Hydraulic Loading (gpm/$ft^2$) | 7.4 | Based on vessel cross sectional area of 21.6 $ft^2$ |
| Average Use Rate (gpd) | 345,600 | Based on 320 gpm for 18 hr/day |
| Hydraulic Utilization (%) | 75% | – |
| Estimated Working Capacity (BV) | 66,000<br>85,200[(a)] | Based on arsenic breakthrough at 10 µg/L |
| Estimated Breakthrough (1,000 gal) | 79,000 | Both vessels combined |
| Estimated Media Life (month) | 7.6 | Based on average use rate |
| ***Backwash*** | | |
| Flowrate (gpm) | 194 to 238 | Recommended by STS |
| Hydraulic Loading (gpm/$ft^2$) | 9 to 11 | Recommended by STS |
| Frequency (time/month) | 1 | Manually or based on a Δp threshold |
| Duration (min/vessel) | 20 to 25 | – |

(a) Estimated by assuming that SORB 33™-S and -P media have similar adsorptive capacity.
NA = not applicable

Flow meters (+GF+SIGNET 8550 ProcessPro™ Flow Transmitter) installed in the supply line of each adsorption vessel monitored instantaneous flowrates through the vessels. The flowmeters also tracked the volume of water treated in each vessel. Δp readings across each vessel were monitored by differential pressure gauges (WIKA Differential Pressure Gauge). The adsorption vessels were backwashed sequentially whenever the Δp across one vessel reached 10 psi. System controller (Figure 4-6) controlled the operation of the actuated valve tree for the adsorption, backwash, and forward fast rinse cycles.

- **Backwash**. STS recommended that the SORB 33™ media be backwashed monthly using raw water to loosen up the media bed, and remove particulates and media fines accumulating in the beds. The APU-300 system was designed and programmed with an automatic backwash feature that would place the vessels into backwash based on a set timer or when the Δp across a vessel had reached 10 psi. The backwash wastewater was directly discharged into a drainage pond adjacent to the treatment facility (Figure 4-7).

**Figure 4-6. Treatment Process Components**
*( APU-300 System Valve Tree [top left and middle]; Backside of System Piping including Vessel Flow Meter Sensors [top right]; Sampling ports [middle]; and Control Panel [bottom])*

### 4.3 System Installation

The installation of the APU-300 system, as originally designed with the use of a diaphragm valve, a Fleck valve controller along with a riser tube, and an orifice plate for each vessel, was completed in December 2003, with shakedown and startup activities continuing into January 2004. The system installation and building construction activities were carried out by the plant operator as a subcontractor to STS.

**4.3.1 Permitting**. Engineering plans for the system permit application were prepared by Bohannon Huston, an STS subcontractor located in Las Cruces, NM. The plans included diagrams and specifications of the APU-300 system, as well as drawings detailing the connections of the new unit to the

**Figure 4-7. Backwash Wastewater Discharge into Pond**

existing facility. After incorporating comments from Desert Sands MDWCA and Battelle, the plans were submitted by Desert Sands MDWCA to the New Mexico Environmental Department (NMED) Drinking Water Bureau for review and approval on November 18, 2003. The NMED issued a letter of approval on December 22, 2003, requiring that Desert Sands MDWCA flush and disinfect the system and associated plumbing, and retain negative results from bacteriological sampling prior to sending treated water to the distribution system.

**4.3.2 Building Construction.** Desert Sands MDWCA constructed an addition to its existing pump house at Well No. 3 to house the APU-300 system. The structure measures 15 ft × 15.5 ft at the base (232.5 $ft^2$) with a total height of 12 ft, and consists of a concrete floor, a steel frame, insulated steel siding and roofing, and a walk-through door. The structure is just large enough to house the APU-300 system and the inlet and outlet plumbing. A photograph of the new structure, adjacent to the existing block pump house, is shown in Figure 4-8.

The building construction began on October 30, 2003, as the concrete pad was poured. After the system was placed on the pad, work on the frame and roof began on December 23, 2003 and was completed on January 5, 2004. Installation of the siding and insulation was completed by January 23, 2004.

**4.3.3 System Installation, Shakedown, and Startup**. The APU-300 system was delivered to the site on December 1, 2003. The plant operator, subcontracted to STS, performed the off-loading and installation of the system, including connections to the existing entry and distribution piping (Figure 4-9). Figure 4-10 shows the APU-300 system before the building enclosure was built around it. Figure 4-11 shows the media loading to the adsorption vessels. The system installation and media loading were completed and the system shakedown and startup commenced on December 11, 2003.

During system shakedown, it was observed that the system could produce no more than 40 gpm of flow in either the service or backwash mode, and that under-sized orifice plates had caused the unwanted flow restriction. The opening of the orifice plates had to be enlarged in an STS shop and repeatedly tested

**Figure 4-8. Pump House (right) and System Enclosure**

**Figure 4-9. APU-300 System Being Connected to Distribution System**

onsite from 0.5 to 1.5 in (on January 8, 2004) and then to 1.875 in (on January 15, 2004) in order to achieve the 150-gpm/vessel target flowrate in the service mode and 160 gpm/vessel in the backwash mode. Moreover, while operating at 320 gpm, the system experienced a pressure loss of 18 psi across the system, which was significantly higher than the STS specified value of less than 8 psi. The pressure loss across the adsorption vessels and the associated diaphragm valves, Fleck valve controllers, and orifice plates also was elevated, exceeding the maximum value of the $\Delta p$ gauge readouts (i.e., 15 psi). Because of this elevated pressure loss (which was higher than the would-be set point of about 15 psi for triggering the automatic backwash), the pressure-actuated automatic backwash feature at the control panel had to be disabled to avoid the system operating in a constant backwash mode.

**Figure 4-10. APU-300 System before Building Enclosure was Built**

**Figure 4-11. Media Loading to Adsorption Vessels**

Under the conditions described above, the performance evaluation study officially began on January 16, 2004. Battelle provided operator training on data and sample collection and collected the first set of samples from the APU-300 system.

## 4.4 System Operation

Table 4-5 presents timelines of key activities/events that occurred during the system performance evaluations. These demonstration activities are described in more details in the following sections.

**4.4.1 System Retrofit**. In addition to the problems identified during shakedown and startup, several operational difficulties were encountered following commencement of the evaluation study, including one incident on February 3, 2004 when the flow through Vessel A decreased to 40 gpm and the system inlet pressure increased to 100 psi. At the request of Battelle, STS performed a series of hydraulic testing on three similar systems: one that was located at STS' Torrance, CA shop and ready to be shipped to the Queen Anne's County site in Maryland and two that were installed in Brown City, MI, and experiencing similar operational problems (i.e., restricted and imbalanced flow and elevated pressure losses).

**Table 4-5. Demonstration Study Activities and Completion Dates**

| Activity/Event | Date |
|---|---|
| APU-300 System Performance Evaluation Began | January 16, 2004 |
| Final Study Plan Issued | January 19, 2004 |
| Building Construction Completed | January 23, 2004 |
| STS Performed Aggressive Backwash on Both Vessels to Troubleshoot High Δp Issues | February 19, 2004 |
| STS Collected Media Samples | February 26, 2004 |
| STS Installed 3-in-diameter Bypass Line around Fleck Valve Controllers | March 8 to 9, 2004 |
| System Retrofit with Valve Tree Plumbing Installed | May 16 to 24, 2004 |
| STS onsite to troubleshoot and conduct a backwash | January 6, 2005 |
| STS on Site to Perform Repairs and Re-program PLC | April 4 to 5, 2005 |
| Media Changeout (switch from granular SORB 33™-S to pelletized SORB 33™-P) | July 27, 2005 |
| STS Onsite for Troubleshooting and Media Sampling | October 27 to 28, 2005 |
| APU-300 System Performance Evaluation Completed | August 17, 2006 |
| APU-300 Property Transfer Completed | August 25, 2006 |

APU = arsenic package unit; PLC = programmable logic controller;
STS = Severn Trent Services

Before reaching a decision to perform hydraulic testing, STS suggested that the operational problems encountered might have been caused by:

(1) Damaged media – media crushed by zero to 300 gpm flow swings after flow restrictors had been temporarily removed from the system to troubleshoot the flow restriction problem during the initial startup,

(2) Insufficient backwash flowrates – due to the use of restrictor plates, and

(3) Clogged top distributors and/or bottom laterals.

As part of its investigative work, STS performed more aggressive backwashes on both vessels and collected media samples for particle size distribution analyses on February 19 and 26, 2004, respectively. On March 8, 2004, STS installed a 3-in-diameter bypass line around the Fleck valve controller on each vessel with the intent to decrease the pressure loss and increase backwash flowrate. These efforts, however, did not help resolve the problems, and the results of the particle size distribution analyses did not appear to support the speculation concerning media damage. These observations led STS to focus its investigative work on the design and construction of system plumbing.

Hydraulic testing on the two APU-300 systems at Brown City, MI, was conducted on March 19, 2004, with no media loaded in the vessels. While operating the system at 103 to 115 gpm/vessel (versus the design value of 160 gpm/vessel), a pressure loss of 7 to 8 psi was observed across each vessel, and 24 to 26 psi across the entire system. These results suggested that the system plumbing most likely was the source of high pressure losses, and that the media mostly likely was not responsible for the difficulties encountered at Desert Sands MDWCA. Replacement of the restrictive orifices from 1.25 to 1.875 in (as was used for the Desert Sands MDWCA system) did not solve the elevated pressure loss problems. Additional hydraulic testing was therefore conducted at Brown City, MI and STS' Torrance, CA facility in mid-April 2004. Table 4-6 summarizes the test results collected at Brown City, MI, Torrance, CA, and Anthony, NM.

Pressure profile data were collected across the systems at Brown City, MI and the Torrance, CA facility. As listed in Table 4-6 and shown in Figure 4-12, the major system components across each of the two parallel treatment trains included piping inlet, an automatic variable diaphragm valve (to control flow), a strainer, a programmable Fleck valve controller (to control flow from a service to backwash mode), an FRP vessel with a top diffuser and a bottom lateral, a restrictive orifice plate, and outlet piping. Pressure gauges were across the treatment train so that a complete pressure profile might be established. $\Delta p$ readings as measured at Desert Sands MDWCA included those across the strainer, Fleck valve controller, and vessel, which was equipped with a top diffuser and a bottom lateral and loaded with 80 $ft^3$ of media supported by 14 $ft^3$ of under bedding.

The results of the Brown City testing on April 6, 2004 showed that, after removing the restrictive orifice plate, strainer, and top diffuser, pressure losses were observed across the variable diaphragm valve (from 80 to 71 psi) and valve controller and bottom laterals (from 61 to 58 psi). These results were consistent with those observed during the April 8, 2004 testing at Torrance, CA, except for the 1-psi loss (from 44 to 43 psi) across the variable diaphragm valve. It was not clear what had caused the 11 psi loss across the variable diaphragm valve at Brown City; one possible explanation was that the valve was partially throttled during the testing. The pressure loss across the Fleck valve controller, strainer, top diffuser, and bottom laterals at Torrance, CA was 13 psi (from 43 to 30 psi), identical to that found at Brown City, MI. Furthermore, the pressure loss across the top diffuser and bottom lateral was 1 psi (from 34 to 33 psi), indicating little or no loss across these system components.

The test results at Brown City, MI and Torrance, CA were further confirmed during a separate test in Torrance, CA on April 14, 2004, which showed no loss across the variable diaphragm valve, 1 psi loss (from 54 to 53 psi) across top diffuser and bottom lateral, 13 psi loss (from 64 to 50 psi and less 1 psi across the top diffuser and bottom lateral) across the Fleck valve controller, and possibly 20 psi across the restrictive orifice plate (see the 20 psi increase at the inlet after restrictive orifice was restored to the system in Table 4-6). It was therefore evident that the main sources of the pressure loss originated from the Fleck valve controller and restrictive orifice plate.

Upon completion of the hydraulic testing, STS recommended four options to address the problems at Desert Sands MDWCA (and Brown City):

(1) Replace the submersible pump by the host site,
(2) Install a booster pump,
(3) Run the existing submersible pump for longer periods each day, or
(4) Retrofit the STS system.

### Table 4-6. Results of Hydraulic Testing of STS APU-300 Systems

| Site | Date | Vessel | Flowrate (gpm) | Pressure (psi) | | | | | | ΔP (psi) | | System Components | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Vessel | | | | |
| | | | | P1 | P2 | P3 | P4 | P5 | P6 | Vessel[(a)] | System | Variable Diaphragm Valve | Valve Controller | Strainer | Top Diffuser | Media | Underbedding | Bottom Laterals | Restrictive Orifice |
| ***Before System Retrofitting*** | | | | | | | | | | | | | | | | | | | |
| Desert Sands MDWCA, NM | 02/10/04 | A | 120 | 84 | | | | | 54 | >15 | 30 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | B | 180 | 84 | | | | | 54 | >15 | 30 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Brown City, MI | 03/19/04 | A (unit 1) | 115 | 82 | | | | | 58 | 7 | 24 | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | | B (unit 1) | 113 | 82 | | | | | 58 | 8 | 24 | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | | A (unit 2) | 105 | 84 | | | | | 58 | 8 | 26 | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | | B (unit 2) | 113 | 84 | | | | | 58 | 8 | 26 | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| | 04/06/04 | A | 160 | 80 | 71 | 61 | | 58 | 58 | 13 | 22 | ✓ | ✓ | | | | | ✓ | |
| | | B | 160 | 80 | 71 | | | 58 | 58 | 13 | 22 | ✓ | ✓ | | | | | ✓ | |
| Torrance, CA | 04/08/04 | A | 150 | 44 | 43 | 34 | 33 | 30 | 30 | 13 | 14 | ✓ | ✓ | ✓ | ✓ | | | ✓ | |
| | | B | 150 | 44 | | | | | 30 | 13 | 14 | ✓ | ✓ | ✓ | ✓ | | | ✓ | |
| | 04/14/04 | A | 158 | 64 | 64 | 54 | 53 | 50 | | 14 | NA | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| ***After System Retrofitting*** | | | | | | | | | | | | | | | | | | | |
| Torrance, CA | 04/20/04 | A | 165 | 23 | | 22 | 19 | | 19 | 3 | 4 | | | | | | | ✓ | |
| | | B | 165 | 52 | | 51 | 50 | | 50 | 1 | 2 | | | | | | | ✓ | |
| | | A | 170 | 34 | | 33 | 30 | | 30 | 3 | 4 | | | | | | | ✓ | |
| | | B | 155 | 34 | | 34 | 33 | | 30 | 1 | 4 | | | | | | | ✓ | |
| Brown City, MI | 04/29/04 | A | 190 | 62 | | | | | 58 | 0 | 4 | | | | | | | ✓ | |
| | | B | 190 | 62 | | | | | 58 | 0 | 4 | | | | | | | ✓ | |
| Desert Sands MDWCA, NM | 05/24/04 | A | 140 | 66 | | | | | 60 | 3 | 6 | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | | B | 135 | 66 | | | | | 60 | 3 | 6 | | | ✓ | ✓ | ✓ | ✓ | ✓ | |

P1 = at system inlet
P2 = after variable diaphragm valve and before entering strainer, valve controller, and vessel
P3 = at top of vessel
P4 = at bottom of vessel
P5 = after vessel and valve controller and before entering restrictive orifice (if present)
P6 = at system outlet

ΔP across vessel (including valve controller) = P2 − P5
ΔP across vessel = P3 − P4 (after retrofitting)
ΔP across system (treatment train) = P1 − P6
(a) Including valve controller before system retrofitting

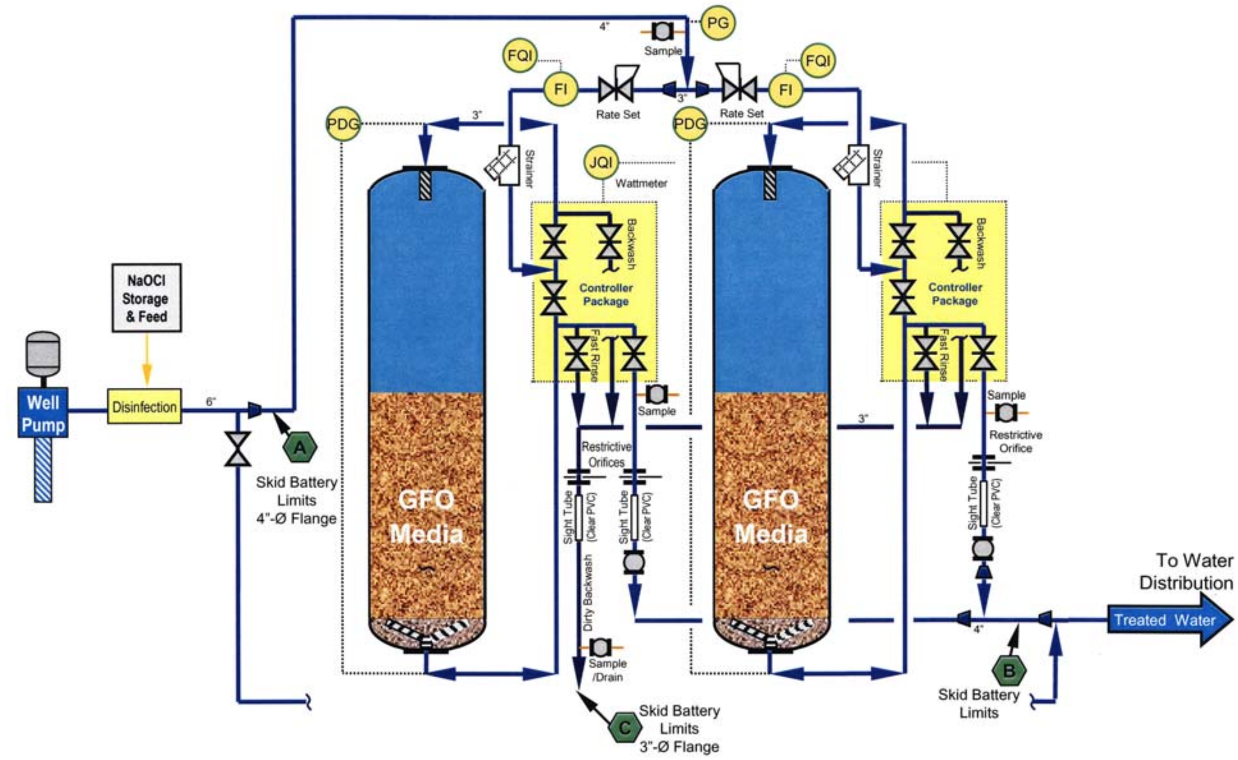



**Figure 4-12. Schematic Diagram of STS APU-300 System before System Retrofit**

After reviewing the pros and cons of each option, Battelle recommended and STS agreed to retrofit the APU-300 systems at both the Desert Sands MDWCA and Brown City sites. The changes included replacement of the 3-in-diameter pipe with 4-in-diameter pipe; removal of the diaphragm valves, restrictive orifice plates, and Fleck valve controllers; and installation of a nested network of fully-ported actuated butterfly valves and a new control panel. A schematic diagram of the new system design is presented in Figure 4-5.

The test results collected at Torrance, CA, Brown City, MI, and Desert Sands MDWCA, NM after the system retrofit are presented in Table 4-6. With the Torrance, CA and Brown City, MI systems operating at 155 to 190 gpm without media or underbedding loaded in the vessels, the pressure losses across the vessel (along with bottom laterals) and the system were 0 to 3 and 2 to 4 psi, respectively. The system was returned to service on May 24, 2004 with the modified pipe design, a new upper distributor, and new control panel in place. STS measured the freeboard as the new upper distributors were being installed, observing between 16.25 and 16.5-in in each vessel. Startup testing of the retrofitted unit showed a pressure loss across the media-filled vessels of 3 psi, and a total pressure loss across the system of 6 psi.

**4.4.2 Operational Parameters.** The operational parameters for the entire performance evaluation study are tabulated and attached as Appendix A. Key parameters are summarized in Table 4-7. The APU-300 system was evaluated with two forms of SORB 33$^{TM}$ media, with the first media run using the granular form and the second media run using the pelletized form. The first media run operated from January 16, 2004, through July 14, 2005. The second media run operated from July 29, 2005, through August 16, 2006. Relevant system operational parameters are discussed in detail below.

**Table 4-7. Summary of APU-300 System Operation**

| Parameter | First Media Run (SORB 33™-S) | | | | | Second Media Run (SORB 33™-P) | | |
|---|---|---|---|---|---|---|---|---|
| | 01/16/04–05/16/04 (before Retrofit) | | 05/24/04–07/14/05 (after Retrofit) | | 01/16/04 – 07/14/05 (Combined) | 07/29/05–08/16/06 | | |
| Cumulative Operating Time (hr) | 493 | | 2,745 | | 3,238 | 3,004 | | |
| Average Daily Operating Time (hr) | 4.3 | | 6.6 | | 6.2 | 7.8 | | |
| Component | Vessel A | Vessel B | Vessel A | Vessel B | System | Vessel A | Vessel B | System |
| Throughput (1,000 gal) | 3,442 | 4,433 | 22,803 | 21,967 | 52,645 | 22,719 | 23,834 | 46,553 |
| Bed Volumes of Water Treated (BV) | 5,737 | 7,388 | 38,005 | 36,612 | 43,871 | 48,963 | 51,366 | 50,165 |
| Average Flowrate (gpm)[a] | 116 | 150 | 138 | 133 | 271 | 121 | 130 | 251 |
| Range of Flowrate (gpm)[b] | 110–150[b] | 140–180[b] | 90–190[b] | 80–175[b] | 205–300[c] | 75–170[b] | 75–185[b] | 225–275[c] |
| Average EBCT (min)[d] | 5.2 | 4.0 | 4.3 | 4.5 | NA | 3.8 | 3.6 | NA |
| Range of EBCT (min)[e] | 4.0–5.4 | 3.3–4.3 | 3.1–6.6 | 3.4–7.5 | NA | 2.7-6.2 | 2.5–6.2 | NA |
| Differential Pressure Across Vessel (psi) | >20 | >20 | 2.5–15[f] | 2.5–15[f] | NA | 2.0–11 | 2.0–11 | NA |
| System Pressure Loss (psi) | NA | NA | NA | NA | 4–30[f] | NA | NA | 2–26 |
| Number of Backwashes | 6 | 6 | 60 | 63 | NA | 50 | 53 | NA |
| Backwash Interval (day) | 1–49 | 7–35 | 1–37 | 1–20 | NA | 1–18 | 1–26 | NA |

(a) Calculated based on cumulative throughput and corresponding operating time.
(b) Based on the instant flowrates measured at Vessels A and B.
(c) Calculated based on the daily operation time and daily throughput measured by the master flowmeter at the wellhead.
(d) Based on the average flowrate; and 80 $ft^3$ and 62 $ft^3$ of media per vessel during the first and second media runs, respectively.
(e) Based on the instant flowrates measured at Vessels A and B; and 80 $ft^3$ and 62 $ft^3$ of media per vessel during the first and second media runs, respectively
(f) For all measurements, except one outlier measured on July 11, 2005.
NA = not applicable

***First Media Run.*** The first media run began on January 16, 2004. Difficulties were encountered during the initial four months of operation, and the system was retrofitted (Section 4.4.1) and returned to service on May 24, 2004. The first media run ended on July 14, 2005. The first media run operated for a total of 3,238 hr based on the well pump hour meter readings collected daily at the wellhead. This operational time represented a utilization rate of approximately 26%, or 6.2 hr/day. The low utilization rate was due primarily to relatively low water demand and the concurrent use of another well, Well No. 2, to supply water to the distribution system.

The first media run treated approximately 52,645,000 gal of water, with 49.9 and 50.1% of water flowing through Vessels A and B, respectively, based on totalizer readings from both vessels. This amount is 4% higher than that (50,712,000 gal) recorded from the master flow meter at the wellhead. Significant imbalance flow was observed between the two vessels before the system retrofit, with 43.7 and 56.3% flowing through Vessels A and B, respectively. The problems associated with the imbalanced flow were resolved after system retrofit, with 50.9 and 49.1% flowing through Vessels A and B, respectively, throughout the remainder of the first media run.

Figure 4-13 (left graph) presents instantaneous flowrates measured at Vessels A and B during the first media run. The imbalance flow before system retrofit was reflected in Figure 4-13, with flowrates through Vessel B significantly higher than those through Vessel A. This trend of constantly higher flow through Vessel B discontinued after system retrofit. The total flow through the APU-300 system remained relatively constant throughout the first media run at 266 and 271 gpm before and after retrofit, respectively (or 83.1 and 84.7% of the design value of 320 gpm). Because the imbalanced flow problem occurred before retrofit, EBCT values varied significantly between the two vessels, averaging at 5.2 min for Vessel A and 4.0 min for Vessel B. After retrofit, the difference in EBCT reduced significantly, with EBCT averaged 4.3 min for Vessel A and 4.5 min for Vessel B. The average EBCT was calculated based on total throughput and total operating hours.

Figure 4-14 (left graph) presents $\Delta p$ readings measured across Vessels A and B during the first media run. Before system retrofit, the APU-300 system experienced elevated $\Delta p$ across both vessels with readings that pegged the pressure gauges with graduations up to 20 psig. $\Delta p$ readings across the entire system based on the difference between the pressure readings at the system inlet and outlet fluctuated from approximately 18 to more than 30 psig during this period. After system retrofit, $\Delta p$ readings across each vessel reduced to as low as 2.5 to 6 psig from most measurements immediately after backwash. Similar to imbalanced flow problems, the problems associated with high $\Delta p$ were solved with system retrofit.

***Second Media Run.*** The second media run began on July 29, 2005 and ended on August 16, 2006, operating for a total of 3,004 hr based on well pump hour meter readings collected daily at the wellhead. The operational time represented a utilization rate of approximately 32.5%, or 7.8 hr/day.

The second media run treated approximately 46,553,000 gal of water, with 48.8 and 51.2% flowing through Vessels A and B, respectively, based on totalizer readings from both vessels. This amount was almost identical to that (i.e., 46,580,000 gal) recorded from the master flow meter at the wellhead. Figure 4-13 (right graph) presents instantaneous flowrates measured at Vessels A and B during the second media run. The two flowrate curves fluctuated slightly but essentially overlapped each other at 120 to 130 gpm throughout the run. The averaged total flow through the APU-300 system was 251 gpm, or 78.4% of the design value. The average EBCT was 3.8 min for Vessel A and 3.6 min for Vessel B, which is 31 to 24% higher than the design value of 2.9 min.

Figure 4-14 (right graph) presents $\Delta p$ readings measured across Vessels A and B during the second media run. In most cases, $\Delta p$ readings across each vessel immediately after backwash ranged from 2 to 5 psig, which were slightly lower than those measured during the first media run. The lower readings observed

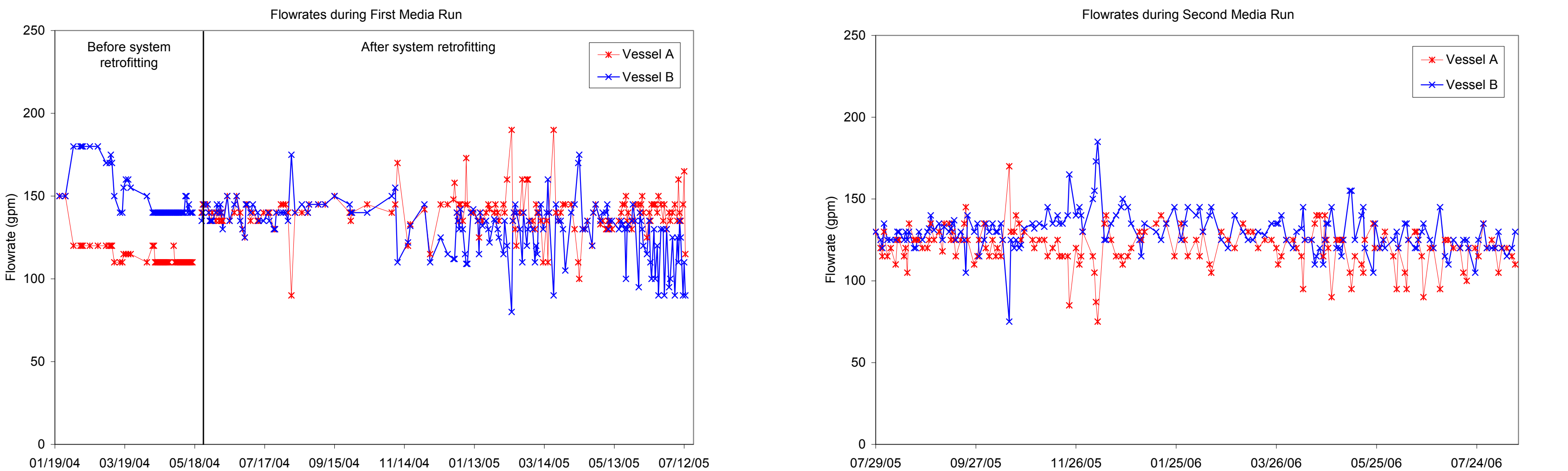



**Figure 4-13. Flowrate Measurements for First (Left) and Second (Right) Media Runs**

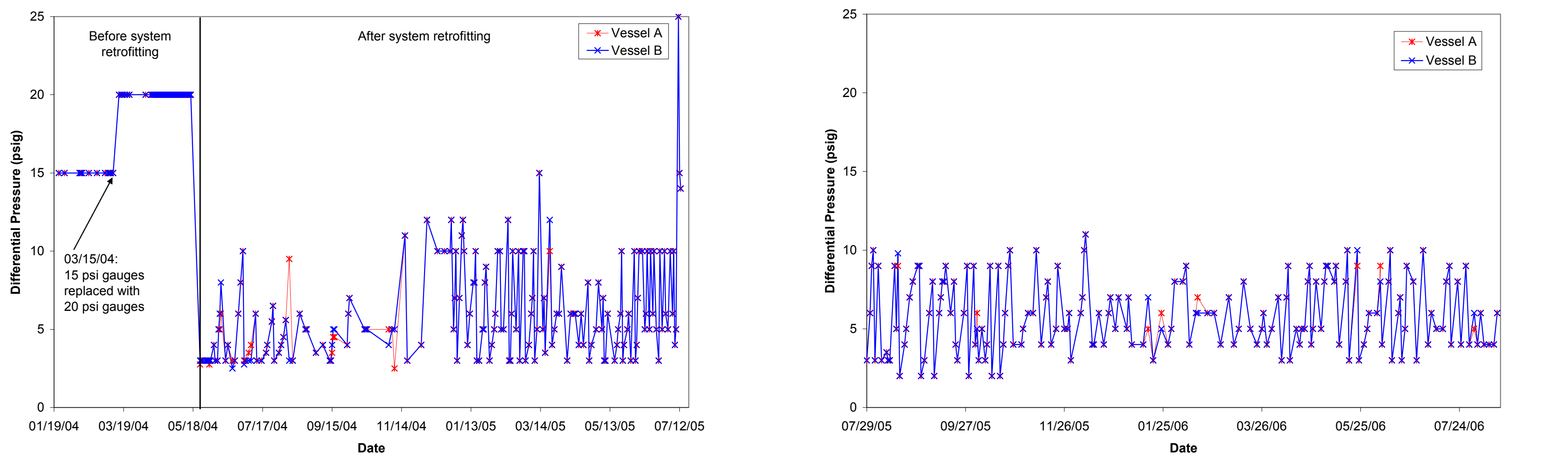



**Figure 4-14. Differential Pressure across Vessels A and B during First (Left) and Second (Right) Media Runs**

probably were due the somewhat larger media size and shorter bed depth associated with the use of pelletized media.

**4.4.3 Media Loss and Breakdown.** A significant amount of media were lost from the adsorption vessels during both media runs. The amount of loss was measured based on the freeboard measurements performed during media changeout (Table 4-8). During the first media run, 42.1% and 45% of the granular media was lost from Vessels A and B, respectively. Apparently, the loss occurred throughout the run rather than during any specific period, according to the periodic freeboard measurements carried out on May 24, 2004, January 6, April 5, and July 25, 2005. Some of the other demonstration sites using SORB 33™-S also experienced media loss, including about 50% during each of two media runs at Rollinsford, NH (Cumming et al., 2008) and at least 14 to 18% during the first 13 months of operation at Queen Anne's County, MD (Chen et al., 2008). The media loss problem improved significantly after switching to the pelletized media, as evidenced by the 12% media loss (with a total throughput of 46,550,000 gal), which was one third of that lost in the first media run (with a total throughput of 52,650,000 gal). This was consistent with the vendor's claim that the pelletized media was somewhat more robust than the granular media. Because the pelletized media were 25% denser, loading a similar weight of the pelletized media resulted in 25% less bed depth, thus yielding more freeboard in the vessels. The less media loss also could have been caused by less wash-away of media or media fines during backwash (assuming similar backwash flowrates) due to the presence of the 0.8-ft more freeboard in the adsorption vessels.

**Table 4-8. Freeboard Measurements and Media Loss**

| First Media Run Granular | | | Second Media Run Pelletized | | |
|---|---|---|---|---|---|
| **Parameter** | **Vessel A** | **Vessel B** | **Parameter** | **Vessel A** | **Vessel B** |
| Volume Loaded ($ft^3$) | 80.0 | 80.0 | Volume Loaded ($ft^3$) | 62.0 | 62.0 |
| Initial Freeboard (in) (May 24, 2004) | 16.3 | 16.5 | Initial Freeboard (in) (July 28, 2005) | 24.0 | 24.0 |
| Freeboard (in) (January 6, 2005) | 25.3 | 24.0 | Freeboard (in) (October 27, 2005) | 24.0 | 23.5 |
| Freeboard (in) (April 5, 2005) | 32.0 | 30.5 | Final Freeboard (in) (September 12, 2006) | NM | 28.0 |
| Final Freeboard (in) (July 25, 2005) | 35.0 | 36.5 | NA | NA | NA |
| Total Media Loss (in) | 18.7 | 20.0 | Total Media Loss (in) | NM | 4.0 |
| Total Media Loss ($ft^3$) | 33.7 | 36.0 | Total Media Loss ($ft^3$) | NM | 7.2 |
| Total Media Loss (%) | 42.1 | 45.0 | Total Media Loss (%) | NM | 11.6 |

NA = not applicable; NM = not measured

Weak physical integrity might have contributed to media loss observed. Sieve analyses conducted by STS indicated that the granular media was breaking down as the run went by. As shown in Table 4-9, the samples collected from Vessel B at a depth of 16 in on July 2005 (or 18 months after system startup) had fewer large particles (i.e., 30% instead of 40% ≥ 1,180 µm) and a larger amount of fines (i.e., 35% instead of 25% ≤ 550 µm) when compared to the virgin granular media. The media breakdown might be linked to frequent or improper backwash (such as the use of excessive backwash loading rates), which is further discussed in Section 4.4.4.

**Table 4-9. Particle Size Distribution of Granular Media before System Startup and during First Media Run**

| Sieve Size | January 2004 Virgin Media Collected before System Startup  | July 2005 Used Media Collected from Vessel B[(a)]  |
|---|---|---|
| U.S. Standard Mesh (μm) | (%) | (%) |
| +16 (>1,180) | 40 | 30 |
| +30 (>550) | 75 | 65 |
| -30 (<550) | 25 | 35 |

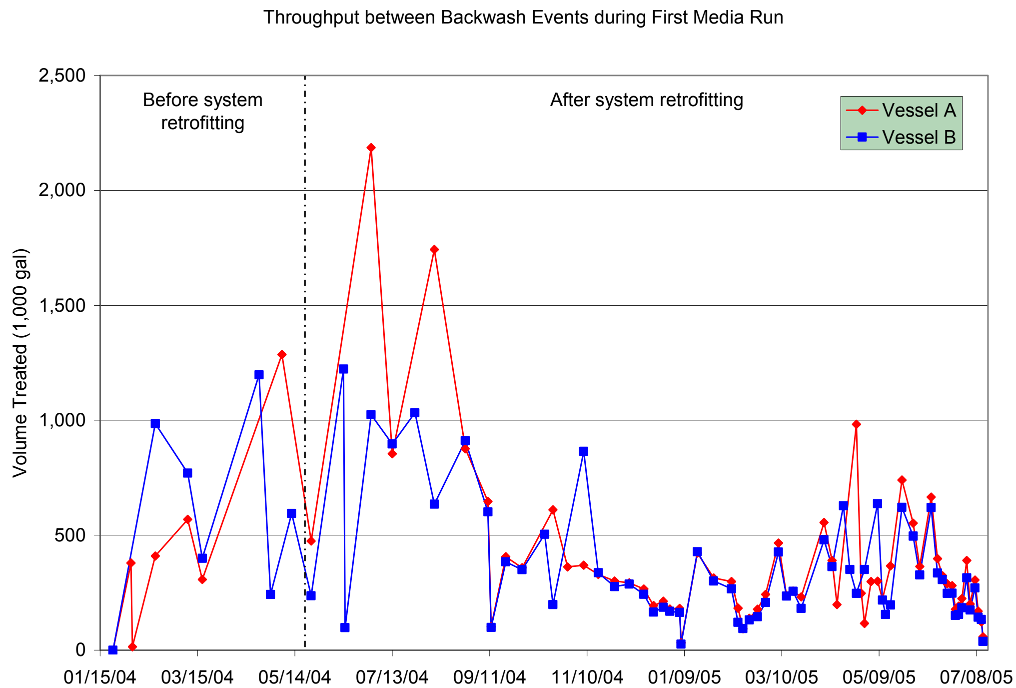
(a) Collected at a depth of 16 in.
Note: Sieve analyses conducted by STS.

**4.4.4 Backwash**. STS recommended the SORB 33™ media be backwashed manually or automatically approximately once per month to loosen up the media bed. Automatic backwash could be initiated either by a timer or a Δp setting. However, due to faster than anticipated increase in Δp during system operation, backwash was conducted far more frequently than was originally anticipated. A brief description of the backwash events follows:

***First Media Run.*** Due to the high Δp problems encountered, backwash was conducted only manually before system retrofit in mid-May 2004. During the first 17 weeks of operation leading to system retrofit, backwash was conducted seven times for Vessel A and eight times for Vessel B. After system retrofit, backwash took place either automatically based on a 10-psi Δp setting or manually when backwash wastewater sampling was required.

Backwash was performed 59 times for Vessel A and 62 times for Vessel B during the remaining 14 months of the first media run. The throughput between two consecutive backwash events is presented in Figure 4-15 (top). After system retrofit, the throughput between backwash events for Vessels A and B decreased during the first four months from over 1,250,000 (2,090 BV) and 2,200,000 gal (3,680 BV), respectively, to around 500,000 gal (840 BV) in mid-September 2004. The throughput further reduced to and then leveled off at an average of around 375,000 gal (630 BV) for both Vessels A and B.

***Second Media Run.*** Backwash was conducted 51 times for both Vessels A and B during the second media run, which lasted for about 12 months. Similar to the first media run, backwash was conducted either automatically based on a 10-psi Δp setting or manually when backwash wastewater sampling was needed. The throughput between two consecutive backwash events for the second media run is presented in Figure 4-15 (bottom). Throughput values between backwash events fluctuated widely between 1,300,000 and 150,000 gal and showed no noticeable trend of increasing or decreasing throughout the run. The averaged throughput between backwash events was 454,000 gal (760 BV) for Vessel A and 476,000 gal (800 BV) for Vessel B. These average throughput values were 1.2 to 1.6 times higher than that recorded in the first media run. The improved physical integrity of the pelletized media might have contributed to the higher throughput between backwash events observed during the second media run.



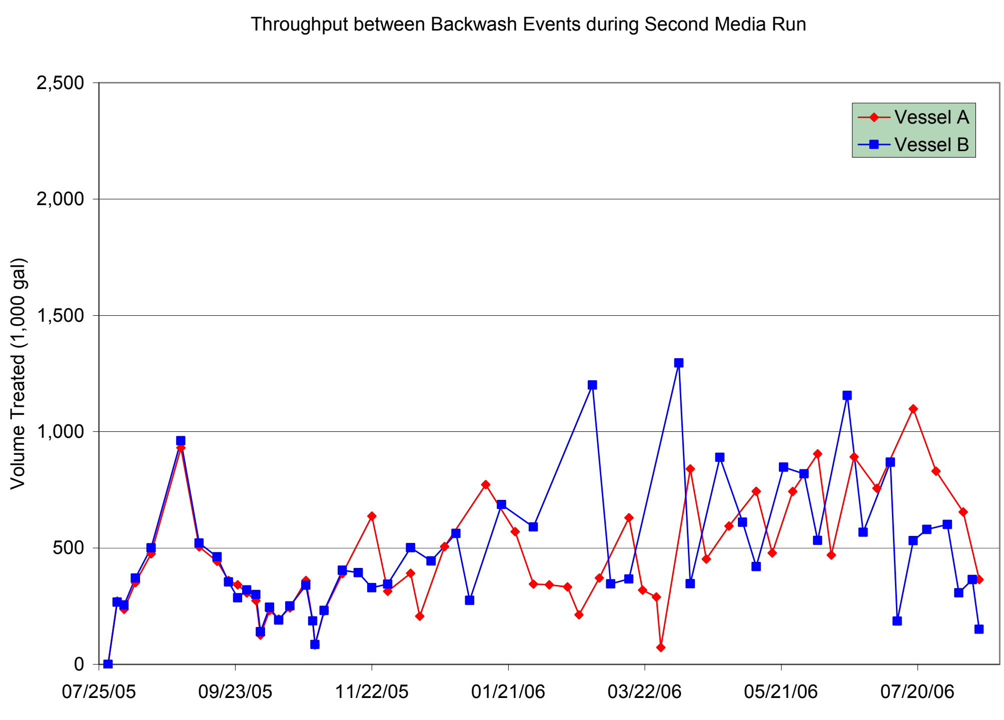




**Figure 4-15. Throughput Between Backwash Events During First (Top) and Second (Bottom) Media Runs**

The backwash was performed at flow rates typically ranging from 200 to 220 gpm. Each backwash event lasted typically for 20 min, followed by a four-min rinse, producing approximately 4000 to 5000 gal of water per vessel during each backwash event. Due to the cycles of water demand, automated backwash events typically took place overnight, when the operator was not present.

**4.4.5 Media Changeout.** During the performance evaluation study, one media changeout was performed by STS on July 27, 2005. Before spent media removal, the heights of the freeboard (i.e., from the flange at the top of the vessels to the media surface) were measured as recorded in Table 4-8. The spent SORB 33$^{TM}$-S media then was sampled and removed from each vessel as described in Section 3.3.4. A vacuum truck was used to remove the spent media and the gravel underbedding. Vacuum removal of the media was paused in each vessel to allow for the collection of spent media samples from the lower portion of the bed in each vessel. After the spent media and gravel were completely removed, the vessels were rinsed, new bottom laterals were installed, and the bottom flanges were reconnected. Each vessel was then half filled with chlorinated water. New gravel was added to each vessel, followed by virgin media, in the pelletized form. All gravel and media were added to the vessels through the 3-in diameter top flange. The vessels were then completely filled with chlorinated water with air bled from the top of each vessel, and the media was allowed to soak overnight. After the media were properly backwashed and freeboard measurements obtained, the system was returned to service.

Spent SORB 33$^{TM}$-P samples also were collected by Desert Sands MDWCA during media removal on September 11, 2006, although the media were not replaced at this time due to the completion of the demonstration study.

**4.4.6 Residual Management.** Residuals produced by the operation of the APU-300 system included backwash wastewater and spent media. Above ground piping for backwash wastewater from both vessels was combined before extending outside the building below the base of the wall. Backwash wastewater was discharged into an evaporation pond, where water either evaporated to the air or infiltrated into the ground (Figure 4-7). Particulates carried in the backwash wastewater remained in the pond.

**4.4.7 System Operation Reliability and Simplicity.** The overall system reliability and simplicity were examined both before and after system retrofit in May 2004. Aside from the excessive pressure losses and imbalanced flow prior to the system retrofit, the only other O&M issue encountered was the temporary failure of digital flow meters on the vessels on two separate occasions for one to two days at a time. After approximately two years of system operation after retrofit, two of the actuated valves (121-A and 123-A) began to stick and had to be replaced with Asahi Type 57 butterfly valves and Asahi Type 94 actuators in September 2006.

Unscheduled downtime during the first media run was caused by the need to address elevated pressure losses and imbalanced flows (Section 4.4.1). The system was shut down on February 19, 2004 for a system inspection, February 26, 2004 for media sampling, March 8, 2004 for the installation of a bypass line around the Fleck valve controller, and May 16 through 24, 2004 for system retrofit. Neither scheduled nor unscheduled downtime was required after system retrofit until the end of the performance evaluation study.

The simplicity of system operation and operator skill requirements are discussed according to pre- and post treatment requirements, levels of system automation, operator skill requirements, preventative maintenance activities, and frequency of chemical/media handling and inventory requirements.

***Pre- and Post-Treatment Requirements***. Pretreatment consisted of the injection of NaOCl upstream of the system for oxidation of As(III), Fe(II), and, perhaps, sulfide. The prechlorination system was already in place to provide chlorine residuals in water before entering the distribution system. Vigilant oversight of the prechlorination system was necessary to ensure that the residual chlorine levels were maintained properly. Post-treatment was not required.

***System Automation***. For the most part, backwash was conducted automatically and triggered by a 10-psi $\Delta p$ setting across each vessel. Backwash also was initiated manually when backwash wastewater sampling was required. Occasionally, only one vessel reached the trigger level and was backwashed, thus enabling it to receive more flow than the other and producing an imbalanced flow. When this occurred, the operator initiated a manual backwash on the second vessel, returning the system to a balanced flow. All other functions of the APU-300 system were automatic.

***Operator Skill Requirements***. Under normal operating conditions, the skill requirements to operate the APU-300 system were minimal. The daily demand on the operator was 15 min to allow the operator to visually inspect the system and record the operating parameters on the log sheets. The operation of the system did not appear to require additional skills beyond those necessary to operate the existing production equipment.

Based on the size of the population served and the treatment technology, the State of New Mexico requires Level 3 Certification for operation of the STS system at MDWCA facility. The State of New Mexico has five levels of certifications for operations of public water supply systems, based on the complexity of the treatment and distribution system, such as the size and type of the system, the capacity of the system in terms of size service area and number of users served, the type and character of the water to be treated, and the physical conditions affecting the treatment plants. The levels range from Level 1, the least complex, to Level 5, the most complex.

***Preventative Maintenance Activities***. Preventative maintenance tasks recommended by STS included monthly inspection of the control panel, quarterly checking and calibration of the flow meters, biannual inspection of the actuator housings, fuses, relays, and pressure gauges, and annual inspection of the butterfly valves. STS recommended checking the actuators at each backwash event to ensure that the valves were opening and closing in the proper sequence. Further, inspection of the adsorber laterals and replacement of the gravel underbedding were recommended concurrent with the media replacement. The operator inspected the valves and wiring monthly, which consumed approximately 15 min/month. The operator also compared the flow meter and totalizer data from the STS system to his existing meters on a consistent basis, which did not require any appreciable time expenditure.

***Chemical/Media Handling and Inventory Requirements***. Chemical use was not required beyond the prechlorination system already in place. At the water production rate observed during the performance evaluation study, Desert Sands MDWCA ordered one 53-gal drum of NaOCl per month. The plant operator switched the metering pump inlet tube from the empty drum to the new drum when necessary.

## 4.5 System Performance

The performance of the APU systems were evaluated based on analyses of water samples collected from the treatment plant, system backwash, and distribution system.

**4.5.1 Treatment Plant Sampling**. Water samples were collected at five locations through the treatment process: including at the inlet (IN), after prechlorination (AC), after Vessels A and B (TA and TB, respectively), and at the combined effluent (TT). The treatment plant water was sampled on 75 occasions (including five duplicate events) during the study, with field speciation performed 25 times (19 times during the first media run and six times during the second media run). Field-speciation samples at IN, AC, and TT were collected once every four weeks from system start-up through January 4, 2006.

Field speciation was discontinued from February 1 through the end of the performance evaluation sampling on August 2, 2006.

Table 4-10 provides a summary of analytical results for arsenic, iron, and manganese during the first media run from January 16, 2004, through July 14, 2005, and the second media run from July 29, 2005, through August 16, 2006. Table 4-11 summarizes the results of the other water quality parameters. The standard deviations for the measurements also are presented in Tables 4-10 and 4-11. Appendix B contains a complete set of analytical results during the operation of the first and second media runs. The analytical data were not significantly different throughout the demonstration study whether using SORB 33$^{TM}$-S for the first media run or SORB 33$^{TM}$-P for the second media run. The results of the water samples collected throughout the treatment plant are discussed below.

***Arsenic***. The key parameter for evaluating the effectiveness of the APU-300 system was the concentration of arsenic in the treated water. As shown in Tables 4-10 and 4-11 as well as Figures 4-16 through 4-18, the adsorptive behavior was very similar between the granular and pelletized media.

Figure 4-16 contains three bar charts showing the concentrations of total As, particulate As, and soluble As(III) and As(V) at the IN, AC, and TT sampling locations for each speciation sampling event. Total arsenic concentrations in raw water ranged from 19.9 to 30.1 µg/L and averaged 23.9 µg/L during the first media run; and it ranged from 18.6 to 25.9 µg/L and averaged 23.4 µg/L during the second media run (Table 4-10). Particulate arsenic concentrations averaged 1.2 and 1.1 µg/L during the first and second media runs, respectively. Soluble As(III) was the predominating species with its concentrations averaging 21.8 and 21.6 µg/L during the first and second media runs, respectively. The remainder of soluble arsenic was As(V) with concentrations averaging 1.4 and 0.9 µg/L , respectively. The arsenic concentrations measured during this study were consistent with those in raw water collected on August 20, 2003 (Table 4-1).

Prechlorination oxidized As(III) to As(V) and provided required chlorine residuals to the distribution system. Samples collected downstream of the chlorine addition point (AC) had average As(III) and As(V) concentrations of 1.9 and 21.4 µg/L, respectively, during the first media run; , and 2.1 and 20.2 µg/L, respectively, during the second media run. Two exceptions were noted on samples collected on June 9, 2004, and January 20, 2005, during which arsenic oxidation did not appear to occur. Onsite free and total chlorine measurements, however, indicated the presence of residual chlorine; therefore, sampling errors were suspected for these AC samples. Typically at the AC location, free chlorine was measured at 0.3 to 0.7 mg/L (as $Cl_2$) during the first media run and 0.6 to 1.0 mg/L during the second media run. Free chlorine residuals measured were very similar to total chlorine levels, which ranged from 0.4 to 0.8 mg/L during the first and second media runs (Table 4-11). The chlorine residuals measured at the TA, TB, and TT locations were similar to those at the AC location, indicating little or no chlorine consumption through the adsorption vessels.

The arsenic breakthrough curves for both media runs are shown in Figure 4-17. The plots clearly demonstrate the similarity in total arsenic concentrations at the IN and AC locations and significant decrease in total arsenic concentrations following adsorption vessels at the TA, TB, and TT locations. Arsenic concentrations at TA and TB were similar, despite the imbalanced flow observed.

As shown in the top of Figure 4-17, during the first media run, concentration spikes exceeding the 10-µg/L As target MCL were observed on December 1, 2004, at both TA and TB locations after treated 21,200 and 23,300 BV of water by Vessels A and B, respectively. These concentration spikes could not be related to any particular incidents after reviewing the field logs. An STS engineer came to the site on January 6, 2005, to perform a backwash. Total arsenic concentrations at the effluent locations went down

**Table 4-10. Summary of Arsenic, Iron, and Manganese Analytical Results for First and Second Media Runs**

| Parameter (Figure, if any) | Sampling Location[(a)] | Number of Samples Media Run 1/ Media Run 2 | Concentration (μg/L) | | | |
|---|---|---|---|---|---|---|
| | | | Minimum Media Run 1/ Media Run 2 | Maximum Media Run 1/ Media Run 2 | Average Media Run 1/ Media Run 2 | Standard Deviation Media Run 1/ Media Run 2 |
| As (total) (see Figure 4-17) | IN | 49/26 | 19.9/18.6 | 30.1/25.9 | 23.9/23.4 | 2.5/1.7 |
| | AC | 49/26 | 19.6/21.1 | 30.1/31.5 | 24.2/23.8 | 2.6/2.1 |
| | TA | 30/18 | NM | NM | NM | NM |
| | TB | 29/18 | NM | NM | NM | NM |
| | TT | 19/8 | NM | NM | NM | NM |
| As (soluble) | IN | 19/6 | 21.2/19.7 | 26.8/24.4 | 23.2/22.2 | 1.5/1.6 |
| | AC | 19/6 | 20.3/21.0 | 27.2/23.7 | 23.2/22.4 | 1.7/0.9 |
| | TT | 19/6 | NM | NM | NM | NM |
| As (particulate) | IN | 19/6 | 0.1/0.1 | 4.7/3.3 | 1.2/1.1 | 1.5/1.4 |
| | AC | 19/6 | 0.1/0.1 | 5.1/9.6 | 1.4/2.5 | 1.9/3.7 |
| | TT | 19/6 | NM | NM | NM | NM |
| As(III) | IN | 19/6 | 17.6/19.1 | 25.2/23.1 | 21.8/21.6 | 1.6/1.4 |
| | AC | 17[(b)]/6 | 0.5/0.9 | 4.6/3.8 | 1.9/2.1 | 1.1/1.0 |
| | TT | 19/6 | NM | NM | NM | NM |
| As(V) | IN | 19/6 | 0.1/0.1 | 6.7/2.1 | 1.4/0.9 | 1.9/0.7 |
| | AC | 17[(b)]/6 | 18.4/18.1 | 23.6/22.0 | 21.4/20.2 | 1.2/1.5 |
| | TT | 19/6 | NM | NM | NM | NM |
| Fe (total) | IN | 49/25[(c)] | <25/<25 | 154/290 | 59.9/98.6 | 28.8/72.4 |
| | AC | 49/26 | <25/<25 | 112/112 | 50.8/53.5 | 24.9/23.4 |
| | TA | 30/18 | <25/<25 | 48.1/<25 | <25/<25 | 10.4/0.0 |
| | TB | 29/18 | <25/<25 | 43.7/<25 | <25/<25 | 8.7/0.0 |
| | TT | 19/8 | <25/<25 | <25/<25 | <25/<25 | 0.0/0.0 |
| Fe (soluble) | IN | 19/6 | <25/<25 | 57.1/39.2 | 27.5/<25 | 16.4/10.6 |
| | AC | 19/6 | <25/<25 | 49.0/<25 | <25/<25 | 9.0/2.8 |
| | TT | 19/6 | <25/<25 | <25/<25 | <25/<25 | 0.0/0.0 |
| Mn (total) | IN | 49/26 | 7.0/6.9 | 24.8/15.7 | 9.5/9.7 | 2.7/1.9 |
| | AC | 49/26 | 7.1/7.4 | 22.0/14.2 | 9.7/9.9 | 2.8/1.9 |
| | TA | 30/18 | <0.1/<0.1 | 5.0/1.0 | 0.6/0.4 | 1.3/0.3 |
| | TB | 29/18 | <0.1/<0.1 | 1.4/0.8 | 0.3/0.5 | 0.3/0.2 |
| | TT | 19/8 | <0.1/<0.1 | 0.8/0.6 | 0.3/0.3 | 0.2/0.2 |
| Mn (soluble) | IN | 19/6 | 6.3/8.7 | 10.5/10.3 | 8.8/9.4 | 1.1/0.7 |
| | AC | 19/6 | 4.7/6.6 | 9.2/8.3 | 6.6/7.4 | 1.3/0.6 |
| | TT | 19/6 | <0.1/<0.1 | 0.5/0.5 | 0.2/0.3 | 0.2/0.2 |

(a) See Table 3-3.
(b) Data not included in calculations for 06/09/04 or 01/20/05 due to suspected sampling errors.
(c) One outlier (i.e., 1,151 μg/L on 07/19/06) not included in calculations.
NM = not meaningful for data related to breakthrough curves; see Figure 4-17 and Appendix B for results.
One-half of detection limit used for non-detect results for calculations.
Duplicate samples included for calculations.

## Table 4-11. Summary of Water Quality Parameter Measurements

| Parameter (Figure, if any) | Sampling Location[a] | Unit | Number of Samples Media Run 1/ Media Run 2 | Concentration/Value Minimum Media Run 1/ Media Run 2 | Maximum Media Run 1/ Media Run 2 | Average Media Run 1/ Media Run 2 | Standard Deviation Media Run 1/ Media Run 2 |
|---|---|---|---|---|---|---|---|
| Alkalinity (as $CaCO_3$) | IN | mg/L | 49/9 | 164/180 | 226/198 | 187/188 | 12/6 |
| | AC | mg/L | 49/9 | 170180 | 216/198 | 186/192 | 9/7 |
| | TA | mg/L | 30/3 | 169/198 | 202/198 | 185/198 | 8/0 |
| | TB | mg/L | 30/3 | 169/194 | 198/198 | 185/197 | 8/2 |
| | TT | mg/L | 19/6 | 173/185 | 201/198 | 186/191 | 7/5 |
| Fluoride | IN | mg/L | 19/6 | 0.2/0.4 | 0.7/0.5 | 0.5/0.4 | 0.1/0.0 |
| | AC | mg/L | 19/6 | 0.2/0.4 | 0.8/0.5 | 0.5/0.4 | 0.1/0.0 |
| | TT | mg/L | 19/6 | 0.2/0.4 | 0.7/0.5 | 0.5/0.4 | 0.1/0.0 |
| Sulfate | IN | mg/L | 19/6 | 170/156 | 255/201 | 190/176 | 25/18 |
| | AC | mg/L | 19/6 | 160/157 | 255/200 | 186/176 | 26/17 |
| | TT | mg/L | 19/6 | 170/158 | 255/199 | 191/173 | 24/18 |
| Orthophosphate (as $PO_4$) | IN | mg/L | 48/3 | <0.05/<0.05 | 0.20/<0.05 | <0.05/<0.05 | 0.0/0.0 |
| | AC | mg/L | 48/3 | <0.05/<0.05 | 0.20/0.2 | <0.05/<0.05 | 0.0/0.0 |
| | TA | mg/L | 29/0 | <0.05/NA | <0.10/NA | <0.05/NA | 0.0/NA |
| | TB | mg/L | 29/0 | <0.05/NA | <0.10/NA | <0.05/NA | 0.0/NA |
| | TT | mg/L | 18/3[a] | <0.05/<0.05 | 0.20/<0.05 | <0.05/<0.05 | 0.0/0.0 |
| Total P (as $PO_4$) | IN | mg/L | 0/6 | NA /<0.03 | NA /<0.03 | NA /<0.03 | NA /0.0 |
| | AC | mg/L | 0/6 | NA /<0.03 | NA /<0.03 | NA /<0.03 | NA /0.0 |
| | TA | mg/L | 0/3 | NA /<0.03 | NA /<0.03 | NA /<0.03 | NA /0.0 |
| | TB | mg/L | 0/3 | NA /<0.03 | NA /<0.03 | NA /<0.03 | NA /0.0 |
| | TT | mg/L | 0/3 | NA /<0.03 | NA /<0.03 | NA /<0.03 | NA /0.0 |
| Silica (as $SiO_2$) | IN | mg/L | 49/9 | 36.4/36.5 | 41.8/39.6 | 38.3/37.8 | 1.0/1.0 |
| | AC | mg/L | 49/9 | 36.4/36.2 | 41.7/39.6 | 38.2/37.8 | 1.1/1.1 |
| | TA | mg/L | 30/3 | 35.3/36.1 | 39.9/38.1 | 37.9/37.0 | 1.0/1.0 |
| | TB | mg/L | 30/3 | 36.2/35.6 | 40.0/38.1 | 38.0/36.9 | 1.1/1.3 |
| | TT | mg/L | 19/6 | 36.6/33.7 | 40.6/38.9 | 38.2/37.6 | 1.0/2.0 |
| Sulfide | IN | µg/L | 22/31[b] | <5/<5 | 5.7/<5 | <5/<5 | 0.0/0.0 |
| TSS | IN | mg/L | 0/4 | NA /<1.0 | NA /1.0 | NA /<1.0 | NA /0.3 |
| | AC | mg/L | 0/2 | NA /<1.0 | NA /<1.0 | NA /<1.0 | NA /0.0 |
| | TT | mg/L | 0/2 | NA /<1.0 | NA /<1.0 | NA /<1.0 | NA /0.0 |
| Nitrate (as N) | IN | mg/L | 17/6 | <0.04/<0.04 | <0.04/0.2 | <0.04/0.1 | 0.0/0.1 |
| | AC | mg/L | 17/6 | <0.04/<0.04 | 0.6/0.4 | 0.06/0.12 | 0.2/0.2 |
| | TT | mg/L | 17/6 | <0.04/<0.04 | 0.1/1.0 | <0.04/0.2 | 0.0/0.4 |
| Turbidity | IN | NTU | 48/9 | 0.2/0.2 | 3.5/1.5 | 0.7/0.7 | 0.7/0.4 |
| | AC | NTU | 48/9 | 0.1/0.1 | 2.4/1.4 | 0.5/0.4 | 0.4/0.4 |
| | TA | NTU | 29/3 | <0.1/<0.1 | 2.7/0.6 | 0.3/0.2 | 0.5/0.3 |
| | TB | NTU | 29/3 | <0.1/<0.1 | 0.8/0.8 | 0.2/0.3 | 0.2/0.4 |
| | TT | NTU | 19/6 | <0.1/<0.1 | 0.7/0.2 | 0.2/0.1 | 0.2/0.1 |
| pH | IN | S.U. | 38/6 | 7.6/7.7 | 8.1/7.9 | 7.7/7.8 | 0.2/0.1 |
| | AC | S.U. | 38/6 | 7.6/7.7 | 8.0/7.9 | 7.7/7.8 | 0.1/0.1 |
| | TA | S.U. | 18/0 | 7.6/ NA | 8.0/ NA | 7.8/ NA | 0.1/ NA |
| | TB | S.U. | 18/0 | 7.6/ NA | 7.9/ NA | 7.8/ NA | 0.1/ NA |
| | TT | S.U. | 19/6 | 7.6/7.7 | 8.0/7.9 | 7.7/7.8 | 0.1/0.1 |

**Table 4-11. Summary of Water Quality Parameter Measurements (Continued)**

| Parameter (Figure, if any) | Sampling Location[(a)] | Unit | Number of Samples Media Run 1/ Media Run 2 | Concentration/Value Minimum Media Run 1/ Media Run 2 | Maximum Media Run 1/ Media Run 2 | Average Media Run 1/ Media Run 2 | Standard Deviation Media Run 1/ Media Run 2 |
|---|---|---|---|---|---|---|---|
| Temperature | IN | ºC | 38/6 | 19.9/29.9 | 31.6/31.6 | 29.9/30.8 | 1.8/0.7 |
| | AC | ºC | 38/6 | 28.8/30.8 | 31.6/31.8 | 30.4/31.2 | 0.7/0.5 |
| | TA | ºC | 18/0 | 28.9/ NA | 31.2/ NA | 30.3/ NA | 0.7/ NA |
| | TB | ºC | 18/0 | 29.0/ NA | 31.1/ NA | 30.3/ NA | 0.6/ NA |
| | TT | ºC | 19/6 | 29.5/30.8 | 31.7/31.8 | 30.7/31.3 | 0.6/0.4 |
| DO | IN | mg/L | 38/6 | 0.1/0.1 | 1.9/0.3 | 0.9/0.2 | 0.5/0.1 |
| | AC | mg/L | 38/6 | 0.2/0.1 | 2.0/0.3 | 1.0/0.2 | 0.5/0.1 |
| | TA | mg/L | 18/0 | 0.4/ NA | 2.0/ NA | 1.2/ NA | 0.4/ NA |
| | TB | mg/L | 18/0 | 0.4/ NA | 1.9/ NA | 1.2/ NA | 0.4/ NA |
| | TT | mg/L | 19/6 | 0.2/0.2 | 2.3/0.2 | 0.9/0.2 | 0.6/0.0 |
| ORP | IN | mV | 26/6 | 20/14 | 101/52 | 57/32 | 22/17 |
| | AC | mV | 27/6 | 454/370 | 562/514 | 509/484 | 30/56 |
| | TA | mV | 11/0 | 471/ NA | 566/ NA | 521/ NA | 29/ NA |
| | TB | mV | 11/0 | 485/ NA | 576/ NA | 527/ NA | 29/ NA |
| | TT | mV | 16/6 | 392/410 | 561/576 | 511/511 | 39/54 |
| Free Chlorine (as $Cl_2$) | AC | mg/L | 35/6 | 0.3/0.6 | 0.7/1.0 | 0.5/0.8 | 0.1/0.2 |
| | TA | mg/L | 17/0 | 0.3/ NA | 0.6/ NA | 0.5/ NA | 0.1/ NA |
| | TB | mg/L | 15/0 | 0.3/ NA | 0.6/ NA | 0.4/ NA | 0.1/ NA |
| | TT | mg/L | 19/6 | 0.3/0.3 | 0.7/0.7 | 0.5/0.5 | 0.1/0.1 |
| Total Chlorine (as $Cl_2$) | AC | mg/L | 33/2 | 0.4/0.6 | 0.8/0.8 | 0.6/0.7 | 0.1/0.1 |
| | TA | mg/L | 15/0 | 0.5/ NA | 0.7/ NA | 0.5/ NA | 0.1/ NA |
| | TB | mg/L | 13/0 | 0.5/ NA | 0.7/ NA | 0.5/ NA | 0.1/ NA |
| | TT | mg/L | 18/1 | 0.4/0.6 | 0.8/0.6 | 0.6/0.6 | 0.1/NA |
| Total Hardness (as $CaCO_3$) | IN | mg/L | 19/6 | 68.9/81.4 | 102/90.0 | 86.6/84.7 | 8.6/3.1 |
| | AC | mg/L | 19/6 | 68.3/74.5 | 111/87.4 | 87.3/83.6 | 9.7/5.1 |
| | TT | mg/L | 19/6 | 68.4/75.2 | 110/88.1 | 86.3/84.0 | 11.3/4.7 |
| Ca Hardness (as $CaCO_3$) | IN | mg/L | 19/6 | 53.1/68.2 | 83.7/75.5 | 70.7/70.6 | 7.8/2.6 |
| | AC | mg/L | 19/6 | 53.3/61.1 | 91.9/73.1 | 71.7/69.3 | 8.5/4.6 |
| | TT | mg/L | 19/6 | 53.3/61.4 | 86.5/74.2 | 70.4/69.6 | 9.3/4.4 |
| Mg Hardness (as $CaCO_3$) | IN | mg/L | 19/6 | 13.2/13.2 | 20.0/15.0 | 15.9/14.1 | 1.6/0.7 |
| | AC | mg/L | 19/6 | 12.6/13.4 | 19.2/15.1 | 15.6/14.2 | 1.9/0.7 |
| | TT | mg/L | 19/6 | 12.4/13.8 | 23.5/15.1 | 15.9/14.3 | 2.4/0.5 |

(a) One outlier (i.e., 1.4 mg/L on 11/29/05) not included in calculations.
(b) Includes 26 duplicate sampling events.
One-half of detection limit used for non-detect results for calculations.
Duplicate samples included for calculations.

to the levels around 5 µg/L at all effluent sampling locations thereafter, and increased gradually thereafter through the end of the first media run. The actual breakthrough of the first media run occurred at approximately 40,600 BV, representing about 62% of the vendor-estimated working capacity of 66,000 BV.

During the second media run (bottom of Figure 4-17), total arsenic concentrations at the effluent locations increased gradually. Breakthrough of arsenic above the 10 µg/L MCL occurred at approximately 49,500 BV, representing about 58 % of the estimated working capacity of 85,200 BV.

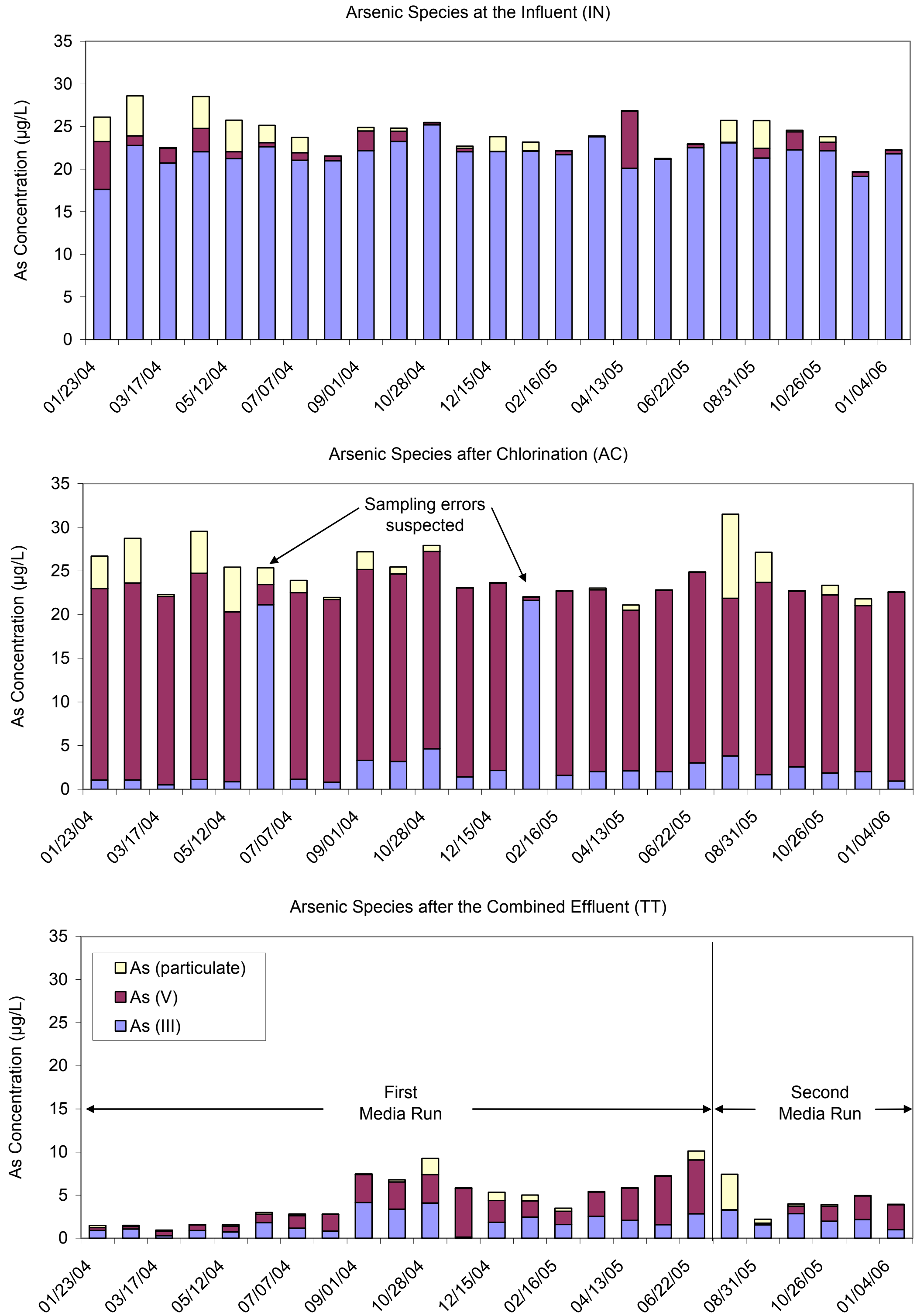
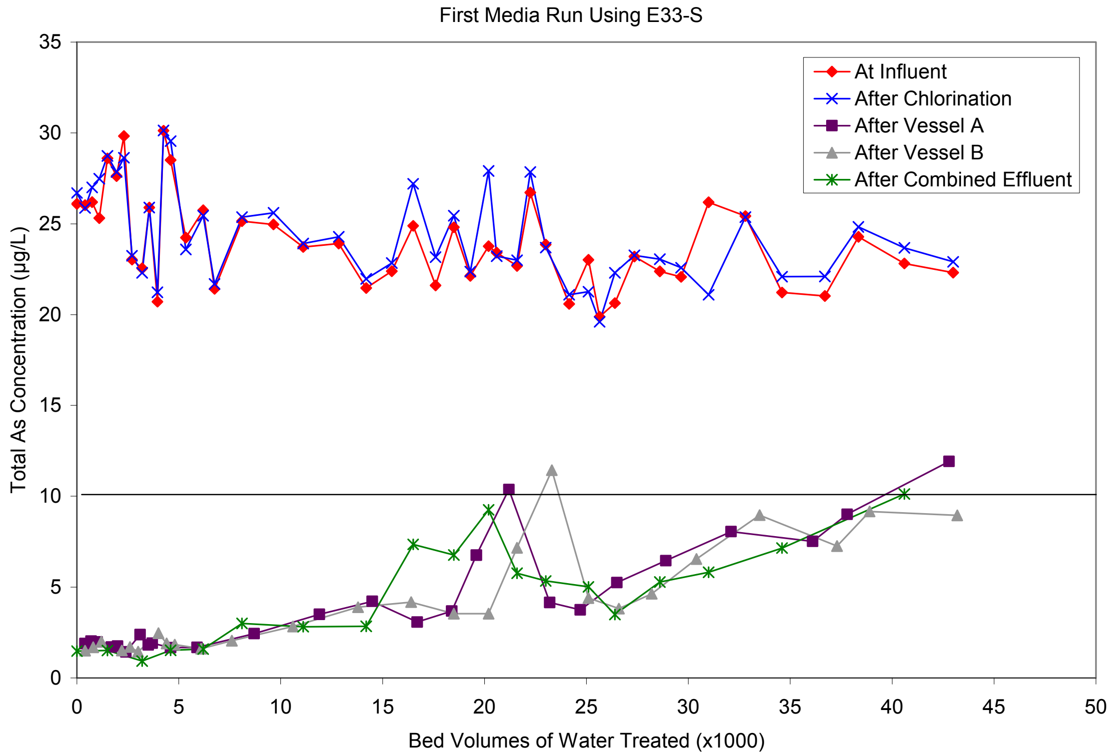



**Figure 4-16. Concentrations of Arsenic Species at Wellhead, After Chlorination, and After Combined Effluent**



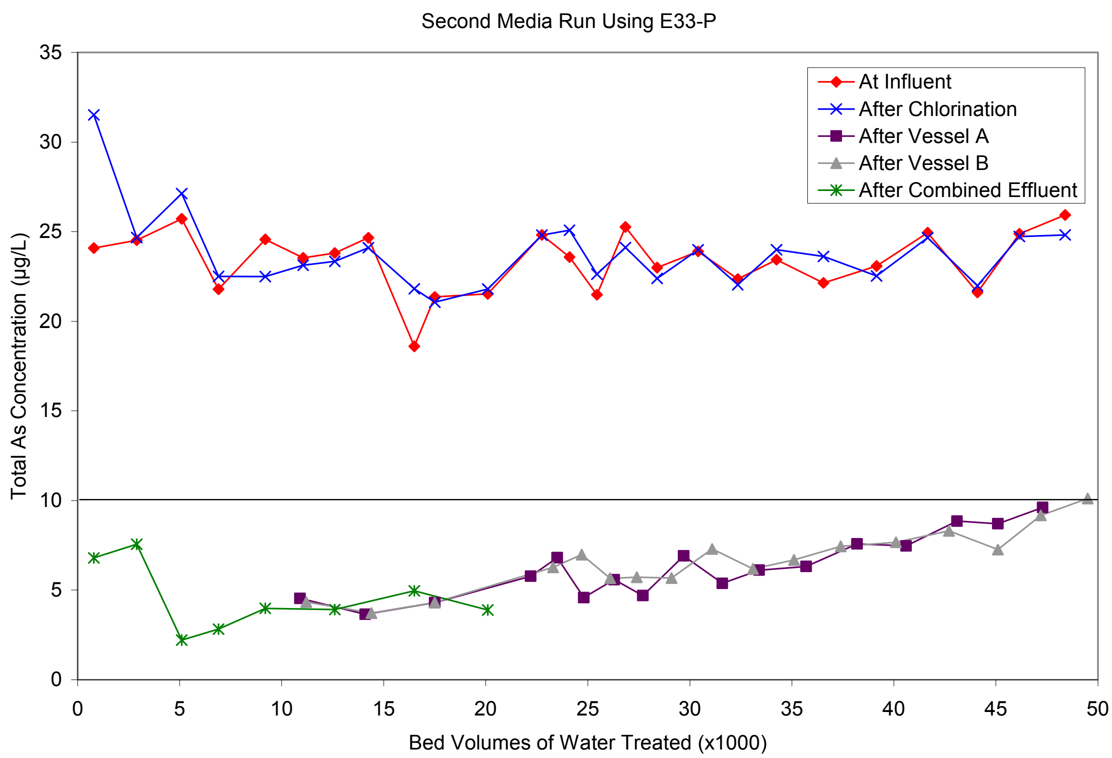
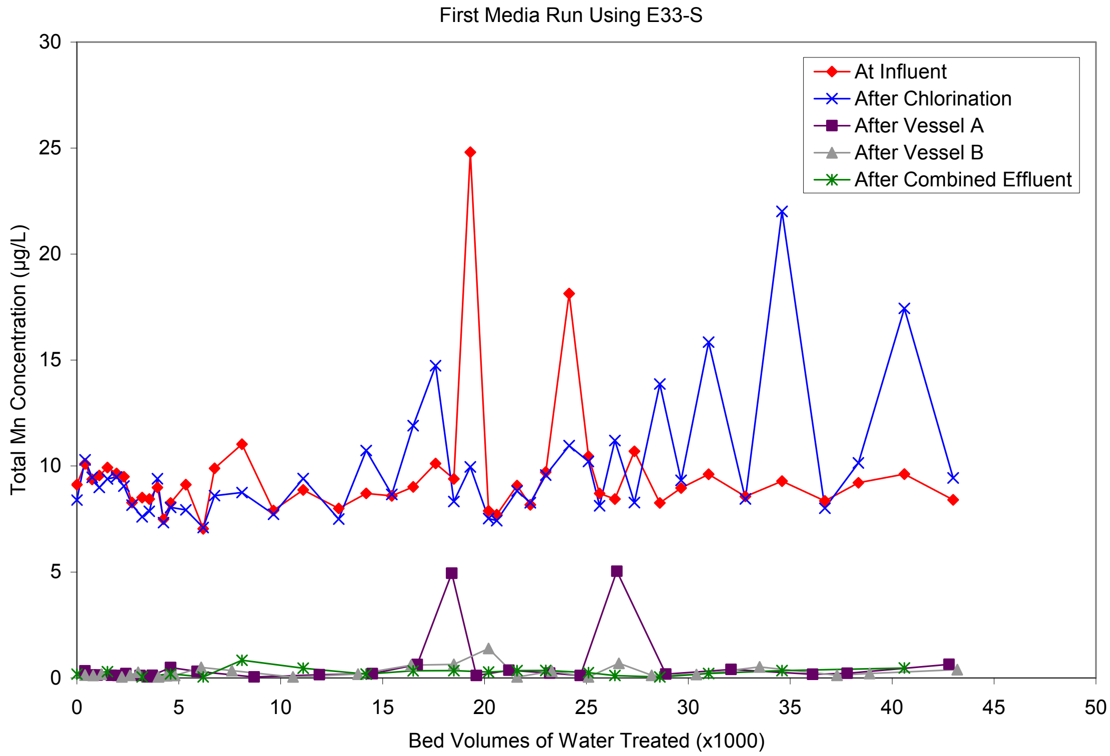




**Figure 4-17. Total Arsenic Breakthrough Curves**



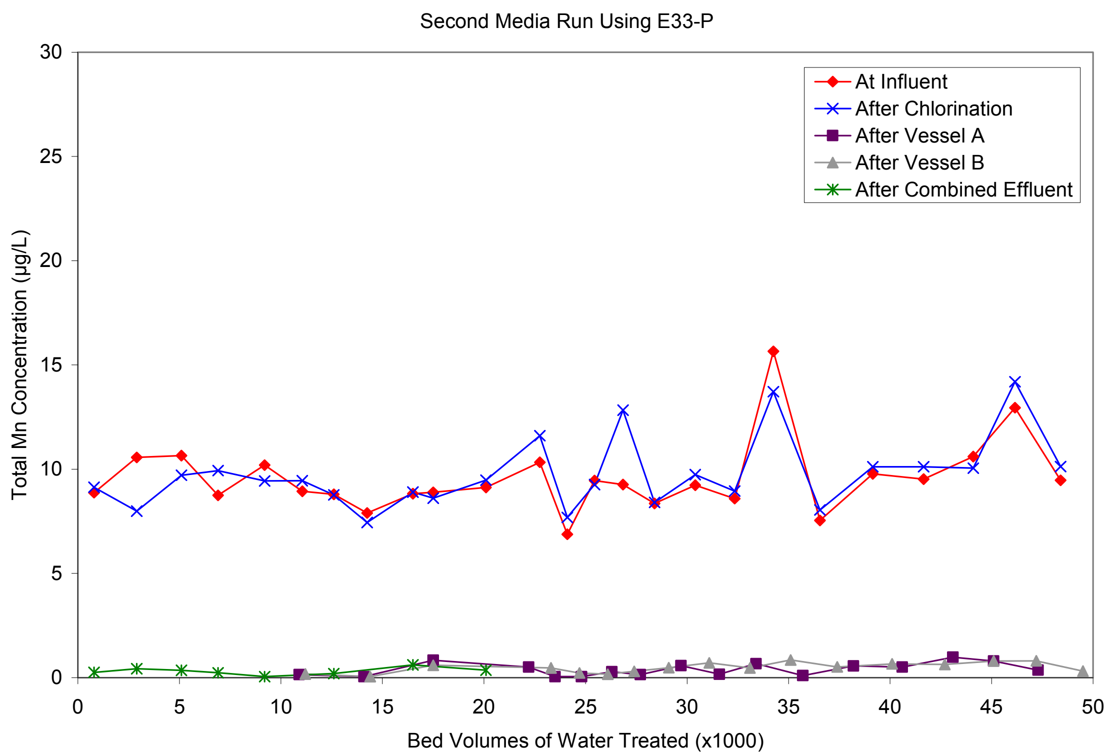




**Figure 4-18. Total Manganese Concentrations Over Time**

***Iron.*** Total iron concentrations in raw water ranged from <25 to 154 µg/L and averaged 59.9 µg/L during the first media run, and from <25 to 290 µg/L and averaged 98.6 µg/L during the second media run (except for one outlier of 1,151 µg/L on July 19, 2006, as shown in Table 4-10). Total iron concentrations following prechlorination at the AC location ranged from <25 to 112 µg/L and averaged 50.8 µg/L during the first media run; and from <25 to 112 µg/L and averaged 53.5 µg/L during the second media run. Nearly all of the total iron concentrations at the TA, TB, and TT locations were <25 µg/L and with averaged concentrations <25 µg/L. Average dissolved iron concentrations were near and/or <25 µg/L at all locations. These data indicate that the majority of the total iron entering the treatment system was in particulate form, and that the iron particles were effectively captured by the media beds.

***Manganese.*** Total Mn concentrations at the various sampling locations are plotted over time in Figure 4-18. Total manganese levels in raw water ranged from 7.0 to 24.8 µg/L and averaged 9.5 µg/L during the first media run, and ranged from 6.9 to 15.7 µg/L and averaged 9.7 µg/L during the second media run (Table 4-10). Soluble manganese levels in raw water and after the prechlorination process averaged 8.8 and 6.6 µg/L, respectively, in the first run; they averaged 9.4 and 7.4 µg/L, respectively, in the second media run. The data indicated that manganese existed primarily in the soluble form in raw water, and chlorination precipitated only <25% (on average) of soluble manganese before water entered the adsorption vessels. This observation was consistent with previous findings that free chlorine was relatively ineffective at oxidizing Mn(II) at pH values less than 8.5 (Knocke et al., 1987 and 1990).

As shown in Table 4-10, total Mn concentrations at the TA, TB, and TT locations were reduced to 0.3 to 0.6 µg/L during both media runs, indicating removal of Mn by the SORB 33$^{TM}$ media. Knocke et al. (1990) reported that the presence of free chlorine in the filter promoted Mn(II) removal on $MnO_x$-coated media, and that in the absence of free chlorine, Mn(II) removal was by adsorption only. In the absence of free chlorine, SORB 33$^{TM}$ media apparently had a limited adsorptive capacity for Mn(II). The presence of 0.3 to 1.0 mg/L (as $Cl_2$) of free chlorine (Table 4-11) apparently was enough to promote the removal of manganese by the SORB 33$^{TM}$ media presumably via a mechanism similar to that proposed by Knocke et al. (1990).

***Other Water Quality Parameters***. In addition to arsenic analyses, other water quality parameters were analyzed to provide insight to the chemical processes occurring within the treatment system. The complete water quality results are attached in Appendix B and summarized in Table 4-11.

Alkalinity (as $CaCO_3$) ranged from 164 to 226 mg/L during the first media run and from 180 to 198 mg/L during the second media run. Sulfate concentrations ranged from 170 to 255 mg/L during the first media run and from 156 to 201 mg/L during the second media run. Both alkalinity and sulfate concentrations remained relatively constant throughout the treatment train, indicating little or no effects by prechlorination or the adsorptive media. Historically, sulfide odor in raw water had been detected by the system operator. Sulfide analysis of raw water was conducted on 53 occasions (including 26 duplicate samples). Sulfide was only detected for two events: 5.2 µg/L (5.1 µg/L for duplicate) on March 3, 2004 and 5.7 µg/L (<5 µg/L for duplicate) on March 31, 2004.

Fluoride concentrations ranged from 0.2 to 0.8 mg/L in all samples throughout the study. Fluoride concentrations did not appear to be affected by the treatment. Orthophosphate (as $PO_4$) concentrations were below or near the method detection limit of 0.10 mg/L for all samples, with two exceptions (i.e., 0.20 mg/L at IN, AC, and TT on January 23, 2004, and 1.4 mg/L, most likely an outlier, at TT on November 17, 2004). Total P (as $PO_4$) concentrations measured during the second media run were under the method detection limit of 0.03 mg/L for all samples. Silica (as $SiO_2$) concentrations, ranging from 33.7 to 40.6 mg/L in vessel effluent, were similar to the levels in raw water only 19 days after system startup, indicating little or no adsorptive capacity for silica.

Onsite pH measurements throughout the study remained consistent across the treatment train at 7.6 to 8.1. DO levels ranged from 0.1 to 2.3 mg/L and were not affected by the prechlorination or the media. ORP readings were collected using a dedicated ORP probe since April 14, 2004. ORP readings at the IN location varied from 14 to 101 mV, indicating a reducing environment. After prechlorination, ORP readings at the AC location increased significantly, ranging from 370 to 562 mV. ORP readings at effluent locations (TA, TB, and TT) ranged from 392 to 576 mV. There did not appear to be a significant difference in ORP values between the AC and treated water samples (TA, TB, and TT), indicating little or no effect from the media.

Total hardness (as $CaCO_3$) ranged from 68.9 to 102 mg/L in raw water, consisting predominantly of calcium hardness (approximately 82%). Hardness was not affected by either prechlorination or the media.

Sodium hypochlorite was added upstream of the treatment system. In addition to the original purpose of disinfecting water, chlorine also oxidized As(III) to As(V) to increase the arsenic adsorptive capacity by the media. Free and total chlorine were monitored at the AC, TA, TB, and TT sampling locations. Free and total chlorine residuals at the AC location ranged from 0.3 to 1.0 mg/L and 0.4 to 0.8 mg/L, respectively. Chlorine residuals measured at the TA, TB, and TT locations were similar to those measured at the AC location, indicating little or no chlorine consumption through the APU-300 system.

**4.5.2 Backwash Wastewater Sampling**. Backwash wastewater was sampled periodically from the sample ports located in the backwash effluent discharge lines from each vessel. Backwash was performed using raw water (non-chlorinated). The unfiltered samples were analyzed for pH, turbidity, and TDS/TSS. Filtered samples using 0.45-µm disc filters were analyzed for soluble arsenic, iron, and manganese. For the last seven backwash wastewater sampling events (taking place since February 1, 2006, through the end of the performance evaluation study), TSS and total As, Fe, and Mn concentrations also were measured. The analytical results are summarized in Table 4-12; results of the sample collected on May 23, 2004 were not included in the data analysis due to a sampling error that the operator filled bottles reserved for filtered samples with a portion of an unfiltered sample. Section 3.3.3 describes the sampling procedures and modifications.

pH values of backwash wastewater ranged from 7.5 to 8.1, similar to those of raw water. Soluble arsenic concentrations ranged from 6.4 to 25.7 µg/L and averaged 13.3 µg/L. This average concentration was lower than that in raw water (i.e., 22.7 µg/L [on average]), indicating removal of some soluble arsenic by the media during backwash. Soluble iron concentrations ranged from <25 to 373 µg/L and averaged 133 µg/L; soluble manganese concentrations ranged from 1.8 to 27.1 µg/L and averaged 10.5 µg/L. Soluble Mn concentrations in backwash wastewater were slightly higher than those in raw water (averaged 9.6 µg/L).

As expected, total arsenic, iron, and manganese concentrations were significantly higher than soluble concentrations, indicating the presence of particulates in backwash wastewater. Particulate As might be associated with either iron particles intercepted by the media beds during the service cycle or the media fines. Assuming the average backwash flowrate was 200 gpm and the backwash duration was 25 min per vessel (Table 4-4), the total amount of backwash wastewater generated during each backwash event would be 10,000 gal. Assuming that 109 mg/L of TSS (i.e., the average of TSS values measured on May 10, June 6, July 18, and August 16, 2006) was produced in 10,000 gal of backwash wastewater from the vessels, approximately 9.1 lb of solids would be discharged during each backwash event. Based on the average total metal (or, more correctly, digested metal) data collected during the last seven backwash events (i.e., 53.3 µg/L of particulate arsenic, 14,635 µg/L of particulate iron, and 851 µg/L of particulate manganese), the solids discharged would be composed of 0.005, 1.2, and 0.07 lb of arsenic, iron, and

## Table 4-12. Backwash Wastewater Sampling Results

| Sampling Event | | Vessel A | | | | | | | | | | | Vessel B | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pH | Turbidity | TDS | TSS | Total As | Soluble As | Particulate As | Total Fe | Soluble Fe | Total Mn | Soluble Mn | pH | Turbidity | TDS | TSS | Total As | Soluble As | Particulate As | Total Fe | Soluble Fe | Total Mn | Soluble Mn |
| No. | Date | S.U. | NTU | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | S.U. | NTU | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| 1 | 05/23/04[a] | 7.5 | 180 | NS | 203 | NS | 3.5 | NS | NS | 825 | NS | 89.0 | 7.9 | 99 | NS | 202 | NS | 5.6 | NS | NS | 2,166 | NS | 131 |
| 2 | 07/13/04 | 7.9 | 220 | 766 | NS | NS | 12.1 | NS | NS | 69.8 | NS | 7.6 | 7.9 | 160 | 756 | NS | NS | 9.6 | NS | NS | 83.0 | NS | 8.2 |
| 3 | 09/30/04 | 8.0 | 0.2[b] | 886 | NS | NS | 9.4 | NS | NS | 160 | NS | 13.0 | 8.1 | 0.1[b] | 780 | NS | NS | 11.3 | NS | NS | 176 | NS | 13.5 |
| 4 | 11/17/04 | 7.8 | 260 | 772 | NS | NS | 9.0 | NS | NS | 136 | NS | 7.6 | 7.9 | 200 | 794 | NS | NS | 12.2 | NS | NS | 152 | NS | 10.2 |
| 5 | 12/06/04 | 7.6 | 240 | 730 | NS | NS | 8.0 | NS | NS | 25.0 | NS | 2.1 | 7.7 | 180 | 710 | NS | NS | 6.4 | NS | NS | 38.0 | NS | 2.6 |
| 6 | 02/07/05 | 7.6 | 220 | 706 | NS | NS | 9.0 | NS | NS | 140 | NS | 7.3 | 7.9 | 330 | 742 | NS | NS | 10.2 | NS | NS | 175 | NS | 8.8 |
| 7 | 06/14/05 | 7.8 | 119[b] | 780 | NS | NS | 25.7 | NS | NS | 70.0 | NS | 6.3 | 7.9 | 111[b] | 772 | NS | NS | 22.2 | NS | NS | 53.0 | NS | 4.8 |
| 8 | 07/07/05 | 7.8 | 70[b] | 852 | NS | NS | 19.6 | NS | NS | 50.0 | NS | 6.9 | 7.9 | 85[b] | 872 | NS | NS | 21.2 | NS | NS | 57.4 | NS | 7.3 |
| 9 | 09/15/05 | 7.6 | 240 | 852 | NS | NS | 7.9 | NS | NS | 111 | NS | 11.1 | 7.7 | 170 | 798 | NS | NS | 9.7 | NS | NS | 106 | NS | 9.7 |
| 10 | 10/12/05 | 8.0 | 220 | 794 | NS | NS | 9.7 | NS | NS | 26.7 | NS | 3.6 | 8.0 | 280 | 786 | NS | NS | 10.3 | NS | NS | 35.9 | NS | 4.1 |
| 11 | 11/09/05 | 7.9 | 300 | 770 | NS | NS | 10.4 | NS | NS | <25 | NS | 2.7 | 7.9 | 110 | 766 | NS | NS | 11.3 | NS | NS | <25 | NS | 1.8 |
| 12 | 02/01/06[c] | 8.0 | NS | 974 | 924 | 143 | 10.9 | 132 | 28,818 | 199 | 1,620 | 15.4 | 8.1 | NS | 782 | 408 | 103 | 16.0 | 86.5 | 32,793 | 163 | 1,267 | 12.5 |
| 13 | 03/15/06 | 8.1 | NS | 802 | 2,180 | 40.4 | 13.1 | 27.3 | 5,463 | 255 | 453 | 17.7 | 8.1 | NS | 812 | 1,850 | 40.7 | 13.1 | 27.6 | 10,106 | 373 | 468 | 27.1 |
| 14 | 04/11/06 | 7.9 | NS | 806 | 1,080 | 72.0 | 16.1 | 56.0 | 30,841 | 62.4 | 1,224 | 6.8 | 8.0 | NS | 762 | 792 | 80.0 | 13.2 | 66.8 | 18,599 | 47.7 | 1,035 | 5.3 |
| 15 | 05/10/06 | 8.0 | NS | 768 | 100 | 48.8 | 15.9 | 32.9 | 6,915 | 194 | 443 | 19.2 | 8.0 | NS | 758 | 70 | 45.2 | 14.5 | 30.7 | 4,317 | 227 | 383 | 19.9 |
| 16 | 06/06/06 | 7.9 | NS | 784 | 154 | 49.3 | 13.6 | 35.7 | 12,758 | 197 | 793 | 16.1 | 7.9 | NS | 744 | 122 | 50.6 | 13.6 | 37.0 | 11,049 | 196 | 707 | 16.2 |
| 17 | 07/18/06 | 8.0 | NS | 760 | 132 | 111 | 19.8 | 90.9 | 16,632 | 325 | 1,381 | 21.7 | 7.9 | NS | 938 | 152 | 80.0 | 15.2 | 64.8 | 13,999 | 307 | 1,110 | 19.7 |
| 18 | 08/16/06 | 7.9 | NS | 742 | 127 | 60.0 | 17.5 | 42.6 | 13,187 | 164 | 910 | 12.0 | 7.9 | NS | 786 | 17 | 33.7 | 15.6 | 18.1 | 2,229 | 113 | 266 | 9.2 |

(a) Operator filled sample bottle with a portion of unfiltered water.
(b) Sample analyzed outside of hold time.
(c) Sampling protocol hereafter revised to include TSS and total As, Fe, and Mn analyses.
NS = not sampled

manganese, respectively (Table 4-12). These amounts, after being converted to the weights of corresponding metal oxides, apparently were lower than those estimated based on TSS. Challenges associated with sampling and sample digestion were believed to have contributed to the discrepancies observed.

Table 4-13 presents the total metal results of backwash solid samples. Backwash solid samples were collected three times on June 6, July 18, and August 16, 2006, from both Vessels A and B. The samples collected were combined to obtain sufficient sample quantitative for total metal analysis and the results are presented in Table 4-13. Iron levels in the solids averaged 329 mg/g (or 33%). Arsenic levels averaged 1.4 mg/g (or 0.14%).

The total throughput between the backwash events conducted on June 6, July 18, and August 16, 2006 for both Vessels A and B was 3,584,000 gal (Figure 4-15). Assuming the average total Fe in source water was 98.6 µg/L and all Fe in source water was collected by the media beds and discharged as backwash solids during backwash events, then there would be approximately 1,338 g of solid Fe was discharged as a part of TSS in the three backwash events. The average TSS values measured on June 6, July 18, and August 16, 2006 was 117.3 mg/L (Table 4-12). Assuming 30,000 gal of backwash wastewater were produced in the three backwash events from both vessels, approximately 13,320 g solids would be discharged during the three backwash events. Therefore, the iron level in backwash solids can be calculated as approximately 10%, which is less than one third of that calculated based on backwash solids metal analysis, indicating the backwash solids contained significant amount of media fine.

**Table 4-13. Backwash Solids Total Metal Analysis**

| Analyte (µg/g) | Mg | Al | Si | P | Ca | Mn | Fe | Ni | Cu | Zn | As | Cd | Pb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vessel A | 3,477 | 5,855 | 772 | 376 | 30,224 | 6,801 | 310,337 | 74.5 | 63.2 | 129 | 1,331 | <0.5 | 13.5 |
| Vessel B | 2,460 | 4,071 | 711 | 310 | 17,525 | 3,455 | 347,988 | 88.0 | 38.4 | 90.1 | 1,496 | <0.5 | 3.6 |

Note: Solids collected from three backwash events (on June 6, July 18, and August 16, 2006) and combined for sufficient sample quantity.
Average compositions calculated from triplicate analyses.

**4.5.3 Spent Media Sampling.** Spent media samples were collected for metals and TCLP analysis (Section 3.3.4) at the end of the first media run on July 27, 2005, and the end of the second media run on September 11, 2006. The results from TCLP analysis (Table 4-14) indicated that the media was non-hazardous and could be disposed of in a sanitary landfill. Only barium was detected at 0.61 to 0.64 mg/L on the spent SORB 33$^{TM}$-S media; and at 0.76 mg/L on the spent SORB 33$^{TM}$-P media. All other Resources Conservation and Recovery Act (RCRA) metals were at concentrations less than the respective method detection limits.

The ICP-MS results of spent media are shown in Table 4-15. The spent media contained mostly iron at 595 mg/g (as Fe) or 946 mg/g (as FeOOH) on the granular media, and at 457 mg/g (as Fe) or 727 mg/g (as FeOOH) on the pelletized media. The FeOOH content of the spent granular media was higher than the 90.1% (by weight) specified by the Bayer AG for the virgin media (Table 4-3), perhaps indicating some iron attachment on the spent media during treatment. The FeOOH content of the spent pelletized media, however, was significantly lower than the 90.1% specified by the Bayer AG for the virgin granular media. STS indicated that the chemical contents are the same for both the granular and pelletized media. It is not clear what caused the low iron content on the spent pelletized media. Challenges associated with

**Table 4-14. TCLP Results of Spent Media**

| Parameter | Method | SORB 33™-S | | SORB 33™-P |
|---|---|---|---|---|
| | | Vessel A | Vessel B | Vessel B |
| Arsenic (mg/L) | EPA 200.7 | <0.12 | <0.12 | <0.10 |
| Barium (mg/L) | EPA 200.7 | 0.64 | 0.61 | 0.76 |
| Cadmium (mg/L) | EPA 200.7 | <0.018 | <0.018 | <0.010 |
| Chromium (mg/L) | EPA 200.7 | <0.043 | <0.043 | <0.010 |
| Lead (mg/L) | EPA 200.7 | <0.040 | <0.040 | <0.050 |
| Mercury (mg/L) | EPA 245.1 | <0.00036 | <0.00036 | <0.0020 |
| Selenium (mg/L) | EPA 200.7 | <0.15 | <0.15 | <0.10 |
| Silver (mg/L) | EPA 200.7 | <0.048 | <0.048 | <0.010 |

sampling and sample digestion were believed to have contributed to the discrepancies observed. The spent granular media also contained higher concentrations of Al, Mn, Cu, Zn and As and lower concentrations of P compared to the spent pelletized media.

The average arsenic loadings on the spent granular and pelletized media were 2.2 and 1.6 mg/g of dry media based on the analytical results shown on Table 4-15. The adsorptive capacity also was calculated by dividing the arsenic mass represented by the area between the influent (AC) and effluent (TT) curves, as shown in Figure 4-17 by the amount of dry media in each vessel. Assuming no media loss, the dry weight of the granular media, i.e., 1,913 lb/vessel, was calculated based on a wet weight of 2,250 lb (i.e., 80 $ft^3$ of media at 28.1 $lb/ft^3$) and a maximum moisture content of 15% (Table 4-3). Similarly, the dry weight of the pelletized media was calculated as 1,845 lb/vessel. Using this approach, the theoretical arsenic loadings on the media were calculated as 2.1 and 1.7 mg/g of dry media for the granular and pelletized media, respectively; of which 105 and 94% were recovered via ICP-MS analysis. The adsorptive capacities and percentages of recovery for both media are summarized in Table 4-16.

**4.5.4 Distribution System Water Sampling**. Distribution system samples were collected to investigate if the water treated by the arsenic removal system would impact the lead, copper, and arsenic levels and other water chemistry in the distribution system. Prior to the installation/operation of the treatment system, baseline distribution water samples were collected on December 8, 11, and 30, 2003. Following the installation of the treatment system, distribution water sampling continued on a monthly basis at the same three locations. The sampling at the distribution system discontinued after December 14, 2005. The samples were analyzed for pH, alkalinity, arsenic, iron, manganese, lead, and copper. First draw samples were collected at the three sampling locations according to the procedure noted in Section 3.3.5. In addition, flushed samples also were collected at the DS2 and DS3 locations, which were non-residences.

The main difference observed between the baseline samples and samples collected after the treatment system startup was a decrease in arsenic concentrations at each of the sampling locations. Arsenic concentrations were reduced from the range of 22.4 to 28.2 μg/L to 1.8 to 19.0 μg/L. Although the arsenic concentrations measured during system operation were lower than the baseline values, they were still higher than the APU-300 system effluent results. This phenomenon was due probably to the blending of water produced by Well No. 3 in the distribution system with untreated water from Well No. 2. A sample collected from Well No. 2 on June 2, 2004 contained 14.9 μg/L of total arsenic.

Measured pH values ranged from 7.1 to 8.2, and alkalinity levels ranged from 176 to 268 mg/L (as $CaCO_3$). Iron concentrations in the first draw samples ranged from <25 to 97.7 μg/L, except for two samples at DS2 (i.e., 783 and 931 μg/L), with the majority of the samples <25 μg/L. Iron concentrations

## Table 4-15. Spent Media Total Metal Analysis

| Analyte (µg/g) | Mg | Al | Si | P | Ca | Fe | Mn | Ni | Cu | Zn | As | Cd | Pb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Media Run 1: SORB 33™-S Samples Collected on 07/27/05*** | | | | | | | | | | | | | |
| Vessel A - Top | 1,915 | 576 | 1,146 | 267 | 2,551 | 602,316 | 3,001 | 126 | 37.9 | 39.2 | 2,192 | <0.2 | 1.0 |
| Vessel A - Bottom | 1,928 | 596 | 979 | 277 | 2,581 | 579,891 | 2,720 | 125 | 31.7 | 34.3 | 2,037 | <0.2 | 0.9 |
| Vessel B - Top | 1,924 | 744 | 1,180 | 297 | 2,578 | 596,164 | 3,011 | 116 | 39.6 | 42.7 | 2,289 | <0.2 | 1.0 |
| Vessel B - Bottom | 1,922 | 627 | 1,254 | 297 | 2,735 | 603,437 | 3,019 | 118 | 38.2 | 38.9 | 2,315 | <0.2 | 0.9 |
| ***Media Run 2: SORB 33™-P Samples Collected on 09/11/06*** | | | | | | | | | | | | | |
| Vessel B - Top | 1,948 | 457 | 618 | 530 | 2,690 | 457,691 | 2,770 | 126 | 23.0 | <50 | 1,767 | <0.5 | 1.0 |
| Vessel B - Middle | 1,814 | 322 | 878 | 510 | 2,529 | 466,760 | 2,358 | 125 | 15.4 | <50 | 1,488 | <0.5 | 0.9 |
| Vessel B - Bottom | 1,878 | 356 | 1,212 | 522 | 2,489 | 447,598 | 2,280 | 122 | 14.7 | <50 | 1,483 | <0.5 | 0.9 |

Note: Average compositions calculated from triplicate analyses.

## Table 4-16. Summary of SORB 33™ Media Adsorptive Capacities

| Period | Media Run 1 (01/16/04–07/14/05) | | Media Run 2 (07/29/05–08/16/06)[a] | |
|---|---|---|---|---|
| Source | Breakthrough Curve (Figure 4-17) | Spent Media (Table 4-15) | Breakthrough Curve (Figure 4-17) | Spent Media (Table 4-15) |
| Unit | mg As/g dry SORB 33™-S | | mg As/g dry SORB 33™-P | |
| Average | 2.1[b] | 2.2 | 1.7[b] | 1.6[c] |
| Recovery | 105% | | 94% | |

(a) Treatment system off from 08/17/06 until media removal on 09/11/06.
(b) Assumed and corrected for 15% moisture content of media.
(c) Based on spent media from Vessel B only. Vessel A emptied prior to sampling.

in the flushed samples from DS2 and DS3 ranged from <25 to 55 μg/L. In general, iron concentrations in the distribution system samples decreased since the system began operating. Manganese concentrations in the distribution system samples ranged from <0.1 to 94.1 μg/L, but the only results greater than 7.7 μg/L were first draw samples at DS2. Manganese levels appear slightly lower since the system began to operate.

Lead levels ranged from 0.2 to 71.7 μg/L, with eight of the 119 samples exceeding the action level of 15 μg/L. Five of the action level exceedances for lead were from first draw samples at DS2, with the remaining three exceedances in first draw samples from DS3. Copper concentrations ranged from <0.1 to 393 μg/L, with no samples exceeding the 1,300 μg/L action level. Neither lead nor copper concentrations in the distribution system appeared to have been affected by the operation of the arsenic treatment unit. The results of the distribution system sampling are summarized in Table 4-17.

## 4.6 System Cost

The cost of the system was evaluated based on the capital cost per gpm (or gpd) of design capacity and the O&M cost per 1,000 gal of water treated. This task required tracking capital cost for the equipment, site engineering, and installation and the O&M cost for media replacement and disposal, replacement parts, chemical supply, electricity consumption, and labor. The building cost was not included in the capital cost because it was outside of the scope of this demonstration project and was funded separately by Desert Sands MDWCA.

**4.6.1 Capital Cost.** The capital investment for the equipment, site engineering, and installation was $153,000 (see Table 4-18). The equipment cost was $112,000 (or 73% of the total capital investment), which included $72,200 for the APU-300 skid-mounted unit, $24,000 for the SORB 33™ media (i.e., $5.34/lb to fill two vessels), and vendor's labor and travel for the system shakedown and startup.

The engineering cost included preparation of the system layout and footprint, design of the piping connections up to the distribution tie-in points, design of the electrical connections, and assemblage and submission of the engineering plans for the permit application (Section 4.3.1). The engineering cost was $23,000, which was 15% of the total capital investment.

The installation cost included equipment and labor to unload and install the APU-300 system, perform the piping tie-ins and electrical work, and load and backwash the media (Section 4.3.3). The installation was performed by STS and the Desert Sands MDWCA plant operator subcontracted to STS. A variety of elevated pressure and flow restriction issues caused the actual system startup date to be delayed, eventually prompting STS to redesign the system's piping, valving, and instruments and controls. The costs for the system retrofitting were not included in this cost analysis. The installation costs were $18,000, or 12% of the total capital investment.

The capital cost of $153,000 was normalized to $478/gpm ($0.33/gpd) of design capacity using the system's rated capacity of 320 gpm (or 460,800 gpd). The capital cost also was converted to an annualized cost of $14,442/yr using a capital recovery factor (CRF) of 0.09439 based on a 7% interest rate and a 20-yr return period. Assuming that the system operated 24 hr/day, 7 day/wk at the design flowrate of 320 gpm to produce 168,192,000 gal/yr, the unit capital cost would be $0.09/1,000 gal. During the first media run, the system operated an average of only 7 hr/day (average of the first and second media run, Table 4-7), producing 40,395,000 gal of water in one year, so the unit capital cost increased to $0.37/1,000 gal at this reduced rate of usage.

## Table 4-17. Distribution System Sampling Results

| Sampling Event | | DS1 | | | | | | | | DS2 | | | | | | | | | | | | | | DS3 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LCR | | | | | | | | Non-Residence[(a)] | | | | | | | | | | | | | | Non-Residence[(a)] | | | | | | | | | | | | | |
| | | 1st Draw | | | | | | | | 1st Draw | | | | | | | Flushed | | | | | | | 1st Draw | | | | | | | Flushed | | | | | | |
| | | Stagnation Time | pH | Alkalinity | As | Fe | Mn | Pb | Cu | pH | Alkalinity | As | Fe | Mn | Pb | Cu | pH | Alkalinity | As | Fe | Mn | Pb | Cu | pH | Alkalinity | As | Fe | Mn | Pb | Cu | pH | Alkalinity | As | Fe | Mn | Pb | Cu |
| No. | Date | hr | S.U. | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | S.U. | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | S.U. | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | S.U. | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | S.U. | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| BL1 | 12/08/03 | 8.0 | 7.1 | 200 | 23.3 | 48.1 | 5.0 | 0.9 | 9.1 | 7.7 | 187 | 26.3 | 36.5 | 6.4 | 22.5 | 99.5 | Not sampled. | | | | | | | 7.8 | 181 | 26.3 | 74.1 | 7.5 | 8.2 | 33.6 | Not sampled. | | | | | | |
| BL2 | 12/11/03 | 8.5 | 7.8 | 178 | 26.0 | 40.1 | 4.0 | 0.6 | 7.1 | 7.8 | 196 | 28.2 | 931 | 94.1 | 16.8 | 206 | Not sampled. | | | | | | | 7.9 | 200 | 23.7 | 40.4 | 7.7 | 1.0 | 10.1 | Not sampled. | | | | | | |
| BL3 | 12/30/03 | 7.7 | 7.7 | 197 | 22.4 | <25 | 2.0 | 1.1 | 17.0 | Not sampled. | | | | | | | 7.8 | 201 | 23.4 | <25 | 2.3 | 1.2 | 8.6 | Not sampled. | | | | | | | 7.8 | 207 | 23.6 | <25 | 2.1 | 1.1 | 9.1 |
| 1 | 02/11/04 | 8.5 | 7.6 | 207 | 10.4 | 49.2 | 1.9 | 0.4 | 14.1 | 7.8 | 182 | 7.4 | 783 | 34.1 | 60.2 | 393 | 7.8 | 186 | 2.5 | 55.2 | 0.6 | 2.9 | 25.7 | 7.7 | 198 | 5.3 | 47.3 | 1.7 | 8.7 | 30.0 | 7.7 | 215 | 6.7 | 48.3 | 2.3 | 1.0 | 17.0 |
| 2 | 03/10/04 | 7.8 | 7.8 | 230 | 8.1 | <25 | 1.9 | 0.7 | 12.5 | 7.8 | 235 | 8.8 | 97.7 | 10.8 | 71.7 | 159 | 7.8 | 230 | 8.3 | <25 | 2.7 | 1.5 | 9.3 | 7.9 | 197 | 2.4 | 22.5 | 5.6 | 41.3 | 315 | 8.0 | 185 | 1.8 | <25 | 0.1 | 6.2 | 14.5 |
| 3 | 04/07/04 | 8.5 | 7.7 | 249 | 9.3 | <25 | 3.5 | 0.2 | 7.5 | 7.8 | 257 | 10.2 | 26.6 | 23.8 | 15.9 | 105 | 7.8 | 265 | 9.5 | <25 | 1.3 | 0.8 | 6.6 | 8.0 | 168 | 2.8 | <25 | 4.1 | 3.3 | 42.5 | 7.9 | 180 | 2.5 | <25 | 0.1 | 0.9 | 10.8 |
| 4 | 05/12/04 | 8.1 | 7.8 | 223 | 9.5 | <25 | 1.7 | 1.7 | 156 | 7.8 | 237 | 7.2 | <25 | 1.8 | 1.7 | 15.5 | 7.8 | 241 | 7.6 | <25 | 2.2 | 2.3 | 11.4 | 7.8 | 229 | 5.1 | <25 | 1.9 | 3.4 | 19.6 | 7.8 | 233 | 5.6 | <25 | 1.0 | 2.1 | 11.0 |
| 5 | 06/23/04 | 8.1 | 8.0 | 183 | 1.8 | <25 | 1.0 | 2.0 | 33.7 | 7.9 | 195 | 3.1 | <25 | 1.4 | 6.0 | 84.7 | 7.9 | 195 | 4.3 | <25 | 1.2 | 9.3 | 1.6 | 8.0 | 195 | 2.5 | <25 | 0.6 | 22.9 | 121 | 7.9 | 175 | 4.5 | <25 | 1.2 | 3.8 | 19.2 |
| 6 | 07/21/04 | 8.1 | 7.7 | 188 | 4.9 | <25 | 0.2 | 0.2 | 4.1 | 7.7 | 203 | 6.0 | <25 | 1.6 | 1.3 | 9.4 | 7.7 | 207 | 6.9 | <25 | 1.8 | 1.2 | 7.8 | 7.7 | 200 | 6.4 | <25 | 1.0 | 1.6 | 8.5 | 7.7 | 200 | 7.2 | <25 | 1.0 | 1.6 | 8.5 |
| 7 | 08/18/04 | 8.1 | 7.5 | 180 | 5.7 | 29.0 | 0.3 | 1.7 | 23.7 | 7.5 | 219 | 8.8 | 60.0 | 2.0 | 1.9 | 9.5 | 7.6 | 219 | 9.4 | 26.4 | 2.0 | 1.4 | 6.4 | 7.7 | 188 | 6.0 | <25 | 0.7 | 2.9 | 11.8 | 7.7 | 188 | 6.2 | <25 | 0.6 | 1.8 | 7.5 |
| 8 | 09/15/04 | 8.1 | 7.8 | 226 | 8.0 | <25 | 1.5 | 0.3 | 10.2 | 7.8 | 222 | 10.2 | <25 | 1.5 | 1.5 | 13.0 | 7.7 | 214 | 10.4 | <25 | 1.5 | 0.8 | 9.2 | 8.0 | 190 | 5.5 | <25 | 0.2 | 1.7 | 15.6 | 8.1 | 186 | 5.4 | <25 | <0.1 | 1.8 | 17.9 |
| 9 | 10/13/04 | 8.1 | 7.7 | 207 | 6.9 | <25 | 4.2 | 0.3 | 6.8 | 7.8 | 191 | 7.0 | <25 | 1.8 | 1.6 | 20.2 | 7.8 | 199 | 7.1 | <25 | 1.9 | 1.2 | 11.3 | 7.9 | 191 | 3.7 | <25 | <0.1 | 18.0 | 200 | 8.0 | 175 | 3.5 | <25 | 3.2 | 1.7 | 16.9 |
| 10 | 11/10/04 | 8.1 | 7.9 | 201 | 4.8 | <25 | 0.5 | 1.3 | 65.1 | 7.9 | 185 | 4.2 | <25 | 0.5 | 0.9 | 8.8 | 8.0 | 185 | 4.8 | <25 | 1.0 | 0.9 | 11.7 | 8.0 | 185 | 3.6 | <25 | 0.2 | 1.4 | 12.2 | 8.0 | 185 | 3.6 | <25 | 0.2 | 0.8 | 8.4 |
| 11 | 12/08/04 | 8.8 | 8.0 | 211 | 12.3 | <25 | 1.8 | 0.2 | 5.5 | 8.0 | 231 | 16.6 | <25 | 2.5 | 0.8 | 12.1 | 8.0 | 223 | 19.0 | <25 | 2.2 | 0.4 | 6.6 | 7.9 | 244 | 18.1 | <25 | 2.1 | 1.0 | 17.8 | 7.9 | 244 | 16.5 | <25 | 2.4 | 0.7 | 13.7 |
| 12 | 01/20/05 | 7.5 | 7.5 | 211 | 7.5 | <25 | 1.2 | 0.2 | 8.7 | 7.7 | 189 | 5.3 | <25 | 0.2 | 0.7 | 9.7 | 7.4 | 181 | 4.7 | <25 | 0.1 | 0.6 | 8.0 | 7.7 | 215 | 6.3 | <25 | 1.7 | 1.1 | 16.0 | 7.5 | 185 | 5.0 | <25 | 0.4 | 0.6 | 9.4 |
| 13 | 02/16/05 | 7.8 | 7.9 | 201 | 6.8 | <25 | 0.8 | 0.3 | 12.1 | 7.7 | 245 | 10.4 | <25 | 3.0 | 0.9 | 18.2 | 7.7 | 250 | 10.7 | <25 | 2.6 | 0.4 | 10.0 | 7.7 | 268 | 10.3 | <25 | 3.1 | 0.9 | 15.3 | 7.7 | 245 | 10.3 | <25 | 2.8 | 0.8 | 13.1 |
| 14 | 03/16/05 | 8.0 | 7.9 | 201 | 6.6 | <25 | 0.0 | 0.1 | 5.0 | 7.9 | 187 | 6.2 | <25 | <0.1 | 0.6 | 8.2 | 8.1 | 192 | 6.4 | <25 | <0.1 | 0.6 | 7.8 | 7.8 | 187 | 6.5 | <25 | <0.1 | 0.6 | 7.9 | 8.0 | 196 | 6.9 | <25 | <0.1 | 0.5 | 7.3 |
| 15 | 04/13/05 | 7.4 | 8.1 | 220 | 7.0 | <25 | 0.5 | 0.2 | 5.4 | 8.2 | 211 | 6.3 | <25 | 0.2 | 0.9 | 11.0 | 8.2 | 211 | 6.2 | <25 | 0.1 | 0.9 | 10.0 | 8.2 | 207 | 6.7 | 61.9 | 0.4 | 1.0 | 10.0 | 8.2 | 211 | 6.4 | <25 | 0.1 | 0.9 | 11.4 |
| 16 | 05/11/05 | 8.0 | 7.3 | 185 | 7.4 | <25 | 0.5 | 0.4 | 4.4 | 7.4 | 185 | 7.3 | <25 | <0.1 | 1.4 | 11.2 | 7.6 | 198 | 8.4 | 30.0 | <0.1 | 1.3 | 9.8 | 7.5 | 198 | 7.7 | <25 | <0.1 | 1.0 | 9.7 | 7.6 | 198 | 8.1 | 32.5 | 0.1 | 1.1 | 9.5 |
| 17 | 06/22/05 | 7.5 | 7.6 | 189 | 10.8 | <25 | 1.7 | 0.3 | 5.1 | 7.7 | 198 | 11.5 | <25 | 1.2 | 5.6 | 52.1 | 7.7 | 198 | 11.5 | <25 | 1.3 | 0.8 | 6.7 | 7.7 | 198 | 9.8 | <25 | 1.3 | 1.8 | 13.4 | 7.7 | 198 | 11.3 | <25 | 1.4 | 0.8 | 7.0 |
| 18 | 08/03/05 | 8.1 | 7.5 | 176 | 7.6 | <25 | 0.6 | 0.3 | 3.3 | 7.6 | 220 | 9.5 | <25 | 1.4 | 1.9 | 11.8 | 7.6 | 211 | 9.8 | <25 | 1.2 | 0.9 | 5.5 | 7.7 | 189 | 3.7 | <25 | 0.2 | 1.4 | 8.8 | 7.7 | 189 | 3.7 | <25 | 0.2 | 1.1 | 7.5 |
| 19 | 09/14/05 | 8.2 | 7.6 | 220 | 5.2 | <25 | 1.8 | 0.5 | 4.9 | 7.5 | 220 | 6.5 | <25 | 2.0 | 1.1 | 8.9 | 7.6 | 207 | 6.2 | <25 | 1.8 | 0.6 | 6.1 | 7.7 | 176 | 3.0 | <25 | 0.1 | 1.3 | 8.0 | 7.7 | 198 | 3.6 | <25 | <0.1 | 1.0 | 7.5 |
| 20 | 10/12/05 | 9.0 | 7.8 | 194 | 4.6 | <25 | 0.5 | 0.3 | <0.1 | 7.9 | 189 | 4.6 | <25 | <0.1 | 2.3 | 12.2 | 7.9 | 194 | 4.7 | <25 | 0.1 | 0.2 | <0.1 | 7.9 | 189 | 4.6 | <25 | <0.1 | 2.5 | 13.8 | 7.9 | 198 | 4.0 | <25 | <0.1 | 0.2 | <0.1 |
| 21 | 11/09/05 | 8.2 | 7.7 | 176 | 4.7 | <25 | <0.1 | 0.4 | 3.6 | 7.7 | 185 | 4.8 | <25 | <0.1 | 0.9 | 10.1 | 7.7 | 176 | 4.9 | <25 | <0.1 | 0.5 | 2.9 | 7.7 | 176 | 4.8 | <25 | <0.1 | 0.7 | 4.5 | 7.7 | 198 | 4.9 | <25 | <0.1 | 0.5 | 4.2 |
| 22 | 12/14/05 | 7.8 | 7.9 | 198 | 7.3 | <25 | 0.7 | 0.4 | 57.9 | 8.1 | 211 | 8.5 | <25 | 1.5 | 1.1 | 28.1 | 8.0 | 211 | 8.8 | <25 | 1.5 | 0.8 | 12.8 | 8.0 | 207 | 7.0 | <25 | 0.3 | 0.3 | 14.7 | 8.0 | 202 | 6.9 | <25 | 0.4 | 0.2 | 8.7 |

(a) Stagnation time not available for non-residences.

Note: Alkalinity measured in mg/L as $CaCO_3$. Action levels: 15 µg/L Pb and 1.3 mg/L Cu. BL = baseline sampling; NA = data not available.

Desert Sands MDWCA constructed an addition to its existing pump house at Well No. 3 to house the APU-300 system (Section 4.3.2). The structure was built by the Desert Sands MDWCA plant operator with the exception of the electrical tie-in. The total cost for the building construction was $3,700, including $2,700 for materials and $1,000 for approximately 80 hr of labor.

**Table 4-18. Capital Investment for APU-300 System**

| Description | Cost | % of Capital Investment Cost |
|---|---|---|
| ***Equipment*** | | |
| APU-300 Skid-Mounted System | $72,200 | – |
| SORB 33™ Media | $24,000 | 2,250 lb for SORB 33™-S; 2,170 lb for SORB 33™-P |
| Misc. Equipment and Materials | $2,500 | – |
| Vendor Labor | $9,500 | – |
| Vendor Travel | $3,800 | – |
| **Equipment Total** | **$112,000** | **73%** |
| ***Engineering*** | | |
| Subcontractor | $16,300 | – |
| Vendor Labor | $6,700 | – |
| **Engineering Total** | **$23,000** | **15%** |
| ***Installation*** | | |
| Subcontractor | $9,000 | – |
| Vendor Labor | $5,600 | – |
| Vendor Travel | $3,400 | – |
| **Installation Total** | **$18,000** | **12%** |
| **Total Capital Investment** | **$153,000** | **100%** |

**4.6.2 O&M Cost.** The O&M cost was $0.74/1,000 gal for media replacement and disposal, replacement parts, chemical supply, electricity, and labor, as summarized in Table 4-19. The media replacement and disposal cost was calculated based upon the throughput to arsenic breakthrough at the end of the second media run for actual costs incurred (i.e., $30,900 to rebed both vessels). This media changeout cost included costs for media, freight, labor, travel expenses, and a media profiling and disposal fee. Upon arsenic breakthrough at 46,553,000 gal during the second media run, the media replacement cost was $0.66/1,000 gal (Figure 4-19).

Because the system was under warranty during the first year of operation, no expenses were incurred for repairs to the system during this time. However, after two years of operation, two actuated valves (121-A and 123-A) began sticking and required replacement. A local company, Parmeter Power and Control, was contracted to perform the replacement for $3,036. This cost included $2,625 for the two valves and $411 for labor and travel costs. The new valves were installed on September 8, 2006.

The only chemical cost was the use NaOCl for prechlorination, which was in place prior to the installation of the APU-300 system to provide chlorine residual prior to distribution. The APU-300 system did not change the use rate of the NaOCl solution, so the chemical cost was negligible.

Electricity consumption also was negligible, particularly since the system retrofit in May 2004. After retrofitting, the electric meter stopped registering power consumption. The operator assumed that the meter was faulty, and replaced it with a new and factory-tested meter, which also did not register any power consumption. It was then determined that the APU-300 system did not consume enough electricity to register regular increases on the meter (i.e., less than 1 kWh/week after retrofit compared to 3-4 kWh/week before retrofit).

The routine, non-demonstration related labor activities consumed only 15 min/day (Section 4.4.7). Based on this time commitment and a labor rate of $18.20/hr, the labor cost was $0.05/1,000 gal of water treated.

**Table 4-19. O&M Costs for APU-300 System**

| Cost Category | Value | Remarks |
|---|---|---|
| ***Media Replacement and Disposal*** | | |
| Media Cost ($/ft$^3$) | $202 | – |
| Media Volume (ft$^3$) | 124 | SORB 33-P media |
| Media Replacement Cost ($) | $25,080 | – |
| Labor Cost ($) | $4,130 | – |
| Media Disposal Fee ($) | $1,690 | Waste profile included |
| Subtotal ($) | $30,900 | – |
| Media Replacement and Disposal Cost ($/1,000 gal) | $0.66 | Second media run throughput = 46,553,000 gal, see Figure 4-19 |
| ***Equipment Replacement*** | | |
| Replacement Valves' Cost ($) | $2,625 | Two actuated valves |
| Labor and Travel Cost ($) | $411 | – |
| Equipment Replacement Cost ($/1,000 gal) | $0.03 | Total system throughput = 99,200,000 gal |
| ***Electricity*** | | |
| Electric Utility Charge ($/kWh) | $0.14 | Rate provided by DSMDWCA |
| Usage (kWh) | 126 | – |
| Total Electricity Cost ($) | $17.64 | Total system throughput = 99,200,000 gal |
| Electricity Cost ($/1,000 gal) | $0.00 | $0.01/1,000 gal prior to retrofit |
| ***Labor*** | | |
| Average Weekly Labor (hr) | 1.75 | 15 min/day |
| Total Labor (hr) | 270 | Total system throughput = 99,200,000 gal |
| Labor Cost ($/1,000 gal) | $0.05 | Labor rate = $18.20/hr |
| **Total O&M Cost ($/1,000 gal)** | **$0.74** | See Figure 4-19 |

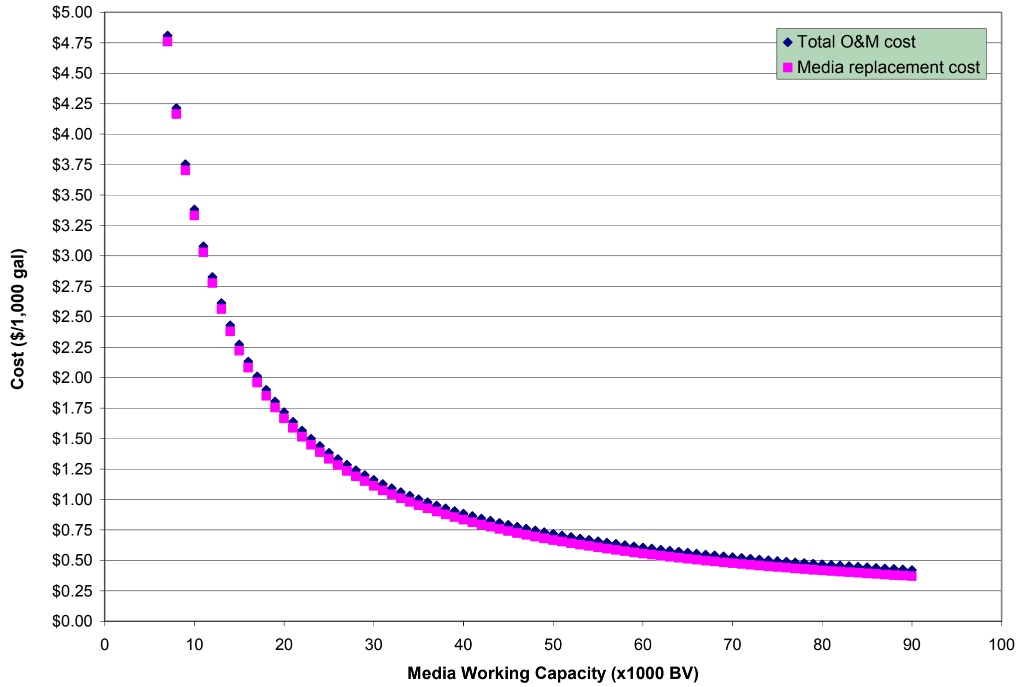



**Figure 4-19. Media Replacement and O&M Cost for APU-300 System**

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# APPENDIX A

# OPERATIONAL DATA

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet

| Week No. | Date | Pump House | | | | | | | Instrument Panel | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 1 | 01/23/04 | 0.0 | 0.0 | 234,081 | 221 | 216 | NA | NA | NA | >15 | >15 | 76 | 56 | 20 |
| | 01/24/04 | 4.9 | 4.9 | 234,153 | 266 | 259 | 88 | 88 | 73 | off | off | 52 | 52 | NA |
| | 01/25/04 | 8.1 | 13.0 | 234,282 | 335 | 327 | 137 | 225 | 188 | off | off | 56 | 56 | NA |
| 2 | 01/26/04 | 5.0 | 18.0 | 234,359 | 375 | 367 | 80 | 305 | 254 | off | off | 58 | 58 | NA |
| | 01/27/04 | 2.0 | 20.0 | 234,403 | 399 | 391 | 48 | 353 | 294 | off | off | 54 | 54 | NA |
| | 01/28/04 | 5.0 | 25.0 | 234,476 | 438 | 428 | 76 | 429 | 358 | >15 | >15 | 78 | 60 | 18 |
| | 01/29/04 | 4.0 | 29.0 | 234,540 | 471 | 461 | 66 | 495 | 413 | off | off | 54 | 54 | NA |
| | 01/30/04 | 4.0 | 33.0 | 234,597 | 501 | 491 | 60 | 555 | 463 | off | off | 60 | 60 | NA |
| | 01/31/04 | 3.0 | 36.0 | 234,658 | 538 | 526 | 72 | 627 | 523 | off | off | 60 | 60 | NA |
| | 02/01/04 | 4.0 | 40.0 | 234,713 | 568 | 558 | 62 | 689 | 574 | off | off | 60 | 60 | NA |
| 3 | 02/02/04 | 4.0 | 44.0 | 234,771 | 584 | 603 | 61 | 750 | 625 | off | off | 55 | 55 | NA |
| | 02/03/04 | 5.6 | 49.6 | 234,845 | 600 | 663 | 76 | 826 | 688 | off | off | 60 | 60 | NA |
| | 02/04/04 | 1.3 | 50.9 | 234,866 | 615 | 681 | 33 | 859 | 716 | 24 | 24 | 80 | 56 | 24 |
| | 02/05/04 | 8.0 | 58.9 | 234,989 | 620 | 757 | 81 | 940 | 783 | off | off | 52 | 52 | NA |
| 4 | 02/09/04 | 11.5 | 70.4 | 235,167 | 753 | 868 | 244 | 1,184 | 987 | off | off | NM | NM | NA |
| | 02/10/04 | 0.4 | 70.8 | 235,174 | 756 | 872 | 7 | 1,191 | 993 | >15 | >15 | 84 | 54 | 30 |
| | 02/11/04 | 5.7 | 76.5 | 235,225 | 799 | 926 | 97 | 1,288 | 1073 | >15 | >15 | 84 | 56 | 28 |
| | 02/12/04 | 4.7 | 81.2 | 235,333 | 830 | 969 | 74 | 1,362 | 1135 | >15 | >15 | 86 | 56 | 30 |
| | 02/13/04 | 4.9 | 86.1 | 235,408 | 863 | 1,015 | 79 | 1,441 | 1201 | off | off | 56 | 56 | NA |
| 5 | 02/16/04 | 14.1 | 100.2 | 235,623 | 956 | 1,111 | 189 | 1,630 | 1358 | off | off | 54 | 54 | NA |
| | 02/17/04 | 5.2 | 105.4 | 235,701 | 990 | 1,158 | 81 | 1,711 | 1426 | off | off | 50 | 50 | NA |
| | 02/18/04 | 5.0 | 110.4 | 235,777 | 1,025 | 1,207 | 84 | 1,795 | 1496 | >15 | >15 | 82 | 56 | 26 |
| | 02/19/04 | 7.5 | 117.9 | 235,891 | 1,074 | 1,277 | 119 | 1,914 | 1595 | off | off | 54 | 54 | NA |
| | 02/20/04 | 5.5 | 123.4 | 235,976 | 1,112 | 1,328 | 89 | 2,003 | 1669 | off | off | 50 | 50 | NA |
| 6 | 02/23/04 | 11.4 | 134.8 | 236,151 | 1,192 | 1,436 | 188 | 2,191 | 1826 | off | off | 50 | 50 | NA |
| | 02/24/04 | 4.3 | 139.1 | 236,216 | 1,221 | 1,476 | 69 | 2,260 | 1883 | off | off | 50 | 50 | NA |
| | 02/25/04 | 4.3 | 143.4 | 236,282 | 1,250 | 1,516 | 69 | 2,329 | 1941 | >15 | >15 | 82 | 56 | 26 |
| | 02/26/04 | 3.9 | 147.3 | 236,342 | 1,279 | 1,555 | 68 | 2,397 | 1998 | off | off | 52 | 52 | NA |
| | 02/27/04 | 2.9 | 150.2 | 236,387 | 1,298 | 1,582 | 46 | 2,443 | 2036 | off | off | 50 | 50 | NA |
| | 02/28/04 | 4.0 | 154.2 | 236,448 | 1,327 | 1,623 | 70 | 2,513 | 2094 | off | off | 50 | 50 | NA |
| | 02/29/04 | 4.2 | 158.4 | 236,511 | 1,356 | 1,660 | 66 | 2,579 | 2149 | off | off | 50 | 50 | NA |
| 7 | 03/01/04 | 4.1 | 162.5 | 236,575 | 1,384 | 1,698 | 66 | 2,645 | 2204 | off | off | 50 | 50 | NA |
| | 03/02/04 | 4.6 | 167.1 | 236,644 | 1,415 | 1,740 | 73 | 2,718 | 2265 | off | off | 52 | 52 | NA |
| | 03/03/04 | 4.0 | 171.1 | 236,715 | 1,446 | 1,782 | 73 | 2,791 | 2326 | >15 | >15 | 82 | 58 | 24 |
| | 03/04/04 | 4.6 | 175.7 | 236,775 | 1,475 | 1,820 | 67 | 2,858 | 2382 | off | off | 54 | 54 | NA |
| | 03/05/04 | 6.9 | 182.6 | 236,801 | 1,480 | 1,836 | 21 | 2,879 | 2399 | off | off | 59 | 54 | 5 |
| | 03/06/04 | 5.0 | 187.6 | 236,876 | 1,521 | 1,883 | 88 | 2,967 | 2473 | >15 | >15 | 82 | 60 | 22 |
| | 03/07/04 | 5.9 | 193.5 | 236,966 | 1,563 | 1,936 | 95 | 3,062 | 2552 | >15 | >15 | 84 | 60 | 24 |
| 8 | 03/08/04 | 1.7 | 195.2 | 236,994 | 1,563 | 1,936 | 0 | 3,062 | 2552 | >15 | >15 | 82 | 56 | 26 |
| | 03/09/04 | 2.8 | 198.0 | 237,035 | 1,594 | 1,977 | 72 | 3,134 | 2612 | off | off | off | off | NA |
| | 03/10/04 | 5.0 | 203.0 | 237,112 | 1,631 | 2,022 | 82 | 3,216 | 2680 | >15 | >15 | 80 | 56 | 24 |
| | 03/11/04 | 5.8 | 208.8 | 237,201 | 1,671 | 2,083 | 101 | 3,317 | 2764 | off | off | off | off | NA |
| | 03/12/04 | 3.3 | 212.1 | 237,253 | 1,694 | 2,105 | 45 | 3,362 | 2802 | off | off | off | off | NA |
| | 03/13/04 | 3.4 | 215.5 | 237,305 | 1,717 | 2,137 | 55 | 3,417 | 2848 | off | off | off | off | NA |
| | 03/14/04 | 6.2 | 221.7 | 237,377 | 1,749 | 2,180 | 75 | 3,492 | 2910 | off | off | off | off | NA |
| 9 | 03/15/04 | 3.0 | 224.7 | 237,455 | 1,784 | 2,227 | 82 | 3,574 | 2978 | >20 | >20 | 80 | 60 | 20 |
| | 03/16/04 | 7.6 | 232.3 | 237,564 | 1,839 | 2,299 | 127 | 3,701 | 3084 | off | off | off | off | NA |
| | 03/17/04 | 6.9 | 239.2 | 237,671 | 1,889 | 2,360 | 111 | 3,812 | 3177 | >20 | >20 | 82 | 60 | 22 |
| | 03/18/04 | 1.9 | 241.1 | 237,698 | 1,902 | 2,377 | 30 | 3,842 | 3202 | >20 | >20 | off | off | NA |
| | 03/19/04 | 8.4 | 249.5 | 237,799 | 1,949 | 2,434 | 104 | 3,946 | 3288 | off | off | off | off | NA |
| | 03/20/04 | 2.2 | 251.7 | 237,864 | 1,979 | 2,472 | 68 | 4,014 | 3345 | >20 | >20 | 84 | 62 | 22 |
| | 03/21/04 | 3.3 | 255.0 | 237,924 | 2,003 | 2,502 | 54 | 4,068 | 3390 | off | off | 54 | off | NA |
| 10 | 03/22/04 | 3.2 | 258.2 | 237,963 | 2,025 | 2,531 | 51 | 4,119 | 3433 | >20 | >20 | 84 | 62 | 22 |
| | 03/23/04 | 4.0 | 262.2 | 238,025 | 2,053 | 2,567 | 64 | 4,183 | 3486 | off | off | off | off | NA |
| | 03/24/04 | 5.1 | 267.3 | 238,103 | 2,088 | 2,613 | 81 | 4,264 | 3553 | >20 | >20 | 84 | off | NA |
| | 03/25/04 | 5.8 | 273.1 | 238,199 | 2,138 | 2,676 | 113 | 4,377 | 3648 | off | off | off | off | NA |
| | 03/26/04 | 4.3 | 277.4 | 238,258 | 2,166 | 2,710 | 62 | 4,439 | 3699 | off | off | off | off | NA |
| | 03/27/04 | 3.6 | 281.0 | 238,315 | 2,192 | 2,743 | 59 | 4,498 | 3748 | off | off | off | off | NA |
| | 03/28/04 | 3.5 | 284.5 | 238,369 | 2,217 | 2,775 | 57 | 4,555 | 3796 | off | off | off | off | NA |

**Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)**

| Week No. | Date | Pump House | | | | | | Instrument Panel | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 11 | 03/29/04 | 4.3 | 288.8 | 238,434 | 2,246 | 2,813 | 67 | 4,622 | 3852 | off | off | NM | 60 | NA |
| | 03/30/04 | 3.5 | 292.3 | 238,494 | 2,273 | 2,848 | 62 | 4,684 | 3903 | off | off | NM | 60 | NA |
| | 03/31/04 | 4.3 | 296.6 | 238,554 | 2,301 | 2,884 | 64 | 4,748 | 3957 | off | off | NM | 58 | NA |
| | 04/01/04 | 4.8 | 301.4 | 238,628 | 2,341 | 2,934 | 90 | 4,838 | 4032 | off | off | NM | 60 | NA |
| | 04/02/04 | 2.9 | 304.3 | 238,674 | 2,363 | 2,960 | 48 | 4,886 | 4072 | off | off | NM | 58 | NA |
| | 04/03/04 | 3.0 | 307.3 | 238,719 | 2,384 | 2,987 | 48 | 4,934 | 4112 | off | off | NM | 58 | NA |
| | 04/04/04 | NA | NA | 238,772 | 2,408 | 3,018 | 55 | 4,989 | 4158 | off | off | NM | 60 | NA |
| 12 | 04/05/04 | 6.3 | 313.6 | 238,816 | 2,428 | 3,043 | 45 | 5,034 | 4195 | off | off | NM | 60 | NA |
| | 04/06/04 | 2.9 | 316.5 | 238,868 | 2,449 | 3,071 | 49 | 5,083 | 4236 | off | off | NM | 60 | NA |
| | 04/07/04 | 2.0 | 318.5 | 238,893 | 2,464 | 3,090 | 34 | 5,117 | 4264 | >20 | >20 | 60 | 82 | 22 |
| | 04/08/04 | 3.9 | 322.4 | 238,952 | 2,497 | 3,130 | 73 | 5,190 | 4325 | off | off | NM | 62 | NA |
| | 04/09/04 | 2.8 | 325.2 | 238,995 | 2,517 | 3,155 | 45 | 5,235 | 4363 | off | off | NM | 58 | NA |
| | 04/10/04 | 3.5 | 328.7 | 239,049 | 2,542 | 3,186 | 56 | 5,291 | 4409 | off | off | NM | 60 | NA |
| | 04/11/04 | 2.9 | 331.6 | 239,093 | 2,562 | 3,212 | 46 | 5,337 | 4448 | off | off | NM | 60 | NA |
| 13 | 04/12/04 | 3.2 | 334.8 | 239,135 | 2,582 | 3,237 | 45 | 5,382 | 4485 | >20 | >20 | 82 | 60 | 22 |
| | 04/13/04 | 2.9 | 337.7 | 239,188 | 2,606 | 3,268 | 55 | 5,437 | 4531 | >20 | >20 | 82 | 60 | 22 |
| | 04/14/04 | 3.2 | 340.9 | 239,235 | 2,627 | 3,296 | 49 | 5,486 | 4572 | >20 | >20 | 84 | 60 | 24 |
| | 04/15/04 | 4.3 | 345.2 | 239,301 | 2,664 | 3,341 | 82 | 5,568 | 4640 | >20 | >20 | 84 | 60 | 24 |
| | 04/16/04 | 3.4 | 348.6 | 239,353 | 2,688 | 3,372 | 55 | 5,623 | 4686 | >20 | >20 | 82 | 60 | 22 |
| | 04/17/04 | 4.0 | 352.6 | 239,413 | 2,715 | 3,407 | 62 | 5,685 | 4738 | >20 | >20 | 84 | 60 | 24 |
| | 04/18/04 | 3.4 | 356.0 | 239,465 | 2,739 | 3,438 | 55 | 5,740 | 4783 | >20 | >20 | 84 | 60 | 24 |
| 14 | 04/19/04 | 4.0 | 360.0 | 239,525 | 2,767 | 3,473 | 63 | 5,803 | 4836 | >20 | >20 | 84 | 60 | 24 |
| | 04/20/04 | 3.6 | 363.6 | 239,580 | 2,791 | 3,505 | 56 | 5,859 | 4883 | >20 | >20 | 84 | 60 | 24 |
| | 04/21/04 | 4.1 | 367.7 | 239,634 | 2,816 | 3,537 | 57 | 5,916 | 4930 | >20 | >20 | 82 | 58 | 24 |
| | 04/22/04 | 2.9 | 370.6 | 239,687 | 2,846 | 3,575 | 68 | 5,984 | 4987 | >20 | >20 | 82 | 60 | 22 |
| | 04/23/04 | 3.3 | 373.9 | 239,737 | 2,870 | 3,604 | 53 | 6,037 | 5031 | >20 | >20 | 80 | 60 | 20 |
| | 04/24/04 | 3.8 | 377.7 | 239,795 | 2,896 | 3,638 | 60 | 6,097 | 5081 | >20 | >20 | 80 | 60 | 20 |
| | 04/25/04 | 4.4 | 382.1 | 239,860 | 2,926 | 3,676 | 68 | 6,165 | 5138 | >20 | >20 | 80 | 60 | 20 |
| 15 | 04/26/04 | 3.8 | 385.9 | 239,919 | 2,953 | 3,711 | 62 | 6,227 | 5189 | >20 | >20 | 82 | 60 | 22 |
| | 04/27/04 | 4.0 | 389.9 | 239,980 | 2,955 | 3,746 | 37 | 6,264 | 5220 | >20 | >20 | 82 | 60 | 22 |
| | 04/28/04 | 4.0 | 393.9 | 240,023 | 2,955 | 3,779 | 33 | 6,297 | 5248 | >20 | >20 | 82 | 60 | 22 |
| | 04/29/04 | 3.1 | 397.0 | 240,101 | 2,955 | 3,817 | 38 | 6,335 | 5279 | >20 | >20 | 82 | 60 | 22 |
| | 04/30/04 | 3.8 | 400.8 | 240,147 | 2,983 | 3,850 | 61 | 6,396 | 5330 | >20 | >20 | 82 | 60 | 22 |
| | 05/01/04 | 5.4 | 406.2 | 240,230 | 3,022 | 3,895 | 84 | 6,480 | 5400 | >20 | >20 | 82 | 60 | 22 |
| | 05/02/04 | 5.1 | 411.3 | 240,291 | 3,030 | 3,953 | 66 | 6,546 | 5455 | >20 | >20 | 82 | 60 | 22 |
| 16 | 05/03/04 | 2.8 | 414.1 | 240,360 | 3,077 | 3,968 | 62 | 6,608 | 5507 | >20 | >20 | 82 | 60 | 22 |
| | 05/04/04 | 3.9 | 418.0 | 240,400 | 3,104 | 4,002 | 61 | 6,669 | 5558 | >20 | >20 | 82 | 60 | 22 |
| | 05/05/04 | 4.5 | 422.5 | 240,478 | 3,136 | 4,042 | 72 | 6,741 | 5618 | >20 | >20 | 80 | 60 | 20 |
| | 05/06/04 | 6.6 | 429.1 | 240,577 | 3,188 | 4,107 | 117 | 6,858 | 5715 | >20 | >20 | 80 | 60 | 20 |
| | 05/07/04 | 5.7 | 434.8 | 240,664 | 3,229 | 4,157 | 91 | 6,949 | 5791 | >20 | >20 | 82 | 60 | 22 |
| | 05/08/04 | 6.2 | 441.0 | 240,759 | 3,274 | 4,210 | 98 | 7,047 | 5873 | >20 | >20 | 80 | 60 | 20 |
| | 05/09/04 | 6.0 | 447.0 | 240,849 | 3,315 | 4,262 | 93 | 7,140 | 5950 | >20 | >20 | 80 | 60 | 20 |
| 17 | 05/10/04 | 5.7 | 452.7 | 240,936 | 3,356 | 4,312 | 91 | 7,231 | 6026 | >20 | >20 | 82 | 60 | 22 |
| | 05/11/04 | 7.5 | 460.2 | 241,034 | 3,402 | 4,368 | 102 | 7,333 | 6111 | >20 | >20 | 80 | 58 | 22 |
| | 05/12/04 | 4.0 | 464.2 | 241,110 | 3,436 | 4,412 | 78 | 7,411 | 6176 | >20 | >20 | 80 | 60 | 20 |
| | 05/13/04 | 6.9 | 471.1 | 241,215 | 3,493 | 4,478 | 123 | 7,534 | 6278 | >20 | >20 | 80 | 60 | 20 |
| | 05/14/04 | 3.3 | 474.4 | 241,266 | 3,517 | 4,507 | 53 | 7,587 | 6323 | >20 | >20 | 80 | 60 | 20 |
| | 05/15/04 | 5.7 | 480.1 | 241,353 | 3,557 | 4,557 | 90 | 7,677 | 6398 | >20 | >20 | 80 | 60 | 20 |
| | 05/16/04 | 12.9 | 493.0 | 241,554 | 3,663 | 4,649 | 198 | 7,875 | 6563 | >20 | >20 | 80 | 60 | 20 |
| 18 | 05/17/04 | *System was turned off for repairing* | | | | | | | | | | | | |
| | 05/18/04 | | | | | | | | | | | | | |
| | 05/19/04 | | | | | | | | | | | | | |
| | 05/20/04 | | | | | | | | | | | | | |
| | 05/21/04 | | | | | | | | | | | | | |
| | 05/22/04 | | | | | | | | | | | | | |
| | 05/23/04 | | | | | | | | | | | | | |
| 19 | 05/24/04 | 4.6 | 497.6 | 241,646 | 3,663 | 4,649 | 0 | 7,875 | 6563 | 2.8 | 3.0 | 66 | 60 | 6 |
| | 05/25/04 | 7.0 | 504.6 | 241,746 | 3,705 | 4,752 | 145 | 8,020 | 6683 | 3.0 | 3.0 | 68 | 62 | 6 |
| | 05/26/04 | 6.2 | 510.8 | 241,846 | 3,759 | 4,779 | 81 | 8,101 | 6751 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 05/27/04 | 5.8 | 516.6 | 241,940 | 3,809 | 4,820 | 91 | 8,192 | 6827 | off | off | 52 | 52 | NA |
| | 05/28/04 | 3.8 | 520.4 | 242,002 | 3,842 | 4,852 | 65 | 8,257 | 6881 | off | off | 52 | 52 | NA |
| | 05/29/04 | 8.9 | 529.3 | 242,146 | 3,919 | 4,929 | 154 | 8,411 | 7009 | 3.0 | 3.0 | 56 | 50 | 6 |
| | 05/30/04 | 6.4 | 535.7 | 242,248 | 3,972 | 4,983 | 107 | 8,518 | 7098 | 3.0 | 3.0 | 62 | 56 | 6 |
| 20 | 05/31/04 | 6.5 | 542.2 | 242,353 | 4,029 | 5,040 | 114 | 8,632 | 7193 | 3.0 | 3.0 | 66 | 60 | 6 |
| | 06/01/04 | 8.8 | 551.0 | 242,498 | 4,104 | 5,116 | 151 | 8,783 | 7319 | 2.8 | 3.0 | 68 | 62 | 6 |
| | 06/02/04 | 7.8 | 558.8 | 242,617 | 4,166 | 5,179 | 125 | 8,908 | 7423 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 06/03/04 | 6.9 | 565.7 | 242,725 | 4,223 | 5,231 | 109 | 9,017 | 7514 | off | off | off | 52 | NA |
| | 06/04/04 | 5.3 | 571.0 | 242,810 | 4,266 | 5,283 | 95 | 9,112 | 7593 | off | off | off | 50 | NA |
| | 06/05/04 | 6.8 | 577.8 | 242,917 | 4,321 | 5,341 | 113 | 9,225 | 7688 | 4.0 | 4.0 | 60 | 52 | 8 |
| | 06/06/04 | 6.4 | 584.2 | 243,018 | 4,373 | 5,396 | 107 | 9,332 | 7777 | 3.0 | 3.0 | 56 | 50 | 6 |

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours | Pump House: Cumulative Operation Hours | Pump House: Master Flow Meter | Instrument Panel: Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) Vessel A | Head Loss (psi) Vessel B | System Pressure (psig) Influent | System Pressure (psig) Effluent | ΔP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | | | | | psig |
| | 06/07/04 | 9.2 | 593.4 | 243,164 | 4,446 | 5,476 | 153 | 9,485 | 7904 | off | off | off | 58 | NA |
| | 06/08/04 | 6.7 | 600.1 | 243,270 | 4,499 | 5,534 | 111 | 9,596 | 7997 | 3.0 | 3.0 | 56 | 50 | 6 |
| | 06/09/04 | 10.4 | 610.5 | 243,432 | 4,580 | 5,621 | 168 | 9,764 | 8137 | 5.0 | 5.0 | 62 | 52 | 10 |
| 21 | 06/10/04 | 9.2 | 619.7 | 243,576 | 4,652 | 5,700 | 151 | 9,915 | 8263 | 5.0 | 6.0 | 67 | 56 | 11 |
| | 06/11/04 | 4.4 | 624.1 | 243,645 | 4,680 | 5,739 | 67 | 9,982 | 8318 | 6.0 | 8.0 | 64 | 58 | 6 |
| | 06/12/04 | 9.5 | 633.6 | 243,795 | 4,761 | 5,821 | 163 | 10,145 | 8454 | off | off | off | 52 | NA |
| | 06/13/04 | 6.1 | 639.7 | 243,891 | 4,808 | 5,872 | 98 | 10,243 | 8536 | off | off | off | 58 | NA |
| | 06/14/04 | 10.3 | 650.0 | 244,054 | 4,837 | 5,970 | 127 | 10,370 | 8642 | off | off | off | 58 | NA |
| | 06/15/04 | 9.2 | 659.2 | 244,203 | 4,910 | 6,054 | 157 | 10,527 | 8773 | 3.0 | 3.0 | 66 | 60 | 6 |
| | 06/16/04 | 7.5 | 666.7 | 244,321 | 4,972 | 6,116 | 124 | 10,651 | 8876 | off | off | off | 62 | NA |
| 22 | 06/17/04 | 9.7 | 676.4 | 244,477 | 5,055 | 6,197 | 164 | 10,815 | 9013 | 4.0 | 4.0 | 70 | 62 | 8 |
| | 06/18/04 | 8.1 | 684.5 | 244,606 | 5,123 | 6,263 | 134 | 10,949 | 9124 | off | off | off | 58 | NA |
| | 06/19/04 | 8.9 | 693.4 | 244,747 | 5,198 | 6,337 | 149 | 11,098 | 9248 | off | off | off | 60 | NA |
| | 06/20/04 | 6.0 | 699.4 | 244,843 | 5,248 | 6,387 | 100 | 11,198 | 9332 | off | off | off | 52 | NA |
| | 06/21/04 | 15.0 | 714.4 | 245,019 | 5,349 | 6,479 | 193 | 11,391 | 9493 | 3.0 | 2.5 | 60 | 56 | 4 |
| | 06/22/04 | 9.1 | 723.5 | 245,164 | 5,415 | 6,555 | 142 | 11,533 | 9611 | off | off | off | off | NA |
| | 06/23/04 | 5.5 | 729.0 | 245,251 | 5,461 | 6,600 | 91 | 11,624 | 9687 | 3.0 | 3.0 | 58 | 52 | 6 |
| 23 | 06/24/04 | 9.8 | 738.8 | 245,407 | 5,542 | 6,683 | 164 | 11,788 | 9823 | off | off | off | 58 | NA |
| | 06/25/04 | 5.8 | 744.6 | 245,509 | 5,589 | 6,732 | 96 | 11,884 | 9903 | off | off | off | 60 | NA |
| | 06/26/04 | 6.4 | 751.0 | 245,602 | 5,643 | 6,786 | 108 | 11,992 | 9993 | 6.0 | 6.0 | 72 | 60 | 12 |
| | 06/27/04 | 6.0 | 757.0 | 245,706 | 5,697 | 6,841 | 109 | 12,101 | 10084 | off | off | off | 58 | NA |
| | 06/28/04 | 6.4 | 763.4 | 245,794 | 5,742 | 6,887 | 91 | 12,192 | 10160 | 8.0 | 8.0 | 76 | 60 | 16 |
| | 06/29/04 | 7.3 | 770.7 | 245,911 | 5,803 | 6,948 | 122 | 12,314 | 10262 | off | off | off | 62 | NA |
| | 06/30/04 | 5.5 | 776.2 | 245,999 | 5,849 | 6,994 | 92 | 12,406 | 10338 | 10.0 | 10.0 | 80 | 60 | 20 |
| 24 | 07/01/04 | 6.8 | 783.0 | 246,109 | 5,907 | 7,051 | 115 | 12,521 | 10434 | 3.0 | 2.8 | 62 | 56 | 6 |
| | 07/02/04 | 5.9 | 788.9 | 246,205 | 5,958 | 7,101 | 101 | 12,622 | 10518 | 3.0 | 3.0 | 58 | 52 | 6 |
| | 07/03/04 | 10.2 | 799.1 | 246,368 | 6,045 | 7,189 | 175 | 12,797 | 10664 | off | off | off | 60 | NA |
| | 07/04/04 | 5.3 | 804.4 | 246,455 | 6,090 | 7,230 | 86 | 12,883 | 10736 | off | off | off | 58 | NA |
| | 07/05/04 | 8.3 | 812.7 | 246,588 | 6,158 | 7,301 | 139 | 13,022 | 10852 | 3.5 | 3.0 | 62 | 56 | 6 |
| | 07/06/04 | 9.1 | 821.8 | 246,735 | 6,227 | 7,385 | 153 | 13,175 | 10979 | off | off | off | 52 | NA |
| | 07/07/04 | 6.1 | 827.9 | 246,832 | 6,277 | 7,437 | 102 | 13,277 | 11064 | 4.0 | 3.0 | 63 | 54 | 9 |
| 25 | 07/08/04 | 13.4 | 841.3 | 247,046 | 6,384 | 7,554 | 224 | 13,501 | 11251 | off | off | off | 58 | NA |
| | 07/09/04 | 8.0 | 849.3 | 247,175 | 6,453 | 7,621 | 136 | 13,637 | 11364 | off | off | off | 60 | NA |
| | 07/10/04 | 9.9 | 859.2 | 247,333 | 6,535 | 7,705 | 166 | 13,803 | 11503 | off | off | off | 62 | NA |
| | 07/11/04 | 8.0 | 867.2 | 247,468 | 6,603 | 7,777 | 140 | 13,943 | 11619 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 07/12/04 | 8.3 | 875.5 | 247,597 | 6,667 | 7,848 | 135 | 14,078 | 11732 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 07/13/04 | 4.7 | 880.2 | 247,672 | 6,703 | 7,891 | 79 | 14,157 | 11798 | off | off | off | 54 | NA |
| | 07/14/04 | 13.4 | 893.6 | 247,886 | 6,815 | 8,006 | 227 | 14,384 | 11987 | off | off | off | 56 | NA |
| 26 | 07/15/04 | 8.3 | 901.9 | 248,022 | 6,886 | 8,076 | 141 | 14,525 | 12104 | off | off | off | 56 | NA |
| | 07/16/04 | 7.0 | 908.9 | 248,136 | 6,947 | 8,137 | 122 | 14,647 | 12206 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 07/17/04 | 11.7 | 920.6 | 248,328 | 7,046 | 8,237 | 199 | 14,846 | 12372 | off | off | off | 52 | NA |
| | 07/18/04 | 9.0 | 929.6 | 248,468 | 7,120 | 8,311 | 148 | 14,994 | 12495 | off | off | off | 52 | NA |
| | 07/19/04 | 8.7 | 938.3 | 248,609 | 7,194 | 8,385 | 148 | 15,142 | 12618 | off | off | off | 52 | NA |
| | 07/20/04 | 9.5 | 947.8 | 248,763 | 7,274 | 8,466 | 161 | 15,303 | 12753 | 3.5 | 3.5 | 61 | 54 | 7 |
| | 07/21/04 | 6.7 | 954.5 | 248,872 | 7,332 | 8,522 | 114 | 15,417 | 12848 | 4.0 | 4.0 | 68 | 60 | 8 |
| 27 | 07/22/04 | 12.1 | 966.6 | 249,069 | 7,456 | 8,626 | 228 | 15,645 | 13038 | off | off | off | 56 | NA |
| | 07/23/04 | 8.2 | 974.8 | 249,197 | 7,501 | 8,694 | 113 | 15,758 | 13132 | off | off | off | 54 | NA |
| | 07/24/04 | 9.9 | 984.7 | 249,349 | 7,580 | 8,774 | 159 | 15,917 | 13264 | off | off | NM | NM | NA |
| | 07/25/04 | 3.8 | 988.5 | 249,418 | 7,651 | 8,811 | 108 | 16,025 | 13354 | 5.5 | 5.5 | 65 | 54 | 11 |
| | 07/26/04 | 8.2 | 996.7 | 249,549 | 7,685 | 8,882 | 105 | 16,130 | 13442 | 6.5 | 6.5 | 65 | 52 | 13 |
| | 07/27/04 | 5.6 | 1002.3 | 249,625 | 7,727 | 8,924 | 84 | 16,214 | 13512 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 07/28/04 | 14.8 | 1017.1 | 249,697 | 7,765 | 8,961 | 75 | 16,289 | 13574 | off | off | off | 56 | NA |
| 28 | 07/29/04 | 6.2 | 1023.3 | 249,798 | 7,820 | 9,013 | 107 | 16,396 | 13663 | off | off | off | 58 | NA |
| | 07/30/04 | 7.5 | 1030.8 | 249,918 | 7,887 | 9,072 | 126 | 16,522 | 13768 | off | off | off | 58 | NA |
| | 07/31/04 | 5.4 | 1036.2 | 250,003 | 7,934 | 9,114 | 89 | 16,611 | 13843 | 3.5 | 3.5 | 59 | 52 | 7 |
| | 08/01/04 | 6.6 | 1042.8 | 250,112 | 7,997 | 9,166 | 115 | 16,726 | 13938 | off | off | off | 56 | NA |
| | 08/02/04 | 4.3 | 1047.1 | 250,191 | 8,041 | 9,205 | 83 | 16,809 | 14008 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 08/03/04 | 7.8 | 1054.9 | 250,310 | 8,109 | 9,261 | 124 | 16,933 | 14111 | off | off | off | 54 | NA |
| | 08/04/04 | 5.2 | 1060.1 | 250,402 | 8,159 | 9,308 | 97 | 17,030 | 14192 | 4.5 | 4.5 | 61 | 52 | 9 |
| 29 | 08/05/04 | 9.9 | 1070.0 | 250,554 | 8,246 | 9,380 | 159 | 17,189 | 14324 | off | off | off | 56 | NA |
| | 08/06/04 | 9.0 | 1079.0 | 250,647 | 8,300 | 9,414 | 88 | 17,277 | 14398 | 5.6 | 5.6 | 66 | 56 | 10 |
| | 08/07/04 | 8.1 | 1087.1 | 250,778 | 8,376 | 9,486 | 148 | 17,425 | 14521 | off | off | off | 52 | NA |
| | 08/08/04 | 8.4 | 1095.5 | 250,915 | 8,446 | 9,559 | 143 | 17,568 | 14640 | off | off | 67 | 56 | 11 |
| | 08/09/04 | 7.7 | 1103.2 | 251,038 | 8,495 | 9,640 | 130 | 17,698 | 14748 | 9.5 | 3.0 | 66 | 52 | 14 |
| | 08/10/04 | 8.5 | 1111.7 | 251,177 | 8,572 | 9,708 | 145 | 17,843 | 14869 | off | off | off | 50 | NA |
| | 08/11/04 | 8.5 | 1120.2 | 251,317 | 8,647 | 9,803 | 170 | 18,013 | 15011 | off | off | off | 56 | NA |
| 30 | 08/12/04 | 7.1 | 1127.3 | 251,423 | 8,704 | 9,834 | 88 | 18,101 | 15084 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 08/13/04 | 5.9 | 1133.2 | 251,528 | 8,760 | 9,888 | 110 | 18,211 | 15176 | off | off | off | 56 | NA |
| | 08/14/04 | 4.3 | 1137.5 | 251,600 | 8,796 | 9,924 | 72 | 18,283 | 15236 | off | off | off | 54 | NA |
| | 08/15/04 | 4.0 | 1141.5 | 251,665 | 8,831 | 9,957 | 68 | 18,351 | 15293 | off | off | off | 53 | NA |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours | Pump House: Cumulative Operation Hours | Pump House: Master Flow Meter | Instrument Panel: Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) Vessel A | Head Loss (psi) Vessel B | System Pressure (psig) Influent | System Pressure (psig) Effluent | ΔP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | | | | | psig |
| | 08/16/04 | 3.4 | 1144.9 | 251,721 | 8,864 | 9,986 | 62 | 18,413 | 15344 | off | off | off | 60 | NA |
| | 08/17/04 | 3.2 | 1148.1 | 251,774 | 8,892 | 10,013 | 55 | 18,468 | 15390 | off | off | off | 58 | NA |
| | 08/18/04 | 2.0 | 1150.1 | 251,807 | 8,910 | 10,030 | 35 | 18,503 | 15419 | 6.0 | 6.0 | 64 | 52 | 12 |
| 31 | 08/19/04 | 4.8 | 1154.9 | 251,885 | 8,948 | 10,073 | 81 | 18584 | 15487 | off | off | off | 58 | NA |
| | 08/20/04 | 4.3 | 1159.2 | 251,954 | 8,982 | 10,112 | 73 | 18657 | 15548 | off | off | off | 60 | NA |
| | 08/21/04 | 4.8 | 1164.0 | 252,034 | 9,026 | 10,152 | 84 | 18741 | 15618 | off | off | off | 58 | NA |
| | 08/22/04 | 4.8 | 1168.8 | 252,112 | 9,069 | 10,190 | 81 | 18822 | 15685 | off | off | off | 56 | NA |
| | 08/23/04 | 5.9 | 1174.7 | 252,209 | 9,123 | 10,238 | 102 | 18924 | 15770 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 08/24/04 | 10.4 | 1185.1 | 252,376 | 9,216 | 10,319 | 174 | 19098 | 15915 | 5.0 | 5.0 | 62 | 52 | 10 |
| | 08/25/04 | 3.8 | 1188.9 | 252,437 | 9,249 | 10,349 | 63 | 19161 | 15968 | off | off | off | 58 | NA |
| 32 | 08/26/04 | 5.2 | 1194.1 | 252,523 | 9,282 | 10,425 | 109 | 19270 | 16058 | off | off | off | 56 | NA |
| | 08/27/04 | 6.1 | 1200.2 | 252,622 | 9,322 | 10,470 | 85 | 19355 | 16129 | off | off | off | 54 | NA |
| | 08/28/04 | 4.9 | 1205.1 | 252,703 | 9,365 | 10,511 | 84 | 19439 | 16199 | off | off | off | 60 | NA |
| | 08/29/04 | 5.6 | 1210.7 | 252,795 | 9,414 | 10,558 | 96 | 19535 | 16279 | off | off | off | 60 | NA |
| | 08/30/04 | 4.9 | 1215.6 | 252,880 | 9,459 | 10,602 | 89 | 19624 | 16353 | off | off | off | 58 | NA |
| | 08/31/04 | 5.5 | 1221.1 | 252,965 | 9,504 | 10,646 | 89 | 19713 | 16428 | off | off | off | 60 | NA |
| | 09/01/04 | 5.9 | 1227.0 | 253,060 | 9,555 | 10,695 | 100 | 19813 | 16511 | 3.5 | 3.5 | 64 | 57 | 7 |
| 33 | 09/02/04 | 6.0 | 1233.0 | 253,167 | 9,611 | 10,750 | 111 | 19924 | 16603 | off | off | off | 60 | NA |
| | 09/03/04 | 5.6 | 1238.6 | 253,250 | 9,656 | 10,793 | 88 | 20012 | 16677 | off | off | off | 58 | NA |
| | 09/04/04 | 4.6 | 1243.2 | 253,326 | 9,697 | 10,831 | 79 | 20091 | 16743 | off | off | off | 56 | NA |
| | 09/05/04 | 4.4 | 1247.6 | 253,397 | 9,736 | 10,867 | 75 | 20166 | 16805 | off | off | off | 54 | NA |
| | 09/06/04 | 4.5 | 1252.1 | 253,472 | 9,777 | 10,904 | 78 | 20244 | 16870 | off | off | off | 60 | NA |
| | 09/07/04 | 5.5 | 1257.6 | 253,561 | 9,827 | 10,947 | 93 | 20337 | 16948 | 4.0 | 4.0 | off | 58 | NA |
| | 09/08/04 | 4.9 | 1262.5 | 253,641 | 9,871 | 10,986 | 83 | 20420 | 17017 | off | off | 67 | 58 | 9 |
| 34 | 09/09/04 | 5.2 | 1267.7 | 253,725 | 9,918 | 11,028 | 89 | 20509 | 17091 | off | off | off | 60 | NA |
| | 09/10/04 | 5.5 | 1273.2 | 253,815 | 9,969 | 11,071 | 94 | 20603 | 17169 | off | off | off | 60 | NA |
| | 09/11/04 | 5.3 | 1278.5 | 253,901 | 10,018 | 11,112 | 90 | 20693 | 17244 | off | off | off | 58 | NA |
| | 09/12/04 | 6.3 | 1284.8 | 254,007 | 10,071 | 11,170 | 111 | 20804 | 17337 | off | off | off | 60 | NA |
| | 09/13/04 | 5.8 | 1290.6 | 254,101 | 10,120 | 11,219 | 98 | 20902 | 17418 | 3.0 | 3.0 | off | 58 | NA |
| | 09/14/04 | 4.9 | 1295.5 | 254,181 | 10,163 | 11,261 | 85 | 20987 | 17489 | 3.0 | 3.0 | off | 60 | NA |
| | 09/15/04 | 5.7 | 1301.2 | 254,275 | 10,212 | 11,309 | 97 | 21084 | 17570 | 3.5 | 4.0 | 58 | 50 | 8 |
| 35 | 09/16/04 | 5.5 | 1306.7 | 254,365 | 10,261 | 11,355 | 95 | 21179 | 17649 | 4.5 | 5.0 | off | 58 | NA |
| | 09/17/04 | 6.0 | 1312.7 | 254,465 | 10,313 | 11,407 | 104 | 21283 | 17736 | 4.5 | 5.0 | off | 58 | NA |
| | 09/18/04 | 5.7 | 1318.4 | 254,556 | 10,361 | 11,454 | 95 | 21378 | 17815 | off | off | off | 60 | NA |
| | 09/19/04 | 5.2 | 1323.6 | 254,641 | 10,408 | 11,496 | 89 | 21467 | 17889 | off | off | off | 58 | NA |
| | 09/20/04 | 3.8 | 1327.4 | 254,704 | 10,439 | 11,526 | 61 | 21528 | 17940 | off | off | off | 58 | NA |
| | 09/21/04 | 3.6 | 1331.0 | 254,767 | 10,477 | 11,554 | 66 | 21594 | 17995 | off | off | off | 60 | NA |
| | 09/22/04 | 4.3 | 1335.3 | 254,833 | 10,513 | 11,592 | 74 | 21668 | 18057 | off | off | off | 54 | NA |
| 36 | 09/23/04 | 3.7 | 1339.0 | 254,894 | 10,545 | 11,624 | 64 | 21732 | 18110 | off | off | off | 58 | NA |
| | 09/24/04 | 4.2 | 1343.2 | 254,965 | 10,582 | 11,660 | 73 | 21805 | 18171 | off | off | off | 60 | NA |
| | 09/25/04 | 3.9 | 1347.1 | 255,028 | 10,615 | 11,693 | 66 | 21871 | 18226 | off | off | off | 56 | NA |
| | 09/26/04 | 3.4 | 1350.5 | 255,090 | 10,648 | 11,737 | 77 | 21948 | 18290 | off | off | off | 60 | NA |
| | 09/27/04 | 4.0 | 1354.5 | 255,150 | 10,680 | 11,737 | 32 | 21980 | 18317 | off | off | off | 60 | NA |
| | 09/28/04 | 4.3 | 1358.8 | 255,221 | 10,719 | 11,792 | 94 | 22074 | 18395 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 09/29/04 | 6.4 | 1365.2 | 255,324 | 10,776 | 11,842 | 107 | 22181 | 18484 | 6.0 | 6.0 | 72 | 60 | 12 |
| 37 | 09/30/04 | 5.4 | 1370.6 | 255,411 | 10,823 | 11,887 | 92 | 22273 | 18561 | 7.0 | 7.0 | 78 | 58 | 20 |
| | 10/01/04 | 1.6 | 1372.2 | 255,439 | 10,835 | 11,904 | 29 | 22302 | 18585 | off | off | off | 56 | NA |
| | 10/02/04 | 5.5 | 1377.7 | 255,530 | 10,882 | 11,952 | 95 | 22397 | 18664 | off | off | off | 58 | NA |
| | 10/03/04 | 4.6 | 1382.3 | 255,606 | 10,922 | 11,991 | 79 | 22476 | 18730 | off | off | off | 56 | NA |
| | 10/04/04 | 3.5 | 1385.8 | 255,663 | 10,951 | 12,021 | 59 | 22535 | 18779 | off | off | off | 58 | NA |
| | 10/05/04 | 4.3 | 1390.1 | 255,733 | 10,988 | 12,057 | 73 | 22608 | 18840 | off | off | off | 60 | NA |
| | 10/06/04 | 3.5 | 1393.6 | 255,793 | 11,020 | 12,088 | 63 | 22671 | 18893 | off | off | off | 56 | NA |
| 38 | 10/07/04 | 4.0 | 1397.6 | 255,857 | 11,054 | 12,122 | 68 | 22739 | 18949 | off | off | off | 60 | NA |
| | 10/08/04 | 3.5 | 1401.1 | 255,916 | 11,085 | 12,152 | 61 | 22800 | 19000 | off | off | off | 60 | NA |
| | 10/09/04 | 4.0 | 1405.1 | 255,982 | 11,120 | 12,186 | 69 | 22869 | 19058 | off | off | off | 56 | NA |
| | 10/10/04 | 4.1 | 1409.2 | 256,047 | 11,155 | 12,219 | 68 | 22937 | 19114 | off | off | off | 54 | NA |
| | 10/11/04 | 3.7 | 1412.9 | 256,110 | 11,188 | 12,251 | 65 | 23002 | 19168 | off | off | off | 60 | NA |
| | 10/12/04 | 3.5 | 1416.4 | 256,176 | 11223 | 12285 | 69 | 23071 | 19226 | off | off | off | 58 | NA |
| | 10/13/04 | 4.8 | 1421.2 | 256,247 | 11,261 | 12,321 | 74 | 23145 | 19288 | 5.0 | 5.0 | 66 | 56 | 10 |
| 39 | 10/14/04 | 6.2 | 1427.4 | 256,347 | 11,313 | 12,373 | 104 | 23249 | 19374 | 5.0 | 5.0 | off | 58 | NA |
| | 10/15/04 | 3.4 | 1430.8 | 256,403 | 11,337 | 12,408 | 59 | 23308 | 19423 | 5.0 | 5.0 | off | 60 | NA |
| | 10/16/04 | 3.1 | 1433.9 | 256,454 | 11,358 | 12,441 | 54 | 23362 | 19468 | off | off | off | 60 | NA |
| | 10/17/04 | 3.7 | 1437.6 | 256,515 | 11,382 | 12,481 | 64 | 23426 | 19522 | off | off | off | 56 | NA |
| | 10/18/04 | 3.5 | 1441.1 | 256,573 | 11,402 | 12,520 | 59 | 23485 | 19571 | off | off | off | 58 | NA |
| | 10/19/04 | 3.7 | 1444.8 | 256,633 | 11423 | 12561 | 62 | 23547 | 19623 | off | off | off | 58 | NA |
| | 10/20/04 | 3.3 | 1448.1 | 256,696 | 11,445 | 12,606 | 67 | 23614 | 19678 | off | off | off | 56 | NA |
| 40 | 10/21/04 | 5.4 | 1453.5 | 256,776 | 11,485 | 12,649 | 83 | 23697 | 19748 | off | off | off | 58 | NA |
| | 10/22/04 | 3.3 | 1456.8 | 256,830 | 11,513 | 12,673 | 52 | 23749 | 19791 | off | off | off | 60 | NA |
| | 10/23/04 | 2.9 | 1459.7 | 256,879 | 11,538 | 12,703 | 55 | 23804 | 19837 | off | off | off | 60 | NA |
| | 10/24/04 | 4.1 | 1463.8 | 256,946 | 11,573 | 12,738 | 70 | 23874 | 19895 | off | off | off | 58 | NA |

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House | | | | | | Instrument Panel | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 41 | 10/25/04 | 3.9 | 1467.7 | 257,011 | 11,607 | 12,772 | 68 | 23942 | 19952 | off | off | off | 60 | NA |
| | 10/26/04 | 2.4 | 1470.1 | 257,061 | 11633 | 12798 | 52 | 23994 | 19995 | off | off | off | 58 | NA |
| | 10/27/04 | 9.1 | 1479.2 | 257,199 | 11,705 | 12,878 | 152 | 24146 | 20122 | off | off | off | 54 | NA |
| | 10/28/04 | 6.4 | 1485.6 | 257,304 | 11,761 | 12,925 | 103 | 24249 | 20208 | off | off | off | 54 | NA |
| | 10/29/04 | 5.4 | 1491.0 | 257,393 | 11,807 | 12,970 | 91 | 24340 | 20283 | off | off | off | 52 | NA |
| | 10/30/04 | 6.0 | 1497.0 | 257,490 | 11,855 | 13,024 | 102 | 24442 | 20368 | off | off | off | 56 | NA |
| | 10/31/04 | 3.3 | 1500.3 | 257,545 | 11,877 | 13,059 | 57 | 24499 | 20416 | off | off | off | 56 | NA |
| 42 | 11/01/04 | 5.9 | 1506.2 | 257,641 | 11,911 | 13,120 | 95 | 24594 | 20495 | off | off | off | 56 | NA |
| | 11/02/04 | 2.8 | 1509.0 | 257,687 | 11935 | 13149 | 53 | 24647 | 20539 | off | off | off | 58 | NA |
| | 11/03/04 | 3.6 | 1512.6 | 257,747 | 11,961 | 13,186 | 63 | 24710 | 20592 | 5.0 | 4.0 | 65 | 55 | 9 |
| | 11/04/04 | 7.7 | 1520.3 | 257,875 | 12,019 | 13,259 | 131 | 24841 | 20701 | off | off | off | 56 | NA |
| | 11/05/04 | 5.9 | 1526.2 | 257,969 | 12,063 | 13,316 | 101 | 24942 | 20785 | off | off | off | 58 | NA |
| | 11/06/04 | 3.0 | 1529.2 | 258,018 | 12,085 | 13,344 | 50 | 24992 | 20827 | 5.0 | 5.0 | 64 | 54 | 9 |
| | 11/07/04 | 6.7 | 1535.9 | 258,126 | 12,133 | 13,410 | 114 | 25106 | 20922 | off | off | off | 54 | NA |
| 43 | 11/08/04 | 6.2 | 1542.1 | 258,227 | 12,177 | 13,471 | 105 | 25211 | 21009 | 2.5 | 5.0 | 63.5 | 56 | 7.5 |
| | 11/09/04 | 4.1 | 1546.2 | 258,295 | 12214 | 13,506 | 72 | 25283 | 21069 | off | off | off | 56 | NA |
| | 11/10/04 | 6.4 | 1552.6 | 258,401 | 12,269 | 13,561 | 110 | 25393 | 21161 | off | off | off | 52 | NA |
| | 11/11/04 | 5.5 | 1558.1 | 258,490 | 12,315 | 13,608 | 93 | 25486 | 21238 | off | off | off | 56 | NA |
| | 11/12/04 | 3.2 | 1561.3 | 258,544 | 12,343 | 13,636 | 56 | 25542 | 21285 | off | off | off | 58 | NA |
| | 11/13/04 | 0.9 | 1562.2 | 258,599 | 12,371 | 13,664 | 56 | 25598 | 21332 | off | off | off | 56 | NA |
| | 11/14/04 | 8.8 | 1571.0 | 258,702 | 12,423 | 13,722 | 110 | 25708 | 21423 | off | off | off | 56 | NA |
| 44 | 11/15/04 | 2.9 | 1573.9 | 258,749 | 12,448 | 13,748 | 51 | 25759 | 21466 | off | off | off | 58 | NA |
| | 11/16/04 | 3.0 | 1576.9 | 258,797 | 12474 | 13772 | 50 | 25809 | 21508 | off | off | off | 56 | NA |
| | 11/17/04 | 3.9 | 1580.8 | 258,859 | 12,507 | 13,808 | 69 | 25878 | 21565 | 11.0 | 11.0 | 80 | 58 | 22 |
| | 11/18/04 | 5.6 | 1586.4 | 258,951 | 12,555 | 13,850 | 90 | 25968 | 21640 | off | off | off | 56 | NA |
| | 11/19/04 | 5.4 | 1591.8 | 259,040 | 12,602 | 13,897 | 94 | 26062 | 21718 | 3.0 | 3.0 | 70 | 64 | 6 |
| | 11/20/04 | 3.4 | 1595.2 | 259,096 | 12,632 | 13,926 | 59 | 26121 | 21768 | off | off | off | 60 | NA |
| | 11/21/04 | 3.2 | 1598.4 | 259,148 | 12,659 | 13,952 | 53 | 26174 | 21812 | off | off | off | 60 | NA |
| 45 | 11/22/04 | 2.9 | 1601.3 | 259,195 | 12,685 | 13,976 | 50 | 26224 | 21853 | off | off | off | 60 | NA |
| | 11/23/04 | 2.6 | 1603.9 | 259,239 | 12710 | 13996 | 45 | 26269 | 21891 | off | off | off | 56 | NA |
| | 11/24/04 | 3.0 | 1606.9 | 259,286 | 12,737 | 14,017 | 48 | 26317 | 21931 | off | off | off | 58 | NA |
| | 11/25/04 | 2.8 | 1609.7 | 259,333 | 12,765 | 14,039 | 50 | 26367 | 21973 | off | off | off | 60 | NA |
| | 11/26/04 | 2.9 | 1612.6 | 259,377 | 12,788 | 14,062 | 46 | 26413 | 22011 | off | off | off | 60 | NA |
| | 11/27/04 | 2.5 | 1615.1 | 259,418 | 12,808 | 14,085 | 43 | 26456 | 22047 | off | off | off | 58 | NA |
| | 11/28/04 | 3.3 | 1618.4 | 259,469 | 12,832 | 14,114 | 53 | 26509 | 22091 | off | off | off | 58 | NA |
| 46 | 11/29/04 | 2.8 | 1621.2 | 259,517 | 12,857 | 14,138 | 49 | 26558 | 22132 | off | off | off | 56 | NA |
| | 11/30/04 | 3.0 | 1624.2 | 259,565 | 12,883 | 14,164 | 52 | 26610 | 22175 | off | off | off | 56 | NA |
| | 12/01/04 | 3.9 | 1628.1 | 259,631 | 12,917 | 14,197 | 67 | 26677 | 22231 | 4.0 | 4.0 | 66 | 58 | NA |
| | 12/02/04 | 7.5 | 1635.6 | 259,756 | 12,982 | 14,262 | 130 | 26807 | 22339 | off | off | off | 54 | NA |
| | 12/03/04 | 4.9 | 1640.5 | 259,833 | 13,022 | 14,301 | 79 | 26886 | 22405 | off | off | off | 58 | NA |
| | 12/04/04 | 4.5 | 1645.0 | 259,907 | 13,063 | 14,338 | 78 | 26964 | 22470 | off | off | off | 60 | NA |
| | 12/05/04 | 3.1 | 1648.1 | 259,957 | 13,091 | 14,362 | 52 | 27016 | 22513 | off | off | off | 60 | NA |
| 47 | 12/06/04 | 1.2 | 1649.3 | 259,976 | 13,101 | 14,372 | 20 | 27036 | 22530 | 12.0 | 12.0 | 80 | 54 | 26 |
| | 12/07/04 | 3.9 | 1653.2 | 260,052 | 13,142 | 14,411 | 80 | 27116 | 22597 | off | off | off | 60 | NA |
| | 12/08/04 | 2.4 | 1655.6 | 260,082 | 13,158 | 14,426 | 31 | 27147 | 22623 | off | off | off | 54 | NA |
| | 12/09/04 | 3.6 | 1659.2 | 260,141 | 13,189 | 14,456 | 61 | 27208 | 22673 | off | off | off | 52 | NA |
| | 12/10/04 | 3.3 | 1662.5 | 260,197 | 13,218 | 14,485 | 58 | 27266 | 22722 | off | off | off | 60 | NA |
| | 12/11/04 | 3.0 | 1665.5 | 260,246 | 13,245 | 14,510 | 52 | 27318 | 22765 | off | off | off | 58 | NA |
| | 12/12/04 | 3.4 | 1668.9 | 260,302 | 13,275 | 14,537 | 57 | 27375 | 22813 | off | off | off | 58 | NA |
| 48 | 12/13/04 | 3.2 | 1672.1 | 260,354 | 13,305 | 14,561 | 54 | 27429 | 22858 | off | off | off | 58 | NA |
| | 12/14/04 | 3.1 | 1675.2 | 260,403 | 13,325 | 14,583 | 42 | 27471 | 22893 | off | off | off | 56 | NA |
| | 12/15/04 | 3.2 | 1678.4 | 260,455 | 13,367 | 14,615 | 74 | 27545 | 22954 | 10.0 | 10.0 | 78 | 58 | 20 |
| | 12/16/04 | 4.0 | 1682.4 | 260,538 | 13,412 | 14,646 | 76 | 27621 | 23018 | off | off | off | 54 | NA |
| | 12/17/04 | 4.2 | 1686.6 | 260,589 | 13,439 | 14,672 | 53 | 27674 | 23062 | off | off | off | 56 | NA |
| | 12/18/04 | 3.0 | 1689.6 | 260,640 | 13,466 | 14,698 | 53 | 27727 | 23106 | off | off | off | 60 | NA |
| | 12/19/04 | 3.1 | 1692.7 | 260,692 | 13,493 | 14,724 | 53 | 27780 | 23150 | off | off | off | 54 | NA |
| 49 | 12/20/04 | 3.3 | 1696.0 | 260,796 | 13,523 | 14,751 | 57 | 27837 | 23198 | off | off | off | 52 | NA |
| | 12/21/04 | 4.0 | 1700.0 | 260,811 | 13,561 | 14,781 | 68 | 27905 | 23254 | 10.0 | 10.0 | 80 | 60 | 20 |
| | 12/22/04 | 3.8 | 1703.8 | 260,870 | 13,595 | 14,808 | 61 | 27966 | 23305 | off | off | off | 56 | NA |
| | 12/23/04 | 3.3 | 1707.1 | 260,927 | 13,625 | 14,837 | 59 | 28025 | 23354 | off | off | off | 56 | NA |
| | 12/24/04 | 3.3 | 1710.4 | 260,982 | 13,654 | 14,866 | 58 | 28083 | 23403 | off | off | off | 52 | NA |
| | 12/25/04 | 7.3 | 1717.7 | 261,102 | 13,719 | 14,925 | 124 | 28207 | 23506 | off | off | off | 58 | NA |
| | 12/26/04 | 2.8 | 1720.5 | 261,163 | 13,755 | 14,953 | 64 | 28271 | 23559 | 10.0 | 10.0 | 78 | 58 | 20 |
| 50 | 12/27/04 | 2.9 | 1723.4 | 261,195 | 13,774 | 14,968 | 34 | 28305 | 23588 | 12.0 | 12.0 | 80 | 56 | 24 |
| | 12/28/04 | 6.7 | 1730.1 | 261,305 | 13,832 | 15,023 | 113 | 28418 | 23682 | off | off | off | 52 | NA |
| | 12/29/04 | 6.8 | 1736.9 | 261,417 | 13,892 | 15,080 | 117 | 28535 | 23779 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 12/30/04 | 3.3 | 1740.2 | 261,472 | 13,921 | 15,108 | 57 | 28592 | 23827 | 7.0 | 7.0 | 76 | 62 | 14 |
| | 12/31/04 | 3.6 | 1743.8 | 261,530 | 13,953 | 15,137 | 61 | 28653 | 23878 | 10.0 | 10.0 | 82 | 62 | 20 |
| | 01/01/05 | 6.3 | 1750.1 | 261,634 | 14,009 | 15,189 | 108 | 28761 | 23968 | 3.0 | 3.0 | 70 | 64 | 6 |
| | 01/02/05 | 4.1 | 1754.2 | 261,702 | 14,045 | 15,224 | 71 | 28832 | 24027 | off | off | off | 58 | NA |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours (hr) | Cumulative Operation Hours (hr) | Master Flow Meter (kgal) | Flow Totalizer Vessel A (kgal) | Flow Totalizer Vessel B (kgal) | Instrument Panel: Total Flow Daily (kgal) | Cumulative Flow Totalizer (kgal) | Cumulative Total Bed Volumes (# of BV) | Head Loss (psi) Vessel A | Head Loss (psi) Vessel B | System Pressure (psig) Influent | System Pressure (psig) Effluent | ΔP (psig) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 01/03/05 | 3.2 | 1757.4 | 261,755 | 14,075 | 15,224 | 30 | 28862 | 24052 | 7.0 | 7.0 | 74 | 60 | 14 |
| | 01/04/05 | 3.4 | 1760.8 | 261,812 | 14,105 | 15,278 | 84 | 28946 | 24122 | off | off | off | 62 | NA |
| | 01/05/05 | 0.7 | 1761.5 | 261,823 | 14,112 | 15,283 | 12 | 28958 | 24132 | 11.0 | 11.0 | 78 | 56 | 22 |
| 51 | 01/06/05 | 2.3 | 1763.8 | 261,863 | 14,135 | 15,301 | 41 | 28999 | 24166 | 12.0 | 12.0 | 76 | 52 | 24 |
| | 01/07/05 | 3.4 | 1767.2 | 261,920 | 14,168 | 15,327 | 59 | 29058 | 24215 | 10.0 | 10.0 | 72 | 52 | 20 |
| | 01/08/05 | 4.9 | 1772.1 | 262,001 | 14,212 | 15,368 | 85 | 29143 | 24286 | off | off | off | 58 | NA |
| | 01/09/05 | 6.8 | 1778.9 | 262,112 | 14,270 | 15,425 | 115 | 29258 | 24382 | off | off | off | 56 | NA |
| | 01/10/05 | 3.1 | 1782.0 | 262,164 | 14,298 | 15,452 | 55 | 29313 | 24428 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 01/11/05 | 3.8 | 1785.8 | 262,227 | 14,331 | 15,484 | 65 | 29378 | 24482 | off | off | off | 58 | NA |
| | 01/12/05 | 7.8 | 1793.6 | 262,352 | 14,397 | 15,549 | 131 | 29509 | 24591 | 6.0 | 6.0 | 70 | 58 | 12 |
| 52 | 01/13/05 | 6.7 | 1800.3 | 262,464 | 14,453 | 15,605 | 112 | 29621 | 24684 | off | off | off | 62 | NA |
| | 01/14/05 | 3.3 | 1803.6 | 262,518 | 14,483 | 15,634 | 59 | 29680 | 24733 | off | off | off | 56 | NA |
| | 01/15/05 | 3.4 | 1807.0 | 262,573 | 14,512 | 15,662 | 57 | 29737 | 24781 | off | 8.0 | off | 56 | NA |
| | 01/16/05 | 8.0 | 1815.0 | 262,691 | 14,569 | 15,727 | 122 | 29859 | 24883 | 8.0 | 8.0 | 68 | 52 | 16 |
| | 01/17/05 | 3.9 | 1818.9 | 262,738 | 14,591 | 15,755 | 50 | 29909 | 24924 | 10.0 | 10.0 | 72 | 52 | 20 |
| | 01/18/05 | 4.0 | 1822.9 | 262,804 | 14,625 | 15,788 | 67 | 29976 | 24980 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 01/19/05 | 5.6 | 1828.5 | 262,898 | 14,674 | 15,836 | 97 | 30073 | 25061 | off | off | off | 58 | NA |
| 53 | 01/20/05 | 2.9 | 1831.4 | 262,944 | 14,699 | 15,861 | 50 | 30123 | 25103 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 01/21/05 | 6.9 | 1838.3 | 263,060 | 14,759 | 15,928 | 127 | 30250 | 25208 | off | off | off | 56 | NA |
| | 01/22/05 | 1.7 | 1840.0 | 263,103 | 14,782 | 15,942 | 37 | 30287 | 25239 | off | off | off | 58 | NA |
| | 01/23/05 | 4.1 | 1844.1 | 263,155 | 14,809 | 15,969 | 54 | 30341 | 25284 | 5.0 | 5.0 | 66 | 50 | 16 |
| | 01/24/05 | 4.0 | 1848.1 | 263,203 | 14,835 | 15,994 | 51 | 30392 | 25327 | off | 5.0 | off | 58 | NA |
| | 01/25/05 | 3.1 | 1851.2 | 263,254 | 14,862 | 16,019 | 52 | 30444 | 25370 | 8.0 | 8.0 | 70 | 56 | 14 |
| | 01/26/05 | 3.5 | 1854.7 | 263,311 | 14,893 | 16,046 | 58 | 30502 | 25418 | 9.0 | 9.0 | 76 | 58 | 18 |
| 54 | 01/27/05 | 1.1 | 1855.8 | 263,330 | 14,905 | 16,056 | 22 | 30524 | 25437 | off | off | off | 58 | NA |
| | 01/28/05 | 1.2 | 1857.0 | 263,349 | 14,915 | 16,065 | 19 | 30543 | 25453 | off | off | off | 56 | NA |
| | 01/29/05 | 3.1 | 1860.1 | 263,399 | 14,941 | 16,090 | 51 | 30594 | 25495 | 3.0 | 3.0 | 62 | 58 | 4 |
| | 01/30/05 | 3.0 | 1863.1 | 263,451 | 14,969 | 16,117 | 55 | 30649 | 25541 | off | off | off | 56 | NA |
| | 01/31/05 | 3.0 | 1866.1 | 263,501 | 14,995 | 16,142 | 51 | 30700 | 25583 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 02/01/05 | 3.5 | 1869.6 | 263,559 | 15,026 | 16,171 | 60 | 30760 | 25633 | off | off | off | 56 | NA |
| | 02/02/05 | 3.6 | 1873.2 | 263,619 | 15,058 | 16,200 | 61 | 30821 | 25684 | 5.0 | 5.0 | 66 | 56 | 10 |
| 55 | 02/03/05 | 8.5 | 1881.7 | 263,756 | 15,135 | 16,267 | 144 | 30965 | 25804 | 6.0 | 6.0 | 78 | 66 | 12 |
| | 02/04/05 | 3.9 | 1885.6 | 263,820 | 15,171 | 16,297 | 66 | 31031 | 25859 | off | off | off | 60 | NA |
| | 02/05/05 | 2.6 | 1888.2 | 263,860 | 15,194 | 16,316 | 42 | 31073 | 25894 | 10.0 | 10.0 | 82 | 62 | 20 |
| | 02/06/05 | 0.8 | 1889.0 | 263,876 | 15,204 | 16,323 | 17 | 31090 | 25908 | off | off | off | 58 | NA |
| | 02/07/05 | 0.0 | 1889.0 | 263,876 | 15,204 | 16,323 | 0 | 31090 | 25908 | 10.0 | 10.0 | 80 | 60 | 20 |
| | 02/08/05 | 6.3 | 1895.3 | 263,981 | 15,259 | 16,377 | 109 | 31199 | 25999 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 02/09/05 | 4.2 | 1899.5 | 264,045 | 15,295 | 16,407 | 66 | 31265 | 26054 | off | off | off | 56 | NA |
| 56 | 02/10/05 | 2.4 | 1901.9 | 264,089 | 15,324 | 16,425 | 47 | 31312 | 26093 | 5.0 | 5.0 | 72 | 62 | 10 |
| | 02/11/05 | 3.1 | 1905.0 | 264,140 | 15,387 | 16,444 | 82 | 31394 | 26162 | off | off | off | 56 | NA |
| | 02/12/05 | 4.1 | 1909.1 | 264,210 | 15,395 | 16,479 | 43 | 31437 | 26198 | off | off | off | 56 | NA |
| | 02/13/05 | 4.1 | 1913.2 | 264,277 | 15,480 | 16,538 | 144 | 31581 | 26318 | off | off | off | 58 | NA |
| | 02/14/05 | 4.4 | 1917.6 | 264,345 | 15,480 | 16,538 | 0 | 31581 | 26318 | 12.0 | 12.0 | 90 | 66 | 24 |
| | 02/15/05 | 4.7 | 1922.3 | 264,424 | 15,524 | 16,574 | 80 | 31661 | 26384 | 3.0 | 3.0 | 70 | 64 | 6 |
| | 02/16/05 | 0.2 | 1922.5 | 264,427 | 15,525 | 16,576 | 3 | 31664 | 26387 | 3.0 | 3.0 | 60 | 54 | 6 |
| 57 | 02/17/05 | 6.6 | 1929.1 | 264,536 | 15,582 | 16,631 | 112 | 31776 | 26480 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 02/18/05 | 4.3 | 1933.4 | 264,607 | 15,619 | 16,669 | 75 | 31851 | 26543 | 10.0 | 10.0 | 78 | 58 | 20 |
| | 02/19/05 | 3.9 | 1937.3 | 264,671 | 15,655 | 16,703 | 70 | 31921 | 26601 | off | off | off | off | NA |
| | 02/20/05 | 0.0 | 1937.3 | 264,671 | 15,655 | 16,703 | 0 | 31921 | 26601 | off | off | off | off | NA |
| | 02/21/05 | 2.1 | 1939.4 | 264,706 | 15,675 | 16,719 | 36 | 31957 | 26631 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 02/22/05 | 5.5 | 1944.9 | 264,797 | 15,727 | 16,762 | 95 | 32052 | 26710 | off | off | off | 56 | NA |
| | 02/23/05 | 7.2 | 1952.1 | 264,914 | 15,797 | 16,814 | 122 | 32174 | 26812 | 10.0 | 10.0 | 74 | 54 | 20 |
| 58 | 02/24/05 | 7.3 | 1959.4 | 265,033 | 15,865 | 16,869 | 123 | 32297 | 26914 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 02/25/05 | 6.2 | 1965.6 | 265,135 | 15,919 | 16,919 | 104 | 32401 | 27001 | off | off | off | 58 | NA |
| | 02/26/05 | 5.2 | 1970.8 | 265,221 | 15,967 | 16,961 | 90 | 32491 | 27076 | off | off | off | 58 | NA |
| | 02/27/05 | 5.3 | 1976.1 | 265,307 | 16,015 | 17,003 | 90 | 32581 | 27151 | 10.0 | 10.0 | 82 | 62 | 20 |
| | 02/28/05 | 2.4 | 1978.5 | 265,346 | 16,039 | 17,021 | 42 | 32623 | 27186 | 10.0 | 10.0 | 80 | 60 | 20 |
| | 03/01/05 | 8.4 | 1986.9 | 265,485 | 16,112 | 17,091 | 143 | 32766 | 27305 | 3.0 | 3.0 | 68 | 62 | 6 |
| | 03/02/05 | 5.9 | 1992.8 | 265,582 | 16,163 | 17,139 | 99 | 32865 | 27388 | off | off | off | 58 | NA |
| 59 | 03/03/05 | 7.3 | 2000.1 | 265,700 | 16,227 | 17,198 | 123 | 32988 | 27490 | off | off | off | 56 | NA |
| | 03/04/05 | 7.5 | 2007.6 | 265,821 | 16,292 | 17,253 | 120 | 33108 | 27590 | 4.0 | 4.0 | 68 | 60 | 8 |
| | 03/05/05 | 5.3 | 2012.9 | 265,910 | 16,339 | 17,304 | 98 | 33206 | 27672 | off | off | off | 58 | NA |
| | 03/06/05 | 7.7 | 2020.6 | 266,039 | 16,409 | 17,368 | 134 | 33340 | 27783 | 6.0 | 6.0 | 76 | 64 | 12 |
| | 03/07/05 | 2.8 | 2023.4 | 266,091 | 16,438 | 17,393 | 54 | 33394 | 27828 | 7.0 | 7.0 | 74 | 60 | 14 |
| | 03/08/05 | 8.0 | 2031.4 | 266,209 | 16,505 | 17,448 | 122 | 33516 | 27930 | 10.0 | 10.0 | 82 | 62 | 20 |
| | 03/09/05 | 9.8 | 2041.2 | 266,369 | 16,591 | 17,528 | 166 | 33682 | 28068 | 3.0 | 3.0 | 62 | 56 | 6 |
| 60 | 03/10/05 | 5.5 | 2046.7 | 266,460 | 16,638 | 17,575 | 94 | 33776 | 28147 | off | off | off | 62 | NA |
| | 03/11/05 | 2.9 | 2049.6 | 266,509 | 16,664 | 17,600 | 51 | 33827 | 28189 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 03/12/05 | 5.0 | 2054.6 | 266,591 | 16,706 | 17,642 | 84 | 33911 | 28259 | off | off | off | 62 | NA |
| | 03/13/05 | 4.8 | 2059.4 | 266,666 | 16,743 | 17,683 | 78 | 33989 | 28324 | 15.0 | 15.0 | 90 | 60 | 30 |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours | Pump House: Cumulative Operation Hours | Pump House: Master Flow Meter | Pump House: Flow Totalizer Vessel A | Pump House: Flow Totalizer Vessel B | Instrument Panel: Total Flow Daily | Instrument Panel: Cumulative Flow Totalizer | Instrument Panel: Cumulative Total Bed Volumes | Instrument Panel: Head Loss (psi) Vessel A | Instrument Panel: Head Loss (psi) Vessel B | Instrument Panel: System Pressure (psig) Influent | Instrument Panel: System Pressure (psig) Effluent | Instrument Panel: ΔP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| | 03/14/05 | 7.1 | 2066.5 | 266,784 | 16,805 | 17,743 | 122 | 34111 | 28426 | off | off | off | 58 | NA |
| | 03/15/05 | 8.6 | 2075.1 | 266,924 | 16,877 | 17,816 | 145 | 34256 | 28547 | off | off | off | 54 | NA |
| | 03/16/05 | 5.5 | 2080.6 | 267,015 | 16,924 | 17,865 | 96 | 34352 | 28627 | 5.0 | 5.0 | 66 | 56 | 10 |
| 61 | 03/17/05 | 10.5 | 2091.1 | 267,185 | 17,000 | 17,939 | 150 | 34502 | 28752 | 7.0 | 7.0 | 66 | 52 | 14 |
| | 03/18/05 | 3.8 | 2094.9 | 267,247 | 17,040 | 17,987 | 88 | 34590 | 28825 | 3.5 | 3.5 | 59 | 52 | 7 |
| | 03/19/05 | 6.5 | 2101.4 | 267,355 | 17,099 | 18,040 | 112 | 34702 | 28918 | off | off | off | 58 | NA |
| | 03/20/05 | 5.3 | 2106.7 | 267,441 | 17,149 | 18,080 | 90 | 34792 | 28993 | off | off' | off | 56 | NA |
| | 03/21/05 | 3.1 | 2109.8 | 267,493 | 17,184 | 18,095 | 50 | 34842 | 29035 | off | off | off | 56 | NA |
| | 03/22/05 | 4.2 | 2114.0 | 267,561 | 17,232 | 18,121 | 74 | 34916 | 29097 | 10.0 | 12.0 | 76 | 54 | 22 |
| | 03/23/05 | 10.4 | 2124.4 | 267,732 | 17,325 | 18,205 | 177 | 35093 | 29244 | off | off | off | 56 | NA |
| 62 | 03/24/05 | 5.5 | 2129.9 | 267,822 | 17,374 | 18,250 | 94 | 35187 | 29323 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 03/25/05 | 6.0 | 2135.9 | 267,921 | 17,427 | 18,299 | 102 | 35289 | 29408 | off | off | off | 58 | NA |
| | 03/26/05 | 5.2 | 2141.1 | 268,007 | 17,473 | 18,341 | 88 | 35377 | 29481 | 5.0 | 5.0 | 72 | 62 | 10 |
| | 03/27/05 | 4.2 | 2145.3 | 268,075 | 17,511 | 18,375 | 72 | 35449 | 29541 | off | off | off | 58 | NA |
| | 03/28/05 | 6.6 | 2151.9 | 268,184 | 17,571 | 18,428 | 113 | 35562 | 29635 | 6.0 | 6.0 | 66 | 54 | 12 |
| | 03/29/05 | 3.1 | 2155.0 | 268,238 | 17,598 | 18,452 | 51 | 35613 | 29678 | off | off | off | 58.0 | NA |
| | 03/30/05 | 2.0 | 2157.0 | 268,265 | 17,615 | 18,467 | 32 | 35645 | 29704 | 6.0 | 6.0 | 66 | 54 | 12 |
| 63 | 03/31/05 | 9.5 | 2166.5 | 268,420 | 17,703 | 18,540 | 161 | 35806 | 29838 | off | off | off | 58 | NA |
| | 04/01/05 | 5.9 | 2172.4 | 268,516 | 17,760 | 18,582 | 99 | 35905 | 29921 | 9.0 | 9.0 | 72 | 54 | 18 |
| | 04/02/05 | 2.7 | 2175.1 | 268,561 | 17,788 | 18,601 | 47 | 35952 | 29960 | off | off | off | off | NA |
| | 04/03/05 | 0.0 | 2175.1 | 268,561 | 17,788 | 18,601 | 0 | 35952 | 29960 | off | off | off | off | NA |
| | 04/04/05 | 0.0 | 2175.1 | 268,561 | 17,788 | 18,601 | 0 | 35952 | 29960 | off | off | off | off | NA |
| | 04/05/05 | 0.0 | 2175.1 | 268,561 | 17,788 | 18,601 | 0 | 35952 | 29960 | off | off | off | off | NA |
| | 04/06/05 | 7.3 | 2182.4 | 268,607 | 17,813 | 18,628 | 52 | 36004 | 30003 | 3.0 | 3.0 | 62 | 56 | 6 |
| 64 | 04/07/05 | 14.2 | 2196.6 | 268,830 | 17,934 | 18,738 | 231 | 36235 | 30196 | off | off | off | 58 | NA |
| | 04/08/05 | 9.3 | 2205.9 | 268,980 | 18,013 | 18,814 | 155 | 36390 | 30325 | off | off | off | 60 | NA |
| | 04/09/05 | 10.1 | 2216.0 | 269,143 | 18,101 | 18,895 | 169 | 36559 | 30466 | 6.0 | 6.0 | 64 | 52 | 12 |
| | 04/10/05 | 8.8 | 2224.8 | 269,284 | 18,178 | 18,964 | 146 | 36705 | 30588 | off | off | off | 56 | NA |
| | 04/11/05 | 9.7 | 2234.5 | 269,437 | 18,248 | 19,052 | 158 | 36863 | 30719 | off | off | off | 60 | NA |
| | 04/12/05 | 10.0 | 2244.5 | 269,594 | 18,320 | 19,142 | 162 | 37025 | 30854 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 04/13/05 | 8.4 | 2252.9 | 269,731 | 18,376 | 19,227 | 141 | 37166 | 30972 | 6.0 | 6.0 | 66 | 54 | 12 |
| 65 | 04/14/05 | 11.3 | 2264.2 | 269,909 | 18,471 | 19,316 | 184 | 37350 | 31125 | off | off | off | 56 | NA |
| | 04/15/05 | 12.9 | 2277.1 | 270,114 | 18,586 | 19,413 | 212 | 37562 | 31302 | off | off | off | 54 | NA |
| | 04/16/05 | 10.0 | 2287.1 | 270,280 | 18,666 | 19,491 | 158 | 37720 | 31433 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 04/17/05 | 11.4 | 2298.5 | 270,451 | 18,755 | 19,592 | 190 | 37910 | 31592 | off | off | off | 55 | NA |
| | 04/18/05 | 10.6 | 2309.1 | 270,619 | 18,831 | 19,689 | 173 | 38083 | 31736 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 04/19/05 | 10.4 | 2319.5 | 270,784 | 18,904 | 19,785 | 169 | 38252 | 31877 | off | off | off | 56 | NA |
| | 04/20/05 | 12.0 | 2331.5 | 270,972 | 19,008 | 19,875 | 194 | 38446 | 32038 | 4.0 | 4.0 | 66 | 58 | 8 |
| 66 | 04/21/05 | 10.5 | 2342.0 | 271,137 | 19,111 | 19,943 | 171 | 38617 | 32181 | off | off | off | 54 | NA |
| | 04/22/05 | 7.2 | 2349.2 | 271,253 | 19,170 | 20,041 | 157 | 38774 | 32312 | off | off | off | 60 | NA |
| | 04/23/05 | 7.5 | 2356.7 | 271,374 | 19,232 | 20,066 | 87 | 38861 | 32384 | off | off | off | 54 | NA |
| | 04/24/05 | 9.8 | 2366.5 | 271,528 | 19,313 | 20,144 | 159 | 39020 | 32517 | 8.0 | 8.0 | 76 | 60 | 16 |
| | 04/25/05 | 5.0 | 2371.5 | 271,617 | 19,358 | 20,190 | 91 | 39111 | 32593 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 04/26/05 | 10.6 | 2382.1 | 271,780 | 19,447 | 20,270 | 169 | 39280 | 32733 | off | off | off | 56 | NA |
| | 04/27/05 | 7.6 | 2389.7 | 271,893 | 19,510 | 20,323 | 116 | 39396 | 32830 | 4.0 | 4.0 | 66 | 58 | 8 |
| 67 | 04/28/05 | 11.5 | 2401.2 | 272,077 | 19,605 | 20,418 | 190 | 39,586 | 32988 | off | off | off | 56 | NA |
| | 04/29/05 | 7.9 | 2409.1 | 272,204 | 19,671 | 20,483 | 131 | 39,717 | 33098 | off | off | off | 56 | NA |
| | 04/30/05 | 6.6 | 2415.7 | 272,311 | 19,722 | 20,541 | 109 | 39,826 | 33188 | off | off | off | 58 | NA |
| | 05/01/05 | 8.2 | 2423.9 | 272,443 | 19,792 | 20,610 | 139 | 39,965 | 33304 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 05/02/05 | 11.6 | 2435.5 | 272,630 | 19,888 | 20,704 | 190 | 40,155 | 33463 | off | off | off | 60 | NA |
| | 05/03/05 | 6.6 | 2442.1 | 272,735 | 19,946 | 20,755 | 109 | 40,264 | 33553 | 8.0 | 8.0 | 76 | 60 | 16 |
| | 05/04/05 | 9.2 | 2451.3 | 272,882 | 20,021 | 20,830 | 150 | 40,414 | 33678 | off | off | off | 58 | NA |
| 68 | 05/05/05 | 9.3 | 2460.6 | 273,029 | 20,085 | 20,917 | 151 | 40,565 | 33804 | off | off | off | 54 | NA |
| | 05/06/05 | 8.6 | 2469.2 | 273,161 | 20,142 | 21,001 | 141 | 40,706 | 33922 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 05/07/05 | 7.6 | 2476.8 | 273,288 | 20,203 | 21,065 | 125 | 40,831 | 34026 | 7.0 | 7.0 | 70 | 56 | 14 |
| | 05/08/05 | 13.9 | 2490.7 | 273,512 | 20,321 | 21,178 | 231 | 41,062 | 34218 | 3.0 | 3.0 | 66 | 60 | 6 |
| | 05/09/05 | 8.9 | 2499.6 | 273,666 | 20,402 | 21,254 | 157 | 41,219 | 34349 | 3.0 | 3.0 | 68 | 62 | 6 |
| | 05/10/05 | 11.0 | 2510.6 | 273,830 | 20,487 | 21,338 | 169 | 41,388 | 34490 | off | off | off | 58 | NA |
| | 05/11/05 | 6.8 | 2517.4 | 273,942 | 20,543 | 21,396 | 114 | 41,502 | 34585 | 6.0 | 6.0 | 70 | 58 | 12 |
| 69 | 05/12/05 | 10.2 | 2527.6 | 274,106 | 20,631 | 21,478 | 170 | 41,672 | 34727 | off | off | off | 58 | NA |
| | 05/13/05 | 9.3 | 2536.9 | 274,255 | 20,710 | 21,551 | 152 | 41,824 | 34853 | off | off | off | 56 | NA |
| | 05/14/05 | 6.7 | 2543.6 | 274,361 | 20,768 | 21,603 | 110 | 41,934 | 34945 | off | off | off | 58 | NA |
| | 05/15/05 | 9.1 | 2552.7 | 274,507 | 20,830 | 21,690 | 149 | 42,083 | 35069 | off | off | off | 54 | NA |
| | 05/16/05 | 8.2 | 2560.9 | 274,639 | 20,909 | 21,748 | 137 | 42,220 | 35183 | off | off | off | 54 | NA |
| | 05/17/05 | 14.6 | 2575.5 | 274,874 | 21,032 | 21,865 | 240 | 42,460 | 35383 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 05/18/05 | 10.2 | 2585.7 | 275,039 | 21,120 | 21,948 | 171 | 42,631 | 35526 | off | off | off | 56 | NA |
| 70 | 05/19/05 | 9.4 | 2595.1 | 275,188 | 21,199 | 22,021 | 152 | 42,783 | 35653 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 05/20/05 | 13.1 | 2608.2 | 275,398 | 21,317 | 22,120 | 217 | 43,000 | 35833 | 5.0 | 5.0 | 62 | 52 | 10 |
| | 05/21/05 | 11.1 | 2619.3 | 275,572 | 21,419 | 22,199 | 181 | 43,181 | 35984 | off | off | off | 58 | NA |
| | 05/22/05 | 9.0 | 2628.3 | 275,715 | 21,504 | 22,265 | 151 | 43,332 | 36110 | 6.0 | 6.0 | 68 | 56 | 12 |

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House | | | | | Instrument Panel | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 71 | 05/23/05 | 15.4 | 2643.7 | 275,956 | 21,649 | 22,369 | 249 | 43,581 | 36318 | 10.0 | 10.0 | 80 | 60 | 20 |
| | 05/24/05 | 13.4 | 2657.1 | 276,169 | 21,764 | 22,472 | 218 | 43,799 | 36499 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 05/25/05 | 12.4 | 2669.5 | 276,368 | 21,869 | 22,571 | 204 | 44,003 | 36669 | 4.0 | 4.0 | 60 | 54 | 6 |
| | 05/26/05 | 12.7 | 2682.2 | 276,569 | 21,983 | 22,663 | 206 | 44,209 | 36841 | off | off | off | 56 | NA |
| | 05/27/05 | 9.1 | 2691.3 | 276,706 | 22,063 | 22,733 | 150 | 44,359 | 36966 | off | off | off | 54 | NA |
| | 05/28/05 | 6.7 | 2698.0 | 276,789 | 22,102 | 22,771 | 77 | 44,436 | 37030 | 5.0 | 5.0 | 62 | 52 | 10 |
| | 05/29/05 | 5.7 | 2703.7 | 276,881 | 22,150 | 22,817 | 94 | 44,530 | 37108 | 6.0 | 6.0 | 66 | 54 | 12 |
| 72 | 05/30/05 | 6.0 | 2709.7 | 276,978 | 22,201 | 22,865 | 99 | 44,629 | 37191 | off | off | off | 54 | NA |
| | 05/31/05 | 11.3 | 2721.0 | 277,160 | 22,297 | 22,956 | 187 | 44,816 | 37347 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 06/01/05 | 9.3 | 2730.3 | 277,309 | 22,377 | 23,028 | 152 | 44,968 | 37473 | off | off | off | 56 | NA |
| | 06/02/05 | 13.7 | 2744.0 | 277,527 | 22,495 | 23,133 | 223 | 45,191 | 37659 | off | off | off | 58 | NA |
| | 06/03/05 | 19.0 | 2763.0 | 277,653 | 22,565 | 23,192 | 129 | 45,320 | 37767 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 06/04/05 | 10.8 | 2773.8 | 277,826 | 22,656 | 23,279 | 178 | 45,498 | 37915 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 06/05/05 | 22.9 | 2796.7 | 277,946 | 22,719 | 23,339 | 123 | 45,621 | 38018 | 4.0 | 4.0 | 62 | 54 | 8 |
| 73 | 06/06/05 | 17.1 | 2813.8 | 278,188 | 22,847 | 23,458 | 247 | 45,868 | 38223 | 7.0 | 7.0 | 70 | 56 | 14 |
| | 06/07/05 | 8.9 | 2822.7 | 278,324 | 22,923 | 23,527 | 145 | 46,013 | 38344 | 10.0 | 10.0 | 74 | 54 | 20 |
| | 06/08/05 | 12.1 | 2834.8 | 278,523 | 23,024 | 23,624 | 198 | 46,211 | 38509 | off | off | off | 58 | NA |
| | 06/09/05 | 14.0 | 2848.8 | 278,745 | 23,143 | 23,734 | 229 | 46,440 | 38700 | off | off | off | 56 | NA |
| | 06/10/05 | 10.4 | 2859.2 | 278,907 | 23,231 | 23,812 | 166 | 46,606 | 38838 | 10.0 | 10.0 | 76 | 66 | 10 |
| | 06/11/05 | 11.3 | 2870.5 | 279,087 | 23,326 | 23,902 | 185 | 46,791 | 38993 | off | off | off | 54 | NA |
| | 06/12/05 | 10.1 | 2880.6 | 279,249 | 23,412 | 23,982 | 166 | 46,957 | 39131 | 5.0 | 5.0 | 64 | 54 | 10 |
| 74 | 06/13/05 | 10.1 | 2890.7 | 279,409 | 23,502 | 24,057 | 165 | 47,122 | 39268 | 6.0 | 6.0 | 66 | 54 | 12 |
| | 06/14/05 | 13.7 | 2904.4 | 279,620 | 23,629 | 24,147 | 217 | 47,339 | 39449 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 06/15/05 | 11.7 | 2916.1 | 279,808 | 23,727 | 24,241 | 192 | 47,531 | 39609 | off | off | off | 56 | NA |
| | 06/16/05 | 13.7 | 2929.8 | 280,026 | 23,842 | 24,350 | 224 | 47,755 | 39796 | 5.0 | 5.0 | 64 | 54 | NA |
| | 06/17/05 | 13.3 | 2943.1 | 280,235 | 23,953 | 24,454 | 215 | 47,970 | 39975 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 06/18/05 | 12.5 | 2955.6 | 280,432 | 24,058 | 24,551 | 202 | 48,172 | 40143 | off | off | off | 58 | NA |
| | 06/19/05 | 9.4 | 2965.0 | 280,581 | 24,137 | 24,624 | 152 | 48,324 | 40270 | 6.0 | 6.0 | 66 | 54 | 12 |
| 75 | 06/20/05 | 11.3 | 2976.3 | 280,759 | 24,242 | 24,701 | 182 | 48,506 | 40422 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 06/21/05 | 9.6 | 2985.9 | 280,912 | 24,327 | 24,775 | 159 | 48,665 | 40554 | off | off | off | 54 | NA |
| | 06/22/05 | 7.9 | 2993.8 | 281,038 | 24,394 | 24,837 | 129 | 48,794 | 40662 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 06/23/05 | 15.0 | 3008.8 | 281,273 | 24,523 | 24,949 | 241 | 49,035 | 40863 | off | off | off | 60 | NA |
| | 06/24/05 | 9.5 | 3018.3 | 281,424 | 24,604 | 25,027 | 159 | 49,194 | 40995 | 3.0 | 3.0 | 66 | 60 | 6 |
| | 06/25/05 | 10.7 | 3029.0 | 281,593 | 24,701 | 25,100 | 170 | 49,364 | 41137 | 10.0 | 10.0 | 80 | 60 | 20 |
| | 06/26/05 | 10.2 | 3039.2 | 281,753 | 24,797 | 25,168 | 164 | 49,528 | 41273 | off | off | off | 60 | NA |
| 76 | 06/27/05 | 11.3 | 3050.5 | 281,931 | 24,893 | 25,255 | 183 | 49,711 | 41426 | 5.0 | 5.0 | 70 | 60 | 10 |
| | 06/28/05 | 12.1 | 3062.6 | 282,122 | 24,994 | 25,350 | 196 | 49,907 | 41589 | off | off | off | 58 | NA |
| | 06/29/05 | 13.2 | 3075.8 | 282,327 | 25,117 | 25,439 | 212 | 50,119 | 41766 | 10.0 | 10.0 | 74 | 54 | 20 |
| | 06/30/05 | 14.3 | 3090.1 | 282,548 | 25,237 | 25,544 | 225 | 50,344 | 41953 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 07/01/05 | 20.4 | 3110.5 | 282,859 | 25,410 | 25,689 | 318 | 50,662 | 42218 | off | off | off | 60 | NA |
| | 07/02/05 | 10.2 | 3120.7 | 283,015 | 25,507 | 25,754 | 162 | 50,824 | 42353 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 07/03/05 | 11.3 | 3132.0 | 283,191 | 25,602 | 25,838 | 179 | 51,003 | 42503 | off | off | off | 58 | NA |
| 77 | 07/04/05 | 12.5 | 3144.5 | 283,383 | 25,708 | 25,929 | 197 | 51,200 | 42667 | 10.0 | 10.0 | 74 | 54 | 20 |
| | 07/05/05 | 16.0 | 3160.5 | 283,626 | 25,839 | 26,047 | 249 | 51,449 | 42874 | off | off | off | 58 | NA |
| | 07/06/05 | 10.0 | 3170.5 | 283,783 | 25,922 | 26,123 | 159 | 51,608 | 43007 | 6.0 | 6.0 | 66 | 54 | 12 |
| | 07/07/05 | 10.7 | 3181.2 | 283,947 | 26,013 | 26,200 | 168 | 51,776 | 43147 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 07/08/05 | 12.0 | 3193.2 | 284,126 | 26,112 | 26,285 | 184 | 51,960 | 43300 | 4.0 | 4.0 | 64 | 58 | 6 |
| | 07/09/05 | 9.5 | 3202.7 | 284,253 | 26,183 | 26,344 | 130 | 52,090 | 43408 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 07/10/05 | 10.5 | 3213.2 | 284,407 | 26,260 | 26,427 | 160 | 52,250 | 43542 | off | off | off | 60 | NA |
| 78 | 07/11/05 | 5.7 | 3218.9 | 284,496 | 26,306 | 26,478 | 97 | 52,347 | 43623 | 25.0 | 25.0 | 110 | 60 | 50 |
| | 07/12/05 | 6.5 | 3225.4 | 284,596 | 26,364 | 26,516 | 96 | 52,443 | 43703 | 15.0 | 15.0 | 80 | 50 | 30 |
| | 07/13/05 | 7.1 | 3232.5 | 284,710 | 26,424 | 26,574 | 118 | 52,561 | 43801 | 14.0 | 14.0 | 86 | 58 | 28 |
| | 07/14/05 | 5.1 | 3237.6 | 284,793 | 26,466 | 26,616 | 84 | 52,645 | 43871 | off | off | off | off | NA |
| | 07/15/05 | *System was switched off from 07/14/05 through 07/28/05. The bottom laterals, under bedding, and media were replaced and other system repairs were performed during the down time.* | | | | | | | | | | | | |
| | 07/16/05 | | | | | | | | | | | | | |
| | 07/17/05 | | | | | | | | | | | | | |
| 79 | 07/18/05 | | | | | | | | | | | | | |
| | 07/19/05 | | | | | | | | | | | | | |
| | 07/20/05 | | | | | | | | | | | | | |
| | 07/21/05 | | | | | | | | | | | | | |
| | 07/22/05 | | | | | | | | | | | | | |
| | 07/23/05 | | | | | | | | | | | | | |
| | 07/24/05 | | | | | | | | | | | | | |
| 80 | 07/25/05 | | | | | | | | | | | | | |
| | 07/26/05 | | | | | | | | | | | | | |
| | 07/27/05 | | | | | | | | | | | | | |
| | 07/28/05 | | | | | | | | | | | | | |
| | 07/29/05 | NA | NA | 285,730 | 26,488 | 26,638 | NA | NA | NA | 3.0 | 3.0 | 60 | 54 | 6 |
| | 07/30/05 | 10.8 | 10.8 | 285,903 | 26,576 | 26,724 | 174 | 174 | 188 | off | off | off | 58 | NA |
| | 07/31/05 | 7.1 | 17.9 | 286,014 | 26,632 | 26,782 | 114 | 288 | 310 | 6.0 | 6.0 | 64 | 52 | 12 |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House | | | | | Instrument Panel | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| | 08/01/05 | 8.1 | 26.0 | 286,141 | 26,698 | 26,846 | 130 | 418 | 450 | 9.0 | 9.0 | 70 | 52 | 18 |
| | 08/02/05 | 7.7 | 33.7 | 286,261 | 26,760 | 26,906 | 122 | 540 | 582 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 08/03/05 | 12.4 | 46.1 | 286,456 | 26,860 | 27,006 | 200 | 740 | 797 | 3.0 | 3.0 | 62 | 56 | 6 |
| 81 | 08/04/05 | 11.8 | 57.9 | 286,642 | 26,952 | 27,106 | 192 | 932 | 1004 | off | off | off | 58 | NA |
| | 08/05/05 | 6.2 | 64.1 | 286,742 | 26,997 | 27,161 | 100 | 1,032 | 1112 | 9.0 | 9.0 | 78 | 60 | 18 |
| | 08/06/05 | 8.4 | 72.5 | 286,875 | 27,068 | 27,229 | 139 | 1,171 | 1262 | off | off | off | 58 | NA |
| | 08/07/05 | 9.1 | 81.6 | 287,021 | 27,142 | 27,305 | 150 | 1,321 | 1423 | 3.0 | 3.0 | 66 | 60 | 6 |
| | 08/08/05 | 10.9 | 92.5 | 287,194 | 27,229 | 27,395 | 177 | 1,498 | 1614 | off | off | off | 60 | NA |
| | 08/09/05 | 5.9 | 98.4 | 287,288 | 27,274 | 27,445 | 95 | 1,593 | 1717 | off | off | off | 56 | NA |
| | 08/10/05 | 9.1 | 107.5 | 287,433 | 27,349 | 27,532 | 162 | 1,755 | 1891 | 3.5 | 3.5 | 61 | 54 | 7 |
| 82 | 08/11/05 | 13.9 | 121.4 | 287,653 | 27,459 | 27,648 | 226 | 1,981 | 2135 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 08/12/05 | 9.5 | 130.9 | 287,804 | 27,535 | 27,727 | 155 | 2,136 | 2302 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 08/13/05 | 8.9 | 139.8 | 287,936 | 27,603 | 27,794 | 135 | 2,271 | 2447 | off | off | off | 58 | NA |
| | 08/14/05 | 7.7 | 147.5 | 288,058 | 27,662 | 27,868 | 133 | 2,404 | 2591 | off | off | off | 60 | NA |
| | 08/15/05 | 5.4 | 152.9 | 288,145 | 27,705 | 27,906 | 81 | 2,485 | 2678 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 08/16/05 | 5.0 | 157.9 | 288,224 | 27,744 | 27,947 | 80 | 2,565 | 2764 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 08/17/05 | 10.2 | 168.1 | 288,387 | 27,825 | 28,033 | 167 | 2,732 | 2944 | 9.0 | 9.8 | 74 | 56 | 18 |
| 83 | 08/18/05 | 14.1 | 182.2 | 288,609 | 27,936 | 28,147 | 225 | 2,957 | 3186 | 2.0 | 2.0 | 62 | 58 | 4 |
| | 08/19/05 | 6.7 | 188.9 | 288,717 | 27,990 | 28,201 | 108 | 3,065 | 3303 | off | off | off | 58 | NA |
| | 08/20/05 | 6.9 | 195.8 | 288,826 | 28,043 | 28,260 | 112 | 3,177 | 3423 | off | off | off | 60 | NA |
| | 08/21/05 | 9.6 | 205.4 | 288,981 | 28,121 | 28,340 | 158 | 3,335 | 3594 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 08/22/05 | 8.7 | 214.1 | 289,117 | 28,192 | 28,406 | 137 | 3,472 | 3741 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 08/23/05 | 8.1 | 222.2 | 289,245 | 28,259 | 28,470 | 131 | 3,603 | 3883 | off | off | off | 60 | NA |
| | 08/24/05 | 8.2 | 230.4 | 289,374 | 28,323 | 28,537 | 131 | 3,734 | 4024 | 7.0 | 7.0 | 70 | 56 | 14 |
| 84 | 08/25/05 | 9.2 | 239.6 | 289,517 | 28,393 | 28,612 | 145 | 3,879 | 4180 | off | off | off | 54 | NA |
| | 08/26/05 | 9.6 | 249.2 | 289,668 | 28,468 | 28,690 | 153 | 4,032 | 4345 | 8.0 | 8.0 | 74 | 58 | 16 |
| | 08/27/05 | 13.1 | 262.3 | 289,872 | 28,569 | 28,795 | 206 | 4,238 | 4567 | off | off | off | 56 | NA |
| | 08/28/05 | 9.7 | 272.0 | 290,024 | 28,645 | 28,874 | 155 | 4,393 | 4734 | off | off | off | 58 | NA |
| | 08/29/05 | 9.5 | 281.5 | 290,174 | 28,718 | 28,953 | 152 | 4,545 | 4898 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 08/30/05 | 5.0 | 286.5 | 290,252 | 28,756 | 28,994 | 79 | 4,624 | 4983 | 9.0 | 9.0 | 62 | 54 | 8 |
| | 08/31/05 | 8.4 | 294.9 | 290,385 | 28,823 | 29,062 | 135 | 4,759 | 5128 | 2.0 | 2.0 | 60 | 50 | 10 |
| 85 | 09/01/05 | 10.2 | 305.1 | 290,549 | 28,905 | 29,146 | 166 | 4,925 | 5307 | off | off | off | off | NA |
| | 09/02/05 | 7.9 | 313.0 | 290,674 | 28,966 | 29,211 | 126 | 5,051 | 5443 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 09/03/05 | 7.2 | 320.2 | 290,781 | 29,021 | 29,265 | 109 | 5,160 | 5560 | off | off | off | 54 | NA |
| | 09/04/05 | 9.0 | 329.2 | 290,922 | 29,091 | 29,336 | 141 | 5,301 | 5712 | off | off | off | 58 | NA |
| | 09/05/05 | 6.2 | 335.4 | 291,019 | 29,139 | 29,388 | 100 | 5,401 | 5820 | 6.0 | 6.0 | 76 | 64 | 12 |
| | 09/06/05 | 7.8 | 343.2 | 291,142 | 29,199 | 29,452 | 124 | 5,525 | 5954 | off | off | off | 58 | NA |
| | 09/07/05 | 8.0 | 351.2 | 291,266 | 29,261 | 29,515 | 125 | 5,650 | 6088 | 8.0 | 8.0 | 70 | 54 | 16 |
| 86 | 09/08/05 | 7.3 | 358.5 | 291,383 | 29,323 | 29,572 | 119 | 5,769 | 6217 | 2.0 | 2.0 | 60 | 56 | 4 |
| | 09/09/05 | 9.0 | 367.5 | 291,527 | 29,394 | 29,648 | 147 | 5,916 | 6375 | off | off | off | 58 | NA |
| | 09/10/05 | 6.9 | 374.4 | 291,638 | 29,447 | 29,707 | 112 | 6,028 | 6496 | off | off | off | 58 | NA |
| | 09/11/05 | 6.2 | 380.6 | 291,735 | 29,493 | 29,759 | 98 | 6,126 | 6601 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 09/12/05 | 5.5 | 386.1 | 291,824 | 29,537 | 29,805 | 90 | 6,216 | 6698 | 7.0 | 7.0 | 68 | 54 | 14 |
| | 09/13/05 | 5.5 | 391.6 | 291,911 | 29,580 | 29,850 | 88 | 6,304 | 6793 | 8.0 | 8.0 | 70 | 54 | 16 |
| | 09/14/05 | 8.0 | 399.6 | 292,037 | 29,643 | 29,915 | 128 | 6,432 | 6931 | 8.0 | 8.0 | 72 | 56 | 16 |
| 87 | 09/15/05 | 7.7 | 407.3 | 292,159 | 29,704 | 29,978 | 124 | 6,556 | 7065 | 9.0 | 9.0 | 72 | 54 | 18 |
| | 09/16/05 | 9.6 | 416.9 | 292,314 | 29,781 | 30,058 | 157 | 6,713 | 7234 | off | off | off | 58 | NA |
| | 09/17/05 | 8.2 | 425.1 | 292,444 | 29,846 | 30,125 | 132 | 6,845 | 7376 | off | off | off | 60 | NA |
| | 09/18/05 | 8.8 | 433.9 | 292,583 | 29,917 | 30,195 | 141 | 6,986 | 7528 | 6.0 | 6.0 | 72 | 60 | 12 |
| | 09/19/05 | 8.6 | 442.5 | 292,723 | 29,990 | 30,264 | 142 | 7,128 | 7681 | off | off | off | 58 | NA |
| | 09/20/05 | 9.3 | 451.8 | 292,869 | 30,065 | 30,332 | 143 | 7,271 | 7835 | 8.0 | 8.0 | 70 | 54 | 16 |
| | 09/21/05 | 9.6 | 461.4 | 293,014 | 30,154 | 30,410 | 167 | 7,438 | 8015 | 4.0 | 4.0 | 70 | 61 | 9 |
| 88 | 09/22/05 | 9.6 | 471.0 | 293,168 | 30,244 | 30,475 | 155 | 7,593 | 8182 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 09/23/05 | 9.7 | 480.7 | 293,319 | 30,335 | 30,538 | 154 | 7,747 | 8348 | off | off | off | 58 | NA |
| | 09/24/05 | 9.1 | 489.8 | 293,461 | 30,407 | 30,618 | 152 | 7,899 | 8512 | off | off | off | 56 | NA |
| | 09/25/05 | 9.9 | 499.7 | 293,618 | 30,498 | 30,679 | 152 | 8,051 | 8676 | off | off | off | 60 | NA |
| | 09/26/05 | 11.0 | 510.7 | 293,793 | 30,579 | 30,775 | 177 | 8,228 | 8866 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 09/27/05 | 10.9 | 521.6 | 293,964 | 30,657 | 30,870 | 173 | 8,401 | 9053 | off | off | off | 58 | NA |
| | 09/28/05 | 7.8 | 529.4 | 294,087 | 30,714 | 30,938 | 125 | 8,526 | 9188 | 9.0 | 9.0 | 72 | 54 | 18 |
| 89 | 09/29/05 | 11.1 | 540.5 | 294,263 | 30,800 | 31,030 | 178 | 8,704 | 9379 | 2.0 | 2.0 | 58 | 54 | 4 |
| | 09/30/05 | 7.4 | 547.9 | 294,381 | 30,859 | 31,091 | 120 | 8,824 | 9509 | off | off | off | 58 | NA |
| | 10/01/05 | 7.5 | 555.4 | 294,500 | 30,918 | 31,152 | 120 | 8,944 | 9638 | off | off | off | 56 | NA |
| | 10/02/05 | 9.3 | 564.7 | 294,645 | 30,988 | 31,238 | 156 | 9,100 | 9806 | 9.0 | 9.0 | 76 | 58 | 18 |
| | 10/03/05 | 9.3 | 574.0 | 294,793 | 31,053 | 31,314 | 141 | 9,241 | 9958 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 10/04/05 | 7.7 | 581.7 | 294,916 | 31,114 | 31,378 | 125 | 9,366 | 10093 | 6.0 | 5.0 | 65 | 54 | 11 |
| | 10/05/05 | 5.3 | 587.0 | 294,983 | 31,149 | 31,411 | 68 | 9,434 | 10166 | 3.0 | 3.0 | 62 | 56 | 6 |
| 90 | 10/06/05 | 10.2 | 597.2 | 295,151 | 31,233 | 31,498 | 171 | 9,605 | 10350 | off | off | off | 58 | NA |
| | 10/07/05 | 6.3 | 603.5 | 295,252 | 31,282 | 31,551 | 102 | 9,707 | 10460 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 10/08/05 | 8.6 | 612.1 | 295,388 | 31,346 | 31,624 | 137 | 9,844 | 10608 | off | off | off | 58 | NA |
| | 10/09/05 | 7.7 | 619.8 | 295,510 | 31,420 | 31,676 | 126 | 9,970 | 10744 | 3.0 | 3.0 | 62 | 56 | 6 |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| | | Pump House | | | | | | Instrument Panel | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week No. | Date | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 91 | 10/10/05 | 8.2 | 628.0 | 295,572 | 31,449 | 31,708 | 61 | 10,031 | 10809 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 10/11/05 | 5.3 | 633.3 | 295,657 | 31,490 | 31,754 | 87 | 10,118 | 10903 | off | off | off | 58 | NA |
| | 10/12/05 | 6.9 | 640.2 | 295,767 | 31,541 | 31,814 | 111 | 10,229 | 11023 | 9.0 | 9.0 | 76 | 58 | 18 |
| | 10/13/05 | 8.1 | 648.3 | 295,898 | 31,605 | 31,882 | 132 | 10,361 | 11165 | 2.0 | 2.0 | 58 | 54 | 4 |
| | 10/14/05 | 6.0 | 654.3 | 295,994 | 31,654 | 31,931 | 98 | 10,459 | 11270 | off | off | off | 58 | NA |
| | 10/15/05 | 5.3 | 659.6 | 296,079 | 31,697 | 31,973 | 85 | 10,544 | 11362 | off | off | off | 56 | NA |
| | 10/16/05 | 5.7 | 665.3 | 296,178 | 31,742 | 32,020 | 92 | 10,636 | 11461 | off | off | off | 54 | NA |
| 92 | 10/17/05 | 5.5 | 670.8 | 296,257 | 31,784 | 32,065 | 87 | 10,723 | 11555 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 10/18/05 | 6.2 | 677.0 | 296,357 | 31,835 | 32,117 | 103 | 10,826 | 11666 | 2.0 | 2.0 | 58 | 54 | 4 |
| | 10/19/05 | 6.9 | 683.9 | 296,468 | 31,891 | 32,173 | 112 | 10,938 | 11787 | off | off | off | 60 | NA |
| | 10/20/05 | 4.4 | 688.3 | 296,538 | 31,937 | 32,215 | 88 | 11,026 | 11881 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 10/21/05 | 6.2 | 694.5 | 296,638 | 31,978 | 32,259 | 85 | 11,111 | 11973 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 10/22/05 | 8.7 | 703.2 | 296,778 | 32,064 | 32,325 | 152 | 11,263 | 12137 | off | off | off | 56 | NA |
| | 10/23/05 | 6.3 | 709.5 | 296,878 | 32,109 | 32,372 | 92 | 11,355 | 12236 | 9.0 | 9.0 | 80 | 62 | 18 |
| 93 | 10/24/05 | 4.4 | 713.9 | 296,947 | 32,145 | 32,405 | 69 | 11,424 | 12310 | 10.0 | 10.0 | 78 | 58 | 20 |
| | 10/25/05 | 9.6 | 723.5 | 297,101 | 32,224 | 32,482 | 156 | 11,580 | 12478 | off | off | off | 58 | NA |
| | 10/26/05 | 6.7 | 730.2 | 297,209 | 32,278 | 32,537 | 109 | 11,689 | 12596 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 10/27/05 | 6.9 | 737.1 | 297,318 | 32,333 | 32,592 | 110 | 11,799 | 12714 | off | off | off | 60 | NA |
| | 10/28/05 | 11.0 | 748.1 | 297,483 | 32,416 | 32,678 | 169 | 11,968 | 12897 | off | off | off | 60 | NA |
| | 10/29/05 | 6.3 | 754.4 | 297,599 | 32,475 | 32,738 | 119 | 12,087 | 13025 | off | off | off | 58 | NA |
| | 10/30/05 | 8.0 | 762.4 | 297,728 | 32,540 | 32,803 | 130 | 12,217 | 13165 | off | off | off | 58 | NA |
| 94 | 10/31/05 | 8.1 | 770.5 | 297,859 | 32,606 | 32,870 | 133 | 12,350 | 13308 | 4.0 | 4.0 | 70 | 62 | 8 |
| | 11/01/05 | 5.4 | 775.9 | 297,937 | 32,645 | 32,910 | 79 | 12,429 | 13393 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 11/02/05 | 4.9 | 780.8 | 298,024 | 32,695 | 32,964 | 104 | 12,533 | 13505 | off | off | off | 56 | NA |
| | 11/03/05 | 6.1 | 786.9 | 298,122 | 32,747 | 33,012 | 100 | 12,633 | 13613 | off | off | off | 56 | NA |
| | 11/04/05 | 5.7 | 792.6 | 298,214 | 32,794 | 33,057 | 92 | 12,725 | 13712 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 11/05/05 | 7.1 | 799.7 | 298,327 | 32,853 | 33,113 | 115 | 12,840 | 13836 | off | off | off | 60 | NA |
| | 11/06/05 | 5.9 | 805.6 | 298,423 | 32,901 | 33,161 | 96 | 12,936 | 13940 | off | off | off | 60 | NA |
| 95 | 11/07/05 | 5.7 | 811.3 | 298,518 | 32,946 | 33,210 | 94 | 13,030 | 14041 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 11/08/05 | 6.5 | 817.8 | 298,616 | 32,996 | 33,262 | 102 | 13,132 | 14151 | off | off | off | 58 | NA |
| | 11/09/05 | 5.6 | 823.4 | 298,707 | 33,035 | 33,315 | 92 | 13,224 | 14250 | 10.0 | 10.0 | 76 | 56 | 20 |
| | 11/10/05 | 7.1 | 830.5 | 298,833 | 33,113 | 33,396 | 159 | 13,383 | 14421 | off | off | off | 58 | Na |
| | 11/11/05 | 9.0 | 839.5 | 298,968 | 33,164 | 33,448 | 103 | 13,486 | 14532 | off | off | off | 58 | NA |
| | 11/12/05 | 6.0 | 845.5 | 299,062 | 33,212 | 33,490 | 90 | 13,576 | 14629 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 11/13/05 | 6.0 | 851.5 | 299,159 | 33,259 | 33,549 | 106 | 13,682 | 14744 | off | off | off | 58 | NA |
| 96 | 11/14/05 | 6.2 | 857.7 | 299,258 | 33,306 | 33,603 | 101 | 13,783 | 14852 | off | off | off | 60 | NA |
| | 11/15/05 | 6.3 | 864.0 | 299,358 | 33,351 | 33,659 | 101 | 13,884 | 14961 | 7.0 | 7.0 | 72 | 58 | 14 |
| | 11/16/05 | 5.5 | 869.5 | 299,445 | 33,388 | 33,709 | 87 | 13,971 | 15055 | 8.0 | 8.0 | 70 | 54 | 16 |
| | 11/17/05 | 7.2 | 876.7 | 299,561 | 33,443 | 33,772 | 118 | 14,089 | 15182 | off | off | off | 58 | NA |
| | 11/18/05 | 7.6 | 884.3 | 299,684 | 33,503 | 33,836 | 124 | 14,213 | 15316 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 11/19/05 | 7.7 | 892.0 | 299,807 | 33,562 | 33,906 | 129 | 14,342 | 15455 | off | off | off | 60 | NA |
| | 11/20/05 | 5.4 | 897.4 | 299,894 | 33,603 | 33,949 | 84 | 14,426 | 15545 | off | off | off | off | NA |
| 97 | 11/21/05 | 6.0 | 903.4 | 299,981 | 33,643 | 33,996 | 87 | 14,513 | 15639 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 11/22/05 | 3.9 | 907.3 | 300,053 | 33,672 | 34,039 | 72 | 14,585 | 15717 | 9.0 | 9.0 | 76 | 58 | 18 |
| | 11/23/05 | 8.4 | 915.7 | 300,188 | 33,740 | 34,110 | 139 | 14,724 | 15866 | off | off | off | 60 | NA |
| | 11/24/05 | 5.3 | 921.0 | 300,275 | 33,783 | 34,154 | 87 | 14,811 | 15960 | off | off | off | 62 | NA |
| | 11/25/05 | 5.3 | 926.3 | 300,371 | 33,826 | 34,197 | 86 | 14,897 | 16053 | off | off | off | 60 | NA |
| | 11/26/05 | 5.6 | 931.9 | 300,450 | 33,870 | 34,244 | 91 | 14,988 | 16151 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 11/27/05 | 5.4 | 937.3 | 300,543 | 33,911 | 34,290 | 87 | 15,075 | 16245 | off | off | off | 60 | NA |
| 98 | 11/28/05 | 5.2 | 942.5 | 300,619 | 33,949 | 34,335 | 83 | 15,158 | 16334 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 11/29/05 | 5.4 | 947.9 | 300,704 | 33,986 | 34,384 | 86 | 15,244 | 16427 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 11/30/05 | 3.2 | 951.1 | 300,757 | 34,008 | 34,421 | 59 | 15,303 | 16490 | 3.0 | 3.0 | 64 | 58 | 6 |
| | 12/01/05 | 6.3 | 957.4 | 300,860 | 34,060 | 34,473 | 104 | 15,407 | 16602 | off | off | off | 60 | NA |
| | 12/02/05 | 5.4 | 962.8 | 300,945 | 34,103 | 34,516 | 86 | 15,493 | 16695 | off | off | off | 58 | NA |
| | 12/03/05 | 17.5 | 980.3 | 301,008 | 34,134 | 34,548 | 63 | 15,556 | 16763 | off | off | off | 58 | NA |
| | 12/04/05 | 11.1 | 991.4 | 301,084 | 34,169 | 34,590 | 77 | 15,633 | 16846 | off | off | off | 60 | NA |
| 99 | 12/05/05 | 7.8 | 999.2 | 301,177 | 34,211 | 34,642 | 94 | 15,727 | 16947 | off | off | off | 58 | NA |
| | 12/06/05 | 5.1 | 1004.3 | 301,259 | 34,250 | 34,685 | 82 | 15,809 | 17036 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 12/07/05 | 6.7 | 1011.0 | 301,367 | 34,296 | 34,748 | 109 | 15,918 | 17153 | 7.0 | 7.0 | 70 | 56 | 14 |
| | 12/08/05 | 7.0 | 1018.0 | 301,477 | 34,338 | 34,817 | 111 | 16,029 | 17273 | 10.0 | 10.0 | 78 | 58 | 20 |
| | 12/09/05 | 6.9 | 1024.9 | 301,585 | 34,378 | 34,886 | 109 | 16,138 | 17390 | 11.0 | 11.0 | 78 | 56 | 22 |
| | 12/10/05 | 8.6 | 1033.5 | 301,724 | 34,447 | 34,957 | 140 | 16,278 | 17541 | off | off | off | 60 | NA |
| | 12/11/05 | 5.7 | 1039.2 | 301,816 | 34,493 | 35,003 | 92 | 16,370 | 17640 | off | off | off | 60 | NA |
| 100 | 12/12/05 | 5.8 | 1045.0 | 301,909 | 34,539 | 35,051 | 94 | 16,464 | 17741 | off | off | off | 58 | NA |
| | 12/13/05 | 5.3 | 1050.3 | 302,003 | 34,585 | 35,099 | 94 | 16,558 | 17843 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 12/14/05 | 3.5 | 1053.8 | 302,051 | 34,616 | 35,132 | 64 | 16,622 | 17912 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 12/15/05 | 6.9 | 1060.7 | 302,162 | 34,675 | 35,184 | 111 | 16,733 | 18031 | off | off | off | 56 | NA |
| | 12/16/05 | 7.4 | 1068.1 | 302,281 | 34,737 | 35,241 | 119 | 16,852 | 18159 | off | off | off | 58 | NA |
| | 12/17/05 | 5.3 | 1073.4 | 302,365 | 34,780 | 35,283 | 85 | 16,937 | 18251 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 12/18/05 | 5.7 | 1079.1 | 302,456 | 34,823 | 35,331 | 91 | 17,028 | 18349 | off | off | off | 56 | NA |

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| | | Pump House | | | | | | | Instrument Panel | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week No. | Date | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| | 12/19/05 | 8.2 | 1087.3 | 302,587 | 34,885 | 35,401 | 132 | 17,160 | 18491 | off | off | off | 60 | NA |
| | 12/20/05 | 4.9 | 1092.2 | 302,665 | 34,923 | 35,441 | 78 | 17,238 | 18575 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 12/21/05 | 7.2 | 1099.4 | 302,780 | 34,978 | 35,502 | 116 | 17,354 | 18700 | off | off | off | 56 | NA |
| 101 | 12/22/05 | 5.7 | 1105.1 | 302,871 | 35,019 | 35,553 | 92 | 17,446 | 18800 | off | off | off | 58 | NA |
| | 12/23/05 | 5.2 | 1110.3 | 302,958 | 35,056 | 35,603 | 87 | 17,533 | 18893 | 6.0 | 6.0 | 60 | 58 | 2 |
| | 12/24/05 | 5.8 | 1116.1 | 303,043 | 35,092 | 35,652 | 85 | 17,618 | 18985 | 7.0 | 7.0 | 72 | 58 | 14 |
| | 12/25/05 | 5.5 | 1121.6 | 303,131 | 35,131 | 35,702 | 89 | 17,707 | 19081 | off | off | off | 60 | NA |
| | 12/26/05 | 5.0 | 1126.6 | 303,211 | 35,169 | 35,745 | 81 | 17,788 | 19168 | off | off | off | 58 | NA |
| | 12/27/05 | 5.7 | 1132.3 | 303,302 | 35,211 | 35,795 | 92 | 17,880 | 19267 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 12/28/05 | 5.2 | 1137.5 | 303,386 | 35,249 | 35,840 | 83 | 17,963 | 19357 | off | off | off | 56 | NA |
| 102 | 12/29/05 | 5.7 | 1143.2 | 303,475 | 35,286 | 35,894 | 91 | 18,054 | 19455 | 7.0 | 7.0 | 72 | 58 | 14 |
| | 12/30/05 | 5.9 | 1149.1 | 303,570 | 35,335 | 35,942 | 97 | 18,151 | 19559 | off | off | off | 56 | NA |
| | 12/31/05 | 7.7 | 1156.8 | 303,694 | 35,397 | 36,004 | 124 | 18,275 | 19693 | off | off | off | 60 | NA |
| | 01/01/06 | 5.6 | 1162.4 | 303,783 | 35,441 | 36,050 | 90 | 18,365 | 19790 | off | off | off | 58 | NA |
| | 01/02/06 | 5.0 | 1167.4 | 303,862 | 35,480 | 36,090 | 79 | 18,444 | 19875 | off | off | off | 60 | NA |
| | 01/03/06 | 5.8 | 1173.2 | 303,954 | 35,525 | 36,137 | 92 | 18,536 | 19974 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 01/04/06 | 4.1 | 1177.3 | 304,018 | 35,558 | 36,169 | 65 | 18,601 | 20044 | 7.0 | 7.0 | 70 | 56 | 14 |
| 103 | 01/05/06 | 8.0 | 1185.3 | 304,148 | 35,623 | 36,236 | 132 | 18,733 | 20186 | off | off | off | 56 | NA |
| | 01/06/06 | 5.3 | 1190.6 | 304,233 | 35,664 | 36,280 | 85 | 18,818 | 20278 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 01/07/06 | 5.4 | 1196.0 | 304,319 | 35,704 | 36,325 | 85 | 18,903 | 20370 | off | off | off | 56 | NA |
| | 01/08/06 | 5.6 | 1201.6 | 304,408 | 35,748 | 36,372 | 91 | 18,994 | 20468 | off | off | off | 56 | NA |
| | 01/09/06 | 6.2 | 1207.8 | 304,507 | 35,793 | 36,426 | 99 | 19,093 | 20574 | off | off | off | 56 | NA |
| | 01/10/06 | 5.8 | 1213.6 | 304,598 | 35,832 | 36,480 | 93 | 19,186 | 20675 | off | off | off | 56 | NA |
| | 01/11/06 | 5.9 | 1219.5 | 304,693 | 35,865 | 36,542 | 95 | 19,281 | 20777 | off | off | off | 58 | NA |
| 104 | 01/12/06 | 5.9 | 1225.4 | 304,787 | 35,915 | 36,586 | 94 | 19,375 | 20878 | off | off | off | 58 | NA |
| | 01/13/06 | 5.7 | 1231.1 | 304,878 | 35,962 | 36,632 | 93 | 19,468 | 20978 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 01/14/06 | 5.3 | 1236.4 | 304,963 | 36,005 | 36,674 | 85 | 19,553 | 21070 | off | off | off | 56 | NA |
| | 01/15/06 | 5.8 | 1242.2 | 305,055 | 36,053 | 36,719 | 93 | 19,646 | 21170 | off | off | off | 58 | NA |
| | 01/16/06 | 5.2 | 1247.4 | 305,141 | 36,099 | 36,760 | 87 | 19,733 | 21264 | 5.0 | 7.0 | 68 | 56 | 12 |
| | 01/17/06 | 4.2 | 1251.6 | 305,206 | 36,133 | 36,790 | 64 | 19,797 | 21333 | off | off | off | 56 | NA |
| | 01/18/06 | 9.5 | 1261.1 | 305,354 | 36,217 | 36,856 | 150 | 19,947 | 21495 | off | off | off | 58 | NA |
| 105 | 01/19/06 | 4.3 | 1265.4 | 305,424 | 36,249 | 36,895 | 71 | 20,018 | 21571 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 01/20/06 | 3.7 | 1269.1 | 305,483 | 36,277 | 36,926 | 59 | 20,077 | 21635 | off | off | off | 56 | NA |
| | 01/21/06 | 4.6 | 1273.7 | 305,557 | 36,313 | 36,964 | 74 | 20,151 | 21714 | off | off | off | 58 | NA |
| | 01/22/06 | 5.2 | 1278.9 | 305,641 | 36,353 | 37,000 | 76 | 20,227 | 21796 | off | off | off | 56 | NA |
| | 01/23/06 | 5.9 | 1284.8 | 305,734 | 36,397 | 37,050 | 94 | 20,321 | 21898 | off | off | off | 56 | NA |
| | 01/24/06 | 5.5 | 1290.3 | 305,821 | 36,435 | 37,107 | 95 | 20,416 | 22000 | 6.0 | 5.0 | 67 | 56 | 11 |
| | 01/25/06 | 5.4 | 1295.7 | 305,907 | 36,478 | 37,166 | 102 | 20,518 | 22110 | off | off | off | 58 | NA |
| 106 | 01/26/06 | 5.6 | 1301.3 | 305,996 | 36,526 | 37,207 | 89 | 20,607 | 22206 | off | off | off | 56 | NA |
| | 01/27/06 | 5.7 | 1307.0 | 306,088 | 36,576 | 37,250 | 93 | 20,700 | 22306 | off | off | off | 58 | NA |
| | 01/28/06 | 5.1 | 1312.1 | 306,169 | 36,618 | 37,289 | 81 | 20,781 | 22393 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 01/29/06 | 5.3 | 1317.4 | 306,254 | 36,662 | 37,376 | 131 | 20,912 | 22534 | off | off | off | 56 | NA |
| | 01/30/06 | 6.4 | 1323.8 | 306,345 | 36,708 | 37,376 | 46 | 20,958 | 22584 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 01/31/06 | 5.2 | 1329.0 | 306,438 | 36,756 | 37,421 | 93 | 21,051 | 22684 | off | off | off | 58 | NA |
| | 02/01/06 | 3.2 | 1332.2 | 306,488 | 36,780 | 37,447 | 50 | 21,101 | 22738 | 8.0 | 8.0 | 70 | 54 | 16 |
| 107 | 02/02/06 | 10.0 | 1342.2 | 306,660 | 36,866 | 37,534 | 173 | 21,274 | 22925 | off | off | off | 58 | NA |
| | 02/03/06 | 5.8 | 1348.0 | 306,744 | 36,908 | 37,576 | 84 | 21,358 | 23015 | off | off | off | 58 | NA |
| | 02/04/06 | 5.4 | 1353.4 | 306,829 | 36,950 | 37,620 | 86 | 21,444 | 23108 | off | off | off | 56 | NA |
| | 02/05/06 | 5.5 | 1358.9 | 306,917 | 36,993 | 37,664 | 87 | 21,531 | 23202 | off | off | off | 56 | NA |
| | 02/06/06 | 5.6 | 1364.5 | 307,006 | 37,036 | 37,711 | 90 | 21,621 | 23298 | 8.0 | 8.0 | 72 | 56 | 16 |
| | 02/07/06 | 5.4 | 1369.9 | 307,072 | 37,077 | 37,756 | 86 | 21,707 | 23391 | off | off | off | 60 | NA |
| | 02/08/06 | 5.3 | 1375.2 | 307,188 | 37,122 | 37,806 | 95 | 21,802 | 23494 | 9.0 | 9.0 | 74 | 56 | 18 |
| 108 | 02/09/06 | 6.6 | 1381.8 | 307,279 | 37,164 | 37,855 | 91 | 21,893 | 23592 | off | off | off | 56 | NA |
| | 02/10/06 | 4.9 | 1386.7 | 307,356 | 37,199 | 37,898 | 78 | 21,971 | 23676 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 02/11/06 | 4.5 | 1391.2 | 307,428 | 37,234 | 37,936 | 73 | 22,044 | 23754 | off | off | off | 58 | NA |
| | 02/12/06 | 5.0 | 1396.2 | 307,509 | 37,273 | 37,997 | 100 | 22,144 | 23862 | off | off | off | 56 | NA |
| | 02/13/06 | 8.1 | 1404.3 | 307,638 | 37,335 | 38,043 | 108 | 22,252 | 23978 | off | off | off | 58 | NA |
| | 02/14/06 | 5.4 | 1409.7 | 307,723 | 37,375 | 38,089 | 86 | 22,338 | 24071 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 02/15/06 | 2.5 | 1412.2 | 307,764 | 37,393 | 38,113 | 42 | 22,380 | 24116 | 7.0 | 6.0 | 67 | 54 | 13 |
| 109 | 02/16/06 | 7.9 | 1420.1 | 307,889 | 37,455 | 38,176 | 125 | 22,505 | 24251 | off | off | off | 58 | NA |
| | 02/17/06 | 5.4 | 1425.5 | 307,975 | 37,499 | 38,218 | 86 | 22,591 | 24344 | off | off | off | 58 | NA |
| | 02/18/06 | 4.9 | 1430.4 | 308,054 | 37,538 | 38,258 | 79 | 22,670 | 24429 | off | off | off | 56 | NA |
| | 02/19/06 | 5.1 | 1435.5 | 308,135 | 37,579 | 38,298 | 81 | 22,751 | 24516 | off | off | off | 56 | NA |
| | 02/20/06 | 5.0 | 1440.5 | 308,214 | 37,619 | 38,337 | 79 | 22,830 | 24601 | off | off | off | 56 | NA |
| | 02/21/06 | 5.8 | 1446.3 | 308,307 | 37,668 | 38,381 | 93 | 22,923 | 24702 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 02/22/06 | 5.9 | 1452.2 | 308,398 | 37,721 | 38,419 | 91 | 23,014 | 24800 | off | off | off | 56 | NA |
| 110 | 02/23/06 | 5.9 | 1458.1 | 308,493 | 37,765 | 38,470 | 95 | 23,109 | 24902 | off | off | off | 56 | NA |
| | 02/24/06 | 5.8 | 1463.9 | 308,585 | 37,810 | 38,516 | 91 | 23,200 | 25000 | off | off | off | 58 | NA |
| | 02/25/06 | 5.0 | 1468.9 | 308,665 | 37,850 | 38,557 | 81 | 23,281 | 25087 | 6.0 | 6.0 | 74 | 62 | 12 |
| | 02/26/06 | 5.4 | 1474.3 | 308,749 | 37,890 | 38,600 | 83 | 23,364 | 25177 | off | off | off | 58 | NA |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House | | | | | Instrument Panel | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) | | System Pressure (psig) | | ΔP |
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| | 02/27/06 | 5.4 | 1479.7 | 308,833 | 37,925 | 38,648 | 83 | 23,447 | 25266 | off | off | off | 58 | NA |
| | 02/28/06 | 6.6 | 1486.3 | 308,939 | 37,973 | 38,707 | 107 | 23,554 | 25381 | off | off | off | 56 | NA |
| | 03/01/06 | 3.1 | 1489.4 | 308,988 | 37,996 | 38,733 | 49 | 23,603 | 25434 | 4.0 | 4.0 | 64 | 56 | 8 |
| 111 | 03/02/06 | 18.1 | 1507.5 | 309,082 | 38,039 | 38,784 | 94 | 23,697 | 25536 | off | off | off | 58 | NA |
| | 03/03/06 | 8.4 | 1515.9 | 309,210 | 38,090 | 38,797 | 64 | 23,761 | 25605 | off | off | off | 60 | NA |
| | 03/04/06 | 5.7 | 1521.6 | 309,301 | 38,136 | 38,843 | 92 | 23,853 | 25704 | off | off | off | 56 | NA |
| | 03/05/06 | 6.2 | 1527.8 | 309,400 | 38,186 | 38,893 | 100 | 23,953 | 25811 | off | off | off | 56 | NA |
| | 03/06/06 | 6.5 | 1534.3 | 309,503 | 38,236 | 38,945 | 102 | 24,055 | 25921 | 7.0 | 7.0 | 74 | 60 | 14 |
| | 03/07/06 | 6.0 | 1540.3 | 309,605 | 38,289 | 38,994 | 102 | 24,157 | 26031 | off | off | off | 60 | NA |
| | 03/08/06 | 6.1 | 1546.4 | 309,694 | 38,339 | 39,045 | 101 | 24,258 | 26140 | off | off | off | 58 | NA |
| 112 | 03/09/06 | 5.0 | 1551.4 | 309,774 | 38,380 | 39,084 | 80 | 24,338 | 26226 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 03/10/06 | 5.8 | 1557.2 | 309,866 | 38,426 | 39,128 | 90 | 24,428 | 26323 | off | off | off | 56 | NA |
| | 03/11/06 | 5.1 | 1562.3 | 309,947 | 38,468 | 39,168 | 82 | 24,510 | 26412 | off | off | off | 56 | NA |
| | 03/12/06 | 4.4 | 1566.7 | 310,020 | 38,505 | 39,204 | 73 | 24,583 | 26490 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 03/13/06 | 7.8 | 1574.5 | 310,141 | 38,565 | 39,263 | 119 | 24,702 | 26619 | off | off | off | 58 | NA |
| | 03/14/06 | 8.6 | 1583.1 | 310,276 | 38,634 | 39,328 | 134 | 24,836 | 26763 | off | off | off | 58 | NA |
| | 03/15/06 | 5.1 | 1588.2 | 310,355 | 38,670 | 39,361 | 69 | 24,905 | 26837 | 8.0 | 8.0 | 70 | 54 | 16 |
| 113 | 03/16/06 | 7.8 | 1596.0 | 310,481 | 38,735 | 39,434 | 138 | 25,043 | 26986 | off | off | off | 58 | NA |
| | 03/17/06 | 6.9 | 1602.9 | 310,589 | 38,789 | 39,487 | 107 | 25,150 | 27101 | off | off | off | 54 | NA |
| | 03/18/06 | 6.4 | 1609.3 | 310,690 | 38,840 | 39,537 | 101 | 25,251 | 27210 | off | off | off | 56 | NA |
| | 03/19/06 | 6.6 | 1615.9 | 310,785 | 38,888 | 39,583 | 94 | 25,345 | 27311 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 03/20/06 | 5.5 | 1621.4 | 310,880 | 38,935 | 39,630 | 94 | 25,439 | 27413 | off | off | off | 58 | NA |
| | 03/21/06 | 7.2 | 1628.6 | 310,992 | 38,989 | 39,688 | 112 | 25,551 | 27533 | off | off | off | 56 | NA |
| | 03/22/06 | 6.8 | 1635.4 | 311,100 | 39,033 | 39,753 | 109 | 25,660 | 27651 | off | off | off | 56 | NA |
| 114 | 03/23/06 | 7.4 | 1642.8 | 311,216 | 39,089 | 39,812 | 115 | 25,775 | 27775 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 03/24/06 | 8.5 | 1651.3 | 311,350 | 39,154 | 39,881 | 134 | 25,909 | 27919 | off | off | off | 56 | NA |
| | 03/25/06 | 6.1 | 1657.4 | 311,446 | 39,199 | 39,931 | 95 | 26,004 | 28022 | off | off | off | 58 | NA |
| | 03/26/06 | 6.4 | 1663.8 | 311,545 | 39,242 | 39,986 | 98 | 26,102 | 28127 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 03/27/06 | 5.8 | 1669.6 | 311,636 | 39,279 | 40,040 | 91 | 26,193 | 28225 | 6.0 | 6.0 | 66 | 54 | 12 |
| | 03/28/06 | 7.3 | 1676.9 | 311,753 | 39,330 | 40,104 | 115 | 26,308 | 28349 | off | off | off | 58 | NA |
| | 03/29/06 | 3.0 | 1679.9 | 311,800 | 39,352 | 40,129 | 47 | 26,355 | 28400 | 4.0 | 4.0 | 62 | 54 | 8 |
| 115 | 03/30/06 | 8.9 | 1688.8 | 311,943 | 39,424 | 40,201 | 144 | 26,499 | 28555 | off | off | off | 56 | NA |
| | 03/31/06 | 9.2 | 1698.0 | 312,088 | 39,495 | 40,274 | 144 | 26,643 | 28710 | off | off | off | 60 | NA |
| | 04/01/06 | 7.9 | 1705.9 | 312,213 | 39,555 | 40,338 | 124 | 26,767 | 28844 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 04/02/06 | 8.6 | 1714.5 | 312,348 | 39,625 | 40,402 | 134 | 26,901 | 28988 | off | off | off | 56 | NA |
| | 04/03/06 | 9.1 | 1723.6 | 312,491 | 39,695 | 40,471 | 139 | 27,040 | 29138 | off | off | off | 58 | NA |
| | 04/04/06 | 8.0 | 1731.6 | 312,614 | 39,759 | 40,532 | 125 | 27,165 | 29273 | off | off | off | 58 | NA |
| | 04/05/06 | 8.2 | 1739.8 | 312,744 | 39,822 | 40,598 | 129 | 27,294 | 29412 | 7.0 | 7.0 | 70 | 56 | 14 |
| 116 | 04/06/06 | 7.1 | 1746.9 | 312,854 | 39,870 | 40,657 | 107 | 27,401 | 29527 | off | off | off | 56 | NA |
| | 04/07/06 | 7.0 | 1753.9 | 312,963 | 39,919 | 40,717 | 109 | 27,510 | 29644 | 3.0 | 3.0 | 66 | 58 | 8 |
| | 04/08/06 | 11.1 | 1765.0 | 313,139 | 40,001 | 40,809 | 174 | 27,684 | 29832 | off | off | off | 58 | NA |
| | 04/09/06 | 9.9 | 1774.9 | 313,294 | 40,072 | 40,892 | 154 | 27,838 | 29998 | off | off | off | 58 | NA |
| | 04/10/06 | 9.7 | 1784.6 | 313,446 | 40,141 | 40,973 | 150 | 27,988 | 30159 | 7.0 | 7.0 | 72 | 58 | 14 |
| | 04/11/06 | 8.1 | 1792.7 | 313,571 | 40,192 | 41,004 | 82 | 28,070 | 30248 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 04/12/06 | 8.2 | 1800.9 | 313,701 | 40,257 | 41,069 | 130 | 28,200 | 30388 | 3.0 | 3.0 | 62 | 56 | 6 |
| 117 | 04/13/06 | 8.8 | 1809.7 | 313,843 | 40,325 | 41,184 | 183 | 28,383 | 30585 | off | off | off | 58 | NA |
| | 04/14/06 | 10.0 | 1819.7 | 314,000 | 40,401 | 41,262 | 154 | 28,537 | 30751 | off | off | off | 58 | NA |
| | 04/15/06 | 10.0 | 1829.7 | 314,155 | 40,476 | 41,340 | 153 | 28,690 | 30916 | off | off | off | 56 | NA |
| | 04/16/06 | 8.0 | 1837.7 | 314,279 | 40,536 | 41,405 | 125 | 28,815 | 31051 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 04/17/06 | 7.4 | 1845.1 | 314,394 | 40,591 | 41,462 | 112 | 28,927 | 31171 | off | off | off | 58 | NA |
| | 04/18/06 | 7.5 | 1852.6 | 314,509 | 40,645 | 41,521 | 113 | 29,040 | 31293 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 04/19/06 | 7.3 | 1859.9 | 314,625 | 40,706 | 41,593 | 133 | 29,173 | 31436 | 5.0 | 5.0 | 66 | 56 | 10 |
| 118 | 04/20/06 | 8.8 | 1868.7 | 314,763 | 40,780 | 41,635 | 116 | 29,289 | 31561 | off | off | off | 58 | NA |
| | 04/21/06 | 8.0 | 1876.7 | 314,890 | 40,848 | 41,714 | 147 | 29,436 | 31720 | 5.0 | 5.0 | 68 | 58 | 10 |
| | 04/22/06 | 6.9 | 1883.6 | 314,998 | 40,903 | 41,765 | 106 | 29,542 | 31834 | off | off | off | 58 | NA |
| | 04/23/06 | 8.1 | 1891.7 | 315,125 | 40,967 | 41,827 | 126 | 29,668 | 31970 | 8.0 | 8.0 | 76 | 60 | 16 |
| | 04/24/06 | 8.6 | 1900.3 | 315,258 | 41,032 | 41,894 | 132 | 29,800 | 32112 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 04/25/06 | 8.2 | 1908.5 | 315,388 | 41,092 | 41,962 | 128 | 29,928 | 32250 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 04/26/06 | 5.4 | 1913.9 | 315,474 | 41,132 | 42,006 | 84 | 30,012 | 32341 | 5.0 | 5.0 | 66 | 56 | 10 |
| 119 | 04/27/06 | 8.5 | 1922.4 | 315,607 | 41,192 | 42,176 | NA | 30,242 | 32588 | off | off | off | 56 | NA |
| | 04/28/06 | 6.8 | 1929.2 | 315,714 | 41,240 | 42,135 | NA | 30,249 | 32596 | 8.0 | 8.0 | 72 | 56 | 16 |
| | 04/29/06 | 6.2 | 1935.4 | 315,812 | 41,288 | 42,185 | 98 | 30,347 | 32702 | off | off | off | 56 | NA |
| | 04/30/06 | 7.7 | 1943.1 | 315,933 | 41,348 | 42,245 | 120 | 30,467 | 32831 | off | off | off | 58 | NA |
| | 05/01/06 | 8.2 | 1951.3 | 316,061 | 41,411 | 42,308 | 126 | 30,593 | 32967 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 05/02/06 | 8.7 | 1960.0 | 316,198 | 41,487 | 42,375 | 143 | 30,736 | 33121 | off | off | off | 56 | NA |
| | 05/03/06 | 8.6 | 1968.6 | 316,331 | 41,545 | 42,432 | 115 | 30,851 | 33245 | 8.0 | 8.0 | 72 | 56 | 16 |
| 120 | 05/04/06 | 8.8 | 1977.4 | 316,467 | 41,614 | 42,505 | 142 | 30,993 | 33398 | 9.0 | 9.0 | 76 | 58 | 18 |
| | 05/05/06 | 9.6 | 1987.0 | 316,617 | 41,685 | 42,583 | 149 | 31,142 | 33558 | 9.0 | 9.0 | 64 | 56 | 8 |
| | 05/06/06 | 7.2 | 1994.2 | 316,729 | 41,738 | 42,640 | 110 | 31,252 | 33677 | off | off | off | 58 | NA |
| | 05/07/06 | 8.5 | 2002.7 | 316,861 | 41,801 | 42,708 | 131 | 31,383 | 33818 | off | off | off | 56 | NA |

## Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours | Cumulative Operation Hours | Master Flow Meter | Flow Totalizer Vessel A | Flow Totalizer Vessel B | Instrument Panel: Total Flow Daily | Cumulative Flow Totalizer | Cumulative Total Bed Volumes | Head Loss (psi) Vessel A | Head Loss (psi) Vessel B | System Pressure (psig) Influent | System Pressure (psig) Effluent | ΔP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | Vessel A | Vessel B | Influent | Effluent | psig |
| 121 | 05/08/06 | 8.7 | 2011.4 | 316,996 | 41,864 | 42,777 | 132 | 31,515 | 33960 | off | off | off | 58 | NA |
| | 05/09/06 | 9.1 | 2020.5 | 317,136 | 41,928 | 42,852 | 139 | 31,654 | 34110 | 8.0 | 8.0 | 72 | 56 | 16 |
| | 05/10/06 | 8.5 | 2029.0 | 317,267 | 41,984 | 42,925 | 129 | 31,783 | 34249 | 9.0 | 9.0 | 74 | 56 | 18 |
| | 05/11/06 | 8.8 | 2037.8 | 317,404 | 42,052 | 42,995 | 138 | 31,921 | 34398 | off | off | off | 56 | NA |
| | 05/12/06 | 6.9 | 2044.7 | 317,514 | 42,105 | 43,050 | 108 | 32,029 | 34514 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 05/13/06 | 9.6 | 2054.3 | 317,663 | 42,176 | 43,128 | 149 | 32,178 | 34675 | off | off | off | 56 | NA |
| | 05/14/06 | 9.8 | 2064.1 | 317,814 | 42,248 | 43,203 | 147 | 32,325 | 34833 | off | off | off | 58 | NA |
| 122 | 05/15/06 | 8.7 | 2072.8 | 317,948 | 42,310 | 43,272 | 131 | 32,456 | 34974 | off | off | off | 56 | NA |
| | 05/16/06 | 9.6 | 2082.4 | 318,096 | 42,378 | 43,350 | 146 | 32,602 | 35131 | 8.0 | 8.0 | NM | 58 | NA |
| | 05/17/06 | 12.4 | 2094.8 | 318,286 | 42,463 | 43,451 | 186 | 32,788 | 35332 | 10.0 | 10.0 | 78 | 58 | 20 |
| | 05/18/06 | 13.2 | 2108.0 | 318,492 | 42,568 | 43,550 | 204 | 32,992 | 35552 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 05/19/06 | 9.4 | 2117.4 | 318,636 | 42,648 | 43,620 | 150 | 33,142 | 35713 | off | off | off | 56 | NA |
| | 05/20/06 | 6.7 | 2124.1 | 318,741 | 42,693 | 43,680 | 105 | 33,247 | 35827 | off | off | off | 58 | NA |
| | 05/21/06 | 14.2 | 2138.3 | 318,959 | 42,805 | 43,773 | 205 | 33,452 | 36047 | off | off | off | 58 | NA |
| 123 | 05/22/06 | 11.0 | 2149.3 | 319,129 | 42,894 | 43,773 | NA | 33,541 | 36143 | off | off | off | 58 | NA |
| | 05/23/06 | 11.3 | 2160.6 | 319,303 | 42,978 | 43,940 | NA | 33,792 | 36414 | 9.0 | 10.0 | 77 | 58 | 19 |
| | 05/24/06 | 8.2 | 2168.8 | 319,430 | 43,038 | 44,004 | 124 | 33,916 | 36547 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 05/25/06 | 12.4 | 2181.2 | 319,624 | 43,130 | 44,103 | 191 | 34,107 | 36753 | off | off | off | 56 | NA |
| | 05/26/06 | 11.0 | 2192.2 | 319,792 | 43,206 | 44,193 | 166 | 34,273 | 36932 | off | off | off | 56 | NA |
| | 05/27/06 | 12.3 | 2204.5 | 319,984 | 43,301 | 44,288 | 190 | 34,463 | 37137 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 05/28/06 | 8.9 | 2213.4 | 320,121 | 43,368 | 44,355 | 134 | 34,597 | 37281 | off | off | off | 56 | NA |
| 124 | 05/29/06 | 7.0 | 2220.4 | 320,231 | 43,422 | 44,092 | NA | 34,388 | 37056 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 05/30/06 | 13.5 | 2233.9 | 320,438 | 43,525 | 44,509 | NA | 34,908 | 37616 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 05/31/06 | 11.7 | 2245.6 | 320,617 | 43,619 | 44,592 | 177 | 35,085 | 37807 | off | off | off | 58 | NA |
| | 06/01/06 | 10.8 | 2256.4 | 320,785 | 43,710 | 44,682 | 181 | 35,266 | 38002 | off | off | off | 56 | NA |
| | 06/02/06 | 11.8 | 2268.2 | 320,965 | 43,800 | 44,700 | 108 | 35,374 | 38119 | off | off | off | 58 | NA |
| | 06/03/06 | 7.3 | 2275.5 | 321,079 | 43,856 | 44,826 | 182 | 35,556 | 38315 | off | off | off | 56 | NA |
| | 06/04/06 | 13.2 | 2288.7 | 321,284 | 43,954 | 44,928 | 200 | 35,756 | 38530 | 6.0 | 6.0 | 68 | 56 | 12 |
| 125 | 06/05/06 | 10.8 | 2299.5 | 321,448 | 44,028 | 45,015 | 161 | 35,917 | 38704 | off | off | off | 58 | NA |
| | 06/06/06 | 13.0 | 2312.5 | 321,644 | 44,111 | 45,125 | 193 | 36,110 | 38912 | 9.0 | 8.0 | 73 | 56 | 17 |
| | 06/07/06 | 13.0 | 2325.5 | 321,849 | 44,211 | 45,227 | 202 | 36,312 | 39129 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 06/08/06 | 11.8 | 2337.3 | 322,027 | 44,298 | 45,315 | 175 | 36,487 | 39318 | off | off | off | 56 | NA |
| | 06/09/06 | 9.4 | 2346.7 | 322,172 | 44,367 | 45,389 | 143 | 36,630 | 39472 | off | off | off | 56 | NA |
| | 06/10/06 | 12.6 | 2359.3 | 322,365 | 44,457 | 45,488 | 189 | 36,819 | 39676 | off | off | off | 56 | NA |
| | 06/11/06 | 15.3 | 2374.6 | 322,508 | 44,522 | 45,564 | 141 | 36,960 | 39828 | 8.0 | 8.0 | 74 | 58 | 16 |
| 126 | 06/12/06 | 5.3 | 2379.9 | 322,629 | 44,581 | 45,679 | 174 | 37,134 | 40015 | 10.0 | 10.0 | 70 | 58 | 12 |
| | 06/13/06 | 13.2 | 2393.1 | 322,882 | 44,702 | 45,752 | 194 | 37,328 | 40224 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 06/14/06 | 12.6 | 2405.7 | 323,072 | 44,796 | 45,844 | 186 | 37,514 | 40425 | off | off | off | 58 | NA |
| | 06/15/06 | 11.9 | 2417.6 | 323,258 | 44,891 | 45,931 | 182 | 37,696 | 40621 | off | off | off | 58 | NA |
| | 06/16/06 | 13.0 | 2430.6 | 323,455 | 44,993 | 46,024 | 195 | 37,891 | 40831 | off | off | off | 54 | NA |
| | 06/17/06 | 9.0 | 2439.6 | 323,597 | 45,066 | 46,089 | 138 | 38,029 | 40980 | 6.0 | 6.0 | 72 | 60 | 12 |
| | 06/18/06 | 10.2 | 2449.8 | 323,747 | 45,137 | 46,165 | 147 | 38,176 | 41138 | 7.0 | 7.0 | 74 | 60 | 14 |
| 127 | 06/19/06 | 14.4 | 2464.2 | 323,970 | 45,241 | 46,281 | 220 | 38,396 | 41375 | 3.0 | 3.0 | 60 | 54 | 6 |
| | 06/20/06 | 10.5 | 2474.7 | 324,131 | 45,318 | 46,362 | 158 | 38,554 | 41545 | off | off | off | 56 | NA |
| | 06/21/06 | 10.2 | 2484.9 | 324,289 | 45,343 | 46,441 | 104 | 38,658 | 41657 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 06/22/06 | 11.6 | 2496.5 | 324,462 | 45,473 | 46,531 | 220 | 38,878 | 41894 | 9.0 | 9.0 | 72 | 54 | 18 |
| | 06/23/06 | 11.0 | 2507.5 | 324,637 | 45,562 | 46,615 | 173 | 39,051 | 42081 | off | off | off | 56 | NA |
| | 06/24/06 | 13.0 | 2520.5 | 324,838 | 45,661 | 46,712 | 196 | 39,247 | 42292 | off | off | off | 58 | NA |
| | 06/25/06 | 11.6 | 2532.1 | 325,016 | 45,751 | 46,796 | 174 | 39,421 | 42480 | off | off | off | 54 | NA |
| 128 | 06/26/06 | 7.3 | 2539.4 | 325,128 | 45,808 | 46,849 | 110 | 39,531 | 42598 | 8.0 | 8.0 | 70 | 54 | 16 |
| | 06/27/06 | 7.7 | 2547.1 | 325,246 | 45,871 | 46,901 | 115 | 39,646 | 42722 | off | off | off | 54 | NA |
| | 06/28/06 | 13.1 | 2560.2 | 325,448 | 45,972 | 47,001 | 201 | 39,847 | 42939 | 3.0 | 3.0 | 62 | 56 | 6 |
| | 06/29/06 | 9.5 | 2569.7 | 325,596 | 46,041 | 47,075 | 143 | 39,990 | 43093 | off | off | off | 58 | NA |
| | 06/30/06 | 11.6 | 2581.3 | 325,775 | 46,125 | 47,167 | 176 | 40,166 | 43282 | off | off | off | 56 | NA |
| | 07/01/06 | 8.1 | 2589.4 | 325,900 | 46,179 | 47,235 | 122 | 40,288 | 43414 | off | off | off | 54 | NA |
| | 07/02/06 | 7.9 | 2597.3 | 326,027 | 46,230 | 47,308 | 124 | 40,412 | 43547 | 10.0 | 10.0 | 74 | 54 | 20 |
| 129 | 07/03/06 | 11.1 | 2608.4 | 326,196 | 46,314 | 47,387 | 163 | 40,575 | 43723 | off | off | off | 54 | NA |
| | 07/04/06 | 12.6 | 2621.0 | 326,388 | 46,410 | 47,482 | 191 | 40,766 | 43929 | off | off | off | 56 | NA |
| | 07/05/06 | 8.8 | 2629.8 | 326,524 | 46,476 | 47,548 | 132 | 40,898 | 44071 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 07/06/06 | 12.4 | 2642.2 | 326,689 | 46,558 | 47,624 | 158 | 41,056 | 44241 | off | off | off | 54 | NA |
| | 07/07/06 | 6.5 | 2648.7 | 326,815 | 46,628 | 47,682 | 128 | 41,184 | 44379 | 6.0 | 6.0 | 68 | 56 | 12 |
| | 07/08/06 | 5.8 | 2654.5 | 326,904 | 46,679 | 47,718 | 87 | 41,271 | 44473 | off | off | off | 58 | NA |
| | 07/09/06 | 5.6 | 2660.1 | 326,992 | 46,718 | 47,765 | 86 | 41,357 | 44566 | off | off | off | 56 | NA |
| 130 | 07/10/06 | 6.2 | 2666.3 | 327,089 | 46,763 | 47,814 | 94 | 41,451 | 44667 | 5.0 | 5.0 | 66 | 56 | 10 |
| | 07/11/06 | 11.7 | 2678.0 | 327,270 | 46,846 | 47,904 | 173 | 41,624 | 44853 | off | off | off | 58 | NA |
| | 07/12/06 | 9.8 | 2687.8 | 327,421 | 46,913 | 47,988 | 151 | 41,775 | 45016 | off | off | off | 58 | NA |
| | 07/13/06 | 11.1 | 2698.9 | 327,595 | 47,007 | 48,081 | 187 | 41,962 | 45218 | off | off | off | 56 | NA |
| | 07/14/06 | 9.9 | 2708.8 | 327,746 | 47,081 | 48,155 | 148 | 42,110 | 45377 | 5.0 | 5.0 | 64 | 54 | 10 |
| | 07/15/06 | 12.0 | 2720.8 | 327,932 | 47,169 | 48,248 | 181 | 42,291 | 45572 | off | off | off | 56 | NA |
| | 07/16/06 | 10.3 | 2731.1 | 328,092 | 47,242 | 48,331 | 156 | 42,447 | 45740 | 8.0 | 8.0 | 80 | 54 | 26 |

# Table A-1. EPA Arsenic Demonstration Project at Desert Sands MDWCA, NM - Daily System Operation Log Sheet (Continued)

| Week No. | Date | Pump House: Operation Hours | Pump House: Cumulative Operation Hours | Pump House: Master Flow Meter | Instrument Panel: Flow Totalizer Vessel A | Instrument Panel: Flow Totalizer Vessel B | Instrument Panel: Total Flow Daily | Instrument Panel: Cumulative Flow Totalizer | Instrument Panel: Cumulative Total Bed Volumes | Head Loss (psi): Vessel A | Head Loss (psi): Vessel B | System Pressure (psig): Influent | System Pressure (psig): Effluent | ΔP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | hr | hr | kgal | kgal | kgal | kgal | kgal | # of BV | | | | | psig |
| 131 | 07/17/06 | 10.0 | 2741.1 | 328,243 | 47,309 | 48,412 | 148 | 42,595 | 45900 | off | off | off | 58 | NA |
| | 07/18/06 | 2.7 | 2743.8 | 328,288 | 47,328 | 48,436 | 43 | 42,638 | 45946 | 9.0 | 9.0 | 72 | 54 | 18 |
| | 07/19/06 | 12.7 | 2756.5 | 328,488 | 47,425 | 48,535 | 196 | 42,834 | 46157 | 4.0 | 4.0 | 67 | 56 | 11 |
| | 07/20/06 | 16.4 | 2772.9 | 328,739 | 47,545 | 48,660 | 245 | 43,079 | 46421 | off | off | off | 58 | NA |
| | 07/21/06 | 11.5 | 2784.4 | 328,916 | 47,629 | 48,750 | 174 | 43,253 | 46609 | off | off | off | 56 | NA |
| | 07/22/06 | 11.9 | 2796.3 | 329,098 | 47,713 | 48,843 | 177 | 43,430 | 46800 | off | off | off | 56 | NA |
| | 07/23/06 | 10.2 | 2806.5 | 329,254 | 47,783 | 48,924 | 151 | 43,581 | 46962 | 8.0 | 8.0 | 70 | 54 | 16 |
| 132 | 07/24/06 | 11.2 | 2817.7 | 329,425 | 47,860 | 49,016 | 169 | 43,750 | 47144 | off | off | off | 58 | NA |
| | 07/25/06 | 10.7 | 2828.4 | 329,591 | 47,937 | 49,100 | 161 | 43,911 | 47318 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 07/26/06 | 10.8 | 2839.2 | 329,758 | 48,013 | 49,186 | 162 | 44,073 | 47492 | off | off | off | 56 | NA |
| | 07/27/06 | 11.5 | 2850.7 | 329,935 | 48,092 | 49,280 | 173 | 44,246 | 47679 | off | off | off | 56 | NA |
| | 07/28/06 | 10.4 | 2861.1 | 330,093 | 48,159 | 49,366 | 153 | 44,399 | 47844 | 9.0 | 9.0 | 72 | 54 | 18 |
| | 07/29/06 | 8.0 | 2869.1 | 330,216 | 48,221 | 49,426 | 122 | 44,521 | 47975 | off | off | off | 56 | NA |
| | 07/30/06 | 7.8 | 2876.9 | 330,338 | 48,290 | 49,485 | 128 | 44,649 | 48113 | 4.0 | 4.0 | 66 | 58 | 8 |
| 133 | 07/31/06 | 9.8 | 2886.7 | 330,488 | 48,353 | 49,557 | 135 | 44,784 | 48259 | off | off | off | 56 | NA |
| | 08/01/06 | 5.3 | 2892.0 | 330,568 | 48,393 | 49,595 | 78 | 44,862 | 48343 | off | off | off | 56 | NA |
| | 08/02/06 | 4.2 | 2896.2 | 330,633 | 48,426 | 49,617 | 55 | 44,917 | 48402 | 5.0 | 6.0 | 65 | 54 | 11 |
| | 08/03/06 | 10.4 | 2906.6 | 330,795 | 48,505 | 49,697 | 159 | 45,076 | 48573 | off | off | off | 54 | NA |
| | 08/04/06 | 4.3 | 2910.9 | 330,863 | 48,535 | 49,732 | 65 | 45,141 | 48643 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 08/05/06 | 5.5 | 2916.4 | 330,948 | 48,576 | 49,775 | 84 | 45,225 | 48734 | off | off | off | 58 | NA |
| | 08/06/06 | 8.7 | 2925.1 | 331,085 | 48,635 | 49,848 | 132 | 45,357 | 48876 | 6.0 | 6.0 | 68 | 56 | 12 |
| 134 | 08/07/06 | 8.6 | 2933.7 | 331,215 | 48,686 | 49,925 | 128 | 45,485 | 49014 | off | off | off | 56 | NA |
| | 08/08/06 | 8.0 | 2941.7 | 331,340 | 48,740 | 49,992 | 121 | 45,606 | 49144 | 4.0 | 4.0 | 62 | 54 | 8 |
| | 08/09/06 | 9.5 | 2951.2 | 331,488 | 48,814 | 50,062 | 144 | 45,750 | 49300 | off | off | off | 54 | NA |
| | 08/10/06 | 6.5 | 2957.7 | 331,590 | 48,863 | 50,113 | 100 | 45,850 | 49407 | off | off | off | 56 | NA |
| | 08/11/06 | 9.1 | 2966.8 | 331,733 | 48,932 | 50,183 | 139 | 45,989 | 49557 | 4.0 | 4.0 | 66 | 58 | 8 |
| | 08/12/06 | 7.0 | 2973.8 | 331,841 | 48,984 | 50,236 | 105 | 46,094 | 49670 | off | off | off | 54 | NA |
| | 08/13/06 | 7.2 | 2981.0 | 331,954 | 49,040 | 50,290 | 110 | 46,204 | 49789 | off | off | off | 56 | NA |
| 135 | 08/14/06 | 7.2 | 2988.2 | 332,065 | 49,092 | 50,347 | 109 | 46,313 | 49906 | 4.0 | 4.0 | 64 | 56 | 8 |
| | 08/15/06 | 8.5 | 2996.7 | 332,197 | 49,154 | 50,414 | 129 | 46,442 | 50045 | off | off | off | 56 | NA |
| | 08/16/06 | 3.4 | 3000.1 | 332,251 | 49,179 | 50,441 | 52 | 46,494 | 50101 | 6.0 | 6.0 | 70 | 58 | 12 |
| | 08/17/06 | 3.9 | 3004.0 | 332,310 | 49,207 | 50,472 | 59 | 46,553 | 50165 | off | off | off | off | NA |

Note: BV calculation for Run 1 (01/23/04-07/14/05) based on 80 $ft^3$ of E33-S media per vessel.

Note: BV calculation for Run 2 (07/29/05-08/16/06) based on 62 $ft^3$ of E33-P media per vessel.

# APPENDIX B

# ANALYTICAL DATA

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA

| Sampling Date | | 01/23/04[c] | | | 01/28/04 | | | | 02/04/04 | | | | 02/11/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | | – | – | 0 | – | – | 362 | 353 | – | – | 657 | 775 | – | – | 963 | 1,183 |
| Alkalinity | mg/L[a] | 173 | 173 | 173 | 173 | 173 | 169 | 169 | 180 | 176 | 180 | 178 | 186 | 190 | 186 | 182 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.5 | – | – | – | – | – | – | – | – | – | – | – | – |
| Sulfate | mg/L | 180 | 170 | 180 | – | – | – | – | – | – | – | – | – | – | – | – |
| Orthophosphate | mg/L[b] | 0.2 | 0.2 | 0.2 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Silica (as $SiO_2$) | mg/L | 41.8 | 41.7 | 37.2 | 40.5 | 40.8 | 38.5 | 39.2 | 36.4 | 37.3 | 35.3 | 36.4 | 36.6 | 37.4 | 36.2 | 37.0 |
| Sulfide | µg/L | <5<br><5 | – | – | – | – | – | – | <5<br><5 | – | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.05 | <0.05 | <0.05 | – | – | – | – | – | – | – | – | – | – | – | – |
| Turbidity | NTU | 3.5 | 1.2 | 0.1 | 0.2 | 0.2 | 0.1 | <0.1 | 0.5 | 0.8 | 0.2 | 0.2 | 0.4 | 0.5 | 0.2 | 0.2 |
| pH | – | 7.8 | 7.9 | 7.9 | 8.1 | 8.0 | 8.0 | 7.9 | 8.1 | 8.0 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 |
| Temperature | ºC | 28.7 | 29.4 | 29.7 | 28.4 | 28.8 | 28.9 | 29.0 | 30.2 | 29.5 | 29.9 | 29.8 | 29.9 | 30.0 | 30.2 | 29.9 |
| DO | mg/L | 1.0 | 1.4 | 2.3 | 1.9 | 2.0 | 2.0 | 1.9 | 1.1 | 1.8 | 1.5 | 1.5 | 1.0 | 1.6 | 1.5 | 1.4 |
| ORP | mV | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Free Chlorine | mg/L | – | 0.5 | 0.3 | – | 0.3 | 0.3 | 0.3 | – | – | 0.4 | 0.4 | – | – | – | – |
| Total Hardness | mg/L[a] | 81.1 | 80.7 | 81.5 | – | – | – | – | – | – | – | – | – | – | – | – |
| Ca Hardness | mg/L[a] | 65.5 | 67.5 | 67.6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Mg Hardness | mg/L[a] | 15.6 | 13.2 | 13.9 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (total) | µg/L | 26.1 | 26.7 | 1.5 | 26.0 | 25.9 | 1.9 | 1.5 | 26.2 | 27.0 | 2.0 | 1.7 | 25.3 | 27.5 | 2.0 | 2.0 |
| As (total soluble) | µg/L | 23.2 | 23.0 | 1.2 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (particulate) | µg/L | 2.9 | 3.7 | 0.2 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (III) | µg/L | 17.6 | 1.1 | 0.9 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (V) | µg/L | 5.6 | 21.9 | 0.3 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fe | µg/L | 45 | 43 | <25 | 73 | 70 | <25 | <25 | 106 | 112 | 45 | 35 | 98 | 97 | 46 | 42 |
| Dissolved Fe | µg/L | <25 | <25 | <25 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Mn | µg/L | 9.1 | 8.4 | 0.2 | 10.1 | 10.3 | 0.3 | 0.1 | 9.4 | 9.5 | 0.1 | 0.1 | 9.6 | 9.0 | 0.1 | 0.2 |
| Dissolved Mn | µg/L | 9.4 | 8.1 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Water quality parameters sampled on January 27, 2004.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 02/18/04 | | | 02/25/04 | | | | 03/03/04 | | | | 03/10/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | | – | – | 1,496 | – | – | 1,715 | 2,167 | – | – | 2,042 | 2,610 | – | – | 2,350 | 3,010 |
| Alkalinity | mg/L[(a)] | 193 | 191 | 189 | 185 | 185 | 185 | 185 | 177 | 179 | 179 | 181 | 181 | 189 | 185 | 181 |
| Fluoride | mg/L | 0.6 | 0.6 | 0.6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Sulfate | mg/L | 190 | 190 | 190 | – | – | – | – | – | – | – | – | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Silica (as $SiO_2$) | mg/L | 38.4 | 39.0 | 38.2 | 39.3 | 38.9 | 39.0 | 38.5 | 37.9 | 37.3 | 37.9 | 38.3 | 36.4 | 36.4 | 36.0 | 36.3 |
| Sulfide | µg/L | – | – | – | – | – | – | – | <5<br><5 | – | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.08 | <0.08 | <0.08 | – | – | – | – | – | – | – | – | – | – | – | – |
| Turbidity | NTU | 2.4 | 0.2 | 0.7 | 0.3 | 0.3 | 0.1 | 0.1 | 0.3 | 0.1 | 0.2 | <0.1 | 0.4 | 0.3 | 0.2 | 0.2 |
| pH | – | 7.8 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | – | – | 8.0 | 7.9 | 7.8 | 7.8 |
| Temperature | ºC | 29.8 | 30.1 | 30.2 | 29.7 | 28.9 | 29.0 | 29.4 | 29.9 | 29.7 | – | – | 30.4 | 30.8 | 30.6 | 30.6 |
| DO | mg/L | 1.2 | 1.3 | 1.4 | 1.2 | 1.2 | 1.1 | 1.6 | 1.3 | 1.3 | – | – | 1.3 | 1.2 | 1.2 | 1.2 |
| ORP | mV | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Free Chlorine | mg/L | – | 0.4 | 0.4 | – | 0.4 | 0.4 | 0.4 | – | – | – | – | – | 0.4 | 0.4 | 0.4 |
| Total Chlorine | mg/L | – | 0.5 | 0.5 | – | 0.5 | 0.5 | 0.5 | – | – | – | – | – | 0.5 | 0.5 | 0.5 |
| Total Hardness | mg/L[(a)] | 89.4 | 87.4 | 89.2 | – | – | – | – | – | – | – | – | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 71.9 | 70.7 | 71.1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 17.5 | 16.7 | 18.1 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (total) | µg/L | 28.6 | 28.7 | 1.5 | 27.6 | 27.9 | 1.7 | 1.5 | 29.8 | 28.6 | 1.8 | 1.7 | 23.0 | 23.2 | 1.4 | 1.4 |
| As (total soluble) | µg/L | 23.9 | 23.6 | 1.4 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (particulate) | µg/L | 4.7 | 5.1 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (III) | µg/L | 22.8 | 1.1 | 1.1 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (V) | µg/L | 1.1 | 22.6 | 0.3 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fe | µg/L | 55 | 36 | <25 | 35 | 31 | <25 | <25 | 39 | 30 | <25 | <25 | 53 | 47 | <25 | <25 |
| Dissolved Fe | µg/L | <25 | <25 | <25 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Mn | µg/L | 9.9 | 9.4 | 0.3 | 9.7 | 9.5 | 0.1 | 0.1 | 9.5 | 9.1 | 0.1 | 0.1 | 8.3 | 8.2 | 0.2 | 0.3 |
| Dissolved Mn | µg/L | 9.0 | 6.0 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 03/17/04 | | | 03/24/04 | | | | 03/31/04 | | | | 04/07/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | | – | – | 3,177 | – | – | 3,112 | 3,995 | – | – | 3,467 | 4,447 | – | – | 3,738 | 4,790 |
| Alkalinity | mg/L[(a)] | 182 | 182 | 178 | 189 | 189 | 185 | 193 | 183 | 181 | 185 | 181 | 180 | 180 | 184 | 180 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.5 | – | – | – | – | – | – | – | – | – | – | – | – |
| Sulfate | mg/L | 190 | 180 | 190 | – | – | – | – | – | – | – | – | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Silica (as $SiO_2$) | mg/L | 38.7 | 38.4 | 38.6 | 38.5 | 38.3 | 38.0 | 38.4 | 37.9 | 37.2 | 37.6 | 37.8 | 39.4 | 40.2 | 39.9 | 40.0 |
| Sulfide | μg/L | – | – | – | – | – | – | – | <5 <5 | – | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.05 | <0.05 | <0.05 | – | – | – | – | – | – | – | – | – | – | – | – |
| Turbidity | NTU | 0.5 | 0.2 | 0.2 | 0.4 | 0.3 | 0.1 | 0.1 | 1.0 | 1.5 | 0.5 | 0.2 | 0.9 | 1.0 | 0.2 | 0.4 |
| pH | – | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.8 | 7.8 | 7.9 | 7.9 | 7.9 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| Temperature | ºC | 30.4 | 30.4 | 30.6 | 30.4 | 31.0 | 30.9 | 31.1 | 30.2 | 30.6 | 31.0 | 31.0 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| DO | mg/L | 1.3 | 1.2 | 1.3 | 1.5 | 1.2 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.1 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| ORP | mV | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Free Chlorine | mg/L | – | 0.4 | 0.4 | – | 0.4 | 0.5 | 0.4 | – | 0.5 | 0.5 | – | – | – | – | – |
| Total Chlorine | mg/L | – | 0.5 | 0.5 | – | 0.5 | 0.5 | 0.5 | – | 0.6 | 0.6 | – | – | – | – | – |
| Total Hardness | mg/L[(a)] | 78.4 | 82.1 | 81.9 | – | – | – | – | – | – | – | – | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 63.9 | 67.4 | 66.6 | – | – | – | – | – | – | – | – | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 14.5 | 14.7 | 15.3 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (total) | μg/L | 22.6 | 22.3 | 0.9 | 25.9 | 25.9 | 2.4 | 2.5 | 20.7 | 21.2 | 1.8 | 1.9 | 30.1 | 30.1 | 1.9 | 1.8 |
| As (total soluble) | μg/L | 22.4 | 22.1 | 0.8 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (particulate) | μg/L | 0.2 | 0.2 | 0.1 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (III) | μg/L | 20.7 | 0.5 | 0.3 | – | – | – | – | – | – | – | – | – | – | – | – |
| As (V) | μg/L | 1.7 | 21.6 | 0.5 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Fe | μg/L | 49 | 32 | <25 | 33 | 30 | <25 | <25 | 71 | 69 | <25 | <25 | <25 | <25 | <25 | <25 |
| Dissolved Fe | μg/L | <25 | <25 | <25 | – | – | – | – | – | – | – | – | – | – | – | – |
| Total Mn | μg/L | 8.5 | 7.6 | <0.1 | 8.4 | 7.9 | 0.1 | 0.1 | 9.0 | 9.4 | <0.1 | 0.1 | 7.5 | 7.3 | 0.1 | 0.1 |
| Dissolved Mn | μg/L | 7.5 | 5.3 | <0.1 | – | – | – | – | – | – | – | – | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Operator was not available to take water quality readings.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 04/14/04 | | | 04/30/04 | | | | 05/12/04 | | | 05/26/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | | – | – | 4,572 | – | – | 4,603 | 6,057 | – | – | 6,176 | – | – | 5,897 | 7,605 |
| Alkalinity | mg/L[(a)] | 164 | 170 | 178 | 199 | 175 | 199 | 179 | 194 | 194 | 188 | 226<br>194 | 190<br>186 | 194<br>190 | 194<br>194 |
| Fluoride | mg/L | 0.7 | 0.7 | 0.7 | – | – | – | – | 0.6 | 0.6 | 0.6 | – | – | – | – |
| Sulfate | mg/L | 190 | 190 | 180 | – | – | – | – | 180 | 180 | 180 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.10 | <0.10 | <0.10 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | <0.10 | <0.10 | <0.10 | <0.10<br><0.10 | <0.10<br><0.10 | <0.10<br><0.10 | <0.10<br><0.10 |
| Silica (as $SiO_2$) | mg/L | 38.2 | 38.1 | 37.6 | 38.1 | 38.0 | 38.0 | 37.9 | 37.4 | 37.5 | 37.7 | 38.3<br>38.1 | 37.3<br>37.1 | 37.9<br>37.1 | 37.6<br>37.2 |
| Sulfide | μg/L | – | – | – | – | – | – | – | <5<br><5 | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.05 | <0.05 | <0.05 | – | – | – | – | <0.05 | <0.05 | <0.05 | – | – | – | – |
| Turbidity | NTU | 0.6 | 0.3 | 0.3 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | 0.7 | 0.6 | 0.5 | 2.8<br>1.5 | 0.8<br>0.5 | 0.4<br>0.7 | 0.5<br>0.8 |
| pH | – | 7.9 | 7.9 | 8.0 | 7.9 | 7.9 | 7.9 | 7.8 | 7.8 | 7.8 | 7.8 | 7.9 | 7.8 | 7.8 | 7.7 |
| Temperature | °C | 29.6 | 29.5 | 29.5 | 30.3 | 30.6 | 30.1 | 30.5 | 30.7 | 30.9 | 31.2 | 31.0 | 31.3 | 31.2 | 31.1 |
| DO | mg/L | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.2 | 1.2 | 1.1 | 1.3 | 1.2 | 1.1 | 1.6 | 1.5 |
| ORP | mV | 42 | 550 | 561 | 48 | 542 | 521 | 525 | 52 | 537 | 541 | 62 | 525 | 503 | 510 |
| Free Chlorine | mg/L | – | 0.4 | 0.5 | – | 0.4 | 0.4 | 0.4 | – | 0.4 | 0.4 | – | 0.5 | 0.5 | 0.5 |
| Total Chlorine | mg/L | – | 0.5 | 0.6 | – | 0.5 | 0.5 | 0.5 | – | 0.5 | 0.5 | – | 0.6 | 0.6 | 0.6 |
| Total Hardness | mg/L[(a)] | 85.7 | 85.3 | 84.0 | – | – | – | – | 101.1 | 111.1 | 110.1 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 71.1 | 70.9 | 69.4 | – | – | – | – | 83.7 | 91.9 | 86.6 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 14.6 | 14.4 | 14.6 | – | – | – | – | 17.4 | 19.2 | 23.5 | – | – | – | – |
| As (total) | μg/L | 28.5 | 29.6 | 1.5 | 24.2 | 23.6 | 1.7 | 1.6 | 25.8 | 25.4 | 1.6 | 21.4<br>21.2 | 21.7<br>21.7 | 1.7<br>2.0 | 2.1<br>2.4 |
| As (total soluble) | μg/L | 24.8 | 24.7 | 1.6 | – | – | – | – | 22.0 | 20.3 | 1.4 | – | – | – | – |
| As (particulate) | μg/L | 3.7 | 4.9 | <0.1 | – | – | – | – | 3.8 | 5.1 | 0.2 | – | – | – | – |
| As (III) | μg/L | 22.0 | 1.1 | 0.9 | – | – | – | – | 21.2 | 0.9 | 0.8 | – | – | – | – |
| As (V) | μg/L | 2.8 | 23.6 | 0.7 | – | – | – | – | 0.8 | 19.4 | 0.6 | – | – | – | – |
| Total Fe | μg/L | <25 | <25 | <25 | 32 | 27 | <25 | <25 | <25 | <25 | <25 | 64<br>51 | 40<br>38 | <25<br><25 | <25<br><25 |
| Dissolved Fe | μg/L | <25 | <25 | <25 | – | – | – | – | <25 | <25 | <25 | – | – | – | – |
| Total Mn | μg/L | 8.3 | 8.1 | 0.2 | 9.1 | 7.9 | 0.5 | 0.5 | 7.0 | 7.1 | <0.1 | 9.9<br>9.1 | 8.6<br>8.4 | 0.3<br>0.3 | 0.3<br>0.3 |
| Dissolved Mn | μg/L | 8.0 | 6.2 | 0.1 | – | – | – | – | 7.1 | 5.9 | <0.1 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Sample out of holding time for laboratory analysis.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

### Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 06/09/04 | | | 06/23/04 | | | | 07/07/04 | | | 07/21/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sampling Location**<br>**Parameter** | **Unit** | **IN** | **AC** | **TT** | **IN** | **AC** | **TA** | **TB** | **IN** | **AC** | **TT** | **IN** | **AC** | **TA** | **TB** |
| Bed Volume | $10^3$ | – | – | 8.1 | – | – | 8.7 | 10.6 | – | – | 11.1 | – | – | 11.9 | 13.8 |
| Alkalinity | mg/L[(a)] | 187 | 187 | 182 | 195 | 179 | 171 | 175 | 197 | 197 | 189 | 180<br>180 | 180<br>180 | 180<br>188 | 184<br>188 |
| Fluoride | mg/L | 0.6 | 0.6 | 0.6 | – | – | – | – | 0.6 | 0.6 | 0.6 | – | – | – | – |
| Sulfate | mg/L | 170 | 170 | 180 | – | – | – | – | 190 | 190 | 190 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Silica (as $SiO_2$) | mg/L | 37.8 | 37.8 | 37.2 | 38.7 | 38.3 | 38.1 | 38.9 | 38.0 | 37.9 | 38.2 | 38.0<br>37.8 | 37.3<br>38.1 | 36.9<br>38.2 | 37.4<br>37.6 |
| Sulfide | μg/L | – | – | – | <5<br><5 | – | – | – | – | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.04 | <0.04 | <0.04 | – | – | – | – | <0.20 | <0.20 | <0.20 | – | – | – | – |
| Turbidity | NTU | 2.6 | 0.6 | 0.3 | 0.8 | 0.7 | 0.4 | 0.5 | 0.2 | 0.2 | 0.1 | 0.4<br>0.4 | 0.5<br>0.4 | 0.3<br>0.3 | 0.4<br>0.3 |
| pH | – | 7.8 | 7.8 | 7.7 | 7.7 | 7.7 | 7.7 | 7.7 | 7.6 | 7.7 | 7.6 | 7.6 | 7.7 | 7.7 | 7.7 |
| Temperature | ºC | 31.6 | 31.5 | 31.6 | 31.1 | 31.3 | 30.9 | 30.8 | 30.6 | 31.2 | 31.0 | 30.2 | 31.0 | 30.6 | 30.8 |
| DO | mg/L | 1.8 | 1.4 | 1.7 | 1.7 | 1.5 | 1.5 | 1.4 | 1.3 | 1.2 | 1.5 | 1.3 | 1.3 | 1.2 | 1.2 |
| ORP | mV | 55 | 488 | 495 | 62 | 501 | 531 | 528 | 81 | 486 | 502 | 62 | 460 | 520 | 507 |
| Free Chlorine | mg/L | – | 0.4 | 0.5 | – | 0.5 | 0.5 | 0.4 | – | 0.4 | 0.4 | – | 0.4 | 0.4 | 0.5 |
| Total Chlorine | mg/L | – | 0.5 | 0.5 | – | 0.5 | 0.5 | 0.5 | – | 0.4 | 0.5 | – | 0.5 | 0.5 | 0.5 |
| Total Hardness | mg/L[(a)] | 89.8 | 90.1 | 86.6 | – | – | – | – | 80.2 | 79.2 | 74.5 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 72.5 | 73.0 | 70.1 | – | – | – | – | 64.1 | 63.1 | 60.6 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 17.3 | 17.1 | 16.5 | – | – | – | – | 16.1 | 16.1 | 13.9 | – | – | – | – |
| As (total) | μg/L | 25.1 | 25.4 | 3.0 | 25.0 | 25.6 | 2.4 | 2.8 | 23.7 | 23.9 | 2.8 | 23.9<br>23.7 | 24.3<br>24.1 | 3.5<br>3.4 | 3.9 |
| As (total soluble) | μg/L | 23.1 | 23.5 | 2.8 | – | – | – | – | 21.9 | 22.5 | 2.6 | – | – | – | – |
| As (particulate) | μg/L | 2.0 | 1.9 | 0.2 | – | – | – | – | 1.8 | 1.4 | 0.2 | – | – | – | – |
| As (III) | μg/L | 22.6 | 21.1[(c)] | 1.8 | – | – | – | – | 21.0 | 1.1 | 1.2 | – | – | – | – |
| As (V) | μg/L | 0.5 | 2.4[(c)] | 1.0 | – | – | – | – | 0.9 | 21.4 | 1.4 | – | – | – | – |
| Total Fe | μg/L | 50 | 28 | <25 | 36 | 34 | <25 | <25 | 58 | 50 | <25 | 46<br>46 | 42<br>43 | <25<br><25 | <25 |
| Dissolved Fe | μg/L | <25 | <25 | <25 | – | – | – | – | 43 | <25 | <25 | – | – | – | – |
| Total Mn | μg/L | 11.0 | 8.8 | 0.8 | 7.9 | 7.7 | <0.1 | <0.1 | 8.9 | 9.4 | 0.5 | 8.0<br>8.3 | 7.5<br>7.8 | 0.2<br>0.1 | 0.2 |
| Dissolved Mn | μg/L | 10.5 | 9.2 | 0.5 | – | – | – | – | 8.6 | 5.7 | 0.3 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Data is questionable.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 08/04/04 | | | 08/18/04 | | | | 09/01/04 | | | 09/15/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 14.2 | – | – | 14.5 | 16.4 | – | – | 16.5 | – | – | 16.7 | 18.5 |
| Alkalinity | mg/L[(a)] | 184 | 188 | 184 | 184 | 180 | 176 | 180 | 181 | 181 | 181 | 182 | 182 | 186 | 182 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.5 | – | – | – | – | 0.4 | 0.4 | 0.4 | – | – | – | – |
| Sulfate | mg/L | 170 | 170 | 180 | – | – | – | – | 170 | 160 | 200 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.06 | <0.06 | <0.06 | <0.06 |
| Silica (as $SiO_2$) | mg/L | 38.1 | 38.0 | 37.8 | 38.8 | 38.1 | 38.2 | 38.1 | 38.2 | 38.0 | 38.4 | 38.5 | 38.3 | 38.4 | 38.8 |
| Sulfide | µg/L | <5<br><5 | – | – | – | – | – | – | <5<br><5 | – | – | – | – | – | – |
| $NO_3$-N | mg/L | <0.04 | <0.04 | <0.04 | – | – | – | – | <0.04 | <0.04 | <0.04 | – | – | – | – |
| Turbidity | NTU | 0.2 | 0.2 | 0.1 | 0.6 | 0.6 | 0.1 | 0.1 | 0.9 | 0.2 | 0.2 | 0.7 | 0.7 | 0.4 | 0.4 |
| pH | – | 7.6 | 7.7 | 7.7 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.7 | 7.6 | 7.6 | 7.6 | 7.6 |
| Temperature | ºC | 30.4 | 30.8 | 31.2 | 30.2 | 30.5 | 30.8 | 30.6 | 30.1 | 30.4 | 30.4 | 29.9 | 30.1 | 30.3 | 30.2 |
| DO | mg/L | 1.1 | 1.2 | 1.1 | 0.9 | 0.9 | 1.3 | 1.4 | 0.9 | 1.0 | 0.8 | 0.8 | 1.1 | 1.3 | 1.2 |
| ORP | mV | 92 | 454 | 468 | 101 | 476 | 471 | 485 | NA | 495 | 515 | 74 | 480 | 490 | 502 |
| Free Chlorine | mg/L | – | 0.5 | 0.4 | – | 0.4 | 0.4 | 0.4 | – | 0.5 | 0.5 | – | 0.5 | 0.5 | 0.5 |
| Total Chlorine | mg/L | – | 0.5 | 0.5 | – | 0.5 | 0.5 | 0.5 | – | 0.6 | 0.6 | – | 0.6 | 0.5 | 0.5 |
| Total Hardness | mg/L[(a)] | 98.3 | 99.2 | 99.3 | – | – | – | – | – | – | – | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 82.0 | 83.0 | 82.9 | – | – | – | – | – | – | – | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 16.3 | 16.2 | 16.4 | – | – | – | – | – | – | – | – | – | – | – |
| As (total) | µg/L | 21.5 | 22.0 | 2.8 | 22.4 | 22.8 | 4.2 | 4.2 | 24.9 | 27.2 | 7.4 | 21.6 | 23.2 | 3.1 | 3.5 |
| As (total soluble) | µg/L | 21.5 | 21.7 | 2.8 | – | – | – | – | 24.5 | 25.2 | 7.4 | – | – | – | – |
| As (particulate) | µg/L | <0.1 | 0.3 | <0.1 | – | – | – | – | 0.4 | 5.0 | <0.1 | – | – | – | – |
| As (III) | µg/L | 21.0 | 0.8 | 0.8 | – | – | – | – | 22.2 | 3.3[(c)] | 4.1[(c)] | – | – | – | – |
| As (V) | µg/L | 0.5 | 20.9 | 2.0 | – | – | – | – | 2.3 | 21.9 | 3.3 | – | – | – | – |
| Total Fe | µg/L | 49 | 61 | <25 | 89 | 88 | <25 | <25 | 68 | 56 | <25 | 108 | 112 | 48 | 44 |
| Dissolved Fe | µg/L | 38 | <25 | <25 | – | – | – | – | 27 | <25 | <25 | – | – | – | – |
| Total Mn | µg/L | 8.7 | 10.7 | 0.2 | 8.6 | 8.7 | 0.2 | 0.6 | 9.0 | 11.9 | 0.3 | 10.1 | 14.7 | 0.6 | 0.7 |
| Dissolved Mn | µg/L | 8.8 | 5.9 | 0.5 | – | – | – | – | 9.6 | 6.0 | 0.4 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Prechlorination system failed the day before sampling. System repaired and chlorine residual returned to normal prior to collecting samples.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 09/29/04 | | | 10/13/04 | | | | 10/28/04 | | | 11/03/04 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 18.5 | – | – | 18.4 | 20.2 | – | – | 20.2 | – | – | 19.6 | 21.6 |
| Alkalinity | mg/L[(a)] | 176 | 185 | 185 | 171<br>171 | 171<br>175 | 187<br>183 | 175<br>175 | 185 | 189 | 189 | 185 | 185 | 181 | 185 |
| Fluoride | mg/L | 0.3 | 0.3 | 0.3 | – | – | – | – | 0.2 | 0.2 | 0.2 | – | – | – | – |
| Sulfate | mg/L | 180 | 170 | 170 | – | – | – | – | 170 | 170 | 170 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.06 | <0.06 | <0.06 | <0.06<br><0.06 | <0.06<br><0.06 | <0.06<br><0.06 | <0.06<br><0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 |
| Silica (as $SiO_2$) | mg/L | 37.8 | 38.4 | 37.7 | 37.5<br>37.4 | 37.2<br>37.2 | 37.2<br>37.4 | 37.8<br>36.5 | 38.0 | 38.2 | 37.8 | 36.8 | 36.9 | 37.3 | 37.3 |
| Sulfide | µg/L | – | – | – | <5<br><5 | – | – | – | – | – | – | <5<br><5 | – | – | – |
| $NO_3$-N | mg/L | <0.04 | <0.04 | <0.04 | – | – | – | – | <0.04 | <0.04 | <0.04 | – | – | – | – |
| Turbidity | NTU | 0.8 | 0.3 | <0.1 | 0.5<br>0.4 | 0.4<br>0.4 | 0.2<br>0.1 | 0.4<br>0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.2 |
| pH | – | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.7 | 7.7 | 7.7 |
| Temperature | ºC | 30.2 | 30.4 | 30.5 | 30.1 | 30.1 | 30.4 | 30.4 | 30.1 | 30.3 | 30.4 | 29.0 | 29.2 | 29.4 | 29.4 |
| DO | mg/L | 0.9 | 1.1 | 1.2 | 0.5 | 1.0 | 1.0 | 0.9 | 0.3 | 0.6 | 0.5 | 0.5 | 0.7 | 0.7 | 0.6 |
| ORP | mV | 90 | 506 | 520 | 79 | 529 | 545 | 552 | 28 | 502 | 392 | 56 | 458 | 494 | 502 |
| Free Chlorine | mg/L | – | 0.5 | 0.5 | – | 0.6 | 0.6 | 0.6 | – | 0.6 | 0.5 | – | 0.5 | 0.5 | 0.5 |
| Total Chlorine | mg/L | – | 0.6 | 0.6 | – | 0.6 | 0.6 | 0.6 | – | 0.7 | 0.5 | – | 0.6 | 0.5 | 0.6 |
| Total Hardness | mg/L[(a)] | 101.6 | 101.0 | 102.4 | – | – | – | – | 90.4 | 95.0 | 99.6 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 83.4 | 83.1 | 84.1 | – | – | – | – | 70.4 | 76.0 | 81.7 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 18.2 | 17.9 | 18.3 | – | – | – | – | 20.0 | 19.0 | 17.9 | – | – | – | – |
| As (total) | µg/L | 24.8 | 25.4 | 6.8 | 22.1<br>23.0 | 22.4<br>22.1 | 3.7<br>3.7 | 3.5<br>3.6 | 23.8 | 27.9 | 9.3 | 23.0 | 23.0 | 6.8 | 7.2 |
| As (total soluble) | µg/L | 24.5 | 24.7 | 6.6 | – | – | – | – | 25.4 | 27.2 | 7.4 | – | – | – | – |
| As (particulate) | µg/L | 0.3 | 0.7 | 0.2 | – | – | – | – | <0.1 | 0.2 | 1.9 | – | – | – | – |
| As (III) | µg/L | 23.2 | 3.2[(c)] | 3.4[(c)] | – | – | – | – | 25.2 | 4.6[(c)] | 4.1[(c)] | – | – | – | – |
| As (V) | µg/L | 1.3 | 21.5 | 3.2 | – | – | – | – | 0.2 | 22.6 | 3.3 | – | – | – | – |
| Total Fe | µg/L | 64 | 49 | <25 | 78<br>81 | 85<br>63 | <25<br><25 | <25<br><25 | 39 | 26 | <25 | <25 | <25 | <25 | <25 |
| Dissolved Fe | µg/L | 47 | <25 | <25 | – | – | – | – | <25 | <25 | <25 | – | – | – | – |
| Total Mn | µg/L | 9.4 | 8.3 | 0.4 | 24.8<br>9.7 | 10.0<br>9.2 | 4.9<br>3.1 | 1.4<br>0.1 | 7.9 | 7.5 | 0.3 | 7.7 | 7.4 | 0.1 | <0.1 |
| Dissolved Mn | µg/L | 9.2 | 6.0 | 0.3 | – | – | – | – | 7.8 | 5.8 | 0.4 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Prechlorination system failed the day before sampling. System repaired and chlorine residual returned to normal prior to collecting samples.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 11/17/04 | | | 12/01/04 | | | | 12/15/04 | | | 01/05/05 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 21.6 | – | – | 21.2 | 23.3 | – | – | 23.0 | – | – | 23.2 | 25.1 |
| Alkalinity | mg/L[(a)] | 185 | 189 | 189 | 183 | 183 | 175 | 187 | 183 | 183 | 187 | 186<br>186 | 190<br>186 | 198<br>198 | 194<br>190 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.7 | – | – | – | – | 0.5 | 0.5 | 0.5 | – | – | – | – |
| Sulfate | mg/L | 170 | 160 | 170 | – | – | – | – | 190 | 190 | 190 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.06 | <0.06 | 1.4[(c)] | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06 | <0.06<br><0.06 | <0.06<br><0.06 | <0.06<br><0.06 | <0.06<br><0.06 |
| Silica (as $SiO_2$) | mg/L | 37.7 | 37.6 | 37.5 | 37.8 | 37.4 | 37.6 | 37.5 | 38.9 | 38.3 | 38.9 | 38.7<br>39.5 | 38.4<br>38.9 | 39.1<br>38.9 | 38.7<br>39.7 |
| Sulfide | µg/L | – | – | – | <5<br><5 | – | – | – | – | – | – | <5<br><5 | – | – | – |
| $NO_3$-N | mg/L | <0.04 | <0.04 | <0.04 | – | – | – | – | <0.04 | <0.04 | <0.04 | – | – | – | – |
| Turbidity | NTU | 0.5 | 0.3 | 0.3 | 0.4 | 0.3 | 0.1 | 0.2 | 1.1 | 0.3 | 0.4 | 0.4<br>0.5 | 0.3<br>0.4 | 0.1<br>0.1 | 0.2<br>0.1 |
| pH | – | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.7 | 7.7 | 7.6 | 7.6 | 7.7 | 7.8 | 7.8 | 7.7 | 7.7 |
| Temperature | ºC | 29.3 | 30.1 | 30.1 | 29.6 | 30.1 | 29.9 | 30.0 | 29.6 | 30.1 | 30.3 | 29.0 | 30.2 | 30.4 | 30.4 |
| DO | mg/L | 0.4 | 0.6 | 0.5 | 0.6 | 0.7 | 0.8 | 0.6 | 0.6 | 0.6 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 |
| ORP | mV | 27 | 540 | 502 | 78 | 530 | 548 | 565 | 63 | 562 | 520 | 52 | 540 | 566 | 576 |
| Free Chlorine | mg/L | – | 0.7 | 0.7 | – | 0.6 | 0.6 | 0.6 | – | 0.6 | 0.6 | – | 0.5 | 0.5 | 0.4 |
| Total Chlorine | mg/L | – | 0.8 | 0.8 | – | 0.7 | 0.7 | 0.7 | – | 0.7 | 0.7 | – | 0.5 | 0.5 | 0.5 |
| Total Hardness | mg/L[(a)] | 82.7 | 83.4 | 82.7 | – | – | – | – | 97.0 | 97.4 | 99.3 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 67.2 | 67.7 | 67.1 | – | – | – | – | 80.8 | 81.0 | 82.4 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 15.5 | 15.7 | 15.6 | – | – | – | – | 16.2 | 16.4 | 16.9 | – | – | – | – |
| As (total) | µg/L | 22.7 | 23.0 | 5.8 | 26.7 | 27.8 | 10.4 | 11.4 | 23.9 | 23.7 | 5.3 | 20.6<br>20.9 | 21.1<br>21.2 | 4.2<br>4.2 | 4.4<br>4.6 |
| As (total soluble) | µg/L | 22.5 | 23.1 | 5.8 | – | – | – | – | 22.1 | 23.6 | 4.4 | – | – | – | – |
| As (particulate) | µg/L | 0.2 | <0.1 | <0.1 | – | – | – | – | 1.8 | 0.1 | 1.0 | – | – | – | – |
| As (III) | µg/L | 22.0 | 1.4 | 0.1 | – | – | – | – | 22.0 | 2.2 | 1.9 | – | – | – | – |
| As (V) | µg/L | 0.5 | 21.7 | 5.7 | – | – | – | – | 0.1 | 21.4 | 2.5 | – | – | – | – |
| Total Fe | µg/L | 34 | <25 | <25 | 64 | 58 | <25 | <25 | 154 | 73 | <25 | 82<br>75 | 68<br>71 | <25<br><25 | <25<br><25 |
| Dissolved Fe | µg/L | <25 | <25 | <25 | – | – | – | – | 57 | <25 | <25 | – | – | – | – |
| Total Mn | µg/L | 9.1 | 8.8 | 0.3 | 8.2 | 8.3 | 0.4 | 0.3 | 9.7 | 9.6 | 0.4 | 18.1<br>10.1 | 11.0<br>10.3 | 0.2<br><0.1 | <0.1<br><0.1 |
| Dissolved Mn | µg/L | 8.9 | 7.3 | <0.1 | – | – | – | – | 9.0 | 5.4 | 0.2 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Data is questionable due to potential sampling or analytical error. All other results from January 28, 2004 through March 2, 2005 have been below reporting limits.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 01/20/05 | | | 02/02/05 | | | | 02/16/05 | | | 03/02/05 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 25.1 | – | – | 24.7 | 26.6 | – | – | 26.4 | – | – | 26.5 | 28.2 |
| Alkalinity | mg/L[(a)] | 181 | 172 | 189 | 200 | 200 | 191 | 195 | 201 | 201 | 201 | 187 | 178 | 187 | 182 |
| Fluoride | mg/L | 0.7 | 0.8 | 0.7 | – | – | – | – | 0.5 | 0.5 | 0.5 | – | – | – | – |
| Sulfate | mg/L | 251 | 249 | 250 | – | – | – | – | 255 | 255 | 255 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Silica (as $SiO_2$) | mg/L | 37.3 | 36.8 | 36.6 | 36.5 | 37.3 | 37.1 | 36.2 | 39.8 | 40.2 | 40.6 | 39.1 | 39.4 | 39.1 | 38.9 |
| Sulfide | µg/L | – | – | – | <5 <5 | – | – | – | – | – | – | <5 <5 | – | – | – |
| $NO_3$-N | mg/L | <0.05 | <0.05 | <0.05 | – | – | – | – | <0.05 | <0.05 | <0.05 | – | – | – | – |
| Turbidity | NTU | 0.2 | 0.2 | <0.1 | 0.2 | 0.1 | <0.1 | <0.1 | 0.4 | 0.3 | <0.1 | 0.3 | 0.2 | <0.1 | <0.1 |
| pH | – | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 | 7.7 | 7.7 | 7.6 | 7.6 | 7.6 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| Temperature | ºC | 30.6 | 31.0 | 31.2 | 30.8 | 31.2 | 30.9 | 30.8 | 30.6 | 30.7 | 30.7 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| DO | mg/L | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.2 | 0.2 | 0.4 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| ORP | mV | 48 | 518 | 537 | 28 | 523 | 544 | 546 | 20 | 520 | 522 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| Free Chlorine | mg/L | – | 0.7 | 0.6 | – | 0.6 | 0.5 | 0.5 | – | 0.6 | 0.5 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| Total Chlorine | mg/L | – | 0.7 | 0.7 | – | 0.6 | 0.6 | 0.5 | – | 0.6 | 0.6 | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] |
| Total Hardness | mg/L[(a)] | 90.3 | 81.1 | 80.2 | – | – | – | – | 76.8 | 82.8 | 68.3 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 74.8 | 67.0 | 65.8 | – | – | – | – | 63.6 | 70.2 | 55.9 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 15.5 | 14.1 | 14.4 | – | – | – | – | 13.2 | 12.6 | 12.4 | – | – | – | – |
| As (total) | µg/L | 23.0 | 21.3[(c)] | 5.0 | 19.9 | 19.6 | 3.7 | 3.8 | 20.6 | 22.3 | 3.5 | 23.2 | 23.3 | 5.3 | 4.6 |
| As (total soluble) | µg/L | 22.0 | 22.0[(c)] | 4.3 | – | – | – | – | 22.1 | 22.7 | 3.1 | – | – | – | – |
| As (particulate) | µg/L | 1.0 | <0.1 | 0.7 | – | – | – | – | <0.1 | <0.1 | 0.4 | – | – | – | – |
| As (III) | µg/L | 22.1 | 21.6[(c)] | 2.5 | – | – | – | – | 21.7 | 1.6 | 1.6 | – | – | – | – |
| As (V) | µg/L | <0.1 | 0.4 | 1.8 | – | – | – | – | <0.1 | 21.1 | 1.5 | – | – | – | – |
| Total Fe | µg/L | 93 | 43 | <25 | 54 | 49 | <25 | <25 | 119 | 96 | <25 | 43 | 37 | <25 | <25 |
| Dissolved Fe | µg/L | 30 | 25 | <25 | – | – | – | – | 55 | <25 | <25 | – | – | – | – |
| Total Mn | µg/L | 10.5 | 10.2 | 0.3 | 8.7 | 8.1 | 0.1 | 0.7 | 8.4 | 11.2 | 0.1 | 10.7 | 8.3 | 5.0 | 0.1 |
| Dissolved Mn | µg/L | 9.2 | 9.1 | 0.1 | – | – | – | – | 9.1 | 4.7 | <0.1 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Data is questionable due to suspected sampling error. It is speculated that the AC sample may actually have been collected from the IN sample tap on this date. Confirmatory analysis of sample produced similar values. (d) In order to reduce the work load, the operator will be taking on-site water quality parameters once every month.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 03/16/05 | | | 03/30/05 | | | | 04/13/05 | | | 04/27/05 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location / Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TT | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 28.6 | – | – | 28.9 | 30.4 | – | – | 31.0 | – | – | 32.1 | 33.5 |
| Alkalinity | mg/L[(a)] | 196 | 196 | 192 | 189 | 189 | 180 | 189 | 211 | 216 | 180 | 220 | 202 | 202 | 198 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.5 | – | – | – | – | 0.4 | 0.5 | 0.4 | – | – | – | – |
| Sulfate | mg/L | 214 | 199 | 200 | – | – | – | – | 201 | 200 | 195 | – | – | – | – |
| Orthophosphate | mg/L[(b)] | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Silica (as $SiO_2$) | mg/L | 39.0 | 38.9 | 39.2 | 38.4 | 38.3 | 37.5 | 38.4 | 39.4 | 39.2 | 39.4 | 39.9 | 40.5 | 39.7 | 40.0 |
| Sulfide | µg/L | – | – | – | – | – | – | – | – | – | – | <5 <5 | – | – | – |
| $NO_3$-N | mg/L | <0.05 | <0.05 | <0.05 | – | – | – | – | <0.05 | <0.05 | 0.06 | – | – | – | – |
| Turbidity | NTU | 0.3 | 0.3 | <0.1 | 0.2 | 0.2 | <0.1 | <0.1 | 0.5 | 0.5 | 0.1 | 0.5 | 0.3 | <0.1 | <0.1 |
| pH | – | 7.6 | 7.6 | 7.7 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | 7.6 | 7.6 | 7.6 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| Temperature | ºC | 29.9 | 30.2 | 30.4 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | 30.3 | 30.5 | 30.6 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| DO | mg/L | 0.7 | 0.2 | 0.2 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | 0.2 | 0.3 | 0.2 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| ORP | mV | 31 | 540 | 558 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | 63 | 505 | 522 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| Free Chlorine | mg/L | – | 0.4 | 0.4 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | – | 0.4 | 0.5 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| Total Chlorine | mg/L | – | 0.4 | 0.4 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | – | 0.5 | 0.5 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] |
| Total Hardness | mg/L[(a)] | 82.9 | 83.1 | 87.1 | – | – | – | – | 83.0 | 83.1 | 81.2 | – | – | – | – |
| Ca Hardness | mg/L[(a)] | 67.0 | 67.6 | 71.9 | – | – | – | – | 68.4 | 68.8 | 66.2 | – | – | – | – |
| Mg Hardness | mg/L[(a)] | 15.9 | 15.5 | 15.2 | – | – | – | – | 14.6 | 14.3 | 15.0 | – | – | – | – |
| As (total) | µg/L | 20.5 | 21.1 | 5.3 | 22.1 | 22.6 | 6.5 | 6.5 | 26.2 | 21.1 | 5.8 | 25.4 | 25.4 | 8.1 | 9.0 |
| As (total soluble) | µg/L | 21.7 | 22.1 | 5.4 | – | – | – | – | 26.8 | 20.5 | 5.8 | – | – | – | – |
| As (particulate) | µg/L | <0.1 | <0.1 | <0.1 | – | – | – | – | <0.1 | 0.6 | <0.1 | – | – | – | – |
| As (III) | µg/L | 21.7 | 2.0 | 2.6 | – | – | – | – | 20.1 | 2.1 | 2.1 | – | – | – | – |
| As (V) | µg/L | <0.1 | 20.1 | 2.8 | – | – | – | – | 6.7 | 18.4 | 3.7 | – | – | – | – |
| Total Fe | µg/L | 48 | 59 | <25 | 56 | 48 | <25 | <25 | 90 | 72 | <25 | 52 | 47 | <25 | <25 |
| Dissolved Fe | µg/L | 29 | <25 | <25 | – | – | – | – | <25 | 49 | <25 | – | – | – | – |
| Total Mn | µg/L | 8.3 | 13.9 | <0.1 | 9.0 | 9.3 | 0.2 | 0.2 | 9.6 | 15.8 | 0.2 | 8.6 | 8.5 | 0.4 | 0.5 |
| Dissolved Mn | µg/L | 8.8 | 6.3 | <0.1 | – | – | – | – | 6.3 | 7.6 | 0.2 | – | – | – | – |

(a) As $CaCO_3$. (b) As $PO_4$. (c) In order to reduce the work load, the operator will be taking on-site water quality parameters once every month.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 05/11/05 | | | 05/25/05 | | | | 06/07/05 | | | | 06/22/05 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location Parameter | Unit | IN | AC | TT | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TT |
| Bed Volume | $10^3$ | – | – | 34.6 | – | – | 36.1 | 37.3 | – | – | 37.8 | 38.9 | – | – | 40.6 |
| Alkalinity | mg/L[(a)] | 198 | 198 | 198 | 178 | 201 | 187 | 187 | 194 | 189 | 194 | 198 | 185 | 189 | 185 |
| Fluoride | mg/L | 0.5 | 0.5 | 0.5 | – | – | – | – | – | – | – | – | 0.4 | 0.4 | 0.4 |
| Sulfate | mg/L | 174 | 178 | 186 | – | – | – | – | – | – | – | – | 176 | 169 | 177 |
| Orthophosphate | mg/L[(b)] | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Silica (as $SiO_2$) | mg/L | 38.4 | 39.0 | 38.9 | 37.9 | 37.7 | 37.6 | 37.7 | 39.1 | 39.0 | 38.6 | 38.5 | 37.6 | 37.9 | 37.4 |
| Sulfide | µg/L | <5<br><5 | – | – | <5<br><5 | – | – | – | – | – | – | – | <5<br><5 | – | – |
| $NO_3$-N | mg/L | <0.05 | 0.6 | <0.05 | – | – | – | – | – | – | – | – | <0.05 | <0.05 | 0.09 |
| Turbidity | NTU | 0.2 | 0.2 | <0.1 | 0.2 | 2.4 | 2.7 | 0.7 | 0.8 | 1.1 | <0.1 | <0.1 | 1.8 | 0.8 | 0.3 |
| pH | – | 7.6 | 7.6 | 7.6 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | 7.6 | 7.6 | 7.7 |
| Temperature | °C | 31.2 | 31.4 | 31.5 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | 31.4 | 31.6 | 31.7 |
| DO | mg/L | 0.2 | 0.3 | 0.3 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | 0.1 | 0.3 | 0.2 |
| ORP | mV | 50 | 476 | 502 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | 35 | 502 | 514 |
| Free Chlorine | mg/L | – | 0.6 | 0.5 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | – | 0.7 | 0.6 |
| Total Chlorine | mg/L | – | 0.7 | 0.6 | NA[(c)] | NA[(c)] | NA[(c)] | NA[(c)] | NA[(d)] | NA[(d)] | NA[(d)] | NA[(d)] | – | 0.7 | 0.7 |
| Total Hardness | mg/L[(a)] | 82.6 | 82.3 | 80.5 | – | – | – | – | – | – | – | – | 85.3 | 86.1 | 83.3 |
| Ca Hardness | mg/L[(a)] | 69.0 | 69.3 | 66.5 | – | – | – | – | – | – | – | – | 70.3 | 71.0 | 68.5 |
| Mg Hardness | mg/L[(a)] | 13.7 | 13.0 | 14.0 | – | – | – | – | – | – | – | – | 15.0 | 15.0 | 14.8 |
| As (total) | µg/L | 21.2 | 22.1 | 7.1 | 21.0 | 22.1 | 7.5 | 7.3 | 24.3 | 24.8 | 9.0 | 9.2 | 22.8 | 23.7 | 10.1 |
| As (total soluble) | µg/L | 21.2 | 22.8 | 7.2 | – | – | – | – | – | – | – | – | 22.9 | 24.8 | 9.1 |
| As (particulate) | µg/L | <0.1 | <0.1 | <0.1 | – | – | – | – | – | – | – | – | <0.1 | <0.1 | 1.1 |
| As (III) | µg/L | 21.2 | 2.0 | 1.6 | – | – | – | – | – | – | – | – | 22.5 | 3.0 | 2.8 |
| As (V) | µg/L | <0.1 | 20.8 | 5.6 | – | – | – | – | – | – | – | – | 0.4 | 21.8 | 6.2 |
| Total Fe | µg/L | 59 | 64 | <25 | 32 | 30 | <25 | <25 | 73 | 59 | <25 | <25 | 90 | 65 | <25 |
| Dissolved Fe | µg/L | 37 | <25 | <25 | – | – | – | – | – | – | – | – | 46 | 25 | <25 |
| Total Mn | µg/L | 9.3 | 22.0 | 0.3 | 8.4 | 8.0 | 0.2 | 0.1 | 9.2 | 10.2 | 0.2 | 0.2 | 9.6 | 17.4 | 0.5 |
| Dissolved Mn | µg/L | 10.5 | 7.5 | 0.4 | – | – | – | – | – | – | – | – | 10.4 | 8.2 | 0.3 |

(a) As $CaCO_3$. (b) As $PO_4$. (c) In order to reduce the work load, the operator will be taking on-site water quality parameters once every month. (d) Operator left early for training and was not able to take on-site water quality parameters.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 07/06/05 | | | | 08/03/05[d] | | | 08/17/05[e] | | | 08/31/05 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sampling Location**<br>**Parameter** | **Unit** | **IN** | **AC** | **TA** | **TB** | **IN** | **AC** | **TT** | **IN** | **AC** | **TT** | **IN** | **AC** | **TT** |
| Bed Volume | $10^3$ | – | – | 42.8 | 43.2 | – | – | 0.8 | – | – | 2.9 | – | – | 5.1 |
| Alkalinity | mg/L[a] | 176 | 198 | 176 | 198 | 185 | 185 | 189 | – | – | – | 185 | 180 | 185 |
| Fluoride | mg/L | – | – | – | – | 0.5 | 0.5 | 0.5 | – | – | – | 0.5 | 0.5 | 0.5 |
| Sulfate | mg/L | – | – | – | – | 176 | 175 | 162 | – | – | – | 194 | 192 | 194 |
| Orthophosphate | mg/L[b] | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | – | – | – | <0.05 | <0.05 | <0.05 |
| Silica (as $SiO_2$) | mg/L | 38.9 | 37.9 | 38.3 | 38.2 | 37.5 | 36.8 | 33.7 | – | – | – | 39.6 | 39.6 | 38.7 |
| Sulfide | μg/L | <5<br><5 | – | – | – | <5<br><5 | – | – | – | – | – | <5<br>- | – | – |
| $NO_3$-N | mg/L | – | – | – | – | 0.06 | <0.05 | <0.05 | – | – | – | 0.2 | 0.3 | 1.0 |
| Turbidity | NTU | 0.3 | 0.4 | <0.1 | <0.1 | 0.7 | 0.3 | <0.1 | – | – | – | 1.5 | 0.2 | 0.2 |
| TSS | mg/L | – | – | – | – | – | – | – | – | – | – | 1 | – | – |
| pH | – | NA[c] | NA[c] | NA[c] | NA[c] | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.8 | 7.8 | 7.8 | 7.7 |
| Temperature | ºC | NA[c] | NA[c] | NA[c] | NA[c] | 31.6 | 31.8 | 31.6 | 29.9 | 30.9 | 31.2 | 31.4 | 31.7 | 31.9 |
| DO | mg/L | NA[c] | NA[c] | NA[c] | NA[c] | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.3 |
| ORP | mV | NA[c] | NA[c] | NA[c] | NA[c] | 14 | 512 | 520 | 52 | 370 | 410 | 65 | 502 | 518 |
| Free Chlorine | mg/L | NA[c] | NA[c] | NA[c] | NA[c] | – | 1.0 | 0.5 | – | 0.6 | 0.3 | – | 0.6 | 0.4 |
| Total Chlorine | mg/L | NA[c] | NA[c] | NA[c] | NA[c] | – | – | – | – | – | – | – | – | – |
| Total Hardness | mg/L[a] | – | – | – | – | 83.2 | 80.7 | 82.6 | – | – | – | 83.1 | 85.0 | 85.5 |
| Ca Hardness | mg/L[a] | – | – | – | – | 69.4 | 67.0 | 68.7 | – | – | – | 69.2 | 70.5 | 70.9 |
| Mg Hardness | mg/L[a] | – | – | – | – | 13.8 | 13.7 | 13.9 | – | – | – | 13.9 | 14.6 | 14.5 |
| As (total) | μg/L | 22.3 | 22.9 | 11.9 | 8.9 | 24.1 | 31.5 | 6.8 | 24.5 | 24.7 | 7.6 | 25.7 | 27.1 | 2.2 |
| As (total soluble) | μg/L | – | – | – | – | 21.5 | 21.9 | 2.7 | – | – | – | 22.5 | 23.7 | 1.8 |
| As (particulate) | μg/L | – | – | – | – | 2.6 | 9.6 | 4.1 | – | – | – | 3.3 | 3.4 | 0.5 |
| As (III) | μg/L | – | – | – | – | 23.1 | 3.8 | 3.3 | – | – | – | 21.3 | 1.7 | 1.6 |
| As (V) | μg/L | – | – | – | – | <0.1 | 18.1 | <0.1 | – | – | – | 1.2 | 22.0 | 0.2 |
| Total Fe | μg/L | 51 | 51 | <25 | <25 | 77 | 41 | <25 | 290 | 33 | <25 | 186 | 47 | <25 |
| Dissolved Fe | μg/L | – | – | – | – | <25 | <25 | <25 | – | – | – | 30 | 18 | <25 |
| Total Mn | μg/L | 8.4 | 9.4 | 0.6 | 0.4 | 8.9 | 9.1 | 0.3 | 10.6 | 8.0 | 0.4 | 10.6 | 9.7 | 0.4 |
| Dissolved Mn | μg/L | – | – | – | – | 8.7 | 7.3 | 0.2 | – | – | – | 10.3 | 8.3 | 0.5 |

(a) As $CaCO_3$. (b) As $PO_4$. (c) In order to reduce the work load, the operator will be taking on-site water quality parameters once every month. (d) System was switched off July 14, 2005 and placed back online July 29, 2005. The bottom laterals, under bedding, and media were replaced and other system repairs were performed during the downtime. (e) The sampling schedule has been modified to reduce the number of analytes starting August 17, 2005.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 09/14/05(c) | | | 09/28/05 | | | 10/12/05(c) | | | | 10/26/05 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sampling Location Parameter** | **Unit** | **IN** | **AC** | **TT** | **IN** | **AC** | **TT** | **IN** | **AC** | **TA** | **TB** | **IN** | **AC** | **TT** |
| Bed Volume | $10^3$ | – | – | 6.9 | – | – | 9.2 | – | – | 10.9 | 11.2 | – | – | 12.6 |
| Alkalinity | mg/L(a) | – | – | – | 180 | 198 | 189 | 198 | 198 | 198 | 198 | 198 | 198 | 198 |
| Fluoride | mg/L | – | – | – | 0.4 | 0.4 | 0.4 | – | – | – | – | 0.4 | 0.4 | 0.4 |
| Sulfate | mg/L | – | – | – | 156 | 157 | 158 | – | – | – | – | 201 | 200 | 199 |
| Orthophosphate | mg/L(b) | – | – | – | <0.05 | <0.05 | <0.05 | – | – | – | – | – | – | – |
| Total P (as $PO_4$) | mg/L(b) | – | – | – | – | – | – | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| Silica (as $SiO_2$) | mg/L | – | – | – | 38.7 | 38.6 | 38.9 | 36.8 | 36.2 | 36.1 | 35.6 | 37.7 | 38.5 | 38.4 |
| Sulfide | µg/L | – | – | – | <5<br><5 | – | – | <5<br><5 | – | – | – | <5<br><5 | – | – |
| $NO_3$-N | mg/L | – | – | – | <0.05 | 0.4 | <0.05 | – | – | – | – | <0.05 | <0.05 | <0.05 |
| Turbidity | NTU | – | – | – | 1.0 | 0.2 | 0.2 | 0.5 | 0.3 | <0.1 | <0.1 | 0.3 | 0.1 | <0.1 |
| TSS | mg/L | – | – | – | – | – | – | – | – | – | – | <1 | <1 | <1 |
| pH | – | NA(c) | NA(c) | NA(c) | 7.8 | 7.9 | 7.9 | NA(c) | NA(c) | NA(c) | NA(c) | 7.8 | 7.8 | 7.8 |
| Temperature | ºC | NA(c) | NA(c) | NA(c) | 31.5 | 31.7 | 31.8 | NA(c) | NA(c) | NA(c) | NA(c) | 30.2 | 30.8 | 30.9 |
| DO | mg/L | NA(c) | NA(c) | NA(c) | 0.2 | 0.2 | 0.2 | NA(c) | NA(c) | NA(c) | NA(c) | 0.2 | 0.2 | 0.2 |
| ORP | mV | NA(c) | NA(c) | NA(c) | 51 | 507 | 576 | NA(c) | NA(c) | NA(c) | NA(c) | 22 | 514 | 522 |
| Free Chlorine | mg/L | NA(c) | 0.8 | 0.6 | – | 0.8 | 0.5 | NA(c) | 0.6 | NA(c) | NA(c) | – | 0.6 | 0.6 |
| Total Chlorine | mg/L | NA(c) | NA(c) | NA(c) | – | – | – | NA(c) | NA(c) | NA(c) | NA(c) | – | 0.8 | 0.6 |
| Total Hardness | mg/L(a) | – | – | – | 81.4 | 74.5 | 75.2 | – | – | – | – | 84.2 | 87.4 | 86.4 |
| Ca Hardness | mg/L(a) | – | – | – | 68.2 | 61.1 | 61.4 | – | – | – | – | 69.9 | 72.4 | 71.3 |
| Mg Hardness | mg/L(a) | – | – | – | 13.2 | 13.4 | 13.8 | – | – | – | – | 14.2 | 15.1 | 15.1 |
| As (total) | µg/L | 21.8 | 22.5 | 2.8 | 24.6 | 22.5 | 4.0 | 23.5 | 23.1 | 4.5 | 4.3 | 23.8 | 23.3 | 3.9 |
| As (total soluble) | µg/L | – | – | – | 24.4 | 22.7 | 3.7 | – | – | – | – | 23.1 | 22.3 | 3.7 |
| As (particulate) | µg/L | – | – | – | 0.2 | <0.1 | 0.2 | – | – | – | – | 0.7 | 1.1 | 0.2 |
| As (III) | µg/L | – | – | – | 22.3 | 2.6 | 2.9 | – | – | – | – | 22.2 | 1.9 | 2.0 |
| As (V) | µg/L | – | – | – | 2.1 | 20.1 | 0.9 | – | – | – | – | 1.0 | 20.4 | 1.8 |
| Total Fe | µg/L | 77 | 53 | <25 | 187 | 33 | <25 | 62 | 65 | <25 | <25 | 43 | 36 | <25 |
| Dissolved Fe | µg/L | – | – | – | <25 | <25 | <25 | – | – | – | – | 39 | <25 | <25 |
| Total Mn | µg/L | 8.7 | 9.9 | 0.2 | 10.2 | 9.4 | <0.1 | 8.9 | 9.4 | 0.1 | 0.2 | 8.8 | 8.8 | 0.2 |
| Dissolved Mn | µg/L | – | – | – | 10.1 | 6.9 | <0.1 | – | – | – | – | 9.0 | 6.6 | 0.2 |

(a) As $CaCO_3$. (b) As $PO_4$. (c) Operator did not have time to collect on-site water quality parameters although free $Cl_2$ was collected for AC and TT on 09/14/05.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

# Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 11/09/05 | | | | 11/30/05 | | | 12/14/05 | | | | 01/04/06 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sampling Location / Parameter** | **Unit** | **IN** | **AC** | **TA** | **TB** | **IN** | **AC** | **TT** | **IN** | **AC** | **TA** | **TB** | **IN** | **AC** | **TT** |
| Bed Volume | $10^3$ | – | – | 14.1 | 14.4 | – | – | 16.5 | – | – | 17.5 | 18.3 | – | – | 20.1 |
| Alkalinity | mg/L(a) | 189 | 189 | 198 | 194 | 185 | 189 | 189 | 185 | 194 | 198 | 198 | 189 | 198 | 194 |
| Fluoride | mg/L | – | – | – | – | 0.4 | 0.4 | 0.4 | – | – | – | – | 0.4 | 0.4 | 0.4 |
| Sulfate | mg/L | – | – | – | – | 161 | 162 | 161 | – | – | – | – | 165 | 170 | 165 |
| Orthophosphate | mg/L(b) | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Total P (as $PO_4$) | mg/L(b) | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| Silica (as $SiO_2$) | mg/L | 36.5 | 37.0 | 36.7 | 36.9 | 38.2 | 38.4 | 38.5 | 37.4 | 37.9 | 38.1 | 38.1 | 38.2 | 36.9 | 37.6 |
| Sulfide | µg/L | <5<br><5 | – | – | – | <5<br><5 | – | – | – | – | – | – | <5<br><5 | – | – |
| $NO_3$-N | mg/L | – | – | – | – | <0.05 | <0.05 | <0.05 | – | – | – | – | <0.05 | <0.05 | <0.05 |
| Turbidity | NTU | 0.2 | 0.1 | <0.1 | <0.1 | 0.2 | 0.1 | <0.1 | 1.0 | 1.4 | 0.6 | 0.8 | 0.5 | 0.5 | 0.2 |
| TSS | mg/L | – | – | – | – | 1 | <1 | <1 | – | – | – | – | <1 | – | – |
| pH | – | NA(c) | NA(c) | NA(c) | NA(c) | 7.7 | 7.7 | 7.7 | NA(c) | NA(c) | NA(c) | NA(c) | 7.7 | 7.7 | 7.8 |
| Temperature | ºC | NA(c) | NA(c) | NA(c) | NA(c) | 31.0 | 31.3 | 31.4 | NA(c) | NA(c) | NA(c) | NA(c) | 30.6 | 30.8 | 30.8 |
| DO | mg/L | NA(c) | NA(c) | NA(c) | NA(c) | 0.3 | 0.3 | 0.2 | NA(c) | NA(c) | NA(c) | NA(c) | 0.1 | 0.2 | 0.2 |
| ORP | mV | NA(c) | NA(c) | NA(c) | NA(c) | 33 | 505 | 524 | NA(c) | NA(c) | NA(c) | NA(c) | 18 | 495 | 512 |
| Free Chlorine | mg/L | – | NA(c) | NA(c) | NA(c) | – | 0.8 | 0.6 | – | NA(c) | NA(c) | NA(c) | – | 0.8 | 0.7 |
| Total Chlorine | mg/L | – | NA(c) | NA(c) | NA(c) | – | NA | NA | – | NA(c) | NA(c) | NA(c) | – | NA | NA |
| Total Hardness | mg/L(a) | – | – | – | – | 90.2 | 87.1 | 88.1 | – | – | – | – | 86.3 | 86.7 | 86.1 |
| Ca Hardness | mg/L(a) | – | – | – | – | 75.5 | 73.1 | 74.2 | – | – | – | – | 71.3 | 72.0 | 71.3 |
| Mg Hardness | mg/L(a) | – | – | – | – | 14.8 | 14.0 | 13.9 | – | – | – | – | 15.0 | 14.7 | 14.8 |
| As (total) | µg/L | 24.7 | 24.1 | 3.7 | 3.7 | 18.6 | 21.8 | 5.0 | 21.4 | 21.1 | 4.3 | 4.3 | 21.5 | 21.8 | 3.9 |
| As (total soluble) | µg/L | – | – | – | – | 19.7 | 21.0 | 4.9 | – | – | – | – | 22.2 | 22.6 | 3.9 |
| As (particulate) | µg/L | – | – | – | – | <0.1 | 0.8 | <0.1 | – | – | – | – | <0.1 | <0.1 | <0.1 |
| As (III) | µg/L | – | – | – | – | 19.1 | 2.0 | 2.2 | – | – | – | – | 21.8 | 0.9 | 1.0 |
| As (V) | µg/L | – | – | – | – | 0.5 | 19.0 | 2.7 | – | – | – | – | 0.4 | 21.6 | 2.9 |
| Total Fe | µg/L | 32 | 26 | <25 | <25 | 46 | 27 | <25 | 42 | 36 | <25 | <25 | 65 | 53 | <25 |
| Dissolved Fe | µg/L | – | – | – | – | 27 | <25 | <25 | – | – | – | – | 29 | <25 | <25 |
| Total Mn | µg/L | 7.9 | 7.4 | <0.1 | <0.1 | 8.8 | 8.9 | 0.6 | 8.9 | 8.6 | 0.8 | 0.6 | 9.1 | 9.5 | 0.4 |
| Dissolved Mn | µg/L | – | – | – | – | 9.0 | 7.8 | 0.4 | – | – | – | – | 9.0 | 7.6 | 0.3 |

(a) As $CaCO_3$. (b) As $PO_4$. (c) In order to reduce work load, the operator will be taking on-site water quality parameters once every month.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B; TT = after tanks combined. NA = data not available.

## Table B-1. Analytical Results from Long-Term Sampling, Desert Sands MDWCA (Continued)

| Sampling Date | | 02/01/06[a] | | | | 02/15/06 | | | | 03/01/06 | | | | 03/15/06 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 22.2 | 23.3 | – | – | 23.5 | 24.7 | – | – | 24.8 | 26.1 | – | – | 26.3 | 27.4 |
| As (total) | µg/L | 24.8 | 24.8 | 5.8 | 6.3 | 23.6 | 25.1 | 6.8 | 7.0 | 21.5 | 22.6 | 4.6 | 5.7 | 25.3 | 24.1 | 5.6 | 5.7 |
| Fe (total) | µg/L | 66.8 | 73.6 | <25 | <25 | <25 | <25 | <25 | <25 | 70.7 | 50.3 | <25 | <25 | 66.3 | 61.0 | <25 | <25 |
| Mn (total) | µg/L | 10.3 | 11.6 | 0.5 | 0.5 | 6.9 | 7.7 | <0.1 | 0.2 | 9.5 | 9.3 | <0.1 | 0.2 | 9.3 | 12.8 | 0.3 | 0.3 |

| Sampling Date | | 03/29/06 | | | | 04/12/06 | | | | 04/26/06 | | | | 05/10/06 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 27.7 | 29.1 | – | – | 29.7 | 31.1 | – | – | 31.6 | 33.1 | – | – | 33.4 | 35.1 |
| As (total) | µg/L | 23.0 | 22.4 | 4.7 | 5.7 | 23.9 | 24.0 | 6.9 | 7.3 | 22.4 | 22.0 | 5.4 | 6.2 | 23.4<br>23.5 | 24.0<br>23.6 | 6.1<br>6.2 | 6.7<br>6.7 |
| Fe (total) | µg/L | 82.3 | 59.5 | <25 | <25 | 97.3 | 56.5 | <25 | <25 | 56.4 | 34.8 | <25 | <25 | 234<br>250 | 112<br>110 | <25<br><25 | <25<br><25 |
| Mn (total) | µg/L | 8.4 | 8.4 | 0.1 | 0.5 | 9.2 | 9.7 | 0.6 | 0.7 | 8.6 | 9.0 | 0.2 | 0.5 | 15.7<br>14.3 | 13.7<br>13.6 | 0.7<br>0.6 | 0.8<br>0.7 |

| Sampling Date | | 05/24/06 | | | | 06/07/06 | | | | 06/21/06 | | | | 07/05/06 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 35.7 | 37.4 | – | – | 38.2 | 40.1 | – | – | 40.6 | 42.7 | – | – | 43.1 | 45.1 |
| As (total) | µg/L | 22.1 | 23.6 | 6.3 | 7.4 | 23.1 | 22.5 | 7.6 | 7.7 | 24.9 | 24.7 | 7.5 | 8.3 | 21.6 | 22.0 | 8.8 | 7.3 |
| Fe (total) | µg/L | 83.2 | 70.8 | <25 | <25 | 119 | 77.2 | <25 | <25 | 62.9 | 53.8 | <25 | <25 | 90.5 | 64.5 | <25 | <25 |
| Mn (total) | µg/L | 7.5 | 8.1 | <0.1 | 0.5 | 9.8 | 10.1 | 0.6 | 0.7 | 9.5 | 10.1 | 0.5 | 0.6 | 10.6 | 10.0 | 1.0 | 0.8 |

| Sampling Date | | 07/19/06 | | | | 08/02/06 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Location<br>Parameter | Unit | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB | IN | AC | TA | TB |
| Bed Volume | $10^3$ | – | – | 45.1 | 47.2 | – | – | | | | | | | | | | |
| As (total) | µg/L | 24.9 | 24.7 | 8.7 | 9.2 | 25.9 | 24.8 | 9.6 | 10.1 | | | | | | | | |
| Fe (total) | µg/L | 1151 | 65.7 | <25 | <25 | 65.2 | 39.5 | <25 | <25 | | | | | | | | |
| Mn (total) | µg/L | 12.9 | 14.2 | 0.8 | 0.8 | 9.5 | 10.1 | 0.4 | 0.3 | | | | | | | | |

(a) Sampling reduced to biweekly for As, Fe, and Mn only.
IN = inlet; AC = after prechlorination; TA = after tank A; TB = after tank B.