THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**ARSENIC ADSORPTION MEDIA FILTER USED IN DRINKING WATER TREATMENT SYSTEMS**		
APPLICATION:	**REMOVAL OF ARSENIC IN DRINKING WATER**		
TECHNOLOGY NAME:	**ADI PILOT TEST UNIT NO. 2002-09 WITH MEDIA G2®**		
COMPANY:	**ADI INTERNATIONAL INC.**		
ADDRESS:	**SUITE 300** **1133 REGENT STREET** **FREDERICTON, NB E3B 3Z2 CANADA**	PHONE: FAX:	**(506) 452-9000** **(506) 459-3954**
WEB SITE: EMAIL:	**www.adi.ca** **mjm@adi.ca**		

The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

NSF International (NSF), in cooperation with the EPA, operates the Drinking Water Systems (DWS) Center, one of seven technology areas under the ETV Program. The DWS Center recently evaluated the performance of an adsorption media filter system for the reduction of arsenic in drinking water. This verification statement provides a summary of the test results for the ADI Pilot Test Unit No. 2002-09 with MEDIA G2® system. Gannett Fleming, Inc., an NSF-qualified field testing organization (FTO), performed the verification testing. The verification report contains a comprehensive summary of the verification test.

ABSTRACT

Verification testing of the ADI International Inc. Pilot Test Unit No. 2002-09 with MEDIA G2® arsenic adsorption media filter system was conducted at the Hilltown Township Water and Sewer Authority (HTWSA) Well Station No. 1 in Sellersville, Pennsylvania from October 8, 2003 through May 28, 2004. The source water was groundwater from Well No. 1, one of HTWSA's three groundwater supply wells. The treatment unit feed water for the verification test was withdrawn from an on-site chlorine detention tank, which contained groundwater that had been disinfected with sodium hypochlorite. Verification testing was conducted under manufacturer-specified operating conditions. The feed water, with an average total arsenic concentration of 21 µg/L and a pH of 7.6, was treated with sulfuric acid to lower the pH to 6.4 prior to the treatment unit. When operated under the manufacturer's specified conditions for this site and at the design flow rate of 1.7 gpm, the ADI International Inc. Pilot Test Unit No. 2002-09 with MEDIA G2® system reduced the total arsenic concentration from an average of 21 µg/L in the feed water to an average of 7 µg/L in the treated water.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

MEDIA G2® is an iron-based adsorption treatment technology for removing arsenic from drinking water supplies, specifically groundwater. MEDIA G2® arsenic adsorption media consists of an inorganic, natural substrate to which iron (ferric hydroxide) has been chemically bonded. The iron attracts metallic ions in water and binds them to the substrate by chemisorption. The arsenic adsorption filter pilot unit used in this test consisted of one vessel containing MEDIA G2® adsorption media which was operated in a downflow mode. Arsenic is removed by the technology by adsorption onto the filter media as water passes through the media. Over time, as the media becomes saturated with arsenic, the concentration of arsenic in the treated water begins to increase. Before the treated water arsenic concentration reaches the pre-determined maximum allowable contaminant level (breakthrough), the media is either replaced or regenerated on-site. ADI has stated that MEDIA G2® can be regenerated four to five times, with a loss in capacity of approximately 10% following each regeneration.

MEDIA G2® is a registered trade mark of ADI International Inc. and is protected by US Patent No. 6,200,482. MEDIA G2® adsorption media is certified under NSF/ANSI Standard 61 for water treatment plant applications. MEDIA G2® treatment units can be used for groundwater supplies of any size and require limited manpower and operating skills. The filter system can operate continuously or intermittently. The filter tank is freestanding, and filter components, which are modular in nature, can be installed by a qualified plumber. The filter system requires only a level surface capable of supporting its weight, sustained ambient temperature above 35°F, a feed water pressure between 20 and 125 psi, and flow rate control.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was the HTWSA Well No. 1 in Sellersville, Pennsylvania. The source water was groundwater from Well No. 1, which was first disinfected with sodium hypochlorite. Well No. 1 is one of three wells currently used to supply the HTWSA water distribution system. The feed water quality was particularly variable for a groundwater supply. During the verification test, the turbidity ranged from 0.15 NTU to 7.6 NTU and averaged 0.70 NTU. The feed water iron concentration ranged from 47 µg/L to 1,120 µg/L and averaged 180 µg/L. The feed water manganese concentration ranged from 77 µg/L to 1,070 µg/L and averaged 140 µg/L. The feed water was characterized as having a high level of hardness,

270 mg/L as $CaCO_3$, and a high degree of buffering as indicated by an alkalinity of 120 mg/L as $CaCO_3$. The raw water pH was relatively stable at 7.6, but the feed water pH varied due to the operation of the acid feed pump. It ranged from 5.7 to 7.1, with an average of 6.4. The feed water total arsenic concentration ranged from 12 µg/L to 63 µg/L and averaged 21 µg/L.

Methods and Procedures

Operations, sampling, and analytical procedures were performed in a manner that ensured the quality of the data collected and provided an accurate evaluation of the treatment system under field conditions. The verification test consisted of three main phases. The first phase, the Integrity Test, evaluated the reliability of equipment operation under the environmental and hydraulic conditions at the well station site during the initial two weeks of testing. The second phase, the Capacity Test, evaluated the capacity of the arsenic adsorption system with respect to arsenic. The third phase of the test monitored the performance of the system for one month following regeneration.

The Integrity Test ran for 13 full days plus eight hours, during which the field test operator was on-site twice per day to monitor the test equipment, collect data, and collect water samples for analysis. The Capacity Test began in conjunction with the Integrity Test on October 8, 2003 and continued through the media regeneration on April 30, 2004. One month of post-regeneration operation began on April 30, 2004 and continued through May 28, 2004. The treatment system was operated continuously, independent of the well operations, using water supplied from the well station's pressurized chlorine detention tank. Flow rate, production volume, and pressure were monitored and recorded twice per day. Raw, feed (before and after addition of sulfuric acid), and treated water samples were analyzed for pH, temperature, turbidity, alkalinity, calcium, magnesium, hardness, free available chlorine, and fluoride by the field test operator. Samples were collected and delivered to the Pennsylvania Department of Environmental Protection Laboratory to be analyzed for silica, sodium, aluminum, iron, manganese, chloride, sulfate, and total phosphorus. Arsenic samples were collected and sent to NSF's laboratories for analysis. A total of 14 sets of arsenic samples were speciated during the test to determine the relative concentration of soluble arsenic compared to total arsenic, and, with respect to the soluble arsenic, the relative amounts of arsenic III and arsenic V.

Complete descriptions of the verification testing results and quality assurance/quality control procedures are included in the verification report.

VERIFICATION OF PERFORMANCE

System Operation

The verification test was conducted under the manufacturer's specified operating conditions. Contact time is a critical parameter for arsenic adsorption efficiency and is dependent upon maintaining the flow rate within the design range of 1.7 gpm ± 0.1 gpm. A pressure-reducing valve was used to reduce the pressure from the chlorine detention tank from 110 psi to 50 psi to make throttling the flow rate easier for the operator. A relatively constant flow rate was maintained, with minimal flow rate adjustments required. The system was operated continuously, 24 hours each day, for the entire test. The filter unit was manually backwashed and rinsed 15 times throughout the test, based on the accumulation of filter bed headloss.

Water Quality Results

The results of total arsenic analyses are shown in Figure VS-1. During the Capacity Test, the feed water total arsenic concentration averaged 21 µg/L, with 13 µg/L in the soluble state. Pretreatment with hypochlorite completely converted the feed water soluble arsenic to the arsenic V species. The treated

water total arsenic concentration averaged 7 µg/L during the Capacity Test, all of which was in the soluble state. For calculation of the media capacity to remove arsenic from the feed water, 430,000 gallons were treated from October 8, 2003 through April 22, 2004 during the Capacity Test. The treated water volume represents 25,000 media bed volumes, based on the calculated bed volume of 2.3 cubic feet and an empty bed contact time of ten minutes. Based on the feed and treated water total arsenic concentrations during the Capacity Test, the capacity of the media for this system, through April 22, 2004, was 470 µg arsenic per gram of media.

One media regeneration was performed during the verification test. As shown in Figure VS-1, treated water arsenic concentrations were elevated for several hours following the media regeneration. However, the post-regeneration treated water arsenic concentration (April 30, 2004 through May 28, 2004) returned to a level similar to that observed at the beginning of the Capacity Test, averaging 4 µg/L, which indicates that the media regeneration was successful.

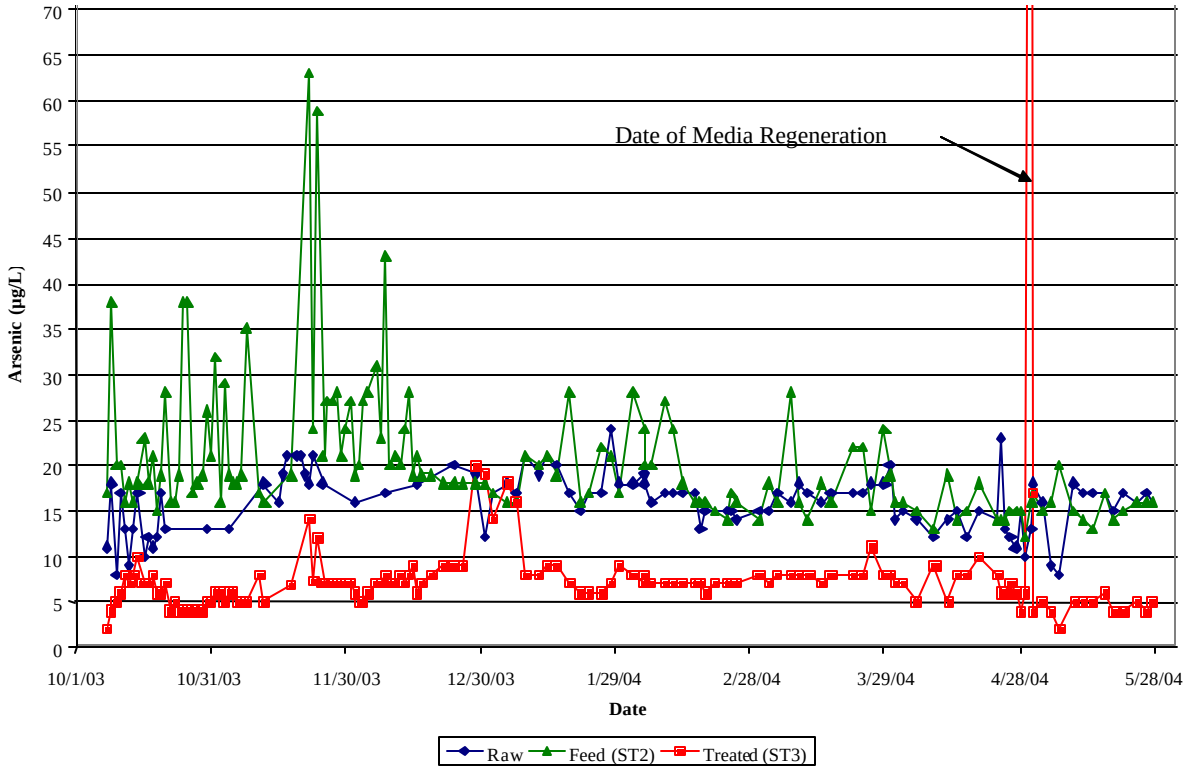

Figure VS-1. Capacity Test Arsenic Concentration.

The addition of sulfuric acid prior to the treatment unit reduced the pH of the raw water from an average of 7.6 to 6.4 in the feed water. The pH reduction corresponded with a 21% reduction in alkalinity. The sulfate concentration increased from an average of 100 mg/L in the raw water to 160 mg/L in the feed water, following the addition of sulfuric acid. The feed water pH appeared to have a significant impact on the treatment unit's ability to remove arsenic. The highest treated water arsenic concentrations occurred when the feed water pH was highest. The manufacturer indicated that the feed water pH should be maintained between 6.5 and 6.8 for optimum arsenic removal, but difficulties encountered with the acid feed pump operation resulted in several periods during the verification test when the pH was above this range. As an example of the correlation, a decrease in feed water pH from 7.1 to 6.2 on the ninth day of the test resulted in a 70% decrease in the treated water arsenic concentration. Thereafter, correlations in treated water arsenic with the feed water pH were not as significant but continued to occur. At the request

of the manufacturer, testing was carried out at reduced pH from April 23, 2004 through April 30, 2004. During the reduced pH operation, the treated water arsenic concentration averaged 6 µg/L.

Feed water calcium and hardness concentrations were reduced only slightly through the adsorption filter. The average feed water iron and manganese concentrations during the Capacity Test, 180 µg/L and 140 µg/L, respectively, were significantly reduced by the adsorption filter. The treated water iron concentration averaged 68 µg/L and the treated water manganese concentration averaged 16 µg/L. Turbidity was also reduced by the adsorption filter during the Capacity Test, from an average of 0.70 NTU in the feed water to 0.30 NTU in the treated water. The silica concentration increased by an average of 15%, from a feed concentration of 28 mg/L to a treated water concentration of 33 mg/L. Sodium, fluoride, chloride, aluminum, and sulfate concentrations were generally unaffected by the adsorption filter.

Operation and Maintenance Results

The verification test began on October 8, 2003 and ended on May 28, 2004. The treatment unit operated manually, including backwash cycles, throughout the test. The majority of operator time and attention was spent on water quality and equipment testing. Equipment operation required minimal operator attention overall, with the exception of the sulfuric acid metering pump, which required frequent re-priming and feed rate adjustment to maintain the feed water pH within the manufacturer's stated operating range. Periodic manual filter backwashes each required 1.5 to 2 hours of operator time, and media regeneration required approximately five hours. Fifteen manual filter backwashes and one media regeneration were performed during the verification test. The backwash water was relatively turbid and contained elevated concentrations of iron, manganese, aluminum, and arsenic. Arsenic in the backwash water was primarily in particulate form, which indicates the removal of particulate material from the filter, not desorption of arsenic from the media. The treated water arsenic concentration returned to approximately that of the new media following the media regeneration, which indicates a successful regeneration. However, a spike in the treated water arsenic concentration occurred when the unit was returned to service following the media regeneration. Modification of the media regeneration procedures and increased on-site monitoring of the treated water arsenic concentration may be required to prevent returning a unit to service with an elevated treated water arsenic concentration immediately following regeneration. Other than monitoring the metering pump and performing filter backwashes, regular operator attention was primarily required to verify, adjust, and maintain a constant flow rate.

Consumables and Waste Generation

Electrical power was required only for the metering pump and a solenoid valve. The solenoid valve was provided to automatically shut off the feed water supply in the event of a power outage to prevent water from entering the treatment unit without pH adjustments. Wastewater from each filter backwash and rinse was discharged to a sanitary sewer adjacent to the well station. The total water usage for each backwash and rinse was approximately 200 gallons, for a total backwash and rinse water usage of 2,800 gallons. The backwash and rinse water usage represents 0.5% of the total throughput of 520,000 gallons during the test, including the Integrity, Capacity, and post-regeneration phases.

The media regeneration, which was performed once during the verification test following seven months of operation, required three bed volumes (50 gallons) of 1% caustic soda, 20 gallons of 0.5% sulfuric acid solution, and rinse water.

Quality Assurance/Quality Control

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a

technical systems audit during the verification test to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

Original Signed by	*Original Signed by*
Sally Gutierrez *8/19/05*	*Robert Ferguson* *8/30/05*
Sally Gutierrez Date	Robert Ferguson Date
Director	Vice President
National Risk Management Research Laboratory	Water Systems
Office of Research and Development	NSF International
United States Environmental Protection Agency	

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and NSF make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end-user is solely responsible for complying with any and all applicable federal, state, and local requirements. Mention of corporate names, trade names, or commercial products does not constitute endorsement or recommendation for use of specific products. This report is not an NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents

Copies of the *ETV Protocol for Equipment Verification Testing for Arsenic Removal* dated April 2002, the verification statement, and the verification report (NSF Report #05/10/EPADWCTR) are available from the following sources:
(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy)