NSF International
Ann Arbor, Michigan

Product-Specific Test Plan Adsorptive Media Process for the Removal of Arsenic Kinetico Inc. and Alcan Chemicals Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50

Prepared by:

GANNETT FLEMING
Harrisburg, Pennsylvania

Under a Cooperative Agreement with the U. S. Environmental Protection Agency

Jeffrey Q. Adams, Project Officer
National Risk Management Research Laboratory
U. S. Environmental Protection Agency
Cincinnati, Ohio

March 2003

Product-Specific Test Plan

Adsorptive Media Process for the Removal of Arsenic

Kinetico Inc. and Alcan Chemicals
Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50

Prepared for:

NSF International
Ann Arbor, Michigan 48105

Prepared by:

Gannett Fleming, Inc.
Harrisburg, PA 17106-7100

Under a Cooperative Agreement with the U.S. Environmental Protection Agency

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The purpose of this Product-Specific Test Plan (PSTP) is to provide procedures for specific types of water treatment units to manufacturers wishing to participate in the EPA/NSF Environmental Technology Verification (ETV) Drinking Water Systems (DWS) Center. By participating in this ETV, manufacturers can have EPA and NSF verified third–party test data produced for their equipment from testing shaped by the manufacturers' performance claims. This verification program will serve to greatly accelerate the entrance of innovative water treatment technologies into the domestic and international marketplace, making cutting-edge water treatment technology widely available. This verification program could result in substantial savings in money and time to water purveyors and manufacturers, since this program may allow manufacturers to reduce or eliminate having to demonstrate product performance at every site considering a specific treatment technology.

In order to have a meaningful verification program, strict operation and testing protocol must be followed. This PSTP endeavors to provide these strict protocols. This PSTP was prepared through reference to the *EPA/NSF ETV Protocol for Equipment Verification Testing for Arsenic Removal* (April 2002), which includes the *EPA/NSF ETV Equipment Verification Testing Plan for Adsorptive Media Processes for the Removal of Arsenic* (Chapter 6), and has attempted to precisely follow the referenced sources. This document can be downloaded at the NSF/ETV web site: www.nsf.org/verification/verification.html and the EPA/ETV web site: www.epa.gov/etv. Paper copies of the Protocol and Test Plan are also available. They can be obtained by contacting NSF International at (734) 769-8010. One of the requirements of the ETV is that the verification testing be conducted by an independent party not associated with any manufacturing interest. The independent party is referred to as the Field Testing Organization (FTO). The FTO for this verification testing is Gannett Fleming, Inc. The verification testing is based upon the premise that the FTO designs a test plan with Data Quality Objectives (DQO) based upon the manufacturer's equipment performance objectives. The subsequent report provides a factual presentation of the test plan.

The treatment unit to be tested in this verification testing is the Kinetico Para-Flo™ PF60 Model AA08AS containing Alcan Chemicals' AAFS50 media (the arsenic adsorption media filter). Kinetico, Inc. and Alcan Chemicals have entered into an agreement to jointly market this treatment unit. It is the FTO's hope that this document will serve the interest of EPA, NSF, the manufacturing community and especially water purveyors.

Abbreviations and Acronyms

ANOVA	Analysis of Variance
ANSI	American National Standards Institute
AWWA	American Water Works Association
AA	Activated Alumina
BET	Brunauer, Emmett and Teller
CA WET	California Waste Extraction Tests
cm	Centimeter
°C	Degrees Celsius
C.U.	Platinum-Cobalt Color Units
D	Depth
DQO	Data Quality Objectives
EBCT	Empty Bed Contact Time
EPA	U. S. Environmental Protection Agency
ETV	Environmental Technology Verification
°F	Degrees Fahrenheit
FRP	Fiberglass Reinforced Plastic
FTO	Field Testing Organization
g	Gram
gpd	Gallons per Day
gpm	Gallons per Minute
H	Height
HazMat	Hazardous Material
HDPE	High Density Polyethylene
ICR	Information Collection Rule
ISE	Ion Selective Electrode
L	Liter
Lb	Pound
LCD	Liquid Crystal Diode
LED	Liquid Emitting Diode
m	Meter
M	Mole
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	Milligram per Liter
MHP	Mobile Home Park
mL	Milliliter
mm	Millimeter
MDL	Method Detection Level
MSDS	Material Safety Data Sheets
N/A	Not Applicable
NA	Not Analyzed
ND	Not Detected
NEMA	National Electrical Manufacturers Association
NIST	National Institute of Standards and Technology

Abbreviations and Acronyms (Contd)

NPDES	National Pollution Discharge Elimination System
NR	Not Reported
NSF	NSF International (formerly known as National Sanitation Foundation)
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PA	Pennsylvania
PADEP	PA Department of Environmental Protection
ppb	Parts per Billion
PE	Performance Evaluation
PRV	Pressure Reducing Valve
PSM	Process Safety Management
psi	Pounds per Square Inch
PSTP	Product-Specific Test Plan
PVC	Poly Vinyl Chloride
QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource and Recovery Act
RMP	Risk Management Plan
SM	*Standard Methods for the Examination of Water and Wastewater*
SOP	Standard Operating Procedure
SS	Stainless Steel
TCLP	Toxicity Characteristic Leaching Procedure
TSTP	Technology Specific Test Plan
UPS	Uninterruptible Power Supply
µg/L	microgram per liter
W	Width
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Gannett Fleming developed this PSTP for conducting an ETV of Kinetico's Para-Flo^{TM} PF60 Model AA08AS containing Alcan Chemicals AAFS50 media (arsenic adsorption media filter). This PSTP describes equipment operation, verification and QA/QC procedures that follow the *EPA/ETV Protocol for Equipment Verification Testing for Arsenic Removal* which includes *Equipment Verification Testing Plan for Adsorptive Media Processes for the Removal of Arsenic* (Chapter 6).

This PSTP establishes that the ETV consists of a single 2-week (13 full days plus 8 hours) Integrity Verification Test and an Adsorption Capacity Verification Test to arsenic break through concentration greater than 10 ppb. Testing is to be conducted on water from Well No. 1 at Orchard Hills Mobile Home Park (MHP) Water Treatment Plant (WTP) located in Shermansdale, PA. The following is included in this document:

- Characterization of Well No. 1 raw water and WTP effluent.
- Test participants, roles and responsibilities, and lines of communication.
- Test schedule.
- Test design including water quality analyses, operating parameters, data collection and management, QA/QC plan and safety.
- Test plan reporting requirements, including data evaluation.

The manufacturer's statement of performance capabilities is (based on bench-scale testing of water from Orchard Hills MHP Well No. 1) "The Para-Flo^{TM} PF60 Model AA08AS with Actiguard AAFS50 media is capable of removing arsenic to below 10 ppb for at least 13,000 bed volumes when the arsenic in the feed water is at most 20 ppb."

The manufacturer's statement of performance capabilities was used to establish the data quality objectives for this test plan.

1.1 Purpose

The purpose of this PSTP is to provide procedures for Kinetico Inc. and Alcan Chemicals to participate in EPA/NSF ETV testing with their Para-Flo^{TM} PF60 Model AA08AS containing Alcan Chemicals' AAFS50 media for arsenic removal (arsenic adsorption media filter). This verification program will serve to greatly accelerate innovative water treatment technologies, such as arsenic adsorptive media removal systems, into the domestic and international marketplace, making cutting edge water treatment technology widely available. This ETV could result in substantial savings in money and time to water purveyors and manufacturers, since this program may allow manufacturers to reduce or eliminate having to demonstrate product performance at every site considering adsorptive media technologies for arsenic removal.

1.2 Participation

1.2.1 Manufacturers (joint venture)

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1.2.2 Field Testing Organization

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Role: FTO QA/QC

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Role: NSF ETV Project Coordinator for PA

1.2.4 Water Company

Robert Goodling, Owner
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1.2.5 Pennsylvania Department of Environmental Protection

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1.2.6 United States Environmental Protection Agency

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1.2.7 TriMatrix Laboratories, Inc.

Mr. Michael W. Movinski, Vice President, Sales and Marketing
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Role: Laboratory Contact

2.1 Verification Test Site Name and Location

The verification test site is Orchard Hills Mobile Home Park (MHP) Water Treatment Plant (WTP) located off of Windy Hill Road in Carroll Township, PA. The WTP, with a permitted capacity of 30 gpm, supplies approximately 200 domestic connections. The sources of supply for the WTP are Well Nos. 1, 11 and 12. The WTP process consists of five pressure manganese greensand filters, two chlorine contact/finished water storage tanks, two high service pumps, and two hydropneumatic tanks.

During this testing a portion of Well No.1 discharge, prior to any treatment, will be diverted to the arsenic adsorption media filter. The arsenic adsorption media filter is set up inside the WTP building, directly in front of several of the manganese greensand filters. The treated water, control module water, and backwash wastewater from the arsenic adsorption media filter will be discharged to an existing drainpipe inside the building, and subsequently conveyed to the MHP Wastewater Treatment Plant (WWTP).

2.2 Verification Testing Organization and Participants

- Kinetico Inc.
- Alcan Chemicals
- Gannett Fleming, Inc.
- NSF International
- McKelvey Environmental Management, Inc.
- Mason Dixon Environmental
- Pennsylvania Department of Environmental Protection (PADEP)
- United States Environmental Protection Agency (EPA)
- TriMatrix Laboratories, Inc.

2.3 Roles and Responsibilities

Figure 2-1. presents the primary participants in the ETV and their organizational relationships.

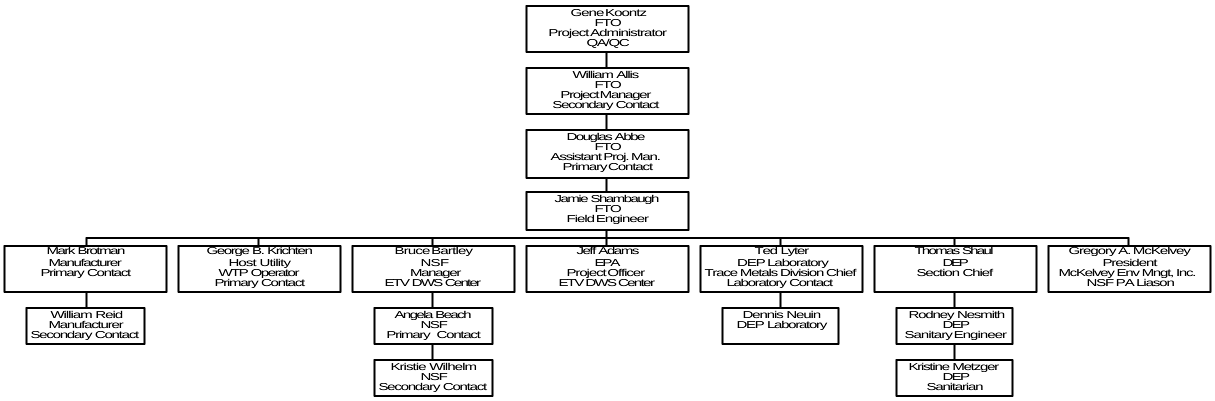

Figure 2-1. Kinetico/Alcan Chemicals Arsenic Adsorption Media ETV Organization Chart

2.3.1 Manufacturers

As the equipment manufacturers, Kinetico Inc. and Alcan Chemicals are responsible for installing their equipment and providing written and verbal instructions on its operation.

- A complete, installed arsenic adsorption media filter loaded with Alcan Chemicals' Actiguard AAFS50 media has been provided and installed at the WTP by Kinetico personnel for verification testing. Associated instrumentation, controls, and the owner's manual (see Appendix A) have been included with the modular filter system.

- Kinetico Inc. and Alcan Chemicals have provided technical support for the development of this PSTP for the arsenic adsorption media filter.

- Kinetico Inc. and Alcan Chemicals will provide technical assistance to Gannett Fleming during operation and monitoring of their arsenic adsorption media filter.

- Kinetico Inc. has plumbed the arsenic adsorption media filter so that it will not drain when Well No. 1 is offline, or otherwise prevent any other condition from occurring that would either damage the system or render data generated by the system not reliable.

2.3.2 Field Testing Organization

As the FTO, Gannett Fleming is responsible for conducting verification testing of the arsenic adsorption media filter. As part of the verification testing, Gannett Fleming is responsible for:

- Defining the roles and responsibilities of appropriate verification testing participants.

- Providing needed logistical support, establishing a communications network, and scheduling and coordinating the activities of all verification testing participants.

- Verifying that the location selected as the test site has feed water quality consistent with the objectives of the verification testing.

- Managing, evaluating, interpreting and reporting on data generated by the verification testing.

- Preparing this PSTP for the verification testing.

- Overseeing and conducting the daily testing activities, obtaining test samples and delivering those samples to the laboratory for analysis, tabulating and analyzing the testing data and preparing the final report.

2.3.3 NSF International

NSF International (NSF) is an independent, not-for-profit organization founded in 1944 for the purpose of developing standards and third-party conformity assessment services to government, manufacturers and consumers of products and systems related to public health, safety, and environmental quality.

NSF entered into an agreement on October 1, 2000 with the United States Environmental Protection Agency (EPA) to create a Drinking Water Systems (DWS) Center dedicated to technology verifications. NSF manages an Environmental Technology Verification (ETV) Program within the DWS Center for the purpose of providing independent performance evaluations of drinking water technologies. Evaluations are conducted using protocols developed with stakeholder involvement. Verified results of product evaluations presented in reports from ETV tests should accelerate a technology's entrance into the commercial marketplace.

The following are specific NSF roles and responsibilities.

- PSTP review to insure compliance with the general requirements of the *EPA/NSF ETV Protocol for Equipment Verification Testing for Arsenic Removal* and specific requirements of *EPA/NSF Equipment Verification Testing Plan for Adsorptive Media Processes for the Removal of Arsenic*
- Test site audit to confirm testing follows the PSTP
- Interim and final report review including technical, format and QA/QC
- Analyzing the arsenic samples throughout the test

2.3.4 McKelvey Environmental Management, Inc.

McKelvey Environmental Management finds, develops and coordinates lines of communication between potential Pennsylvania public water system (PWS) participants of ETV testing, manufacturers of innovative water treatment technologies, field testing organizations and NSF.

2.3.5 Mason Dixon Environmental

Mason Dixon Environmental provides contract services for the operation and maintenance of small public water and wastewater treatment systems. They are currently under contract to operate the Orchard Hills MHP WTP.

2.3.6 Pennsylvania Department of Environmental Protection (PADEP)

The PADEP's mission is to protect Pennsylvania's air, land and water from pollution and to provide for the health and safety of its citizens through a cleaner environment.

The PADEP is the state agency largely responsible for administering Pennsylvania's environmental laws and regulations. Its responsibilities include: reducing air pollution; making sure Pennsylvania's drinking water is safe; protecting water quality in Pennsylvania's rivers and streams; making sure waste is handled properly; managing the Commonwealth's recycling programs and helping citizens prevent pollution and comply with the Commonwealth's environmental regulations. PADEP is committed to general environmental education and encouraging effective public involvement in setting environmental policy.

The roles and responsibilities of PADEP include laboratory analyses for all of the ETV water quality parameters, except arsenic, scheduled to be conducted by an EPA accredited and PADEP certified laboratory.

The PADEP is also responsible for reviewing the test plan and final report since this testing may also serve as a pilot study component of a water supply permit application for the installation of a full-scale version of this type of process at this site. Also, since the site is already a permitted public water supply, the PADEP needs to be involved with any modifications that may occur.

2.3.7 United States Environmental Protection Agency (EPA)

EPA provides leadership in the nation's environmental science, research, education and assessment efforts. EPA works closely with other federal agencies, state and local governments, and Indian tribes to develop and enforce regulations under existing environmental laws. EPA is responsible for researching and setting national standards for a variety of environmental programs and delegates to states and tribes responsible for issuing permits, and monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality. The Agency also works with industries and all levels of environmental quality. The Agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.

The following are specific EPA roles and responsibilities:

- Technical review and QA oversight of PSTP
- Final approval of lab methods other than those listed in the *NSF Protocol for Equipment Verification Testing for Arsenic Removal*
- Technical review of the final report

2.3.8 TriMatrix Laboratories, Inc.

TriMatrix Laboratories, Inc., in Grand Rapids, MI will be performing the Toxicity Characteristic Leaching Procedure (TCLP) and California Waste Extraction Test (CA WET) on the spent Actiguard AAFS50 media.

2.4 Site Characteristics

The WTP is housed within a masonry block building located within the MHP. The building is heated to a minimum temperature of 50º F. Bordering the MHP boundary, in close proximity to the back of the WTP building, is land under cultivation. Well No. 1 is located near the entrance to the MHP, approximately 100 yards north of the WTP.

The WTP is supplied by Well Nos. 1, 11 and 12, of which a portion of Well No. 1 discharge will be used as the source water for the arsenic adsorption media filter verification testing.

The WTP consists of five manganese greensand pressure filters which treat the combined flow from Well Nos. 1, 11 and 12 for iron and manganese removal. Two chemicals are fed at the WTP, sodium hypochlorite for oxidation and disinfection, and polyphosphate for sequestration and corrosion control. The operation of the wells/filtration process is based on a level control system in two finished water storage tanks, located within the WTP building. Water from the finished water storage tanks is pumped to hydropneumatic tanks via booster pumps. The hydropneumatic tanks supply the distribution system. Low and high-pressure switches associated with the hydropneumatic tanks activate and deactivate the booster pumps. The well pumps operate based on level sensors in the storage tanks.

The frequency and duration(1) of well pump operation depends on distribution system demand and well water level/production capacity. Cumulative well run time ranges from 4 to 8 hours per day at a flow range of 10 gpm to 20 gpm.

- Characterization of Well No. 1 water quality is presented in Table 4-1.
- No chemicals will be fed to the water from Well No. 1 prior to or at the point of diversion from the well discharge main to the arsenic adsorption media filter.
- Well No. 1 operates intermittently depending on system demand, automatically starting and stopping based on the level in the finished water storage tanks. This operation will be modified for the 13-day plus 8 hour Integrity Verification Test so that Well No. 1 will be operated manually to assure a minimum of two hours of continuous operation. The Gannett Fleming field engineer will conduct manual operations after training provided by the MHP WTP operator.

(1) On two different weekdays it was observed by Mark Brotman of Kinetico that Well No. 1 cycled on/off for 8 to 15 minute periods from 1:00 PM to 6:30 PM. Mark Brotman noted on February 10, 2003 that Well No. 1 cycled on and off for approximately 2 to 5 minute intervals between 15:00 hours and 17:30 hours. George Krichten of Mason Dixon Environmental provided the estimated daily range of accumulative hours of operation.

- An existing WTP drainpipe will serve to collect treated water and backwash wastewater from the arsenic adsorption media filter. The treated water will be discharged to waste to avoid having to repump the water into the distribution system.

- The WTP drainpipe is connected to the MHP sewer system, which conveys wastewater flows to the MHP WWTP. A permit is not required for this discharge. This discharge has been coordinated with the MHP WWTP.

- Samples of spent media will be evaluated by the TCLP and the CA WET by TriMatrix Laboratories, Inc. at the conclusion of testing.

- Spent media will be properly disposed in accordance with classification based on the TCLP and CA WET, following the conclusion of the ETV. The disposal of media for manifesting purposes will be the responsibility of the manufacturer.

- The unit used in this verification test will be removed by Kinetico Inc. after the testing is complete.

3.0 Equipment Capabilities and Description

3.1 Equipment Capabilities

3.1.1 Statement of Performance Capabilities

Kinetico Inc./Alcan Chemicals have provided the following statement of performance capability (based on bench-scale testing of water from Orchard Hills MHP Well No. 1) "The Para-Flo™ PF60 Model AA08AS with Actiguard AAFS50 media is capable of removing arsenic to below 10 ppb for at least 13,000 bed volumes when the arsenic in the feed water is at most 20 ppb."

This statement is provided for the purpose of shaping the data quality objectives (DQO) for this test plan.

3.2 Equipment Description

3.2.1 Basic Scientific and Engineering Concepts of Treatment

The conceptual treatment process for the arsenic adsorption media filter is based on passing arsenic-contaminated feed water through a bed of media that has a strong affinity for arsenic.

- Arsenic Media Description[1]

  Activated alumina media has historically provided cost effective, reliable performance as a material for producing a granular adsorbent media for removal of arsenic from feed water. Actiguard AAFS50 is an iron-enhanced activated alumina media, which has been determined to significantly promote the adsorption effectiveness of conventional activated alumina. As water passes down through a filter vessel containing this media, the arsenic concentration declines until it is no longer detectable. As the upper portion of the media becomes saturated, the treatment band (mass transfer zone) progresses downward until all adsorptive capacity is used and arsenic breakthrough occurs.

  Adsorption is the physical attachment of the adsorbate (arsenic) to the surface of the adsorbent media grains (activated alumina). The removal capacity and effectiveness of the arsenic removal media is dependent on a number of factors, of which surface area is of primary importance. The surface area is a function of the porosity of the media grains. Adsorbent media contains a large quantity of very small pores throughout the media grains. Other factors that determine the capacity and effectiveness of adsorbent media are accessibility of the pore sites for arsenic ions, time available for arsenic ions to migrate to pore sites, competing ions for pore sites, concentration of arsenic in the feed water, pH of the feed

(1) From Chapter 6 – *Adsorptive Media Processes for the Removal of Arsenic* of the *EPA/NSF ETV Protocol for Equipment Verification Testing for Arsenic Removal*

water, and flow characteristics of the feed water that conveys the arsenic into the bed of adsorbent media.

The Kinetico/Alcan Chemicals arsenic adsorption media filter uses Actiguard AAFS50 proprietary granular iron-enhanced activated alumina media. Tests performed by Alcan Chemicals indicate that AAFS50 has up to five times[(2)] the arsenic adsorption capacity compared to standard activated alumina. Tables 3-1 and 5-2 present information specific to this media.

Table 3-1.
Manufacturing and Procedures Specific to
Alcan Chemicals' Actiguard AAFS50 Adsorptive Media

Item	Manufacturing/Procedures
Raw material used to make adsorptive media	Activated alumina
Method of manufacture	Chemical processes: proprietary Thermal processes: proprietary Sizing/Screening methods: proprietary Packaging methods: proprietary
Preconditioning Procedure	Wetting requirements: 10 bed volumes of feed water Waste: discharged to MHP WTP drain pipe (to sewer)
Regeneration Procedure	N/A
Regeneration Results	N/A

- Arsenic adsorption media filter
  Filter operations are automatically controlled by the filter control module. The control module houses water-driven gears, mechanically interconnected pulse-turbine meter and valves. The movement of the gears determines the position of the filter valves. Following the throughput of a set total volume of water, the pulse-turbine meter triggers the water-driven gears to manipulate valves so that the operating mode of one filter is switched from service to backwash, purge and finally return to service. The other filter remains in service providing treated water for the backwashing filter.

(2) Alcan AAFS50 marketing brochure, see Appendix B.

3.2.2 Filter System Components

The arsenic adsorption media filter is a modular equipment process consisting of the following components:

- Two pressure filter tanks (main & remote) piped for parallel operation.
- One built-in control module situated on top of the main filter tank, consisting of a pulse-turbine meter, water-driven gear mechanism and valves for controlling filter modes of operation
- One feed water sample tap and one treated water sample tap
- One influent pipe and one effluent pipe connecting the main filter tank to the remote filter tank
- One feed water pipe connected to the control module
- One treated water pipe connected to the control module
- Alcan Chemicals' Actiguard AAFS50 media loaded in each filter tank
- Two waste ports (backwash wastewater and gear mechanism drive water discharge) incorporated in the control module

The following equipment is provided by Kinetico specifically for the ETV and is not normally included with the arsenic adsorption media filter:

- Two pressure gauges, one located on the feed water pipe and one located on the treated water pipe
- One Y-check valve located just downstream of the hose bib diversion valve
- Two totalizer water meters, one located on the feed water pipe and one located on the treated water pipe
- One diaphragm valve for flow regulation, located on the treated water pipe just upstream of the rotameter
- One rotameter located on the treated water pipe downstream of the diaphragm valve
- One pressure regulating valve located just upstream of the diaphragm valve on the treated water pipe

3.2.3 Photographs of equipment

See Appendix C.

3.2.4 Drawing of equipment

See Figure 3.1.

3.2.5 Data plate

A data plate will be installed on the arsenic adsorption media filter main tank which will provide the following information:

Equipment Name: Para-Flo™ PF60 with Actiguard Media
Model Number: AA08AS
Media Number: AAFS50

Manufacturers' Names and Addresses:

Kinetico Incorporated	Alcan Chemicals
10845 Kinsman Road	525 S. Washington Street
Newbury, Ohio 44065	Suite #9
	Naperville, Illinois 60540

Additional Information
Serial Number: 0052690
Service flow: 1.8 – 2.0 gpm
Unit installed for NSF and EPA Environmental Technology Verification Program.
Call (440) 564.4233 for more information.

Warning and Caution Statements:
Testing in progress, please do not disturb.
This unit is designed to operate with a minimum inlet pressure of 30 psi, maximum of 125 psi.

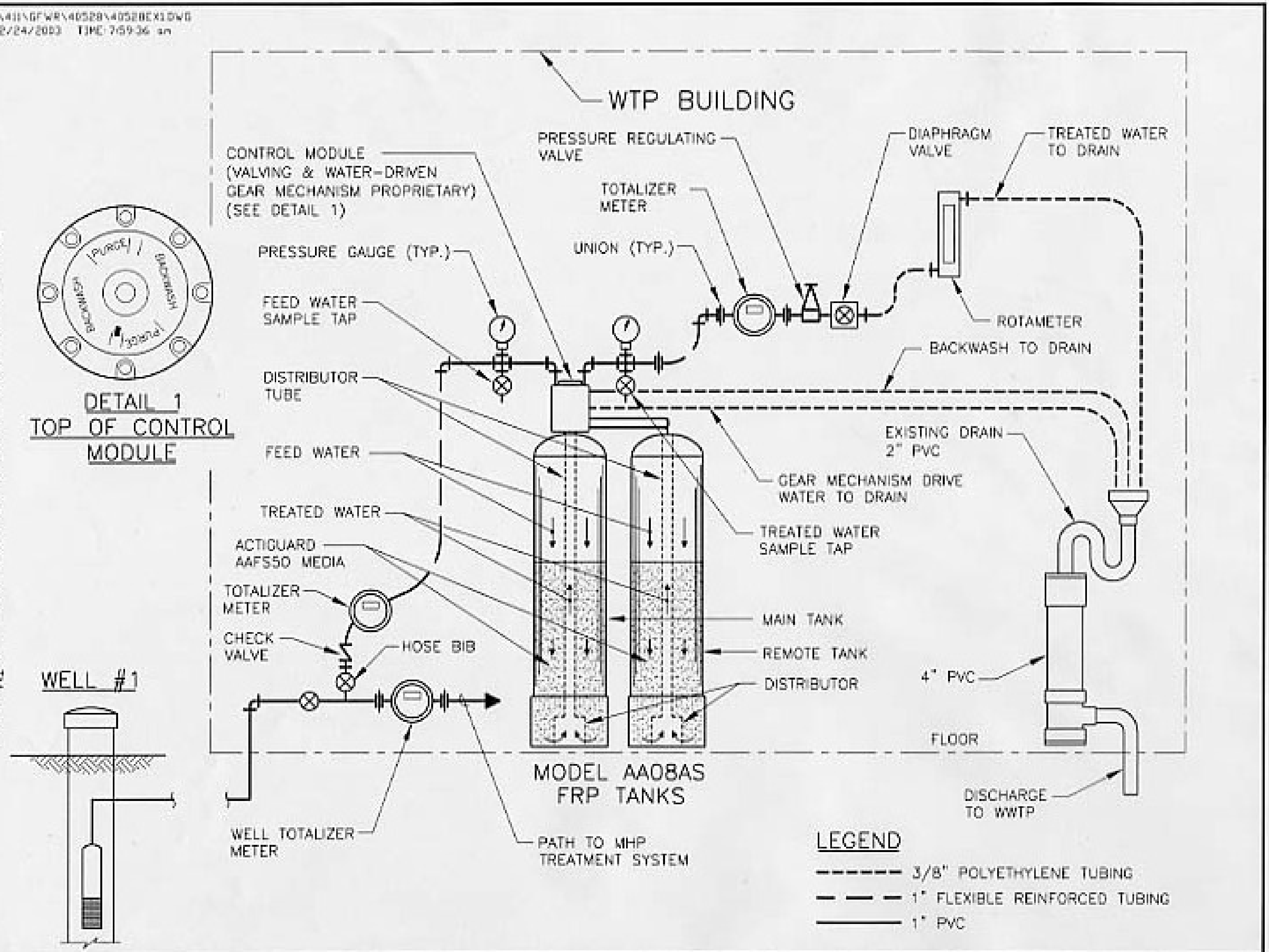

Figure 3-1 Schematic of Kinetico Para-Flo™ PF60
Model AA08AS with Actiguard AAFS50 and Appurtenances at Orchard Hills MHP

3.2.6 Principles of Operation

This modular filter system consists of dual, pressurized filter tanks designed for parallel operation in the downflow mode. The filter system does not require electricity to operate. Both filter tanks are in service except when one filter tank is off line for backwashing. During this event, the other filter tank supplies the treated water for the backwash. The filter system can operate either intermittently or continuously. Modes of operation are automatically controlled based on volume of throughput using a proprietary control module containing a pulse-turbine meter. Valve operation is controlled by a water-driven gear mechanism within the control module that is mechanically interconnected with the pulse-turbine meter. (The gear mechanism drive water is only required during backwash and purge, and is supplied by the filter remaining in service.) There are no other triggers for automatic initiation of operating modes. The control module has a set screw for manually adjusting the actuator to conduct a manual backwash, as described in the proprietary Technical Manual (on file at NSF International and Gannett Fleming).

The combined total flow and flow rate from the filter tanks will be monitored with two accessory totalizer meters and a rotameter. Flow rate will be adjusted with a nonintegral diaphragm valve located on the treated water side of the filter tanks. There are no flow gauges to monitor backwash wastewater. This rate will be checked using the "bucket and stopwatch" method. The collection of backwash and purge water for volume determination and water quality analyses will occur once every other month during the System Capacity Test. Assuming the incremental throughput readings from each totalizer meter match with reasonable accuracy during those periods when no backwashes have occurred, than for the instances when backwashes do occur and the wastewater is not collected, the incremental feed water totalizer meter reading minus the incremental treated water totalizer meter reading should be the volume of backwash and purge water used for both filter tanks. Also, in the event that one totalizer meter should fail, the other meter will serve as a backup.

The difference in feed water and treated water pressure readings will provide loss of head across both filters.

Grab samples for on-site and laboratory analyses will be collected from the feed water and treated water sample taps, located immediately upstream and downstream of the adsorption media filter tanks. Samples from these taps will be collected following the opening of their respective ball valves and a flush period of around five seconds.

As arsenic-contaminated feed water passes down through the filter vessels containing Actiguard AAFS50 arsenic adsorption media, the arsenic concentration declines until it is no longer detectable. As the upper portion of the adsorption media becomes saturated, the treatment band progresses downward until all adsorptive capacity is used.

While Actiguard AAFS50 is in fact regenerable, the additional adsorption capacity of this media over conventional activated alumina offers an advantage such that regeneration is not necessarily economically viable in a small system. The media is removed and replaced with new media prior to breakthrough, based on a predetermined life of media for a specific site water quality.

3.2.7 Operator Requirements

The arsenic adsorption media filter will operate in concert with Well No. 1, based on automatic on-demand mode, during the adsorptive media verification test. The MHP WTP well pumps operate off of the finished water storage tank levels, activated on preset low level and deactivated on preset high level. Therefore, operator attention will be minimal during the adsorptive media verification test, and will mainly consist of monitoring the equipment to confirm proper operation.

Since Well No. 1 normally operates for only brief durations in automatic mode, the well pump will be operated manually by the Gannett Fleming field engineer during the 13-day plus 8 hour Integrity Test, for a minimum of 2 hours of continuous operation on a daily basis.

Eventually spent Actiguard AAFS50 media must be removed and replaced, following breakthrough of arsenic. Data will be generated that will represent the actual volume of water treated by the 1.4 cubic feet of Actiguard AAFS50 media and the resultant treated water arsenic concentrations.

The system will backwash automatically after a throughput of 10,500 gallons ± 10%. Operator initiation is not required. The system will also automatically re-initiate service operation of the filter backwashed. The position of an indicator dot on top of the control module actuator (see Figure 3-1) will provide evidence that a backwash has occurred during those periods that the plant is unmanned.

3.2.8 Required Consumables

- Actiguard AAFS50 activated alumina media: approximately 0.7 cubic feet per filter tank (~1.4 cubic feet total)
- Treated water: 62 gallons backwash and rinse per cycle

3.2.9 Rates of Waste Production

Approximately 62 gallons of filter backwash wastewater and purge (rinse) wastewater are generated following every 10,500 gallons ± 10% of throughput.

The Actiguard AAFS50 media, when used as a one-time use media, must be disposed in a manner that complies with all state and federal regulations for ultimate waste disposal. Kinetico and Alcan Chemicals have stated that spent Actiguard AAFS50 media is suitable for disposing in a landfill (see Appendix E test result from prior TCLP extract performed on an Actiguard

AAFS50 sample). In order to confirm this claim, the Gannett Fleming field engineer will sample a portion of the spent media at the conclusion of the Adsorption Capacity Verification Testing for laboratory TCLP and CA WET testing. The media sampling protocol presented in Table 3-2 will be followed by the field engineer.

Table 3-2.
Sampling Protocol for Alcan Chemicals' AAFS50 Adsorptive Media

Occurrence	Prerequisite Procedure	Media Sampling Procedure
Once, following arsenic breakthrough in Adsorption Capacity Verification Test	Kinetico's Procedure for Media Replacement in Appendix D	Core one sample from each filter tank using a 1.5 inch diameter, 4 foot long thin-walled copper tube; collect in a plastic bag, shake vigorously and divide into equal sample volumes and collect in sealed plastic bags for delivery to laboratory for TCLP and CA WET analyses, respectively.

3.2.10 Equipment Performance Range

The manufacturer has stated that their arsenic adsorption media system may not be appropriate for feed water quality containing high levels of potentially interfering ions such as sulfate, silica, fluoride, and phosphate, depending on pH. The equipment flow range and minimum pressure are presented on Table 5-1.

3.2.11 Applications of Equipment

- Adsorption media is appropriate for groundwater not under the influence of surface water.
- Neither Kinetico Inc. nor Alcan Chemicals are aware of any data supporting chemical interference by iron or manganese. The MHP Well No. 1 has relatively high manganese that will not be treated prior to passing through the system.
- The manufacturer states that the process is appropriate for "very small" and "small" systems having limited manpower and operating skills. It is also appropriate for "medium" systems.

Table 3-3 below presents a relative comparison of adsorption media to other arsenic removal technologies.

Table 3-3.
Relative Comparisons to Other Arsenic Removal Technologies

Arsenic Removal Process	Equipment Cost	Water Loss	Chemical Requirements	Ease of Operations
Adsorption Media	low	very low	none to low	simple
Ion Exchange	moderate	high	high	moderate
Coagulation/Media Filtration	moderate	low/moderate	moderate	moderate
Coagulation/Microfiltration	high	high	high	high
Reverse Osmosis or Nanofiltration	very high	very high	moderate	moderate

Arsenic Removal Process	Labor Requirements	Power	Hazardous Residuals	Interference from Competing Ions
Adsorption Media	low	low	low	low to moderate
Ion Exchange	low to moderate	moderate	high	moderate to high
Coagulation/Media Filtration	moderate to high	high	high	low to moderate
Coagulation/Microfiltration	moderate to high	high	high	low to moderate
Reverse Osmosis or Nanofiltration	moderate	very high	high	low

3.2.12 Licensing Requirements Associated with Equipment Operation

States generally require a specific grade of waterworks operator permit in order to operate a filter process on a public water supply. However, this requirement does not apply for the ETV since all of the treated water will be discharged to waste.

In Pennsylvania, to operate a full-scale version of this treatment technology for the Orchard Hills MHP public drinking water supply, a D9 license would be required. "D" refers to a capacity of 0.1 mgd or less, and "9" refers to inorganics removal.

3.2.13 Known Limitations of Equipment

Groundwater containing high levels of potentially interfering ions such as sulfate, silica, fluoride and phosphate may not be appropriate, depending on pH.

4.1 Objectives

The objectives of this verification testing are in the following areas:

- Produce data to meet the Data Quality Objectives (DQO) shaped by the manufacturers' performance objectives;
- Present data on the impact of variations in feed water quality such as turbidity, arsenic, pH, silica, fluoride, iron, and manganese on equipment performance;
- The logistical, human and economic resources necessary to operate the equipment; and
- The reliability, ruggedness, cost, range of usefulness, and ease of operation.

4.2 Equipment Characteristics

4.2.1 Qualitative Factors

The equipment will, as much as is feasible, be operated in such a way as to maintain its operating parameters within the manufacturers' recommendations. Contact time is a critical parameter for arsenic adsorption efficiency and is dependent on maintaining flow within the design range. The nature and frequency of the changes required to maintain the operating conditions will be used in the qualitative evaluation of the equipment.

Frequent and significant adjustments will indicate relatively lower reliability and higher susceptibility to environmental conditions, and also the degree of operator experience that may be required. The effect of operator experience on the treatment results will be evaluated.

The modular nature of the filter components, similar to a residential ion exchange water softener, makes equipment installation easy and straightforward. The equipment can be installed by a qualified plumber. This also makes the equipment easy to move and reinstall at another location. The filter tanks are freestanding, requiring only a level surface capable of supporting 210 pounds, and maintenance of ambient temperature above 35°F.

4.2.2 Quantitative Factors

The following factors will be quantified for site specific conditions based upon data collected during this testing program:

- Rate of media exhaustion
- Frequency of media replacement
- Backwash water quantity and quality
- Backwash and purge duration and frequency
- Estimated labor hours for operation and maintenance

These quantitative factors will be used as an initial benchmark to assess equipment performance and develop operation and maintenance costs.

4.3 Water Quality Considerations

4.3.1 Feed Water Quality

A "snapshot" of Well No. 1 raw water quality is presented on Table 4-1. The water is generally of good quality except for arsenic and manganese concentrations which exceed their maximum contaminant levels (MCL). The water is low in turbidity, color, and iron. The water has a moderate level of hardness and is near neutral in pH. The water requires treatment for manganese by the full-scale WTP prior to distribution since the manganese level is significantly higher than the secondary maximum contaminant level (MCL) of 0.05 mg/L. The arsenic level is almost twice the current MCL of 10 µg/L.

Alcan Chemicals has indicated that no pretreatment is required for the arsenic adsorption media system. Alcan states: "Manganese is very far down on the selectivity series, and Alcan Chemicals does not expect that it will be an issue. (Ion selectivity series is included in Table 5-2). Additional work has shown media adsorption capacity for arsenic to be independent of the manganese in the water. In addition, iron is really only a problem if it is present in very high amounts as it precipitates and clogs the bed. This is easily rectified with a backwash or other type of agitation. This is a mechanical function, not a chemical interference, that would be common to any granular bed. Again, there is no indication that iron in solution has any negative impact whatsoever on the media's ability to adsorb arsenic".

4.3.2 Treated Water Quality

Finished water quality from the WTP tends to have a moderate level of hardness, moderate alkalinity and near neutral pH. Manganese in the treated water is below the MCL. Arsenic is more than double the current MCL.

Table 4-1.
Orchard Hills MHP Water Quality Data

Parameter	Well No. 1 Raw Water	MHP WTP Treated Water(1)
pH	7.2	7.4
Color	<5	<5
Alkalinity (mg/L as $CaCO_3$)	NA	102
Arsenic, Total (µg/L)	17.4	23.2
Turbidity (NTU)	<1	<1
TDS (mg/L)	160	196
Hardness, Total (mg/L as $CaCO_3$)	95	90
Calcium, Total (mg/L)	25.7	23
Magnesium, Total (mg/L)	7.4	7.8
Iron, Total (mg/L)	0.04	<0.02
Manganese, Total (mg/L)	0.15	0.02

(1) Treated water from a combination of Wells No. 1, 11 and 12.

4.4 Recording Data

The following information will be recorded on-site:

- Experimental run number
- Water type (feed, treated, waste type)
- Hours of operation
- Treated water flow rate
- Feed water production
- Treated water production
- Feed water pressure
- Treated water pressure
- Feed water temperature
- Feed water turbidity
- Treated water turbidity
- Feed water pH
- Treated water pH
- Feed water arsenic concentration (qualitatively with field test kit)
- Treated water arsenic concentration (qualitatively with field test kit)
- Occurrence of a backwash
- Backwash water flow rate (when field engineer is present)
- Backwash duration (when field engineer is present)
- Backwash total volume (measured directly when field engineer is present)

4.5 Recording Statistical Uncertainty for Assorted Water Quality Parameters

For the analytical data obtained during verification testing, 95% confidence intervals will be calculated by Gannett Fleming for arsenic data and for all other water quality data where the sample set contains eight or more values.

The consistency and precision of water quality data can be evaluated with the use of the confidence interval. A confidence interval describes a population range in which any individual population measurement may exist with a specified percent confidence. The following formula will be employed for confidence interval calculation:

$$\text{confidence interval} = \overline{X} \pm t_{n-1,\ 1-\frac{\alpha}{2}} \left(S/\sqrt{n}\right)$$

where: $\overline{X}$ is the sample mean;
S is the sample standard deviation;
n is the number independent measures included in the data set;
t is the Student's t distribution value with n-1 degrees of freedom;
α is the significance level, defined for 95% confidence as: 1 - 0.95 = 0.05.

According to the 95% confidence interval approach, the á term is defined to have the value of 0.05, thus simplifying the equation for the 95% confidence interval in the following manner:

$$95\% \text{ confidence interval} = \overline{X} \pm t_{n-1,\,0.975}\left(S / \sqrt{n}\right)$$

Results of these calculations will be expressed as the sample mean plus or minus the width of the confidence interval.

pH statistics will be calculated on a log basis.

4.6 Verification Testing Schedule

Verification testing activities include equipment set up and shakedown, equipment integrity and adsorptive capacity verification tests, and water quality sampling and analysis. The test schedule will be developed to encompass all of these activities.

The test is tentatively scheduled to begin in March 2003. The integrity and adsorptive capacity verification tests will be initiated simultaneously. The integrity verification test will run for a 2-week (13 full days plus 8 hours) period. The adsorptive capacity verification test will run until 12 ppb(1) of arsenic is detected in the treated water. Alcan Chemicals has estimated that the media could treat between 139,000 and 199,000 gallons of Well No. 1 feed water to a breakthrough concentration of 10 ppb arsenic. At a 2-gpm process flow rate, this equates to 1,219 to 1,746 hours of operation. According to the WTP operators, the wells operate between 4 and 8 hours per day. Based on an average of the values, the test may last between 6.4 and 9.2 months.

(1) Kinetico/Alcan Chemicals have requested that 12 ppb be used as the stopping point to ensure that the threshold of 10 ppb has actually been crossed, and is not due to analytical error.

5.1 Equipment Operations and Design

The *EPA/NSF ETV Testing Plan Adsorptive Media Processes for the Removal of Arsenic* specifies the procedures that will be used to ensure the accurate documentation of both equipment performance and treated water quality. Strict adherence to these procedures will result in definition of verifiable performance of equipment.

Design aspects of the water treatment process equipment will be shared with interested regulatory officials.

5.1.1 Design Criteria

The following table presents design criteria for the arsenic adsorption process and appurtenances.

Table 5-1.
Equipment Design Criteria

Para-Flo™ PF60 Model AA08AS	
No. of Filter Tanks	2
Filter Tank Dimensions	
Diameter (ID)	8 inches
Height (including integral control module)	46 inches
Height (vessel only)	40 inches
Mode of Operation	parallel
Design Flow, Total	1.9 ± 0.1 gpm
Flow Range, Total	1.8 to 2.0 gpm
Design Capacity, Total	2.0 gpm
EBCT at 2 gpm	4.6minutes
Minimum Recommended Feed Pressure	30 psi
Filter Media	
Depth	21 inches
Freeboard above media	17.5 inches
Volume per tank	0.61 cu. ft.
Weight per tank	39.76 lbs
Volume, total	1.22 cu. ft.
Mesh Size (Tyler mesh series)	28 x 48
Media expansion during backwash	50%
Filter Tank Material	FRP
Control	automatic based on total throughput of 10,500 gallons ± 10%
Backwash	
Flow Rate	4.0 gpm
Duration	13 minutes
Time between backwash and rinse	3 minutes

Table 5-1. (continued)
Equipment Design Criteria

Purge		
	Flow Rate	1.9 gpm ± 0.1 gpm
	Duration	5 minutes
Pressure Gauges		
	Manufacturer	Ashcroft® Duralife
	Type	1084, Grade 2A
	Pressure Range	0 –100psi (accuracy of ±0.5%)
Totalizer Meters		
	Manufacturer	ABB
	Type	positive displacement
	Series	V100 (feed)/C700 (filtrate)
	Accuracy	± 1.5%
Rotameter		
	Manufacturer	Blue-White
	Model	F-50376N
	Maximum Reading	2.0 gpm
	Accuracy	no data
	Pressure, max	250 psi
Treated Water Throttling Valve		
	Manufacturer	George Fischer
	Type	Diaphragm
	Material of Construction	Type 304, DN25, PVC-U
	Size	1 inch
	Control	Manual
Three Way Regulating Valve		
	Manufacturer	Watts Industries, Inc.
	Model No.	2A645
	Maximum Inlet Pressure	300 psi
	Reduced Pressure Range	3 to 50 psi
Y-Check Valve		
	Manufacturer	George Fischer
	Size Code/Size	1 inch
	Material of Construction	Type 304, DN25, PVC-U

5.1.2 Arsenic Adsorption Media

The following table presents specifications for the arsenic adsorption media being tested.

Table 5-2.
Alcan Chemicals' Actiguard AAFS50 Media Specifications

Chemical Constituents	Weight, %
Al_2O_3 + proprietary additive	83
Silicon as SiO_2	0.020
Titanium as TiO_2	0.002
Loss on Ignition	17
Physical Properties	
Bulk Density	0.91 g/cm^3 (56.8 lbs/ft^3)
BET[1] Area	220 m^2/g
Attrition	0.3%
Voids	48%
Pore Size	no data
Pore volume	<0.35 cm^3/g
Abrasion loss	<5% (due to spray coating fines, smaller than 48 mesh)
Moisture (weight)	0-300ºC: 25% 300-1000ºC: 10%
Sieve sizes, US sieve series	28 x 48
Particle Size	no data
Effective Size	0.37 mm
Uniformity Coefficient	1.48

Ionic Preference Series

- Anions: $OH^- > HAsO_4^- > Si(OH)_3 > O^- > F^- > HSeO_3^- > SO_4^{2-} > CrO_4^{2-} > HCO_3^- > Cl^- > NO_3$
- Cations: $Th > Al > U^{(4)} > Zr > Ce^{(4)} > Fe^{(3)} > Ce^{(3)} > Ti > Hg > UO_2 > Pb > Cu > Ag > Zn > Co > Fe^{(2)} > Ni > Tl > Mn$

Approvals

- Certified to NSF/ANSI 61
- TCLP (see Appendix E)

MSDS

See Appendix F

(1) The BET theory is used to estimate the number of molecules required to cover the absorbent surface with a monolayer of adsorbed molecules, N_m. Multiplying N_m by the cross-sectional area of an adsorbate molecule yields the sample's surface area.

5.1.3 Field Test Equipment

The following table presents the analytical and calibration equipment that will be used on-site.

Table 5-3.
Field Analytical and Calibration Equipment

Equipment	Manufacturer/Model/Specs
Spectrophotometer	Hach Model DR/2010
Turbidimeter	Hach Model 2100P Portable Ratio^{TM} Optical System (meets or exceeds USEPA method 180.1 criteria)
pH/ISE Meter	Orion Model 290A with Triode pH Electrode Model 91-578N (resolution 0.1/0.01/0.001, accuracy ± 0.005); and Fluoride Combination Electrode Model 96-09 (reproducibility ± 2%)
Thermometer	Miller & Weber (range 0-32ºC; NIST traceable)
Arsenic Field Test Kit	Industrial Test Systems (ITS), Inc. Model QUICK Low Range II (optimum accuracy below 6 ppb)
Dead weight pressure gauge tester	Amthor Testing Instrument Co. Inc. (Type No. 460; range 0-6000 psi)
Burettes for analytical titrations	50 mL capacity with 0.1 mL subdivisions and 1000 mL reagent reservoir
Stopwatch and "bucket"	Digital stopwatch and 2.0 L graduated cylinder with 10 mL increments for rotameter, totalizer meters, and control module drive water calibration checks. Fifty gallon container for backwash wastewater flow calibration
Platform Scale	Triner Scale Model 303, Serial No. 87D-065, Capacity 202 lbs.

5.2 Communications, Documentation, Logistics, and Equipment

It is Gannett Fleming's responsibility to coordinate communication between all verification testing participants.

All field activities will be thoroughly documented using the following forms of record:

- Field Logbook
- Field Data Sheets

- Photographs
- Laboratory Submission Sheets and Reports
- Laptop Computer

Gannett Fleming will be responsible for maintaining all field documentation. A bound field logbook will be used to record all water treatment equipment operating data. Each page will be sequentially numbered and labeled with the project name and number. Completed pages will be signed and dated by the individual responsible for the entries. Errors will have one line drawn through them and this line will be initialed and dated.

All photographs will be inserted in the field logbook. The time, date, direction, subject of the photograph and identity of the photographer will be included with each entry. Any deviations from the approved final PSTP will be thoroughly documented in the field logbook at the time of inspection and in the verification report.

Laboratory submission forms will accompany all samples shipped to the PADEP and NSF Laboratories. Copies of laboratory submission forms for all samples will be provided at the time of the QA/QC inspection and included in the verification report.

5.3 Equipment Operation and Water Quality Sampling for Verification Testing

The field activities will conform to requirements provided in this PSTP that were developed and approved for the verification testing to be conducted. The sampling and sample analyses that occur during this verification testing program will be performed according to the procedures detailed by Gannett Fleming in this PSTP.

If unanticipated or unusual situations are encountered that may alter the plans for equipment operation, water quality sampling, or data quality, Gannett Fleming will discuss the situation and plan modifications with the NSF technical lead and PADEP. Any deviations from the approved final PSTP will be documented.

During routine operation, the following will be documented daily:

- The number of hours the arsenic adsorption media filter is operated.
- The number of hours the operator was working at tasks at the treatment plant related to the operation of the arsenic adsorption media filter.
- Description of tasks performed during arsenic adsorption media filter operation.

5.4 Task 1: System Integrity Verification Testing

5.4.1 Introduction

During Task 1 Gannett Fleming will evaluate the reliability of equipment operation under the environmental and hydraulic conditions at the Orchard Hills MHP WTP site, while being supplied by Well No. 1, and determine whether performance objectives stated in Section 5.5.2

can be achieved for arsenic removal at the design operating parameters for the arsenic adsorption media system. The adsorption media filter will be operated for integrity testing purposes within the operational range presented in the equipment design criteria and the manufacturer's statement of performance capabilities.

5.4.2 Experimental Objectives

- Establish equipment operational reliability under field conditions.
- Document feed water quality relative to maximum value of 20 ppb stated in performance objective.
- Collect operational and water quality data under field conditions that can be related to the operating time, throughput and water quality objectives stated by the manufacturer.

5.4.3 Work Plan

- A platform scale will be used to weigh the media prior to installation into each filter tank. The weight of the media will be reported as well as the measurement of "freeboard" from the top of the media to the top of the unit (top of the opening in each filter tank where the media is added).
- Protocol for start-up - See Alcan Chemicals' Technical Bulletin for Actiguard AAFS50 in Appendix G. The initial 10 bed volumes of treated water (flushing water) volume will be discounted prior to recording the totalizers' start-up readings.
- Monitoring and on-site data collection schedule is presented on Table 5-4.
- The treatment system will operate intermittently due to the intermittent operation of Well No. 1. However, the treatment system is required to operate for at least 2 hours continuously each day during the integrity test, as specified in the test plan. The 2-hour continuous operation per day will be performed and witnessed by the FTO field engineer, using manual mode of operation for Well No. 1 at the WTP control panel.
- Grab samples for on-site and laboratory analyses will be collected based on the sampling schedule presented on Table 5-5. The feed water and treated water sample taps will be flushed for at least five seconds prior to sample collection.
- A sampling plan for arsenic that includes the Integrity Verification Test is presented on Table 5-7.
- Three days of the daily feed water and treated water samples will be collected to speciate arsenic, as specified in Table 5-7. The protocol for arsenic speciation is presented in Appendix H.
- Daily and weekly samples collected for on on-site analysis will be analyzed immediately after collection during the 2-hour period of continuous operation. (Alkalinity, total hardness, calcium hardness, and fluoride may be analyzed in the

Gannett Fleming Treatability Lab, within two hours of leaving the site and always on the same day). Sample collection and handling procedures will follow *Standard Methods 3010 B*.

- Daily and weekly samples for laboratory analysis will be collected during the 2-hour period of continuous operation. At least one hour of operation will have occurred prior to sample collection for arsenic. All of the samples will be collected by the Gannett Fleming field engineer, in appropriate sample bottles prepared with preservatives, as required, that are specific to the analytical methods to be used. Additionally, the samples will be stored and shipped in accordance with appropriate procedures and holding times, as specified by the PADEP and NSF Laboratories. A water quality sampling protocol for laboratory analysis describing volumes, preservation, holding times and laboratory sample identification for each water quality parameter is presented on Table 5-11. The methods to be used by the laboratory for the scheduled analytical procedures are presented on Table 5-5, and described in Task 5, Quality Assurance/Quality Control.
- One backwash will occur during the System Integrity Verification Test, which will be manually initiated by the field engineer. Backwash water flow, duration, and volume will be monitored volumetrically and recorded. Water quality will be analyzed as listed on Table 5-9.

5.4.4 Analytical Schedule

- Operational Data Collection
    - Treated water flow rate will be monitored and adjusted, as needed, with the rotameter and diaphragm valve located on the treated water pipe. Flow rate will be recorded twice per day, before and after adjustment. Flow rate will be set at 1.9 gpm ± 0.10 gpm.
    - Feed water and treated water production will be monitored twice per day at the totalizer meters located on the feed water and treated water pipes.
    - Hours of operation will be monitored and recorded once per day based on the run time of Well No. 1. Well pump run time is totalized at the motor control center.
    - Feed water pressure will be monitored twice per day at the pressure gauge located on the feed water pipe. Minimum and maximum operating pressures for the filter tanks are 30 psi and 125 psi, respectively.
    - Treated water pressure will be monitored twice per day at the pressure gauge located on the treated water pipe. This will be performed at the same time as the feed water pressure measurement. The difference between these valves will represent headloss through the system.

Table 5-4.
On-site Equipment Operating Parameter Monitoring and Data Collection Schedule

Parameter	Monitoring Frequency	Monitoring Method
Treated water flow rate	Check & record twice per day (adjust when 5% above or below target; record before and after adjustment)	Rotameter
Feed water and treated water production	Check & record twice per day	Feed and treated totalizer meters
Hours of production	Check & record once per day	Daily log of Well No. 1 operation
Feed water pressure	Check & record twice per day	Feed water pressure gauge
Treated water pressure	Check & record twice per day	Treated water pressure gauge

- Water Quality Data Collection
  - The water quality of the feed water and treated water will be characterized by analysis of the water quality parameters listed on Table 5-5.
  - Samples will be collected during the 2-hour period of continuous operation, following a minimum of 1 hour of operation.
  - Temperature, pH, turbidity, and qualitative arsenic must be analyzed on-site.
  - The water quality analyses presented on Table 5-5 are conducted to provide state drinking water regulatory agencies with background data on the quality of the feed water being treated and the quality of the treated water.

Table 5-5.
Water Quality Sampling Schedule System Integrity Verification Testing

Parameter	Sampling Frequency	Test Streams to be Sampled	Standard Method(1)	EPA Method	Hach Method
On-Site Analyses					
Arsenic	(2)	Adsorptive Media Feed Water & Treated Water	(See Appendix I)		
pH	Twice Daily	Adsorptive Media Feed Water & Treated Water	4500-H^+ B	--	--
Temperature	Daily	Adsorptive Media Feed Water & Treated Water	2550 B	--	--
Turbidity	Daily	Adsorptive Media Feed Water & Treated Water	2130 B	--	--
Alkalinity(3)	Daily	Adsorptive Media Feed Water & Treated Water	--	--	8221
Calcium(3)	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	8222
Magnesium(3)	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	Calculated (8226-8222)
Hardness(3)	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	8226
Fluoride(3)	Daily	Adsorptive Media Feed Water & Treated Water	4500-F^- C	--	--
Laboratory Analyses					
Arsenic(4)	Daily	Adsorptive Media Feed Water & Treated Water	--	200.8	--
Silica	Daily	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Aluminum	Daily	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Iron	Weekly	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Manganese	Weekly	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Chloride	Weekly	Adsorptive Media Feed Water & Treated Water	--	300.0	--
Sulfate	Weekly	Adsorptive Media Feed Water & Treated Water	--	300.0	--
Total Phosphorus	Weekly	Adsorptive Media Feed Water & Treated Water	--	365.1	--

(1) APHA, AWWA and WPCF (1995). *Standard Methods for Examination of Water and Wastewater*. 19th ed. Washington, D.C. APHA
(2) See Table 5.7. Arsenic field test kit will be used for periodic qualitative arsenic checks.
(3) Analyzed on-site or at the Gannett Fleming Treatability Lab
(4) The NSF International laboratory will perform laboratory arsenic analyses. The PADEP Laboratory will analyze all other laboratory analyses during the Integrity Test.

5.4.5 Evaluation Criteria and Minimum Reporting Requirements

- Operational performance evaluation
  - o A table and time series plot will be produced to present all feed water and treated water arsenic laboratory data from the System Integrity Verification testing. The System Integrity Verification testing demonstrates the initial ability of the adsorptive media to remove the feed water arsenic concentration to below detectable levels in the treated water.
- Treated water flow rate
  - o A table of treated water flow rates will be tabulated.
- Backwash waste stream and control module discharge flow rates
  - o A table of backwash waste stream and control module flow rates will be tabulated
- A plot of feed and treated water pressure and system headloss will be presented. This information can be used to infer power requirements in system that will pump directly through the system. No direct measurement of power is possible, since the system does not require electricity.

5.5 Task 2: Adsorptive Capacity Verification Testing

5.5.1 Introduction

The objectives of this task are to produce quality operational and water quality data up through and including what Kinetico Inc. and Alcan Chemicals have defined as the breakthrough arsenic level for their arsenic adsorption system. The performance of the adsorptive media is a function of the feed water quality, contact time, rest time and type of adsorptive media used. Arsenic breakthrough is highly dependent on the concentration and adsorptive characteristics (isotherm) of the arsenic to be treated by the adsorptive media. Design and empty bed contact time (EBCT) will help define the performance of a given media for a given feed water quality.

A tabulation of physical data requirements for the arsenic adsorption media is presented on Table 5-2.

Adsorption capacity verification testing will be performed one time for the arsenic adsorption media system using the feed water from Well No. 1 at Orchard Hills MHP.

Table 5-6.
Water Quality Sampling Schedule Media Adsorption Capacity Verification Testing

Adsorption Capacity Verification Testing Parameter	Sampling Frequency	Test Streams to be Sampled	Standard Method[1]	EPA Method	Hach Method
On-Site Analyses					
Arsenic	[2]	Adsorptive Media Feed Water & Treated Water	(See Appendix I)		
pH[3]	Daily	Adsorptive Media Feed Water & Treated Water	4500-H^+ B	--	--
Temperature[3]	Daily	Adsorptive Media Feed Water & Treated Water	2550 B	--	--
Turbidity[3]	Daily	Adsorptive Media Feed Water & Treated Water	2130 B	--	--
Alkalinity[4]	3/Week	Adsorptive Media Feed Water & Treated Water	--	--	8221
Calcium[4]	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	8222
Magnesium[4]	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	Calculated (8226-8222)
Hardness[4]	Weekly	Adsorptive Media Feed Water & Treated Water	--	--	8226
Fluoride[4]	Weekly[7]	Adsorptive Media Feed Water & Treated Water	4500-F^- C	--	--
Laboratory Analyses					
Arsenic[5]	Weekly[6]	Adsorptive Media Feed Water & Treated Water	--	200.8	--
Silica	Weekly[7]	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Aluminum	Weekly[7]	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Iron	Weekly	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Manganese	Weekly	Adsorptive Media Feed Water & Treated Water	--	200.7	--
Chloride	Weekly	Adsorptive Media Feed Water & Treated Water	--	300.0	--
Sulfate	Weekly	Adsorptive Media Feed Water & Treated Water	--	300.0	--
Total Phosphorus	Weekly	Adsorptive Media Feed Water & Treated Water	--	365.1	--
TCLP[8]	Once	Spent Actiguard AAFS50 Adsorptive Media	--	SW-846 EPA 1311	--
CA WET[8]	Once	Spent Actiguard AAFS50 Adsorptive Media	(See Appendix E)		

(1) APHA, AWWA and WPCF (1995). *Standard Methods for Examination of Water and Wastewater*. 19th ed. Washington, D.C. APHA.
(2) Arsenic field test kit will be used for periodic qualitative arsenic checks as specified in Table 5-7.
(3) Gannett Fleming will be on-site 3 days per week to collect data. Each day that the FTO is not on-site, a representative from the Orchard Hills MHP WTP will be gathering the data and recording it in the logbook.
(4) Analyzed on-site or at the Gannett Fleming Treatability Lab.
(5) The NSF International laboratory will perform laboratory arsenic analyses. The PADEP Laboratory will analyze all other laboratory analyses during the Capacity Test.
(6) See arsenic sampling plan on Table 5-7.
(7) More frequent sampling of this parameter will occur if data collected daily during Task 1 show that the concentration of the parameter fluctuates or is at a higher concentration than expected. A higher frequency of this parameter will also be considered during the last two months of sample collection.
(8) TriMatrix Laboratories, Inc. will perform the TCLP and CA WET.

Table 5-7.
Arsenic Sampling Plan

Laboratory Analyses

Test Period	Sample Sources	Sample Frequency	Sampling Period	No. of Days Samples Speciated[2]	Hold Samples	Total No. Analyses
Shakedown	feed, treated	daily	2 days	2	none	12
Integrity Verification	feed, treated	daily	13 days 8 hours	3	none	40
Adsorption Capacity Verification	feed, treated	weekly	first 6 months[1]	2[2]	none	56
Adsorption Capacity Verification	feed, treated	daily	final 2 months[1]	1[2]	12 per week	min: 20 max: 124
On-site Qualitative Analyses[3]						
Integrity Verification	feed, treated	Weekly	13 days 8 hours	N/A	N/A	4
Adsorption Capacity Verification	feed, treated	weekly	first 6 months[1]	N/A	N/A	48
Adsorption Capacity Verification	feed, treated	3x per week	final 2 months[1]	N/A	N/A	48

(1) Based on Kinetico/Alcan estimate of approximately 8 month run time to breakthrough (1.9 gpm flow rate, 6 hours daily operation and 164,000 gallon throughput). If breakthrough does not occur by the estimated time of 8 months, the test and sampling plan will continue until breakthrough occurs.

(2) This is considered the minimum number of days samples are speciated during the capacity verification testing. If arsenic is detected in the treated water, feed and treated water samples collected the following week will be speciated and analyzed.

(3) Method procedure presented in Appendix I.

5.5.2 Experimental Objectives

The experimental objective is to provide quality operating and water quality data relative to Kinetico Inc. and Alcan Chemicals process performance objective.

Gannett Fleming has identified the following manufacturers' process performance objective based on bench-scale testing of water from Orchard Hills MHP Well No. 1:

"The Para-Flo^{TM} PF60 Model AA08AS with Actiguard AAFS50 media is capable of removing arsenic to below 10 ppb for at least 13,000 bed volumes when the arsenic in the feed water is at most 20 ppb."

The water quality and performance objective is based upon intermittent operation of the equipment anticipated to average a total of approximately 6 hours per day, and an anticipated total throughput of greater than 136,000 gallons. The design flow rate is 1.9 gpm ± 0.1 gpm.

5.5.3 Work Plan

The measured feed water arsenic concentration during verification testing must average within 10% of the amount stated in the manufacturers' performance objective.

- Equipment Operation

  Task 2 Adsorption Capacity Verification Testing will begin simultaneously with Task 1 System Integrity Verification Testing. The operating conditions will be as stated under 5.4.3 Work Plan for Task 1: System Integrity Verification Testing.

TABLE 5-8.
ADSORPTION MEDIA CAPACITY VERIFICATION DATA REPORT

MANUFACTURER ______________________ PRODUCT NAME ______________________ MODEL NO ____________
ADSORPTIVE MEDIA ______________________ RATED CAPACITY ______________________ mg/L/FT^3

			Feed Water Production		Treated Water Production							Qualitative Arsenic Analyses			
Date/Time	Well No. 1 Incremental Time[a]	Rotameter Flow Rate (gpm)	Totalizer Meter (gallons)	Incremental Volume[b] (gallons)	Totalizer Meter (gallons)	Incremental Volume[b] (gallons)	Feed Pressure (psig)	Treated Pressure (psig)	Differential Pressure[c] (psig)	Feed pH	Treated pH	Feed Arsenic (mg/L)	Treated Arsenic (mg/L)	Arsenic Removed[d] (mg/L)	Cumulative Arsenic Removed (mg)

(a) Time (n) - Time (n-1) in minutes
(b) Flow Totalizer Meter Reading (n) - Meter Reading (n-1) in gallons
(c) Feed Pressure - Treated Pressure
(d) [[Feed Arsenic (n) - Treated Arsenic (n)] + [Feed Arsenic (n-1) - Treated Arsenic (n-1)]] / 2 x [Meter(n)] in mg

5.5.4 *Analytical Schedule*

- Operational Data Collection
  - Treated water flow rate will be monitored twice per day at the rotameter located on the treated water pipe. Flow rate will be 1.9 gpm ± 0.10 gpm.
  - Feed and treated water production will be monitored twice per day at the totalizer meters located on the feed and treated water pipes.
  - Hours of production will be monitored once per day based on the hours of Well No. 1 operation for the previous 24 hours as recorded in the WTP logbook from a run time timer.
  - Feed water pressure will be monitored twice per day initially, at the pressure gauge located on the feed water pipe.
  - Treated water pressure will be monitored twice per day initially, at the pressure gauge located on the treated water pipe.

- Sample Holding

  As indicated on Table 5-7, as the media approaches 70% of its predicted capacity, samples for laboratory arsenic will be collected on a daily basis and held (approximately 2 weeks) pending the results of the weekly arsenic samples. This is done in the event that arsenic breakthrough is missed with the weekly sampling. If a breakthrough should happen to be missed, the hold samples will be submitted for analysis. The first field kit detection of arsenic at a level of 2 ppb or higher in the treated water (and all previous treated water lab results for arsenic were non-detects) will also trigger sample collection for laboratory arsenic analysis and/or submittal of any recently collected samples being held for future arsenic analysis.

  Fluoride, silica, and aluminum samples will be collected weekly, at a minimum, during Task 2. More frequent sampling of a parameter will occur if data collected daily during Task 1 show that the concentration of the parameter fluctuates or is at a higher concentration than expected. A higher frequency of these parameters, including Alkalinity, will also be considered during the last two months of sample collection.

- Water Quality Data Collection

  The adsorptive media feed water quality, treated water quality and wastewater quality will be characterized by the analysis of the water quality parameters listed in Tables 5-6 and 5-9. The sampling frequency is described in Tables 5-6, 5-7, and 5-9. This frequency is intended to provide sufficient water quality data to effectively characterize the breakthrough profile of arsenic and to develop a representative wastewater quality profile. The exact sampling interval and duration will depend on the length of the verification testing. If breakthrough does not occur by the estimated time of 8 months, the verification test and sampling plan will continue until breakthrough occurs.

  Grab samples of backwash wastewater will be collected for the water quality analyses at the frequency presented on Table 5-9. The backwash and purge collection procedure is for one of the two filter tanks. The samples will be mixed to maintain a relatively homogenous suspension during sample collection.

- Arsenic Speciation
  The minimum arsenic speciation frequency is presented on Table 5-7. If arsenic is detected in a treated water laboratory analysis, follow-up samples of feed and treated water will be speciated for arsenic. In addition, if the arsenic field test detects arsenic in the treated water than the next sample collected for laboratory arsenic analysis should be speciated.

- Spent Media Analysis
  - TCLP and CA WET will be performed on spent Actiguard AAFS50 media, as described in Section 3.2.9 and Appendix E. The physical condition of the spent media will be noted and reported.
  - A 1.5-inch thin-walled copper tube 4 feet in length will be used to core one sample of spent Actiguard AAFS50 adsorption media from each of the two filter tanks. The Kinetico procedure for media replacement in Appendix D will be followed through Step 8.a. (with the exception of emptying the media into the bucket) to gain access to the media contained in each filter tank, and to decant the water out of each tank. Following decant, the copper tube will be used to obtain a core sample through the entire depth of the media from each tank. Each core will be discharged into a large plastic bag. The bag will be vigorously shaken to provide a homogenous media sample. The media sample will subsequently be unloaded onto a flat surface (cardboard, perhaps) and divided into two samples of roughly equal volume. Each sample will be collected in a separate sample bag and marked with appropriate information indicating its source and required laboratory tracking information. One sample will be used for TCLP. The second sample will be used for CA WET.
  - A media gradation analysis will be performed on the spent Actiguard AAFS50 media and compared to the gradation analysis of new media, presented in Appendix J, to determine the extent of media physical degradation, if any.

5.5.5 Evaluation Criteria and Minimum Reporting Requirements

- Record of Arsenic Removal
  - An arsenic breakthrough curve showing adsorptive media treated water concentrations versus volumes treated will be plotted. Feed water arsenic concentrations will be included on the same plot.
  - A spreadsheet table will tabulate arsenic feed water concentrations and calculate the average feed water arsenic concentration.
  - The performance objective for treated volume and water quality will be represented on the plot.

- Process Control
    - o Adsorptive media feed water and treated water arsenic (qualitative), pH, pressure, and water production will be recorded on Table 5-8, which will be used to calculate incremental feed and treated water production, differential pressure, and cumulative arsenic removed. Included will be the adsorptive media feed water average, standard deviation and percent standard deviation for each parameter.

Table 5-9.
Backwash Wastewater, Purge Water and Control Module Drive Water Monitoring, Sampling and Analyses

Parameter	Purge and Backwash Wastewater Sample Type	Control Module Drive Water	Frequency(2)	Method
Flow Rate	yes	yes	every second month	"bucket"(3)(4) & stopwatch
Volume	yes	yes	every second month (directly)	graduated container(3)
Duration	yes	yes	every second month	stopwatch
Turbidity	grab(1)	grab(1)	every second month	SM 2130-B
pH	grab(1)	grab(1)	every second month	SM 4500-H^+
Arsenic	grab(1)	grab(1)	every second month	EPA 200.8
Manganese	grab(1)	grab(1)	every second month	EPA 200.7
Iron	grab(1)	grab(1)	every second month	EPA 200.7
Aluminum	grab(1)	grab(1)	every second month	EPA 200.7

(1) Grab samples will be collected, using a 2-liter beaker, from a continuously mixed batch tank. Backwash and purge wastewaters will be collected in 50 and 30-gallon containers, respectively. Grab sample for control module drive water will be collected with a 2-liter beaker.

(2) Based on PADEP request, see Appendix K

(3) The "bucket" will be 50 and 30-gallon containers for calibrating backwash and purge flow rates, respectively. Increments in liters will be marked on the sides of these containers based on incrementally filling the containers beforehand with a 2 liter graduated cylinder.

(4) A 2.0 graduated cylinder will be the "bucket" for determining control module drive water discharge flow rate.

5.6 Task 3: Documentation of Operating Conditions and Treatment Equipment Performance

5.6.1 Introduction

During each day of verification testing, arsenic adsorption media filter operating conditions will be documented, including the rate of head loss gain. The volumetric flow rate through an adsorptive media vessel is a critical parameter, and must be monitored and documented. Adsorptive media performance is affected by the EBCT, which varies directly with the volumetric flow rate through the vessel.

5.6.2 Experimental Objectives

The objective of this task is to accurately and fully document the operating conditions and performance of the equipment.

The task will be performed in conjunction with both the System Integrity Verification Testing and the Adsorption Capacity Verification Testing.

5.6.3 Work Plan

During each day of verification testing, both System Integrity Testing and Adsorption Capacity Testing, treatment equipment operating parameters will be monitored and recorded on a routine basis. This will include a complete description of all applicable data. Table 5-8 will be used to record applicable operating data.

A complete description of the treatment process will be given on volume and detention time for both filters at the rated flow. Data on the adsorptive media tanks will be provided and will include EBCT, depth, effective size and uniformity coefficient of the adsorptive media. The type and source of adsorptive media used will be stated.

5.6.4 Schedule

Table 5-10 presents the schedule for observing and recording equipment operation and performance data. The schedule applies to both System Integrity Verification Testing and Adsorption Capacity Verification Testing.

Table 5-10.
Schedule for Observing and Recording Equipment Operation and Performance Data

Operational Parameter	Action*
Treated water flow rate	Check and record in logbook twice per day, adjust when >5% above or below target. Record before and after adjustment.
Filter system feed water and treated water pressures	Record in logbook initial clean bed feed water and treated water pressure at the start of the run, and thereafter record twice per day.
Total hours operated per day	Record in logbook at end of day or at beginning of the following workday, based on hours of Well No. 1 operation recorded in WTP logbook.
Tasks performed during equipment operation	Record in logbook tasks performed on a daily basis.
Number of hours per day operator attends to all tasks related to the treatment process	Record number of hours required by operator to accomplish all tasks.
Totalizer Meter Readings	Record totalizer meter readings twice daily.

*During the Capacity Test, a representative of the Orchard Hills MHP WTP will record the operational data for the days when the FTO is not on-site.

5.6.5 Evaluation Criteria

Where applicable, the data developed from this task will be presented relative to Kinetico Inc. and Alcan Chemical's statement(s) of performance objectives.

An objective evaluation of the difficulty of operations will be based on assessment of time required for process monitoring and hydraulic control.

5.7 Task 4: Data Management

5.7.1 Introduction

The data management system that will be used in this verification involves the use of computer spreadsheet software and manual recording of system operating parameters.

5.7.2 Experimental Objectives

The objective of this task is to establish a viable structure for the recording and transmission of field testing data by Gannett Fleming, such that NSF receives sufficient and reliable data for verification purposes.

5.7.3 Work Plan

The following outline is for data handling and data verification by Gannett Fleming:

The field-testing operator will record operating and water quality data and calculations by hand, in a laboratory notebook.

- Daily measurements will be recorded on specially prepared data log sheets.
- The logbook will be permanently bound with consecutively numbered pages.
- The logbook will indicate the starting and ending dates that apply to entries in the logbook.
- All pages will have appropriate headings to avoid entry omissions.
- All logbook entries will be made in black water-insoluble ink.
- All corrections in the logbook will be made by placing one line through the erroneous information and initialed by the field-testing operator
- Pilot operating logs will include a description of the adsorptive media equipment, description of test run(s), names of visitors, description of any problems or issues, etc; such descriptions will be provided in addition to experimental calculations and other items.

The original logbook will be stored on site. The original logbook will be photocopied at least once per week and copies forwarded to the project engineer of Gannett Fleming. This protocol will not only ease referencing the original data, but offer protection of the original record of results.

The database for this verification testing program will be set up in the form of custom-designed spreadsheets. The spreadsheets will be capable of storing and manipulating each monitored water quality and operational parameter from each task, each sampling location, and each sampling time. All data from the laboratory notebooks and data log sheets will be entered into the appropriate spreadsheets. Data entry will be conducted off-site by the designated field-testing operator. All recorded calculations will also be checked at this time. Following data entry, the spreadsheet will be printed out and the printout will be checked against the handwritten data sheet by another individual. Any corrections will be noted on the hard copies and corrected on the screen, and then a corrected version of the spreadsheet will be printed out. Each step of the verification process will be initialed by the field-testing operator or supervisor performing the entry or verification step.

Each experiment (e.g. each test run) will be assigned a run number that will then be tied to the data from the experiment through each step of data entry and analysis. As samples are collected and sent to the PADEP and NSF Laboratories, the data will be tracked by use of system of run numbers. Data from the PADEP and NSF Laboratories will be received and reviewed by the field testing operator. These data will be entered into the data spreadsheets, corrected, and verified in the same manner as the field data.

5.8 Task 5: Quality Assurance/Quality Control (QA/QC)

5.8.1 Introduction

Quality assurance and quality control for the operation of the arsenic adsorption media filter and the measured water quality parameters will be maintained during the verification testing program.

5.8.2 Experimental Objectives

The objective of this task is to maintain strict QA/QC methods and procedures during this verification. Maintenance of strict QA/QC procedures is important in that if a question arises when analyzing or interpreting data collected for the arsenic adsorption media filter, it will be possible to verify exact conditions at the time of testing.

5.8.3 Work Plan

Equipment flow rates will be verified and verification recorded on a routine basis. A routine daily walk-through during testing will be established to verify that each piece of equipment or instrumentation is operating properly. The items listed below are in addition to any specified checks outlined in the analytical methods.

It is extremely important that system flow rates are maintained at set values and monitored frequently. Doing so allows a constant and known EBCT to be maintained in the adsorptive media. Adsorptive media performance is directly affected by the EBCT, which in turn is proportional to the volumetric flow rate through the media. Therefore, an important QA/QC objective will be the maintenance of a constant volumetric flow rate through the adsorptive media by frequent monitoring and documentation. Documentation will include an average and standard deviation of recorded flow rates through the adsorptive media.

- Weekly QA/QC Verifications
    - In-line rotameter (clean any foulant buildup as needed and verify flow rate volumetrically)
    - In-line totalizer meters (clean any foulant buildup as needed and verify flow rate)
    - Tubing (verify good condition of all tubing and connections, replace as necessary)

5.8.4 Analytical Methods

The analytical methods utilized in this study for on-site and laboratory monitoring of adsorptive media feed and treated water quality are described in the section below.

- **Arsenic**
  Arsenic analyses will be performed in the NSF Laboratory using EPA Method 200.8. These analyses are the most critical for the entire ETV test. Minimum analytical turnaround time is required to achieve optimum process control. This method requires that ultra-pure (optimum) grade nitric acid must be used, not reagent grade, to avoid the trace amounts of arsenic that can be present in reagent grade nitric acid.

  Arsenic analyses will also be performed on-site for qualitative purposes using the Model QUICK Low Range II field test kit from Industrial Test Systems (ITS), Inc. The arsenic field test kit has an optimum accuracy below 6 ppb and has a reaction time less than 15 minutes. The complete method procedure is presented in Appendix I.

- **pH**
  Analyses for pH will be performed on-site according to Standard Method 4500-H^+ B (Electrometric Method). A three-point calibration of the pH meter used in this study will be performed once per day when the instrument is in use. Certified pH buffers 4.0, 7.0, and 10.0 will be used. The pH electrode will be stored in the appropriate solution defined in the instrument manual.

- **Alkalinity**
  Analyses for alkalinity will be performed on-site or at the Gannett Fleming Treatability Lab using Hach Method 8221(Buret Titration Method).

- **Fluoride**
  Analyses for fluoride will be performed on-site or at the Gannett Fleming Treatability Lab according to Standard Method 4500-F^- C (Ion-Selective Electrode Method).

- **Chloride**
  Analyses for chloride will be performed in the PADEP Lab according to EPA Method 300.0.

- **Sulfate**
  Analyses for sulfate will be performed in the PADEP Lab according to EPA Method 300.0.

- **Silica**
  Analyses for silica will be performed in the PADEP Lab according to EPA Method 200.7.

- **Aluminum**
  Analyses for aluminum will be performed in the PADEP Lab according to EPA Method 200.7.

- **Total Phosphorus**
  Analyses for phosphate will be performed in the PADEP Lab according to EPA Method 365.1.

- **Calcium**
  Analyses for calcium will be performed on-site or in the Gannett Fleming Treatability Lab using Hach Method 8222 (Buret Method), with 0.020 N titrant.

- **Hardness**
  Analyses for hardness will be performed on-site or in the Gannett Fleming Treatability Lab using Hach Method 8226 (ManVer 2 Buret Titration), with 0.020 N titrant.

- **Magnesium**
  Magnesium will be calculated by subtracting the Calcium result (Hach Method 8222) from the Hardness result (Hach Method 8226).

- **Iron**
  Analyses for iron will be performed in the PADEP Lab using EPA Method 200.7.

- **Manganese**
  Analyses for manganese will be performed in the PADEP Lab using EPA Method 200.7.

- **Turbidity**
  Turbidity analyses will be performed on-site according to Standard Method 2130 B using a portable turbidimeter.

- **Temperature**
  Temperature will be analyzed on-site according to Standard Method 2550 B.

- **TCLP**
  Toxicity Characteristic Leaching Procedures will be performed on spent Actiguard AAFS50 media by TriMatrix Laboratories, Inc. using SW-846 and EPA Method 1311. TriMatrix Laboratories, Inc. will use Method SW-846 6010B for As, Ba, Cd, Cr, Cu, Ni, Pb, Se, Ag, and Zn; and Method SW-846 7470A for Hg.

- **CA WET**
  California Waste Extraction Test will be performed on spent Actiguard AAFS50 media by TriMatrix Laboratories, Inc. using the procedure and metal analysis methods presented in Appendix E. TriMatrix Laboratories, Inc. will use Method SW-846 6010B for As, Ba, Cd, Cr, Cu, Ni, Pb, Se, Ag, and Zn; and Method SW-846 7470A for Hg.

5.8.5 Samples Shipped Off-Site for Analysis

Samples for inorganic analysis, including arsenic, chloride, sulfate, silica, aluminum, total phosphorus, iron, and manganese, will be collected and preserved in accordance with Standard Method 3010 B, paying particular attention to the sources of contamination as outlined in Standard Method 3010 C. The samples will be refrigerated at approximately 2º to 8ºC immediately upon collection, shipped in a cooler, and maintained at a temperature of approximately 2º to 8ºC. Samples will be processed for analysis by the PADEP and NSF Laboratories within 24 hours of collection. The laboratories will keep the samples at approximately 2º to 8ºC until initiation of analysis. Table 5-11 presents the sampling protocol that will be followed during the ETV.

5.8.6 Tests and Data Specific to Adsorptive Media Type Evaluated

The Alcan Chemical's AAFS50 adsorptive media used for this testing is described by data on the adsorptive media type, characteristics, and tests, listed in Tables 3-1 and 5-2.

5.9 Operations and Maintenance

The following are recommendations for criteria to be included in the Para-Flo™ Operation and Maintenance (O&M) Manual for adsorptive media removal of arsenic, as described in the Technology Specific Test Plant (TSTP) within the ETV Protocol. The listing below is not currently included as one complete document provided by the manufacturers; Kinetico Inc. plans to submit a complete O&M Manual to the FTO before the completion of the verification test. Gannett Fleming will review Kinetico's O&M Manual and will report on the applicability of the manual in the final report from the verification test.

5.9.1 Operations

Kinetico Inc. provided an Owner's Manual and Installation Guide that did provide most of the needed data and information needed to conduct the test. Technical sheets were also submitted and are intended for Gannett Fleming and NSF review only and not for publication. The Owner's Manual and Installation Guide are included in Appendix A; the technical sheets are on file at Gannett Fleming and NSF. These manuals present specific information on the mechanical operation of the filter tanks for a variety of media types, which include Actiguard AAFS50.

Kinetico Inc. and Alcan Chemicals needed to provide readily understood information on the required or recommended procedures (task specific SOPs) that were not included in a complete O&M Manual related to the proper operation of the arsenic adsorption media filter. Gannett Fleming has discussed the following issues with Kinetico Inc. and Alcan Chemicals and has received all of the equipment information to proceed with testing:

- Monitoring of Preconditioning of Adsorptive Media
  - Utilizing manufacturer's procedure specific for Actiguard AAFS50 adsorptive media including backwashing initially with at least 10 bed volumes to remove fines.
  - Backwash parameters (flow rate and time.)
  - Volume of wastewater
  - Wastewater disposal requirements
- Monitoring Operation
  - Use of an arsenic field test kit for the purpose of monitoring feed and treated arsenic levels.
  - Feed water pressure
  - Treated water flow rate
  - Treated water pressure
  - Maintenance and operator labor requirements
  - Spare parts requirements
- Operability

  During verification testing and during compilation of process operating data, attention will be given to the arsenic adsorption media filter operability aspects. Among the factors that will be considered are:
  - Fluctuation of flow rates, as well as the time interval at which flow adjustment is needed.
  - Ease of adjusting the flow rate when it is outside the design range.
- Adsorptive Media Replacement Procedure and Disposal and Wastewater Disposal
  - Media replacement procedure.
  - Contacting the state regulatory agency acknowledging the volumes and nature of wastewater residue from the preconditioning of the media,

backwash wastewater, and spent media for the purpose of determining the appropriate disposal methods and permitting requirements.

5.9.2 Maintenance

Kinetico Inc. and Alcan Chemicals will provide readily understood information on the required or recommended maintenance schedule for each piece of operating equipment including, but not limited to:

- manual valves
- on-line measuring instruments
- control module

Kinetico Inc. and Alcan Chemicals will provide readily understood information on the required or recommended maintenance schedule for non-mechanical or non-electrical equipment including, but not limited to:

- adsorptive media vessels
- feed lines

Gannett Fleming will comment on the quality of this information in the final report.

Table 5-11.
Water Quality Sampling Protocol

					DEP Sample ID Protocol – Sample Submission Sheet						NSF Test Tracking ID	
					Sequence Number[1]							
Parameter	Sample Bottle	Sample Volume	Sample Preservation	Sample Hold Time	Feed	Treated	SAC No.[1]	Bottle Cap ID	Collector No.[1]	Date/Time Collected	Integrity	Capacity
Laboratory												
Aluminum & Silica	125 mL HDPE	100 mL	Nitric Acid to pH <2.0; iced	6 months	101	102	107	M	1749	✔	I	II
Iron & Manganese	125 mL HDPE	100 mL	Nitric Acid to pH <2.0; iced	6 months	201	202	106	M	1749	✔	I	II
Sulfate & Chloride	500 mL HDPE	250 mL	iced	28 days	201	202	106	N/A	1749	✔	I	II
Total Phosphorus	125 mL HDPE	100 mL	Sulfuric Acid to pH <2.0; iced	28 days	201	202	106	P	1749	✔	I	II
TCLP	Plastic Bag		N/A	N/A	N/A	N/A	242	N/A	1749	✔	N/A	II

(1) Information also required on samp le bottle.

The QAPP for this verification testing specifies procedures that will be used to ensure data quality and integrity. Careful adherence to these procedures will ensure that data generated from the verification testing will provide sound analytical results that can serve as the basis for the performance verification.

6.1 Purpose and Scope

The purpose of this section is to outline steps that will be taken by Gannett Fleming and by the PADEP and NSF Laboratories to ensure that data resulting from this verification testing is of known quality and that a sufficient number of critical measurements are taken.

6.2 Quality Assurance Responsibilities

A number of individuals will be responsible for monitoring equipment-operating parameters and for sampling and analysis QA/QC throughout the verification testing. Primary responsibility for ensuring that both equipment operation, sampling and analysis activities comply with the QA/QC requirements of this PSTP rests with Gannett Fleming.

QA/QC activities for the PADEP and NSF Laboratories, that will analyze samples sent off-site, will be the responsibility of this analytical laboratory's supervisor. If problems arise or any data appear unusual, they will be thoroughly documented and corrective actions will be implemented as specified in this section. The QA/QC measurements made by the PADEP and NSF Laboratories are dependent on the analytical methods being used.

The PADEP Laboratory will provide copies of the raw data (run logs, bench sheets) to Gannett Fleming and NSF on a monthly basis (or more frequently as decided by PADEP). Copies of run logs and raw data for other analyses (chloride, sulfate, total phosphorous, etc.) will be sent to NSF on a periodic basis (monthly or other reasonable time period) as they are completed. Copies of the emailed results sent to Gannett Fleming, as results are available, will also be copied to NSF. Final laboratory reports with all results will be copied to NSF, as they are complete.

NSF will review the raw data records for compliance with QC requirements and check, at a minimum, 10% of the data against the reported results (emails and/or final lab reports). This check will be performed in an expeditious manner, within 10 days of receipt for the arsenic data and within 15 days once the final lab reports are received.

PADEP and the NSF Laboratories will retain and will not discard the arsenic and metals samples until NSF notifies PADEP and the NSF Laboratories that the data is valid and the samples can be discarded. NSF will provide written release for samples via email to the designated PADEP and NSF Laboratory representatives. Samples with short holding times can be discarded by PADEP and the NSF Laboratories using their normal procedures.

This procedure will reduce the risk that data quality problems could jeopardize the test program. If problems are detected, PADEP and the NSF Laboratories will be notified immediately and will take appropriate corrective action. This procedure does not release PADEP or the NSF Laboratories from having the primary responsibility to produce analytical results that meet the QA requirements and follow the specified EPA procedures.

6.3 Data Quality Indicators

The data obtained during the verification testing must be of sound quality for conclusions to be drawn on the equipment. For all measurement and monitoring activities conducted for equipment verification, NSF and EPA require that data quality parameters be established based on the proposed end uses of the data. Data quality parameters include four indicators of data quality: representativeness, accuracy, precision, and statistical uncertainty.

Treatment results generated by the equipment and by the laboratory analyses must be verifiable for the purposes of this program to be fulfilled. High quality, well-documented analytical laboratory results are essential for meeting the purpose and objectives of this verification testing. Therefore, the following indicators of data quality will be closely evaluated to determine the performance of the equipment when measured against data generated by the analytical laboratory.

6.3.1 Representativeness

Representativeness refers to the degree to which the data accurately and precisely represent the conditions or characteristics of the parameter represented by the data. In this verification testing, representativeness will be ensured by executing consistent sample collection protocol, including sample locations, timing of sample collection, sampling procedures, sample preservation, sample packaging, and sample shipping. Representativeness also will be ensured by using each method at its optimum capability to provide results that represent the most accurate and precise measurement it is capable of achieving. For equipment-operating data, representativeness entails collecting a sufficient quantity of data during operation to be able to detect a change in operations. For most water treatment processes involving arsenic removal, detecting a +/- 10% change in an operating parameter (i.e., headloss, pressure) is sufficient.

6.3.2 Accuracy

The definition of accuracy depends on the context, and is defined as the following:

- Water quality analyses – difference between a sample result and the reference or true value for the sample. Loss of accuracy can be caused by:
  - errors in standards preparation
  - equipment calibrations
  - loss of target analyte in the extraction process
  - chemical interferences
  - systematic or carryover of contamination from one sample to the next
- Arsenic speciation resin columns QA check – each lot of the arsenic speciation resin columns will be checked once against samples with known concentrations of As III and As V by the person who will be performing the speciation procedure onsite. This QC check will assure that the resin was properly prepared by the manufacturer, is performing as expected, and is being used correctly. The samples will be sent to the NSF Laboratory after speciation to analyze.
- pH QA - checks will consist of conducting a 3-point calibration of the pH meter daily using certified pH buffers 4.0, 7.0 and 10.0. If the accuracy of the pH electrode falls outside 95% to 105%, the electrode will be rehabilitated according to manufacturer's recommendations or discarded.
- Temperature QA checks - readings will be made using a thermometer in accordance with Standard Methods 2550. The thermometer will have a scale marked for every 0.1°C. Since the thermometer used will be a NIST-traceable certified reference thermometer, calibration will not be required.
- Turbidimeter QA checks - the portable turbidimeter will be calibrated according to the manufacturer's instructions on a weekly basis using primary turbidity standards. Secondary standards will be used daily to verify the primary standard calibration. A performance evaluation sample will be analyzed prior to the start of testing.
- Hach test kits – split samples will be collected during the first two days of Task 1 for the parameters that will be measured by the onsite Hach test kits, including Alkalinity, Calcium, and Hardness. These split samples will determine if there are any interferences present in the water affecting the results of the Hach methods. If the difference of each result from the Hach method and the PADEP laboratory falls outside of 30%, then the source of the discrepancy will be determined and the use of the Hach test kits will be reevaluated.

Accuracy of analytical readings is measured through the use of spiked samples, that is, a known quantity of a target analyte is added to a sample. The percent recovery is calculated as a measure of the accuracy. Acceptance limits for percent recovery are analyte and concentration specific. Tables 6-1 and 6-2 present the frequency and the acceptable accuracy limits for the laboratory and on-site spiked samples, respectively.

Table 6-1.
Laboratory Water Quality Indicators

Parameter	Lab Spike Frequency	Acceptable Accuracy (% Recovery)	Lab Duplicate Frequency	Acceptable Precision*
Arsenic	10%	± 30	10%	± 30%
Iron	10%	± 30	10%	± 30%
Manganese	10%	± 30	10%	± 30%
Aluminum	10%	± 30	10%	± 30%
Silica	10%	± 30	10%	± 30%
Chloride	10%	± 20	10%	± 11%
Sulfate	10%	± 20	10%	± 11%
Total Phosphorus	10%	± 10	0	N/A

*All precision limits are based on Relative Percent Standard Deviation as shown in Section 6.3.3. For all laboratory duplicate analyses, the first analysis is considered the sample and that result is reported. The duplicate analysis is used for calculating precision per Section 6.3.3.

The calibration procedures for the analyses of samples for parameters shown in Table 6-1 will be as follows:

A calibration check standard is analyzed at a frequency of 10% with acceptable criteria of ±15% for arsenic and ±10% for iron, manganese, aluminum and silica. A calibration check standard is analyzed at a frequency of 10% with acceptable criteria of ±10% for chloride, sulfate, and total phosphorus. If a spiked sample is not within acceptable criteria, the sample and spike are either reanalyzed or re-spiked and re-analyzed. If still not within acceptable criteria, a comment is placed on the report indicating possible matrix interference. The same procedure applies to duplicates. A comment in that case may be that the sample may not be homogenous. If a calibration check standard does not meet the acceptable criteria, the samples following the last acceptable calibration check standard must be reanalyzed.

Table 6-2.
On-site Water Quality Indicators

Parameter	Spike Frequency	Acceptable Accuracy (% Recovery)	Duplicate Frequency	Acceptable Precision*
Alkalinity	10%	± 30	10%	± 30%
Calcium	10%	± 30	10%	± 30%
Hardness	10%	± 30	10%	± 30%
Fluoride	10%	± 30	10%	± 30%

*All precision limits are based on Relative Percent Standard Deviation as shown in Section 6.3.3. For all on-site duplicate analyses, the first analysis is considered the sample and that result is reported. The duplicate analysis is used for calculating precision per Section 6.3.3.

On-site analyses for pH, temperature, and turbidity do not lend themselves to spike samples and percent recovery or blank analyses. Turbidity accuracy will be documented by analysis of a performance evaluation sample at the beginning of the testing protocol. The acceptable limits for the analysis of the PE samples are presented on Table 6-5. Accuracy for pH and temperature will be assured by calibration procedures previously described.

- Equipment operating parameters – difference between the reported operating condition and the actual operating condition.
  - Water flow – difference between the reported flow indicated by a flow meter and the flow as actually measured on the basis of known volumes of water and carefully defined times as practiced in hydraulics laboratories or water meter calibration shops. The "bucket and stopwatch" technique will be used to determine the accuracy of the rotameter and accessory totalizer meters.
  - Headloss measurement – accuracy will be determined by using a dead weight pressure tester to check the calibration of the pressure gauges.

Meters and gauges will be checked at the frequencies presented on Table 6-3 for accuracy, and when proven to be dependable over time, the time interval between accuracy checks will be increased. Inaccurate pressure gauges and meters will be replaced.

Table 6-3.
Field Instrument Calibration Schedule

Instrument	Calibration Method	Frequency	Acceptable Accuracy
Pressure Gauges	dead weight calibration tester	biannual	± 10%
Rotameter	volumetric "bucket & stop watch"	weekly	± 10%
Totalizer Meters	volumetric "bucket & stop watch"	weekly	± 1.5%
Portable Turbidimeter	secondary turbidity standards primary turbidity standards	daily weekly	PE sample
Portable pH/ISE Meter with Combination pH/Temperature Electrode	three-point calibration using 4.0, 7.0 and 10.0 buffers	daily	± 5%
Thermometer (NIST-traceable)	calibration not required(1)	N/A	
Portable pH/ISE Meter with Fluoride Ion Selective Electrode	0.1 mg/L or 0.5 mg/L fluoride standard, and 10.0 mg/L fluoride standard(2)	daily	± 2%

(1) Copy of NIST-traceable certification in Appendix L.
(2) The standards used will depend on the concentration of fluoride detected; the analytical method recommends that the standards used to calibrate the meter bracket the measured concentration, with the upper range standard greater than the low range standard by a factor of at least ten.

6.3.3 Precision

Precision refers to the degree of mutual agreement among individual measurements and provides an estimate of random error. Analytical precision is a measure of how far an individual measurement may be from the mean of replicate measurements. The standard deviation and the relative standard deviation recorded from sample analyses will be reported as a means to quantify sample precision. The percent relative standard deviation will be calculated in the following manner:

$$\text{Percent Relative Standard Deviation} = S(100) / X_{average}$$

where: S = standard deviation
$X_{average}$ = the arithmetic mean of the recovery values

Standard Deviation is calculated as follows:

$$\text{Standard Deviation} = \sqrt{\sum_{i=1}^{n} \frac{(Xi - X)^2}{n - 1}}$$

where: X_i = the individual recovery values
X = the arithmetic mean of the recovery values
n = the number of determinations

For acceptable analytical precision under the verification testing program, the percent relative standard deviation for drinking water samples must be less than 30%.

Tables 6-1 and 6-2 present the frequency of laboratory and on-site duplicates, respectively, and the acceptable percent relative standard deviation for each analyte.

6.3.4 Statistical Uncertainty

Statistical uncertainty of the water quality parameters analyzed will be evaluated through calculation of the 95% confidence interval around the sample mean. Description of the confidence interval calculation is provided in Section 4.5 – Recording Statistical Uncertainty.

6.4 Quality Control Checks

This section describes the QC requirements that apply to both the treatment equipment and the on-site water quality analyses. It also describes the corrective action to be taken if the QC parameters fall outside of the evaluation criteria. The quality control checks provide a means of measuring the quality of data produced.

6.4.1 Quality Control for Equipment Operation

This section explains the methods that will be used to check the accuracy of equipment operating parameters and the frequency with which these quality control checks will be made. If the quality of the equipment operating data cannot be verified, then the water quality analytical results may be of no value. Because water cannot be treated if equipment is not operating, obtaining valid equipment operating data is a prime concern for verification testing.

6.4.2 *Water Quality Data*

After treatment equipment is being operated and water is being treated, the results of the treatment are interpreted in terms of water quality. Therefore the quality of water sample analytical results is just as important as the quality of the equipment operating data.

- **Duplicate Samples.** Duplicate samples must be analyzed to determine the precision of analysis. Duplicate samples will be collected and analyzed for all laboratory analyses for every ninth sample collected. One sample will be collected and subsequently split into two aliquots, representing the regular sample and the duplicate sample. Each aliquot will comply with all of the sampling requirements presented on Table 5-11. The frequency of field duplicate sampling and the estimated total number of duplicates is presented on Table 6-4.
- **Method Blanks.** Method blanks will be used to evaluate analytical method-induced contamination, which may cause false positive results. The PADEP and NSF Laboratories will produce and analyze method blanks for each laboratory method used in this ETV. The frequency of method blank analyses required is presented on Table 6-4.
- **Travel Blanks.** Travel blanks will be provided by the FTO to the analytical laboratory to evaluate travel-related contamination. Travel blanks will be provided for every trip to lab. The frequency of sending trip blanks to the laboratory is presented on Table 6-4.

Table 6-4. Schedule of Field Duplicates, Method Blanks and Trip Blanks for Laboratory Analyses

	Field Duplicates (1)		Method Blanks	Travel Blanks
Parameter	Frequency	Total Number	Frequency	Frequency
Arsenic	1/10	Max 22(2)	1/Analytical Batch	1/trip
Chloride	1/10	6	1/Analytical Batch	1/trip
Sulfate	1/10	6	1/Analytical Batch	1/trip
Silica	1/10	Max 45(2)	1/Analytical Batch	1/trip
Aluminum	1/10	Max 45(2)	1/Analytical Batch	1/trip
Iron	1/10	6	1/Analytical Batch	1/trip
Manganese	1/10	6	1/Analytical Batch	1/trip
Phosphorus	1/10	6	1/Analytical Batch	1/trip

(1) All field duplicates will begin the first week of the Integrity Test.
(2) May be significantly less if hold samples are not analyzed.

- **Performance Evaluation Samples for Water Quality Testing.** Performance evaluation samples are samples of known concentration prepared by an independent performance evaluation (PE) lab and provided as unknowns to an analyst to evaluate his or her analytical performance. Analyses of laboratory PE samples were conducted before verification testing. The control limits for the PE samples will be used to evaluate the field analytical method performance.

  A PE sample comes with statistics that have been derived from the analysis of the sample by a number of laboratories using EPA-approved methods. These statistics include a true value of the PE sample, a mean of the laboratory results obtained from the analysis of the PE sample, and an acceptance range for sample values. The field laboratory and the PADEP Laboratory are expected to provide results from the analysis of the PE samples that meet the performance objectives of the verification testing.

PE sample results for the PADEP Laboratory are included in Appendix M. PE checks will be performed prior to testing for all of the on-site parameters listed in Table 6-5.

Table 6-5.
PE Samples for On-site Analyses[1]

Parameter	Acceptance Limits
pH	6.71 – 8.2
Turbidity, NTU	5.48 – 7.33
Alkalinity, mg/L	35.8 – 42.6
Calcium, mg/L	71.5 – 87.5
Arsenic, ug/L[2]	TBD
Total Hardness, mg/L	135 – 183
Fluoride, mg/L	1.47 – 1.79

(1) Analyses of PE samples will be conducted prior to the initiation of verification testing. Objective is to provide results from the analysis of the PE samples that are within the acceptance range included with the specific PE samples provided by the laboratory certified to provide PE samples.
(2) Performed on the arsenic test kit.

6.5 Data Reduction, Validation, and Reporting

To maintain good data quality, specific procedures will be followed during data reduction, validation, and reporting. These procedures are detailed below.

6.5.1 Data Reduction

Data reduction refers to the process of converting the raw results from the equipment into concentration or other data in a form to be used in the comparison. The purpose of this step is to provide quality data that will be presented in a form that is useful for all stakeholders. These data will be obtained from logbooks, instrument outputs, and computer outputs.

6.5.2 Data Validation

There are two types of data validation that need to be addressed, field data and laboratory data.

For the field data (including data collected from the field laboratory):

- The operator will verify the correctness of data acquisition and reduction;
- The field team supervisor or another technical person will review calculations and inspect laboratory logbooks and data sheets to verify accuracy of data recording and sampling;
- Calibration and QC data will be examined by the individual operators and the field team supervisor;

- Project managers will verify that all instrument systems are in control and that QA objectives for accuracy, precision, and method detection limits have been met.

For the laboratory data:

- Calibration and QC data will be examined by the individual analysts and the laboratory supervisor;
- Laboratory managers will verify that all instrument systems are in control and that QA objectives for accuracy, precision, and method detection limits have been met. Method detection limits are presented on Table 6-6.

Table 6-6.
Method Detection Limits (MDL) and Laboratory Reporting Limits

	Analytical Method	MDL (mg/L)	Laboratory Report Limit (mg/L)
Arsenic	EPA 200.8	0.002	0.002
Aluminum	EPA 200.7	0.081	0.2
Iron	EPA 200.7	0.008	0.02
Manganese	EPA 200.7	0.007	0.01
Silica	EPA 200.7	0.038	0.5
Chloride	EPA 300.0	0.230	<0.5
Sulfate	EPA 300.0	0.076	1.0
Phosphorus	EPA 365.1	0.002	0.01

Analytical outlier data are defined as those QC data lying outside a specific QC objective window for precision and accuracy for a given analytical method. Should QC data be outside of control limits:

- The analytical laboratory or field team supervisor will investigate the cause of the problem
- If the problem involves an analytical problem, the sample will be reanalyzed.
- If the problem can be attributed to the sample matrix, the result will be flagged with a data qualifier.
- The data qualifier will be included and explained in the final analytical report.

6.5.3 Data Reporting

This section contains a list of the water quality and equipment operation data to be reported. The data tabulation will list the results for feed water and treated water quality analyses and equipment operating data. All QC information such as calibrations, blanks and reference samples will be included in an appendix. All raw analytical data will also be reported in an appendix. All data will be reported in hardcopy and electronically in a spreadsheet on a regular basis to NSF for QA review, included in database format.

The PADEP Laboratory will provide copies of the raw data (run logs, bench sheets) to Gannett Fleming and NSF on a monthly basis (or more frequently as decided by PADEP). Copies of run logs and raw data for other analyses will be sent to NSF on a periodic basis (monthly or other reasonable time period) as they are completed. Copies of the emailed results sent to Gannett Fleming, as results are available, will also be copied to NSF. Final laboratory reports with all results will be copied to NSF, as they are complete.

NSF will review the raw data records for compliance with QC requirements and check, at a minimum, 10% of the data against the reported results (emails and/or final lab reports). This check will be performed in an expeditious manner, within 10 days of receipt for the arsenic data and within 15 days once the final lab reports are received.

PADEP and the NSF Laboratories will retain and will not discard the arsenic and metals samples until NSF notifies PADEP and the NSF Laboratories that the data is valid and the samples can be discarded. NSF will provide written release for samples via email to the designated PADEP and the NSF Laboratory representatives. Samples with short holding times can be discarded by PADEP and the NSF Laboratories using their normal procedures.

This procedure will reduce the risk that data quality problems could jeopardize the test program. If problems are detected, PADEP and the NSF Laboratories will be notified immediately and will take the appropriate corrective action. This procedure does not release PADEP and the NSF Laboratories from having the primary responsibility to produce analytical results that meet the QA requirements and follow the specified EPA procedures.

6.6 System Inspections

On-site system inspections and audits for sampling activities, field operations, and laboratories will be conducted as specified by the ETV Testing Plan *Adsorptive Media Processes for the Removal of Arsenic*. NSF will conduct an on-site audit, and the Gannett Fleming QA officer will perform quarterly on-site inspections and audits, and an annual laboratory audit to determine if this PSTP is being implemented as intended. The Gannett Fleming QA officer will also conduct an on-site inspection during the first two weeks of operation. Separate inspection reports will be completed after the inspections and provided to the participating parties.

6.7 Reports

6.7.1 Status Reports

Gannett Fleming will prepare periodic reports to pertinent parties such as Kinetico Inc., Alcan Chemicals, NSF, PADEP, and the utility where testing is done. These reports will discuss project progress, problems and associated corrective actions, and future scheduled activities associated with the verification testing. When problems occur, Kinetico Inc., Alcan Chemicals and Gannett Fleming project managers will discuss them and estimate the type and degree of impact, and describe the corrective actions taken to mitigate the impact and to prevent a recurrence of the problems. The frequency, format, and content of these reports are outlined below.

- Frequency:
  - Weekly during integrity testing
  - Monthly during adsorption capacity testing

- Format:
  - o Excel spreadsheet data tables with status report memo
- Content:
  - o Water quality tables
  - o Production data

6.7.2 Inspection Reports

Any QA inspections that take place in the field or at the analytical laboratory while the verification testing is being conducted will be formally reported by Gannett Fleming to NSF, Kinetico Inc., and Alcan Chemicals.

Table 6-7.
Field Testing Organization QA Officer Inspections and Audits of Test Site and Laboratory

Frequency		
Test Site	Laboratory	Report
quarterly[1]	annually	Any procedures that are not consistent with PSTP requirements are noted and subsequently reported to NSF in memo form.

(1) In addition to the inspection conducted during the first two weeks of operation.

6.8 Corrective Action

If, during the course of the verification testing, established equipment operation acceptance limits are exceeded, Gannett Fleming will require that corrective action be implemented. Acceptance limits are discussed in the appropriate sections of this document. If corrective action is necessary, Gannett Fleming will document the required action, the party responsible and the results of the action. Any suspect data gathered during or before the implementation of the corrective action will be discarded.

7.1 Data Management and Analysis

All operational and analytical data will be gathered and included in the Final ETV Report. The data will consist of results of analyses and measurements that are detailed in the Tasks section of this PSTP. The data will be entered into computer spreadsheets and submitted in electronic and hard copies. In addition, all QA/QC summary forms, field notebooks, and photographs will be provided.

7.2 Report of Equipment Testing

The testing report will be issued in two phases. An initial report will be issued after the Integrity Test. This report will be supplemented at the conclusion of the Capacity Test. The report will be issued in draft form for review prior to final publication.

The reports will be prepared by Gannett Fleming. The reports will consist of:

- Introduction
- Forward (Phase 1)
- Introduction (Phase 1)
- Description and Identification of Product Tested (Phase 1)
- Procedures and Methods Used in Testing (Phase 1)
- Results and Discussion (Phase 1 – Integrity, Phase 2 – Capacity)
- References
- QA/QC Results (Phases 1 and 2)
- Each piece of data or information identified for collection in the *ETV Testing Plan for Adsorptive Media Processes for the Removal of Arsenic* (Phase 1 and 2)
- Laboratory raw data and validated data (hard copy and electronic spreadsheets) (Phase 1 and 2)
- Field notebooks (Phase 1 and 2)
- Photographs (Phase 1)
- Results from the use of other field analytical methods (Phase 1 and 2)

This report will be prepared in Microsoft Word® with data and graphics presented using Microsoft Excel® spreadsheets.

8.1 Hazardous Chemicals

The only hazardous chemicals that will be stored on-site during this verification testing are reagents required for the on-site analyses. Latex gloves and eye protection will be available for the operator.

8.2 Conformance to Electrical Codes

All equipment electrical connections will comply with appropriate electrical codes. This consists of bench-top analytical equipment since the arsenic adsorption process does not have an electrical requirement.

8.3 Ventilation of Hazardous Gasses

No hazardous gasses will be generated during this verification testing.

8.4 Orchard Hills MHP WTP Facility

The test equipment and some analytical equipment will be housed within the existing WTP. Prior to starting the test, the field engineer will become familiarized with the facilities via training provided by Mason Dixon Environmental. This training will include:

- A facility tour
- Presentation of the WTP O&M manual
- A review of the chlorination facilities
- A review of the electrical facilities
- Specific operating instructions to start and stop Well No. 1
- A presentation of emergency contact information and people to be contacted
- Location of MSDS sheets