Field Operations Document Environmental Technology Verification

of the
Kinetico CPS100CPT
Coagulation and Filtration System
for the Removal
of Arsenic
from Drinking Water

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FOREWORD

The following Field Operations Document (FOD) was prepared for the Environmental Technology Verification of the Kinetico Macrolite® CPS100CPT Prefiltration by Coagulation and Pressure Filtration System for arsenic reduction. It was prepared by the Field Testing Organization, Cartwright, Olsen & Associates, LLC (COA) in accordance with the Protocol and Test Plan established by NSF and EPA for the removal of arsenic

The ETV program is a cooperative program of the NSF and EPA developed to evaluate in a structured and comprehensive manner new and innovative water treatment technologies. The program was designed with the needs of small systems in mind, although the technologies may be applicable to larger public water supplies as well.

The purpose of this document is to coordinate the understanding of COA, Kinetico, Inc., NSF and EPA with respect to the objectives and methodologies of the testing. It is intended to serve as an on-site working document, and is subject to some modification as testing proceeds. While it is a public document and is not intended to be proprietary, it is written for the benefit of principal parties and for the convenience of the reviewers of the final verification and performance report, and not for the general public. Accordingly, while some background is offered, it is not intended to be a tutorial on the technology. It is expected that future reviewers of the performance report will have at their disposal copies of this document to offer them a background to the testing procedures.

This FOD is based on the EPA/NSF ETV *Protocol for Equipment Verification Testing for Arsenic Removal,* dated January 18, 2000, including Chapter 3, *NSF Equipment Verification Testing Plan - Coagulation and Filtration for Removal of Arsenic* and conforms to those documents.

The Kinetico Coagulation System is a Direct Filtration System consisting of coagulant chemical injection into the raw water, a mixing chamber and a backwashable pressure filter system. The filter system consists of two identical 10 inch diameter filter tanks piped for alternating service, thereby providing continuous flows of 5 gpm. The media, called Macrolite®, consists of synthetic ceramic spheres, and is more fully described within the body of the document.

The technology in this FOD is well established; however, the use of a synthetic ceramic media as a filter media is relatively new, so some adaptation to the common filtration technology is required. Macrolite® has properties that the manufacturer feels ideally suited to filtration—especially for smaller particulate matter. Moreover, the coagulation and filter system has control and monitoring functions that are exclusive to the design. These functions are also verified in this study.

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1.0 INTRODUCTION

1.1 EXECUTIVE SUMMARY

The following is the Field Operations Document (FOD) for the Environmental Technology Verification (ETV) third party field testing of the Kinetico, Inc. (KI) coagulation and backwashable Macrolite® Pressure Filtration System. The KI filter system will be operated on Spiro Tunnel Bulkhead water from the Park City water source. Testing will be conducted at the Park City Municipal Corporation Water Treatment Plant.

The FOD was prepared by Cartwright, Olsen and Associates, LLC (COA) as the Field Testing Organization (FTO) utilizing qualification criteria established by the NSF and USEPA for incorporating the field testing of all package systems. The Protocol and Test Plan used were: *Protocol of Equipment Verification Testing For Arsenic Removal*, dated January 18, 2000 and Chapter 3 of NSF/EPA Test Plan: *NSF Equipment Verification Testing Plan Coagulation and Filtration for Removal of Arsenic.*

The equipment is intended to be applicable to small drinking water systems as defined by the US EPA.

The purpose of the testing is to verify the performance expectations of the manufacturer through a carefully designed study involving rigorous QA/QC controls. Kinetico Inc. expects to achieve an effluent stream containing 5µg/L of arsenic from an influent stream containing up to 225 µg/L of arsenic utilizing 5 to 20 mg/L of $FeCl_3$ with a contact time of up to 10 minutes at a flow rate of 5 gpm (10 gpm per square foot). This is the benchmark against which the system will be tested.

The following are the maximum and minimum influent conditions as limitations to the system.

Inlet flow rate—maximum	5 gpm
Inlet flow rate—minimum	0 gpm
Maximum static pressure	100 psi
Minimum inlet dynamic pressure	35 psi
Maximum temperature	100 F
Minimum temperature	35 F
Maximum inlet turbidity	8 NTU

Testing is performed in the field and consists of two phases:

I) An initial operations phase and
II) A testing and verification phase

The initial operations phase consists of two tasks:

A) An evaluation of the source water characteristics for establishing the suitability of the site for the performance study
B) Initial test runs to determine the readiness of the equipment for the second phase

The testing and verification phase consists of six tasks designed to measure the equipment performance against the manufacturer's claims. The six tasks are:

1) Verification testing runs and routine equipment operation
2) Test runs for feed and finished water
3) Documentation of operating conditions and treatment equipment performance
4) Documentation of microbiological contaminant removal
5) Data management
6) Data quality assurance/quality control

These tasks and the testing procedures are more fully described in this document below. Following the testing and verification phase, the data will be reviewed, summarized and a full verification report generated by COA for submission to the NSF/EPA. EPA will publish the final report for distribution to interested State and Municipal water treatment regulators and engineers.

1.2 ACRONYMS, ABBREVIATIONS, FORMULA AND SYMBOLS

APHA	American Public Health Association
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
C	Celsius degrees
cfu	Colony forming unit(s)
COA	Cartwright, Olsen and Associates, LLC
CV	Curriculum Vitae
d	Day(s)
DI	Deionized (demineralized) water
EPA	US Environmental Protection Agency
ESWTR	Enhanced Surface Water Treatment Rule
ETV	Environmental Technology Verification
FOD	Field Operations Document
ft^2	Square foot (feet)
FPT	Female Pipe Thread
FTO	Field Testing Organization
gpm	Gallon(s) per minute
HPC	Heterotrophic plant count bacteria
Hr	Hour(s)
ICR	Information Collection Rule
Kg	Kilogram(s)
KI	Kinetico Incorporated
L	Liters
µm	Micron(s)
m^2	Square meter(s)
m^3/d	Cubic meter(s) per day
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mgd	Million gallon(s) per day
mg/L	Milligram(s) per liter
min	Minute(s)
mL	Milliliter(s)
MPN	Most probable number

NIST	National Institute of Standards and Technology
NSF	NSF International, Formerly National Sanitation Foundation
NTU	Nephelometric turbidity unit(s)
PCL	Programmable logic controller
PFW	Particle Free Water.
PLC	Programmable Logic Computer
Ppb	Parts per billion (μg/L)
psi	Pound(s) per square inch
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
scfm	Standard cubic feet per minute
sec	Second(s)
SM	Standard Methods for the Examination of Water and Wastewater
SWTR	Surface Water Treatment Rule
T	Temperature
TC	Total coliform bacteria
TDS	Total dissolved solids
TOC	Total organic carbon
TSS	Total Suspended Solids
Ten State's Standards	Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, *Recommended Standards for Water Works.*
USEPA	United States Environmental Protection Agency
UV-254	Ultraviolet light absorbance at 254 nanometers
WEF	Water Environment Federation.

2.0 EQUIPMENT VERIFICATION TESTING RESPONSIBILITIES

2.1 VERIFICATION TESTING ORGANIZATION AND PARTICIPANTS

The Field Testing Organization, Cartwright, Olsen and Associates, LLC (COA), is responsible for the supervision of all elements in the testing sequence, including collection of samples, calibration and verification of instruments, data collection and analysis, and test data management.

Kinetico Incorporated (KI), in cooperation with COA, will be responsible for the installation of the equipment under test. COA, as the FTO will supervise any and all repair and maintenance procedures for documentation into the final report.

Responsibilities specific to COA:

- COA will ensure that the selected site meets the requirements of the test.
- COA will act as coordinator of all communications relevant to the testing period and will coordinate all activities.
- COA will manage all data collection, validation studies and analysis.
- COA and Park City Municipal Corporation personnel will operate the equipment under test during the testing period. The equipment will be under the supervision of COA as the Field Testing Organization.
- COA will interpret performance results and generate the final report to EPA/NSF.

Following is a list of the persons, firms and associates of COA as members of the Field Testing Organization.

Cartwright, Olsen & Associates, LLC
19406 East Bethel Blvd.
Cedar, Minnesota 55011
(612) 434-1300
Fax (612) 434-8450
e-mail: p.olsen@ix.netcom.com

– Peter S. Cartwright, P.E., Principal Investigator, QA/QC.
– Philip C. Olsen, Managing Partner.
– Debra E. Huffman, Ph.D., Principal Investigator (Microbiology).
– Lawrence Henke, Associate, Documentation, Field Technician.
– Russell G. Olsen, Field Engineer, Technician.

Park City Municipal Corporation personnel that will perform non-supervisory labor associated with the operation and monitoring of equipment including the following:

Name	Utah State Certification
Rich Hilbert	grade III distribution, grade II treatment
Scott Clayburn	grade III distribution, grade II treatment
Jay Glazier	grade III distribution, grade II treatment
Ron Kohler	grade III distribution, grade II treatment
Leo Williams	grade IV distribution, grade III treatment
Ken Mitchel	grade IV distribution, backflow certified

Joel Conger	grade IV distribution, grade IV treatment, backflow certified
Paul Jerominski	grade III distribution, grade III treatment
Ryan Williams	no certification (in training)

The Public Works Director is Mr. Jerry Gibbs: phone (435)615-5310, fax (435)615-4904. The primary contact at Park City Municipal Corporation is Mr. Rich Hilbert: phone (435)615-5321, fax (435)658-9022.

The address of the Park City Municipal Corporation is:

Park City Municipal Corporation
445 Marsac Avenue
P.O. Box 1480
Park City, Utah 84060

The address of the testing is:

Sprio Water Treatment Plant
1884 Three Kings Drive
Park City, Utah 84060

All chemical analyses will be performed by the State of Utah Division of Drinking Water Laboratory. These analyses will be made under the direct supervision of Larry P. Scanlan, Environmental Scientist III. Mr. Scanian's curriculum vitae (CV) and a copy of the State Laboratory QA/QC manual is located in Appendix E.

The Manufacturer of the Equipment is:

Kinetico Incorporated
10845 Kinsman Road
Newbury, Ohio 44065
(440) 564-9111 or (800) 432-1166
Fax (440) 564-9541

- Bill Prior, President
- Glen Latimer, Operations Manager

KI staff associated with the ETV Project include:

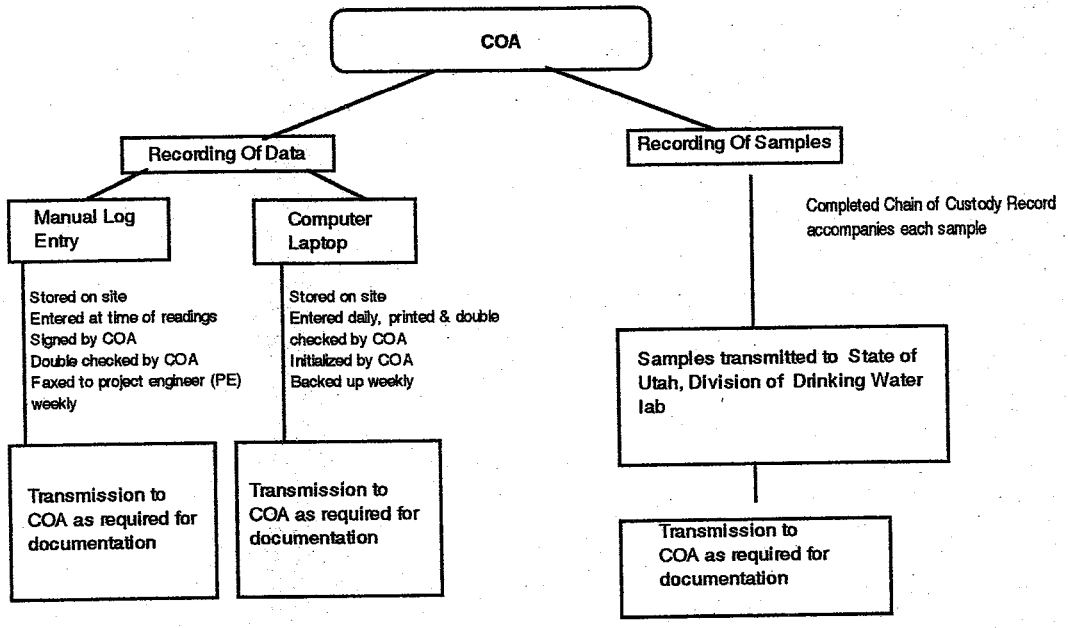
- Skip Wolfe, Project Manager, Engineer
- Chip Fatheringham, Engineering Technician
- Jeremy Litz, Electrical Engineer
- Wilfreid Schott, Engineer
- Dan Combs, Accountant
- Vicky Zbozein, Administrator
- Holly Nickita, Secretary

2.2 ORGANIZATION

An organizational chart illustrating communication is shown in Figure 2-1.

FIGURE 2-1

ORGANIZATIONAL CHART



2.3 VERIFICATION TESTING SITE

The site selected for challenge testing of the Kinetico CPS100CPT Coagulation and Filtration System is the Park City Municipal Corporation, Public Works Department, P.O. Box 1480, Park City, Utah, 84060-1480.

The Park City Municipal Corporation has direct access to Spiro Tunnel Bulkhead water. This water source will be used for verification testing. Typical untreated water quality of water at the intake location is summarized in Table 2–2. A schematic of the test layout and its installation in the plant is attached (Figure 2-2).

Influent water quality to the Kinetico CPS100CPT Coagulation and Filtration System will be verified and documented as a function of Task A in initial operations and described in the final report.

2.4 SITE CHARACTERISTICS

2.4.1 Arsenic Chemistry

Arsenic is the 20th most abundant element in the earth's crust and is a component of over 245 minerals. Because the physical appearance of arsenic resembles that of a metal, it is classified as a metalloid and is located in group Va of the Periodic Table. It readily forms both oxide and sulfide compounds in the environment.

Arsenic also enters the environment as the result of both manufacturing and natural processes. Arsenic trioxide (As_2O_3) is formed during smelting operations and has created significant air and land pollution problems. Arsenic also is released through the burning of certain fossil fuels and volcanic eruptions.

In natural waters, soluble arsenic is virtually always present in the oxidation states of either of +3(III) or +5(V) valence. An organic species (methylated), has been detected; however, concentrations of this organic compound rarely exceed 1ppb and it is considered of little or no significance as a drinking water contaminant.

In oxygenated waters, the As (V) valence is dominant, existing in the anionic forms of $H_2AsO_4^-$, $HAsO_4^=$ and $AsO_4^{\equiv}$. In waters containing little or no oxygen (anoxic), As (III) exists in the nonionic form, H_3AsO_3 below a pH of 9.22, and the anionic form, $H_2AsO_3^-$ at a pH above 9.22.

2.4.2 Health Concerns

Arsenic has significant notoriety as a poison, even featured in a stage play, "Arsenic and Old Lace". Recent studies have indicated that arsenic in drinking water is more dangerous than previously thought, with risks to exposure comparable to that of radon and second hand tobacco smoke. In humans, ingested arsenic can cause liver, lung, kidney, bladder and skin cancers. Arsenite [As(III)] is significantly more toxic than arsenate [As(V)].

2.4.3 Regulatory

The present USEPA MCL (Maximum Contaminant Level) for arsenic in drinking water is 50 ppb (0.05 mg/L). As a result of increased health concerns, the arsenic MCL will be lowered, and data are currently under review by the USEPA. The revised MCL is expected to be between 5 and 20 ppb, with an MCLG (Maximum Contaminant Level Goal) of 0. The World Health Organization (WHO) has established a provisional arsenic limit of 10 ppb.

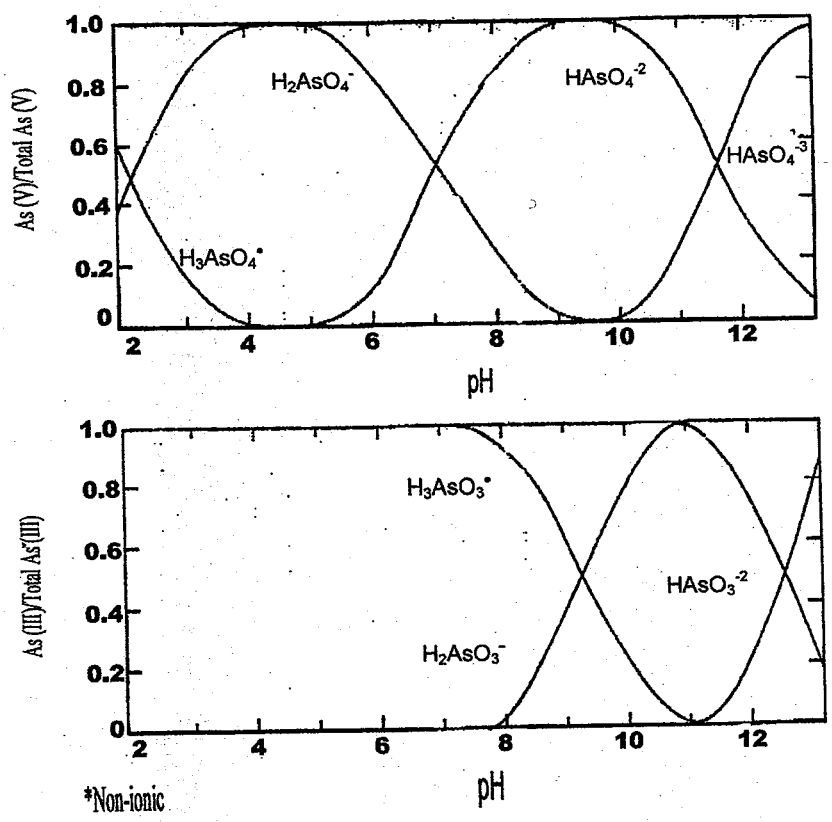
The Table 2-1 lists the properties of selected inorganic arsenic compounds.

Table 2-1
Selected Inorganic Arsenic Compounds

Property Synonyms	**Arsenic** Arsenic black, colloidal arsenic, gray arsenic	**Arsenic Trioxide** Arsenic oxide, arsenious acid, arsenious oxide, white arsenic	**Sodium Trioxide** Disodium arsenate, sodium biarsenate, arsenic acid disodium salt	**Sodium Arsenate** Arsenious acid sodium salt, sodium metaarsenite
Chemical formula	As	As_2O_3 (As_4O_6)	Na_2HAs0_4	$NaAsO_4$
Molecular weight	74.92	197.84	185.91	129.91
Valence state	0	3	5	3
Water Solubility	Insoluble	Soluble 37 g/L at 200C. 101 g/l at 1000C	Soluble	Very Soluble

Figure 2-2 illustrates water soluble arsenic speciation as a function of pH.

FIGURE 2-2
Arsenic Speciation (Valence State) As A Function Of pH



Source: "Arsenic removal by Adsorption," Shailendra K. Gupta and Kenneth Y. Chen, Journal WPCF (Water Pollution Control Federation), March 1978, p.503.

2.4.4 Water Source

The Spiro Tunnel Bulkhead source is considered a groundwater source under the State of Utah source protection program. It is located at N40° 41' 20.8" and W111° 31' 25.0". Water is developed from water bearing fissures in an abandoned silver mine tunnel which is approximately 13,000 lineal feet deep. Water exits the tunnel at a parshall flume and enters the treatment plant which is located about 300 yards away. The tunnel is located 1,000 feet or more under remote unoccupied forest in a mountainous region. There is no use of manmade chemicals on ground above this source.

The water source used for this test is known as the Spiro Tunnel Bulkhead source, is stable with respect to quality and is developed at the far end of the Spiro Tunnel behind an undisturbed "bulkhead" wall. Because this water source contains arsenic, for the potable supply, it is currently diluted with the treatment plant finished water to form a blend which meets the present arsenic standard. For this test, only the untreated, unblended Spiro Tunnel Bulkhead supply will be used.

The treatment plant was built in February of 1993, has nominal capacity of 1,000 gpm, and is designed to remove iron, manganese, and arsenic from the raw water. This source is one of two active sources serving the water system. The water system serves 6,500 residents, and as much as 10,000 people per day during the winter season.

Spiro Tunnel Bulkhead water quality before treatment is listed in Table 2-2. Data on TOC, particulates, algae, odor number and color are not immediately available in the State water quality record system, but are all expected to be low and well within current normal drinking water levels.

Printouts of water quality parameters are attached as Appendix B.

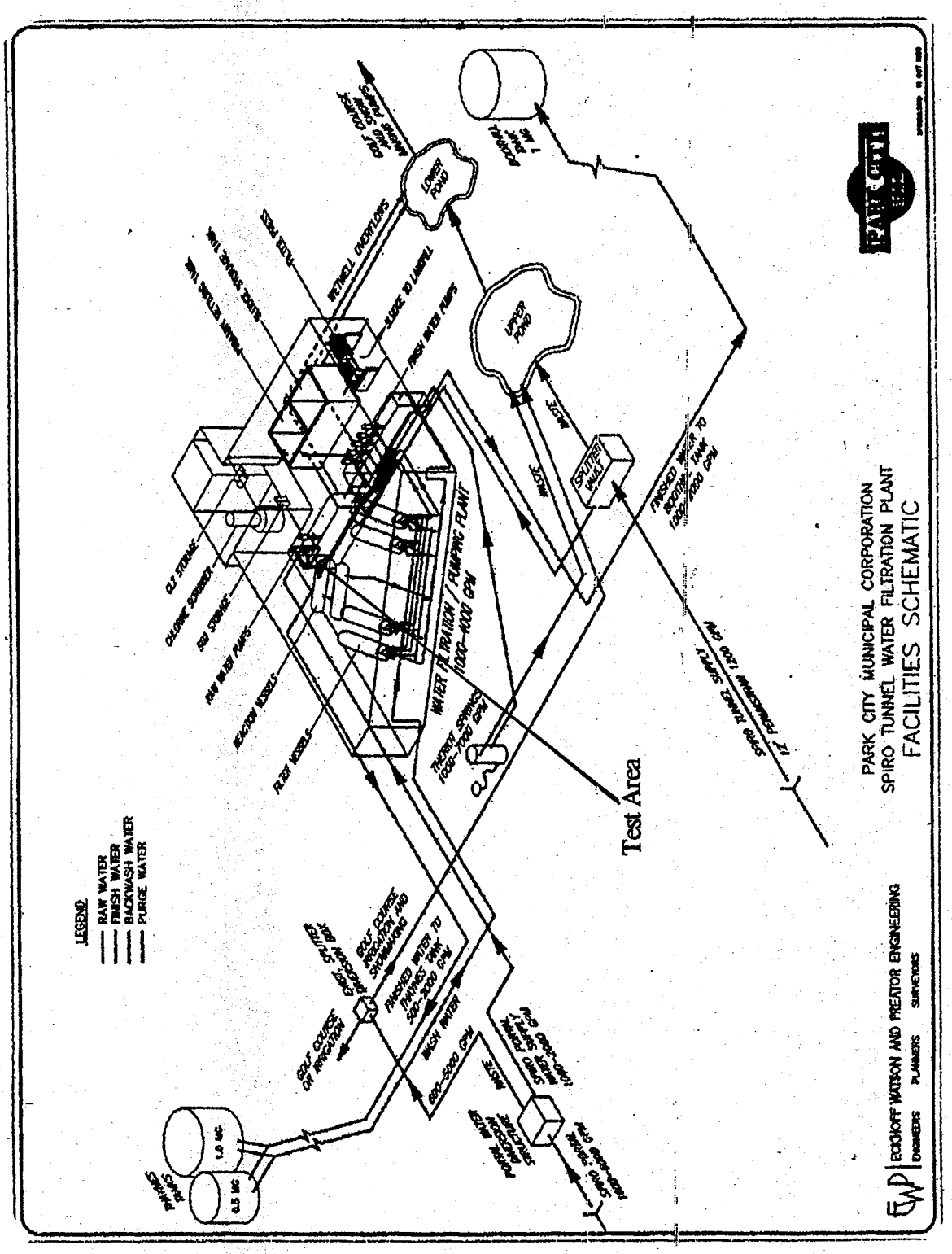
Figure 2-3 illustrates the approximate location of the pilot test equipment within the Park City Municipal Corporation Water Filtration Plant.

TABLE 2-2
Untreated Spiro Tunnel Bulkhead Water Quality Parameters

Collection Date	pH	TDS (mg/L)	Arsenic Total AS (µg/L)	Turbidity (NTU)	Alkalinity (mg/L)	Total Hardness (mg/L)	Iron Total Fe (mg/L)	Calcium Ca (mg/L)	Chloride Cl (mg/L)	Sulfate SO_4 (mg/L)	Manganese Total Mn (µg/L)	Antimony Sb (µg/L)	Beryllium Be (µg/L)	Cadmium dc (µg/L)	Cyanide CN (µg/L)	Nitrite NO_2 (mg/L)	Nitrate NO_3 (mg/L)	Selenium Se (µg/L)	Thallium T (µg/L)	Mercury Hg (µg/L)	Fluoride F (mg/L)	Barium B (µg/L)	Magnesium Mg (mg/L)	Sodium Na (mg/L)
12/17/1999	7.3	620	70	1.1	17	-	0.24	110	6	259	10	10	<1.	<1.	<2.	-	-	4	3	<0.2	0.21	31	38	5.7
5/4/1999	-	-	-		-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-
2/2/1999	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-
3/17/1998	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-
5/1/1997	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	0.16	-	-	-	-	-	-	-
3/4/1996	-	584	60	1.3	-	-	-	-	-	301	-	6	1	<1	2	<0.02	<0.02	<2.	6	<0.02	-	-	-	-
9/25/1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.15	-	-	-	-	-	-	-
10/31/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-	-	-
2/1/1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-	-	-
2/26/1993	7.5,7.6	540,660	26,75	1,1.5	140	420,540	2.6,2.7	110,160	1	300,450	5,30	6	4,5	<4	5	<0.01	0.04,0.86	<5	<2.<500	<1	-	-	-	-
2/18/1992	8.2	568	59	-	145	-	0.23	123	10	279	20	-	-	<2.4	-	-	<0.5	2	-	<1.1	-	-	-	-
1/17/1991	7.4	562	62	2	141	680	0.07	119	2	284	10	-	-	5	-	<0.02	0.08	-	-	<0.2	-	-	-	-
7/30/1990	-	-	225	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/25/1990	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/18/1990	-	-	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/11/1990	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/4/1990	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/29/1990	-	-	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/21/1990	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/14/1990	-	-	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/7/1990	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/30/1990	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/23/1990	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/16/1990	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/9/1990	-	-	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/2/1990	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/13/1989	7.4	520	<20	1	152	445	0.21	106	4	260	10	-	-	<1	-	-	-	-	-	-	-	-	-	-
11/6/1987	7.8	570	54	1.9	141	463	0.19	114	5	310	10	-	-	1	-	-	-	-	-	-	-	-	-	-
7/21/1982	-	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/25/1981	-	-	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8/21/1981	7.7	632	75	4	141	460	0.34	116	4	300	25	-	-	<1	-	<0.01	0.05	<1	-	<0.1	-	-	-	-
8/29/1980	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LIMIT		500	50	5		400	0.3		250	250	50	6	4	5	200	1	10	50	2	2	-	-	-	-

(-) not sampled

FIGURE 2-3
Schematic Of Pilot Installation For Verification Period



3.0 EQUIPMENT CAPABILITIES AND DESCRIPTION

3.1 EQUIPMENT CAPABILITIES

The highly respected filtration scientist, Appiah Amirthqarajah, once wrote "It is ironic that filtration fails when pretreatment fails, and theory also fails when pretreatment fails." At the same time he commented, "Chemical pretreatment with particle destabilization is the single most important factor for the production of the best quality filtered water" (Amirtharajah, 1988).

Particles in colloidal suspensions, where electrostatic forces keep the particles dispersed, have proven to be a challenge to depth filtration. In many cases, chemical pretreatment, by agglomerating the particles into larger floc, will allow solids separation of water matrices that otherwise resist filtration.

Large water treatment systems have long employed coagulation, flocculation, settling and filtration for the production of quality water. Small systems have been more reluctant to build treatment plants that use coagulation because of the higher level of operator training required and the need for continuing monitoring. With the soon to be implemented Enhanced Surface Water Treatment Rules (ESWTR), and imminent revised arsenic MCL, coagulation may be a suitable technology for smaller systems allowing them to meet tough new standards with a modest increase in costs.

Of the several treatment regimens that incorporate coagulation are those that include a settling basin, where the floc is allowed to settle by gravity and the supernatant decanted and filtered. This is a scheme common to municipal gravity filter systems. The Kinetico Coagulation and Filtration system is a Direct Filtration System, where the coagulant is added to the raw water in a constant stream, mixed in a mixing chamber, and then the solids separated through backwashable granulated media filtration. Because the process stream is slow (5 gpm), detention can be accomplished with an off-the-shelf pressure vessel. The process rate of 5 gpm allows for a daily total of 7,200 gallons; thus it is well suited to small system requirements where waters must be treated to reduce arsenic levels.

Kinetico Incorporated has successfully piloted several filtration systems that employ coagulation as pretreatment.

Only in recent times have we been able to quantify the collection of material within the filter bed, especially the particulate matter that lies below our visual capabilities. We now know that particles that we cannot see can also be removed by filtration. Still under study, however, are the mechanisms through which particulate matter is accumulated within the filter media.

It has been assumed that along with simple straining, which is the physical capture of a mass too large to move through the pores between the media granules, small particles are captured through other attachment mechanisms. Most of those mechanisms involve a surface charge attraction of the particle to granulated media and as a result many experiments have been performed to both better understand the process and to seek methods to improve it. Some particles are also assumed to be collected by impact on the surface of the filter media granules; while the actual mechanisms are not clearly understood, straining is certainly among them.

The most common filtration system used in municipal treatment is the gravity filter, which uses the weight or head of the water to force it through the filter at very low flow rates. Normal gravity filters, often called "rapid" sand filters, have a normal flow rate of 3 gpm per square foot of surface, or less. Other filters, such as slow sand filters, have even slower service flow rates.

Also included among rapid sand filters are pressure filters, where the water is forced through a media bed by high head pressures, and where the media are contained in a pressure vessel. They have long been used for iron and manganese removal, but have not been as readily accepted for surface water treatment (Ten State's Standards, 1992). The advantages—especially to small systems—of rapid sand pressure filters are many. They are relatively passive treatment systems, involve minimal operator attention, are low in cost and long lived. Of concern, however, is whether pressure filters can capture and contain particles that are small, and more importantly, contaminants that may pose a threat to public health, such as arsenic.

The primary issue then here is whether the Kinetico pressure filter CPS100CPT can effectively reduce the total concentration of arsenic to meet the anticipated arsenic MCL.

The operation of this equipment is more technically sophisticated than a filter alone, and requires more extensive training in the proper dosing of coagulating chemistry, therefore, the state and municipal health authorities may have requirements for operation beyond those of a filter. Kinetico, Inc. (KI) requires no special licensing, and will offer operator training upon equipment installation and start-up.

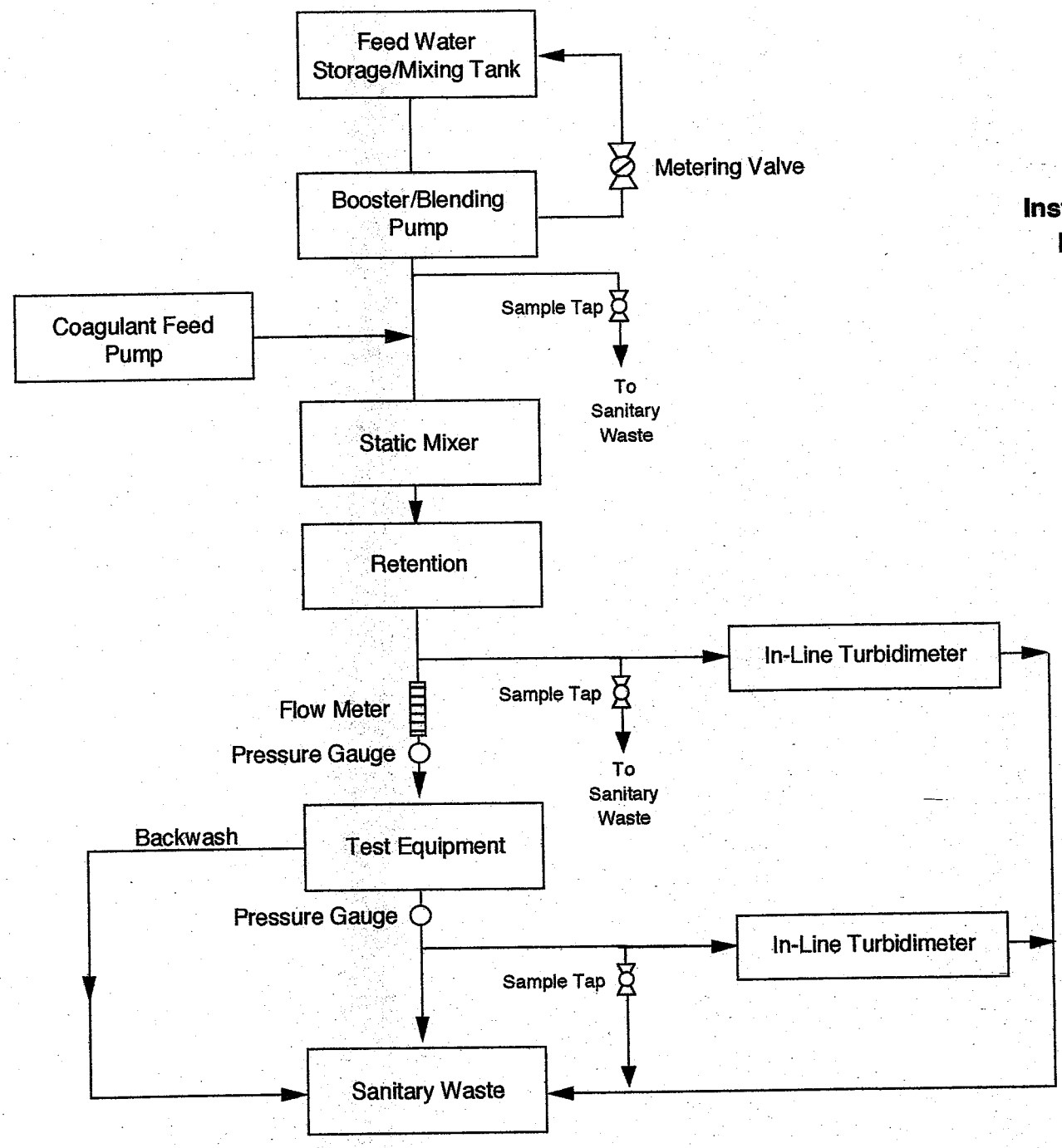
3.2 EQUIPMENT DESCRIPTION

This environmental technology verification (ETV) test is designed to challenge the Kinetico, Inc. CPS100CPT filter system to convert soluble arsenic into an insoluble precipitate and to contain it at flow rates of 5 gpm (9-10 gpm/ft^2). Kinetico, Inc. expects that the filter system will achieve a total arsenic concentration of ≤ 5 µg/L at a flow rate of 5 gpm (9-10 gpm/ft^2) filter bed surface area, from an influent stream containing up to 225 µg/L of arsenic.

In the Park City Spiro Tunnel Bulkhead Municipal Water Supply, almost all of the arsenic is in the soluble arsenate (V) form (see ChemTech-Ford letter in Appendix B). The Kinetico CPS100CPT System utilizes chlorine and ferric chloride ($FeCl_3$) to convert the arsenate to an insoluble precipitate which is removed in the Macrolite ® media.

Figure 3-1 is a schematic of the pilot plant and Table 3-1 lists the operating characteristics of the Kinetico CPS100CPT System.

FIGURE 3-1
Schematic Of Pilot Plant For Verification Period



Pilot Installation Detail

TABLE 3-1
Kinetico CPS100CPT System Operating Characteristics

Inlet flow rate—maximum	5 gpm
Inlet flow rate—minimum	0 gpm
Maximum static pressure	100 psi
Minimum inlet dynamic pressure	35 psi
Expected pressure drop	15/30 psi
Minimum outlet pressure	10 psi
High pH	pH 8
Low pH	pH 3
Maximum temperature	100° F
Minimum temperature	35° F
Maximum inlet turbidity	8 NTU
Normal outlet turbidity	0.10 NTU
Maximum allowable outlet turbidity	0.50 NTU

The filter media is Macrolite®, a stable, ceramic substance synthesized into small, slightly elongated spheres. The mesh size for this test will be 70 mesh (US Standard Sieve). At this mesh size, the individual grains have a diameter of 0.008 inches (210 microns).

The equipment tested will be two identical filters vessels operating alternately. Each filter vessel is 10 inches in diameter and 60 inches high, constructed of fiberglass, and pressure rated to 100 psi.

The water flow will be controlled with air activated George Fischer valves mounted on face piping constructed of Schedule 80 PVC. The valves also have handles for manual activation.

The system, along with controls and a backwash pump is mounted on an epoxy coated, welded steel frame.

An illustration of the filter is attached as Figure 3-2.

Automated? or semi-automatic?

The KI CPS100CPT is an automated, 100% redundant system with electronic monitoring and electronic controls for placing a filter vessel on line, backwash and rinse (filter to waste) cycles. The automation is performed by a programmable industrial computer with a touch screen monitor and interface control. Turbidimeters, flow meters and particle counting serve a monitoring and control function, although in the instance of the ETV test, monitoring will be subjected to more rigorous QA/QC.

The KI CPS100CPT Filter System is designed to backwash under any of the following conditions:

Effluent Turbidity	0.5 or greater (adjustable)
Differential pressure	20 psid or greater
Run Time	24 hours
By Manual Initiation	

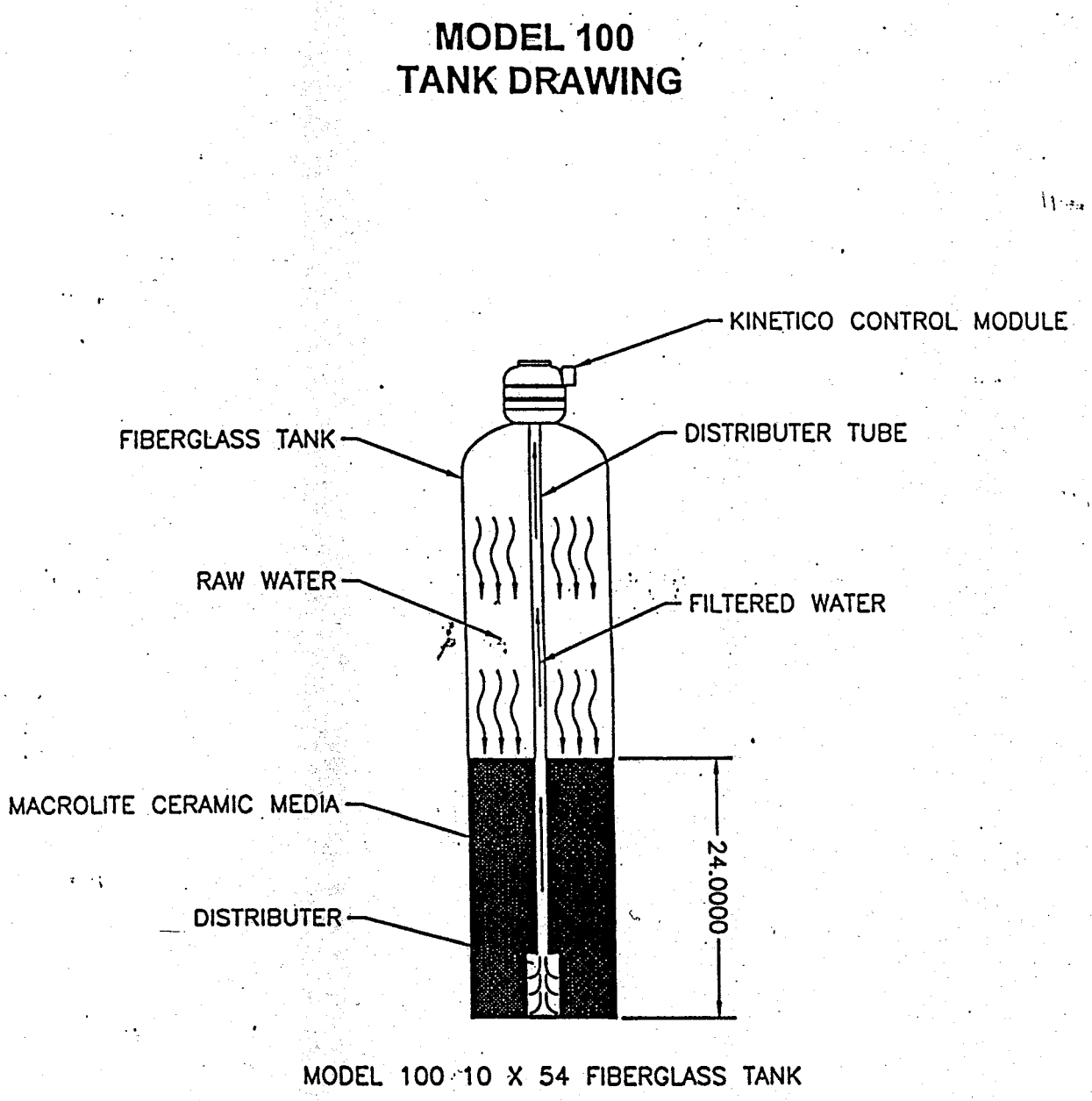
The KI CPS100CPT is designed to backwash until a minimum turbidity of 5 NTU is reached. Built in are several controls to allow repeated backwash if the initial sequence is insufficient. In addition, controls to signal an alarm in the event of backwash failure are incorporated into the system.

<u>The usual backwash sequence is as follows:</u>

1. The off-line tank rinses clean (3-5 min.)
2. The backwashing tank is drained slightly. (1 min.)
3. The backwashing tank is air sparged for 30 seconds, with air at 70 cubic feet per hour per square foot;
4. The tank is allowed to settle. (1 min.)
5. The backwashing tank is backwashed with water from the on-line tank at a rate no higher than 3.5 gpm. (20 min.)
6. Tank returns to service.

The KI CPS100CPT assumes a finished water storage tank and intermittent flows, which are common to small system requirements. Several of the control functions are initiated by sensors in the storage tank. One such is the return to on-line filtration, initiated when a storage tank reaches a pre-established low level. When that occurs, the next filter vessel on active standby is placed into a filter to waste position. The verification study will not employ a storage tank so these functions will be challenged artificially.

FIGURE 3-2
Illustration Of Kinetico KI CPS100CPT Filter



3.2.1 Design Specifications and Limitations

The Kinetico CPS100CPT is designed for small system applications. The tanks can be made of fiberglass or of steel. Fiberglass tanks will be used for this ETV test. The piping is Schedule 80 PVC. Polyethylene tanks are used for the reaction tanks and to hold the coagulant chemicals.

The following are the maximum and minimum influent conditions.

TABLE 3-2
Maximum And Minimum Influent Conditions

Inlet flow rate—maximum	5 gpm
Inlet flow rate—minimum	0 gpm
Maximum static pressure	100 psi
Minimum inlet dynamic pressure	35 psi
Maximum temperature	100° F
Minimum temperature	35° F
Maximum inlet turbidity	8 NTU

GR Sec. 3.2 No statement on typical consumption of chemicals and waste production. e.g., ferric chloride.

The coagulant chemistry is chlorine plus Ferric chloride, injected into the feedwater stream by Pulsafeeder metering pumps, followed by one or more reaction tanks to facilitate coagulation.

The filter media, Macrolite® employed has a US sieve size of 70. That is equivalent to 0.008 inches (0.2 mm or 210 microns) average diameter for each sphere. The pore size for three such spheres that are touching will leave a void that is 15.47% of the diameter of the spheres, or 32.5 microns.

Surface attachment mechanisms, which are not entirely understood, probably play a role in containment. Some of the surface mechanisms have been related to pH and to ionic strengths as well as to surface charges.

Macrolite® media has a surface charge that varies with pH. At pH 2.3 and pH 8 it has no charge. Between those points, the charge is positive, with a maximum positive charge at pH 3-4; outside that range (<pH2.3 and > pH8) the charge is negative.

Moreover, the surface of the spherical granules is rough, suggesting that some particles may become trapped on the surface through adhesion as well as through surface charge attraction. The pore area and volume are described below.

Macrolite® —a synthetic filter medium—is not covered under AWWA standards for filter media (B100-89). Standard B100-89 is a purchase guide for filter media and is not intended as a design standard; however, many of the testing parameters will be of interest to public health administrators, especially those physical characteristics which may impact on the longevity of the material. Thus, hardness, specific gravity, acid solubility, uniformity coefficients, particle sieve size distributions (within manufacturing

lots and from lot to lot) and other similar physical data have been furnished by the manufacturer and are noted below. The physical characteristics of Macrolite® will be further discussed in the final verification report presented to NSF.

Macrolite® of the 70/80 mesh size has a bulk density of 0.96 grams/cc. The specific gravity (as measured by ASTM D2840) is 2.23 g/cc. The collapse strength for the media of this size has not been measured; however, for a larger sphere (30/50 mesh) the collapse strength (as measured by ASTM D 3102) is a nominal 7000 psi for 10% and nominal 8000 psi for 20% collapse. A magnified view of Macrolite® is provided in Figure 3-2.

The uniformity of the Macrolite® 70/80 mesh media was analyzed in accordance with AWWA Standard B100-96 by Bowser-Morner, Inc. in December, 1997. The results of this analysis are summarized below:

TABLE 3-3
Uniformity Of The MACROLITE® 70/80 Mesh Media

Sieve Size, USA Std.	Nominal, mm	Effective, mm	Percent passing
#45	0.355	0.360	100.0
#50	0.300	0.307	99.9
#60	0.250	0.249	79.8
#70	0.212	0.212	28.9
#80	0.180	0.180	7.2
#100	0.150	0.150	0.4

Effective Size: 0.19 mm
Uniformity Coefficient: 1.2

In addition, a Kinetico Inc. internal laboratory analysis of 70 mesh media employing a mercury/penetrometer (Micrometrics Autopore II 9220) instrument produced the following results:

TABLE 3-4
Internal Laboratory Analysis Of 70 Mesh Media

Total intrusion volume	0.2098 mL/g
Total pore area	0.18 sq-m/g
Median pore diameter volume	53.7990 µm
Median pore diameter area	52.5351 µm
Median pore diameter 4V/A	46.5685 µm

A Material Safety Data Sheet is included as a part of Appendix A. Macrolite® media meets the requirements of NSF Standard 61 and is NSF listed.

3.2.2 Statement Of Performance.

The Kinetico CPS100CPT System will produce the following effluent characteristics

TABLE 3-5
Kinetico CPS100CPT System Effluent Characteristics

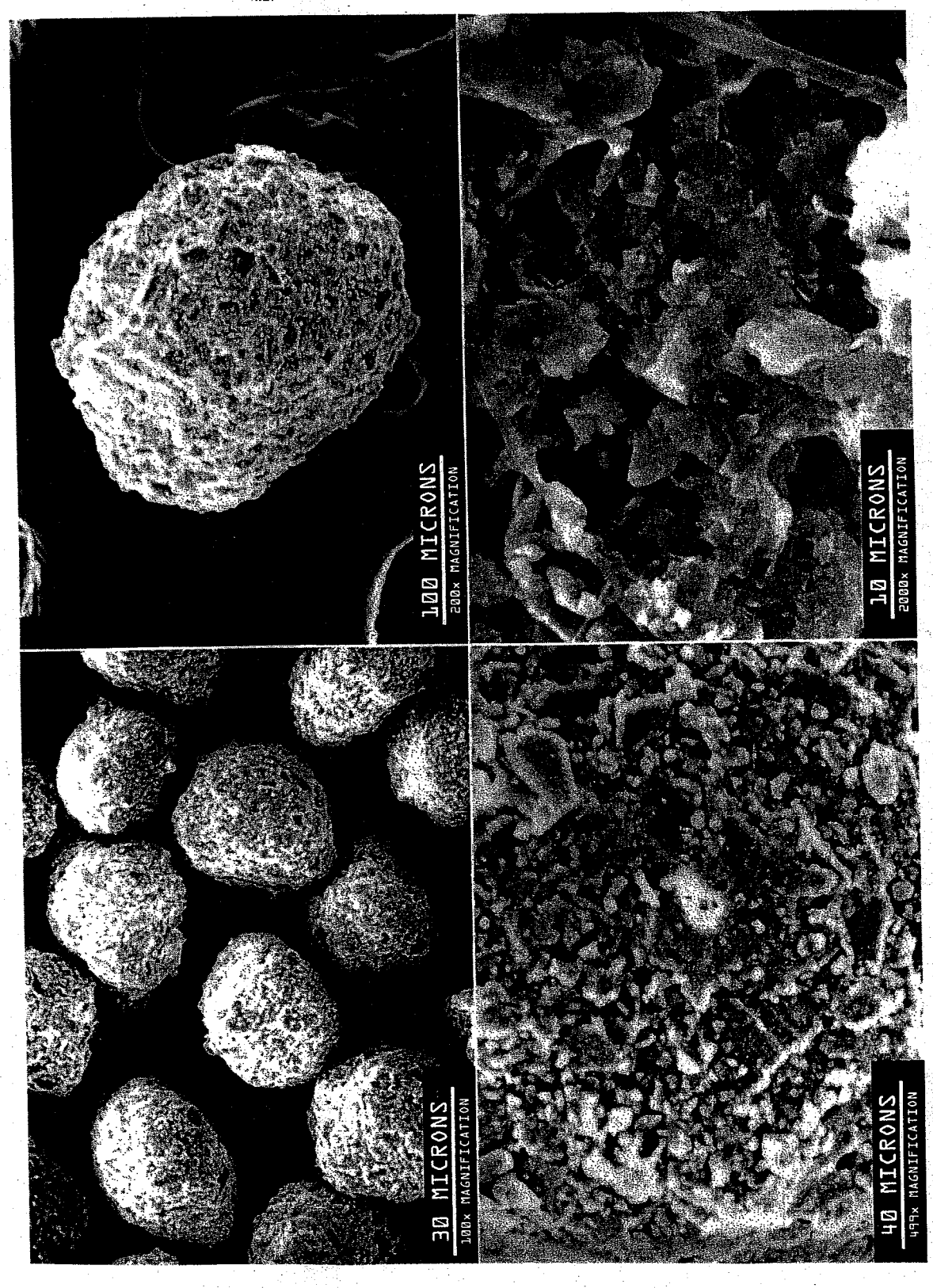
Inlet flow rate—maximum	5 gpm
Inlet flow rate—minimum	0 gpm
Expected pressure drop	15/30 psi
Minimum outlet pressure	10 psi
High pH	pH 8
Low pH	pH 3
Maximum temperature	100° F
Minimum temperature	35° F
Normal outlet turbidity	0.10 NTU
Maximum allowable outlet turbidity	0.50 NTU

The Kinetico CPS100CPT Pressure Filtration System is expected to produce a 95% (1.5 log) removal of particles of 3 µm and a 2 log removal of particles of 5 µm or larger of 5 gpm (10 gpm/ft^2), and with a maximum pressure differential of less than 15 psi.

3.2.3 Installation Requirements

- Room temperature range — 50-120° F
- Voltage/frequency/amperage — 120/220/480 v/60 Hz/ 30 amps
- Ceiling height — 8 feet
- Phone service for instrumentation — 2 lines

FIGURE 3-3
Magnification Of MACROLITE ® Media



MACROLITE®
Scanning Electron Microscope Photos

KINETICO®

4.0 EXPERIMENTAL DESIGN

4.1 PURPOSE

The purpose of this test is to verify the performance of the Kinetico coagulation and direct backwashable depth filtration system in a formal and comprehensive manner to offer State and Local public health professionals an opportunity to evaluate the system for specific applications. Accordingly, the test will:

1) Verify performance claims of the manufacturer of the Kinetico filter with respect to arsenic reduction;
2) Correlate arsenic reduction to the anticipated revised arsenic MCL;
3) Compare the performance with the performance recommendations for the "Partnership for Safe Water";
4) Determine the effects of possible variations in water quality on performance;
5) Measure the operational costs for the system;
6) Determine reliability and underscore other operational parameters.

This testing and verification period is designed to challenge the Kinetico, Inc. CPS100CPT Coagulation and Pressure Filtration System, which employs Macrolite®, a stable, ceramic media—fully described above—as a backwashable granulated bed and its ability to remove arsenic from water. The purpose of the test is to offer state public health regulators an evaluation of the system for applicability to specific small system needs.

Coagulant chemicals, ferric chloride and chlorine, will be added to the water stream through a Pulsafeeder metering pump, followed by one or more reaction tanks to provide detention time. Following mixing and detention, the water will be directed to the filters. The concentration of $FeCl_3$ chlorine, and size and number of reaction tanks will be determined during the initial operations phase.

During the challenge period, the coagulant will be added, the water passed through the reaction tanks, passed through the filters, and the filter effluent studied to determine the level of arsenic removal. In addition, other conditions such as start/stop, backwash, filter ripening and arsenic removal from the bed will also be evaluated.

Monitoring of arsenic concentration in both influent and effluent water will allow investigators to determine filtration performance

Important to the overall evaluation of performance is a characterization of the raw water quality matrix. Water quality considerations are intended to challenge the coagulation and filtration process in typical applications, not necessarily applications of extreme conditions which would not likely be encountered. The ability of the coagulant and the filters to react to modest changes in water quality are important, however.

All testing will be performed in accordance with the procedures and protocols established in *Standard Methods*. All on-site testing instruments will be calibrated and/or standardized daily by staff under the supervision of COA.

The analyses of water quality data from grab samples will be analyzed for 95% confidence interval by COA. The confidence formula is that noted in Chapter 1 of the EPA/NSF ETV Protocol and repeated in section 4.5 below.

4.2 EQUIPMENT CHARACTERISTICS

The equipment is designed to be used in water contaminated with arsenic.

The performance of the Kinetico, Inc. CPS100CPT Coagulation and Pressure Filtration system will be challenged with feed water containing arsenic at a known concentration, passing it through the filter system at the design flow rate, and then measuring the effluent concentration of that contaminant.

Small systems are particularly vulnerable to changes in process flow, and assurance that coagulated arsenic will not detach or be driven through the media during these episodes is of considerable concern to small system operators.

4.2.1 Qualitative Factors

Under test also are operational aspects of the Kinetico CPS100CPT System (for example, the measurement of head loss) as well as other factors that might impact performance. Hands-on operation of the system by staff under the supervision of COA, will be instrumental in determining the skill level required to maintain and service the filter system.

The KI CPS100CPT Filter System can be controlled either automatically, or through a manual over-ride. During initial operations, certain functions will be manually controlled. During the operational phase of the verification period, the system will be operated in the automatic mode.

4.2.2 Quantitative Factors

Among the relevant factors in the verification process are costs associated with the system. Especially important is the dosing requirement of the coagulant chemical. Table 5-3 lists the operating data to be recorded during this testing. Power consumptions, waste disposal issues and operations and maintenance issues will be addressed, along with the effect of each on the length of operating cycle. OK

4.3 WATER QUALITY CONSIDERATIONS

The Kinetico, Inc. CPS100CPT Coagulation and Pressure Filtration System is designed for application to small systems where the source might be surface water or well water under the influence of surface water. Along with the natural arsenic concentration, the filter system will remove particulate matter and the filter load of those materials—along with their possible origin—will be studied. Coagulants are often used in waters colored by organic acids or excessive turbidities along with microorganisms that otherwise resist filtration. Specifically, the water quality characteristics to be recorded and analyzed are:

- Water Source
- Turbidity
- Temperature (the daily range is important to chemical performance
- pH (also of significance in chemical pretreatment)
- Total Alkalinity
- Total Hardness
- Total Organic Carbon
- UV Absorbance

- True Color
- Arsenic (concentration and species)
- Algae
- Iron
- Manganese
- Aluminum
- Sulfate
- Dissolved oxygen

In addition, the type and concentration of coagulant chemicals will be detailed, along with their concentrations in the feedwater and range of effectiveness. Each run will be identified as appropriate. ok

4.3.1 Source Water Quality

The Park City Spiro Tunnel Bulkhead source water historical data are attached as Appendix B.

4.3.2 Treated Water Quality

The Kinetico, Inc. CPS100CPT Coagulation and Pressure Filtration System is designed to remove arsenic, both precipitated and soluble As(V). ok

The presence of aluminum, iron, manganese, silica or clay particulate matter (background turbidity) will naturally impact on filter performance and may shorten filter runs.

4.4 DATA RECORDING

The chemical parameters and operator read operating data will be maintained in a bound log book and transferred to computer spread sheets. The control system for the CPS100CPT includes automatic data recording access and automatic systems will be employed where possible. Other readings will be manually logged.

In addition to the items noted above in 4.3 and in the data sheets (contained in Appendix D), any variations in the treatment plant regimen will be noted. Among the changes possible are variations of chemical coagulant aids and unusual source water episodes. The source water is raw water from the Spiro Tunnel Bulkhead supply. ok

Also to be recorded are the following:

- Type of chemical added, dose and chemical combination.
- Water type (raw water, pretreated or spiked feed water, product water, waste water).
- Experimental run (i.e. 1st run, 2nd run, 3rd run, etc.).

4.5 RECORDING STATISTICAL UNCERTAINTY

Statistical 95% confidence calculations will be performed for arsenic data, and confidence intervals determined by taking three discrete samples of arsenic at one operating set during the testing period. Sampling requirements are noted below in the work plan below.

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

S = standard deviation
n = number of measurements in data set
t = distribution value with n-1 degrees of freedom
α = the significance level defined for 95% confidence as: 1- 0.95 = 0.05.

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

4.6 VERIFICATION TESTING SCHEDULE

If the manufacturer determines it appropriate, bench-scale (jar) testing will proceed initial operations. Water treatment equipment will be operated continuously for a minimum of 320 hours (the equivalent of 13 full days plus one 8-hour work shift). During this time, coagulation and filtration package treatment equipment will be operated continuously from start-up until turbidity breakthrough or terminal head loss is attained. Interruptions in filtration will occur only as needed for backwashing of the filters or maintenance of the contact clarification pretreatment unit.

Filter runs will not be stopped before turbidity breakthrough or terminal head loss is achieved, with the exception of equipment failure or power interruption.

The duration of each filter run and the number of gallons of water produced per square foot of filter area will be recorded in the operational results.

During routine equipment operation, the package water treatment equipment will be operated to meet the system demands and water quality requirements.

Anticipated Time Line Charts are located in Appendix C.

5.0 FIELD OPERATIONS PROCEDURES

This section of the FOD describes the testing procedures to be performed for the verification of the Kinetico, Inc. CPS100CPT Coagulation and Pressure Filtration System. Each of the following tasks will be performed four times using the same skid mounted equipment.

5.1 TASK A: CHARACTERIZATION OF FEED WATER

5.1.1 Objective

The objective of this task is to determine the suitability of the feed water to the application of the technology.

5.1.2 Data

Analytical data from the untreated Spiro Tunnel Bulkhead water source are listed in Table 2-2. During this verification testing, parameters to be studied include (but are not limited to) the following:

- Turbidity,
- Temperature,
- pH,
- Total Alkalinity,
- Hardness,
- True Color,
- UV_{254} Absorbance,
- Aluminum,
- Algae
- Total Suspended Solids (TSS) (backwash water only),
- Iron
- Manganese
- Total Organic Carbon (TOC)
- Sulfate,
- Dissolved oxygen
- Arsenic (speciated)

Data from other sources will be subjected to QA/QC evaluation as to method, sampling technique and confidence calculations.

Factors that could influence water chemistry will be included where appropriate.

5.2 TASK B: INITIAL TEST RUNS

5.2.1 Objective

The objective of this task is to establish operational data including coagulant, filter run times and backwashing schedules, and to qualify the equipment for performance with the selected source water.

5.2.2 Data Required

An important element of this task is the performance of jar testing to select a suitable coagulant chemical and its proper dosage. Once jar testing is complete, initial test runs will be performed to both terminal headloss and to turbidity breakthrough.

Initial test runs will be performed to both terminal headloss and to turbidity breakthrough. Flow rate variations and the character of finished water will also be studied to determine optimum operational conditions. Backwashing will be initiated manually, when either a terminal headloss is reached or when turbidity breakthrough occurs. Filters will be backwashed until the waste stream runs clear, as determined by a turbidity of 5 NTU or less. Filters will be run to waste for a minimum of two bed volumes of the filter and the time to clear noted in the logbook. Terminal headloss will be considered to be when the filter experiences a 12 psi pressure drop. Turbidity breakthrough is considered reached when the turbidity in the effluent water is 0.5 NTU.

Upon return to service, the filter ripening period will be monitored and timed. These data will be used to determine the benchmarks for backwash, rinse and run cycles during the testing and verification period.

The coagulant chemistry will be ferric chloride. Specification and data sheets, along with MSDS Sheets and other appropriate documentation for this chemical ,are attached as Appendix H.

Before runs are made in which coagulant is used, the package plant equipment will be operated with uncoagulated feed water for one 24-hour run, The samples will be collected from the feed water, claifier effluent, and the filter effluent at 6, 12, 18 and 24 hours of operation to determine if arsenic losses occur through the system. Even though this test run is made during the Initial Operations, the data will be presented in the Verification Testing Report.

5.3 TASK 1: VERIFICATION TESTING RUNS AND ROUTINE EQUIPMENT OPERATION

5.3.1 Objective

The objective of this task is to verify the performance of the Kinetico CPS100CPT unit. This unit is expected to product an effluent stream containing less than 5 μg/L of total arsenic from an influent stream containing up to 220 μg/L of total arsenic.

5.3.2 Initial Operations

The verification test period will be defined in initial operations. The equipment is to be operated continuously during this period. A single season period is required; however, varying water quality parameters and other conditions may impact performance, and these will be recorded.

5.3.3 Routine Equipment Operation

Since the KI CPS100CPT Coagulation and Filtration System treats a water that naturally contains concentrations of arsenic appropriate for verification testing, routine operation

for water production is anticipated during verification runs. The operating and water quality data collected and furnished to the SDWA primacy agency during these times shall also be supplied to COA and incorporated into the Performance Verification Report.

5.3.4 Schedule

The schedule requires the equipment to be run continuously for 320 hours. The KI CPS100CPT has control functions that allow for differing conditions to initiate backwash. The control functions that allow backwash initiation due to headloss will be verified, as well as the controls that initiate backwash on turbidity breakthrough.

To meet the goals of the verification testing, the following conditions will be met:

- The KI CPS100CPT System will be operated continuously for a minimum of 320 hours (the equivalent of 13 full days plus one 8-hour work shift).
- During this time, the system will be operated continuously from start-up until turbidity breakthrough or terminal head loss is attained.
- Interruptions in filtration will occur only as needed for backwashing of the filters or maintenance contact clarification pretreatment unit.
- Filter runs will not be stopped before turbidity breakthrough or terminal head loss is achieved, with the exception of equipment failure or power interruption.
- The duration of each filter run and the number of gallons of water produced per square foot of filter area will be recorded in the operational results.
- During routine equipment operation, the package water treatment equipment will be operated to meet the system demands and water quality requirements.

Table 5-1 summarizes the operational objectives of this testing.

TABLE 5-1
Filtration Performance Capability Objectives

CHARACTERISTIC	DEFINITION	CRITERIA
Initial turbidity	Filtrate turbidity at 15 minutes into run	0.5 NTU or less
Length of ripening period	Time to reach 0.2 NTU	0.5 hours or less
Length of further ripening period	Time to reach 0.1 NTU	1.0 hour or less
Operating turbidity	Turbidity from matured filter	0.10 NTU or less
All turbidity	All data to be taken at equal intervals	0.5 NTU or less in 95% of all samples, or in all data from continuous turbidimeters
Time to reach turbidity breakthrough	Time to reach 5 feet headloss (manufacturer claims 8.6 feet headloss before breakthrough)	8 hours minimum
Water production	Volume of water during a filter run	5,000 gallons per sq. ft. (2,750 gallons)

5.3.5 Evaluation Criteria

The goal of this task is to operate the equipment for the 320 hour period, including time for filter backwashing and other necessary operating activities, during verification testing. Data shall be provided to substantiate the operation for 320 hours or more.

5.4 TASK 2: FEED AND FINISHED WATER QUALITY CHARACTERIZATION

5.4.1 Objective

The objective of this test is to evaluate the water quality matrices of the influent water and effluent water and to identify the composition of the removed particulate material, with the relationships to the terminal headloss and/or turbidity breakthrough point. Certain feedwater parameters will be noted and finished water will be examined relative to the level of removal attained. The parameters are listed in Table 5-2 .

5.4.2 Initial Test Runs

Based on the initial test runs, the terminal headloss and turbidity breakthrough point will be established, and the performance of the filter will be evaluated relative to the water quality parameters.

5.4.3 Testing Schedule For Quality Parameters

The testing schedule for water quality parameters identified in Table 5-2.

Samples of both feedwater and filtered water will be analyzed.

TABLE 5-2
Analytical Methods And Testing Frequency

PARAMETER	FACILITY	*STANDARD METHODS* [1] NUMBER OR OTHER METHOD REFERENCE	EPA METHOD[2]	MINIMUM FREQUENCY
Temperature	on-site	2550 B		daily
pH	on-site	4500-H^+ B	150.1 / 150.2	3
Total Alkalinity	lab	2320 B		daily
Total Hardness	lab	2340 C		weekly
Total Organic Carbon	lab	5310 C		weekly
UV_{254} Absorbance	lab	5910 B		weekly
Turbidity	on-site	2130 B / Method 2	180.1	daily
Aluminum	lab	3111 D / 3113 B / 3120 B	200.7 / 200.8 / 200.9	weekly
Iron	lab	3111 D / 3113 B / 3120 B	200.7 / 200.8 / 200.9	weekly
Manganese	lab	3111 D / 3113 B / 3120 B	200.7 / 200.8 / 200.9	weekly
Suspended solids in backwash water	lab	2450 D		Task 4
Algae,	lab	10200H		weekly 4
Sulfate	lab	4500-SO, B, C, or D	300.0, 375.2	weekly
Dissolved Oxygen	on-Site	4500		daily
True Color	on-Site	2120 B (Hach Company modification of SM 2120 measured in spectrophotometer at 455 nm)		weekly
Arsenic concentration and species	lab	3113 B / 3114 B / 3120 B	200.7 / 200.8 / 200.9	Task 4

Notes:

1) Standard Methods Source: 18th Edition of Standard Methods for the Examination of Water and Wastewater, 1992, American Water Works Association.
2) EPA Methods Source: EPA Office of Ground Water and Drinking Water. EPA Methods are available from the National Technical Information Service (NTIS).
3) Once per 8 hours during runs with (when pilot plant is staffed) no arsenic sampling. Each time arsenic samples are taken, coagulated water pH will be measured.
4) Weekly or once during each set of treatment conditions for which arsenic sampling is done.

5.4.4 Evaluation Criteria

The package plant will be evaluated with respect to manufacturer's claims of performance, with the requirements of the anticipated revised arsenic MCL as a basis.

5.5 TASK 3: OPERATING CONDITIONS AND TREATMENT EQUIPMENT PERFORMANCE.

5.5.1 Introduction

Operating conditions will be documented during each day of verification testing. These will include descriptions of chemicals used for coagulation, pretreatment chemistry for coagulation, treatment processes used, and operating conditions. In addition, the performance of the water treatment equipment will be documented, including rate of filter head loss gain, frequency and duration of filter backwashing, and need for cleaning of pretreatment clarifiers.

5.5..2 Objective

The objective of this task is to accurately and fully document the operating conditions applied during treatment and the equipment performance. This task is intended to result in operational data describing the operation of the equipment which can be used to develop cost estimates.

5.5.3 Work Plan

The two filter vessels are intended to be operated on an alternating basis at 5 gpm, for a throughput flowrate of 9.1 gpm/ft^2 bed area. When one filter reaches the end of the run, as determined by one of the conditions noted above in 5.4.2, the stand-by vessel is brought on line and the first backwashed and placed into a standby mode. This process is automatically controlled by electrically activated, motorized ball valves, with no discernible loss of flow.

A description of the testing equipment will include:

- Complete description of each process, with data on volume and detention time of each process basin at rated flow.
- Data on each layer of the filtering and support material, including:

  - Depth
  - Material type
  - Effective size
  - Uniformity coefficient

During verification testing, the following items will be monitored, collected, recorded , or analyzed:

- Treatment equipment operating parameters for both pretreatment and filtration, including:
  - Pretreatment chemistry
  - Mixing and flocculation intensities

- Operating parameters for clarification ahead of filtration, rate of flow, and filtration rate
- Process detention times

- Filter head loss and backwashing data.

- Chemical dosages for all chemicals used.

- Electrical energy consumed by the treatment equipment or aggregate horsepower of all motors supplied with the equipment for estimating the maximum power consumption during operation.

5.5.4 Schedule

Table 5-3 presents the schedule for observing and recovering coagulation and filtration package plant operating and performance data.

5.5.5 Evaluation Criteria

Where applicable, the data developed from this test will be compared to statements of performance capabilities with respect to filter head loss, frequency and duration of filter backwashing, and the need for pretreatment clarified cleaner.

The results of operating and performance data will be tabulated for inclusion in the Performance Verification Report, and will include:

- average rate of flow for equipment, gallons/day;
- average filtration rate, g.p.m./sf;
- average run lengths, hours
- average daily chemical usage and cost for treatment chemicals;
- average daily energy cost
- average daily backwash water production, and;
- average daily sludge production

TABLE 5-3
Package Treatment Plant Operating Data

OPERATING DATA	ACTION
Chemicals Used	Record on a daily basis: type: supplier, commercial strength (e.g. as percent Fe or Al. Specific gravity of liquid coagulants or percent purity and chemical formula of dry coagulants) and, dilution for stock solution to be fed (if desired).
Chemical Type, Feed Volume and Dosage	Check and record every 2 hours. Refill as needed, note volumes and time of refill. Maintain all calculations on coagulant chemical solution preparation and all data on coagulant chemicals as purchased from supplier or chemical manufacturer. Calculate the chemical dosage for each filter run in which arsenic challenge testing was carried out.
Feedwater Flow and Filter Flow	Check and record each two hours. Adjust when flow >10% above or below goal. Record flows before and after adjustment.
Filter Head Loss	Record initial clean bed total head loss at start of filter run. Record total head loss every two hours. Record terminal head loss at end of filtration.
Filtered Water Production	Record gallons of water produced per square foot of filter bed area for each filter run. (This figure is the product of filtration rate (gpm/ft^2) and length of filter run in minutes performed at constant rate).
Filter Backwash	Record time and duration of each filter backwashing. Record water volume use to wash filter.
Sludge Production	Record volume of sludge and percent solids in filter cake.
Suspended solids in washwater	This requirement is replaced by the process of running all backwash water through a filter press and measuring total solids in the filter cake.
Electrical Power	Record meter reading once per day.
Hours operated per day	Record in log book at end of day or at beginning of first shift on each following work day.
All parameters will be checked only during times when pilot plant is staffed.	

ok

5.6 TASK 4: ARSENIC REMOVAL

5.6.1 Introduction

Arsenic removal may be a primary purpose of coagulation and filtration of some surface and ground waters in the future. Consequently, the effectiveness of coagulation and filtration treatment processes for arsenic removal will be evaluated in this task. Assessment of treatment efficacy will be made on the basis of turbidity measurements in Task 3 and on the basis of arsenic removal for ground water treatments in this task.

5.6..2 Experimental Objectives

The objective of this task is to evaluate arsenic removal during verification testing by measuring arsenic naturally present in the feed water.

5.6.3 Work Plan

Task 4 will be carried out during the verification testing runs conducted in Task 1. The treatment equipment will be operated using the chemical pretreatment conditions that provide effective clarification (if used) and filtration.

Evaluation of arsenic removal will be performed by analyzing arsenic in the feed and filtered waters.

A minimum of 48 hours of operation involving collection of 11 or more arsenic samples will be conducted to provide statistically verifiable arsenic removal data for each condition of coagulant chemical type and dosage, coagulation pH, feed water arsenic species, and feed water arsenic concentration tested.

5.6.4 Analytical Schedule

Turbidity in feed water samples will be measured on a continuous basis. Filtered water analysis will be conducted using a bench top turbidimeter.

Chemistry samples will be collected from the filter effluent. Samples will not be collected until the treatment plant has been in operation for a total of three (3) theoretical detention times (the theoretical detention time is the volume of water held in the treatment equipment, divided by the rate of flow) as measured through the pretreatment process up to the filter. For arsenic sampling purposes, the time of operation when three pretreatment detention times have elapsed will be considered time zero. Arsenic samples will be collected at time zero and at 1, 3, and 6 hours past time zero. Thereafter, arsenic samples will be collected once every 6 hours until the end of the filter run or until the filter run has lasted 48 hours from time zero. This will result in collection of 11 sets of arsenic samples in a 48-hour run. Because four sets of arsenic samples are to be collected during the first 6-hours of a filter run, conducting more than one filter run during the 48-hours period required for a given set of treatment conditions would result in collection of more than 11 sets of arsenic samples. During each sampling event, one 250-mL sample will be collected at each sampling location. The exact time of sampling will be recorded so turbidity measurements can be determined at the time of sampling.

COA will then submit collected water samples to the State of Utah Laboratory for arsenic testing. The Laboratory has a minimum detection limit for arsenic of 0.04 μg/L.

5.6.5 Evaluation Criteria

Performance of coagulation and filtration package plants will be evaluated in the context of KI's statement of performance capabilities with respect to arsenic removal. For arsenic removal by coagulation and filtration, the following information will be provided:

- valence of arsenic being treated by coagulation and filtration, i.e. As(III) or As(V);
- pH of coagulated water;
- coagulant chemical used, and;
- coagulant dosage

5.7 TASK 5: DATA MANAGEMENT

5.7.1 Introduction

The data management system used in the verification testing program will involve the use of computer spreadsheet software and manual recording of operational parameters for the water treatment equipment on a daily basis.

5.7.2 Objective

The objective of this task is to tabulate the collection of data for completeness and accuracy, and to permit ready retrieval for analysis and reporting. In addition, the use of computer spread sheets will allow manipulation of the data for arrangement into forms, useful for evaluation. A second objective is the statistical analysis of the data as described in the Protocol.

COA as the FTO for the project will be responsible for the maintenance of the logbooks and field notebooks. Data will be collected in bound logbooks and on charts from the instrumentation panels and individual testing instruments. There will be a single field logbook containing all on-site operating data which will remain on site and will contain instrument readings, on-site analyses and any comments concerning the test run with respect to either the nature of the feedwater or the operation of the equipment.

Data will be entered into a computer spreadsheet program (Excel) on a daily basis from the logbook and from any analytical reports. A back-up copy of the log book and computer data will be maintained off site. The database for the project will be set up in the form of a custom-designed spreadsheet. All data from the laboratory notebooks and the data logbook will be entered into the appropriate spreadsheet. Data entry will be conducted on-site under COA supervision. All recorded calculations will be checked at this time. Following data entry, the spreadsheet will be printed out and the print-out will be checked against the handwritten data sheet. 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. Each step of the verification process will be initialized by the COA operator or engineer performing the entry or verification step.

Each page of the logbook will be sequentially numbered and identified as Kinetico ETV Test. Each completed page will be signed by the on-duty FTO staff. Errors will be crossed with a single line and initialed. Deviations from the FOD whether by error or by a change in the conditions of either the test equipment or the water conditions will be

noted in the logbook. The logbook will include a carbon copy of each page. The original logbook will be stored on-site, the carbon copy sheets will be forwarded to the project engineer of COA at least once per week. This will not only ease referencing the original data, but offer protection of the original record of results.

Pilot operating logs will include a description of test runs, names of visitors, description of any problems or issues, in addition to experimental calculations and other items.

Also entered into the logbook will be any photographs of the station, test equipment or the installation. The existence of video tapes or other documentation will be entered. Photographs must be noted as to direction, time, subject and identity of the photographer.

Included in the logbook will be copies of chain of custody, field sheets and laboratory notes. Original chain of custody forms will travel with the samples. Examples of the spreadsheet format, chain of custody forms and laboratory worksheets are included as Appendix D.

While the use of laptop computers and electronic data recording is encouraged, any use will be documented in the logbook. Laptop computers will be employed in the spreadsheet analysis and the contents of the data spreadsheets will be noted in the logbook.

Computer data can be transferred either electronically or by physical transfer of data discs.

Analysis of arsenic data will be analyzed separately for 95% confidence in accordance with the confidence formula noted in Chapter 1 of the EPA/NSF ETV Protocol:

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

S = standard deviation
n = number of measurements in data set
t = distribution value with n-1 degrees of freedom
α = the significance level defined for 95% confidence as: 1- 0.95 = 0.05.

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

5.7.3 Work Plan

5.7.3.1 Data Handling

The Kinetico CPS100CPT instrumentation is controlled by an industrial, programmable computer (IC693 9460) readily attachable to data recording devices; manual logbooks will be used to record data not connected to automatic records such as flow rates, pressure and differential gauge readings and power consumption. All data will be maintained by the FTO and the data entered into the spreadsheet database. The data

acquisition system for this evaluation study is a Telogers R-3307. The O&M manuals for the PLC and Data system are attached as Appendix A of this FOD.

5.7.4 Statistical Analysis

The water quality data grab samples will be analyzed for statistical uncertainty. COA will calculate 95% confidence intervals for all data as described in the Protocol

Data on coagulation chemical changes during filter runs, or low rate variations, would require statistical analysis. Such statistical analysis will be presented as graphs to assist regulators and plant designers to evaluate applicability of the system to specific requirements. Data on the grab samples will be correlated to any pressure losses and the time of the filter run (whether just prior to or following backwash, for example).

5.8 TASK 6: QA/QC

The objective of this task is to control the methods and instrumentation procedures such that the data are not subject to corruption. Adherence to analytical methods as published in *Standard Methods* will be assured. Moreover, instrumentation and standard reagents will be referenced to the National Institute of Standards and Technology (NIST). Instruments used to gather data will be standardized and calibrated in accordance with the schedules noted below.

5.8.1 QA/QC Verifications

QA/QC verifications to be performed at the beginning of each testing period include instrumentation checks, cleaning and maintenance of the turbidimeters, pressure gauges, tubing and other components. Flow meters will be calibrated with "bucket and stopwatch". Turbidimeters will be tested for volumetric accuracy and standardized.

In addition, daily verification of turbidimeters will be performed.

<u>Daily QA/QC Verifications will include:</u>

In-line turbidimeter flow rates verified (bucket and stopwatch);
In-line turbidimeter readings standardized against a calibrated bench turbidimeter;
Chemical feed pump flow rates (verified volumetrically over a specific period of time).

<u>Bi-weekly QA/QC Verifications will include:</u>

In-line flow meters cleaned and verified (bucket and stopwatch).

<u>QA/QC Verifications at the beginning of each testing period will include:</u>

Cleaning and re-calibration of in-line turbidimeters;
Check of differential pressure transmitter signal and pressure gauge readings with pressure meter;
Inspection of turbidimeter tubing for unimpeded flow and integrity.

5.8.2 Specific Instrumentation Methods

Specific Instrumentation methods for on site QA/QC accuracy are as follows:

5.8.2.1 pH

Analysis will be by *SM* 4500-H^+. A three point calibration (pH 4, 7 and 10) with Oaktron NIST traceable pH buffers will be performed daily. Between tests the pH probe will be kept wet in KCl solution. For on-site determination of pH, field procedures will be used to limit absorbance of carbon dioxide to avoid skewing results by poorly buffered water.

5.8.2.2 Temperature

Temperatures will be measured in accordance with *SM* 2550 two times daily at times selected to bracket the extremes of water temperature at the site. The thermometer will be in 0.1° C increments, and will be calibrated weekly against an NIST precision thermometer.

5.8.2.3 Turbidity

Turbidity is an important measure of overall filter performance, and has been recorded in many prior pilot tests; hence the inclusion of turbidity data is an important addition to the data collection. Since the data are only as valuable as the confidence in them allowed by proper testing, *Standard Methods* 2130 protocol will be employed.

The turbidimeters will remain on during the duration of the testing period. On line and bench top turbidimeters will be used, and the bench top turbidimeter will be the calibration standard for the test. The benchtop turbidimeter will be calibrated at the start of testing and then weekly, during the testing period, against standards of 0.1, 0.5 and 3.0 NTU. Manufacturer's procedures for maintenance will be followed and the schedules for maintenance and cleaning noted in the log book. All glassware will be dedicated and cleaned with lint free tissues to prevent scouring or deposits on the cells.

The method for collecting grab samples will consist of running a slow, steady stream from the sample tap, triple-rinsing a dedicated sample beaker in this stream, allowing the sample to flow down the side of the beaker to minimize bubble entrainment, double-rinsing the sample vial with the sample, carefully pouring from the beaker down the side of the sample vial, wiping the sample vial clean, inserting the sample vial into the turbidimeter, and recording the measured turbidity. OK

For the case of cold water samples that cause the vial to fog preventing accurate readings, allow the vial to warm up by submersing partially into a warm water bath for approximately 30 seconds.

5.8.2.4 Pressure Gauges

While absolute pressure is less important than relative pressure and pressure differentials, differential pressure gauges, or matched gauges with calibration, and accurate to 1 psi, will be used to measure pressure losses across the vessels. The pressure gauges for this study are Orange Research Differential Pressure Instruments. The operating and installation instructions are included as a portion of Appendix A.

5.8.3 Procedures for Chemical and Biological Samples Shipped For Off-Site Analysis

Procedures for Chemical and Biological Samples Shipped for Off-Site Analysis are as follows:

5.8.3.1 Organic Parameters, Total Organic Carbon and UV Absorbance

Samples for these analysis will be collected in glass bottles supplied by The State of Utah Division of Drinking Water and will be delivered by courier to the test lab. Samples will be preserved, held and shipped in accordance with *Standard Methods* 5010B and *SM* 1060.

5.8.3.2 Algae Samples:

Samples will be collected in glass bottles supplied as above and kept at 4° C in the proper shipping cooler. Algae samples will be preserved with Lugol's solution.

5.8.3.3 Inorganic Samples

Inorganic Samples will be collected, preserved and shipped in accordance with *Standard Methods* 3010B and C and 1060 and EPA §136.3, 40 CFR Ch.1. Proper bottles and preservatives where required (iron and manganese for example) will be used. Although the travel time is brief, samples will be shipped in coolers at 4° C.

5.8.3.4 True Color

True color will be measured in accordance with a spectrophotometer at 455 nm, using a Hach Company adaptation of the *Standards Methods* 2120 procedure. Samples should be collected in clean plastic or glass bottles and analyzed as soon after collection as possible. If samples cannot be analyzed immediately, they will be stored at 4 °C for up to 24 hours, and then warmed to room temperature before analysis. The filtration system described in *Standards Methods* 2120 C will be used, and the results will be expressed in terms of PtCo color units.

6.0 QUALITY ASSURANCE PROJECT PLAN

6.1 PURPOSE AND SCOPE

The purpose of this section is to ensure data quality and integrity. The primary responsibility for recording and monitoring the data lies with COA, although other individuals, especially those in off-site analytical laboratories, have responsibilities for supplying the data in accessible and reliable formats.

The inorganic laboratory for this project is the State of Utah, Division of Drinking Water Laboratory . A copy of the State of Utah, QA/QC manual is attached to this FOD as Appendix E. This laboratory has had EPA certification since the inception of the EPA Laboratory Certification program. The Utah State Health lab has also been authorized by the EPA to inspect and certify other environmental laboratories in the state of Utah.

This section outlines steps that will be taken by operators of the equipment and by the analytical laboratory to ensure that data resulting from this verification testing are of known quality and a sufficient number of critical measures are taken.

6.2 QUALITY ASSURANCE RESPONSIBILITIES

A number of individuals may be responsible for monitoring the operating parameters for the testing equipment and for the sampling and analysis QA/QC throughout the verification testing. Primary responsibility for ensuring that both equipment operations and sampling and analysis activities comply with this QA/QC section of the FOD rests with COA.

QA/QC activities for the State of Utah, Division of Drinking Water Laboratory that analyzes samples sent off-site will be the responsibility of that analytical laboratories' 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 laboratory are dependent on the analytical methods being used.

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 performance. For all measurements and monitoring activities conducted for equipment verification testing, 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 procedures, 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 operation. For most water treatment processes involving arsenic removal, detecting a +/- 10 percent change in an operating parameter is sufficient. Pressures and flows rates will also be recorded on a daily basis in order to track changes in operational conditions that exceed this 10 percent range.

6.3.2 Accuracy

For water quality analyses, accuracy refers to the difference between an experimentally determined sample result and the accepted reference value for the sample. Analytical accuracy is a measure of analytical bias due to systematic errors. Loss of accuracy can be caused by such processes as errors in standards preparation, equipment calibrations, loss of target analyte in the extraction process, interferences, and systematic or carryover contamination from one sample to the next.

In this verification testing, COA will be responsible for maintaining consistent sample collection procedures, including sample locations, timing of sample collection, sampling procedures, sample preservation, sample packaging, and sample shipping to maintain a high level of accuracy in system monitoring. In addition, analytical accuracy will be quantified by executing random spiking procedures for the specific inorganic constituents chosen for testing. On-site analytical equipment will be calibrated by utilizing the following:

pH	Standard Method 4500-H^+. The pH meter will have a three point calibration daily against NIST traceable pH standards (4, 7 and 10). The anticipated range of the pH at this location is 7.4 - 8.2. The specific model and make of the pH meter, turbidimeter, and thermometer will be noted in the report prepared for EPA.
Turbidity	Standard Method 2130. The bench top turbidimeter will be calibrated at the beginning of each verification period, and weekly thereafter against standards of 0.1, 0.5, and 3.0 NTU. Secondary standards will be used on a daily basis to verify calibration of the primary standards. Samples will be taken from a sample tap at a slow steady stream and along the side of a triple rinsed dedicated beaker to avoid air entrapment. The sample is poured from the beaker into a double rinsed clean sample vial.

All glassware for turbidity measurements will be kept clean and handled with lint free laboratory tissue.

Temperature — Temperature readings may vary throughout the year and water temperature affects the performance of the arsenic removal system. Temperature will be recorded daily with a NIST certified thermometer accurate to 0.1°C, as per Standard Method 2550.

For equipment operating parameters, accuracy refers to the difference between the reported operating conditions and the actual operating condition. For equipment operating data, maintaining a high level of accuracy will require collecting a sufficient quantity of data during operation to be able to detect a change in operations. For water flow, accuracy may be the 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 (bucket and stopwatch technique) as practiced in hydraulics laboratories or water meter calibration shops. Meters and gauges will be checked periodically for accuracy, and when proven to be dependable over time, the time interval between accuracy checks can be increased.

From an analytical perspective, accuracy represents the deviation of the analytical value from the known value. Since true values are never known in the field, accuracy measurements are made on analysis of QC samples analyzed with field samples. QC samples for analysis will be prepared with laboratory control samples, matrix spikes and spike duplicates. Recoveries for spiked samples are calculated in the following manner:

$$\% \text{ Recovery} = \frac{100 \bullet (SSR - SR)}{SA}$$

SSR = Spiked sample result
SR = Sample result
SA = Spike amount added

Recoveries for laboratory control samples are calculated as follows:

$$\% \text{ Recovery} = \frac{100 \bullet \text{ (found concentration)}}{\text{true concentration}}$$

For acceptable analytical accuracy under the verification testing program, the recoveries reported during analysis of the verification testing samples must be within control limits, where control limits are defined as the mean recovery plus or minus three times the standard deviation.

The Utah State Health Laboratory uses acceptance criteria on drinking water samples for arsenic analysis which were published by the US EPA in 1991. In this project, arsenic samples will be analyzed in the ICP-MS (inductively coupled plasma mass spectrometry) method. This minimum reporting limit by this method is approximately

0.5 μg/L. Results above this level for this project will be reported to the nearest 0.1 μg/L. Acceptance criteria for spiked samples are based on a regression equation which tends to broaden as the analytical limit is approached. For arsenic, the equation for calculating the 1 sigma acceptance limits in μg/L is 0.0636* (True Value) + 0.3171. Using this equation, a sample with a true value of 7 μg/L would have 95% acceptance limits (2 sigma) of ± 1.5 μg/L (±21%) and a true value of 30 μg/L would have acceptance limits of ±5.4 μg/L(±18%) from the true value.

Accuracy can also be affected by the sample matrix itself. Sulfate levels of the Spiro Bulkhead supply exceed 400 μg/L (as $SO_4^=$). Sample matrix interference is evaluated through the analyst's spiking of the water. Recovery on matrix spikes and matrix spike duplicates must be within ±30% of the true value.

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 measurement 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 may be reported as a means to quantify sample precision. The percent relative standard deviation may be calculated in the following manner:

$$\text{\% Relative Standard Deviaiton} = \frac{S \cdot 100}{X_{average}}$$

where

S = standard deviation
$X_{average}$ = the arithmetic mean of the recovery value

Standard Deviation is calculated as follows:

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

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%.

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.

6.4 WATER QUALITY AND OPERATIONAL CONTROL CHECKS

This section describes the QC requirements that apply to both the treatment equipment and the on-site measurement of water quality parameters. It also contains a discussion of 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. The selection of the appropriate quality control checks depends on the equipment, the experimental design and the performance goals.

6.4.1 Quality Control For Equipment Operation

This section will explain the methods to be used to check on 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 within specifications, obtaining valid equipment operating data is a prime concern for verification testing.

6.4.1.1 Work Plan

Equipment flowrates and associated signals will be documented and 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. In-line monitoring equipment such as flowmeters, etc., will be checked to confirm that the readout matches with the actual measurement and that the signals being recorded are correct. The items listed below are in addition to any specified checks outlined in the analytical methods.

6.4.1.1.1 QA/QC Verifications

- Chemical feed pump flowrates (verified volumetrically over a specific time period);
- Flow rates to on-line analytical equipment, verified volumetrically over a specific time period.

6.4.1.1.2 Monthly QA/QC Verifications

- In-line flowmeters/rotameters - clean equipment to remove any debris or biological buildup and verify flow volumetrically to void erroneous readings;
- On-Line pH meters, conductivity meters, turbidimeters etc. - clean out reservoirs and re-calibrate, if employed;
- Tubing - verify good condition of all tubing and connections; replace if necessary.

6.4.2 Analytical Methods

The analytical methods utilized in the equipment verification testing plan for on-site monitoring of all water quality are described in the section below. Use of either bench-top or on-line field analytical equipment will be acceptable for the verification testing.

6.4.2.1 pH

Analyses for pH will be performed according to Standard Method 4500-H*. 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 in the range of 4, 7 and 10 will be used. The pH probe will be stored in the appropriate solution defined in the instrument manual.

6.4.2.2 Conductivity

Analyses for conductivity will be performed according to Standard Method 2510 B. A three-point calibration of the conductivity meter used in the verification testing will be performed once per day when the instrument is in use. Certified conductivity solutions in the expected range will be used. The probe will be stored in the appropriate solution defined in the instrument manual.

6.4.2.3 Turbidity

Turbidity analyses will be performed according the Standard Method 2130 with a bench-top turbidity. During the pilot testing period, the bench-top turbidimeter will be left on continuously. Once each turbidity measurement is complete, the unit will be switched back to its lowest setting. All glassware used for turbidity measurements will be cleaned and handled using lint-free tissues to prevent scratching. Sample vials will be stored inverted to prevent deposits from forming on the bottom surface of the cell.

COA will document any problems experienced with the turbidity monitoring instruments, and will also document any subsequent modifications or enhancements made to monitoring instruments.

Bench-Top Turbidimeter: Grab samples will be analyzed using a bench-top turbidimeter. Readings from this instrument will serve as reference measurements throughout the study. The bench-top turbidimeter will be calibrated within the expected range of sample measurements at the beginning of pilot plan operation and on a weekly basis using primary turbidity standards of 0.1, 0.5 and 5.0 NTU. Secondary turbidity standards will be obtained and checked against the primary standards. Secondary standards will be used on a daily basis to verify calibration of the turbidimeter and to re-calibrate when more than one turbidity range is used.

The method for collecting grab samples will be performed according to the following protocol: 1) running a slow, steady stream from the sample tap, 2) triple-rinsing a dedicated sample breaker in this stream, 3) allowing the sample to flow down the side of the beaker to minimize bubble entrapment, 4) double-rinsing the sample vial with the sample, 5) carefully pouring from the beaker down the side of the sample vial, 6) wiping the sample vial clean, 7) inserting the sample vial into the turbidimeter, and 8) recording the measured turbidity. In the

case of cold water samples that cause the vial to fog preventing accurate readings, the vial will be allowed to warm up by partial submersion in a warm water bath for approximately 30 seconds.

6.4.2.4 Analysis for Inorganic Chemical Contaminants

Methods to be employed for analysis of a specific analytical parameter have been explicitly identified in this FOD. The methods selected for analyses of all inorganic constituents will comply with those described in the most recent edition of Standard Methods or a comparable EPA Method.

where +2 ICPMS for As OK

Table 5-2 specifies methods

6.4.3 Water Quality Data

After treatment equipment is operating within specifications and water is being treated, the results of the treatment are interpreted in terms of water quality. The quality of the water sample analytical results is just as important as the quality of the equipment operating data. Therefore, the QAPP must emphasize the methods to be employed for sampling and analytical QA. The important aspects of sampling and analytical QA are given below. Table 5.1 identifies the water quality parameters to be tested and lists the measurement schedule.

OK and methods

6.4.3.1 Duplicate Analysis of Selected Water Quality Parameters

Duplicate samples will be analyzed for the on-line parameters of pH, turbidity, and conductivity at specified intervals in order to determine the precision of analysis. The duplicate analyses will be performed according to the requirements for calculation of 95% confidence intervals as presented in Section 4.5. For each batch of 20 arsenic samples or less a laboratory standard is analyzed twice and must be within ±15% of the true value, and have a relative percent deviation of ±3 standard deviations for the duplicate value. At least one arsenic duplicate analysis will be run by the Lab every week.

OK

6.4.3.2 Method Blanks

Method blanks will be used for arsenic samples to evaluate analytical method-induced contamination, which may cause false positive results. For each batch of 20 arsenic samples or less, a laboratory reagent blank is analyzed which must be below the method reporting limit.

Travel blanks will be analyzed twice during the project to evaluate possible travel related contamination. Method blanks will be evaluated twice during the project to evaluate possible field method induced contamination (known blank samples are carried through the filtration and ion exchange process and evaluated for detected arsenic and antimony).

A PE (Performance Evaluation) sample comes with statistics that have been derived from the analysis or the sample by a number of laboratories using EPA-approved methods. These statistics include a true value of the PE samples, a mean of the laboratory results obtained from the analysis of the PE samples and an acceptable range for sample values. The analytical laboratory is expected to provide results from the analysis of the PE sample that meet the performance objectives of the verification testing.

OK

In addition to normal laboratory quality control methods associated with the analytical methods, the laboratory receives external quarterly blind audit samples (reagent blank water spikes) prepared by the Division of Water Quality (Arne Hultquist (801) 538-6068). This program has been in place since 1988. A blind audit samples for trace metal was submitted to the laboratory as a part of this program in late March of 2000, before the ETV project began. ok

When analytical results are received from the State Health Laboratory, the Division of Water Quality prepares a report which identifies the fictitious name of the audit sample, the laboratory number assigned to the sample, and the analytical results. Samples are prepared from US EPA PE trace metal concentrates, and have a known analytical value and acceptable range of 95% confidence interval for reporting. Regular meetings are scheduled with laboratory personnel to discuss any trends or problems discovered through the audit sample process. ok.

6.4.3.3 Analysis For Inorganic Chemical Contamination

The methods selected for analysis of all inorganic constituents will comply with those described in the most recent edition of Standard Methods or a comparable EPA Method. The appropriate Standard Methods references are listed in Table 5.1. or Table 5-2

6.4.3.4 Performance Evaluation Samples For On-Site Water Quality Testing

Prior to analysis, special mass spectrometer tuning is accomplished by analyzing 6 replicates for 8 elements and must have a relative standard deviation of < 5% in the instrument signal. Four elements are evaluated using internal standards, whose response must be with 60 - 125% of the internal standard response in the original spike. For each instrument calibration, one standard reference material is analyzed and must indicate recovery within the 90 - 110% range.

The analytical process for arsenic and antimony begin with an initial performance mid range check sample following establishment of the analytical curve. Results must be within ±15% of the true vale. Following that, every 10th sample measured will have a midrange check sample inserted into the analytical stream and must meet the same acceptance criteria for the analytical process to proceed.

PE samples are samples whose composition is unknown to the analyst. Analysis of PE samples will be conduced for arsenic before pilot testing is initiated by submission of samples to the analytical laboratory. Control limits for the PE samples will be used to evaluate the sampling method and analytical performance of the equipment testing organization and analytical laboratory, respectively. One kind of PE sample that would be used for on-site QA in most studies done under this protocol would be PE conductivity sample.

Because of some special sampling already scheduled by the Division of Water Quality for the week of April 17, another set of blind audit samples will be prepared and submitted in cooperation with the Division of Drinking Water (Larry Scanlan (801) 536-4204). At this time, spiked samples will be prepared in reagent blank water with known values of arsenic and antimony in the 30 μg/L range and in the 7 μg/L range, from commercial standard reference material standards, to evaluate the accuracy of the analytical processes.

While antimony is normally not requested in audit samples by the Division of Water Quality because it is not normally regulated in the programs of their Division, the audit samples sent in during the week of April 17 will include requests for antimony. Antimony is not part of the NSF/ETV project for arsenic removal, but was requested by Park City officials in order to help address a local problem, and to evaluate possible treatment alternatives. As a result, antimony audit samples will only be submitted during the week of April 17, 2000.

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 procedures to be used will be equipment dependent. The purpose of this step is to provide data that will be used to verify the Statement of Performance Capabilities. These data will be obtained from logbooks, instrument outputs, and computer outputs as appropriate.

6.5.2 Data Validation

The operator will verify the correctness of data acquisition and reduction. COA will review calculations and inspect laboratory logbooks and data sheets to verify accuracy of data recording and sampling. Information on data acquisition and analytical QA/QC will be examined by analytical technicians and by the laboratory supervisor. Laboratory and project mangers will verify that all instrument systems are correctly calibrated and the QA/QC objectives for accuracy, precision, and method detection limits have been met.

Analytical outlier data are defined as those QC data lying outside a specified QC objective window for accuracy and precision 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

At a minimum, the data tabulation will list the results for feedwater, concentrate and permeate water quality analyses, the results of inorganic constituent removal analyses and equipment operating data. All QC information such as calibrations, blanks and reference samples are to 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 common spreadsheet or database format.

6.6 SYSTEM INSPECTIONS

On-site system inspections for sampling activities, field operations, and laboratories may be conducted as specified by the NSF Equipment Verification Testing Plan. These

inspections will be performed by the verification testing entity to determine if the NSF Equipment Verification Testing Plan is being implemented as intended. Separate inspection reports will be completed after the inspections and provided to the participating parties.

6.7 REPORTS

6.7.1 Status Reports

COA will prepare periodic reports for distribution to pertinent parties, e.g., Manufacturer, NSF, EPA, the community. These reports will discuss project progress, problems and associated corrective actions, and further scheduled activities associated with the verification testing. Each report will include an executive summary at the beginning of the report to introduce the salient issues of the testing period. When problems occur, the Manufacturer and COA project managers will discuss them, 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.

6.7.2 Inspection Reports

Any QA inspections that take place at the field testing or at the analytical laboratory during verification testing will be formally reported by COA, the verification entity, and the Manufacturer.

6.8 CORRECTION ACTION

Contingencies are by their nature unpredictable; however, COA will document contingency plans for foreseeable problems to include analytical instrument backup, delays due to weather, equipment malfunction, or to problems associated with the site during the initial operations period and before formal verification begins. These plans will be maintained on site so that on-site operators can quickly respond to problems.

It is not possible to predict or control what the possible matrix effects of the Park City water will be, other than to ensure that recoveries are within ±30% as specified above.

If audit sample results are found to be outside the analytical limits specified above, a meeting will be held with laboratory personnel within four days of receipt of the data to evaluate possible problems and discuss potential solutions, and another set of performance evaluations samples will be submitted to the laboratory for analysis before the project ends.

7.0 DATA MANAGEMENT, ANALYSIS AND REPORTING

7.1 DATA MANAGEMENT AND ANALYSIS

Data from daily written logs relating to the operation of the equipment will be tabulated in electronic spreadsheets. In addition, data from laboratory analysis, along with relevant QA/QC data will be entered from hard copy into electronic spreadsheet form. These data will be correlated with data from the turbidimeter and other on-line apparatus. In this manner, graphic displays of the data showing relationships between meaningful parameters can be analyzed and conveniently displayed for the final verification report.

Raw data will be furnished in appendices, along with discussion of any anomalies in the testing procedure, raw water source, or operating conditions that may impact the performance of the equipment.

Photographs, drawings, visitors logs, and field notebooks will be permanent and incorporated into the final report.

In summary, data to be compiled include:

- Laboratory Results on Water Quality Parameters
- On-site Water Testing Results
- Operations Logs of Flow meters, Pressure Readings, Chemical Consumption, Power Use, Total Water Volumes,
- Photographs, Visitor Logs, Time Lines and Schedules.

7.2 PERFORMANCE VERIFICATION REPORT DRAFT

A final report will be prepared by the COA following the testing period for submission to NSF and EPA. Included in the report will be a consolidation of the data, achieved results as determined by the data presented, a record of all aspects of the testing period and a discussion of all factors concerning the operation and maintenance of the equipment. The basic outline for the report will be:

- Introduction
- Executive Summary
- Description and Identification of the Product Tested
- Procedures and Methods Used in Testing
- Results and Discussion
- References
- Glossary
- Appendices (containing logs, prior report copies, relevant correspondence, and raw data forms)
- FOD
- QA/QC Results and Verifications of Instrument Calibrations

8.0 SAFETY AND ENVIRONMENTAL MEASURES

The testing site is at a public water works facility. The site safety plan and Right to Know Employees' Manual have been reviewed by COA for application to the testing plant. Manufactures' safety procedures for handling pressure vessels, chemical feed pumps and for the use of on-site hazardous chemicals will also be followed.

General safety considerations associated with portable, skid mounted water processing systems with the accompany weight and stability issues must be addressed; however, these are incident to the test proper, and not to the use of the equipment.

Safety considerations include the following:

- storage, handling and disposal of hazardous chemicals including acids, caustics and oxidizing agents.
- conformance with electrical code.
- chemical hazards and biohazards.

Normal maintenance for wet and/or slippery floors, noise and ventilation is also a concern, but one with common sense procedures.

9.0 OPERATIONS AND MAINTENANCE

During the testing and verification period, the COA will evaluate the manufacturer supplied O&M manual to evaluate the instructions and procedures for their applicability to small system operators.

Maintenance issues will include (but not be limited to) the following components of the system:

- Valves
- Meters
- Pumps
- Motors
- Backwashing apparatus
- Pressure vessel opening mechanism
- Measuring and analytical instrumentation, such as turbidimeters and pressure gauges.

In addition, cleaning and parts replacement will be addressed to prevent premature aging and rusting of vessels.

The COA will also evaluate the manufacturer provided operating procedures. Among the issues to be addressed are:

- Chemical feed calibration, set points for frequency and stroke
- Chemical dilution and mixing
- Filtration rate control through flow controls or valves
- Determination of head loss schedules
- Filter run limits determination
- Backwashing rates and start mechanisms
- Control of backwash rate and duration
- Determination of backwash frequency
- Determination of backwash length
- Return of filter to service, including filter to waste period
- Can filter run be stopped without initiating backwash?
- Inlet and outlet pressure readings
- Head loss indication or calculations
- Raw water turbidity
- Filtrate turbidity
- Rate of flow control
- Procedures for turbidity breakthrough
- Turbidity levels and turbidity meter calibration procedures

Troubleshooting guides will include contingency plans for:

- loss of chemical feed
- loss of flow
- uncontrolled flow rates
- loss of meter or gauge readings
- leaking vessels

- high turbidity
- no turbidity reading
- too rapid filter head loss
- excessive headloss following backwash
- stuck, broken (won't seal) or leaky valves.

Questions included in the Test Plan addressing operation and maintenance of the package plant —apart from the ETV test set-up itself—will be reviewed by COA for inclusion into the verification report. Among the issues are:

- pressure measurement at the vessel,
- rate of flow measurement device, (if volume meter or flow meter),
- on line turbidity measurement and any fail-safe controls and signals,
- ease of media replacement,
- procedure for seal and entrained air release,
- ease of operation relative to other components of the treatment system (additional prefiltration, chemical feed, check valves, etc.),
- efficiency and performance of other treatment equipment.

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11.0 GLOSSARY

Backwashable Depth Filter
A bag filter, cartridge filter, or granulated media filter intended to filter uncoagulated or coagulated water and designed to be backwashed when either turbidity breakthrough occurs or terminal headloss is reached.

Coagulant
Although technically the coagulant is the product of a chemical reaction that is formed when chemicals are added to water containing colloidal suspensions, the term is often used to refer to the chemicals that are added. These include aluminum and ferric salts, along with organic polymers.

Coagulant aid
Activated silica when used to coagulate suspensions.

Coagulation
The destabilization of colloidal and suspended materials in water using coagulant chemicals, thus allowing the particles to agglomerate into floc.

Colloid
In water treatment the term refers to irreversible colloids such as clays, metal salts and microbes which coagulate into larger agglomerates in water, thus allowing filtration.

Conventional filtration treatment
A treatment train involving coagulation, flocculation, sedimentation, and filtration.

Direct filtration
A process involving coagulation through chemical coagulant addition and filtration, but excluding the sedimentation step.

Filtration
A process for removing particulate matter from water by passage through porous media.

Flocculation
The employment of stirring through hydraulic or mechanical means to agglomerate smaller floc into larger particles for more ready separation.

Granular Media Filter
A deep bed filter containing granular media used to filter water that has not been coagulated. These filters rely on straining particles out of the water, or by attachment of the particles to the media.

Sedimentation
Separation of solids prior to filtration by gravity settling or through other hydraulic means.

Ten State's Standards
A compilation of accepted civil engineering water treatment plant design standards, published as "Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, *Recommended Standards for Water Works*".

APPENDIX A

O & M Manual

OPERATIONS / MAINTENANCE MANUAL

for

Model # CPS100CPT
5 GPM SYSTEM

Kinetico Macrolite® Pressure Filtration

MANUFACTURED BY:

KINETICO INCORPORATED
Newbury, Ohio 44065
(216) 564-9111
(800) 432-1166

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SECTION 1

SYSTEM WARRANTY AND GUARANTEES

WARRANTIES

Equipment

Subject to the terms hereof, Kinetico Incorporated (hereinafter referred to as "Kinetico") warrants all equipment, with the exception of the Macrolite®, manufactured by Kinetico to be free from defects in materials and workmanship for a period of twelve (12) months from the date of installation. Macrolite is warranted for five (5) years from date of installation. Kinetico's liability to the Buyer, with regard to the above warranty, is limited to the repair or replacement of any parts or materials proved upon Kinetico's inspection to be defective. Such parts will be provided free of charge during this period. The repair or replacement of parts must be performed by Kinetico or its authorized agent to receive warranty coverage.

Kinetico shall not be liable to replace or repair parts damaged by chemical action or wear caused by the presence of unspecified materials in the influent or conditions of installation not properly specified by the Buyer. This warranty does not cover damage to equipment or materials caused by the Buyer whole or in part by improper handling, installation, storage, maintenance, Acts of God, improper servicing, or attempting to operate the equipment in excess of its rated capacity or recommended use, intentional or otherwise. Damage to the system due to excessive pressure, temperature or freezing, is also not covered by this warranty. Under no circumstances shall Kinetico be liable for expenses involved in the return of merchandise or equipment.

Labor Warranty

On-site labor charges required for the trouble-shooting, removing and replacing of defective parts are included as part of this warranty.

After the twelve month warranty period, on-site labor charges are billed at the rate of six hundred dollars ($600.00) per day plus expenses. If a local Kinetico representative is available, charges for on-site labor could be considerably less.

No Other Warranties

There exists no other expressed warranty beyond those listed above. Any and all implied warranties, including any warranty of merchantability or fitness for a particular purpose, are limited to the duration of this written warranty and are excluded to the extent permitted by law. There are no warranties other than those contained herein. In no event shall Kinetico be liable for indirect, special or consequential damages in connection with the use of this system, except as specified or referenced in this section.

TROUBLES..OOTING - PUMP
(Continued)

Symptom	Possible Cause	Correction
3. Pump has water spraying out of shaft area or is wet.	**A.** Pump seal failure. **B.** Nearby plumbing leak.	**A.** Check pump inlet strainer; replace seal. **B.** Locate and correct.
4. Pump casing overheats.	**A.** Pump inlet and/or outlet valve(s) closed. ***Never run a pump against a dead head, i.e. no flow.***	**A.** Determine why. If OK, open valve(s).
5. Pump is abnormally noisy.	**A.** Foreign material stuck in housing. **B.** Cavitation. **C.** Bent blades on cooling fan.	**A.** Check housing for foreign material. **B.** Check feed piping for restrictions. **C.** Check the cooling fan in the rear of the pump.

START-UP PROCEDURE

Assembling the System

1. Unpack the system from the crate. *KEEP THE CRATE FOR RETURN SHIPMENT*

2. Attach loose plumbing to the proper place. All loose plumbing is connected with unions making assembly and disassembly very easy.
   The two lines will connect the tanks to the inlet and backwash 3-way ball valves.

3. Check all unions and pressure type joints for the proper gaskets and/or O-rings also ensure that they are tight.

4. Insure that the "Y" strainer has been cleaned and its proper screen installed.

5. Insure all plumbed joints are glued and all isolation valves are closed.

6. Check pump mounting to insure the pump is properly secured.

7. Hook up inlet, outlet and waste hose.

8. Hook up the air line from the small portable air compressor to the bank of 6 air solenoids on the system. Also plug the compressor into the supplied outlet on the system skid.

USE CAUTION WHEN AROUND THE AIR ACTUATED BALL VALVES. THE MANUAL OVERRIDE HANDLES CAN CRUSH FINGERS.

Start-up of the system

1. Check that all the ball valves are in their proper position before turning on the water to the system.

2. **Be sure to initially keep all the system switches in the off position.**

3. Slowly turn on the inlet water and allow one of the tanks to fill up. If the inlet isn't pressurized or if the pump is needed turn the pump switch to the on position. Be sure to adjust the pressure regulator after the pump so that the system runs at approximately 40 - 50 psi on the inlet at a 5 gpm flow rate.
4. Manually turn the backwash 2-way ball valve located at the bottom of the tanks to allow the other tank to fill from the bottom. Run for approximately 10 minutes in this mode.

TROUBLESHOOTING - SOLENOID VALVES*

Symptom	Possible Cause	Correction
1. Valve will not operate (i.e., will not open or close when required).	A. Dirt or trapped particle stuck in valve. B. Inlet pressure to valve is too high. C. Too much back pressure. D. Improper voltage or no power to valve. E. Loose or disconnected wire. F. Burned out actuator.	A. Clean and replace any broken parts. B. Check valve specification and/or possibly reduce inlet pressure. C. Check valve requirements specification. Remove downstream restrictions. D. Check voltage and signal at valve. E. Check terminals. Reconnect or tighten as necessary. F. Replace and reconnect.
2. Valve actuator overheats (some solenoid valves, when used in 100% duty cycle, are normally hot).	A. Valve has improper voltage on it.	A. Check wiring voltage.
3. Valve only partially opens or closes.	A. Foreign material in valve orifice.	A. Clean the valve orifice of all foreign materials.

TROUBLESHOOTING - PUMP

Symptom	Possible Cause	Correction
1. Pump will not run.	A. Tripped overloads. B. Incorrect switch settings on control panel. C. Blown fuses. D. Service disconnect is in "OFF" position. E. Plant voltage and pump voltage requirement incompatible. F. Loose or disconnected wiring. G. Pump output "OFF" on PLC output.	A. Check pump free to rotate and no fuses blown; reset. B. Place switches in correct position. C. Check pump free to rotate, loose wiring terminal connections, correct fuse size; replace. D. Turn on. E. Check pump wiring diagram for voltage supplied. F. Reconnect and/or tighten connections. G. Check computer logic.
2. Pump runs but pressure output is low.	A. Inlet valve(s) are closed. B. Pump inlet strainers are clogged. C. Pump impeller is damaged or fouled. D. Pump electrical motor RPM low/amp draw high. E. Improper setting of pressure relief or pressure regulator valve. F Pump casing air bound.	A. Determine why. If OK, open valve(s). B. Locate source of debris and correct. Remove, inspect, clean, reinstall. C. Inspect pump inlet strainer. Clean, repair or replace impeller. D. See 1.A., 1.D., and 1.F. E. Reset to correct pressure. F. Check for suction air leaks, vent air from casing.

ROUTINE MAINTENANCE - TURBIDIMETERS

1. Check the turbidimeters for the presence of a warning light. If the warning light is on, press the **DIAG** button on the keypad. The meter will then display a diagnostic code. A table on the inside of the door along with the diagnostic code can then be used to determine the problem. Once the problem is diagnosed, refer to the turbidimeter operators' manual for the corrective action or call Kinetico for assistance.

ROUTINE MAINTENANCE - PUMP

1. Observe pump operation. Note any different, excessive noise, or vibration that is unusual from normal operation. Check that valving is properly set on the system to help prevent dead heading (running pump with no flow). Overheating on pump casing is an indication of either no flow or too low of a flow through the pump.

ROUTINE MAINTENANCE - VALVES

1. Most manual valves require very little routine maintenance apart from the daily visual inspection. Over prolonged running, some valves may require replacement of various 0-ring seals and gaskets as seen fit.

BACKWASH MODE

There are three parameters that can automatically (controlled by the PLC) send a designated filter into a backwash. These backwash parameters are changeable set points but are generally set at the following:

Effluent Turbidity	0.50 or greater
Differential Pressure	20 PSI or greater
24 Hour Timer	On/Off Switch dependant on protocol

A backwash can be initiated by either manual initiation or when any one of these conditions has been met. Once a backwash has been started it can not be stopped by any means. Power interruption will not affect the backwash cycle.

A backwash will only be started automatically when the backwash switch is in the AUTO position. The outlet solenoid valve switch should be in the AUTO position at all times. If this switch is not in the auto position, the valve will have to be operated manually by turning the switch into open or closed position, depending on what cycle the system is currently in. Once a backwash cycle has been started, whether manually or automatically, the yellow LED above the switch will flash until the backwash cycle has been completed. After the backwash cycle has been completed, the system will not allow another backwash cycle to be initiated for approximately 20 minutes. During this twenty minute period, the yellow LED will remain solid. After the lockout period, the yellow LED will turn off completely. A manual backwash is achieved by turning the switch to the manual position and holding it there for two seconds. The above LED sequence is identical for a manually initiated backwash cycle.

BACKWASH SEQUENCE

Once a backwash is initiated the system automatically follows a set sequence controlled by the PLC program. The sequence of a backwash event are as follows:

1. The tank that was offline rinses up until clean.
   Time: 3 - 5 minutes

2. The tank to be backwashed is allowed to drain down slightly. This ensures that no media will escape from the top of the tank during air sparge.
   Time: 1 minute

3. Air sparge of the dirty tank. Air is pumped into the bottom of the tank to agitate the media bed and break up any solids to make them easier to backwash out with water. The flow rate of the air is approximately 70 cubic feet per hour per square foot.
   Time: 30 seconds

TROUBLESHOOTING - PLC's

Symptom	Possible Cause	Correction
1. Outputs will not turn on.	A. PLC is not in run mode.	A. Determine cause, return to run mode.
	B. Loose or disconnected wiring.	B. Check terminals, reconnect and/or tighten wiring.
	C. PLC output card is not fully seated on rack.	C. Seat correctly on rack.
	D. Panel voltages incorrect.	D. Determine cause(s), i.e., correct transformers with correct primary and secondary connections.
	E. Blown fuse or circuit breaker.	E. Replace or fix.
	F. Output card is not wired correctly and that all proper commons are tied to the proper voltage.	F. Check wiring diagrams/schematic/PLC program and wire correctly.
	G. Commons not all connected to proper voltage.	G. Check wiring diagram/schematic/PLC program and wire correctly.
	H. System "AUTO" switch is not in "AUTO" position.	H. Determine why and return to "AUTO" position.

Be sure to close the backwash diaphragm valve down to allow only a maximum of 3.5 gpm through the system.

5. Manually turn the inlet and backwash 3-way ball valves to allow the first tank to backwash. Run for approximately 20 minutes or until the waste water runs clear for at least 5 minutes.

6. Manually turn the inlet and backwash 3-way ball valves back to their original positions and backwash the other tank for approximately 20 minutes or until the waste water runs clear.

7. Manually turn all the actuated ball valves back to their original positions.

8. Turn the outlet solenoid switch to the auto position.

9. Turn the system switch to the on position.

10. Allow system to run for 8 -12 hours to allow it to settle before collecting any data.

11. After system has run for the 8 - 12 hours turn the backwash switch to the auto position and the system will run automatically.

Data Collection Set-up

Turbidimeters

To set the high and low range of the ntu use the following procedure:

1. Press the HIGH OUT/LO OUT key until the lower display reads "HI OUT"

2. Use the up and down and side to side arrow keys to raise or lower the value

3. Press the HIGH OUT/LO OUT key until the lower display reads "LO OUT"

4. Use the up and down and side to side arrow keys to raise or lower the value

5. Press ENTER to enter the values. The lower display will read ENTRY OK to confirm the entry.

6. If the lower display readout flashes "TOO HI" refer to the Great Lakes Manual pages 30-31 and follow the instructions for setting the range.
Refer to the Great Lakes Instruments manual pages 30-31 for further help.
Teloger Data Logger *Refer to the Telog manual pages 4-11 & 4-12 to set up the recorder channels.*

PRESSURE FILTRATION SYSTEM

The Kinetico Pressure Filtration System involves standard downflow filtration and an upflow backwash through a granular bed application. Filter units are housed in two10-inch diameter fiberglass tanks mounted on a polyurethane-coated, welded steel frame. The filter beds are comprised of Macrolite® with specially made stainless steel distributors. Macrolite is manufactured by Kinetico Incorporated and is exclusively used by Kinetico Incorporated for use in water treatment filtration systems.

The entire system is controlled through a programmable logic controller (PLC) in a central control panel that monitors system performance through various sensors. These sensors consist of various turbidimeters, flow meters and pressure sensors. A lighted display on the control panel indicates the current system operations.

A backwash can be initiated by a specified turbidity in the effluent water supply, pressure drop across the filters, a switchable (on/off) 24 hour timer, or by manual initiation. When a backwash is signaled, the programmable logic controller closes the service water outlet valve. During a backwash cycle, a single tank is backwashed with the other tank providing filtered water to the tank in backwash. The water from the backwash is routed to drain. There are turbidimeters throughout the system, one monitoring the inlet supply stream and another monitoring outlet water quality. The effluent turbidimeter is also used to initiate the backwash process along with controlling and monitoring the rinse water.

FEATURES AND BENEFITS

Fully Automatic Electronic Control and Monitoring System
The system is equipped with a programmable logic controller (PLC) which controls all monitoring and system functions. Through inputs from various turbidimeters, pressure sensors and flow meters, the PLC can determine when a backwash is required.

Compact/Modular Design
All units are of a skid mounted modular design that provides easy on-site installation. Skids are polyurethane-coated welded steel, providing both system stability and corrosion resistance.

Utilizes Macrolite Ceramic Spheres as Filtration Media
Along with superior filtering capability, this media allows flow rates up to 10 gpm per square foot of filter area, while yielding a minimal pressure drop. Its ceramic nature makes Macrolite extremely durable and chemically inert. There is also an advantage to be found in backwashing. Macrolite expands very easily, allowing lower backwash flow rates and an overall lower amount of backwash water to dispose of, further reducing operation and maintenance costs.

4. Settle time. Allows media to settle before beginning a water backwash, so that no media will escape from the top of the tank.

   Time: 1 minute

5. Water backwash. The system uses water from the clean tank to backwash the dirty tank. NOTE: The flow rate should be no higher than 3.5 gpm during this time.

   Time: 20 minutes

6. System returns to service, collecting effluent turbidity data.

ROUTINE MAINTENANCE - GENERAL

1. Fill out log sheet recording such data as, pressures throughout the system, output quality, input quality and backwash frequency. See specific log sheet provided with this manual.

2. Visually check that all manual valves are set to their proper open or closed position in order for the system to operate correctly. You may wish to mark or lock certain valves into their proper position to prevent unauthorized tampering.

3. The turbidimeters should be cleaned every day and when the system diagnostics warn that the system needs cleaning. Instructions to clean the turbidimeter are as follows:

   A. Open the Model 8220 enclosure door to access flow chamber.

   B. Turn the three-way service valve to the CALIBRATION/DRAIN position and use the tubing to drain the flow chamber.

   C. After draining the flow chamber, unscrew and remove flow chamber cover lockring and window to access removable baffle assembly.

   D. Remove baffle assembly. Note that baffle assembly is "keyed" with rod and hole to fit in flow chamber one way only.

   E. Wipe inside surface of flow chamber with a clean, damp cloth.

   F. Rinse baffle assembly with clean water. Wipe off with a clean dry cloth if necessary.

   G. Insert baffle assembly into flow chamber and replace cover, O-ring, window and lockring. Make sure O-ring is properly seated before tightening lockring.

   H. Turn the three-way service valve back to the OPERATE position (arrow towards inlet fitting).

4. Verify sensor and meter are reading correctly by checking with a second hand meter.

LIMITATION OF REMEDIES AND LIABILITY

Buyer's exclusive remedies and Kinetico's total liabilities are expressly limited to the language in Section 2 of this manual. These limitations will survive the expiration of the warranty and guarantees.

SECTION 2

PROCESS GUARANTEE

Subject to the restrictions indicated below, Kinetico Incorporated guaranties the system will meet the design and effluent specifications for a period of five years or 60 months from the completion of installation. This guarantee is subject to the stipulation that the influent to the Kinetico system conforms to the specifications listed in accepted system proposal. Further, this guarantee may only be invoked upon:

The system's failure to meet the specified NTU in five percent or greater of the measurements taken each month by system operators in accordance with the requirements of the state drinking water regulations for filtration systems applied to surface water in effect at the date of purchase, or; the system's failure to remove ninety-nine percent (99%) of all *Giardia Lamblia* cysts.

Kinetico must be contacted by the Buyer in writing ("notice") if it appears that the system is not meeting effluent specifications. Buyer will provide Kinetico with at least sixty (60) days from the date of notice to allow Kinetico to correct the problem. Similarly, Kinetico will have the same period of time, from the date of its knowledge of the test results, to return the system to compliance. The guarantee may only be invoked if Kinetico fails to return the system to compliance within this time frame.

Should Kinetico fail to meet this guarantee, its sole obligation (and Buyer's sole remedy) under this section is to remove the system at its expense and refund the purchase price of the system to the Buyer.

If it is determined that Kinetico or its system is not responsible for the failure to meet the effluent specifications, the Buyer will pay Kinetico for its reasonable costs incurred in investigating and solving the problem.

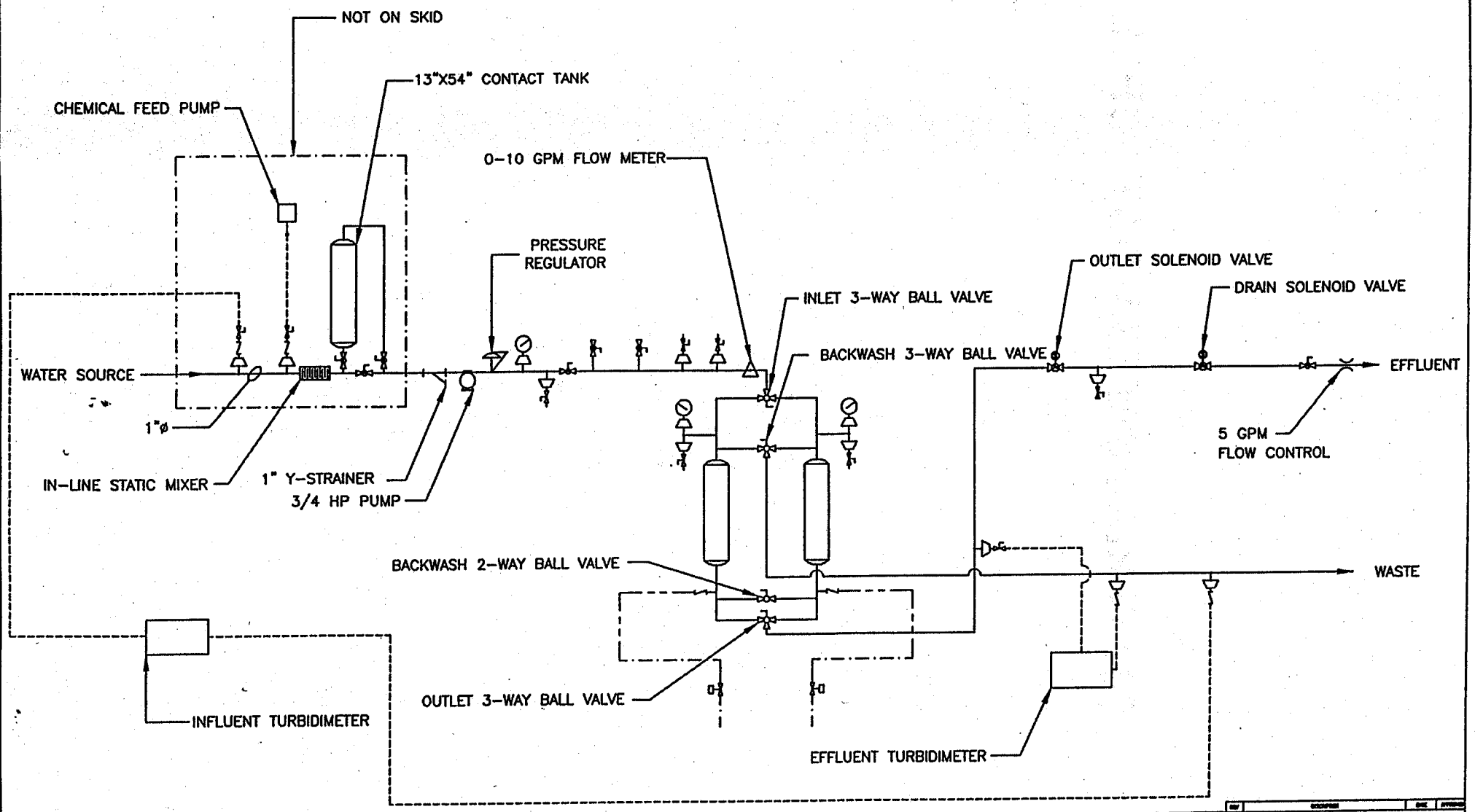
DESIGN GUARANTEE

The Buyer may choose to operate the Kinetico system at a flow rate or loading that is lower than the rated value for the system provided these rates are not below the minimum rates specified in this manual. At a later date, the Buyer may then choose to increase either the flow rate or loading, or both, to the level at which the system is rated. If, within two years of the installation, the customer does choose to effect this increase, Kinetico guarantees that it will, at its own expense, make any changes to the system that are needed for the system to run at specified flow rates and loadings.

NO ENVIRONMENTAL GUARANTEE

Compliance with environmental regulations regarding Buyer's public water system are outside of Kinetico's control and, therefore, the sole responsibility of the Buyer. Kinetico does not guarantee results in terms of achieving or maintaining compliance with any environmental regulations, whether now or hereafter in effect, that may apply to Buyer's public water system. Buyer shall indemnify and hold harmless Kinetico from any and all causes of action relating to Buyer's responsibility.

SECTION 3



COMMUNITY WATER SYSTEMS DIVISION

KINETICO INCORPORATED
CPS100CPT
FLOW SCHEMATIC

C.F.
A
N/A
0

MATERIAL SAFETY DATA SHEET

Kinetico Incorporated
10845 Kinsman Road
Newbury, Ohio 44065

Phone (216) 564-9111

Material Safety Data Sheet

TRADE NAME:
KINETICO MACROLITE ® CERAMIC SPHERES

ISSUED: DECEMBER 14, 1994

1. INGREDIENT

INGREDIENT	C.A.S. NO.	PERCENT
NEPHELINE SYENITE	37244-96-5	85.0 - 95.0
ALUMINUM OXIDE	1344-28-1	1.0 - 15.0
BENTONITE	1302-78-9	0.1 - 15.0

THIS PRODUCT CONTAINS THE FOLLOWING TOXIC CHEMICAL OR CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF TITLE III OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 AND 40 CFR PART 372 ALUMINUM OXIDE.

2. PHYSICAL DATA

BOILING POINT	N/A
VAPOR PRESSURE	N/A
VAPOR DENSITY	N/A
EVAPORATION RATE:	N/A
SOLUBILITY IN WATER	N/A
SP. GRAVITY:	0.4-1.3
PERCENT VOLATILE:	N/A
VOLATILE ORGANICS:	N/D
VOC LESS H2O & EXEMPT SOLVENT	N/D
pH:	SL BASIC
VISCOSITY:	N/A
MELTING POINT	N/D

APPEARANCE AND ODOR: TAUPE SPHERES, NO ODOR

3. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT:	N/A
FLAMMABLE LIMITS - LEL:	N/A
FLAMMABLE LIMITS - UEL:	N/A
AUTOIGNITION TEMPERATURE:	N/D
EXTINGUISHING MEDIA:	N/D

N/A

SPECIAL FIRE FIGHTING PROCEDURES:
NONE

UNUSUAL FIRE AND EXPLOSION HAZARDS:
NONE

Abbreviations: N/D - Not Determined N/A - Not Applicable

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Material Safety Data Sheet

TRADE NAME:
KINETICO MACROLITE ® CERAMIC SPHERES

ISSUED: DECEMBER 14, 1994

4. REACTIVITY DATA

STABILITY: STABLE
INCOMPATIBILITY - MATERIALS TO AVOID:
NONE
HAZARDOUS POLYMERIZATION: Will Not Occur
HAZARDOUS DECOMPOSITION PRODUCTS:
NONE

5. ENVIRONMENTAL INFORMATION

SPILL RESPONSE:
OBSERVE PRECAUTIONS FROM OTHER SECTIONS. USE DUST MASK TO AVOID INHALING DUST. COLLECT SPILLED MATERIAL.

RECOMMENDED DISPOSAL:
DISPOSE OF WASTE IN A SANITARY LANDFILL.

ENVIRONMENTAL DATA:
N/A

6. SUGGESTED FIRST AID

EYE CONTACT:
IMMEDIATELY FLUSH EYES WITH LARGE AMOUNTS OF WATER. CALL A PHYSICIAN.

SKIN CONTACT:
WASH WITH SOAP AND WATER.

INHALATION:
REMOVE PERSON TO FRESH AIR.

IF SWALLOWED:
GIVE ONE TO TWO GLASSES OF WATER. CALL A PHYSICIAN.

7. PRECAUTIONARY INFORMATION

OTHER PRECAUTIONARY INFORMATION:
AVOID EYE CONTACT WITH THE DUST. USE OF EYE PROTECTION SUCH AS CHEMICAL SAFETY GOGGLES IS SUGGESTED. AVOID INHALATION OF DUST. USE RESPIRATORY PROTECTION WHERE LOCAL EXHAUST VENTILATION IS NOT AVAILABLE.

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Material Safety Data Sheet

TRADE NAME:
KINETICO MACROLITE ® CERAMIC SPHERES

ISSUED: DECEMBER 14, 1994

7. PRECAUTIONARY INFORMATION (continued)

EXPOSURE LIMITS

INGREDIENTS	VALUE	UNIT	TYPE	AUTH	SKIN*
NEPHELINE SYENITE.....	NONE	NONE	NONE	NONE	
ALUMINUM OXIDE	10 as dust	mg/m3	TWA	OSHA	
ALUMINUM OXIDE.....	10 as A1	mg/m3	TWA	ACGIH	
BENTONITE.....	NONE	NONE	NONE	NONE	

***SKIN NOTATION:** Listed substances indicated with "Y" under SKIN refer to the potential contribution to the overall exposure by the cutaneous route including mucous membrane and eye, either by airborne or, more particularly, by direct contact with the substance. Vehicles can alter skin absorption.

SOURCE OF EXPOSURE LIMIT DATA:
- ACGIH: American Conference of Governmental Industrial Hygienists
- OSHA: Occupational Safety and Health Administration
- NONE: None Established

8. HEALTH HAZARD DATA

EYE CONTACT:
MAY CAUSE EYE IRRITATION IF DUST GETS INTO EYES.

SKIN CONTACT:
SKIN IRRITATION IS NOT EXPECTED FROM NORMAL USE AND HANDLING.

INHALATION:
BREATHING OF THE DUST MAY CAUSE IRRITATION OF THE RESPIRATORY SYSTEM.

IF SWALLOWED:
MACROLITE BRAND CERAMIC SPHERES ARE EXPECTED TO BE PRACTICALLY NON-TOXIC ORALLY.

SECTION CHANGE DATES

Abbreviations: N/D - Not Determined N/A - Not Applicable

The information on this Data Sheet represents our current data and best opinion as to the proper use in handling of this material under normal conditions. Any use of the material which is not in conformance with this Data Sheet or which involves using the material in combination with any other material or any other process is the responsibility of the user.

APPENDIX B

Record Of Water Quality Data For Park City, Utah

Water Quality Measurements
For Corrosion Control

PARK CITY

9/13/99

Source Name	Source #	Lab Number	Date Collected	pH	Alka-linity (mg/L)	Tot Fe (mg/L)	Tot Mn (µg/L)	Turbid -ity (NTU)	Ca (mg/L)	Total Hard-ness (mg/L)	TDS (mg/L)	Specific Con-ductance µmho/cm	Chloride (mg/L)	Sulfate (mg/L)
SPIRO T BULKHEA	06	U903848	5/4/99											
SPIRO T BULKHEA	06	U900941	2/2/99											
SPIRO T BULKHEA	06	U801870	3/17/98											
SPIRO T BULKHEA	06	U004597	5/1/97											
SPIRO T BULKHEA	06	U002380	3/4/96					1.3			584			301
SPIRO T BULKHEA	06	U033859	9/25/95											
SPIRO T BULKHEA	06	nEN3119	10/31/94											
SPIRO T BULKHEA	06	x744905	2/1/94											
SPIRO T BULKHEA	06	x939506	2/26/93	7.6	140	2.6	30	1.5	110	420	540		1	300
SPIRO T BULKHEA	06	x939501	2/26/93	7.5	140	2.7	5	1	160	540	660		1	450
SPIRO T BULKHEA	06	F92226B	2/18/92	8.2	145	0.23	20		123		568		10	279
SPIRO T BULKHEA	06	F91374C	1/17/91	7.4	141	0.07	10	2	119	680	562		2	284
SPIRO T BULKHEA	06	C904314	7/3/90											
SPIRO T BULKHEA	06	C903999	6/25/90											
SPIRO T BULKHEA	06	C903725	6/18/90											
SPIRO T BULKHEA	06	C903489	6/11/90											
SPIRO T BULKHEA	06	C903235	6/4/90											
SPIRO T BULKHEA	06	C903047	5/29/90											
SPIRO T BULKHEA	06	C902898	5/21/90											
SPIRO T BULKHEA	06	C902699	5/14/90											
SPIRO T BULKHEA	06	C902495	5/7/90											
SPIRO T BULKHEA	06	C902215	4/30/90											
SPIRO T BULKHEA	06	C902038	4/23/90											
SPIRO T BULKHEA	06	C901916	4/16/90											
		Recommended Limit :				0.3	50	5.0		400	500		250	250

Source Name	Source #	Lab Number	Date Collected	pH	Alkalinity (mg/L)	Tot Fe (mg/L)	Tot Mn (µg/L)	Turbidity (NTU)	Ca (mg/L)	Total Hardness (mg/L)	TDS (mg/L)	Specific Conductance µmho/cm	Chloride (mg/L)	Sulfate (mg/L)
SPIRO T BULKHEA	06	C901728	4/9/90											
SPIRO T BULKHEA	06	C901579	4/2/90											
SPIRO T BULKHEA	06	F892317	10/13/89	7.4	152	0.21	10	1	106	445	520		4	260
SPIRO T BULKHEA	06	F875154	11/6/87	7.8	141	0.19	10	1.9	114	463	570		5	310
SPIRO T BULKHEA	06	C823620	7/21/82					2.1						
SPIRO T BULKHEA	06	C815666	9/25/81											
SPIRO T BULKHEA	06	C814945	8/21/81	7.7	141	0.34	25	4	116	460	632	825	4	300
SPIRO T BULKHEA	06	F802148	8/29/80											
		Recommended Limit :				0.3	50	5.0		400	500		250	250

Follow Up on Inorganic Chemical Violations (Form 1)

13-Sep-99

System Number	Date Collected	Source Number	Source Name	Lab Number	Total Arsenic (µg/L)	Total Antimony (µg/L)	Beryllium (µg/L)	Total Cadmium (µg/L)	Cyanide (µg/L)	Turbidity (NTU)	Dissolved Iron (µg/L	Total Iron (mg/L)	Total Managanese (µg/L)
22011	5/4/99	06	SPIRO T BULKHEA	U903848		12							
22011	2/2/99	06	SPIRO T BULKHEA	U900941									
22011	3/17/98	06	SPIRO T BULKHEA	U801870									
22011	5/1/97	06	SPIRO T BULKHEA	U004597									
22011	3/4/96	06	SPIRO T BULKHEA	U002380	60	6	1	< 1	2	1.3			
22011	9/25/95	06	SPIRO T BULKHEA	U033859									
22011	10/31/94	06	SPIRO T BULKHEA	nEN3119									
22011	2/1/94	06	SPIRO T BULKHEA	x744905									
22011	2/26/93	06	SPIRO T BULKHEA	x939506	75	6	4	< 4	5	1.5		2.6	30
22011	2/26/93	06	SPIRO T BULKHEA	x939501	26	<100	5	< 4	5	1		2.7	5
22011	2/18/92	06	SPIRO T BULKHEA	F92226B	59			< 24				0.2	20
22011	1/17/91	06	SPIRO T BULKHEA	F91374C	62			5		2		0.07	10
22011	7/3/90	06	SPIRO T BULKHEA	C904314	225								
22011	6/25/90	06	SPIRO T BULKHEA	C903999	65								
22011	6/18/90	06	SPIRO T BULKHEA	C903725	90								
22011	6/11/90	06	SPIRO T BULKHEA	C903489	70								
22011	6/4/90	06	SPIRO T BULKHEA	C903235	50								
22011	5/29/90	06	SPIRO T BULKHEA	C903047	75								
22011	5/21/90	06	SPIRO T BULKHEA	C902898	95								
22011	5/14/90	06	SPIRO T BULKHEA	C902699	110								
22011	5/7/90	06	SPIRO T BULKHEA	C902495	10								
22011	4/30/90	06	SPIRO T BULKHEA	C902215	80								
22011	4/23/90	06	SPIRO T BULKHEA	C902038	80								
22011	4/16/90	06	SPIRO T BULKHEA	C901916	70								
22011	4/9/90	06	SPIRO T BULKHEA	C901728	< 5								
22011	4/2/90	06	SPIRO T BULKHEA	C901579	80								
22011	10/13/89	06	SPIRO T BULKHEA	F892317	< 20			< 1		1	<30	0.2	10
22011	11/6/87	06	SPIRO T BULKHEA	F875154	54			1		1.9	60	0.2	10
Primary or secondary drinking water limit :					50	6	4	5	200	5	300	0.3	50

System Number	Date Collected	Source Number	Source Name	Lab Number	Total Arsenic (µg/L)	Total Antimony (µg/L)	Beryllium (µg/L)	Total Cadmium (µg/L)	Cyanide (µg/L)	Turbidity (NTU)	Dissolved Iron (µg/L	Total Iron (mg/L)	Total Managanese (µg/L)
22011	7/21/82	06	SPIRO T BULKHEA	C823620	60					2.1			
22011	9/25/81	06	SPIRO T BULKHEA	C815666	55								
22011	8/21/81	06	SPIRO T BULKHEA	C814945	75			< 1		4		0.3	25
22011	8/29/80	06	SPIRO T BULKHEA	F802148	4								
Primary or secondary drinking water limit :					50	6	4	5	200	5	300	0.3	50

Follow Up on Inorganic Chemical Violations (Form 2)

PARK CITY

13-Sep-99

System Number	Date Collected	Source Number	Source Name	Lab Number	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Total Mercury (µg/L)	Dissolved Selenium (µg/L)	Total Selenium (µg/L)	Sulfate (mg/L)	TDS (mg/L)	Thallium (µg/L)
22011	5/4/99	06	SPIRO T BULKHEA	U903848								
22011	2/2/99	06	SPIRO T BULKHEA	U900941		0.2						
22011	3/17/98	06	SPIRO T BULKHEA	U801870		0.1						
22011	5/1/97	06	SPIRO T BULKHEA	U004597		0.16						
22011	3/4/96	06	SPIRO T BULKHEA	U002380	< 0.02	< 0.02	< 0.2		< 2	301	584	6
22011	9/25/95	06	SPIRO T BULKHEA	U033859		8.15						
22011	10/31/94	06	SPIRO T BULKHEA	nEN3119		0.05						
22011	2/1/94	06	SPIRO T BULKHEA	x744905		0.05						
22011	2/26/93	06	SPIRO T BULKHEA	x939506	< 0.01	0.04	< 1		< 5	300	540	< 2
22011	2/26/93	06	SPIRO T BULKHEA	x939501	< 0.01	0.86	< 1		< 5	450	660	< 500
22011	2/18/92	06	SPIRO T BULKHEA	F92226B		< 0.5	< 1.1		2	279	568	
22011	1/17/91	06	SPIRO T BULKHEA	F91374C	< 0.02	0.08	< 0.2			284	562	
22011	7/3/90	06	SPIRO T BULKHEA	C904314								
22011	6/25/90	06	SPIRO T BULKHEA	C903999								
22011	6/18/90	06	SPIRO T BULKHEA	C903725								
22011	6/11/90	06	SPIRO T BULKHEA	C903489								
22011	6/4/90	06	SPIRO T BULKHEA	C903235								
22011	5/29/90	06	SPIRO T BULKHEA	C903047								
22011	5/21/90	06	SPIRO T BULKHEA	C902898								
22011	5/14/90	06	SPIRO T BULKHEA	C902699								
22011	5/7/90	06	SPIRO T BULKHEA	C902495								
22011	4/30/90	06	SPIRO T BULKHEA	C902215								
22011	4/23/90	06	SPIRO T BULKHEA	C902038								
22011	4/16/90	06	SPIRO T BULKHEA	C901916								
22011	4/9/90	06	SPIRO T BULKHEA	C901728								
Primary or secondary drinking water limit :					1	10	2	50	50	500	1000	2

System Number	Date Collected	Source Number	Source Name	Lab Number	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Total Mercury (µg/L)	Dissolved Selenium (µg/L)	Total Selenium (µg/L)	Sulfate (mg/L)	TDS (mg/L)	Thallium (µg/L)
22011	4/2/90	06	SPIRO T BULKHEA	C901579								
22011	10/13/89	06	SPIRO T BULKHEA	F892317	<0.02	0.09	< 0.2		< 1	260	520	
22011	11/6/87	06	SPIRO T BULKHEA	F875154	<0.02	0.12	< 0.2		< 1	310	570	
22011	7/21/82	06	SPIRO T BULKHEA	C823620								
22011	9/25/81	06	SPIRO T BULKHEA	C815666								
22011	8/21/81	06	SPIRO T BULKHEA	C814945	<0.01	0.05	< 0.1		< 1	300	632	
22011	8/29/80	06	SPIRO T BULKHEA	F802148								
Primary or secondary drinking water limit :					1	10	2	50	50	500	1000	2

APPENDIX C

Time Line Chart

ETV TIME LINE

Kinetico Coagulation and Filtration System

ACTIVITY	Week 1	Week 2	Week 3	Week 4	Week 5
Installation of Kinetico CPS100CPT Pilot Testing Unit COA & Kinetico	→				
Initial Operations COA		→			
ETV Performance Runs COA			→	→	
Shut Down COA					→

APPENDIX D

Sample Log Book

WATER QUALITY PARAMETERS – DAILY
KINETICO, INC.
(measured on-site)

										From Lab			
Date	Time	Coagulation Chemistry	Water Sample	Temperature	pH	Continuous Turbidity (NTU)	Bench Turbidity (NTU)	Dissolved Oxygen (mg/L)	True Color (Weekly)	Alkalinity (from Lab) (mg/L)	Arsenic (mg/L) As (III)	Arsenic (mg/L) As (V)	Technician Initials
			Raw Feedwater										
			Clarified Water										
			Filtrate										
			Raw Feedwater										
			Clarified Water										
			Filtrate										
			Raw Feedwater										
			Clarified Water										
			Filtrate										
			Raw Feedwater										
			Clarified Water										
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			Filtrate										
			Raw Feedwater										
			Clarified Water										
			Filtrate										
			Raw Feedwater										
			Clarified Water										
			Filtrate										
			Raw Feedwater										
			Clarified Water										
			Filtrate										

OPERATING DATA LOG
KINETICO, INC.

Date	Time	Run Time (Hours) Filter		Flow Rate (gpm)		Filtrate Production ($gpm/ft^2/min$)e*	Pressure (psi)		ΔP (psi)	Coagulation Chemical Dosage	Air Sparge	Backwash Volume (gal)	Electric Power (kwh)	Notes	Technician Initials
		A	B	Feedwater	Filtrate		In	Out							

* Coagulation Chemical

Type: _____

Supplier: _____

Strength: _____

Dilution: _____

WATER QUALITY PARAMETERS – WEEKLY
KINETICO, INC.
(Measured by Lab)

Date	Time	Water Sample	Hardness (mg/L)	TOC (mg/L)	UV254 Absorbance	Aluminun (mg/L)	Iron (mg/L)	Manganese (mg/L)	Sulfate (mg/L)	Algae	Additional Notes	Technician Name
		Raw Feedwater										
		Clarified Water										
		Filtrate										
		Raw Feedwater										
		Clarified Water										
		Filtrate										
		Raw Feedwater										
		Clarified Water										
		Filtrate										
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		Filtrate										
		Raw Feedwater										
		Clarified Water										
		Filtrate										
		Raw Feedwater										
		Clarified Water										
		Filtrate										

TASK 4 - WATER QUALITY PARAMETERS
LOG SHEET
KINETICO ETV – TEST SITE

Parameter	Units	Date	Time	Reading			FTO Initials
				Feed Water	Clarified Water	Filtrate	
Temperature							
pH							
Turbidity							
Dissolved Oxygen							
True Color							

TASK 4 - WATER QUALITY SAMPLING SCHEDULE
LOG SHEET
KINETICO ETV – TEST SITE
1 Sample During Task 4

Parameter	Units	Date	Time	Sampling			FTO Initials
				Feed Water	Clarified Water	Filtrate	
Total Alkalinity							
Hardness							
Algae							
TOC							
UV 254 Absorbance							
p							
Iron							
Manganese							
Arsenic III							
Arsenic V							

VISITOR LOG
KINETICO ETV – TEST SITE

DATE	TIME IN	TIME OUT	NAME	ORGANIZATION	REASON FOR VISIT	FTO Initials

APPENDIX E

Utah Department of Health
Division of Epidemiology & Laboratory Services QA/QC Manual

November 1999

LARRY P. SCANLAN

Education

University of Denver
1970 B.S. Chemistry

Employment

Environmental Scientist III	6 years (to present) with Utah Dept. of Environmental Quality, Division of Drinking Water, Salt Lake City, Utah.
Chemist IV	1 year with DataChem Laboratories as a chemist IV (most senior non-supervisory chemist), Salt Lake City, Utah.
Environmental Chemist	1 year with Richards Industrial Microbiology Laboratories, Inc., Pleasant Grove, Utah
Water Quality Director	3 years with Central Utah Water Conservancy District, Orem, Utah.
Water Quality Specialist	14 years with Utah Dept. of Environmental Quality, Division of Drinking Water, Salt Lake City, Utah.
Research Chemist	4 years with U.S. Geological Survey, Water Resources Division, Salt Lake City, Utah and Denver, Colorado.

Awards

- US Environmental Protection Agency Certificate of Appreciation for co-authoring Utah's Cryptosporidium Guidance Document which received acclaim from EPA Region VIII and other states, April 25, 1995.
- Commendation from Utah Safe Drinking Water Committee, January 28, 1988 for five years of managing Utah's mandatory operator certification program with "vision, persistence, and dedication."

Professional Activities

Member	American Water Works Association Internet Advisory Board, 1998-present (see *http://www.awwa.org*)
Member	American Water Works Association Technical Advisory Workgroup (TAW) on arsenic, 1994-present
Chairman	American Water Works Association, Intermountain Section Technical Program 1994 - Sun Valley, Idaho 1995 - Park City, Utah 1996 - Idaho Falls, Idaho 1986 - Park City, Utah
Member	American Water Works Association Research Foundation Project Advisory Committee on Innovative Treatment Technology for Small Water Systems, 1989-91
Chairman	American Water Works Association, Intermountain Section, 1988-89
Member	19th Edition of Standard Methods, Organic Contaminants in Water Committee, 1992-1997
Member	18th Edition of Standard Methods, Particle Counting Committee, 1989-91
Member	17th Edition of Standard Methods, Calcium Carbonate Committee, 1985-88
Member	American Water Works Association Coagulation and Filtration Committee, 1983-1989
Member	American Water Works Association, 1975-present
Member	American Chemical Society, 1970-present

Registration

Registered Environmental Health Scientist in state of Utah, #367, issued 1978, current 1999.
Certified Utah Water Treatment Plant Operator, Grade 4 (highest Utah classification), #88528, issued 1988.
Certified Utah Distribution System Operator, Grade 4 (highest Utah classification), #88528 issued 1988.

Publications

Scanlan, L.P., *Arsenic Occurrence and Treatment Issues from a State Perspective*, *Proceedings of the Inorganic Contaminants Workshop, American Water Works Association*, Albuquerque, New Mexico, February 27-29, 2000.

Scanlan, L.P. *A Critical Look at Arsenic Occurrence Estimates, In progress December 1999. To be submitted to the Journal of the American Water Works Association* for publication.

Gritton, Kenneth S., Higby, L., Scanlan, L.P., et. al. *Improved Process For Dissolved Arsenic Removal, 42nd Annual Conference of the Intermountain Section of the American Water Works Association*, St. George, Utah, September 15, 1999.

Scanlan, L.P. *New Regulations: Radon and Arsenic Occurrence in Utah, presentation to the 42nd Annual Conference of the Intermountain Section of the American Water Works Association*, St. George, Utah, September 15, 1999.

Lewis, D. R., Scanlan, L.P. et.al., *The Feasibility of Epidemiologic Studies of Waterborne Arsenic, Journal of Environmental Health*, V60, No. 9, p. 14, May 1998.

Topham, R.J., Scanlan, L.P., *A New Paradigm in Environmental Database Systems, proceedings of the 1996 American Water Works Association Computer Conference*, Chicago, Illinois, April 22, 1996, pp. 193-199.

Scanlan, L.P. *Arsenic Removal in the 1990's: Full Scale Experience from Park City, Utah," Larry. Scanlan and Jerry W. Gibbs, P.E., Proceedings of the American Water Works Associations Water Quality Technology Conference*, San Franciso, California, p. 609, November 6-10, 1994.

Scanlan, L..P. *Local and Federal Surveillance for Water Supply Managers Using PCs, presented to the first American Water Works Association Computers and Automation in the Water Industry Conference*, Denver, Colorado, April 3, 1989.

Scanlan, L.P., Talbot, S.H. *A Primer on Computer Telecommunications and Hardware, presented to the first AWWA Computers and Automation in the Water Industry Conference*, Denver, Colorado, April 4, 1989.

Scanlan, L.P. *Disinfection, Know the Alternatives, presented to the Annual Meeting of the National Rural Water Association*, Omaha, NB, October 27, 1988.

Scanlan, L.P., *Lead in Drinking Water - A System's Problem In A Customer's Home, presentation to the Annual Meeting of the National Rural Water Association*, Charleston, SC, October 21, 1987.

Scanlan, L. P., *Case Histories in Legionella Eradication: A Chemical Perspective, Proceedings of the American Water Works Associations Water Quality Technology Conference*, Baltimore, MD, November 17, 1987.

Technical and Management Personnel Involved in Testing of Environmental Samples For Arsenic And Other Metals:

Charles Brokopp, Dr. P.H., Director of the Division of Epidemiology and Laboratory Services:

Dr. Brokopp is the director of the Utah Health Department Laboratory and has the ultimate authority for all testing performed at this site.

Doctor of Public Health: University of North Carolina, School of Public Health
Bachelor of Science: Medical Technology
Bachelor of Science: Biology-Zoology

From 1994 to the present, Dr. Brokopp has directed the Division of Epidemiology and Laboratory Services, one of the four divisions within the Utah Department of Health. From 1990 to 1994 he was director of the Public Health Laboratories, Oregon Health Division. From 1988 to 1990 he served as Chief of the Bureau of Laboratories, Idaho Department of Health and Welfare. From 1980 to 1988, Dr. Brokopp was the State Epidemiologist, Idaho Department of Health and Welfare.

Wayne Pierce, MPA, Director of the Bureau of Environmental Chemistry and Toxicology, Division of Epidemiology and Laboratory Services:

Mr. Pierce directs the environmental chemistry testing and forensic toxicology services of the Utah State Health Laboratory. He also approves the quality assurance activities performed to assure valid and documented measurements are performed by the laboratory analysts. Mr. Pierce received a Bachelor of Science in Chemistry, attended graduate school in chemistry and later earned a Masters of Public Administration degree. He is a Diplomate of the American Board of Forensic Toxicology. Mr. Pierce has served in his current responsibilities since 1983.

Zenon Pawlak, PhD, Chief of the Metals Section:

Dr. Pawlak received a PhD in Chemistry and has supervised the Metals Section of the Utah State Health Laboratory since 1990. From 1989 to 1990, he worked as an environmental chemist at Data Chem Laboratories in Salt Lake City, Utah. Prior to 1989 he performed research in Chemistry at Brigham Young University.

Gabriela Kuswik-Rabiega, PhD, Chemist III in the Metals Section:

Since 1993, Dr. Rabiega has performed testing of environmental samples for trace metals using ICP, ICP/MS, Atomic Absorption using Graphite Furnace and Cold Vapor Atomic Absorption. She has also performed radiochemistry tests on environmental samples during this same period. Dr. Rabiega has a PhD in Chemistry. Prior to her current employment, she performed research in chemistry, biochemistry and radiobiology at the University of Utah.

Alia Rauf, MS, Chemist III in the Metals Section:

Since 1994, Ms. Rauf has performed testing for trace metals using Graphite Furnace Atomic Absorption, ICP, ICP/MS, and Cold Vapor Atomic Absorption. She has also performed sample preparation techniques that include TCLP extraction for hazardous waste analysis and various digestion methods of samples prior to instrumental analysis. Ms. Rauf has a Masters of Science in Chemistry. Prior to her current employment, she worked for five years as an environmental chemist at Chem Tech Ford in Salt Lake City, Utah.

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Utah State Health Laboratory
Bureau of Laboratory Improvement

ON-SITE EVALUATION

UTAH
DEPARTMENT OF HEALTH
DIVISION OF LABORATORY SERVICES

SALT LAKE CITY, UTAH
APRIL 8-9, 1997

Region VIII
999 18th Street, Suite 500
Denver, Colorado 80202-2466

TECHNICAL AND MANAGEMENT SERVICES
DIVISION

UTAH DEPARTMENT OF HEALTH
DIVISION OF LABORATORY SERVICES

AUDIT REPORT

FACILITY	State of Utah Department of Health Division of Laboratory Services 46 N. Medical Drive Salt Lake City, Utah 84113-1105
RESPONSIBLE PERSON	Mr. Craig Odekirk, Chief Quality Assurance Section
DATE OF AUDIT	April 8-9, 1997
AUDIT TEAM	James Gindelberger, QA Chemist U.S. EPA, Region VIII Allan Curtis, Organic Chemist U.S. EPA, Region VIII Gary Perryman, Inorganic Chemist U.S. EPA, Region VIII

I SUMMARY

An on-site audit of the Utah Department of Health, Division of Laboratory Services was conducted to determine the laboratory's compliance with the primacy requirements as stated in 40 CFR Section 142.10. The focus of the audit was to determine the laboratory's compliance with the laboratory certification requirements for the Safe Drinking Water Act (SDWA) analyses.

The individual auditors' reports contain specific findings or recommendations and appear in the Findings sections (parts A, B and C) of this report. The audit findings are summarized below. Certification of the State of Utah Department of Health, Division of Laboratory Services is recommended for the following parameters:

INORGANIC ANALYTES (16)

Antimony	Arsenic	Barium	Beryllium
Cadmium	Chromium	Copper	Cyanide
Fluoride	Lead	Mercury	Nickel
Nitrate	Nitrite	Selenium	Thallium

VOLATILES (21)

Benzene
Carbon Tetrachloride
Chlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
1,2-Dichloroethane
1,1-Dichloroethylene
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Dichloromethane
1,2-Dichloropropane
Ethylbenzene
Styrene
Tetrachloroethylene
Toluene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Vinyl Chloride
Total Xylenes

TRIHALOMETHANES (4)

Bromodichloromethane
Bromoform
Chlorodibromomethane
Chloroform

MISCELLANEOUS (1)

PCBs

PESTICIDES (12)

Alachlor
Atrazine
Chlordane
Endrin
Heptachlor
Heptachlor Epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Lindane
Methoxychlor
Simazine
Toxaphene

HERBICIDES (7)

2,4-D
2,4,5-TP (Silvex)
Dalapon
Dinoseb
Pentachlorophenol
Picloram
Dicamba

CARBAMATES (5)

Carbofuran
Oxamyl (Vydate)
Aldicarb
Aldicarb Sulfoxide
Aldicarb Sulfone

POLYNUCLEAR AROMATIC HYDROCARBONS (1)

Benzo(a)Pyrene

ADIPATES/PHTHALATES (2)

Bis(2-ethylhexyl)adipate
Bis(2-ethylhexyl)phthalate

The expiration date of this certification is April 9, 2000.

Division of Epidemiology and Laboratory Services

QUALITY ASSURANCE PROGRAM PLAN

Revised July 1999

Approved By C. Brokopp

Charles D. Brokopp Dr.PH
Director

2.0 Quality Assurance Program Plan Identification Form

Document Title:	The Quality Assurance Program Plan for the Division of Laboratory Services
Organization Title:	Division of Laboratory Services
Address:	Division of Laboratory Services 46 Medical Drive Salt Lake City, Utah 84113-1105
Responsible Official:	Charles Brokopp, Dr. P.H. Phone Number (801) 584-8406
Q.A. Officer:	Craig D. Odekirk Phone Number (801) 584-8468
Q.A. Coordinator	David Mendenhall Phone Number (801) 584-8470

Plan Coverage: This is a document describing the State of Utah's Division of Epidemiology and Laboratory Services Quality Assurance Program Plan. The plan covers all environmental chemistry and microbiology data generated from sampling done in the State of Utah and submitted to the Division for analysis. The coverage in this plan will be as resources and priorities allow.

Approval for Agency:

Name:	Charles Brokopp, Dr. P.H.
Title:	Director Division of Epidemiology and Laboratory Services
Signature:	_____ Date: _____

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3.0

Introduction and Definitions

3.0 Introduction and Definitions

3.1 EPA policy requires participation in a centrally managed quality assurance program by all laboratories whose monitoring and measurement efforts are supported or mandated through contracts, grants, regulations, or other formalized agreements with the EPA. To implement EPA policy, the Division of Laboratory Services has prepared a Quality Assurance Program Plan covering all monitoring which generates and processes environmental data for State use.

3.2 The Division of Laboratory Services does no sampling; therefore, this document will be confined to the quality assurance of sample handling, analysis, and data treatment from the time samples are submitted for analysis until the results are forwarded to the using organization requesting the analysis.

3.3 Specific requirements for Safety and Waste Disposal are found in the respective Division manuals.

3.4 Definitions

Standards Terminology:

Neat Standard Material - A pure form of a single analyte. May be purchased from any supplier but must be at least 96% pure. Example: Ultra high purity grade chemicals.

Stock Standard Solution - A concentrated material containing a verified standard that is a method analyte, or a concentrated solution of a single analyte prepared in the laboratory from a Neat Standard Material. Examples: Barium at 1000mg/l or Benzene at 1000μg/l.

Primary Standard Solution - A solution of several analytes prepared in the laboratory from the Stock Standard Solution or purchased from an outside source and diluted as needed to prepare Working Standard Solutions and other needed analyte solutions.

Working Standard Solutions - Solutions prepared from the Primary Dilution Standard Solution or Stock Standard Solution at concentration levels applicable for the linear range of the instrumentation. The Working Standard Solutions are used to calibrate the instrument's response with respect to analyte concentration. The Working Standard Solutions or Primary Standard Solutions are verified, when appropriate with a Reference Material before use.

Verification Terminology:

Reference Material - Any outside source of a known concentration other than the source which was used to prepare the Working Standard Solutions. The Reference Material is purchased from single compounds or in purchased solution. If purchased in solution, document the neat material or single compounds are from different lot sources than were used to prepare the Working Standard Solutions. Currently, the "certified solutions" some suppliers are selling may come from a common lot source sold by another supplier. Verify or request lot numbers and neat sources when purchasing materials.

Example: Purchase your Stock or Primary Standard Solutions from HACH supplier. Verify with a Stock Standard from ERA supplier. Check with ERA and HACH for sources of their Neat stocks.

*** Must verify all Standards and Spikes before use in the laboratory. Document the verification with (date/file/analyst), the verifications should be documented in the Standard Preparation Logbook.**

Accuracy Terminology:

Laboratory Spiked Blank (LSB) or Laboratory Fortified Blank (LFB) - An aliquot of reagent water/solvent to which known quantities of the method analytes are added in the laboratory. The LSB is analyzed exactly like a sample (including digestion, extraction, etc.), and its purpose is to determine whether methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

Laboratory Spiked Sample Matrix (LSM) or Laboratory Fortified Sample Matrix (LFM) - An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LSM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate sample aliquot and the measured values in the LSM corrected for background concentrations.

Precision Terminology:

Laboratory Spiked Blank (LSB) or (LFB) and the Laboratory Spiked Blank Duplicate (LSBD) or (LFBD) - Separate aliquots of reagent water to which known amounts of the method analytes are added in the laboratory. The LSB and LSBD are spiked and analyzed exactly like a sample and their purpose is to give a measure of precision

associated with laboratory procedures, not the sample collection, preservation, or storage procedures.

Miscellaneous Terminology:

Laboratory Reagent Blank (LRB) - An aliquot of analyte-free water treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. A LRB is analyzed with each analytical batch to determine if contamination is present in the laboratory.

Instrument Blank (IB) - The solvent system used for preparing standards analyzed on the instrument exactly as the samples would be. The instrument blank does not go through any stages of the Method, used only to determine problems with the instrument.

Column Check Standard (CCS) - The elution pattern must be reconfirmed with a column check of standard compounds after activating or deactivating a batch of adsorbent. These compounds must be representative of each elution fraction. Recovery as accuracy specified in the methods is considered acceptable column check.

Internal Standard (IS-Organics only) - A pure analyte(s) added to a solution in known amount(s) and used to measure the relative responses of other method analytes and surrogates that are components of the same solution. The internal standard must be an analyte that is not found in the sample. The Internal Standard is used to monitor instrument deviations.

Surrogate Standards-(SS-Organics only) - Compounds which are similar to analytes of interest in chemical composition, extraction, and chromatography, but are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogates. The Surrogate recoveries are used to monitor method extractions for each sample analyzed.

Laboratory Performance Checks (LPC)- A solution of various analytes used to check the gas chromatographic column performance and/or the instrument sensitivity.

Reporting Terminology:

Minimum Detectable Limit (MDL) - As defined at 40 CFR §136 Appendix B.

Minimum Reportable Limit (MRL) - The lowest concentration which will be indicated on a final analytical report for a particular method and matrix. All results found below the MRL shall be reported as less than the MRL. The MRL can be raised to account for matrix effects or dilutions if necessary. If the MRL is changed from the standard MRL for a particular analyte, an explanatory comment must be included in the final report.

4.0

Program Description

4.0 Program Description

Our Laboratory supports several programs of the Department Environmental Quality, State of Utah by analyzing a variety of samples.

1. Division of Water Quality

Analysis of environmental water for content of metals, inorganic, organic analytes, physical parameters and radiologicals (Uranium, Gross Alpha + Beta, Radium-226, Radium-228 and Radon-222). Samples are obtained from lakes, streams, underground water and industrial effluents. Laboratory Methodology needs to be consistent with requirements of the Clean Water Act (CWA).

2. Division of Drinking Water/Sanitation

Analysis of drinking water samples for content of metals, inorganic, organic analytes and physical parameters and radiologicals (Uranium, Gross Alpha + Beta, Radium-226, Radium-228 and Radon-222). Methodology needs to be consistent with the Safe Drinking Water Act(SDWA).

3. Division of Solid and Hazardous Waste

Support for hazardous waste site identification and characterization. Perform oversight monitoring for Treatment Storage and Disposal Facilities (TSDF) permits. Methodology involves SW-846 procedures for listed hazardous wastes and characteristics of hazardous waste for organics, metals and physical characteristics.

4. Division of Air Quality

Analysis of lead in air filters; analysis of air samples for aldehydes and ketones, PM-10s, and reactive acidic and basic gases.

5. Division of Emergency Response and Remediation

Identification and characterization of unknown materials for the presence of hazardous

compounds (organic and inorganic). Detection underground contamination from.Superfund sites and Underground Storage Tanks.

6. Division of Radiation Control

Analysis of environmental water and soil samples for Uranium, Gross Alpha + Beta, Radium-226 and Radium-228. Determination of gamma radiation from Uranium mine tailings, low level radioactive disposal facilities and radioactive material spills.

Individual environmental monitoring programs and specific description of each is determined by personnel within the Divisions listed above.

5.0

Program Organization and Responsibility

5.0 Program Organization and Responsibility

5.1 Laboratory Director

The QA/QC responsibilities of the director:

1. Implements the QA program within the laboratory and has the ultimate responsibility for the QA program.
2. Gives final approval to the laboratory's Quality Assurance program plan.
3. May suspend testing when documented quality for a method is in question.

5.2 Bureau Director/Assistant Director

The QA/QC responsibilities of the director and assistant director:

1. Maintain current information on regulations and approved methodologies for the various programs that the laboratory serves.
2. Guide implementation of the QA program within the bureau.
3. Focal point for improvements and changes to the QA program; approve and initiate these changes.
4. May suspend testing when a method is out of control.
5. The intermediary between the QA officer and the section chief/analyst in QA/QC. Receive copies of written corrective action.
6. Review hard copies of drinking water reports for completeness and mark these reports according to whether any regulated contaminants exceed maximum contaminant levels.
7. Serves on the QA team.

5.3 Section Chief

The QA/QC responsibilities of the section chiefs:

1. Must see that each analyst in the section is trained in the QA/QC and analytical methods that are assigned to them.
2. Organizes and schedules the analytical testing program with consideration for sample holding times and using EPA approved methods.
3. Oversee the log-in of all samples and check to see that each sample was logged-in correctly.
4. Ensures compliance with laboratory's QA program and that approved methodology is used within the section.
5. Reviews or sees that the data is reviewed for completeness and that the QC requirements are met.
6. Oversees or performs the review and approval of all analytical data.

7. Initiates corrective action forms as necessary. Reports persistent or recurring out-of-control situations to the bureau or assistant bureau director.
8. Notifies clients of any problems with their samples discovered during the analysis and/or during data verification.
9. Oversees the disposal of samples after the analysis and data review are completed. Ensure that the sample disposal SOP is followed.
10. Oversees the section's instrumentation, helps coordination of repair and maintenance in regards to the production of quality data.
11. Participates in the improvement of the QA/QC program plan.
12. Serves on the QA team.

5.4 Analyst

The QA/QC responsibilities of the Analysts:

1. Participates in the improvement of the QA/QC program plan.
2. Responsible for the implementation the method's quality control.
3. Performs analytical procedures and data recording in accordance with SOPs that have been approved by the section chief.
4. Performs data processing and data verification.
5. Initiates appropriate corrective action for out-of-control situations, such as instrument malfunction, calibration failure, contamination or other non conformance as appropriate. Reports persistent or recurring out-of-control situations to the section chief. Corrective action must be documented on the QA computer program, corrective action form, or through a memo.
6. Writes and revises standard operating procedures (SOP's) as changes in the methods are approved by the section chief.
7. Assists with sample disposal as assigned.
8. Assists in training new staff and in cross training staff.
9. Reports errors with sample log-in and master log to the affected parties and section chief.
10. May be empowered to perform quality assurance activities for which section chiefs have overall responsibility.
11. Performs routine maintenance of instruments, keeps laboratory clean to avoid sample contamination.
12. Actively participates with the section chief in correcting instrument malfunctions.

5.5 QA Officers

1. Serves as an agent for the Laboratory director for all QA activities.
2. Serves as collection agent of information from the regulators, provides the staff with periodic updates. Is a resource for information concerning Federal and State regulations. When requested provides guidance on method development, reporting requirements, and legal defensibility.
3. Manages laboratory participation in EPA certification programs. Coordinates the distribution of EPA performance evaluation (water supply study WS, water pollution study WP) samples. Provides response to certification authorities with respect to any identified problem areas.
4. Suggests modifications to the QA program which could improve our efficiency and quality of our results.
5. Calls attention to newly developed method requirements and monitors their implementation into the existing laboratory procedures.
6. Submits in writing monthly QA Report to Laboratory Director. The monthly report will evaluate QA activities for the month and reports on precision and accuracy of methods plus other significant aspects of quality related activities.
7. When requested assists with the interpretation and resolving of issues on the QA summary or audit report.
8. When called upon, performs comprehensive audits of individual analytical methods from sample receipt to the final report. The results of these audits are used to guide the improvement of laboratory processes. Submits reports of method audits of the laboratory to the laboratory director.
9. Reviews and verifies completion of corrective actions in response to audits and major QA non-compliance issues.
10. Maintains current list of Quality Assurance documents and revisions including SOP's.
11. Provides training on QA requirements and specific topics as requested by the analyst and/or section chief. This may include providing guidelines for QA orientation to newly hired analyst and providing QA review training as needed.
12. Periodic in depth review of analytical data to verify the laboratory is meeting stated Quality Control goals and method requirements.
13. Serves on the QA team and functions as administrator.

5.6 Special Project Coordinator

The QA/QC responsibilities of the special project coordinator:

1. Develops project specific QA to meet project objectives and client needs,

were applicable.

2. Coordinates with section chief and staff within the laboratory to ensure that quality issues are met at all stages of a project.
3. Notifies clients of any problems with their samples discovered during the analysis and/or during data verification.
4. May review data packages for completeness and compliance to client needs.
5. Generates and signs analytical reports, where applicable.
6. May serve on the QA team.

5.7 Sample Receiving

1. Promptly log samples into computer. Maintain a review system to ensure correct entry. Contact the appropriate section chief for assistance as needed, such as non routine samples, rush, and samples from special projects.
2. Notify the section chief or designee of rush, high priority, samples upon arrival in the lab.
3. Deliver to the lab or analyst the samples and a copy of the request forms within 4 hours of receiving them.
4. For chain of custody samples, a copy of the chain of custody form must be given to the analyst or section chief.
5. Must keep the chain of custody refrigerator organized so that samples may be easily retrieved.
6. Samples with very short holding times, 48 hours or less, must be logged in as soon as possible and delivered to the labs within a couple of hours of receiving them. Turbidity, TDS, TSS, and TVS samples fall into this group. BOD sample bottles must be delivered immediately or refrigerated in the sample receiving area.
7. One member serves on the QA team.

5.8 Computer team

1. Whoever makes changes in APPX system will document the program code and will notify all APPX users by E-mail or by other appropriate means.
2. Any APPX changes needed by users must be pre-approved by the bureau director or his designee.
3. Develop standard operating procedure for QC program.
4. Assist in training new analysts. Assist in training analysts when changes are made in the computer programs.

5. Assist analyst and section chief in solving computer program problems.
6. Initiates changes in programs to meet or improve on the overall QC objectives of the laboratory.
7. Write and review procedures for entering QA data and results.

Program organization and responsibility within the Division of Epidemiology and Laboratory Services is shown in Figures 5-1 and 5-2.

Organization and Responsibility
MICROBIOLOGY

10 April, 1997

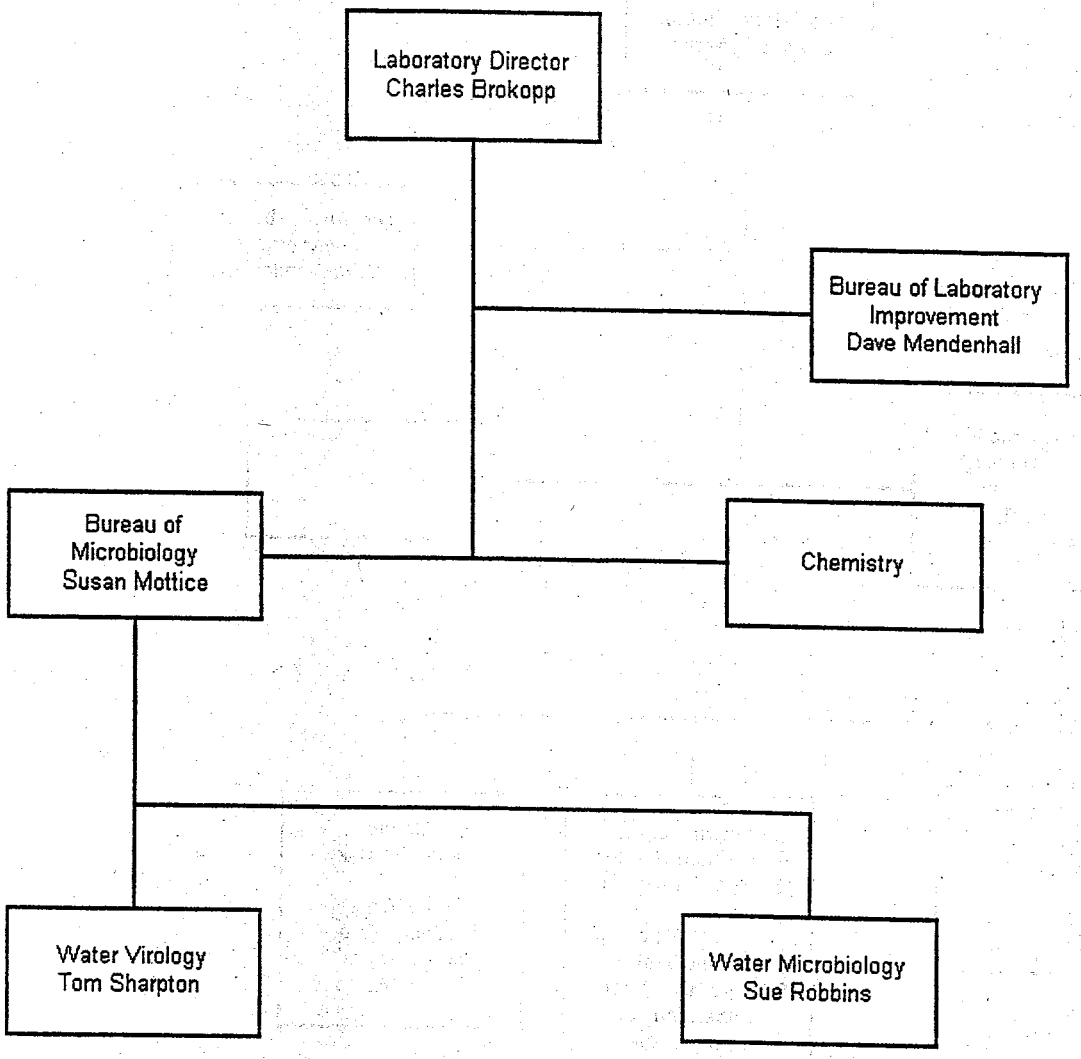

Figure 5-1

Organization and Responsibility
CHEMISTRY
20 October 1999

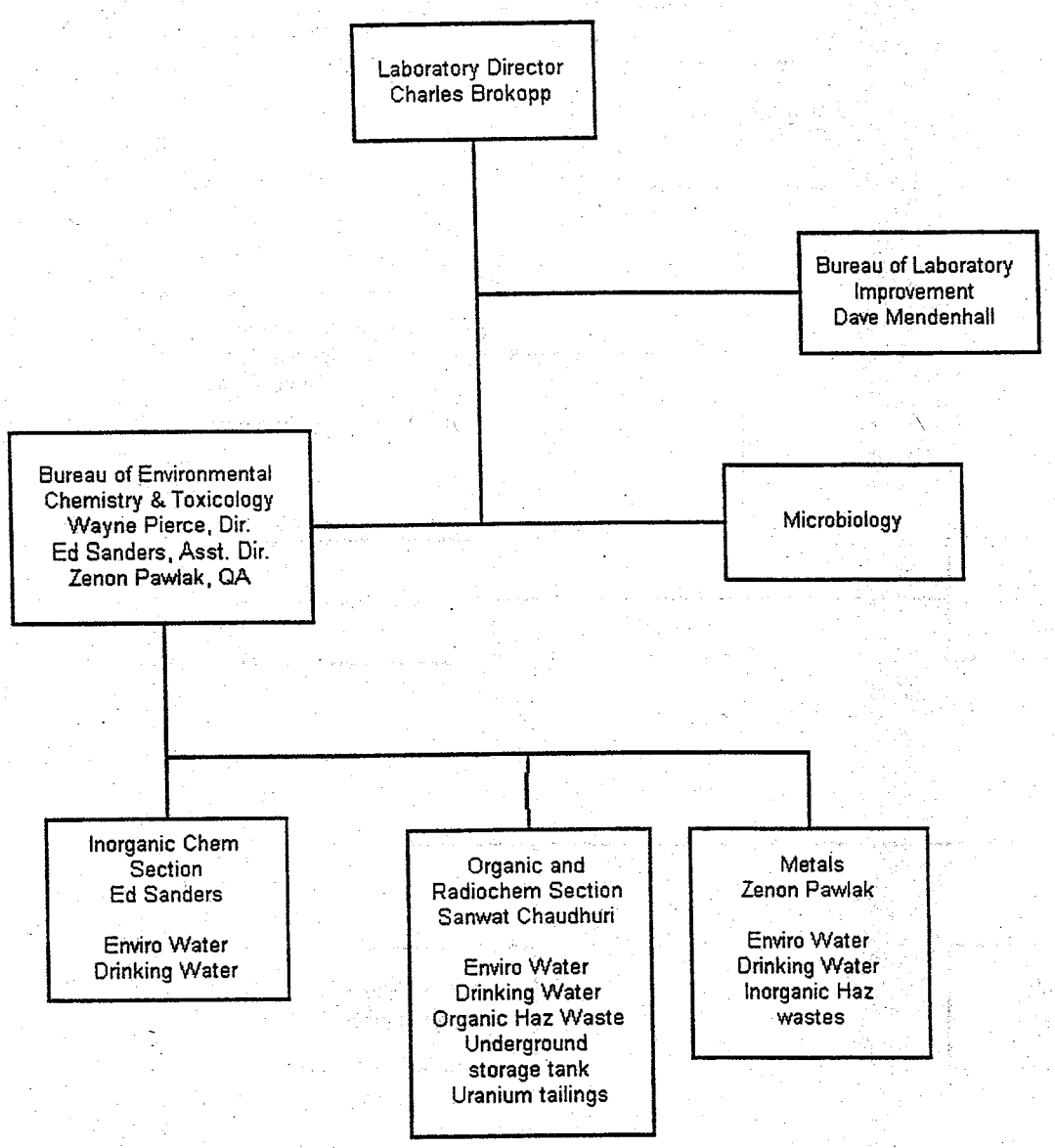

Figure 5-2

6.0

Quality Assurance Objectives for Measurement Data in Terms of Precision, Accuracy, Representativeness and Comparability

6.0 Quality Assurance Objectives for Measurement Data in Terms of Precision, Accuracy, Representativeness and Comparability.

6.1 Each using organization will ensure that their sampling techniques will yield results that are representative of the system being measured. (Specific details of sampling criteria are addressed in their respective Quality Assurance Project Plans).

6.2 All data generated by the Division of Laboratory Services will be expressed in units consistent with the data generated by other laboratories reporting similar analyses to allow comparability of data among organizations.

6.3 Specific objectives for each data quality element (Calibration verification, LSM, LSB, etc.) are described in section 15. Appendix A states reporting limits for nominal cases. Appendix A also lists overall precision and accuracy goals for some analyses. Where provided these statements are based on the historical performance of data quality indicators (LSM and LSM\D recoveries).

7.0

Sampling Procedures

7.0 Sampling, Documentation, and Sample Acceptance

7.1 QA/QC begins with the creation of a sample and its documentation by the Customer/Sampler. Thereafter, each person who handles and/or processes that sample documentation package is responsible and accountable for the QA/QC requirements of that sample. very decision for deviating from the original requested QA/QC and every conversation with the customer and/or regulator must be documented and initialed. Legally, the Sample/Document "evidence" package begins with the initial sampling and ends with the reporting of the final results.

7.2 The Division of Epidemiology and Laboratory Services (DELS) does not perform sampling. Sampling SOPs are the responsibility of using organizations and are addressed in their respective Quality Assurance Project Plans. DELS personnel will assist the personnel of all using organizations in the preparation of sample containers or by providing sample containers for sample preservation in the field. DELS will make the division's sample acceptance policy, DELS QAPP Section 7.0, available to all using organizations.

7.3 When the DELS prepares sample containers for sample collection the following will apply:

TEST: METHOD	CONTAINER TYPE	VOLUME	PRESERVATIVE	HOLDING TIME
Ammonia: Method 350.3	Plastic[1]	500 ml	H_2SO_4 to pH < 2 store at 4°C	28 Days
Alkalinity(See Total Alkalinity)				
Bacillus	Sterile Plastic	200 ml	Sodium Thiosulfate, store at 4°C	48 Hours
BOD_5: Method 405.1	Plastic[1]	2 liter	No preservative, store at 4°C	48 Hours
BTEX: Modified Method 602	Glass[2] Teflon lined silicon septa	2/40 ml	1:1 HCl to pH<2 store at 4°C	14 Days
Carbamates: Method 531.1	Amber Glass[2] with Teflon cap liner	40 ml	1.2 ml Monochloracetic Acid Buffer, store at 4°C, Sodium Thiosulfate if residual chlorine present	28 days
Chlorinated Pesticides (Soil): Method 8150	Wide Mouth[3] Glass with Teflon Lined Lid	4 oz	Keep cool at 4°C,	extract within 14 days, analyze within 40 days
Chloride: Method 323.3	Plastic[1]	2 Liter	No preservative store at 4°C	28 Days
Chlorophyll a: Method SM10200H	Opaque Plasic[1]	Variable Filtration Volume	Keep Frozen	3 Weeks