MEMORANDUM

To: Dabra Seiken

From: Steven Passafaro
Marc Cicalese
Michael Rowe

CC: Daniel Groher, Robert Simeone, Penelope Reddy

Date: 23 July 2021

Re: **Arsenic Treatment Plant Revised Pilot Test Work Plan**

Pursuant to the request from the U.S. Army Corps of Engineers (USACE), Renova-Sovereign Joint Venture (RSJV) has prepared this memorandum to summarize the upcoming pilot test of an alternative metals removal system using Potassium Permanganate ($KMnO_4$) at Arsenic Treatment Plant (ATP), located at the Shepley's Hill Landfill (SHL) in Devens, Massachusetts. The purpose of this pilot test is to determine and demonstrate if the proposed alternative metals removal system can be used to effectively replace the existing microfilter system, establish the equipment specifications and process design required to meet the discharge criteria, and improve the performance and safety of the ATP. A general description of the approach of the pilot test and temporary system modifications is presented below.

Background

RSJV initially proposed to conduct a pilot test of a Lamella Gravity Settler and a Dynasand Filter in the Fall of 2020 based on the results of laboratory testing. A general description of the approach associated with this pilot test was presented in a previous memorandum developed by RSJV in July 2020 and a former subcontractor. However due to issues associated with COVID-19, the availability of subcontracted personnel to travel to the jobsite and the shipment of equipment required for the implementation in the Fall of 2020 was affected, resulting in a cancellation of the planned pilot test. As a result, RSJV decided to perform an on-site jar test in December 2020 to evaluate different oxidants to effectively remove the arsenic to gain additional information to refine the proposed pilot test that was delayed. The jar testing was performed on-site in December 2020 to overcome the previous issues associated with the oxidation of the inorganics in jar test samples during shipment to an off-site testing facility in May 2020 and to simulate treatment that would take place at the ATP. Therefore, additional jar tests were performed in December 2020, and based on the evaluation of the results, a follow-up bench scale test was conducted in April 2021 to further refine the methodology of the proposed pilot test.

December 2020 Jar Test Study

An on-site jar test study was conducted in December 2020 by a new subcontractor, WesTech Engineering (WesTech), to evaluate the effectiveness of utilizing sodium hypochlorite, hydrogen peroxide, calcium hydroxide (lime), and ferric chloride ($FeCl_3$) as an alternative to the use of chlorine dioxide. Based on the results of this study, WesTech concluded that lime was the best alternative and proposed a process of oxidation with $FeCl_3$ and lime addition, followed by clarification and filtration as an alternative treatment process. While lime will remove the dissolved iron, manganese, and arsenic in the influent water, it also creates a much larger quantity of sludge significantly increasing waste disposal costs, creates the potential for fouling, and raises the pH of treated water. A copy of the January 2021 WesTech *On-Site Testing Report* is included as **Attachment 1**.

April 2021 Additional Bench Scale Testing

Based on the RSJV engineering review of the December 2020 jar testing and its experience and research of other effective oxidants to treat dissolved arsenic in groundwater, it was determined that potassium permanganate ($KMnO_4$) should be evaluated as an alternative oxidant. $KMnO_4$ is frequently used in the water treatment industry to remove dissolved iron, manganese and arsenic from groundwater. It is known to be relatively easy to handle and store, does not dramatically change the pH of water, is an excellent oxidizer and relatively insensitive to pH from other treatment processes, and does not generate a tremendous amount of sludge in comparison to lime. Since $KMnO_4$ was not studied during the December 2020 WesTech jar testing, RSJV determined that there was value in conducting additional testing in April 2021 using $KMnO_4$ prior to implementing a full-scale pilot test in Summer 2021.

In lieu of conducting additional jar testing to determine the effectiveness of the $KMnO_4$, it was decided to perform a bench scale test to simulate the inclined plate clarifier process at a flow rate of approximately 0.25 gallons per minute (gpm). The bench scale process is shown as Figure 1 of the *$KMnO_4$ Bench Scale Test Results* memo included as **Attachment 2.**

The April 2021 bench scale testing demonstrated that arsenic can be efficiently removed using approximately 88 mg/L of $KMnO_4$ with and without the addition of $FeCl_3$. While most of the arsenic was co-precipitated and a floc was produced, a final filter polish was required using a 5-micron filter to get the lighter arsenic particles that carried over and to achieve permitted discharge levels for arsenic. Therefore, based on the results of the bench scale testing, the best alternative proposed was a process of oxidation with $KMnO_4$ and possibly $FeCl_3$, followed by clarification and filtration as an alternative to the current treatment process. A copy of the June 2021 $KMnO_4$ bench test results memo is included as **Attachment 2**.

Proposed Pilot Test Equipment

The following section details the equipment to be used as part of the proposed $KMnO_4$ pilot test, and pilot test operations are detailed in the following section. A copy of the proposed pilot test flow diagram is included as **Figure 1** at the end of this memorandum, and equipment cutsheets are included as **Attachment 3**.

The proposed temporary $KMnO_4$ pilot test system will be setup outside of the building footprint and in the paved and secure parking area of the ATP. The pilot test system will generally consist of the following: chemical injection and transfer pump(s), three (3) polyethylene plastic tanks, one (1) 10,000-gallon clarifier with an IFR 6041 tube settler system, one (1) 21,000-gallon holding tank and filters. The clarifier effluent will be tested through the existing microfilters as well as a sand filter to determine effectiveness and maintenance requirements.

Prior to arrival of the pilot test equipment, RSJV has modified the raw water influent line to install a three-way valve. This modification will allow the redirection of flow from the extraction wells through a temporary hose to the pilot test system during each day of testing. In addition, it will also allow for the redirection of flow from the pilot test back to the existing treatment system during nights and weekends to minimize overall downtime during the pilot. Modifications to the control system of the ATP will also be conducted prior to the pilot test to allow for operation of the extraction well pumps independent of the current ATP system.

Two (2) temporary mix tanks will be placed in series outside of the building footprint. The initial 1,000-gallon tank (Tank 1) will include a mixer and be used for rapid mixing of the raw influent water with $KMnO_4$ or sodium permanganate ($NaMnO_4$) depending on the test to be performed. A static mixer will also be added as an alternative to Tank 1 to evaluate the effectiveness of mixing without the use of a tank mixer. The second 1,000-gallon tank (Tank 2) will also include a mixer and will be used for additional flocculation or for addition of ferric chloride ($FeCl_3$) or ferric sulfate ($Fe_2(SO_4)_3$) depending on the test being performed.

Tank 2 will then flow into the 10,000-gallon clarifier with an IFR 6041 tube settler system to allow for the coprecipitated iron, manganese, and arsenic to settle out. Water will next be directed to either a sand filter or the existing microfilters to remove the lighter solids to meet the permitted discharge criteria. Following filtration, treated water may either be run through the existing ATP System or temporarily stored in an onsite holding tank (Tank 4) prior to discharge. If the treated water from the pilot system is directed into the holding tank, it will be tested using onsite field test kits to determine arsenic levels prior to discharge. If the arsenic concentration of the treated water as determined by the field test kits are below permitted levels, then it will be directed to the existing effluent sump by gravity for discharge to the Devens POTW. If arsenic concentrations are above permit levels, then it will be pumped back to the existing ATP system for further treatment prior to discharge to the POTW.

Sludge will be pumped from the bottom of the clarifier to a 1,000-gallon conical-bottom tank (Tank 3) using a double-diaphragm pump for sludge settling, thickening, and dewatering. A separate pump will then be used to pump supernatant from Tank 3 to the influent of the clarifier. Sludge will then be pumped from the bottom of Tank 3 to the existing ATP filter-bed roll-off (FBRO).

Lastly, all chemicals will be stored within the ATP, and portable spill containment berms will be used to provide secondary containment for all equipment to the extent feasible. The portable berms will be deployed prior to deployment of all equipment, and no chemical will be stored outside designated areas.

Pilot Test Operations

The proposed pilot test will be initially conducted at approximately ~30 gpm to fine tune operation of the system and optimize chemical dosing. Upon completion of the optimization, the pilot test will then be conducted between 50 and 60 GPM during each day to provide a true test of the pilot system's ability to effectively treat the extracted groundwater at the required flowrate. The pilot test will not be conducted overnight, and extracted groundwater will be directed through the existing ATP system during this period.

As noted in the above section, raw water will be directed from the three-way valve to Tank 1 where it will be dosed with $KMnO_4$ to facilitate flocculation. Water will then be sent through Tank 2 for additional flocculation as necessary, the clarifier for settling, and either the sand filter or the existing microfilters for final solids removal. Following filtration, treated water will then be directed to either the existing ATP system or the holding tank, as follows:

1. Discharge through the Existing ATP System: To ensure it meets the discharge criteria, treated water from the pilot system will be directed through the sand filter and then to the head of the existing ATP system for additional treatment prior to discharge to the Devens POTW while the pilot system is optimized. During this period, split samples will be collected from the pilot test discharge for laboratory analysis of arsenic by EPA Method 6020 and for field analysis using the onsite arsenic field test kits. The results of the lab and arsenic field test kits will be correlated to verify the accuracy of the field test kits and will be provided to the Devens Utility Department for review.

2. Discharge through the Holding Tank: Under this scenario, treated water from the clarifier will be directed to either the sand filter or the existing ATP microfilters (i.e., without the injection of the chlorine dioxide) for final solids removal. Following filtration, the treated water will next be directed to the holding tank. The treated water in the holding tank will then be tested using onsite field test kits to determine arsenic levels. If the arsenic concentration of the treated water as determined by the field test kits are below permitted levels and the accuracy of the arsenic field

test kits were verified during the discharge through the existing ATP system, then it will be directed to the existing effluent sump by gravity for discharge to the Devens POTW. If arsenic concentrations are above permit levels, then it will be pumped from the holding tank to the head of the existing ATP system for further treatment prior to discharge to the POTW.

Treated water generated during the pilot test will be periodically field tested using an Arsenic Quick (5 – 500 ppb) or Quick II Test Kit (10 – 200 ppb), a Hach Model IR-20 Iron (0-4 mg/l) and Manganese (0-3 mg/l) Color Disc Test Kit, a CHEMetrics Model K-6010D High Range Iron (0-30 ppm & 30-300 ppm) Test Kit, a turbidity meter, and/or a portable pH meter throughout each day of the pilot test. In addition, confirmatory laboratory samples will also be collected from the influent and/or effluent of the proposed pilot system, as determined by the field engineer for laboratory analysis of arsenic by EPA Method 6020, total suspended solids, and iron and manganese by EPA Method 6010. Once the proposed pilot system is optimized, effluent treated water samples will also be collected from the pilot effluent for analysis of all monitoring parameters (i.e., metals, total toxic organics, total petroleum hydrocarbons, chloride, nitrate, and sulfate) listed under Part 1 Sections A and B of the existing June 2019 MassDevelopment *Landfill Discharge Permit*.

Sludge generated from the clarifier will be initially contained within Tank 3 and then pumped to the existing FBRO for thickening and dewatering. At the end of the pilot test, the sludge will be removed for off-site disposal under a waste manifest in the same manner as the sludge normally generated by the existing system.

During the pilot test, representative samples of the sludge will be collected for additional comprehensive sludge dewatering testing at an offsite facility to determine the proper polymer type and dose to effectively flocculate the solids to optimize the effectiveness and efficiency of a proposed onsite sludge press to be installed in in the future. The results of this bench scale testing along with recommendation for the filter press system will be included in the pilot study results and recommendation report.

It is assumed that that ATP will be off-line periodically and for short durations during the pilot test. To minimize downtime, the three-way valve installed at the system influent will be used to redirect flow back to the existing ATP system during periods when the pilot test is not conducted (i.e., overnight and weekends).

Pilot Test Completion Report

Following completion of the pilot test, RSJV will meet with USACE to discuss preliminary data and proposed recommendations. Following the meeting, RSJV will prepare a pilot study results and recommendation report which will include the results of the pilot study, a preliminary design for a full-scale system, a list of equipment and materials that would be required to install the alternative arsenic treatment system, and any required system or building modifications.

Pilot Test Schedule

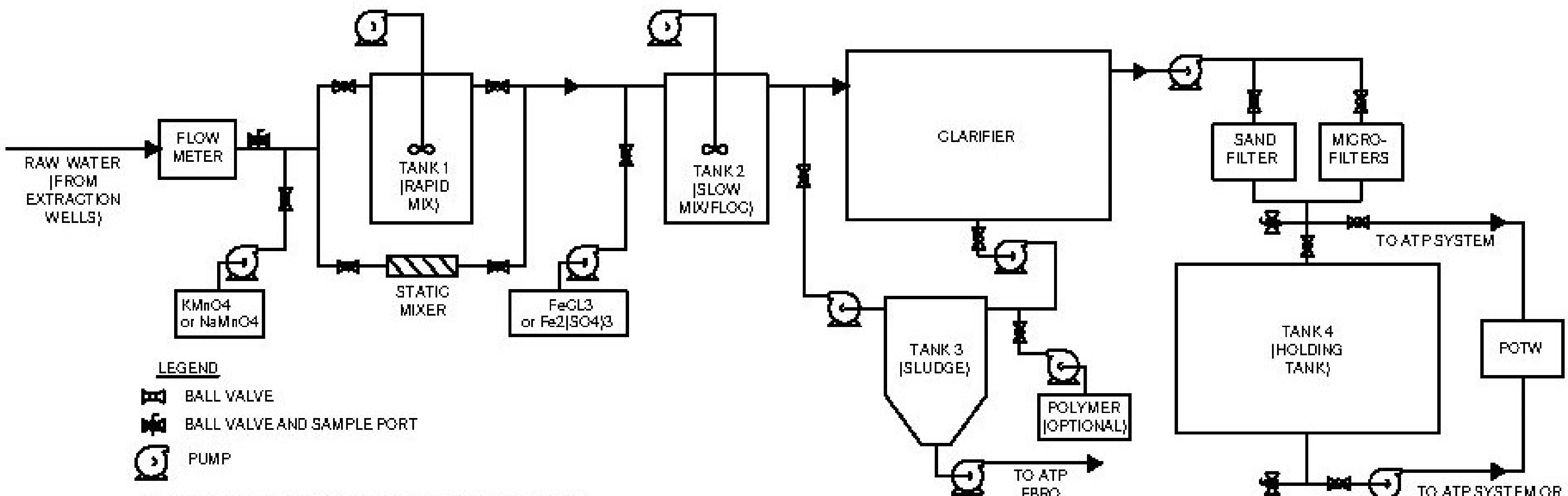
RSJV is planning to perform the pilot test in August 2021. The initial week of the test will be used for setup and preparation. The pilot test will then be conducted during Weeks 2 and 3 with dismantling and removal during Week 4. Final scheduling will occur following review of this memorandum by regulatory agencies, and a minimum of two-weeks' notice will be provided to all parties prior to implementation of the pilot.

We appreciate the prompt review of this memorandum with the hope that we can quickly come to an agreement on the proposed $KMnO_4$ pilot test. The RSJV appreciates the opportunity to work collaboratively and cooperatively with all stakeholders to develop a safer and effective treatment of the extracted arsenic impacted groundwater.

* * * *

Attachment 1 - *On-Site Testing Report Devens Arsenic Groundwater Remediation* – WesTech
Attachment 2 - *Arsenic Treatment Plant KMnO4 Bench Scale Test Results Memorandum* – RSJV
Attachment 3 - Equipment Cutsheets
Attachment 4 – Response to Regulator Comments

FIGURE 1
KMnO4 PILOT TEST
PROCESS & FLOW DIAGRAM



NOTE: THIS IS A CONCEPTUAL PROCESS AND FLOW DIAGRAM FOR ILLUSTRATION PURPOSES. MODIFICATION TO THIS DIAGRAM MAY BE ADJUSTED DURING THE PERFORMANCE OF THE PILOT AS DIRECTED BY THE ENGINEER.

Attachment 1
On-Site Testing Report Devens Arsenic Groundwater Remediation

On-Site Testing Report

Devens Arsenic Groundwater Remediation

Owner

Devens, Massachusetts

Engineer

SOVEREIGN CONSULTING INC.
AN ENVIRONMENTAL SERVICES FIRM

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WESTECH

Introduction

WesTech Engineering travelled to Devens, MA to conduct jar testing and free settling suspension - SuperSettler™ testing at a water treatment plant operated by Sovereign Consulting Inc. The objective of the testing was to determine chemical types, dosages, and the applicability of a SuperSettler™ Inclined Plate Clarifier to remove Arsenic from well water.

Typical Arsenic concentration in the well water may vary from 1700 to 3300 µg/L. The client desires a discharge concentration below 60 µg/L. The anticipated flow is 60 gpm (gallons per minute). Typical operations will be 24 hours per day, 7 days per week.

Arsenic concentration was measured with Industrial Test Systems Quick II Arsenic for Water Quality Test kit. Samples were filtered through a 1.5 micron filter prior to analysis. Once the treatment options were identified, a free settling test was performed and raw samples from this test were sent to a local laboratory for total arsenic level confirmation.

The initial characteristics of the sample are shown below.

Table 1: Sample Characteristics

Initial Characteristics	
pH	6.2
Arsenic (µg/L)	>160*

* Analyzed with Industrial Test Systems Quick II Arsenic. The client states arsenic level may vary from 1700 to 3300 µg/L. The Quick II Arsenic test can not read levels above 160 µg/L.

Jar Testing

Jar testing was completed to screen and establish chemical dosages using a portable four-jar test apparatus with paddle type impellers and 1-liter square jars.

The following chemicals were evaluated:

- Hydrogen Peroxide
- Sodium Hypochlorite
- Calcium Hydroxide - Lime
- Ferric Chloride

Preliminary testing with ferric chloride at 0, 10, 20 and 30 mg/L were performed. A dose of 20 mg/L was considered adequate for testing. Hydrogen peroxide and sodium hypochlorite solutions were prepared at a concentration of 1 mg/L using concentrated solutions of 3% and 7.5% respectively. Tests were completed with the sample at temperature of approximately 25 ^{o}C .

All three chemicals, hydrogen peroxide, sodium hypochlorite, and calcium hydroxide, performed similar during testing. It is also important to sate the pH was not significantly reduced by the ferric chloride.

Jar Test #1

Jar Test #1 used oxidant, hydrogen peroxide and ferric chloride at different doses to determine if chemical pretreatment could reduce arsenic levels.

The procedure for Jar Test #1 is as follows.

1. Add 1 liter of sample to the square beaker.
2. Add hydrogen peroxide and rapid mix (200 rpm) for 10 seconds to disperse the chemical.
3. After rapid mix, reduce to 100 rpm and mix for 5 minutes to allow reaction to occur.
4. Add the ferric chloride and rapid mix (200 rpm) for 10 seconds to disperse the chemical then mix for approximately 5 - 10 minutes at 50 rpm to allow reaction to occur.
5. Track pH throughout mixing time. pH was stable during test.
6. After mixing let sample settle for 15 and 30 minutes, withdraw sample and filter through a 1.5 micron filter pad to remove any solids. Analyze for residual arsenic.

Dosages and results are shown in Table 2.

Table 2: Jar Test #1

Jar Test #1				
Sample	**1**	**2**	**3**	**4**
Hydrogen Peroxide (mg/L)	10	20	25	30
Ferric Chloride (mg/L)	20	20	20	20
Arsenic Levels @ 15 minutes (µg/L)	30	20	10	6
Arsenic Levels @ 30 minutes (µg/L)	25	10	6	3

As seen above, the dosages utilized in Jar Test #1 removed arsenic below the desired 60 µg/L levels with a 10 - 15 minutes mix time. The pH was stable throughout the testing around 6.1 after the chemicals were added.

Jar Test #2

Jar Test #2 was conducted to determine the dosage of sodium hypochlorite and ferric chloride needed to remove arsenic below 60 µg/L.

The procedure for Jar Test #2 is as follows.

1. Add 1 liter of sample to the square beaker.
2. Add sodium hypochlorite and rapid mix (200 rpm) for 10 seconds to disperse the chemical.
3. After rapid mix, reduce to 100 rpm and mix for 5 minutes to allow reaction to occur.
4. Add the ferric chloride and mix for approximately 5 minutes to allow reaction to occur.
5. Track pH throughout mixing time, pH was stable during test.
6. After mix time withdraw sample and filter through a 1.5 micron filter pad to remove any
7. solids. Analyze for residual Arsenic.

Dosages and results are shown in Table 3.

Table 3: Jar Test #2

Jar Test #2				
Sample	**1**	**2**	**3**	**4**
Sodium Hypochlorite (mg/L)	10	20	30	40
Ferric Chloride (mg/L)	20	20	20	20
Arsenic Levels @ 15 minutes (µg/L)	>160	40	30	20
Arsenic Levels @ 30 minutes (µg/L)	>160	30	25	15

As seen above, a minimum dosage of 20 mg/L of sodium hypochlorite removed arsenic below the desired 60 µg/L levels. The pH increased to approximately 6.4 after the chemical additions.

Jar Test #3

The same procedure used in jar test 1 and 2 was applied to jar test 3 using lime and ferric chloride. Dosages and results are shown in Table 4.

Table 4: Jar Test #3

Jar Test #3				
Sample	**1**	**2**	**3**	**4**
Lime (mg/L)	10	20	30	40
Ferric Chloride (mg/L)	20	20	20	20
pH after chemical treatment	7.2	8.0	8.6	8.8
Arsenic Levels @ 15 minutes (µg/L)	100	60	40	30
Arsenic Levels @ 30 minutes (µg/L)	80	50	25	20

Observations from the jar testing:

1. Arsenic levels were tested using Test Systems Quick II Arsenic for Water Quality Test kit. The sample was filtered and analyzed for residual arsenic.
2. Increasing either the oxidizer dose (hydrogen peroxide or hypochlorite) or lime increased the arsenic removal.
3. Letting the sample tested settle for 30 minutes after chemical treatment resulted in lower arsenic levels than the 15 minutes.
4. With lime at 40 mg/L the pH increased to approximately 9.2 before adding the ferric chloride. After ferric was added, the pH stabilized around 9.0.

An additional jar testing was conducted without ferric chloride treatment. The results are presented in table 5.

Table 5: Jar Test #4

Jar Test #4 – No Ferric Treatment			
Sample	**Arsenic Level 15 min (µg/L)**	**Arsenic Level 30 min (µg/L)**	**pH**
Hydrogen Peroxide – 20 mg/L	40	30	6.3
Sodium Hypochlorite – 30 mg/L	20	20	6.5
Lime – 30 mg/L	20	10	9.0

Figure 1 shows the jar tester used during testing.

Figure 1: Jar Testing

Polymer Screening

A polymer screening was conducted on water samples after treatment with 20 mg/L of ferric chloride to identify the best polymer regime for the sample. BASF Magnafloc brand polymers were used in this evaluation because reliable information regarding charge density and molecular weight of their products is readily available. Varying dosages of each polymer were evaluated regarding floc structure, settling characteristics, and effluent clarity.

All polymers tested performed well. It was determined that BASF Magnafloc 1011 (MF 1011) performed the best and required the lowest dosage. MF 1011 is a medium molecular weight anionic polyacrylamide flocculant. Equivalent polymers from different manufacturers should work just as well.

During polymer screening, it was noticed that coagulant was needed to assist the with flocculation. Therefore, Ferric Chloride was tested at different dosages to determine the optimum dosage. It was determined that a dose in the range of 10 - 30 mg/L of ferric chloride produced the best results. The polymer screening was done after the sample was dosed with 20 mg/ L of the coagulant.

It was determined that a dosage of 4 mg/L polymer was adequate. Polymer dosage was kept constant during subsequent Supersettler testing. Increasing polymer dosage did not result in improved clarity.

Supersettler® Testing

Free settling suspension tests were conducted on samples to determine the applicability of a WesTech Supersettler®. Two series of tests were completed: one series without coagulant (ferric chloride) and one series with the addition of ferric chloride at a dose of 20 $\mathrm{mg/L}$.

For first series of tests, with no ferric, one liter of sample was mixed with an oxidizer using the jar tester, then transferred to 1000 mL gradated cylinders. Polymer at a dosage of 4 mg/L was added and mixed for approximately 1 minute. After the turbulence stopped a timer was started. At the appropriate time, the upper 10 cm of supernatant from each cylinder was taken to conduct total arsenic tests.

For the ferric chloride addition series, one liter of sample was mixed using the jar tester with an oxidizer for approximately 5 minutes, then a 20 mg/L dose of ferric chloride was added for a total time of 10 minute. Polymer at a dosage of 4 mg/L was added and mixed for approximately 1 minute. After the turbulence stopped a timer was started. At the appropriate time, the upper 10 cm of supernatant from each cylinder was taken to conduct total arsenic tests.

The tables below show the results for both series of test for each oxidant with and without ferric chloride. Tables 6 and 7 show the results of testing with 25 mg/L of hydrogen peroxide with and without ferric chloride.

Table 6: H_2O_2 Testing with No Ferric

Removal Time – min	Total Arsenic – $\mathrm{\mu m/L}$
15:00	>160
20:00	>160
30:00	>160

Table 7: H2O2 Testing with 20 mg/L Ferric

Removal Time – min	Total Arsenic Lab – $\mathrm{\mu m/L}$	Total Arsenic Test Kit (Unfiltered) - $\mathrm{\mu m/L}$
15:00	120	40
20:00	94.8	30
30:00	82.2	30

Tables 8 and 9 show the results of testing with 30 mg/L of lime with and without ferric chloride.

Table 8: Lime Testing with No Ferric

Removal Time – min	Total Arsenic Lab – $\mathrm{\mu m/L}$	Total Arsenic Test Kit (Unfiltered) - $\mathrm{\mu m/L}$	pH
8:34	123	50	9.1
10:00	112	40	9.1
12:00	101	40	9.0

Table 9: Lime Testing with 20 mg/L Ferric

Removal Time – min	Total Arsenic Lab – $\mu m/L$	Total Arsenic Test Kit (Unfiltered) - $\mu m/L$	pH
8:34	123	40	8.6
10:00	112	30	
12:00	101	13	

Tables 10 and 11 show the results of testing with 35 mg/L of sodium hypochlorite with and without ferric chloride.

Table 10: NaOCl Testing with No Ferric

Removal Time – min	Total Arsenic – $\mu m/L$
12:00	>160
15:00	>160
20:00	>160

Table 11: NaOCl Testing with 20 mg/L Ferric

Removal Time – min	Total Arsenic Lab – $\mu m/L$	Total Arsenic Test Kit (Unfiltered) - $\mu m/L$	pH
12:00	105	60	6.4
15:00	120	25	6.2
20:00	95.5	25	6.4

Conclusions

Jar Testing

- Jar Testing showed that, hydrogen peroxide, sodium hypochlorite, and lime, worked well when combined with 20 mg/L of ferric chloride in lowering dissolved arsenic below the desired 60 µg/L level. A dose of 20 mg/L was considered adequate for testing. This dosage could change if the inlet arsenic concentration varies.
- Samples from the jar testing were filtered prior to arsenic analyses using the Test Systems Quick II Arsenic for Water Quality Test kit. The low arsenic levels after filtration confirms the chemical treatment does work to lower dissolved values
- pH readings during jar testing were stable after the addition of ferric chloride. However, lime at 40 mg/L increased the pH to approximately 9.2 prior to adding ferric. After the ferric addition, the pH decreased to approximately 8.8.

Supersettler® Testing

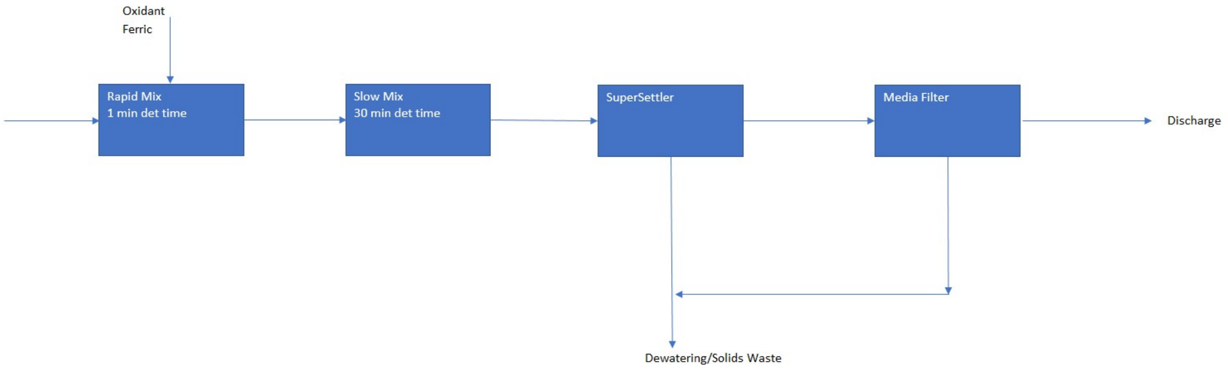
- As expected, ferric chloride is required for arsenic removal. Tests with no ferric chloride had a significantly higher arsenic levels, with the tests with sodium hypochlorite and hydrogen peroxide reading above 160 µg/L.
- Lime showed to be a viable option for this process. Besides the good results during test, which includes helping with settling, lime is less expensive and widely available. However, at dosages above 40 mg/L the pH increased to approximately 9.2.
- Testing indicated that a 5 minute mixing after the addition of the oxidizer and 5 minutes mixing after the addition of ferric chloride showed to be adequate. Mixing was performed at 200 rpm for the first 15 seconds and then 50 rpm for the remaining mixing time.
- Total arsenic results decreased with time during all tests. This indicates the need of a media filter to help achieve the desired arsenic levels.

Final Recommendations

The total removal process is a four step process:

1. Add an oxidant to ensure arsenic is in the arsenite form to allow for co-precipitation of arsenic with iron.
   - All oxidants tested performed well enough to achieve the project goal of <60 µg /L arsenic.
   - Selection of oxidant should be based on best fit for the operation of the plant.
   - Mix tank with detention time of 5 minutes
2. Add ferric to coprecipitate arsenic
   - Testing showed a dose of 20 mg/L to be sufficient for removal of arsenic.
   - Mix tank with detention time of 5 minutes
3. Clarification
   - SuperSettler testing indicates that inclined plates are a good fit for this process.
   - Per testing data, the unit sizing will depend on chemical choice:
     - H_2O_2 – 0.08 gpm/ft^2 (750 ft^2)
     - Lime – 0.2 gpm/ft^2 (300ft^2)
     - NaOCl – 0.12 gpm/ft^2 (500 ft^2)
4. Filtration
   - Media filtration is required to ensure all precipitated solids are removed to meet the treatment goal of < 60 µg/L arsenic.
   - There are multiple filtration technologies that are likely viable technological options:
     - Multimedia Filtration (Gravity or Pressure)
     - Continuous Backwashing Sand Filtration
     - Disc Filtration
     - Ultrafiltration
   - Based on site preferences, a piloting can be used to verify any of the above technologies.
   - Pilot testing would include all unit processes to simulate the full scale operation.

Figure 2: Block Diagram



Attachment 2
Arsenic Treatment Plant KMnO4 Bench Scale Test Results Memorandum

RENOVA/SOVEREIGN JOINT VENTURE

MEMORANDUM

To: Dabra Seiken

From: Steven Passafaro, PE
Michael Rowe, PE
Marc Cicalese

CC: Daniel Groher

Date: 03 June 2021

Re: **Arsenic Treatment Plant $KMnO_4$ Bench Scale Test Results**

Renova-Sovereign Joint Venture (RSJV) has prepared this memorandum to present the results of the bench testing conducted in April 2021 at the Arsenic Treatment Plant (ATP), located at the Shepley's Hill Landfill (SHL) in Devens, Massachusetts. A previous on-site jar test study was conducted in December 2020 by WesTech Engineering (WesTech) to evaluate the effectiveness of utilizing sodium hypochlorite, hydrogen peroxide, calcium hydroxide (lime), and ferric chloride ($FeCl_3$) as an alternative to the use of chlorine dioxide. Based on the results of this study, WesTech concluded that lime was the best alternative and proposed a process of oxidation, $FeCl_3$ and lime addition, clarification and filtration as an alternative treatment process. While lime will remove the dissolved iron, manganese and arsenic in the influent water, it also creates a much larger quantity of sludge. Based on a review of the WestTech report hydrogen peroxide and $FeCl_3$ would be another alternative, although less effective. Given that hydrogen peroxide could be effective, we evaluated other oxidants. Based on our research and evaluation, it was decided to test Potassium Permanganate ($KMnO_4$). $KMnO_4$ is frequently used in the water treatment industry to remove dissolved iron, manganese and arsenic from groundwater. It is known to be relatively easy to handle and store, does not dramatically change the pH of water, is an excellent oxidizer and relatively insensitive to pH from other treatment processes, and does not generate a tremendous amount of sludge in comparison to lime. For these reasons and because $KMnO_4$ was not studied during the December 2020 WesTech Jar Testing, RSJV determined that there was value in conducting additional bench testing in April 2021 using $KMnO_4$ prior to implementing a full-scale pilot test in Summer 2021 of an alternative metals removal system.

Objectives of $KMnO_4$ Bench Scale Test

The primary objectives of the $KMnO_4$ Bench Scale Test are:

1. Determine if $KMnO_4$ is effective in precipitating arsenic to meet the current POTW discharge criteria.
2. Determine if the use of $FeCl_3$ in addition to $KMnO_4$ is necessary to provide more effective removal of arsenic. While $FeCl_3$ is often used to aid in flocculation, it also generates chlorine gas as a byproduct. Therefore, this test was included to determine if there are any tangible benefits so adding $FeCl_3$ which would outweigh the potential negative impacts to indoor air quality.
3. Lastly, the use of potential cationic and anionic polymers was also evaluated to determine if the precipitated metal would floc out more rapidly and possibly eliminate the need for post filtration by meeting the current arsenic POTW discharge criteria.

Bench Scale Test Design

The bench scale system is presented on **Figure 1**, and **Figure 2** presents a diagram of how the bench scale system was tied into the existing system. The bench scale system was designed to duplicate, at a smaller scale, the system that was proposed by WesTech in their January 2021 *On-Site Testing Report* as an intermediate step prior to a full-scale pilot test proposed for Summer 2021. This was done to verify the dynamic conditions of flow compared to the static conditions in the jar tests, including total length of rise, distance between parallel plates, velocity of the water through the system, retention times and mixing times and energy.

The test design was based upon a standard 58-degree settling tube setup with three 13.5-liter mixing chambers. Water was pumped from the untreated influent of the ATP at a rate of approximately 1 liter per minute (lpm) to the first of three bench scale chambers located in series as shown in **Figure 1**. The first chamber was used to inject and rapid mix the $KMnO_4$. The second chamber was then used to slow mix $FeCl_3$ as necessary and to allow the floc to form. The third chamber was either used for additional flocculation or for anionic or cationic polymer addition, depending on the test being performed. Each chamber gravity fed into the next so that there were no impellers utilized.

Following the bench scale mix chambers, treated water flowed through three parallel 58-degree bench scale settling tubes at a rate of approximately 1 lpm prior to discharge into the existing effluent sump of the ATP. Two of the settling tubes were opaque, and one settling tube was clear to monitor and record the quantity and quality of the floc. The floc formation was monitored with a video camera and recorded so that that the characteristics of the floc could be documented.

Chemical metering pumps were used to inject the $KMnO_4$ and other chemical additives into each mixing chamber. Hoses between the metering pumps allowed the injection rate to be verified per minute in a graduated cylinder for all chemicals, and the injection rates of the chemicals could be varied with both stroke and frequency to obtain the desired ratio/feed rate.

During the first two days of testing, RSJV evaluated and tested various combination and concentrations of $KMnO_4$, $FeCl_3$, and the polymers to determine the most suitable chemical addition scenarios for testing and chemical analysis. Samples of the bench scale test effluent were collected periodically during this time for onsite testing using an arsenic field test kit and confirmatory laboratory testing to refine the dose and concentration of all chemicals. On the final day of testing, the effluent was also filtered with a 5-micron filter, and the results of the filtered samples were compared with unfiltered samples.

Results

Laboratory results from the final day of testing including water quality and dosing information are included on **Table 1**. In summary, it was determined through all test results and visual observations that $KMnO_4$ was able to effectively oxidize the dissolved iron, manganese, and arsenic so that the material would settle within 20 minutes (and even faster with dose modification). The oxidation with $KMnO_4$ occurred extremely rapidly, so that the volume in the slow mix and rapid mix tanks had little effect on the total settling time. During initial testing, the mixing speed had little effect on the flocculation, and floc formation occurred with a 2-minute retention time overall for all doses. In addition, preliminary results with on-site field test kits and subsequent laboratory analysis of filtered and unfiltered samples indicated that the addition of a 5-micron filter is necessary to remove the suspended arsenic to meet discharge requirements.

The rate of $KMnO_4$ injection was run initially at 52.26 mg of $KMnO_4$ per liter of influent water. At this rate there was a pink cast to the water, and the testing was not run lower than this during for the first days of testing. It was found that addition of $KMnO_4$ until a slight pink cast was observed in the water was the upper end of the required dosage for oxidation with $KMnO_4$ with a 20-minute settling time and 5-micron filtration to achieve permitted discharge levels of arsenic.

Increasing the $KMnO_4$ above the theoretical stoichiometric value made the water progressively pinker/purple, and the floc settled out less effectively. This can be attributed to micro-bubbles that are chemisorbed or entrapped within the floc, which is stronger than the density difference of the coagulated material. Literature review suggests that the increase in manganese in the water negatively affects the coagulation of iron, which then is carried by the water flow. In addition, $KMnO_4$ at extremely high dosages (approximately 80 mg/l done in a single jar test to determine feasibility) was able to achieve permitted discharge levels of arsenic without additional filtering, but the mixer was an extremely dark purple and would not be acceptable for direct discharge.

While the floc initially looked better, there was no reduction in arsenic in the filtered effluent with the addition of $FeCl_3$. As the $FeCl_3$ concentration was increased, the floc got lighter and did not settle as quickly as confirmed by jar testing. In addition, $FeCL_3$ was also found to adjust the pH downward.

Oxidation-reduction potential (ORP) higher than 350 demonstrated a decrease in the efficiency of arsenic removal. This may be due to reduced efficiency to create an effective high-density floc when the ORP ranges between 450 and 600. Removal of dissolved arsenic and iron occurred better at pH above 7, and dense flocculation was somewhat inhibited when the pH was below 7.

Finally, the addition of anionic and cationic polymers made little if any change to the settling time of the floc. Their use prior to settling tubes did not eliminate the need for post filtration.

Conclusions

While the study demonstrated that arsenic can be efficiently removed using $KMnO_4$, it was not possible to increase the settling velocity up the settling tubes to demonstrate the minimum settling time required to ensure removal to compliance levels. While most of the arsenic is co-precipitated and flocs out, a final filter polish is required to get the lighter arsenic particles that carry over. As a result, a 5-micron filtered was required for the treated water to achieve permitted discharge levels for arsenic.

The information obtained from this bench scale test will be used to design a full-scale pilot test system. It will be the goal of the pilot to test a full-scale system using $KMnO_4$ and post treatment filtering at the normal operational rate of 50 to 60 gpm. If the pilot test is successful, the existing chlorine dioxide injection and microfiltration system filters could be replaced by a standard settling clarifier system followed by sand filtration. It is also noted that the existing microfilters would also effectively remove the suspended arsenic after the clarifier to meet the discharge criteria. Since the clarifier would be effective in removing the majority of the precipitate metals from the groundwater, the microfilters would no longer be treating all of the precipitated solids, thereby significantly reducing the backwash cycles and the clean-in-place's (CIP) that are currently performed. It is estimated that the CIP cycles could go from every month to every six months. The proposed full scale pilot system will be presented in a second memorandum for review prior to implementation in Summer 2021.

FIGURE 1
DEVENS SHEPLEY'S HILL LANDFILL ATP
P&ID OF TEST SETUP

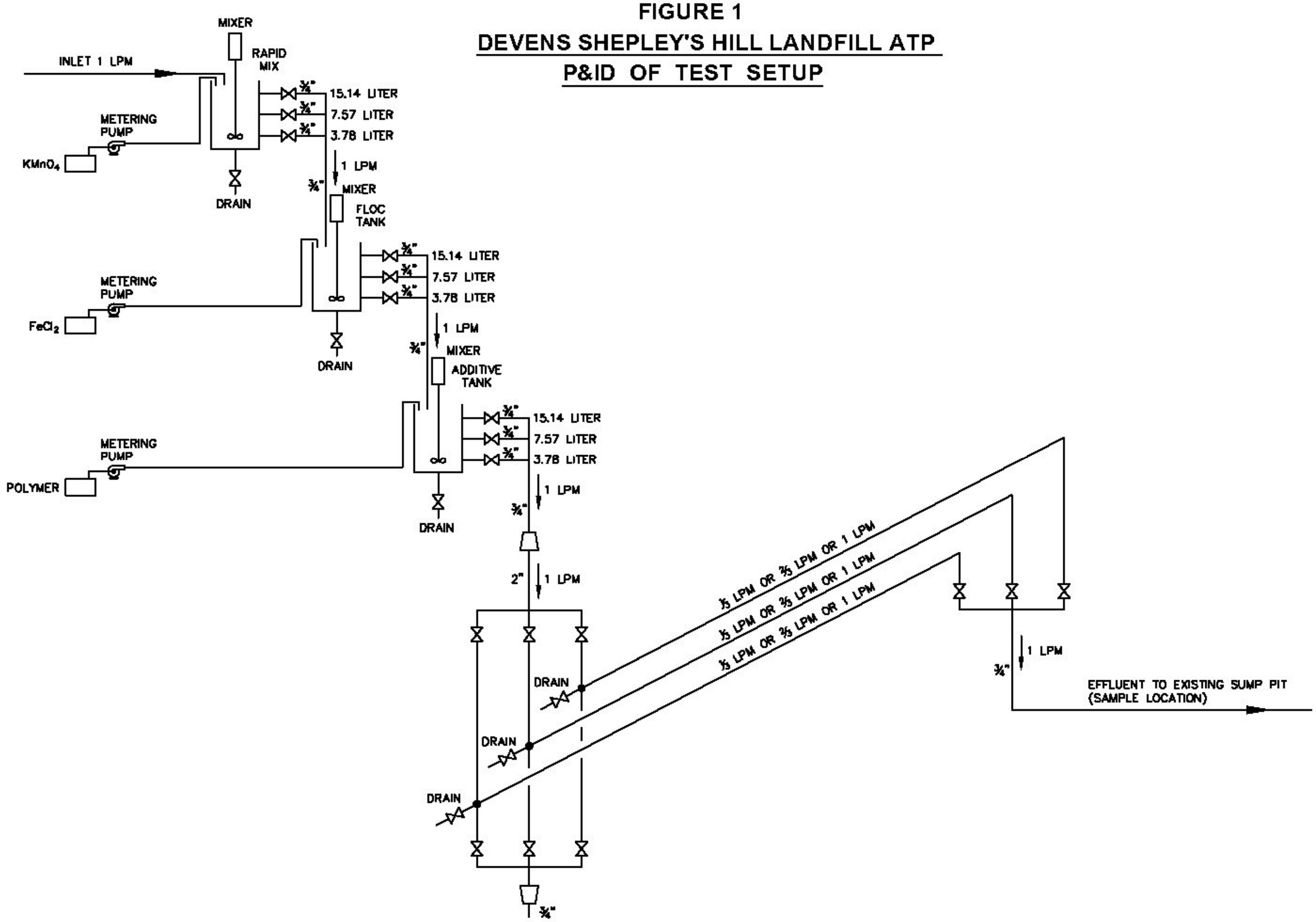


FIGURE 2
DEVENS SHEPLEY'S HILL LANDFILL ATP
INTERCONNECTION OF TEST SETUP WITH EXISTING TREATMENT SYSTEM

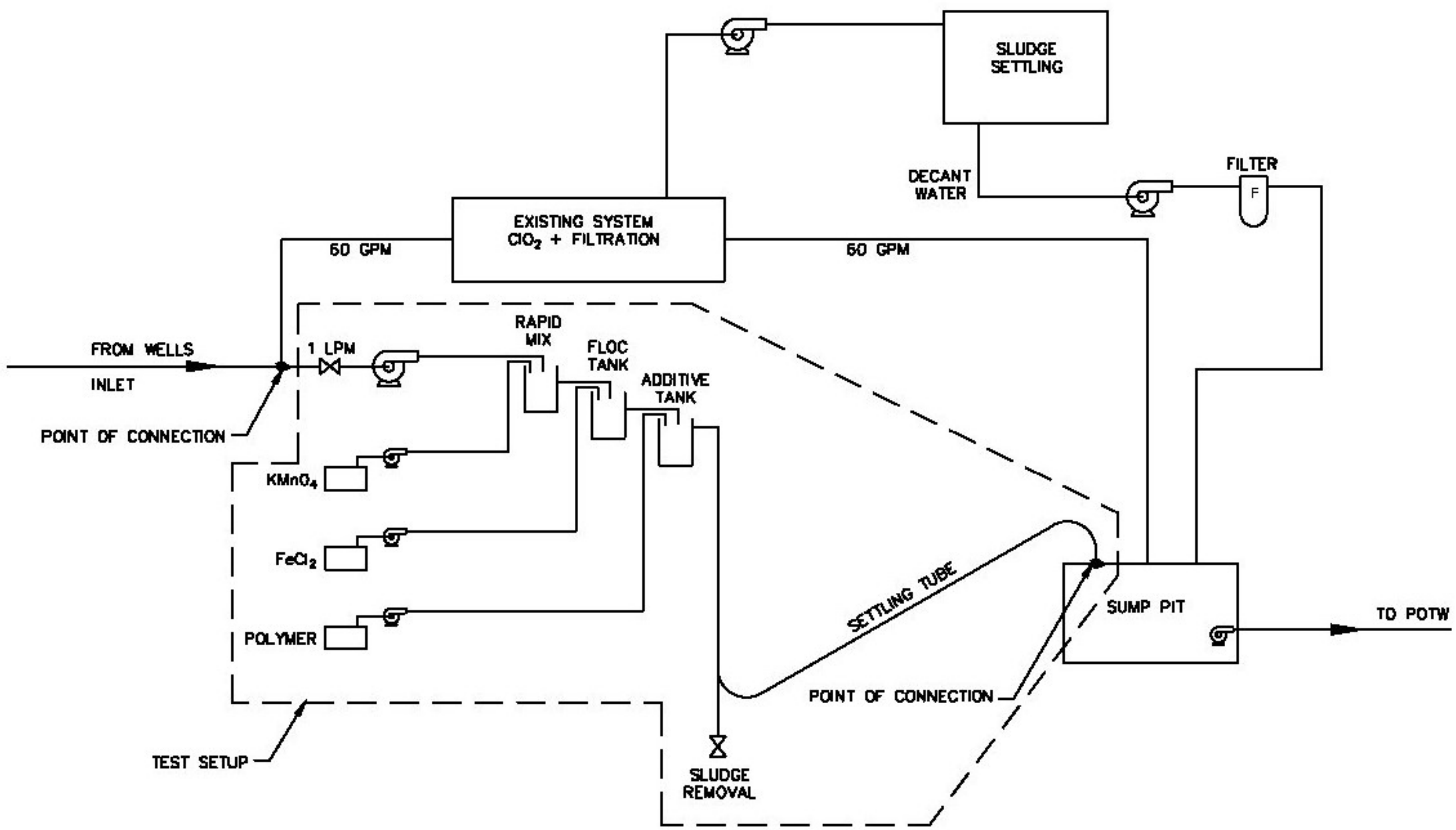


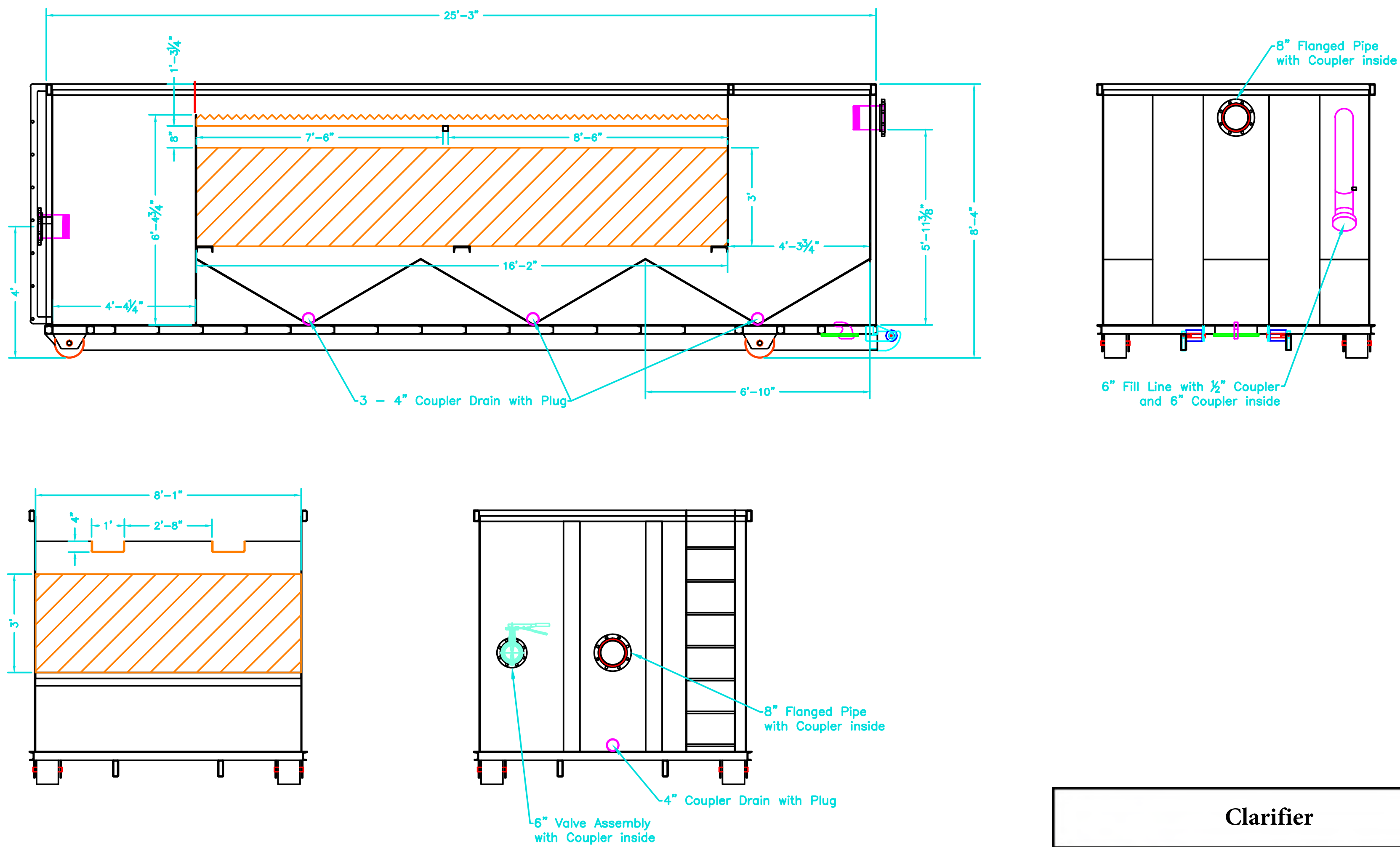
Table 1
Bench Scale Testing Results
Devens Arsenic Treatment Plant

Test No.	Test Description	Date	Time	Lab ID Number	Laboratory Arsenic (ug/l)	pH	DO (%)	ORP	FeCl3 Dose (mg/l)	KMnO4 Dose (mg/l)	Test Influent Groundwater Flowrate GPM
1	15 mg/l FECL3, 52.26 mg/l KMNO4, started to floc	4/22/2021	0835	MC042221001	462	NR	NR	NR	15	52.3	0.26
2	15 mg/l FECL3, 52.26 mg/l KMNO4, filtered sample	4/22/2021	0900	MC042221002FIL	37	NR	NR	NR	15	52.3	0.26
2	15 mg/l FECL3, 52.26 mg/l KMNO4, unfiltered sample	4/22/2021	0901	MC04221003UNF	238	NR	NR	NR	15	52.3	0.26
3	15 mg/l FECL3, 88.44 mg/l KMNO4, filtered sample	4/22/2021	0930	MC042221004FIL	16	7.21	82	294	15	88.4	0.26
3	15 mg/l FECL3, 88.44 mg/l KMNO4, unfiltered sample	4/22/2021	0931	MC042221005UNF	187	7.21	82	310.2	15	88.4	0.26
4	No FECL3, 88.44 mg/l KMNO4, filtered sample	4/22/2021	1000	MC042221006FIL	9	NR	NR	NR	0	88.4	0.26
4	No FECL3, 88.44 mg/l KMNO4, unfiltered sample	4/22/2021	1001	MC042221007UNF	211	NR	NR	NR	0	88.4	0.26
5	No FECL3, 136.7 mg/l KMNO4, filtered sample	4/22/2021	1030	MC042221008FIL	17	7.03	78.2	512.2	0	136.6	0.26
5	No FECL3, 136.8 mg/l KMNO4, unfiltered	4/22/2021	1031	MC042221009UNF	318	7.03	82.3	535	0	136.6	0.26
6	No FECL3, 116.6 mg/l KMN04 filtered	4/22/2021	1100	MC0422210010FIL	62	7.12	84	547	0	116.6	0.26
6	No FECL3, 116.6 mg/l KMN04 unfiltered	4/22/2021	1101	MC0422210011UNF	274	7.09	84	563	0	116.6	0.26
7	20 mg/l FECL3, 106.5 KMNO4 filtered	4/22/2021	1130	MC0422210012FIL	119	7.12	73.8	574	20	106.5	0.26
7	20 mg/l FECL3, 106.5 KMNO4 unfiltered	4/22/2021	1131	MC0422210013UNF	310	7.12	78.6	582.1	20	106.5	0.26
8	20 mg/l FECL3, 106.5 KMNO4 filtered	4/22/2021	1200	MC0422210014FIL	151	7.06	83.5	590	20	106.5	0.26

Notes:

- Devens POTW Arsenic permitted discharge rate is 75 ug/l
- Exceeds Devens POTW As discharge lmit
- 5 micron used for filtered samples
- NR = Not Recorded

Attachment 3
Equipment Cutsheets

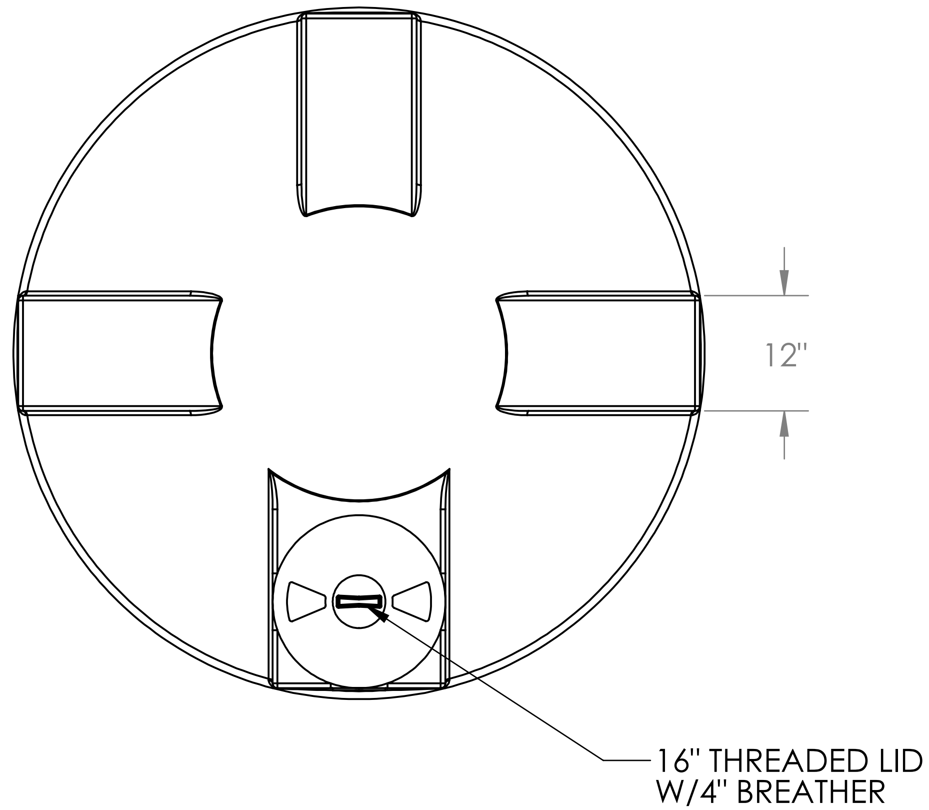


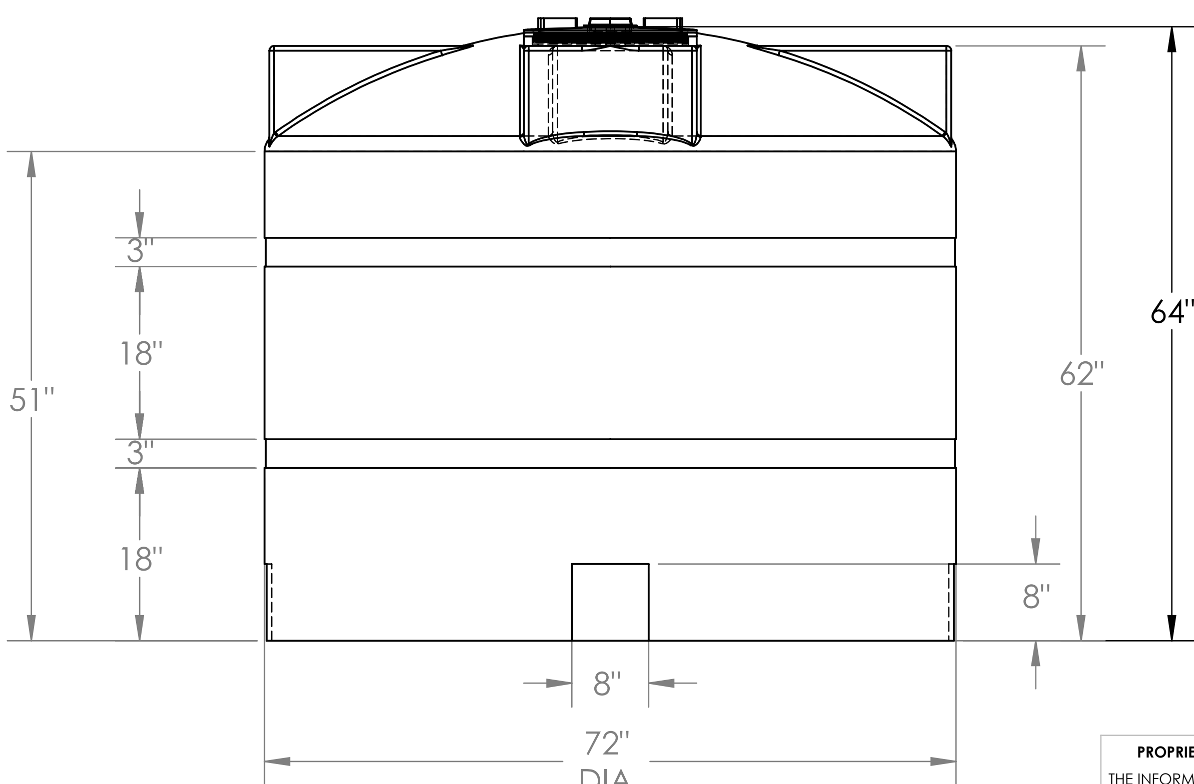
Clarifier

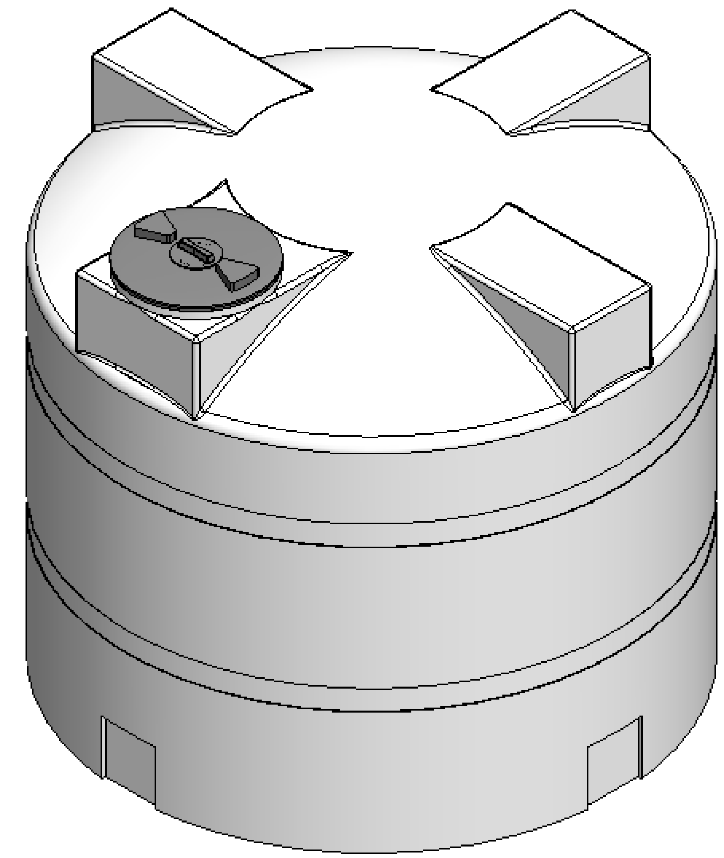
Lockwood Remediation Technologies, LLC

89 Crawford Street
Leominster, Massachusetts 01453
O: 774-450-7177
F: 888-835-0617

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
B-2	A	WEIGHT CHANGE	3-3-2010	EBW







NOTES:

1. MATERIAL: POLYETHYLENE
2. WEIGHT: 160 LBS. STD. RATED 1.5 S.G.
   212 LBS. HD. RATED 2.0 S.G.

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	EBW	5-29-09
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

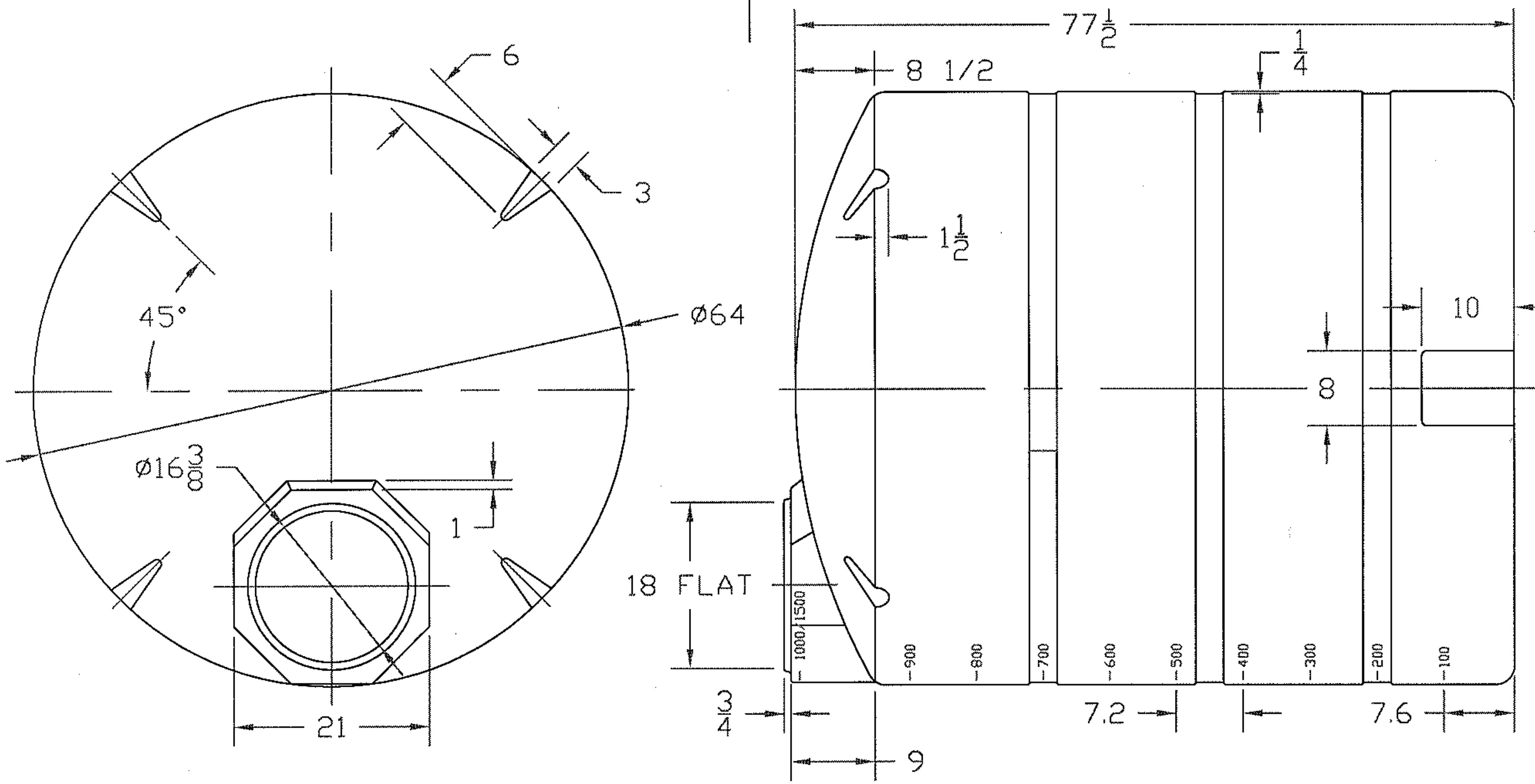
CUSTOM ROTO-MOLDING, INC.

TITLE:
1000 GALLON VERTICAL TANK

SIZE	DWG. NO.	REV
B		A

SCALE: 1:50 WEIGHT: SHEET 1 OF 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	REDRAWN	09JAN97	

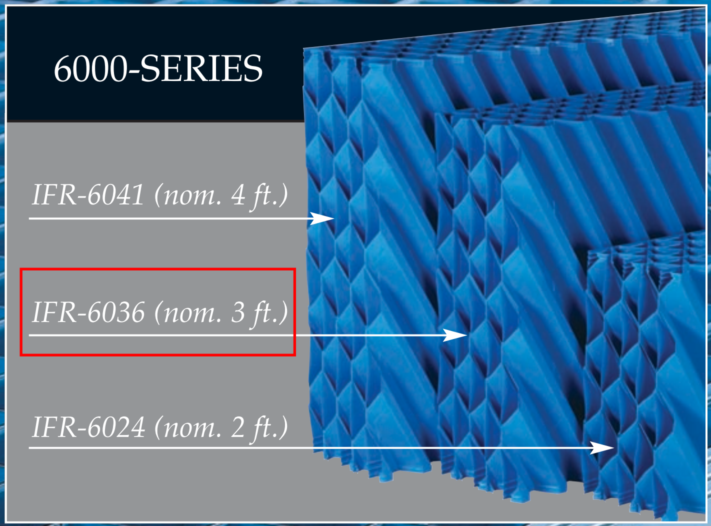


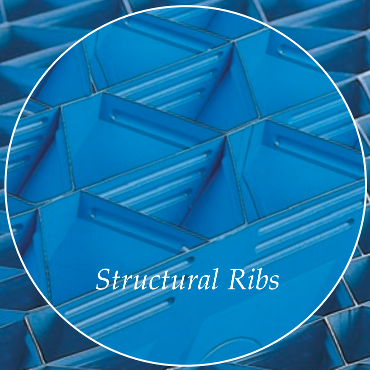
NORWESCO
ST. BONIFACIUS, MN

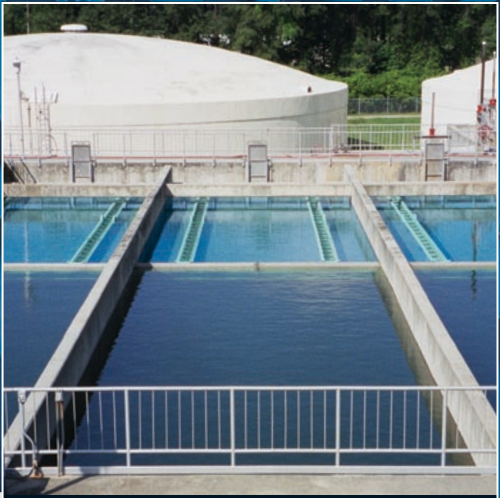
1000 GALLON VERTICAL TANK

JTP 09JAN97	SIZE A	FSCM NO.	DWG NO.	REV A
	SCALE 1/16		SHEET	

ACCU-PAC® TUBE SETTLERS







City of Myrtle Beach, South Carolina

NSF®

Certified to ANSI/NSF 61

AccuPac®

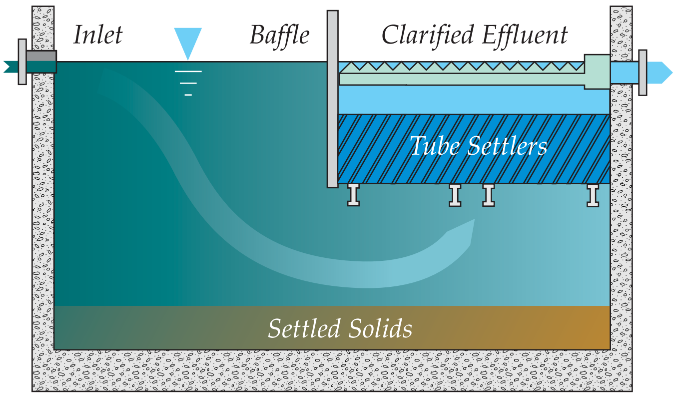
6000-Series Tube Settlers improve plant efficiency and quality for water clarification in potable water and wastewater applications.

BRENTWOOD INDUSTRIES

ACCU-PAC® TUBE SETTLERS

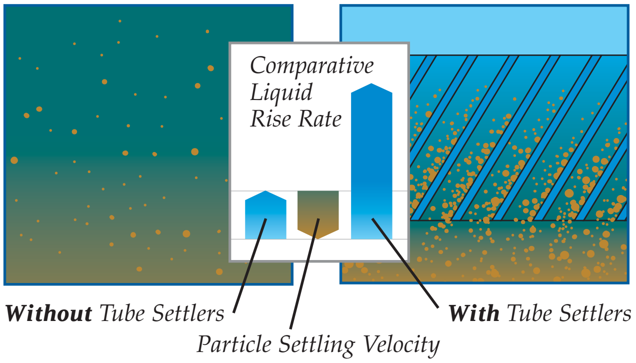
New Jersey-American Water Co.
Tinton Falls, New Jersey

AccuPac® 6000-Series Tube Settlers utilize individual, isolated tubular channels, each sloped at 60°, to expand the settling capacity of water and wastewater clarifiers. Engineered with the individual tubes rising in the same direction to eliminate mixing currents and unstable flow patterns. Constructed of flame-resistant, self-extinguishing PVC that is also inert to naturally occurring constituents in water and wastewater. Potable (blue) 6000-series modules are Tested and Certified by NSF to ANSI/NSF Standard 61.



IMPROVE EFFICIENCY

The shape and configuration of 6000-series modules are engineered to minimize the Reynolds Number and to create laminar flow for rapid settling of solids. This enhanced settling reduces chemical coagulant use and downstream filter backwash requirements. For plant design and upgrading, less settling area is needed.

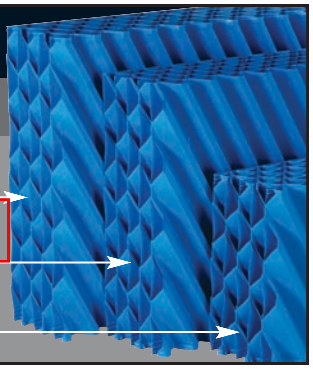


CONFIGURATIONS

For use in either circular or rectangular tanks, standard module sizes are 6, 8, 10, or 12 ft. lengths and 1 or 2 ft. widths. Other sizes available upon request. Available in both potable (blue) and non-potable (black).

6000-SERIES

NOMINAL SIZE	TUBE LENGTH	MODULE HEIGHT
4′	47″	41″
3′	42″	36″
2′	28″	24″



Brentwood also offers complete systems including supports, baffles, surface grating, troughs, and weirs as required for both municipal and industrial projects.

Non-metallic chain and flight sludge collection systems for rectangular clarifiers are available from our Polychem division.

NSF® Certified to ANSI/NSF 61

STRUCTURAL INTEGRITY

The 6000-SeriesTube Settler modules are self-supporting and constructed of prime, rigid, UV-protected PVC. Integrated structural ribs provide substantial loading strength (maximum 250 lbs/ft²). The unique design assures a solid interface during installation. Brentwood's sheet forming and bonding processes ensure tremendous strength and long-term durability.

HIGH-TUBIDITY, HIGH RATE APPLICATIONS

3′ and 4′ IFR-6000 modules are particularly effective in high-turbidity, and higher rate applications

TUBE SETTLER MAXIMUM APPLICATION RATES

Flow (GPM): Required flow through the basin.

Area (FT²): Tube settler area within the basin.

Application Rate (AR): $\frac{GPM}{FT^2}$

IFR-6024 (2 ft.)	IFR-6036 (3 ft.)	IFR-6041 (4 ft.)
AR = ≤ 2.5	AR = ≤ 4.0	AR = ≤ 4.5

BRENTWOOD INDUSTRIES

Brentwood Industries, Inc.
Mailing Address P.O. Box 605, Reading, PA 19603, USA
Shipping Address 610 Morgantown Road, Reading, PA 19611
Phone 610.236.1100 *Fax* 610.736.1280
Email wwsales@brentw.com
Website www.BrentwoodProcess.com

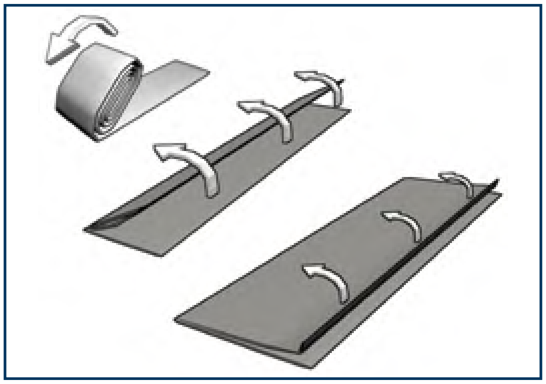
Printed 06/03

Portable Spill Berms

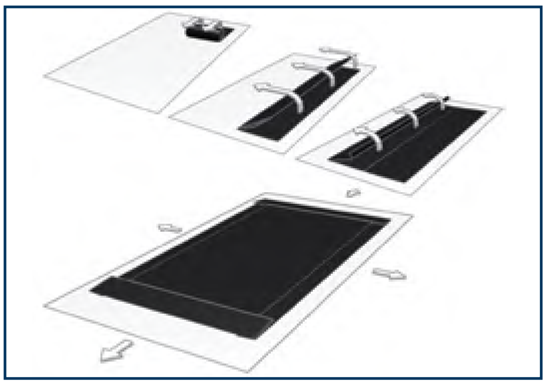
Portable secondary containment berms

- One piece pop-up berm is ready to use
- Bracketed berm easily sets up in minutes
- Manufactured with UV and chemically resistant membranes
- Durable and light-weight
- Portable, reusable, and repairable
- Prompt manufacturing lead time
- Custom designs engineered to meet your specific needs

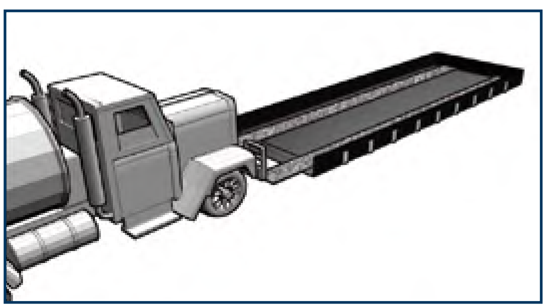
Berm Installation



1. Unpack all components and locate the ground cover. The ground cover is the thick cloth type material. Unfold the ground cover and position it in the desired location.

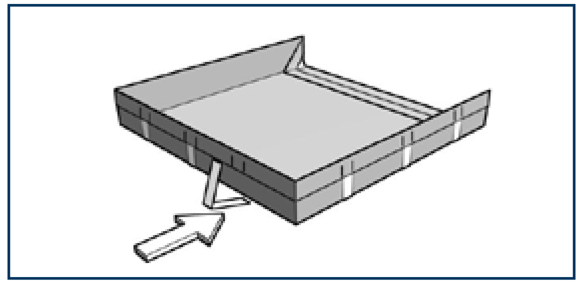


2. Next, locate the spill berm. Unfold the spill berm and center it on top of the ground cover.



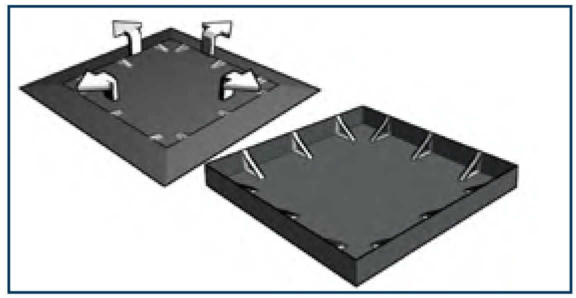
3. If the optional track guard is used, position it on top of the erected berm.

Bracketed Berm



For the bracketed berm, locate the aluminum angle brackets. Insert the angle brackets into the perimeter pockets on three sides of the spill berm. Use the unsupported end for equipment entry. After equipment is in place, insert the angle brackets on the fourth side to complete the installation.

Pop Up Berm



For the InstaBerm, pull all four sidewalls of the spill berm outward so that they are standing upright. Straighten the top angles of the wall supports inside the berm. The walls will move further outward as the berm is filled.

APPLICATIONS

- Roll-off Containers
- Tanker Trucks
- Frac Tanks
- Decon Wash Pads
- Emergency Response
- Drum Storage
- Portable Pumps

The Pulsatron Series A Plus offers manual function controls over stroke length and stroke rate as standard with the option to select external pace for automatic control.

Ten distinct models are available, having pressure capabilities to 250 PSIG (17 BAR) @ 12 GPD (1.9 lph), and flow capacities to 58 GPD (9.1 lph) @ 100 PSIG (7.0 BAR), with a standard turndown ratio of 100:1, and optional ratio of 1000:1. Metering performance is reproducible to within ± 3% of maximum capacity.

Features

- Manual Control by on-line adjustable stroke rate and stroke length.
- Highly Reliable timing circuit.
- Circuit Protection against voltage and current upsets.
- Solenoid Protection by thermal overload with auto-reset.
- Water Resistant, for outdoor and indoor applications.
- Internally Dampened To Reduce Noise.
- Guided Ball Check Valve Systems, to reduce back flow and enhance outstanding priming characteristics.
- Few Moving Parts and Wall Mountable.
- Safe & Easy Priming with durable leak-free bleed valve assembly (standard).
- Optional Control: External pace with auto/manual selection.

Controls

Manual Stroke Rate

Manual Stroke Length

External Pacing - Optional

External Pace With Stop - Optional (125 SPM only)

Controls Options		
Feature	Standard Configuration	Optional Configuration [1]
External Pacing	---	Auto / Manual Selection [2]
External Pace w/ Stop (125 SPM only)	---	Auto / Manual Selection [2]
Manual Stroke Rate	10:1 Ratio	100:1 Ratio
Manual Stroke Length	10:1 Ratio	10:1 Ratio
Total Turndown Ratio	100:1 Ratio	1000:1 Ratio

Note 1: On S2, S3 & S4 sizes only.

Note 2: Not available on 1000:1 turndown pumps.

Operating Benefits

- Reliable metering performance.
- Rated “hot” for continuous duty.
- High viscosity capability.
- Leak-free, sealless, liquid end.

Aftermarket

- KOPkits
- Gauges
- Dampeners
- Pressure Relief Valves
- Tanks
- Pre-Engineered Systems
- Process Controllers (PULSAblue, MicroVision)

PULSAtron® Series A Plus Electronic Metering Pumps

PULSAtron® Series A Plus

Specifications and Model Selection

MODEL			LBC2	LB02	LBC3	LB03	LB04	LB64	LBC4	LBS2	LBS3	LBS4
Capacity nominal (max.)		GPH	0.25	0.25	0.42	0.50	1.00	1.25	2.00	0.50	1.38	2.42
		GPD	6	6	10	12	24	30	48	12	33	58
		LPH	0.9	0.9	1.6	1.9	3.8	4.7	7.6	1.9	5.2	9.14
Pressure[3] (max.)	GFPP, PVDF, 316SS or PVC (W code) w/TFE Seats)	PSIG (Bar)	250 (17)	150 (10)	250 (17)	150 (10)	100 (7)	100 (7)	50 (3.3)	250 (17)	150 (10)	100 (7)
	PVC (V code) Viton or CSPE Seats / Degas Liquid End		150 (10)							150 (10)		
Connections:		Tubing	1/4" ID X 3/8" OD						3/8" ID X 1/2" OD	1/4" ID X 3/8" OD		
		Piping	1/4" FNPT									
Strokes/Minute		SPM	125							250		

Note 3: Pumps with rated pressure above 150 PSI will be de-rated to 150 PSI Max. when selecting certain valve options, see Price Book for details.

Engineering Data

Pump Head Materials Available:	GFPPL
	PVC
	PVDF
	316 SS
Diaphragm:	PTFE-faced CSPE-backed
Check Valves Materials Available:	
Seats/O-Rings:	PTFE
	CSPE
	Viton
Balls:	Ceramic
	PTFE
	316 SS
	Alloy C
Fittings Materials Available:	GFPPL
	PVC
	PVDF
Bleed Valve:	Same as fitting and check valve selected, except 316SS
Injection Valve & Foot Valve Assy:	Same as fitting and check valve selected
Tubing:	Clear PVC
	White PE

Important: Material Code - GFPPL=Glass-filled Polypropylene, PVC=Polyvinyl Chloride, PE=Polyethylene, PVDF=Polyvinylidene Fluoride, CSPE=Generic formulation of Hypalon, a registered trademark of E.I. DuPont Company. Viton is a registered trademark of E.I. DuPont Company. PVC wetted end recommended for sodium hypochlorite.

Engineering Data

Reproducibility:	+/- 3% at maximum capacity
Viscosity Max CPS:	1000 CPS
Stroke Frequency Max SPM:	125 / 250 by Model
Stroke Frequency Turn-Down Ratio:	10:1 /100:1 by Model
Stroke Length Turn-Down Ratio:	10:1
Power Input:	115 VAC/50-60 HZ/1 ph
	230 VAC/50-60 HZ/1 ph
Average Current Draw:	
@ 115 VAC; Amps:	0.6 Amps
@ 230 VAC; Amps:	0.3 Amps
Peak Input Power:	130 Watts
Average Input Power @ Max SPM:	50 Watts

Custom Engineered Designs – Pre-Engineered Systems

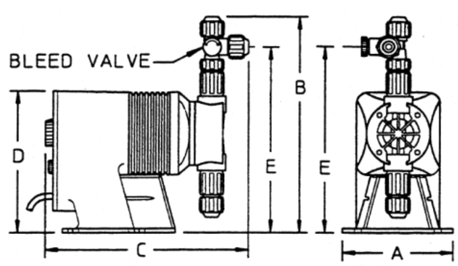
Pre-Engineered Systems

Pulsafeeder's Pre-Engineered Systems are designed to provide complete chemical feed solutions for all electronic metering applications. From stand alone simplex pH control applications to full-featured, redundant sodium hypochlorite disinfection metering, these rugged fabricated assemblies offer turn-key simplicity and industrial-grade durability. The UV-stabilized, high-grade HDPE frame offers maximum chemical compatibility and structural rigidity. Each system is factory assembled and hydrostatically tested prior to shipment.

Dimensions

Series A PLUS Dimensions (inches)						
Model No.	A	B	C	D	E	Shipping Weight
LB02 / S2	5.0	9.6	9.5	6.5	8.2	10
LBC2	5.0	9.9	9.5	6.5	8.5	10
LBC3	5.0	9.9	9.5	6.5	8.5	10
LB03 / S3	5.0	9.9	9.5	6.5	8.5	10
LB04 /S4	5.0	9.9	9.5	6.5	8.5	10
LB64	5.0	9.9	9.5	6.5	8.5	10
LBC4	5.0	9.9	9.5	6.5	8.5	10

NOTE: Inches X 2.54 = cm



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IDEX CORPORATION

sc200™ UNIVERSAL CONTROLLER

Applications
- Drinking Water
- Wastewater
- Industrial Water
- Power

One Controller for the Broadest Range of Sensors.

Choose from 30 digital and analog sensor families for up to 17 different parameters.

Maximum Versatility

The sc200 controller allows the use of digital and analog sensors, either alone or in combination, to provide compatibility with Hach's broad range of sensors, eliminating the need for dedicated, parameter-specific controllers.

Ease of Use and Confidence in Results

Large, high-resolution, transreflective display provides optimal viewing resolution in any lighting condition. Guided calibration procedures in 19 languages minimize complexity and reduce operator error. Password-protected SD card reader offers a simple solution for data download and transfer. Visual warning system provides critical alerts.

Wide Variety of Communication Options

Utilize two to five analog outputs to transmit primary and secondary values for each sensor, or integrate Hach sensors and analyzers into MODBUS RS232/RS485, Profibus® DP, and HART networks.

Password protected SD card reader offers a simple solution for data download and transfer, and sc200 and digital sensor configuration file duplication and backup.

HACH®
Be Right™

Controller Comparison

	Previous Models			
Features	**sc100™ Controller**	**GLI53 Controller**	**sc200™ Controller**	**Benefits**
Display	64 x 128 pixels 33 x 66 mm (1.3 x 2.6 in.)	64 x 128 pixels 33 x 66 mm (1.3 x 2.6 in.)	160 x 240 pixels 48 x 68 mm (1.89 x 2.67 in.) Transreflective	• Improved user interface—50% bigger • Easier to read in daylight and sunlight
Data Management	irDA Port/PDA Service Cable	N/A	SD Card Service Cable	• Simplifies data transfer • Standardized accessories/ max compatibility
Sensor Inputs	2 Max Direct Digital Analog via External Gateway	2 Max Analog Depending on Parameter	2 Max Digital and/or Analog with Sensor Card	• Simplifies analog sensor connections • Works with analog and digital sensors
Analog Inputs	N/A	N/A	1 Analog Input Signal Analog 4-20mA Card	• Enables non-sc analyzer monitoring • Accepts mA signals from other analyzers for local display • Consolidates analog mA signals to a digital output
4-20 mA Outputs	2 Standard	2 Standard	2 Standard Optional 3 Additional	• Total of five (5) 4-20 mA outputs allows multiple mA outputs per sensor input
Digital Communication	MODBUS RS232/RS485 Profibus DP V1.0	HART	MODBUS RS232/RS485 Profibus DP V1.0 HART 7.2	• Unprecedented combination of sensor breadth and digital communication options

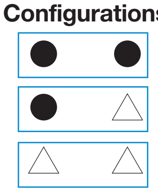
Choose from Hach's Broad Range of Digital and Analog Sensors

Parameter	Sensor	Digital or Analog
Ammonia	AMTAX™ sc, NH4D sc, AISE sc, AN-ISE sc	●
Chlorine	CLF10 sc, CLT10 sc, 9184 sc	●
Chlorine Dioxide	9185 sc	●
Conductivity	GLI 3400 Contacting, GLI 3700 Inductive	△
Dissolved Oxygen	LDO® Model 2, 5740 sc	●
Dissolved Oxygen	5500	△
Flow	U53, F53 Sensors	△
Nitrate	NITRATAX™ sc, NO3D sc, NISE sc, AN-ISE sc	●
Oil in Water	FP360 sc	●
Organics	UVAS sc	●
Ozone	9187 sc	●
pH/ORP	pHD	●
pH/ORP	pHD, pH Combination, LCP	△
Phosphate	PHOSPHAX™ sc	●
Sludge Level	SONATAX™ sc	●
Suspended Solids	SOLITAX™ sc, TSS sc	●
Turbidity	1720E, FT660 sc, SS7 sc, ULTRATURB sc, SOLITAX sc, TSS sc	●
Ultra Pure Conductivity	8310, 8311, 8312, 8315, 8316, 8317 Contacting	△
Ultra Pure pH/ORP	8362	△

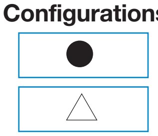
● = Digital △ = Analog

Connect up to two of any of the sensors listed above, in any combination, to meet your application needs. The diagrams below demonstrate the potential configurations. Operation of analog sensors requires the controller to be equipped with the appropriate sensor module. Contact Hach Technical Support for help with selecting the appropriate module.

2 Channel Configurations



1 Channel Configurations



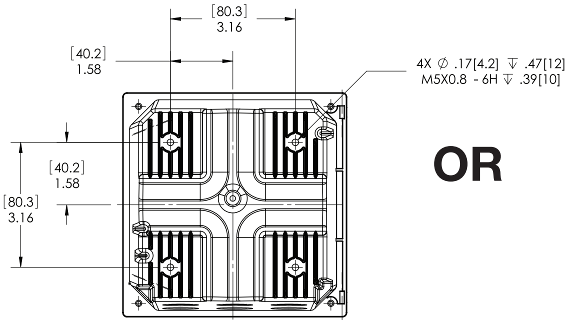
Specifications*

Dimensions (H x W x D)	5.7 in x 5.7 in x 7.1 in (144 mm x 144 mm x 181 mm)
Display	Graphic dot matrix LCD with LED backlighting, transreflective
Display Size	1.9 x 2.7 in. (48 mm x 68 mm)
Display Resolution	240 x 160 pixels
Weight	3.75 lbs. (1.70 kg)
Power Requirements (Voltage)	100 - 240 V AC, 24 V DC
Power Requirements (Hz)	50/60 Hz
Operating Temperature Range	-20 to 60 °C , 0 to 95% RH non-condensing
Analog Outputs	Two (Five with optional expansion module) to isolated current outputs, max 550 Ω , Accuracy: ± 0.1% of FS (20mA) at 25 °C, ± 0.5% of FS over -20 °C to 60 °C range Operational Mode: measurement or calculated value
Analog Output Functional Mode	Linear, Logarithmic, Bi-linear, PID
Security Levels	2 password-protected levels
Mounting Configurations	Wall, pole, and panel mounting
Enclosure Rating	NEMA 4X/IP66
Conduit Openings	1/2 in NPT Conduit
Relay: Operational Mode	Primary or secondary measurement, calculated value (dual channel only) or timer
Relay Functions	Scheduler (Timer), Alarm, Feeder Control, Event Control, Pulse Width Modulation, Frequency Control, and Warning
Relays	Four electromechanical SPDT (Form C) contacts, 1200 W, 5 A
Communication	MODBUS RS232/RS485, PROFIBUS DPV1, or HART 7.2 optional
Memory Backup	Flash memory
Electrical Certifications	EMC CE compliant for conducted and radiated emissions: - CISPR 11 (Class A limits) - EMC Immunity EN 61326-1 (Industrial limits) Safety cETLus safety mark for: - General Locations per ANSI/UL 61010-1 & CAN/CSA C22.2. No. 61010-1 - Hazardous Location Class I, Division 2, Groups A,B,C & D (Zone 2, Group IIC) per FM 3600 / FM 3611 & CSA C22.2 No. 213 M1987 with approved options and appropriately rated Class I, Division 2 or Zone 2 sensors cULus safety mark - General Locations per UL 61010-1 & CAN/CSA C22.2. No. 61010-1

**Subject to change without notice.*

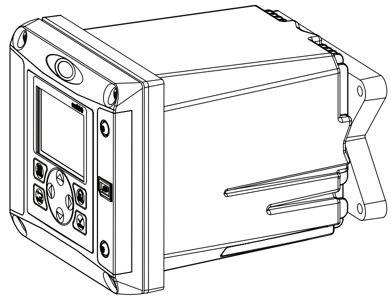
Dimensions

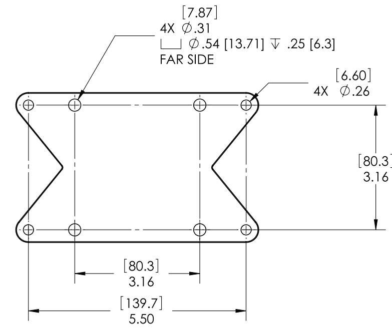
Surface Mounting Dimensions



Mounting Dimensions
(Rear View)

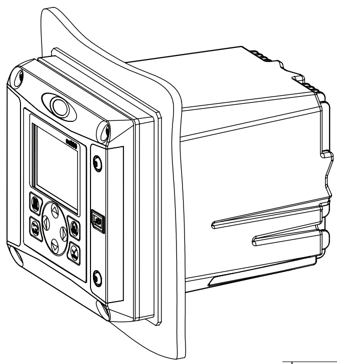
OR

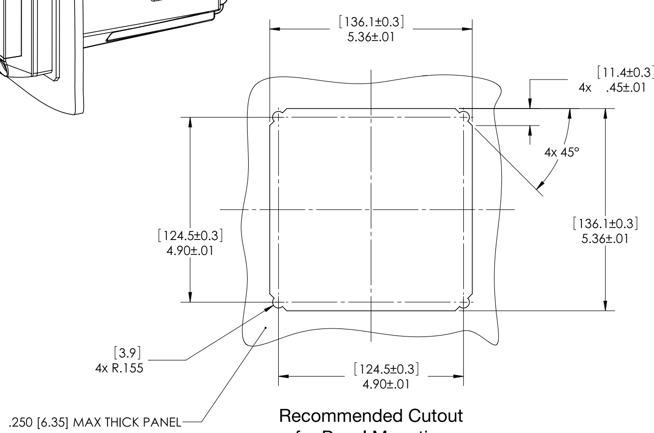




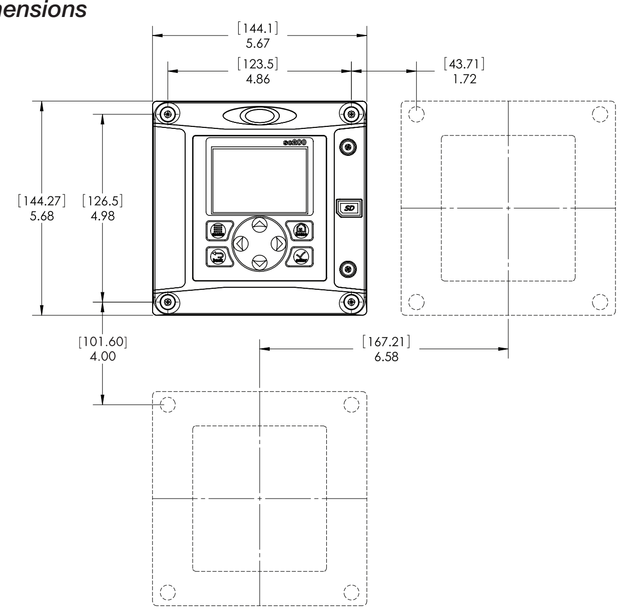
Bracket (supplied) for Surface Mounting
(Not compatible with Weather and Sun Shield
p/n 9220600 when surface mounting.)

Panel Mounting Dimensions



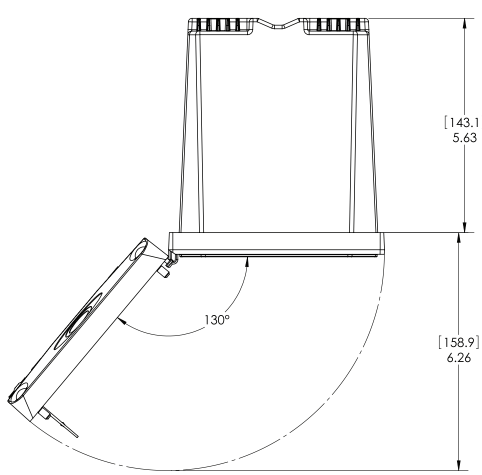


Recommended Cutout
for Panel Mounting

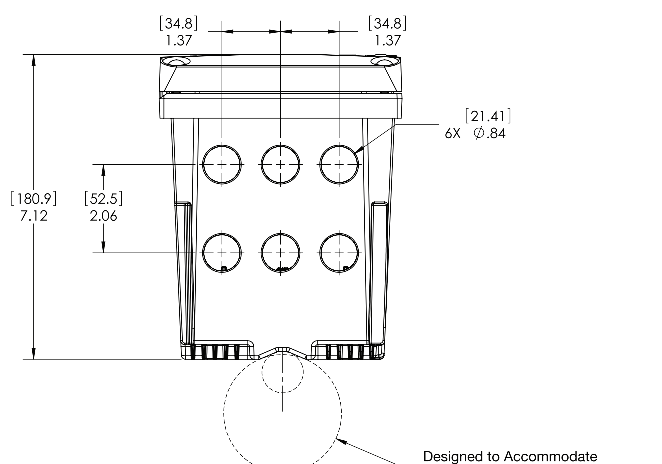


Minimum Spacing Dimensions
for Group Mounting

Top and Bottom Views



Door Opening Details



Ordering Information

sc200 for Hach Digital and Analog Sensors

LXV404.99.00552	sc200 controller, 2 channels, digital
LXV404.99.00502	sc200 controller, 1 channel, digital
LXV404.99.00102	sc200 controller, 1 channel, pH/DO
LXV404.99.00202	sc200 controller, 1 channel, Conductivity
LXV404.99.01552	sc200 controller, 2 channels, digital, Modbus RS232/RS485
LXV404.99.00112	sc200 controller, 2 channel, pH/DO

Note: Other Sensor combinations are available. Please contact Hach Technical Support or your Hach representative.

Note: Communication options (MODBUS, Profibus DPV1, and HART) are available. Please contact Hach Technical Support or your Hach representative.

sc200 for Ultrapure Sensors

9500.99.00602	sc200 controller, 1 channel, ultrapure conductivity
9500.99.00702	sc200 controller, 1 channel, ultrapure pH
9500.99.00662	sc200 controller, 2 channel, ultrapure conductivity
9500.99.00772	sc200 controller, 2 channel, ultrapure pH

Sensor and Communication Modules

9012900	Analog pH/ORP and DO module for GLI Sensors
9013000	Analog Conductivity module for GLI Sensors
9012700	Flow module
9012800	4-20 mA Input Module
9525700	Analog pH/ORP Module for Polymetron Sensors
9525800	Analog Conductivity Module for Polymetron Sensors
9013200	Modbus 232/485 Module
9173900	Profibus DP Module
9328100	HART Module
9334600	4-20 mA Output Module (Provides 3 additional mA Outputs)

Accessories

9220600	sc200 Weather and Sun Shield with UV Protection Screen
8809200	sc200 UV Protection Screen
9218200	SD card reader (USB) for connection to PC
9218100	4 GB SD card

HACH COMPANY World Headquarters: Loveland, Colorado USA

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Outside United States:	970-669-3050 tel	970-461-3939 fax	int@hach.com

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In the interest of improving and updating its equipment, Hach Company reserves the right to alter specifications to equipment at any time.

Be Right™

Sand Media Filter

48-2SSK

Overview:

The 48-2SSK sand media filter features two media tanks for silica filtration media and provides a 25 square foot filtration area for flows up to 425 GPM.

Features:

- 500 lbs. gravel and 1300 lbs. sand per tank
- AC and DC powered automatic filter backwash controller that allows for timed, pressure differential or manual backwash intervals
- Fitted with air vents and pressure gauges
- Corrosion resistant
- Stainless steel inlet, outlet and backwash manifolds
- Pressure sustaining valve to aid in backwash operation
- Solar battery charger for DC operation in remote locations
- Filter tanks are constructed out of 304 stainless steel
- 8" media loading and removal ports
- Most effective backwash rate is 190GPM min

Specs:

Max Flow	425 GPM
Material	Stainless Steel
Max PSI	100 PSI
Dry weight	2000 lbs.
Footprint:	132" x 43"
Filtration Area:	25 square feet
Inlet x outlet	6" x 6" Victaulic

Accessories:

- Spillguard
- Stainless Steel 304 and Carbon Steel storage tanks in Bi-Level, Mixer, Weir and Manifold configurations
- Polyethylene storage tanks
- Cartridge and bag filters
- HDPE pipe and fittings
- Roll off boxes, dewatering bins and vacuum boxes
- Flow meters and pressure reducing/ sustaining valves
- Aluminum Victaulic pipe and fittings
- Suction and discharge hose

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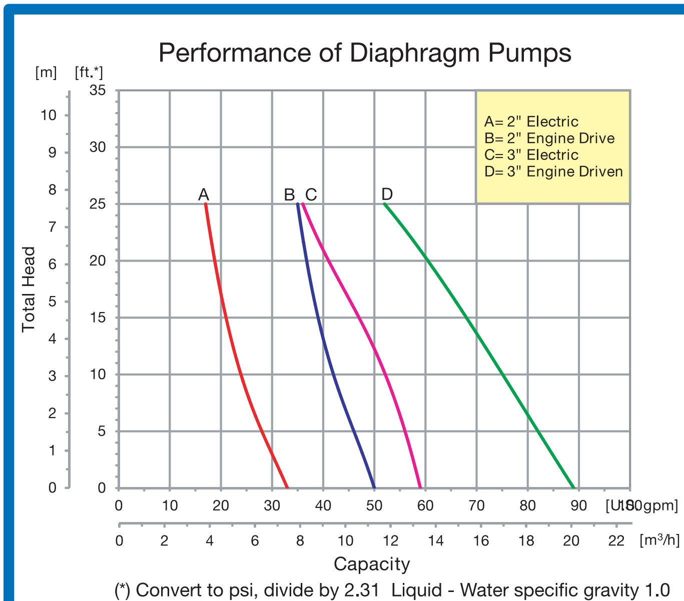
PUMPS • TANKS • FILTRATION • PIPE • SPILLGUARDS

TSURUMI PUMP

TD5 Self-Priming Diaphragm Pumps

- Sand cast aluminum construction for portability and durability
- Thermoplastic santoprene diaphragm
- 2" or 3" NPT suction and discharge ports
- Self-priming to 25 ft. Lift
- Maximum solids handling up to 1-5/8"
- Modular component design permits easy maintenance and cleanout
- Driver options: Gasoline, diesel or electric single & three phase motors
- Delivers up to 90 gpm
- 90° rotatable base on all models

The Tsurumi Pump diaphragm pumps features a 2-stage, heavy duty forged gear driven transmission. Often referred to as Mud or Sludge Pumps, diaphragm pumps are designed to pump mud, slurry, sewage and thick liquids that have the ability to flow. Tsurumi Pump diaphragm pumps are available with a choice of drivers to meet your application requirements: gasoline, diesel or single or three phase electric motor. Built-in check valve assures self-priming to 20 feet after initial prime. Heavy duty forged gear driven transmission is designed to operate pump at 40 strokes per minute for electric motor models and 60 strokes per minute for engine driven models. Each unit includes a 2" or 3" NPT steel suction strainer, two NPT nipples and a wheel kit for portability. **Suction and discharge port sizes cannot be reduced.**



TSURUMI (AMERICA), INC.
1625 Fullerton Court Glendale Heights, IL 60139
Tel: 1-888-878-7864 • www.tsurumipump.com

Self-Priming Diaphragm Pumps

TSURUMI PUMP

TD5 Self-Priming Diaphragm Pumps

2" Self-Priming Diaphragm Pumps

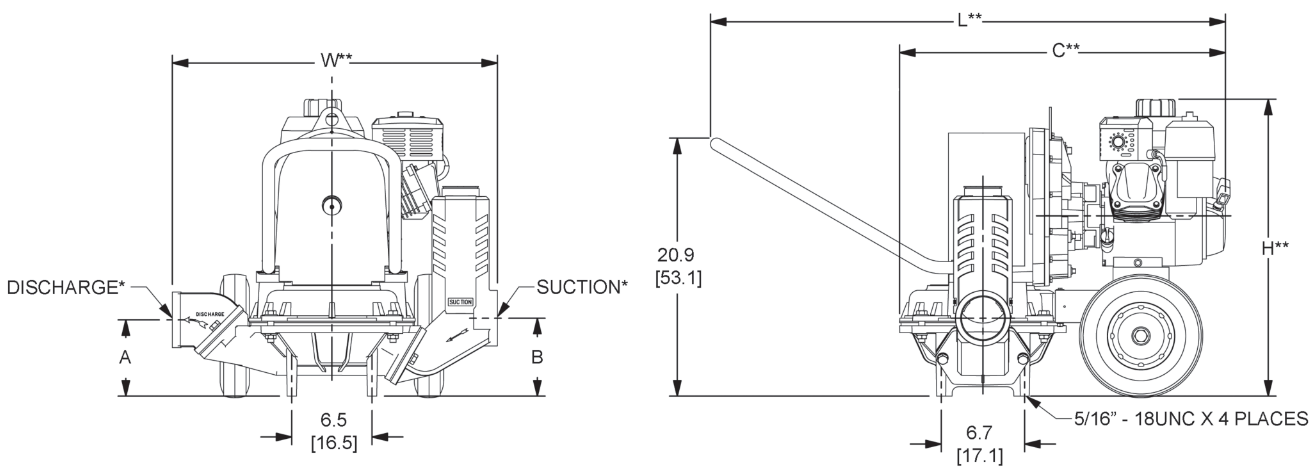
Model	Curve	Driver	Run Time (Hours)	Tank Size (Gal./Ltr.)	Ship Wt. (lbs.)	SUC*	DIS*	L**	W**	H**
TD5-200	B	Honda GX120	2.0	0.52/2.0	160	2 "	2 "	43.3[110.1]	20.1[51.0]	23.2[59.0]
TD5E-200	A	1.5HP Electric Motor	N/A	N/A	165	2 "	2 "	44.1[112.0]	20.1[51.0]	23.2[59.0]

Maximum solids handling capacity: 1-1/4" diameter

3" Self-Priming Diaphragm Pumps

Model	Curve	Driver	Run Time (Hours)	Tank Size (Gal./Ltr.)	Ship Wt. (lbs.)	SUC*	DIS*	L**	W**	H**
TD5-300	D	Honda GX120	2.0	0.52/2.0	175	3"	3"	43.4[110.1]	26.4[67.0]	23.4[59.4]
TD-E-300	C	1.5HP Electric Motor	N/A	N/A	185	3"	3"	44.1[112.0]	26.4[67.0]	23.4[59.4]

Maximum solids handling capacity: 1-5/8" diameter
(*) Standard NPT (female) pipe thread
(**) This dimension may vary due to engine manufacturer's specifications.
NOTE: Dimensions are in inches [centimeters] and have a tolerance of ±1/8"



Model	A	B	C**
TD5(E)-200	6.2 [15.7]	6.3[16.0]	28.6[72.7]
TD5(E)-300	6.2 [15.7]	6.3[16.0]	28.6[72.7]

**This dimension may vary due to engine manufacturer's specifications.
NOTE: Dimensions are in inches (centimeters) and have a tolerance of +- 1/8".

Standard Features

- Driver Options: Gasoline, Electric Single & Three Phase Motors
- 2" or 3" NPT Port Sizes
- Maximum Temperature 180°F
- Models TD5E-200/300 - 1.5 HP Single Phase, 115/230 VAC Motor with Manual Reset Overload

TSURUMI (AMERICA), INC.
1625 Fullerton Court Glendale Heights, IL 60139
Tel: 1-888-878-7864 • www.tsurumipump.com

LB Series

Top discharge provides maximum motor cooling while allowing continuous duty operation.

Available in single-phase or three-phase. Pumps fit into 8-inch pipes.

LB Series Features

LB(T)-1500:

High chrome semi-open impeller resists wear for adhesive particles.

Diode motor protectors prevent stator damage in high amperage or run-dry situations.

Up to 70' shut off head

Slimline design allows pumps to fit into 8" pipes.

LB Series Features

LB-800:

Designed to fit an 8" pipe.

Up to 60' shut off head.

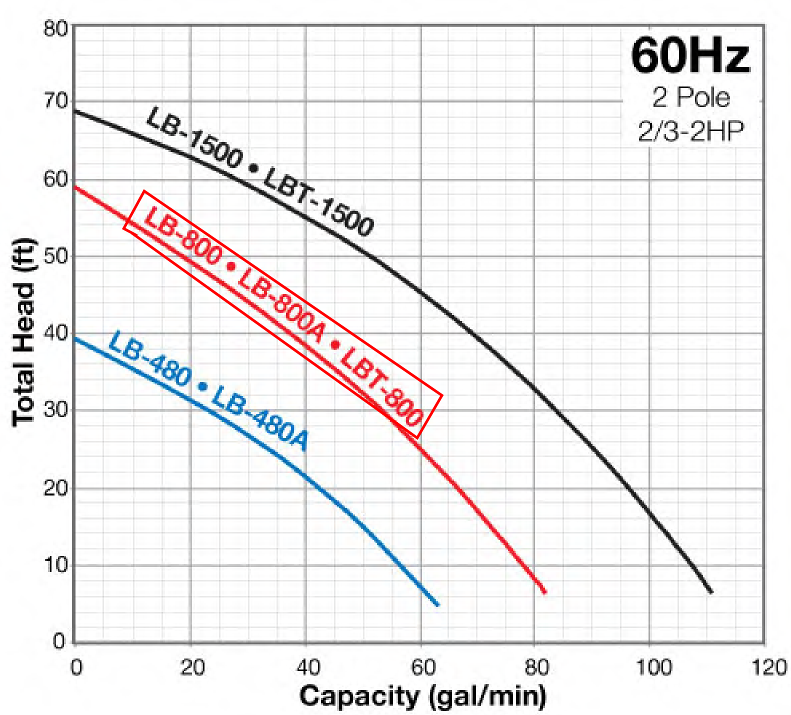
Available in 110V and 220V single-phase with 50 foot cables.

Double Inside Mechanical Seal With SiC faces provides the longest operational life.

Oil Lifter provides lubrication of the seal faces.

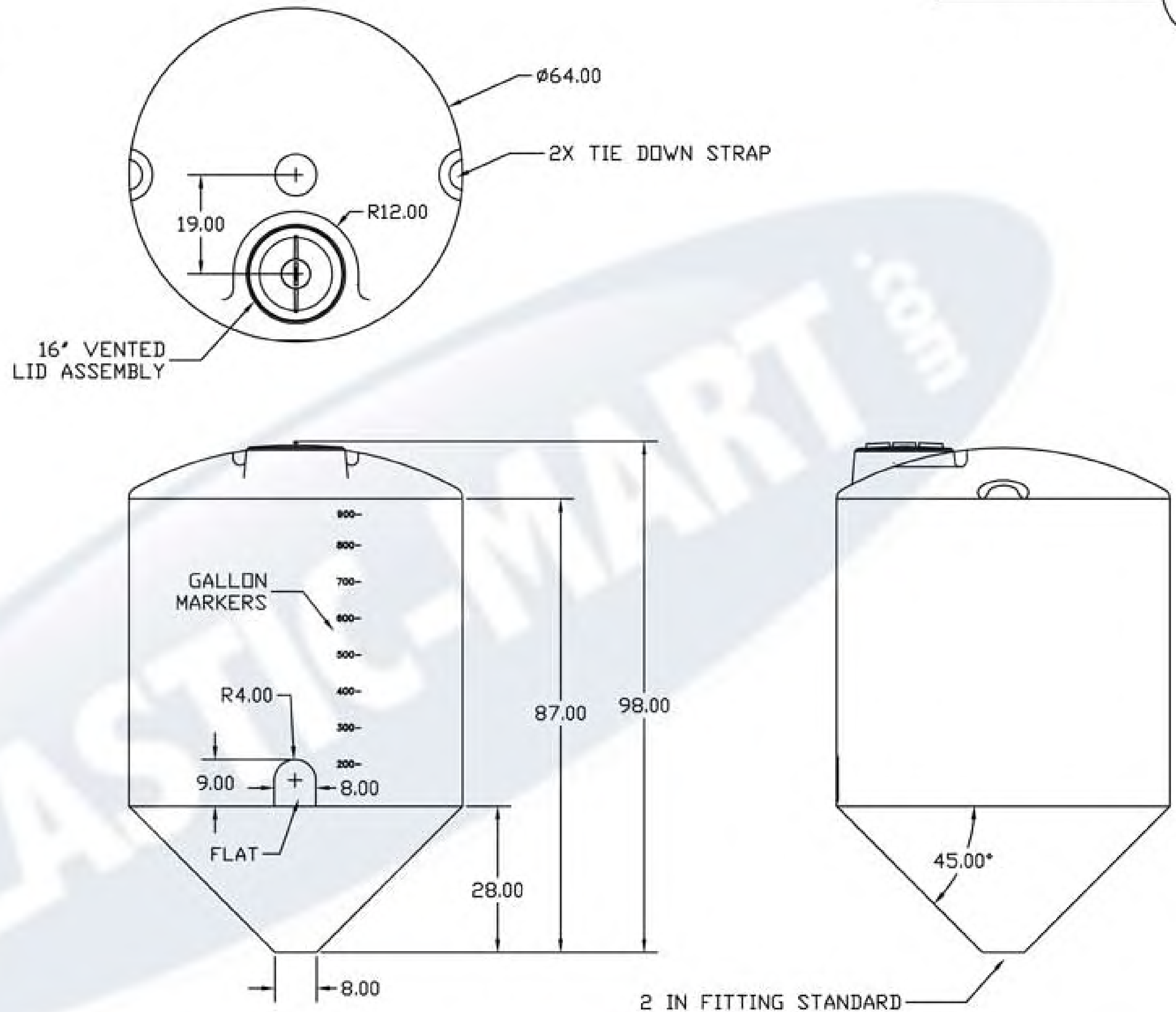
OPTIONAL ACCESSORIES
Float Switch for automatic operation
TS-302 for 110V, TS-303 for 220V.

Performance Range



Model	Discharge Size (in.)	Motor Output (HP)	Voltage (V)	Cable Length (ft.)	Diameter (in.)	Height (in.)	Weight (lbs.)
LB-1500	3	2	110V or 220V	50	7 3/8	23 5/16	72
LB-480	2	2/3	110V	32	7 3/8	11 1/4	28
LB-480A	2	2/3	110V	32	8 3/4	11 1/4	30
LB-800	2	1	115V or 230V	50	7 3/8	13 7/16	35
LB-800A	2	1	115 or 230	50	8 3/4	23 5/16	38
LBT-1500	2 or 3	2	230 or 460 or 575V	50	7 3/8	23 5/16	85
LBT-800	2	1	230 or 460 or 575V	50	7 3/8	13 7/16	35

CB1000-64 | A



A	ISOLATED TANK FROM STAND	5/23/06	NVE
REV	DESCRIPTION	DATE	APPRD

DRAWN / DATE
EDB 5/7/96

APPRD. / DATE
REH 4/18/07

MATERIAL

HDPE OR EQUIVALENT
REFERENCE MATERIAL DATA SHEET
FOR SPECIFIC PROPERTIES.

ALL DIMENSIONS ARE IN DECIMAL INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED
± 1% @ 68° F

THIRD ANGLE PROJECTION
ANSI 14.5M

NOTES:

1. NOM. WALL @ .350
2. SHOT WEIGHT 250 LBS.

PLASTIC-MART **866-310-2556**

CLIENT / DESCRIPTION
1000 GALLON CONE BOTTOM TANK

SCALE
N.S.

PART NO.
CB1000-64

Attachment 4
Response to Regulator Comments

RENOVA/SOVEREIGN JOINT VENTURE

MEMORANDUM

To: Dabra Seiken

From: Steven Passafaro

CC: Daniel Groher, Penelope Reddy, Robert Simeone, Marc Cicalese

Date: 23 July 2021

Re: **ATP Revised Pilot Test Work Plan**
Response to Regulator Comments
Remedial Action Operations at the Shepley's Hill Landfill, Former Fort Devens

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Renova-Sovereign Joint Venture (RSJV) has prepared this memorandum to provide responses to regulator comments on the July 2021 Arsenic Treatment Plant (ATP) Revised Pilot Test Work Plan. For ease of review, the original comment has been provided in italics followed by the response.

MassDEP Comments

No Comments

USEPA Comments

1. *Page 4 of 6, Pilot Test Operations - In addition to arsenic, analysis of manganese and iron is important for confirming performance characteristics and optimizing chemical dosing. Alternative or supplemental field test methods should be considered to provide a larger analytical working range that may help avoid need for sample dilution. CHEMetrics** provides colorimetric test kits based on the same chemical indicators that have larger analytical working ranges: 1) manganese (K-6502D, Analytical Range 0-60 ppm, MDL 9 ppm, $65 per 30 tests), and 2) total & soluble iron (K-6010, Analytical Range 0-1 ppm & 1-10 ppm, MDL 0.05 ppm, $72 per 30 tests soluble iron; K-6010D, Analytical Range 0-30 ppm & 30-300 ppm, MDL 5 ppm, $77 per 30 tests soluble iron).*
   *** - FYI only; does not constitute endorsement by EPA.*

   Response: We agree that the analysis of iron and manganese is important for confirming performance characteristics and optimizing chemical dosing. As a result, we intend to obtain a CHEMetrics Model K-6010D High Range Iron (0-30 ppm & 30-300 ppm) Test Kit to supplement our existing Hach Model IR-20 Iron (0-4 mg/l) and Manganese (0-3 mg/l) Color Disc Test Kit.

2. *Attachment 2, Iron Coagulant - EPA recommends substituting ferric sulfate in place of ferric chloride to help circumvent potential generation of chlorine gas and potentially reduce the corrosivity of treated water due to elevated chloride concentration. Commercial ferric sulfate coagulant can be purchased in granular form (e.g., ALAR F201** from ALAR Water Treatment**).*
   *** - FYI only; does not constitute endorsement by EPA.*

Response: Ferric sulfate will be added to the pilot test to evaluate its effectiveness versus ferric chloride.

MassDevelopment Comments

1. *Page 3 of 6, Pilot Test Operations: During pilot system optimization, samples will be collected from the pilot test discharge for lab and field analysis of arsenic. The sample results will be correlated to verify the accuracy of the field test kits. How many samples are anticipated to be taken to allow a confident measure of verification of accuracy? Will the lab and field analyses be performed on split samples?*

   Response: The number and frequency of laboratory and field tests will be determined by the field engineer based on the optimization of the pilot system and the test being performed. All discharge samples collected for laboratory analysis will be split and analyzed using the test kits as well. The results of laboratory arsenic tests will be expedited to allow for the timely acquisition of data. Upon acquisition of multiple days of data, the results of the laboratory and field test kits will be shared with the Devens Utilities Department to ensure the accuracy of the tests meet the Department's requirements prior to direct discharge of treated water to the effluent of the ATP from the pilot test holding tank without further treatment through the existing ATP system.

2. *Page 4 of 6, Pilot Test Operations: Treated water generated during the pilot test will be "periodically" field tested for arsenic and other constituents throughout each day of the pilot test. How often is "periodically"? Confirmatory lab samples will also be collected as determined by the field engineer. How frequently do you anticipate taking these samples for lab analyses during the initial phase of the pilot test?*

   Response: As noted in the response to Comment No. 1, the number and frequency of laboratory and field tests will be determined by the field engineer based on the optimization of the pilot system and the test being performed. Although it is not possible to precisely determine the number of samples collected each day at this time, it is anticipated that a series of samples will be collected with each adjustment to the dosage of each treatment chemical. This is a similar approach to the sampling frequency from the April 2021 bench testing.

3. *Page 4 of 6, Pilot Test Schedule: The anticipated duration of the pilot testing is four weeks with one week for setup and preparation, two weeks for pilot testing, and one week for dismantling and removal. Given that there may be "hiccups" in the process, is that enough time to gain the necessary information required to develop a full-scale design if the pilot testing results meet your goals?*

   Response: The schedule as currently proposed will allow for flexibility to obtain the data necessary to develop a full-scale design while dealing with any unanticipated issues. Also, and if necessary, the pilot test can be extended to gather additional data as determined by the field engineer.

4. *Attachment 1, WesTech Pilot Test Report: In Tables 7, 8, 9 and 11, the arsenic concentrations in samples using the field test kit (unfiltered) were far lower than in samples analyzed by the lab. Is this an indication that the field test kits are far less accurate than the lab tests? Or is this not an "apples to apples" comparison due to some aspect of the testing (such as filtration of samples)?*

Response: As noted in the comment, the results of field-testing unfiltered samples do not provide comparable data to laboratory analyses. During the pilot test, treated water will be filtered using a sand filter and/or the existing ATP microfilters prior to the collection of post-treatment field and laboratory samples. It is anticipated that the field and laboratory results of these filtered samples will demonstrate better accuracy than the results of the unfiltered samples. To allow for a greater range of testing, we have also ordered an Arsenic Quick (5 – 500 ppb) Test Kit to supplement the Quick II Test Kit (10 – 200 ppb) originally proposed for the pilot test. Regardless, direct discharge, as discussed in response to Comment No. 2, of treated water will not occur until the accuracy of the field test kits are adequately demonstrated.