



551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989



November 12, 2024

Subject: Request for Proposal
Berkshire Well Site Arsenic Media Replacement and Inspection Project

Contact: Nick Cooper, General Manager
661-831-0989
ncooper@greenfieldcwd.org

To Whom It May Concern,

Greenfield County Water District (**District**) is requesting proposals to remove and replace the arsenic media and gravel and inspect the two (2) - eight (8) ft. diameter x eleven (11) ft. tall vessels located at the Berkshire Well Site.

Proposals must be received by: 4:00 p.m., Friday, December 20, 2024
Award Project: Regular Scheduled Board Meeting, Monday, January 13, 2024.

The District is an equal employment opportunity organization.

This solicitation does not commit the District to award a contract to any bidder or pay any cost incurred in the preparation and presentation of proposals.

Should you have any questions concerning this Request for Proposal, please contact Nick Cooper.

Sincerely,

A handwritten signature in blue ink, appearing to be "Nick Cooper".

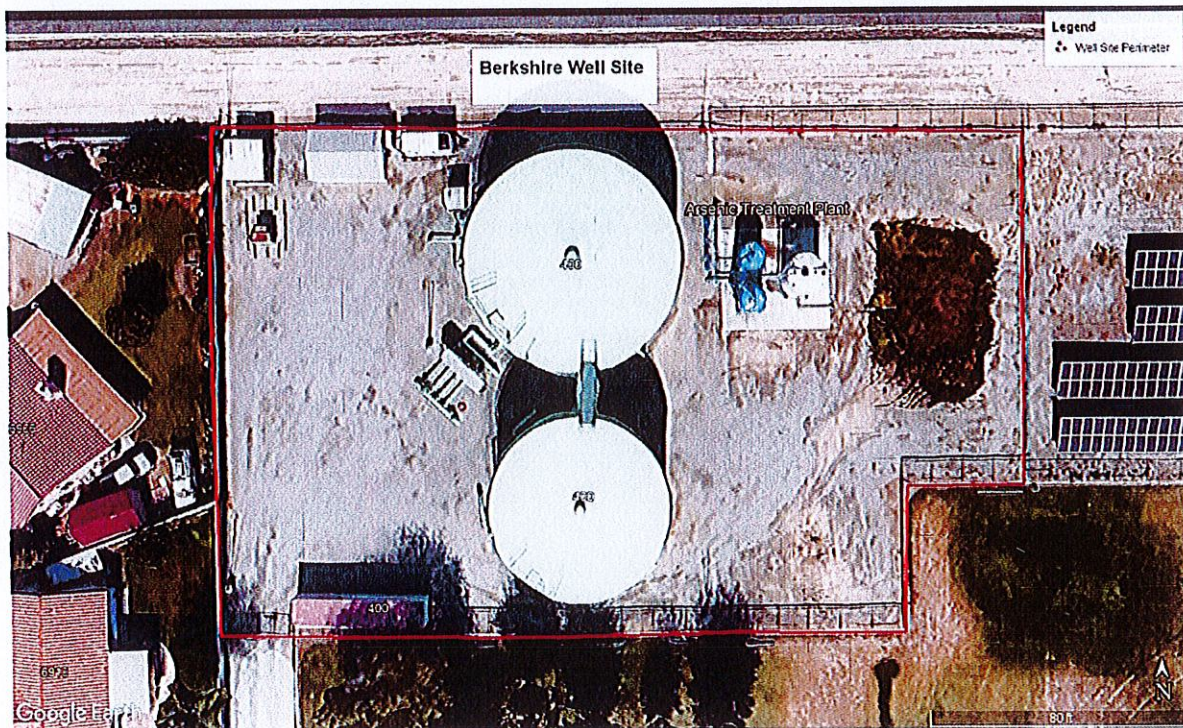
Nick Cooper
General Manager



1. Background and Need for Services

The District is requesting proposals for services to replace the arsenic media and gravel and inspect the two (2) - eight (8) ft. diameter x eleven (11) ft. tall vessels (**Exhibit A**) located at the District's Berkshire Well Site. All work must be completed by May 30, 2025.

2. Overview



- Berkshire Well Site is located at 400 Berkshire Rd. Bakersfield, CA 93307.
- Arsenic treatment plants were installed in 2019.
- Sites allows for discharge water.
- Contractor must be self-sufficient. Power will be available at well site.
- Contractor shall have the necessary certifications and training to complete the scope of work.

3. Scope of Work

Scope of Work performed by District certified operators:

- Dewater vessels prior to contractor and/or sub-contractor beginning work.
- Lock out -tag out all motors.
- Per tank, once disinfection is completed; District operators will fill tank, sample and review water quality before discharging to distribution system per AWWA Standards.



- Disinfection chemicals for conditions and the initial backwash of the filters. Approx. 6 gallons of 12.5% Sodium Hypochlorite total for both vessels.
- Spent media must have a Toxicity Characteristic Leaching Procedure (TCLP) test done before disposal in order to confirm that it meets the federal guidelines. District operators will retrieve composite core sample from the vessels and send sample to an approved lab for the TCLP (8 RCRA) metals testing. A copy of the TCLP test results will be provided to contractor a minimum of two (2) weeks prior to the scheduled service.

Scope of Work performed by Contractor includes:

- Contractor shall follow District's Operations and Maintenance Manual (**Exhibit B**).
- Contractor will provide crew, labor, equipment and expertise required to remove gravel and spent media, inspect vessel, replace gravel and media, return treatment plant to online and dispose of gravel and media.
- Contractor will supply bedding gravel and granular Bayoxide E33 media for change out.
- Contractor will remove gravel and spent media in each vessel and place into appropriate transportable containers. Contractor shall remove containers for disposal from well site.
- Inspection of vessels includes but not limited to the following:
 - Observe any plugged channels or wear on header or laterals. Flow water up through the collectors to ensure equal distribution.
 - Inspect interior coating for exposure to metal and reseal exposed spots with the proper coating.
 - All manways shall be inspected. Manway gaskets shall be replaced.
 - During inspection, contractor shall notify District of any needed replacement parts.
- The vessels shall be refilled with new gravel, new media, disinfected and put back into service.
- Contractor shall meet all laws, regulations and standards required for inspecting, cleaning, repairing and disinfecting potable water storage tanks, including but not limited to regulations and standards from California State Water Control Board, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, and American Water Works Association (AWWA).
- Prior to entering tanks, Contractor must follow all confined space entry procedures defined by OSHA.

4. Communication

- Contact the District Manager to schedule start date.
- Inform District Manager of recommended upgrades, repairs, rehabilitations, and replacements in a timely and effective manner. When possible, the opportunity to complete repairs should be given to the District while the vessels are offline.



5. Proposal Format

a) Background

- Provide a summary of background qualifications and related experience within last 5 years.

b) Contact Information

- Provide the name, phone number and email address of the contact to which questions about the proposal may be directed too.

c) Personnel & Qualifications

- Specialized Qualifications of the Project Manager and Team.
- Involvement and commitment of key personnel.
- Ability to perform within the schedule.
- Current depth of technical expertise.

d) Subcontractors

- Should Contractor utilize subcontractors for portions of this work, subcontractor contact information, qualifications and scope of work shall be included in the submittal.
- If subcontractors will not be utilized, please note, subcontractors will not be utilized.

e) Itemized Cost and Time

- Provide a breakdown of the cost and time required to complete scope of work.

f) References

- Provide a list of at least three references. Preferably references within Kern County.

6. Job Walk

Please schedule a job walk with Nick Cooper.

7. Questions

All questions/inquiries related to this Request for Proposal should be made in writing to Nick Cooper, who may be reached using the information above, no later than **4:00 p.m., Friday, December 6, 2024.**



551 TAFT HWY | BAKERSFIELD, CA 93307
Phone (661) 831-0989

8. Proposal Submittal

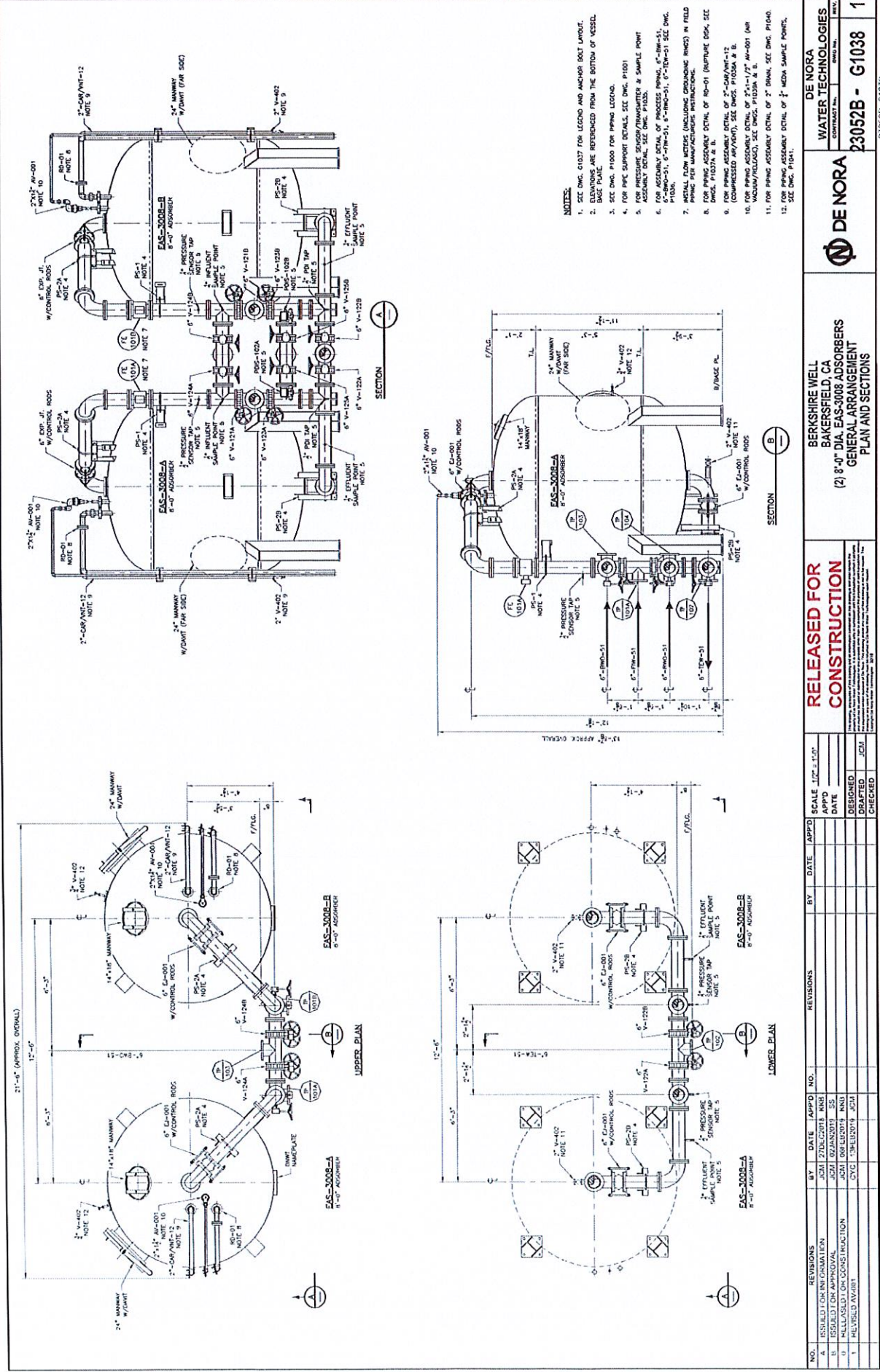
All proposals shall be submitted no later than **4:00 p.m., Friday, December 20, 2024**, to:

Email or Deliver Proposals:
Greenfield County Water District
551 Taft Hwy
Bakersfield, CA 93307
Attention: Nick Cooper, General Manager, ncooper@greenfieldc wd.org

9. Award Project

The District intends to award the Contract at the regular scheduled board meeting to be held on **Monday, January 13, 2024**.

Exhibit A



- NOTES:**
1. SEE DWG. G137 FOR LEGEND AND ANCHOR BOLT LAYOUT.
 2. ELEVATIONS ARE REFERENCED FROM THE BOTTOM OF VESSEL BASE PLATE.
 3. SEE DWG. P1000 FOR PILING LEGEND.
 4. FOR PNE SUPPORT DETAILS SEE DWG. P1001.
 5. FOR PRESSURE SENSOR/TRANSMITTER & SAMPLE POINT ASSEMBLY DETAILS SEE DWG. P1030.
 6. FOR PRESSURE SENSOR/TRANSMITTER & SAMPLE POINT ASSEMBLY DETAILS SEE DWG. P1030.
 7. METALL FLOW METERS (INCLUDING ORANGE RINGS) IN FIELD PIPING FOR MANUFACTURER'S INSTRUCTIONS.
 8. FOR PNE ASSEMBLY DETAILS OF 2" CW/WT-12 (COMPRESSED AIR/VAULT), SEE DWS. P1030A & B.
 9. FOR PNE ASSEMBLY DETAILS OF 2" AW-001 (AIR VACUUM/RELEASE), SEE DWS. P1030A & B.
 10. FOR PNE ASSEMBLY DETAILS OF 2" AW-001 (AIR VACUUM/RELEASE), SEE DWS. P1030A & B.
 11. FOR PNE ASSEMBLY DETAILS OF 2" AW-001 (AIR VACUUM/RELEASE), SEE DWS. P1030A & B.
 12. FOR PNE ASSEMBLY DETAILS OF 2" AW-001 (AIR VACUUM/RELEASE), SEE DWS. P1030A & B.

NO.	REVISIONS	BY	DATE	APPRO	NO.	REVISIONS	BY	DATE	APPRO
A	ISSUED FOR INFORMATION	JCM	2/28/2018	PAR					
B	ISSUED FOR APPROVAL	JCM	3/6/2018	PAR					
C	ISSUED FOR CONSTRUCTION	JCM	3/6/2018	PAR					
1	FIELD ASSEMBLY	CYC	10/16/2018	JCM					

SCALE: 1/2" = 1'-0"

DESIGNED: JCM
 CHECKED: JCM

RELEASED FOR CONSTRUCTION

DE NORA
 WATER TECHNOLOGIES
 CONTRACT NO. 23052B - G1038

DE NORA
 BAKERSFIELD, CA
 (2) 8'-0" DIA. EAS-3008 ADSORBERS
 GENERAL ARRANGEMENT
 PLAN AND SECTIONS

23052B-G1038

Exhibit B



De Nora Water Technologies, Inc.
SORB 33® As Removal System

PROCESS DESCRIPTION

**Greenfield County, CA
Berkshire Well**

**Project # 23052
June 2019**



Chapter 1 INTRODUCTION

1.1 Arsenic Removal System Description

The SORB 33[®] Arsenic Adsorption System is a commercially available product specifically designed for arsenic (chemical symbol – As) removal for small systems at the wellhead. SORB 33[®] products are standard packaged systems engineered for arsenic removal. A central component of the integrated SORB 33[®] system is the Bayoxide[®] E33 iron-based adsorption media developed and manufactured by Lanxess specifically for the removal of arsenic from drinking water. The granular ferric oxide media exhibits a high capacity for arsenic adsorption and, unlike other iron-based media, is delivered in a dry crystalline form. The E33 media is robust, easy to handle, stored and shipped dry, and has NSF 61 approval for use in drinking water.

Water from the source well is pumped through a vessel, called an adsorber, containing the media. As the water passes through the fixed bed of media, the arsenic is reduced to well below 10 micrograms per liter ($\mu\text{g/L}$) (the US EPA's Maximum Contaminant Level) until the media reaches its capacity. The spent media, which will pass the EPA's TCLP test for toxicity, is then removed and disposed of as non-hazardous waste. Unlike several other arsenic removal technologies, there is no chemical regeneration or flocculation, making the process simple, reliable, and minimizes labor. The media's high capacity for arsenic enables long operating life (typically 6 to 36 months between media change-outs depending on well usage and influent arsenic levels), thus minimizing operational attention requirements.

1.2 Arsenic Adsorption Chemistry

Arsenic Forms & Speciation: Arsenic in ground water is generally found in one of two inorganic valence states – As^{+3} or arsenite, **As(III)**, and As^{+5} or arsenate, **As(V)**. The more common and stable form is As(V). It exists in two ionic forms depending upon the water's pH. It is present in an oxidizing environment, i.e., where the electromotive force (EMF) or ORP of the water is positive or slightly negative. As(III) exists where the EMF is more negative. It readily oxidizes to Arsenic (V) when exposed to air or to a disinfecting oxidant. As a rule of thumb, Arsenic (III) will be found in waters containing higher levels of iron and/or manganese.

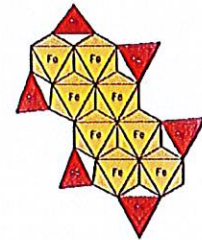
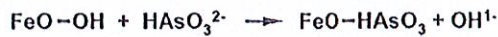
Adsorption Reaction: De Nora's SORB 33[®] Arsenic Removal Process is a fixed bed adsorption system using a granular ferric oxide media, or adsorbent, called Bayoxide[®] E33 for the adsorption of dissolved arsenic onto the solid media. It employs a simple "Pump & Treat" process that flows pressurized well water through a fixed bed pressure vessel containing the media where arsenic removal occurs.

In the SORB 33 Process, both As(III) and As(V) oxyanions are removed from water via a combination of adsorption or occlusion (adhesion) by reaction with ferric oxide ions. Above pH 7, the primary mechanism is the adsorption of arsenic oxyanions (HAsO_3^-) to the surface hydroxyl groups of ferric oxide hydroxide (FeO-OH) as illustrated on the following page.



Adsorption is a continuous process conducted at a specific flow, or loading, rate, normally about 7 gpm/ft², downward through the fixed bed adsorber for operating periods of about 1-4 months. In addition to specific flow rate, the other key process parameter is empty bed contact time (EBCT). This variable dictates the amount of water contact time within the bed required to effectively complete arsenic adsorption; the typical design value is 3.5 minutes.

As(V) Adsorption Reaction with Bayoxide® E33



The media adsorbs As(V) with rapid kinetics, but will also adsorb As(III) more slowly. Arsenite is nonionic at normal water pH's, and therefore, it will not be adsorbed as an anion. Adsorption kinetics for As(III) are slower than that of As(V), most likely because it is first oxidized by the media to As(V) before it is adsorbed.

1.3 Arsenic Adsorption Performance

Arsenic removal performance via adsorption is illustrated graphically using a "Breakthrough Curve" such as the one shown below. Performance of an adsorbent is measured by the number of bed volumes of water that can be treated with one bed volume (BV) of media before it exhausts, i.e. can no longer adsorb arsenic efficiently. The adsorption curve below is the predicted performance for Bayoxide E33 media used to treat the water. The projected volume per vessel in the table below represents the concentration at which the treated water's Arsenic level is nearing the MCL of 10 µg/L. This is called the breakthrough point.

Monitoring of SORB 33 performance is done by routine analysis of the treated water. Initially, this can be done monthly. As the treated water Arsenic level increases, this frequency is increased to semi-monthly to be able to schedule media replacement as close to the breakthrough point as possible without exceeding the MCL.

Figure 1 is the breakthrough curve for the adsorber. Based upon a performance model, the media will treat 115 million gallons (98,800 BV's).

Bayoxide E33 performance is unlike breakthrough curves for water softening resins or other adsorbents, which breakthrough rapidly to influent levels leaving little time for media change-out. Using Bayoxide E33, arsenic will continue to be adsorbed even after it exceeds the MCL.

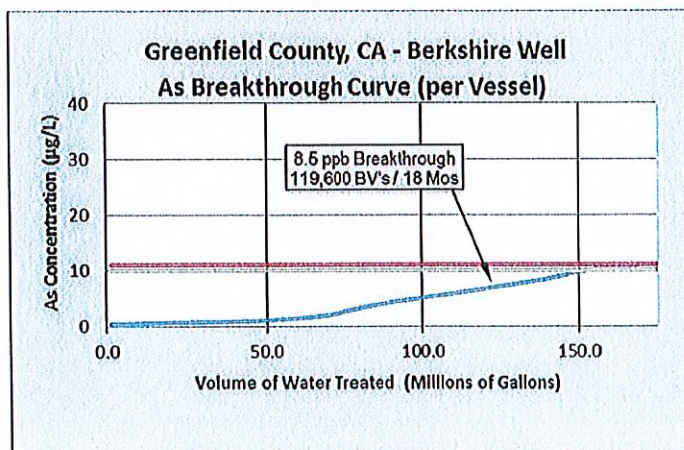


Figure 1



1.4 Water Analysis & Design Parameter Data

The constituent's analysis (assays) in the water used to determine the SORB 33 system performance is listed in Table 1. Assay values not reported are listed as not available (N/A).

Table 1: System Design Water Analysis

Berkshire Well - Water Analysis							
pH	8.13	Alkalinity	96 ppm	Chromium	N/A	ppb Cr	
EMF (ORP)	N/A	Chloride	8 ppm Cl ⁻	Iron	63	ppb Fe	
Water Temp.	75 °F	Fluoride	0.17 ppm F	Manganese	5	ppb Mn	
Arsenic	11.1 ppb As	Hardness	62 ppm	Selenium	N/A	ppb Se	
As(III)	N/A ppb As	Phosphate	0.15 ppm PO ₄	Tungsten	N/A	ppb W	
TTI Dissolved Solids	192 ppm	Silica	21 ppm SiO ₂	Uranium	N/A	ppb U	
Turbidity	0 NTU	Sulfide	N/A ppb S	Vanadium	15.8	ppb V	

Table 1

General system information and the system design parameters are shown below in Table 2. Each of the key variables including system size, media volume, performance, service and backwash rates are listed in this table.

Table 2: General Information

Project Name & General Information			
Client:	Greenfield County Water District	Average Flow:	0.86 MGD Avg
Name of Site:	Berkshire Well	Well Capacity:	1,200 gpm
Primary Contact:	Rex Mason	Treatment Flow:	693 gpm
Engineer:	Quad Knopf	Op Factor: 12.0 Hrs/Day or 50%	42.3% Bypass
System Design			
SORB 33® Model No:	EAS-3008	Contact Time (EBCT) & Bed Depth:	3.4 min / 3.1 ft
Adsorber No & Size:	Two 8.0 ft Diameter	Average Treatment Rate:	864,000 gal/Day
System Footprint:	20'L x 10'W x 12'H	Design Flow Rate per Adsorber:	346 gpm
Flow Configuration:	Parallel w/ Bypass	Loading Rate (Specific Velocity):	6.9 gpm/ft ²
Adsorptive Media:	Bayoxide E33 Granules	Estimated Working Capacity:	119,600 BVs
Media Quantity:	9,904 lbs (4.49 MT)	Total Media Cycle Life:	18.3 Months
	311 cubic ft		
Backwash Volume:	7,150 gal/vessel	Volume Treated per Cycle:	
SORB Backwash Rate:	550 gpm	Arsenic Analysis:	11.1 µg/L As
pH Adjustment:			
Special Features:	Backwash Reclaim;	Pres:	75 psig



1.5 Safety Considerations

Safety at a water treatment site is of no less priority than the importance of good operation and maintenance of a plant. The De Nora SORB System is designed and constructed with the understanding that safety features are inherent in the physical facilities of the plant. The OSHA standard has been the guideline for the system during design and construction. The operators of the system should also observe it.

De Nora recommends the system owners and operators draft Standard Operating procedures (SOP's) to address any routinely performed procedures with safety acknowledgements of the task incorporated. These tasks include valve position changes, backwashing, rinsing, treatment valving, etc.



Chapter 2 PROCESS OPERATION

The following sections describe each of the water treatment steps with the equipment provided by De Nora. Other equipment not provided by De Nora should be referenced by the other vendors' documentation.

Greenfield County, CA Berkshire Well SORB 33[®] Arsenic Removal System consists of the following equipment supplied by De Nora:

- Two 8'- \emptyset SORB 33 adsorbers operated manually and in parallel flow configuration
- Valve tree containing all valves required for treatment and backwashing
- Influent flowmeters
- Bypass flowmeter
- Differential pressure devices for each vessel
- Pressure gauges to compare with DP devices
- Pressure relief valves for each vessel
- Various sample points throughout the system
- Backwash Reclaim System

2.1 Adsorption Treatment

Arsenic removal via adsorption is done by a downward flow of water through a fixed bed of media contained in a pressure vessel. SORB 33[®] adsorption units are designed to match well pump capacities unless otherwise specified by the client.

Flow meters FIT-101A and FIT-101B in the adsorber feed lines totalize the volume of well water being fed to that vessel. It is important to record the totalizer reading when media is replaced in the vessel, because the media life and performance are determined by the volume of water treated prior to breakthrough. Routine arsenic analysis of treated water samples is used to monitor treatment performance and determine when the media must be replaced.

As water is treated through the adsorber, the pressure differential ("delta P" or ΔP), measured by instruments PDI-102A and PDI-102B across the adsorber will slowly increase. The vessel should be taken off-line for media backwashing when its ΔP increases above 10 psi unless the backwashing step is scheduled beforehand. If this "resistance to flow" increases more rapidly in one vessel than the other, it will show a reduction in flow rate relative to the other rather than an increasing ΔP . This is because both vessels are discharging water into the same effluent header. After a backwash, the clean media bed should measure a ΔP of only 1-3 psi. Pressurized System water will be used as the backwash source, and the well will be offline during backwashing. DP measurements should always be compared to the pressure gauges installed in the influent and effluent lines.

During treatment, an oxidant/disinfectant, typically NaOCl or Cl₂, will be fed upstream of the arsenic removal system with the goal of maintaining an arsenic removal system effluent Cl₂ residual of at least 0.5 mg/l. This ensures complete oxidation of As(III) to As(V) for most efficient As removal as well as prevents the growth of iron reducing bacteria.



The system utilizes a treatment bypass to extend the life of the media. The following equation and table should be used to optimize the bypass percentage required to achieve a blended arsenic concentration of 7 ppb:

$$Bypass(\%) = \frac{BypassFlow(gpm)}{TotalWellFlow(gpm)} = \left[1 - \left(\frac{As_{in} - As_{target}}{As_{in} - As_{out}} \right) \right] * 100$$

Table 3: Bypass Percentages

As Out As In	1 ppb	2 ppb	3 ppb	4 ppb	5 ppb	6 ppb	7 ppb
8.6 ppb	79%	76%	71%	65%	56%	38%	0%
9.1 ppb	74%	70%	66%	59%	49%	32%	0%
9.6 ppb	70%	66%	61%	54%	43%	28%	0%
10.1 ppb	66%	62%	56%	49%	39%	24%	0%
10.6 ppb	63%	58%	53%	45%	36%	22%	0%
11.1 ppb	59%	55%	49%	42%	33%	20%	0%
11.6 ppb	57%	52%	47%	39%	30%	18%	0%
12.1 ppb	54%	50%	44%	37%	28%	16%	0%
12.6 ppb	52%	47%	42%	35%	26%	15%	0%
13.1 ppb	50%	45%	40%	33%	25%	14%	0%
13.6 ppb	48%	43%	38%	31%	23%	13%	0%
14.1 ppb	46%	41%	36%	30%	22%	12%	0%

“As In” refers to the arsenic concentration of the influent water in ppb (µg/L), “As Out” refers to the arsenic concentration of the treated effluent in ppb (µg/L), and the percentage values in the middle represent the bypass percentage required to achieve the blend target of 7 ppb. The percentage should be multiplied by the total flow to the system, and the bypass flow control valve should be adjusted until the bypass flowmeter reads the correct flowrate.

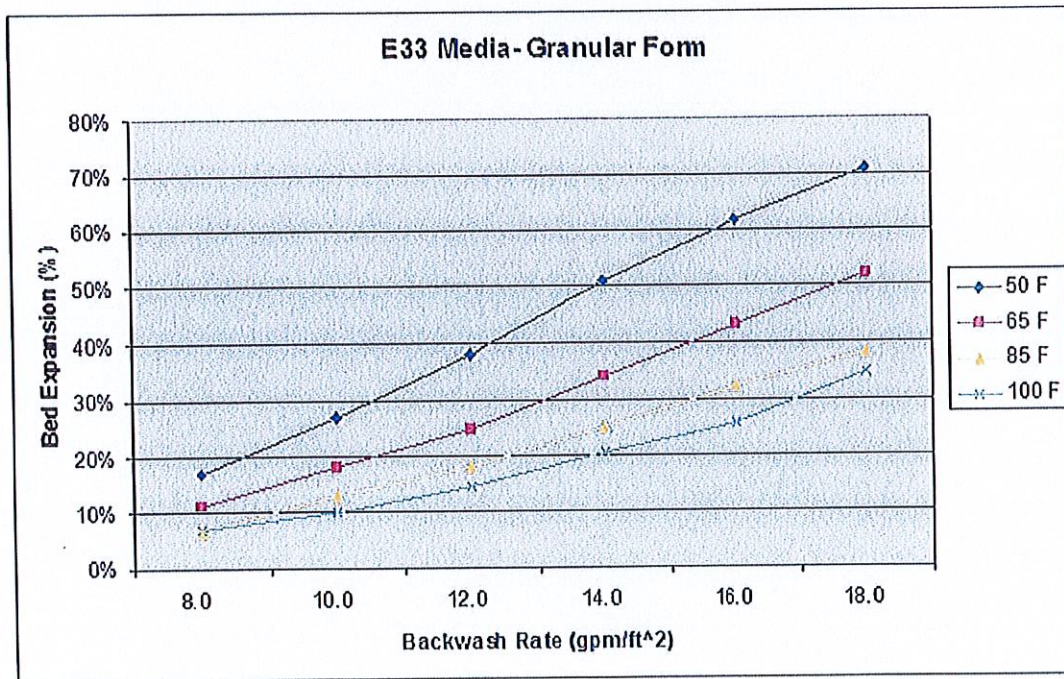


2.2 Media Backwash and Rinse

Adsorber backwash events are initiated by the operator based upon an increasing differential pressure through each vessel. The differential pressure is measured by the differential pressure devices (PDI-102) and is monitored by the difference between the influent and effluent pressure gauges, PI-173 and PI-174. To account for the volume of water used for backwashing, operators should record the forward and reverse totalizer value before and after each backwash.

Backwash flowrates should vary with water temperature due to variable expansion. Each time a backwash is conducted, the Backwash Flow Rates chart below should be used to produce a bed expansion target of 20 to 30% for an effective backwash.

Figure 1 – Arsenic Media Backwash Expansion vs. Water Temperature



Determine the best unit flow backwash rate (gpm/ft²) for the current water temperature. Then multiply by the 50.3 ft² vessel surface area to determine backwash water rate in gpm. Example: At a water temperature of 65 deg F and 20% bed expansion, this gives a backwash rate of approximately 10.5 gpm/ft² or 528 gpm (50.3 ft² X 10.5 gpm/ft²).



Table 4 describes the different adsorber valves.

Table 4: Valve Descriptions

Valve or Loop No	Valve Description
Adsorber A	
V-121A	RWW – Raw Water Feed
V-122A	TEW – Treated Effluent Water
V-123A	BWI – Backwash Water Influent
V-124A	BWE – Backwash Waste Effluent
V-125A	RWO – Forward Rinse Waste
Adsorber B	
V-121B	RWW – Raw Water Feed
V-122B	TEW – Treated Effluent Water
V-123B	BWI – Backwash Water Influent
V-124B	BWE – Backwash Waste Effluent
V-125B	RWO – Forward Rinse Waste
Common	
FCV-108	TBW – Treatment Bypass Water

Table 5 describes the step by step sequence of operations during the adsorption cycle and the steps that the operator will follow to backwash an adsorber using these valves.



Table 5: Backwash Sequence (Adsorber A)

Activity	Step	Mechanical/Action
Adsorption Service	0	<ul style="list-style-type: none"> Both vessels operate in parallel Open V-121 A&B, V-122 A&B Influent flowmeters FIT-101 A&B totalize volume of water treated through each vessel
Backwash Preparation: Vessel A	A1	<p>Set Bypass Valve Position</p> <ul style="list-style-type: none"> Manual Valve FCV-108 controls flowrate through FIT-108 <p>Note: The well must be in operation to supply water for backwash.</p> <ul style="list-style-type: none"> First, throttle FCV-108 to allow the required backwash water flow rate through the adsorbers as measured by FIT-101A&B. Close Raw Water Valve V-121A (Adsorber Inlet) Close Treated Water Valve V-122A (Adsorber Outlet) Open Backwash Water Influent Valve V-123A Open Backwash Waste Effluent Valve V-124A
Backwash: Vessel A	A2	<ul style="list-style-type: none"> Slowly Close Adsorber B Raw Water Valve V-121B until Adsorber A FIT-101A reads the required Backwash Water Flow as determined in Figure 1. Continue backwash for 12 minutes Visually monitor backwash waste to ensure media particles are not being blown out
Rinse Preparation	A3	<ul style="list-style-type: none"> Slowly Open Adsorber B Raw Water Valve V-121B Close Backwash Water Influent Valve V-123A Close Backwash Waste Effluent Valve V-124A
Forward Rinse: Vessel A	A4	<ul style="list-style-type: none"> Open Raw Water Valve V-121A (Adsorber Inlet) Open Forward Rinse Waste Valve V-125A Slowly Close Adsorber B Raw Water Valve V-121B until FIT-101A measures 400 gpm Continue rinse for 2 minutes or until the rinse effluent is clear
Back to Service	A5	<ul style="list-style-type: none"> Open Adsorber B Raw Water Valve V-121B Close Forward Rinse Waste Valve V-125A Open Treated Water Valve V-122A (Adsorber Outlet) Slowly Throttle Bypass Valve FCV-108 until the required treatment flows are attained

The same sequence is followed for Absorber B but switching the valves on the opposite adsorber.



2.3 System Monitoring & Sampling

The SORB 33 System is designed to be operated unattended except when backwashes are conducted. The flow rate and pressure differential of the adsorber should be checked on a routine basis.

The treated effluent quality should be visually checked routinely. Also, the adsorber backwash effluent should be checked every time to observe the dirt load in the initial effluent after 2 minutes of backwashing and near the termination of each backwash. The initial samples should be turbid or red with solids. The terminal samples should be light orange in turbidity. The forward rinse effluent from the adsorber should be checked 1 minute after rinse flow has started. This effluent should be clear.

The following sampling and analysis schedule is recommended. Field test kits are adequate for analyses (Arsenic Econo-Quick II™ Test Kit):

- Treated Effluent from Adsorber: As – twice per month, Cl₂ residual – twice per month
- Feed Water: As – once per month; pH - daily
- Backwash Effluent: Qualitative Solids Level of initial & terminal backwashes, rinse – every event
- Spent Media: TCLP prior to media changeout



Adsorber Breakthrough Monitoring: The adsorber should be monitored individually as well as complete system monitoring after bypass and blending (if applicable). Laboratory arsenic analysis from the adsorber's treated effluent is recommended to be taken at a minimum of once a month depending on system use and volume of water treated. By tracking the effluent arsenic level, breakthrough can be predicted thus allowing for adequate time for new media orders.

$$\text{Bed Volumes (BV)} = \frac{\text{Total treated (gallons)}}{\text{Media Volume (ft}^3\text{)}} \times \frac{1 \text{ (ft}^3\text{)}}{7.481 \text{ (gallons)}}$$

$$\text{Empty Bed Contact Time (EBCT)} = \frac{\text{Media Volume (ft}^3\text{)}}{\text{Flow Rate (gpm)}} \times \frac{7.481 \text{ (gallons)}}{1 \text{ (ft}^3\text{)}}$$

Greenfield County Berkshire Well Calculations

$$\text{Bed Volumes (BV)} = \frac{311 \text{ (ft}^3\text{)}}{311 \text{ (ft}^3\text{)}} \times \frac{1 \text{ (ft}^3\text{)}}{7.481 \text{ (gallons)}}$$

$$\text{Empty Bed Contact Time (EBCT)} = \frac{311 \text{ (ft}^3\text{)}}{693 \text{ (gpm)}} \times \frac{7.481 \text{ (gallons)}}{1 \text{ (ft}^3\text{)}}$$

3.36 minutes (3 min 22 sec)

Equipment Monitoring: During operation, monitor the following parameters:

PDI-102 (or PI-173 & PI-174) – Differential pressure through each adsorber, normally in the 2-4 psi range, is a measure of the media's condition, i.e., how well fluffed or packed it is. An increase of this ΔP indicates that the media is getting more packed down and is resisting flow. The adsorber should be backwashed when the ΔP reaches 10 psi.

Influent Flow Meter (FE-101) - Flow to each vessel should be monitored to ensure that the maximum hydraulic loading rate is not exceeded (402 gpm).



2.4 Residuals Handling

There are two residuals, or waste, streams generated from the SORB 33® As Removal process. The Bayoxide® E33 media becomes spent, or exhausted, after several months of service. It is removed and disposed of as a non-hazardous solid waste.

The second residual is the wastewater generated from media backwashing which is done on a frequency of once every 1-4 months, depending on the influent water quality (Fe, Mn, etc.). It is non-hazardous, containing only a few PPM of iron oxide media fines.

Initial Backwashing contains fine E33 Bayoxide media particles in the range of 0.04–0.60 mm (400-28 mesh Tyler Sieve size). This material is non-hazardous and will not disturb biological processes if discharged into a sanitary sewer line. A one-time permit may be required to do this.

The backwash waste is captured in an on-site backwash reclaim tank. After backwashing, the waste can decant for a minimum of 8 hours to allow all fines to settle. Backwash reclaim will be an operator controlled event. After an 8-24 hour decant period the operator will initiate backwash reclaim by selecting the auto mode on the backwash reclaim control panel. During reclaim operator will toggle the reclaim switch between off and auto so that backwash reclaim pump PC-01 runs while the well pump is running. While in auto the control panel will monitor the reclaim tank level by ultrasonic level sensor LIT-301. When LIT-301 measures an operator set low level setpoint, typically 10-20%, reclaim pump PC-01 will be disabled.

2.5 Process Controls

All the valving for the system is manual. Flow meters with totalizers are to be monitored regularly for proper flow and totalizer readings when samples are taken for arsenic analysis.

Flow transmitters, FIT-101A, FIT-101B and FIT-108 will communicate with the sites SCADA. They will have high and low alarms with initial set points per the table below. The alarm setpoints will be operator adjustable depending on site requirements.

Instrument Tag	Initial High Flow Alarm Setpoint	Initial Low Flow Alarm Setpoint
FIT-101A / 101B	425 gpm	300 gpm
FIT-108	650 gpm	300 gpm

Each vessel will have a pressure transmitter on their respective influent and effluent lines. These will communicate with the sites SCADA. When the measured pressure differential is greater than 10 psi SCADA will read a high-pressure differential alarm, PDAH-102A or PDAH-102B.

$$\text{If PIT-102} - \text{PIT-103} \geq 10 \text{ PSI, then PDAH-102}$$



Backwash reclaim is initiated by the operator at the backwash reclaim panel. When the backwash reclaim is put in auto, backwash water will be reclaimed until LIT-301 reads a low level to prevent PC-01 from running dry. While in auto the control panel will receive a well running signal from the well pump. Additionally, when the well pump is running the backwash reclaim pump will activate and when the well pump is not running the backwash reclaim pump will deactivate. In hand, the pump will run regardless of the level reading from LIT-301 or the status of the well pump.

There will be a high-level alarm if LIT-301 measures the level in TK-01 to be unacceptably high. The high level can be set by the operator at the level indicator on the De Nora panel. There will be a local alarm indicator at the De Nora panel and an alarm signal will also be sent to SCADA. There is a local push button alarm reset on the De Nora panel.

2.6 System Shutdown & Standby

Standby: The SORB 33® System can remain idle for a few weeks without any required action. If the system is to be down for an extended period (~1 month or more), the adsorber should be backwashed with water containing double the normal chlorine dose. Prior to start-up, water with 2-4 ppm free chlorine residual should be fed to the adsorber, and it should be allowed to be rewetted for 2 hours prior to being backwashed again. These measures guard against biological growth in the adsorber during shutdown. After normal operation resumes, the chlorine dose can be reduced to the normal level.

Shutdown: Treatment will stop when the well pump shuts down. Valves V-121 and V-122 on the vessel should remain open while the system is in this idle, or standby, mode.

Chapter 3 ADSORPTION MEDIA

3.1 Bayoxide® E33 Media

Lanxess (formerly Bayer AG) partnered with De Nora during the late 1990's to develop a granular ferric oxide (GFO) media called Bayoxide® E33 (E33) for use in drinking water As adsorption. Lanxess is a large chemical company who are also specialists in the production of applied iron oxide technologies. They developed a product that met DNWT's specifications of high As capacity, robustness, ease of handling and purity.

Lanxess produces E33 at their Uerdingen facility in Leverkusen, Germany. It is a dry crystalline product with a particle size range of 0.3-2.0 mm (10-50 mesh) and is packaged and shipped in 750 kg supersacks (1,654 lbs). E33 has a bulk density of about 29 lbs/ft³ and a long shelf life. The Uerdingen facility has the capacity to meet all DNWT's needs for the UK, the US and elsewhere in the world. Table 5 below lists the key product specifications.

Chemical Designation	Synthetic Iron Oxide Hydroxide - α -FeOOH	CAS	No. 20344-49-4
FeOOH Content	90% Typ	Average Specific Surface Area	150 m ² /g
Average Bulk Density	29 lb/ft ³	Moisture Content	8% Typ
Particle Size Distribution	0.3 – 2. mm	Particle Density	3.6 g/cm ³

Table 5 Bayoxide® E33 Product Data

3.2 Media Conditioning

During installation, new Bayoxide E33 media should be chlorinated, soaked, and backwashed as part of its conditioning process. After gravel installation, water is added to a level above the gravel. Chlorination is then done by adding 50% of the required conditioning amount to the vessel. The media is then added, and the vessel is filled to a level above the media. The other half of the chlorine is then added. The total volume of chlorine to add is below:

One Gallon 12.5% Sodium Hypochlorite per 70 ft³ of Media

After fill & chlorination, the media should be "wetted" (soaked) for at least 4 hours to remove any air bubbles. It is then backwashed first at 50% of the design rate, then at normal backwash rate until the backwash effluent begins to clear up. The effluent will not turn clear but will appear light brown in color.

3.3 Spent Media Disposal

Procedures for the media's non-hazardous solid waste classification vary from state to state. Typically, its classification must be verified by the EPA's Toxicity Leachability Characterization Procedures (TCLP). Samples of spent media are submitted to a state- certified laboratory for the TCLP test. Upon completion and approval, the spent media is disposed of in a non-hazardous landfill.



Chapter 4 STARTUP PROCEDURES

4.1 Media Storage

1. Until installation, Bayoxide® E33 media should be stored in original shrink-wrapped sacks, in a dry warehouse or covered securely with tarps to prevent direct sunlight for prolonged time. Sacks should be stored on pallets to keep them off the ground.
2. Media support gravel should also be stored similarly to the E33 media.
3. Any small tears in bags from unloading or delivery should be first reported, photos taken at time of incident or discovery and sealed with duct tape. Report any media losses to DNWT immediately.
4. Damage to bag lifting loops may require rebagging to permit safe handling later.
5. Inspect bags periodically to make sure rodents or insects have not damaged them.

4.2 Preparation for Startup

1. Have DNWT review operating manual, backwash sequence, and control design prior to plant startup.
2. Flush and backwash water source should be clean potable water containing no chemical other than chlorine. If other chemicals are present, such as pipe corrosion inhibitors, they could adsorb onto the media and shorten its life. Have DNWT review any proposed chemical additions.
3. Flush and disinfect all process piping and vessels with low turbidity water from a potable water source. Make sure any fine passages in underdrain components do not become plugged with debris.
4. Hydrotest all piping and tanks.
5. Complete proper piping, valves, tank, and other auxiliary treatment system component disinfection for the presence of coliform and heterotrophic bacteria per AWWA potable water disinfection standards and any additional local regulatory requirements.
6. If control system is being completed by another vendor, test backwashing sequence before gravel and media loading to ensure proper operation.
7. Test all valves and calibrate control equipment prior to media loading
8. Virgin media backwash water supply is required at a rate of 11-13 gpm/ft² from a potable water source depending on water temperature. One vessel will be backwashed at a time.
9. Backwash water source should be flow-regulated (throttled valve or pump VFD) to prevent excessive water flow.
10. Permanent or temporary backwash control valves if supplied by other vendors for virgin media backwash water supply should be capable of controlling the slow increase in water flow from the supply source in a controlled manner, to prevent water hammer to the underdrain system, gravel, media, and instrumentation.



11. Check stored support gravel for contamination. Contaminated gravel cannot be loaded into the vessel and should be reported upon discovery.

4.3 Start-up

1. Internal coating and equipment inspection should be conducted prior to gravel or media loading. Vessel internals should be checked for residual oil and grease, which can adversely coat the media. A confined space entry may be required (proper confined space entry equipment supplied by contractor).
2. Media MSDS available for operators' use.

4.4 Chlorination

1. All media is to be saturated fully with chlorine prior to being put into service. Media will adsorb approximately 15-17 grams of free chlorine (Cl_2) per cubic foot of media. **Chlorine does not have an adverse effect on the media.** *For calculating chlorine, saturation is assumed at 17.0 grams Cl_2 per cubic feet of media*
2. Add half of the 3.5 gallons of 5.25%-6.5% NaOCl or 1.5 gallons 10%-12% NSF approved bleach per 52 ft³ of media (1 sack) into the water before media addition. Load media.
3. After media installation, the vessel is then filled to a level above the media. The other half of the NaOCl is then added. The top manway is sealed, and the vessel is then completely filled with water allowing chlorinated solution to contact all internal vessel surfaces exposed during normal treatment operations. Allow for a minimum soak period of 4 hours, ideally overnight, for media wetting and chlorine saturation.

4.5 Media Installation

1. Take care not to damage bag lifting loops with sharp edges from forklifts or from rough handling. Bags with damaged lifting loops either must be rebagged or remain on the original pallet and be installed more slowly under careful supervision by cutting the sides of the bag.
2. Crane straps or cables should be at least 10 feet long to prevent lifting straps from being at sharp angles during lifting. Four lifting cables or straps will be needed, one for each bag lifting loop.
3. As bags are lifted off pallets, sweep off any debris on the bottom of the bags. Small abrasion tears from moving may be sealed with duct tape. If holes are due to animal or insect infestation, the media may be contaminated and should be inspected carefully.
4. Position bag over the top manhole of the vessel. Untie the elephant trunk that is folded up on the bottom of the bag. A loop of rope may be tied around the trunk to control the flow of media from the bag.
5. A particulate respirator should be worn to avoid breathing the non-hazardous media dust.
6. Untie the first trunk seal cord, and extend the trunk into the manhole. Open the second upper trunk seal cord, and allow the media to fall into the water inside the vessel.
7. Install the required number of bags of media per vessel



8. Level the media in the vessel if it is preventing the addition of all the sacks to the vessel. Close and seal the top manhole. Allow to soak at least 4 hours, per the chlorination instructions.

4.6 Initial Backwash

1. Backwashes should be conducted after the media has been allowed to saturate with chlorine.
2. The backwash flow should be increased in increments until the full rate is achieved over a 3-5 minute period. This allows the media to level and prevents any chance of media loss through the top distributor/collector.
3. Backwash is performed on virgin media at 11-13 gpm/ft². This process may take 15-20 minutes to remove virgin media fines from shipping and manufacturing. Initial color of the water will be dark red just like the media. Normal sized media will not be discharged if the correct backwash water rate is used. **NOTE:** Virgin media backwash is 1.5 to 2 times the volume of a standard backwash. Alternate provisions for water disposal must be made since this volume will exceed the available Backwash Tank volume.
4. Samples are taken of dirty backwash water every 2 minutes in clear sample bottles or other clear containers to determine that full-size media particles are not being discharged, and to determine when the water clarity has improved as much as possible.
5. Once two consecutive samples have not changed in their red coloration and few media fines are present, backwashing is terminated. The sample will never fully clear of small particles, which will lend a slight red hue to the sample. Slowly reduce flow over a 2-minute period to allow media reclassification before the water flow is reduced to zero.
6. After virgin media backwash is completed, the vessel should be run using well water or potable distribution system supply in the forward flow mode at its design flow rate with the initial effluent discarded to sewer, ditch or dirty backwash tank for 2 to 3 minutes. This allows effluent turbidity to be reduced quickly to standard treatment water quality, and prevents small particles loosened by backwashing to be discharged to the distribution system. This is also recommended practice for subsequent backwashes as well.

4.7 Start-up Completion and Operation

1. Ongoing monitoring should include flow rate, influent and effluent arsenic concentration, differential pressure across the media, and volume of water treated by each vessel.
2. High differential pressure across the vessel can cause the media to be crushed. Backwashes should be scheduled before differential pressure reaches 10 psi or if effluent arsenic begins to rise (evidence of channeling within the media).
3. When the predicted useful life of the media is approaching, check arsenic removal performance more frequently by sampling the treated effluent for arsenic.
4. Standard backwash water rate should be 9.5 to 13 gpm/ft², depending on water temperature, sustained for 12 minutes to achieve 20% bed expansion. Control should include a smooth 2-minute ramp up from and down to zero flow.



4.8 Vessel Stand-By After Media Loading

Prior to placing the vessels in standby, the minimum residual of the water in the vessels should be 0.8 mg/L free Cl_2 . If the feed water is unchlorinated, then a 10% sodium hypochlorite (NaOCl) solution should be added into the top of the vessel (via dosing pump or manually through the manway) before the end of the 1st 2 weeks of standby. One gallon should be added to 4' to 6'- \emptyset vessels; 2 gallons for 7' to 10'- \emptyset vessels; and 4 gallons to 12' & 14'- \emptyset vessels.

In hot climates, especially if the vessels are outdoors, the water inside the vessels should be displaced by fresh, 0.8 mg/L minimum chlorinated well water once every four (4) weeks. If chlorinated water is not used, the vessels should be dosed with the 10% NaOCl volume noted above. The frequency of water replacement can be increased to every eight (8) weeks for indoor vessels in colder climates. Drained water can be submitted for BaCT sample analysis to ensure no biological growth has begun. Free chlorine residuals should be checked weekly to ensure the disinfectant residual has not been depleted.

4.9 Startup and Inspection Service

A DNWT Process Engineer should be onsite during media installation, initial backwashing, and plant startup. Follow up plant consultation with plant operators should be conducted by a DNWT Process Engineer 2 months after startup, 6 months after startup and then yearly. Startup and onsite inspection services are available at DNWT prevailing daily rate, plus expenses at cost. Typical startup time required, depending on number of adsorber vessels, is one day for media loading, one to two days for initial backwash, and two days for initial operation, plus travel days. A typical inspection visit would require one to two days onsite and two additional days for travel and written report.

Please Note: Proper media storage, backwashing, operating practice, and experienced follow-up attention is required to maximize media performance and media life. Changes to these procedures or recommendations could void any media performance warranty. Consult with DNWT about any deviation from recommended practices.



Chapter 5 MAINTENANCE & OPERATIONS

5.1 Media Installation & Replacement

Routine sampling of raw and treated water (from each adsorber) for Arsenic analyses should be done, preferably at least once per month. Reference Section 2 to see how the media performs with gradually increasing effluent arsenic levels over this period and for recommended sampling frequency increases.

DNWT should be notified when the effluent arsenic level is in the 5-6 µg/L range, so that plans can be made for media replacement.

For ordering Bayoxide® E33 media replacement, contact the After-Market Department:

De Nora Water Technologies
Park West One, Cliff Mine Rd., Suite 600, Pittsburgh, PA 15275
Main Phone: (800) 364-1600

5.2 Routine Maintenance

Maintenance and its frequency are listed for the key system components:

Flow Meters – Verify calibration accuracy annually. If the vessels can be put into series flow, this will allow verification of accuracy of the two flowmeters. If flow varies more than 10%, contact a DNWT representative if under warranty or the manufacturer’s local servicing representative.

Differential Pressure Device – Verify calibration accuracy annually.

Adsorber Collectors– Inspect every 3 years. During media change-out, drain adsorber of water, and vacuum out gravel completely. Observe any plugged channels or wear on header or laterals. Flow water up through the collectors to ensure equal distribution. Replace under bedding with new gravel and disinfect prior to media fill.

Vessel Interior Coating – Interior coating should be visually inspected with every media change-out. Any exposure of metal should be resealed with the proper coating. Further oxidation of the surface could permanently damage the vessel.

Manways – All manways should be inspected every media change-out for a clean and undamaged sealing surface. Manway gaskets should be replaced each media changeout. A set of gaskets should always be available during a media changeout to ensure installation can be completed in the given time.



5.3 Troubleshooting

No Flow through an Adsorber: Check position indicator of V-121 and V-122 valves.

Uneven Flow Through the Adsorbers: The low flow adsorber may need to be backwashed even though its differential pressure gauge is not reading a high ΔP . Check the records for its last backwash. If recently backwashed, check the position indicators of the V-121 and V-122 valves to make sure they are 100% open.

Low Flow through Adsorbers: Check the differential pressure measurements. If they are reading high, adsorber(s) should be backwashed.

Low Backwash Water Flow Rate: Check Backwash water manual valve alignments. Check the position of the V-123 and V-124 valves to make sure they are 100% open. Verify the other adsorber raw influent valve, V-121, is throttled to move more water to the backwashing adsorber. Verify the bypass valve is adjusted properly to provide sufficient flow to the adsorbers. Check the flow meter to make sure its flow rate is correct.

5.4 De Nora Water Technologies Contact Information

The primary process contacts for troubleshooting help and process support are:

System Design & Technical Assistance:

Pittsburgh Process Engineer Dial 0 - Ask Operator for a Process Engineer

1000 Cliff Mine Rd, Park West One, Suite 600, Pittsburgh, PA 15275

Office: 800-364-1600

Project Management:

Pittsburgh Project Management Dial 0 - Ask Operator for a Project Manager
Engineering Manager

1000 Cliff Mine Rd, Park West One, Suite 600, Pittsburgh, PA 15275

Office: 800-364-1600

Aftermarket Sales:

Pittsburgh After Market Sales Dial 0 - Ask Operator for Aftermarket Sales Person

1000 Cliff Mine Rd, Park West One, Suite 600, Pittsburgh, PA 15275

Office: 800-364-1600