Shaw® Shaw Environmental, Inc.

Field Work Variance No. KAFB-FWV-08



# FIELD WORK VARIANCE

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|---|---|---|---|
| Project Name/Number | 140705 | | |
| Contract No. | USACE Contract No. W912DY-10-D-0014 Delivery Order 0002 | | |
| Applicable Document(s) | LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL) CONTAINMENT INTERIM MEASURE WORK PLAN PART 1—CHARACTERIZATION PLAN Bulk Fuels Facility Spill solid waste management units ST-106 and SS-111 | Date | July 2011 |

Problem Description:

Work plan clarifications regarding extraction well drilling, installation, and sampling techniques. KAFB BFF LNAPL Containment Plan Interim Measures Work Plan Chapter 6.0, do not accurately describe methods for installation and sampling of Extraction Wells. The work plan requires clarification regarding sampling and installation guidelines for the two extraction wells.

Recommended solution:

The new requirements for the extraction well drilling, design, and completion are included in the revised Section 6.0 *Extraction Well Installation* of the LNAPL containment work plan. Figure 6.1 in this Field Work Variance replaces figure 6.1 in the KAFB BFF LNAPL Containment Plan Interim Measures Work Plan.

Impact on present and completed work:

None.

Requested by: Dale Flores,

Recommended solution/disposition:

The Project Geologist will communicate these verifications to field staff, and copies of this FWV will be available on site for field staff.

Clarification ☒ Minor Change ☐ Major Change ☐

Signature Dale J. Flores Date:09/29/11

*Technical Reviewer*

*Shaw Environmental Inc, Approvals:* *If Major Change:*

Signature _____ Date _____ Signature _____ Date _____

*Project/Task Manager* *Sr. Project Manager*

Signature _____ Date _____

*Project QC System Manager*

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## FIELD WORK VARIANCE CONTINUATION SHEET

Continue FWV discussions below by noting section title(s) to be continued (i.e., Problem Description, Solution/disposition, Final Disposition, etc). Use additional continuation sheets as needed.

References:

Shaw Environmental, Inc. LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL) CONTAINMENT INTERIM MEASURE WORK PLAN PART 1—CHARACTERIZATION PLAN Bulk Fuels Facility Spill solid waste management unit ST-106 and SS-111

# 6. EXTRACTION WELL INSTALLATION

Before the pumping tests and critical to the final design of the LNAPL containment system, the two extraction wells, KAFB-106157 and KAFB-106158, must be installed.

## 6.1 Permitting

Well construction permits for the two extraction wells will be obtained from the New Mexico Office of the State Engineer. A signed right-of-entry has been obtained for wells located off of the Kirtland AFB property. Additionally, a permit with the NMED Ground Water Quality Bureau will be obtained for the discharge of waste water associated with the proposed pumping tests.

## 6.2 Drilling Program

The drilling program will consist of a phased installation of two extraction wells using an ARCH drilling rig. The proposed well completion of the two extraction wells and one injection well are shown on Figures 6-1.

## 6.3 Requirements and Procedures

The procedures for well installation, development, and reporting are discussed in the following sections.

### 6.3.1 Borehole Clearance

The site will be marked for proposed drilling locations. Utility locates will be conducted at the well locations in advance of mobilization to begin drilling and well installation. Additionally, New Mexico One-Call (811) will be notified at least 48 hours prior to the start of work. Each boring will also be hand-augered for the first 5 feet bgs or until refusal by the hand augers.

### 6.3.2 Equipment Decontamination

Equipment and materials mobilized to the site will be free of foreign materials and maintained in a clean condition throughout work activities. Equipment and materials include, but are not limited to rods, bits, core samplers, and sampling equipment. Steps will be taken to clean equipment and tools before use, during sampling, and between well locations. Well installation activities will conform to New Mexico Office of the State Engineer well permit requirements, applicable codes, manufacturer's specifications, regulatory guidelines (e.g., Occupation Safety and Health Administration ), and trade standards. Good housekeeping practices will be enforced to accommodate storm water best management practices on site. Drilling cuttings and liquids will be handled according to the Waste Management Plan (Appendix C).

### 6.3.3 Drilling

Drilling will begin after the drilling permits are obtained and the sites have been cleared for underground utilities. Each well boring will be advanced using the ARCH method. The ARCH method uses steel insulator casing advanced with a drill bit/rod to prevent borehole collapse. The well borings will be drilled using a 13¾-inch nominal drive casing down to a depth of approximately 200 feet bgs. The casing will be telescoped down to an 11⅝-inch outside diameter drive casing to total depth. The extraction well borings will be drilled to 50 feet below first-encountered groundwater, which is estimated to be 480 ~~500~~ feet bgs.

### 6.3.4 Logging and Soil Sample Collection/Analysis

Each extraction and monitoring/observation well boring will be described on a boring log similar or equivalent to the form found in Appendix D, Form 1 and in accordance with ASTM International (ASTM) D5434-09 (*Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock*). The geologist will log the boring as it is being drilled by retrieving cuttings from the hopper and recording relevant data, as listed below, on either the appropriate boring log or in a bound field logbook. Boring log forms may be transcribed from a field logbook, but must be completed a weekly basis at a minimum on.

Soil cuttings will be collected and logged every 5 vertical feet from ground surface down to the total depth of the wells. Data that will be included in the logs, when applicable are described as follows:

- The identifying number and location of each boring will be recorded.
- ~~Drilling logs and other scaled drawings will be drawn at a scale that is practical for the well depth. In addition, if sampling intervals are greater than 10 feet apart, the log can be represented with breaks in order to skip unlogged intervals. All measurements will be accurate to $^{1}/_{10}$ of a foot.~~
- Soil will be classified every five feet in accordance with the Unified Soil Classification System (USCS). These classifications will be applied in the field by the geologists and will be subject to revision based on laboratory tests and subsequent review by the Project Geologist.
- A full description of soil samples will be made,~~.~~ ~~For split-spoon, thin wall, soil core, or otherwise intact samples, the description~~ and will include but not be limited to, the USCS two-letter classification, ~~plus a more complete verbal description of color,~~ consistency, soil moisture, grain size, and size distribution.
- Depth limits, and the type and number of each sample taken will be indicated. All samples will be numbered consecutively.
- ~~The number of blows required for each 6-inch penetration of split-spoon sampler and for each 12-inch penetration of casing will be indicated, as well as hammer weight and length of fall for split-spoon or driven samplers; and hydraulic pressure used to push thin-wall tubes. If thin-wall tubes are pushed manually, that will be indicated.~~
- ~~The start and finish times for all rock coring runs will be noted, including a description and depth of any drilling anomalies such as voids, loss of fluids or air, odors, etc.~~
- Depth to water as first encountered during drilling, along with the method of determination, will be noted. Any distinct water-bearing zones below the first zone also will be noted. Other observations during drilling will be noted, such as bit chatter, rod binding, rod drops, flowing or heaving sands, bit pressure, rod rotations per minute, and water pressure.
- If drilling fluid is used, the fluid losses, the interval over which they occur, and the quantity losses, will be recorded.
- A general description of the drilling equipment used will be provided. This description, including such information as rod size, bit type, pump type, rig manufacturer, and model, may be provided in a general legend.
- Dates and times of start and completion of boring will be indicated.

- The names of the contractor, driller, and rig geologist will be noted.
- The size and length of casing or auger used in each borehole will be noted.
- Observations of visible contamination for each sample or from cuttings that appear contaminated will be made.
- Field instrument readings will be noted.

As the boring is drilled, the rig geologist will evaluate adjacent samples recovered, together with observation of the drill cuttings, wash water (if any), drill performance, etc., to determine appropriate stratigraphic definitions or distinctions within the soil column. Such contacts or breaks between strata must be determined by the rig geologist and indicated on the boring log. In general, a stratigraphic unit contains only similar soil that can be classified within the same two-letter USCS classification category symbol. In some cases, significant differences in soil color, grain-size distribution, strength, etc., would be sufficient to classify soil having the same two-letter USCS classification category symbol into two or more distinct strata.

After the rig geologist has indicated the appropriate stratigraphic breaks on the log, he/she will develop and record an appropriate description for each defined stratigraphic unit. Each description will contain information about the color, grain-size distribution, consistency, moisture, etc., and the appropriate two-letter USCS classification category symbol.

***Classification of Soil***

All classification data will be written directly onto the boring log. The method of deriving the classification will be described, or reference to this section or other manuals will be made. Handling of samples during soil classification will be coordinated with chemical sampling activities, if appropriate.

***USCS Classification***

Soil is to be classified according to the USCS (ASTM D2488-09a, *Standard Practice for Description and Identification of Soils [Visual-Manual Procedure]*). This method of classification is detailed in Appendix D, Form 2. This classification method identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols.

In the USCS system, fine-grained soil (or fines) is classified as those which will pass through a No. 200 U.S. standard sieve (0.074 millimeter [mm]) and are of two types: silt "M" and clay "C." Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors only. Organic material "O" is a common component of soil but has no size range, and is recognized by its composition.

Gravely soil is identified by a "G" as the first letter in the two-letter symbol, whereas sandy soil is identified with an "S." The term, "rock fragments," will be used to indicate granular materials resulting from the breakup of rock. These materials are normally angular, indicating little or no transport from their source. When the term, "rock fragments" is used, it will be followed by a size designation, such as ¼ to ½ diameter or "coarse-sand size," either immediately after the entry or in the remarks column. The USCS classification will not be affected by this variation in terms.

The second letter in the two-letter USCS symbol provides information about the grain-size distribution of granular soil, or the plasticity characteristics of fine-grained soil. These second-letter modifiers are "P" for well sorted, "W" for well graded/poorly sorted, "C" for clayey, "M" for silty, "L" for low plasticity, or "H" for high plasticity. Note that the term, "poorly graded," implies a uniform grain-size distribution and is the same as "well sorted."

***Color***

Soil colors will be described using a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as “gray” or “light gray” or “blue-gray.” Since color can be used in correlating units between sampling locations, it is important that color descriptions be kept consistent throughout field operations.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Soil sampling devices tend to smear the sample surface creating color differences between the sample interior and exterior. In accordance with ASTM D1535-08e1 (*Standard Practice for Specifying Color by the Munsell System*), Munsell color charts or equivalent must be used based on project requirements.

***Relative Density and Consistency***

To classify the relative density and/or consistency of a soil, the geologist must first identify the soil type. Granular soil predominantly contains sands and gravels and are generally non-cohesive (particles do not adhere well when compressed). Finer-grained soil (silts and clays) is cohesive (particles will adhere together when compressed).

***Soil Component***

In nature, soil is comprised of particles of varying sizes and shapes and is combinations of the various soil types. Appendix D, Form 2 lists grain-size classifications to be used in describing soil or rocks. The following terms are useful in the description of soil components:

| The Identifying Proportion of the Component Defining Range of Percentages by Weight | |
|---|---|
| Trace | 0 to 10 percent |
| Little | 11 to 20 percent |
| Some | 21 to 35 percent |
| Most | 36 to 50 percent |

### *Moisture*

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual‘s judgment. A suggested parameter for judging this in a fine-grained soil would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

### *Stratification*

Stratification can only be determined after the split-spoon sampler is opened. The stratification or bedding thickness for soil and rock is dependent on grain size and composition. The classification to be used for stratification description is described below:

**Thickness Approximate Metric and English Equivalent Classification**

| Metric | English | Classification |
|---|---|---|
| >1 meter | > 3.3 ft | Very thick |
| 30 cm to 1 meter | 1.0 ft to 3.3 ft | Thick bedded |
| 10 cm to 30 cm | 4.0 in to 1.0 ft | Medium bedded |
| 3 cm to 10 cm | 1.0 in to 4 in | Thin bedded |
| 1 cm to 3 cm | 2/5 in to 1 in | Very thin bedded |

**Thickness Approximate Metric and English Equivalent Classification**

| Metric | English | Classification |
|---|---|---|
| 3 mm to 1 cm | 1/8 in to 2/5 in | Laminated |
| 1 mm to 3 mm | 1/32 in to 1/8 in | Thinly laminated |
| <1 mm | <1/32 in | Micro laminated |

### 6.3.5 Pumping Well Construction

Two pumping test wells will be installed. Appropriate personal protective equipment (PPE) will be worn in accordance with the Accident Prevention Plan (Shaw, 2010a).

Wells will be constructed inside the temporary steel drive casing used to advance the borehole. The steel casing will be incrementally withdrawn as the well is constructed. The well assembly will be hung from a lifting bail during installation to maintain tension on the casing. Based on data collected from previous studies, the extraction wells are expected to have total depths of approximately 550 feet bgs. The top of the screens in each well will be at least 40 feet above the water table to accommodate future groundwater level rises.

Extraction well construction specifications, provided below and shown on Figure 6-1, may be modified if field conditions warrant. Extraction wells will consist of an 8-inch inner diameter (8⅝ outside diameter), carbon steel, Schedule 40, 0.322-inch wall (or approved equivalent) casing and an 8-inch inside diameter, double-strong, 304 stainless-steel, wire-wrapped well screen with 0.030-inch slots. The extraction wells will have approximately 100 feet of screen (Figure 6-1). Centralizers will be installed at the top, middle, and bottom of the screened zone within the sand-pack interval. Centralizers will be installed nominally every 40 feet on the blank casing above the screen and hammer locked in place at the casing joints.

Before setting the casing into the borehole, 6 inches of gravel-pack material will be placed at the bottom of the borehole. All well construction annular materials will be placed in the borehole, as described in the bullets below, through the temporary drive casing for installation of the sand pack, bentonite seal, and cement. ~~The drive casing will be pulled from the borehole periodically during well construction~~ . The drilling subcontractor will drill and install groundwater containment wells. These wells will be used for hydraulic control of the LNAPL groundwater contamination plumes. The locations will be established by Shaw E&I based on the remedial goals and site accessability.

- Each well will be tested for utility clearance to five feet with a hand auger or a post hole digger.
- The well borings for both extraction and injection wells will be advanced using ARCH drilling methods to approximately 60 feet below the water table. The wells will be installed approximately 540 feet below grade at the two locations.
- The Extraction wells will be constructed with 90 feet of 8-inch diameter welded joint 0.030 slot stainless steel continuous wrap screen with double strong wires and rods, a 10-foot blank stainless steel pump sleeve section placed approximately 30 feet below the current water table, and a Schedule 40 carbon steel casing riser (Figure 6-1). The well will be constructed with 60 feet of screen/pump sleeve below the water table and 40 feet of screen above the water table to accommodate future water table rises. The steel well casing will extend approximately 2.5 feet above grade as a temporary completion during well development. The final depth of the pump sleeve will be decided in the field based on lithology encountered during drilling.
- Prior to start of well drilling the contractor will provide manufacturer's written documentation that the screen sections meet the design requirements, the carbon steel casing shall be marked as per design requirements, and the Contractor will confirm that the casing welder is experienced in welding of stainless steel casing.
- An engineered 10-20 sand pack filter pack will be installed in the annular space between the well casing/screen and the borehole from the bottom of the borehole to approximately 10 foot above the top of the screened interval. The filter pack will be slurried with clean potable water and tremied into place to prevent bridging and to ensure continuous placement, while the casing is slowly removed. A 10-foot hydrated bentonite seal will be emplaced above the sand filter pack and incrementally hydrated with potable water in 1-foot lifts.
- An engineered 10-20 sand pack filter pack will be installed in the annular space between the well casing/screen and the borehole from the bottom of the borehole to approximately 10 foot above the top of the screened interval. The filter pack will be slurried with clean potable water and tremied into place to prevent bridging and to ensure continuous placement, while the casing is slowly removed. A 10-foot hydrated bentonite seal will be emplaced above the sand filter pack and incrementally hydrated with potable water in 1-foot lifts.

- ~~A sand pack comprised of clean, 10-20 graded silica sand will be placed around the well screen and blank casing so that the top of sand is at least 10 feet above the top of the screen. Sand gradation may be modified based on visual inspection of the formation materials obtained from core during drilling.~~

- ~~A minimum 5 foot-thick seal of sodium bentonite-chips or pellets will be installed above the filter pack. The bentonite seal will be hydrated with 5 gallons of water after each bucket of pellets and allowed to stand for at least 2 hours before the annular grout seal is placed.~~

- After the last lift has hydrated for 2-hours, a cement grout with 6 percent bentonite and 2 percent calcium chloride by weight mixed at a weight density not less than 12.5 pounds per gallon will be emplaced by tremie pipe to approximately 1.5 foot below the ground surface. The contractor will provide a mud balance and measure the grout weight density twice during placement to certify the grout specification.

- The wells will be developed no sooner than 48 hours after the grout has cured and no later than 7 days. Initial development will consist of a combination of swabbing, jetting, bailing, and/or pumping until little or no sediment enters the well across the entire screened interval below the water table. The contractor will not be required to develop the screen interval above the water table.

~~The surface completion will include a 4-foot by 4-foot concrete pad, traffic bollards, and a reinforced steel-locking well cap. The surface seal will extend to a minimum of 12 inches around the perimeter of the pad and a minimum of 36 inches bgs.~~

The drive casing will be pulled from the borehole periodically during construction. Well construction diagrams will be completed for each installed well.

### 6.3.6 Well Development

Once constructed, the wells will be developed to improve hydraulic communication between the well and aquifer. The wells will be allowed to stabilize for at least 48 hours before they are developed to allow time for the cement to cure. Wells will be developed using a truck-mounted pump rig equipped with wire line swab/bailer equipment. The swab/bailer is moved up and down within the screened interval to create a strong back-and-forth flow of water between the bore and formation. The well is then bailed to remove soil particles until groundwater is nominally clear as measured with a sand content kit. Groundwater

temperature, pH, turbidity, alkalinity, and electrical conductivity are monitored during the development process.

The following procedure will be used to develop the wells:

- Initial development will consist of swabbing, bailing, and pumping until little or no sediment enters the well (**approximately 10 hours**). Contain the development and purge water in a temporary tank to be installed at each wellhead.
- Following initial development, the well will be continuously pumped using an electric submersible pump capable of pumping at a minimum rate of **80 gallons** per minute. Temperature, pH, specific conductivity and turbidity will be monitored during pumping, and readings will be taken after every well volume is purged. Pumping will continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between 4 consecutive readings) and the water is clear and free of fines. The main goal of well development is to reduce the turbidity to less than 10 NTUs (however, under 100 NTUs is acceptable). If these parameters have not stabilized after **10 hours** of continuous pumping, the well will be allowed to sit overnight and development will continue the following day for a maximum of two hours. If the turbidity still does not fall below 100 NTUs, the client project geologist will be contacted and further direction will be sought.
- If the addition of water is necessary to facilitate surging and bailing, only formation water previously pumped from that well into the purge tank may be used. At the completion of the well development activities at each well, a sample from the well will be collected and immediately photographed to document the results of the procedure.
- The site geologist will monitor and record on the well development record form, depicted in Figure B4.1-1, and in the field log book all field parameters such as pumping rates, pH, temperature, specific conductance and pertinent information.
- ~~Surge the well with a surge block lowered on a wire line. The surge block will be constructed using Teflon® or rubber disks sized to fit without interference with the well casing. Two disks will be placed on one steel rod approximately 3 to 4 feet apart.~~
- ~~Bail out accumulated soil from the well. A steel bailer approximately 10 feet long will be used. The bailer will be raised and lowered with the sand line on the pump rig.~~

This surging, bailing, and pumping process will be repeated until the well is developed. The well will be considered developed when the discharge water is visibly free of sediment/soil particles, as measured with a sand content kit, or when the field parameters have stabilized to within 10 percent of the previous measurement. Field parameters, including specific conductance, pH, temperature, and sand content, will

be measured during development and recorded on a well development field sheet. Water pumped out of the well during development will be containerized, sampled, and staged for disposal pending sample results, as described in the Waste Management Plan (Appendix C).

## 6.4 Borehole Geophysical Data Collection

Geophysical logging will be performed in the cased hole after the total depth has been reached to refine the geologic data from the borehole. Before construction of the wells, geophysical measurements will be performed in each of the extraction and injection wells. Well borehole geophysics will consist of neutron, and gamma logging, and will be conducted on the two extraction wells described in this Characterization Plan. Induction logging will not be completed in the extraction and injection wells due to the interference of the steel casing.

### 6.4.1 Downhole Geophysical Logging

Geophysical techniques have proven to be valuable tools in determining lithology, porosity, and moisture condition of various stratigraphic units. Downhole geophysical logging will be conducted using neutron, and gamma (large crystal) logs. The objective of this effort is to characterize the subsurface conditions, particularly permeable zones, with a vertical accuracy of less than 1 foot.

The logs will be run from the bottom of the borehole (approximately 550 feet bgs) to ground surface through the drive or well casing. Equipment will be decontaminated at each well location before conducting logging activities. The logs will be evaluated/interpreted along with soil boring logs and well construction reports.

All logging equipment will be calibrated in accordance with manufacturer's specifications. "Shop" calibrations will be performed within 30 days of the logging event. Calibrations will be conducted before

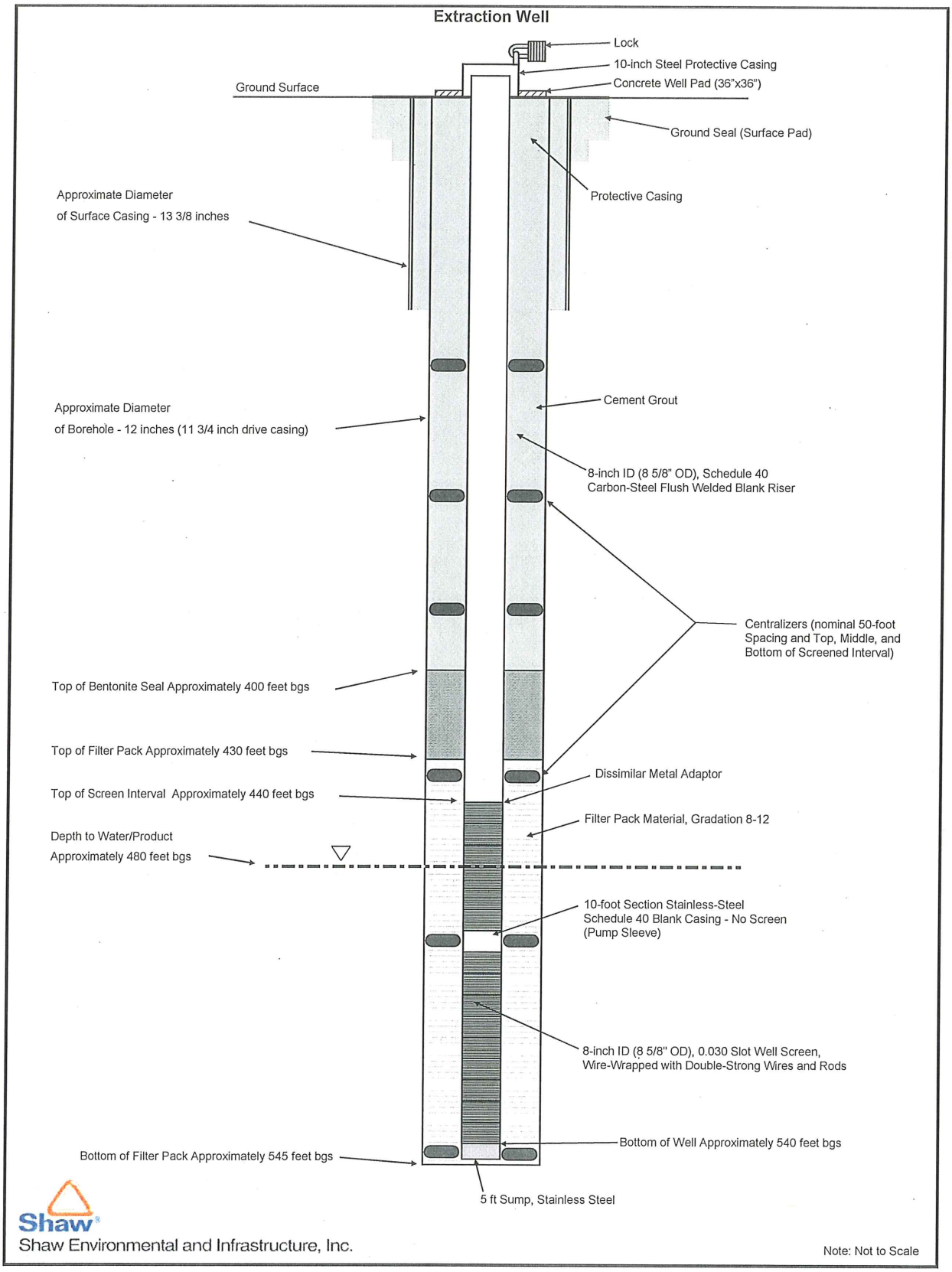


**Figure 6-1. Extraction Well Construction**