CB&I
312 Directors Drive
Knoxville, TN 37923
Tel: +1 865 690 3211
Fax: +1 865 690 3626
StevenT.Downey@CBI.com

October 17, 2014

U.S. Army Engineer District, Nashville
ATTN: CELRN-EC-E (Ms. Paula Coleman)
110 Ninth Avenue South, Room 682
U.S. Court House Annex
Nashville, Tennessee 37203

Subject: **Submittal of the Final Site-Wide Work Plan for Monitoring Well Abandonment and Site Restoration Activities Former Plum Brook Ordnance Works, Sandusky, Ohio IDIQ Contract No. W912P5-12-D-0001: Shaw Project Number 150053**

Dear Ms. Coleman:

In accordance with the requirements of delivery order DO0004 Indefinite Delivery Indefinite Quantity (IDIQ) of Contract No. W912P5-12-D-0001 awarded to CB&I Federal Services LLC, we are pleased to submit the Final Site-Wide Work Plan for Monitoring Well Abandonment and Site Restoration Activities at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. This report was prepared consistent with other PBOW work plans.

Enclosed for your records are four copies of this report. Copies have also been sent to those on the distribution list as indicated for their records.

Should you have any questions or require additional information regarding this submittal, please do not hesitate to contact me at (865) 694-7496.

Sincerely,

Steven. T. Downey, PE, PMP
Project Manager

Please Reply To: Steven T. Downey
Phone: 865 694 7496
E-Mail Address: StevenT.Downey@CBI.com

200-1e
G05OH001826_03.04_1004_a

Distribution List

Name	Copies
U.S. Army Engineer District, Nashville ATTN: CELRN-EC-E (Ms. Paula Coleman) 110 Ninth Avenue South, Room 682 Annex Nashville, TN 37203	4 (with CDs)
U.S. Army Engineer District, Huntington ATTN: CELRH-PM-PP-P (Mr. Rick Meadows) 502 Eighth Street Huntington, West Virginia 25701-2070	4 (with CDs)
Mr. Paul Jayko Site Coordinator Division of Emergency and Remedial Response (DERR) Ohio Environmental Protection Agency 347 North Dunbridge Road Bowling Green, Ohio 43402-0466	2 (with CDs)
Mr. Brian Tucker Ohio Environmental Protection Agency Division of Emergency and Remedial Response (DERR) Central Office Lazarus Government Ctr. 50 W. Town Str., Suite 700 Columbus, Ohio 43216-1049	1(with CD)
Mr. Robert Lallier Environmental Coordinator NASA - Plum Brook Station 6100 Columbus Avenue Sandusky, Ohio 44870	1(with CD)
U.S. Army Corps of Engineers (**electronic only**) HTRW Center of Expertise ATTN: CEHNC-CX-EG (Vern StJohn) 1616 Capitol Avenue Omaha, Nebraska 68144-3869	(CD only)
Mr. John Blakeman (**electronic only**) PBOW RAB Co-chairman 2412 Scheid Road Huron, Ohio 44839	(CD only)

DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-E

Project Description: Monitoring Well Abandonment Plan
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912P5-12-D-0001 Delivery Order No. 0004

Project No. 150053 Task/Phase Number: 09000000

Document Type		Identify specific section or segment covered by this checkprint	Document Origin
☐	Technical / Cost Proposal		X Originator Developed
☐	RFP		☐ Edited Standard
☐	Contract / Subcontract		☐ Client Furnished
X	SHP, SSAP, CDAP, QAPP or QCP	Final Abandonment Plan	
☐	Report		**Document Status**
☐	Risk Assessment / Evaluation		☐ Preliminary
☐	Specifications & Plans		☐ Internal Draft
☐	Design Calculations		☐ Draft
☐	Tables		☐ Draft Final
☐	Drawings / Figures		X Final
☐	Other:		☐ Other:

	Required Person	Signature	Date
Originator	Eric Weaver	Eric W. Weaver	10-17-14
Project Review	Michael Gunderson	[illegible]	10-17-14
Technical Editing	Don Groseclose	Betty Villatore for	10-17-14
Quality Assurance Mgr	Ken Martinez	[illegible]	10-17-14
Project Manager	Steve Downey	Steve T Downey	10-17-14

NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

Site-Wide Work Plan
Monitoring Well Abandonment and Site Restoration Activities
FUDS Project No. G05OH001826

Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

Commander
U.S. Army Corps of Engineers, Nashville District
Post Office Box 1070
Nashville, Tennessee 37202-1070

Prepared by:

CB&I Federal Services LLC
312 Directors Drive
Knoxville, Tennessee 37923

CB&I Project Number 150053

October 2014

Table of Contents

Page

List of Appendices iii
List of Tables iv
List of Figures iv
List of Acronyms v
1.0 Project Description 1-1
1.1 Plum Brook Ordnance Works Facility History 1-1
1.2 Project Scope 1-4
2.0 Scope of Work and Objectives 2-1
2.1 Scope of Work 2-1
2.2 Objectives 2-1
3.0 Field Activities 3-1
3.1 Monitoring Well Abandonment Procedures 3-1
3.1.1 Site Security 3-1
3.1.2 Pre-Abandonment Inspection 3-2
3.1.3 Monitoring Well abandonment Procedures 3-2
3.1.3.1 Overburden Well Abandonment 3-2
3.1.3.2 Bedrock Well Abandonment 3-2
3.1.4 Removal of Surface Materials 3-3
3.1.5 Site Restoration 3-3
3.2 Site Access 3-4
4.0 Sample Analysis and Decontamination Procedures 4-1
4.1 Sample Number System 4-1
4.2 Analytical Program 4-1
4.3 Decontamination Procedures 4-2
5.0 Sample Preservation, Packing, and Shipping 5-1
6.0 Investigation-Derived Waste Management Plan 6-1
6.1 Groundwater 6-1
6.2 Decontamination Fluid 6-1
6.3 Personal Protective Equipment 6-1
6.4 Investigation-Derived Waste Sampling 6-1

Table of Contents *(Continued)*

Page

7.0 Reporting 7-1
8.0 References 8-1
Tables
Figures

List of Appendices

Appendix A – *Ohio EPA Technical Guidance Manual for Groundwater Investigations, Chapter 9, Sealing Abandoned Monitoring Wells and Boreholes,* Ohio Environmental Protection Agency, Division of Drinking and Ground Waters, February 2009

Appendix B – Right-of-Entry Agreements for Offsite Monitoring Wells

Appendix C – Monitoring Well Abandonment Forms
Overburden Well Abandonment Form
Flush Mount Overburden Well Abandonment Form
Bedrock Well Abandonment Form
Flush Mount Bedrock Well Abandonment Form

Appendix D – Response to Comments

List of Tables

Table	Title	Follows Tab
3-1	Monitoring Well Construction Details	
4-1	Summary of Analytical Parameters and Methods	

List of Figures

Figures	Title	Follows Tab
1-1	PBOW Vicinity Map	
1-2	Proposed Monitoring Wells To Be Abandoned	

List of Acronyms

CBI	CB&I Federal Services LLC
DNT	dinitrotoluene
DOD	U.S. Department of Defense
EPA	Environmental Protection Agency
FUDS	Formerly Used Defense Sites
GSA	General Service Administration
IDW	investigation-derived waste
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
PBOW	Plum Brook Ordnance Works
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RWP	Red Water Pond
Shaw	Shaw Environmental, Inc.
SWP	site-wide work plan
SWSAP	site-wide sampling and analysis plan
TNT	trinitrotoluene
USACE	U.S. Army Corps of Engineers
WAA	War Assets Administration

1.0 Project Description

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense (DOD) properties. The former Plum Brook Ordnance Works (PBOW) is located in Sandusky, Erie County, Ohio (Figure 1-1). PBOW is being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites (FUDS). The investigation is being managed and technically overseen by the Nashville District of the U.S. Army Corps of Engineers (USACE). The 9,000-acre PBOW facility was used for the manufacture of explosives during World War II. The site is currently owned by the National Aeronautics and Space Administration (NASA) and operated as the Plum Brook Station of the John Glenn Research Center at Lewis Field.

This site-wide work plan (SWP) has been prepared by CBI Federal Services LLC (CBI) for the fieldwork to be carried out in support of monitoring well abandonment and surface restoration activities across the PBOW site. This SWP was developed in accordance with the PBOW site-wide sampling and analysis plan (SWSAP) (Shaw Environmental & Infrastructure, Inc. [Shaw], 2008a) and the quality assurance project plan (QAPP) (Shaw, 2008b) to ensure that work performed at the subject site will be of the quality required to satisfy the overall and site-specific project objectives. A site-wide accident prevention/site-wide safety and health plan (Shaw, 2008c) has also been prepared for this investigation to help provide a safe work environment.

1.1 Plum Brook Ordnance Works Facility History

PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1-1). Although located primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is generally bounded on the north by Bogart Road, on the south by Mason Road, on the west by Patten Tract Road, and on the east by U.S. Highway 250. The area surrounding PBOW is mostly agricultural and residential.

PBOW was established by the War Department as a government-owned, contractor-operated facility for the production of 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (DNT), and pentolite during World War II. The PBOW site originally consisted of approximately 9,100 acres, approximately 3,500 acres of which were used as a buffer area outside the facility fence line. The property was acquired in the name of the United States of America in 1941. The government contractor, Trojan Powder Company, operated the production facility from December 1941 until

1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during this period.

At the end of production in September 1945, PBOW was placed in standby operation status and the Army conducted decontamination and decommissioning activities. On December 17, 1945, the U.S. Army Ordnance Department (Ordnance Department) obtained physical control of the site. The Ordnance Department continued decontamination efforts until August 1946. In 1946, over 6,200 acres, 3,231 located within the fenced area, were transferred to the War Assets Administration (WAA), and approximately 2,800 acres were transferred to the Ravenna Arsenal. This 2,800-acre parcel, transferred to Ravenna Arsenal and referred to as the Magazine Area (and also the Plum Brook Depot), was transferred again in July 1947 to the Erie Ordnance Depot, LeCarne, Ohio (War Department, 1947). The Magazine Area included approximately 2,300 acres inside the fence line and 500 acres of the buffer area, outside the fence line.

In 1949, the General Service Administration (GSA) took control of WAA's portion of the PBOW property, which included an indeterminate amount of acreage outside of the fence line due to conveyances by WAA to private landowners during the late 1940s and early 1950s. It is believed that farmers were given the opportunity to buy back land in the buffer area, outside the fence line.

In June 1954, the Army reacquired the 3,231 acres within the PBOW fence line that were previously transferred to the WAA and subsequently to GSA. From August 1954 to sometime in 1958, further decontamination was performed by the Army. The decontamination included removal and disposal of contaminated surface and subsurface soil around the buildings and wooden and ceramic waste disposal lines containing TNT. This included thousands of pounds of TNT that were discovered in catch basins and removed and incinerated at the burning grounds.

Two property use agreements were entered into by the Army and the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA, in March 1956 and January 1958, respectively. The first agreement was for approximately 500 acres on which NACA built a nuclear reactor. The second agreement gave NACA (NASA as of October 1958) use of an additional 2,700 acres within the fenced area but outside the Magazine Area, for a total of 3,231 acres under the two use agreements. At this time, NASA had use of all property inside the PBOW fence except the 2,300 acres in the Magazine Area. The Army declared this 3,231-acre property as excess in October 1958.

In September 1961, the Army declared the Magazine Area as excess, and NASA formally requested custody of the property in October 1961 (NASA, 1961). On March 15, 1963, accountability and custody of the PBOW property (6,031 acres) were transferred from the Department of the Army to NASA.

However, prior to NASA's acceptance of the property in March 1963, Ravenna Arsenal performed additional decontamination and subsequently certified 500 acres of the former PBOW property as decontaminated and suitable for unrestricted future use. This decontamination certification was only for the 500 acres in the former pentolite manufacturing area (area where NASA built the nuclear reactor) under the first use agreement. NASA identified additional DOD-related contamination in 1963, after transfer of the property. NASA performed further decontamination efforts and the removal of structures in 1964.

NASA has operated and maintained the property inside the fence line since 1963, and the facility currently located there is the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of its John Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the site have been demolished or are currently on standby or inactive status. During 1967 through 1971, NASA purchased approximately 2,000 acres outside the fence line from local farmers as "buffer." On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. This excess included approximately 1,500 acres of farmland outside the fence, including those acres purchased from farmers beginning in 1967, and was sold as farmland (NASA, 2013). Also, 46 acres outside the fence in the northeast corner of the PBOW facility near the guard house were conveyed to the Perkins Township Board of Education for use as a bus transportation area. In addition, the 2,152 acres of PBOW declared excess included a 604-acre parcel in the western part of the fenced area known as "Parcel 59." This area, although previously declared excess, was not transferred and remains under NASA control. According to a NASA newsletter, NASA presently controls approximately 6,432 acres (NASA, 2013); this includes approximately 5,500 acres within the fence line and 900 acres outside the fence which have been leased for agriculture (NASA, 2012).

The former PBOW FUDS property includes the entire 9,100 acres, but the only project areas that have been approved (or proposed) for the property are located within the fenced area (currently controlled by NASA). The fence generally runs along the patrol road. The area outside the fence was used as a buffer zone during the PBOW manufacturing period, and there is no known or suspected DOD-related contamination outside the fence line. The Red Water Pond (RWP) Areas are within the former PBOW and current NASA fence line.

Figure 1-2 shows the PBOW site, including the upgradient and downgradient locations, along with the monitoring wells to be abandoned.

1.2 Project Scope

A Final Decision Document for groundwater has been prepared specifying no further action (USACE, 2014). Therefore, the monitoring well network for PBOW site groundwater is no longer deemed necessary to project closeouts, and considerable maintenance costs can be saved through monitoring well abandonment. While all existing monitoring wells that were installed as part of the FUDS will be abandoned, this work plan only addresses 53 monitoring wells that are covered either under the site-wide groundwater program or have been included in PBOW sites that have been previously closed out.

2.0 Scope of Work and Objectives

2.1 Scope of Work

As specified in the scope of work (USACE, 2014), following development of a quality control plan, an SWP, and a site-specific safety and health plan, the monitoring well abandonment and surface restoration activities tasks will include:

- Well abandonment activities
- Disposal of investigation-derived waste
- Analytical work
- Preparation/submittal of monitoring well abandonment report
- Project management
- GIS deliverable.

2.2 Objectives

Specific objectives of the monitoring well abandonment and surface restoration activities are:

- Permanently abandon select overburden and bedrock monitoring wells across the PBOW site

- Remove all surface material (protective casing, concrete pad, etc.)

- Restore the ground surface at the abandonment locations to be compatible with the surrounding area.

3.0 Field Activities

Monitoring wells will be abandoned consistent with Ohio Environmental Protection Agency (EPA) Guidance (Ohio EPA, 2009). The monitoring wells are shown on Figure 1-2 and listed in Table 3-1. Monitoring wells were selected for abandonment based on the fact that the sites have been remediated or have been closed out with no further action. The remaining PBOW wells are on active sites and will be abandoned during individual project closeout activities.

3.1 Monitoring Well Abandonment Procedures

Overburden and bedrock monitoring well abandonment procedures described below have been developed based on the *Ohio EPA Technical Guidance Manual for Groundwater Investigations, Chapter 9, Sealing Abandoned Monitoring Wells and Boreholes* (Appendix A) and comply with EM 1110-1-4000 (USACE, 1998). The preferred abandonment procedure for overburden wells is removal of the polyvinyl chloride (PVC) well riser and screen, followed by grouting of the borehole. If the well riser and screen cannot be removed, the well will be abandoned in place. For all bedrock wells, the depth and well construction methods preclude removal of the PVC riser and well screen; therefore, all bedrock monitoring wells will be abandoned in place. None of the monitoring wells that are being abandoned have a filter pack that extends into more than one ground water zone. The following sections specify the procedures to be used for well abandonment.

3.1.1 Site Security

All sites will be secured by placing traffic cones, caution tape, and signage as necessary to keep unauthorized personnel from entering the job site. In general, unauthorized access is not an issue on the PBOW site itself, since most well locations are relatively isolated from normal NASA activities. However, there are a few sites within PBOW that may require roads to be temporarily closed (e.g., well BED-MW23 along Pentolite Road) while well abandonment activities occur to reduce the risk related to vehicular traffic. In addition, abandonment activities will be conducted in offsite areas, most of which are relatively isolated. However, well BED-MW33 is located adjacent to a public park (off NASA property), and caution will be exercised to schedule work activity during times of minimal park activity (e.g., early morning). Additionally, wells BED-MW29 and BED-MW30 are located on private property (off NASA property). An attempt will be made to notify the property owners of the well abandonment activities; however, in the event the property owners cannot be reached, the Department of the Army has executed Right-of-Entry Agreements in place for each property to allow access to the wells for survey, exploration or HTRW Investigation. These documents will be kept onsite during abandonment activities in the

event the documentation is needed. A copy of the three Right-of-Entry Agreements is included as Appendix B.

3.1.2 Pre-Abandonment Activities

Prior to monitoring well abandonment, all wells will be inspected and the well condition noted on a monitoring well inspection form. Total well depth and depth to water will be noted prior to abandonment to aid in determining well abandonment materials required (e.g., sand, bentonite, grout) and also to estimate the amount of groundwater that may be generated during abandonment due to displacement by the grout emplacement. Photographs will be taken of each well prior to abandonment. Note that photographs will also be taken to document the depth to which well materials are removed and final site restoration (see following sections).

3.1.3 Monitoring Well Abandonment Procedures

3.1.3.1 Overburden Well Abandonment

The preferred method of well abandonment is removal of the PVC well casing and screen, followed by pressure grouting of the borehole. Attempts will be made at all overburden wells to mechanically remove the PVC casing and screen by attaching the PVC to a backhoe/skid steer bucket with a towing strap and pulling the casing vertically out of the ground. This may require removal of the outer steel/aluminum protective casing to access the PVC riser. It is anticipated that some of the PVC casing riser/screen will not be able to be removed, particularly on deeper overburden wells. Overburden wells will be pressure grouted using a tremie pipe and a high solids bentonite grout (20-30% bentonite) from the bottom of the well up to ground level irrespective if the entire PVC screen/riser can be totally removed.

It is anticipated that residual groundwater within the PVC well riser will be displaced by the grout and if not controlled would discharge to the ground surface. To prevent this, a PVC T-fitting will be used to capture any groundwater displaced during the grouting procedure.

3.1.3.2 Bedrock Well Abandonment

For all bedrock wells, the well screen will be filled with clean sand (10/20 grade) to a level at least one foot above the top of the well screen. Approximately 25 pounds of sand will be required to fill a typical (10 foot long) 2” inside diameter well screen to an elevation of 1 foot above the top of the well screen. In addition, at least one foot of bentonite chips will be added to the well casing to seal off the screened interval. The depth to the top of the sand and the top of the bentonite seal will be documented on a monitoring well abandonment form (Appendix C). The bentonite seal will be allowed to hydrate for a minimum of 12 hours prior to sealing the

PVC riser. The remaining PVC riser will be pressure grouted using a tremie pipe and high solids bentonite grout. It is anticipated that residual groundwater within the PVC well riser will be displaced by the grout and if not controlled would discharge to the ground surface. To prevent this, a PVC T-fitting will be used to capture any groundwater displaced during the grouting procedure.

Bedrock monitoring wells, specifically those screened in the Delaware Limestone, have the potential for off-gassing of hydrogen sulfide. Typically this occurs during purging and sampling, when lowering the water level within the well casing allows release of built-up gas pressure. However, in some cases, release of hydrogen sulfide has been observed to occur during undisturbed conditions. Because of the potential for hydrogen sulfide emissions from bedrock monitoring wells, the sand and bentonite seal will be placed prior to mobilization of the drilling subcontractor. This will limit exposure to unnecessary personnel during this phase of the well abandonment, will reduce the potential for standby time, and will seal the wells, reducing the probability for release of hydrogen sulfide during pressure grouting.

3.1.4 Removal of Surface Materials

Following monitoring well abandonment and allowing at least 24 hours for the grout to cure, all surface material including concrete pad, steel outer casing, and bollards will be removed. Soil will be excavated from around the steel outer casing and PVC well casing to a minimum depth of 3 feet below ground surface. The steel outer casing and PVC casing will be cut off at a minimum of 3 feet below ground surface. The surface casing, concrete, and bollards will be disposed of in a local landfill. All loose soil will be physically removed from the well material prior to disposal. PVC well screen/riser from contaminated areas will be pressure washed prior to disposal. All investigation-derived waste (IDW) will be containerized, tested, and disposed.

3.1.5 Site Restoration

The site shall be restored to the original grade and reseeded. Additional topsoil will be used where necessary to re-establish the original surface grade. In areas of manicured lawns, the area will be reseeded with grass (fescue). In areas that are not routinely mowed and with concurrence from the USACE and NASA, the areas will be reseeded with Indian Grass. Additionally, a piece of metal (rebar) will be placed in the hole, within two feet of the ground surface, prior to completion of surface grading to allow the abandoned well to be found by metal detector or magnetometer.

Each monitoring well location will be photographed before, during, and after well abandonment to document condition of the monitoring well, depth of casing removal, and final restoration.

3.2 Site Access

Names of CBI personnel and CBI subcontractors, if applicable, will be provided by CBI to Mr. Robert Lallier, NASA Environmental Coordinator, at least 72 hours in advance so that site access can be arranged. All personnel entering the former PBOW facility will be appropriately trained and instructed by Plum Brook Station concerning site safety issues. All CBI personnel and any subcontracted personnel involved shall be U.S. citizens.

All CBI personnel will meet each morning at a selected “headquarters”-type area at the NASA/Plum Brook Station for the morning tailgate safety/job safety analysis meeting, equipment calibration, gathering of needed material, and replenishing of water. At the end of each day, if not performed throughout the day, the IDW generated during fieldwork will be moved to the CBI IDW storage area located in the secured NASA staging area.

4.0 Sample Analysis and Decontamination Procedures

4.1 Sample Number System

The sample numbering system to be used during this investigation will conform to the USACE Nashville District's numbering convention. Specifically, each sample will be assigned a unique sample identification number that describes where the sample was collected. Each number consists of a group of letters and numbers, separated by hyphens. The sample media and numbering system are described as follows.

Project Code	Year	Sample Type[a]	Site Identification[b]	Sample Number
PBOW	14	XX	XXXX	XXXX

[a]Sample Type: IDW – Investigative-Derived Waste
[b]Site: MWA – Monitoring Well Abandonment.

The complete sample number will be recorded by the CBI field geologist/geotechnical engineer in the field activity daily log, in the boring log (if applicable), and in the sample collection log as appropriate.

4.2 Analytical Program

The analytical program has been designed to acquire sufficient and defensible data for the disposal of IDW (both groundwater and decontamination water). One IDW sample will be collected per drum of IDW generated from the grouting and decontamination activities. Table 4-1 summarizes the analytical parameters required and associated laboratory methods to be used during this investigation.

A contract laboratory will analyze the water IDW samples for nitroaromatics, volatile organic compounds, semivolatile organic compounds, target analyte list metals, reactivity, corrosivity, and ignitability by the methods listed in Table 4-1. The list of analytes was determined by the disposal requirements and disposal facility. All applicable analyses will meet the recommended method guidance found in *Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods* (EPA, 1996) and its subsequent updates. They will meet the quality assurance/quality control requirements outlined in EM-200-1-6, *Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects* (USACE, 1997). Accutest Southeast is the primary analytical laboratory and is accredited under the DOD ELAP for the projects analytical methods

and compliant with *Quality Systems Manual for Environmental Laboratories*, Version 4.2 (DOD, 2010).

4.3 Decontamination Procedures

Decontamination requirements and procedures are specified in detail in Chapter 5.0 of the SWSAP (Shaw, 2008a) and will be followed duringwell abandonment activities. The CBI field coordinator must contact Plum Brook Station for access to a potable water source for decontamination use. Decontamination for all equipment used in well abandonment will consist of steam rinse with potable water or wash and scrub using a brush with nonphosphate detergent then rinse with potable water.

Decontamination wash water and rinse water will be managed for disposal as described in Section 6.2.

5.0 Sample Preservation, Packing, and Shipping

Sample containers and caps will be new, certified as precleaned, and made of materials recommended by EPA in Title 40, Code of Federal Regulations, Part 136 and SW-846 (EPA, 1996). Sample containers and preservatives/preservation methods are summarized in Table 4-1. Sample containers will be supplied and shipped to the job site by the designated primary laboratory. Accutest (the primary lab) will provide the sample preservatives.

Each sample container will be bagged before placement in the cooler. Sample holding times will be calculated from the date the sample is collected.

Samples for chemical analysis will be placed in coolers as soon as possible after collection and packed to minimize container breakage by using styrofoam peanuts and/or bubble wrap to fill void spaces in the cooler. Coolers will be taped, marked, and sealed and custody will be maintained as described in Chapter 6.0 of the SWSAP. Samples will be cooled to a temperature of approximately 4 degrees Celsius and maintained at that temperature by means of double-bagged ice until the cooler is received at the laboratory. Coolers will be shipped to the laboratory by a next-day delivery service. The temperature of each cooler will be taken with an infrared thermometer or equivalent upon receipt. Notification of shipment, including air bill number, will be telephoned or faxed to the laboratory on the day of sample collection. If this is not possible, the laboratory will be notified the following morning.

Completed analytical request/chain-of-custody records will be secured and included with each shipment of coolers to:

ATTN: Sue Bell
Project Manager Accutest Labs
4405 Vinland Road, C-15
Orlando, FL 32811P:813-741-3338
sueb@accutest.com

6.0 Investigation-Derived Waste Management Plan

Anticipated IDW during field activities includes purge water, decontamination fluid, and disposable personal protective equipment. Detailed procedures for IDW management are provided in Chapter 8.0 of the SWSAP (Shaw, 2008a). The following is a brief summary of the procedures for handling IDW.

6.1 Groundwater

Groundwater will be placed in 55-gallon drums throughout completion of well abandonment activities. IDW drums will be labeled to indicate project name and date collected. Groundwater storage drums will be placed on pallets on bermed plastic sheeting to prevent release to the soil in the event of drum failure. The drum storage location will be at a place chosen or designated by NASA's Environmental Coordinator, Mr. Robert Lallier.

6.2 Decontamination Fluid

Limited quantities of decontamination fluid, including wash water, nonphosphate soapy water, and final rinse water, will be kept in plastic tubs or similar container during the decontamination process. The fluids will be combined with the IDW groundwater and placed in 55-gallon drums when any of the solutions become dirty from the decontamination process or upon completion of well abandonment activities.

6.3 Personal Protective Equipment

Limited quantities of personal protective equipment and sampling equipment, including Tyvek® suits, latex/nitrile gloves, plastic, etc. will be generated during well abandonment activities and IDW sampling. All personal protective equipment will be double-bagged and disposed of in the CBI rented dumpster. If any of the sampling equipment and PPE appears to be grossly contaminated, it will be decontaminated prior to disposal.

6.4 Investigation-Derived Waste Sampling

All water IDW will be sampled at the completion of fieldwork. Table 4-1 summarizes the analytical parameters and methods for the IDW samples. For groundwater, one sample will be collected from each drum generated. The groundwater samples will then be submitted to the identified laboratory for nitroaromatics, volatile organic compounds, semivolatile organic compounds, TAL metals, reactivity, corrosivity, and ignitability. A normal (21-day) turnaround time will be used unless otherwise directed by the Project Manager.

When the analytical results are received, CBI personnel will evaluate the results and make a determination of off-site disposal methods. Possible disposal facilities will be identified by CBI; however, selection of the facility or facilities to receive the IDW will be the responsibility of USACE.

7.0 Reporting

Following completion of all field activities, a Monitoring Well Abandonment Report will be submitted to document the work completed. This report will include maps showing the monitoring wells that were abandoned, methods of abandonment, any deviations from procedures specified in this SWP, IDW disposal documentation, field photographs, and completed well abandonment forms. In addition to the well abandonment forms in Appendix C, the well abandonment information will be submitted to Ohio Department of Natural Resources either via hardcopy form (see Appendix A, page 9-7) or online at the following web address:
https://apps.ohiodnr.gov/water/maptechs/submitlogs/driller_login.asp

8.0 References

National Aeronautical and Space Administration (NASA), 2013, "NASA's Plum Brook Station Reaches 50-Year Milestone," ***AeroSpace Frontiers***, Volume 15, Issue 3, March.

National Aeronautical and Space Administration (NASA), 2012, ***NASA's Infrastructure and Facilities: An Assessment of the Agency's Real Property Leasing Practices***, Audit Report, Office of Inspector General, Report No. IG-12-020, August.

National Aeronautics and Space Administration (NASA), 1961, ***Request for Transfer of Excess Real Property, Land and Buildings, Plum Brook Ordnance Works, Sandusky, Ohio***, October 23.

Ohio Environmental Protection Agency, 2009, ***Technical Guidance Manual for Groundwater Investigations, Chapter 9, Sealing Abandoned Monitoring Wells and Boreholes,*** February.

Shaw Environmental, Inc. (Shaw), 2008a, ***Site-Wide Sampling and Analysis Plan, Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

Shaw Environmental, Inc. (Shaw), 2008b, ***Site-Wide Quality Assurance Project Plan, Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

Shaw Environmental, Inc. (Shaw), 2008c, ***Site-Wide Health and Safety Plan, Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

U.S. Army Corps of Engineers (USACE), 2014, ***Scope of Work, Site-wide Monitoring Well Abandonment and Surface Restoration Services and Preparation of Final Wastewater Treatment Plant No. 2 Proposed Plan, Draft Decision Document and Final Decision Document, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** April.

U.S. Army Corps of Engineers (USACE), 1998, ***Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic and Radioactive Waste Sites,*** EM 1110-1-4000, November 1998.

U.S. Army Corps of Engineers (USACE), 1997, ***Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects***, EM 200-1-6, October 1997.

U.S. Department of Defense (DOD), 2010, ***Quality Systems Manual for Environmental Laboratories***, Version 4.2, October.

U.S. Environmental Protection Agency (EPA), 1996, ***Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods***, EPA Publications SW-0846, Third Edition, Update III, (http://www.epa.gov/sw-846/sw846.htm).

War Department, 1947, "Sub-depot of Ravenna Re-designated as part of Erie Ordnance Depot," effective July 1, 1947, ***General Orders***, May 20.

TABLES

Table 3-1

Monitoring Well Construction Details
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well ID	Well Depth (feet bgs)	Casing Type	Casing Diameter (inches)	Screen Interval (feet bgs)
Monitoring Wells Screened in Overburden				
AA2-GW-002	18.50	PVC (40)	2	8.25-18.25
AA3-GW-002	16.00	PVC (40)	2	5.75-15.75
AA3-GW-003	18.25	PVC (40)	2	8.0-18.0
AA3-GW-004	18.25	PVC (40)	2	8.0-18.0
AA3-GW-005	18.25	PVC (40)	2	8.0-18.0
ABG-GW-002	6.75	PVC (40)	2	2.50-6.50
PR-MW07	22.30	PVC	2	4.3 - 22.3
PR-MW09	19.00	PVC	2	4.0 - 19.0
TNTA-MW10	11.00	PVC	2	3.0 - 11.0
TNTA-MW11	11.40	PVC	2	3.4 - 11.4
TNTC-MW03	14.00	PVC	2	5.0 - 14.0
TNTC-MW04	18.80	PVC	2	8.8 - 18.8
TNTC-MW05	29.70	PVC	2	4.7 - 29.7
WA-MW01	22.30	PVC	2	4.3 - 22.3
WA-MW02	13.00	PVC	2	3.0 - 12.0
IT-MW01	9.00	PVC	2	4.0 - 9.0
IT-MW02	18.30	PVC	2	6.0 - 16.0
IT-MW05	21.00	PVC	2	8.5 - 18.5
IT-MW06	18.50	PVC	2	6.0 - 16.0
IT-MW09	14.50	PVC	2	4.1 - 14.1
IT-MW10	19.80	PVC	2	9.3 - 19.3
Monitoring Wells Screened in Shale				
ABG-BEDGW-001	21.00	Steel to 7', PVC (40) to 21'	10" to 7', 2" to 21'	10.75-20.75
BG8-BEDGW-001	20.00	Steel to 4', PVC (40) to 20'	10" to 4', 2" to 20'	4.75-19.75
BED-MW20	48.50	PVC	4" to 35', 2" to 48.5'	28.5-48.5
BED-MW25	38.00	PVC	2	27.5-37.5
BED-MW26	57.75	PVC	2	42.25-57.25
BED-MW28	41.90	6" Steel to 23.65'	6	26.65-41.65
BED-MW29	37.90	6" Steel to 25'	6"	27.65-37.65
TNTB-BEDGW-001	24.00	Steel to 9', PVC (40) to 24'	10" to 9', 2" to 24'	8.75-23.75
TNTB-BEDGW-002	24.20	Steel to 8', PVC (40) to 24.2'	10" to 8', 2" to 24.2'	13.95-23.95
TNTB-BEDGW-003	43.00	PVC	2	32.5-42.5
TNTB-BEDGW-004	25.50	PVC	2	15-25

Table 3-1

Monitoring Well Construction Details
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well ID	Well Depth (feet bgs)	Casing Type	Casing Diameter (inches)	Screen Interval (feet bgs)
Monitoring Wells Screened in Delaware Limestone				
AA2-BEDGW-001	43.00	Steel to 20', PVC (40) to 43'	10" to 20', 2" to 43'	27.75-42.75
AA3-BEDGW-001	53.00	Steel to 28', PVC (40) to 53'	10" to 28', 2" to 53'	37.75-52.75
AA3-BEDGW-002	55.25	Steel to 26.5', PVC (40) to 55.25'	6" to 25.6', 2" to 55.25'	45.0 to 55.0
AA3-BEDGW-003	50.00	Steel to 23.5', PVC(40) to 51.0'	6" to 23.5, 2" to 51.0'	40.0-50.0
AA3-BEDGW-004	75.50	Steel to 34.5', open borehole	6" to 27', 4" to 34.5'	34.5-75.5 open borehole
BED-MW13	75.50	PVC	4" to 46.5'	46.5-75.5 open borehole)
BED-MW14	52.20	PVC	4" to 29.0'	29.0-49.4 open borehole
BED-MW15	74.40	PVC	4" to 31.5'	31.5-74.4 open borehole
BED-MW16	74.00	PVC	4" to 49.2'	49.2-74.0 open borehole
BED-MW17	64.40	PVC	4" to 45.0'	45.0-64.4 open borehole
BED-MW18	75.40	PVC	4" to 51.0'	51.0-75.4 open borehole
BED-MW19	49.50	PVC	4" to 32.0'	24.5-49.5
BED-MW23	73.00	PVC	2	53-73
BED-MW24	41.00	PVC	2	25.5-40.5
BED-MW30	57.30	6" Steel to 29.5'	6"	42.3-57.3
BED-MW33	88.50	6" Steel to 19.5'	6"	68.5-88.5
TNTA-BEDGW-001	85.00	PVC	2	70-85
TNTC-BEDGW-001	85.00	PVC	2	70-85
2BG-BEDGW-001	48.00	Steel to 22', PVC (40) to 48'	2	38-48
2BG-BEDGW-002	72.00	Steel to 24.5',PVC (40) to 72'	2	42-72
2BG-BEDGW-003	61.00	Steel to 22.5',PVC (40) to 61'	2	41-61

Data ***not*** highlighted is part of the extended continued groundwater remedial investigation.
Coordinates scaled to the Ohio State Plane coordinate system, North Zone, NAD 1983. Vertical datum is NAVD 1929.

Table 4-1

Summary of Analytical Parameters and Methods
Monitoring Well Abandonment
Former Plum Brook Ordnance Works, Sandusky, Ohio

Matrix	Parameter	Analytical Method[a]	Sample Container[b]	Preservation Requirements	Holding Time
Liquid IDW and Decon Water	TCL VOCs	SW-846 5030B/8260B	(3) 40 ml VOA vial	Cool to 4°C, HCL to pH <2	14 days
	TCL SVOCs	SW-846 3510C/8270D	(2) 1 L amber glass	Cool to 4°C	7 days extraction/40 days
	Nitroaromatics	SW-846 3535A/8330A	(1) 1 L amber glass	Cool to 4°C	7 days extraction/40 days
	Total TAL Metals	SW-846 3005A/6010C/7470A	(1) 250 mL HDPE	Cool to 4°C, HNO_3 to pH <2	6 months (28 days for Hg)
	Ignitability	SW-846 1010A	(1) 1 L Amber	Cool to 4°C	ASAP
	pH	SW-846 9040C			
	Corrosivity	SW-846 1110A			
	Reactive Cyanide	7.3.3/7.3.4			
	Reactive Sulfide	7.3.3/7.3.4			

°C - Degrees Celsius.
HCI - Hydrochloric acid.
HDPE - High-density polyethylene.
Hg - Mercury.
HNO_3 - Nitric acid.
L - Liter.
mL - Milliliter.
SVOC - Semivolatile organic compound.
TAL - Target analyte list.
TCL - Target compound list.
VOC - Volatile organic compound.
IDW - Investigative-derived waste.
ASAP - As soon as possible.

[a]Analyses found in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* USEPA Publication, Third Edition.
[b]Number of containers required in ( ).

FIGURES

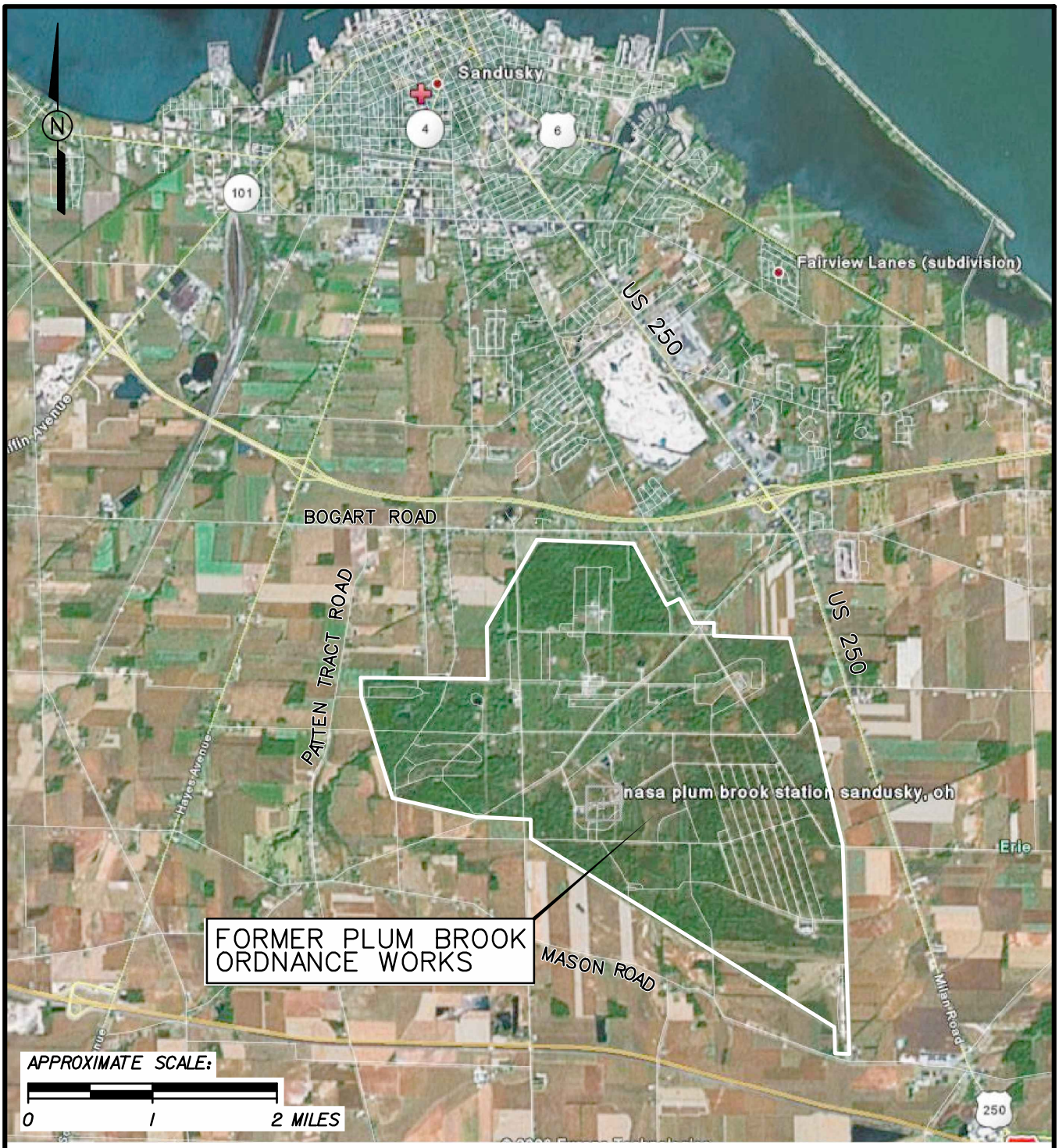
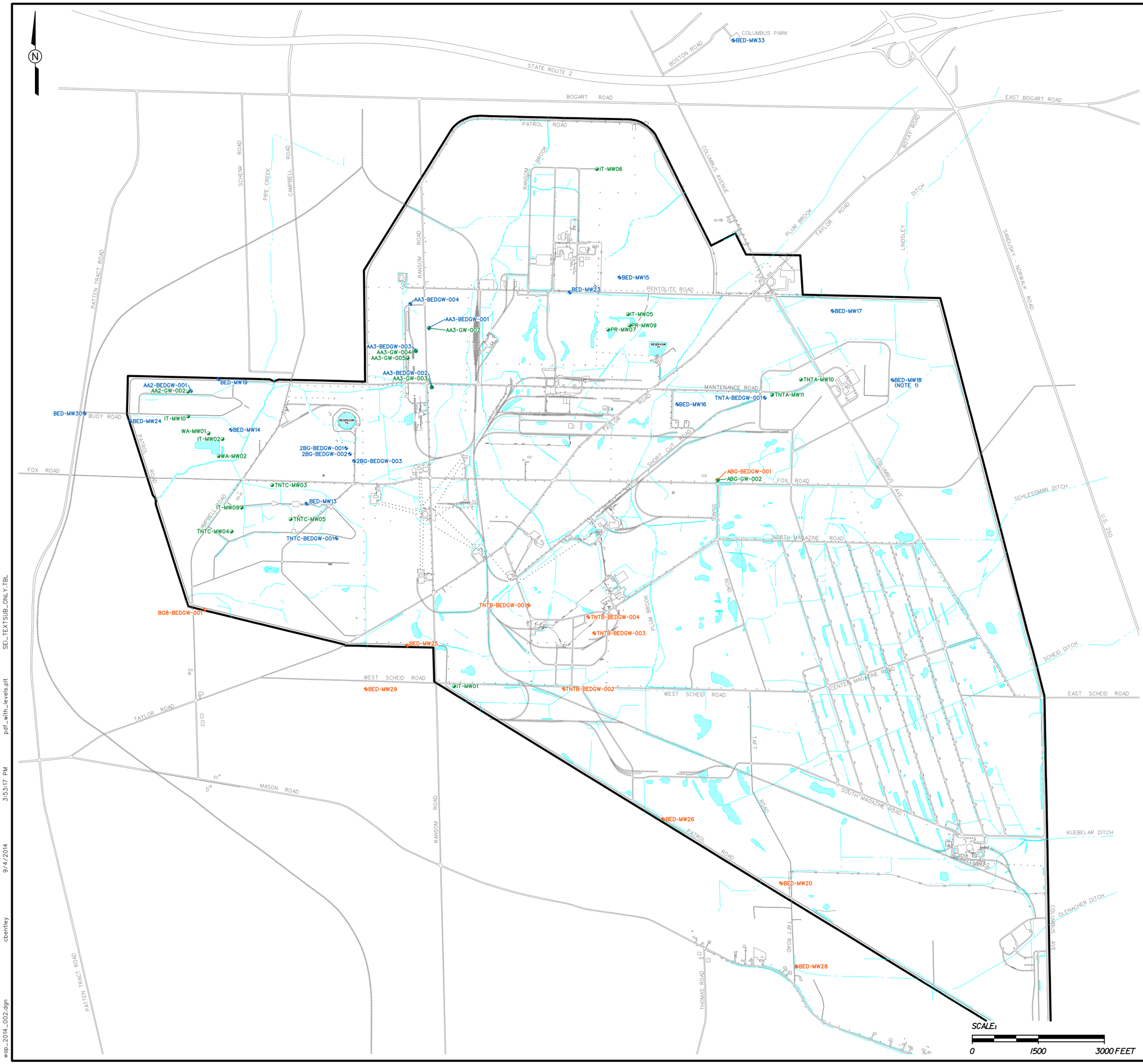


FIGURE 1-1
PBOW VICINITY MAP

WELL ABANDONMENT PLAN
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

SEI_TEXTSUB_ONLY.TBL
pdf_with_levels.plt
3:54:28 PM
9/4/2014
cbentley
wap_2014_001.dgn



LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- POND
- CREEK, DITCH, CONVEYANCE
- RAILROAD
- ROAD
- FENCE
- PBOW BOUNDARY

NOTES:

1. BED-MW18 IS SCREENED IN BOTH SHALE AND LIMESTONE.

FIGURE 1-2
PROPOSED MONITORING WELLS TO BE ABANDONED

WELL ABANDONMENT PLAN

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

CB&I Federal Services LLC

SEL_TEXTSUB_ONLY.TBL pdf_with_levels.plt 3:53:17 PM 9/4/2014 cbentley wap_2014_002.dgn

APPENDIX A

OHIO EPA TECHNICAL GUIDANCE MANUAL FOR GROUNDWATER INVESTIGATIONS, CHAPTER 9, SEALING ABANDONED MONITOROING WELLS AND BOREHOLES

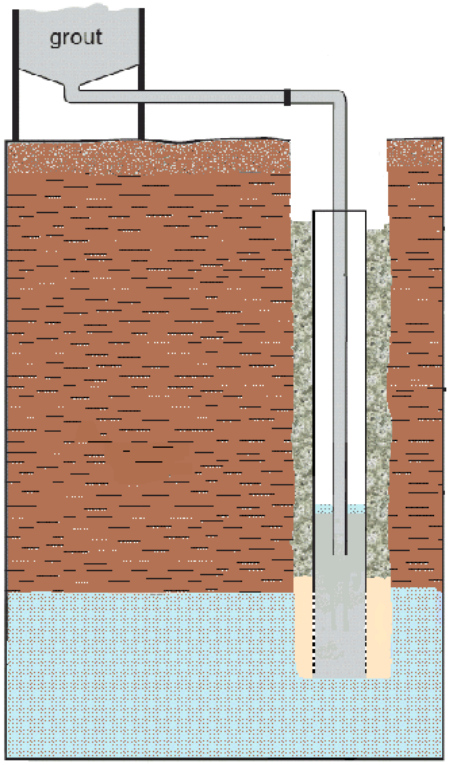
State of Ohio
Environmental Protection Agency

Division of Drinking and Ground Waters

Technical Guidance Manual for Ground Water Investigations

Chapter 9

Sealing Abandoned Monitoring Wells and Boreholes



February 2009

Governor : Ted Strickand
Director : Chris Korleski

TECHNICAL GUIDANCE MANUAL FOR GROUND WATER INVESTIGATIONS

CHAPTER 9

SEALING ABANDONED MONITORING WELLS AND BOREHOLES

October 2009
Revision 2

Ohio Environmental Protection Agency
Division of Drinking and Ground Waters
P.O. Box 1049 50 W. Town Street, Suite 700
Columbus, Ohio 43216-1049
Phone: 614-644-2752
http://www.epa.state.oh.us/ddagw/

PREFACE

The subject of this document is techniques to characterize hydrogeology beneath a site. It is part of a series of chapters incorporated in Ohio EPA's *Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring* (TGM), which was originally published in 1995. DDAGW now maintains this guidance as a series of chapters rather than as an individual manual. These chapters can be obtained at http://www.epa.state.oh.us/ddagw/tgmweb.aspx.

The TGM identifies technical considerations for performing hydrogeologic investigations and ground water monitoring at potential or known ground water pollution sources. The purpose of the guidance is to enhance consistency within the Agency and inform the regulated community of the Agency's technical recommendations and the basis for them. In Ohio, the authority over pollution sources is shared among various Ohio EPA divisions, including the Emergency and Remedial Response (DERR), Hazardous Waste Management (DHWM), Solid and Infectious Waste (DSIWM), and Surface Water (DSW), as well as other state and local agencies. DDAGW provides technical support to these divisions.

Ohio EPA utilizes ***guidance*** to aid regulators and the regulated community in meeting laws, rules, regulations and policy. Guidance outlines recommended practices and explains their rationale. Note that the term implies no enforcement authority. The Agency may not require an entity to follow methods recommended by this or any other guidance document. It may, however, require an entity to demonstrate that an alternate method produces data and information that meet the pertinent requirements. Ohio EPA recognizes that inflexibility in the language and/or interpretation of guidance can lead to the adoption of inappropriate measures, delay, and inefficiency. The procedures used to meet requirements usually should be tailored to the specific needs and circumstances of the individual site, project, and applicable regulatory program, and should not comprise a rigid step-by-step approach that is utilized in all situations.

ACKNOWEDGMENTS

This guidance was developed by Ohio EPA's Division of Drinking and Ground Waters (DDAGW). The following are acknowledged.

Lisa Koenig, DDAGW-CO had primary responsibility for researching and writing this chapter in 1995 and completing this updated version.

Jeff Patzke, DDAGW-CO who served as editor and project coordinator the Technical Guidance Manual.

Jeff Martin, DDAGW-CO, **Rich Bendula**, DDAGW-SWDO, and **Ralph Baker**, DDAGW-NWDO, and **Eric Sainey**, DERR-CO provided technical input to the updated version.

The Ohio EPA would also like to thank the numerous people who provided input during the development of the 1995 document. The comments and recommendations from the DDAGW-District Offices, and other Ohio EPA Divisions, State and Federal Agencies, private consultants, and regulated community were greatly appreciated.

TECHNICAL CHANGES FROM FEBRUARY 2005

The Ohio EPA Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring (TGM) was finalized in 1995. This document represents an update to Chapter 9 (Monitoring Well and Borehole Abandonment) of the 1995 TGM.

No major changes were made. Some clarification was added for when disinfection of a well/borehole is needed prior to sealing.

TABLE OF CONTENTS

PREFACE.....9-iii
ACKNOWEDGMENTS.....9-iv
TECHNICAL CHANGES FROM FEBRUARY 2005..... 9-v
TABLE OF CONTENTS 9-vi
SEALING MATERIALS..... 9-1
PROCEDURES 9-2
PLANNING..... 9-2
FIELD PROCEDURE..... 9-3
REFERENCES 9-8

CHAPTER 9
SEALING ABANDONED MONITORING WELLS AND BOREHOLES

Boreholes that are not completed as monitoring wells and monitoring wells that no longer are being sampled or used for ground water level measurements are considered abandoned and should be sealed properly. Proper sealing is necessary to: 1) prevent poor quality water from one saturated zone entering another, 2) prevent contamination of the ground water by surface contaminants, 3) restore an aquifer to as close to its original condition as possible, 4) eliminate physical hazards, and 5) reduce potential for future liability. A suitable program should be designed and implemented to meet these objectives. This guidance document provides recommendations on sealing materials, procedures to appropriately seal an abandoned well/borehole and documentation of sealing activities. The sealing material and method depends on: 1) the design and construction of the well/borehole, 2) hydrogeologic conditions, 3) the chemical environment, 4) safety hazards and 5) disposal of contaminated materials removed. In general, sealing should consist either of a method for well removal and simultaneous grouting of the borehole with bentonite, neat cement, or a bentonite/cement mixture, or a method for grouting in-place that ensures complete sealing. Additional guidance on sealing of all types of wells can be found in the "State of Ohio Technical Guidance For Sealing Unused Wells" (SCCGW, 1996).

SEALING MATERIALS

The chosen sealing material should:

- Not react with contaminants, ground water, or geologic materials.
- Have a hydraulic conductivity comparable to or lower than the in-situ material.
- Form a tight bond with the borehole wall and well casing.
- Be resistant to cracking and/or shrinking.
- Be of sufficient structural strength to withstand subsurface pressures.
- Be capable of being placed at the appropriate depth.

Chapter 7 (Monitoring Well Design and Installation) should be consulted for details on different types of sealants and their application. No single material exhibits all of the desirable characteristics. Therefore, every situation should be evaluated carefully to determine the appropriate choice. Generally, materials used are comprised of concrete, neat cement, or sodium bentonite.

Most wells completed in unconsolidated formations or non-creviced rock may be satisfactorily sealed with neat cement or bentonite. Wells that penetrate limestone or other creviced or channeled rock formations should be filled with concrete grout or neat cement to ensure seal permanence. The use of fine-grained materials to seal creviced rock may not be desirable because the materials might be displaced by flow of water through crevices (American Water Works Association, 1984). Neat cement or sodium bentonite should be used for sealing an abandoned well/borehole below the water table (Gordon and Koch, 1988). Above the water table, bentonite should be utilized. Sodium bentonite chips or pellets placed above the water table require addition of water during sealing. Neat cement may shrink if placed above the water table.

A common sealing practice is to use a bentonite-cement mixture. Some have recommended a two to six weight percent of bentonite mixed with neat cement to reduce shrinkage. However, this may actually increase shrinking as it ties up water that would be incorporated in the cement. In addition, bentonite can not compensate for shrinkage, as much of the sodium associated with bentonite mixed into a cement slurry is replaced by calcium due to ion exchange. Calcium bentonite has little or no expansive capacity (Smith, 1994). Therefore, cement-bentonite sealants should be used with care (Christman et al., 2002; Edil et al., 1992).

At no time should a borehole or well be backfilled with cuttings or with any materials of unknown integrity. However, in some geologic environments, such as coarse gravel, where excessive loss of sealing materials may occur, or when grout may affect the water quality of nearby monitoring wells, clean sand or gravel or crushed rock in conjunction with regular materials can be used (Gordon and Koch, 1988; Kraemer et al., 1991).

PROCEDURES
PLANNING

Careful review should be conducted prior to sealing abandoning monitoring wells. This may include:

- Review of records pertaining to well construction and repair or modifications.
- Review of analytical chemical data for soil and ground water.
- Review of the hydrogeologic/geologic characteristics in the vicinity of the well.
- Current conditions of the well, such as, total depth, amount of siltation, etc.

If a well is to be left in place, borehole geophysical techniques may be helpful in determining its integrity. This may include caliper logs to measure inside diameter; television logs to identify casing breaks, screen size, etc.; gamma logs to verify geologic information; cement bond logs to determine if the casing is firmly attached to the grout; flow logs to determine if vertical flow occurs within the casing; and hydraulic integrity tests to determine if the casing is intact (ASTM, D5299-99). For additional information on downhole logs, see Chapter

Prior to the sealing of monitoring wells, it is recommended that a work plan detailing the procedures/methods be submitted to the appropriate regulatory authority.[1] The information should include:

- Reasons for sealing.
- Identification and location coordinates.
- Casing diameter and material.
- Screen material, length, and depth.
- Total depth.
- Geologic materials opposite well screen.
- Drilling log and construction diagrams.

---

[1]If a regulated entity is conducting a hydrogeologic investigation or a ground water monitoring program, a ~~well sealing~~ work plan should be submitted prior to initiating the program. In this situation, a separate workplan is not necessary.

- Type and concentrations of contaminants present[2], if any.
- Procedure for disposal of any contaminated media.
- Method for sealing.
- Type of sealing material.
- An estimation of the volume of sealing material needed.
- Measures to protect the health and safety of individuals.

FIELD PROCEDURE

Monitoring wells have often been sealed by pulling the surface casing where possible, followed by pouring cement or bentonite into the hole. This procedure is inappropriate, especially if the construction of the well is unknown or the well intake spans more than one saturated zone. Incomplete seals may form due to bridging. Additionally, the procedure has little effect on the filter pack, which may allow communication between saturated zones.

The following basic procedure is recommended for sealing monitoring wells and boreholes. Steps 1 and 2 are not necessary for sealing of exploratory boreholes. It should be understood that no single method and material are suitable for all situations. Site-specific characteristics may merit modifications or procedures not discussed below. Additional information can be found in the references listed.

1. Inspect the well and remove any obstacles (i.e., pumps, pressure lines, other debris, etc.) that may interfere with the placement and performance of the sealing material. If necessary, a camera survey can help to identify the depth and construction of the well if this information is not known. The outer protective casing should be removed.

2. When the annular seal is inadequate, the filter pack connects two or more water bearing zones, water is flowing from around the outside of the casing, or when construction details are not known, the casing, screen, annular seal and filter pack should be removed. The casing and well screen can be removed by pulling or bumping the casing, overdrilling around the casing using a hollow stem auger, or drilling out the well using a solid stem auger or rotary bit (see Table 9.1). The method used should depend on the type, length, and diameter of the casing, conditions of the annular seal, and site geology. Aller et al. (1991) and ASTM 5299-99 provided a discussion on various removal techniques. The borehole should be overdrilled using a bit with a diameter at least 1.5 times greater than the original diameter of the borehole. Drilling should be slightly deeper than the original depth to assure complete removal. To achieve an effective seal, the borehole should be cleared of any excess mud filtercake.

   In some instances, such as when safety problems occur or when dealing with large diameter wells, casing removal can be difficult. If circumstances prevent complete removal of casing and screen, then the following procedure can be used (based on Renz, 1989):

[2]If contamination was detected or suspected in the original well or boring, appropriate health and safety requirements should be followed.

a. The well can be filled with clean (ANS/NSF 61[3]) disinfected sand to one foot above the screen in the event that the screened area is adjacent to a highly permeable formation.

b. One foot of bentonite chips/pellets can be placed above the screen in a manner that prevents bridging (i.e., through a tremie pipe or by tamping after installation). (Note: Chips are recommended below the water table because they will sink, whereas pellets will often float to the water table.)

c. The chips/pellets should be hydrated, if placed above the water table.

d. To allow the sealant to permeate and be effective, the casing should be perforated to one foot above the bentonite seal either by splitting it vertically (synthetic casing) or by making horizontal cuts every two feet with a retractable blade (steel casing).

Since the primary purpose of sealing is to eliminate vertical fluid movement, it is recommended that the casing and screen be removed and the boring be overdrilled to remove the annular seal and filter pack. However, monitoring wells can be sealed in-place when the construction details are known, the annular seal is intact, and the filter pack does not cross more than one ground water zone.

Table 9.1 Techniques for casing removal.

TECHNIQUE	***METHOD***
Pulling or bumping	Use a rig to pull out the well casing; this may be appropriate only for steel casing since plastic/Teflon casing may break.
Overdrilling	Drill around the well using the well casing as a guide, then pull out the casing. This method is limited by well diameter due to the high torque required to turn large diameter augers.
Drilling through well	Use a solid stem or rotary bit to drill the casing out. This can be done only with plastic/Teflon well material. It can be difficult to retrieve the cutting.

3. Where evidence of microbiological growth is present, a monitoring well may need to be disinfected. However, before disinfecting, an evaluation as to whether this would affect water quality monitoring results in the proximity should be made.

   When needed, wells should be disinfected by slowly wetting the circumference of the well/borehole with the disinfection solution by using a tremie pipe starting from the bottom

[3] NSF/ANSI Standard 61: Drinking Water System Components -- Health Effects are both American National Standards, which means that the NSF Standards and the processes used to develop them conform to ANSI's requirements for voluntary consensus standards (http://www.nsf.org/business/water_distribution/standards.asp?program=WaterDistributionSys).

of the well and working upwards to assure that all sides are wetted by the solution. The solution should be well mixed within the well/borehole and purged before sealing with grout. Contact of disinfectant with bentonite should be avoided. The bentonite grout will not seal properly if it comes into contact with the disinfection solution. The disinfectant should:

- Have a concentration in the water column of approximately fifty milligrams per liter (mg/L) total chlorine, but no more than 100 mg/L.

- Have standard ANSI/NSF 60 certification. Standard ANSI/NSF 60 refers to "Standard ANSI/NSF 60, Drinking Water Treatment Chemicals - Health Effects", February 9, 2001, Document Number NSF/ANSI 60-2001 (NSF Web Site).

4. The borehole should be pressure grouted using a tremie pipe as the drilling stem is removed. The sealant should be applied in one continuous procedure to prevent segregation, dilution, and bridging (Aller et al., 1991). The pipe should be in constant contact with the sealant to prevent air pockets from forming. The borehole should be sealed from the bottom up to the frost line (approximately two to three feet from the surface). The overflowing grout should be regularly evaluated as it reaches the surface. When the observed material is similar to that being pumped in, this stage of the sealing is considered complete. Wells sealed in-situ should be sealed from the bottom up to approximately three feet from the surface.

   Small diameter wells or boreholes (<2 inches) may present special challenges. A small diameter (3/4 inch) grout pipe can be used; however, high pumping pressures or less viscous materials may be necessary (ASTM D5299). Grouting machines are available for use with small diameter wells. A grouting machine reduces problems of bridging and incomplete seals associated with adding materials from the ground surface.

   When sealing wells that have two or more saturated zones or in flowing wells, it may be necessary to use a packer assembly. An inflatable packer can be placed at the top of the producing water zone to stop or restrict flow. The borehole can be sealed by pressure grouting from the bottom of the hole to the top of the packer. The packer can then be deflated and the grouting process continued.

   If dry sealant is introduced by gravity pouring, care must be taken that bridging does not occur. This can be accomplished by slowly adding the grout and stopping periodically (e.g., every five feet) to measure, tamp the grout and add water to hydrate. The amount of added water should be in accordance with manufacturer specifications. Coarse grade or bentonite pellets should be poured over a wire mesh to remove fines.

5. The grout plug should be inspected 24 hours after installation to check for settling; grout should be added if needed. If the well is sealed in-place, the casing should be cut off approximately three feet below ground level and a PVC or stainless steel cap should be emplaced. The boring should be grouted to within two to three feet from the surface with appropriate material. Monitoring wells sealed in-place should be marked with a piece of metal to allow for location by a metal detector or magnetometer (Aller et al., 1991).

6. The remaining area above the plug should be completed in a manner that is compatible with the site. For example, its top can be covered with one to two feet of soil if vegetative growth is desired. If the area is to be surfaced, then the final seal can be completed with cement or concrete.

7. Proper sealing of monitoring wells/boreholes should be documented and reported to the Ohio EPA division regulating the site. The information should include, at a minimum:

   Identification (e.g., registration number, location, owner, and any other features).

   - Well construction details.
   - Date, time, person responsible, and contractor/consultant performing the work.
   - Authority under which sealing was performed.
   - Procedures and materials used (including predicted volume of grout, volume of grout used, and an explanation if any discrepancy exists between these values).
   - Method/procedures for disposal of any contaminated materials. (Disposal of any contaminated material must be in accordance with any federal, state, or local regulations.)

Additionally, Ohio Revised Code 1521.05(B)(9) requires that a well sealing report be filed with the Ohio Department of Natural Resources (ODNR). Figure 9.1 is an example of the form. It can be obtained from ODNR, Division of Water (614-265-6739).

WATER WELL SEALING REPORT
(For Abandoned or Unused Wells)
OHIO DEPARTMENT OF NATURAL RESOURCES
Division of Water, Ground Water Resources Section
1939 Fountain Square Drive
Columbus, Ohio 43224-1360

LOCATION

County_____ Township_____ Section _____
Property Owner_____
Address of Property_____
Location:_____ miles _____ (n, e, s, w) of _____ (nearest intersection)

on the _____ (n, e, s, w) side of _____ (road name)

ORIGINAL WELL

ODNR Well Log Number_____ Copy attached? Yes or No (circle one)

MEASURED CONSTRUCTION DETAILS Date of measurements_____

Depth of Well_____ Static Water Level_____
Size of Casing_____ Length of casing_____
Well Condition_____

SEALING PROCEDURE

Method of Placement_____

			Sealing Material	Volume
Placement:	From_____	To_____		
	From_____	To_____		
	From_____	To_____		

Was Casing Removed? Yes or No (circle one)
Condition of Casing_____
Perforations: From_____ To_____
From_____ To_____
Date Sealing Performed_____
Reason(s) for Sealing_____

CONTRACTOR

Name_____ ODH Registration #_____
Address_____
City/State/Zip_____ Signature_____

DNR 7810.93 **SUBMIT COMPLETED FORM TO ODNR-DIVISION OF WATER**

SAMPLE

Figure 9.1 ODNR form for reporting well abandonment procedures.

(Contact ODNR, Division of Water for Form. 614-265-6739).

REFERENCES

Aller, L., T. W. Bennett, G. Hackett, R. J. Petty, J. H. Lehr, H. Sedoris, D.M. Nielsen, and J. E. Denne. 1991. Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Las Vegas, Nevada. EPA/600/4-89/034. (In cooperation with the National Water Well Association).

American Society for Testing Materials. Method D5299-99(2005). Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and other Devices for Environmental Activities. American Society for Testing Material Standards. Philadelphia, Pennsylvania.

American Water Works Association. 1984. Appendix I: Abandonment of Test Holes, Partially Completed Wells, and Completed Wells. American Water Works Association Standard for Water Wells. American Water Works Association. Denver, Colorado. pp. 45-47.

Christman, M., C.H. Benson, T.B. Edil. 2002. Geophysical Study of Annular Well Seals. Ground Water Monitoring and Remediation. Volume 22, Number 3, pp. 104-12.

Edil, T.B., M.M.K. Chang, L.T. Lan, T.V. Riewe. 1992. Sealing Characteristics of Selected Grouts for Water Wells. Ground Water. Volume 30, Number 3, pp. 351-361.

Gordon, D. L. and D. Koch. 1988. Guidelines for Plugging Abandoned Water Wells. Iowa Department of Natural Resources, Geological Survey Bureau. Technical Information Series 15. Iowa City, Iowa.

Kraemer, C. A., J. A. Shultz, and J. W. Ashley. 1991. Monitoring Well Post-Installation Considerations. In: D. M. Nielsen (editor), Practical Handbook of Ground-Water Monitoring. Lewis Publishers, Inc. Chelsea, Michigan. pp. 333-363.

Renz, M. E. 1989. In-Situ Decommissioning of Ground Water Monitoring Wells.Water Well Journal. Vol. 43, No. 5, pp. 58-60.

Smith, A. Stuart. 1994 Well & Borehole Sealing: Importance, Materials, Methods and Recommendations for Decommissioning. Ground Water Publishing Co. Dublin, Ohio.

State Coordinating Committee on Ground Water. 1996. State of Ohio Technical Guidance for Sealing Unused Wells.

APPENDIX B

RIGHT-OF-ENTRY AGREEMENTS FOR OFFSITE MONITORING WELLS

DEPARTMENT OF THE ARMY
Right of Entry for Survey, Exploration, and HTRW Investigation

PROJECT: Plum Brook Ordnance Works

OWNER: Joanne R. Shickley
C/O Robert Shickley
4603 Mason Road
Sandusky, Ohio 44870
(419) 503-1830

The undersigned, hereinafter called the "Owner", hereby grants to the United States of America, hereinafter called the "Government", a permit or right-of-entry upon the following terms and conditions:

1. The Owner hereby grants to the Government an irrevocable right to enter upon the lands hereinafter described at any time within a period of **5 years** from the date of this instrument in order to re-install (if necessary), operate and maintain a flush-mounted groundwater monitoring well (MW29), and take and analyze groundwater samples. Following expiration of the monitoring period, the Government shall either request an extension of the monitoring period or abandon the monitoring well in accordance with the State of Ohio Regulations, at no cost to Owner. Upon abandoning the monitoring well, the Government shall restore Owner's property to the condition existing at the signing hereof.

2. The permit includes the right of ingress and egress on other lands of the Owner not described below, provided such ingress and egress is necessary and not otherwise conveniently available to the Government.

3. All tools, equipment, and other property taken upon or placed upon the Owner's property by the Government shall remain the property of the Government and must be removed by the Government at any time within a reasonable period after the expiration of this permit of right-of-entry.

4. If any action of the Government's employees or agents in the exercise of the right-of-entry results in damage to the real property, the Government will, at its sole discretion, either repair such damage or make an appropriate settlement with the owner. In no event shall such repair or settlement exceed the fair market value of the fee title to the real property at the time immediately preceding such damage. The Government's liability under this clause is subject to the availability of appropriations for such payment, and nothing contained in this agreement may be considered as implying that Congress will at a later date appropriate funds sufficient to meet any deficiencies. The provisions of this clause are without prejudice to any rights the Owner may have to make a claim under applicable laws for any damages other than those provided for herein.

5. If aircraft flights over said lands, or entry upon the land by means of helicopter or other type aircraft are necessary, the Government shall inform the Owner, in advance, of each such flight or entry.

6. The Corps of Engineers will furnish a copy of the water sample analysis results to the owner.

7. The land affected by this permit or right-of-entry is located in the State of Ohio, County of Erie, and is described as follows: As Tax ID # 2500358000; Permanent Parcel #25103200014000; Tax Map No. 11; Taxing District 25 Oxford Twp. – Perkins LSD. Exhibit A shows the location of the property.

WITNESS MY HAND AND SEAL THIS 10 ***DAY OF*** April***, 2013.***

Robert R. Shickley *(SEAL)*
Joanne R. Shickley, Owner

UNITED STATES OF AMERICA

by _____
STEVEN B. SHIDELER
CHIEF, REAL ESTATE DIVISION

ENG FORM 1258, as modified by 5-2-1996 endorsement

Hayes Ave
Skidder Rd
Mason Rd W
Erie Sand Barrens
Nature Preserve
Ohio Turnpike (Toll road)
James W. Shocknessy Ohio Turnpike (Toll road)
Farm Service Agency, Map data ©2013 Google

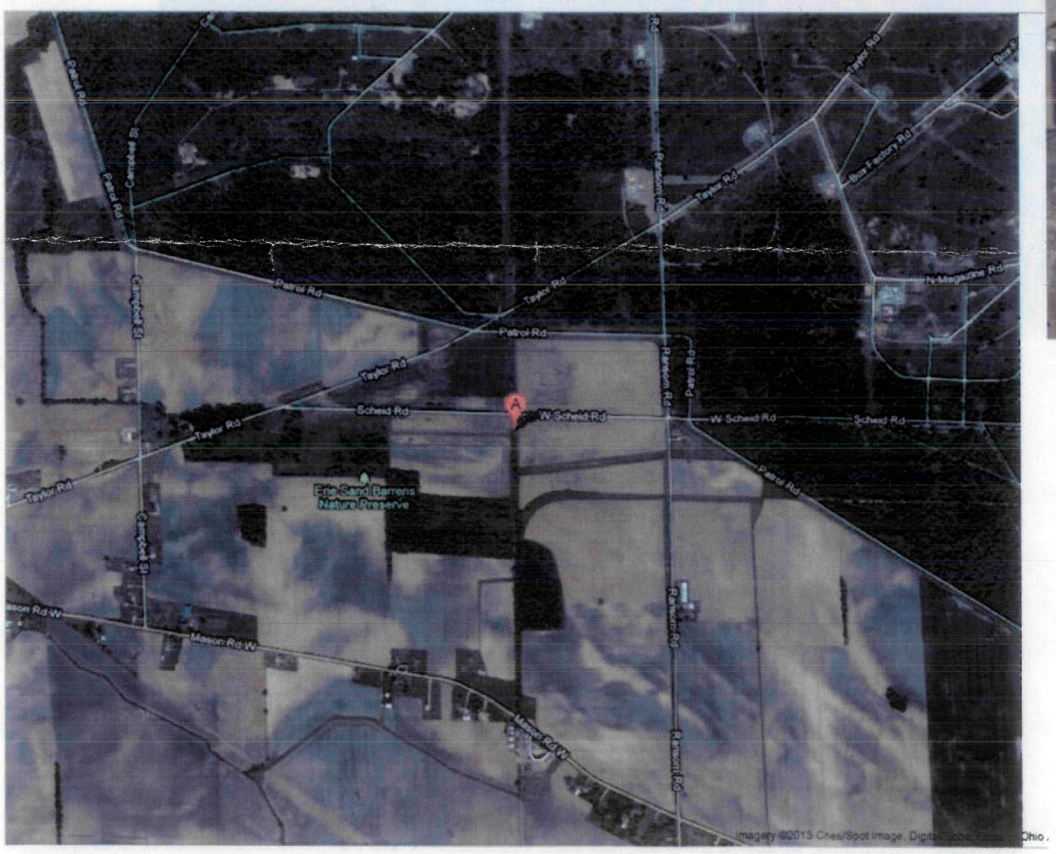

Campbell St
Taylor Rd
Petrol Rd
Schaid Rd
W Schaid Rd
Ransom Rd
Erie Sand Barrens
Nature Preserve
Mason Rd W
imagery ©2013 Cnes/Spot Image, Digital Globe

EXHIBIT A

DEPARTMENT OF THE ARMY
Right of Entry for Survey, Exploration, and HTRW Investigation

PROJECT: Plum Brook Ordnance Works

OWNER: Thomas A. Galloway
6019 Schenk Road
Sandusky, Ohio 44870
(419) 656-1894

The undersigned, hereinafter called the "Owner", hereby grants to the United States of America, hereinafter called the "Government", a permit or right-of-entry upon the following terms and conditions:

1. The Owner hereby grants to the Government an irrevocable right to enter upon the lands hereinafter described at any time within a period of **5 years** from the date of this instrument in order to re-install (if necessary), operate and maintain a flush-mounted groundwater monitoring well (MW30), and take and analyze groundwater samples. Following expiration of the monitoring period, the Government shall either request an extension of the monitoring period or abandon the monitoring well in accordance with the State of Ohio Regulations, at no cost to Owner. Upon abandoning the monitoring well, the Government shall restore Owner's property to the condition existing at the signing hereof.

2. The permit includes the right of ingress and egress on other lands of the Owner not described below, provided such ingress and egress is necessary and not otherwise conveniently available to the Government.

3. All tools, equipment, and other property taken upon or placed upon the Owner's property by the Government shall remain the property of the Government and must be removed by the Government at any time within a reasonable period after the expiration of this permit of right-of-entry.

4. If any action of the Government's employees or agents in the exercise of the right-of-entry results in damage to the real property, the Government will, at its sole discretion, either repair such damage or make an appropriate settlement with the owner. In no event shall such repair or settlement exceed the fair market value of the fee title to the real property at the time immediately preceding such damage. The Government's liability under this clause is subject to the availability of appropriations for such payment, and nothing contained in this agreement may be considered as implying that Congress will at a later date appropriate funds sufficient to meet any deficiencies. The provisions of this clause are without prejudice to any rights the Owner may have to make a claim under applicable laws for any damages other than those provided for herein.

5. If aircraft flights over said lands, or entry upon the land by means of helicopter or other type aircraft are necessary, the Government shall inform the Owner, in advance, of each such flight or entry.

6. The Corps of Engineers will furnish a copy of the water sample analysis results to the owner.

7. The land affected by this permit or right-of-entry is located in the State of Ohio, County of Erie, and is described as follows: As Tax ID # 32100200042. Exhibit A shows the location of the property.

WITNESS MY HAND AND SEAL THIS 11 ***DAY OF*** April***, 2013.***

Thomas A Galloway *(SEAL)*
Thomas A. Galloway, Owner

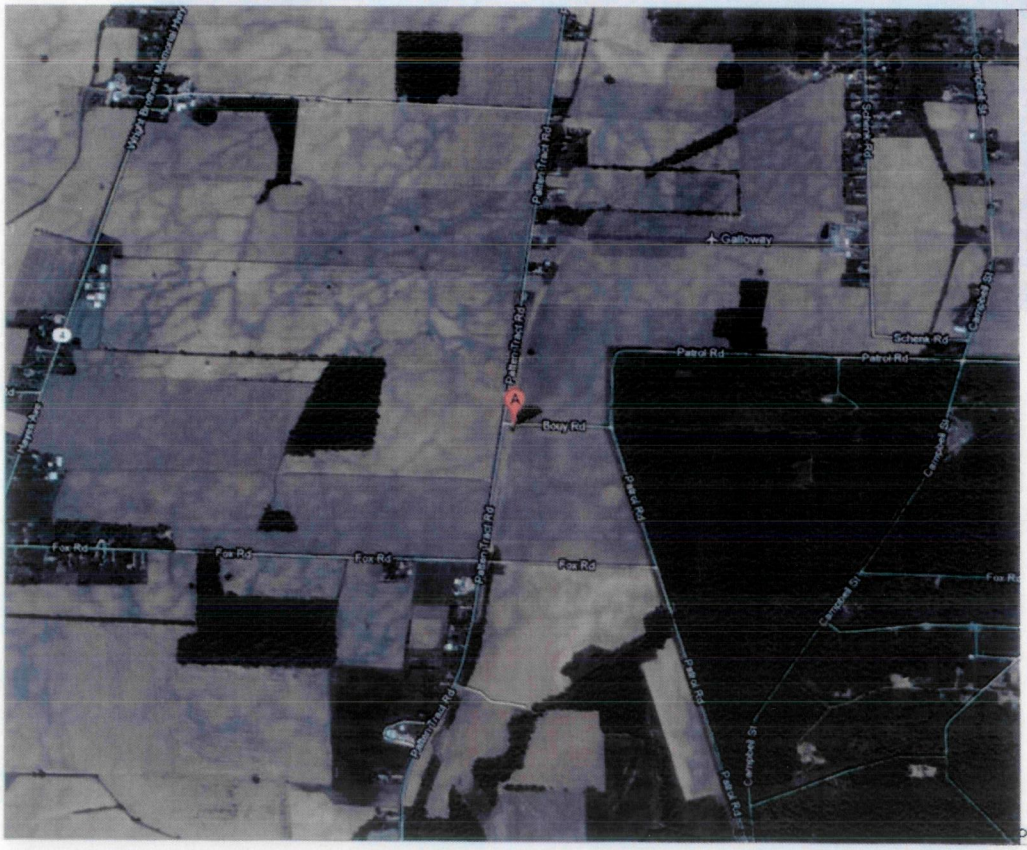
UNITED STATES OF AMERICA

by

STEVEN B. SHIDELER
CHIEF, REAL ESTATE DIVISION

ENG FORM 1258, as modified by 5-2-1996 endorsement

Main St
Tiffin Ave
Bardhar Rd
Bogart Rd W
W Bogart Rd
Hayes Ave
Skidden Rd
Mason Rd W
Columbus-Sandusky Rd
Erie Sand Barrens
Nature Preserve
Ohio Turnpike (Toll road)
Portland Rd
A


Galloway
Patrol Rd
Schena Rd
Bouy Rd
Fox Rd
Palmer Tract Rd
Campbell St
A

Ohio Turnpike (Toll road)
DA Farm Service Agency, Map data ©2013 Google

EXHIBIT A

DEPARTMENT OF THE ARMY
Right of Entry for Survey, Exploration, and HTRW Investigation

PROJECT: Plum Brook Ordnance Works

OWNER: Township Trustees of Perkins Township
Attn: Eric Dodrill
2610 Columbus Ave.
Sandusky, Ohio 44870
(419) 656-0671

The undersigned, hereinafter called the "Owner", hereby grants to the United States of America, hereinafter called the "Government", a permit or right-of-entry upon the following terms and conditions:

1. The Owner hereby grants to the Government an irrevocable right to enter upon the lands hereinafter described at any time within a period of **5 years** from the date of this instrument in order to re-install (if necessary), operate and maintain a flush-mounted groundwater monitoring well, and take and analyze groundwater samples. Following expiration of the monitoring period, the Government shall either request an extension of the monitoring period or abandon the monitoring well in accordance with the State of Ohio Regulations, at no cost to Owner. Upon abandoning the monitoring well, the Government shall restore Owner's property to the condition existing at the signing hereof.

2. The permit includes the right of ingress and egress on other lands of the Owner not described below, provided such ingress and egress is necessary and not otherwise conveniently available to the Government.

3. All tools, equipment, and other property taken upon or placed upon the Owner's property by the Government shall remain the property of the Government and must be removed by the Government at any time within a reasonable period after the expiration of this permit of right-of-entry.

4. If any action of the Government's employees or agents in the exercise of the right-of-entry results in damage to the real property, the Government will, at its sole discretion, either repair such damage or make an appropriate settlement with the owner. In no event shall such repair or settlement exceed the fair market value of the fee title to the real property at the time immediately preceding such damage. The Government's liability under this clause is subject to the availability of appropriations for such payment, and nothing contained in this agreement may be considered as implying that Congress will at a later date appropriate funds sufficient to meet any deficiencies. The provisions of this clause are without prejudice to any rights the Owner may have to make a claim under applicable laws for any damages other than those provided for herein.

5. If aircraft flights over said lands, or entry upon the land by means of helicopter or other type aircraft are necessary, the Government shall inform the Owner, in advance, of each such flight or entry.

6. The Corps of Engineers will furnish a copy of the water sample analysis results to the owner.

7. The land affected by this permit or right-of-entry is located in the State of Ohio, County of Erie, and is described as follows: As Tax ID # 3262008000; Permanent Parcel #32137102006; Tax Map No. 41; Taxing District 32 Perkins Twp. – Perkins LSD. Exhibit A shows the location of the property.

WITNESS MY HAND AND SEAL THIS 12th *DAY OF* May, *2013.*

_____ *(SEAL)*
Chairman, Township Trustees of Perkins Township

UNITED STATES OF AMERICA

by _____

STEVEN B. SHIDELER
CHIEF, REAL ESTATE DIVISION

ENG FORM 1258, as modified by [illegible]

W Bogart Rd
W Bogart Rd
E Bogart Rd
Columbus Ave
Miami Rd
250
A

Boston Rd
Home
PC Patrol
A

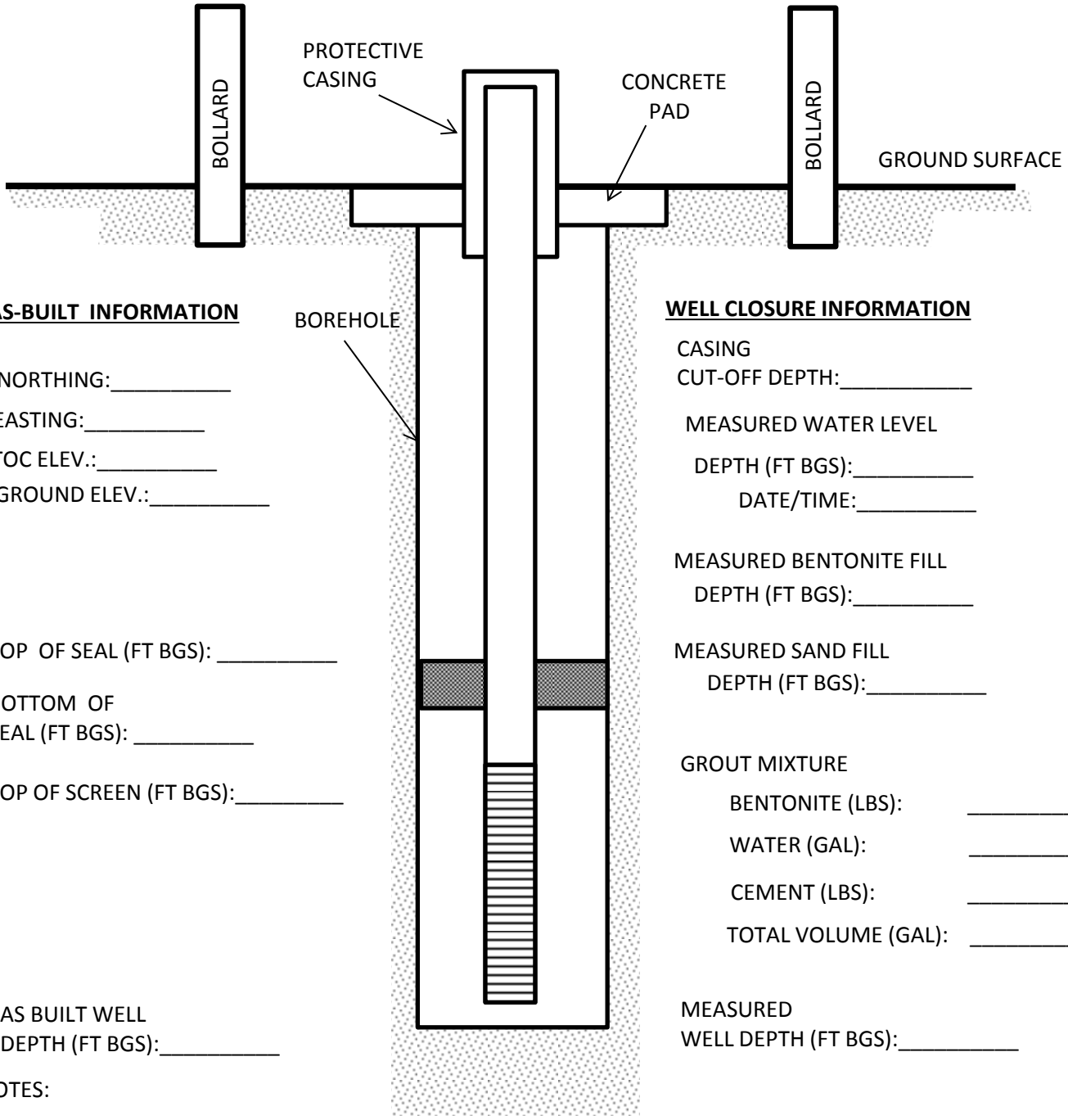
EXHIBIT A

APPENDIX C

MONITORING WELL ABANDONMENT FORMS

MONITORING WELL:_____ SITE:_____ FUDS PROJECT NO._____

OVERBURDEN WELL ABANDONMENT FORM
PLUM BROOK ORDNANCE WORKS - SANDUSKY, OHIO



AS-BUILT INFORMATION

NORTHING:_____

EASTING:_____

TOC ELEV.:_____

GROUND ELEV.:_____

TOP OF SEAL (FT BGS): _____

BOTTOM OF SEAL (FT BGS): _____

TOP OF SCREEN (FT BGS):_____

AS BUILT WELL DEPTH (FT BGS):_____

WELL CLOSURE INFORMATION

CASING CUT-OFF DEPTH:_____

MEASURED WATER LEVEL

DEPTH (FT BGS):_____

DATE/TIME:_____

MEASURED BENTONITE FILL DEPTH (FT BGS):_____

MEASURED SAND FILL DEPTH (FT BGS):_____

GROUT MIXTURE

BENTONITE (LBS): _____

WATER (GAL): _____

CEMENT (LBS): _____

TOTAL VOLUME (GAL): _____

MEASURED WELL DEPTH (FT BGS):_____

NOTES:

_____

_____

_____

_____

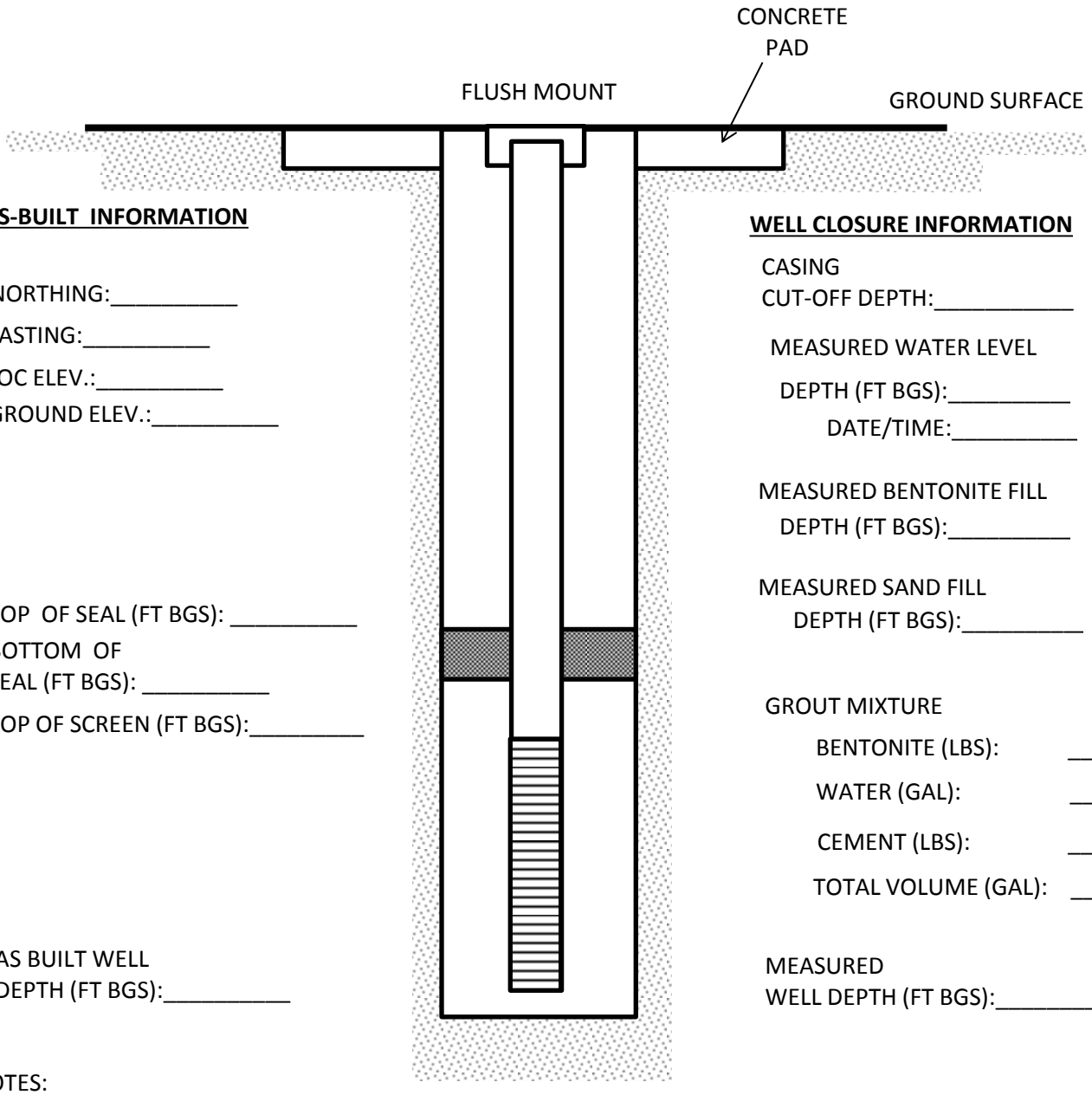
_____

_____

RIG GEOLOGIST:_____ DATE:_____

MONITORING WELL:_____ SITE:_____ FUDS PROJECT NO._____

FLUSHMOUNT OVERBURDEN WELL ABANDONMENT FORM
PLUM BROOK ORDNANCE WORKS - SANDUSKY, OHIO



AS-BUILT INFORMATION

NORTHING:_____

EASTING:_____

TOC ELEV.:_____

GROUND ELEV.:_____

TOP OF SEAL (FT BGS): _____

BOTTOM OF SEAL (FT BGS): _____

TOP OF SCREEN (FT BGS):_____

AS BUILT WELL DEPTH (FT BGS):_____

WELL CLOSURE INFORMATION

CASING CUT-OFF DEPTH:_____

MEASURED WATER LEVEL

DEPTH (FT BGS):_____

DATE/TIME:_____

MEASURED BENTONITE FILL DEPTH (FT BGS):_____

MEASURED SAND FILL DEPTH (FT BGS):_____

GROUT MIXTURE

BENTONITE (LBS): _____

WATER (GAL): _____

CEMENT (LBS): _____

TOTAL VOLUME (GAL): _____

MEASURED WELL DEPTH (FT BGS):_____

NOTES:

_____

_____

_____

_____

_____

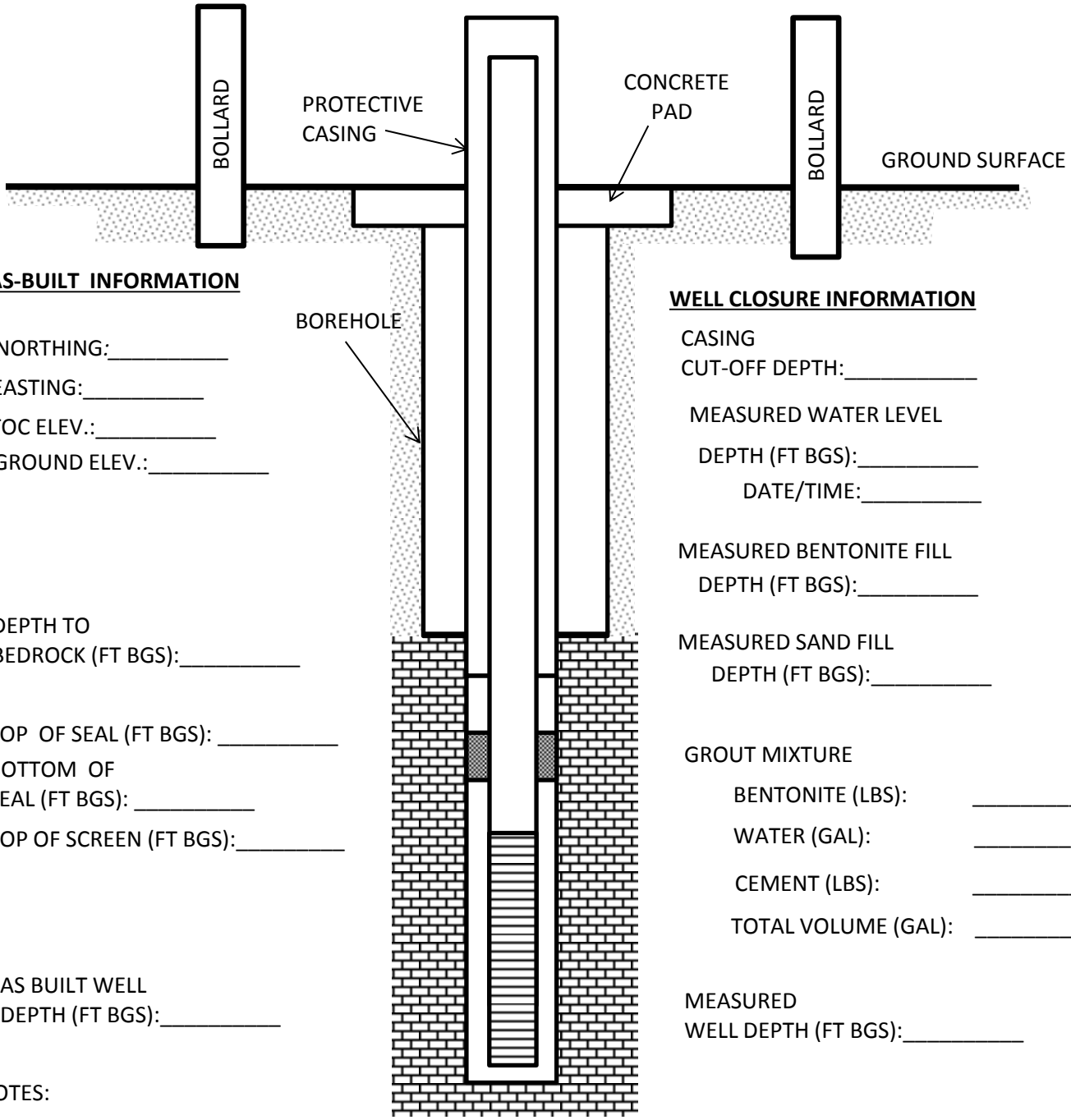
_____

_____

RIG GEOLOGIST:_____ DATE:_____

MONITORING WELL:_____ SITE:_____ FUDS PROJECT NO._____

BEDROCK WELL ABANDONMENT FORM
PLUM BROOK ORDNANCE WORKS - SANDUSKY, OHIO



AS-BUILT INFORMATION

NORTHING:_____

EASTING:_____

TOC ELEV.:_____

GROUND ELEV.:_____

DEPTH TO BEDROCK (FT BGS):_____

TOP OF SEAL (FT BGS): _____

BOTTOM OF SEAL (FT BGS): _____

TOP OF SCREEN (FT BGS):_____

AS BUILT WELL DEPTH (FT BGS):_____

WELL CLOSURE INFORMATION

CASING CUT-OFF DEPTH:_____

MEASURED WATER LEVEL

DEPTH (FT BGS):_____

DATE/TIME:_____

MEASURED BENTONITE FILL DEPTH (FT BGS):_____

MEASURED SAND FILL DEPTH (FT BGS):_____

GROUT MIXTURE

BENTONITE (LBS): _____

WATER (GAL): _____

CEMENT (LBS): _____

TOTAL VOLUME (GAL): _____

MEASURED WELL DEPTH (FT BGS):_____

NOTES:

_____

_____

_____

_____

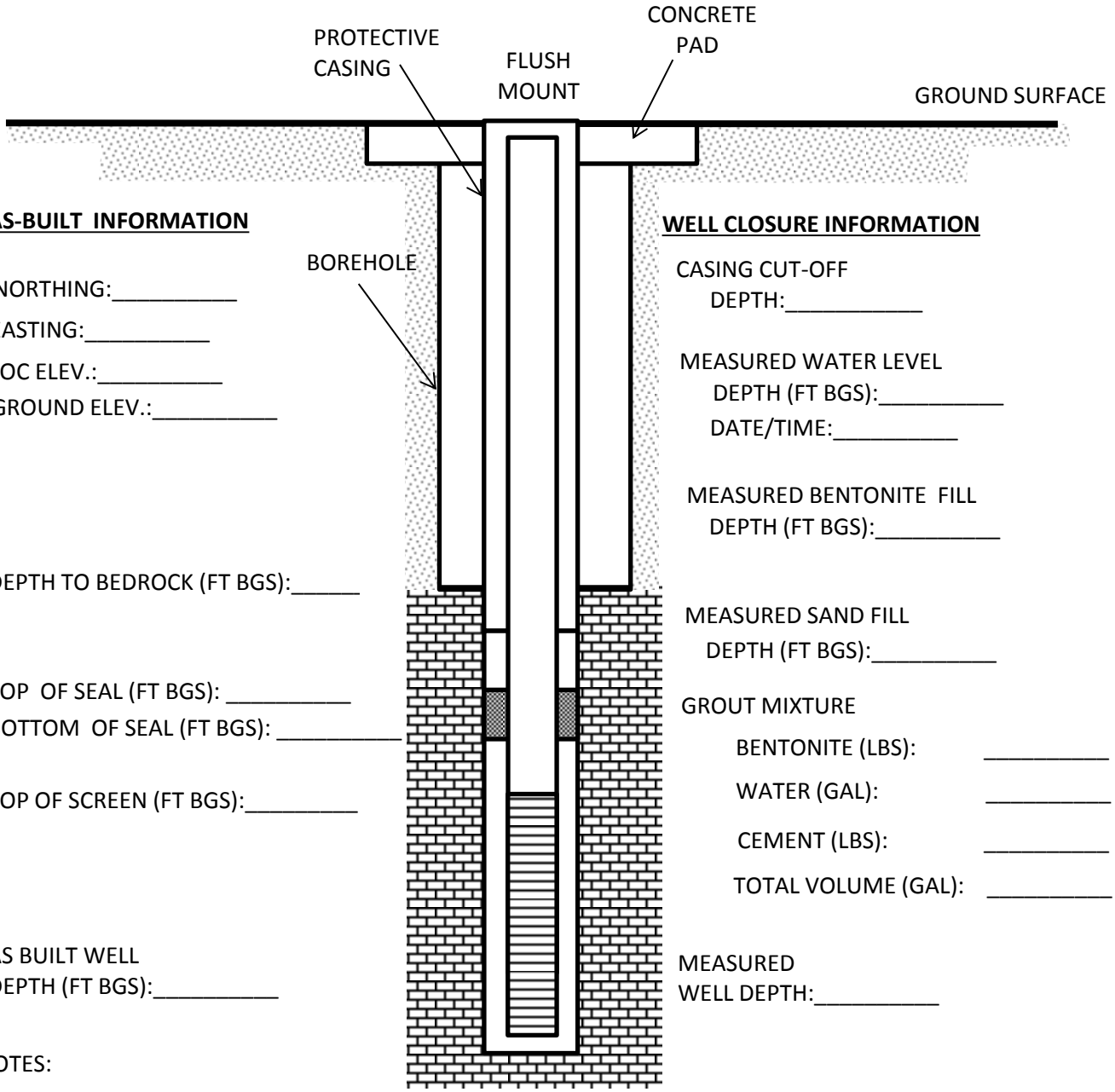
_____

_____

RIG GEOLOGIST:_____ DATE:_____

MONITORING WELL:_____ SITE:_____ FUDS PROJECT NO._____

FLUSHMOUNT BEDROCK WELL ABANDONMENT FORM
PLUM BROOK ORDNANCE WORKS - SANDUSKY, OHIO



AS-BUILT INFORMATION

NORTHING:_____

EASTING:_____

TOC ELEV.:_____

GROUND ELEV.:_____

DEPTH TO BEDROCK (FT BGS):_____

TOP OF SEAL (FT BGS): _____

BOTTOM OF SEAL (FT BGS): _____

TOP OF SCREEN (FT BGS):_____

AS BUILT WELL DEPTH (FT BGS):_____

WELL CLOSURE INFORMATION

CASING CUT-OFF DEPTH:_____

MEASURED WATER LEVEL DEPTH (FT BGS):_____

DATE/TIME:_____

MEASURED BENTONITE FILL DEPTH (FT BGS):_____

MEASURED SAND FILL DEPTH (FT BGS):_____

GROUT MIXTURE

BENTONITE (LBS): _____

WATER (GAL): _____

CEMENT (LBS): _____

TOTAL VOLUME (GAL): _____

MEASURED WELL DEPTH:_____

NOTES:

_____

_____

_____

_____

_____

_____

RIG GEOLOGIST:_____ DATE:_____

APPENDIX D

RESPONSE TO COMMENTS

Response to Review Comments
Draft Site-Wide Work Plan

Monitoring Well Abandonment and Site Restoration Activities

Former Plum Brook Ordnance Works, Sandusky, Ohio

Comment received September 22, 2014 from Paul Jayko, Site Coordinator, DERR-NWDO

Comment 1: Ohio EPA concurs with the overall approach of abandoning overburden (unconsolidated) and bedrock (consolidated) monitoring wells at the NASA Plum Brook Ordnance Works Station (PBOW). However, Ohio EPA recommends that CB&I Federal Services LLC include the following revision in a final Site-Wide Work Plan for Monitoring Well Abandonment and Site Restoration Activities (Work Plan).

<u>Overburden Wells</u>

a. Clean Silica sand should not be placed in shallow overburden wells. They should be pressure grouted from the bottom up to ground level irrespective if the entire PVC screen/riser length can be totally removed or not. Section 3.1.3.1 of the Work Plan should be revised accordingly. The emplacement of sand in the overburden well is inappropriate as the zone displays low yields during periods of low precipitation (seasonal) and poor ground water quality and wouldn't be utilized as a source of potable water for a residence.

Response: Section 3.1.3.1 of the Work Plan will be revised to include the following, "Shallow overburden wells will be pressure grouted from the bottom of the well up to ground level irrespective if the entire PVC screen/riser length can be totally removed."