FINAL REPORT

MONITORING WELL RECONSTRCTION / REHABILITATION REPORT

Rio Grande Canalization Project Restoration Sites
Sierra and Dona Ana Counties, New Mexico
El Paso County, Texas

Prepared for

International Boundary & Water Commission
United States & Mexico, US Section
El Paso, Texas

Contract No. IBM17C0007

Prepared by

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LIST OF ACRONYMS & ABBREVIATIONS

BCA	Broad Canyon Arroyo
BE	Berino East
bgs	Below Ground Surface
BW	Berino West
CCB	Crow Canyon B
CCE	Country Club East
cfm	Cubic Feet Per Minute
COR	Contracting Officer Representative
EGC	EGC, Inc
gpm	Gallon Per Minute
GPS	Global Positioning System
HAS	Hollow Stem Auger
LEL	Leasburg Extension Lateral
ME	Mesilla East
MW	Monitoring Well
NMAC	New Mexico Administrative Record
NMOSE	New Mexico Office of State Engineer
No.	Number
PM	Project Manager
PVC	Polyvinyl Chloride
SOW	Statement of Work
SP	Sunland Park
SPB	Seldon Point Bar
TAC	Texas Administrative Code
US	United States
USACE	US Army Corp of Engineers
USIBWC	International Boundary and Water Commission
VC	Valley Creek

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1.0 INTRODUCTION

EGC, Inc. (EGC) was contracted by the United States International Boundary and Water Commission (USIBWC) to perform rehabilitation and reconstruction of existing shallow groundwater monitoring wells (MWs) under Contract Number (No.) IBM17C0007.

Under the original Statement of Work (SOW) dated 10 August 2017, EGC was tasked to conduct a condition assessment of shallow groundwater monitoring wells (MWs) at river habitat restoration sites in the Rio Grande Canalization Project area located in Sierra and Dona Ana Counties, New Mexico and El Paso County, Texas (see Figure 1 at the end of this Section). The purpose of this assessment was to identify MWs needing to be either reconstructed or rehabilitated (e.g. obstructions removed, repainted). In addition to reconstructing/rehabilitating the MWs, EGC was tasked with retrieving pressure transducers (sondes) located at the bottom of several of the MWs.

EGC conducted the condition assessment of the MWs between 27 November 2017 and 01 December 2017 and identified the MWs needing to be either reconstructed or rehabilitated in the *Well Condition Assessment of USIBWC Groundwater Monitoring Wells Report* dated 16 December 2017. From this Report, EGC developed the *Well Rehabilitation Plan for USIBWC Groundwater Monitoring Wells* (Rehab Plan) (see Appendix A), which was approved by the USIBWC and signed by EGC on 26 February 2018. Based on this Rehabilitation Plan, EGC completed the following tasks between 27 February 2018 and 10 March 2018:

- Reconstruction of eight (8) MWs
- Rehabilitation of 21 MWs
- Retrieval of five sondes
- Repainting of 10 MW shrouds

Additionally, on 11 July 2018, EGC conducted well development of the eight reconstructed MWs referenced above.

The original SOW was modified on 05 September 2018 to include the reconstruction (and plugging) of the following MWs:

- LEL-MW-1
- BW-MW-1
- SPB-MW-3
- BCA-MW-2

All of the before mentioned tasks were completed in accordance with the following:

- USIBWC Contract No. IBM17C0007
- The Project SOWs
- The *Work Plan for Rehabilitation/Reconstruction of Existing Groundwater Monitoring Wells* dated November 2017 (Work Plan)
- The Rehab Plan
- New Mexico Administrative Code (NMAC) Title 19, Chapter 27, Part 4—*Well Driller Licensing; Construction, Repair and Plugging*
- Texas Administrative Code (TAC) Title 16, Chapter 76—*Well Drillers and Water Well Pump Installers*
- Chapter 5 of the US Army Corp of Engineers (USACE) Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites Engineering Manual

This report represents the *Final Monitoring Well Reconstruction/Rehabilitation Report*, which provides the details for completing the afore-mentioned tasks.

Figure 1. Location of USIBWC MWs

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2.0 RECONSTRUCTION OF MONITORING WELLS

EGC was tasked to reconstruct shallow groundwater MWs at river habitat restoration sites in the Rio Grande Canalization Project area located in Sierra and Dona Ana Counties, New Mexico and El Paso County, Texas under Contract No. IBM17C0007 and the subsequent contract modification. The reconstructed MWs included the following:

- First Mobilization
  - SP-MW-1
  - CCE-MW-2
  - CCE-MW-3
  - VC-MW-1
  - BE-MW-1
  - ME-MW-1
  - CCB-MW-2
  - CCB-MW-3
- Second Mobilization
  - LEL-MW-1
  - BW-MW-1
  - SPB-MW-3
  - BCA-MW-2

NOTE: The original SOW required SPB-MW-3 to be plugged and a new SPB-MW-3 to be constructed on property owned by the USIBWC. However, the USIBWC directed EGC not to complete this task during the first mobilization.

Prior to reconstructing MWs in New Mexico, EGC had to complete and submit the New Mexico Office of State Engineer (NMOSE) Form WR-07—*Application for Permit to Drill, A Well With No Water Right* for both reconstruction mobilizations; the USIBWC Project Manager (PM) signed both applications. On 6 February 2018 and 3 October 2018, respectively, the NMOSE issued permits for the drilling (and plugging) of the MWs (see Appendix B). Once the MWs were constructed (and the old wells plugged), the drillers submitted a *Well Record & Log* to the NMOSE (see Appendix C). Because the State of Texas does not require a permit for MW construction, the drillers submitted a well report to the Texas Department of Licensing and Regulation after completing the construction (and plugging) of the MWs located in Texas (see Appendix D). The licensed drillers-of-record were Mr. Shane Currie (New Mexico) and Mr. Jason Hafliger (Texas). For the MWs located in New Mexico, Jose Salas (first mobilization) and Mr. Cesar Munia (second mobilization) acted as the certified Drill Rig Supervisors. The licenses for both drillers-of-record are found in Appendix E.

As part of the both the Rehab Plan (first mobilization) and the proposal for additional wells (second mobilization), EGC proposed depths for each MW based on historical data ensuring the minimum requirements of the Project SOW were met—at least 12 feet deep at sites above Leasburg Dam and at least 16 feet at sites below Leasburg Dam. Table 1 lists the proposed construction depths versus the actual construction depths for each MW (see Tables Section).

Once the well casings were installed, the drillers performed surface completion, which included the construction of well pad at each MW. The well pads were constructed of concrete and were approximately 20-inches thick (18-inches below ground surface (bgs) and 2-inches above ground surface) with a 12-inch diameter surface dimension. All of the well pads were sloped slightly away from the protective well shroud to drain precipitation. The well shrouds (4-inch inside diameter and lockable) were buried at least 18-inches below grade with the top of the casing approximately 2.5-feet above the top of the well pad. The well shrouds were painted yellow with the well name stenciled in black.

The construction details for each MW, including screen lengths, constructed and backfilled depths, and surface completion notes, are shown in Appendix F. The Well Construction forms and boring logs are in Appendix G, and the field notes regarding drilling and well plugging are shown in Appendix H. Table 2 summarizes the well construction details, and Tables 3 (first mobilization and 4 (second mobilization) provide the survey data for each of the reconstructed wells (see Tables Section).

2.1. FIRST MOBILIZATION

The original SOW dated 10 August 2017 required EGC to reconstruct MWs identified during the well condition assessment. A total of eight MWs were identified as damaged, missing, or containing a high level of sand in the well indicating a potentially damaged well casing. The boreholes for these eight MWs were completed using a truck mounted hollow stem auger (HSA) rig with the exception of MW CCB-MW-3, which used a track mounted direct push drilling rig (Geoprobe) due to limited accessibility. Once the boreholes were created, the well casing was set into the borehole. The well casing consisted of five feet of two-inch diameter 0.010-inch machine slotted polyvinyl chloride (PVC) screen, which was flush-threaded to a two-inch diameter solid PVC riser (length of riser varied with each well). The annular space surrounding each well screen was filled with a 10/20 filter sand followed by 0.375-inch (3/8”) coarse grade bentonite hole plug to 1.5 feet bgs and completed with a neat cement grout. Due to flowing sands, the proposed depths for BE-MW-1, CCE-MW-2, CCE-MW-3, and VC-MW-1 could not be reached; the USIBWC Contracting Officer Representative (COR) was contacted to get approval of the drilled depths.

The original wells were abandoned by removing the well pads, well risers, and the well casings and backfilling with a bentonite hole-plug/cement mix to approximately to within 6-inches of grade with surface soil placed on top to the ground surface. Because the entire well casing at CCB-MW-2 could not be removed, the casing was cut 2-feet bgs and backfilled in a similar manner as the other MWs. The original well borehole for SP-MW-1 could not be located; therefore, it was not plugged.

The MWs were developed in accordance with Section 3.2.1.3 of the Work Plan by first surging the groundwater in each MW to remove any sediment from the filter pack and bottom of the well and then bailing each MW using 1.5-inch by 36-inch polyvinyl disposable bailers until near turbid-free returns were encountered. During the bailing effort, the temperature, pH, and specific conductivity were monitored (one reading per well volume). Each MW was surged/bailed until stabilization of the groundwater parameters (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings) were reached. Table 5 provides a summary of the development of each MW (see Tables Section).

A survey was completed at the conclusion of the well construction activities to provide an accurate location of the reconstructed wells. The latitude, longitude, and horizontal datum used was NAD83 while NAVD88 was used as the vertical elevation datum of the top of the well casing, as well as, the ground level elevation. Tables 3 provides the survey data for each of the reconstructed wells (see Tables Section).

2.2. SECOND MOBILIZATION

The original SOW was modified on 05 September 2018 to include the reconstruction of four additional MWs. The boreholes for these MWs were completed using a track mounted direct push drilling rig (Geoprobe). Once the borehole was created, the well casing was set into the borehole. The well casing consisted of five feet of two-inch diameter 0.010-inch machine slotted PVC screen, which was flush-threaded to a two-inch diameter solid PVC riser (length of riser varied with each well). The annular space surrounding each well screen was filled with a 10/20 filter sand pack followed by a bentonite slurry to 1.5 feet bgs and completed with a neat cement grout. The proposed depth for BCA-MW-1 could not be reached due to a rock formation at approximately 14 feet bgs; the Geoprobe could not cut through the rock. Because the required depth of 12 feet bgs had been obtained, EGC terminated drilling.

The original wells were plugged by removing the well pads, well risers, and the well casings and backfilling with a bentonite slurry to within 6-inches of grade with surface soil placed on top to the ground surface.

Monitoring Well LEL-MW-1 was selected for reconstruction due to the sonde becoming stuck inside the well casing because of an unknown obstruction (possibly sediment). Due to the location of LEL-MW-1 (surrounded by plantings), USIBWC directed EGC to construct the new MW away from the plantings (approximately 100 feet) and identify the new MW as LEL-MW-4. Because EGC was able to remove the sonde by tugging on the sonde cable, LEL-MW-1 was not plugged.

The USIBWC provided global positioning (GPS) coordinates (32.517365°, -106.971320°) for the new location of SPB-MW-3. Once on-site, EGC used the coordinates to spot the new location of the MW, and the USIBWC COR concurred with the location. Because of the distance between the original MW and the new MW, the USIBWC PM had EGC identify the new MW as SPB-MW-4. After installing the new MW, the original MW was plugged.

Because of the two field changes, EGC called the NMOSE on 04 December 2018 and notified Ms. Lily Sensiba, signatory of the NMOSE permit,

- LEL-MW-1 was not plugged and the new MW name is LEL-MW-4; and
- SPB-MW-3 was plugged and the new name is SPB-MW-4.

Ms. Sensiba notated these changes in the NMOSE database, and EGC notified the USIBWC COR of the phone conversation with the NMOSE.

The MWs were developed in accordance with Section 3.2.1.3 of the Work Plan by surging the MWs using a 1.5 gallon per minute (gpm) surge pump to remove any sediment from the filter pack and bottom of the well until near turbid-free returns were encountered. During the surging process, the temperature, pH, and specific conductivity were monitored (one reading per well volume). Each MW was surged until stabilization of the groundwater parameters (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings) were reached. Table 5 provides a summary of the development of each MW (see Tables Section).

A survey of the newly constructed wells was completed by the USIBWC to provide an accurate location of the reconstructed wells. The coordinates were based on the State Plane (New Mexico Central), and the top of the well casing was measured from the ground level. Tables 4 provides the survey data for each of the reconstructed wells (see Tables Section).

3.0 REHABILITATION OF MONITORING WELLS

The Rehab Plan identified 21 MWs requiring rehabilitation due to obstructions primarily caused by roots or sand (silt) entering the wells. Rehabilitation activities included removing sand and roots from the well casings, replacement of sonde cables, and stabilizing casings within the well shrouds.

Sand was removed from 10 well casings using a 350 cubic foot per minute (cfm) air compressor by directing compressed air through a 1-inch PVC pipe and allowing sand to be removed out through the remaining area inside the 1.5-inch PVC well casing.

Roots were removed from seven wells using two methods: a sharpened 1-inch steel pipe and a drain auger. The sharpened steel pipe was used to cut small roots along the casing or to attach to a large root ball and remove the root ball in one piece. The drain auger was found to be effective in removing small roots within a well casing by spinning the auger through the casing and pulling out the roots. Due to the likely redevelopment of the roots, it is recommended roots be removed periodically.

The well risers for MWs VC-MW-2 and LEL-MW-3 were stabilized inside the well shrouds by adding 10/20 filter sand between the well casing and well shroud. EGC discovered the riser extensions for these wells were not properly attached; therefore, the extensions were reattached before sand was added.

The sonde cable at LEL-MW-1 was replaced with 7x19 vinyl coated stainless steel cable from US Cargo Control (Item No. 719VCSSAC18316). The sonde was connected to the new cable using an aluminum ferrel and redeployed into the well. Sometime after replacing the sonde cable, the sonde became stuck inside the well casing due to some unknown reason, possibly a buildup of sediment. Because of the sonde being stuck, USIBWC decided to reconstruct LEL-MW-1 as part of the Contract modification.

An unknown obstruction was noted at BCA-MW-2 during the well condition assessment. EGC attempted to rehabilitate this MW; however, after only a small amount of sand was removed, it was determined that the MW was severely bent a short distance bgs. Because the well could not be rehabilitated, the USIBWC decided to reconstruct this MW as part of the Contract modification. During the abandonment process of BCA-MW-2 (second mobilization), a Geoprobe drill rod was discovered inside the well casing (see Figure 2 on the next page). A review of the 2014 Well Installation Report[1] revealed there was an issue with the installation of BCA-MW-2, but the issue was not revealed. Also, there is no mention in the original boring logs or Report as to why drilling

[1] HDR EOC, *Groundwater Monitoring Well Installation and Groundwater Level Monitoring Report*, October 2014

rod was placed inside the well casing. Because placing drilling rod in well casing is not a common practice, EGC is unable to offer any insight into why the rod was inside the casing.

Figure 2. Drill Rod Inside BCA-MW-2

The rehabilitation details for each MW are listed in Appendix F and summarized in Table 6 (see Tables Section). Rehabilitation field notes are listed in Appendix I. Depth-to-water measurements were taken during the rehabilitation process and are presented using the provided USIBWC Monitoring Well Field Depth-to-Water forms (see Appendix J). A similar form is presented for the Field Assessment (see Appendix K).

3.1. REPAINTING OF MONITORING WELLS

The Rehab Plan proposed nine wells for repainting due to the well identification lettering being faded or mislabeled (the SPB wells had been previously misidentified as "SP" during the original well construction). However, a total of 10 wells were repainted to include SPB-MW-3, which was originally scheduled for abandonment and reconstruction. All three of the SPB wells were repainted without the letters "MW" (e.g. SPB-1) due to space limitations on the well shrouds.

Photos of the repainted wells are shown in Appendix F, and Table 8 summarizes the repainted wells (see Tables Section).

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4.0 RETRIEVAL OF SONDES

In total, EGC was tasked to retrieve seven water level sondes. The retrieved sondes were located in the following MWs:

- First Mobilization
  - VA-MW-1
  - VB-MW-1
  - BW-MW-1
  - CCA-MW-1
  - TRU-MW-1
- Second Mobilization
  - BW-MW-1
  - LEL-MW-1

The retrieved sondes were redeployed by attaching them to new 7x19 vinyl coated stainless steel cable from US Cargo Control (Item No. 719VCSSAC18316) using aluminum ferrels. Once connected, the sondes were suspended in a position near the bottom of the individual wells. Before redeploying the sondes, the data was transferred to the USIBWC supplied HOBO Shuttle (portable hard drive).

For the first mobilization, EGC studied historical drill logs and concluded the sondes had been buried in sand; therefore, the sand was removed using a compressed air method similar to the rehabilitation process. After the sands were removed, a 1-inch Schedule 40 PVC tremie pipe with four, approximately 1.5-inch slits cut on the end was used to press around the sonde wedging it in the tremie pipe for removal. The data was transferred from each sonde with the exception of VA-MW-1. USIBWC later sent the VA-MW-1 sonde to the manufacturer for repair, and the data was recovered. EGC recommends the sondes retrieved during the first mobilization be periodically adjusted to ensure they do not become re-buried in sediment/sand.

During the second mobilization, EGC was able to retrieve the sonde in BW-MW-1 during the well abandonment process by cutting open the well casing and removing the sonde. Upon removing the well casing from the borehole, EGC noted the original well screen was broken, and sediment was above the screen (see Figure 3 on the next page). For LEL-MW-1, EGC was able to free the sonde from the well by continuously tugging on the sonde cable. Because the sonde data could not be transferred to the HOBO Shuttle, EGC was directed to place a sonde cap onto the new cable and deploy the cap into LEL-MW-4. EGC returned the LEL-MW-1 sonde to the USIBWC COR. USIBWC sent the sonde to the manufacturer for repair and redeployed the sonde in February 2019.

Table 7 summarizes the sondes retrieval and redeployment (see Tables Section).

Figure 3. BW-MW-1 Original Well Screen

TABLES

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Table 1. Well Construction Depths: Proposed vs. Actual

Well ID	Proposed Total Depth (feet, bgs)	Actual Total Depth (feet, bgs)
First Mobilization		
SP-MW-1	16.0	16.0
CCE-MW-2	16.0	15.3
CCE-MW-3	16.0	15.0
VC-MW-1	16.0	15.9
BE-MW-1	18.0	17.3
ME-MW-1	21.0	21.75
CCB-MW-2	19.0	19.1
CCB-MW-3	17.0	17.1
Second Mobilization		
BW-MW-1	17.0	17.8
LEL -MW-4	21.0	20.5
BCA-MW-2	16	13.5
SPB-MW-4	16	17.5

NOTES
1. bgs = below ground surface
2. Actual Total Depth = Bottom of Screen
3. LEL-MW-4 replaced LEL-MW-1
4. SPB-MW-4 replaced SPB-MW-3

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Table 2. Well Construction Summary

Well ID	Date led	TOC Elevation (feet)	Ground Surface Elevation (feet)	DTW Observed During Drilling (feet, bgs)	Screen Interval (feet, bgs)	Well Sand Interval (feet, bgs)	Well Seal Interval (feet, bgs)	Well Bottom (feet, bgs)
First Mobilization								
SP-MW-1	27 Feb 2018	3740.797	3737.928	10	11–16	9–16.5	1.5–9	16
CCE-MW-2	28 Feb 2018	3746.466	3743.776	5	10.3–15.3	8–17	1.5–8	15.3
CCE-MW-3	28 Feb 2018	3748.794	3745.418	8	10–15	8–17	1.5–8	15.0
VC-MW-1	28 Feb 2018	3755.347	3751.821	10	10.9–15.9	9–16	1.5–9	15.9
BE-MW-1	1 Mar 2018	3809.628	3806.575	10	12.3–17.3	9–20	1.5–9	17.3
ME-MW-1	2 Mar 2018	3880.937	3877.817	10	16.75–21.75	13–25	1.5–13	21.75
CCB-MW-2	3 Mar 2018	4084.842	4081.273	12	14.1–19.1	11.7–20	1.5–11.7	19.1
CCB-MW-3	8 Mar 2018	4073.475	4070.531	8	12.1–17.1	6–20	1.5–6	17.1
Second Mobilization								
BW-MW-1	17 Nov 2018	3.05	3809.133	8.8	12.8–17.8	10–18.3	1.5–10	17.8
LEL-MW-4	28 Nov 2018	2.90	3897.434	6.6	15.5–20.5	14–21	1.5–14	20.5
BCA-MW-2	28 Nov 2018	3.00	3988.328	6.98	8.5–13.5	6–14	1.5–6	13.5
SPB-MW-4	29 Nov 2018	2.90	3979.545	3.8	12.5–17.5	10.5–18	1.5–10.5	17.5

NOTES:
1. USIBWC gathered the TOC Elevation and Ground Surface Elevation for the Second Mobilization MWs
2. TOC = Top of Casing
3. DTW = Depth to Groundwater
4. ft = feet
5. bgs = below ground surface
6. Well Bottom = Bottom of Screen (screen cap was 0.5 feet)

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Table 3. Monitoring Well Survey Data (First Mobilization)

Well	Latitude (N)	Longitude (W)	Northing	Easting	TOC Elevation	Ground Elevation	Casing Height
SP-MW-1	31.80610366	-106.5819709	293362.102	1537294.365	3740.797	3737.928	2.87
CCE-MW-2	31.83243972	-106.6074697	10685155.098	349028.928	3746.466	3743.776	2.69
CCE-MW-3	31.82654431	-106.6035510	10682945.252	350123.219	3748.794	3745.418	3.38
VC-MW-1	31.86230484	-106.6049717	10695958.713	350415.702	3755.347	3751.821	3.53
BE-MW-1	32.07523088	-106.6605681	391344.684	1513250.173	3809.628	3806.575	3.05
ME-MW-1	32.25095028	-106.8171630	455487.995	1465083.800	3880.937	3877.817	3.12
CCB-MW-2	32.70665331	-107.2550121	622271.250	1331284.125	4084.842	4081.273	3.57
CCB-MW-3	32.70072183	-107.2445353	620082.822	1334486.582	4073.475	4070.531	2.94

Notes:

1. Survey data collected by EGC
2. The latitude, longitude, and horizontal datum used was NAD83 while NAVD88 was used as the vertical elevation datum of the top of the well casing, as well as, the ground level elevation
3. Measurements in Feet

Table 4. Monitoring Well Survey Data (Second Mobilization)

Well	Latitude (N)	Longitude (W)	Northing	Easting	TOC Elevation	Ground Elevation	Casing Height
BW-MW-1	32°05'00.87"N	106°39'54.11"W	394386.197	1511879.342	3.05	3809.133	2.94
LEL-MW-4	32°20'15.24"N	106°50'04.37"W	487026.713	1459881.23	2.90	3897.434	2.75
BCA-MW-2	32°32'19.37"N	106°59'13.01"W	560494.944	1413316.803	3.00	3988.328	2.86
SPB-MW-4	32°31'02.44"N	106°58'16.72"W	552687.851	1418083.022	2.90	3979.545	2.89

Notes:

1. Survey data collected by USIBWC
2. Coordinates are State Plane (New Mexico Central)
3. Measurements are in Feet

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Table 5. Well Development Data

Well ID	Date	Attempt	Time	DTW (feet, bgs)	Temp (ºF)	Specific Conductivity (uS/cm)	pH
SP-MW-1 [5a]	11 Jul 2018	Initial	8:00	6.00	76.0	723	7.85
		Final	8:21	6.00	75.9	718	7.74
CCE-MW-3 [5a]	11 Jul 2018	Initial	8:40	5.61	75.9	1,347	7.78
		Final	8:55	6.34	75.4	1,354	7.81
CCE-MW-2 [5a]	11 Jul 2018	Initial	9:08	5.25	76.5	679	7.98
		Final	9:21	5.25	75.3	674	7.97
VC-MW-1 [5a]	11 Jul 2018	Initial	10:05	5.05	79.8	647	7.94
		Final	10:20	5.60	79.8	642	8.02
BE-MW-1 [5a]	11 Jul 2018	Initial	12:00	6.30	76.7	912	7.19
		1	12:16	6.12	76.7	888	7.41
		2	12:30	6.13	76.6	732	7.64
		Final	12:45	6.13	76.6	731	7.77
ME-MW-1 [5a]	11 Jul 2018	Initial	13:31	6.67	78.0	609	8.03
		1	13:42	6.67	77.5	596	7.96
		2	13:52	6.67	77.0	637	7.89
		3	14:04	6.68	77.1	620	7.94
		4	14:15	6.67	77.0	638	7.99
		5	14:26	6.69	77.6	659	7.91
		6	14:35	6.67	76.7	670	7.88
		Final	14:45	6.70	76.7	676	7.69
CCB-MW-2 [5a]	11 Jul 2018	Initial	16:40	8.95	73.5	669	7.65
		Final	16:52	8.00	72.1	664	7.65
CCB-MW-3 [5a]	11 Jul 2018	Initial	17:04	7.00	75.9	967	7.53

Well ID	Date	Attempt	Time	DTW (feet, bgs)	Temp (ºF)	Specific Conductivity (uS/cm)	pH
		Final	17:18	7.02	75.4	960	7.73
BW-MW-1 5b	27 Nov 2018	Initial	15:30	8.80	69.7	493	8.51
		1	15:43	8.45	70.1	660	8.23
		Final	15:57	7.95	69.8	682	8.05
LEL-MW-4 5b	28 Nov 2018	Initial	11:00	6.60	66.6	531	8.63
		1	11:13	5.97	67.4	817	7.86
		Final	11:25	5.50	68.2	909	7.68
BCA-MW-2 5b	28 Nov 2018	Initial	16:45	6.98	67.1	288	7.89
		1	16:59	6.73	66.7	615	7.36
		Final	17:12	6.51	65.4	651	7.31
SPB-MW-4 5b	29 Nov 2018	Initial	12:35	3.80	64.2	660	8.26
		1	12:48	3.51	63.2	806	8.07
		Final	13:00	3.25	63.7	998	7.99

NOTES:

1. DTW = Depth-to-Water
2. bgs = Below Ground Surface
3. °F = Degrees Fahrenheit
4. uS/cm = microSiemens per centimeter

5a First Mobilization = Well surged for 60s with bailer before taking measurements

5b. Second Mobilization = Well developed using a 1.5 gpm surge pump

6. Stabilization =
   - < 10% change for Temperature & Specific Conductivity or
   - < 0.2 pH units change

Table 6. Rehabilitation Summary

Well ID	Original Depth (BTOC, ft)	Condition	Rehabilitation Activity
SP-MW-3	15.5	Sand obstruction 6.32 feet BTOC	Compressed air method used to remove sand to a final total depth recorded at 15.10 ft BTOC.
AB-MW-1	15.4	Root obstruction at approximately 12 ft BTOC.	Roots cut using sharpened steel pipe. Compressed air method used to remove sand to a final total depth recorded at 14.31 ft BTOC.
AB-MW-2	15.3	Roots surrounding sonde cable.	Roots broken through using PVC pipe. Steel pipe unable to pass due to bent casing. Compressed air method used to remove sand to a final total depth recorded at 14.92 ft BTOC.
VC-MW-2	15.6	Riser loose within steel protector. Faded lettering.	Sand pack was added inside the well shroud to stabilize the riser. Well was repainted to clearly identify the well.
VB-MW-2	15.7	Sand obstruction at 14.40 ft BTOC.	Sand removed using compressed air method to a total depth of 15.12 ft BTOC. Well repainted to easily identify well.
BW-MW-1	19.4	Sand obstruction at 15.05 ft BTOC.	Sand removed using compressed air method to a total depth of 16.48 ft BTOC.
BW-MW-2	19.3	Sand obstruction at 8.56 ft BTOC.	Sand removed using compressed air method to a total depth of 18.86 ft BTOC.
BMD-MW-2	23.5	Roots found within well casing.	Roots punctured with PVC pipe and removed with compressed air method.
ME-MW-3	19.3	Sand obstruction at 8.28 ft BTOC.	Sand removed using compressed air method to a total depth of 18.60 ft BTOC.
LEL-MW-1	19.0	Replaced steel cable.	Replaced steel cable as was held together improperly at the crimp.
LEL-MW-3	19.1	Loose riser within steel protector.	Added 10/20 sand between riser and shroud to stabilize well riser.
BCA-MW-1	15.2	Sand obstruction at 11.48 ft BTOC.	Sand removed using compressed air method to a total depth of 15.08 ft BTOC.
BCA-MW-2	15.6	Unknown obstruction at 6.70 ft BTOC.	Sand removed using compressed air method. Well was found to be bent severely not allowing rehabilitation equipment to enter the well.
RS-MW-1	20.0	Sand obstruction at 8.50 ft BTOC.	Sand removed using compressed air method to a total depth of 18.65 ft BTOC.
RS-MW-5	19.0	Sand obstruction at 12.95 ft BTOC.	Sand removed using compressed air method to a total depth of 15.70 ft BTOC.

Well ID	Original Depth (BTOC, ft)	Condition	Rehabilitation Activity
RS-MW-6	15.0	Root obstruction at 7.03 ft BTOC.	Roots removed using drain auger to the constructed depth.
RS-MW-7	19.5	Root obstruction at 13.21 ft BTOC.	Roots removed using drain auger to the constructed depth.
CCB-MW-1	15.0	Sand obstruction at 13.86 ft BTOC.	Sand removed using compressed air method to a total depth of 14.43 ft BTOC.
CCA-MW-1	19.0	Sand obstruction at 9.80 ft BTOC.	Sand removed using compressed air method to a total depth of 18.89 ft BTOC.
TRU-MW-2	15.8	Root obstruction at 7.95 ft BTOC.	Roots removed using sharpened steel pipe to the constructed depth at 15.61 ft BTOC.
TRU-MW-3	15.1	Root obstruction at 6.64 ft BTOC.	Large root ball removed using sharpened steel pipe to the constructed depth of 15.13 ft BTOC.

NOTES:
1. ft = feet
2. BTOC = below top of casing

Table 7. Sonde Retrieval and Redeployment

Well ID	Status
VB-MW-1	Data retrieved; redeployed at a depth of approximately 14.5 ft BTOC
BW-MW-1	Data retrieved; redeployed at a depth of approximately 16.5 ft BTOC
CCA-MW-1	Data retrieved; redeployed at a depth of approximately 18.9 ft BTOC
TRU-MW-1	Data retrieved; redeployed at a depth of approximately 17.4 ft BTOC
VA-MW-1	Data unable to be retrieved; redeployed at a depth of approximately 18.5 ft BTOC

Table 8. Repainted Wells

Well ID	Reason for Repainting
JAR-MW-1	Well identification markings faded.
JAR-MW-2	Well identification markings faded.
JAR-MW-3	Well identification markings faded.
SPB-MW-1	Well identification markings mislabeled as “SP”. Well paint faded. Repainted “SPB-1”.
SPB-MW-2	Well identification markings mislabeled as “SP”. Well paint faded. Repainted “SPB-2”.
SPB-MW-3	Well identification markings mislabeled as “SP”. Well paint faded. Repainted “SPB-3”.
VA-MW-1	Yellow paint and identification markings faded.
VA-MW-2	Yellow paint and identification markings faded.
VB-MW-2	Yellow paint and identification markings faded.
VC-MW-2	Yellow paint and identification markings faded.

APPENDIX A
WELL REHABILITATION PLAN FOR USIBWC GROUNDWATER MONITORING WELLS IDENTIFIED IN THE *WELL CONDITION ASSESSMENT REPORT*

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26 February 2018
Elizabeth Verdecchia
Natural Resources Specialist
USIBWC, U.S. Section
4171 N Mesa St Suite C100
El Paso, TX 79902

Re: Well Rehabilitation Plan for USIBWC Groundwater Monitoring Wells Identified in the *Well Condition Assessment Report* (IBM17C0007)

Ms. Verdecchia:

This Letter Report and its attachments represent the Well Rehabilitation Plan (Rehab Plan) as required by Task 2 of the Statement of Work (SOW) dated 10 August 2017. This Rehab Plan provides recommendations for the wells identified as needing rehabilitation in the *Well Condition Assessment Report* dated 08 December 2017.

Based on the data collected during the Groundwater Monitoring Well Condition Assessment Fieldwork (27 Nov–1 Dec 2017), a total of 16 monitoring wells (MW) were determined to not require any action, and a total of 39 MWs were to determined to be in need of either rehabilitation, removal of sondes, redrilling, and/or repainting. **Attachment A** lists the rehabilitation plan for each monitoring well, and Table 1 below summarizes the number of wells for each rehabilitation category.

Table 1. No. of Wells Per Category

Category	No. of Wells
Rehabilitation	21
Retrieval of Sondes	5
Redrill	8
Repaint	9

Rehabilitation activities will consist primarily of removing obstructions from the well, which are primarily caused by roots or sand (silt) entering the well. However, the obstructions in some wells could not be identified during the Well Assessment as being either roots or sand (silt) obstructions.

Removal of roots will be completed with a custom fabricated root cutter, which will be lowered into the well with the drill rig. Sand (silt) will be removed from the well with a combination of bailing and airlifting. For the wells with an unknown obstruction, further evaluation will be made onsite to ensure the correct method of obstruction removal, if possible, is used. The concern with the unknown obstructions is the obstruction may be caused by damage to the well such as a joint separation, which cannot be fixed and would require replacement or abandonment. The techniques used to remove the obstructions will be recorded in the field log, along with the condition of the well development for each MW after the obstruction is removed. If it is determined sand is still entering the MW, the USIBWC will be notified.

In addition to the removal of obstructions, two well stick-ups may need stabilization with the addition of sand or bentonite, and one well needs to have the sonde cable replaced. See **Attachment A** for well rehabilitation details.

Five water level data collecting sondes have become disconnected from steel cables and lost down the well in which they were placed. While there is no one method for retrieving the sondes, retrieving items lost down a well is typically achieved by modifying techniques while in the field. The primary technique EGC will attempt to retrieve the sondes from the individual wells will be pushing a pipe over the sonde causing the sonde to become wedged inside the pipe allowing the sonde to be lifted out of the well. If the primary technique is not successful, EGC will use its best field judgment to determine an alternative technique(s). As part of the retrieval, all techniques attempted at each MW will be documented in the Project field log. If after exhausting all efforts the EGC team is unable to retrieve a sonde, the USIBWC will be notified of the need to re-install a sonde at the well site in either the same well or a different well located on the site. Once the sondes are retrieved, EGC will download the data with USIBWC's HoboShuttle and redeploy the sondes using vinyl coated, stainless steel cable.

During the Well Assessment, eight MWs were determined to be in need of redrilling due to either the well being damaged or sand obstructed to near the top of the screened interval. In addition to the eight MWs, SPB-MW-3 was identified in the SOW as needing to be relocated from its current location to a location inside the USIBWC property boundary. However, during the course of finalizing this Rehab Plan, IBWC made the decision not to move SPB-MW-3. The well construction details for the eight total MWs are listed in **Attachment B**. The proposed well drilling depths were originally based on the original drilling data found in the 2014 *Groundwater Monitoring Well Installation and Groundwater Level Monitoring Report*. These well depths have been revised and are now based on low water table data received from the USIBWC, which was captured from the sonde data loggers. The goal of the proposed depths is to ensure the top of the screen is located below the low water table level. **Attachment C** shows the top of the proposed screen interval compared to the observed low water table provided by USIBWC. The proposed wells are located in approximately the same location as the existing wells with a 10-foot offset. The final placement of the new wells will be based on current site conditions and vegetation in the area.

As stated in Paragraph 3.2.1 of the Work Plan, the MWs will be drilled using either a Direct Push Technology (DPT) or Hollow-Stem Auger (HAS) drilling method depending on the condition of the site. The drilling method used for each MW will be recorded in both the field book and the boring logs.

The well installation procedures to be used for this Project are referenced from the US Army Corp of Engineers (USACE) *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*, which is often used to establish consistent guidelines for monitoring well installation even in non-hazardous waste sites. As this Project is considered a wetland-type project, the USACE *Technical Standard for Water-Table Monitoring of Potential Wetland Sites* is also referenced. Both of these documents are included as **Attachment D** of this Plan.

As part of the redrilling process, the current MWs will have to be "plugged" by backfilling the well boreholes with bentonite. During the Well Assessment, neither the steel protector (shroud) for Well ME-MW-1 nor the existing borehole could be located; therefore, the area will need to be further explored during the redrill event in order to properly plug the borehole. The well drilling licenses for the States of New Mexico and Texas are in **Attachment E**.

During the Well Assessment, MW steel protectors were discovered needing repainting due to the lettering being faded or the MW being mislabeled. For the MWs being redrilled, a new steel protector will be installed as part of the surface completion of the well. In addition to the eight new wells receiving new and painted steel protectors, there are nine existing MWs proposed for repainting.

Please contact me with any questions or concerns.

Sincerely,

Scott Quint
Project Manager
EGC, Inc

Attachment A

Rehabilitation Plan for Monitoring Wells

Attachment A1. Rehab Plan for Monitoring Wells

Well Name	Assement Findings				Rehab Plan	Assessment Field Notes
	Rehab	Retrieve Sonde	Re-drill	Repaint		
AB-MW-1	X				Remove obstruction	Root obstruction
AB-MW-2	X				Remove obstruction	Root obstruction
BCA-MW-1	X				Remove obstruction	Sand level high in casing
BCA-MW-2	X				Remove obstruction	Unknown obstruction. Location across soft sand area.
BCA-MW-3					No Action Required	Well functioning properly.
BE-MW-1			X		Redrill	**DAMAGED**. Silted to grade. Casing on top.
BE-MW-2					No Action Required	Concrete 1" above grade.
BMD-MW-1					No Action Required	Cement 4" above grade.
BMD-MW-2	X				Remove obstruction	Root obstruction. Cement out of grade 5"..
BW-MW-1	X	X			Remove obstruction & Retrieve sonde	Sand level high in casing. Deeper sonde (air pressure) is lost down the well.
BW-MW-2	X				Remove obstruction	Sand level high in casing
CCA-MW-1	X	X			Remove obstruction & Retrieve sonde	Sand obstruction. Sonde lost down hole.
CCA-MW-2					No Action Required	Dark water may be caused by weed material in well.
CCA-MW-3					No Action Required	Well functioning properly.
CCB-MW-1	X				Remove obstruction	Sand level high in casing
CCB-MW-2			X		Redrill	Sand obstructed near land surface
CCB-MW-3			X		Redrill	Sand obstructed near land surface

Attachment A1. Rehab Plan for Monitoring Wells

Well Name	Assement Findings				Rehab Plan	Assessment Field Notes
	Rehab	Retrieve Sonde	Re-drill	Repaint		
CCE-MW-1					No Action Required	Cap not on due to sonde, cement out of grade.
CCE-MW-2			X		Redrill	Loose casing. Indicates damaged below surface.
CCE-MW-3			X		Redrill	Sand obstructed near land surface
CL-MW-1					No Action Required	Cut lock. Replaced with lock from CL-MW-2. Sonde discolored.
CL-MW-2					No Action Required	Well functioning properly.
JAR-MW-1				X	Repaint	1 1/2" exposed cement. Lettering faded.
JAR-MW-2				X	Repaint	Well functioning properly. Repaint well.
JAR-MW-3				X	Repaint	Well functioning properly. Repaint well.
LEL-MW-1	X				Replace sonde cable	Sonde cable connected by crimp only. Replace cable.
LEL-MW-2					No Action Required	Well functioning properly.
LEL-MW-3	X				Add sand/bentonite seal	Dark water may be caused by weed material in well.
ME-MW-1			X		Redrill	**DAMAGED**. Well was not located using the GPS coordinates provided by IBWC.
ME-MW-2					No Action Required	1 1/2 cement out of grade.
ME-MW-3	X				Remove obstruction	Sand obstruction. Riser cap was off and fallen into the steel protector.
RS-MW-1	X				Remove obstruction	Sand obstructed. Lock missing and not replaced. Access blocked by trees/shrubs. Brush hog as needed for access.
RS-MW-2					No Action Required	Replaced lock.
RS-MW-4					No Action Required	Well functioning properly.

Attachment A1. Rehab Plan for Monitoring Wells

Well Name	Assement Findings				Rehab Plan	Assessment Field Notes
	Rehab	Retrieve Sonde	Re-drill	Repaint		
RS-MW-5	X				Remove obstruction	Sand level high in casing
RS-MW-6	X				Remove obstruction	Root obstruction. Did not reach water.
RS-MW-7	X				Remove obstruction	Root obstruction. Did not reach water.
SP-MW-1			X		Redrill	**DAMAGED**. Well bore not found, casing snapped.
SP-MW-2					No Action Required	Cap not on due to sonde.
SP-MW-3	X				Remove obstruction	Sand obstruction.
SPB-MW-1				X	Repaint	Lettering marked "SP" instead of "SPB".
SPB-MW-2				X	Repaint	Lettering marked "SP" instead of "SPB".
SPB-MW-3			X		Redrill	**Well outside USIBWC property**. Abandon current well.
TRU-MW-1		X			Retrieve sonde	Sonde down hole.
TRU-MW-2	X				Remove obstruction	Root obstruction. Reached water. However, the constructed depth was 24.2 feet, but the assessed depth was 8.6 feet.
TRU-MW-3	X				Remove obstruction	Root obstruction. Reached water. However, the constructed depth was 19.9 feet, but the assessed depth was was near depth to water measurement of 6.6 feet.
VA-MW-1		X		X	Retrieve sonde / Repaint	Lock corroded, sonde down hole, top of protector damaged.
VA-MW-2				X	Repaint	Repaint, numbers faded.
VB-MW-1		X			Retrieve sonde	Sonde at bottom at ~18 ft.
VB-MW-2	X			X	Remove obstruction / Repaint	Sand level high in casing. Lock corroded.
VC-MW-1			X		Redrill	**DAMAGED**

Attachment A1. Rehab Plan for Monitoring Wells

Well Name	Assement Findings				Rehab Plan	Assessment Field Notes
	Rehab	Retrieve Sonde	Re-drill	Repaint		
VC-MW-2	X			X	Add sand/bentonite seal / Repaint	Riser not packed well. 4' BTOC.
YE-MW-1					No Action Required	Well functioning properly.
YE-MW-2					No Action Required	Drilling sand in bail, may want to redrill.
YE-MW-3					No Action Required	1" exposed concrete.
TOTALS	**21**	**5**	**9**	**9**		

Note: Total number of Wells requiring no action = **16**

Attachment B

Well Construction Details

Attachment B1. Redrilling Summary

Well Name	State Location	Proposed Drill Depth (ft bgs)	Concrete Depth (ft bgs)	Bentonite Depth (ft bgs)	Filter Sand Depth (ft bgs)	Filter Sand Material	Screen Depth (ft bgs)	Screen Material	Screen Slot Size (in)
BE-MW-1	NM	18	0-1.5	1.5-11	11-18	10-20	13-18	Sch. 40 PVC	0.010
CCB-MW-2	NM	19	0-1.5	1.5-12	12-19	10-20	14-19	Sch. 40 PVC	0.010
CCB-MW-3	NM	17	0-1.5	1.5-10	10-17	10-20	12-17	Sch. 40 PVC	0.010
CCE-MW-2	NM	16	0-1.5	1.5-9	9-16	10-20	11-16	Sch. 40 PVC	0.010
ME-MW-1	NM	21	0-1.5	1.5-14	14-21	10-20	16-21	Sch. 40 PVC	0.010
SP-MW-1	NM	16	0-1.5	1.5-9	9-16	10-20	11-16	Sch. 40 PVC	0.010
SPB-MW-3***	NM	16	0-1.5	1.5-9	9-16	10-20	11-16	Sch. 40 PVC	0.010
CCE-MW-3	TX	16	0-1.5	1.5-9	9-16	10-20	11-16	Sch. 40 PVC	0.010
VC-MW-1	TX	16	0-1.5	1.5-9	9-16	10-20	11-16	Sch. 40 PVC	0.010

Notes:
***SPB-MW-3 is to be moved according to the SOW
NM = New Mexico
TX = Texas
bgs = below ground surface

Attachment C

Low Water Analysis

Attachment C1. Deepest Recorded DTW Level For Proposed Redrilled Wells

Well Name	Low Water Depth (bgs)	Depth of Top of Screen (5 ft screen)	Proposed Depth (bgs)	Original Drill Depth (bgs)	Depth of Screen Below Low Water (ft)
BE-MW-1	11.11	13	18	16	-1.89
CCB-MW-2	12.76	14	19	16	-1.24
CCB-MW-3	10.65	12	17	16	-1.35
CCE-MW-2	8.68	11	16	12	-2.32
CCE-MW-3	8.57	11	16	16	-2.43
ME-MW-1	14.54	16	21	16	-1.46
SP-MW-1	8.67	11	16	12	-2.33
SPB-MW-3	8.73	11	16	16	-2.27
VC-MW-1	9.34	11	16	16	-1.66

bgs = below ground surface

Attachment D

Well Drilling Technical References

EM 1110-1-4000
1 Nov 98

US Army Corps
of Engineers

ENGINEERING AND DESIGN

Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites

This manual is approved for public release, distribution is unlimited.

ENGINEER MANUAL

CEMP-RT
CECW-EG

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

EM 1110-1-4000

Manual
No. 1110-1-4000

1 November 1998

Engineering and Design
MONITORING WELL DESIGN, INSTALLATION, AND DOCUMENTATION AT HAZARDOUS TOXIC, AND RADIOACTIVE WASTE SITES

1. Purpose. This Engineer Manual (EM) provides the minimum elements for consideration in the design, installation, and documentation of monitoring well placement (and other geotechnical activities) at projects known or suspected to contain chemically hazardous, toxic, and/or radioactive waste.

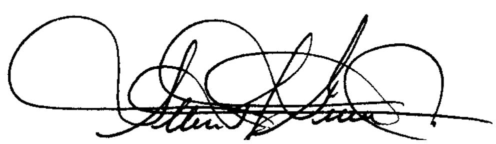
2. Applicability. This EM applies to all U.S. Army Corps of Engineers (USACE) commands having hazardous, toxic, and radioactive waste (HTRW) project responsibilities. For special considerations of radioactive, biological, or mixed (chemical and radioactive) waste components, contact the USACE Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX) in Omaha, Nebraska.

3. References. References are provided in Appendix A.

4. Distribution Statement. Approved for public release, distribution is unlimited.

5. Discussion. The technical understanding and evaluation of HTRW studies involves an appreciation of the interactions between geology, hydrology, geotechnical engineering, and chemistry. This scenario is complicated by the trace (low parts per billion) levels of regulated chemical species that are detectable in the environment and when detected or suspected may trigger intricate and costly response actions. Slight deviations from prescribed drilling, well installation, sampling, or analytical procedures may bias or invalidate both the reported concentrations of these regulated species and the technical basis upon which the Corps makes decisions. These relationships are further complicated by the heterogeneous, anisotropic character of the natural environment itself. This situation requires environmental characterization based upon procedures that are standardized, documented, understood, and followed. This manual outlines that effort.

FOR THE COMMANDER:



ALBERT J. GENETI, JR.
Major General, USA
Chief of Staff

2 Appendices
App A - References
App B - Abbreviations

This manual supersedes EM 1110-1-4000, dated 31 August 1994.

CEMP-RT

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

EM 1110-1-4000

Manual
No. 1110-1-4000

1 November 1998

Engineering and Design
MONITORING WELL DESIGN, INSTALLATION, AND DOCUMENTATION AT HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE SITES

Table of Contents

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Chapter 1
Introduction

1-1. Purpose

This Engineer Manual (EM) provides geotechnical and chemical guidelines for U.S. Army Corps of Engineers (USACE) elements in the planning, installing, and reporting of soil and/or bedrock borings, monitoring wells, and other geotechnical and geochemical devices at hazardous, toxic, and radioactive waste (HTRW) sites. These guidelines are a compilation of those procedures necessary for the acquisition of environmentally representative geotechnical data and samples, using conservative methods documented in a comprehensive manner.

1-2. Applicability

a. This EM applies to all USACE commands, elements and their contractors (including architect-engineers, [AE's]) having military and/or civil works hazardous, toxic and radioactive waste (HTRW) site responsibilities and/or engaged in programs within the Comprehensive Environmental Resource, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); the Superfund Amendments and Reauthorization Act (SARA); the Defense Environmental Restoration Program (DERP); non-mission HTRW work for other (non-Corps) offices; work within host nation agreements; or any other Corps-managed HTRW activities.

b. Only HTRW work involving *chemical* issues are covered within this manual. Biological waste components of HTRW are not addressed. Supplemental instructions will be provided as appropriate procedures are identified. In the interim, any requests for assistance in those areas should be directed to the Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX) within the U.S. Army Engineer District, Omaha (CENWO), Attention: HTRW - Center of Expertise, Geoenvironmental & Process Engineering Branch (CENWO-HX-G); or Headquarters, U.S. Army Corps of Engineers (HQUSACE), Attention: Directorate of Military Programs, Policy and Technology Branch (CEMP-RT).

c. The specific application of and adherence to these guidelines must be tailored to each project as a function of the contaminants of concern; local geohydrologic setting; geotechnical judgment; available resources; applicable regulatory requirements; policy and guidance; public concerns; and project mission.

1-3. References

Appendix A contains a list of those publications referenced by and relevant to this manual.

1-4. Terminology

a. General. As in any relatively new field using the principles, terminology, and personnel of several other fields, there is a certain lack of communication over the language used to express data and mechanisms within this new field. The situation is further compounded by alternative methods, both traditional and innovative, to complete actual projects. The additional requirements for permits, licenses, and other federal and state regulatory procedures, and the potential for litigation, add to the HTRW site complexities.

b. Corps situation.

(1) Within USACE, a given HTRW project may be performed totally in-house, partially in-house, or by one or more contractors/AE's (either independently reporting to the Corps or through a system of prime- and subcontracting). One Corps office may broker the work of another who in turn contracts the effort. In some cases, one Corps district may design a project and award the contract while a second district supervises construction.

(2) Providing program level technical guidance in this administrative situation requires the guidance to be specific, while allowing any field activity to adapt the guidance to its needs. The intent is to foster the defense of variances, not the defense of recommended methods and procedures. This approach is warranted to provide the Corps with compatibility and continuity of HTRW investigations while allowing functional flexibility. With this in mind, the following three terms are introduced: the *field activity* (FA); the *field drilling organization* (FDO); and the *drilling and well installation plan*. These terms are defined in paragraphs 1-4*c*(2), (3), and (1), respectively. Generically, these terms refer to a client-contractor-contract relationship. This relationship can be applied to both in-house and contracted efforts, thereby providing consistency for the geotechnical portion of the Corps HTRW involvements.

c. Definitions (alphabetically arranged). These definitions are intended to guide the reader through the use of this manual. While other terms with equivalent definitions may be familiar to some readers, the terminology as defined here provides a common basis for the **CONSISTENT** understanding by **ALL** readers.

(1) Field Sampling Plan (FSP). The FSP is contained within the Sampling and Analysis Plan (SAP), and describes the drilling and well installation plan. The SAP and FSP requirements are outlined in EM 200-1-3. The FSP is approved by the FA or FDO before field activities begin. The plan specifies the particulars of the field effort; for example: borehole/well/sample locations, depths, equipment, materials, procedures and alternatives, quality control measures, and other topics required by the responsible FA. Implementation is by the FDO.

(2) Field activity (FA). That Corps element minimally headed by a Commander or Director; e.g., district, laboratory, or agency, assigned or otherwise acquiring the responsibility to administer a contract, agreement, or in-house Corps procedure to research, investigate, design, and/or construct a project involving hazardous and/or toxic wastes.

(3) Field drilling organization (FDO). That office within the Corps or contracted by the Corps responsible for execution of the drilling plan. In a contracted arrangement, the prime contractor is regarded as the FDO. Subcontractors, even though they may physically perform the field work, are the responsibility of the prime contractor, whom the Corps holds contractually accountable.

(4) Geotechnical data quality management (GDQM). The development and application of those policies and procedures required to obtain and utilize accurate and representative geotechnical information throughout the entire HTRW project cycle, from predesign investigations to postconstruction monitoring.

(5) Hazardous, toxic, and radioactive waste (HTRW). A USACE idiom referring to substances which because of their properties, occurrence, or concentration, may potentially pose a threat to human health and welfare, or to the environment. This includes materials defined by federal regulations as hazardous waste, hazardous substances, and pollutants.

(6) Monitoring well. A monitoring well is a device designed and constructed for the acquisition of groundwater samples that are representative of the chemical quality of the aquifer adjacent to the screened interval, unbiased by the well materials and installation process; and which, if so designed, provides access to measure potentiometric head across the screened interval.

(7) Redevelopment/well rehabilitation. A procedure which restores the original or near original pumping capacity to an existing well by the removal of sediment, precipitation, flocculent, surface run-in, or other built-up materials from within that well.

(8) Screened interval. That portion of a well which is directly open to the host environment/aquifer by way of openings in the well screen.

(9) Site safety and health plan (SSHP). A project-unique document approved by the responsible FA for FDO compliance. The plan includes the identification of hazardous substances present, recommended action upon encountering those substances, project/site safety requirements, organizational safety responsibilities, and the identification of supporting health and safety activities.

(10) Well development. A procedure which locally improves or restores the aquifer's hydraulic conductivity, well capacity, and removes well drilling fluids, muds, cuttings, mobile particulates, and entrapped gases from within and adjacent to a newly installed well.

d. Acronyms. Appendix B contains a list of the abbreviations used in this manual.

1-5. Background

a. EM 1110-1-4000. As a GDQM mechanism, this manual provides guidance for collection and documentation of geotechnical information. Site-specific deviations should be described and supported in the drilling and well installation plan.

(1) Technical understanding and evaluation of HTRW studies involve an appreciation of the interactions among many fields including geology, hydrology, geotechnical engineering, and chemistry. This scenario is complicated by the trace (low parts per billion) levels of regulated chemical species that are detectable in the environment and which, when detected or suspected, trigger intricate and costly response actions. Slight deviations from prescribed drilling, well installation, sampling, or analytical procedures may bias or invalidate the reported concentrations. This sensitivity requires that procedures be relevant, standardized, documented, understood, and followed. Despite these procedures, the normal heterogeneity and anisotropy of natural field occurrences are, in themselves, frequently sufficient to confuse the appropriate interpretation of the

gathered field data.

(2) The specific content of this manual will be periodically updated based upon reader suggestions, lessons learned, technological advances, and Corps needs. Issues of significant concern will be disseminated Corpswide in a more expeditious manner.

(3) Not all geotechnical personnel will agree on every practice advocated herein. Any such variations should be over a matter of degree, not substance. If the reader perceives a technical difficulty in any of this manual's contents, the reader is requested to contact the proponent.

b. Proponency. The technical proponents for this manual are the Policy and Technology Branch, Environmental Division, Directorate of Military Programs (CEMP-R), and the Geotechnical and Materials Branch, Engineering Division, Directorate of Civil Works (CECW-EG), Headquarters, U.S. Army Corps of Engineers. All comments and suggestions should be directed to HQUSACE, CEMP-R, 20 Massachusetts Avenue, N.W., Washington, D.C. 20314-1000.

Chapter 2
Boreholes and Wells:
Site Reconnaissance, Locations, Quantities, and Designations

2-1. Site Reconnaissance

Site visits are suggested for project geotechnical personnel as early as practical in the planning for any subsurface exploration. The purpose of this reconnaissance is to evaluate physical site conditions and logistical support availability. Particular items of interest would include geologic and geographic settings, site access, proximal utilities, service areas, sample shipment facilities, and potential hazards. Application of this knowledge will contribute to enhancing the technical approach and cost realism for subsequent project development.

2-2. Locations and Quantities

The locations and quantities of boreholes and wells should be selected to effectively ascertain desired geologic, hydrologic, and/or chemical parameters. The number of borings or wells specified in the drilling plan should not be altered without coordination with the FA. The drilling and well installation plan should permit relocations when necessitated by proximal utilities or drilling difficulties. The criteria for selection of the new location(s) should be included as a portion of the drilling plan and should indicate when coordination would be required with the FA.

2-3. Designations

Borehole and well designations (identification numbers) should not be unilaterally changed in the field or in a centralized computer database without prior approval of the installing Corps organization or non-Corps agency. After receiving approval, the requesting FA should physically renumber those sites where a designation is posted in the field. Temporary conversions not involving the alteration of either field markings or a centralized database may be done for reporting purposes without approval of the installing organization or agency. Such temporary changes may be necessary, for instance, if the data entry format of a given computer system is not compatible with the characters in the existing well designation. A conversion table should be included in the final report to document any permanent *or* temporary boring/well designation changes.

Chapter 3
Drilling Operations

3-1. Physical Security

The FDO should comply with all security policies at the project site. The FDO is responsible for securing its own equipment. The FDO should address any special situations in the drilling plan.

3-2. Drilling Safety and Underground Utility Detection

When drilling in areas of known or suspected hazardous materials, appropriate health and safety precautions should be implemented. Guidance adaptable for drilling activities is available in Occupational Safety and Health Administration (OSHA) documents (particularly, 29 CFR 1910.120 and 29 CFR 1926), ER 385-1-92, and EM 385-1-1. The FDO should determine all applicable regulations, requirements, and permits with regard to drilling safety and underground utility detection. These items should be included in the safety plan. The safety plan should be approved by the FA prior to any drilling.

3-3. Permits, Licenses, Professional Registration, and Rights-of-Entry

The FA should be responsible for identifying all applicable permits, licenses, professional registration, rights-of-entry, and applicable state and local regulatory procedures for drilling, well installation, well decommissioning/ abandonment, and topographic surveying (to include any requirements for the submission of well logs, samples, etc.). Acquisition and submission of these items to state or local authorities should be coordinated between the FA and FDO, with the responsibilities of each specified in the drilling plan. The need for any rights-of-entry should be specified in the drilling plan along with the organization(s) responsible for their acquisition.

3-4. Site Geologist

A "site geologist" (defined as an earth science or engineering professional with a college degree in geology, civil engineering, or related field; experienced in HTRW projects, soil and rock logging, and monitoring well installation), should be present at each operating drill rig. This geologist should be responsible for logging; acquisitioning (and possibly shipment) of samples; monitoring of drilling operations; recording of water losses/gains and groundwater data; preparing the boring logs and well diagrams; and recording the well installation and decommissioning procedures conducted with that rig. Each site geologist should be responsible for only one operating rig. The geologist should have onsite sufficient tools, forms, and professional equipment in operable condition to efficiently perform the duties as outlined in this manual and other relevant project documents. Items in the possession of each site geologist should include, as a minimum, a copy of this manual, a copy of the approved drilling and well installation plan, log forms, the approved safety plan, a 10-power (minimum) hand lens, and a measuring tape (weighted with stainless steel or chemically stable, nonmetallic material) long enough to measure the deepest boring/well within the project, heavy enough to reach that depth, and small enough to readily fit within the appropriate annulus or opening. Each site geologist should also have onsite a water-level measuring device (preferably electrical), pH and electric conductivity meters, a turbidimeter, a thermometer, an instrument for measuring dissolved oxygen, and materials necessary to prepare the samples for storage or shipment. At some sites, the geologist may be also responsible for monitoring gases during drilling. If so, the geologist should have the necessary instruments and be proficient in their use and calibration.

3-5. Equipment

a. Condition. All drilling, sampling, and supporting equipment brought to a site should be in operable condition and free of leaks in the hydraulic, lubrication, fuel, and other fluid systems where fluid leakage would or could be detrimental to the project effort. All switches (to include safety switches), gages, and other electrical, mechanical, pneumatic, and hydraulic systems should be in a safe and operable condition prior to arrival onsite.

b. Cleaning. All drilling equipment should be cleaned with steam or pressurized hot water before arriving at the project installation/site. After arrival but prior to project commencement, all drilling equipment including rigs, support vehicles, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., should be cleaned with steam or pressurized hot water using approved water (see paragraph 3-9*b*) at the installation decontamination point. Guidance for decontamination of field equipment may be found in ASTM D 5088. Samplers and other equipment, such as water level indicators, oil/water interface probes, etc. may require additional decontamination steps. A similar cleaning should also occur between each boring/well site. After the onsite cleaning, only the equipment used or soiled at a particular boring or well should need to be recleaned between sites. Unless circumstances require otherwise, water tank interiors may not need to be cleaned between each boring/well at a given project. Prior to use, all casings, augers, recirculation and water tanks, etc., should be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, may not have to be removed from drilling equipment, depending upon the paint composition and its contact with the environment and contaminants of concern. All equipment should be decontaminated before it is removed from the project site. If drilling requires telescoping casing because of differing levels of contamination in subsurface strata, then decontamination may be necessary before setting each string of smaller casing and before drilling beyond any casing. To the extent practical, all cleaning should be performed in a single remote area that is surficially crossgradient or downgradient from any site to be sampled. Waste solids and water from the cleaning/decontamination process should be properly collected and disposed. This may require that cleaning be conducted on a concrete pad or other surface from which the waste materials may be collected. Guidance for decontamination of field equipment used at low level radioactive waste sites may be found in ASTM D 5608.

3-6. Drilling Methods

a. Objective. The objective of selecting a drilling method for monitor well installation is to use that technique which

(1) Provides representative data and samples.

(2) Eliminates or minimizes the potential for subsurface contamination and/or cross-contamination.

(3) Minimizes drilling costs.

b. Methods. Table 3-1 presents types of drilling methods. Detailed descriptions of different drilling methods may be found in EPA/600/4-89/034, EPA/625/R-93/003a, USGS WRI Report 96-4233, USGS TWRI Book 2 Chapter F1, ASTM D 6286, Driscoll (1986), and U.S. Army FM 5-484. Where possible, ASTM drilling method-specific guides are referenced with the drilling methods listed below.

(1) Hollow stem augers. Method references: ASTM D 5784 and EPA/600/4-89/034.

(2) Cable tool/churn drill. Method reference: ASTM D 5875.

(3) Water/mud rotary. Method references: ASTM D 5781, D 5783, and D 5876.

(4) Air/pneumatic rotary methods. Method reference: D 5782.

(5) Sonic/vibratory. Method reference: EPA/625/R-94/003.

(6) Direct Push. Method references: ASTM Standard Guides D 6001 and D 6282, and EPA/510/B-97/001.

c. Special concerns.

(1) Dry methods.

(a) Hollow stem augers are technically advantageous in most situations because of their “dry” method of drilling. A dry drilling method is preferred for HTRW work. Dry methods advance a boring using purely mechanical means without the aid of an aqueous or pneumatic drilling “fluid” for cuttings removal, bit cooling, or borehole stabilization. In this way, the chemical interface with the subsurface is minimized, though not eliminated. Local aeration of the borehole wall, for example, may occur simply by the removal of compacted or confining soil or rock.

(b) Vibratory, or sonic drilling, employs the use of high-frequency mechanical vibration to take continuous core samples of overburden soils and most hard rock. A sonic drill rig uses an oscillator, or head, with eccentric weights driven by hydraulic motors, to generate high sinusoidal force in a rotating drill pipe. The frequency of vibration of the drill bit or core barrel can be varied to allow optimum penetration of subsurface materials. Sonic drilling penetrates a formation by displacement, shearing, or fracturing. Displacement occurs by fluidizing the soil particles (sands and light gravels) and causing them to move either into the formation or into the center of the drill pipe. Shearing occurs in dense silts, clays, and shales, if the axial oscillations of the drill pipe overcomes the elastic nature of the material. The penetration of cobbles, boulders, and rock is caused by fracturing of the material by the inertial moment of the drill bit. Although, rock drilling and sampling requires the addition of water or air to remove drill cuttings, the volume of drill cuttings generated during sonic drilling is usually much less than those generated from some other drilling methods. Drilling through unconsolidated material can be done in the dry, without the use of drilling fluids such as air or water-based fluids and additivies. Overall, the sonic drilling method can also offer the advantages of obtaining relatively undisturbed soil and rock samples at higher drilling rates than conventional methods, with high percentage of core recovery, and produces less investigation-derived waste.

TABLE 3-1
DRILLING METHODS

Method	Drilling Principle	Depth Limitation m (Ft.)	Advantages	Disadvantages
Direct-Push	Advancing a sampling device into the subsurface by applying static pressure, impacts, or vibration or any combination thereof to the above ground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil strata.	30 (100)	Avoids use of drilling fluids and lubricants during drilling. Equipment highly mobile. Disturbance of geochemical conditions during installation is minimized. Drilling and well screen installation is fast, considerably less labor intensive. Does not produce drill cuttings, reduction of IDW.	Limited to fairly soft materials such as clay, silt, sand, and gravel. Compact, gravelly materials may be hard to penetrate. Small diameter well screen may be hard to develop. Screen may become clogged if thick clays are penetrated. The small diameter drive pipe generally precludes conventional borehole geophysical logging. The drive points yield relatively low rates of water.
Auger, Hollow- and Solid-Stem	Successive 1.5m (5-ft) flights of spiral-shaped drill stem are rotated into the ground to create a hole. Cuttings are brought to the surface by the turning action of the auger.	45 (150)	Fairly inexpensive. Fairly simple and moderately fast operation. Small rigs can get to difficult-to-reach areas. Quick setup time. Can quickly construct shallow wells in firm, noncavey materials. No drilling fluid or lubricants required. Use of hollow-stem augers greatly facilitates collection of split-spoon samples, continuous sampling possible. Small-diameter wells can be built inside hollow-stem flights when geologic materials are cavey.	Depth of penetration limited, especially in cavey materials. Cannot be used in rock or well-cemented formations. Difficult to drill in cobbles or boulders. Log of well is difficult to interpret without collection of split spoons due to the lag time for cuttings to reach ground surface. Soil samples returned by auger flight are disturbed making it difficult to determine the precise depth from which the sample came. Vertical leakage of water through borehole during drilling is likely to occur. Solid-stem limited to fine-grained, unconsolidated materials that will not collapse when unsupported. Borehole wall can be smeared by previosly-drilled clay. With hollow-stem flights, heaving sand can present a problem. May need to add water down-auger to control heaving or wash materials from auger before completing well.
Jetting	Washing action of water forced out of the bottom of the drill rod clears hole to allow penetration. Cuttings brought to surface by water flowing up the outside of the drill rod.	15 (50)	Relatively fast and inexpensive. Driller often not needed for shallow holes. In firm, noncavey deposits where hole will stand open, well construction fairly simple. Minimul equipment required. Equipment highly mobile.	Somewhat slow with increasing depth. Limited to drilling relatively shallow depth, small diameter boreholes. Extremely difficult to use in very coarse materials, i.e., cobbles and boulders. Large quantities of water required during drilling process. A water supply is needed that is under enough pressure to penetrate the geologic materials present. Use of water can affect groundwater quality in aquifer. Difficult-to-interpret sequence of geologic materials from cuttings. Presence of gravel or larger materials can limit drilling. Borehole can collapse before setting monitoring well if borehole uncased.

TABLE 3-1
DRILLING METHODS

Method	Drilling Principle	Depth Limitation m (Ft.)	Advantages	Disadvantages
Cable-tool (percussion)	Hole created by dropping a heavy "string" of drill tools into well bore, crushing materials at bottom. Cuttings are removed occasionally by bailer. Generally, casing is driven just ahead of the bottom of the hole; a hole greater than 6 inches in diameter is usually made.	300+ (1,000 +)	Can be used in rock formations as well as unconsolidated formations. Can drill through cobbles and boulders and highly cavernous or fractured rock. Fairly accurate logs can be prepared from cuttings if collected often enough. Driving a casing ahead of hole minimizes cross-contamination by vertical leakage of formation waters and maintains borehole stability. Recovery of borehole fluid samples excellent throughout the entire depth of the borehole. Excellent method for detecting thin water-bearing zones. Excellent method for estimating yield of water-bearing zones. Excellent method for drilling in soil and rock where lost circulation of drilling fluid is possible. Core samples can be easily obtained. Excellent for development of a well.	The potential for cross-contaminated samples is very high. Decontamination can be difficult. Heavy steel drive pipe used to keep hole open and drilling "tools" can limit accessibility. Cannot run some geophysical logs due to presence of drive pipe. Relatively slow drilling method. Heavier wall, larger diameter casing than that used for other drilling methods normally used. Temporary casing can cause problems with emplacement of effective filter pack and grout seal. Heaving of unconsolidated sediment into bottom of casing can be a problem.
Mud Rotary	Rotating bit breaks formation; cuttings are brought to the surface by a circulating fluid (mud). Mud is forced down the interior of the drill stem, out the bit, and up the annulus between the drill stem and hole wall. Cuttings are removed by settling in a "mud pit" at the ground surface and the mud is circulated back down the drill stem.	1,500+ (5,000 +)	Drilling is fairly quick in all types of geologic materials, hard and soft. Borehole will stay open from formation of a mud wall on sides of borehole by the circulating drilling mud. Eases geophysical logging and well construction. Geologic cores can be collected. Can use casing-advancement drilling method. Borehole can readily be gravel packed and grouted. Virtually unlimited depths possible.	Expensive, requires experienced driller and fair amount of peripheral equipment. Completed well may be difficult to develop, especially small diameter wells, because of mud or filter-cake on wall of borehole. Lubricants used during drilling can contaminate the borehole fluid and soil/rock samples. Geologic logging by visual inspection of cuttings is fair due to presence of drilling mud. Beds of sand, gravel, or clay may be missed. Location of water-bearing zones during drilling can be difficult to detect. Drilling fluid circulation is often lost or difficult to maintain in fractured rock, root zones, or in gravels and cobbles. Difficult drilling in boulders and cobbles. Presence of drilling mud can contaminate water samples, especially the organic, biodegradable muds. Overburden casing usually required. Circulation of drilling fluid through a contaminated zone can create a hazard at the ground surface with the mud pit and cross-contaminate clean zones during circulation.

TABLE 3-1
DRILLING METHODS

Method	Drilling Principle	Depth Limitation m (Ft.)	Advantages	Disadvantages
Reverse Rotary	Similar to hydraulic rotary method except the drilling fluid is circulated down the borehole outside the drill stem and is pumped up the inside, just the reverse of the normal rotary method. Water is used as the drilling fluid, rather than a mud, and the hole is kept open by the hydrostatic pressure of the water standing in the borehole.	1,500+ (5,000 +)	Drilling readily accomplished in soils and most hard rock. Drilling is relatively fast and for drilling large diameter boreholes. Borehole is accessible for geophysical logging prior to installation of well. Creates a very "clean" hole, not dirtied with drilling mud. Large diameter of borehole permits relatively easy installation of monitoring well. Can be used in all geologic formations. Very deep penetrations possible. Split-spoon sampling possible.	Drilling through cobbles and boulders may be difficult. Use of drilling fluids, polymeric additives, and lubricants can affect the borehole chemistry. A large water supply is needed to maintain hydrostatic pressure in deep holes and when highly conductive formations are encountered. Expensive--experienced driller and much peripheral equipment required. Hole diameters are usually large, commonly 18 inches or greater. Cross-contamination from circulating water likely. Geologic samples brought to surface are generally poor; circulating water will "wash" finer materials from sample.
Air Rotary	Very similar to hydraulic rotary, the main difference is that air is used as the primary drilling fluid as opposed to mud or water.	1,500+ (5,000 +)	Can be used in all geologic formations; most successful in highly fractured environments. Useful at most any depth. Drilling in rock and soil is relatively fast. Can use casing-advancement method. Drilling mud or water not required. Borehole is accessible for geophysical logging prior to monitoring well installation. Well development relatively easy.	Relatively expensive. Cross-contamination from vertical communication possible. Air will be mixed with the water in the hole and blown from the hole, potentially creating unwanted reactions with contaminants; may affect "representative" samples. Air, cuttings and water blown from the hole can pose a hazard to crew and surrounding environment if toxic compounds encountered. Compressor discharge air may contain hydrocarbons. Organic foam additives to aid cuttings removal may contaminate samples. Overburden casing usually required.
Sonic (vibratory)	Employs the use of high-frequency mechanical vibration to take continuous core samples of overburden soils and most hard rock.	150 (500)	Can obtain large diameter, continuous and relatively undisturbed cores of almost any soil material without the use of drilling fluids. Can drill through boulders, wood, concrete and other construction debris. Can drill and sample most softer rock with high percentage of core recovery. Drilling is faster than most other methods. Reduction of IDW.	Rock drilling requires the addition of water or air or both to remove drill cuttings. Extraction of casing can cause smearing of borehole wall with silt or clay. Extraction of casing can damage well screen. Equipment is not readily available and is expensive.

TABLE 3-1
DRILLING METHODS

Method	Drilling Principle	Depth Limitation m (Ft.)	Advantages	Disadvantages
Air-Percussion Rotary or Down-the-Hole (DTH) Hammer	Air rotary with a reciprocating hammer connected to the bit to fracture rock.	600 (2,000)	Very fast penetrations. Useful in all geologic formations. Only small amounts of water needed for dust and bit temperature control. Cross-contamination potential can be reduced by driving casing. Can use casing-advancement method. Well development relatively easy.	Relatively expensive. As with most hydraulic rotary methods, the rig is fairly heavy, limiting accessibility. Overburden casing usually required. Vertical mixing of water and air creates cross-contamination potential. Hazard posed to surface environment if toxic compounds encountered. DTH hammer drilling can cause hydraulic fracturing of borehole wall. The DTH hammer requires lubrication during drilling. Organic foam additives for cuttings removal may contaminate samples.

(c) Another dry method, known as the direct push method, involves sampling devices that are directly inserted into the soil to be sampled without drilling or borehole excavation. Direct push sampling also includes the use of the Site Characterization and Analysis Penetrometer System (SCAPS) which has contaminant screening capability in addition to indirect soil stratigraphy information (ASTM D 5778 and D 6067). Direct push sampling consists of advancing a sampling device into the subsurface by applying static pressure, impacts, or vibration or any combination thereof to the above ground portion of the sampler extensions until the sampler has been advanced its full length into the desired soil strata. Direct push methods may be used to collect both soil (ASTM D 6282) and water samples (ASTM D 6001). In some cases the method may combine water sampling and/or vapor sampling with soil sampling in the same investigation. The direct push sampling method is widely used as a preliminary site characterization tool for the initial field activity of a site investigation. Direct push sampling is an economical and efficient method for obtaining descrete soil and water samples without the expense of drilling and its related decontamination and waste cuttings disposal costs. This method may be especially advantageous at a radioactive site, where the reduction of IDW is of special importance. The equipment generally used in direct push sampling is small and relatively compact allowing for better mobility around the site and access to confined areas. The rapid sample gathering provided by direct push methods can be used to determine the chemical composition of the soils and ground water in the field in certain circumtances. This method may offer an immediate determination of the need for further monitoring points. It must be cautioned, however, that certain temporary well points installed by this method may not be allowed as permanent monitoring wells by some state and local regulations.

(2) Pneumatic methods. When air is used it should be detailed in the drilling plan, to include the following items:

(a) Situation favoring air usage.

(b) Air drilling method to be used.

(c) Expected subsurface contaminants, and how field personnel will be protected from any adverse effects caused by these contaminants in the returned air and particles blown from the borehole or well.

(d) The potential effects of air usage upon the chemical analyses of groundwater and soil (especially for volatile species) and the mitigation procedures to negate the detrimental aspects of these effects.

(e) The potential effects of air usage upon the physical, hydrological, and structural character of the surrounding soil and/or rock and the mitigation to address the negative aspects of these effects.

(f) Measures to be taken to reduce oil usage and to limit aquifer aeration.

(g) Specify the type of air compressor and compressor lubricating oil and require that sufficient samples of the initial reservoir (and any refill) oil be retained by the FDO, along with a record of oil loss (recorded on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon project completion.

(h) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes should be made if oil is visibly detected in the filtered air, as by an oil stain on clean, writing paper after directing the filtered air from a hose onto the paper “300 mm” (“a foot”) away for “15 seconds.” (While these numbers are arbitrary, they are provided as examples for FDO guidance and intra/interproject consistency.)

(i) Prohibit the use of any additive except approved water for dust control and cuttings removal.

(j) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

(k) Discuss the volume of air and pressure rating required for drilling and whether a downhole hammer, rotary bit, or both can be used. The air volume and pressure required should be adequate for the hole diameter, boring depth, available equipment, and site conditions.

(l) Detail the use of any bottled gas with emphasis on air composition, quality, quantity, method of bottling, and anticipated use.

(m) Air usage should be fully described in the boring log to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluation of the system performance, both design and actual.

(3) Aqueous methods.

(a) Aqueous drilling methods use a fluid, usually water, or a water and bentonite mix, for cuttings removal, bit cooling, and hole stabilization. For HTRW work, the use of these materials increases the potential to add a new contaminant or suite of contaminants to the subsurface environment adjacent to the boring. Even the removal of one or more volumes of water equal to that which was lost during drilling will not remove all of the lost fluid. In addition, the level of effort to be expended upon well development is directly tied to the amount of water loss during drilling: a minimum of three times the volume lost to be removed during development. Therefore, the less fluid loss, the less the development effort (time and cost).

(b) The situation is further complicated when bentonite is used. While bentonite tends to reduce the amount of drilling fluid loss, the residual bentonite remaining around the boring after development may provide sufficient sorptive material to modify local groundwater chemistry for some parameters (for example, metals).

3-7. Recirculation Tanks and Sumps

If possible, only portable recirculation tanks should be used for mud/water rotary operations and similar functions. The use of dug sumps or pits (lined) should be used only if necessary, as when the volume necessary to handle problem holes that encounter running sand or gravel is greater than can be handled by a portable tank. This is important in order to minimize cross-contamination and to enhance both personal safety and work area restoration.

3-8. Materials

a. Bentonite. Bentonite is the only drilling fluid additive that is typically allowed under normal circumstances. This includes any form of bentonite (powders, granules, or pellets) intended for drilling mud, grout, seals, etc. Organic additives should not be used. Exception might be made for some high yield bentonites, to which the manufacturer has added a small quantity of polymer. The use of any bentonite should be discussed in the drilling plan and approved by the FA. Bentonite should only be used if absolutely necessary to ensure that the borehole will not collapse or to improve cuttings removal. The following data should be included in the drilling plan and submitted along with a sample of the material for approval:

(1) Brand name(s).

(2) Manufacturer(s).

(3) Manufacturer's address and telephone number(s).

(4) Product description(s) from package label(s) or manufacturer's brochure(s), to include any polymer or other additives.

(5) Intended use(s) for this product.

(6) Potential effects on chemical analyses of subsequent samples.

b. Water.

(1) To the extent practical, the use of drilling water should be held to a minimum at HTRW sites. When water usage is deemed necessary, the source of any water used in drilling, grouting, sealing, filter placement, well installation, well decommissioning/abandonment, equipment washing, etc. should be approved by the FA prior to arrival of the drilling equipment onsite and specified in the drilling plan. Desirable characteristics for the source include:

(a) An uncontaminated aquifer origin;

(b) Wellhead upgradient of potential contaminant sources;

(c) Be free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the FDO using a laboratory validated by USACE for those contaminants using methods within that validation, and knowledge of the water-chemistry is the most important factor in water approval;

(d) The water is untreated and unfiltered;

(e) The tap has accessibility and capacity compatible with project schedules and equipment; and

(f) Only one designated tap for access.

(2) Surface water bodies should not be used, if at all practical.

(3) If a suitable source exists onsite, that source should be used. If no onsite water is available, the FDO should both locate a potential source and submit the following data in writing to the FA for approval prior to the arrival of any drilling equipment onsite. A suggested format is given in Figure 3-1.

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of any treatment and filtration prior to tap (e.g., none, chlorination, fluoridation, softening, etc.).

(e) Time of access (e.g., 24 hours per day, 7 days per week, etc.).

(f) Cost per liter (gallon) charged by owner/operator.

(g) Results and dates of all available chemical analyses over past 2 years. Include the name(s) and addresses of the analytical laboratory(s).

(h) Results and date(s) of chemical analysis for project contaminants by a laboratory validated by USACE for those contaminants.

(4) The FDO should have the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The FDO also should be responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

c. Grout.

(1) Cement. Cement grout, when used in monitoring well construction or borehole/well decommissioning, should be composed of Type I Portland cement (ASTM C 150), bentonite (2-5% dry bentonite per 42.6 kg (94 lb) sack of dry cement) and a maximum of 23 to 26 L (6-7 gal) of approved noncontaminated-water per sack of cement. The addition of bentonite to the cement admixture will aid in reducing shrinkage and provide plasticity. Note that the maximum amount of dry bentonite allowed here varies from the 10 percent allowable in ASTM D 5092. The amount of water per sack of cement required for a pumpable mix will vary with the amount of bentonite used. The amount of water used should be kept to a minimum. When a sulfate resistant grout is needed, Types II or V cement should be used instead of Type I. Neither additives nor borehole cuttings should be mixed with the grout. The use of air-entrained cement should be avoided to negate potential analytical interference in groundwater samples by the entraining additives.

(2) Bentonite. Bentonite grout is a specially designed product, which is differentiated from a drilling fluid by its high solids content, absence of cement and its pumpability. A typical high solids bentonite grout will have a solids content between 20 and 30 percent by weight of water and remain pumpable. By contrast, a typical low solids bentonite, as used in a drilling fluid, contains a solids content between 3 and 6 percent by weight of water. The advantages of using bentonite grout include (Oliver 1997) :

- Bentonite grouts, when hydrated, exert constant pressure against the walls of the annulus, leaving no room for contaminants to travel in the well.
- Bentonite grouts are more flexible and do not shrink and crack when hydrated, creating a low permeability seal.
- Placement using bentonite grouts is much easier because more time is allowed for setting.
- Bentonite high solids grouts require less material handling than cement.
- Bentonite grouts are chemically inert, which protects personal safety, equipment, and water quality.
- Bentonite grouts have no heat of hydration making them compatible with polyvinyl chloride (PVC) casing.
- Wells constructed with bentonite grouts can be easily reconstructed if necessary.
- Cleanup of bentonite grouts is much easier than with cement grouts.

Situations where bentonite grout should not be used are when additional structural strength is needed or when excessive chlorides or other contaminants such as alcohols or ketones are present. Under artesian conditions the bentonite does not have the solids content found in a cement-bentonite grout and will not settle where a strong uplift is present. Where structural support is needed, bentonite grout does not set up and harden like a cement and will not supply the support a cement-bentonite grout will provide (Colangelo 1988).

(3) Equipment. All grout materials should be combined in an aboveground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout should be recirculated through the grout pump prior to placement. Grout should be placed using a grout pump and pipe/tremie. The grout pipe should be of rigid construction for vertical control of pipe placement. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are suggested stock for tremies. If hoses or flexible plastics must be used, they may have to be fitted with a length of steel pipe at the downhole end to keep the flexible material from curling and embedding itself into the borehole wall. This is especially true in cold weather when the coiled material resists straightening. Grout pipes should have **SIDE** discharge holes, **NOT** end discharge. The side discharge will help to maintain the integrity of the underlying material (especially the bentonite seal).

d. Granular filter pack.

(1) Proper design of hydraulically efficient monitoring wells can be accomplished by designing the well in such a way that either the natural coarse-grained formation materials or artificially introduced coarse-grained materials, in conjunction with appropriately sized intake openings, retain the fine materials outside the well while permitting water to enter. Thus, there are two types of wells and well intake designs for wells installed in unconsolidated or poorly-consolidated geologic materials: natural developed wells and wells with an artificially introduced filter pack. In both types of wells, the objective of a filter pack is to increase the effective diameter of the well and to surround the well intake with an envelope of relatively coarse material of greater permeability than the natural formation material (EPA/600/4-89/034). The decision to design the well using the natural formation as the filter pack should include consideration that the natural formation material may slough in high enough above the top of the well screen to leave insufficient room for the bentonite seal. All granular filters should be approved by the FA prior to drilling and should be discussed in the drilling plan. Discussions should include composition, source (natural formation or artificial), placement, and gradation. The FDO should either prescribe the gradation of the filter pack in the field sampling plan (FSP) or detail that it will be determined after a sieve analysis of the stratum in which the screen is to be set has been performed. If the actual gradation is to be determined during drilling, more than one filter pack gradation should be on hand so that well installation will not be unnecessarily delayed. A 0.5 L (one-pint) representative sample for visual familiarization of each proposed granular filter pack, accompanied by the data below, should be submitted by the FDO to the FA for approval prior to drilling. Each sample should be described, in writing (see Figure 3-2 for submittal format), in terms of:

(a) Lithology;

(b) Grain size distribution;

(c) Brand name, if any;

(d) Source, both manufacturing company and location of pit or quarry of origin for artificial filter packs;

(e) Processing method for artificial filter packs, e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.; and

(f) Slot size of intended screen.

(2) Granular filter packs should be visually clean (as seen through a 10-power hand lens), free of material that would pass through a No. 200 (75 µm [0.0029 in.]) sieve, inert, siliceous, composed of rounded grains, and of appropriate size for the well screen and host environment. Organic matter, soft, friable, thin, or enlongated particles are not permissible. A chemical analysis, including analytes of project concern, may be advisable in some circumstances. However, the reproducibility of that result should be evaluated against the spatial and temporal variability of the aggregate source and processing methods. The filter material should be packaged in bags by the supplier and therein delivered to the site.

e. Well screens, casings, and fittings.

(1) Typically, only PVC, polytetrafluoroethylene (PTFE), and/or stainless steel should be used. All PVC screens, casings, and fittings should conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage or ASTM Standard Specification F 480 and bear the appropriate rating logo. If the FDO uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the FDO should

WATER APPROVAL

Project for Intended Use:

1. Water source:
   Owner:
   Address:
   Telephone Number:

2. Water tap location:
   Operator:
   Address:

3. Type of source:
   Aquifer:
   Well depth:
   Static water level from ground surface:
   Date measured;

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per liter (gallon) charged by Owner/Operator:

7. Attach results and dates of chemical analyses for past 2 years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of chemical analyses for project analytes by the laboratory certified by, or in the process of being certified.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

FOA APPROVAL (A)/DISAPPROVAL (D) (Check one)

Project Officer: A D

Project Geologist/Date: A D

Figure 3-1. Suggested format for use in obtaining water approval

include in the drilling plan a written statement from the manufacturer/supplier (and endorsed by the FDO) that the screens and/or casing have been appropriately rated by NSF or ASTM. Specific materials should be specified in the drilling plan approved by the FA. All materials should be as chemically inert as technically practical with respect to the site environment.

(2) All well screens should be commercially fabricated, slotted or continuously wound, and have an inside diameter (ID) equal to or greater than the ID of the well casing. An exception may be needed in the case of continuously wound screens because their supporting rods may reduce the full ID. If the monitoring well is to be subject to aquifer testing (slug test or pump test), a continuous wound screen should be used. Stainless steel screens may be used with PVC or PTFE well casing. No fitting should restrict the ID of the joined casing and/or screen. All screens, casings, and fittings should be new.

(3) Couplings within the casing and between the casing and screen should be compatibly threaded. Thermal or solvent welded couplings on plastic pipe should not be used. This caution also applies to threaded or slip-joint couplings thermally welded to the casing by the manufacturer or in the field. Several thermally welded joints have been known to break during well installation on a single project. The avoidance should remain until the functional integrity of thermal welds has been substantiated.

(4) Pop rivets, or screws should not be used on monitor wells. Particular problems with their use include anomalous analytical results, restriction of the well ID, and a loss of well integrity at the point of application.

f. Well caps and centralizers.

(1) The tops of all well casings should be telescopically covered with a slip-joint-type cap. Each cap should be composed of PVC, PTFE, or stainless steel. Each cap should be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost, and secure enough to preclude debris and insects from entering the well. Caps and risers may be threaded. However, sufficient annular space should be allowed between the well and protective casing to enable one to thaw any frosted shut caps. Caps should be vented, or loose enough to allow equilibration between hydrostatic and atmospheric pressures. Special cap (and riser) designs should be provided by the FA or FDO for wells in floodplains and those instances where the top of the well may be below grade, e.g., in roadways and parking lots.

(2) The use of well centralizers should be considered for wells deeper than 6 m (20 ft). When used, they should be of PVC, PTFE, or stainless steel and attached to the casing at regular intervals by means of stainless steel fasteners or strapping. Centralizers should not be attached to any portion of the well screen or bentonite seal. Centralizers should be oriented to allow for the unrestricted passage of the tremie pipe(s) used for filter pack and grout placement.

g. Well protection materials. Elements of well protection are intended to protect the monitoring well from physical damage, to prevent erosion and/or ponding in the immediate vicinity of the monitoring well, and to enhance the validity of the water samples.

(1) The potential for physical damage is lessened by the installation of padlocked, protective iron/steel casing over the monitoring well and iron/steel posts around the well. The casing and posts should be new. The protective casing diameter or minimum dimension should be 100 mm (4 in.) greater than the nominal diameter of the monitor well, and the nominal length should be 1.5 m (5 ft). The protective posts should be at least 80 mm (3 in.) in diameter and the top modified to preclude the entry of water. If extra protection is necessary, the protective posts can be filled with concrete. Nominal length of the posts should be 1.8 m (6 ft). Special circumstances necessitating different materials should be addressed in the drilling plan.

(2) Erosion and/or ponding in the immediate vicinity of the monitoring well may be prevented by assuring that the ground surface slopes away from the monitoring well protective casing and by the spreading of a 150 mm (6-in.) thick, 2.4 m (8-ft) diameter blanket of 19- to -75-mm (3/4- to 3-in.) gravel around the monitoring well.

(3) The validity of the water samples is enhanced by a locking cover on the protective casing. The cover should be hinged or telescoped but not threaded. Lubricants on protective covers should be avoided. Threaded covers tend to rust and/or freeze shut. Lubricants applied to the threads to reduce this closure tend to adhere to sampling personnel and their equipment. All locks on these covers should be opened by a single key and, if possible, should match any locks previously installed at the site(s), and be made of noncorrosive matrial, such as brass.

h. Glues and solvents. The use of glues and solvents in monitoring well installation should be prohibited.

i. Tracers. Tracers or dyes should not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically approved in the drilling plan. The drilling plan should describe any

GRANULAR FILTER PACK APPROVAL

Project for Intended Use:

1. Filter Material Brand Name:
2. Lithology:
3. Grain Size Distribution:
4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:
6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

FOA APPROVAL (A)/DISAPPROVAL (D)	(Check one)	
Project Officer Name/Date:	A	D
Project Geologist Name/Date:	A	D

Figure 3-2. Suggested format for obtaining approval for filter pack

approved usage; chemical, radiological, and/or biological composition of the substances; and potential effects upon subsequent chemical, radiological, or biological analyses of the injected media. Discussion should also be provided of the expected, post-injection visual appearance of the media into which the substances are to be introduced. The discussion should also include relevant Federal and state regulations and those agencies' opinions relative to the approved usage.

j. Lubricants. If lubrication is needed on the threads or couplings of downhole drilling equipment, it should be biodegradable and nontoxic. Vegetable oil/shortening or PTFE tape may be used. Additives containing lead or copper should not be used. The only lubricant recommended for monitoring well joints is PTFE tape. The use and type of lubricants should be included in the drilling plan and boring logs/well construction diagrams.

k. Hydraulic fluids. Any hydraulic or other fluids in the drilling rig, pumps, transmissions, or other field equipment/vehicles should **NOT** contain any polychlorinated biphenyls (PCBs).

l. Antifreeze. The use of any antifreeze (either a commercially available automotive variety or a local derivation) to prevent overnight water line freezing should require FA approval. If antifreeze is added to any pump, hose, etc., where contact with drilling fluid is possible, this antifreeze should be completely purged with approved water prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. A sample of the clean (approved) water that has been circulated through the equipment after antifreeze removal should be retained for laboratory analysis. Only antifreeze without rust inhibitors and/or sealants should be considered. Antifreeze usage should be noted on the boring log, including the dates, reasons, quantities, composition, and brand names of antifreeze used. Antifreeze usage should be a last resort option. No antifreeze should be used in the drilling operation. Overnight storage in a heated garage may be a better option than spending time purging antifreeze and getting frozen equipment ready to operate.

m. Agents and additives. The use of any materials or substances other than those recommended herein for drilling, well installation, or development should be prohibited. Included in this suggested prohibition are lead shot, lead wool, burlap, dispersing agents (e.g., phosphates), acids, explosives, disinfectants, organic based drilling additives, metallic based lubricants, chlorinated and petroleum based solvents, adhesives, etc.

n. Summary. A materials usage summary, or MSDS should be provided of any drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. An example summary is provided at Figure 3-3.

3-9. Surface Runoff

Surface runoff, e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, should not enter any boring or well either during or after construction. To help avoid such entry, the use of starter casing, recirculation tanks, berms around the borehole, surficial bentonite packs, etc., is recommended.

3-10. Drilling Through Contaminated Zones

a. Many borings and wells are drilled in areas that are clean relative to the deeper zones of interest. However, circumstances do arise that require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation may be addressed by the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleared of all previous drill fluids prior to proceeding into the deeper, “cleaner” environment. In this procedure, the outer drill casing is set and sealed within an “impermeable” layer or at a level below which the underlying environment is thought to be cleaner than the overlying environment. The drilling fluids used to reach this point are appropriately discarded, replaced by a new or fresh supply. This system can be repeated, resulting in telescopic drill casing through which the final well casing is placed. These situations should be addressed on a case-by-case basis in the drilling plan.

b. Caution should be exercised to prevent further migration of contaminants via boreholes, especially dense non-aqueous phase liquid (DNAPL) migration. A recommended investigation strategy is to drill in expected DNAPL zones only after subsurface conditions have been characterized by drilling in surrounding DNAPL-free areas (the “outside-in” strategy). In DNAPL zones, drilling should generally be minimized and should be suspended when a potential trapping layer is first encountered. Drilling through DNAPL zones into deeper strategraphic units should be avoided. Also non-invasive methods, such as geophysical or geochemical surveys, can be useful at some sites to roughly define subsurface geologic or contaminant conditions (USEPA OSWER Directive 9283.1-06).

3-11. Soil Sampling

a. Intact samples. Unless otherwise specified in the drilling plan, intact soil samples for physical descriptions, retention, and physical analyses should be taken continuously and retained for the first 3 m (10 ft) and every 1.5 m (5 ft) or at each change of material, whichever occurs first, thereafter. Soil samples should be collected at intervals that are consistent with the goals of the project. These samples should be representative of their host environment. Borehole cuttings do not usually provide the desired information and, therefore, are not usually satisfactory. Sampling procedures should be detailed in the drilling plan. Additional guidance on soil sampling can be found in EM 200-1-3, EM 1110-1-1906 and ASTM Standard Guide D 6169.

b. Odors. At the detection of any anomalous odors (or vapor readings) from the boring or intact samples, drilling should cease for an evaluation of the odors and to determine the crew's safety. After the field safety representative completes this evaluation and implements any appropriate safety precautions as may be required in the site safety and health plan (SSHP), drilling may only then resume. If the odors or vapor readings are judged by the field personnel to be contaminant-related, intact soil samples should be continuously taken until the odors/readings are within background ranges. These samples should be retained and preserved in appropriate screw-capped sample jars for possible chemical analysis. With the resumption of background readings, routine sampling should resume. Specific procedures should be detailed in the FSP and SSHP.

c. Volume. Representative soil samples of sufficient volume for physical testing from each sampled interval should be retained for future reference or appropriate analysis. Upon boring completion, the number of samples retained from that boring may be reduced, retaining at least representative samples of major units, key samples, and those for testing requirements. Minimum information on each sample container should include the project, depth below surface, and boring and sample number. All samples known or suspected to contain contaminants of concern should be so marked on both the sample container and boring log. No geotechnical data should appear on the container that is not specified on the boring log. Containers should be kept from becoming frozen. Soil samples known or suspected of being contaminated may have to be handled, stored, tested, and/or disposed of as hazardous waste. Storage, packaging, and shiping instructions for soil samples for physical testing should be prescribed in the drilling plan. USEPA has published additional guidance concerning the management of investigation-derived wastes (IDW) for Superfund projects (USEPA, EPA/540/G-91/009 and USEPA, OSWER Publication 9345.3-03FS) that should be incorporated into the drilling plan, as appropriate.

d. Physical testing. Physical soil testing is a function of the project. The drilling plan should detail specific testing guidance and requirements. The appropriate number of field samples selected for physical soil testing as well as sample retrieval locations should be determined by the project geotechnical personnel. Procedures and equipment for soil testing are described in the current EM 1110-2-1906 (or ASTM Standard Test Method D 2487). Downhole geophysical logging may reduce the need for sampling. Tested samples should be representative of the range and frequency of soil types encountered in the project area and should specifically include the screened interval of each completed well. In addition, samples should be obtained from borings that cover the geographic and geologic range within the project area. The FDO should select the particular samples. Samples selected for physical testing that are suspected to be contaminated should be labeled as such. Tests should include moisture content and those tests necessary to determine the soil classification as described in D 2487. Laboratory and summary sheets should be submitted to the FA after final test completion. The drilling and safety plans should address any contaminant-related safety precautions for the physical analysis of these samples. The FDO is responsible for communicating these concerns to the laboratory performing the soil testing. The testing laboratory is responsible for taking all the necessary health and safety precautions adequate to protect the laboratory personnel. Samples for physical analysis which are known or suspected to be contaminated should be tested only in a soils laboratory equipped and managed to process contaminated samples.

e. Soil samples for chemical analysis.

(1) Samples should be extracted from an as intact, minimally disturbed condition as technically practical. Once at the surface, the sampler should be opened, sample extracted, and bottled in as short a time as possible. Samples for volatile analysis should be bottled, and capped within a **VERY** short time (about 15 seconds from the time of opening the sampler). Each soil sample for volatile analysis should have minimal head space for representative analytical results.

(2) All sampling equipment that will contact the sample should be thoroughly decontaminated between samples. This can be accomplished by the use of a hot-water pressure washer or as follows:

(a) Scrub equipment with a low-sudsing, nonphosphate detergent in approved water.

(b) Rinse with approved water.

(c) When sampling for metals, rinse with 0.1 N nitric acid (4.2 mL of concentrated nitric acid added to 1,000 mL (33 fl oz) of water). (**CAUTION**: Add acid to water, never add water to concentrated acid.) Continue rinsing the sampling equipment now with distilled or deionized water. If the sampling equipment being used is made of stainless steel, the use of 0.1 N hydrochloric acid (rather than 0.1 N nitric acid) is preferred to avoid oxidation (rusting) of the stainless steel. The 0.1 N hydrochloric acid is prepared by adding 3.1 mL of concentrated hydrochloric acid to 1,000 mL (33 fl oz) of water. The same **CAUTION** applies: add the concentrated acid to the water, not the water to the acid.

(d) When sampling for organic volatiles, semivolatiles, or pesticides/PCBs, rinse with pesticide grade isopropanol followed by rinsing with distilled or deionized water. When using isopropanol to decontaminate a sampler, the sampler must be allowed to completely air dry prior to reassembly.

MATERIALS SUMMARY

PROJECT: GENERAL AAP

Date: Oct-Nov 1987

Brand/Description (Example Entries)	Material Source/Supplier (Example Entries*)	(Example Entries*)
PVC casing	4.0" ID, Schedule 40, flush threaded;	ABC Mfg; Aville, Minnesota 2" ID, Schedule 40, flush
threaded		
PVC screen	0.05" slot, 4.0" ID; Schedule 40,	ABC Mfg; Aville, Minnesota flush threaded, 0.02" slot, 2" ID; Schedule 40, flush threaded
Bentonite (drilling fluid and grout) Wyoming	Tru-gel	A. O. Bentonite; Bville,
Granular bentonite (seal)	Gran-Bent	White Mud, Cville, Montana
Bentonite pellets (seal)	(No brand name available)	PELBENT, Dville, Utah
Sand (filter pack)	8-12 silica sand	State Sand, Mville,
Colorado; supplier:		
EFG Co., Eville, Utah		
Cement (grout)	Portland Type II	A. Lumber Co., Eville, Utah
Drilling water	St. Peter Sandstone	Production Well #1, Tap at
well house		
Drilling rod lubricant	Slick Turn	Oil Products Co., Fville,
Texas		
Air compressor oil	Oil #40	Oil Products Co., Fville,

Figure 3-3. Example materials summary

(3) Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in EM 200-1-3.

f. Liners. If sample liners are used, the following should apply:

(1) Use clear liners or take extra samples to ensure that the sample is of sufficient quantity and quality for the intended analyses;

(2) Liner seams and ends should be "airtight," i.e., "moisture impermeable";

(3) Borehole/drilling fluids should not be trapped within the liner;

(4) Liner or sealant interaction with the sample should not alter the sample's chemical composition; and

(5) Liners must be free of contamination and be decontaminated prior to use. Decontamination may not be necessary if the liners have been packaged by the manufacturer and has intact packaging up to the time of use.

g. Location. All soil samples, except those for physical and/or chemical analysis and reference should remain onsite, neatly stored at an FA-designated location. The disposition of these samples should be arranged by the FA. Samples from HTRW sites may have to be stored, and later disposed of, off site. Depending on the site and its accessibility to the public, it may be permissible (depending on state regulations) to stage the drums neatly on pallets immediately adjacent to the boring/monitoring well location. If the option exists to dispose of IDW by spreading it on the ground at the sampling location, it may not be cost-effective to stage the drums in a central location and then move them back to the boring/monitoring well location for disposal. Sample retention and disposal should be given detailed attention in the SAP.

3-12. Rock Coring

Bedrock should be cored unless the drilling plan specifies otherwise. Coring, using a diamond- or carbide-studded bit (ASTM D 2113) , produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few meters [feet]), the enlargement of a previously cored hole, or the drilling of highly fractured intervals. Except as noted below, guidance for preserving, storing, photographing, marking, cataloging, and handling of rock core samples may be found in ASTM D 5079.

a. The coring of bedrock or any firm stratigraphic unit should be conducted in a manner to obtain maximum intact recovery. The physical character of the bedrock (i.e., fractures, poor cementation, weathering, or solution cavities) may lessen recovery, even with the best of drillers and equipment.

b. The minimum core size should be an "N" series, 50 mm (2 [plus]-in.) diameter. Larger bit (hence, core) diameters may be needed to enhance core recovery.

c. While drilling in bedrock, and especially while coring, drilling fluid pressures should be adjusted to minimize drilling fluid losses and hydraulic fracturing. All pumping pressures should be recorded.

d. Rock cores should be stored in covered core boxes to preserve their relative position by depth. Intervals of lost core should be noted in the core sequence. Boxes should be marked on the cover (both inside and outside) and on the ends to provide project name, boring number, cored interval, and box number in cases of multiple boxes. Any core box known or suspected to contain contaminated core should be appropriately marked on the log and on the box cover (inside and out), and on both ends. The weight of each fully loaded box should not exceed 34 kg (75 lb). No geotechnical or contaminant data should appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for a given boring should be on hand prior to coring that site.

e. The core within each completed box should be photographed after the core surface has been cleaned or peeled, as appropriate, and wetted. Each photo should be in sharp focus and contain a legible scale in centimeters (feet and tenths of feet). The core should be oriented so that the top of the core is at the top of the photo. Each photo should be annotated on the back with the project name, bore/well designation, box number, cored depths pictured, and date photographed. One set of glossy color prints should be sent to the FA after the last coring. In addition, all negatives should be delivered to the FA after the FA has received the prints. (See ER 1110-1-1803 for additional guidance on core management.)

f. All rock core, except that for analysis and reference, should be neatly stored at an FA-designated location. The disposition of these samples should be arranged by the FDO. Specific instructions for the storage or required packaging and method of shipment to the laboratory should be provided in the drilling plan.

g. Bedrock cores known or suspected of being contaminated may have to be handled, stored, tested, and/or disposed of as hazardous waste. Such a consideration and determination should be made prior to drilling plan approval. This determination may alter drilling methods, coring frequency, data quality, costs, etc. Geophysical downhole logging or borehole camera techniques could be considered as alternatives in some cases. The drilling plan should reflect the final decision and possible alternatives that retain viability.

3-13. Abandonment/Decommissioning

Abandonment (also termed decommissioning) is that procedure by which any boring or well is permanently closed. Abandonment/decommissioning procedures should preclude any current or subsequent fluid media from entering or migrating within the subsurface environment along the axis or from the endpoints of any boring or well penetrating that environment.

a. Planned abandonment requirements and procedures should be described in the FSP plan and incorporate USACE guidance and applicable state and/or Federal regulatory abandonment requirements.

b. The closure of any borings or wells not scheduled for abandonment per drilling plan should be approved by the FA prior to any casing removal, sealing, or back-filling. Abandonment requests should be submitted by the FDO to the FA with the following data, plus recommendation:

(1) Designation of boring/well in question;

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.);

(3) Reason for closure; and

(4) Action taken, to include any replacement boring or well.

c. Each boring or well to be abandoned/decommissioned should be sealed by grouting from the bottom of the boring/well to the ground surface. This should be done by placing a tremie pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space(s) between the innermost well casing and borehole (to include any casings in between) should be grouted in the same manner.

d. After 24 hours, the FDO should check the abandoned site for grout settlement. That day, any settlement depression should be filled with grout and rechecked 24 hours later. Additional grout should be added using a tremie pipe inserted to the top of the firm grout, unless the depth of the unfilled portion of the hole is less than 4.5 m (15 ft) and this portion is dry. This process should be repeated until firm grout remains at ground surface.

e. An abandoned well may be grouted with the well screen and casing in place. However, local regulations or a lack of data concerning well construction, condition, or other factors may require the removal of the well materials and a partial or total hole redrilling prior to sealing the well site. See ASTM Standard Guide D 5299 for a discussion of other decommissioning procedures.

f. For each abandoned boring/well, a record should be prepared to include the following as applicable.

(1) Project and boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 6 m (20 ft) north and 6 m (20 ft) west of Well 14.

(3) Open depth of well/annulus/boring prior to grouting.

(4) Casing or items left in hole by depth, description, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Reason for abandonment.

(8) Description and total quantity of grout used initially.

(9) Description and daily quantities of grout used to compensate for settlement.

(10) Dates of grouting.

(11) Disposition of materials removed/displaced from decommissioned boring/well; e.g., objects, soil, and groundwater.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: type (well, drill, protective), height above ground, size, and composition of each.

(14) Report all depths/heights from ground surface.

(15) The original record should be submitted to the FA.

g. Replacement well/borings (if any) should be offset at least 6 m (20 ft) from any abandoned site in a presumed up- or cross-gradient groundwater direction.

3-14. Work Area Restoration and Disposal of Drilling and Cleaning Residue

All work areas around the wells and/or borings should be restored to a condition essentially equivalent to that of preinstallation. This includes the disposal of borehole cuttings and rut removal. Borehole cuttings, discarded samples, drilling fluids, equipment cleaning residue, and water removed from a well during installation, development, and aquifer testing should be disposed of in a manner approved by the FA, host installation, and consistent with applicable state and federal regulations. These types of materials are considered investigation-derived wastes (IDW). (See USEPA EPA/540/G-91/009 for USEPA guidance on the management of these materials.) Whatever procedures are followed, the leaving of barrels containing drill cuttings, excess samples, and water at various unsecured locations around the site at the completion of well installation is not appropriate. All drums/barrels filled onsite should be permanently labeled (in a waterproof manner and resistant to fading) and inventoried as to their contents and source. Restoration and disposal procedures (to include disposal location(s)) should be discussed in the FSP. Depending on the site and its accessibility to the public, it may be permissible (depending on state regulations) to stage the drums neatly on pallets immediately adjacent to the boring/monitoring well location. If the option exists to dispose of IDW by spreading it on the ground at the sampling location, it may not be cost-effective to stage the drums in a central location and then move them back to the boring/monitoring well location for disposal.

Chapter 4
Borehole Logging

4-1. General

Each boring log should fully describe the subsurface environment and the procedures used to gain that description. Guidance on field logging of subsurface explorations of soil and rock may be found in ASTM Standard Guide D 5434.

4-2. Format

All borings should be recorded in the field on Engineer (ENG) Form 1836 and 1836-A, per EM 1110-1-1804 (Figure 4-1) or on ENG Form 5056-R and 5056A-R, developed for HTRW work (see Figure 4-2). This guidance applies to in-house and contracted activities. Suggested data for recording are discussed throughout this manual. Because of the large quantity of information routinely required on logs at HTRW sites, a scale of 25 mm (1 in.) on the log equaling 300 mm (1 ft) of boring is usually adequate.

4-3. Submittal

Each original boring log should be submitted directly from the field to the FA after each boring is completed. In those cases where a monitoring well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram may be submitted together.

4-4. Original Logs and Diagrams

Only the "original" boring log (and diagram) should be submitted from the field to the FA. Carbon, typed, or reproduced copies are not considered "original." The original should be of sufficient legibility and contrast to provide comparable quality in reproduction.

4-5. Time of Recording

Logs should be recorded directly in the field without transcribing from a field book or other document. This technique lessens the chance for errors of manual copying and allows the completed document to be field-reviewed closer to the time of drilling.

4-6. Routine Entries

In addition to the data desired by the FDO and uniquely required by the drilling plan, the information should include those items listed in ASTM Standard Guide D 5434, except items under section 6.1.4 in D 5434. The other exceptions would be weather conditions, and certain items concerning sample handling procedures in sections 6.1.6 and 6.1.7 in D 5434. Sample handling procedures are required to be entered in the field logbook that is described in EM 200-1-3. The following information should also be routinely entered on the boring log.

a. Each boring and well (active and abandoned) should be uniquely numbered and located on a sketch map as part of the log.

b. Depths/heights should be recorded in meters (feet) and decimal fractions thereof (millimeters or tenths of feet). English units are acceptable if typically used by the site geologist.

c. Field estimates of soil classifications shall be in accordance with ASTM Standard Practice D 2488 and shall be prepared in the field at the time of sampling by the geologist. Guidance on soil and rock classification may also be found in EM 1110-1-1906, Spigolon 1993, Murphy 1985 and U.S. Army FM 5-410.

d. Each soil sample taken should be fully described on the log. The descriptions of intact samples should include the parameters shown in Table 4-1.

e. In the field, visual numeric estimates should be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning should be defined on each log.

f. When used to supplement other sampling techniques, disturbed samples (e.g., wash samples, cuttings, and auger flight samples) should be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" should be minimally described for these samples along with a description of drill action and water losses/gains for the corresponding depth. Notations should be made on the log that these descriptions are based on observations of disturbed material rather than intact samples.

g. Rock core should be fully described on the boring log. Typical rock core parameters are shown in Table 4-2.

h. For rock core, a scaled graphic sketch of the core should be provided on or with the log, denoting by depth, location, orientation, and nature (natural or coring-induced) of all core breaks. Also mark the breaks purposely made to fit the core into the core boxes. If fractures are too numerous to be individually shown, their location may be drawn as a zone and described on the log. Also note, by

HTRW DRILLING LOG

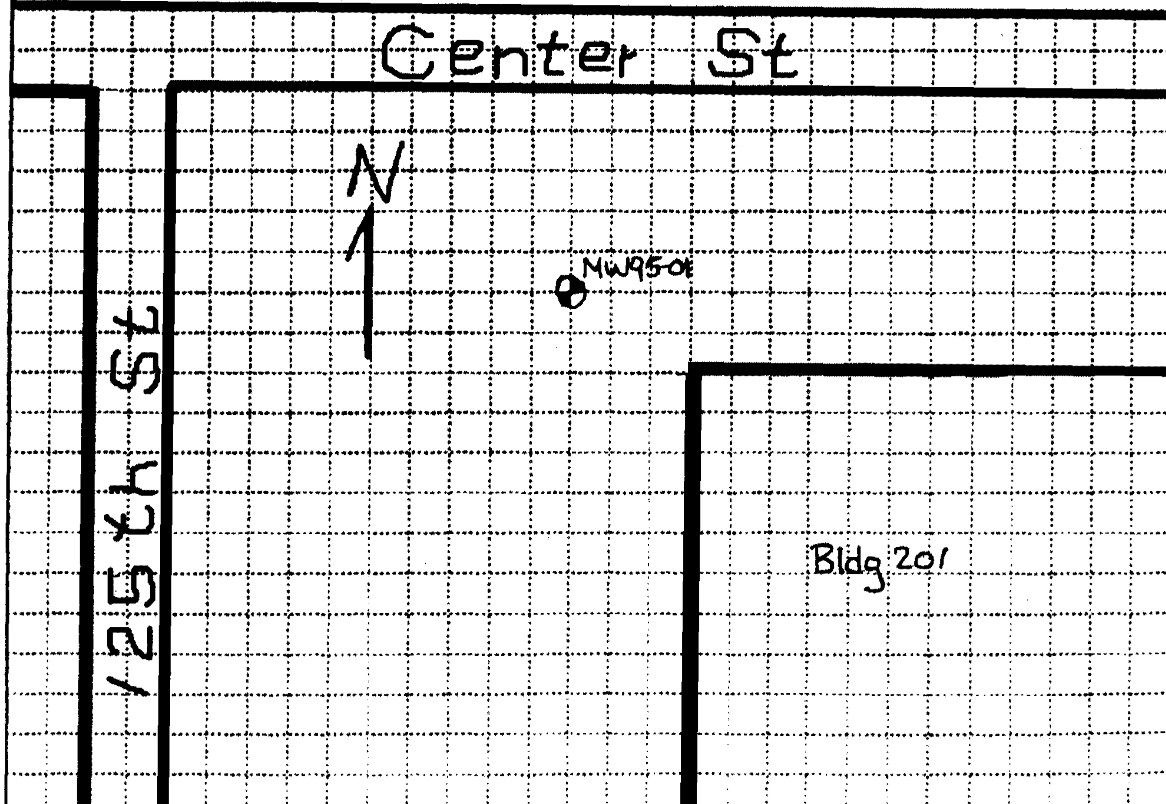
DISTRICT: OMAHA		HOLE NUMBER: MW95-01
1. COMPANY NAME: CONTRACTING FIRM, INC.	2. DRILL SUBCONTRACTOR: SUBCONTRACT DRILLERS, INC	SHEET 1 OF 3 SHEETS
3. PROJECT: BIG SUPERFUND SITE	4. LOCATION: Site A	
5. NAME OF DRILLER: JOE SUPER DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 Milwaukee Heavy Duty Drill Rig	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT: CME-75, using 4 1/4" hollow stem augers, 3" O.D. stainless steel split-spoons (chemical and geotech), bullet bit (outer) drag bit (inner)	8. HOLE LOCATION: See Map Below	
	9. SURFACE ELEVATION: Not Yet Available	
	10. DATE STARTED: 8-6-95	11. DATE COMPLETED: 8-7-95
12. OVERBURDEN THICKNESS: 12.0'	15. DEPTH GROUNDWATER ENCOUNTERED: 5.0'	
13. DEPTH DRILLED INTO ROCK: ϕ	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED: 4.5' TOC ~72 hours (in well)	
14. TOTAL DEPTH OF HOLE: 12.0'	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES
	ϕ	ϕ	ϕ

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
			BTEX 4x4oz	TRPH 2x8oz	Lead 2x8oz	ϕ

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR
		8-6-92		Field Geologist

LOCATION SKETCH/COMMENTS SCALE: 1" = 20'



PROJECT: BIG SUPERFUND SITE HOLE NO. MW95-01

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

Figure 4-1. Boring log format (Sheet 1 of 3)

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER	MW95-01
PROJECT	BIG SUPERFUND SITE
INSPECTOR	Field Geologist
SHEET	2 OF 3 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	0 – 2	SC - Clayey Sand, medium dense, nonplastic, noncemented, dry, medium brown, fine grained, sub-rounded, 15-20% pieces of concrete	Calibrated Hnu w/ isobutylene at 55 ppm at 190 psi; BACKGROUND = 0.8; BREATH = 0.8; SCREEN = 0.9	0.0; 1.3'; NO SAMPLE OR NO RECOVERY	S-MW01-02/BT 2x4oz jar; -02/T 1x8oz jar; -02/L 1-8oz jar	5, 10, 12, 12	Drilling in cow pasture - numerous manure piles - may be increasing Hnu readings; N (Blow) = 22; Rec (Recovery) = 1.3'; TIME - 1012
	3 – 5	SC - Clayey sand, same as above	BREATH = 0.8; SCREEN = 0.7	3.0'; 4.8'		9, 9, 12, 11	N = 21; Rec = 1.8'; Time - 1019
	5 – 8						Plug came off end of central rod. Tried driving split spoon - no recovery. Offset ~1.5' and drilled back down to 8.0'
	8 – 10	CL - Sandy Lean Clay, stiff, low to medium plastic, noncemented, moist, ~15% very fine-grained sand, dark brown; SP - Poorly Graded Sand, loose, nonplastic, noncemented, dry to slightly moist, light brown to white, very fine to fine-grained		8.0'; 10.0'		2, 4, 5, 6	N = 9; Rec = 2.0'; TIME = 1048

PROJECT: BIG SUPERFUND SITE — HOLE NO. MW95-01

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

Figure 4-1. (Continued) (Sheet 2 of 3)

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER	MW95-01
PROJECT	BIG SUPERFUND SITE
INSPECTOR	Field Geologist
SHEET	3 of 3 SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)
	10	SP- Poorly Graded Sand, dense, non-plastic, patchy light cementation, moist, light brown to grayish white, very fine to fine-grained, subrounded	Breath = 0.8 Screen = 0.7	10.0 – 12.0'		6 24 56 60	N=80 Rec = 2.0' Time - 1144
	11						
	12	BOTTOM OF HOLE=12.0'					Bailed sand from inside bottom of augers. Installed well to top of seal. 8-7-95 - Grouted to surface. Did surface completion. See attached well construction diagram.
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						

PROJECT BIG SUPERFUND SITE — HOLE NO. MW95-01

ENG FORM 5056A-R, AUG 94 (Proponent: CECW-EG)

Figure 4-1. (Concluded) (Sheet 3 of 3)

HTRW DRILLING LOG

DISTRICT

HOLE NUMBER

1. COMPANY NAME

2. DRILLING SUBCONTRACTOR

SHEET OF SHEETS

3. PROJECT

4. LOCATION

5. NAME OF DRILLER

6. MANUFACTURER'S DESIGNATION OF DRILL

7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT

8. HOLE LOCATION

9. SURFACE ELEVATION

10. DATE STARTED

11. DATE COMPLETED

12. OVERBURDEN THICKNESS

15. DEPTH GROUNDWATER ENCOUNTERED

13. DEPTH DRILLED INTO ROCK

16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED

14. TOTAL DEPTH OF HOLE

17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT

HOLE NO.

Figure 4-2. HTRW Drilling Log

HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER

PROJECT

INSPECTOR

SHEET OF SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)

PROJECT

HOLE NO.

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

Figure 4-2 (Concluded)

Table 4-1
SOIL PARAMETERS FOR LOGGING

PARAMETER	EXAMPLE
Classification	Sandy clay
Depositional environment and formation, if known	Glacial till, Twin Cities Formation
ASTM D 2488 Group Symbol	CL (field estimate)
Secondary components and estimated percentages	Sand: 25 percent Fine sand 5 percent Coarse sand 20 percent
Color (Soil color charts such as Munsell Soil or the Geological Society of America (GSA) Rock Color Chart are helpful for describing the color of soil samples. If a color chart is used, give both narrative and numerical description and note which chart was used. Suggested standard colors can be found in Spigolon 1993)	Gray: (Gr) (7.5 YR 5.0 (Munsell))
Plasticity	Low plasticity
Consistency (cohesive soil)	Very soft, soft, medium stiff, very stiff, hard
Density (noncohesive soil)	Loose, medium loose, dense, very dense
Moisture content Use a relative term. Avoid a percentage unless a value has been measured.	Dry, moist, wet, saturated
Structure and orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain angularity	Rounded

depth, the intervals of all lost core and hydrologically significant details. This sketch should be prepared at the time of core logging, concurrent with drilling.

i. A record of the brand name and amount of any bentonite used for each boring should be made on the log, along with the reason for and start (by depth) of this use. If measured, record mud viscosities and weight.

j. The drilling equipment used should be generally described on each log. Include such information as rod size, bit type, pump type, rig manufacturer, and model.

k. Each log should record the drilling sequence; e.g.:

(1) Opened hole with 8-in. auger to 9 ft;

(2) Set 8-in. casing to 10 ft;

(3) Cleaned out and advanced hole with 8-in. roller bit to 15 ft (clean water, no water loss);

(4) Drove 1-3/8-in. ID X 2-in. outside diameter (OD) sampler to 16.5 ft;

(5) Advanced with 8-in. roller bit to 30 ft, 15-gal water loss;

(6) Drove 1-3/8-in. ID X 2-in. OD sampler to 31.5 ft;

(7) Hole heaved to 20 ft; and

(8) Mixed 25 lb of ABC bentonite in 100 gal of water for hole stabilization and advanced with 8-in. roller bit to 45 ft, etc.

l. All special problems and their resolution should be recorded on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates and times for the start and completion of borings should be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies should be noted on the log by depth. When depths are estimated, the estimated range

Table 4-2
ROCK CORE PARAMETERS FOR LOGGING

PARAMETER	EXAMPLE
Rock type	Limestone, sandstone, granite
Formation	Anytown Formation
Modifier denoting variety	Shaly, calcareous, siliceous, micaceous
Bedding/banding characteristics	Laminated, thin bedded, massive, cross bedded, foliated
Color (Color charts such as Munsell or the GSA Rock Color Chart are helpful for describing the color of rock samples. If a color chart is used give both narrative and numerical description and note which chart was used. Suggested standard colors can be found in Spigolon 1993).	Light brown: (lBr)
Hardness	Soft, very hard
Degree of cementation	Poorly cemented, well cemented
Texture	Dense, fine-, medium-, coarse-grained, glassy, porphyritic, crystalline
Structure and orientation	Horizontal bedding, dipping beds at 30 degrees, highly fractured, open vertical joints, healed fractures, slickensides at 45 degrees, fissile
Degree of weathering	Unweathered, slightly weathered, highly weathered
Solution or void conditions	Solid, cavernous, vuggy with partial infilling by clay
Primary and secondary permeability, include estimates and rationale	Low primary; well cemented High secondary: several open joints
Lost core interval and reason for loss	50-51 ft, noncemented sandstone likely

should be noted along the boundary.

o. The depth of first encountered free water should be indicated along with the method of determination; e.g., “37.6 ft from direct measurement after drilling to 40.0 ft”; “40.1 ft from direct measurement in 60-ft hole when boring left overnight, hole dry at end of previous shift”; or “25.0 ft based on saturated soil sample while sampling 24-26 ft.” Any other distinct water level(s) found below the first should also be described.

p. The interval by depth for each sample taken, classified, and/or retained should be noted on the log. Record the length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).

q. A record of the blow counts, hammer type and weight, and length of hammer fall for driven samplers should be made. For thin wall samplers, indicate whether the sampler was pushed or driven and the pressure/blow count per drive. Blow counts should be recorded in 150 mm (0.5 ft) foot increments when standard penetration (ASTM D 1586) samplers (35 mm [1-3/8 in.] ID X 50 mm [2 in.] OD) are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken. Blow counts, in addition to their engineering significance, may be useful for stratigraphic correlation. (See Hsai-Wong Fang (1991) for interpretation of blow counts when 75-mm (3-in.) samplers are used).

r. When drilling fluid is used, a quantitative record should be maintained of fluid losses and/or gains and the interval over which they occur. Adjustment should be made for fluid losses due to spillage and intentional wasting (e.g., recirculation tank cleaning) to more closely estimate the amount of fluid lost to the subsurface environment.

s. Record the drilling fluid pressures typically used during all drilling operations (aqueous and pneumatic) and the driller's comments on drillability, drill speed, down pressure, rotation speed, etc.

t. Note the total depth of drilling and sampling on the log.

u. Record significant color changes in the drilling fluid return, even when intact soil samples or rock core are being obtained. Include the color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change.

v. Soil gas readings, if taken, should be recorded on the log. Each notation should include interval sampled and reading. A general note on the log should indicate meter manufacturer, model, serial number, and calibration material. If several meters are used, key the individual readings to the specific meter.

w. Special abbreviations used on a log and/or well diagram should be defined in the log/diagram where used.

Chapter 5
Monitoring Well Installation

5-1. General

A monitoring well is a device designed for the acquisition of groundwater samples that represent the chemical quality of the aquifer adjacent to the screened interval, unbiased by the well materials and installation process, and which provides access to measure the potentiometric surface for that screened interval. The screened interval consists of that portion of the device that is directly open (e.g., horizontally adjacent) to the host aquifer by way of openings in the well casing (hereafter called the "screen") AND indirectly open (e.g., vertically adjacent) to the aquifer by way of the filter pack (or other permeable material) extending below and/or above the screen. While the maximum length of the screened interval is fixed for a given well (by the length of the filter pack), the effective or functional length may vary with water table fluctuations or sampling techniques. Additional guidance on monitoring well installation may be found in ASTM D 5092.

5-2. Well Clusters

Each monitoring well is a mechanism through which to obtain a representative sample of groundwater and, to measure the potentiometric surface in that well. To help ensure this representation in the case of well clusters, each well of a cluster should be installed in a separate boring. Multiple well placements in a single boring are too difficult for effective execution and evaluation to warrant single hole usage.

5-3. Well Screen Usage

Each overburden well should have a screen, as per Figure 5-1, 5-2, or 5-3 (or of a technically equivalent construction as in ASTM D 5092). Under normal conditions, the extra effort for screen installation in bedrock wells can be more than offset by the assurance of an unobstructed opening to the required depth during repeated usage. When conditions permit, and when allowed by state or local law, an open, unscreened well may be constructed in firm stable bedrock. However, well integrity and consistent access to the original sampled interval during prolonged monitoring must be maintained.

5-4. Beginning Well Installation

a. The installation of each monitoring well should begin within 12 hours of boring completion for holes uncased or partially cased with temporary drill casing. Installation should begin within 48 hours in holes fully cased with temporary drill casing. Once installation has begun, no breaks in the installation process should be made until the well has been grouted and drill casing removed. Anticipated exceptions should be requested in writing by the FDO to the FA prior to drilling. Data to include in this request are:

(1) Well(s) in question;

(2) Circumstances; and

(3) Recommendations and alternatives.

b. In cases of unscheduled delay such as personal injury, equipment breakdowns, or sudden inclement weather or scheduled delays such as borehole geophysics, no advance approval of delayed well installation should be needed. In those cases, resume installation as soon as practicable. However, partially completed borings should be properly secured during periods of drilling inactivity to preclude the entry of foreign materials or unauthorized personnel to the boring. In cases where a partially cased hole into bedrock is to be partially developed prior to well insertion, the well installation should begin within 12 hours after this initial development.

c. Temporary casing and hollow stem augers may be withdrawn from the boring prior to well installation if the potential for cross-contamination is not likely and if the borehole walls will not slough during the time required for well installation. This procedure is usually successful in firm clays and in bedrock that is not intensely fractured or highly weathered.

d. If the borehole will not remain stable long enough to complete placement of all necessary well materials in their proper position, it may be necessary to install some or all of the well materials prior to removal of the casing or hollow stem augers. In this situation, the hollow stem augers or casing should have an inside diameter sufficient to allow the installation of the prescribed diameter screen and casing plus annular space for a pipe through which to place the filter pack and grout.

e. Any materials, especially soils, blocking the bottom of the drill casing or hollow stem auger should be dislodged and removed from the casing prior to well insertion. This action both reduces the potential for cross--contamination and makes well installation easier.

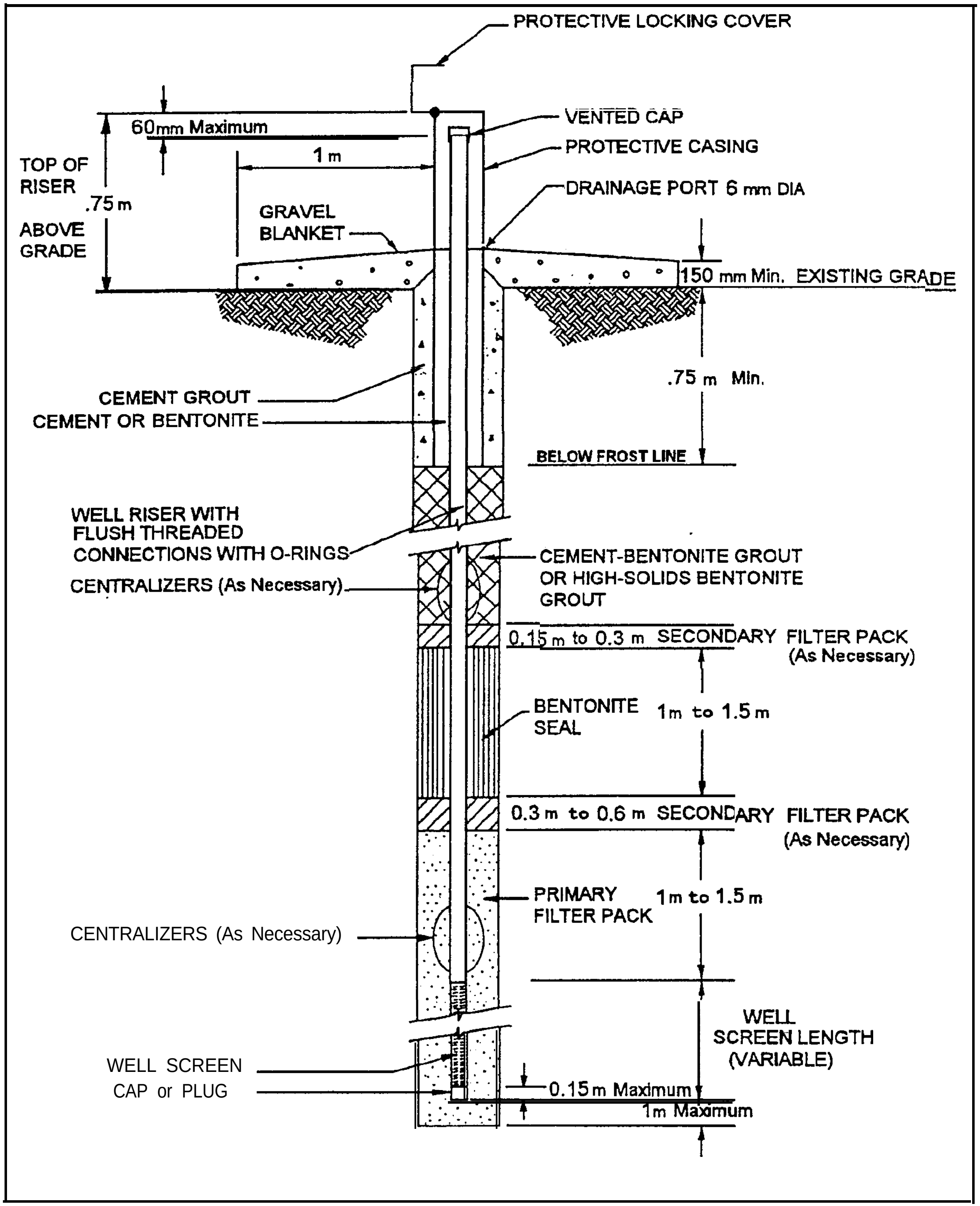


Figure 5-1. Schematic construction of single-cased well with gravel blanket

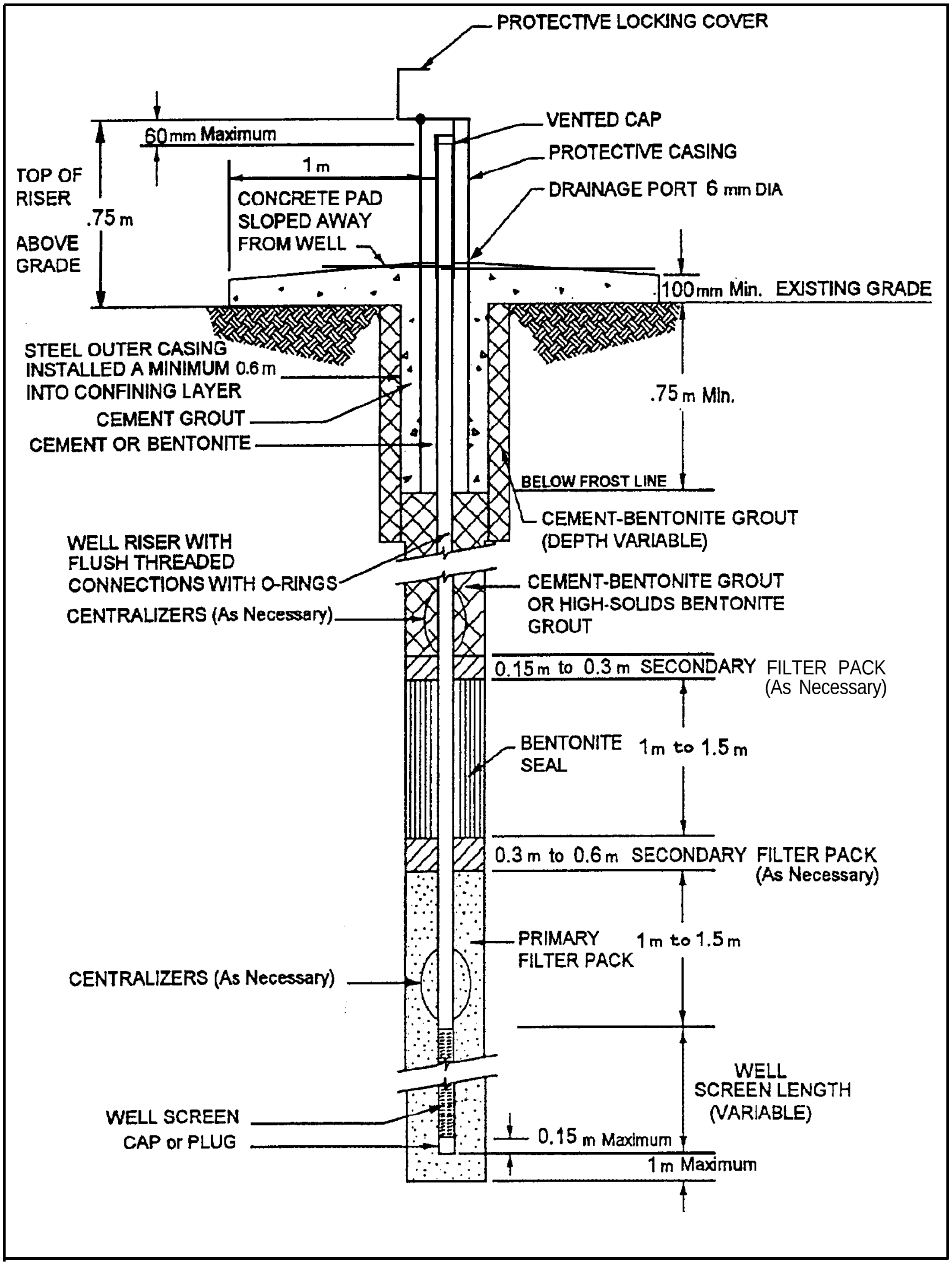
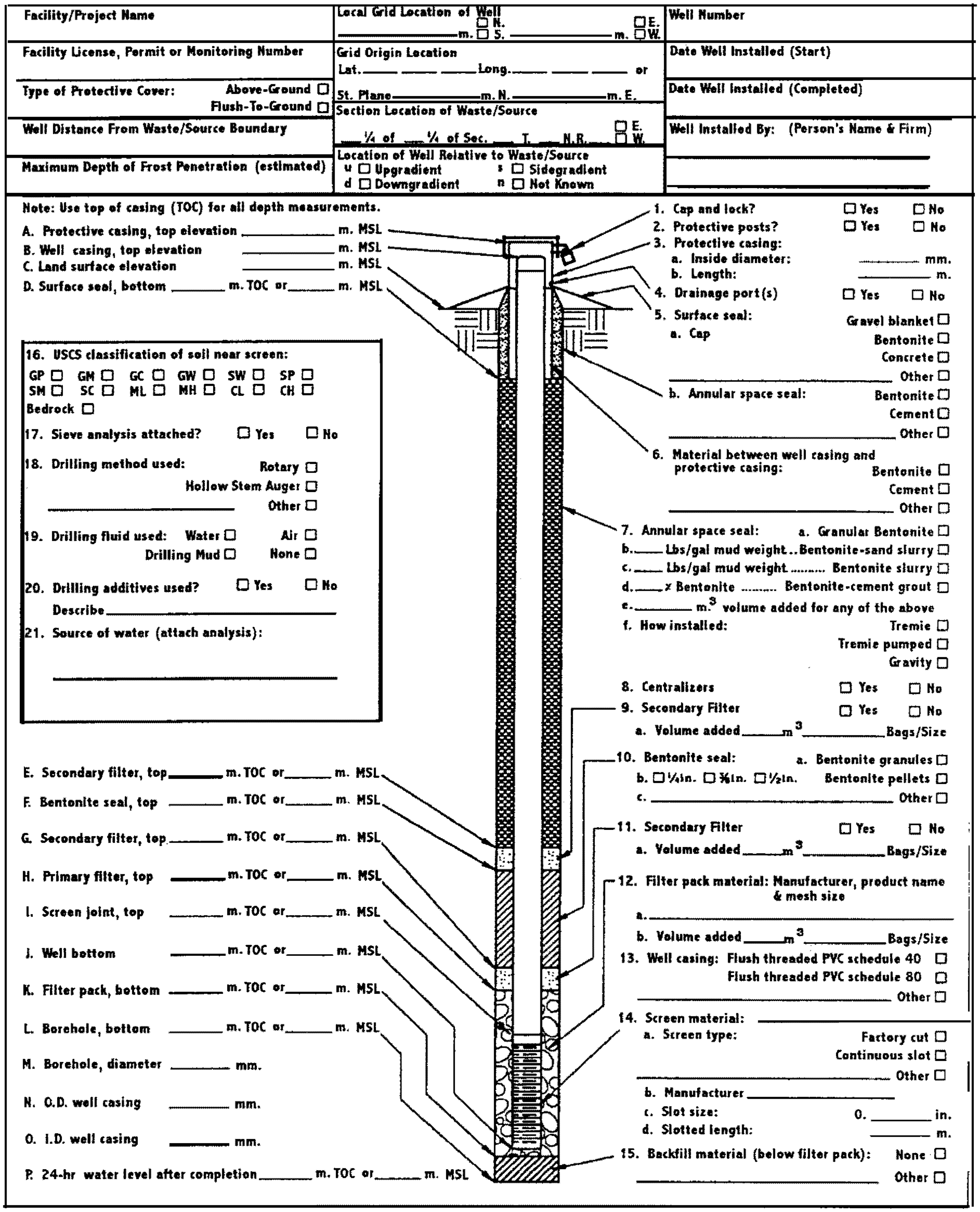


Figure 5-2. Schematic construction of multi-cased well with concrete pad



Facility/Project Name

Local Grid Location of Well ______ m. ☐ N. ☐ S. ______ m. ☐ E. ☐ W.

Well Number

Facility License, Permit or Monitoring Number

Grid Origin Location Lat. ___ ___ ___ Long. ___ ___ ___ or

Date Well Installed (Start)

Type of Protective Cover: Above-Ground ☐ Flush-To-Ground ☐

St. Plane ______ m. N. ______ m. E.

Date Well Installed (Completed)

Section Location of Waste/Source

Well Distance From Waste/Source Boundary

___ ¼ of ___ ¼ of Sec. ___ T. ___ N.R. ___ ☐ E. ☐ W.

Well Installed By: (Person's Name & Firm)

Maximum Depth of Frost Penetration (estimated)

Location of Well Relative to Waste/Source
u ☐ Upgradient s ☐ Sidegradient
d ☐ Downgradient n ☐ Not Known

Note: Use top of casing (TOC) for all depth measurements.

A. Protective casing, top elevation ______ m. MSL
B. Well casing, top elevation ______ m. MSL
C. Land surface elevation ______ m. MSL
D. Surface seal, bottom ______ m. TOC or ______ m. MSL

16. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

17. Sieve analysis attached? ☐ Yes ☐ No

18. Drilling method used: Rotary ☐ Hollow Stem Auger ☐ ______ Other ☐

19. Drilling fluid used: Water ☐ Air ☐ Drilling Mud ☐ None ☐

20. Drilling additives used? ☐ Yes ☐ No
Describe ______

21. Source of water (attach analysis):
______

E. Secondary filter, top ______ m. TOC or ______ m. MSL
F. Bentonite seal, top ______ m. TOC or ______ m. MSL
G. Secondary filter, top ______ m. TOC or ______ m. MSL
H. Primary filter, top ______ m. TOC or ______ m. MSL
I. Screen joint, top ______ m. TOC or ______ m. MSL
J. Well bottom ______ m. TOC or ______ m. MSL
K. Filter pack, bottom ______ m. TOC or ______ m. MSL
L. Borehole, bottom ______ m. TOC or ______ m. MSL
M. Borehole, diameter ______ mm.
N. O.D. well casing ______ mm.
O. I.D. well casing ______ mm.
P. 24-hr water level after completion ______ m. TOC or ______ m. MSL

1. Cap and lock? ☐ Yes ☐ No
2. Protective posts? ☐ Yes ☐ No
3. Protective casing:
a. Inside diameter: ______ mm.
b. Length: ______ m.
4. Drainage port(s) ☐ Yes ☐ No
5. Surface seal: Gravel blanket ☐
a. Cap Bentonite ☐ Concrete ☐ ______ Other ☐
b. Annular space seal: Bentonite ☐ Cement ☐ ______ Other ☐
6. Material between well casing and protective casing: Bentonite ☐ Cement ☐ ______ Other ☐
7. Annular space seal: a. Granular Bentonite ☐
b. ___ Lbs/gal mud weight .. Bentonite-sand slurry ☐
c. ___ Lbs/gal mud weight .... Bentonite slurry ☐
d. ___ % Bentonite .... Bentonite-cement grout ☐
e. ______ m^3 volume added for any of the above
f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☐
8. Centralizers ☐ Yes ☐ No
9. Secondary Filter ☐ Yes ☐ No
a. Volume added ______ m^3 ______ Bags/Size
10. Bentonite seal: a. Bentonite granules ☐
b. ☐ ¼in. ☐ ⅜in. ☐ ½in. Bentonite pellets ☐
c. ______ Other ☐
11. Secondary Filter ☐ Yes ☐ No
a. Volume added ______ m^3 ______ Bags/Size
12. Filter pack material: Manufacturer, product name & mesh size
a. ______
b. Volume added ______ m^3 ______ Bags/Size
13. Well casing: Flush threaded PVC schedule 40 ☐ Flush threaded PVC schedule 80 ☐ ______ Other ☐
14. Screen material: ______
a. Screen type: Factory cut ☐ Continuous slot ☐ ______ Other ☐
b. Manufacturer ______
c. Slot size: 0. ______ in.
d. Slotted length: ______ m.
15. Backfill material (below filter pack): None ☐ ______ Other ☐

Figure 5-3. Schematic construction diagram of monitoring well

f. Once begun, well installation should not be interrupted due to the end of the driller's work shift, darkness, weekend, or holiday.

g. If possible, the FDO should ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The FDO should have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 days or less. For longer schedules, the FDO should ensure that the above-mentioned materials needed for at least 14 days of operation are onsite prior to well drilling. The balance of materials should be in transit prior to well drilling. Any site-specific factors that preclude the availability of needed secure storage areas should be identified and resolved in the drilling plan.

5-5. Screens, Casings, and Fittings

a. All well screens and well casings should be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Prewashing may not be necessary if the materials have been packaged by the manufacturer and have their packaging intact up to the time of installation. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal should be removed by means of SANDING, unless removable in approved water. Solvents, except approved water, should NOT be used for removal of marking. Washed screens and casings should be stored in plastic sheeting until immediately prior to insertion into the borehole.

b. Bottoms of well screens should be placed no more than 1 m (3 ft) above the bottom of the drilled borehole. If significant overdrilling is required (as for determining stratigraphy), a pilot boring should be used. The intent here is to narrow the interval of aquifer being sampled, limit the potential for stagnant or no-flow areas near the screen, and preclude unwanted backfill materials (e.g., grout or bentonite) from entering or passing through the interval to be screened and sampled. The casing/screen should be suspended from the surface and should not rest on the bottom of the borehole during installation of the filter pack and annular seal.

c. All screen bottoms should be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug should be within 150 mm (0.5 ft) of the open portion of the screen. No solvents or glues should be permitted for attachment.

d. Silt or sediment traps (also called cellars, tail pipes, or sumps) should NOT be used. A silt trap is a blank length of casing attached to and below the screen. Trap usage fosters a stagnant, turbid environment which could influence analytical results for trace concentrations.

e. The top of each well should be level such that the difference in elevation between the highest and lowest points on the top of the well casing or riser should be less than or equal to 6 mm (0.02 ft).

f. The borehole should be of sufficient diameter to permit at least 50 mm (2 in.) of annular space between the borehole wall and all sides of the well (centered riser and screen). When telescoping casings (one casing within another), the full 50 mm (2-in.) annulus may not be practical or functional. In this case, a smaller spacing may be acceptable, depending on site specifics.

g. Well screen lengths may be a function of hydrostratigraphy, temporal considerations, environmental setting, analytes of concern, and/or regulatory mandate. Screen lengths should be specified in the drilling plan.

h. The actual inside diameter of a nominally sized well is a function of screen construction and the wall thickness/schedule of both the screen and casing. In the case of continuously wound screens, their interior supporting rods may reduce the full inside diameter. This consideration is critical when planning the sizes for pumps, bailers, surge devices, etc.

i. When physical or biological screen clogging is anticipated, the larger open-area per unit length of continuously wound screens has an advantage over the slotted variety.

5-6. Granular Filter Pack

a. When artificial filter packs are used, a tremie pipe for filter pack placement is recommended, especially when the boring contains drilling fluid or mud. A record should be maintained of the amount of water used to place the filter pack, which should be added to the volume of water to be removed during well development.

b. The filter pack should extend from the bottom of the boring to 1 to 1.5 m (3 to 5 ft) above the top of the screen unless otherwise specified in the drilling plan. This extra filter allows for settlement (from infiltration and compaction) of the filter pack during development and repeated sampling events. The additional filter helps to maintain a separation between the bentonite seal and well screen.

c. Sometimes, depending on the gradation of the primary filter pack and the potential for grout intrusion into the primary filter pack, a secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. To be effective, the secondary filter should extend 0.3 to 0.6 m (1 to 2 ft) above the primary filter pack.

d. The final depth to the top of the granular filter should be directly measured (by tape or rod) and recorded. Final depths should not be estimated, for example, as based on volumetric measurements of placed filter.

5-7. Bentonite Seals

a. Bentonite seals, especially those set in water, should typically be composed of commercially available pellets. Pellet seals should be 1 to 1.5 m (3 to 5 ft) thick as measured immediately after placement without allowance for swelling. Granular bentonite may be an alternate if the seal is set in a dry condition. Tremie pipes are not recommended.

6. Slurry seals can be used when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Typically, the specific gravity of cement grout placed atop the slurry seal will be greater than that of the slurry. Therefore, the intent to use a slurry seal should be detailed in the drilling plan, and details should include a discussion of how the grout will be precluded from migrating through the slurry. Slurry seals should have a thick, batter-like (high viscosity) consistency with a placement thickness of 1 to 1.5 m (3 to 5 ft). Typically, only high-solids bentonite grouts are used that consist of a blend of powdered bentonite and fresh water mixed to a minimum 20 percent solids by weight of pumpable slurry with a density of 9.4 pounds per gallon or greater.

c. In wells designed to monitor possible contamination in firm bedrock, the bottom of the bentonite seal should be located at least 1 m (3 ft) below the top of firm bedrock, as determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. Special designs will be needed to monitor contamination in fractured bedrock. Guidance on design of ground-water monitoring systems in karst and fractured-rock aquifers may be found in ASTM D 5717.

d. The final depth to the top of the bentonite seal should be directly measured (by tape or rod) and recorded. Final depths should not be estimated, as, for example, based on volumetric measurements of placed bentonite.

e. Numerous opinions have been expressed regarding bentonite hydration time, bentonite placement procedures under water versus in a dry condition, and the potential installation delays and other consequences caused by these factors. By not allowing sufficient time for the bentonite seal to hydrate and form a low permeable seal, grout material could infiltrate into the bentonite seal and possibly into the filter pack. It is recommended waiting a minimum of 3 to 4 hours for hydration of bentonite pellets, or tablets when cement grout is used above the bentonite seal. If bentonite chips are used, the minimum hydration time could be twice as long. Normally chips should only be used if it is necessary to install a seal in a deep water column. Because of their high moisture content and slow swelling tendencies, chips can be dropped through a water column more readily than a material with a low moisture content, such as pellets or tablets. Bentonite chips should not be placed in the vadose zone. A 1 m (3 ft) minimum bentonite pellet seal must be constructed to protect the screen and filter pack from downhole grout migration. When installing a bentonite seal in the vadose zone (the zone above the water table), water should be added to the bentonite for it to properly hydrate. The amount of water required is dependent on the formation. It is recommended that the bentonite seal be placed in 0.15 to 0.3 m (6 in to 1 ft) lifts, with each lift hydrated for a period of 30 minutes. This method will assure that the bentonite seal is well hydrated and accomplish its intended purpose. A 0.15 to 0.3 m (6 in. to 1 ft) layer of fine to medium sand (secondary filter pack) placed atop the bentonite seal may further enhance barrier resistance to downward grout migration.

5-8. Grouting

All prescribed portions of grout material should be combined in an aboveground rigid container and mechanically (not manually) blended to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout should be placed around the monitoring well as follows.

a. The grout should be placed from within a rigid side discharge grout pipe located just over the top of the seal. The grout or tremie pipe should be decontaminated prior to use.

b. Prior to exposing any portion of the borehole above the seal by removal of any drill casing (to include hollow-stem augers), the annulus between the drill casing and well casing should be filled with sufficient grout to allow for planned drill casing removal. The grout should not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(1) If all drill casing is to be removed in one operation, the grout should be pumped through the grout pipe until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The drill casing should then be removed, making certain that borehole exposure to the atmosphere is minimal. During the removal of hollow stem augers, the grout pipe may have to be periodically reinserted for additional grouting to compensate for the larger annular space created by the augers' helical coil.

(2) If drill casing is to be incrementally removed with intermittent grout addition, the grout should be pumped through the grout pipe until it reaches a level that will permit at least 3 m (10 ft) of grout to remain in the well/drill casing annulus AFTER removing the selected length of drill casing. Using this method, at least 6 m (20 ft) of grout should be within the drill casing before removing 3 m (10 ft) of driven casing or considerably more than 6 m (20 ft) of grout for the removal of 3 m (10 ft) of hollow stem auger. With this method, the grout pipe needs only to be reinserted to the base of the casing yet to be removed before repeating the grout insertion process.

c. If the ungrouted portion of the hole is less than 4.5 m (15 ft) deep and without fluids after casing removal, the ungrouted portion may be filled by pouring grout from the surface without a pipe.

d. If drill casing (to include hollow-stem auger) was not used, grouting should proceed to surface in one continuous operation. Care should be taken, however, in deep wells when using cement grout around PVC casing. Extreme heat, commonly known as heat of hydration, can be generated by the cement during hydration and curing. The heat generated can be sufficient enough to soften or weaken PVC casing, resulting in collapse of the casing. Grouting in multiple lifts may be necessary in this situation.

e. Once begun, the grouting process should be continuous until all the drill casing has been removed and all annular spaces are grouted to the ground surface.

f. Protective casing should be installed on the same day as grouting begins.

g. The FDO should check the site for grout settlement and add more grout to fill any depression that day. Repeat this process until firm grout remains at ground surface. This process should be completed within 24 hours of the initial grout placement. Incremental quantities of grout added in this manner should be recorded on the well completion diagram to be submitted to the FA.

h. For grout placement in a dry and open hole less than 4.5 m (15 ft) deep, the grout may be manually mixed and poured in from the surface as long as seal integrity is maintained.

i. No grout should be placed or allowed to migrate below the bentonite seal and into the well screen.

5-9. Well Protection

a. Protective casing should be installed around each monitoring well the same day as initial grout placement. The annulus formed between the outside of the protective casing and borehole should be filled to the ground surface with grout. The annulus between the monitoring well and protective casing should be filled to a minimum of 150 mm (0.5 ft) above the ground surface with cement or bentonite as part of the overall grouting procedure. Specific details of well protection should be approved by the FA. These details and specific elements to be included in the well construction diagrams should be described in the drilling and well installation plan.

b. All protective casing should be steam or hot-water-pressure cleaned prior to placement; free of extraneous openings; and devoid of any asphaltic, bituminous, encrusting, and/or coating materials, except the black paint or primer applied by the manufacturer.

c. Recommended minimum elements of protection design include the following list.

(1) A 1.5 m (5-ft) minimum length new, black iron/steel pipe (protective casing) extending about 0.75 m (2.5 ft) above ground surface and set in grout (see Figures 5-1, 5-2, and 5-4). The bottom of the protective casing should extend below the frost line to preclude damage from frost heave.

(2) A protective casing inside diameter at least 100 mm (4 in.) greater than the nominal diameter of the well riser.

(3) A hinged cover or loose-fitting telescopic slip-joint cap to keep direct precipitation and cap runoff out of

the casing. Threaded covers should be avoided because of the tendency to rust or freeze shut.

(4) All protective casing covers/caps secured to the casing by means of a noncorrosive padlock from the date of protective casing installation. All manhole covers should also be lockable.

(5) If practical, have all padlocks at a given site opened by the same key. The FDO should provide four of these keys to an FA-designated representative at the project.

(6) No more than 60 mm (0.2 ft) from the top of the protective casing to the top of the well casing. This, or a smaller spacing, is needed for subsequent water-level determinations by some acoustical equipment which must rest upon the well casing in order to function.

(7) All painting of the protective casing must be done offsite, prior to installation. Only the outside of the casing should be painted. Each well should be identified by a number placed on the outside of the well casing. Various methods of identification have been successfully used such as painting the number on the protective casing with the help of a painting stencil, attaching a metal imprinted noncorrosive metal tag, or imprinting the number directly on the steel protective casing. The color of the casing, the well number and method of application should be specified by the design FA in the drilling and well installation plan, and should be in accordance with the requirements prescribed by the owner and state and local technical regulations. Painting should be completed and dry prior to initially sampling the well.

(8) The erection of protective posts should be considered when physical damage resulting from construction equipment or vehicles is likely. When necessary, steel posts should be erected with a minimum diameter of 80 mm (3 in.). Each post should be radially located a minimum of 1 m (3 ft) from the well and placed 0.6 to 1 m (2 to 3 ft) below ground surface, having 1 m (3 ft) minimally above ground surface. Posts are typically filled with concrete and set in post holes which are backfilled with concrete. The post should be painted orange using a brush. Installation should be completed prior to sampling the well. Flags or barrier markers in areas of high vegetation may be helpful.

(9) When posts are used in conjunction with concrete pads, the posts should be located **OUTSIDE** of the pad. Posts inside of a pad (especially near a comer or edge) may cause the pad to crack, either by normal stress relief or if severely struck as by a vehicle.

(10) The above-mentioned posts should be supplemented with three-strand barbed wire in livestock grazing areas. Post and wire installation should be installed prior to sampling.

(11) Place a 6 mm (l/4 in.) diameter hole (drainage port) in the protective casing centered, no more than 3 mm (l/8 in.) above the grout filled annulus between the monitoring well riser and the protective casing.

(12) The application of at least a 150 mm (0.5 ft) thick coarse gravel 19- to 75-mm (3/4- to 3-in.) particle size pad extending 1 m (3 ft) radially from the protective casing (see Figure 5-4 for layout and dimensions). Prior to placement of this gravel pad, any depression around the well should be backfilled to slightly above the level of the surrounding ground surface with uncontaminated cohesive soil. This will prevent a "bathtub" effect of water collecting in the gravel pad around the well casing. Construction of the gravel pad is suggested prior to development. Some long-term, heavy traffic, or high visibility locations may warrant a concrete pad specially designed for site conditions. Any concrete pad usage, especially in cold climates, should be designed to withstand frost heaving. Frost uplift may adversely affect well and pad integrity. A concrete pad should be at least 100 mm (4 in.) thick and 1 m (3 ft.) square. Round concrete pads are also acceptable.

(13) All elements of well protection should be detailed in the drilling plan. In addition, unique well protection requirements for floodplains, frost heaving, heavy traffic areas, parking lots, as well as wells finished at or below grade, and other special circumstances should also be covered on a case-by-case basis, in the drilling plan. As an example, a suggested well design to minimize the effects of frost heaving is shown in Figure 5-6. An example of a flush-to-ground completion is shown in Figure 5-5. Additional guidance on monitoring well protection may be found in ASTM Standard Practice D 5787.

5-10. Shallow Wells

Shallow, less than 4.5 m (15 ft), well construction may be more problematic than deep. Sufficient depth may not be available to utilize the full lengths of typical well components when the aquifer to be monitored is near the surface. The FA should tailor design criteria to the actual environment and project objectives for appropriate shallow well construction.

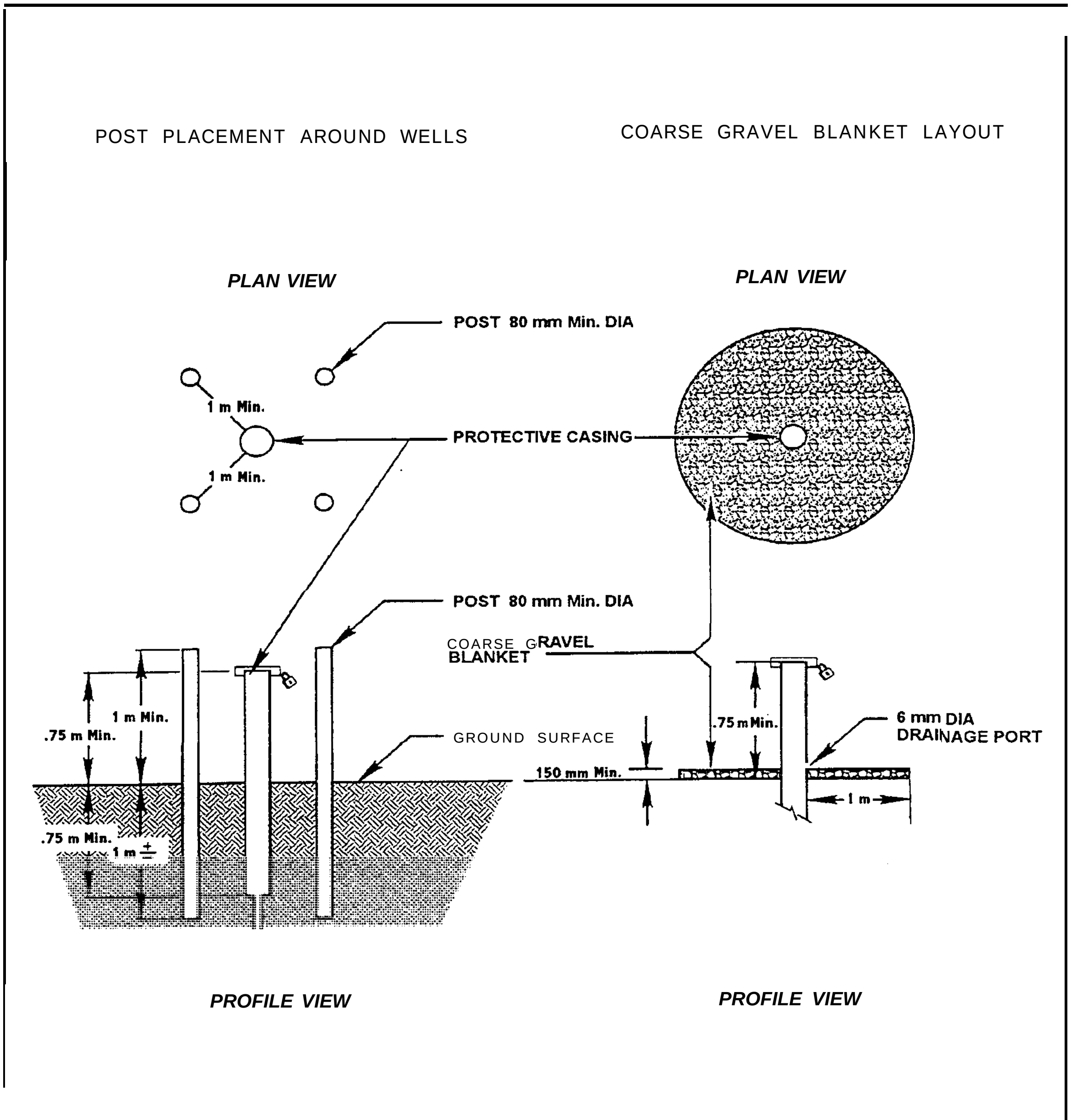


Figure 5-4. Post placement and gravel blanket layout around wells. (Adapted from a figure provided by International Technology Corporation)

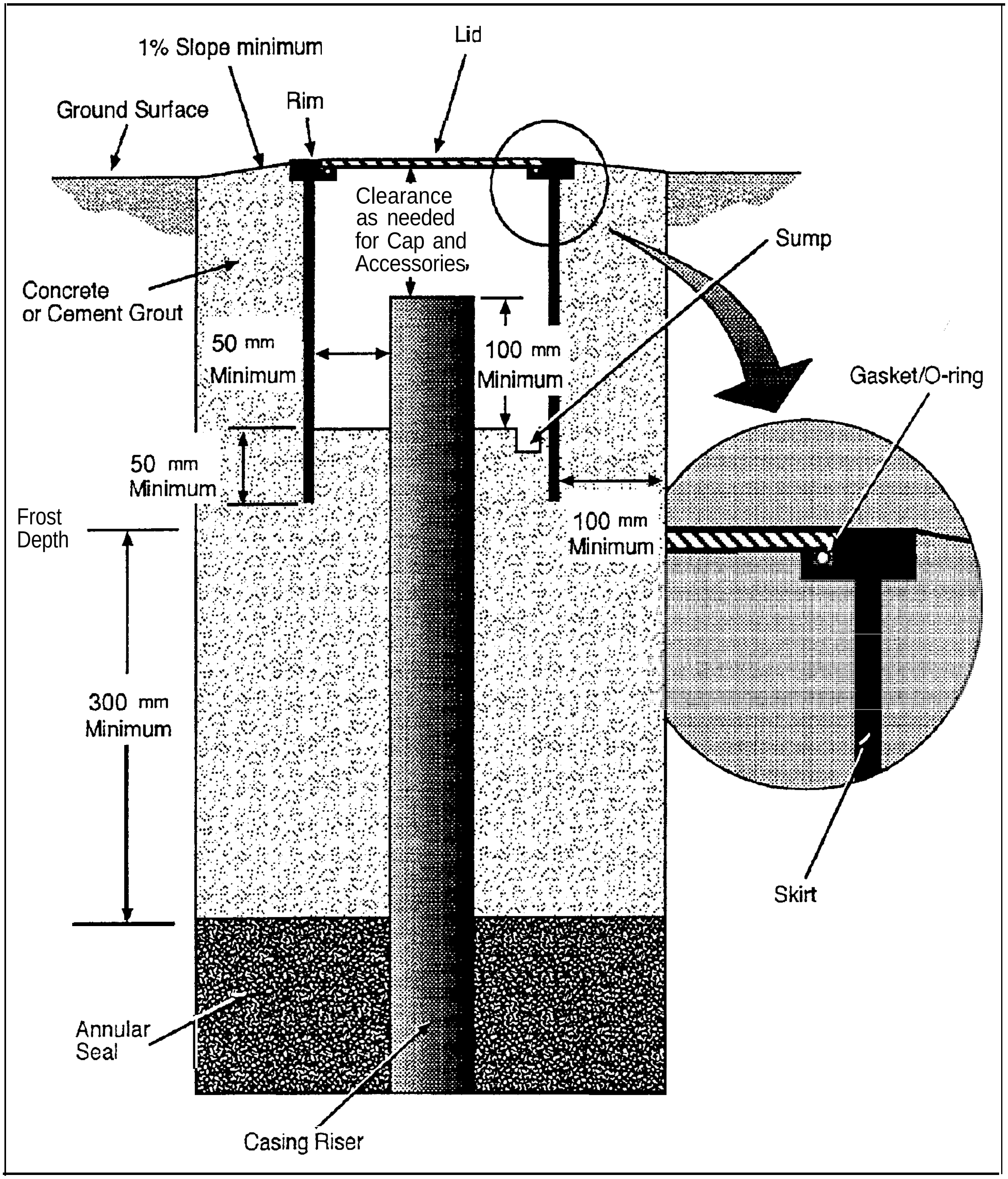


Figure 5-5. Schematic construction of flush-to-ground completion. (Figure provided by Ronald Schalla)

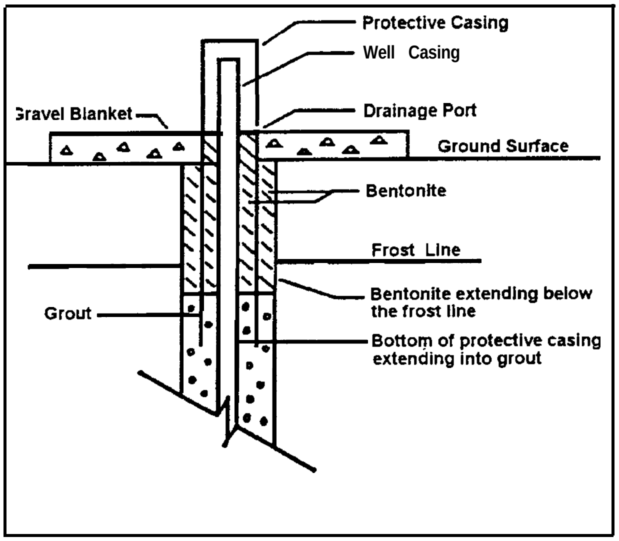


Figure 5-6. Well design parameters to minimize frost heave

5-11. Drilling Fluid Removal

When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid that would preclude or hinder the specified well installation, the borehole fluid should be removed or displaced with approved water. This removal is intended to remove or dilute the thick fluid and thus facilitate the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation should be recorded on the well diagram or boring log and later on the well development record. Any fluid removal prior to well placement should be contingent upon the driller's and the geologist's evaluation of hole stability, e.g., long enough for the desired well and seal placement.

5-12. Drilling Fluid Losses in Bedrock

If large drilling fluid losses occur in bedrock and if the hole is cased to bedrock, the FDO should remove at least three times this volumetric loss prior to well insertion. The intent is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing, thereby reducing subsequent development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed through the above procedure.

5-13. Well Construction Diagrams

a. Each installed well should be depicted in a well diagram. An example of a well diagram is shown in Figure 5-3. This diagram should be attached to the original bore log for that installation and graphically denote, by depth from ground surface.

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers,

(9) Height of riser (stickup) without cap/plug above ground surface.

(10) Protective casing detail.

(a) Height of protective casing without cap/cover, above ground surface.

(b) Bottom of protective casing below ground surface.

(c) Drainage port location and size.

(d) Gravel pad height and extent.

(e) Protective post configuration.

(11) Water level (ASTM D 4750) 24 hours after completion with date and time of measurement.

(12) Estimated maximum depth of frost penetration.

b. Describe the following on the diagram.

(1) The actual quantity and composition of the

grout, bentonite seals, and granular filter pack used for each well.

(2) The screen slot size in millimeters (inches), slot configuration, total open area per meter (foot) of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The material between the bottom of the boring and the bottom of the screen.

(4) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(5) The joint design and composition.

(6) The centralizer design and composition.

(7) The depth and description of any permanent pump or sampling device. For pumps include the voltage, phase requirements, and electrical plug configuration.

(8) The protective casing composition and nominal inside diameter.

(9) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, casing repairs or adjustments, etc.

(10) The dates and times for the start and completion of well installation.

c. Each diagram should be attached to the original boring log and submitted from the field to the FA.

d. Only the original well diagram and boring log should be submitted to the FA. Carbon, typed, or reproduced copies should be retained by the FDO. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. Special abbreviations used on the well completion diagram should be defined on the diagram.

Chapter 6
Well Development

6-1. General

Well development is the procedure that locally improves or restores the aquifer's hydraulic conductivity and removes well drilling fluids, muds, cuttings, mobile particulates, and entrapped gases from within and adjacent to a newly installed well. The resulting inflow should be physically and chemically representative of that portion of the aquifer adjacent to the screened interval. The appropriate development method/procedure to use will vary according to the hydrologic characteristics of the aquifer, the geologic composition of the screened interval, the drilling method, and the type of well completion. Of the various methods available for use in developing wells in general, mechanical surging, pumping, backwashing, and bailing are best suited. Additional guidance on the development of ground-water monitoring wells may be found in ASTM Standard Guide D 5521.

6-2. Timing and Record Submittal

The final development of monitoring wells should be initiated no sooner than 48 hours after or more than 7 days beyond the final grouting of the well. Predevelopment, or preliminary development may be initiated before this minimum 48 hour period. Preliminary development takes place after the screen, casing and filter pack have been installed, but before the annular seal is installed. Preliminary development is done in order to remove any mud cake that may be on the side of the borehole in a timely manner. Predevelopment is also recommended if the well is installed with the intent of using the natural formation material as the filter pack. Because this type of well design is based on the assumption that well development will remove a significant fraction of the formation materials adjacent to the well screen (therefore causing some sloughing in the borehole), developing the well after installing the annular seal may result in portions of the annular seal collapsing into the vicinity of the well screen. It is not good practice to wait and develop all the monitoring wells on a project after the last one is complete. The record of well development should be submitted to the FA.

6-3. Development Methods

A thorough discussion of monitoring well development methods can be found in ASTM Standard Guide D 5521.

a. Mechanical Surging. Operation of a piston-like device termed a surge block affixed to the end of a length of drill rod, or drill stem, is a very effective development method that can be effective in all diameter of wells, even in stratified formations having variable permeability. The up-and-down plunging action alternately forces water to flow into and out of the well, similar to a piston in a cylinder. The use of a surge block can agitate and mobilize particulates around the well screen. Periods of surging should be alternated with periods of water extraction from the well so that sediment, brought into the well, is removed. Surging should initially be gentle to assure that water can come into the well and that the surge block is not so tight as to damage the well pipe or screen. For short well screens (1.6 m (5 ft) or less) set in a homogeneous formation, the surge block does not have to be operated within the screen interval. However, if the screened interval includes materials of high and low permeabilities, the block may have to be operated gently within the screen.

b. Pumping. A commonly used development method consists of pumping a well at a higher rate than water will be extracted during purging or sampling events. This overpumping, however, is usually only successful in relatively non-stratified, clean-sand formations. By pumping the well at a higher rate than expected during sampling, the mobilized particulates may be removed, thereby providing a cleaner well for sampling. Overpumping should be supplemented with the use of a bottom discharge/filling bailer, (for sediment removal). During development, water should be removed throughout the entire water column in the well by periodically lowering and raising the pump intake. A disadvantage of only pumping the well is that the smaller soil grains of the filter pack may be bridged in the screen or in the filter pack, as the direction of flow is only towards the screen. To overcome this, overpumping is often used in conjunction with backwashing or surging.

c. Backwashing. Backwashing is the reversal of water flow in a well, causing soil particles to dislodge that may have become wedged in or bridged around the screen due to overpumping of the well. Backwashing when supplemented with overpumping, facilitates the removal of fine-grained materials from the formation surrounding the borehole. A commonly used backwashing procedure called “rawhiding” consists of starting and stopping the pump intermittently to allow the rising water in the well pipe to fall back into the well. This backwashing procedure produces rapid changes in the pressure head within the well. If rawhiding is to be used, there cannot be a backflow prevention valve in the pump or eductor line. Another method of backwashing is to pump water into the well in sufficient volume to maintain a head greater than that in the formation. This method of backwashing should only be done when the water pumped into the well is of known and acceptable chemistry. The impact of added water on in situ water quality should be evaluated and, this water should be removed by pumping after development is complete. This method of backwashing, not withstanding the quality of water pumped into the well, may not be allowed by local, state, or federal agencies. Do not use this method in cases where the water pumped into the well is potentially contaminated.

d. Bailing. The use of bailers is an effective way of manually developing small diameter wells that have a high static water table or are relatively shallow in depth (<4.5 m (15 ft)). As the diameter of the bailer is commonly close to the same diameter as the well screen, the bailer agitates the water in the well in much the same manner as a surge block, but to a lesser extent. It is good practice to surge the well using the bailer for 10 to 20 minutes prior to beginning bailing. To have its most effective surging action, the bailer should be operated throughout the screened interval. Bottom loading bailers can extract sediment that has settled to the bottom of the well by rapid short upward/down motions of the bailer at the bottom of the well which stir up the sediment and take it into the bailer. Pumps may be replaced by bottom filling bailers where well size or slow recharge rates restrict pump usage. Bailers should not be left inside the wells after development is completed. Such storage promotes accidental bailer release or loss down the well and inhibits convenient and accurate water-level measurements.

e. High-velocity hydraulic jetting. Another effective method available for use in developing some monitoring wells, is high-velocity hydraulic jetting. This method employs several horizontal jets of water operated from inside the well screen so that high-velocity streams of water exit through the screen and loosen fine-grained material and drilling mud residue from the formation. The loosened material moves inside the well screen and can be removed from the well by concurrent pumping or by bailing. Because of the size of the equipment required, this method is more easily applied to wells of 100 mm (4 in.) or greater diameter. Jetting is particularly successful in developing highly stratified unconsolidated formations, consolidated bedrock wells, large-diameter wells, and natural formation wells. Jetting is generally simple to use, effectively rearranges and breaks down bridging in the filter pack, and effectively removes mud cakes around screen. The disadvantage of using jetting even in ideal conditions is the introduction of foreign water and possible contaminants into the aquifer. Jetting is not effective in cases where slotted pipe is used for the screen. Jetting is much more effective where continuous-wrap v-wire screens, having a greater open area, are used.

f. Special Concerns.

(1) Where monitoring well installations are made in formations that have low hydraulic conductivity, none of the preceeding well development methods may be found to be completely satisfactory. In this situation clean water can be circulated down the well casing, out through the well intake and gravel pack, and up the open borehole prior to placement of the grout or seal in the annulus. Relatively high water velocities can be maintained, and the mud cake from the borehole wall will be broken down effectively and removed. Flow rates should be controlled to prevent floating the gravel pack out of the borehole. Because of the relatively low hydraulic conductivity of geologic materials outside the well, a negligible amount of water will penetrate the formation being monitored. However, immediately following the procedure, the well sealant should be installed and the well pumped to remove as much of the water used in the development process as possible (Barcelona et al. 1985). Adding water to the well for flushing should only be done, however, when no better options are available. In some fine grained deposits vigorous development can be detrimental to the well. If vigorous development is attempted in such wells, the turbidity of water removed from the well may actually increase many times over. In some fine-grained formation materials, no amount of development will measurably improve formation hydraulic conductivity or the hydraulic efficiency of the well. Alternative sampling methods, such as lysimeters (ASTM D 4696), should be considered in low conductivity formations.

(2) Drilling methods. The drilling process influences not only development procedures but also the intensity with which these procedures must be applied. Typical problems associated with special drilling technologies that must be anticipated and overcome are: 1) When drilling an air rotary borehole in rock formations, fine particulate matter typically builds up on the borehole walls and plugs fissures, pore spaces, bedding planes and other permeable zones. The matter must be removed and the openings restored by the development process; 2) If casing has been driven or if augers have been used, the interface between the natural formation and the casing or the auger flights are “smeared” with fine particulate matter that must subsequently be removed in the development process; 3) If a mud rotary technique is used, a mud cake builds up on the borehole wall that must be removed during the development process; and 4) If there have been any additives, as may be necessary in mud rotary, cable tool or augering procedures, the

development process must attempt to remove all of the fluids that have infiltrated into the natural formation (EPA/600/4-89/034). A comparison of the advantages and disadvantages of various drilling methods is in Table 3-1.

6-4. Development Criteria

a. Development should proceed until the following criteria are met:

(1) Satisfaction of applicable federal, state, and local regulatory requirements. Some of these requirements may specify that development continue until the readings for some indicator parameters like pH, conductivity, temperature, oxidation-reduction potential (ORP), dissolved oxygen (DO), or turbidity have stabilized; e.g., vary within a specified range. Stabilization is commonly considered to have been achieved after all parameters have stabilized for three successive readings. Generally three successive readings should be within ±0.2 for pH, ±3% for conductivity, ±10 mV for oxidation-reduction potential (ORP), ±1 degree Celsius for temperature, and ±10% for turbidity and DO. In general the order of stabilization is pH, temperature, and conductivity, followed by ORP, DO and turbidity (Puls and Barcelona 1996).

(2) The well water is clear to the unaided eye and the turbidity of the water removed is at some specified level. Some regulators may require that the turbidity, as measured in nephlometric turbidity units (NTUs), be less than 5 NTUs. It should be noted that natural turbidity levels in ground water may exceed 10 NTUs. Turbidity is always the last indicator parameter to stabilize. There are instances where minimizing turbidity will result in a sample that is not representative of the water that is moving through the formation. If the ground water moving through the formation is, in fact, turbid, or if there is free product moving through the formation, then some criteria may cause a well to be constructed such that the actual contaminant that the well was installed to monitor will be filtered out of the water. Therefore, it is imperative that the design, construction and development of the monitoring well be consistent with the objective of obtaining a sample that is representative of conditions in the ground.

(3) The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 30 mm (0.1 ft) for screens equal to or less than 3 m (10 ft) long.

(4) A minimum removal of three times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30 percent annular porosity). **IN ADDITION** to the “three times the standing water volume” criteria, further volumetric removal should be considered as follows:

(a) For those wells where the boring was made without the use of drilling fluid (mud and/or water), but water was added to the well during well installation, then three times the amount of any water unrecovered from the well during installation should be removed (in addition to three times the standing volume).

(b) For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove three times the measured (or estimated) amount of total fluids lost while drilling, plus three times that used for well installation (in addition to three times the standing volume).

(5) If the primary purpose of development is to rectify damage done during drilling to the borehole wall and the adjacent formation, the time for development may be based on the response of the well to pumping (ASTM D 4050). An improvement in recovery rate of the well indicates that the localized reduction in hydraulic conductivity has been effectively rectified by development. A commonly used method for determining hydraulic conductivity is the instantaneous change in head, or slug test. The slug test method involves causing a sudden change in head in the well and measuring the water level response within the well. Head change can be induced by suddenly injecting or removing a known quantity or “slug” of water into the well. However, instead of injecting a “slug” of water, a solid or mechanical slug of known volume should be used. The mechanical slug may be constructed of a section of weighted pipe, of known volume, capped on both ends. Water level and elapsed-time data can be recorded with a data logger and pressure transducer. Both “rising heads” and “falling heads” are recorded. Guidance on conducting slug tests may be found in ASTM Standard D 4044.

b. Prior to placement of the seal, if the borehole contains an excessively thick, particulate-laden fluid which would hinder proper well installation, this fluid should be diluted and/or flushed with clean water and purged from the well. Water should not be added to a well as part of development once the initial bentonite seal atop the filter pack is placed. It is essential that any water added to the well is of known and acceptable chemistry. The impact of added water on in situ water quality should be evaluated and removed after development is complete.

c. The use of air to develop a well **SHOULD NOT** be allowed. The introduction of air into a well enhances the occurrence of chemical, physical, and biological changes to the local aquifer system monitored by the well. Furthermore, procedures involving compressed air at HTW sites increase potential exposure/health risks to site personnel from the volatilization and misting of the aerated water. If air development is deemed the most appropriate method for a site, the above factors should be evaluated and mitigation procedures documented in the drilling plan.

d. If any of the following circumstances occur, the FA should be contacted for guidance:

(1) Well recharge so slow that the required volume of water cannot be removed during 48 consecutive hours of development;

(2) Persistent water discoloration after the required volumetric development; and

(3) Excessive sediment remaining after the required volumteric removal.

6-5. Development-Sampling Break

Time should be allowed for equilibration of the well with the formation after development before sampling of the well is undertaken. Well development should be completed at least 14 days before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to surficially equilibrate to their new environment and for that environment to re-stabilize after the disturbance of drilling. Though a significant volume of water may be pulled through the well during development, the well and granular backfill surfaces over which this water passes are not likely to be at chemical equilibrium with the aquifer. Intuitively, the hiatus allows time for that equilibrium to be created, thereby enhancing the probability of the resulting sample to be more representative of the local aquifer. The 14-day hiatus is a "rule-of-thumb," unsubstantiated by rigorous scientific analysis. If a different value is proposed based upon technical data or overall project considerations, such a change should be evaluated and, if deemed appropriate, implemented. Generally, high permeability formations require less time (e.g., several days) to equilibrate than low permeability formations (e.g., several weeks). The FSP should state the amount of time that will be required to permit the equilibration of the monitoring well following development and prior to sampling and the justification for selection of that time interval.

6-6. Development Water Sample

For each well, a 0.5 L (1-pint) sample of the last water to be removed during development should be placed in a clear glass jar and labeled with well number and date. No preservation of these samples is required. Each sample should be individually agitated and immediately photographed close-up by the FDO with a 35-mm camera and color print film, using a back-lit setup to show water clarity. These photos, minimally 125 mm x 175 mm (5 in. x 7 in.), individually identified with project name, well number, and photo date, should be provided to the FA after all wells are developed. The film negatives should be provided to the FA after the FA has received the prints. The FDO should dispose of these water samples in the same manner as the rest of the water removed during development.

6-7. Well Washing

Part of well development should include the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation will be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the well cap and blank casing, between the top of the well and the water table. This washing should be conducted before and/or during development, not after development.

6-8. Well Development Record

The following data should be recorded as part of development and submitted to the FA:

a. Project name, location.

b. Well designation, location.

c. Date(s) and time(s) of well installation.

d. Date(s) and time(s) of well development.

e. Static water level from top of well casing before and 24 hours after development.

f. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion.

(3) Lost during thick fluid displacement.

(4) Added during granular filter placement.

g. Quantity of fluid in well prior to development:

(1) Standing in well.

(2) Contained in saturated annulus (assume 30 percent porosity).

h. Field measurement of pH (ASTMs D1293 and D5464), conductivity (ASTM D1125), oxidation-reduction (redox) potential (ASTM D1498), dissolved oxygen (ASTMs D888 and D5462), turbidity (ASTM D1889), and temperature (EPA Method 170.1) before, twice during, and after development using an appropriate device and method. Field methods for these parameters can also be found in EPA 600/4-79/020, and Standard Methods.

i. Depth from top of well casing to bottom of well.

j. Screen length.

k. Depth from top of well casing to top of sediment inside well, before and after development (from actual measurements at time of development).

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and any noted odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface (from actual measurement at time of development).

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

6-9. Potential Difficulties

Many difficulties may arise during development and presample purging. Some are readily apparent but troublesome to resolve; e.g., a well that is easily pumped dry but slow to recharge or one that will not produce clear, particulate-free water. Other difficulties are not easily observed but may bias the analytical results, e.g., pulling-in distant parts of the aquifer in an effort to achieve a repetitively consistent field reading or aerating the aquifer adjacent to the well in a hurried attempt at well development. In addition, the unanticipated presence of dense (or light) nonaqueous phase liquids (NAPL) in the screened interval would affect the chemical homogeneity of that interval and hydrologic parameters derived from that well. The anticipation, evaluation, and tentative solution for these problems should begin early in the formulation of each drilling plan.

Chapter 7
Well and Boring Acceptance Criteria

7-1. Well Criteria

Wells should be acceptable to the FA. Well acceptance should be on a case-by-case basis. The following criteria should be used along with individual circumstances in the evaluation process.

a. The well and material placement should meet the construction and placement specifications of the drilling and well installation plan unless modified by amendments.

b. Wells should not contain portions of drill casing or augers unless they are specified in the drilling plan as permanent casing.

c. All well casing and screen materials should be free of any unsecured couplings, ruptures, or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) of the installed well should form a continuous and uniform structure, free of any detectable fractures, cracks, or voids.

e. Any casing or screen deformation or bending should be minimal to allow the insertion and retrieval of the pump and/or bailer optimally designed for that size casing, e.g., a 75 mm (3-in.) pump in a 100 mm (4-in.) schedule 80, PVC casing is optimal; a 50 mm (2-in.) pump in a 100 mm (4-in.) casing is not optimal.

f. All joints should be constructed to provide a straight, nonconstricting, and watertight fit.

g. Completed wells should be free of extraneous objects or materials; e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc. This prohibition should not apply to intentionally installed equipment per drilling plan.

h. For those monitoring wells where the screen depth was determined by the FDO, the well should have sufficient free water at the time of the water-level measurement to obtain a representative groundwater level for that well. These same wells should have sufficient free water at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analyses.

i. All boring logs, well diagrams, development records, topographic survey data, and related photographs and negatives should have been completed per the drilling plan and received by the FA.

j. Keys to the padlocks securing the well covers should be in the possession of the FA and the FA project representative prior to well acceptance.

7-2. Abandoned/Decommissioned Borings and Wells

Borings not completed as wells should be abandoned/ decommissioned per paragraph **3-14** of this manual.

7-3. Well and Boring Rejection

Wells and borings not meeting drilling plan criteria are subject to rejection by the FA.

Chapter 8
Water Levels

8-1. Measurement Frequency and Coverage

The frequency of water-level measurement is project related. At a minimum, for those projects involving the installation of any monitoring wells, at least one complete set of *static* water-level measurements should be made over a single, consecutive 10-to-12-hour period for all project-related wells, both newly installed and specified existing wells. These measurements should be taken at least 24 hours after development or sampling. Static levels in borings not converted to wells should be included if practical and technically appropriate. This set of measurements should include a notation for the presence of any streams, lakes, and/or open water bodies (natural and man-made) within proximity, e.g., about 90 m (300 ft) of these wells. Elevation measurements of any surface water bodies should be a consideration within the drilling and well installation plan.

8-2. Vertical Control

The depth to groundwater should be measured and reported to the nearest 3 mm (0.01 ft). Measurement should be made from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing should be surveyed for vertical control. The surveyed mark on the top of the casing should be permanently marked with a notch cut in the casing to ensure that depth to water is always measured from the same elevation. Surface water levels should be measured at least to the nearest 30 mm (0.1 ft) using an adjacent temporary or permanent survey marker as a datum for current and future reference.

8-3. Reporting and Usage

All water level data should be presented as elevations in tabular form. Where sufficient data points exist, the elevations should be contoured to denote flow directions, gradients, and any hydrological interconnections between aquifers and surface water bodies.

8-4. Methods

Guidance on determining liquid levels in a borehole or monitoring well may be found in ASTM D 4750.

Chapter 9
Topographic Survey

9-1. Licensing

All topographic survey efforts conducted under contract should be certified by a surveyor with a current surveyor's license in the project state. Any licensing requirements within the project state for contract or Corps of Engineers surveyors should be determined by the FA.

9-2. Horizontal Control

Each boring and/or well installation should be topographically surveyed to determine its map coordinates referenced to either a Universal Transverse Mercator (UTM) grid or the State Plane Coordinate System (SPCS). These surveys should be connected to the UTM or SPCS by third order, Class II control surveys in accordance with the Standards and Specifications for Geodetic Control Networks (Federal Geodetic Control Committee 1984). If the project is in an area remote from UTM or SPCS benchmarks and such horizontal control is not warranted, then locations measured from an alternate system depicted on project plans may suffice, at least on a temporary basis. All borings, wells, temporary and/or permanent markers should have an accuracy of ±300 mm (±1 ft) within the chosen system.

9-3. Vertical Control

Elevations for the natural ground surface (not the top of the coarse gravel blanket) and a designated point on the rim of the uncapped well casing (not protective casing) for each bore/well site should be surveyed to within 3 mm (±0.01 ft) and referenced to the National Geodetic Vertical Datum of 1929 (NGVD of 1929) or the North American Vertical Datum, 1988 Adjustment (NAVD 88). These surveys should be connected by third order leveling to the NGVD of 1929 or NAVD 1988 in accordance with the Standards and Specifications for Geodetic Control Networks. If the project is in an area remote from NGVD benchmarks and such vertical control is not warranted, then elevations measured from a project datum may suffice, at least on a temporary basis.

9-4. Field Data

The topographic survey should be completed as near to the time of last well completion as possible. Survey field data (as corrected), to include loop closures and other statistical data in accordance with the Standards and Specifications referenced above, should be provided to the FA. Closure should be within the horizontal and vertical limits given above. These data should clearly be listed in tabular form including the coordinates (and system) and elevation (ground surface and top of well) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control, benchmarks, caps, plates, chiseled cuts, rail spikes, etc., should be described in terms of their name, character, physical location, and reference value. These field data should become part of the project records maintained by the FA.

9-5. Geospatial Data Systems

Geospatial data is non-tactical data referenced either directly or indirectly to a location on the earth. Geospatial data identifies the geographic location and characteristics of natural or constructed features and boundries on the earth. Monitoring wells and the data generated from them meet these definitions and therefore must be documented according to the metadata standards cited in ER 1110-1-8156. ER 1110-1-8156 requires geospatial data to be documented using the Federal Geographic Data Committee Content Standards for Digital Geospatial Metadata. Guidance on geospatial data systems (GDS) may also be found in EM 1110-1-2909 and ASTM Standard Specification D 5714.

Chapter 10
Borehole Geophysics

10-1. Usage and Reporting

The use of geophysical techniques, if required, should be specified in the drilling plan. In the absence of this specification, the FDO should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of its efforts. Special applications may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock determination, buried drum detection, borehole and well logging, etc. When approved for use, geophysical techniques should be discussed in the drilling plan to include the purpose; particular method(s) and equipment; selection rationale; physical and procedural assumptions; limitations (theoretical and site specific); resolution; accuracy; and quality control. Safety aspects of geophysical applications should be included in the safety plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials.

10-2. Methods

General geophysical methodology is covered in EM 1110-1-1802. Geophysical techniques applied to HTRW studies are found in USEPA 625/R-92/007, 600/2-87/078, 600/7-84/064, and in Benson, Glaccum, and Noel (1982). Additional guidance on planning and conducting borehole geophysical logging can be found in ASTM Standard Guide D 5753.

Chapter 11
Vadose Zone Monitoring

11-1. Usage and Reporting

Data acquisition from the vadose (unsaturated) zone should be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed.

When vadose zone monitoring is proposed,the drilling plan should include the purpose; particular method(s) and equipment; selection rationale; physical and procedural assumptions; limitations (theoretical and site-specific); quality control; and any analytical variances from the current USACE protocol.

11-2. Methods

Guidance on vadose zone monitoring may be found in ASTM Standard Guides D 4696 and D 5126. A general discussion of vadose monitoring can be found in Everett, Wilson, and Hoylman (1984).

Chapter 12
Data Management System

12-1. Benefits

The use of a computerized system will enhance reporting procedures by means of intra-report consistency, reduction of editorial review, broadening of graphical capabilities, and ease of data retrieval for project review and inter-project comparisons. Each FA is encouraged to utilize a computerized data management system for technical data.

12-2. Assistance Sources

Several existing systems are available for utilization by individual FAs. New systems are also being developed at the DOD level to combine existing systems and reduce redundancy in data reporting systems. Guidance on boring log data management may be found in the USACE Waterways Experiment Station contract report GL-93-1. Assistance can be obtained from the HTRW CX, at CENWO-HX-G.

12-3. Geospatial Data Systems

Geospatial data is non-tactical data referenced either directly or indirectly to a location on the earth. Geospatial data identifies the geographic location and characteristics of natural or constructed features and boundries on the earth. Monitoring wells, and the data generated from them, meet these definitions and therefore must be documented according to the metadata standards cited in ER 1110-1-8156. ER 1110-1-8156 requires geospatial data to be documented using the Federal Geographic Data Committee Content Standards for Digital Geospatial Metadata. Guidance on geospatial data systems (GDS) may also be found in EM 1110-1-2909 and ASTM D 5714.

Appendix A
References

A-1. Required Publications

29 CFR 1910.120
Code of Federal Regulations, 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

29 CFR 1926
Code of Federal Regulations, 29 CFR 1926, Safety and Health Regulations for Construction.

ER 385-1-92
Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities.

ER 1110-1-263
Chemical Data Quality Management for Hazardous Waste Remedial Activities.

ER 1110-1-1803
Care, Storage, Retention, and Ultimate Disposal of Exploratory and Other Cores.

ER 1110-1-8156
Policies, Guidance, and Requirements For Geospatial Data and Systems.

ER 1110-2-1807
Use of Air Drilling in Embankments and Their Foundations.

ER 1165-2-132
Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects.

EM 200-1-2
Technical Project Planning (TPP) Process.

EM 200-1-3
Requirements for the Preparation of Sampling and Analysis Plans.

EM 385-1-1
Safety and Health Requirements Manual.

EM 1110-1-1802
Geophysical Exploration.

EM 1110-1-1804
Geotechnical Investigations.

EM 1110-1-1906
Soil Sampling.

EM 1110-1-2909
Geospatial Data and Systems.

EM 1110-2-1906
Laboratory Soils Testing.

EM 1110-2-3506
Grouting Technology.

FM 5-410
U.S. Army Field Manual, " Military Soils Engineering."

FM 5-430
U.S. Army Field Manual, "Planning and Design of Roads, Airbases, and Heliports in the Theater of Operations."

FM 5-484
U.S. Army Field Manual, "Multiservice Procedures For Well-Drilling Operations."

TM 5-818-2
U.S. Army Technical Manual, "Pavement Design For Seasonal Frost Conditions."

TM 5-818-3
U.S. Army Technical Manual, "Pavement Evaluation For Frost Conditions."

TM 5-852-6
U.S. Army Technical Manual, "Arctic and Subarctic Construction: Calculation Methods For Determination of Depth of Freeze and Thaw In Soils."

CEGS 02522
U.S. Army Corps of Engineers Guide Specification, "Ground-Water Monitoring Wells."

CWGS 02010
U.S. Army Corps of Engineers Guide Specification, "Subsurface Drilling, Sampling, and Testing."

GL-93-1
U.S.Army Corps of Engineers, Contract Report GL-93-1 (July 93), User's Guide for the Boring Log Data Manager, Version 2.0, Computer Applications in Geotechnical Engineering (CAGE) Project, Geotechnical Laboratory, Waterways Experiment Station, 3909 Halls Ferry Road,

Vicksburg, MS 39180-6199.

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Benson, R.C., Glaccum, R.A., and Noel, M.R. 1982. "Geophysical Techniques for Sensing Buried Wastes and Waste Migration," Environmental Monitoring Systems Laboratory, U.S. EPA, Las Vegas, NV, EPA/600/7-8-4/064.

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"Standards and Specifications for Geodetic Control Networks," National Oceanic and Atmospheric Administration, Rockville, MD.

Federal Geographic Data Committee 1994
"Content Standards for Digital Geospatial Metadata," 1994, FGDC Secretariat, USGS, 590 National Center, 12201 Sunrise Valley Drive, Reston, VA, 20192.

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Hsai-Wong Fang. 1991. "Foundation Engineering Handbook."

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Murphy, William L. 1985. "Geotechnical Descriptions Of Rock and Rock Masses," Technical Report GL-85-3, U.S.Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

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Standard Methods
"Standard Methods for the Examination of Water and Wastewater," American Public Health Assoc. (APHA), American Water Works Assoc. (AWWA), and the Water Pollution Control Federation (WPCF), 19th Edition, 1995.

USEPA, EPA/510/B-97/001
"Expedited Site Assessment Tools For Underground Storage Tank Sites," U.S. EPA, Office of Solid Waste, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/530/SW-86/055, OSWER Directive 9950.1
"RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD)," U.S. EPA, Office of Solid Waste, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/540/G-88/003, OSWER Directive 9283.1-2
"Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites," U.S.EPA, Office of Emergency and Remedial Response, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/540/G-91/009
"Management of Investigation-Derived Wastes During Site Inspections," U.S. EPA, Office of Research and Development, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/540/S-95/503
"Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation," Ground Water Issue, July 1995, U.S. EPA, Robert S. Kerr Environmental Laboratory, Ada, OK.

USEPA, EPA/600/2-87/078
"Nondestructive Testing Techniques to Detect Contained Subsurface Hazardous Waste," U.S. EPA, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/600/4-79/020
"Methods for Chemical Analysis of Water and Wastes," U.S.EPA, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/600/4-89/034
"Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells," U.S. EPA, Office of Research and Development, 401 M St., SW, Washington, DC 20460.

USEPA, EPA/600/7-84/064
"Geophysical Techniques for Sensing Buried Wastes and Waste Migration," U.S. EPA, Environmental Monitoring Systems Laboratory, Las Vegas, NV 89114.

USEPA, EPA/625/6-87/016
"Handbook: Ground Water," U.S.EPA, Robert S. Kerr Environmental Reseach Laboratory, Ada, OK 74820.

USEPA, EPA/625/12-91/002
"Description and Sampling of Contaminated Soils: A Field Pocket Guide," U.S. EPA, Center for Environmental Research Information, 26 W. MLK Dr., Cincinati, OH 45268.

USEPA, EPA/625/R-92/007
"Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites," U.S. EPA, Office of Research and Development, Washington, DC 20460.

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"Guide to Management of Investigation-Derived Wastes," U.S.EPA, Office of Solid Waste, 401 M St., SW, Washington, DC 20460.

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C 150 Specification for Portland Cement

D 888 Test Method for Dissolved Oxygen in Water

D 1125 Test Method for Electrical Conductivity and Resistivity of Water

D 1293 Test Method for pH in Water

D 1498 Practice for Oxidation-Reduction Potential of Water

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils

D 1785 Specification for Polyvinyl Chloride (PVC) Plastic Pipe Schedules 40, 80 and 120

D 1889 Test Method for Turbidity in Water

D 2113 Practice for Rock Core Drilling and Sampling of Rock for Site Investigation

D 2487 Test Method for Classification of Soils for Engineering Purposes.

D 2488 Practice for Description and Indentification of Soils (Visual-Manual Procedures).

D 4044 Test Method (Field Procedure) for Instantaneous Change in Head (Slug Tests) for Determining Hydraulic Properties of Aquifers

D 4050 Test Method (Field Porcedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems

D 4220 Practice for Preserving and Transporting Soil Samples

D 4448 Guide for Sampling Groundwater Monitoring Wells.

D 4696 Guide for Pore-Liquid Sampling from the Vadose Zone

D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)

D 5079 Practice for Preserving and Transporting Rock Core Samples

D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites.

D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.

D 5126 Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone

D 5299 Guide for the Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock.

D 5462 Test Method for On-Line Measurement of Low Level Dissolved Oxygen in Water

D 5464 Test Methods for pH Measurement of Water of Low Conductivity

D 5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers.

D 5608 Practice for the Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

D 5714 Specification for Content of Digital Geospatial Metadata

D 5717 Guide for Design of Ground-Water Monitoring Systems in Karst and Fractured-Rock Aquifers.

D 5737 Guide for Methods for Measuring Well Discharge

D 5753 Guide for Planning and Conducting Borehole Geophysical Logging

D 5778 Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils

D 5781 Guide for the Use of Dual Wall Reverse-Circulation Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices

D 5782 Guide for the Use of Direct Air Rotary Drilling for Geonvironmental Exploration and the Installation of Subsurface Water Quality Montoring Devices

D 5783 Guide for the Use of Direct Rotary Drilling With Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices

D 5784 Guide for the Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Devices

D 5787 Practice for Monitoring Well Protection.

D 5872 Guide for Use of Casing Advancement Drilling Methods For Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices

D 5875 Guide for Use of Cable-Tool Drilling and Sampling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices

D 5876 Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices

D 5978 Guide for Maintenance and Rehabilitation of Ground Water Monitoring Wells

D 6001 Guide for Direct Push Water Sampling for

Geoenvironmental Investigations

D 6067 Test Method for Using the Electronic Cone Penetrometer for Environmental Site Characterization

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations.

D 6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations.

D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization

F 480 Specifications for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80.

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Appendix B
Abbreviations

AE Architect-Engineer

ASTM American Society for Testing and Materials

CECW-EG Geotechnical and Materials Branch, Engineering Division, Directorate of Civil Works, Headquarters, U.S. Army Corps of Engineers

CEMP-RT Policy and Technology Branch, Environmental Division, Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers

CENWO-HX-G Geoenvironmental and Process Engineering Branch, HTRW Center of Expertise, Omaha District, Missouri River Region

CERCLA Comprehensive Environmental Resource, Compensation, and Liability Act

CFR Code of Federal Regulations

DERP Defense Environmental Restoration Program

EM Engineer Manual

ENG Engineer

FA Field Activity

FDO Field Drilling Organization

FGDC Federal Geographic Data Committee

FSP Field Sampling Plan

GDQM Geotechnical Data Quality Management

GSA Geological Society of America

HQUSACE Headquarters, United States Army Corps of Engineers

HTRW Hazardous, Toxic, and Radioactive Waste

ID Inside Diameter

IDW Investigation-Derived Waste

CX HTRW Center of Expertise

DNAPL Dense Nonaqueous Phase Liquid

DO Dissolved oxygen

DTH Down-the-Hole (Hammer)

MRR Missouri River Region

N Normal

NAPL Nonaqueous Phase Liquid

NAVD North American Vertical Datum

NGVD National Geodetic Vertical Datum

NSF National Sanitation Foundation

NTU Nephelometric Turbidity Unit

OD Outside Diameter

ORP Oxidation-Reduction Potential

OSHA Occupational Safety and Health Administration

OSWER Office of Solid Waste and Emergency Response (EPA)

pH The negative logarithm of the effective hydrogen ion concentration in gram equivalents per liter

PCB Polychlorinated Biphenyl

PTFE Polytetrafluoroethylene

PVC Polyvinyl Chloride

RCRA Resource Conservation and Recovery Act

SAP Sampling and Analysis Plan

SARA Superfund Amendments and Reauthorization Act

SCAPS Site Characterization and Analysis

	Penetrometer System
SPCS	State Plane Coordinate System
SSHP	Site Safety and Health Plan
TSCA	Toxic Substance Control Act
TTIA	Technology Transfer Improvements Act
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator

Technical Standard for Water-Table Monitoring of Potential Wetland Sites

by U.S. Army Corps of Engineers

PURPOSE: This technical note describes national standards for the collection, analysis, interpretation, and reporting of hydrologic data, which may be used to help determine whether wetlands are present on disturbed or problematic sites that may be subject to Clean Water Act regulatory jurisdiction. These standards may be supplemented or superseded by locally or regionally developed standards at the discretion of the appropriate Corps of Engineers District.

BACKGROUND: Wetland determinations in the majority of cases are based on the presence of readily observable field indicators of hydrophytic vegetation, hydric soils, and wetland hydrology, according to procedures given in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) (hereafter called the Corps Manual). These three characteristics are the best available evidence that an area has performed in the past, and continues to perform, the functions associated with wetland ecosystems.

The Corps Manual (Part IV, Section F, Atypical Situations) recognizes that wetland determinations on some sites may be difficult because of human disturbance that may have altered or destroyed wetland indicators. In addition, some naturally occurring wetland types may lack indicators or may have indicators present only at certain times of year or during certain years in a multi-year cycle (Part IV, Section G, Problem Areas). Wetland determinations in these atypical and problem situations increasingly involve the use of direct hydrologic monitoring to confirm the presence of wetlands in cases where soils or vegetation have been significantly disturbed or are naturally problematic, or where the hydrology of the site has been altered recently such that soil and vegetation indicators may give a misleading impression of the site's current wetland status.

The Corps Manual provides only a general discussion of wetland hydrology concepts and does not provide a suitable standard that can be used to design a hydrologic monitoring study or interpret hydrologic data, particularly in cases where groundwater is an important water source. Therefore, the purpose of this Technical Standard is to provide a minimum standard for the design, construction, and installation of water-table monitoring wells, and for the collection and interpretation of groundwater monitoring data, in cases where direct hydrologic measurements are needed to determine whether wetlands are present on highly disturbed or problematic sites.

USE OF THE TECHNICAL STANDARD: The Technical Standard is intended for use in atypical and problem situations as described in the Corps Manual. Atypical situations are broadly defined as any wetlands where indicators of hydrophytic vegetation, hydric soil, or wetland hydrology may be lacking due to recent human activities or natural events. Problem areas are wetlands that may lack wetland indicators at certain times due to normal variations in environmental conditions. This standard is designed to determine a site's current hydrologic status and may not be appropriate for evaluating past or pre-disturbance conditions.

This standard should not be used to overrule a wetland determination based on indicators of hydrophytic vegetation, hydric soil, and wetland hydrology on sites that are not significantly disturbed or problematic. Wetland indicators reflect natural processes that occur in wetlands and generally provide the best evidence that functioning wetlands are present on a site. The actual hydrologic regime required to produce and maintain a wetland may vary locally and regionally due to climate, landforms, geology, soils, and plant and animal adaptations. Therefore, any wetland hydrologic standard is necessarily an approximation and should be used only when an indicator-based wetland determination is not possible or would give misleading results.

In addition, this standard is not intended to overrule other scientific evidence that particular regional or local wetland types may be associated with hydrologic conditions different from those described here, including the seasonal timing, depth, duration, and frequency of saturation. Standards used to verify wetland hydrology in such cases should be based on the best available scientific information concerning a particular local or regional wetland type.

The Technical Standard is designed solely to determine the location of the water table for wetland jurisdictional purposes. It should not be used for water-quality monitoring or other purposes. This national standard may be supplemented or superseded by locally or regionally developed standards at the discretion of the District, and well-documented and justified deviations from the standard are acceptable with the approval of the District. It is always good practice to discuss the goals and design of the monitoring study with Corps regulatory personnel before initiating work. This may help to avoid disagreements and problems of interpretation later. This standard is subject to periodic review and revision as better scientific information becomes available.

SITE CHARACTERIZATION: A detailed site characterization should be completed before initiating the groundwater monitoring program. Site information is needed to determine appropriate well locations, installation depths, and other design features. The site characterization should begin with a review of all pertinent off-site information including county soil surveys, topographic maps, aerial photographs, and National Wetland Inventory (NWI) maps, if available. This review should be followed by a field investigation to verify the off-site information and gather additional data. At a minimum, the following site information should be collected (see Warne and Wakeley (2000) for detailed guidance):

- Detailed site map showing the location of property and project-area boundaries (determine coordinates of boundary points and landmarks, if possible).
- Topographic map showing the watershed boundary, water features (e.g., lakes, streams, minor drainages), and direction of water movement across the site.
- Current vegetation and land use.
- Detailed description of any modifications to site hydrology (e.g., water diversions or additions including ditches, subsurface drains, dams, berms, channelized streams, irrigation, modified surface topography, etc.).
- Soil profile descriptions including locations of soil test pits (indicate on site map and determine coordinates, if possible).

Soil profile descriptions are an important part of the site characterization because they may dictate appropriate depths for installation of water-table monitoring wells. Of critical importance is the identification of soil strata that can restrict downward water movement and create a perched water table. Examples of soil strata that may produce perched water tables include fragipans, spodic horizons, argillic horizons, and shallow bedrock. If a shallow restrictive soil layer is identified, care must be taken during well installation to ensure that the layer is not penetrated. Penetration of the restrictive layer may result in misleading water-level readings.

Soil profile descriptions should include horizon depths and (for each horizon) information about texture, color, induration (cementation), redoximorphic features, and roots, so that significant differences in permeability can be evaluated (Sprecher 2000). A blank Soil Characterization Data Form is provided for this purpose (Appendix A). Soil profiles must be described at least to the anticipated installation depth of the wells; profile descriptions to 24 in. or more are recommended. Several soil characteristics indicate that downward water flow may be impeded and that perched water tables may exist. Features to note include the following (Sprecher 2000):

- Abrupt change from many roots to few or no roots.
- Abrupt change in soil texture.
- Abrupt change in ease of excavation.
- Abrupt change in water content, such as presence of saturated soil horizons immediately above soil horizons that are dry or only moist.
- Redoximorphic features at any of the distinct boundaries listed above.

WELL PLACEMENT: A detailed discussion of monitoring well placement within the project site is beyond the scope of this Technical Standard. In general, well placement depends on the objectives of the investigation and characteristics of the site. If the objective is to determine whether wetland hydrology is present at a particular point, a single well may be sufficient. However, multiple wells may be necessary to determine if wetland hydrology occurs on a complex site where topography and human alterations (e.g., road construction, ditching) have produced considerable hydrologic variation. Well locations and depths are dictated by site conditions including topographic relief and the depth and continuity of restrictive soil layers. Portions of a site that are most likely to meet wetland hydrology standards (e.g., low-lying areas such as depressions, floodplain backwaters, swales and washes, fringes of lakes and ponds, toes of slopes, or other areas with shallow restrictive soil layers) should be identified during site characterization and considered for well placement.

If the objective is to confirm wetland boundaries based on groundwater measurements, then multiple wells installed along transects perpendicular to the expected wetland boundary are needed (Figure 1). The number and spacing of wells along each transect depend on the topographic gradient and the precision needed in defining the wetland boundary. Other site information that may help in placing wells and identifying boundaries includes changes in topographic gradient, proximity to hydrologic alterations (e.g., ditches), and changes in soil characteristics or vegetation.

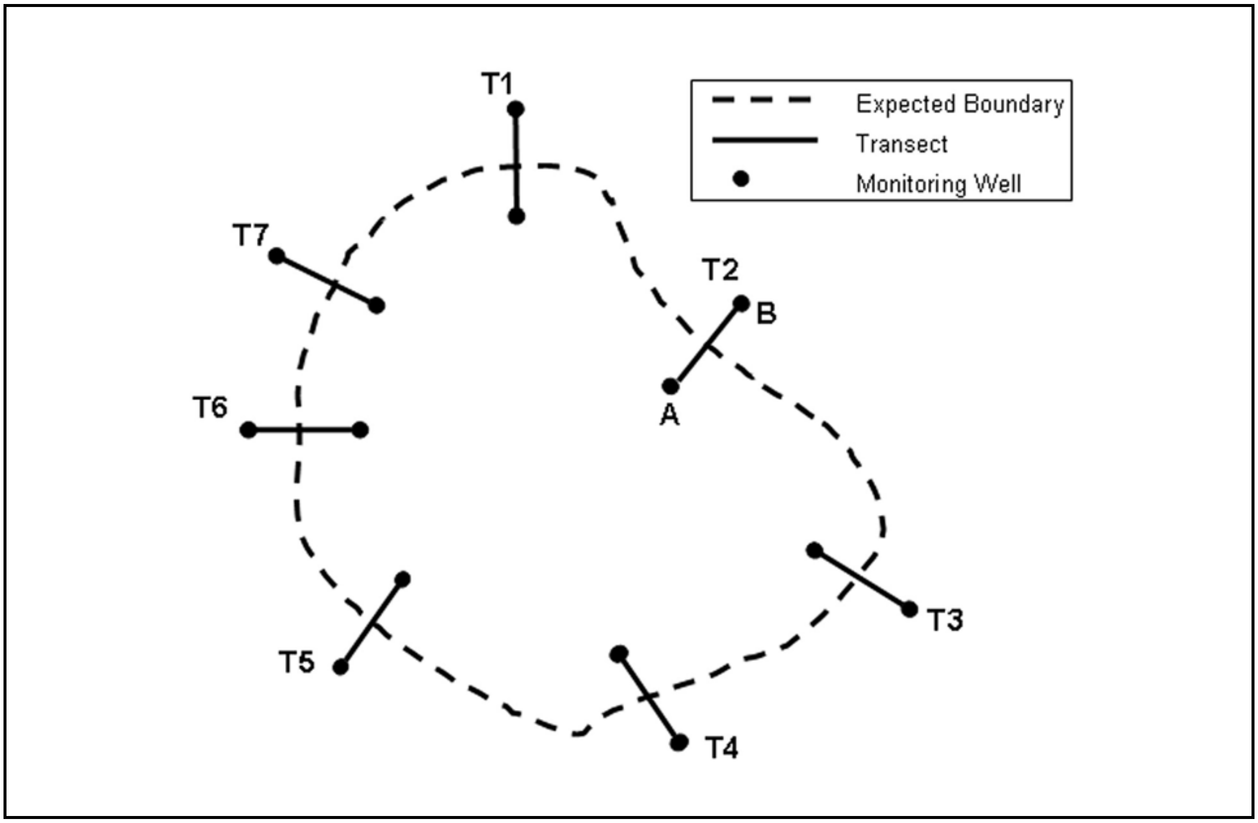

Figure 1. Example of monitoring wells located along transects across the expected wetland boundary. Transects extend from obvious upland to obvious wetland. Two or more wells are needed along each transect (e.g., at locations A and B).

MONITORING WELL CONSTRUCTION: In most cases, a standard monitoring well installed to a depth of 15 in. below the soil surface should be used to measure water-table depth on potential wetland sites. Shallower installation depths may be needed if restrictive soil layers exist within 15 in. of the surface. Monitoring wells must not penetrate any such restrictive layer. The standard design is for a well installed by augering. Depending upon site conditions, wells installed by driving may also be acceptable (see the section on Monitoring Well Installation). Installation of one or more additional deeper (4-5 ft) wells at each site is also encouraged to help in interpreting water-table fluctuations and warn of sudden changes in water-table depth. Deeper wells are not required but, if used, should not penetrate any restrictive soil layers. The performance of all wells must be tested and verified before use.

Monitoring Well Components. A standard monitoring well installed by augering is shown in Figure 2 and consists of the following main components: well screen, riser, well caps, sand filter pack, and bentonite sealant. Specifications for each of these components are given below.

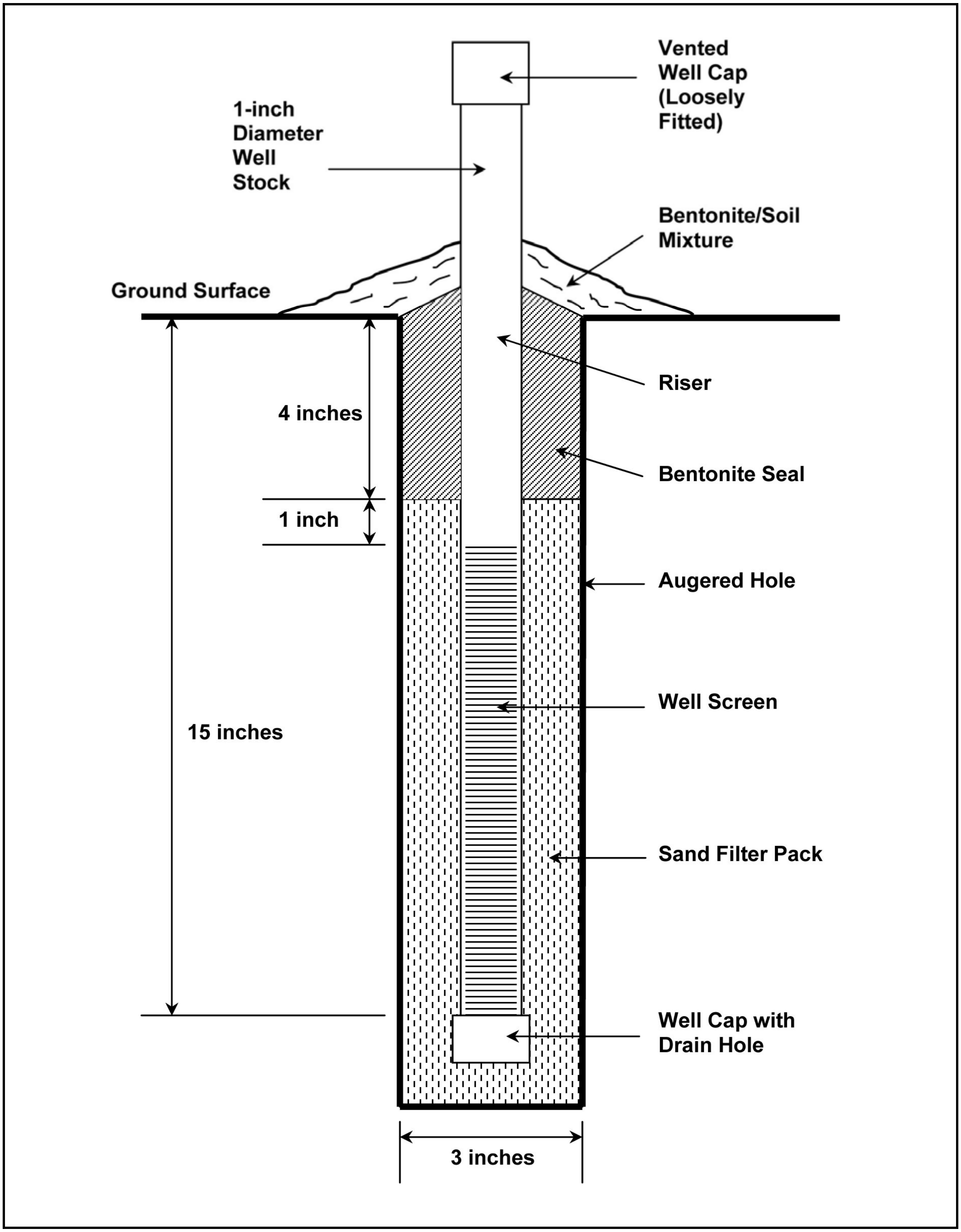

Figure 2. Standard 15-in. monitoring well installed by augering

Well Stock. Shallow monitoring wells should be made from commercially manufactured well stock. Schedule 40, 1-in. inside diameter PVC pipe is recommended. The diameter of the pipe allows sufficient room for hand measurement of water levels while minimizing well volume and maximizing responsiveness to water-table changes. The small diameter also minimizes auger hole diameter, volume of the filter pack, and the quantity of bentonite needed to seal the bore hole. However, if required by automated water-level recorders, then 2-in.-diam pipes can be substituted. Well stock larger than 2 in. in diameter should be avoided.

Well Screen and Bottom Cap. Recommended slot opening and slot spacing for the well screen are 0.010 in. and 0.125 in., respectively. The slotted screen should extend from approximately 5 in. below the ground surface down to the bottom of the well. Hand-slotted or drilled well screens should not be used.

One problem with the use of commercial well screen for very shallow monitoring wells is that there often is a length of unslotted pipe and joint or threads below the screen. In shallow monitoring situations, this extra length often must be inserted into underlying soil material that should be left undisturbed. In combination with a commercial well point, this extra length also provides a reservoir where water can remain trapped after the outside groundwater has dropped, resulting in the potential of misleading or incorrect readings during water-table drawdown. To avoid this problem, commercial well screen should be cut to the desired length within the slotted portion of the pipe. A PVC cap should be glued at the bottom of the screen and a small drain hole should be drilled in the bottom cap (Figure 2).

Riser. The riser is the unslotted PVC pipe that extends from the top of the well screen to above the ground surface (Figure 2). The riser should extend far enough above the ground to allow easy access but not so high that the leverage of normal handling will crack below-ground seals. In locations that do not pond or flood, 9 to 12 in. above the ground surface is usually sufficient. A longer riser may be needed on inundated sites or where automatic recording devices are used.

Well Top Cap. A well cap is required to protect the top of the well from contamination and rainfall. Caps should be attached loosely so they can be removed easily without jarring or dislodging the well, or cracking the bentonite seal. Tight-fitting caps, either threaded or unthreaded, should be avoided because they may seize to the riser and require rough handling to remove. A suitable well cap can be constructed from a short length of PVC pipe of a larger diameter than the riser, with a glued PVC cap at one end (Sprecher 2000). The constructed well cap can be attached loosely to the riser by drilling a hole through both the cap and the riser and connecting the two with a wire lock pin. The cap should be vented to allow equilibration of air pressure inside and outside of the well.

Filter Pack. A filter pack is placed around the well screen to remove fine particles and provide a zone of high hydraulic conductivity that promotes water movement toward the well (Figure 2). Filter packs can be classified into two major categories, natural and artificial. Natural packs are created by manually repacking any excavated soil around the well screen, ensuring that large voids are absent. Natural packs are recommended in coarse-textured, sandy soils. In fine-textured soils, an artificial pack should be used. See Table 1 for recommendations on the use of filter packs for soils of different textures.

Commercially available silica sand is recommended for use as artificial pack material and is usually well-sorted, well-rounded, clean, chemically inert, and free of all fine-grained clays, particles, and organic material. Silica sand is available from water-well supply houses in uniformly graded sizes. Sand that passes a 20-mesh screen and is retained by a 40-mesh screen (20-40 sand) is recommended with a 0.010-in. well screen.

Table 1
USDA Soil Texture Classes and Recommendations for Sand Filter Packs

USDA Soil Texture	Sand Pack
Muck, Mucky Peat, Peat	None
Coarse Sand	None
Medium Sand	None
Fine Sand	None
Loamy Sand	None
Sandy Loam	Recommended
Loam	Recommended
Silt Loam	Recommended
Silt	Recommended
Sandy Clay Loam	Required
Silty Clay Loam	Required
Clay Loam	Required
Sandy Clay	Required
Silty Clay	Required
Clay	Required

Bentonite Sealant. Bentonite is a type of clay that absorbs large quantities of water and swells when wetted. It is used in well installation to form a tight seal around the riser to prevent water from running down the outside of the pipe to the well screen. With this protective plug, only groundwater enters the slotted well screen.

When installing a monitoring well, 4 in. of bentonite should be placed around the riser immediately at and below the ground surface (Figure 2). This 4-in. ring of bentonite rests directly on top of the filter pack around the well screen. Above the bentonite ring, additional bentonite mixed with natural soil material should be mounded slightly and shaped to slope away from the riser so that surface water will run away from the pipe rather than pond around it at the ground surface.

Bentonite is available from well drilling supply companies in powder, chip, or pellet form. Chips are easiest to use in the field. They can be dropped directly down the annular space above the sand filter pack. If this zone is already saturated with water, the chips will absorb water in place, swell tight, and seal off the sand filter from above. If the bentonite chips are dropped into a dry annular space, they should be packed dry and then water should be added down the annular space so the clay can swell shut.

Modified Well Design for Clay Soils. In heavy clay soils, such as Vertisols, water movement occurs preferentially along cracks and interconnected large pores. These cracks may deliver water to a standard monitoring well through its vertical, slotted walls. Even when the surrounding soil is unsaturated, water may remain in the well for days due to impeded drainage into the slowly permeable clay. This problem can be reduced, but not eliminated, by using a well that is slotted or open only at the bottom. In addition, the sand filter pack should be installed only around the immediate well opening and should not extend up the riser. The annular space around the riser should be packed with the natural clay soil material or filled with bentonite.

Because Vertisols in wetland situations tend to be episaturated (i.e., they perch water at or near the surface but may remain unsaturated below), monitoring should focus on detection of surface ponding and saturation in the upper few inches of the soil. For this purpose, wells shorter than 15 in. may be needed.

MONITORING WELL INSTALLATION

Installation Methods. The recommended method for installing shallow monitoring wells involves the use of a bucket auger with an outside diameter 2 in. greater than the well diameter (e.g., 3 in. for a standard 1-in. well). As an alternative, wells may be installed by driving them into the ground. Driven wells may be preferred in areas with noncohesive coarse-grained (sandy) soils, rocky soils (e.g., glacial tills), or in saturated organic materials (i.e., mucks or peats). Procedures for both installation methods are given below. No matter which installation method is selected, wells must be tested for performance before being used. These procedures assume that the soil profile at the well location has already been described and that the appropriate well depth (i.e., 15 in. or less) has been determined based on the presence or absence of restrictive soil layers. A Monitoring Well Installation Data Form (Appendix B) should be completed to document the design and installation of each well (Sprecher 2000).

Augering. Recommended equipment includes a bucket auger 2 in. larger than the diameter of the well being installed, a tamping tool (e.g., wooden or metal rod), bentonite chips, silica sand, and the constructed monitoring well. A pump or bailer may be needed to test the well after installation. The following procedure is used to install the well:

1. Auger a hole in the ground to a depth approximately 2 in. deeper than the bottom of the well. Be sure the hole is vertical.
2. Scarify the sides of the hole if it was smeared during augering.
3. Place 2 to 3 in. of silica sand in the bottom of the hole.
4. For a 15-in. well with 10 in. of well screen, make a permanent mark on the well riser 5 in. above the top of the screen. Insert the well into the hole to the proper depth; the permanent mark on the riser should be even with the soil surface. Do not insert through the sand.
5. Pour and gently tamp more of the same sand in the annular space around the screen and 1 in. above the screen.
6. Pour and gently tamp 4 in. of bentonite chips above the sand to the ground surface. If necessary, add water to cause the bentonite sealant to expand.
7. Form a low mound of a soil/bentonite mixture on the ground surface around the base of the riser to prevent surface water from puddling around the pipe.

Driving. Well installation by driving is recommended when site conditions prevent augering (e.g., noncohesive sandy soils, soils with many coarse fragments, saturated organic soils). In addition, driven wells are acceptable whenever their performance can be shown to be equivalent to that of an augered well. Plans to use driven wells for regulatory purposes should be discussed in advance with the appropriate Corps of Engineers District office.

A driven well is similar in design and construction to the augered well described previously, with the addition of a well point in place of the bottom cap (Figure 3). Well points are commercially available and can be vented to permit draining by drilling a hole in the bottom. A special driving tool may be needed to install the well without damaging the PVC pipe.

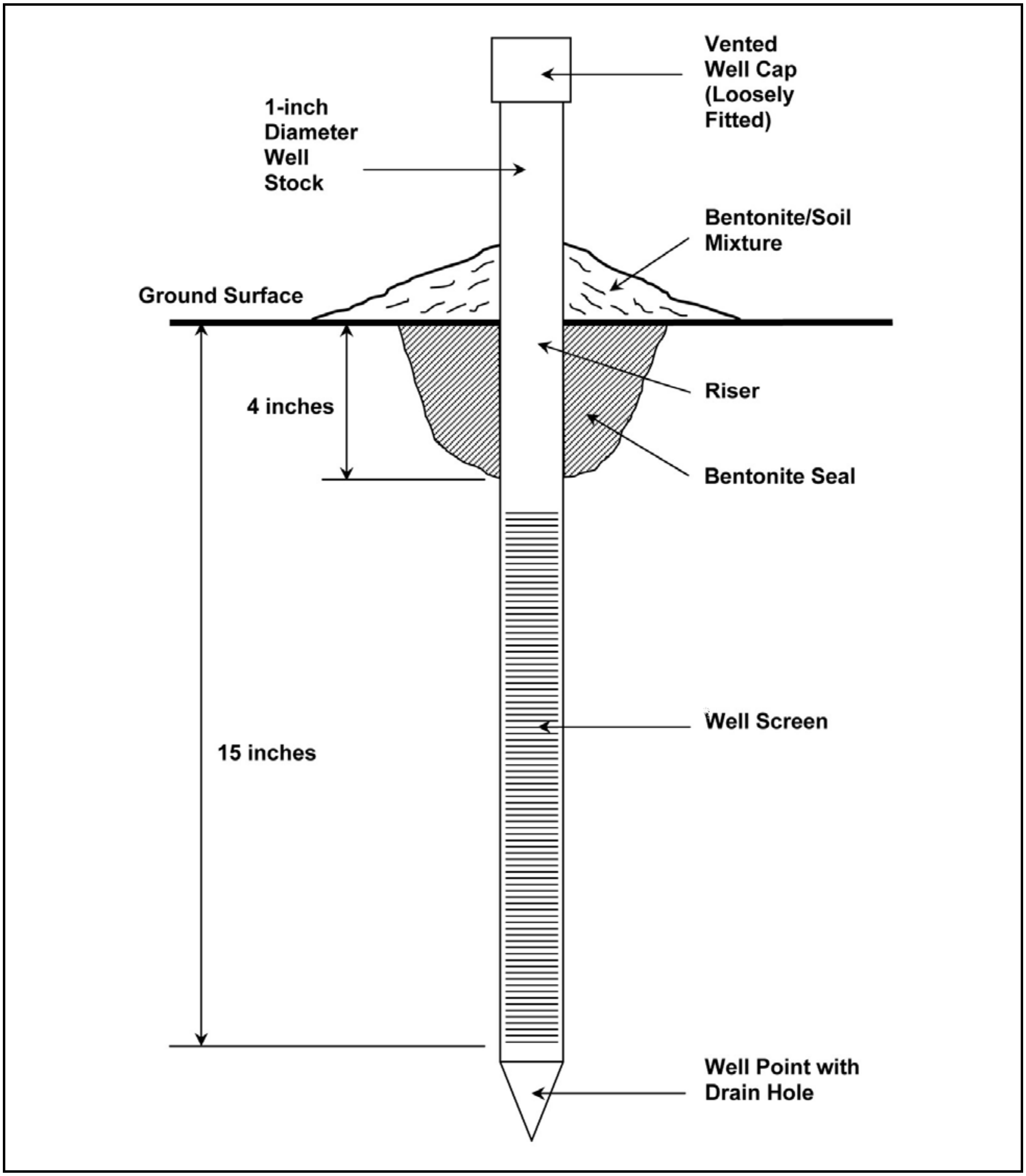

Figure 3. Standard 15-in. monitoring well installed by driving

Required materials include bentonite chips and the constructed monitoring well with vented well point. A pump or bailer may be needed to test the well after installation and, depending on site conditions, a driving device may be required. The following procedure is used to install the well:

1. For a standard 15-in. well, make a permanent mark on the riser 15 in. above the bottom of the well screen. With the well cap removed, use a driving device to drive the well vertically into the ground until the mark is at the ground surface. In organic soil materials, the well may simply be pushed into the ground.

2. Dig out a ring of soil around the well riser to a depth of 4 in. Fill this space with bentonite chips and add water, if necessary, to form a tight seal.

3. Form a low mound of a soil/bentonite mixture on the ground surface around the base of the riser to prevent surface water from puddling around the pipe.

Establishing Riser Height. Water-level measurements are typically recorded as the "depth to water" from the top of the well riser. The depth of the water table below the ground surface is determined by subtracting the riser height from the "depth to water" measurement. Therefore, after installing the well, measure and permanently record the height of the riser above the ground surface. If automated water-level recording devices are used, follow the manufacturer's instructions for calibration of water-level readings relative to the ground surface. Riser height should be checked after soils have thawed in spring, and should be re-checked periodically when water-table measurements are taken or electronic data are downloaded.

Surface Water. In areas subject to flooding or ponding, a separate staff gauge or automated device is required to measure the depth of surface water.

MONITORING WELL TESTING AND MAINTENANCE: During well installation, particularly with driven wells, fine soil particles may clog the well screen, impeding water flow and increasing the response time of the well. The performance of the well should be tested by (1) emptying the well by pumping or bailing and monitoring how quickly the water level returns to the initial level, or (2) if the well is dry, filling it with water and monitoring the rate of outflow. The water level in the well should reestablish itself at approximately the same rate as it would in a freshly dug hole without any pipe. In soils with a high percentage of clay, this could require several hours. If the water does not return to the initial level in a reasonable amount of time, pull the instrument out of the ground, clean it, reinstall it, and retest it. If water-table readings are questionable at any time during the monitoring period, one option is to move some distance away from the well location, auger to the depth in question, and determine whether the water level in the auger hole is the same as that indicated by the monitoring well.

Routine Maintenance. Monitoring well responsiveness should be tested at the beginning of the monitoring period and at least every 2-3 months thereafter by the procedure described above, because wells can plug over time due to bacterial growth and movement of fine soil particles. Well performance can also be affected by cracking of the bentonite seal, sediment deposition in the well, and movement of the ground surface and/or monitoring well due to frost heaving or shrink-swell action. To ensure accurate water-level readings, check for vertical displacement of the well after spring thaw and periodically during sampling by re-measuring the height of the riser above the ground surface and adjusting water-table measurements or resetting the well, as needed.

MAKING WATER-LEVEL MEASUREMENTS: Water levels in monitoring wells should be measured with an accuracy of ±0.25 in., if possible. Measurements may be made manually or with automated equipment. The use of automated water-level recorders is recommended unless an uninterrupted schedule of frequent site visits can be maintained. Automated recorders are also recommended in areas with highly variable or flashy hydrology. Whichever method is selected, it should be used consistently throughout the duration of the monitoring study.

Manual Readings. Water-level measurements can be made easily with a steel measuring tape marked with chalk or a water-soluble marker. Another approach is to use an electric device that sounds or flashes when the sensor, attached to the end of a graduated tape, makes contact with the water. Measurement devices that displace large amounts of water (e.g., dowel rods) should not be used.

Automated Readings. Automated recording devices record water levels with down-well transducers or capacitance-based sensors. An important consideration when purchasing automatic recording devices is the ability to compensate internally for variations in barometric pressure. These variations can be significant in wetland determinations. Automated equipment is more costly than hand measurement, but the devices can be used again in future studies. The credibility of monitoring results is enhanced with the high frequency of water-level readings that automated wells allow. Automated water-level recorders should be checked frequently for accuracy by comparison with manual readings. If automated readings are not within instrument specifications, the device should be recalibrated.

Required Timing, Frequency, and Duration of Readings. Water-level measurements must be taken at least once each day, beginning 5-7 days before the first day of the growing season and continuing until the end of the growing season or until the minimum standard for wetland hydrology is met that year. If automated recorders are used, readings four times per day are recommended (use the lowest reading each day). On sites subject to flooding or ponding, depth of surface water must be measured each day that water-table readings are made.

Growing season beginning and ending dates shall be based on the median dates (i.e., 5 years in 10, or 50 percent probability) of 28 °F air temperatures in spring and fall as reported in WETS tables provided by the USDA-NRCS National Water and Climate Center. WETS tables are based on long-term temperature data collected at National Weather Service (NWS) cooperative weather stations throughout the United States and are available on the Internet at http://www.wcc.nrcs.usda.gov/climate/wetlands.html. For a particular project site, growing season information from the nearest available weather station should be used unless, due to elevation or other factors, a more distant weather station is considered to be more representative of conditions at the project site. Alternative local or regional procedures for determining growing season dates may be used at the District's discretion.

Because hydrologic conditions are naturally variable, many years of groundwater monitoring data may be needed to establish what is typical for a given site. This is particularly true in the arid western United States where rainfall can be sparse, unpredictable, and highly localized. In general, ten or more years of water-table monitoring data may be needed to determine whether minimum standards for water-table depth, duration, and frequency in wetlands are met. However, because long-term monitoring is often impractical in a regulatory context, short-term studies may provide sufficient information if the normality of precipitation during the monitoring period is considered. Determining "normal" rainfall is addressed in the following section.

ANALYSIS AND INTERPRETATION OF MONITORING DATA

Technical Standard for Wetland Hydrology. Wetland hydrology is considered to be present on an atypical or problem site if the following standard is met:

> *The site is inundated (flooded or ponded) or the water table is ≤12 inches below the soil surface for ≥14 consecutive days during the growing season at a minimum frequency of 5 years in 10 (≥50% probability). Any combination of inundation or shallow water table is acceptable in meeting the 14-day minimum requirement. Short-term monitoring data may be used to address the frequency requirement if the normality of rainfall occurring prior to and during the monitoring period each year is considered.*

The Corps Manual discusses wetland hydrology in general, but does not provide a wetland hydrology criterion suitable for use in interpreting monitoring well data. The standard given above is based on recommendations by the National Academy of Sciences (National Research Council 1995). By requiring a water table within 12 in. of the surface, this standard ensures that saturation by free water or the capillary fringe occurs within the "major portion of the root zone" described in the Manual. A 14-day minimum duration standard is assumed to apply nationwide unless Corps Districts have adopted a different standard at the local or regional level. The Corps Manual addresses the need for long-term data (10 or more years) in analyses of stream-gauge data but does not consider the use of short-term data in wetland determinations, nor does it address the frequency issue in relation to water-table monitoring. This Technical Standard allows the use of short-term monitoring data to address the frequency requirement for wetland hydrology, if the normality of rainfall is considered.

The depth to saturation depends both on the position of the water table and the height of the tension-saturated capillary fringe (National Research Council 1995). While its presence has an influence on both plant growth and soil features, the upper limit of the capillary fringe is difficult to measure in the field and impractical as a basis for hydrologic monitoring. The Technical Standard for Wetland Hydrology is based on the depth of the water table because, in most cases, water-table depth can be monitored readily and consistently through the use of shallow wells with either manual or automated data collection. Water-table measurements should not be corrected for a capillary fringe unless other evidence, such as tensiometer readings, laboratory analysis of soil water content, or evidence of soil anoxia, indicates that the height of the saturated capillary fringe is greater than a few inches.

Determining Normal Precipitation. Short-term water-table monitoring data (i.e., <10 years) must be interpreted in relation to the amount of precipitation that fell during and for at least 3 months prior to the monitoring period each year. This is done by comparing the precipitation record for a given year with the normal range of precipitation based on long-term records collected at the nearest appropriate NWS cooperative weather station. The USDA-NRCS National Water and Climate Center calculates normal precipitation ranges for each month (defined as between the 30^{th} and 70^{th} percentiles of monthly precipitation totals) for NWS stations throughout the United States. The information is published in WETS tables available on the Internet (http://www.wcc.nrcs.usda.gov/climate/wetlands.html).

Sprecher and Warne (2000, Chapter 4) describe three methods for evaluating precipitation normality within a given year. The first method is taken from the NRCS Engineering Field Handbook (Natural Resources Conservation Service 1997) and involves the direct application of WETS tables in relation to monthly rainfall totals at the project site. At a minimum, this method shall be used to determine whether rainfall was normal immediately before and during a groundwater monitoring study. The analysis should focus on the period leading up to and during the time when water tables are usually high in that climatic region. In many parts of the country, this is at the beginning of the growing season, when precipitation is abundant and evapotranspiration is relatively low. The second method described by Sprecher and Warne (2000) evaluates daily precipitation data on the basis of 30-day rolling sums, and the third method combines the two procedures. If daily precipitation data are available, the combined method is recommended. The evaluation of precipitation normality should include the three months prior to the start of the growing season and extend throughout the entire monitoring period each year.

For many wetlands, water tables in a given year may be affected by precipitation that occurred in previous years, especially if monitoring occurs after an extended period of drought or precipitation excess. After a series of dry years, for example, it may take several years of normal or above-normal rainfall to recharge groundwater and return water tables to normal levels. Therefore, in evaluating wetland hydrology based on short-term monitoring, it is necessary to consider the normality of rainfall over a period of years prior to the groundwater study. Recent precipitation trends can be determined by comparing annual rainfall totals at the monitoring site with the normal range given in WETS tables for two or more years prior to the monitoring study, or by examining trends in drought indices, such as the Palmer Drought Severity Index (Sprecher and Warne 2000). This issue may not be important in soils with perched water tables that respond to the current year's rainfall and dry out seasonally.

Interpreting Results. If ten or more years of water-table monitoring data are available for a site, the long-term record probably includes years of normal, below normal, and above normal precipitation and thus reflects the average hydrologic conditions on the site. Therefore, wetland hydrology can be evaluated directly by the following procedure:

1. For each year, determine the maximum number of consecutive days that the site was either inundated or the water table was ≤12 in. from the ground surface during the growing season. Wetland hydrology occurred in a given year if the number of consecutive days of inundation or shallow water tables was ≥14 days.

2. The Technical Standard for Wetland Hydrology was met if wetland hydrology occurred in at least 50 percent of years (i.e., ≥5 years in 10).

This procedure may not be appropriate during extended periods of drought or precipitation excess. Furthermore, in some regions with highly variable precipitation patterns (e.g., the arid West) more than ten years of groundwater monitoring data may be needed to capture the typical hydrologic conditions on a site.

If fewer than ten years of water-table data are available, then the normality of precipitation preceding and during the monitoring period must be considered. One option is to apply the procedures described in the section on "Determining Normal Precipitation" for each year that water tables were monitored. In addition, annual precipitation or drought severity indices should be evaluated for two or more years prior to the monitoring period on any site that lacks a perched water table. Wetland hydrology can then be evaluated by the following procedure:

1. Select those years of monitoring data when precipitation was normal, or select an equal number of wetter-than-normal and drier-than-normal years.

2. If wetland hydrology (i.e., any combination of inundation or water table ≤12 in. from the surface for ≥14 consecutive days during the growing season) occurred in ≥50 percent of years (e.g., 3 years in 5), then the site most likely meets the Technical Standard for Wetland Hydrology.

It is important to remember that, even in normal rainfall years, many wetlands will lack wetland hydrology in some years due to annual differences in air temperatures (which affect evapotranspiration rates) and the daily distribution of rainfall that are not considered in this analysis. This is particularly true of borderline wetlands that may have shallow water tables in only 50-60 percent of years. Therefore, this procedure may fail to identify some marginal wetlands.

Another option, particularly for very short-duration monitoring studies (e.g., ≤3 years), is to evaluate water-table measurements in conjunction with groundwater modeling. Hunt et al. (2001) described one such approach, called the Threshold Wetland Simulation (TWS), which uses the DRAINMOD model. Actual water-table measurements in a given year are compared with those of a simulated, threshold wetland (i.e., one that meets wetland hydrology requirements in exactly 50 percent of years). The TWS approach requires detailed long-term precipitation and temperature data, soil characteristics, and considerable expertise with the DRAINMOD program.

No method to determine wetland hydrology based on short-term water-table measurements is entirely reliable or free of assumptions. Therefore, ultimate responsibility for the interpretation of water-table monitoring data rests with the appropriate Corps District.

REPORTING OF RESULTS: Warne and Wakeley (2000) provided a comprehensive checklist of information that should be included in the report of a groundwater monitoring study. The report should also include a justification for any deviations from procedures given in this Technical Standard.

The report should include a clear, graphical presentation of daily water-table levels at each well plotted over time and shown in relation to the soil surface and the 12-in. depth, the depth of the monitoring well, growing season starting and ending dates, local precipitation that year, and normal precipitation ranges based on WETS tables. Another useful feature is a diagram of the soil profile at the well location including depths and textures of each major horizon. An example graph with many of these features is shown in Figure 4 (Sprecher 2000).

ACKNOWLEDGMENTS: The initial outline for this Technical Standard was developed at a workshop in Decatur, GA, in September 2003. Participants (in alphabetical order) were Mr. William Ainslie, U. S. Environmental Protection Agency (USEPA), Region 4; Mr. Bradley Cook, Minnesota State University, Mankato; Mr. Jason Hill, Tennessee Tech University (TTU); Ms. Julie Kelley, Geotechnical and Structures Laboratory (GSL), U. S. Army Engineer Research and Development Center (ERDC); Dr. Barbara Kleiss, Environmental Laboratory (EL), ERDC; Dr. Vincent Neary, TTU; Mr. Chris Noble, EL-ERDC; Dr. Bruce Pruitt, Nutter and Associates, Inc.; Dr. Thomas Roberts, TTU; Mr. Paul Rodrigue, USDA Natural Resources Conservation Service (NRCS);

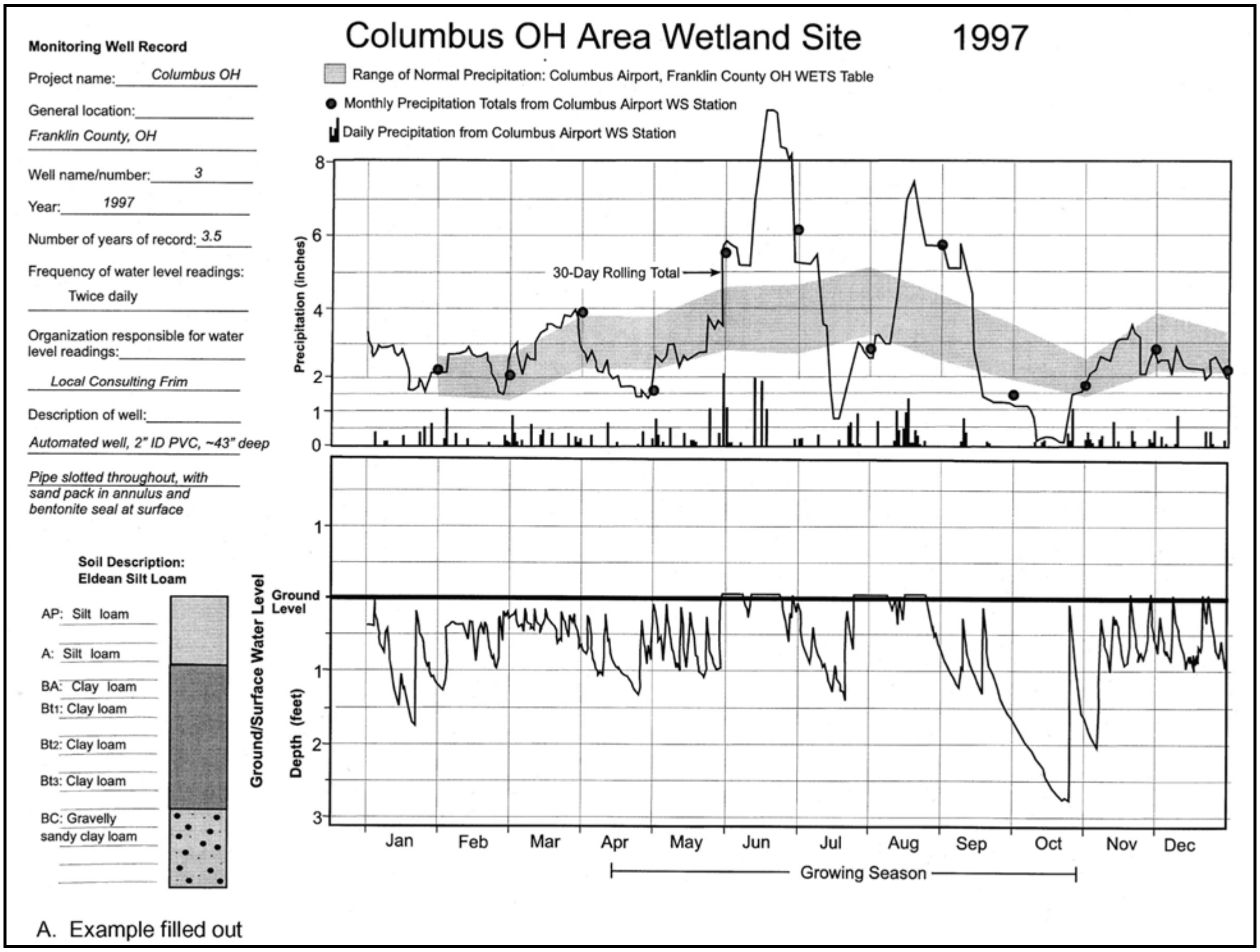

Figure 4. Example of graphical presentation of water-table monitoring data (Note that this example uses a deeper well than the 15 in. specified in this Technical Standard)

Dr. Steven Sprecher, U. S. Army Engineer (USAE) District, Detroit; and Dr. James Wakeley, EL-ERDC. The first draft was written by Drs. Neary and Wakeley and Messrs. Hill and Noble. Technical reviewers included Harry Baij, Jr., USAE District, Anchorage; Mark Clark, NRCS; David D'Amore, U. S. Forest Service (USFS); Jackie DeMontigny, USFS; Michiel Holley, USAE District, Anchorage; Wesley Miller, NRCS; James Miner, Illinois State Geological Survey; Joe Moore, NRCS; Dr. Chien-Lu Ping, University of Alaska, Fairbanks; Ann Puffer, USFS; and Ralph Rogers, USEPA Region 10. A subcommittee of the National Technical Committee for Hydric Soils (NTCHS) provided an independent peer review in accordance with Office of Management and Budget guidelines. The authors are grateful to NTCHS members Drs. Michael Vepraskas and R. Wayne Skaggs, North Carolina State University; and Mr. Ed Blake, Mr. P. Michael Whited, Ms. Lenore Vasilas, and Mr. G. Wade Hurt, NRCS, for their comments and suggestions. The work was supported by Headquarters, U. S. Army Corps of Engineers through the Wetlands Regulatory Assistance Program (WRAP).

POINTS OF CONTACT: For additional information, contact Dr. James S. Wakeley, U. S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, (601-634-3702, *James.S.Wakeley@erdc.usace.army.mil*) or the Program Manager of the Wetlands Regulatory

Assistance Program, Mr. Bob Lazor (601-634-2935, *Bob.L.Lazor@erdc.usace.army.mil*). This technical note should be cited as follows:

> U. S. Army Corps of Engineers. (2005). "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," *WRAP Technical Notes Collection* (ERDC TN-WRAP-05-2), U. S. Army Engineer Research and Development Center, Vicksburg, MS.

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Hunt, W. F., III, Skaggs, R. W, Chescheir, G. M., and Amatya, D. M. (2001). "Examination of the Wetland Hydrologic Criterion and its Application in the Determination of Wetland Hydrologic Status," Report No. 333, Water Resources Research Institute of the University of North Carolina, North Carolina State Univ., Raleigh.

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Sprecher, S. W. (2000). "Installing monitoring wells/piezometers in wetlands," WRAP Technical Notes Collection, ERDC TN-WRAP-00-02, U.S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/elpubs/pdf/tnwrap00-2.pdf)

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Warne, A. G., and Wakeley, J. S. (2000). "Guidelines for conducting and reporting hydrologic assessments of potential wetland sites," *WRAP Technical Notes Collection*, ERDC TN-WRAP-00-01, U.S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/elpubs/pdf/tnwrap00-1.pdf)

APPENDIX A. SOIL CHARACTERIZATION DATA FORM

Soil Characterization Data Form

Project Name________________________________ Date_________________________
Personnel___________________________________ Soil Pit ID____________________

Horizon Depths (inches)	Texture	Matrix Color (Munsell moist)	Redoximorphic Features		Induration (none, weak, strong)	Roots
			Color	Abundance		

Comments:

APPENDIX B. MONITORING WELL INSTALLATION DATA FORM

Monitoring Well Installation Data Form

Project Name ______________________________ Date of Installation _______________
Project Location ____________________________ Personnel ______________________
Well Identification Code _____________________
Attach map of project, showing well locations and significant topographic and hydrologic features.

Characteristics of Instrument:
Source of instrument/well stock____
Material of well stock ______________________ Diameter of pipe _________________
Slot width_______________________________ Slot spacing _____________________
Kind of well cap __________________________ Kind of well point/end plug _________
Installation:
Was well installed by augering or driving? ____
Kind of filter sand_________________________ Kind of bentonite_________________
Depth to lowest screen slots _______________ Riser height above ground _________
Was bentonite wetted for expansion? ____
Method of measuring water levels in instrument ___________________________________
How was instrument checked for clogging after installation?__________________________

Instrument Diagram[a]	Soil Characteristics					
	Texture	Matrix Color	Redoximorphic Features		Induration (none, weak, strong)	Roots
			Color	Abundance		

[a]Show depths (heights) of riser, well screen, sand pack, and bentonite in relation to soil horizons.

APPENDIX B
NM OSE WELL DRILLING PERMITS

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Tom Blaine, P.E.
State Engineer

Las Cruces Office
1680 HICKORY LOOP, SUITE J
LAS CRUCES, NM 88005

Trn Nbr: 619481
File Nbr: LRG 15537

Feb. 06, 2018

R. SCOTT QUINT
EGC, INC
17806 IH-10 WEST, SUITE 3000
SAN ANTONIO, TX 78257

Greetings:

Enclosed is your copy of the above numbered permit that has been approved subject to the conditions set forth on the approval page.

A Well Record & Log (OSE Form wr-20) shall be filed in this office within twenty (20) days after completion of drilling, but no later than 02/06/2019

Appropriate forms can be downloaded from the OSE website www.ose.state.nm.us or will be mailed upon request.

Sincerely,

Yvette C. Lopez
Water Resource Specialist
(575)524-6161, ext. 1008

Enclosure

explore

4.22747

File No. LRG 15537

NEW MEXICO OFFICE OF THE STATE ENGINEER

Office of the State Engineer — Interstate Stream Commission

WR-07 APPLICATION FOR PERMIT TO DRILL

A WELL WITH NO WATER RIGHT

(check applicable box):

GREAT SEAL OF THE STATE OF NEW MEXICO 1912

For fees, see State Engineer website: http://www.ose.state.nm.us/

Purpose:	☐ Pollution Control And/Or Recovery	☐ Ground Source Heat Pump
☐ Exploratory Well (Pump test)	☐ Construction Site/Public Works Dewatering	☐ Other(Describe):
☒ Monitoring Well	☐ Mine Dewatering	

A separate permit will be required to apply water to beneficial use regardless if use is consumptive or nonconsumptive.

☐ Temporary Request - Requested Start Date: Requested End Date:

Plugging Plan of Operations Submitted? ☐ Yes ☐ No

1. APPLICANT(S)

Name: US International Boundary and Water Commission	Name: EGC, INC
Contact or Agent: check here if Agent ☐ Elizabeth Verdecchia	Contact or Agent: check here if Agent ☒ R. Scott Quint
Mailing Address: 4171 North Mesa, Suite C-100	Mailing Address: 17806 IH-10 West, Suite 300
City: El Paso	City: San Antonio
State: TX Zip Code: 79902-1441	State: TX Zip Code: 78257
Phone: 915.832.4701 ☐ Home ☒ Cell Phone (Work):	Phone: 210.324.7501 ☐ Home ☒ Cell Phone (Work):
E-mail (optional): elizabeth.verdecchia@ibwc.gov	E-mail (optional): scott.quint@egc-inc.net

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FOR OSE INTERNAL USE — Application for Permit, Form WR-07, Rev 11/17/16

File No.: LRG 15537	Trn. No.: 619481	Receipt No.:
Trans Description (optional):		
Sub-Basin:	PCW/LOG Due Date: 2/6/19	

2. WELL(S) Describe the well(s) applicable to this application.

Location Required: Coordinate location must be reported in NM State Plane (NAD 83), UTM (NAD 83), or Latitude/Longitude (Lat/Long - WGS84).
District II (Roswell) and District VII (Cimarron) customers, provide a PLSS location in addition to above.

☐ NM State Plane (NAD83) (Feet)
☐ NM West Zone
☐ NM East Zone
☐ NM Central Zone

■ UTM (NAD83) (Meters)
☐ Zone 12N
■ Zone 13N

☐ Lat/Long (WGS84) (to the nearest 1/10th of second)

Well Number (if known):	X or Easting or Longitude:	Y or Northing or Latitude:	Provide if known: -Public Land Survey System (PLSS) (*Quarters or Halves, Section, Township, Range*) OR - Hydrographic Survey Map & Tract; OR - Lot, Block & Subdivision; OR - Land Grant Name
POD 50 BE-MW-1	343266.923	3549980.886	
51 CCB-MW-2	288628.142	3621016.333	
52 CCB-MW-3	289595.73	3620335.008	
53 CCE-MW-2	347881.117	3522991.219	
54 ME-MW-1	328825.936	3569587.616	

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NOTE: If more well locations need to be described, complete form WR-08 (Attachment 1 – POD Descriptions)
Additional well descriptions are attached: ■ **Yes** ☐ **No** **If yes, how many** 2

Other description relating well to common landmarks, streets, or other:
All wells are located along the Rio Grande River in Sierra and Dona Ana Counties.

Well is on land owned by: USIBWC

Well Information: NOTE: If more than one (1) well needs to be described, provide attachment. **Attached?** ■ **Yes** ☐ **No**
If yes, how many 7

Approximate depth of well (feet):	Outside diameter of well casing (inches):
Driller Name: Shane B. Currie	Driller License Number: WD-1575

3. ADDITIONAL STATEMENTS OR EXPLANATIONS

Seven existing monitoring wells (MWs) need to be redrilled along the Rio Grande River. The MWs are part of the USIBWC Rio Grande Canalization Project area in Sierra and Dona Ana Counties and are used to monitor groundwater (GW) levels at the sites identified for restoration of aquatic habitat and a mosaic of native riparian plant communities. The GW level data collected is used to determine planting depths at restoration sites and to identify sites that need supplemental irrigation. The planned monitoring duration will be five years.

As part of the redrilling process, the current MWs will be "plugged". Personnel will use a tremie pipe to pump cement grout (per Subsection A of 19.27.4.31 NMAC Guidelines) from the bottom of the well to two feet below the surface with the well head being cut off at two feet. The cement grout will be a Type I Portland cement mixed on site with approximately 5.5 gallons of water per 94 pound sack of cement. The well pads and bollards will be removed from the location and the site being brought back to grade with the use of a skid loader.

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: LRG 15537	Trn No.: 619481

NEW MEXICO OFFICE OF THE STATE ENGINEER

ATTACHMENT 1
POINT OF DIVERSION DESCRIPTIONS

This Attachment is to be completed if more than one (1) point of diversion is described on an Application or Declaration.

a. Is this a: ☐ Move-From Point of Diversion(s) ☐ Move-To Point of Diversion(s)	**b. Information on Attachment(s):** Number of points of diversion involved in the application: _____ Total number of pages attached to the application: _____

☐ **Surface Point of Diversion** OR ▣ **Well**	
Name of ditch, acequia, or spring:	
Stream or water course:	
Tributary of:	

c. Location (Required):
Required: Move to POD location coordinate must be either New Mexico State Plane (NAD 83), UTM (NAD 83), or Lat/Long (WGS84)

NM State Plane (NAD83) (feet)	UTM (NAD83) (meters)		OTHER (allowable only for move-from descriptions - see application form for format)
NM West Zone ☐ NM Central Zone ☐ NM East Zone ☐	Zone 13N ▣ Zone 12N ☐	☐ Lat/Long–(WGS84) 1/10th of second	☐ PLSS (quarters, section, township, range) ☐ Hydrographic Survey, Map & Tract ☐ Lot, Block & Subdivision ☐ Grant
POD Number: 55 SP-MW-1	X or Longitude 3520045.962	Y or Latitude 350245.369	Other Location Description:
POD Number: 56 SPB-MW-3	X or Longitude 3599446.13	Y or Latitude 314815.88	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:
POD Number:	X or Longitude	Y or Latitude	Other Location Description:

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LAS CRUCES, NM

FOR OSE INTERNAL USE

Form wr-08
POD DESCRIPTIONS - ATTACHMENT 1

File Number: LRG 15537	Trn Number: 619481
Trans Description (optional):	

4. SPECIFIC REQUIREMENTS: The applicant must include the following, as applicable to each well type. Please check the appropriate boxes, to indicate the information has been included and/or attached to this application:

Exploratory:	**Pollution Control and/or Recovery:**	**Construction De-Watering:**	**Mine De-Watering:**
☐ Include a description of any proposed pump test, if applicable. **Monitoring:** ☒ Include the reason for the monitoring well, and, ☒ The duration of the planned monitoring.	☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for the pollution control or recovery operation. ☐ The estimated maximum period of time for completion of the operation. ☐ The annual diversion amount. ☐ The annual consumptive use amount. ☐ The maximum amount of water to be diverted and injected for the duration of the operation. ☐ The method and place of discharge. ☐ The method of measurement of water produced and discharged. ☐ The source of water to be injected. ☐ The method of measurement of water injected. ☐ The characteristics of the aquifer. ☐ The method of determining the resulting annual consumptive use of water and depletion from any related stream system. ☐ Proof of any permit required from the New Mexico Environment Department. ☐ An access agreement if the applicant is not the owner of the land on which the pollution plume control or recovery well is to be located.	☐ Include a description of the proposed dewatering operation, ☐ The estimated duration of the operation, ☐ The maximum amount of water to be diverted, ☐ A description of the need for the dewatering operation, and, ☐ A description of how the diverted water will be disposed of. **Ground Source Heat Pump:** ☐ Include a description of the geothermal heat exchange project, ☐ The number of boreholes for the completed project and required depths. ☐ The time frame for constructing the geothermal heat exchange project, and, ☐ The duration of the project. ☐ Preliminary surveys, design data, and additional information shall be included to provide all essential facts relating to the request.	☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for mine dewatering. ☐ The estimated maximum period of time for completion of the operation. ☐ The source(s) of the water to be diverted. ☐ The geohydrologic characteristics of the aquifer(s). ☐ The maximum amount of water to be diverted per annum. ☐ The maximum amount of water to be diverted for the duration of the operation. ☐ The quality of the water. ☐ The method of measurement of water diverted. ☐ The recharge of water to the aquifer. ☐ Description of the estimated area of hydrologic effect of the project. ☐ The method and place of discharge. ☐ An estimation of the effects on surface water rights and underground water rights from the mine dewatering project. ☐ A description of the methods employed to estimate effects on surface water rights and underground water rights. ☐ Information on existing wells, rivers, springs, and wetlands within the area of hydrologic effect.

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LAS CRUCES, NM

ACKNOWLEDGEMENT

I, We (name of applicant(s)), R. Scott Quint on behalf of the USIBWC

Print Name(s)

affirm that the foregoing statements are true to the best of (my, our) knowledge and belief.

Applicant Signature

Applicant Signature 2017-01-25

ACTION OF THE STATE ENGINEER

This application is:

☒ approved ☐ partially approved ☐ denied

provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare and further subject to the attached conditions of approval.

Witness my hand and seal this 6 day of February 20 18 , for the State Engineer,

Tom Blaine, P.E., STATE ENGINEER ______, State Engineer

By: BY
Signature
Yvette C. Lopez
Water Resources Professional II

Print

Title:
Print

STATE OF NEW MEXICO STATE ENGINEER

FOR OSE INTERNAL USE

Application for Permit, Form WR-07

File No.: LRG 15537	Trn No.: 619481

NEW MEXICO STATE ENGINEER OFFICE
PERMIT TO EXPLORE

SPECIFIC CONDITIONS OF APPROVAL

17-4 No water shall be appropriated and beneficially used under this permit.

17-6 The well authorized by this permit shall be plugged completely using the following method per Rules and Regulations Governing Well Driller Licensing, Construction, Repair and Plugging of Wells; Subsection C of 19.27.4.30 NMAC unless an alternative plugging method is proposed by the well owner and approved by the State Engineer upon completion of the permitted use. All pumping appurtenance shall be removed from the well prior to plugging. To plug a well, the entire well shall be filled from the bottom upwards to ground surface using a tremie pipe. The bottom of the tremie shall remain submerged in the sealant throughout the entire sealing process; other placement methods may be acceptable and approved by the state engineer. The well shall be plugged with an office of the state engineer approved sealant for use in the plugging of non-artesian wells. The well driller shall cut the casing off at least four (4) feet below ground surface and fill the open hole with at least two vertical feet of approved sealant. The driller must fill or cover any open annulus with sealant. Once the sealant has cured, the well driller or well owner may cover the seal with soil. A Plugging Report for said well shall be filed with the Office of the State Engineer in a District Office within 30 days of completion of the plugging.

17-7 The Permittee shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical.

17-B The well shall be drilled by a driller licensed in the State of New Mexico in accordance with 72-12-12 NMSA 1978. A licensed driller shall not be required for the construction of a well driven without the use of a drill rig, provided that the casing shall not exceed two and three-eighths (2 3/8) inches outside diameter.

NEW MEXICO STATE ENGINEER OFFICE
PERMIT TO EXPLORE

SPECIFIC CONDITIONS OF APPROVAL (Continued)

17-C The well driller must file the well record with the State Engineer and the applicant within 30 days after the well is drilled or driven. It is the well owner's responsibility to ensure that the well driller files the well record.
The well driller may obtain the well record form from any District Office or the Office of the State Engineer website.

17-G If artesian water is encountered, the well driller shall comply with all rules and regulations pertaining to the drilling and casing of artesian wells.

17-Q The State Engineer retains jurisdiction over this permit.

17-R Pursuant to section 72-8-1 NMSA 1978, the permittee shall allow the State Engineer and OSE representatives entry upon private property for the performance of their respective duties, including access to the ditch or acequia to measure flow and also to the well for meter reading and water level measurement.

LOG The Point of Diversion LRG 15537 POD50 must be completed and the Well Log filed on or before 02/06/2019.

LOG The Point of Diversion LRG 15537 POD51 must be completed and the Well Log filed on or before 02/06/2019.

LOG The Point of Diversion LRG 15537 POD52 must be completed and the Well Log filed on or before 02/06/2019.

LOG The Point of Diversion LRG 15537 POD53 must be completed and the Well Log filed on or before 02/06/2019.

NEW MEXICO STATE ENGINEER OFFICE
PERMIT TO EXPLORE

SPECIFIC CONDITIONS OF APPROVAL (Continued)

LOG The Point of Diversion LRG 15537 POD54 must be completed and the Well Log filed on or before 02/06/2019.

LOG The Point of Diversion LRG 15537 POD55 must be completed and the Well Log filed on or before 02/06/2019.

LOG The Point of Diversion LRG 15537 POD56 must be completed and the Well Log filed on or before 02/06/2019.

SEE ATTACHED FOR CONDITIONS OF APPROVAL

ACTION OF STATE ENGINEER

Notice of Intention Rcvd:
Formal Application Rcvd: 01/26/2018
Date Returned - Correction:

Date Rcvd. Corrected:
Pub. of Notice Ordered:
Affidavit of Pub. Filed:

This application is approved provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare of the state; and further subject to the specific conditions listed previously.

Witness my hand and seal this 06 day of Feb A.D., 2018

Tom Blaine, P.E. , State Engineer

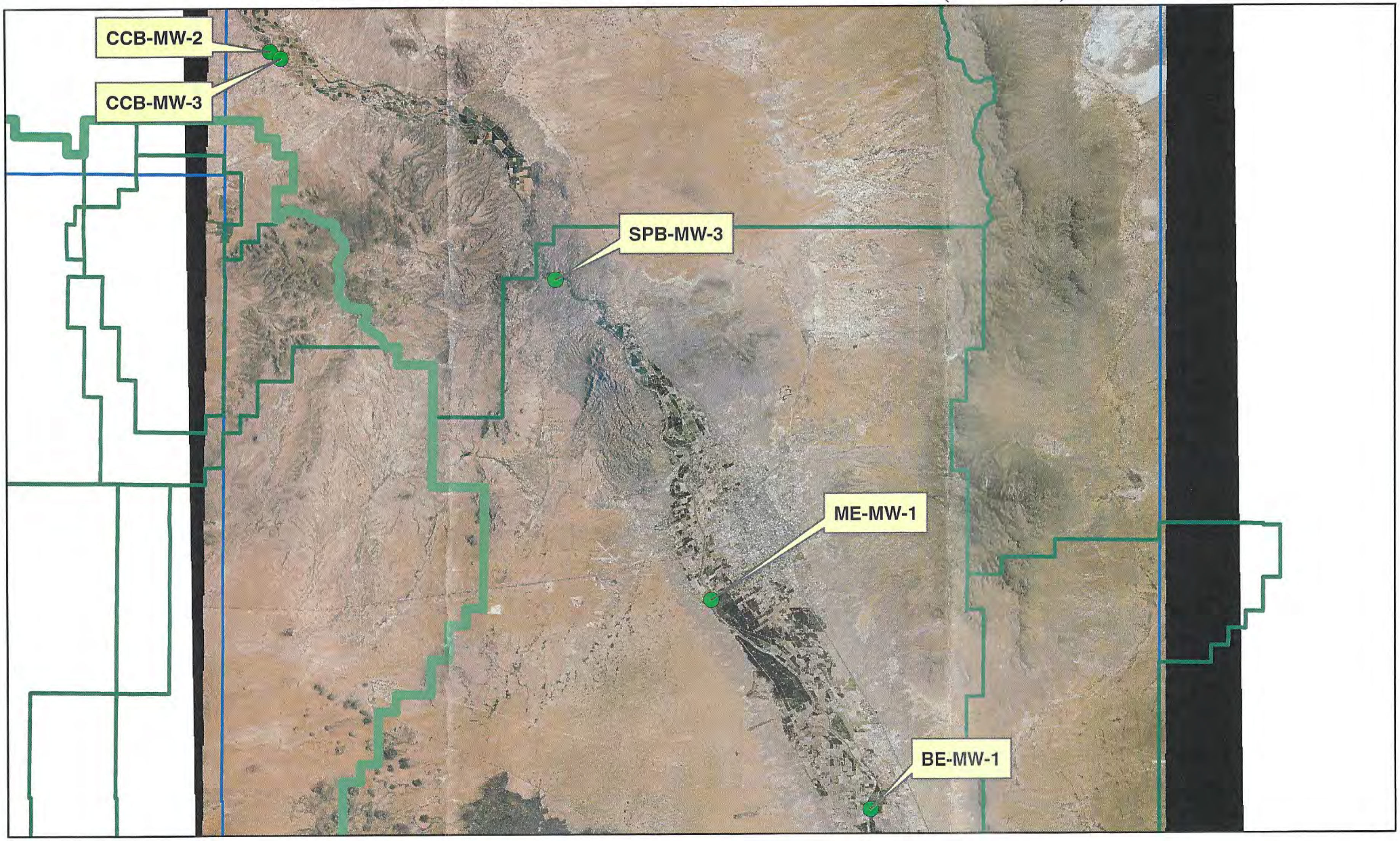
By: [signature]
YVETTE LOPEZ

STATE OF NEW MEXICO STATE ENGINEER

Trn Desc: LRG 15537 POD50-56

File Number: LRG 15537
Trn Number: 619481

SITE MAP: MONITORING WELLS (IBWC)



January 17, 2018
Edward J Enriquez
Water Resource Specialist Senior
WRAP District IV
New Mexico State Plane Central
2016 Aerial Photograph

N

Legend

- DIST IV BOUNDARY
- DECLARED GROUNDWATER BASINS
- NM COUNTIES

Office of the State Engineer
Interstate Stream Commission

OFFICE OF THE STATE ENGINEER/INTERSTATE STREAM COMMISSION – LAS CRUCES OFFICE

OFFICIAL RECEIPT NUMBER: 4 - 22747 DATE: 1-26-18 FILE NO.: ______

TOTAL: 35 . 00 RECEIVED: Thirty Five DOLLARS CHECK NO.: 1035 CASH: ______

PAYOR: Ronald Quist ADDRESS: ______ CITY: ______ STATE: ______

ZIP: ______ RECEIVED BY: JC

INSTRUCTIONS: Indicate the number of actions to the left of the appropriate type of filing. Complete the receipt information. **Original** to payor; **pink** copy to Program Support/ASD; and **yellow** copy for Water Rights. If a mistake is made, void the original and all copies and submit to Program Support/ASD as part of your daily deposit.

A. Ground Water Filing Fees

___	1. Change of Ownership of Water Right	$ 2.00
___	2. Application to Appropriate or Supplement Domestic 72-12-1 Well	$ 125.00
___	3. Application to Repair or Deepen 72-12-1 Well	$ 75.00
___	4. Application for Replacement 72-12-1 Well	$ 75.00
___	5. Application to Change Purpose of Use 72-12-1 Well	$ 75.00
___	6. Application for Stock Well	$ 5.00
___	7. Application to Appropriate Irrigation, Municipal, or Commercial Use	$ 25.00
___	8. Declaration of Water Right	$ 1.00
___	9. Application for Supplemental Non 72-12-1 Well	$ 25.00
___	10. Application to Change Place or Purpose of Use Non 72-12-1 Well	$ 25.00
___	11. Application to Change Point of Diversion and Place and/or Purpose of Use from Surface Water to Ground Water	$ 50.00
___	12. Application to Change Point of Diversion and Place and/or Purpose of Use from Ground Water to Ground Water	$ 50.00
___	13. Application to Change Point of Diversion of Non 72-12-1 Well	$ 25.00
___	14. Application to Repair or Deepen Non 72-12-1 Well	$ 5.00
7	15. Application for Test, Expl. Observ. Well	$ 5.00
___	16. Application for Extension of Time	$ 25.00
___	17. Proof of Application to Beneficial Use	$ 25.00
___	18. Notice of Intent to Appropriate	$ 25.00

B. Surface Water Filing Fees

___	1. Change of Ownership of a Water Right	$ 5.00
___	2. Declaration of Water Right	$ 10.00
___	3. Amended Declaration	$ 25.00
___	4. Application to Change Point of Diversion and Place and/or Purpose of Use from Surface Water to Surface Water	$ 200.00
___	5. Application to Change Point of Diversion and Place and/or Purpose of Use from Ground Water to Surface Water	$ 200.00
___	6. Application to Change Point of Diversion	$ 100.00
___	7. Application to Change Place and/or Purpose of Use	$ 100.00
___	8. Application to Appropriate	$ 25.00
___	9. Notice of Intent to Appropriate	$ 25.00
___	10. Application for Extension of Time	$ 50.00
___	11. Supplemental Well to a Surface Right	$ 100.00
___	12. Return Flow Credit	$ 100.00
___	13. Proof of Completion of Works	$ 25.00
___	14. Proof of Application of Water to Beneficial Use	$ 25.00
___	15. Water Development Plan	$ 100.00
___	16. Declaration of Livestock Water Impoundment	$ 10.00
___	17. Application for Livestock Water Impoundment	$ 10.00

C. Well Driller Fees

___	1. Application for Well Driller's License	$ 50.00
___	2. Application for Renewal of Well Driller's License	$ 50.00
___	3. Application to Amend Well Driller's License	$ 50.00

D. Reproduction of Documents

___ @ 0.25¢ $______

___ Map(s) $______

E. Certification $______

F. Other $______

G. Comments:

______

All fees are non-refundable.

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.) LRG-15537-POD57 (LEL-MW-4)	WELL TAG ID NO.	OSE FILE NO(S). LRG-15537
WELL OWNER NAME(S) US International Boundary and Water Commisision		PHONE (OPTIONAL)
WELL OWNER MAILING ADDRESS 4171 North Mesa, Suite C-100		CITY El Paso; STATE TX; ZIP 79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	20	16.3	N
	LONGITUDE	106	50	03.8	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND

* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

Along the Rio Grande River in Dona Ana County (Sec 03, TWS 23S, RNG 01E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER			NAME OF WELL DRILLING COMPANY
1575	Shane Currie			Talon/LPE
DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/28/18	11/28/18	20.5	21	6.6

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	15.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
15.5	20.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	14	4	Bentonite	1.06	Tremie
14	21	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	21	21	Silts & Fine Sands	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

FOR OSE INTERNAL USE

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
LRG-15537-POD58 (BW-MW-1)		LRG-15537

WELL OWNER NAME(S)	PHONE (OPTIONAL)
US International Boundary and Water Commission	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 North Mesa, Suite C-100	El Paso	TX	79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	05	01.01	N
	LONGITUDE	106	39	54.2	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHIP, RANGE) WHERE AVAILABLE
Along the Rio Grande River in Dona Ana County (Sec 32, TWS 25S, RNG 03E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/27/18	11/27/18	17.8	18	8.8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	12.8	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
12.8	17.8	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1	4	Bentonite/Grout Mixute	0.09	Tremie
1	10	4	Bentonite	0.88	Tremie
10	18	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.	
LOCATION		WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	18	18	Silts & Fine Sands	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
LRG-15537-POD59 (BCA-MW-2)		LRG-15537

WELL OWNER NAME(S)	PHONE (OPTIONAL)
US International Boundary and Water Commission	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 North Mesa, Suite C-100	El Paso	TX	79902-1441

WELL LOCATION (FROM GPS)	DEGREES	MINUTES	SECONDS	
LATITUDE	32	32	19.6	N
LONGITUDE	106	59	13.2	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE
Along the Rio Grande River in Dona Ana County (Sec 30, TWS 25S, RNG 02E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/28/18	11/28/18	13.5	14	6.98

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	8.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
8.5	13.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	6	4	Bentonite	0.44	Tremie
6	14	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL	DEPTH (feet bgl)		THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
	FROM	TO				
	0	13	13	Clay with Fine to Fine Sands	Y N	
	13	14	1	Fine Sands with Rock	Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	
					Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/2017)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.) LRG-15537-POD60 (SPB-MW-4)	WELL TAG ID NO.	OSE FILE NO(S). LRG-15537
WELL OWNER NAME(S) US International Boundary and Water Commission		PHONE (OPTIONAL)
WELL OWNER MAILING ADDRESS 4171 North Mesa, Suite C-100		CITY El Paso; STATE TX; ZIP 79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS		
	LATITUDE	32	31	02.5	N	* ACCURACY REQUIRED: ONE TENTH OF A SECOND
	LONGITUDE	106	58	16.8	W	* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

Along the Rio Grande River in Dona Ana County (Sec 05, TWS 21S, RNG 01W)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER			NAME OF WELL DRILLING COMPANY
1575	Shane Currie			Talon/LPE
DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/29/18	11/29/18	17.5	18.0	3.8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	12.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
12.5	17.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	10.5	4	Bentonite	0.75	Tremie
10.5	18.0	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	16.5	16.5	Clay to Sands	Y N	
16.5	17.5	1	Clay with Sands to Fine With Rock	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/2017)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 2 OF 2

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 BW-MW-1

Well owner: US International Boundary and Water Commission   Phone No.: ____

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso   State: TX   Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575   Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/27/18   Date well plugging concluded: 11/27/18

5) GPS Well Location: Latitude: 32 deg, 05 min, 014 sec
Longitude: -106 deg, 39 min, 904 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl), by the following manner: ____

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature] 1/2/2019

Signature of Well Driller Date

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 BCA-MW-2

Well owner: US International Boundary and Water Commission Phone No.: ______

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso State: TX Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575 Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/28/18 Date well plugging concluded: 11/28/18

5) GPS Well Location: Latitude: 32 deg, 32 min, 024 sec
Longitude: -106 deg, 59 min, 218 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl), by the following manner: ______

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature] 1/2/2019

Signature of Well Driller Date

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 SPB-MW-4

Well owner: US International Boundary and Water Commission Phone No.: ______

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso State: TX Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575 Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/29/18 Date well plugging concluded: 11/29/18

5) GPS Well Location: Latitude: 32 deg, 31 min, 021 sec
Longitude: -106 deg, 58 min, 336 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl), by the following manner: ______

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature]
Signature of Well Driller

1/2/2019
Date

APPENDIX C
NEW MEXICO WELL LOGS

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TALON LPE

FIRST MOBILIZATION

To whom it may concern:

Talon/LPE has submitted the attached Well Record & Log, please submit a record of receipt and acknowledgment of the well record either via mail or email to jhafliger@talonlpe.com

Thank you,

Jason Hafliger
Drilling Operations Manager

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
CCB-MW2		

WELL OWNER NAME(S)	PHONE (OPTIONAL)		
USIBWC			
WELL OWNER MAILING ADDRESS	**CITY**	**STATE**	**ZIP**
4171 N Mesa St	Garfield	NM	87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	42	24.0192	N
	LONGITUDE	-107	15	18.277	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND

* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
3/3/18	3/3/18	19.1	20	9

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: HSA

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
3	14.1	6	Plastic PVC	Riser	2		
14.1	19.1	6	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	6	Concrete	0.30	Poured
1.5	11.7	6	3/8 Course Grade Bentonite	2	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	2.5		Brown, Fine grain silty sands	Y ✔N	
2.5	5		Tan sands, 0.25-0.50mm grain size, Rounded, Moderately sorted, <10% Granule	Y ✔N	
5	7.5		Tan sands, 0.25-4mm size, Subrounded, Moderately sorted, Dry	Y ✔N	
7.5	10		sands, 0.25-20mm size Medium grained pebbles, Sub angular, Moderately seper	Y ✔N	
10	12.5		Tan sands, 0.5-4mm grain size, Sub rounded, Moderately sorted, Wet	✔Y N	
12.5	15		Brown very coarse sands, 0.71-2mm grain size, Sub rounded, Moderately sorted,	✔Y N	
15	17.5		Same as above	✔Y N	
17.5	20		Same as above	✔Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST	TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Jarod Michalsky

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie — 5/10/2018

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/2017)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.): CCB-MW3	WELL TAG ID NO.	OSE FILE NO(S).
WELL OWNER NAME(S): USIBWC		PHONE (OPTIONAL)
WELL OWNER MAILING ADDRESS: 4171 N Mesa St		CITY: Garfield; STATE: NM; ZIP: 87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS		
	LATITUDE	32	42	2.6676	N	* ACCURACY REQUIRED: ONE TENTH OF A SECOND
	LONGITUDE	-107	14	40.366	W	* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHIP, RANGE) WHERE AVAILABLE: On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
3/8/18	3/8/18	17.1	20	6

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: DPT

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
3	12.1	4	Plastic PVC	Riser	2		
12.1	19.1	4	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	4	Concrete	0.13	Poured
1.5	6	4	3/8 Course Grade Bentonite	0.39	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	1		Brown, Silty sands, Organic debris	Y ✔N	
1	2		Tan sands, 0.25-4mm grain size, Sub angular, Poorly sorted	Y ✔N	
2	4		Poor recovery due to loose unconsolidated sands	Y ✔N	
4	6		Tan/Grey, 0.5-4mm grain sized sands w/ <15% 10-30mm sized pebbles, Dry	Y ✔N	
6	7		Same as above, Moist	Y ✔N	
7	8		Poor recovery due to unconsolidated sands/pebbles	Y ✔N	
8	10		Brown/Grey, 0.5-2mm grain sized sands w/ <5% 10mm sized pebbles, Saturated	✔Y N	
10	12		Poor recovery due to unconsolidated sands/pebbles	✔Y N	
12	15		Grey sands, 0.35-4mm grain size w/ <5% 10mm sized pebbles, Saturated	✔Y N	
15	17		Poor recovery due to unconsolidated sands/pebbles	✔Y N	
17	20		Boring terminated at 17' BLS	✔Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Gabe Perez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie — 5/10/2018

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/2017)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 2 OF 2

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
BE-MW1		

WELL OWNER NAME(S)	PHONE (OPTIONAL)
USIBWC	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 N Mesa St	Garfield	NM	87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	4	30.8352	N
	LONGITUDE	-106	39	38.272	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
3/1/18	3/1/18	17.3	20	8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: HSA

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-2.7	12.3	6	Plastic PVC	Riser	2		
12.3	17.3	6	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	6	Concrete	0.30	Poured
1.5	9	6	3/8 Course Grade Bentonite	1.47	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	2		Tan, Fine grained sands, Silty, 0.125-0.177mm grain size	Y ✔N	
2	5		Brown silty sands, 0.250-0.350mm grain size, Rounded, Well sorted, Dry	Y ✔N	
5	7		Tan sands, 0.250-0.500mm grain size, Rounded, Well sorted, Moist	Y ✔N	
7	10		Brown sands, 0.250-0.500mm grain size, Sub rounded, Well sorted, Moist	✔Y N	
10	12		Brown sands, 0.250-0.500mm grain size, Sub rounded, Well sorted, Wet	✔Y N	
12	15		Tan sands, 0.250-0.500mm grain size, Sub rounded, Well sorted, Saturated	✔Y N	
15	17		Same as above	✔Y N	
17	20		Same as above	✔Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Jarod Michalsky

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie

SIGNATURE OF DRILLER / PRINT SIGNEE NAME

5/10/2018

DATE

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/2017)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

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1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
ME-MW1		

WELL OWNER NAME(S)	PHONE (OPTIONAL)
USIBWC	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 N Mesa St	Garfield	NM	87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS		
	LATITUDE	32	15	3.3912	N	* ACCURACY REQUIRED: ONE TENTH OF A SECOND
	LONGITUDE	-106	49	1.636	W	* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHIP, RANGE) WHERE AVAILABLE

On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
3/2/18	3/2/18	21.75	25	8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: HSA

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-3	16.75	6	Plastic PVC	Riser	2		
16.75	21.75	6	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	6	Concrete	0.30	Poured
1.5	13	6	3/8 Course Grade Bentonite	2.26	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	2		Brown silty sands, 0.125-0.177mm grain sizesd, Round	Y ✓N	
2	5		Brown sands, 0.250-0.500mm grain size, Sub rounded, Well sorted, Dry	Y ✓N	
5	7		Brown sands, 0.25-0.50mm grain size, Sub rounded, Moderately sorted, Dry	Y ✓N	
7	10		Tan sands, 0.25-0.50mm grain size, Rounded, Well sorted, Moist	✓Y N	
10	12		Tan sands, 0.25-0.50mm grain size, Rounded, Well sorted, Wet	✓Y N	
12	15		Same as above, Saturated	✓Y N	
15	17		Same as above	✓Y N	
17	20		Same as above	✓Y N	
20	22		Same as above	✓Y N	
22	25		Tan sands, 0.25-0.50mm grain size, Rounded, Well sorted, Saturated	✓Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Jarod Michalsky

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie — 5/10/2018

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.): SP-MW1	WELL TAG ID NO.:	OSE FILE NO(S).:
WELL OWNER NAME(S): USIBWC		PHONE (OPTIONAL):
WELL OWNER MAILING ADDRESS: 4171 N Mesa St		CITY: Garfield; STATE: NM; ZIP: 87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS		
	LATITUDE	31	48	21.9733	N	* ACCURACY REQUIRED: ONE TENTH OF A SECOND
	LONGITUDE	-106	34	55.0952	W	* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHIP, RANGE) WHERE AVAILABLE: On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.: 1575	NAME OF LICENSED DRILLER: Shane Currie			NAME OF WELL DRILLING COMPANY: Talon/LPE
DRILLING STARTED: 2/27/18	DRILLING ENDED: 2/27/18	DEPTH OF COMPLETED WELL (FT): 16	BORE HOLE DEPTH (FT): 16.5	DEPTH WATER FIRST ENCOUNTERED (FT): 8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: HSA

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-2	11	6	Plastic PVC	Riser	2		
11	16	6	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	6	Concrete	0.30	Poured
1.5	9	6	3/8 Course Grade Bentonite	1.47	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	5		White to tan, Rounded, 0.2350-0.350mm Sands, Well sorted, Moist	Y ✔N	
5	5		Loss due to loose unconsolidated fines	Y ✔N	
5	6		White to tan, Rounded, 0.500-0.177mm Sand, Well sorted, Very moist	Y ✔N	
6	7		Grades to dark brown	Y ✔N	
7	10		Loss due to unconsolidated fines	Y ✔N	
10	15		Gray & tan, Rounded, 0.177-0.500mm Sands, Well sorted, Saturated	Y ✔N	
15	16		Grey/tan, Sub rounded, 0.177-0.500mm Sand, Moderately sorted, Saturated	Y ✔N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST — TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Jarod Michalsky

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie — 5/10/2018

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
CCE-MW2		

WELL OWNER NAME(S)	PHONE (OPTIONAL)
USIBWC	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 N Mesa St	Garfield	NM	87936

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	31	49	56.7829	N
	LONGITUDE	-106	36	26.8884	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

On Rio Grande River bed

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
2/28/18	2/28/18	15.3	17	5

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: HSA

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-2.7	10.3	6	Plastic PVC	Riser	2		
10.3	15.3	6	Plastic PVC	Screen	2		0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1.5	6	Concrete	0.30	Poured
1.5	8	6	3/8 Course Grade Bentonite	1.28	

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	2		Tan, Fine grained sands & silt, 0.125-0.177mm Grain size	Y ✔N	
2	5		Tan sands, 0.177-0.350mm Grain size, Well rounded, Well sorted, Moist	Y ✔N	
5	7		Brown sands, 0.177-0.350mm Grain size, Well rounded, Well sorted, Saturated	✔Y N	
7	10		·own sands, 0.250-0.710mm Grain size, Sub rounded, Moderately sorted, Saturat·	✔Y N	
10	12		Grey/brown sands, 0.350-0.500mm Grain size, Rounded, Well sorted, Saturated	✔Y N	
12	15		Same as above	✔Y N	
15	17		Grey sands, 0.250-0.350mm Grain size, Rounded, Well sorted, Saturated	✔Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Jarod Michalsky

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie (signature) Shane Currie

SIGNATURE OF DRILLER / PRINT SIGNEE NAME

5/10/2018

DATE

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WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.) LRG-15537-POD57 (LEL-MW-4)	WELL TAG ID NO.	OSE FILE NO(S). LRG-15537
WELL OWNER NAME(S) US International Boundary and Water Commisision		PHONE (OPTIONAL)
WELL OWNER MAILING ADDRESS 4171 North Mesa, Suite C-100		CITY El Paso · STATE TX · ZIP 79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	20	16.3	N
	LONGITUDE	106	50	03.8	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE
Along the Rio Grande River in Dona Ana County (Sec 03, TWS 23S, RNG 01E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/28/18	11/28/18	20.5	21	6.6

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	15.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
15.5	20.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	14	4	Bentonite	1.06	Tremie
14	21	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	21	21	Silts & Fine Sands	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
LRG-15537-POD58 (BW-MW-1)		LRG-15537

WELL OWNER NAME(S)	PHONE (OPTIONAL)
US International Boundary and Water Commission	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 North Mesa, Suite C-100	El Paso	TX	79902-1441

WELL LOCATION (FROM GPS)	DEGREES	MINUTES	SECONDS	
LATITUDE	32	05	01.01	N
LONGITUDE	106	39	54.2	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND

* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHIP, RANGE) WHERE AVAILABLE

Along the Rio Grande River in Dona Ana County (Sec 32, TWS 25S, RNG 03E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/27/18	11/27/18	17.8	18	8.8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	12.8	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
12.8	17.8	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	1	4	Bentonite/Grout Mixute	0.09	Tremie
1	10	4	Bentonite	0.88	Tremie
10	18	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	18	18	Silts & Fine Sands	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.)	WELL TAG ID NO.	OSE FILE NO(S).
LRG-15537-POD59 (BCA-MW-2)		LRG-15537

WELL OWNER NAME(S)	PHONE (OPTIONAL)
US International Boundary and Water Commission	

WELL OWNER MAILING ADDRESS	CITY	STATE	ZIP
4171 North Mesa, Suite C-100	El Paso	TX	79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS	
	LATITUDE	32	32	19.6	N
	LONGITUDE	106	59	13.2	W

* ACCURACY REQUIRED: ONE TENTH OF A SECOND
* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE

Along the Rio Grande River in Dona Ana County (Sec 30, TWS 25S, RNG 02E)

2. DRILLING & CASING INFORMATION

LICENSE NO.	NAME OF LICENSED DRILLER	NAME OF WELL DRILLING COMPANY
1575	Shane Currie	Talon/LPE

DRILLING STARTED	DRILLING ENDED	DEPTH OF COMPLETED WELL (FT)	BORE HOLE DEPTH (FT)	DEPTH WATER FIRST ENCOUNTERED (FT)
11/28/18	11/28/18	13.5	14	6.98

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT):

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	8.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
8.5	13.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	6	4	Bentonite	0.44	Tremie
6	14	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.

LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES **(attach supplemental sheets to fully describe all units)**	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	13	13	Clay with Fine to Fine Sands	Y N	
13	14	1	Fine Sands with Rock	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

[signature] Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

WELL RECORD & LOG

OFFICE OF THE STATE ENGINEER

www.ose.state.nm.us

1. GENERAL AND WELL LOCATION

OSE POD NO. (WELL NO.) LRG-15537-POD60 (SPB-MW-4)	WELL TAG ID NO.	OSE FILE NO(S). LRG-15537
WELL OWNER NAME(S) US International Boundary and Water Commission		PHONE (OPTIONAL)
WELL OWNER MAILING ADDRESS 4171 North Mesa, Suite C-100		CITY El Paso; STATE TX; ZIP 79902-1441

WELL LOCATION (FROM GPS)		DEGREES	MINUTES	SECONDS		
	LATITUDE	32	31	02.5	N	* ACCURACY REQUIRED: ONE TENTH OF A SECOND
	LONGITUDE	106	58	16.8	W	* DATUM REQUIRED: WGS 84

DESCRIPTION RELATING WELL LOCATION TO STREET ADDRESS AND COMMON LANDMARKS – PLSS (SECTION, TOWNSHJIP, RANGE) WHERE AVAILABLE
Along the Rio Grande River in Dona Ana County (Sec 05, TWS 21S, RNG 01W)

2. DRILLING & CASING INFORMATION

LICENSE NO. 1575	NAME OF LICENSED DRILLER Shane Currie			NAME OF WELL DRILLING COMPANY Talon/LPE
DRILLING STARTED 11/29/18	DRILLING ENDED 11/29/18	DEPTH OF COMPLETED WELL (FT) 17.5	BORE HOLE DEPTH (FT) 18.0	DEPTH WATER FIRST ENCOUNTERED (FT) 3.8

COMPLETED WELL IS: ☐ ARTESIAN ☐ DRY HOLE ☐ SHALLOW (UNCONFINED)

STATIC WATER LEVEL IN COMPLETED WELL (FT)

DRILLING FLUID: ☐ AIR ☐ MUD ADDITIVES – SPECIFY:

DRILLING METHOD: ☐ ROTARY ☐ HAMMER ☐ CABLE TOOL ☑ OTHER – SPECIFY: Geoprobe

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM (inches)	CASING MATERIAL AND/OR GRADE (include each casing string, and note sections of screen)	CASING CONNECTION TYPE (add coupling diameter)	CASING INSIDE DIAM. (inches)	CASING WALL THICKNESS (inches)	SLOT SIZE (inches)
-5	12.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	
12.5	17.5	4	New Sch. 40 Plastic PVC	Flush Joint	2	0.237	0.010

3. ANNULAR MATERIAL

DEPTH (feet bgl) FROM	TO	BORE HOLE DIAM. (inches)	LIST ANNULAR SEAL MATERIAL AND GRAVEL PACK SIZE-RANGE BY INTERVAL	AMOUNT (cubic feet)	METHOD OF PLACEMENT
0	2	4	Bentonite/Grout Mixute	0.18	Tremie
2	10.5	4	Bentonite	0.75	Tremie
10.5	18.0	4	10/20 Sand	0.62	Tremie

FOR OSE INTERNAL USE

WR-20 WELL RECORD & LOG (Version 06/30/17)

FILE NO.	POD NO.	TRN NO.
LOCATION	WELL TAG ID NO.	PAGE 1 OF 2

4. HYDROGEOLOGIC LOG OF WELL

DEPTH (feet bgl) FROM	DEPTH (feet bgl) TO	THICKNESS (feet)	COLOR AND TYPE OF MATERIAL ENCOUNTERED - INCLUDE WATER-BEARING CAVITIES OR FRACTURE ZONES (attach supplemental sheets to fully describe all units)	WATER BEARING? (YES / NO)	ESTIMATED YIELD FOR WATER-BEARING ZONES (gpm)
0	16.5	16.5	Clay to Sands	Y N	
16.5	17.5	1	Clay with Sands to Fine With Rock	Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	
				Y N	

METHOD USED TO ESTIMATE YIELD OF WATER-BEARING STRATA:

☐ PUMP ☐ AIR LIFT ☐ BAILER ☐ OTHER – SPECIFY:

TOTAL ESTIMATED WELL YIELD (gpm): 0.00

5. TEST; RIG SUPERVISION

WELL TEST: TEST RESULTS - ATTACH A COPY OF DATA COLLECTED DURING WELL TESTING, INCLUDING DISCHARGE METHOD, START TIME, END TIME, AND A TABLE SHOWING DISCHARGE AND DRAWDOWN OVER THE TESTING PERIOD.

MISCELLANEOUS INFORMATION:

PRINT NAME(S) OF DRILL RIG SUPERVISOR(S) THAT PROVIDED ONSITE SUPERVISION OF WELL CONSTRUCTION OTHER THAN LICENSEE:

Ronnie Rodriguez

6. SIGNATURE

THE UNDERSIGNED HEREBY CERTIFIES THAT, TO THE BEST OF HIS OR HER KNOWLEDGE AND BELIEF, THE FOREGOING IS A TRUE AND CORRECT RECORD OF THE ABOVE DESCRIBED HOLE AND THAT HE OR SHE WILL FILE THIS WELL RECORD WITH THE STATE ENGINEER AND THE PERMIT HOLDER WITHIN 30 DAYS AFTER COMPLETION OF WELL DRILLING:

Shane Currie Shane Currie — 1/2/2019

SIGNATURE OF DRILLER / PRINT SIGNEE NAME — DATE

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 BW-MW-1

Well owner: US International Boundary and Water Commission   Phone No.: ____

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso   State: TX   Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575   Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/27/18   Date well plugging concluded: 11/27/18

5) GPS Well Location: Latitude: 32 deg, 05 min, 014 sec
Longitude: -106 deg, 39 min, 904 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl), by the following manner: ____

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature]
Signature of Well Driller

1/2/2019
Date

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 BCA-MW-2

Well owner: US International Boundary and Water Commission   Phone No.: ____

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso   State: TX   Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575   Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/28/18   Date well plugging concluded: 11/28/18

5) GPS Well Location: Latitude: 32 deg, 32 min, 024 sec
   Longitude: -106 deg, 59 min, 218 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl), by the following manner: ____

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature] 1/2/2019

Signature of Well Driller Date

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: LRG-15537 SPB-MW-4

Well owner: US International Boundary and Water Commission Phone No.: ____________

Mailing address: 4171 North Mesa, Suite C-100

City: El Paso State: TX Zip code: 79902-1441

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Talon/LPE

2) New Mexico Well Driller License No.: WD-1575 Expiration Date: 7/30/2020

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Ronnie Rodriguez

4) Date well plugging began: 11/29/18 Date well plugging concluded: 11/29/18

5) GPS Well Location: Latitude: 32 deg, 31 min, 021 sec
Longitude: -106 deg, 58 min, 336 sec, WGS 84

6) Depth of well confirmed at initiation of plugging as: 16 ft below ground level (bgl),
by the following manner: ____________

7) Static water level measured at initiation of plugging: Dry ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: 10/03/18

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
	0-16' Benonite/Grout Mixture	28.27	211.51	Tremie Pipe	

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Shane Currie, say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

[signature]
Signature of Well Driller

1/2/2019
Date

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APPENDIX D
TEXAS WELL REPORTS

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STATE OF TEXAS WELL REPORT for Tracking #474131

Owner:	**USIBWC**	Owner Well #:	**CCE-MW3**
Address:	**4171 N Mesa St** **El Paso, TX 79902**	Grid #:	**49-12-4**
Well Location:	**N/A** **El Paso, TX 79932** **On Rio Grande River Floodplain**	Latitude:	**31° 49' 35.56" N**
		Longitude:	**106° 36' 12.89" W**
		Elevation:	**3746.5**
Well County:	**El Paso**		
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2018**   Drilling End Date: **2/28/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	**17**	**Sand**	**8/16**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1.5**	**Cement 2 Bags/Sacks**
1.5	**8**	**Bentonite 3 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Concrete w/well Protector**

Water Level: **5 ft.** below land surface on **2018-02-28**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **TALON / LPE**

921 N BIVINS ST
AMARILLO, TX 79107

Driller Name: **Jason Hafliger** License Number: **60099**

Comments: **No Data**

Report Amended on 5/30/2018 by Request #25046

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**Tan sand, 0.250-0.350mm grain sized, Subrounded, Well sorted, Dry**
2	**5**	**Brown, Silty sand, 0.177-0.250mm grain sized, Well sorted, Well rounded, Moist**
5	**7**	**Dk brown, Silty sand, 0.177-0.250mm grain sized, Well sorted, Well rounded, Wet**
7	**10**	**Grey, Silty sand, 0.177-0.250mm grain sized, Well sorted, Well rounded, Saturated**
10	**12**	**Grey, Silty sand, 0.177-0.250mm grain sized, Well sorted, Well rounded, Saturated**
12	**15**	**Grey-brown, Silty sand w/ <5% 4mm sized granules, 0.177-0.250mm grain sized, Subrounded, Moderately sorted, Saturated**
15	**16**	**Grey-brown, Silty sand, 0.177-0.250mm grain sized, Rounded, Well sorted, Saturated**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**-2**	**10**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**10**	**15**

16	**17**	**Grey, Silty sand, 0.177-0.250mm grain sized, Subrounded, Moderately sorted, Saturated. Boring terminated at 17ft BLS.**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #474129

Owner:	**USIBWC**	Owner Well #:	**VC-MW-1**
Address:	**4171 N Mesa St El Paso, TX 79902**	Grid #:	**49-12-1**
Well Location:	**N/A El Paso, TX 79932**	Latitude:	**31° 51' 44.42" N**
	Rio Grande River Flood Plain	Longitude:	**106° 36' 17.9" W**
Well County:	**El Paso**	Elevation:	**3755.4**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/28/2018** Drilling End Date: **3/1/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6	**0**	**16**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
9	**16**	**Sand**	**8/16**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Concrete w/well Protector**

Water Level: **8 ft.** below land surface on **2018-02-28**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **TALON / LPE**

921 N BIVINS ST
AMARILLO, TX 79107

Driller Name: **Jason Hafliger** License Number: **60099**

Comments: **No Data**

Report Amended on 5/30/2018 by Request #25045

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**Tan, Fine grained sands & Silt, 0.125-0.177mm grain size**
2	**3**	**Brown Sands, 0.177-0.250mm grain size, Well rounded, Well sorted, Dry**
3	**8**	**Tan sands, 0.250-0.350mm grain size, Rounded, Well sorted, Moist**
8	**10**	**Grey sands, 0.250-0.500mm grain size, Rounded, Well sorted, Wet**
10	**12**	**Grey sands, 0.177-0.500mm grain size, Well rounded, Well sorted, Saturated**
12	**15**	**Same as above**
15	**17**	**Same as above. Boring terminated at 17' BLS.**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**-2**	**10.9**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**10.9**	**15.9**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

APPENDIX E
WELL DRILLERS LICENSES

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NEW MEXICO OFFICE OF THE STATE ENGINEER

WELL DRILLER LICENSE

Name: **SHANE B. CURRIE**

Expiration: **JULY 31. 2014**

Company Name: **TALON/LPE Ltd.**

License No: **WD-1575**

ADDITIONAL NFORMATION ON BACK

The person listed on the front of this card is licensed as a well driller by the Office of the State Engineer and may supervise the drilling and construction of wells in New Mexico. Each well driller, when managing well drilling activities, shall have this license available for inspection upon request.

For additional information contact the Office of the State Engineer at (575) 622-6521 in Roswell, (505) 827-6120 in Santa Fe, or www.ose.state.nm.us

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The State of Texas

Texas Department of Licensing and Regulation

THIS IS TO CERTIFY

SHANE CURRIE

HAVING GIVEN SATIFACTORY EVIDENCE OF QUALIFICATIONS REQUIRED BY TITLE 2, TEXAS WATER CODE CHAPTER 32 - WATER WELL DRILLERS AND TITLE 2, TEXAS WATER CODE CHAPTER 33, IS GRANTED THIS

LICENSE

AND IS HEARBY AUTHORIZED TO PRACTICE AS A

WATER WELL DRILLER AND PUMP INSTALLER

SO LONG AS THIS LICENSE IS NOT REVOKED AND IS RENEWED ACCORDING TO LAW

LICENSE NUMBER

54499AI

IN WITNESS WHEREOF
THE TEXAS DEPARTMENT OF LICENSING AND REGULATION HAS AFFIXED ITS HAND AND SEAL OF THE STATE OF TEXAS

BY William H. Kuntz, Jr.

William H. Kuntz, Jr., Executive Director

№ 59259

Texas Department of Licensing and Regulation

Result Listing

Name and Location	Other Information
HAFLIGER, JASON DANIEL 921 N BIVINS ST AMARILLO TX 79107-6806 County: POTTER	**Water Well Driller and Pump Installer** License #: 60099 Expiration Date: 09/26/2018 Type: M Phone: (806) 467-0607 Continuing Education Status: N/A

Driller Designations:

(W) - water well;

(M) - monitoring well;

(C) - closed loop geothermal well;

(N) - injection well;

(D) - dewatering well;

(A) - master well driller which includes all designations previously listed.

Pump Installer Designations:

(L) - windmills, hand pumps, and pump jacks;

(P) - single phase pumps;

(K) - three phase pumps;

(T) - line-shaft turbine pumps;

(I) - master water well pump installer which includes all designations previously listed.

Search Again | Back

APPENDIX F
DETAILS FOR RECONSTRCTED AND REHABILITATED MONITORING WELLS

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SP-MW-1

Date Redrilled: 27 February 2018

Reason: Well destroyed; original well borehole not found.

Well Construction Description:
Groundwater elevation was approximately 10 feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to medium grained alluvial flowing sands. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 16 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 13 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to nine feet bgs, followed by 0.375-inch (3/8”) coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

CCE-MW-2

Date Redrilled: 28 February 2018

Reason: Riser not secured. Sand obstruction 8.79 feet below top of casing (BTOC).

Well Construction Description:
Groundwater elevation was approximately five feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to coarse-grained alluvial flowing sands. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 15.3 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 13 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 8-feet bgs, followed by 0.375-inch (3/8”) coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

The original well was abandoned by removing the well pad, well riser, and the well casing. The borehole was then filled with bentonite hole-plug to approximately one-foot bgs and backfilled with concrete to within six inches bgs, and then surface soil was placed on top of the concrete to the ground surface.

CCE-MW-3

Date Redrilled: 28 February 2018

Reason: Sand obstruction 2.54 feet below top of casing (BTOC).

Well Construction Description: Groundwater elevation was approximately eight feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to coarse-grained alluvial flowing sands with less than 5% sand granules. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 15 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 12 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to eight feet bgs, followed by 0.375-inch (3/8") coarse grade bentonite hole plug to 1.5 feet bgs, and completed with cement grout. The well was surface completed using a concrete pad with a stainless steel, lockable well shroud.

The original well was abandoned by removing the well pad, well riser, and the well casing. The borehole was then filled with bentonite hole-plug to approximately one-foot bgs and backfilled with concrete to within six inches bgs, and then, surface soil was placed on top of the concrete to the ground surface.

VC-MW-1

Date Redrilled: 28 February 2018 and 01 March 2018

Reason: Damaged well

Well Construction Description:
Groundwater elevation was approximately 10 feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to medium grained alluvial flowing sands. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 16 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 13 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to nine feet bgs, followed by 0.375-inch (3/8") coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

The original well was abandoned by removing the well pad, well riser, and the well casing. The borehole was then filled with bentonite hole-plug to approximately one-foot bgs and backfilled with concrete to within six inches bgs, and then soil was placed on top of the concrete.

BE-MW-1

Date Redrilled: 01 March 2018

Reason: Well riser damaged, silt to grade.

Well Construction Description:
Groundwater elevation was approximately 10 feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to coarse-grained alluvial flowing sands. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 17.3 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 15 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to nine feet bgs, followed by 0.375-inch (3/8”) coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

The original well was abandoned by removing the well pad, well riser, and the well casing. The borehole was then filled with bentonite hole-plug to approximately one-foot bgs and backfilled with concrete to within six inches bgs, and then surface soil was placed on top of the concrete.

ME-MW-1

Date Redrilled: 02 March 2018

Reason: Original well not located.

Well Construction Description:
Groundwater elevation was approximately 10 feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to coarse-grained alluvial flowing sands. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 21.75 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 19.75 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 13 feet bgs, followed by 0.375-inch (3/8") coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

The original well boring was located, and the borehole was filled with bentonite hole-plug to approximately one-foot bgs and backfilled with concrete to within six inches bgs. Surface soil was placed on top of the concrete to surrounding grade.

CCB-MW-2

Date Redrilled: 03 March 2018

Reason: Sand obstruction 2.71 feet below top of casing (BTOC).

Well Construction Description: Groundwater elevation was approximately 12 feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to very coarse-grained alluvial flowing sands and granules. The well was installed using Hollow Stem Auger (HSA) to an approximate depth of 19.1 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen flush-threaded to 16 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to approximately 11.7 feet bgs, followed by 0.375-inch (3/8”) coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

The original well was abandoned by removing the well pad and well riser. An attempt was made to remove the entire well casing, but it could not be removed. The casing was cut approximately two feet bgs; backfilled with concrete to within six inches bgs; and native material to ground surface.

CCB-MW-3

Date Redrilled: 08 March 2018

Reason: Sand obstruction 2.95 feet below top of casing (BTOC).

Well Construction Description: Groundwater elevation was approximately eight feet below ground surface (bgs). The geology of the monitoring well location is comprised of tan fine to coarse-grained alluvial flowing sands and pebbles. The well was installed using Direct Push Technology (DPT) to an approximate depth of 17.1 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen with pre-packed sand filter screen flush-threaded to 15 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to six feet bgs, followed by 0.375-inch (3/8") coarse grade bentonite hole plug to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel riser.

The original well was abandoned by removing the well pad, well riser, and the entire well casing. The borehole was then filled with bentonite hole-plug to approximately one-foot bgs and concrete filled to grade, and then surface soil was placed on top of the concrete to the ground surface.

SP-MW-3

Date Rehabilitated: 28 February 2018

Reason: Sand obstruction 6.32 feet below top of casing (BTOC).

Rehabilitation Description:
Compressed air method used to remove sand to a final total depth recorded at 15.10 feet BTOC.

AB-MW-1

Date Rehabilitated: 28 February 2018

Reason: Root obstruction at approximately 12 feet below top of casing (BTOC).

Rehabilitation Description:
Roots cut using sharpened steel pipe. Compressed air method used to remove sand to a final total depth recorded at 14.31 feet BTOC.

AB-MW-2

Date Rehabilitated: 28 February 2018

Reason: Roots found on sonde cable.

Rehabilitation Description:
Roots broken through using PVC pipe. Steel pipe unable to pass due to bent casing. Compressed air method used to remove sand to a final total depth recorded at 14.92 feet below tope of casing (BTOC).

VC-MW-2

Date Rehabilitated: 28 February 2018

Reason: Riser loose within steel protector. Faded lettering.

Rehabilitation Description:
Sand pack was added inside the steel protector to stabilize the riser. Well was repainted to clearly identify the well.

VB-MW-1

Date Rehabilitated: 28 February 2018 and 01 March 1, 2018

Reason: Sonde lost in the well.

Rehabilitation Description:
Successfully removed the sonde by

- Removing sand using compressed air method similar to the rehabilitation process.
- Using a 1-inch Schedule 40 PVC tremie pipe with four, 1.5-inch slits cut on the end to press around the sonde wedging it in the tremie pipe for removal.

Once removed, the sonde data was collected, and then, redeployed using 7x19 vinyl coated stainless steel cable from US Cargo Control (Item No. 719VCSSAC18316) with aluminum ferrels. Final total depth recorded at 14.51 feet below top of casing (BTOC).

Sonde Serial Number: 10329234

VB-MW-2

Date Rehabilitated: 07 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand obstruction at 14.40 feet below top of casing (BTOC). Sand removed using compressed air method to a total depth of 15.12 feet BTOC. Well repainted to easily identify well.

VA-MW-1

Date Rehabilitated: 10 March 2018

Reason: Sonde lost in the well.

Rehabilitation Description:
Successfully removed the sonde by

- Removing sand using compressed air method similar to the rehabilitation process.
- Using a 1-inch Schedule 40 PVC tremie pipe with four, 1.5-inch slits cut on the end to press around the sonde wedging it in the tremie pipe for removal.

Once removed, the sonde data was attempted to be collected; however, the data could not be transferred to the sonde HOBO. The sonde was redeployed using a USIBWC recommended epoxy coated stainless steel cable with aluminum ferrels.

The well was repainted yellow and stenciled lettering black to easily identify well.

Sonde Serial Number: 10329243

NOTE: The EGC team identified flowing sands in the well, which made the removal of the sonde extremely difficult.

VA-MW-2

Date Repainted: 02 March 2018

Reason: Faded lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black to easily identify well.

BW-MW-1

Date Rehabilitated: 05 March 2018 and 07 March 2018.

Reason: Sonde lost in the well. Sand obstruction in casing.

Rehabilitation Description:
Successfully removed the sonde by

- Removing sand using compressed air method similar to the rehabilitation process.
- Using a 1-inch Schedule 40 PVC tremie pipe with four, 1.5-inch slits cut on the end to press around the sonde wedging it in the tremie pipe for removal.

Once removed, the sonde data was collected, and then, redeployed using a USIBWC recommended epoxy coated stainless steel cable with aluminum ferrels

Sand removed to total depth of 16.48 feet below top of casing (BTOC).

Sonde Serial Number: 10329227

BW-MW-2

Date Rehabilitated: 07 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 18.86 feet below top of casing (BTOC).

BMD-MW-2

Date Rehabilitated: 07 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 20.90 feet below top of casing (BTOC).

ME-MW-3

Date Rehabilitated: 07 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 18.60 feet below top of casing (BTOC). Riser cap retrieved from area between riser and steel protector and placed back onto the riser. The riser was discovered to be disconnected from the well casing. The riser was reconnected, and pipe-insulating foam was placed on the riser to add stability.

LEL-MW-1

Date Rehabilitated: 03 March 2018

Reason: Sonde cable connected only by crimped section.

Rehabilitation Description:
Replaced sonde cable with redeployed using 7x19 vinyl coated stainless steel cable from US Cargo Control (Item No. 719VCSSAC18316) and aluminum ferrls. Then, deployed to the original depth.

LEL-MW-3

Date Rehabilitated: 03 March 2018

Reason: Riser loose within steel protector.

Rehabilitation Description:
10/20 sand added inside steel protector to stabilize riser. Riser appeared to be loosely connected to casing.

SPB-MW-1

Date Repainted: 05 March 2018

Reason: Mislabeled lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

SPB-MW-2

Date Repainted: 05 March 2018

Reason: Mislabeled lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

SPB-MW-3

Date Repainted: 05 March 2018

Reason: Mislabeled lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

NOTE: As part of the original SOW, Monitoring Well SPB-MW-3 was to be abandoned and redrilled; however, the USIBWC removed this tasking. Due to the well being mislabeled as “SP-MW-3,” the EGC team repainted it to assist with identifying the well in the future.

BCA-MW-1

Date Rehabilitated: 09 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 15.08 feet below top of casing (BTOC).

BCA-MW-2

Date Rehabilitated: 09 March 2018

Reason: Unknown obstruction.

Rehabilitation Description:
Sand removed using compressed air method. After reaching what appeared to be PVC at 6.70 feet below top of casing (BTOC), the EGC team determined the well casing was bent—angling toward the River. EGC recommends this well be redrilled.

RS-MW-1

Date Rehabilitated: 09 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 18.65 feet below top of casing (BTOC).

RS-MW-5

Date Rehabilitated: 09 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 15.70 feet below top of casing (BTOC).

RS-MW-6

Date Rehabilitated: 09 March 2018

Reason: Root obstruction.

Rehabilitation Description:
Small roots removed using a pipe drain auger to the original constructed depth.

RS-MW-7

Date Rehabilitated: 09 March 2018

Reason: Root obstruction.

Rehabilitation Description:
Small roots removed using a pipe drain auger. Small roots removed and measured to bottom of constructed depth.

CCB-MW-1

Date Rehabilitated: 08 March 2018

Reason: Sand obstruction.

Rehabilitation Description:
Sand removed using compressed air method to a total depth of 14.43 feet below top of casing (BTOC).

CCA-MW-1

Date Rehabilitated: 08 March 2018.

Reason: Sonde lost in the well. Sand obstruction in casing.

Rehabilitation Description:
Successfully removed the sonde by

- Removing sand using compressed air method similar to the rehabilitation process.
- Using a 1-inch Schedule 40 PVC tremie pipe with four, 1.5-inch slits cut on the end to press around the sonde wedging it in the tremie pipe for removal.

Once removed, the sonde data was collected, and then, redeployed using a USIBWC recommended epoxy coated stainless steel cable with aluminum ferrels

Sand removed to total depth of 18.89 feet below top of casing (BTOC).

Sonde Serial Number: 10329226

JAR-MW-1

Date Repainted: 05 March 2018

Reason: Faded lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

JAR-MW-2

Date Repainted: 05 March 2018

Reason: Faded lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

JAR-MW-3

Date Repainted: 05 March 2018

Reason: Faded lettering.

Rehabilitation Description:
The well was repainted yellow and stenciled lettering black with correct lettering to identify well.

TRU-MW-1

Date Rehabilitated: 09 March 2018

Reason: Sonde lost in the well. Sand obstruction in casing.

Rehabilitation Description:
Successfully removed the sonde by

- Removing sand using compressed air method similar to the rehabilitation process.
- Using a 1-inch Schedule 40 PVC tremie pipe with four, 1.5-inch slits cut on the end to press around the sonde wedging it in the tremie pipe for removal.

Once removed, the sonde data was collected, and then, redeployed using a USIBWC recommended epoxy coated stainless steel cable with aluminum ferrels

Sand removed to total depth of 17.43 feet below top of casing (BTOC).

Sonde Serial Number: 10329225

TRU-MW-2

Date Rehabilitated: 09 March 2018

Reason: Root obstruction.

Rehabilitation Description:
Small roots removed using sharpened steel pipe. Small roots removed and measured to bottom of constructed depth at 15.61 feet below top of casing (BTOC).

TRU-MW-3

Date Rehabilitated: 09 March 2018

Reason: Root obstruction.

Rehabilitation Description:
Small roots removed using sharpened steel pipe. Small roots removed and measured to bottom of constructed depth at 15.13 feet below top of casing (BTOC).

BW-MW-1

Date Redrilled: 27 November 2018

Reason: The water level sonde became stuck after rehabilitating the well during the First Mobilization in Feb/Mar 2018.

Well Construction Description:
Groundwater elevation was 8.8 feet below ground surface (bgs). The geology of the monitoring well location is comprised of brown/gray fine sands. The well was installed using Direct Push Technology (DPT) to an approximate depth of 18.3 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen with a 0.5-inch bottom cap. The screen was flush-threaded to approximately 20 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 10 feet bgs, followed by a bentonite/Portland cement slurry to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

LEL-MW-4

Date Redrilled: 28 November 2018

Reason: The water level sonde in LEL-MW-1 became stuck after rehabilitating the well during the First Mobilization in Feb/Mar 2018. LEL-MW-1 was abandoned but not plugged, and a new well was constructed (LEL-MW-4).

Well Construction Description:
Groundwater elevation was 6.6 feet below ground surface (bgs). The geology of the monitoring well location is comprised of brown/gray sands. The well was installed using Direct Push Technology (DPT) to an approximate depth of 21.0 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen with a 0.5-inch bottom cap. The screen was flush-threaded to approximately 20 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 14 feet bgs, followed by a bentonite/Portland cement slurry to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

BCA-MW-2

Date Redrilled: 28 November 2018

Reason: The well could not be rehabilitated during the First Mobilization in Feb/Mar 2018 due to an unknown obstruction.

Well Construction Description:
Groundwater elevation was 6.98 feet below ground surface (bgs). The geology of the monitoring well location is comprised of fine sands until approximately 12 feet where it becomes rocky. The well was installed using Direct Push Technology (DPT) to an approximate depth of 14.0 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen with a 0.5-inch bottom cap. The screen was flush-threaded to approximately 15 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 6 feet bgs, followed by a bentonite/Portland cement slurry to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

SPB-MW-4

Date Redrilled: 28 November 2018

Reason: The original well was constructed outside of the IBWC property boundary. Therefore, a new well (SPB-MW-4) was constructed within the property boundary.

Well Construction Description:
Groundwater elevation was 3.8 feet below ground surface (bgs). The geology of the monitoring well location is comprised of brown sands with some rock towards the bottom of the well. The well was installed using Direct Push Technology (DPT) to an approximate depth of 18.0 feet bgs and constructed using five feet of two-inch diameter 0.010-inch machine slotted PVC screen with a 0.5-inch bottom cap. The screen was flush-threaded to approximately 20 feet of two-inch diameter solid PVC riser. The annular space surrounding each well screen was filled with a 10/20 filter sand pack to 10.5 feet bgs, followed by a bentonite/Portland cement slurry to 1.5 feet bgs, and completed with a neat cement grout. The well was surface completed using a two-foot by two-foot concrete pad with a stainless steel, lockable well shroud.

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APPENDIX G
WELL CONSTRUCTION FORMS & LOGS

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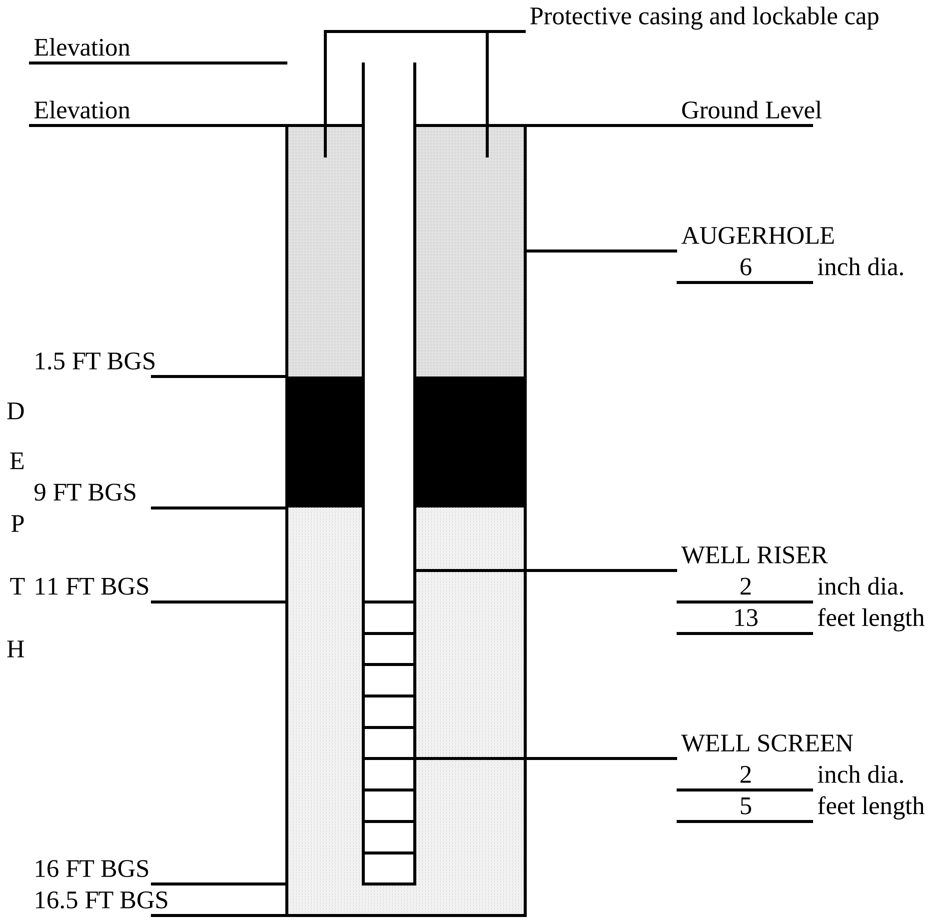
Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: SP-MW1
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 2/27/2018
Completion Date: 2/27/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX
FILTER MATERIAL		***LEGEND***
Type: 10-20 SILICA SAND Setting: 9-16 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

q:gentile\fs\site d1\USIBWC_WellConstruct.xls

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: New Mexico

DRILLING METHOD: Hollow Stem Auger

SAMPLING METHOD: Split Spoon

BORING NO. SP-MW1

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL		~8 ft bgs			TIME	TIME
TIME					1018	1458
DATE					DATE: 2/27/2018	DATE: 2/27/2018
CASING DEPTH						

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

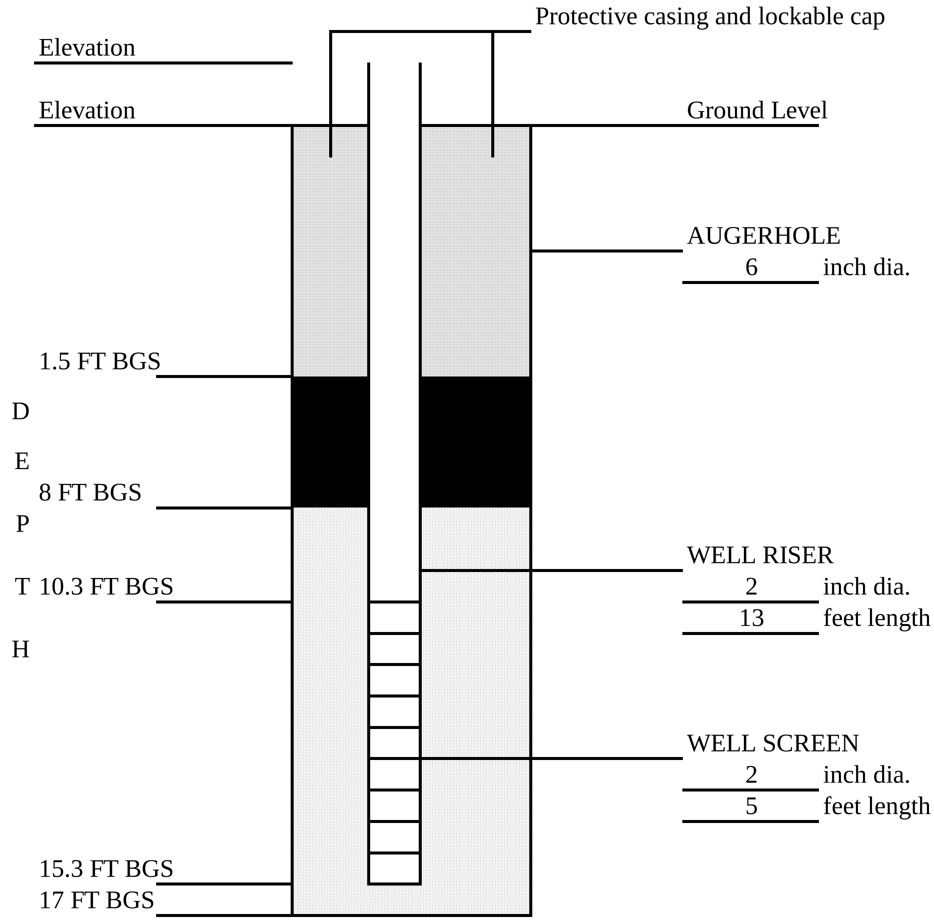
DATE

SURFACE CONDITIONS: SAND AND GRASS GROWTH

SAMPLER TYPE	INCHES DRIVEN	TIME		DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
SS				0		
				1	SP	WHITE TO TAN ROUNDED SANDS, 0.235-0.350mm. WELL SORTED. MOIST
				2		
				3		
				4		
	60 / 10	1023		5		LOSS DUE TO LOOSE UNCONSOLIDATED FINES
					SP	WHITE TO TAN ROUNDED 0.500-O.177mm SANDS. WELL SORTED VERY MOIST.
				6		
				7	SP	GRADES TO DARK BROWN
				8		
				9		
	60 / 27	1038		10		LOSS DUE TO UNCONSOLIDATED FINES
					SP	GRAY AND TAN ROUNDED 0.177-0.500mm SANDS. WELL SORTED. SATURATED.
				11		
				12		
				13		
				14		
	60 / 17	1127		15	SW	GRAY AND TAN SUBROUNDED 0.177-0.500mm SANDS. MODERATE SORTED. SATURATED.
	12 / 8	1208		16		BORING TERMINATED AT 16 FT BGS
				17		
				18		
				19		
				20		

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: CCE-MW2
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 2/28/2018
Completion Date: 2/28/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX

FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 8-17 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

q:gentile\fs\site d1\USIBWC_WellConstruct.xls

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: Texas

DRILLING METHOD: Hollow Stem Auger

SAMPLING METHOD: Grab Shovel Sample

BORING NO.	CCE-MW2
SHEET	1 OF 1

WATER LEVEL		~8 ft bgs		
TIME				
DATE				
CASING DEPTH				

DRILLING	START	FINISH
TIME	1319	1455
DATE:	2/28/2018	2/28/2018

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

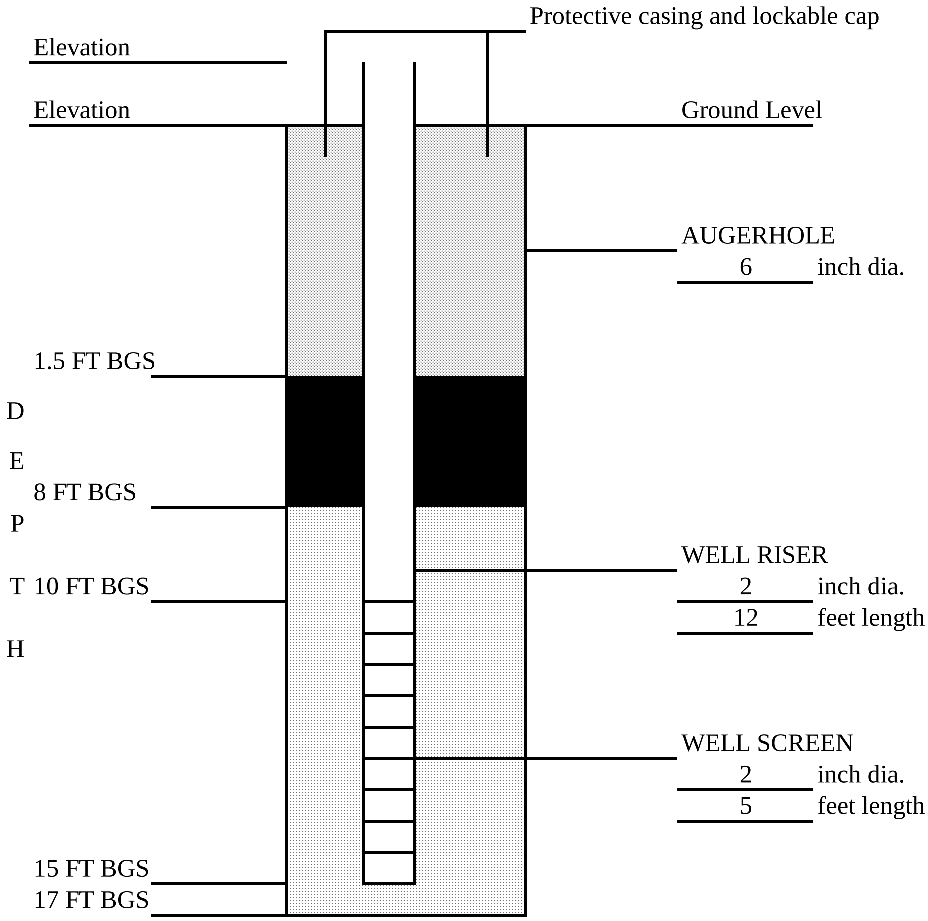
DATE

SURFACE CONDITIONS: GRASSES AND SHRUB GROWTH. SANDS

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SM	TAN FINE GRAINED SANDS AND SILTE 0.125-0.177mm GRAIN SIZE
		1		
	1320	2	SP	TAN SANDS 0.177-0.350mm GRAIN SIZE. WELL ROUNDED. WELL SORTED. MOIST
		3		
		4		
	1321	5	SP	BROWN SANDS 0.177-0.350mm GRAIN SIZE. WELL ROUNDED. WEL SORTED. SATURATED.
		6		
	1328	7	SP	BROWN SANDS 0.250-0.710mm GRAINSIZE. SUBROUNDED. MODERATELY SORTED. SATURATED.
		8		
		9		
	1329	10	SP	GREY/BROWN SANDS 0.350-0.500mm GRAIN SIZE. ROUNDED. WEL SORTED. SATURATED.
		11		
	1338	12		SAME AS ABOVE.
		13		
		14		
	1339	15	SP	GREY SANDS 0.250-0.350mm GRAIN SIZE. ROUNDED. WELL SORTE SATURATED.
		16		
	1348	17		BORING TERMINATED AT 17 FT BGS
		18		
		19		
		20		

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: CCE-MW3
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 2/28/2018
Completion Date: 2/28/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX
FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 9-15 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

TALON LPE
DRILLING CONTR.

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: Texas

DRILLING METHOD: Hollow Stem Auger

SAMPLING METHOD: Grab Shovel Sample

BORING NO. CCE-MW3

SHEET 1 OF 1

WATER LEVEL		~8 ft bgs		
TIME				
DATE				
CASING DEPTH				

DRILLING	
START	FINISH
TIME	TIME
821	1036
DATE: 2/28/2018	DATE: 2/28/2018

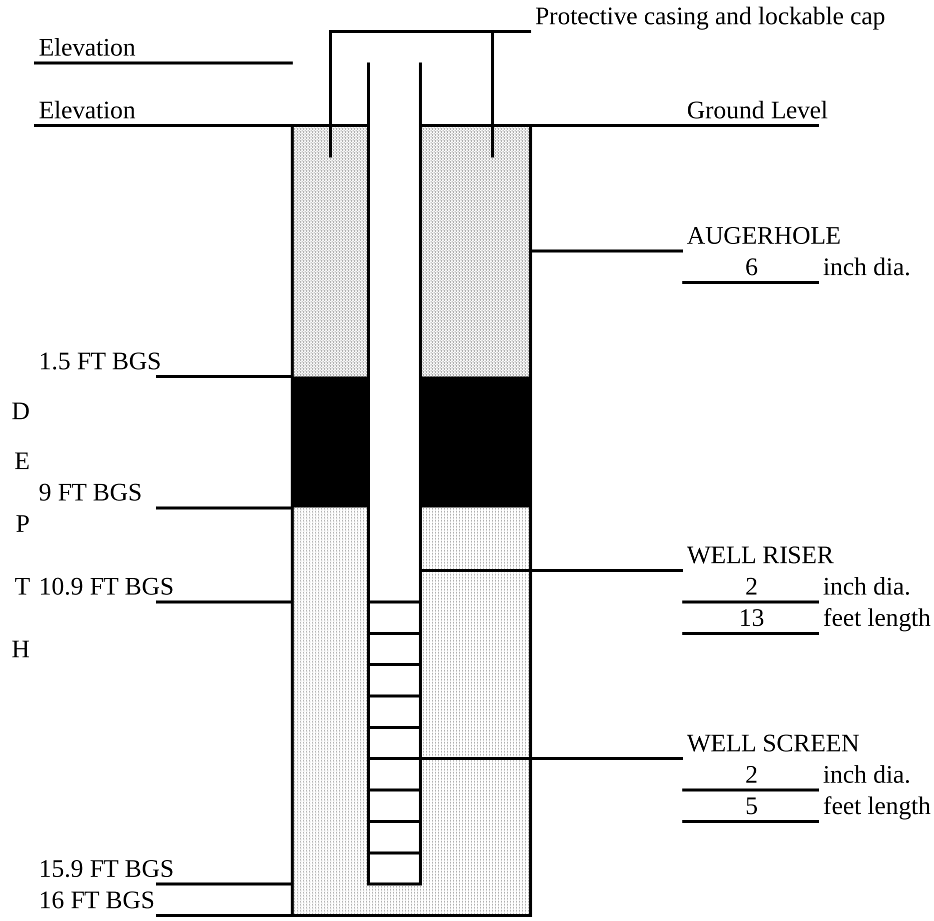
SURFACE CONDITIONS: GRASSES AND SHRUB GROWTH

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SP	TAN SANDS 0.250-0.350mm GRAIN SIZE. SUBROUNDED. WELL SORTED. DRY
		1		
	0823	2	SM	BROWN SILTY SAND. 0.177-0.250mm GRAIN SIZE. WELL SORTED. WELL ROUNDED. MOIST.
		3		
		4		
	0824	5	SM	DARK BROWN SILTY SAND 0.177-0.250mm GRAIN SIZE. WELL SORTED. WELL ROUNDED. WET.
		6		
	0834	7	SM	GREY SILTY SAND. 0.177-0.250mm GRAIN SIZE. WELL SORTED WELL ROUNDED. SATURATED.
		8		
		9		
	0835	10	SM	GREY/BROWN SILTY SAND. 0.177-0.250mm GRAIN SIZE. WELL SORTED. WELL ROUNDED. SATURATED.
		11		
	0901	12	SM	GREY/BROWN SILTY SAND (0.177-0.250mm GRAIN SIZE WITH <5% 4mm SIZE GRANULES. SUBROUNDED, MODERATELY SORTED SATURATED
		13		
		14		
	0903	15	SM	GREY/BROWN SILTY SAND 0.177-0.250mm GRAIN SIZE. ROUNDED. WELL SORTED. SATURATED.
		16	SM	GREY SILTY SAND 0.177-0.710mm GRAIN SIZE. SUBROUNDED. MODERATELY SORTED.SATURATED.
		17		BORING TERMINATED AT 17 FT BGS
		18		
		19		
		20		

BY Trihydro Corporation
CHK'D BY
DATE

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: VC-MW1
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 2/28/2018
Completion Date: 3/1/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX
FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 10.9-15.9 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: Texas
	DRILLING METHOD: Hollow Stem Auger		BORING NO. VC-MW1
	SAMPLING METHOD: Grab Shovel Sample		SHEET 1 OF 1

					DRILLING	
					START	FINISH
WATER LEVEL		~8 ft bgs			TIME 1654	TIME 1802
TIME						
DATE					DATE: 2/28/2018	DATE: 2/28/2018
CASING DEPTH						

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

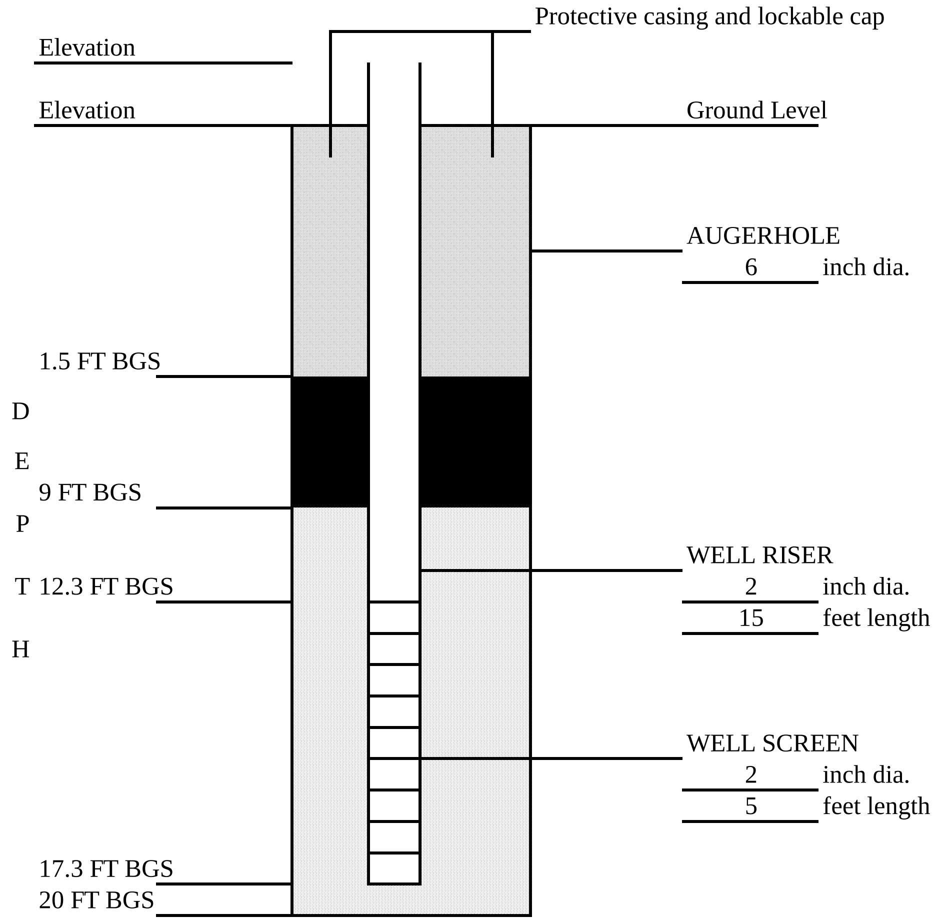
DATE

SURFACE CONDITIONS: PATCHY GRASSES AND SAND

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SM	TAN FINE GRAINED SANDS AND SILT 0.125-0.177mm GRAIN SIZE
		1		
	1656	2	SP	BROWN SANDS 0.177-0.250mm GRAIN SIZE. WELL ROUNDED. WELL SORTED. DRY
		3		
		4		
	1657	5	SP	TAN SANDS. 0.250-0.350mm GRAIN SIZE. ROUNDED. WELL SORTED MOIST
		6		
	1701	7	SP	SAME AS ABOVE
		8		
		9		
	1702	10	SP	GREY SANDS 0.250-0.500mm GRAIN SIZE. ROUNDED. WELL SORTED. WET.
		11		
	1708	12	SP	GREY SANDS. 0.177-0.500mm GRAIN SIZE. WELL ROUNDED. WELL SORTED. SATURATED.
		13		
		14		
	1709	15	SP	SAME AS ABOVE.
		16	SP	SAME AS ABOVE.
	1716	17		BORING TERMINATED AT 17 FT BGS
		18		
		19		
		20		

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: BE-MW1
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 3/1/2018
Completion Date: 3/1/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: Setting: SAKRETE HIGH STRENGTH CONCRETE MIX
FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 9-10.9 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

q:gentile\fs\site d1\USIBWC_WellConstruct.xls

LOCATION OF BORING	**JOB NO.** 52M-002-GOV	**CLIENT:** USIBWC	**LOCATION**: New Mexico
	DRILLING METHOD: Hollow Stem Auger		BORING NO. BE-MW1
	SAMPLING METHOD: Grab Shovel Sample		SHEET 1 OF 1

WATER LEVEL		~8 ft bgs		
TIME				
DATE				
CASING DEPTH				

DRILLING	START	FINISH
TIME	1022	1355
DATE:	3/1/2018	3/1/2018

DRILLING CONTR. TALON LPE

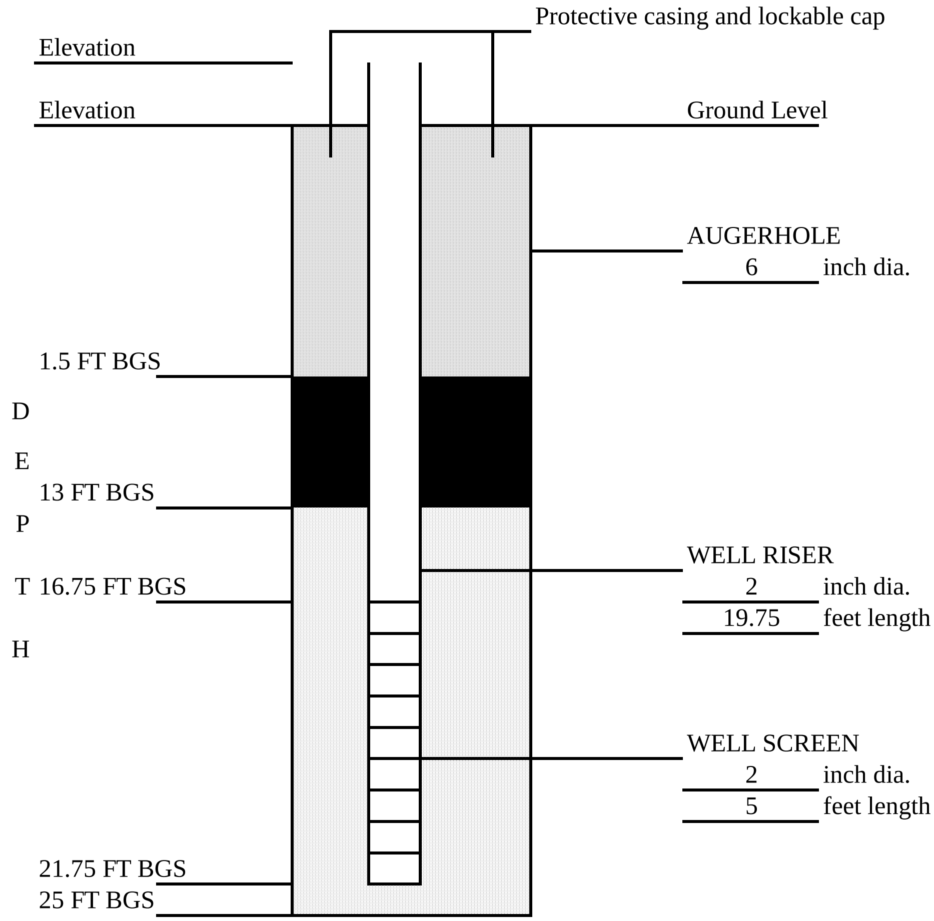
BY Trihydro Corporation DATE CHK'D BY

SURFACE CONDITIONS: GRASSES AND BRUSH

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SM	TAN FINE GRAINED SANDS AND SILTS. 0.125-0.177mm GRAIN SIZE
		1		
	1023	2	SM	BROWN SILTY SANDS 0.250-0.350mm GRAIN SIZE. ROUNDED. WEL SORTED. DRY
		3		
		4		
	1024	5	SP	TAN SANDS. 0.250-0.500mm GRAIN SIZE. ROUNDED. WELL SORTEI MOIST
		6		
	1029	7	SP	BROWN SANDS. 0.250-0.500mm GRAIN SIZE. SUNROUNDED. WELL SORTED. MOIST
		8		
		9		
	1030	10	SP	BROWN SANDS. 0.250-0.500mm GRAIN SIZE. SUNROUNDED. WELL SORTED. WET.
		11		
	1034	12	SP	TAN SANDS 0.250-0.500mm GRAIN SIZE. SUBROUNDED. WELL SORTED. SATURATED.
		13		
		14		
	1036	15	SP	SAME AS ABOVE.
		16		
	1042	17	SP	SAME AS ABOVE.
		18		
		19	SP	SAME AS ABOVE.
	1043	20		BORING TERMINATED AT 20 FT BGS

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: ME-MW1
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 3/2/2018
Completion Date: 3/2/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: Setting: SAKRETE HIGH STRENGTH CONCRETE MIX
FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 13-21.75 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: New Mexico

DRILLING METHOD: Hollow Stem Auger

SAMPLING METHOD: Grab Shovel Sample

BORING NO. ME-MW1

SHEET 1 OF 2

WATER LEVEL		~8 ft bgs			
TIME					
DATE					
CASING DEPTH					

DRILLING	START	FINISH
TIME	1241	1433
DATE	3/2/2018	3/2/2018

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

DATE

SURFACE CONDITIONS: GRASSES, VERY LOOSE SILTY SANDS

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SM	TAN FINE GRAINED SANDS AND SILTS. 0.125-0.177mm GRAIN SIZE
		1		
	1242	2	SP	BROWN SANDS 0.250-0.500mm GRAIN SIZE. SUBROUNDED. WELL SORTED. DRY
		3		
		4		
	1244	5	SP/SC	BROWN SANDS 0.250-0.500mm GRAIN SIZE WITH CLAY LENSES. SUBROUNDED. MODERATELY SORTED. DRY
		6		
	1251	7	SP	TAN SANDS 0.25-0.50mm GRAIN SIZE. ROUNDED. WELL SORTED. MOIST
		8		
		9		
	1254	10	SP	TAN SANDS 0.25-0.50mm GRAIN SIZE. ROUNDED. WELL SORTED WET.
		11		
	1301	12	SP	SAME AS ABOVE. SATURATED.
		13		
		14		
	1303	15	SP	SAME AS ABOVE.
		16		
	1343	17	SP	SAME AS ABOVE.
		18		
		19	SP	SAME AS ABOVE.
	1344	20		BORING TERMINATED AT 20 FT BGS

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: New Mexico

DRILLING METHOD: Hollow Stem Auger	BORING NO. ME-MW1
SAMPLING METHOD: Grab Shovel Sample	SHEET 2 OF 2

					DRILLING START	DRILLING FINISH
WATER LEVEL		~8 ft bgs			TIME	TIME
TIME					1241	1433
DATE					DATE: 3/2/2018	DATE: 3/2/2018
CASING DEPTH						

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

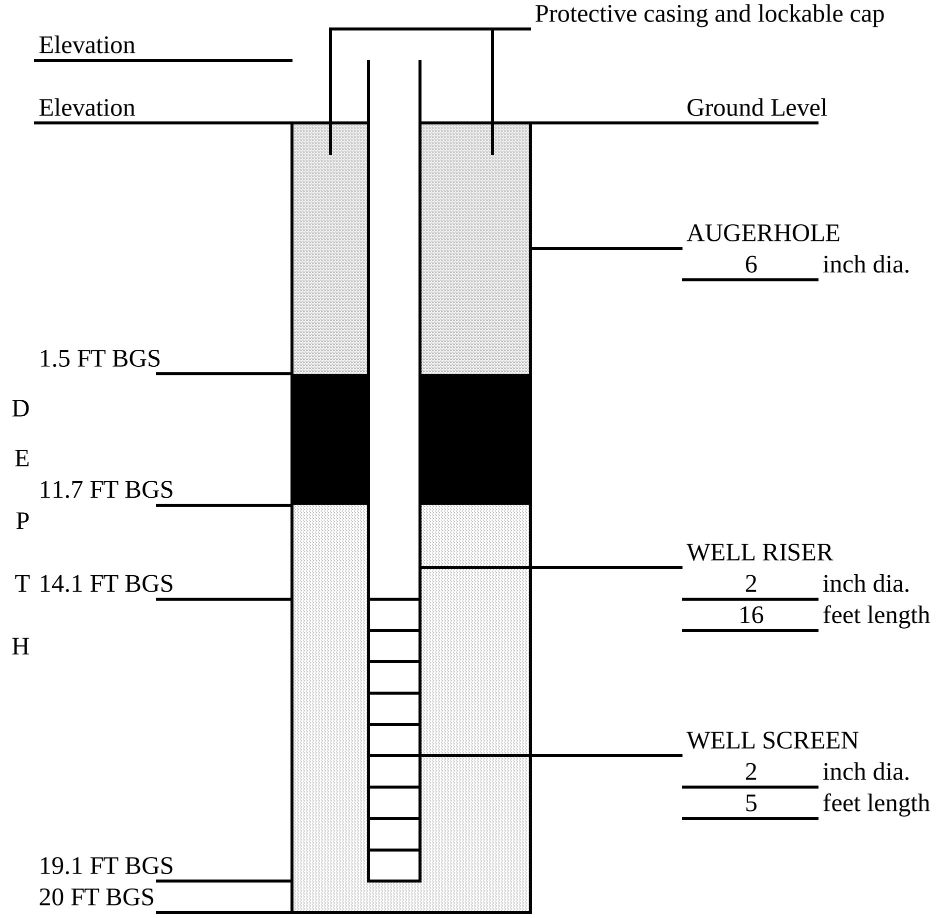
DATE

SURFACE CONDITIONS: GRASSES, VERY LOOSE SILTY SANDS

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		20		
		21		
	1347	22	SP	TAN SANDS. 0.25-0.50mm GRAIN SIZE. ROUNDED. WELL SORTED. SATURATED
		23		
		24		
	1348	25	SP	SAME AS ABOVE BORING TERMINATED AT 25 FT BGS
		26		
		27		
		28		
		29		
		30		
		31		
		32		
		33		
		34		
		35		
		36		
		37		
		38		
		39		
		40		

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: CCB-MW2
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: JAROD MICHALSKY
Starting Date: 3/3/2018
Completion Date: 3/3/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX
FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 11.7-19.1 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: New Mexico

DRILLING METHOD: Hollow Stem Auger

SAMPLING METHOD: Grab Shovel Sample

BORING NO. CCB-MW2

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL		~9 ft bgs			TIME	TIME
TIME					700	830
DATE					DATE: 3/3/2018	DATE: 3/3/2018
CASING DEPTH						

DRILLING CONTR. TALON LPE

BY Trihydro Corporation

CHK'D BY

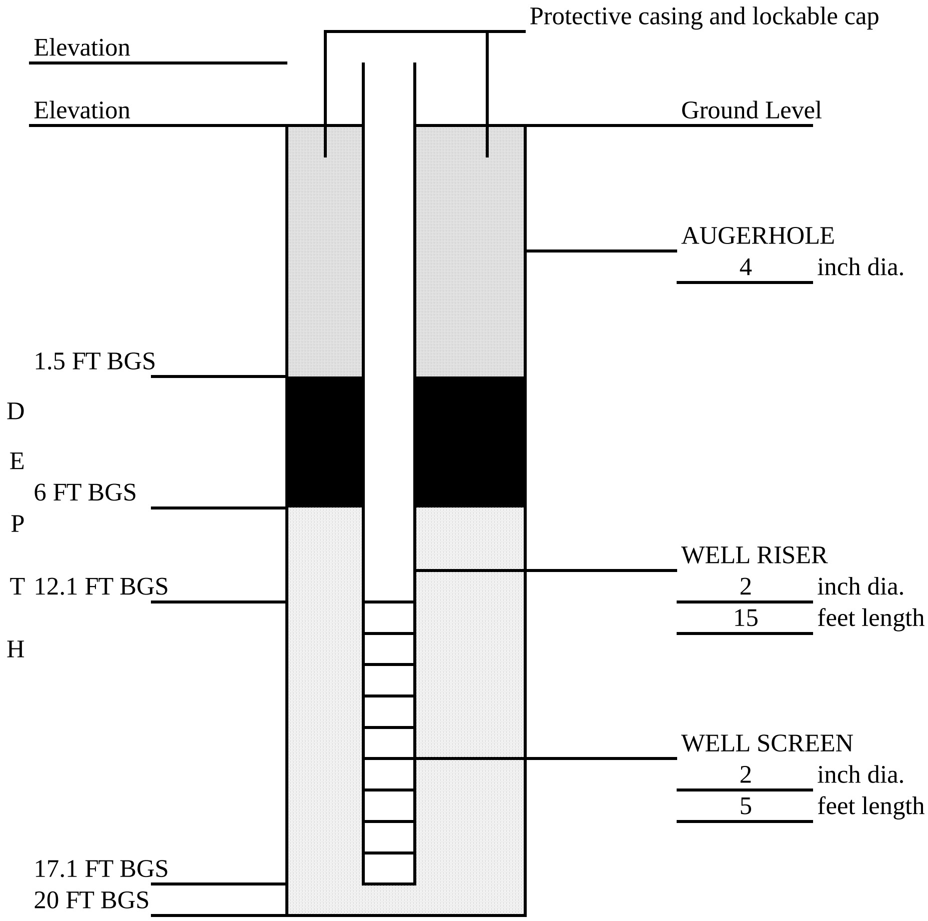
DATE

SURFACE CONDITIONS: SHRUBS AND LOOSE SILTY SAND

SAMPLER TYPE	TIME	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA		0	SM	BROWN FINE GRAINED SILTY SANDS.
		1		
	0708	2	SP	TAN SANDS. 0.25-0.50mm GRAIN SIZE. ROUNDED. MODERATELY SORTED. <10% GRANULES 4mm SIZE. DRY.
		3		
		4		
	0709	5	SP	TAN SANDS. 0.25-4mm SIZE. SUBROUNDED. MODERATELY SORTE DRY
		6		
	0716	7	SW	TAN SANDS WITH MEDIUM GRAINED PEBBLES. 0.25-20mm GRAIN SIZE. SUBANGULAR. MODERATELY SORTED. DRY
		8		
		9		
	0717	10	SW	TAN SANDS. 0.5-4mm GRAIN SIZE. SUBROUNDED. MODERATELY SORTED. WET
		11		
	0753	12	SW	BROWN VERY COARSE SANDS. 0.71-2mm GRAIN SIZE. SUBROUNDED. MODERATELY SORTED. SATURATED
		13		
		14		
	0754	15	SW	SAME AS ABOVE.
		16		
	0800	17	SW	SAME AS ABOVE.
		18		
		19	SW	SAME AS ABOVE.
	0802	20		BORING TERMINATED AT 20 FT BGS

Monitoring Well
Construction Details

DRILLING SUMMARY
Well Number: CCB-MW3
Geologist: VICKI BIERWIRTH
Drilling Company: TALON LPE
Driller: G. PEREZ
Starting Date: 3/8/2018
Completion Date: 3/8/2018



WELL DESIGN

CASING MATERIAL	*SCREEN MATERIAL*	*SEAL MATERIAL*
Surface: STAINLESS STEEL Monitor: 2" PVC	Type: SCHEDULE 40 PVC Slot Size: 0.010"	Seal #1 Type: 3/8" COARSE GRADE BENTONITE HOLE PLUG Seal #2 Type: SAKRETE HIGH STRENGTH Setting: CONCRETE MIX

FILTER MATERIAL		*LEGEND*
Type: 10-20 SILICA SAND Setting: 6-12 FT BGS Type: FILTER PRE-PACK Setting: 12-17 FT BGS		Cement/Bentonite Grout (Seal # 2) Bentonite Seal (Seal # 1) Silica Sandpack

Client: USIBWC	Project: WELL REHABILITATION	Project No.: 52M-002-GOV

Trihydro

TALON LPE
DRILLING CONTR.

LOCATION OF BORING	JOB NO. 52M-002-GOV	CLIENT: USIBWC	LOCATION: New Mexico

DRILLING METHOD: DIRECT PUSH (DPT)

SAMPLING METHOD: 2" Plastic Sleeve

BORING NO. CCB-MW3

SHEET 1 OF 1

					DRILLING START	DRILLING FINISH
WATER LEVEL		~6 ft bgs			TIME	TIME
TIME					820	1520
DATE					DATE: 3/8/2018	DATE: 3/8/2018
CASING DEPTH						

SURFACE CONDITIONS: GRASSES AND BRUSH

SAMPLER TYPE	INCHES RECOVERED	TIME		DEPTH IN FEET	SOIL GRAPH	DESCRIPTION
HSA				0		5" BROWN SILTY SOILS/ORGANIC DEBRIS
				1	SW	TAN SANDS 0.25-4mm GRAIN SIZE. SUBANGULAR. POORLY SORTE DRY.
				2		POOR RECOVERY DUE TO LOOSE UNCONSOLIDATED SANDS
				3		
	48/28	0824		4	SW	TAN/GREY SANDS 0.5-4mm GRAIN SIZE. WITH <15% 10-30mm SIZE PEBBLES. DRY
				5		
				6		SAME AS ABOVE. MOIST. POOR RECOVERY DUE TO LOOSE UNCONSOLIDATED SANDS
				7		
	48/29	0845		8	SW	BROWN/GREY SANDS 0.5-2mm GRAIN SIZE. WITH < 5% 10mm SIZE PEBBLES. SATURATED.
				9		
				10		POOR RECOVERY DUE TO LOOSE UNCONSOLIDATED SANDS.
				11		
	48/24	0857		12	SW	GREY SANDS 0.35-4mm GRAIN SIZE WITH <5% 10mm SIZED PEBBLES. SATURATED.
				13		
				14		
				15		POOR RECOVERY DUE TO LOOSE UNCONSOLIDATED SANDS.
	48/33	0920		16		
				17		BORING TERMINATED AT 17 FT BGS
				18		
				19		
				20		

BY Trihydro Corporation
CHK'D BY
DATE

Monitoring Well Construction

Date: 27 Nov 2018

Location ID: BW-MW-1

Site Name: Berino West

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

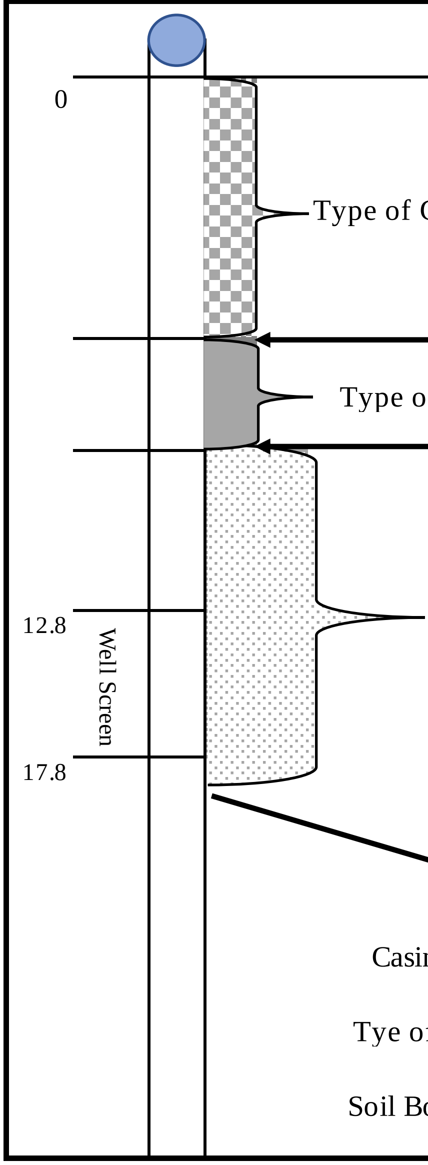
Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Type of Well: Groundwater Monitoring

Well Construction Description: 2-inch PVC with 5-foot screen (slot size = 0.010 inches); Well Screen Cap = 0.5 feet



Type of Grout: Quick-Gel Bentonite/Portland Cement Slurry

Beginning of Seal Depth: 1.5 FT

Type of Grout: Bentonite/Portland Cement Slurry

End of Seal Depth: 10 FT

Filter Pack Type and Size: 10/20 Sand

18.3 FT TOTAL DEPTH OF WELL

Casing Type: Sch 40

Tye of Screen: Sch 40

Soil Boring Coordinates: 32.083581°, -106.665051°

Lithologic Log

Date: 27 Nov 2018

Location ID: BW-MW-1

Site Name: Berino West

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Sample Method: Core

Depth (FT)	PID (PPM)	Lithology	Lithologic Description
0			0 - 2 Feet: Brown/Gray Silt
			2 - 4 Feet: Brown/Gray Fine Silt
5			4 - 8 Feet: Brown/Gray Fine Silt / Moist Sand
10			8 - 12 Feet: Brown/Gray Fine Silt / Moist Sand
			12 - 16 Feet: Brown/Gray Fine Silt / Moist Sand
15			16 - 18.3 Feet: Brown/Gray Fine Silt / Moist Sand
20			TD = 18.3 Feet Bottom of Screen = 18.3 - 0.5 = 17.8 Feet (bottom cap is 0.5 feet) DTW = 8.8 Feet
25			
30			Soil Boring Coordinates: 32.083581º, -106.665051º

EGC, Inc.

A State of Texas Registered Geoscience Firm

Monitoring Well Construction

Date: 28 Nov 2018 Location ID: LEL-MW-4

Site Name: Leasburg Extension Lateral

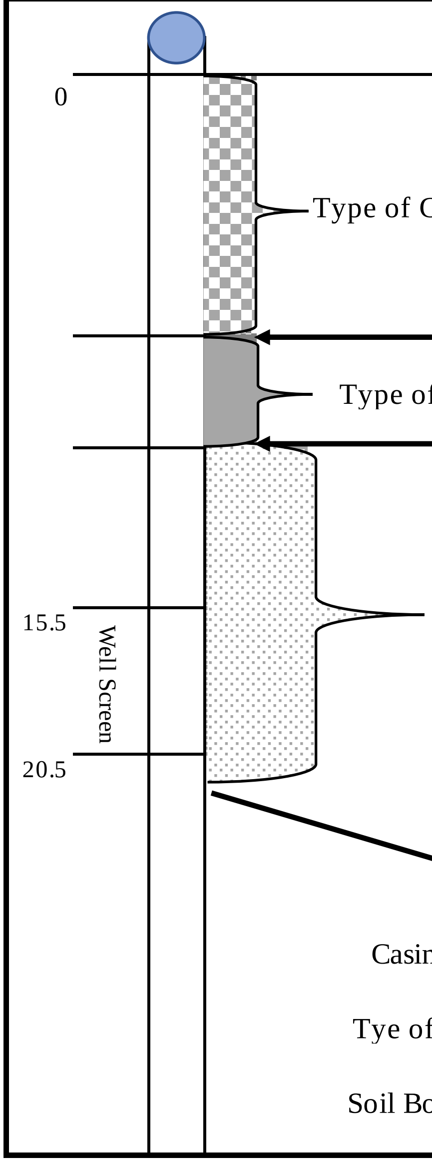
Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

Drilling Company: Talon LPE Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez Type of Well: Groundwater Monitoring

Well Construction Description: 2-inch PVC with 5-foot screen (slot size = 0.010 inches); Well Screen Cap = 0.5 feet



Type of Grout: Quick-Gel Bentonite/Portland Cement Slurry

Beginning of Seal Depth: 1.5 FT

Type of Grout: Bentonite/Portland Cement Slurry

End of Seal Depth: 14 FT

Filter Pack Type and Size: 10/20 Sand

21.0 FT TOTAL DEPTH OF WELL

Casing Type: Sch 40

Tye of Screen: Sch 40

Soil Boring Coordinates: 32.337515°, -106.834321°

EGC, INC.

A State of Texas Registered Geoscience Firm

Lithologic Log

Date: 28 Nov 2018 Location ID: LEL-MW-4

Site Name: Leasburg Extension Lateral

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

Drilling Company: Talon LPE Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez Sample Method: Core

Depth (FT)	PID (PPM)	Lithology	Lithologic Description
0			0 - 2 Feet: Brown/Gray Sands (mostly compacted)
			2 - 4 Feet: Brown/Gray Sands
5			4 - 8 Feet: Brown/Gray Sands (moist)
10			8 - 12 Feet: Brown/Gray Sands (moist)
			12 - 16 Feet: Brown/Gray Fine Sands (moist)
15			16 - 20 Feet: Brown Wet Sand
20			20-21 Feet: Brown Wet Sand
25			TD = 21 Feet Bottom of Screen = 21.0 - 0.5 = 20.5 Feet (bottom cap is 0.5 feet) DTW = 6.6 Feet
30			Soil Boring Coordinates: 32.337515°, -106.834321°

EGC, Inc.

A State of Texas Registered Geoscience Firm

Monitoring Well Construction

Date: 28 Nov 2018

Location ID: BCA-MW-2

Site Name: Broad Canyon Arroyo

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

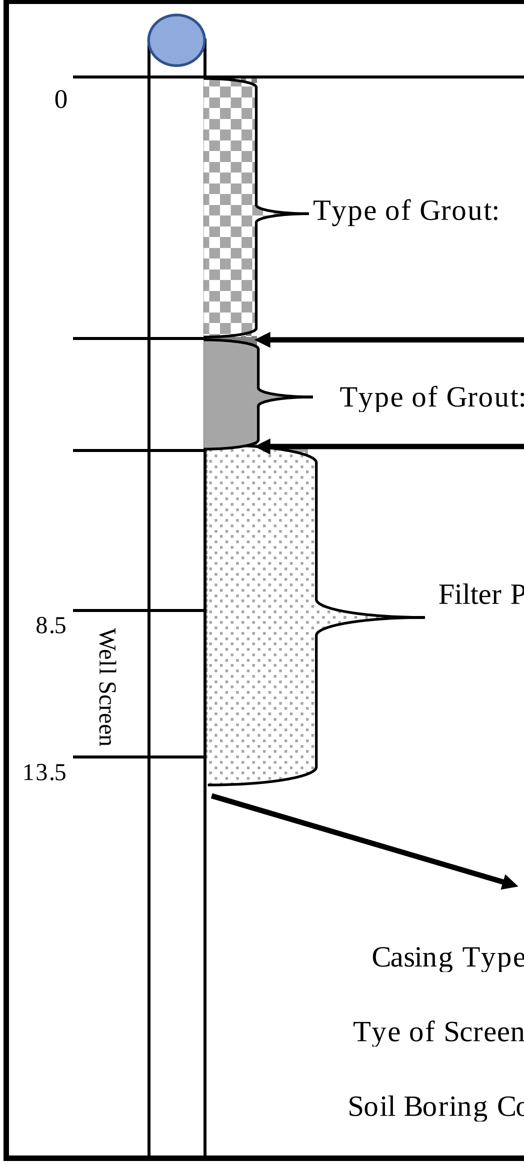
Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Type of Well: Groundwater Monitoring

Well Construction Description: 2-inch PVC with 5-foot screen (slot size = 0.010 inches); Well Screen Cap = 0.5 feet



Type of Grout: Quick-Gel Bentonite/Portland Cement Slurry

Beginning of Seal Depth: 1.5 FT

Type of Grout: Bentonite/Portland Cement Slurry

End of Seal Depth: 6 FT

Filter Pack Type and Size: 10/20 Sand

14.0 FT TOTAL DEPTH OF WELL

Casing Type: Sch 40

Tye of Screen: Sch 40

Soil Boring Coordinates: 32.538635°, -106.986901°

Lithologic Log

Date: 28 Nov 2018

Location ID: BCA-MW-2

Site Name: Broad Canyon Arryo

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Sample Method: Core

Depth (FT)	PID (PPM)	Lithology	Lithologic Description
0			0 - 4 Feet: Brown Soft Silty Clay with Some Fines
5			4 - 6 Feet: Missing due to groundwater 6 - 8 Feet: Fine Silts (moist)
10			8 - 11 Feet: Fine Sands (wet)
			11 - 12 Feet: Rock Mixed with Fine Sands (wet)
			12 - 14 Feet: Rock Mixed with Fine Sands (wet)
15			*Drilling terminated due to the Geoprobe not being able to cut through the rock*
20			TD = 14 Feet Bottom of Screen = 14.0 - 0.5 = 13.5 Feet (bottom cap is 0.5 feet) DTW = 6.98 Feet
25			
30			Soil Boring Coordinates: 32.538635º, -106.986901º

Monitoring Well Construction

Date: 28 Nov 2018

Location ID: SPB-MW-4

Site Name: Seldon Point Bar

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

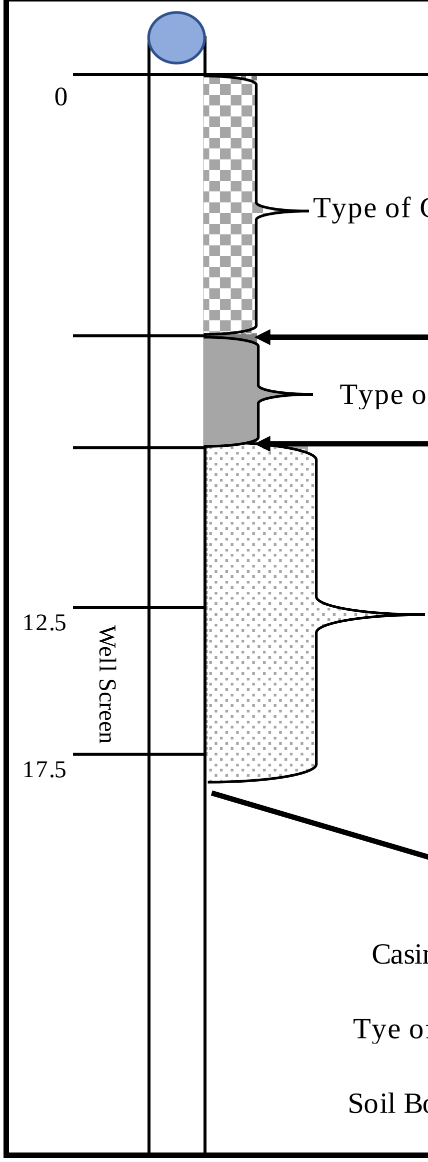
Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Type of Well: Groundwater Monitoring

Well Construction Description: 2-inch PVC with 5-foot screen (slot size = 0.010 inches); Well Screen Cap = 0.5 feet



Type of Grout: Quick-Gel Bentonite/Portland Cement Slurry

Beginning of Seal Depth: 1.5 FT

Type of Grout: Bentonite/Portland Cement Slurry

End of Seal Depth: 10.5 FT

Filter Pack Type and Size: 10/20 Sand

18.0 FT TOTAL DEPTH OF WELL

Casing Type: Sch 40

Tye of Screen: Sch 40

Soil Boring Coordinates: 32.517358º, -106.971326º

EGC, Inc.

A State of Texas Registered Geoscience Firm

Lithologic Log

Date: 29 Nov 2018

Location ID: SPB-MW-4

Site Name: Seldon Point Bar

Weather Conditions: Sunny & Clear

Logging Geologist: Rene Hefner

Drilling Company: Talon LPE

Drilling Method: DPT (Geoprobe)

Driller's Name: Ronnie Rodriguez

Sample Method: Core

Depth (FT)	PID (PPM)	Lithology	Lithologic Description
0			0 - 2 Feet: Brown Clay
			2 - 4 Feet: Brown Clay (moist at ~3.5 feet)
5			4 - 6 Feet: Brown Clay with Some Fines (moist)
			6 - 8 Feet: Brown Sands (moist)
10			8 - 12 Feet: Brown Sands (wet)
			12 - 15 Feet: Brown Sands with Some Brown Clay (wet)
15			15 - 16 Feet: Brown Clay (wet)
			16 - 18 Feet: Brwon Fines with Some Rock (wet)
20			TD = 18 Feet
			Bottom of Screen = 18.0 - 0.5 = 17.5 Feet (bottom cap is 0.5 feet)
25			DTW = 3.8 Feet
30			Soil Boring Coordinates: 32.517358º, -106.971326º

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APPENDIX H
WELL DRILLING FIELD NOTES

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Trihydro Corporation

DAILY RECORD OF EVENTS

DATE: 02/27/18 | PAGE 1 OF 2

NAME: V. BIERWIRTH (VAB)

TO (FILE/PM): C. RADANT

CLIENT: USIBWC | SITE: Texas | PROJECT #: 52M-002-GOV

WEATHER: mid 50's SUNNY | WORK PERFORMED: GW MONITORING WELL INSTALL

Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:

SUBJECT: Well Rehabilition

0650 LEAVE HOTEL FOR MEETING LOCATION TO MEET DRILLERS IN EL PASO, TX

0745 ARRIVE AT ~~LOT~~ MEETING LOCATION, PREPARE FIELD EQUIPMENT FOR WORK ACTIVITIES TODAY

0840 EGC + VAB MOB TO SP-MW1 TO ASSESS AND LOCATE FORMER WELL LOCATION.

0850 ARRIVE AT SP-MW1 LOCATION. WELL CASING/WELL WERE NOT LOCATED

0920 C. RADANT + TALON DRILLING ONSITE. REVIEW HASP + TSM.

0940 USIBWC REPRESENTATIVES ONSITE. C. RADANT MOB OFFSITE TO COLLECT WELL CAPS, SINCE 5' WELL SCREENS ARE BEING PLACED INSTEAD OF 10' WELL SCREENS.

0958 MOB DRILL RIG TO AREA INSTRUCTED BY USIBWC TO SET WELL.

1014 BEGIN DRILLING SP-MW1. COLIN RADANT ONSITE.

1100 DISCUSS WELL PLACEMENT W/ KELLY OF USIBWC. WE ARE INSTRUCTED TO STICK W/ THE SCOPE UNLESS A STRATIGRAPHIC ANOMALY OCCURS THAT WARRANTS MODIFICATION TO THE WELL PLACEMENT. USIBWC LIZ + KELLY OFFSITE.

1138 SPLIT SPOON STUCK IN THE AUGER ROD. WORKING TO RELEASE THE SPLIT SPOON. ~~COLIN OFFSITE TO GATHER SUPPLIES.~~

1217 SPLIT SPOON EXTRACTED FROM THE HSA. DRILL HOLE CAVE IN @ 7' BLS. MUST REDRILL

1220 LUNCH BREAK.

1250 BEGIN PROCESS TO REDRILL CAVE IN OF SP-MW1

1333 REDRILL COMPLETE. WATER + SAND INFILTRATED HSA. CANNOT GET WELL INTO DRILL ~~HOL~~ HOLE. MUST REDRILL W/ PLUG IN BOTTOM OF HSA.

1446 WELL IS IN PLACE. HSA RODS HAVE BEEN PULLED.

1458 SAND + BENTONITE IN PLACE FOR SP-MW1

1506 CONSTRUCT SURFACE COMPLETION/WELL PAD.

1528 COLIN OFFSITE TO MEET W/ REHAB CREW. DRILL CREW. PACK EQUIPMENT.

1540 MOB TO CCE-MW3. IN TEXAS.

1600 BEGIN WELL ABANDONMENT ACTIVITIES.

1607 ORIGINAL CCE-MW3 REMOVED. IT WAS FILLED WITH FILTER PACK SAND. HOLE FILLED W/ BENTONITE CHIPS TO 5.5 FT BLS.

1618 FINISH ABANDONMENT OF CCE-MW3. MOB TO CCE-MW2.

1632 SET UP OVER ORIGINAL CCE-MW2. IN NEW MEXICO

1638 WELL ABANDONMENT OF CCE-MW2 COMPLETE. BENTONITE TO 3 FT BLS. MOB TO VC-MW1

1658 SET UP OVER VC-MW1 IN TEXAS. ABANDON WELL REMOVE WELL CASING.
PLACE BENTONITE DOWN HOLE 8' BLS.

1721 WELL ABANDONMENT COMPLETE AT VC-MW1

~~07~~1730 MOB OFFSITE TO MEET OTHER TEAM AT CIRCLE K.

1820 ARRIVE IN LAS CRUCES. E.O.D.

Trihydro CORPORATION

DAILY RECORD OF EVENTS

DATE: 2/28/18

PAGE 1 OF 2

NAME: V. BIERWIRTH (VAB)

TO (FILE/PM): COLIN RADANT

CLIENT: USIBWC

SITE: TX/NM

PROJECT #: 52M-002-GOV

WEATHER: mid 40's SUNNY

WORK PERFORMED: INSTALL GW MW.

Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:

SUBJECT: WELL REHABILITATION

0615	LEAVE LAS CRUCES FOR MEETING SITE.
0700	ARRIVE AT MEETING LOCATION.
0705	DRILLERS (TALON) ONSITE. TSM CONDUCTED.
0730	S. QUINT + VAB MOB TO CCE-MW3. DRILLERS COLLECTING WATER FOR DRILLING OPERATIONS. COMPLETE FIELD DOCUMENTS.
0755	TALON DRILLERS ONSITE. SET UP EQUIPMENT OVER CCE-MW3. BEGIN PAINTING CASING STICK UP.
0821	BEGIN DRILLING CCE-MW3.
0933	PULLED TOOLING TO PLACE PLUG ON DRILL BIT. CAVE IN @ 8' BLS
1005	CCE-MW3 WELL IN PLACE. BEGIN ~~PUL~~ TO PULL TOOLING + PLACE SAND
1036	DRILLING + WELL PLACEMENT COMPLETE. CCE-MW3 PLACED AT 15 FT BLS. LIZ FROM USIBWC ~~@~~ IS OK WITH WELL PLACEMENT WITHIN 1' OF PROPOSED DEPTH.
1100	MOB TO SP-MW1 TO PAINT AND FILL WITH SAND PACKER.
1130	LIZ FROM USIBWC ONSITE.
1140	MOB TO CCE-MW3 AND FINISH WELL COMPLETION
1213	CONSTRUCTING WELL PAD. LIZ FROM USIBWC OFFSITE.
1237	COMPLETE ACTIVITIES AT CCE-MW3. MOB TO CCE-MW2
1313	SET UP OVER CCE-MW2.
1250	PAINT CASING STICKUP.
1319	BEGIN DRILLING CCE-MW2.
1455	DRILLING COMPLETE. BEGIN SETTING WELL. OVERDRILLED WELL TO 17 FT BLS. ATTEMPTED TO UNPLUG THE PLUG ~~FO~~ FROM THE BIT USING WELL PVC, DID NOT WORK. PLACED INNER DRILL BIT INTO AUGER AND REMOVED PLUG. FLOWING SANDS INFILTRATED. SET THE WELL @ 15.3' BLS. * SIDE NOTE WHEN ~~O~~ ~~R~~ ORIGINALLY DRILLING WELL THE INNER BIT BECAME STUCK INSIDE THE AUGER UPON REMOVING THE TOOLING. KNEW FLOWING SANDS WOULD BE AN ISSUE.
1528	WELL FOR CCE-MW2 IS SET. SURFACE COMPLETION ACTIVITIES BEGIN.
~~1611~~ 1600	COMPLETION OF WELL IS FINISHED.
1614	PACK UP + MOB TO VC-MW1
1654	BEGIN DRILLING VC-MW1
1705	SCOTT QUINT OFFSITE TO PAINT VC-MW2
1802	SCOTT QUINT ONSITE. VC-MW2 IS REPAINTED. MW FOR VC-MW1 GOT STUCK IN AUGERS. HAD TO PULL TOOLING. REDRILLING OCCURRING.

1830 MW PVC GOT STUCK IN TOOLING AGAIN. PULLING TOOLING DUE TO SUN SETTING. WILL ATTEMPT REDRILL TOMORROW MORNING. PACKING EQUIPMENT.

1850 MOB OFFSITE.

1930 ARRIVE IN LAS CRUCES. E.O.D.

VB

DAILY RECORD OF EVENTS

Trihydro Corporation

DATE: 3/1/18 | PAGE 1 OF 2

NAME: V. BIERWIRTH (VAB)

TO (FILE/PM): C. RADANT (CR)

CLIENT: USIBWC

SITE: Texas/New Mexico

PROJECT #: 52M-002-GOV

WEATHER: high 40s sunny

WORK PERFORMED: MW install and Abandonment.

Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:

SUBJECT:

0545	VB + SCOTT QUINT LEAVE THE HOTEL
0630	ARRIVE ONSITE DRILLERS ONSITE.
0645	CONDUCT TSM.
0650	DRILLERS (TALON) SET UP OVER HOLE VC-MW1
0713	BEGIN REDRILLING OF VC-MW
0735	WELL SET. MULTIPURPOSE GREASE USED ON PLUG TO CREATE SEAL
0757	WELL SET. BEGIN SURFACE COMPLETION ACTIVITIES
0840	MOB OFFSITE TO CIRCLE K TO REFUEL.
0930	ARRIVE ONSITE AT BE-MW1
0940	BEGIN WELL ABANDONMENT OF ORIGINAL BE-MW1 - FILLED W/ 1-2mm VERY COARSE CLEAN SANDS.
1009	WELL REMOVED FROM GROUND. BEGIN TO PREP FOR REDRILL OF BE-MW-1
1100	WELL CASING PVC GOT STUCK ~~TO~~ IN THE AUGER TOOLING. PULL TOOLING
1120	REDRILL BE-MW1. LIZ + KELLY / USIBWC ONSITE.
1146	2nd ATTEMPT AT REDRILL UNSUCCESSFUL. PLUG REMOVED FROM THE AUGER BUT ~~FOLLOWING~~ FLOWING SANDS GOT THE WELL STUCK WITHIN THE TOOLING. TAKING A BREAK FROM DRILLING TO DRY TOOLING + CUT NEW PLUG FOR TOOLING. NEW PLUG NOT WORKING.
1200	DOWNTIME DUE TO CHARGING EQUIPMENT BATTERY TO FORM PLUG. LIZ + KELLY / USIBWC OFFSITE.
1310	RESUME DRILLING WITHOUT BIT. JUST A PLUG AT THE END OF THE DRILL TOOLING. WAS ABLE TO KNOCK PLUG OUT OF TOOLING. FLOWING SANDS ROSE THE WELL TO 16.5' BLS. WAS ABLE TO PUSH WELL DOWN W/ RIG AND FLUSHING WATER DOWN THE TOOLING. TD @ 17.3'. TRIED FILLING WELL PVC CASING WITH WATER + APPLY PRESSURE TO WELL PVC. ADDED WATER TO OUTSIDE OF CASING IN DRILL TOOLING. APPLY PRESSURE. TD @ 17.3'. RECEIVED THE OK FROM LIZ (IBWC) THAT 17.3 IS STILL WITHIN SOW. PROCEED W/ COMPLETING WELL BE-MW1. SCOTT QUINT PREPARING FORM FOR WELL PAD.
1500	WELL COMPLETION ACTIVITIES. COMPLETE. NEED ADDITIONAL CONCRETE TO COMPLETE WELL PAD. MOB TO LAS CRUCES FOR SUPPLIES.
1545	ARRIVE AT HOME DEPOT LAS CRUCES.
1600	~~DEPORT~~ DEPART HOMEDEPOT (QUINT + VB) FOR BE-MW1.
1645	ARRIVE ONSITE WAIT FOR DRILLERS.
1700	DRILLERS ONSITE RESUME SURFACE WELL COMPLETION

LEAVE SITE FOR
1730 ~~ARRIVE IN~~ LAS CRUCES
1800 ARRIVE IN LAS CRUCES.

3/1/18

Trihydro CORPORATION

DAILY RECORD OF EVENTS

DATE: 3/2/18 | PAGE 1 OF 1

NAME: V. BIERWIRTH (VAB)

TO (FILE/PM): C. RADANT. (CR)

CLIENT: USIBWC

SITE: New Mexico

PROJECT #: 52M-002-GOV

WEATHER: 63° SUNNY

WORK PERFORMED: Well Installment

Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:

SUBJECT: Well Rehabilitation

1030	~~LEV~~ LEAVE HOTEL FOR ME MW1. DRILLERS HEAD TO HOME DEPOT FOR SUPPLIES.
1100	ARRIVE ONSITE. WAIT FOR DRILLERS TO ARRIVE.
1200	DRILLERS ONSITE. LOCATE PREVIOUS WELL BORING. C. RADANT
	⊛ ONSITE TO DISCUSS LOGISTICS. ELOY JOINS THE DRILL TEAM.
1220	C. RADANT OFFSITE. VAB CONDUCT TSM. PREP FOR DRILLING
	OPERATIONS. VAB PAINT WELL CASING (SHROUD) STICKUP.
1241	BEGIN DRILLING ME-MW1
⊛ 1210	HOLE PLUG PLACED INTO OPEN BORING HOLE.
1323	PULLED TOOLING AT 15' BLS TO REMOVE INNER BIT AS SANDS WERE
	INFILTRATING. ADDING PLUG ~~AND~~ TO RESUME DRILLING
1334	RESUME DRILLING
1400	DRILLED TO 25' bls. Set the WELL AT 21.75' BLS.
1433	WELL SET. BEGIN SURFACE WELL COMPLETION.
1530	FINISH WORK. PACK EQUIPMENT. DEMOB.
1600	ARRIVE IN LAS CRUCES. EOD.

VB

Trihydro Corporation

DAILY RECORD OF EVENTS

DATE: 3/3/18 | PAGE 1 OF 1

NAME: V. BERWIRTH (VAB)

TO (FILE/PM): C. RADANT (CR

CLIENT: USIBWC | SITE: New Mexico | PROJECT # 52M-002-GOV

WEATHER: 35° SUNNY | WORK PERFORMED: Well installment + abandonment

Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:

SUBJECT: Well Abandonment + Well Install

0520 LEAVE HOTEL FOR CCB MW2.

0630 ARRIVE ONSITE. CONDUCT TSM.

0645 BEGIN OPERATIONS TO ABANDON ORIGINAL CCB-MW2. CASING STICK UP REMOVED. WELL PVC FILLED W/SILT TO GRADE. ATTEMPT TO REMOVE PVC WAS MADE. WILL CUT WELL BELOW GRADE AND CEMENT BORING.

0700 BEGIN TO DRILL CCB MW2

0830 ~~WELL~~ DRILLING CCB-MW2 COMPLETE. WELL IS SET BEGIN SURFACE COMPLETION.

0850 VAB PAINT CASING STICK UP. PACK UP EQUIPMENT

0900 HEAD TO CCB-MW3. SITE ASSESSMENT OF THE CONCLUDES THAT CURRENT EQUIPMENT WILL NOT BE ABLE TO ACCESS WELL LOCATION WITHOUT GETTING STUCK.

0920 C. RADANT ONSITE TO DISCUSS OPTIONS. TRACK MOUNTED RIG NEEDED TO ACCESS SITE.

0945 DISMISS DRILLERS. VAB, COLIN, SCOTT QUINT RETURN TO CCB-MW2 TO STENCIL ON LETTERS.

1015 ~~1000~~ OFFSITE (ALL CREWS OFFSITE)

1045 RETURN TO LAS CRUCES. E.O.D.

VB

Trihydro CORPORATION — DAILY RECORD OF EVENTS

DATE: 3/5/18 | PAGE 1 OF 1

NAME: V. BIERWIRTH (VAB)

TO (FILE/PM): COLIN RADANT. (CR)

CLIENT: USIBWC | SITE: New Mexico | PROJECT #: 52M-002-GOV

WEATHER: low 50's SUNNY | WORK PERFORMED: SONDE RETRIEVAL. + PAINT WELLS

Borings Installed: ____ # Soil Samples Collected ____ # GW Samples Collected ____ Other:

SUBJECT: Well Rehabilitation

CR+VAB

0745	MEET WITH SCOTT QUINT TO DISCUSS FIELD OPERATIONS TODAY.
0800	MOB TO SUNBELT TO RETRIEVE CAMERA. PICK UP EQUIPMENT.
0820.	MOB TO TRUEVALUE TO PICK UP ADDITIONAL SUPPLIES.
0830	MOB TO BW-MW1
0915	ARRIVE AT BW-MW1.
	STEPS TAKEN TO ~~RETRE~~ RETRIEVE SONDE.
	1) PLACE CAMERA INTO WELL. SEE SAND AT THE BOTTOM. DO NOT SEE A SONDE. DTW ~6FT BLS. ~4FT OF SAND AT BOTTOM OF CASING.
	2) PLACE METAL ROD W/HOOK AT BOTTOM. FEEL SAND.
	3) PLACE CAMERA INTO WELL. SEE SAND.
	4) PLACE METAL ROD ~~INTO~~ INTO WELL. STIR UP SAND AT BOTTOM.
	5) PLACE BAILER INTO WELL TO TRY AND BAIL WATER/SAND OUT. BAILED WATER UNTIL CLEAR.
	6) PLACE CAMERA INTO WELL. SEE SAND.
	7) PLACE METAL ROD INTO WELL. STIR UP SAND + FEEL FOR SONDE
1002	ABANDON EFFORTS + PACK MATERIALS.
1030	MAKE PHONE CALLS AND COME UP WITH IDEAS TO RETRIEVE SONDES.
1130	MOB TO TRUE VALUE TO FIND EQUIPMENT THAT MAY HELP RETRIEVE SONDES. RETURN CAMERA RENTAL.
1200	BREAK FOR LUNCH.
1300	MOB TO JAR WELLS TO PAINT.
1400	ARRIVE ONSITE BEGIN PAINTING. JAR-MW1, 2, +3.
1520	MOB TO SPB WELLS.
1600	ARRIVE ONSITE. BEGIN PAINTING SPB-MW1, 2, +3.
1715	RETURN TO TRUCK. PACK EQUIPMENT. RETURN TO HOTEL.
1745	ARRIVE AT HOTEL. E.O.D.

VAB

Trihydro CORPORATION	DAILY RECORD OF EVENTS	DATE: 3/7/18 NAME: VICKI BIERWIRTH (VAB) TO (FILE/PM): COLIN RADANT (CR)	PAGE 1 OF 1
CLIENT: USIBWC	SITE: New Mexico	PROJECT # 52M-002-GOV	
WEATHER: mid 60's cloudy	WORK PERFORMED: Well Abandonment + Install		
	# Borings Installed: ______	# Soil Samples Collected ______ # GW Samples Collected ______	Other:
SUBJECT: Well Rehabilitation			

1400	VAB LEAVE ~~0751~~ HOTEL FOR MEETING LOCATION NEAR CCB-MW3.
1450	ARRIVE AT MEETING LOCATION. FILL OUT FIELD PAPERWORK.
1640	TALON AT MEETING LOCATION. MOB TO CCB-MW3.
1700	ARRIVE AT CCB-MW3. UNLOAD EQUIPMENT
1720	BEGIN TO PULL WELL CCB-MW3
1735	PULLED WELL. FILLED ENTIRELY WITH CLEAN COARSE FILTER PACK SAND.
1800	DECIDE TO DRILL WELL IN THE MORNING. PACK EQUIPMENT.
1830	RIG GETS STUCK UPON LEAVING. PULL TRUCK OUT.
1900	LEAVE SITE.
1950	ARRIVE IN LAS CRUCES. E.O.D.

VAB

Trihydro CORPORATION

DAILY RECORD OF EVENTS

DATE: 3/8/18
PAGE 1 OF 1
NAME: V. BIERWIRTH (VAB)
TO (FILE/PM): COLIN RADANT (CR)
CLIENT: USIBWC
SITE: New Mexico
PROJECT #: 52M-002-GOV
WEATHER: 50°s CLOUDY
WORK PERFORMED: Well Install / Abandonment
Borings Installed: ______ # Soil Samples Collected ______ # GW Samples Collected ______ Other:
SUBJECT: Well Rehabilitation

0600	LEAVE HOTEL FOR SITE.
0700	ARRIVE ONSITE. ~~FILL OUT~~ PREPARE FIELD DOCUMENTS.
0715	CR + SCOTT CLINT ONSITE.
0730	CR OFFSITE TO COLLECT FIELD SUPPLIES.
0750	TALON ONSITE. CONDUCT TSM. UNLOAD EQUIPMENT. CR ONSITE.
0810	SET UP OVER THE ~~HO~~ LOCATION FOR CCB-MW3
0820	BEGIN DRILLING CCB-MW3
~~0920~~ 0900	SAMPLE ROD STUCK WITHIN DRILLING RODS DUE TO FLOWING SANDS.
0920	SAMPLE REMOVED FROM DRILL ROD.
0930	TALON ON WATER BREAK
1010	BEGIN RE-DRILLING CCB-MW3 TO INSTALL WELL
1040	FLOWING SANDS CAUSING ISSUES IN SETTING THE WELL. PULLED TOOLING. TALON MOB OFFSITE TO GATHER WATER TANK
1110	LIZ (USIBWC) ONSITE.
1140	LIZ OFFSITE.
1215	VAB OFFSITE.
1320	VAB ONSITE.
1423	DRILLERS ONSITE. PREPARE TO REDRILL CCB-MW3. CR OFFSITE TO REHAB
1447	LIZ (USIBWC) ONSITE.
1454	BEGIN REDRILL W/WATER IN THE ~~AUGER~~ DRILL RODS.
1520	WELL SET + TOOLING PULLED. BEGIN SURFACE COMPLETION. HOLE PLUG + CONCRETE IN ORIGINAL CCB-MW3
1600	LOAD EQUIPMENT.
1645	VAB OFFSITE. MOB TO EL PASO.
1845	ARRIVE AT HOTEL IN EL PASO. E.O.D.

[signature]

EGC, Inc.

Date:	27 Nov 2018	Name:	Scott Quint
Client:	IBWC	Site Name:	BW-MW-1
Site Location:	Rio Grande River, NM		
Weather:	Clear & Sunny		
Subject:	Installation of a groundwater monitoring well		

TIME	NOTES
0705	Arrive on-site and scout new well location
0715π	Perform safety tailgate
0720	Begin setup
0755	Start drilling
	Collect core samples every four feet
	Encountered groundwater at ~8–9 feet
0852	The drill pipe has become stuck due to flowing sands
	Driller poured water down drill pipe to help unstick the pipe
0915	Drill pipe removed and a cap was placed on the bottom to help prevent sands from flowing inside pipe
0920	Begin redrilling borehole
0945	Drill pipe has become stuck again
1025	Pipe removed
1045	Re-cap drill pipe and re-drill borehole
1100	Set well screen and casing
	Remove drill pipe
	TD = 18.3 feet bgs
	Cap on bottom of screen was 0.5 feet; therefore, bottom of screen was 17.8 feet bgs.
1125	Well construction began (e.g. filter pack, seal, grout)
1150	Abandon old well by pulling the surface completion and well casing
	Sonde retrieved from the old well
1230	Broke for lunch; drillers went to buy cement
1430	Plug old well with bentonite/Portland cement slurry
1500	New well surface completion
1530	Begin well development using a surge pump
1645	Set well shroud
1700	Leave site

Date:	28 Nov 2018
Name:	Scott Quint
Client:	IBWC
Site Name:	LEL-MW-4 / LEL-MW-1
Site Location:	Rio Grande River, NM
Weather:	Clear & Sunny
Subject:	Installation of a groundwater monitoring well

TIME	NOTES
0645	Arrive on-site and scout new well location
0700	Call Liz (IBWC PM) to discuss the location of the new monitoring well (MW)
	Due to the number of plantings surrounding LEL-MW-1, discussed with Liz on how to best plug the MW.
0745	Based on discussion from Liz, set-up drill rig on new MW location
0800	Start drilling
	Collect core samples every four feet
	Encountered groundwater at ~6–7 feet bgs
0855	Set well casing and remove drill pipe (outer casing)
	TD = 21.0 feet, bgs
	Cap on bottom of screen was 0.5 feet; therefore, bottom of screen was 20.5 feet
0905	Well construction began (e.g. filter pack, seal, grout)
0940	Retrieved sonde from LEL-MW-1
	Due to location of LEL-MW-1, IBWC decided not to plug the MW
	IBWC directed EGC to name new MW LEL-MW-4
	The data from sonde could not be transferred. Liz directed to attached the sonde cap to the new cable and deploy the cap into the new MW.
0955	Begin surface completion at new well
10:00	Take DTW at LEL-MW-1 (6.26 feet, bgs) and TD = ~9.0 feet, bgs
1100	Begin well development using a surge pump
1130	Deploy sonde cap into new MW
1145	Leave site

EGC, INC.

Date: 28 Nov 2018 Name: Scott Quint
Client: IBWC Site Name: BCA-MW-2
Site Location: Rio Grande River, NM
Weather: Clear & Sunny
Subject: Installation of a groundwater monitoring well

TIME	NOTES
1330	Arrive on-site and scout new well location
1415	Start set-up
1430	Plug the original well due to the new well installation point being in front of original well
	After removing the surface completion, a drill rod (~12 feet) was discovered inside the well casing
	Some type of geotextile material was wrapped around the screen
1500	Set-up to drill new well
	New well located ~8 feet further from the River than the original well
	Location determined to avoid as many plantings as possible
1545	Set well casing and remove drill pipe (outer casing)
	Encountered rock at ~12 feet and had to terminate drilling at 14 feet
	TD = 14 feet, bgs
	Cap on bottom of screen was 0.5 feet; therefore, bottom of screen was 13.5 feet
1545	Well construction began (e.g. filter pack, seal, grout)
1600	Begin surface completion at new well
1645	Begin well development using a surge pump
1730	Leave site

Date:	29 Nov 2018
Name:	Scott Quint
Client:	IBWC
Site Name:	SPB-MW-4
Site Location:	Rio Grande River, NM
Weather:	Clear & Sunny
Subject:	Installation of a groundwater monitoring well

TIME	NOTES
0815	Arrive on-site and scout new well location
	Used GPS coordinates IBWC provided to locate new well location
0820	Evaluated River crossing to ensure the skid steer could cross
0900	Start moving equipment across the River
0945	Set-up for drilling
1020	Liz arrived on-site
	Liz verified the location of the new well and gave authorization to drill
1045	Drill new well
1100	Set well casing and remove drill pipe (outer casing)
	TD = 18 feet, bgs
	Cap on bottom of screen was 0.5 feet; therefore, bottom of screen was 17.5 feet bgs
1105	Well construction began (e.g. filter pack, seal, grout)
1120	Begin surface completion at new well
1200	Abandon old well by pulling the surface completion and well casing
1215	Finish surface completion at new well
1235	Begin well development using a surge pump
1300	Begin moving equipment back across River
1415	Leave site

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APPENDIX I
WELL REHABILITATION FIELD NOTES

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2/27/18

800 MET DRILLERS
900 SET UP. HASP REVIEW,
TAILGATE.
930 BEGIN DRILLING SP-1.
(SEE DRILLING NOTES.
1500 MET REHAB TEAM.
ATTEMPT TO CUT ROOTS.
ROOTS CUT TO ~13 FT.
SAND. OFF SITE.

- REHAB TEAM TO RETRIEVE
AIR COMPRESSOR FOR
SAND REMOVAL

2/28/18.

800 MET REHAB/REDRILL TEAM
815 BEGIN REHAB AT
SP-3. SAND AT ~7.8 FT.
SAND REMOVED TO 15.1 FT.
ASSESSED 15.1 FT WAS BOTTOM
OF CONSTRUCTED WELL.

930 REHAB AB-2. ROOTS ON
SONDE (DATA TAKEN). DTW 8.35.
STEEL WOULD NOT CUT DOWN
WELL DUE TO WELL NOT
BEING STRAIGHT. SAND
REMOVED TO 14.92 FT.
BOTTOM OF WELL.

DTW 8.21
1030 REHAB AB-1. REMOVED
~6" OF SAND/SILT.
BOTTOM HAS HARD SAND.
COULD NOT BREAK UP
WITH WATER (~1/4 GAL)
AND ALL-THREAD. ~~B~~ SAND
LAYER AT 14.31 BTOC.

1300 TO VINTON A/B. PAINTED
VB-MW-2 + VA-MW-1
YELLOW. ATTEMPT TO
REMOVE SONDE AT VB-MW-1.
- WIRE TWISTS
- 1" ~~STAB~~ PVC "STAB"
USED ALL THREAD, SONDE
APPEARS BURRIED. DTW 7.77
DTW 8.17

1530 REHAB VB-MW-2. REMOVED
~4" SAND, BOTTOM AT
14.12 FT (CONFIRMED
WITH ALL THREAD.)

1700 CONFIRMED WITH ALL
THREAD SONDE BURIED
AT VA-MW-1. DTW 7.95

1730 OFF SITE

SONDE #1
3/1/18 10329234

730 ON SITE, CONTINUE
SONDE REMOVAL AT
VB-2.
1100 SONDE REMOVED. DATA TAKEN
↳ 14.51 BTOC
1130 TALON OFF SITE
1245 TALON ON SITE.
BEGIN SONDE RETRIEVAL
AT VA-1. ATTEMPTED
WIRE REMOVAL. FEELS
LIKE SAND IN ALL AREAS
WITH ALL THREAD AND
TREME PIPE. REMOVE
SAND AND AND WATER.
SAND + WATER RECOVER
QUICKLY (~6" SAND
IN <5 MIN).
1630 ~~SMEAL RIG~~ COMPRESSOR STUCK IN
SAND. WILL NEED SKID
TO REMOVE AFTER HOURS.

3/2/18

830 ON SITE. MOBE TO BW AREA FOR REHAB. LOSE TRACTION & STOP.
1030 MOBE TO BOND. SMEAL & COMPRESSOR STUCK. STOP WORK FOR EQUIPMENT
1130 LEAVE 3rd TALON WORKER WITH DRILL TEAM.
1300 REPAINT SP-3. PAINT VA-2.
1630 OFF SITE. (SEE DRILL NOTES FOR DRILLING SPECS).

3/3/18

730 DRILL TEAM STARTS
EARLY. REHAB LEL-1, LEL-3,
1030 MEET DRILL TEAM
AT CCB-3. STOP
WORK DUE TO ACCESS
ISSUES. DRILLER DEMOBE.
1100 OFF SITE.

3/5/18

730 NO TALON PERSONNEL ON SITE.
ATTEMPT TO CAMERA WELL AT BW-1. NO SONDE VISIBLE. (ASSUMED) BURRIED. RETURN CAMERA.
1200 NOTIFIED TALON WILL NOT BE ON SITE.
1400 PAINT JAR-1 THRU JAR-3.
1600 PAINT SPB-1 THRU SPB-3
1700 OFF SITE.

3/6/18

800 MEET TALON ON SITE. SMEAL WOULD NOT START. OFF SITE FOR RENTAL EQUIPMENT

1300 TALON COULD NOT LOCATE COMPRESSOR CALL DAY TO SOLIDIFY EQUIPMENT OPERATIONS. SMEAL STARTED AND OFF SITE.

3/7/18

700 ON SITE - VINTON
ATTEMPT TO REMOVE
SONDE AT VINTON A.
(VA-MW-1).

900 SONDE REMOVED FROM
VB-1 FOR REFERENCE.
(REDEPLOYED AT 1130.)
1100 VB-2 SAND REMOVED.
1200 ON SITE AT BW-1. DTW 9.07
ATTEMPT TO REMOVE SONDE
BUT HIT HARD SAND/SURFACE.
(UPPER SONDE REMOVED.)
1430 SONDE REMOVED. NEW
CABLES ~~REP~~ REPLACE OLD &
REDEPLOY.

1500 REHAB BW-2.
TD - 9.22

1545 REHAB BMD-2.
TD - 12.70

1700 REHAB ME - 3.
TD - 8.3

3/8/18

700 THC ON SITE.
800 TALON ON SITE (CCB-3)
SET UP AND DRILL
WELL.
1100 TALON OFF SITE FOR
WATER TANK.
1430 TALON RETURN. CR
OFF SITE TO ATTEMPT
REHAB AT RS-6 + RS-7.
1500 3 FT SHARPENED STEEL
SECTION WOULD NOT
GO PAST SURFACE ELEV. AT RS6
1515 SIMILAR RESULTS AT
RS-7 AS RS-6.
1530 WELL ~~COM~~ DRILL COMPLETE
1630 WELL COMPLETE
1745 REHAB ~~R~~ CCB-1
~~TD~~ DTW - 9.55
1715 REMOVE SONDE AT
CCA-1. REPLACE CABLE. REDEPLOY.
SERIAL #: SQ
~~TD~~ DRY
1800 OFF SITE

3/9/18

800 ON SITE. TRU - 1.
SONDE REMOVED.
- TRU- 2 + 3 ROOTS
REMOVED. 15.12 BTOC.
1100 RS -6 ROOTS REMOVED ~~DTW~~
RS - 7 ROOTS REMOVED DTW 7.60
RS-5 ROOTS/SAND REMOVED
RS - 1 SAND REMOVED.
1430 BCA - 2. 6.7' DEPTH
WELL APPEARS TO BE
BENT TOWARDS RIVER.
BCA-1. SAND REMOVED
1630 VA -1. ATTEMPT
TO REMOVE SONDE.
UNSUCCESSFUL.

3/10/18

800 ON SITE. VA-1
SONDE REMOVAL.
900 VA-1 SONDE
REMOVED.
OFF SITE.

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APPENDIX J
MONITORING WELL FIELD SHEET—WELL REHABILITATION

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Groundwater Levels Monitoring Field Sheet - Rehabilitation

Site	Well ID	Casing Height	Participants	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Anapra Bridge	AB-MW-1	3.41	EGC	2/28/2018	10:30	8.21	4.80	
	AB-MW-2	3.35	EGC	2/28/2018	09:30	8.35	5.00	
Below Mesilla Dam	BMD-MW-2	2.48	EGC	3/7/2018	15:45	12.70	10.22	
Berino East	BE-MW-1	3.29	EGC	3/1/2018	10:24	10.00	7.00	3.0 foot casing height from surveyed data. DTW measurement from grade.
Berino West	BW-MW-1	3.39	EGC	3/7/2018	12:00	9.07	5.68	
	BW-MW-2	3.30	EGC	3/7/2018	12:00	9.22	5.92	
Broad Canyon Arroyo	BCA-MW-1	3.19	EGC	3/9/2018	14:00	8.84	5.65	
	BCA-MW-2	3.62	EGC	3/9/2018	14:40	Dry		
Country Club East	CCE-MW-2	3.19	EGC	2/28/2018	13:28	5.00	1.60	3.4 foot casing height from surveyed data. DTW measurement from grade.
	CCE-MW-3	3.27	EGC	2/28/2018	08:34	8.00	5.30	2.7 foot casing height from surveyed data. DTW measurement from grade.
Crow Canyon A	CCA-MW-1	3.03	EGC	3/9/2018	10:00	9.81		
Crow Canyon B	CCB-MW-1	2.96	EGC	3/8/2018	17:45	9.55	6.59	
	CCB-MW-2	3.24	EGC	3/3/2018	07:17	12.00	12.00	3.5 foot casing height from surveyed data. DTW measurement from grade.
	CCB-MW-3	3.30	EGC	3/8/2018	08:45	8.00	8.00	3.0 foot casing height from surveyed data. DTW measurement from grade.
Leasburg Extension	LEL-MW-1	3.01	EGC	3/3/2018	07:30	7.91	4.90	
	LEL-MW-3	3.11	EGC	3/3/2018	07:50	8.08	4.97	
Mesilla East	ME-MW-1	3.36	EGC	3/2/2018	12:59	10.00	10.00	3.1 foot casing height from surveyed data. DTW measurement from grade.
	ME-MW-3	3.31	EGC	3/7/2018	17:00	8.30	4.99	
Rincon Siphon	RS-MW-1	3.98	EGC	3/9/2018	12:50	Dry		
	RS-MW-5	2.97	EGC	3/9/2018	12:30	6.66	3.69	
	RS-MW-6	3.05	EGC	3/9/2018	11:00	7.60	4.55	
	RS-MW-7	3.51	EGC	3/9/2018	11:30	9.60	6.09	
Sunland Park	SP-MW-1	3.46	EGC	2/27/2018	10:38	10.00	10.00	2.9 foot casing height from surveyed data. DTW measurement from grade.
	SP-MW-3	3.50	EGC	2/28/2018	08:15	Dry		
Trujillo	TRU-MW-1	3.19	EGC	3/9/2018	08:00	7.55	4.36	
	TRU-MW-2	3.79	EGC	3/9/2018	09:05	8.23	4.44	
	TRU-MW-3	3.08	EGC	3/9/2018	08:30	6.83	3.75	
Valley Creek	VC-MW-1	3.38	EGC	2/28/2018	17:02	10.00	10.00	3.6 foot casing height from surveyed data. DTW measurement from grade.
	VC-MW-2	3.56	EGC	-	-	-	-	No measurement taken.
Vinton A	VA-MW-1	3.26	EGC	2/28/2018	17:00	7.14	3.88	
Vinton B	VB-MW-1	3.08	EGC	2/28/2018	13:00	7.77	4.69	
	VB-MW-2	3.71	EGC	2/28/2018	15:30	8.17	4.46	

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APPENDIX K
MONITORING WELL FIELD SHEETS—FIELD ASSESSMENT

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Groundwater Levels Monitoring Field Sheet - Field Assessment

Site	Well ID	Casing Height	Participants	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Anapra Bridge	AB-MW-1	3.41	EGC	11/28/2017	10:50	8.10	4.69	
	AB-MW-2	3.35	EGC	11/28/2017	11:30	8.32	4.97	
Below Mesilla Dam	BMD-MW-1	2.44	EGC	11/29/2017	14:45	11.15	8.71	
	BMD-MW-2	2.48	EGC	11/29/2017	14:50	10.88	8.40	
Berino East	BE-MW-1	3.29	EGC	11/29/2017	12:35	Dry	-	
	BE-MW-2	3.21	EGC	11/29/2017	12:50	8.84	5.63	
Berino West	BW-MW-1	3.39	EGC	11/29/2017	13:20	9.05	5.66	
	BW-MW-2	3.30	EGC	11/29/2017	13:45	8.49	5.19	
Broad Canyon Arroyo	BCA-MW-1	3.19	EGC	12/1/2017	12:05	7.97	4.78	
	BCA-MW-2	3.62	EGC	12/1/2017	12:35	Dry	-	
	BCA-MW-3	3.35	EGC	12/1/2017	12:15	11.95	8.60	
Clark Lateral	CL-MW-1	3.20	EGC	12/1/2017	08:50	10.90	7.70	
	CL-MW-2	3.04	EGC	12/1/2017	08:40	11.60	8.56	
Country Club East	CCE-MW-1	3.28	EGC	11/28/2017	08:10	9.78	6.50	
	CCE-MW-2	3.19	EGC	11/28/2017	08:00	Dry	-	
	CCE-MW-3	3.27	EGC	11/28/2017	08:25	Dry	-	
Crow Canyon A	CCA-MW-1	3.03	EGC	11/30/2017	11:00	Dry	-	
	CCA-MW-2	3.43	EGC	11/30/2017	11:15	9.82	6.39	
	CCA-MW-3	3.24	EGC	11/30/2017	11:30	9.58	6.34	
Crow Canyon B	CCB-MW-1	2.96	EGC	11/30/2017	12:15	9.53	6.57	
	CCB-MW-2	3.24	EGC	11/30/2017	11:45	Dry	-	
	CCB-MW-3	3.30	EGC	11/30/2017	12:00	Dry	-	
Jaralosa	JAR-MW-1	2.31	EGC	11/30/2017	09:14	7.94	5.63	
	JAR-MW-2	2.91	EGC	11/30/2017	09:30	8.93	6.02	
	JAR-MW-3	2.82	EGC	11/30/2017	09:25	7.73	4.91	

Attachment J. Groundwater Levels Monitoring Field Sheet - Field Assessment

Site	Well ID	Casing Height	Participants	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Leasburg Extension Lateral	LEL-MW-1	3.01	EGC	12/1/2017	11:25	7.90	4.89	
	LEL-MW-2	3.04	EGC	12/1/2017	11:15	8.00	4.96	
	LEL-MW-3	3.11	EGC	12/1/2017	11:35	8.06	4.95	
Mesilla East	ME-MW-1	3.36	EGC	12/1/2017	08:00	Dry	-	
	ME-MW-2	3.21	EGC	12/1/2017	07:30	9.26	6.05	
	ME-MW-3	3.31	EGC	12/1/2017	08:20	Dry	-	
Rincon Siphon	RS-MW-1	3.98	EGC	11/30/2017	15:25	Dry	-	
	RS-MW-2	3.55	EGC	11/30/2017	15:10	8.35	4,8	
	RS-MW-4	2.95	EGC	11/30/2017	14:35	6.54	3.59	
	RS-MW-5	2.97	EGC	11/30/2017	15:45	6.26	3.29	
	RS-MW-6	3.05	EGC	11/30/2017	13:10	Dry	-	Witnessed wildfire; sotpped assessment to call & wait for FD.
	RS-MW-7	3.51	EGC	11/30/2017	16:10	9.63	6.12	
Seldon Point Bar	SPB-MW-1	2.91	EGC	12/1/2017	13:25	7.06	4.15	
	SPB-MW-2	3.16	EGC	12/1/2017	13:20	7.45	4.29	
	SPB-MW-3	3.05	EGC	12/1/2017	13:10	8.37	5.32	
Sunland Park	SP-MW-1	3.46	EGC	11/29/2018	07:50	Dry	-	
	SP-MW-2	3.43	EGC	11/29/2017	07:00	9.58	6.15	
	SP-MW-3	3.50	EGC	11/29/2017	07:30	Dry	-	
Trujillo	TRU-MW-1	3.19	EGC	11/30/2017	08:35	7.37	4.18	
	TRU-MW-2	3.79	EGC	11/30/2017	08:15	7.41	3.62	
	TRU-MW-3	3.08	EGC	11/30/2017	08:25	6.64	3.56	
Valley Creek	VC-MW-1	3.38	EGC	11/29/2017	09:25	Dry	-	
	VC-MW-2	3.56	EGC	11/29/2017	09:10	9.75	6.19	
Vinton A	VA-MW-1	3.26	EGC	11/29/2017	11:30	7.55	4.29	
	VA-MW-2	3.65	EGC	11/29/2017	11:15	8.00	4.35	

Attachment J. Groundwater Levels Monitoring Field Sheet - Field Assessment

Site	Well ID	Casing Height	Participants	Date	Time	Water Level Reading TOC	Water Depth (Reading TOC - Casing Height)	Comments/Observations
Vinton B	VB-MW-1	3.08	EGC	11/29/2017	10:45	7.75	4.67	
	VB-MW-2	3.71	EGC	11/29/2017	10:30	8.06	4.35	
Yeso East	YE-MW-1	3.12	EGC	11/30/2017	09:50	9.94	6.82	
	YE-MW-2	3.50	EGC	11/30/2017	10:05	7.72	4.22	
	YE-MW-3	2.88	EGC	11/30/2017	10:20	9.14	6.26	

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