LA-UR-10-1424
March 2010
EP2010-0137

Summary Report for Plugging and Abandonment of Test Wells TW-2, TW-2A, and TW-2B

Los Alamos
NATIONAL LABORATORY
EST.1943

Prepared by the Environmental Programs Directorate

LA-UR-10-1424
EP2010-0137

Summary Report for Plugging and Abandonment of Test Wells TW-2, TW-2A, and TW-2B

March 2010

Responsible project manager:

Printed Name	Signature	Title	Organization	Date
Ted Ball	for	Project Manager	Environmental Programs	3/15/10

Responsible LANS representative:

Printed Name	Signature	Title	Organization	Date
Bruce Schappell	for	Executive Director	Environmental Programs	3/15/10

Responsible DOE representative:

Printed Name	Signature	Title	Organization	Date
Everett Trollinger	for	Federal Project Director	DOE-LASO	3/15/10

EXECUTIVE SUMMARY

This report describes the methods Los Alamos National Laboratory (the Laboratory) used to plug and abandon groundwater-monitoring wells Test Well (TW) TW-2, TW-2A, and TW-2B. The test wells are located on Los Alamos County land in Pueblo Canyon, Los Alamos, New Mexico.

TW-2 and TW-2A were plugged and abandoned in accordance with direction from the New Mexico Environment Department (NMED). TW-2B was plugged and abandoned because the borehole is old, historically dry, and represented a potential conduit to the subsurface.

Plugging and abandonment activities at the TW-2 group of wells occurred from January 13, to February 8, 2010 using a Foremost DR-24 drill rig and ancillary equipment. Before the wells were abandoned, the dedicated sampling systems were removed from TW-2 and TW-2A on December 12 and 14, 2009, respectively.

TW-2B was abandoned first, followed by TW-2A and TW-2. Where telescoping casing existed, as many of the internal casing strings as possible were removed to gain access to the outer casing for the purpose of perforating and sealing the boreholes via grouting. TW-2B was grouted to ground surface on January 22, 2010. TW-2A and TW-2 were grouted to ground surface on February 8, 2010. With the exception of the TW-2B borehole, where bentonite chips were used at certain intervals, the boreholes were plugged and abandoned from bottom to top via tremie pipe with Portland Type I/II/V cement and municipal water.

CONTENTS

Figures

Tables

Appendixes

Appendix A	Office of the State Engineer Plugging Records for Wells TW-2, TW-2A, and TW-2B
Appendix B	Video Logging (on DVD included with this document)

Acronyms and Abbreviations

bgs	below ground surface
Consent Order	Compliance Order on Consent
I.D.	inside diameter
LANL	Los Alamos National Laboratory
MOV	Management, Operations, and Verification
NMED	New Mexico Environment Department
TA	technical area
TW	test well
TD	total depth

1.0 INTRODUCTION

This report summarizes the methods LANL used to plug and abandon groundwater-monitoring Test Wells (TW) TW-2, TW-2A, and TW-2B. Well abandonment was consistent with the requirements and guidelines in Sections IV.B.1.b.v and X.D, Well Abandonment, of the Compliance Order on Consent (the Consent Order). Additionally, the plugging and abandonment procedures complied with 19.27.4 New Mexico Administrative Code Rules and Regulations Governing Well Driller Licensing; Construction, Repair and Plugging of Well. The following documents helped guide the implementation of the scope of work for the TW-2, TW-2A, and TW-2B plugging and abandonment project:

- Work Plan to Plug and Abandon Well TW-2 (LANL 2009, 107436.4)
- Work Plan to Plug and Abandon Well TW-2A (LANL 2009, 107436.8)
- Work Plan to Plug and Abandon Well TW-2B (LANL 2009, 107436.10)
- Field Work Plan to Plug and Abandon Test Wells TW-2, TW-2A, and TW-2B (TerranearPMC 2009, 108563)

2.0 BACKGROUND

Wells TW-2, TW-2A, and TW-2B are located in Pueblo Canyon, Los Alamos, New Mexico (Figure 2.0-1). TW-2 was installed in 1949 to monitor the water in the regional aquifer in Pueblo Canyon downgradient of the wastewater treatment plant at Technical Area 45 (TA-45). TW-2A was installed in 1950 to test the potential perched-intermediate depth water encountered at 165 ft below ground surface (bgs) while drilling TW-2. TW-2B was installed in 1950 in an attempt to isolate a second zone of perched water identified during the drilling of TW-2. TW-2B was never completed as a well and was only a partially cased borehole. The well construction diagrams for the test wells before they were plugged and abandoned are presented in Figures 2.0-2, 2.0-3, and 2.0-4 and are based on video logs and field observations.

2.1 Well History

Drilling and installation of the test wells was performed using a cable tool rig.

TW-2, installed in 1949 to monitor the water in the regional aquifer in Pueblo Canyon downgradient of the wastewater treatment plant at TA-45, was originally completed to 789 ft, with a slotted screen section. In 1990, the 6-in. casing and screen were removed, and a 6-in.-inside diameter (I.D.) casing was hung in the well from 0 to 834 ft, with the lower section slotted from 774 to 824 ft. Based on the available well-completion notes (Purtymun and Swanton 1998, 099096), TW-2 did not have an annular seal or a filter pack around the screen.

TW-2A, installed in 1950 to monitor intermediate perched groundwater in Pueblo Canyon downgradient of the wastewater treatment plant at TA-45, was completed to 129.5 ft, with a slotted screen section from 123 to 129.5 ft. Based on the available well-completion notes (Purtymun and Swanton, 099096), TW-2A did not have an annular seal or a filter pack around the screen.

TW-2B was installed in 1950 in an attempt to isolate a second zone of perched water above the regional aquifer identified during the drilling of TW-2. When TW-2B was drilled, the perched aquifer was either not present or was of such limited extent that it could not be located. Based on the available well-completion

notes (Purtymun and Swanton, 099096), TW-2B did not have a screened interval and was completed as an open hole.

2.2 Rationale for Plugging and Abandonment

Wells TW-2 and TW-2A were abandoned in accordance with direction from the New Mexico Environment Department (NMED) as required under the Consent Order. Well TW-2B was plugged and abandoned because the open hole was historically dry and represented a potential conduit to the subsurface. The plugging records submitted to the New Mexico Office of the State Engineer for each well are included in Appendix A.

2.0 SCOPE OF ACTIVITIES

The scope of activities used to plug and abandon wells TW-2, TW-2A and TW-2B is presented below.

3.1 Plug and Abandonment Design and Approach

Before the wells were abandoned, all aboveground and belowground appurtenances, including pumps, transducers, data loggers, control panels, concrete pads, were removed. The test wells were gamma logged and video surveyed to document preabandonment conditions. The results of the logging from the test wells are described below.

The abandonment approach implemented at the test wells was to remove as many of the internal casing strings as possible to gain access to outer casing strings for the purpose of perforating and sealing the boreholes via grouting. Work took place within the wells from inside to outside and from the smallest diameter to the larger diameter casing. Pneumatic casing cutters and perforators were run in the hole on drill rods, requiring the use of a rotary-drilling rig and compressed air.

Grouting at TW-2, installed to 834 ft bgs, took place in stages to prevent potentially high hydrostatic grouting pressures from blowing out formations. Grouting in stages also allowed time for the grout to set while other work with larger diameter casing strings was performed simultaneously. Grouting at both TW-2A and TW-2B took place in essentially one stage since they were not as deep, and the hydrostatic pressure associated with a single lift of grout would likely not be substantial enough to blow out the formations within the perforated intervals.

3.2 Borehole Logging

TW-2, TW-2A, and TW-2B were video and gamma logged before well abandonment to document borehole conditions. Additional video logging was also conducted and is described below.

3.2.1 Video Logging

A downhole video camera and gamma ray tool was run in well TW-2A on December 20, 2009, and in wells TW-2 and TW-2B on December 21, 2009. The logs were run to document screen conditions before abandonment, confirm well screen depths, measure static water levels before plugging and abandonment, and confirm the total depths (TDs) of the wells. The Laboratory's geophysical trailer and camera were used to complete this logging. A second video was run in well TW-2A on January 23, 2010, to document borehole, casing, and screen condition after the 8-in. casing string was removed. The Laboratory's geophysical trailer and camera were also used to complete this logging. A second video was

also run in well TW-2B on January 18, 2010, to confirm perforating technique and adequacy. Jet West Geophysical Services conducted this logging, and the video log is presented in Appendix B on DVD.

At TW-2, the video recorded a static water level at approximately 807 ft bgs. The video's depth meter and camera lights malfunctioned shortly after this depth, and the screen depth and TD of the well could not be confirmed via video logging.

3.2.2 Geophysical Logging

Geophysical logging was conducted before plugging and abandonment activities to document well conditions.

3.3 Plugging and Abandonment

Plugging and abandonment activities included mobilization, dedicated sampling system removal as required, downhole geophysical logging, casing removal, casing perforation, pressure-grouting, surface completion, and demobilization. All activities were performed following appropriate standard operating procedures and Laboratory-approved health and safety documents. Wells TW-2, TW-2A, and TW-2B were plugged and abandoned in accordance with the NMED-approved work plans. Figures 3.3-1, 3.3-2, and 3.3-3 show the final well configurations after plugging and abandonment.

3.3.1 Field Activities

Mobilization of a workover rig and ancillary equipment to the well site was performed on December 12, 2009. Following a field Management, Operations, and Verification (MOV) that included inspection of heavy equipment, the dedicated sampling system was removed from TW-2A. On December 14, 2009, the dedicated sampling system was removed from TW-2. The workover rig and ancillary equipment were demobilized from the site on the same day.

Plugging and Abandonment of TW-2B

At TW-2B, the preliminary video logging on December 21, 2009, recorded a dry hole with pump components in the bottom of the hole. The video documented an 8-in. casing string from surface to approximately 125 ft bgs, and open borehole from that depth to TD of 225 ft bgs.

The dual-rotary drill rig and ancillary equipment were mobilized to TW-2B on January 12, 2010. A field MOV that included inspection of heavy equipment was performed on January 13. On January 15, pressure-grouting began in the open hole from the TD of 225 ft bgs. The volume and type of abandonment materials used to abandon TW-2B are presented in Table 3.3-1. Approximately 61.5 ft^3 of neat cement grout was used to plug the bottom of the borehole from 225 ft bgs to 191 ft bgs. The amount of material was five times the calculated volume to fill this section (34 ft^3), and the decision was made to allow the cement to cure before additional grout was pumped.

An attempt was made to remove the 8-in. casing that extended from ground surface to approximately 125 ft bgs (Figure 2.0-4) while the first lift of grout was curing. Approximately 125% string pull back weight was exerted on the 8-in. casing, but the casing did not move. On January 16, the 8-in. casing was perforated from 108.5 to 117.6 ft bgs. The 8-in. casing was then cut at 105 ft bgs and the upper portion of the casing string was removed from the well.

After the upper 105 ft of 8-in. casing was removed from the borehole, an attempt was made to remove the 12-in. surface casing. Approximately 125% string pull back weight was exerted on the 12-in. casing, but the casing did not move. On January 18, Jet West Geophysical Services was on-site to verify the 8-in. casing perforations via video logging. The 8-in. casing perforations were confirmed from 108.5 to 117.6 ft bgs. The video revealed 12-in. surface casing from surface to 10.6 ft bgs. Open hole, which appeared to be 12-in.in diameter, was recorded from 10.6 ft bgs to the top of the 8-in. casing at 105 ft bgs.

Approximately 112.3 ft^3 of cement grout was used from January 18 to January 19, to plug the borehole from 191 to 167 ft bgs. Because of cement loss to the formation, the Laboratory sought and received approval from the Office of the State Engineer to abandon a portion of the borehole with bentonite chips instead of cement grout. Approximately 22.8 ft^3 of 3/8-in. bentonite chips were used from January 19 to January 20 to plug the borehole from 167 to 132 ft bgs. From January 20 to January 21, 128.3 ft^3 of cement grout was used to plug the borehole from 132 to 61 ft bgs. The Laboratory again sought and received approval to abandon a portion of the borehole with bentonite chips instead of cement grout. On January 21, approximately 43.6 ft^3 of 3/8-in. bentonite chips were used to plug the borehole from 61 to 31 ft bgs. On January 22, 48.1 ft^3 of cement grout was used to plug the borehole from 61 to 2 ft bgs. A surface pad will later be installed to a depth of 2 ft. The calculated volume of material to fill the borehole was 125.5 ft^3, whereas the actual volume used was approximately 416.6 ft^3 (Table 3.3-1). The final borehole configuration is shown in Figure 3.3-3.

Plugging and Abandonment of TW-2A

On January 22, 2010, the drill rig was moved off of TW-2B and was staged over TW-2A. The preliminary video logging conducted on December 20, 2009, had documented 8-in. casing from ground surface to approximately 112 ft bgs, and 6-in. casing swaged into the 8-in. casing at 112 ft bgs and extending to 123 ft bgs. The 6-in. screen was recorded from approximately 123 ft bgs to 128 ft bgs, with the bottom of the casing at approximately 129.5 ft bgs.

On January 22, 2010, a groundwater-level measurement of 102.2 ft bgs was recorded just prior to abandonment. The entire string of 8-in. casing from ground surface to approximately 112 ft bgs (Figure 2.0-3) was removed after exerting 125% string pull back weight. On January 23, a video log was run in the well to document the borehole, casing, and screen condition. The video revealed 12-in. casing from surface to 8.1 ft bgs, open borehole from 8.1 to 112 ft bgs, 6-in. casing from 112 to 123 ft bgs, and screen perforations beginning at 123 ft bgs. The camera run was terminated at 124 ft bgs.

On January 24, an attempt was made to fish out the 6-in. casing. During the fishing operation, the mandrel on the fishing spear broke off when it was inserted into the 6-in. casing. The fishing operation was unsuccessful; however, a tremie pipe was able to be inserted to the bottom of the 6-in. casing, and grouting the borehole commenced the same afternoon.

Approximately 192.51 ft^3 of cement grout was used from January 24 to January 25 to plug the borehole from 129.5 to 27 ft bgs. The volume and type of abandonment materials used to abandon TW-2A are presented in Table 3.3-2. On February 8, 34.8 ft^3 of cement grout was used to plug the borehole from 27 to 2 ft bgs. A surface pad will be installed to a depth of 2 ft at a later date. The calculated volume of material to fill the borehole was 43.8 ft^3, whereas the actual volume used was approximately 227.3 ft^3 (Table 3.3-1).The final borehole configuration is shown in Figure 3.3-2.

Plugging and Abandonment of TW-2

On January 26, 2010, the drill rig was moved off the TW-2A site and was staged over TW-2. An attempt was made to remove the 6-in. casing string that extended from ground surface to approximately 834 ft bgs (Figure 2.0-2) with 125% string pull back weight, but the casing did not move. The 6-in. casing was perforated from 800 to 820 ft bgs. The 6-in. casing string was then cut at 775 ft bgs, and the upper portion of the casing string was removed from the borehole. On January 27, an attempt was made to remove the 8-in. casing string that extended from ground surface to approximately 779 ft bgs with 125% string pull back weight, but the casing did not move. The 8-in. casing was perforated from 716 to 768 ft bgs. The first grouting sequence was initiated at this point, and the borehole was pressure-grouted with 78.9 ft^3 of cement grout from TD at 834 ft bgs to 645 ft bgs. The volume and type of abandonment materials used to abandon TW-2 are presented in Table 3.3-3.

On January 29, the 8-in. casing string was cut at 520 ft bgs and the upper portion of the casing string was removed from the borehole. An attempt was made to remove the 10-in. casing string that extended from ground surface to 519 ft bgs with 125% string pull back weight, but the casing did not move. The 10-in. casing was perforated from 374 to 414 ft bgs. After perforation, the 10-in. casing string was cut at 200 ft bgs, and the upper portion of the casing string was removed from the borehole. An attempt was made to remove the 12-in. casing string from ground surface to approximately 197 ft bgs with 125% string pull back weight, but the casing did not move. The 12-in. casing was perforated from 130 to 161 ft bgs. After perforation, the 12-in. casing string was cut at 60 ft bgs, and the upper portion of the casing string was removed from the borehole. The second grouting sequence was initiated at this point. A calculated lift from 645 to 200 ft bgs was emplaced by using 220.6 ft^3 of cement grout.

On February 1, the 16-in. casing that extended from ground surface to approximately 57 ft bgs was cut at 30 ft bgs, and the upper portion of the casing was removed from the borehole. The top of the cement grout that was emplaced from the second grouting sequence was measured at 523 ft bgs. From February 1 to February 8, approximately 1505.3 ft^3 of cement grout was used to plug the borehole from 523 to 2 ft bgs. A surface pad will later be installed to a depth of 2 ft. The theoretical volume of material to fill the borehole was 465.1 ft^3, whereas the actual volume used was approximately 1804.8 ft^3 (Table 3.3-1). The final borehole configuration is shown in Figure 3.3-1.

The Laboratory did not seek approval to abandon portions of the borehole with bentonite chips instead of with cement grout because abandonment with bentonite chips could have produced voids in the seal in the annular space between the borehole wall and casing strings. Pumping the grout in sequential lifts through 2-in. tremie pipe ensured the screened interval, perforated intervals, and annular spaces were sealed from bottom to top.

Actual versus Calculated Grout Volumes

Observations were made at all three wells that borehole diameters were larger than what was documented in available well completion records. The video logs and documented observations in the field indicate that casing strings were set in large-diameter boreholes (typical for cable tool drilling). For instance, 8-in. casing strings appear to have been set in borehole diameters of 10 in. or larger, with annular spaces of 1 in. or more between the casing strings and borehole walls. The calculated volumes to fill the boreholes versus the actual volumes used support these observations. While grout losses to the formation certainly occurred, those losses are not as substantial as the calculated volumes versus actual volumes make them appear.

3.3.2 Completion

The wells were cement-grouted to 2 ft bgs, and 2 ft × 2 ft × 2-ft-deep concrete surface pads with brass markers will be installed above each abandoned well. Brass survey markers will be surveyed in accordance with Section IX.B.2.f of the Consent Order.

4.0 POSTABANDONMENT ACTIVITIES

Postabandonment activities are described below.

4.1 Well Site Restoration

Plugging and abandonment activities at the TW-2 group of wells did not disturb site conditions, and no restoration efforts were required.

4.2 Waste Management

Contact waste was generated during the plugging and abandonment of wells TW-2, TW-2A and TW-2B. The Laboratory removed the concrete surface pads at the former well sites. Contact waste included the dedicated sampling systems and well casing strings. All contact waste will be recycled by the Laboratory.

5.0 DEVIATIONS FROM PLANNED ACTIVITIES

The use of 3/8-in. bentonite chips at TW-2B was not planned but was necessitated by cement loss to formation.

5.1 Approved Modifications to Work Plan

The Laboratory sought and received approval from the Office of the State Engineer to abandon specific intervals in the TW-2B borehole with bentonite chips instead of cement grout to minimize fugitive grout impacting nearby wells.

6.0 SUMMARY

Wells TW-2, TW-2A, and TW-2B were plugged and abandoned in accordance with the NMED-approved work plans. Before abandonment activities, all above- and belowground appurtenances, including pumps, transducers, data loggers, control panels, concrete pads, were removed. As many of the internal casing strings as possible were removed from the test wells to gain access to outer casing strings for the purpose of perforating and sealing via grouting. Work took place within the wells from inside to outside, working on the smallest diameter casing first. With the exception of the TW-2B borehole, where bentonite chips were used at certain intervals, the boreholes were plugged and abandoned from bottom to top via tremie pipe with Portland Type I/II/V cement and municipal water.

7.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility

(RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), November 2009. "Work Plan to Plug and Abandon Well TW-2," Los Alamos National Laboratory document LA-UR-09-7267, Los Alamos, New Mexico. (LANL 2009, 107436.4)

LANL (Los Alamos National Laboratory), November 2009. "Work Plan to Plug and Abandon Well TW-2A," Los Alamos National Laboratory document LA-UR-09-7315, Los Alamos, New Mexico. (LANL 2009, 107436.8)

LANL (Los Alamos National Laboratory), November 2009. "Work Plan to Plug and Abandon Well TW-2B," Los Alamos National Laboratory document LA-UR-09-7314, Los Alamos, New Mexico. (LANL 2009, 107436.10)

Purtymun, W.D., and A.S. Swanton, February 5, 1998. "Engineering, Geology, and Construction Data of Twenty-Five Test Holes and Test Wells on and Adjacent to the Pajarito Plateau," draft, Los Alamos National Laboratory, Los Alamos, New Mexico. (Purtymun and Swanton 1998, 099096)

TerranearPMC, November 2009. "Field Work Plan to Plug and Abandon Test Wells TW-2, TW-2A, and TW-2B," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2009, 108563)

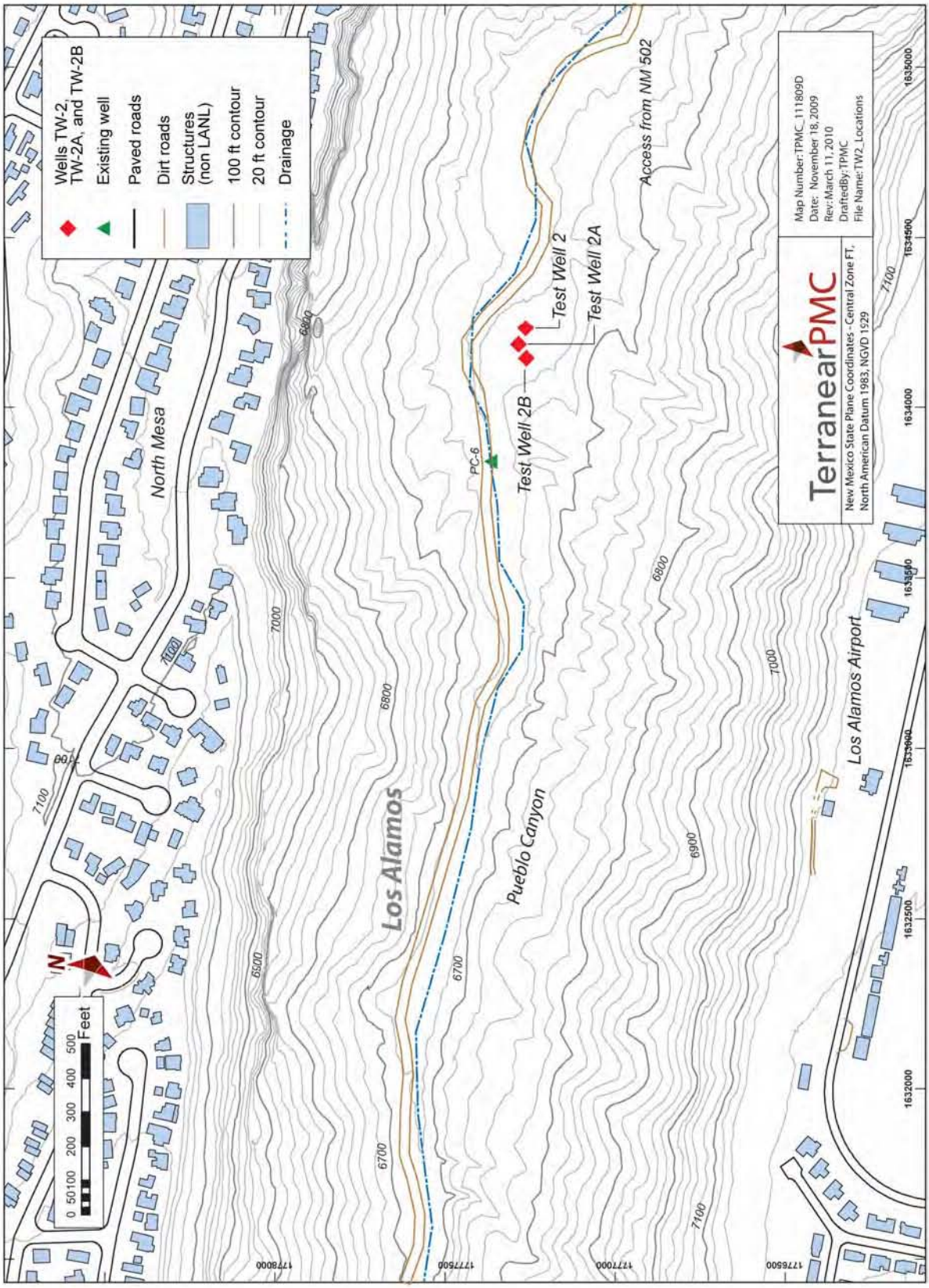

Figure 2.0-1 Locations of TW-2, TW-2A, and TW-2B

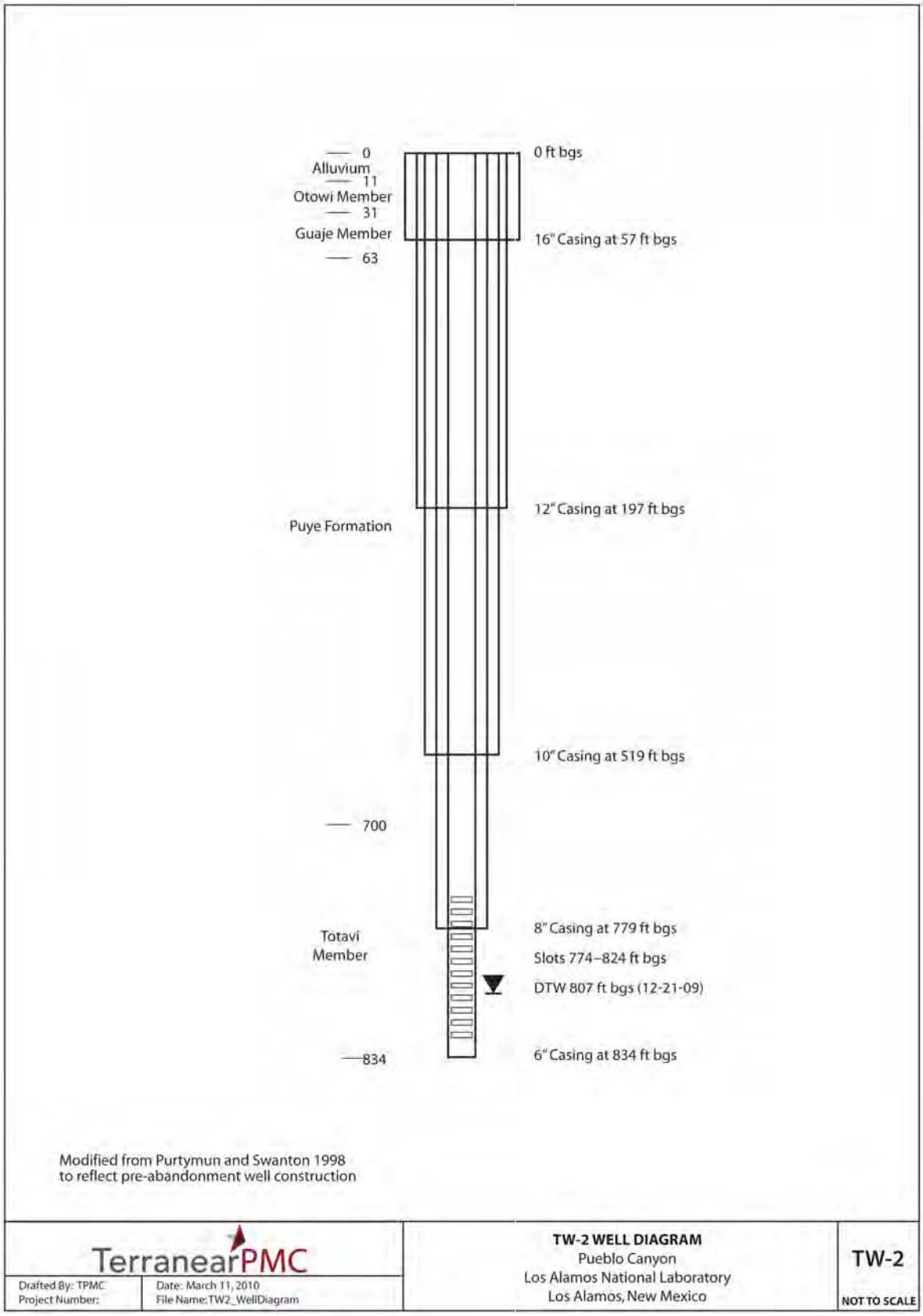

Figure 2.0-2 As-built well construction diagram of TW-2

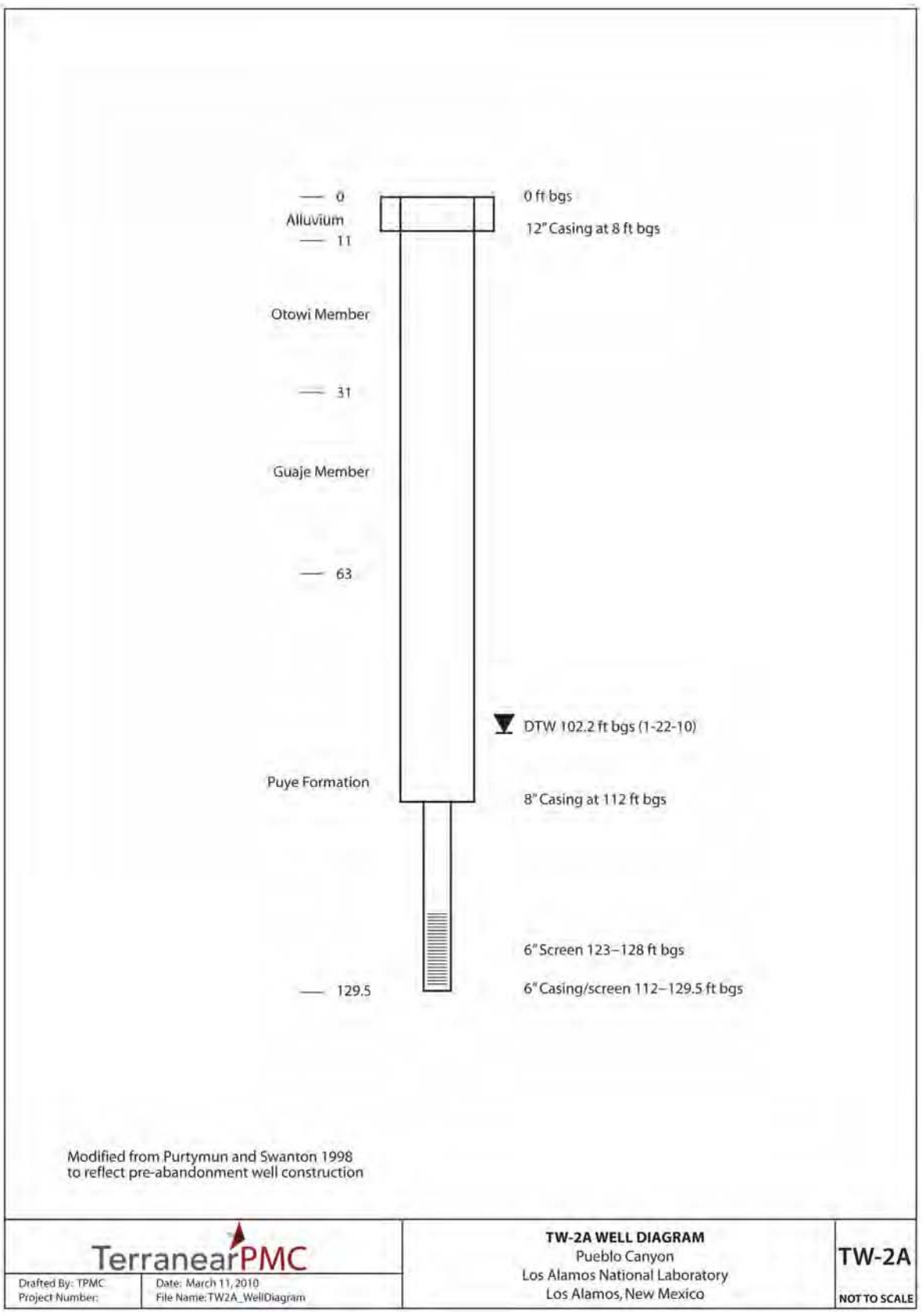

Figure 2.0-3 As-built well construction diagram of TW-2A

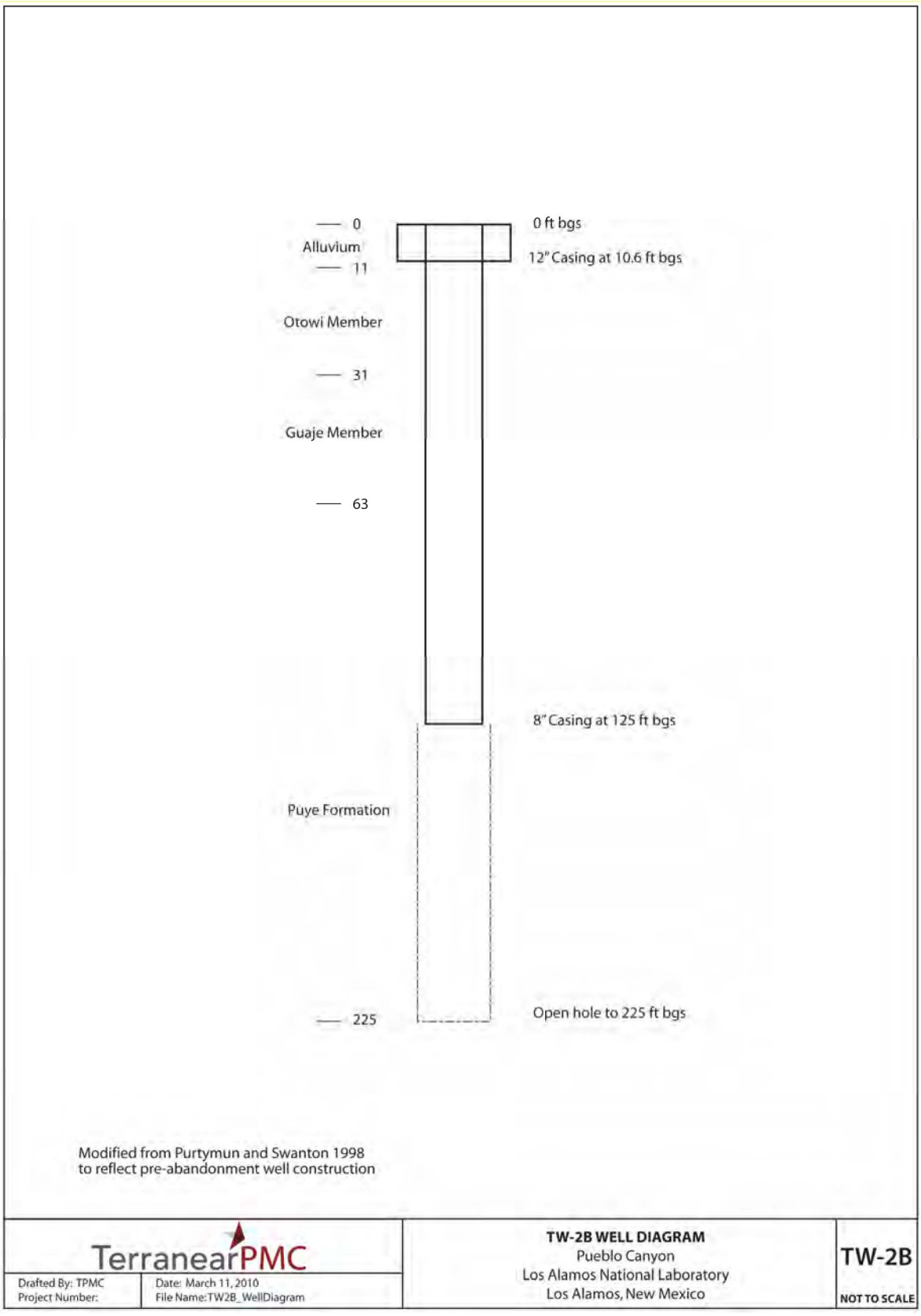

Figure 2.0-4 As-built well construction diagram of TW-2B

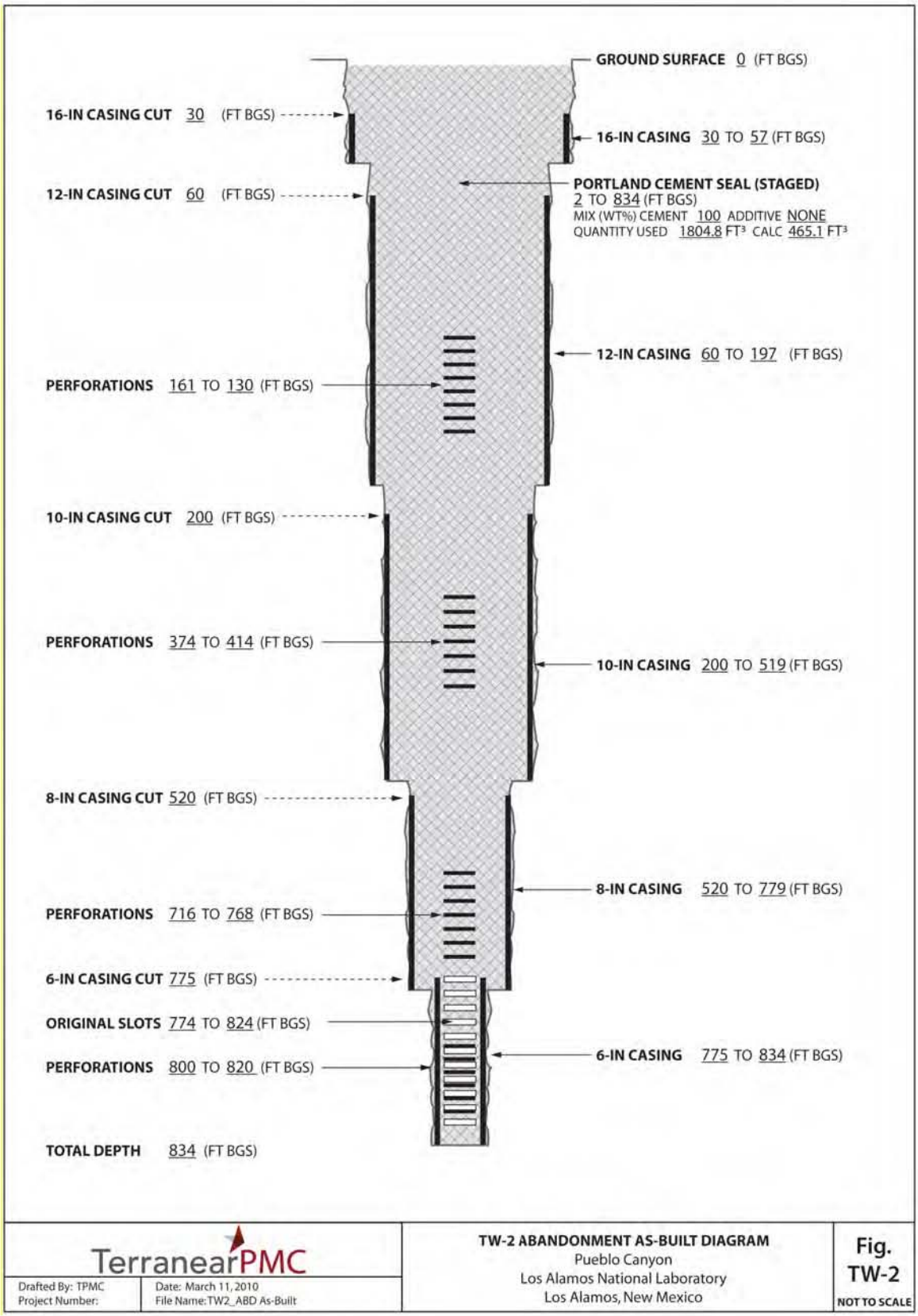

Figure 3.3-1 As-built well abandonment diagram of TW-2

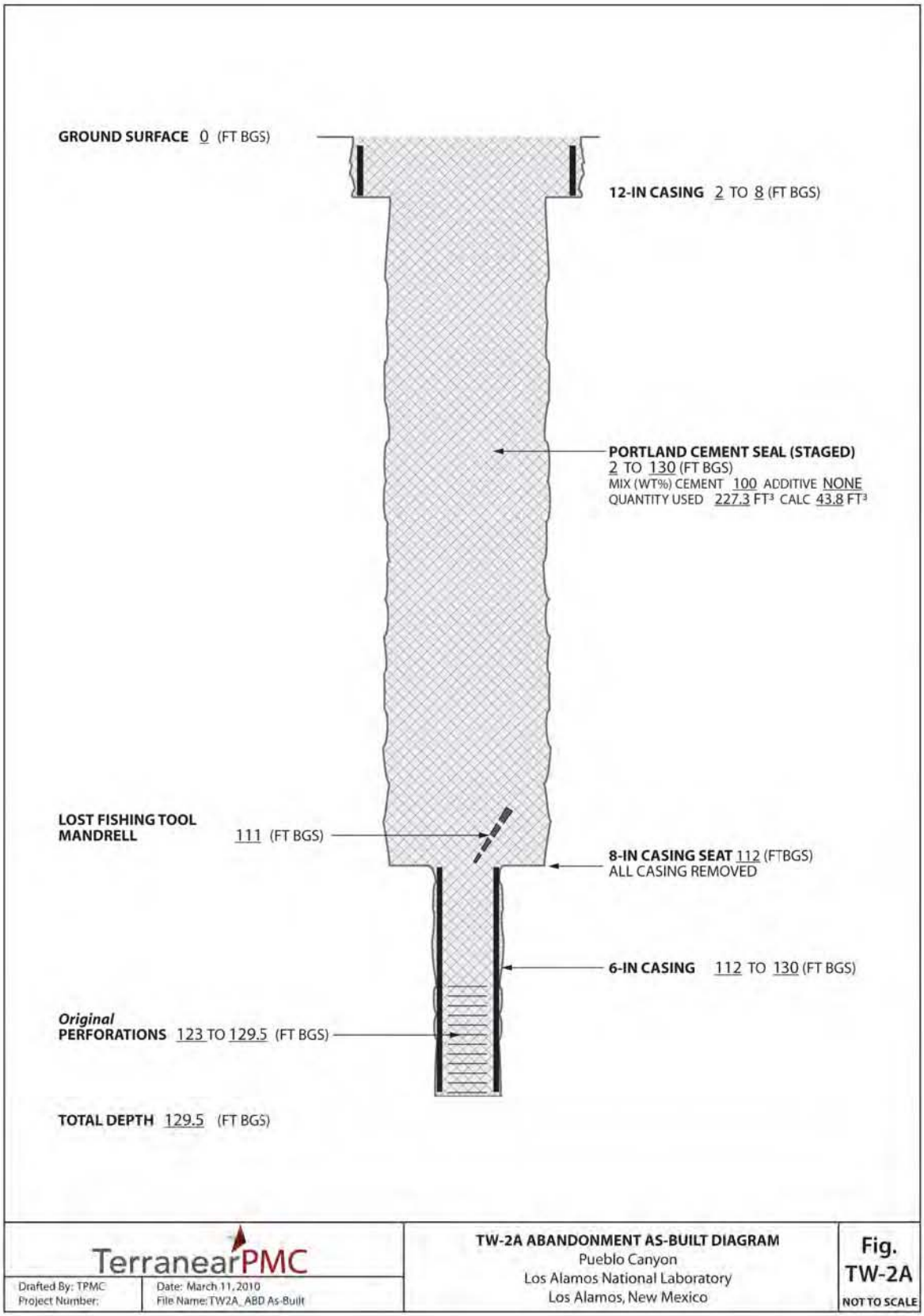

Figure 3.3-2 As-built well abandonment diagram of TW-2A

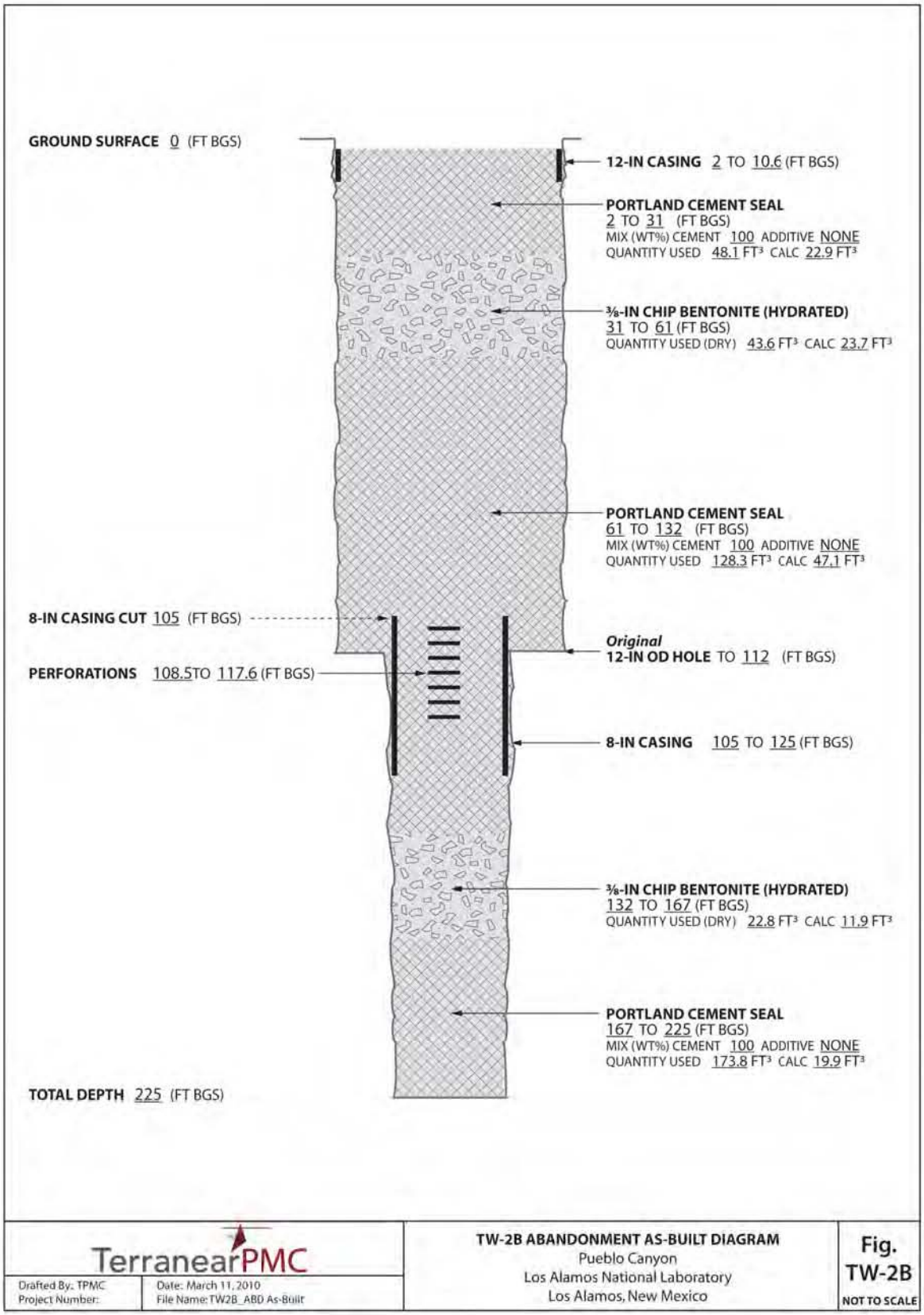

Figure 3.3-3 As-built well abandonment diagram of TW-2B

Table 3.3-1
Quantity and Materials Used to Grout Well TW-2B

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II/V Cement Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8 in. Bentonite Used (lb)	Calculated Volume[a] (ft^3)	Actual Volume (ft^3)
1/15/10	225–191	3948	240	—[b]	11.6	61.5
1/18/10	191–173	4136	240	—	6.2	64.2
1/19/10	173–167	3102	180	—	2.1	48.1
1/19/10	167–140	—	75	1200	9.2	16.1
1/20/10	140–132	—	35	500	2.7	6.7
1/20/10	132–78	5170	300	—	33.7	80.2
1/21/10	78–61	3102	180	—	13.4	48.1
1/21/10	61–31	—	210	3250	23.7	43.6
1/22/10	31–2	3102	180	—	22.9	48.1
Total		**22,560**	**1640**	**4950**	**125.5**	**416.6**

[a] Calculated volumes are based on the following dimensions:
- 2–112 ft bgs: 12-in. borehole/casing
- 112–225 ft bgs: 8-in. borehole/casing

[b] — = Not applicable.

Table 3.3-2
Quantity and Materials Used to Grout Well TW-2A

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II/V Cement Used (lb)	Quantity Municipal Water Used (gal.)	Calculated Volume* (ft^3)	Actual Volume (ft^3)
1/24/10	129.5–93	3102	180	10.0	48.1
1/25/10	93–59	4136	240	11.6	64.2
1/25/10	59–27	5170	300	11.0	80.2
2/08/10	27–2	2256	130	11.2	34.8
Total		**14,664**	**850**	**43.8**	**227.3**

*Calculated volumes are based on the following dimensions:
- 2–8 ft bgs: 12-in. borehole/casing
- 8–112 ft bgs: 8-in. borehole/casing
- 112–129.5 ft bgs: 6-in. borehole/casing

Table 3.3-3
Quantity and Materials Used to Grout Well TW-2

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II/V Cement Used (lb)	Quantity Municipal Water Used (gal.)	Calculated Volume[a] (ft^3)	Actual Volume (ft^3)
1/28/10	834–645	5076	300	56.9	78.9
1/31/10	645–523	14,100	900	41.8	220.6
2/01/10	523–394	10,340	600	70.1	160.4
2/02/10	394–354	9306	540	22.0	144.4
2/03/10	354–nr	8272	480	—[b]	128.3
2/04/10	nr[c]	7238	420	—	112.3
2/05/10	nr	16,544	960	—	256.7
2/06/10	nr–185	9306	540	95.7	144.4
2/06/10	185–106	14,476	840	62.4	224.6
2/07/10	106–60	15,246	840	36.3	197.9
2/08/10	60–2	8789	510	79.9	136.4
Total		**118,693**	**6930**	**465.1**	**1804.8**

[a] Calculated volumes are based on the following dimensions:
- 2–57 ft bgs: 16-in. borehole/casing
- 57–197 ft bgs: 12-in. borehole/casing
- 197–519 ft bgs: 10-in. borehole/casing
- 519–779 ft bgs: 8-in. borehole/casing
- 779–834 ft bgs: 6-in. borehole/casing

[b] — = Not applicable.

[c] nr = Not recorded. Measurement attempts were made but were unreliable due to the cut 10-in. casing and open annular space.

Appendix A

Office of the State Engineer Plugging Records
for Wells TW-2, TW-2A, and TW-2B

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: Test Well (TW)-2

Well owner: U.S. Department of Energy/Los Alamos National Laboratory Phone No.: 505-667-5931

Mailing address: P.O. Box 1663

City: Los Alamos State: New Mexico Zip code: 87545

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Boart Longyear

2) New Mexico Well Driller License No.: WD-1664 Expiration Date: 1/31/2011

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Terranear PMC, LLC

4) Date well plugging began: January 26, 2010 Date well plugging concluded: February 8, 2010

5) GPS Well Location (BRASS CAP): East: 493986.9
North: 1777205.8

Well coordinates are New Mexico State Plane Grid Coordinates, Central Zone (North American Datum, 1983[NAD 1983]).

6) Depth of well confirmed at initiation of plugging as: 834 ft below ground level (bgl), by the following manner: video log, manual tag

7) Static water level measured at initiation of plugging: 808 ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: December 17, 2009

9) Were all plugging activities consistent with an approved plugging plan? NO If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

Attempts to remove all casing strings in TW-2 were made, but the casing strings were unable to be removed at 125 % string pull back weight. The 6-in. casing was perforated from 800 to 820 ft bgs. The 6-in. was then cut at 775 ft bgs and the casing string was removed. The 8-in. casing was perforated from 716 to 768 ft bgs. The first grouting sequence was initiated at this point and the borehole was pressure-grouted with Portland Type I/II/V cement from TD (834 ft bgs) to approximately 645 ft bgs. The 8-in. casing was then cut at 520 ft bgs and removed from the hole. The 10-in. casing was perforated from 374 to 414 ft bgs. The 10-in. casing was then cut at 200 ft bgs and removed from the hole. The 12-in. casing was perforated from 130 to 161 ft bgs. The 12-in. casing was then cut at 60 ft bgs and removed from the hole. The second grouting sequence was initiated at this point, and grout was installed from 645 ft bgs to a calculated lift of 200 ft bgs. The 16-in. casing was then cut at 30 ft bgs. The previous lift of grout was tagged at 523 ft bgs and the third grouting sequence was initiated. Grout was installed from 523 ft to approximately 16 ft bgs. The remaining 16-in. casing was removed from the hole and grout was installed from 16 to 2 ft bgs. A 2-ft X 2-ft X 2-ft (deep) concrete surface pad will be installed at ground surface with a brass survey marker and will be surveyed.

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.)
2	**Portland Type I/II/V**	**1020 gallons**	**597.43 gallons**	**Tremie pipe**	**16-in. casing cut at 30 ft bgs. 16-in. casing grouted in place from 30 to 57 ft bgs.**
60	**Portland Type I/II/V**	**3160 gallons**	**738.75 gallons**	**Tremie pipe**	**12-in. casing perforated first from 130 to 161 ft bgs. 12-in. casing cut at 60 ft bgs and removed. 12-in. casing grouted in place from 60 to 197 ft bgs.**
185	**Portland Type I/II/V**	**7080 gallons**	**1404.58 gallons**	**Tremie pipe**	**10-in. casing perforated first from 374 to 414 ft bgs. 10-in. casing cut at 200 ft bgs and removed. 10-in. casing grouted in place from 200 to 519 ft bgs.**
523	**Portland Type I/II/V**	**2240 gallons**	**737.86 gallons**	**Tremie pipe**	**8-in. casing perforated first from 716 to 768 ft bgs. 8-in. casing cut at 520 ft bgs and removed. 8-in. casing grouted in place from 520 to 779 ft bgs.** **6-in. casing perforated first from 800 to 820 ft bgs. 6-in. casing cut at 775 ft bgs and removed. 6-in. casing grouted in place from 775 to 834 ft bgs.**
834					

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Mark Everett, 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.

Original with signature on file at the OSE

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: Test Well (TW)-2A

Well owner: U.S. Department of Energy/Los Alamos National Laboratory Phone No.: 505-667-5931

Mailing address: P.O. Box 1663

City: Los Alamos State: New Mexico Zip code: 87545

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Boart Longyear

2) New Mexico Well Driller License No.: WD-1664 Expiration Date: 1/31/2011

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Terranear PMC, LLC

4) Date well plugging began: January 22, 2010 Date well plugging concluded: February 8, 2010

5) GPS Well Location (BRASS CAP): East: 493940.6
North: 1777226.0

Well coordinates are New Mexico State Plane Grid Coordinates, Central Zone (North American Datum, 1983[NAD 1983]).

6) Depth of well confirmed at initiation of plugging as: 129.5 ft below ground level (bgl), by the following manner: video log, manual tag

7) Static water level measured at initiation of plugging: 105 ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: December 17, 2009

9) Were all plugging activities consistent with an approved plugging plan? NO If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

The entire 8-in. casing string was removed. Video logging revealed the 6-in. casing string began at 112 ft bgs and screen perforations began at 123 ft bgs (the video log was terminated at 124 ft bgs). An attempt was made to fish out the 6-in. casing and screen, but the casing and screen could not be removed. The 12-in. casing was set from surface to 8.1 ft bgs, and did not require perforation. An attempt was made to remove the 12-in. casing, but the string was unable to be removed at 125% string pull back weight. The 12-in. casing was cut off at 2 ft bgs. The entire borehole was pressure-grouted in one continuous lift with Portland Type I/II/V cement from the bottom to approximately 2 ft bgs. A 2-ft X 2-ft X 2-ft (deep) concrete surface pad will be installed at ground surface with a brass survey marker and will be surveyed.

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.)
2	**Portland Type I/II/V**	**260 gallons**	**84.10 gallons**	**Tremie pipe**	**12-in. casing grouted in place from 2 to 8.1 ft bgs. Open borehole plugged below 12-in. casing.**
27	**Portland Type I/II/V**	**1080 gallons**	**168.96 gallons**	**Tremie pipe**	**8-in. open borehole plugged.**
93	**Portland Type I/II/V**	**360 gallons**	**74.89 gallons**	**Tremie pipe**	**8-in. casing removed from surface to 112 ft bgs. 6-in. casing grouted in place from 112 to 129.5 ft bgs.**
129.5					

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Mark Everett, 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.

Original with signature on file at the OSE

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: Test Well (TW)-2B

Well owner: U.S. Department of Energy/Los Alamos National Laboratory Phone No.: 505-667-5931

Mailing address: P.O. Box 1663

City: Los Alamos State: New Mexico Zip code: 87545

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Boart Longyear

2) New Mexico Well Driller License No.: WD-1664 Expiration Date: 1/31/2011

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Terranear PMC, LLC

4) Date well plugging began: January 15, 2010 Date well plugging concluded: January 22, 2010

5) GPS Well Location (BRASS CAP): East: 493900
North: 1777200
Well coordinates are New Mexico State Plane Grid Coordinates, Central Zone (North American Datum, 1983[NAD 1983]).

6) Depth of well confirmed at initiation of plugging as: 225 ft below ground level (bgl), by the following manner: video log

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: December 17, 2009

9) Were all plugging activities consistent with an approved plugging plan? NO If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

Video logging revealed 8-in. casing from surface to 125 ft bgs, and open hole from 125 ft bgs to TD (225 ft bgs). The 8-in. casing was unable to be removed at 125 % string pull back weight, and was perforated from 108.5 to 117.6 ft bgs. The 8-in. casing was then cut at 105 ft bgs and the casing string was removed from the borehole. A second video run was made to verify the perforations and cut. The perforations and cut were confirmed, and the video documented 12-in. casing set from surface to 10.6 ft bgs and 12-in. open hole to the top of the 8-in. casing cut. Thus, the 12-in. casing did not require perforation. An attempt was made to remove the 12-in. casing, but the string was unable to be removed at 125% string pull back weight. The 12-in. casing was cut off at 2 ft bgs. An attempt was made to pressure-grout the entire borehole in one continuous lift with Portland cement, but significant material loss to the formation occurred and bentonite chips were

emplaced at formation loss intervals. The borehole was grouted to 2 ft bgs, and a 2-ft X 2-ft X 2-ft (deep) concrete surface pad will be installed at ground surface with a brass survey marker and will be surveyed.

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.)
2	**Portland Type I/II/V**	**360 gallons**	**171.39 gallons**	**Tremie pipe**	**12-in. casing grouted in place from 2 to 10.6 ft bgs. Open borehole plugged below 12-in. casing.**
31	**3/8" Bentonite Chips**	**326 gallons**	**177.30 gallons**	**Tremie pipe**	**12-in. open borehole plugged.**
61	**Portland Type I/II/V**	**360 gallons**	**100.47 gallons**	**Tremie pipe**	**12-in. open borehole plugged.**
78	**Portland Type I/II/V**	**600 gallons**	**252.14 gallons**	**Tremie pipe**	**8-in. casing perforated first from 108.5 to 117.6 ft bgs. 8-in. casing grouted in place from 105 to 125 ft bgs.**
132	**3/8" Bentonite Chips**	**170.40 gallons**	**89.60 gallons**	**Tremie pipe**	**8-in. open borehole plugged.**
167	**Portland Type I/II/V**	**1300 gallons**	**148.48 gallons**	**Tremie pipe**	**8-in. open borehole plugged.**
225					

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Mark Everett, 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.

Original with signature on file at the OSE

Signature of Well Driller

Date

Appendix B

Video Logging
(on DVD included with this document)