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Plugging and Abandonment Summary Report for Test Well 8

Los Alamos
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EXECUTIVE SUMMARY

This report describes the methods used by Los Alamos National Laboratory (LANL or the Laboratory) to plug and abandon Test Well 8 (TW-8) located in Technical Area 05 (TA-05) of the Laboratory, in Mortandad Canyon, Los Alamos, New Mexico. Because of its age, construction, and possible contribution to contamination in the regional aquifer, TW-8 was plugged and abandoned at the direction of the New Mexico Environment Department.

The 8-in. carbon-steel well casing was highly corroded and may have affected the quality of groundwater sampled by the well. In addition, the 8-in. well casing string was suspended in an open borehole from 60 ft to 1065 ft below ground surface (bgs) and was a potential pathway for alluvial and intermediate groundwater to reach regional groundwater. In 2003, replacement monitoring well R-1 was installed upgradient of TW-8.

Plugging and abandonment activities at TW-8 occurred from May 31 to August 13, 2009, using a pump-hoist rig, a drill rig, and ancillary equipment. An aquifer pumping test (reported separately) was conducted before the plugging and abandonment of TW-8. After the pumping test was performed, a mechanically actuated perforating tool was used to perforate the 8-in. well casing from 760 ft to 707 ft bgs. The casing interval was perforated to allow increased open area for movement of sealing material into the annulus between the 8-in. casing and the 13.375-in. borehole. After the interval was perforated, the 8-in. casing was pressure-grouted to 105.5 ft bgs via tremie pipe with a mixture of Portland Type I/II/V cement, Baroid IDP-381 cement additive, and potable water.

After the lower portion of the well was abandoned, a Foremost DR-24HD drill rig was used to advance 24-in. flush-welded drill casing over the well to 65 ft bgs. After overdrilling, the 20-in. casing and 14-in. surface casing were removed. A casing cutter was then used to cut the 8-in. well casing at 80.3 ft bgs. The upper portion of 8-in. casing was removed, and the borehole was pressure-grouted via tremie pipe to the bottom of the 24-in. casing. Pressure-grouting continued while the 24-in. casing was extracted.

TW-8 was grouted to ground surface on August 13. A total of 18,799 gal. of cement grout was used to abandon the well, annulus, and open borehole.

CONTENTS

Figures

Tables

Appendix

1.0 INTRODUCTION

This report summarizes the methods used by Los Alamos National Laboratory (LANL or the Laboratory) to plug and abandon Test Well 8 (TW-8). The well abandonment was consistent with requirements and guidelines outlined in sections IV.B.1.b.v and X.D (Well Abandonment) of the Compliance Order on Consent (the Consent Order) and the work plan (LANL 2007, 099155) approved by the New Mexico Environment Department (NMED) (NMED 2007, 099216).

2.0 BACKGROUND

TW-8 is located in Mortandad Canyon, Los Alamos, New Mexico, in Technical Area 05 (TA-05) of the Laboratory. The well was drilled and installed in 1960 to a total depth (TD) of 1065 ft below ground surface (bgs). The well location is shown in Figure 2.0-1. TW-8 was a single-screen well and was constructed as follows:

- From 0 to 42 ft bgs: 20-in. carbon-steel surface casing with no annular fill outside the casing.
- From 0 to 64 ft bgs: 14-in. outside-diameter (O.D.) carbon-steel casing with annular seal from 0 to 62 ft bgs.
- From 0 to 1065 ft bgs: 8-in. inside-diameter (I.D.) carbon-steel threaded and coupled casing with no annular seal from 0 to 1065 ft bgs.
- From 953 to 1065 ft bgs: Well screen consisting of torch-cut slots in the bottom of the 8-in. well casing with slots 6-in. long, 0.125-in. wide, and spaced 90° apart horizontally. Vertical spacing of horizontal rows was 6-in.

2.1 Well History

The TW-8 installation provided a monitoring point to detect for the possibility of contaminants entering the regional aquifer. Drilling was performed using a cable-tool drill rig and support equipment. Drilling fluids were not used because cable-tool drilling does not require drilling additives.

The stratigraphy encountered during borehole drilling included, in descending order: alluvium, the Tshirege Formation, the Cerro Toledo Formation, the Otowi Formation, the Guaje Pumice Bed, and the Puye Formation.

As shown in the well completion diagram (Figure 2.1-1), 20-in. carbon-steel surface casing was driven to a depth of 42 ft bgs to seal out alluvial water. There was no annular seal outside the 20-in. casing. A string of 14-in. carbon-steel casing was suspended inside the 20-in. casing and cemented in place from 0 to 62 ft bgs. The 8-in. carbon-steel casing string was installed from the surface to the TD of 1065 ft bgs. The 8-in. well string was suspended in the 14-in. well casing from the surface to 64 ft bgs. From 64 to 85 ft bgs, the 8-in. well casing was suspended in an 18- to 20-in. open borehole and from 85 to 1065 ft bgs, the 8-in. well casing was suspended inside a 13.625-in. open borehole. A packer of machinery belting was placed on the outside of the 8-in. well casing at a depth of 465 ft bgs. The packer was intended to provide a bridge for grout introduced at the well head after installation, but there is no record that grout was introduced (LANL 2007, 098935).

TW-8 was a single-screen well installed without a filter pack. The well screen consisted of slots cut with an oxygen/acetylene torch in the bottom of the 8-in. carbon-steel well casing. Slots were 6 in. long, 0.125 in. wide, and were spaced 90°apart horizontally. The vertical spacing of horizontal rows was 6 in. The screened interval was set from 953 to 1065 ft bgs, within the top of the regional aquifer.

Well development activities at TW-8 consisted of bailing the well for 3 h. The 0.125-in. slots that were cut into the 8-in. carbon-steel casing were much larger than the slots in wire-wrapped screens that are currently in use at the Laboratory, which measure 0.010 in. and 0.020 in. Wide slot size and lack of a filter pack contributed to a considerable amount of formation fines drawn through the well screen during development and could explain the minimal amount of well development after installation.

2.2 Rationale for Plugging and Abandonment

At the direction of the NMED, TW-8 was plugged and abandoned because of its age, construction, and possible contribution to contamination in the regional aquifer. Corrosion in the well had resulted from the use of carbon-steel casing and may have affected the quality of groundwater sampled at the well. In addition, the annulus of the well was a potential pathway for alluvial and intermediate groundwater to reach regional groundwater because there was no annular fill for most of the length of the well casing.

In 2003, TW-8 was replaced by well R-1 (located upgradient of TW-8) (Figure 2.0-1). Low-level contamination in groundwater from TW-8 along with the absence of contaminants in well R-1 supported the idea that contaminants were leaking from the surface to the regional aquifer through pathways associated with the annulus of TW-8. Replacement well R-1 meets monitoring objectives for regional groundwater in that reach of Mortandad Canyon (LANL 2007, 098935).

3.0 SCOPE OF ACTIVITIES

The scope of activities is presented below.

3.1 Plugging and Abandonment Design and Approach

Before plugging and abandonment activities, the well was logged on multiple occasions using the Laboratory's video camera to document current well conditions. The results of the video log from TW-8 are discussed below. In addition, an aquifer test using a temporary pump was conducted. The aquifer test was outside the scope of the plugging and abandonment effort and will be reported separately.

Following the aquifer test, the 8-in. well casing was perforated from 760 ft to 707 ft bgs using a mechanically actuated perforating tool. Perforating the 8-in. casing interval allowed the grout to penetrate the annular space between the well casing and borehole wall. After the 8-in. well casing was perforated, pressure-grouting was conducted.

After the well was abandoned with cement grout to approximately 105.5 ft bgs, the 20-in., 14-in., and 8-in. casings were overdrilled with 24-in. flush-welded drill casing to 65 ft bgs. Once overdrilling was completed, the 20-in. casing and 14-in. casing were simultaneously removed. A pneumatic casing cutter was then utilized to cut the 8-in. well casing at 80.3 ft bgs. The upper portion of 8-in. casing was removed and the borehole was pressure-grouted via tremie pipe to the bottom of the 24-in. casing. Pressure-grouting continued while the 24-in. casing was removed from the borehole.

3.2 Borehole Logging

3.2.1 Video Logging

Multiple downhole video camera surveys were run in the TW-8 well from June 2, 2009, to July 21, 2009, to assist in fishing operations, document current screen conditions, confirm screen depth location, measure the static water level (SWL) before plugging and abandonment activities, and evaluate the

perforations produced by the mechanical perforating tool. The Laboratory's geophysical trailer and camera were used to complete this logging. Top of casing (stick-up measured at 2.4 ft above ground surface) was used as the datum for all video depth measurements. The purpose of each video and the recorded observations are noted in Table 3.2-1. SWL was noted in two consecutive videos at 1000.2 ft. Visibility below the water level was very poor and could not be improved by using clear water to displace the turbid water. Multiple camera runs were conducted to verify location and relative quality of the perforations produced by the mechanical perforation tool. A DVD from the final July 21, 2009, video camera survey is included as Appendix A.

3.2.2 Geophysical Logging

No geophysical logging was conducted at TW-8.

3.3 Plugging and Abandonment

Plugging and abandonment activities included mobilization, dedicated sampling system removal, downhole video logging, pressure-grouting, overdrilling, casing removal, surface completion, site restoration, and demobilization. All activities were performed following appropriate standard operating procedures and Laboratory-approved health and safety documents. TW-8 was plugged and abandoned in accordance with the NMED-approved work plan (LANL 2007, 099155).

3.3.1 Field Activities

Plugging and abandonment activities at TW-8 occurred from May 31 to August 13, 2009. Mobilization of a pump hoist workover rig and ancillary equipment to the well site was performed on May 31. Following a field management and operations verification (MOV) that included inspection of heavy equipment, the dedicated sampling system was removed from the well on June 1. Approximately 500 ft of the dedicated 2-in. polyvinyl chloride (PVC) transducer tube remained in the hole after removing the dedicated sampling system. On June 2, a video log was conducted to identify the depth and location of the 2-in. PVC pipe (Table 3.2-1). Four strings of PVC pipe were identified at various depths. The tops of the PVC strings were observed to be frayed and splintered.

From June 10 to 13, the 2-in. PVC slave tube strings were fished out of the 8-in. well casing using an overshot tool. Fragments that remained in the hole after fishing were bailed out using a sand bailer. Small fragments of PVC, fine formation sediments, and rust were bailed from the bottom of the well casing along with approximately 975 gal. of water. After bailing, a groundwater level measurement of 999.08 ft bgs was recorded, and the bottom of the well was measured at 1056.8 ft bgs.

A break in activities occurred when the workover rig was mobilized off site on June 14 to remove the dedicated sampling system at well MCOBT-4.4. The workover rig was mobilized back to TW-8 on June 20.

On June 21, a temporary 10-hp, 20 gal./min. submersible pump was installed in TW-8 to perform an aquifer pumping test (outside the scope of the plugging and abandonment work, as indicated above). After the 24-hr pump test was completed, the temporary pump assembly was removed from the well and the workover rig was mobilized off site.

On July 13, a PulStar 100K workover rig and ancillary equipment were mobilized to TW-8. Following an MOV on July 14, a mechanically actuated perforating tool (mill knife) was tripped into the 8-in. well casing on a string of 2-in. carbon-steel drop pipe. The mill knife was actuated with a cable and was used to perforate the 8-in. well casing from 760 ft to 707 ft bgs before grouting. The perforation interval was based on stratigraphy and the base of the basalt having been recorded at 725 ft bgs during drilling. It was

reasoned that if perched groundwater should be present at the TW-8 location, the basalt interval would be the most probable lithological unit of origin. An effective sealing job could be achieved by breaching the basal basalt contact with the perforations and giving the abandonment grout an outlet to the formation within this interval. This was accomplished; the 53-ft section was perforated between July 14 and July 21. Perforations were made every 6 in. and 120° apart.

Problems were then encountered with the mill knife as the perforating task continued. The blade of the mill knife was replaced five times during the perforating operation. The video camera was run in the well on July 21 to investigate why the blade was breaking and to confirm that the mill knife was cutting the well casing (Appendix A). The camera inspection indicated that the well couplings were the likely cause for some of the broken blades. The coupled unions of the well casing have short intervals where the casing is considerably thicker than the regular pipe intervals between the coupled unions. The camera inspection revealed that the mill knife was perforating the casing when functioning properly and deployed in uncoupled pipe.

After the 8-in. well casing was perforated, well TW-8 was abandoned from 1057 ft bgs (physical measurement) to 105.5 ft bgs with a mixture of Portland Type I/II/V cement, Baroid IDP-381 cement additive and municipal water. The interval was pressure-grouted via tremie pipe from July 23 to July 25. On July 23, the well was grouted from 1057 ft bgs to 739.4 ft bgs using 5280 gal. of cement slurry. On July 24, the 8-in. casing was grouted from 739.4 ft bgs to 105.5 ft bgs, and the borehole annulus was grouted from 739.4 ft bgs to 707 ft bgs using 3872 gal. of cement slurry. The volume and type of abandonment materials used are presented in Table 3.3-1.

Pressure was achieved in two forms: via a pneumatic pump during emplacement and via hydrostatic head for forcing the grout into the formation. A pneumatic diaphragm pump was used to deliver the grout from a cement hopper at the ground surface to the bottom of the well in a 2-in. tremie pipe. Pumping the grout in two continuous lifts built a column of grout inside the well casing that ensured the screen interval and then the perforated interval were both under continuous head pressure.

The addition of Baroid IDP-381 helped ensure a thorough plugging operation. IDP-381 is a cement curing retardant that enhances the cement's flow properties and improves bonding characteristics. Small samples of the cement used at TW-8 indicated that the cement's actual set time was between 24 and 36 h.

The PulStar 100k workover rig was mobilized off site on July 25 and mobilization of the dual-rotary drill rig and ancillary equipment was performed on July 30. Following another MOV, the 20-in., 14-in., and 8-in. casing were overdrilled with 24-in. flush-welded drill casing. Circulation of cuttings was accomplished by using air without the use of water or drilling additives. On August 1, the 24-in. drill casing was advanced to 23 ft bgs with very little circulation of cuttings. On August 2, an auxiliary 1150 ft^3/min air compressor was brought on site. The 24-in. drill casing was advanced to 30 ft bgs, but circulation remained poor. On August 3, the 24-in. drill casing was advanced to 50 ft bgs. From 30 to 40 ft bgs, circulation of cuttings was minimal. However, from 40 to 50 ft bgs, circulation of cuttings was achieved, due in part to being in a saturated formation. On August 4, the 24-in. drill casing was advanced to 65 ft bgs, at which point the drill casing had difficulty rotating or advancing. From August 4 to August 5, the 20-in. casing and 14-in. casing were removed simultaneously from the borehole.

On August 5, an 8-in. pneumatic casing cutter was tripped into the well. The 8-in. well casing was cut at 80.3 ft bgs and was extracted from the borehole. From August 6 to August 13, pressure-grouting the remaining annular space, 8-in. well casing, and open borehole continued as the 24-in. drill casing was removed. Approximately 9647 gal. of grout was used to finish abandoning the borehole.

3.3.2 Completion

After the 24-in. drill casing was extracted from the borehole and the borehole grouted to ground surface, a 2 ft long x 2 ft wide concrete surface pad was installed (Figure 3.3-1). A brass marker was surveyed during well completion in accordance with Section IX.B.2.f of the Consent Order, which states that pertinent structures may be horizontally located with a global-positioning system to within 0.5 ft. The surveyed location is recorded in the as-built figure in the network evaluation report (LANL 2007, 098935). No new survey of the abandoned well is planned.

4.0 POSTABANDONMENT ACTIVITIES

Postabandonment activities are described below.

4.1 Well Site Restoration

Plugging and abandonment activities were not obtrusive to site conditions, and very minimal site restoration will be required.

4.2 Waste Management

Contact waste, circulation fluids, drill cuttings, and decontamination water were generated during the plugging and abandonment. The Laboratory removed the concrete surface pad at TW-8. Contact waste included dedicated sampling system components, conductor casing, well casing, and cement pad. All contact waste will be recycled by the Laboratory.

Drill cuttings were produced from overdrilling. Drill cuttings were directly land-applied following standards operating procedure ENV-RCRA SOP-011.0 (Land Application of Drill Cuttings).

Decontamination water was generated from decontaminating the dedicated and temporary sampling systems. Decontamination water was placed into 55 gal. drums. Decontamination water will be evaluated for treatment and disposal at one of the Laboratory's six wastewater treatment facilities.

No excess cement grout was generated during the plugging and abandonment of TW-8.

5.0 DEVIATIONS FROM PLANNED ACTIVITIES

The following are deviations to the work planned.

- The natural gamma log was not run as planned. This was an oversight on the part of the field crew.
- The screen interval at TW-8 was not perforated as planned. After several video logging runs, it was apparent that the torch-cut screen did not require perforating to adequately seal the screen interval. The torch-cut openings were considerably larger than the perforations achieved with the mill knife.

6.0 SUMMARY

TW-8 was perforated from 760 ft to 707 ft bgs using a mechanically actuated mill knife before plugging and abandonment. During plugging and abandonment activities, the 8-in. well casing and surrounding annulus were plugged using cement grout. The 20-in. casing, 14-in. casing, and 8-in. casing were then

overdrilled with 24-in. drill casing before extraction. All of the 20-in. casing and 14-in. casing were removed along with a portion of the 8-in. well casing. Following overdrilling activities, the remainder of the well and annulus were plugged and abandoned from bottom to top via tremie pipe with a mixture of Portland Type I/II/V cement, Baroid IDP-381 cement additive, 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), June 2007. "Mortandad Canyon Groundwater Monitoring Well Network Evaluation," Los Alamos National Laboratory document LA-UR-07-4343, Los Alamos, New Mexico. (LANL 2007, 098935)

LANL (Los Alamos National Laboratory), October 2007. "Work Plan to Plug and Abandon Mortandad Canyon Wells Test Well 8 and MCOBT-4.4," Los Alamos National Laboratory document LA-UR-07-7243, Los Alamos, New Mexico. (LANL 2007, 099155)

NMED (New Mexico Environment Department), December 7, 2007. "Notice of Approval, Work Plan to Plug and Abandon Mortandad Canyon Wells Test Well 8 and MCOBT-4.4," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2007, 099216)

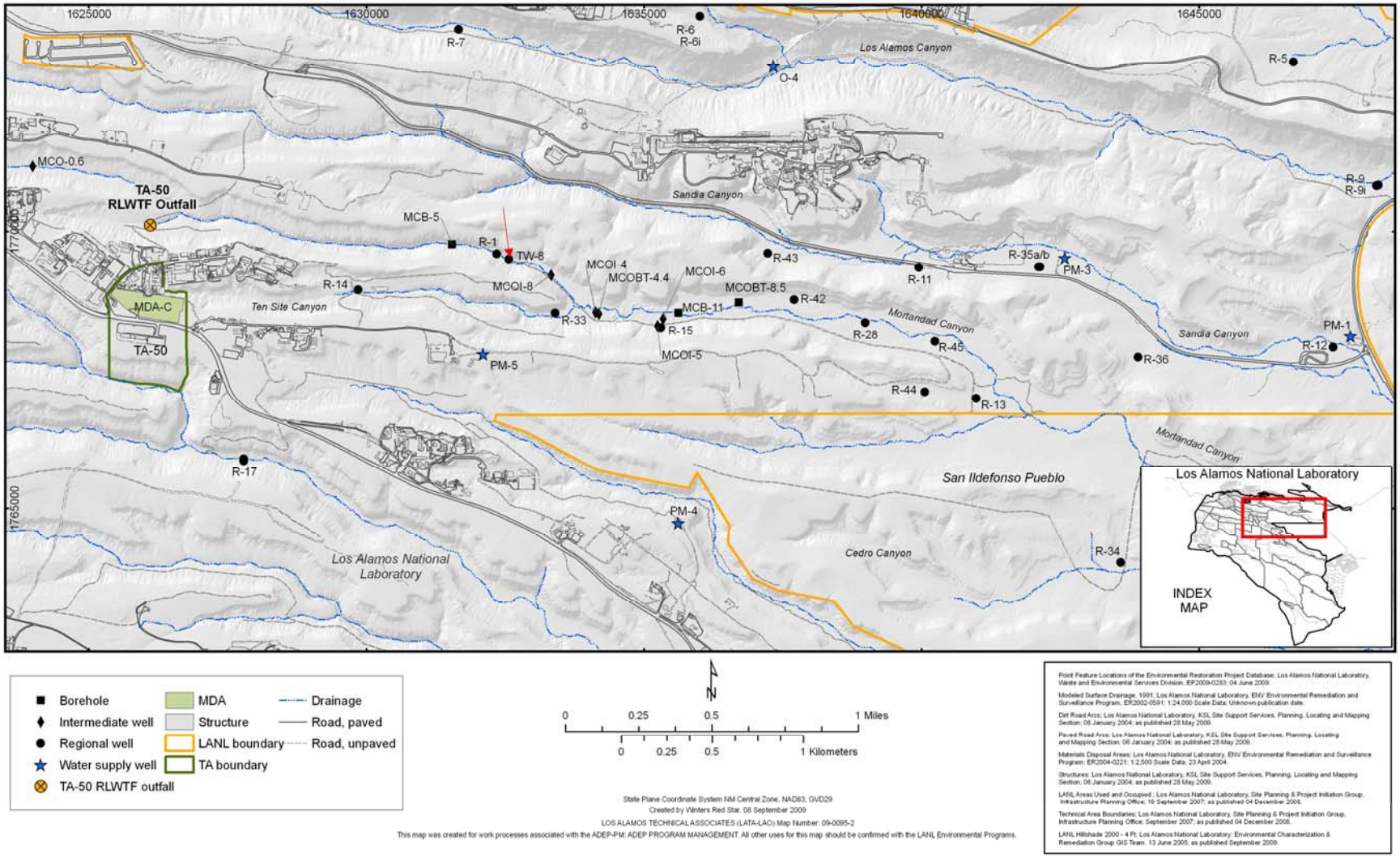
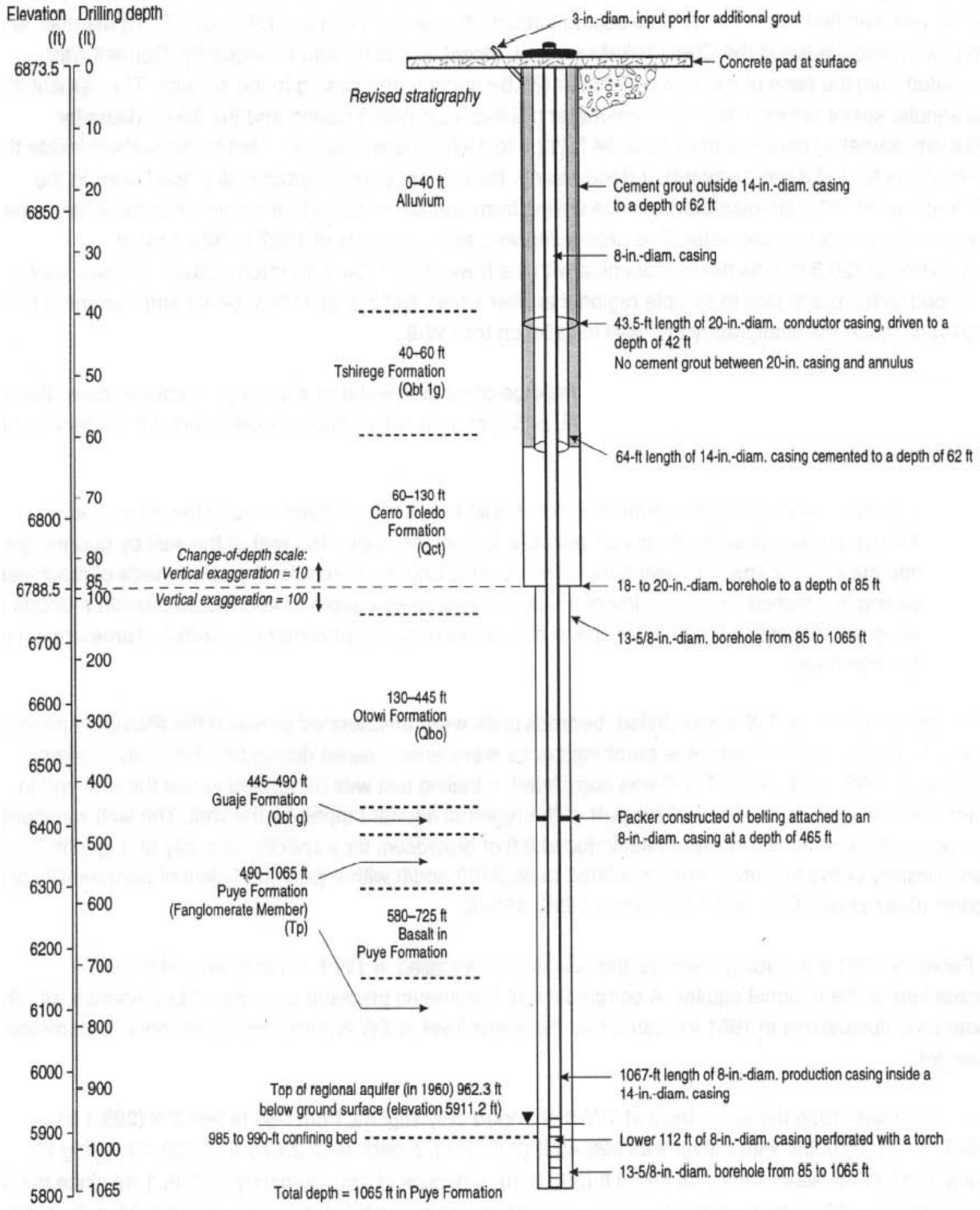


Figure 2.0-1 Location of well TW-8



Source: Modified from LANL 2007, 098935.

Figure 2.1-1 TW-8 well construction diagram

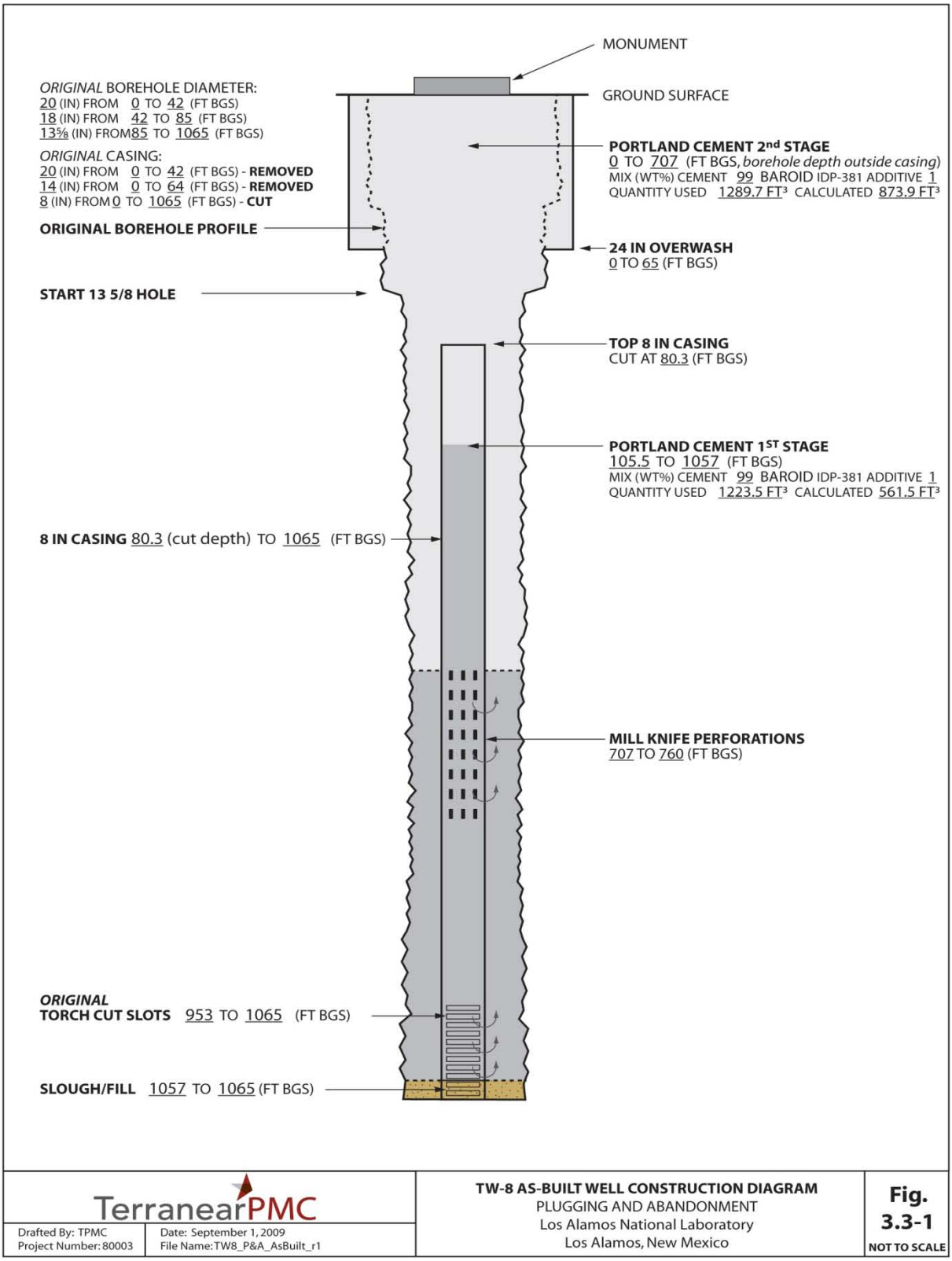


Figure 3.3-1 TW-8 postplugging and postabandonment diagram

Table 3.2-1
Video Log Information

Video Date	Purpose	Run Details	Observations
6/2/09	Locate depth and orientation of 500 ft of dropped 2-in. schedule 40 PVC	With centralizers; 0 ft to 939.17 ft	Top of first PVC stand at 939.17 ft
6/2/09	Same as above	Without centralizers; 0 ft to 987 ft	Top of PVC also at 943.83 ft, 960.42 ft, 987 ft; torched slots visible
6/10/09	Assess location of any remaining PVC after removal of 440 ft PVC	Without centralizers; 0 ft to 1047 ft	SWL at 1000.17 ft; visibility very poor because of turbidity
6/11/09	Clear water was run into the well overnight; re-run camera to assess location of any PVC below the SWL	Without centralizers; 0 ft to 1068.58 ft	Little improvement in visibility; SWL at 1000.17 ft; possible sediment interface at 1057 ft
7/16/09	Evaluate mechanical perforations from 710 ft to 760 ft	Without centralizers; 0 ft to 760 ft	Casing perforations noted from 759 ft to 760 ft
7/19/09	Evaluate mechanical perforations from 710 ft to 760 ft	Without centralizers; 0 ft to 761 ft	No perforations were present from 733 ft to 738 ft and from 757.5 ft to 759.5 ft
7/21/09	Evaluate mechanical perforations from 710 ft to 760 ft	Without centralizers; 0 ft to 724 ft	Interval perforated

Table 3.3-1
Quantity and Materials Used to Plug and Abandon Well TW-8

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II/V (lb)	Quantity Municipal Water (gal.)	Quantity Baroid IDP-381 (lb)	Calculated Volume (gal.)	Actual Volume (gal.)
7/23/2009	1057-739.40	45,120	4,200	480	2,423.16[a]	5,280
7/24/2009	739.40-105.50	33,088	3,080	352	1,776.93[b]	3,872
8/6/2009	707.00-419.10	26,696	2,272	156	2,196.56	3,124
8/7/2009	419.10-124.63	19,740	1,680	114	2,246.69	2,310
8/10/2009	124.63-21.40	20,398	1,736	108	1,591.19	2,387
8/11/2009	21.40-4.00	14,100	1,200	31	408.68	1,650
8/13/2009	4.00-surface	1,504	100	2	93.95	176
Totals		**160,646**	**14,268**	**1,243**	**10,737.16**	**18,799**

[a] Calculated volume is based on a 13.625-in. borehole.

[b] Calculated volume is based on a 13.625-in. borehole from 739.4 to 707.0 ft bgs, and 8-in. well casing from 707.0 to 105.5 ft bgs.

Appendix A

Video Camera Run of July 21, 2009
(on DVD included with this document)