Basic Data Report For Monitor Well DOE-2 Reconfiguration Activities

Waste Isolation Pilot Plant

U.S. Department of Energy
Carlsbad Field Office

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Basic Data Report
For Monitor Well DOE-2 (C-2682)

Waste Isolation Pilot Plant

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ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
BLM	U.S. Bureau of Land Management
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
OSE	Office of State Engineer (New Mexico)
P&A	plugging and abandonment
ROW	right-of-way
SNL	Sandia National Laboratories
TK-70	Tube-Kote 70
TLCP	Toxicity Characteristic Leaching Procedure
WIPP	Waste Isolation Pilot Plant

1.0 INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy (DOE) facility disposing of transuranic and mixed waste under the Hazardous Waste Facility Permit (Permit NM4890139088-TSDF, as amended) issued by the New Mexico Environment Department (NMED). WIPP is located approximately 26 miles east of Carlsbad, New Mexico, in eastern Eddy County (Figure 1-1). Disposal panels are being excavated in the Permian Salado Formation at a depth of approximately 2,150 feet (ft) below ground surface (bgs).

Over the years a number of groundwater monitor wells have been installed for site characterization and to monitor temporal and spatial changes in groundwater elevation and chemistry at WIPP. Many of the wells used for this purpose were constructed of carbon steel casing that has deteriorated to varying degrees due to corrosion. For some wells the deterioration has led to failure of the well integrity. In such cases, the well must either be reconfigured or completely plugged, according to regulatory requirements, to prevent commingling of groundwater from different formations. Other wells are nearing the end of their useful life and/or are duplicative of other wells that serve the same purpose. Because of these integrity issues, WIPP has begun a program to plug and abandon wells that are no longer useful for the monitoring program or are redundant, and to reconfigure other wells for future monitoring. One such well is known as DOE-2, which was reconfigured to monitor only the Bell Canyon Formation.

The New Mexico Office of the State Engineer (OSE) permitted monitoring well DOE-2 as well C-2682. This well has been part of the far-field monitoring network since 1984. The well was used to obtain water level elevations and hydraulic parameters from both the Bell Canyon Formation and the Culebra Member of the Rustler Formation. Recently the well was reconfigured to provide only Bell Canyon Formation water level data. This basic data report provides a historical account of the well from the original installation to the current configuration.

1.1 History of Well DOE-2

DOE-2 (OSE File C-2682) is located approximately two miles north of the center of the WIPP site in Section 8, Township 22 south, Range 31 east (Figure 1-1). DOE-2 was drilled and cored to a depth of 981 ft bgs in 1984, and deepened to 4,325 ft bgs in 1985. Surface casing was set to a depth of 35 ft bgs during the first drilling period, and during the 1985 drilling period, the surface casing was set to a depth of 1,009 ft bgs (Figure 1-2). Following drilling and hydraulic testing, DOE-2 was configured with a packer set at 4,051 ft bgs with 2.375-inch tubing to surface. This configuration was designed to allow water level monitoring of the hydrostatic heads in the Salado and Castile Formations in the annulus and the hydrostatic heads in the Bell Canyon Formation in the tubing. In 1986 the well was reentered to remove the deep packer and tubing and install an inflatable bridge plug (open-hole packer) at 875 ft bgs. The 9.625-inch casing was shot perforated from 822 ft bgs to 848 ft bgs to monitor the Culebra interval.

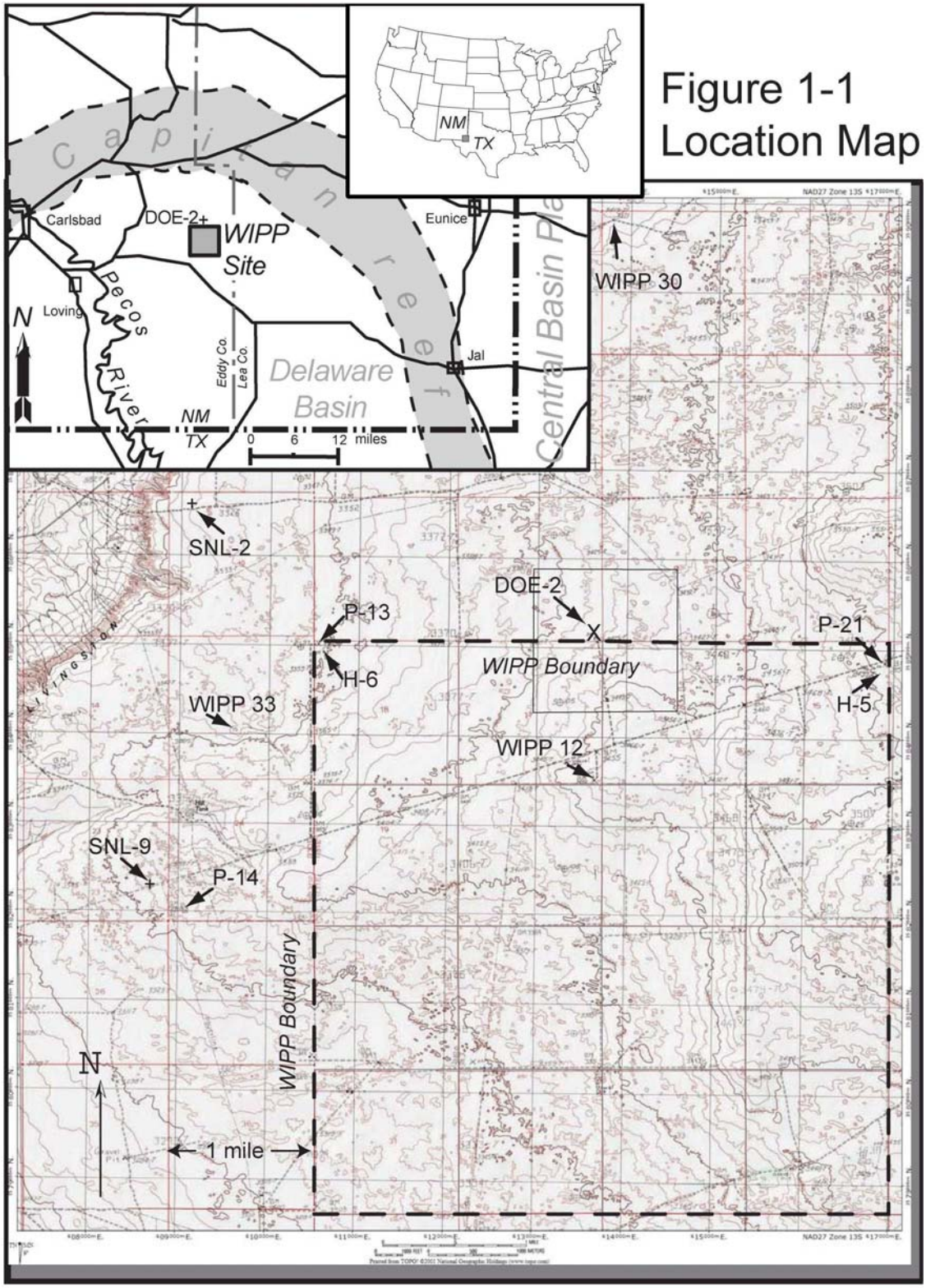
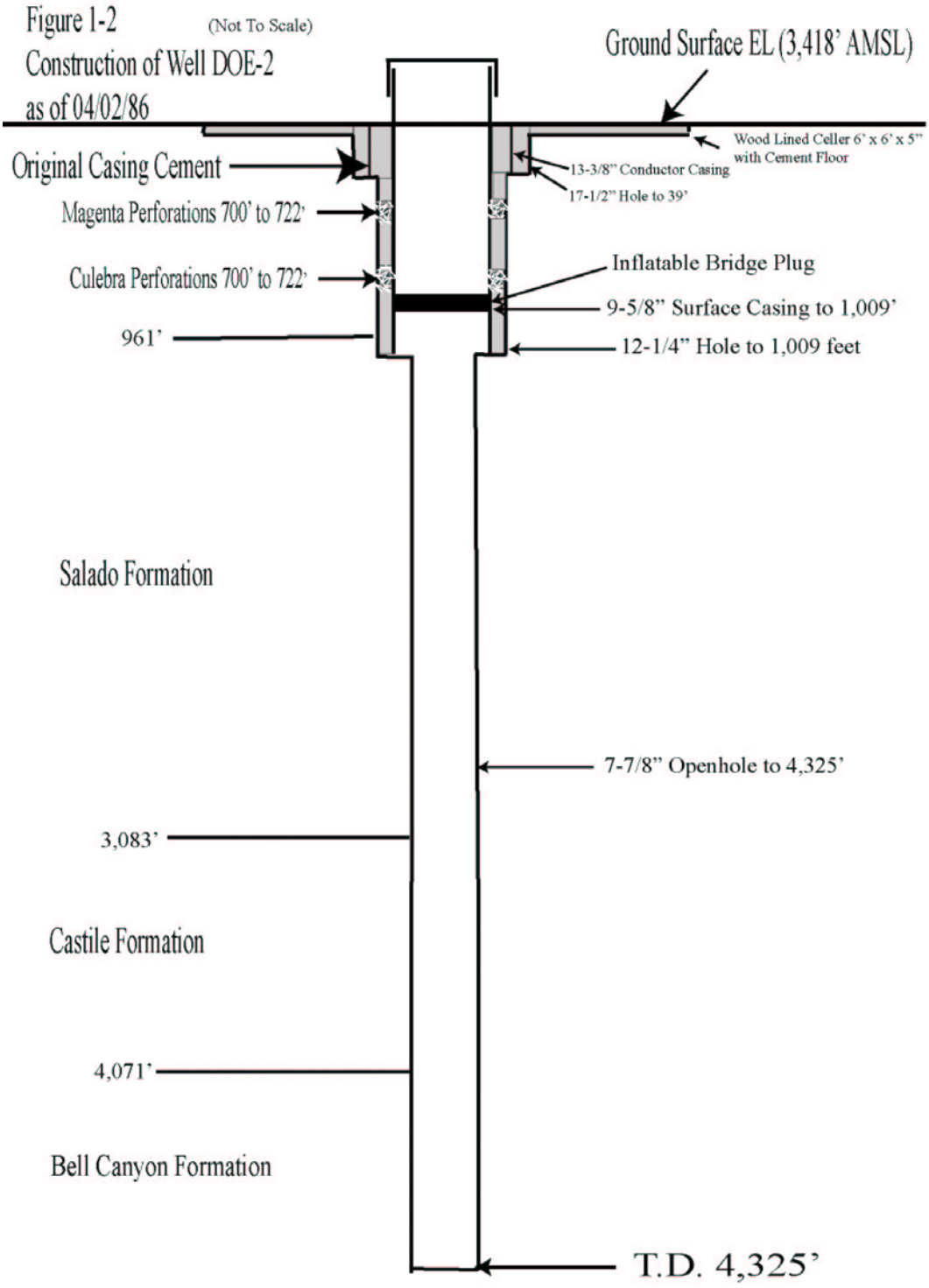


Figure 1-1
Location Map

Adapted from Powers 2004



In 2001 Sandia National Laboratories (SNL) reentered the well and perforated the Magenta Member for multilevel monitoring.

WIPP has retained a Right-of-Way (ROW) reservation lease with the U.S. Bureau of Land Management (BLM) since August 30, 2002 (ROW NM-108365). The ROW contains special stipulations regarding maintenance, reconfiguration, and plugging and abandonment (P&A). One of the stipulations requires that any monitoring well that penetrates the salt section be cased. DOE-2 was completed as an open hole through the salt section. Therefore, based on this stipulation, the BLM required WIPP to reconfigure this well or plug and abandon it to prevent the salt section exposure to the groundwater.

During February 2004 this well was reentered to reconfigure it as a Bell Canyon Formation monitoring well. The purpose of this reconfiguration was twofold. First, when the well was drilled, the completion was not compliant with OSE and BLM requirements, in that water bearing formations were possibly commingling and the Salado Formation was not sealed off with well casing. Second, Culebra Member of the Rustler Formation water levels in this well are suspect, possibly due to improper sealing of the bridge plug.

1.2 Regulatory Requirements for Reconfiguration of DOE-2

Prior to initiating the P&A/reconfiguration program, the applicable regulations were analyzed. The following regulations were reviewed during this analysis.

- Section 72-14 New Mexico Statutes Annotated (NMSA) 1978, regarding drilling, casing, repairing, and abandonment of artesian wells

- New Mexico Office of the State Engineer Rules and Regulations regarding application filing for well drilling, repair, plugging and abandonment

- State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (Order No. R-111-P) regarding the protection of mineral resources from commingling or leaking water sources

- BLM Stipulations for ROWs NM107944 and NM108365.

In the following sections there are terms used which are unique to the geology of southeastern New Mexico.

- "Potash Area" is defined in Oil Conservation Commission Order No. R-111-P. This represents the area of which potash mining operations are now in progress, or in which core tests indicated commercial potash reserves. This area is conterminous with the Known Potash Leasing Area as determined by the BLM. DOE-2 is located in this area and is subject to these regulations.

- "Salt section" refers to the Salado Formation in which the McNutt Potash unit is deposited. Figure 1-2 graphically depicts the depth of the Salado Formation.

The applicable portions of the listed regulations are described in the following sections.

1.2.1 New Mexico Statutes

Section 72-13-4 NMSA prescribes the rules and regulations governing the drilling, casing, repairing, and abandonment of artesian wells. This section authorizes the State Engineer to "prescribe and enforce reasonable rules and regulations consistent with terms of this act." Additionally, this section states that application to the State Engineer is required to drill, repair, plug or abandon an artesian well. All wells completed in the Magenta and Culebra Members of the Rustler Formation are considered artesian.

1.2.2 New Mexico OSE Rules and Regulations

Article 1-1 Filing

This article defines the necessary action for filing an application to drill, repair, plug or abandon wells in the state of New Mexico. Prior to repair/reconfiguration activities, the OSE must be notified through the application process of WIPP's intent to repair/reconfigure the monitor wells at the site.

Article 4-16 Casing-Cementing-Testing

This article describes the cementing and cement testing approval requirements for emplacing cement plugs in wells and boreholes. This is the only regulation that prescribes types of cement, mixture ratios, and additive requirements. It is primarily for casing cementation during well installation, but is also acceptable for plugging.

The article specifies pump and plug methodology. The primary specification in this Article is the use of Class C neat cement at a density of fifteen pounds per gallon.

The article also specifies that cementing/P&A programs shall be witnessed and approved by an authorized representative of the State Engineer.

Article 4-19 Artesian Wells - Repair

This article provides specifications that are most applicable to the P&A program. Prior to commencement of repairs (i.e., reconfiguration), a representative of the State Engineer must inspect the well to "determine if the condition of the well is such that it may be repaired." Additionally, "the hole shall be open to allow the entrance of equipment for well logging and leakage measurement," which implies a degree of well integrity testing (e.g., cement bond log, ultrasonic imaging log).

Article 4-19.1 Plugging

This article prescribes that "All work shall be done under the supervision of the State Engineer or his representative, or a representative of the appropriate Artesian Conservancy District who shall designate the amount of cement to be used and the depths at which cement plugs shall be set."

Article 4-20 Test or Exploratory Wells

This article contains the rules for test or exploratory wells, which include the WIPP monitoring wells. However, for P&A (Article 4-20.2) of these wells the regulations defer to the artesian specifications contained in Article 4-19. Additionally, the article further states "Such wells shall be plugged in accordance with Article 4-19.1 so that fluids will be permanently confined to the specific strata in which they were originally encountered," thus preventing the commingling of water bearing zones.

1.2.3 State of New Mexico Energy, Minerals, and Natural Resources Department Oil Conservation Commission (Order No. R-111-P)

These regulations are designed to protect mineral resources from commingling or leaking water sources. The primary concern here is the Potash Area and protection of the salt section and any water bearing horizon. The regulations state:

1. "All wells heretofore and hereafter drilled within the Potash Area shall be plugged in a manner and in accordance with the general rules or field rules established by the Division that will provide a solid cement plug through the salt section and any water-bearing horizon and prevent liquids or gasses from entering the hole above or below the salt section."

2. "The fluid used to mix the cement shall be saturated with the salts common to the salt section penetrated and with suitable proportions but not more than three (3) percent of calcium chloride by weight of cement being considered the desired mixture possible." This regulation was discussed with the Oil Conservation Commission and BLM regarding applicability to cementing for reconfiguration. It was determined through this discussion that it applied to drilling of wells and not the reconfiguration application for this program.

2.0 WELL RECONFIGURATION

DOE-2 was reconfigured during February 2004 and March 2004 to monitor only the Bell Canyon Formation. The purpose of this reconfiguration was twofold. First, when the well was drilled, the completion was not compliant with OSE and BLM requirements, in that water bearing formations were possibly commingling and the Salado Formation was not sealed off with the well casing and cement. Second, water level measurements for the Culebra Member of the Rustler Formation in this well are suspect, possibly due to a failed packer.

Figure 1-2 shows the configuration of well DOE-2, as built in 1986, prior to this reconfiguration. The new configuration for DOE-2 was planned to monitor only the Bell Canyon Formation. To do this the existing packers and tubing needed to be removed

from the borehole, the casing needed to be prepared for geophysical logging, new tubing and packers needed to be installed, and the well cemented from the packer to the surface. The following sections describe the reconfiguration process for DOE-2.

2.1 Removal of Packers and Tubing

Removal of the packer took place February 11-19, 2004. Typical removal of packers and tubing involves connecting the drill rig elevator to the existing tubing and applying enough pressure to break the shear pin and drain the packer fluid, thus relieving the pressure, then pulling the remaining packer mandrel assembly and element from the hole. For this well, an open-hole packer was used as a bridge plug; therefore, no tubing was available to latch onto. Instead, a J-hook tool was used to go down the hole with the drill rig tubing to grab onto the packer for release. The center of the packer was reportedly set at a depth of 871 ft bgs. However, when attempting to retrieve the packer it was initially tagged 100 ft deeper, indicating the packer could have slipped over time. Available data for this packer indicated it is a Baker water-inflatable packer with a shear pressure of 20,000 pounds per square inch.

In DOE-2, there was a significant amount of debris on top of the packer that prevented latching onto the packer and pulling it out of the hole. Due to this circumstance, the drill rig had to circulate the well casing and borehole with water to remove the debris from on top of the packer (Appendix A). The debris consisted predominantly of well casing scale from corrosion and some fine sediment. Circulation of the casing removed a good portion of the lighter, less dense material, but due to the weight of the casing debris, and the low viscosity of water used as the circulating medium, it was difficult to remove the metal in great enough volume to allow the retrieval tool (J-hook) to latch onto the packer. Additionally, the packer appeared to be moving down the hole as the drill rig circulated the debris from the hole. After two days of circulating and debris removal, the bridge plug/packer was removed from the hole.

2.2 Casing Preparation

On February 20, 2004, following the removal of the packer, the casing was scraped to remove debris and significant pitting from the casing surface in preparation for geophysical logging. The casing was scraped from the bottom to the top until resistance was no longer evident on the scraping tool. Remaining debris was circulated and removed.

2.3 Drilling of Borehole

Once scraping was completed the tremie pipe was run into the hole to determine the total depth and prepare for cement emplacement. During tremie pipe placement an obstruction was encountered at a depth of 1,125 ft bgs.

Following this discovery, the tremie pipe was removed and reconfigured with a 7-7/8-inch drill bit to attempt to breakup and wash out the obstruction. Drilling (i.e., reaming) the borehole took place between February 25, 2004, and March 7, 2004,

with a work break in between. Ten feet of the obstruction were washed out until refusal upon hard formation material. The washed out material consisted primarily of casing scale. At this point, the fluid used to remove the cuttings from the hole was fresh water, which proved to have a viscosity too low to remove the heavier metal scale from the borehole. Every time circulation stopped, the debris would settle out of the water on top of the obstruction. At this point, it was decided to obtain the necessary equipment and materials to use an alternate drilling fluid to remove the debris.

To do this, a portable mud pit, cuttings shaker, and drilling mud system were mobilized to the well pad. Drilling mud was employed to lift the heavy metallic casing debris and formation material from the borehole. Drilling mud consisted of salt clay and starch mixed with brine to a viscosity sufficient to lift materials from the hole. The tremie pipe was placed into the hole until refusal at a depth of 1,125 ft bgs.

At refusal the drilling fluid was employed down hole to wash out the debris and obstructions. Circulation with progressive lowering of the tremie, without the benefit of mechanical action, was successful until refusal at 1,610 ft bgs. The tubing hit refusal points at depths of 1,280 ft, 1,312 ft, 1,464 ft and 1,545 ft bgs; however, the obstructions were broken up and washed out until refusal at 1,610 ft bgs. At this depth the obstruction was consolidated preventing the tremie pipe from penetration. At this point it was decided to mobilize drill pipe to the site to ream the borehole obstructions.

Drill pipe, with a 3.5-inch diameter and configured with a 7-7/8-inch tri-cone rotary drill bit, was used to drill below 1,610 ft bgs. Drilling was slow due to formation material, which appeared to be halite and traces of anhydrite in the cuttings. After drilling for a period of time at a rate of 2 ft per minute, rubber pieces started coming out of the hole. The rubber was from a packer element left in the hole in 1986 when it was reconfigured by SNL. During this period SNL removed a downhole packer and stripped off element from the mandrel. They were unable to retrieve the element so the well had been completed above this interval as presented in Figure 1-2.

After an attempt to drill through the element, it was decided to try and retrieve the material. The drill pipe was removed from the hole and configured with a 7-5/8-inch overshot tool. The overshot tool was set at 1,610 ft bgs and rotated on top of the element, while the borehole was circulated. A significant number of rubber element pieces were removed from the hole by drilling fluid while the overshot tool was rotated. After drilling the estimated length of the element, the overshot tool was removed from the borehole. The overshot tool did not recover the element; however, there was significant evidence on the interior and exterior of the tool, in addition to recovered rubber pieces, suggesting that the element was likely "chewed up" during the process.

The drill pipe and bit were reconfigured and reentered into the hole to make sure there was clearance to total depth. Reaming of the hole was smooth for the most part with the exception of hitting obstructions at 1,630 ft, 1,640 ft, 2,380 ft, 2,631 ft, 3,014 ft, 3,996 ft, 4,060 ft, 4,090 ft, and 4,270 ft bgs. Reaming ceased at 4,290 ft bgs, which is the total depth of the hole. The original depth was 4,325 ft bgs; however, it was not possible to drill past 4,290 ft bgs due to refusal.

2.4 Geophysical Logging

Following the removal of the packers, casing scraping, and drilling the borehole, the well was ready for geophysical logging on March 7, 2004. Halliburton Energy Services performed the logging. The types of geophysical logs performed were a 4-Arm Caliper Log, Cement Bond Log, and a Casing Inspection Log.

The 4-Arm Caliper Log was performed to provide information regarding the open-hole section of the borehole, and by inference, the degree of halite dissolution and/or creep in the borehole, other formation stability, and the ability to determine optimum packer placement and preliminary cement volumes for plugging the open sections between the casing and the packer. The greatest apparent diameter from the borehole was in excess of 16 inches at a depth of 1,003 ft bgs in the upper Salado Formation. Based on this log, it was determined the best location to install the center of the reconfiguration packer was in the Anhydrite I unit of the Castile Formation at a depth of 4,015 ft bgs (Appendix B).

The Cement Bond Log was performed to evaluate the integrity of the cement bond with the casing and with the adjacent formation to assure there is no ability for interstitial commingling of groundwater between water bearing zones (i.e., Magenta and Culebra Members). The bond log was run from 280 ft bgs to a depth of 1,009 ft bgs, the bottom of casing. According to interpretations made by the Halliburton Field Representative, Richard Kelley, the cement bond is excellent with no indications of channeling. There is bonding to both the pipe and formation (Appendix B).

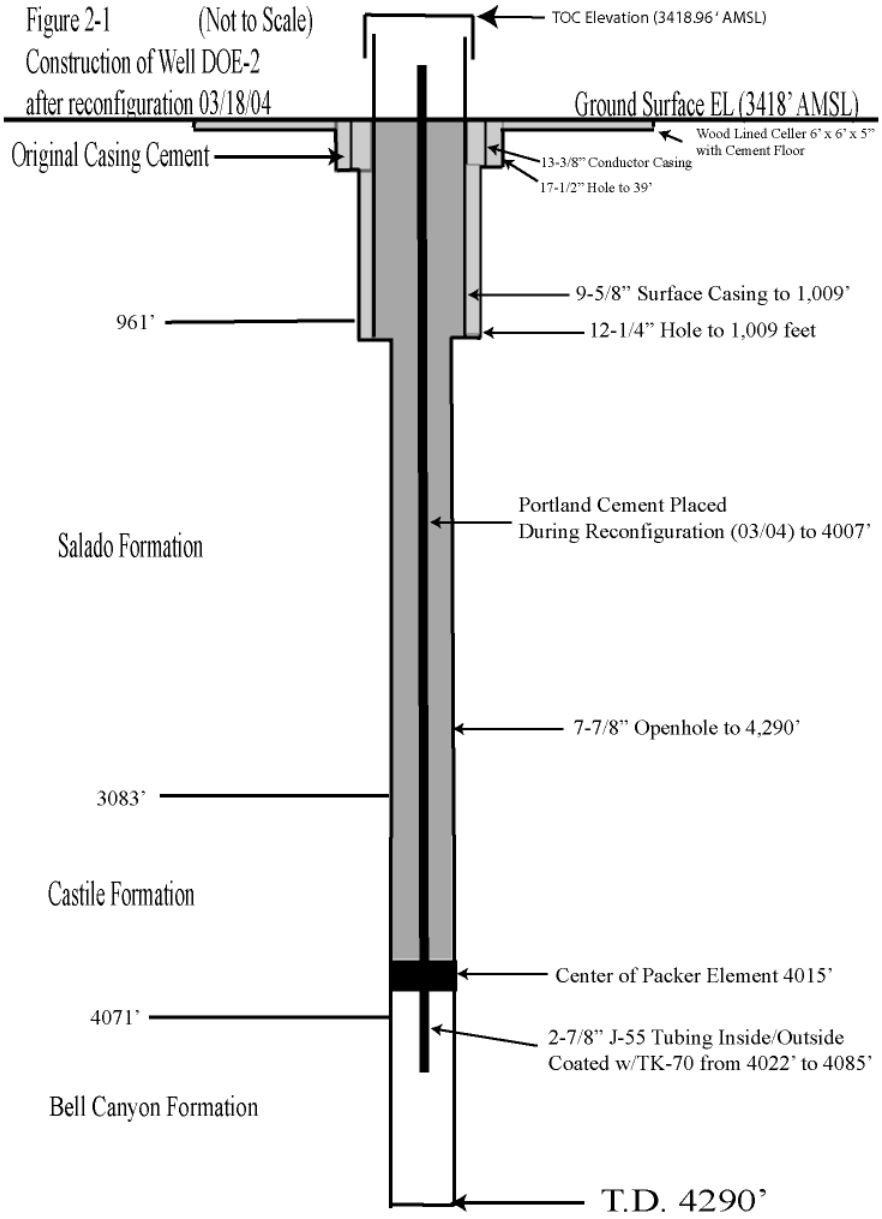
The Casing Inspection Log was performed to measure the wall thickness of the casing to determine if detrimental corrosion has occurred since installation that would require corrective action prior to full well reconfiguration. According to the Halliburton Field Representative, Richard Kelley, the quality of the pipe is overall very good, with slight thinning from 826-872 ft bgs (Appendix B). Copies of all logs are contained in the project files at the WIPP site.

2.5 Reconfiguration and Cement Emplacement

After geophysical logging and determining the packer placement, the tubing and packer were installed in the borehole during March 8-9, 2004. Materials consisted of 2.875-inch, 65#, J-55 tubing coated with Tube-Kote 70 (TK-70) manufactured by Tuboscope®. TK-70 is a thick film, epoxy coating especially suited for harsh environments. TK-70 resists hydrocarbons and provides outstanding protection of the steel tubing. TK-70 resists most mechanical damage normally experienced in the field while retaining a high level of corrosion resistance. TK-70 was used on the tubing to provide a longer life of the monitor well than typical steel tubing would. This material was used because this well is used to monitor the hydrostatic head in the Bell Canyon Formation and, due to the corrosive nature of the aqueous chemistry of this formation, it was important to impede the reaction with bare steel. For this application, 79.51 ft of tubing that is below the packer and submersed in the Bell Canyon Formation was coated both on the inside and the outside with TK-70. The remaining tubing from the

top of the packer to the surface was coated only on the inside to prevent corrosion from contact with Bell Canyon Formation water and with ambient air (Figure 2-1).

Figure 2-1 shows the as-built construction of DOE-2 after reconfiguration. Tubing coated on the inside with TK-70 was installed from the surface to the top of the packer at approximately 4,010 ft bgs. Tubing coated on the inside and outside was installed from the bottom of the packer to a depth of 4,085 ft bgs. A new packer, built by Weatherford Tool Company, was installed for this configuration. A 10.375-inch open-hole, water-inflatable packer was installed with the center of the packer set at 4,015 ft bgs (Appendix A).



Following installation of the tubing and packer the well was prepared for cementing. Tremie pipe was placed into the hole to a depth of 4,000.75 ft bgs, 9.25 ft above the top of the packer. Portland cement was prepared at the Lafarge materials plant in Carlsbad, New Mexico, and trucked to the well pad for emplacement. Cement from the trucks was poured into a tub at ground surface and pumped by tremie pipe into the borehole in lifts. The first lift created a 100-foot column of cement on top of the packer. This column was allowed to cure overnight before more lifts were emplaced. Cement was emplaced in the well over the course of three days (March 16-18, 2004) and three lifts. Lifts consisted of 108, 648, and 216 cubic ft of cement, respectively, for a total of 972 cubic ft.

2.6 Other Background

Well workover services were performed by Stewart Brothers Drilling Company, 306 Airport Road, Milan, New Mexico, under contract with Washington TRU Solutions LLC. Their New Mexico Water Well Driller License number is WD-331. Fishing tool services and packers were provided by Weatherford, 2117 N. French Drive, Hobbs, New Mexico 88241. Geophysical logging was conducted by Halliburton Energy Services, 2311 First Street, Artesia, New Mexico 88210. Mike Stapleton of the New Mexico Office of the State Engineer was notified of cement emplacement; however, he did not witness the activity.

3.0 WASTE MANAGEMENT

During drilling activities and emplacement of cement during plugging activities, the brine water in the borehole was displaced to the surface. The water was captured from the wellhead casing through a right-angle discharge pipe at the surface, then into a trough. A transfer pump moved the water from the trough into a 500-barrel tank for storage prior to disposal. The captured water was characterized for disposal by analysis using Toxicity Characteristic Leaching Procedure (TCLP). The TCLP analyses were performed for Resource Conservation and Recovery Act metals. All analyses indicated the brine water nonhazardous. Following receipt of the analytical results the brine water collected at DOE-2 was disposed in the lined H-19 evaporation pond. A total of 500 barrels were disposed in the H-19 evaporation pond.

Analytical reports and disposal records are retained on site in the site compliance records.

4.0 SUMMARY

DOE-2 (OSE File C-2682) is located approximately two miles north of the center of the WIPP site in Section 8, Township 22 south, Range 31 east (Figure 1-1). DOE-2 was drilled and cored to a depth of 981 ft bgs in 1984, and deepened to 4,325 ft bgs in 1985. Surface casing was set to a depth of 35 ft bgs during the first drilling period and during the 1985 drilling period the surface casing was set to a depth of 1009 ft bgs (Figure 1-2). Following drilling and hydraulic testing, DOE-2 was configured with a packer set at 4,051 ft bgs with 2.375-inch tubing to surface. This configuration was

designed to allow water level monitoring of the Salado and Castile Formations hydrostatic heads in the annulus and the Bell Canyon Formation hydrostatic heads in the tubing. In 1986 the well was reentered to remove the deep packer and tubing and install an inflatable bridge plug (open hole packer) at 875 ft bgs. The 9.625-inch casing was shot perforated from 822 ft bgs to 848 ft bgs to monitor the Culebra interval.

Due to BLM requirements and uncertainty in water level measurements, the well was reconfigured to only monitor the hydrostatic head in the Bell Canyon Formation. The reconfiguration efforts took place between February 11, 2004, and March 18, 2004, and consisted of, in order, removing packers, scraping the casing, reaming the borehole, performing geophysical logging, installing a packer and tubing, and emplacing cement from the packer to surface.

Appendix A - Photographs

Debris Circulated out of DOE-2

Appendix A - Photographs

Removed Packer/Bridge Plug From DOE-2

Appendix A - Photographs

New Packer Installed in DOE-2

Appendix A - Photographs

Installation of New Packer in DOE-2

Appendix B - Field Report by Haliburton Energy Services Field Representative Richard Kelley

Log Analysis of the DOE #2 Well

The cement bond quality is excellent with no indications of channeling. There is bonding to both the pipe and the formation. The information on the log is good up to 280' at which point we have entered surface pipe or have come out of fluid.

The quality of the pipe is overall very good. There is some slight thinning from 826-72'.

The caliper log is self explanatory. It shows the both the total volume and the annular volume which is assuming 2.75" pipe being inserted into the hole.

The Tools

The cement bond tool is the conventional low frequency acoustic bond tool. This tool can only be used for the overall quality of the cement. It will indicate channels but will not output a map of the channels.

The casing inspection tool used was a high frequency acoustic tool (CAST -V). This tool arrives at the thickness by the frequencies returning to the receivers. It obtains the internal diameter from the travel time of the sonic signal. This tool is only designed for an overall quality of the pipe. It is unlikely to determine small holes since it is not taking readings on 100% of the pipe.

The caliper tool is a four armed caliper tool which takes reading from the X - Y axis. The volumes are then calculated from these readings.

Should there be any questions regarding this, I can be reached at 505-914-0324.

Richard Kelley
Field Sales Representative
Halliburton Energy Services