



Southern Nevada Water Authority

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7030M and SPR7030M2 in Spring Valley



June 2011

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SOUTHERN NEVADA
WATER AUTHORITY

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7030M and SPR7030M2 in Spring Valley

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June 2011

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SOUTHERN NEVADA WATER AUTHORITY
Groundwater Resources Department
Water Resources Division
◆ snwa.com

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ACRONYMS

ARCH	Air Rotary Casing Hammer
ASTM	American Society for Testing and Materials
MP	Measuring Point
MS	Mild Steel
NAD83	North American Datum of 1983
RGU	Regional Geologic Unit
ROP	Rate of Penetration
SCH	Schedule
SNWA	Southern Nevada Water Authority
UTM	Universal Transverse Mercator
WOB	Weight on Bit

ABBREVIATIONS

ags	above ground surface
amsl	above mean sea level
bgs	below ground surface
ft	foot
gal	gallon
gpm	gallons per minute
I.D.	inside diameter (of casing)
in.	inch
lb	pound
m	meter
ml	milliliter
mi	mile
O.D.	outside diameter (of casing)
psi	pounds per square inch
qt	quart
rpm	revolutions per minute
sec	second

INTRODUCTION

In support of the Southern Nevada Water Authority's (SNWA) Clark, Lincoln, and White Pine Counties Groundwater Development Project, six monitor wells were completed in northern Spring Valley in White Pine County, Nevada, between January 2011 and April 2011 as part of the Shoshone and Cleveland Ranch Monitor Well Program. This program was implemented to document baseline and long-term hydrologic conditions in order to identify and quantify potential effects of SNWA pumping on Federal resources (SNWA, 2009).

Monitor Wells SPR7030M and SPR7030M2 were completed on private property owned by the Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter Day Saints. The wells are located in northern Spring Valley in Section 32, T16N, R67E, at an elevation of approximately 5,610 ft amsl (Figure 1). The well site is approximately 23 mi southeast of Ely, Nevada and is accessed from State Route 893 by an unimproved dirt road. This well site is on the east side of the Schell Creek Range, east of Cleve Canyon and is approximately 250 ft to the southwest of the Cleveland Ranch South Spring (Figure 2).

1.1 PURPOSE AND SCOPE

The purpose of this report is to describe the geologic, well completion, and water-pressure data collected for Monitor Wells SPR7030M and SPR7030M2. The scope involves a discussion of drilling histories, the evaluation of lithologic samples collected from the drill cuttings, drilling statistics, well head pressure readings, and final well completions. The drilling statistics are also correlated with the borehole lithology. The geochemical data on these wells will be presented in a separate SNWA report.

1.2 OBJECTIVES OF SPR7030M AND SPR7030M2

The objectives for the monitor wells are to:

- Further refine the distribution and understanding of Spring Valley aquifer systems through the collection of additional hydrologic, geologic, groundwater-chemistry, water-quality data, and water-level data.
- Provide permanent groundwater-level monitoring locations to establish baseline hydrologic conditions, observe pumping and climatic effects, and provide an accurate and timely assessment of groundwater conditions.
- Comply with Nevada Division of Water Resources requirements outlined in the Spring Valley Hydrologic Monitoring and Mitigation Plan. (SNWA, 2009)

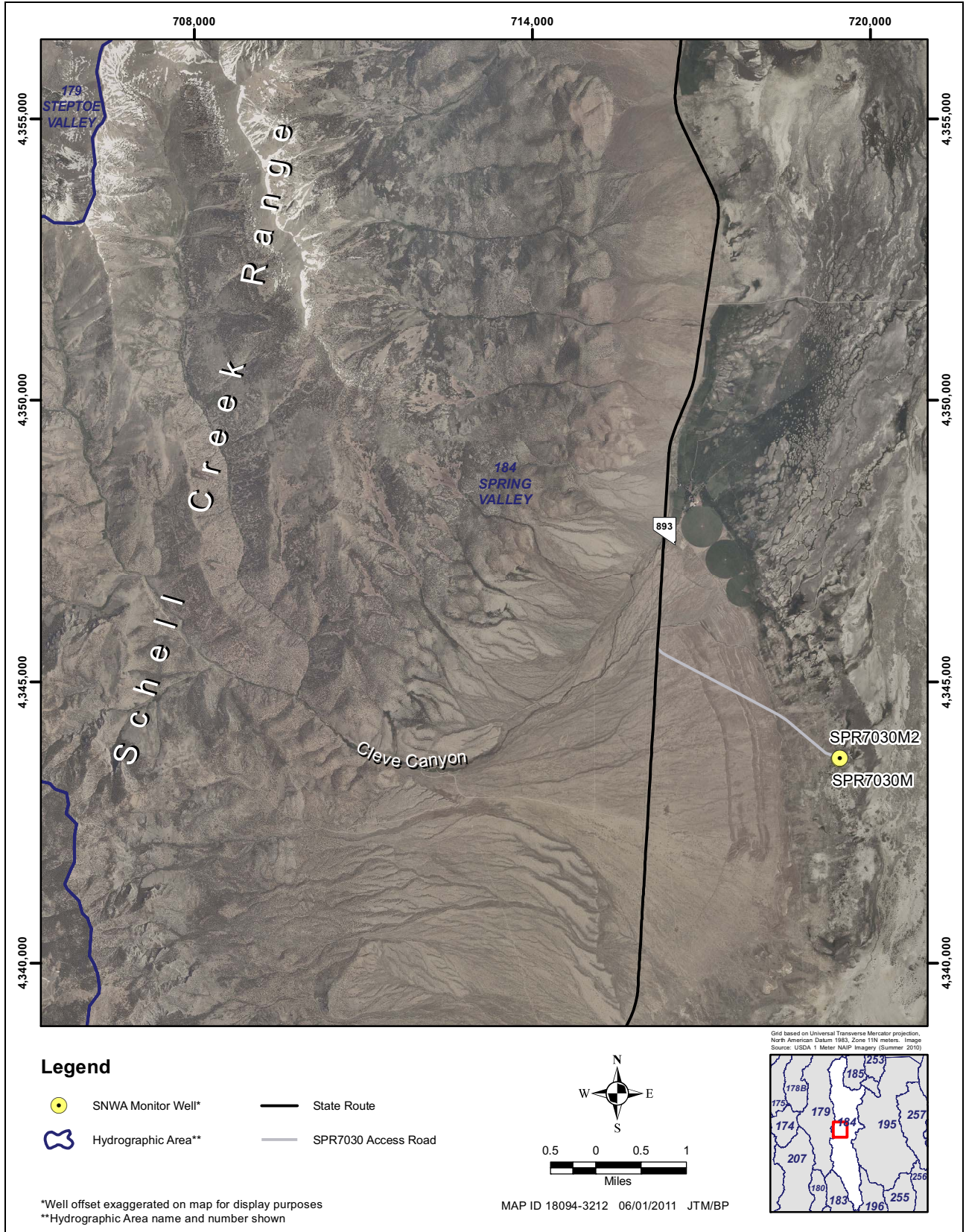
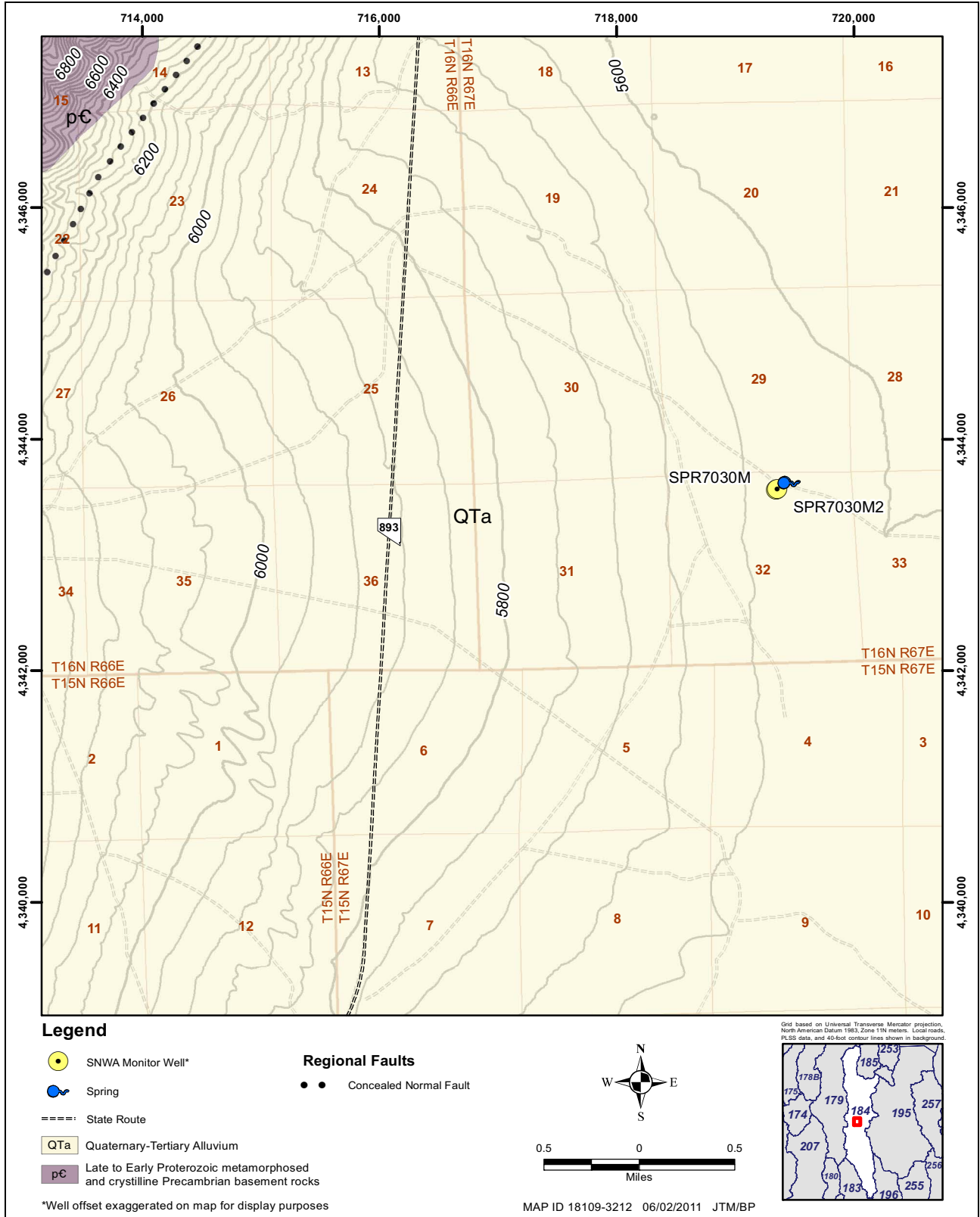


FIGURE 1
LOCATION OF MONITOR WELLS SPR7030M AND SPR7030M2



Source: Hose and Blake (1976); Dixon et al. (2007); Unit designations are the RGUs defined in Dixon et al. (2007).

FIGURE 2
SURFICIAL GEOLOGY AT MONITOR WELLS SPR7030M AND SPR7030M2

2.0

WELL SITE DESCRIPTION

This section discusses the surficial and structural geology in the vicinity of Monitor Wells SPR7030M and SPR7030M2 as they relate to the lithology encountered in the boreholes.

2.1 GEOLOGIC SETTING

Spring Valley Hydrographic Area lies within the Great Basin subprovince (Fenneman, 1931) formed during regional extension during the late Tertiary Period (Dixon et al., 2007). The western margin of the valley is marked by regional north-trending range-front faults that are associated with extensional tectonics.

Monitor wells SPR7030M and SPR7030M2 are situated at the base of an alluvial fan to the east of the Schell Creek Range ([Figure 1](#)). The surface geology at the well sites consists of Quaternary alluvium comprised of Paleozoic carbonates and clastics derived from the Schell Creek range to the west (Hose and Blake, 1976).

2.1.1 GEOLOGIC UNITS ENCOUNTERED AT THE WELLS

The geologic unit encountered in Monitor Wells SPR7030M and SPR7030M2 is alluvium. The alluvium consists primarily of clastic detritus eroded from the Schell Creek Range to the west ([Figure 2](#)). The alluvium is part of the surficial alluvium and basin fill (QTa) regional geologic unit (RGU) (Dixon et al., 2007).

2.1.2 GEOLOGIC STRUCTURES AT THE WELLS

Several structures have been identified west of the well site but there are none within a mile of the site. A major range bounding fault, described by Dixon et al. (2007), is present 4.5 mi to the west of the site.

3.0

MONITOR WELL SPR7030M

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and head pressure data for Monitor Well SPR7030M.

3.1 SPR7030M SUMMARY

Monitor Well SPR7030M was drilled and completed from February 18 to February 21, 2011, to a depth of 98 ft bgs. A 9.625-in. borehole was drilled using Air Rotary Casing Hammer (ARCH) drilling technique. The ARCH system consists of a non-rotating, flush-threaded casing, driven in conjunction with a conventional air-rotary drill string. The casing is driven with a mast mounted hydraulic casing hammer. This drilling technique was chosen for the ability to collect precisely located samples while sealing off the formations encountered including water bearing zones. During completion of the well, the flush threaded casing is extracted after the well casing has been set, and the gravel pack is being installed. The monitor well was completed with 4.5-in. O.D. (4.0-in. I.D.) well casing from 2 ft ags to 97 ft bgs with a mill slot interval from 54 to 97 ft bgs. Artesian conditions were encountered at the bottom of the borehole and required the use of an inflatable packer to complete the well. The 5-in. inflatable packer was used to contain the artesian flow and seal off the slotted interval allowing for the upper portion of the borehole to be sealed with grout. The monitor well site is depicted in [Figure 3](#) and the borehole and well construction data are shown on [Table 1](#).



FIGURE 3
VIEW OF MONITOR WELL SPR7030M
LOOKING NORTH

**TABLE 1
MONITOR WELL SPR7030M BOREHOLE AND WELL STATISTICS**

LOCATION DATA	
Surveyed Coordinates	Universal Transverse Mercator (UTM), Zone 11, North American Datum of 1983 (NAD83), N 4,343,633 m; E 719,460 m
Ground Elevation	5,608 ft amsl
DRILLING DATA	
Spud Date	2/18/2011
Total Depth (TD)	98 ft bgs
Date TD Reached	2/18/2011
Date Well Completed	2/21/2011
Hole Diameter	9.625-in. from 0 to 98 ft bgs
Drilling Techniques	Air rotary casing hammer from 0 to 98 ft bgs
Drilling Fluid Materials Used	None
CASING DATA	
	4.5-in. Mild steel casing from +2 to 97 ft bgs
WELL COMPLETION DATA	
	53 ft of blank, mild steel 4.5-in. casing from +2 to 51 ft bgs 5-in. packer from 51 to 54 ft bgs 43 ft of mill slot, mild steel 4.5-in. casing from 54 to 97 ft bgs. <u>Grout, Packer, and Bentonite Depths</u> 0 to 48 ft bgs (grout) 48 to 51 ft bgs bentonite chips 51 to 54 ft bgs 5-in. inflatable packer 54 to 98 ft bgs open borehole
GROUNDWATER LEVEL	Artesian, 11.08 psi (05/10/2011)
DRILLING CONTRACTOR	WDC Exploration & Wells
OVERSIGHT	Southern Nevada Water Authority

3.2 DRILLING HISTORY

Monitor Well SPR7030M was drilled on February 18, 2011 ([Figure 4](#)) using an ARCH drilling techniques to advance a 9.625-in. diameter borehole to 98 ft bgs. No delays occurred during the advancement of the borehole. Water (approximately 250 gallons) was added to assist with removing the drill cuttings from the borehole in the interval from 17 to 30 ft bgs.

3.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7030M at 10-ft intervals during the drilling process. These samples were described using SNWA Field Operating Procedures, and were correlated to lithologic units described by Hose and Blake (1976).

The borehole was drilled within Quaternary Alluvium. The alluvium encountered consisted of clays and gravels with varying amounts of sand and silt. Clay is commonly present in the cuttings from 10 to 30 ft bgs and 40 to 60 ft bgs and consists of a low to medium plasticity lean clays to high plasticity fat clay. The sand and gravel clasts are subangular to subrounded, and well graded when not associated with abundant silts and clay. The clasts are of quartzite which vary in color from pink to dark gray, with a micritic to fine sucrosic texture, with occasional calcite coatings. Mixed with the quartzite gravel are various amounts of sand, silt and clay, which vary in color from light yellow to reddish brown and pale green.

A summary of the lithologic log is presented in [Figure 5](#). The drill cuttings were affected by the drilling process, which caused a reduction in the overall grain size.

3.4 DRILLING PARAMETERS

The Drilling Parameters collected are as follow:

- Rate of Penetration (ROP)
- Weight on Bit (WOB)
- Air Pressure
- Drill Bit Rotation

These drilling parameters are presented in [Figure 6](#). Drilling data were collected from land surface to the bottom of the borehole at 98 ft bgs.

The Rate of Penetration log shows a relatively consistent rate of penetration from ground surface to 98 ft bgs varying from 2 to 3.5 min/ft with an exception at 17 ft bgs, the rate of penetration increased to less than 1 min/ft and is correlated with a clay zone. The Weight on Bit log is a direct correlation with the weight of the drill string. During drilling, only the weight of the drill string was used to advance the borehole. The air pressure was held constant at approximately 150 psi from ground surface to 98 ft bgs. The Drill Bit Rotation log reflects a spike of 160 rpm at 30 ft bgs and correlates to a transition from a fat clay to a well graded gravel. For the remainder of the borehole was consistent at 120 rpm.

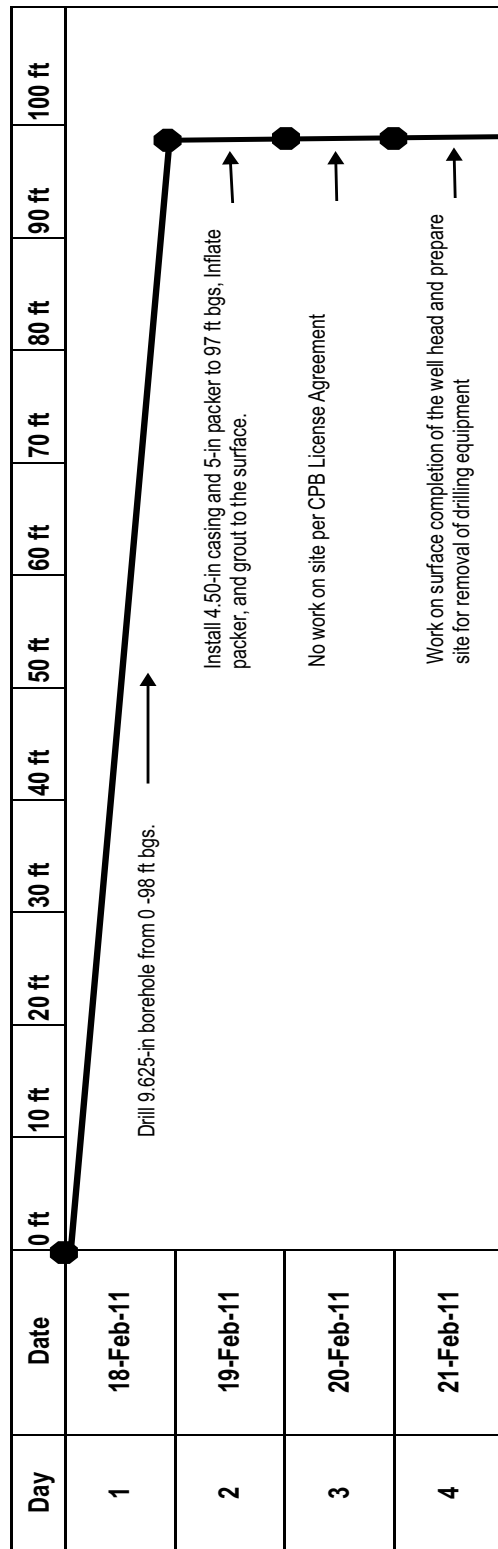


FIGURE 4
MONITOR WELL SPR7030M DRILLING HISTORY

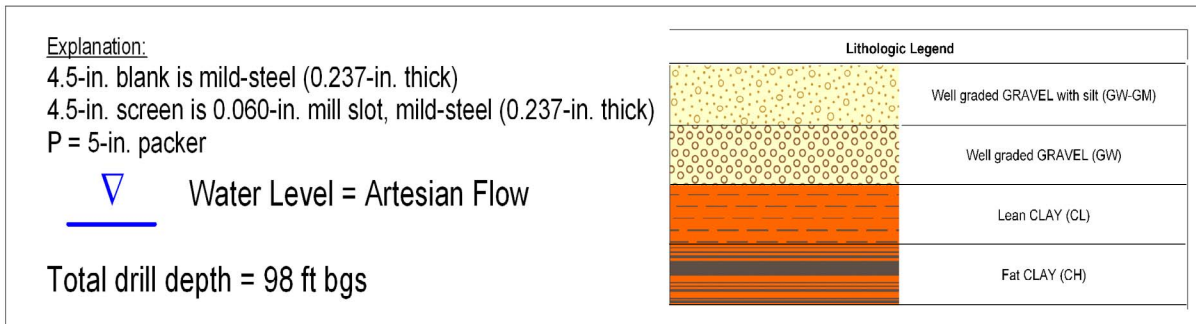
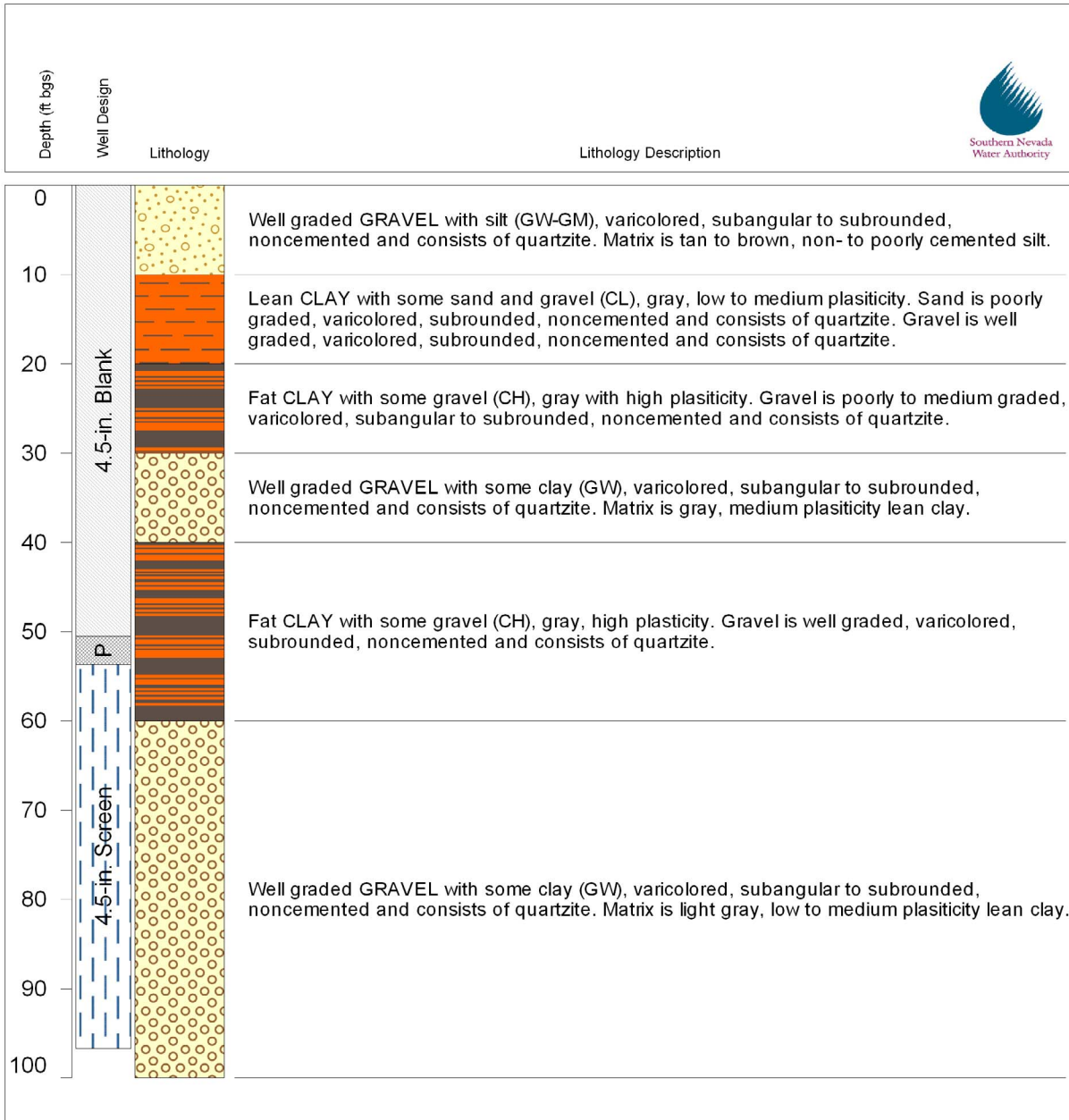
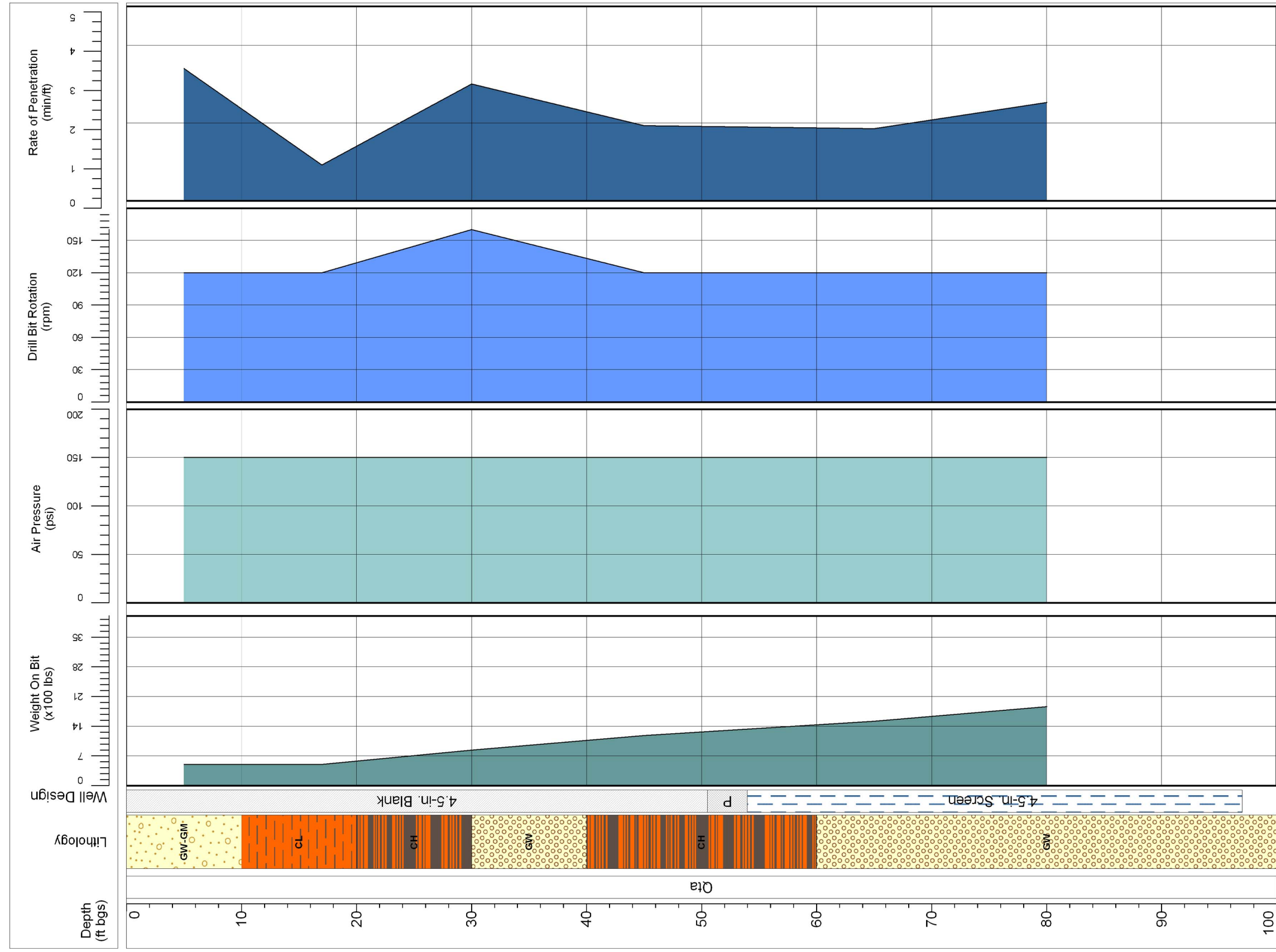


FIGURE 5
MONITOR WELL SPR7030M BOREHOLE STRATIGRAPHIC COLUMN



Explanation

Qta = Quaternary-Tertiary Alluvium
 GW-GM = Well graded Gravel with silt
 CL = Fat Clay
 CH = Fat Clay

Water Level = Artesian (5/10/2011)



SNWA Monitor Well SPR7030M
 Drilling Parameters
 Collected By: SNWA
 From 1/18/2011 to 2/18/2011

FIGURE 6
MONITOR WELL SPR7030M DRILLING PARAMETERS

3.5 WELL COMPLETION

Installation of the 4.5-in. well casing was started on February 19, 2011 and completed on February 21, 2011. A schematic diagram of the well completion is shown on [Figure 7](#).

The 4.5-in. completion string was constructed of ASTM A508B schedule 40 mild steel and included 53 ft of blank casing starting at 2 ft ags to 51 ft bgs. A total of 43 ft of mill slot casing was installed from 54 to 97 ft bgs. The slot size of the casing is 0.060 in. with 8 openings per linear ft. A waiver (No. R-665) was granted by the Nevada Division of Water Resources on February 8, 2011 to not gravel pack the well as the artesian pressure was too great to allow for continuous gravel pack envelope. An inflatable packer was installed as part of the completion string to seal off the artesian flow and slotted interval. This packer was installed in a clay zone from 40 to 60 ft bgs and allowed for grouting the upper portion of the well.

With the 4.5-in. completion string and 5-in. inflatable packer installed on February 19, 2011, completion operations continued with the placement of a 3 ft section of bentonite pellets on the top of the inflated packer from 48 to 51 ft bgs. The annulus between the borehole and casing was then grouted to the surface using a 16 lb per gallon mix of portland cement, sand, bentonite powder, and barite. A 4-in. ball valve was installed on the top of the 4.5-in. casing and a locking cover was secured over the casing on February 21, 2011.

3.6 ARTESIAN PRESSURE DATA

This section discusses artesian pressure measurements collected after well construction and aquifer testing. A total of 5 measurements ranging from 10.93 to 11.10 psi have been noted between May 10 and May 25, 2011. These measurements vary 0.17 psi with an average of 11.04 psi. The approximate surface elevation at the well is 5,608 ft amsl and with the artesian pressure readings would give an average groundwater elevation of 5,633.5 ft amsl (25.50 ft ags) for this period. Pressure measurements for Monitor Well SPR7030M are listed in [Table 2](#).

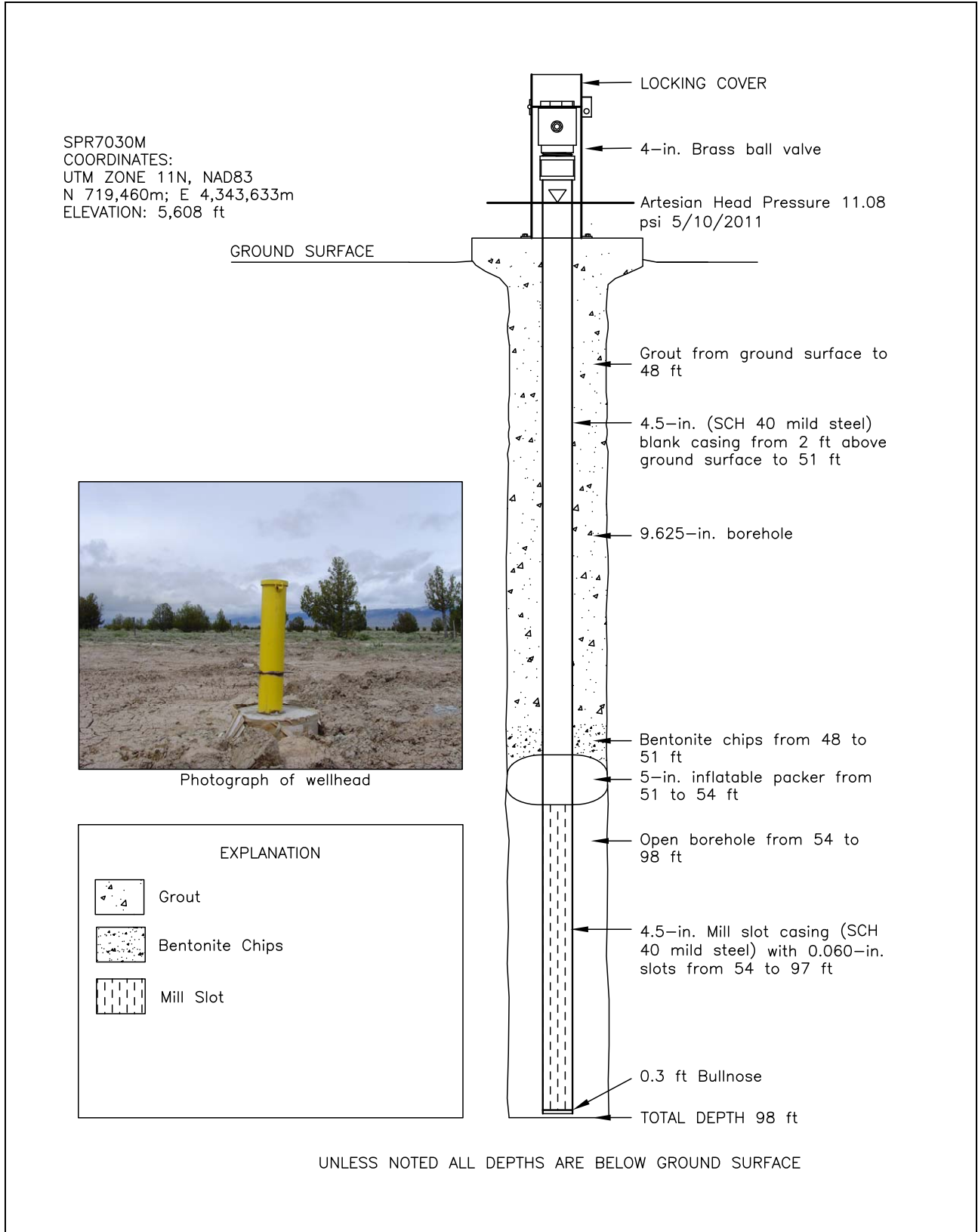


FIGURE 7
MONITOR WELL SPR7030M WELL COMPLETION DIAGRAM

TABLE 2
MONITOR WELL SPR7030M ARTESIAN PRESSURE MEASUREMENTS

Date	Time	Pressure (psi)	Elevation^a (ft amsl)	Data Source
5/10/2011	16:16	11.08	5,634	SNWA
5/16/2011	15:05	11.03	5,633	SNWA
5/17/2011	11:50	10.93	5,633	SNWA
5/21/2011	13:36	11.05	5,633	SNWA
5/25/2011	12:35	11.10	5,634	SNWA

^aApproximate elevation, a professional survey will be performed at a later time.

4.0

MONITOR WELL SPR7030M2

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and head pressure data for Monitor Well SPR7030M2.

4.1 SPR7030M2 SUMMARY

Monitor Well SPR7030M2 was drilled and completed from January 26 to February 21, 2011 to a depth of 240 ft bgs. A 9.625-in. borehole was drilled using ARCH drilling technique. The monitor well was completed with 4.5-in. O.D. (4.0-in. I.D.) well casing from 2 ft ags to 236 ft bgs with a mill slotted interval from 194 to 236 ft bgs. Artesian conditions were encountered during drilling of the borehole and required the use of an inflatable packer to complete the well. A 5-in. inflatable packer was used to contain the artesian flow and seal off the slot interval allowing for the upper portion of the borehole to be sealed with grout.

The monitor well site is depicted on [Figure 8](#), and the borehole and well construction data are shown on [Table 3](#).



FIGURE 8
VIEW OF MONITOR WELL SPR7030M2
LOOKING WEST

**TABLE 3
MONITOR WELL SPR7030M2 BOREHOLE AND WELL STATISTICS**

LOCATION DATA	
Surveyed Coordinates	UTM, Zone 11, NAD83, N 4,343,623 m; E 719,453 m
Ground Elevation	5,614 ft amsl
DRILLING DATA	
Spud Date	1/26/2011
Total Depth (TD)	240 ft bgs
Date TD Reached	2/5/2011
Date Well Completed	2/21/2011
Hole Diameter	9.625-in. from 0 to 240 ft bgs
Drilling Techniques	Air Rotary Casing Hammer from 0 to 240 ft bgs
Drilling Fluid Materials Used	None
CASING DATA	4.5-in. mild steel casing from +2 to 236 ft bgs
WELL COMPLETION DATA	192 ft of blank mild steel 4.5-in. casing from +2 to 170 and 174 to 194 ft bgs, 42 ft of 4.5-in. mill slot mild steel casing from 194 to 236 ft bgs <u>Grout, Packer and Bentonite Depths</u> 0 to 166 ft bgs on outside of completion casing (grout) 166 to 170 ft bgs bentonite chips 170 to 174 ft bgs 5-in. inflatable packer 174 to 240 ft bgs open borehole
GROUNDWATER LEVEL	Static Water Level: Artesian - 18 psi (2/7/2011)
DRILLING CONTRACTOR	WDC Exploration & Wells
OVERSIGHT	Southern Nevada Water Authority

4.2 DRILLING HISTORY

Monitor Well SPR7030M2 was drilled from January 26 to February 5, 2011 ([Figure 9](#)). Drilling commenced with the ARCH drilling method to advance a 9.625-in. borehole to 240 ft bgs. During advancement of the borehole, artesian conditions were encountered which created delays. Drilling was stopped to address significant groundwater flows at a depth of 90 to 110 ft bgs. This high pressure flow zone was associated with coarse gravels. Once the drill casing was advanced past the coarse grained interval more silt and clay rich zones were encountered, and flow into the well decreased. Delays also occurred during drilling due to mechanical failures of the drill rig and work schedule stipulations from the land owner.

4.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7030M2 at 10-ft intervals during the drilling process. These samples were described using SNWA field operating procedures, and were correlated to lithologic units described by Hose and Blake (1976).

The borehole was drilled within Quaternary Alluvium. The alluvium consisted of clays and gravels. Clay is present in the intervals from 10 to 30, 40 to 60, 110 to 120, 160 to 190, and 220 to 230 ft bgs. The clay intervals encountered at 110 to 120 and 160 to 190 ft bgs provided a natural seal between SPR7030M and SPR7030M2 slotted sections. The gravels encountered consist of quartzite clasts that vary in color from pink to dark gray, have a micritic to fine sucrosic texture, occasional calcite coatings, and are moderate to well rounded. Mixed with the limestone and quartzite gravels are various amounts of sand, silt and clay, which vary in color from light yellow to reddish brown and pale green. The gravels are noncemented. The drill cuttings were affected by the drilling process, which caused a reduction in the overall grain size. A summary of the lithologic log is presented in ([Figure 10](#)).

4.4 DRILLING PARAMETERS

The Drilling Parameters are as follows:

- Rate of Penetration (ROP)
- Weight on Bit (WOB)
- Air Pressure
- Drill Bit Rotation

Drilling parameters are presented on [Figure 11](#). The drilling parameter values were collected from land surface to the total depth of the borehole at 240 ft bgs.

The Rate of Penetration log shows a good rate of penetration from 20 to 85 ft bgs with a gradual decrease in penetration rates (25 min/ft) from 80 to 140 ft bgs due to an artesian zone encountered at 90 to 110 ft bgs. From 140 to 160 ft bgs the penetration rates increased to approximately 10 min/ft and remained there to the total depth. No data was collected below 200 ft bgs.

The Weight on Bit log is a direct correlation with the weight of the drill string. During advancement of the borehole, the driller allowed the full drill string weight on the bit. The air pressure initially started at 150 psi to assist with cuttings removal in the fine grained clays but was lowered to 120 psi

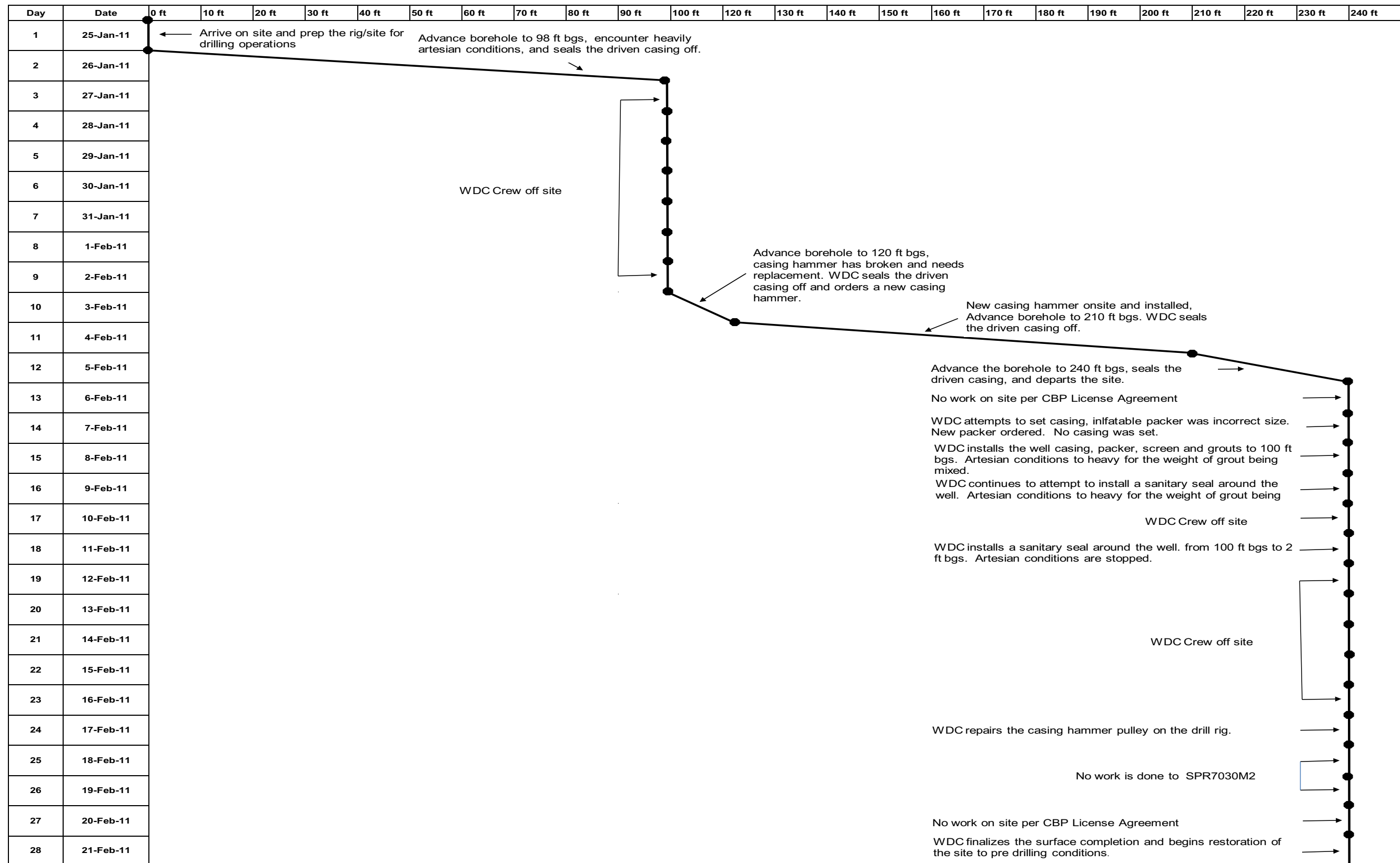


FIGURE 9
MONITOR WELL SPR7030M2 DRILLING HISTORY

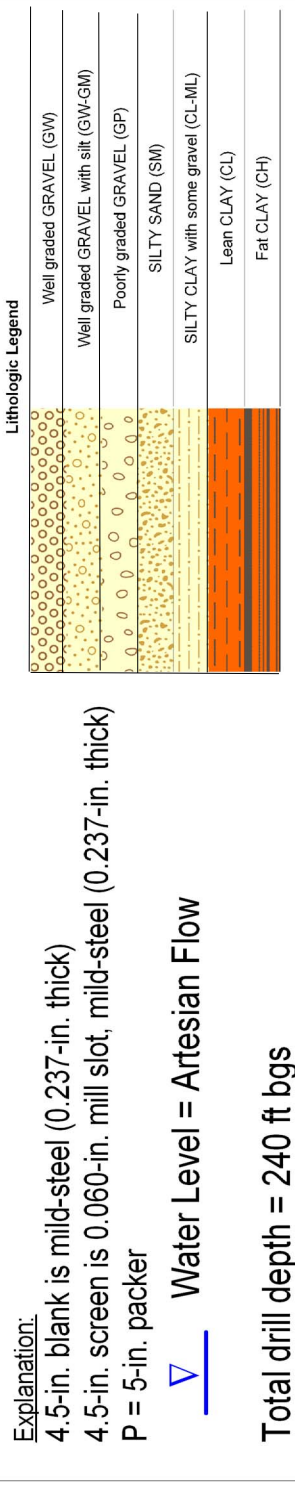
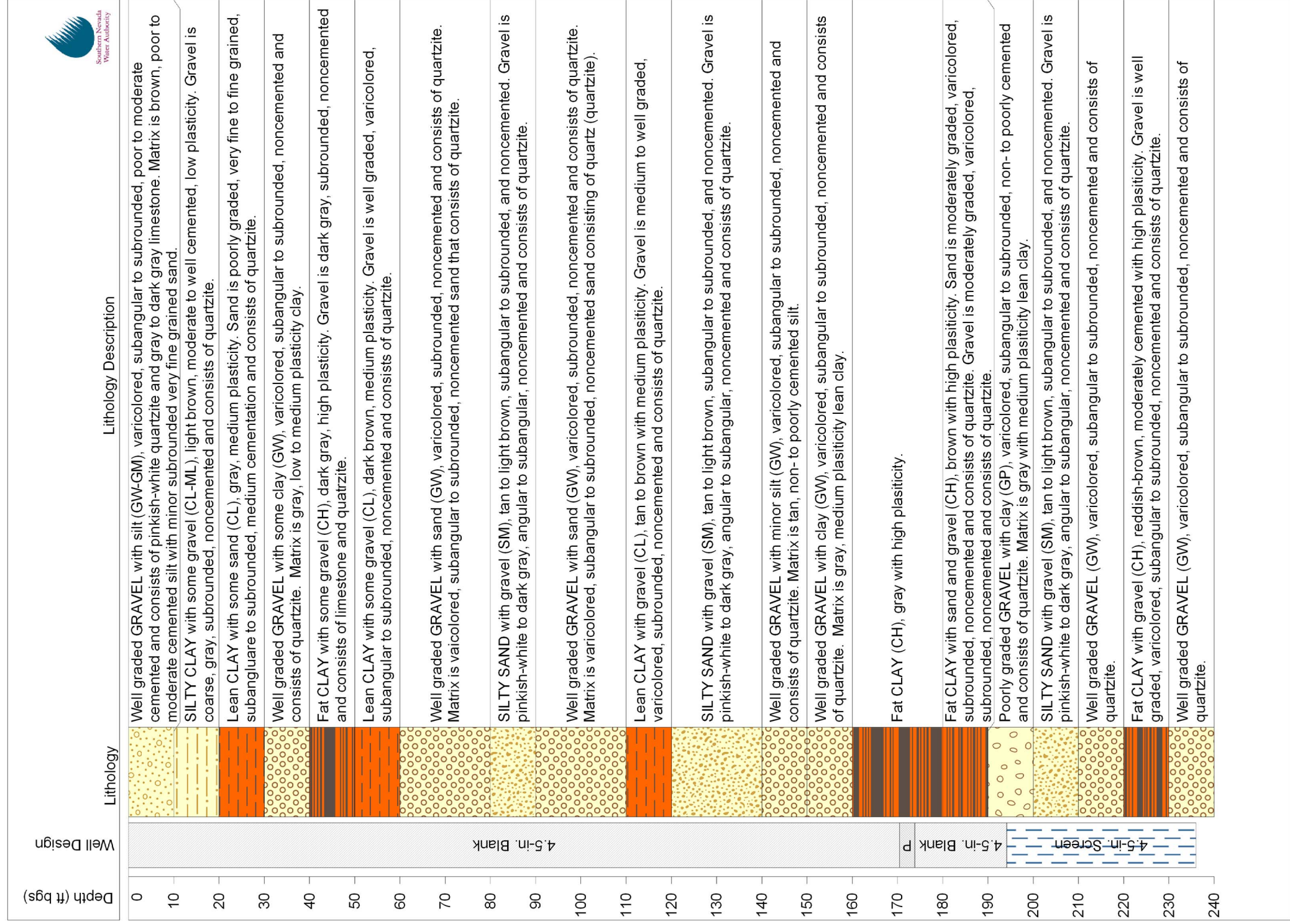
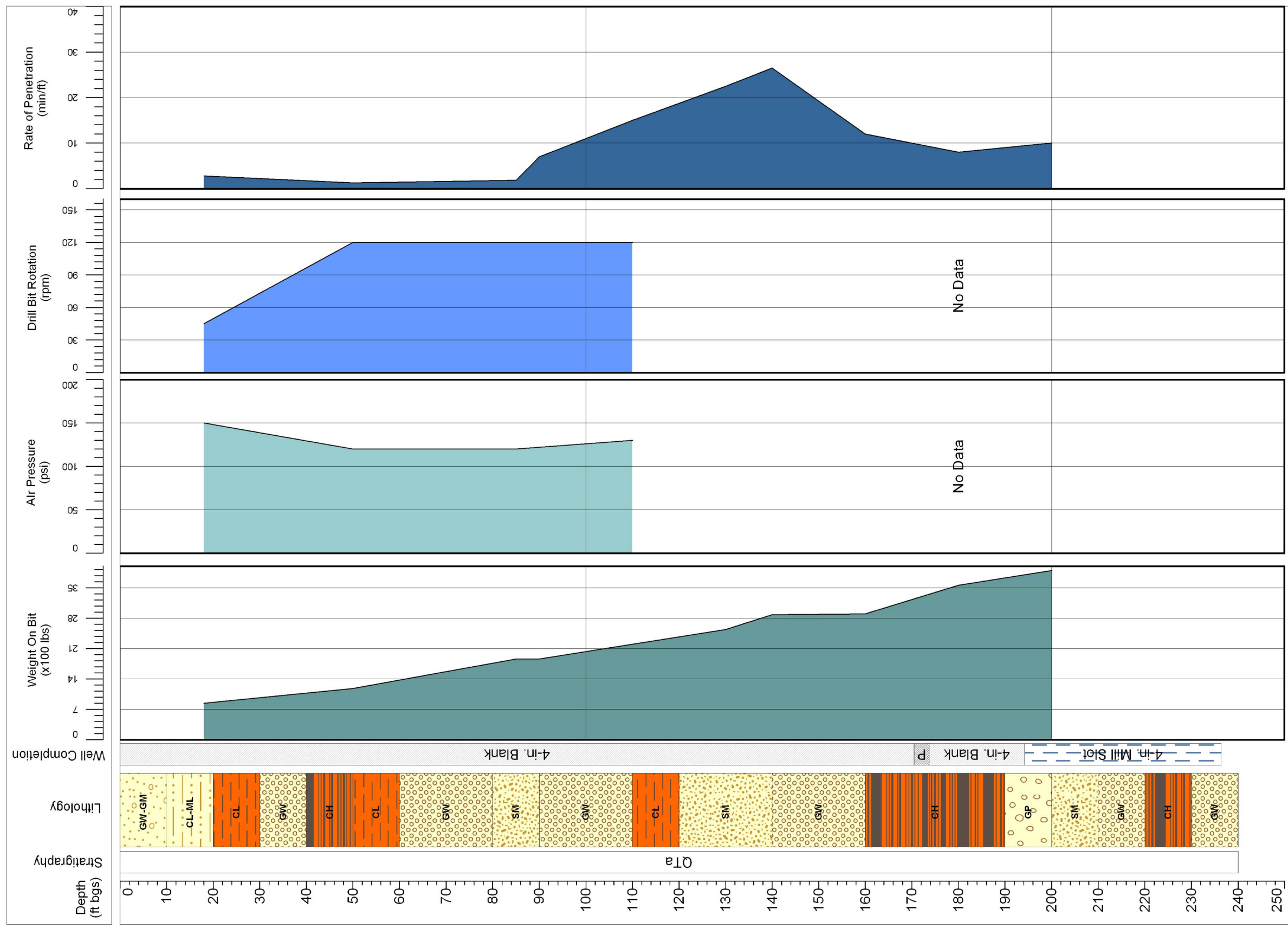


FIGURE 10
 MONITOR WELL SPR7030M2 BOREHOLE STRATIGRAPHIC COLUMN



Explanation
 QTa = Quaternary-Tertiary Alluvium
 GW = Well graded Gravel
 GW-GM = Well graded Gravel with Silt
 CL-ML = Silty Clay
 CL = Clay
 GP = Poorly Graded Gravel
 SM = Silty Sand
 CH = Fat Clay
 Water Level = Artesian (2/2/2011)

SNWA Monitor Well SPR7030M2
 Drilling Parameters
 Collected By: SNWA
 From 1/26/2011 to 2/4/2011



FIGURE 11
MONITOR WELL SPR7030M2 DRILLING PARAMETERS

from 20 to 120 ft bgs. The Drill Bit Rotation log reflects a low rotational speed at 20 ft, and then was consistent at 120 rpm after 50 ft bgs.

4.5 WELL COMPLETION

Installation of the 4.5-in. well casing was started on February 8, 2011 and completed on February 21, 2011. A schematic diagram of the well completion is in [Figure 12](#).

The 4.5-in. completion string was constructed of ASTM A503B mild steel and included 192 ft of blank casing from 2 ft ags to 170 and 174 to 194 ft bgs. A total of 42 ft of mill slot casing was installed from 194 to 236 ft bgs. The aperture size of the casing is 0.060 in. with 8 openings per linear ft. A waiver (No. R-665) was granted by the Nevada Division of Water Resources on February 8, 2011 to not gravel pack the well. A 5-in. packer was installed in a clay zone from 160 to 190 ft bgs to seal off the artesian flow of the lower portion of the well and to keep the grout from entering the slotted section of the well completion. This clay interval, along with the interval from 110 to 120 ft bgs, provided a natural seal between the monitor wells slotted zones. The packer was inflated to 80 psi and sealed off the artesian flow below 174 ft bgs.

With the 4.5-in. completion string and the 5-in. inflatable packer installation finalized on February 8, 2011, completion operations continued with the placement of a 4 ft section of bentonite pellets on top of the inflated packer from 166 to 170 ft bgs. The annulus was then grouted to the surface using a 16 to 22 lb per gallon mix of portland cement, sand, bentonite powder, and barite. A 4-in. ball valve was installed on the casing and a locking cover was secured over the 4.5-in. casing.

4.6 ARTESIAN PRESSURE DATA

This section discusses artesian pressure measurements collected after well construction and aquifer testing. A total of 7 measurements ranging from 12 to 18 psi have been noted between February 2, and May 25, 2011. These measurements vary 6 psi with an average of 15.8 psi. The approximate surface elevation at the well is 5,614 ft amsl and with the artesian pressure readings would give an average groundwater elevation of 5,650.5 ft amsl. The pressure measurements for Monitor Well SPR7030M2 is listed in [Table 4](#).

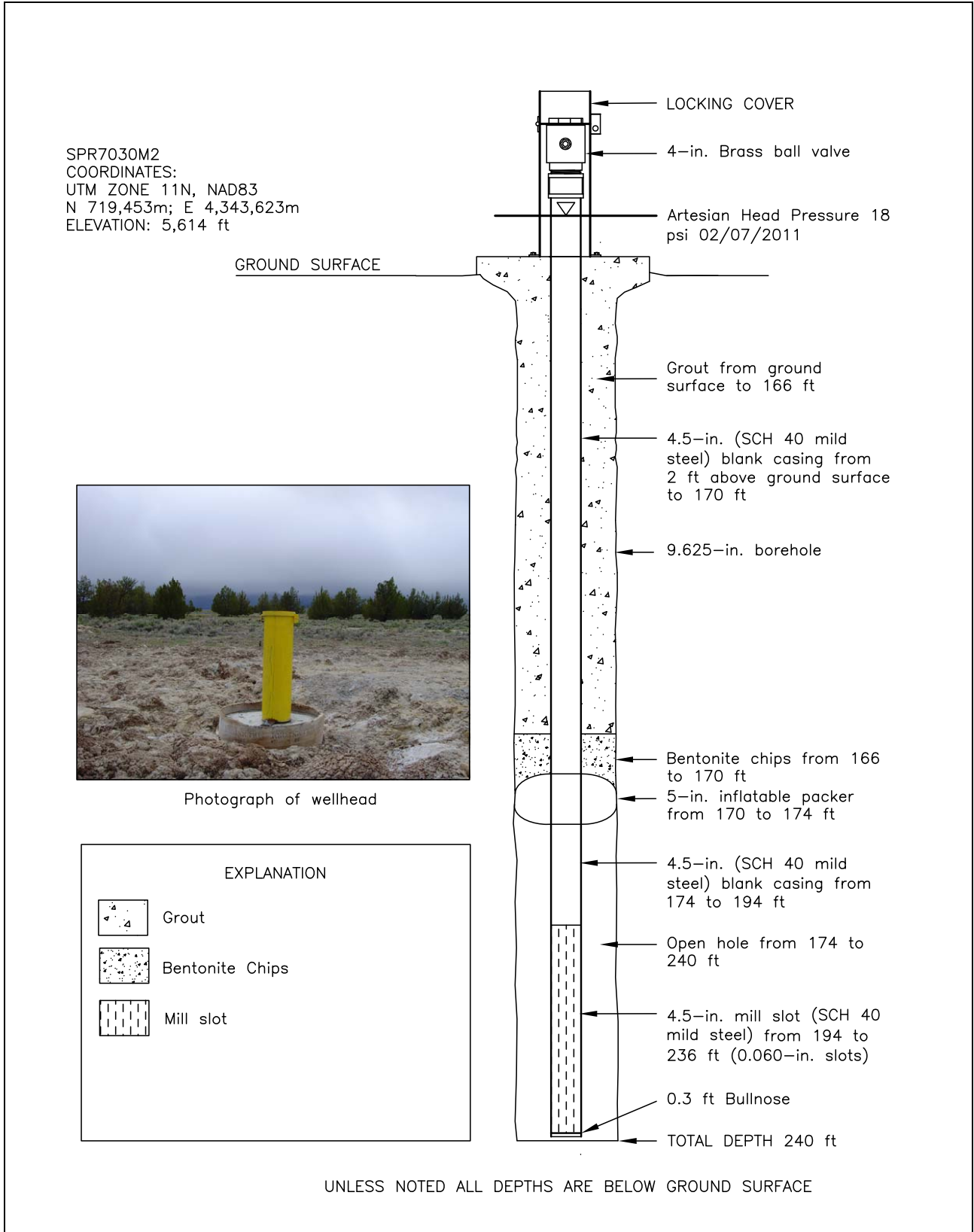


FIGURE 12
MONITOR WELL SPR7030M2 WELL COMPLETION DIAGRAM

TABLE 4
MONITOR WELL SPR7030M2 ARTESIAN PRESSURE MEASUREMENTS

Date	Time	Pressure (psi)	Elevation^a (ft amsl)	Data Source
2/7/2011	6:37	18	5,659	SNWA
2/10/11	15:00	12	5,645	SNWA
5/10/11	16:37	16.20	5,655	SNWA
5/16/11	15:15	16.10	5,654	SNWA
5/17/11	11:55	16.10	5,654	SNWA
5/21/11	13:38	16.00	5,655	SNWA
5/25/11	12:40	16.40	5,656	SNWA

^aApproximate elevation

5.0

SUMMARY

Monitor Wells SPR7030M and SPR7030M2 were drilled from January to February 2011, on the west side of Spring Valley. Monitor Well SPR7030M is located approximately 40 ft N35E of Monitor Well SPR7030M2. These wells are located 250 ft southeast of the Cleveland Ranch South Spring and were drilled to satisfy requirements of the Spring Valley Hydrologic Monitoring and Mitigation Plan as approved by the Nevada Division of Water Resources on February 9, 2009. Program objectives included evaluation of hydrogeologic conditions adjacent to the Cleveland Ranch South Spring. Two monitor wells were completed to different depths at the site. Data collected during the drilling was used to define site lithology, identify the presence and characteristics of aquitards or aquifers, and document hydraulic gradients of the local groundwater system. These wells will provide permanent locations for groundwater monitoring and provide data to estimate hydraulic properties in the vicinity of the wells and nearby spring.

The 9.625-in. borehole for Monitor Well SPR7030M was drilled to a total depth of 98 ft bgs and was completed with 4.5-in. casing to 97 ft bgs with a slotted interval from 54 to 97 ft bgs. The 9.625-in. borehole for Monitor Well SPR7030M2 was drilled to a total depth of 240 ft bgs and completed with 4.5-in. casing to 236 ft bgs with a slotted interval from 194 to 236 ft bgs.

Drilling parameters provided additional data for analysis. These drilling parameters were consistent with the coarse grained gravels and clay zones encountered, and were verified in the lithologic samples. The gravels consist of quartzite clasts. Clay layers are present in both wells and the clay intervals encountered in SPR7030M2 from 110 to 120 ft bgs and 160 to 190 ft bgs provided a natural seal between the slotted completions of the two monitor wells. A completion interval of 97 ft separate the bottom of SPR7030M and the top of SPR7030M2 slotted interval.

There is a difference between the preliminary groundwater elevation of the two monitor wells resulting in a notable vertical hydraulic gradient. Additional pressure data and a professional elevation survey will need to be collected to verify this observed vertical hydraulic gradient.

These monitor wells will be incorporated into the SNWA Regional Monitoring Network. Pressure data will be collected regularly to evaluate groundwater conditions.

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