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Southern Nevada Water Authority

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7029M and SPR7029M2 in Spring Valley

June 2011

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SOUTHERN NEVADA
WATER AUTHORITY

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7029M and SPR7029M2 in Spring Valley

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June 2011

1. Southern Nevada Water Authority, Las Vegas, NV

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 of Testing and Materials
BLM	Bureau of Land Management
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
min	minute
O.D.	outside diameter (of casing)
psi	pounds per square inch
qt	quart
rpm	revolutions per minute
sec	second

1.0 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 SPR7029M and SPR7029M2 are located in eastern Spring Valley in Section 25, T16N, R66E, at an elevation of approximately 5,870 ft amsl (Figure 1). The site is approximately 19.5 mi southeast of Ely, Nevada, and is accessed directly from State Route 893. This well site is on the east side of the Schell Creek Range, just east of Cleve Canyon.

1.1 PURPOSE AND SCOPE

The purpose of this report is to describe the geologic, water-level, and well completion data collected for Monitor Wells SPR7029M and SPR7029M2. The scope involves a discussion of drilling history, the evaluation of lithologic samples collected from the drill cuttings, drilling statistics, depth-to-water levels, and final well completions. The drilling statistics are also correlated with the borehole lithology. Water-level data are provided. The geochemical data on these wells will be presented in a separate SNWA report.

1.2 OBJECTIVES OF SPR7029M AND SPR7029M2

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.
- Estimate the hydraulic properties of the geologic strata penetrated by the monitor wells.
- Comply with Nevada Division of Water Resources requirements outlined in the Spring Valley Hydrologic Monitoring and Mitigation Plan. (SNWA, 2009)

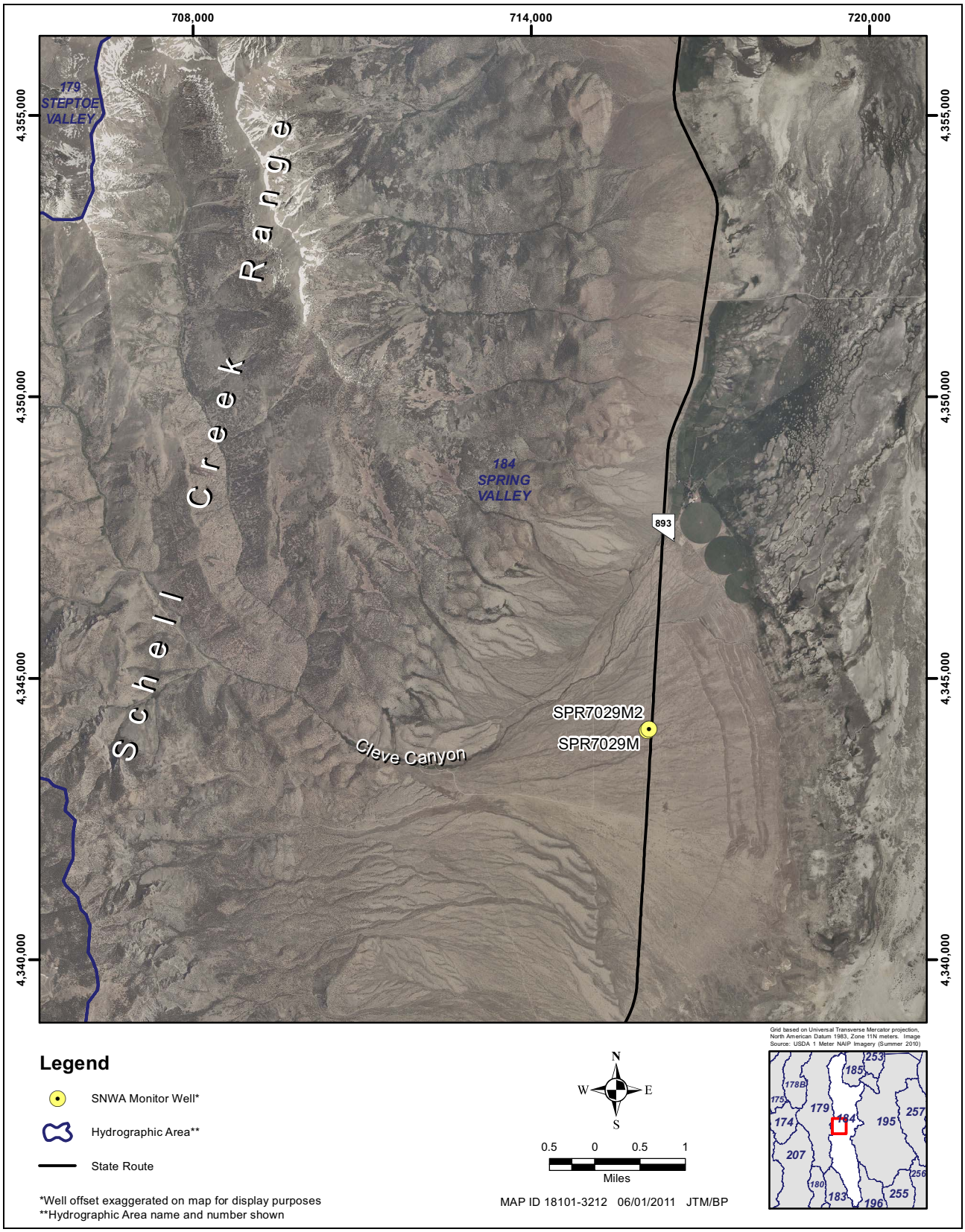


FIGURE 1
LOCATION OF MONITOR WELLS SPR7029M AND SPR7029M2

2.0

WELL SITE DESCRIPTION

This section discusses the surficial and structural geology in the vicinity of Monitor Wells SPR7029M and SPR7029M2 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.

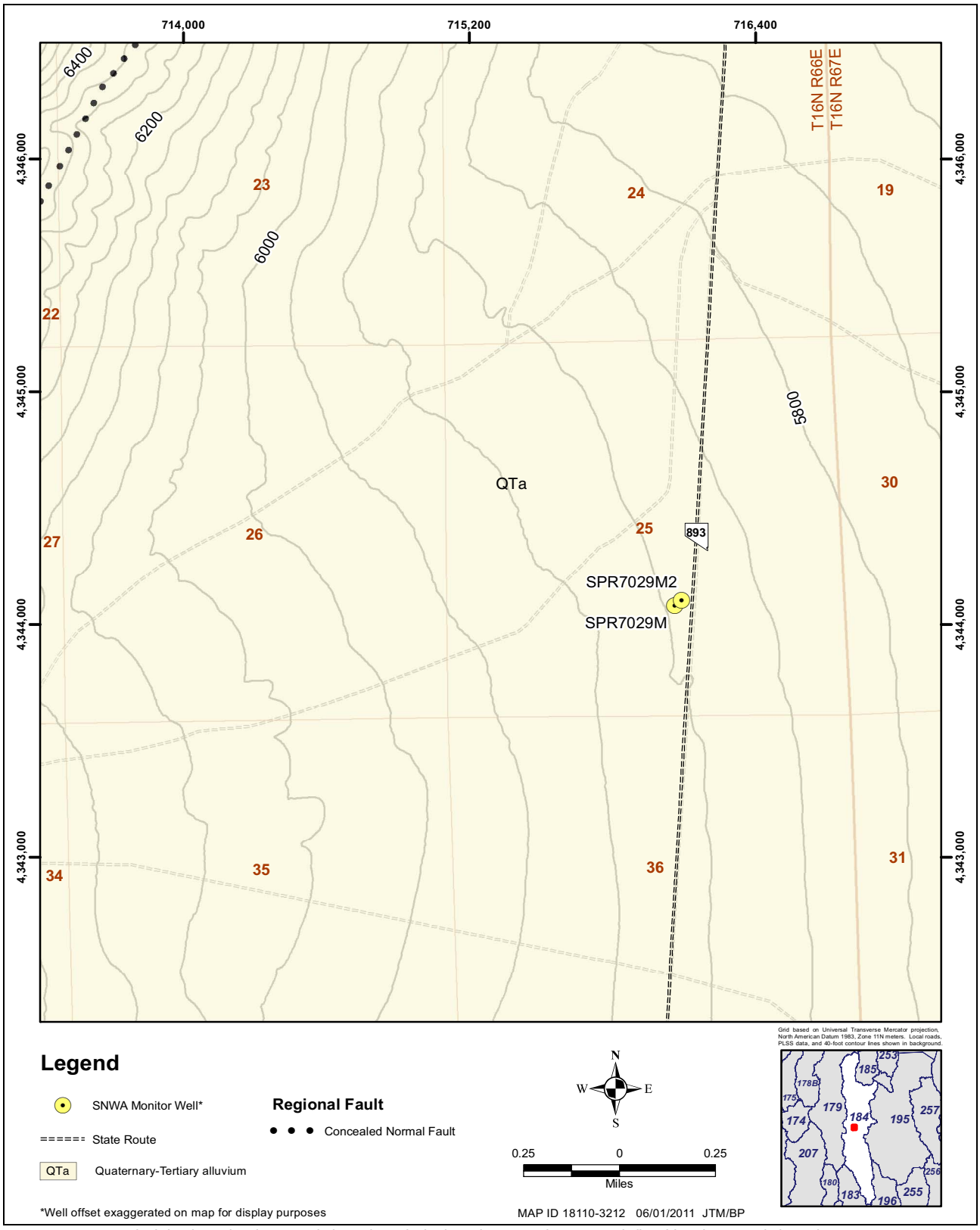
Monitor Wells SPR7029M and SPR7029M2 are situated near the western margin of Spring Valley (Figure 2). The surface geology at the well sites consists of Quaternary alluvium comprised of Paleozoic carbonates and clastics with occasional Tertiary volcanics making up the hills to the east (Hose and Blake, 1976).

2.1.1 GEOLOGIC UNITS ENCOUNTERED AT THE WELLS

The geologic unit encountered in Monitor Wells SPR7029M and SPR7029M2 is alluvium. The alluvium consists primarily of carbonate and clastic detritus eroded from the Schell Creek Range to the west (Figure 1) and 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

There are no mapped structures present on the wellsite. The nearest structure is a major range bounding fault described by Dixon et al. (2007) to the north west of the site.



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 SPR7029M AND SPR7029M2

3.0

MONITOR WELL SPR7029M

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and water-level data for Monitor Well SPR7029M.

3.1 SPR7029M SUMMARY

Monitor Well SPR7029M was drilled and completed from April 18 to April 29, 2011, to a depth of 275 ft bgs. A 11.75-in. temporary conductor casing was installed to a depth of 38 ft bgs and a 9.625-in. borehole was drilled using conventional mud drilling techniques. The monitor well was completed with 4.5-in. nominal well casing from 2 ft ags to 260 ft bgs with a slotted interval from 220 to 260 ft bgs.

The monitor well site is depicted on Figure 3 and the borehole and well construction statistics are shown on Table 1.

FIGURE 3
VIEW OF MONITOR WELL SPR7029M
LOOKING WEST

3.2 DRILLING HISTORY

Monitor Well SPR7029M was drilled from April 18 to April 27, 2011 (Figure 4). Drilling commenced when WDC Drilling used an Air Rotary Casing Hammer (ARCH) drilling method to advance a 11.75-in. diameter temporary conductor casing to 38 ft bgs.

TABLE 1
MONITOR WELL SPR7029M BOREHOLE AND WELL STATISTICS

LOCATION DATA Surveyed Coordinates	Universal Transverse Mercator (UTM), Zone 11, North American Datum of 1983 (NAD83), N 4,344,089 m; E 716,055 m	
Ground Elevation	5,870 ft amsl	
DRILLING DATA Spud Date	4/18/2011	
Total Depth (TD)	275 ft bgs	
Date TD Reached	4/27/2011	
Date Well Completed	4/29/2011	
Hole Diameter	11.75-in. from 0 to 38 ft bgs 9.625-in. from 38 to 275 ft bgs	
Drilling Techniques	ARCH from 0 to 38 ft bgs Conventional Mud Rotary from 38 to 275 ft bgs	
Drilling Fluid Materials Used	Quick-Gel (112 bags) Soda Ash (2.25 bags) Quik-Trol (2.5 buckets)	
Drilling Fluid Properties	*Properties* Viscosity Range = 45 to 58 s/qt Weight Range = 8.6 to 8.9 lbs Filtrate Range = 8 to 13.2 ml Filter Cake Range = 2/32 to 3/32-in.	*Average* 52 s/qt 8.8 lbs 10.2 ml 3/32-in.
CASING DATA	4.5-in. Mild Steel Completion Casing from +2 ft ags to 260 ft bgs	
WELL COMPLETION DATA	222 ft of blank 4.5-in. completion casing from +2 to 220 ft bgs 40 ft of 4.5-in. mill slot screen casing from 220 to 260 ft bgs <u>Grout, Bentonite and Gravel Pack Depth</u> 0 to 207 ft bgs between completion casing and borehole (grout) 207 to 213 ft bgs bentonite chips 213 to 262 ft bgs Carmeuse^{tm} 8-12 gravel pack	
GROUNDWATER LEVEL	Static Water Level: 196.89 ft bgs (04/27/2011) Groundwater Elevation: 5,673 ft amsl	
DRILLING CONTRACTOR	WDC Exploration & Wells	
OVERSIGHT	Southern Nevada Water Authority	

On April 19, 2011, WDC repaired the lift pump for the mud system and began switching over to a conventional mud rotary drilling method. Drilling continued from April 20 to April 21, 2011 to a depth of 183 ft bgs. From April 22 to April 25, 2011 no drilling operations were conducted.

Drilling resumed on April 26, 2011 with cleaning the borehole from 90 to 183 ft bgs due to formation sloughing. On April 27, 2011 WDC reached the total depth of 275 ft bgs. Drilling progress was slow due to quartzite cobbles and large boulders. Water was added to the drilling fluid (200 gallons) to compensate for the loss of drilling effluent from 63 to 170 ft bgs. Water (7,000 gallons) was also added at approximately 264 ft bgs to the total depth of the borehole to clean out and thin down the drilling fluids.

3.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7029M 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 gravels with varying amounts of silt and clay. Clay is present in the cuttings from 40 to 100 ft bgs and consists of medium plasticity lean clays. The gravels are angular to well rounded, and consist of varicolored quartzite and dark gray to black limestone. Mixed with the gravels are various amounts of tan silt and clay. The gravels are poorly to noncemented.

The drill cuttings were affected by the drilling process which caused an overall reduction in overall grain size. A summary of the lithologic log is presented in Figure 5.

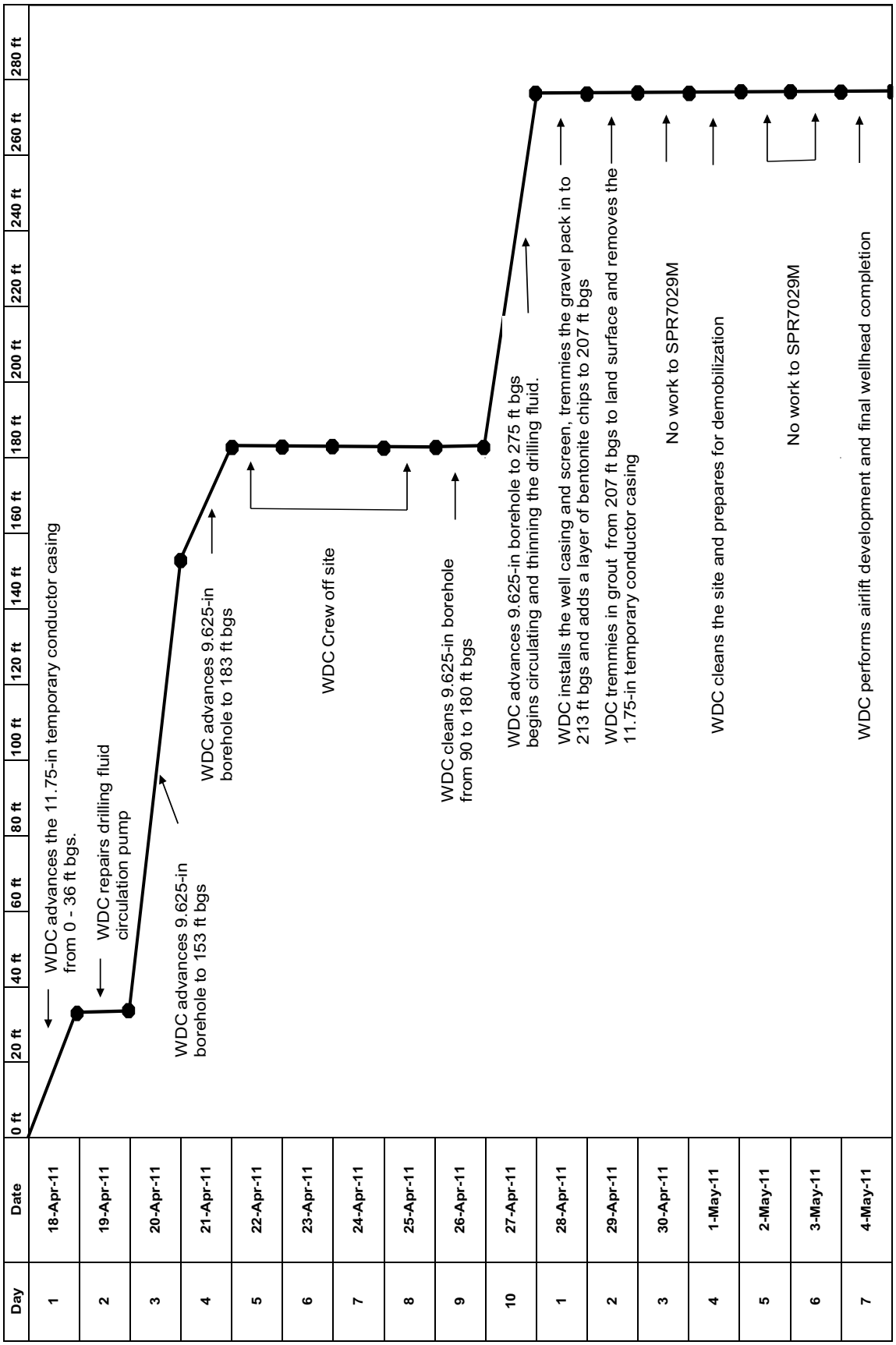
3.4 DRILLING PARAMETERS

The Drilling Parameters are as follows:

- Rate of Penetration (ROP)
- Weight on Bit (WOB)
- Pump Pressure
- Drill Bit Rotation
- Rotary Torque

These drilling parameters are presented on Figure 6. Drilling data were collected from land surface to the total depth of the borehole at 275 ft bgs. Data collected from land surface to the bottom of the temporary conductor casing at 38 ft bgs were of poor quality due to circulation issues associated with cobbles and boulders that caused the driller to vary the drilling parameters significantly.

The Rate of Penetration log shows a moderate rate from 40 to 145 ft bgs varying from 1 to 15 min/ft. Lower ROP (15 min/ft) occur when the drill bit encountered more uniform gravels. Increased rates of penetrations were when silt and clay was encountered. From 145 to 245 ft bgs, the ROP steadily increased to less than 1 min/ft as the WOB steadily increased. From 245 ft bgs to the bottom of the borehole at 275 ft bgs, the ROP steadily decreased due to loss of circulation and borehole wall sloughing.



Day	Date
1	18-Apr-11
2	19-Apr-11
3	20-Apr-11
4	21-Apr-11
5	22-Apr-11
6	23-Apr-11
7	24-Apr-11
8	25-Apr-11
9	26-Apr-11
10	27-Apr-11
1	28-Apr-11
2	29-Apr-11
3	30-Apr-11
4	1-May-11
5	2-May-11
6	3-May-11
7	4-May-11

FIGURE 4
MONITOR WELL SPR7029M DRILLING HISTORY

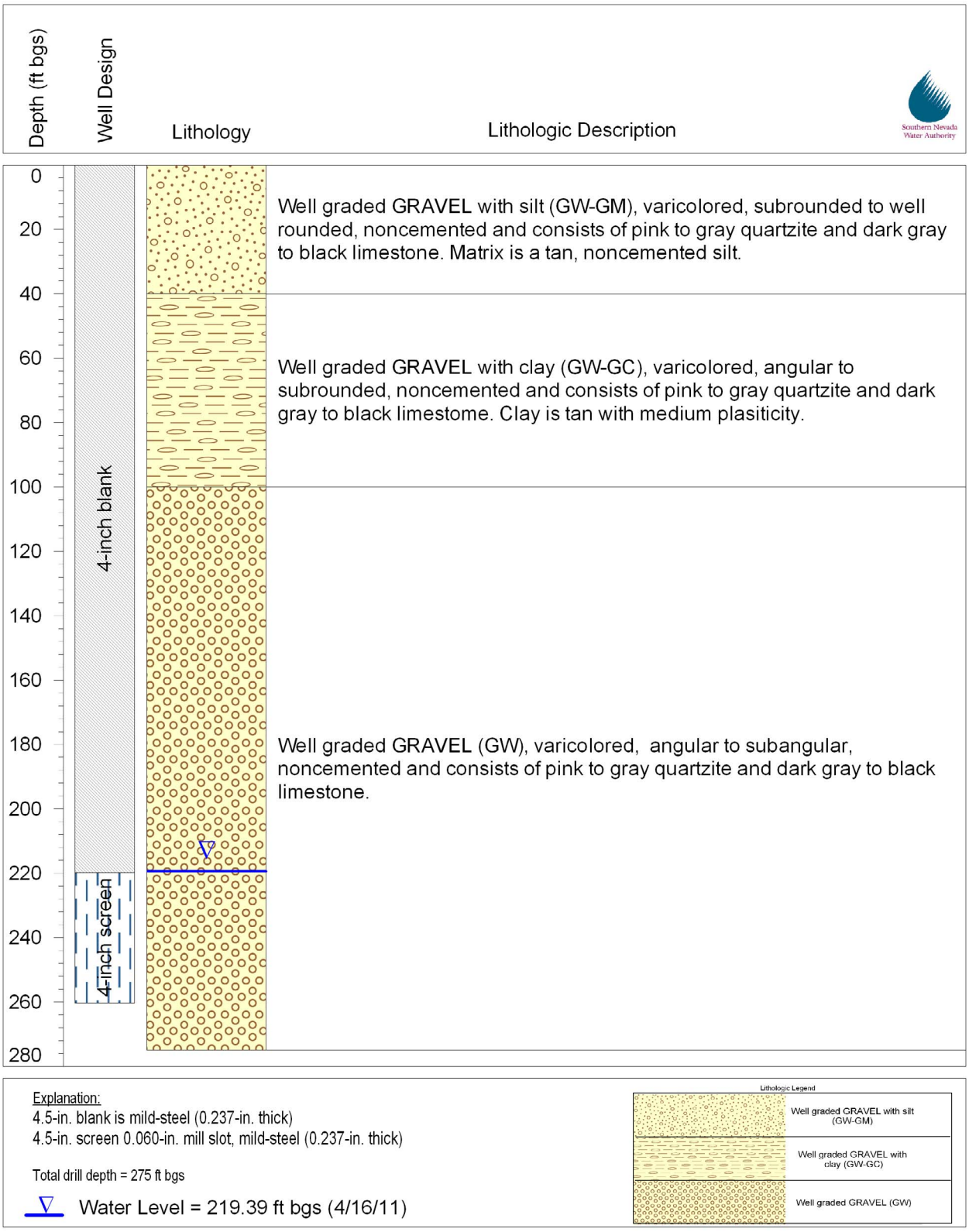


FIGURE 5
MONITOR WELL SPR7029M BOREHOLE STRATIGRAPHIC COLUMN

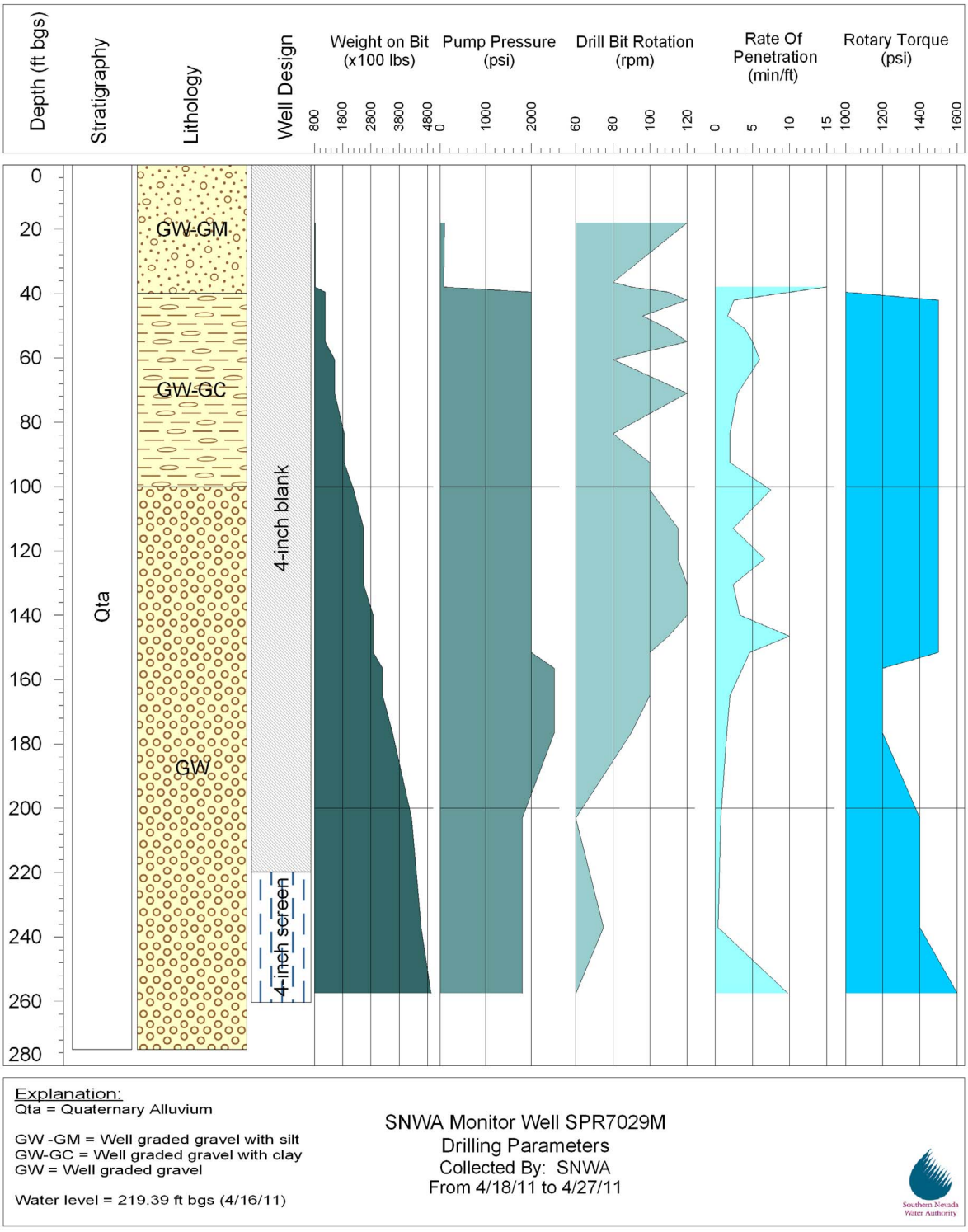


FIGURE 6
MONITOR WELL SPR7029M DRILLING PARAMETERS

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 log reflects the increase in WOB as additional drill pipe was added to the drill string.

The pump pressure was steady at approximately 200 psi from 20 to 40 ft bgs; it then was increased to 2,000 psi from 40 to 150 ft bgs in an attempt to increase the penetration rate and to better remove the drill cuttings from the borehole. From 150 to 180 ft bgs, the driller increased the pump pressure to 2,500 psi to assist with drill cuttings removal. At 180 ft bgs the driller decreased the pump pressure back down to approximately 1,800 psi and continued at that pressure for the remainder of the borehole.

The Drill Bit Rotation log reflects variable rates in the interval between 25 and 90 ft bgs of 80 to 120 rpm due to the driller increasing and decreasing the speed based on the size of the alluvial material encountered. From 90 to 130 ft bgs, the drill bit rotation was increased to 120 rpm and remained at 120 rpm until 140 ft bgs. From 140 to 210 ft bgs, the rotation speed was decreased to 60 rpm as the rate of penetration increased. For the remainder of the borehole, the drill bit rotation was reasonably consistent, varying between 60 and 70 rpm.

The Rotary Torque was constant at 1,500 psi from 40 to 150 ft bgs. Between 150 and 175 ft bgs, the torque decreased to 1,200 psi in a zone of slightly smaller gravel size. Torque increased to 1,400 psi between 205 and 235 ft bgs and then increased again to 1,600 psi due to sloughing conditions between 235 and the total depth of the borehole.

3.5 WELL COMPLETION

Installation of the 4.5-in. well casing was started and completed on April 29, 2011. A schematic diagram of the well completion is shown in Figure 7.

The 4.5-in. completion string was constructed of schedule 40 mild steel and included 222 ft of blank casing starting at 2 ft ags to 220 ft bgs. A total of 40 ft of mild steel mill slot casing was installed from 220 to 260 ft bgs. The slot size is 0.060 in. with 8 openings per linear ft. Installation of the gravel pack from 213 to 262 ft bgs and bentonite seal from 207 to 213 ft bgs was completed on April 28, 2011.

With the 4.5-in. completion string in place on April 28, 2011 completion operations continued with the emplacement of Carmeuse^{tm} Silica Sand 8-12 gravel pack. A total of seventy, 50 lb sacks of gravel pack were placed in the annulus between the borehole and the 4.5-in. completion casing. Gravel pack installation progress went quickly, as water was added into the mixing funnel/hopper. Chlorine and AquaClear PFD were also added intermittently during the installation of the gravel pack. The volume of gravel pack installed exceeded estimations because of an enlarged borehole diameter.

On May 4, 2011, airlift development of the gravel pack was performed on the well for 6.5 hrs. Upon completion of development, the temporary conductor casing was removed, the annuls between the well casing and the borehole wall was grouted to the surface, and a locking wellhead cap and protective locking well cover were installed.

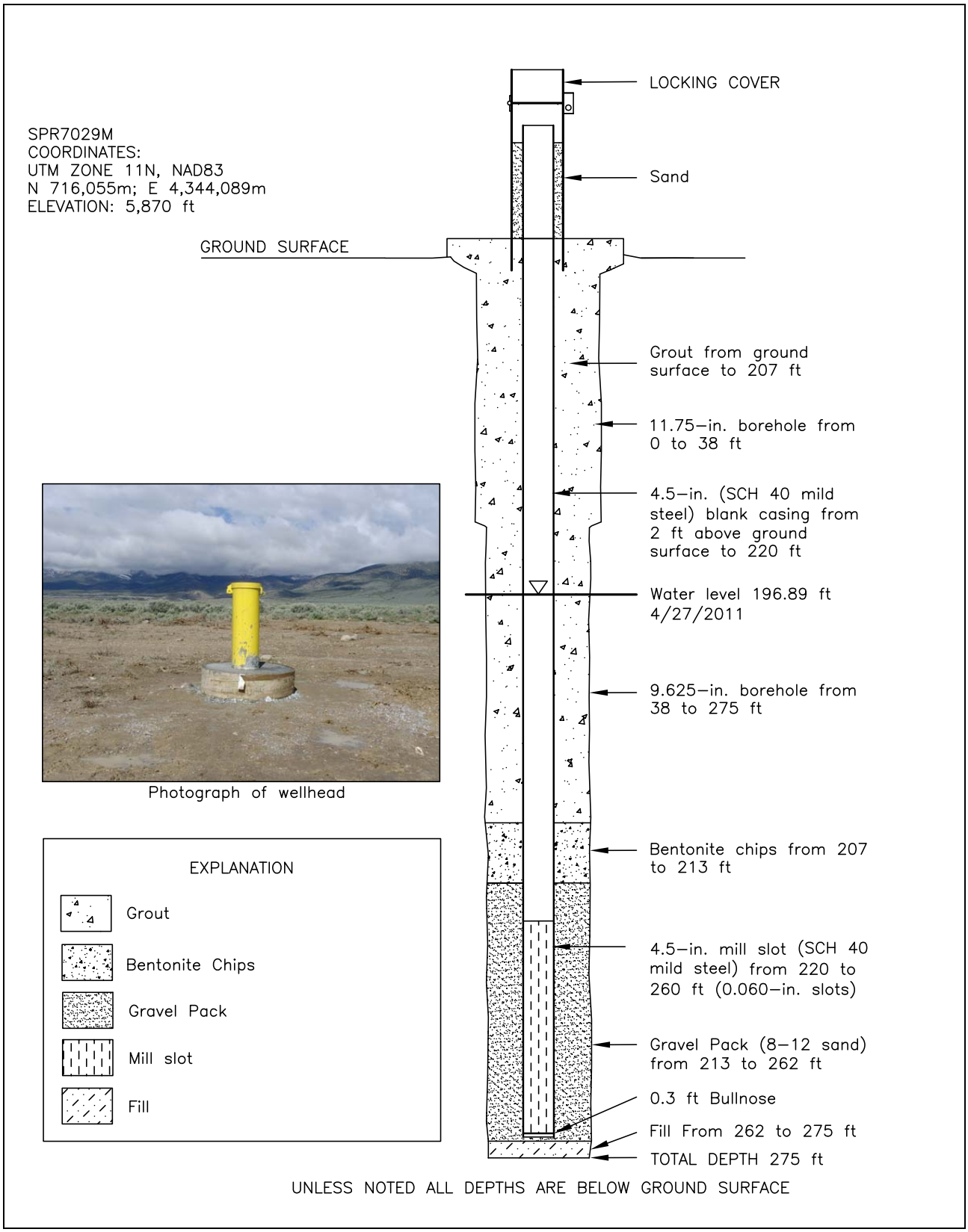


FIGURE 7
MONITOR WELL SPR7029M WELL COMPLETION DIAGRAM

3.6 WATER-LEVEL DATA

This section discusses depth-to-water measurements collected after well construction and development. No measurements were performed during the drilling of Monitor Well SPR7029M because the borehole was drilled using a technique that created a wall cake on the borehole wall reducing hydraulic communication with the formation. A total of 6 measurements ranging from 196.89 to 215.55 ft bgs were noted between April 27 and May 19, 2011. These measurements vary 18.66 ft with an average depth-to-water of 204.79 ft bgs. The surface elevation at the well is approximately 5,870 ft amsl, and the average groundwater elevation is 5,665 ft amsl. Depth-to-water measurements for Monitor Well SPR7029M are listed in Table 2.

TABLE 2
MONITOR WELL SPR7029M WATER-LEVEL MEASUREMENTS

Date	Time	Depth (ft bgs)	Elevation[a] (ft amsl)	Data Source
4/27/2011	10:01	196.89	5,673	SNWA
4/28/2011	10:09	199.29	5,671	SNWA
4/28/2011	16:43	199.90	5,670	SNWA
4/29/2011	14:09	201.56	5,668	SNWA
5/17/2011	9:34	215.54	5,664	SNWA
5/19/2011	8:24	215.55	5,664	SNWA

[a]Approximate elevation, a professional survey will be performed at a later time.

4.0

MONITOR WELL SPR7029M2

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and water-level data for Monitor Well SPR7029M2.

4.1 SPR7029M2 SUMMARY

Monitor Well SPR7029M2 was drilled and completed from April 1 to April 18, 2011, to a depth of 437 ft bgs. A 20-in. O.D. conductor casing was installed using an auger drilling method to a depth of 28 ft bgs, a 9.875-in. pilot borehole was drilled to 440 ft bgs, and a 17.5-in. borehole was drilled using conventional mud rotary drilling techniques to a depth of 437 ft bgs. The monitor well was completed with 12.75-in. O.D. (12-in. I.D.) well casing from 2 ft ags to 422 ft bgs with a slotted interval from 382 to 422 ft bgs.

The monitor well site is depicted on Figure 8, and the borehole and well construction statistics are shown on Table 3.

FIGURE 8
VIEW OF MONITOR WELL SPR7029M2
LOOKING WEST

TABLE 3
MONITOR WELL SPR7029M2 BOREHOLE AND WELL STATISTICS

LOCATION DATA Surveyed Coordinates	UTM, Zone 11, NAD83, N 4,344,122 m; E 716,052 m	
Ground Elevation	5,883 ft amsl	
DRILLING DATA Spud Date	4/1/2011	
Total Depth (TD)	440 ft bgs	
Date TD Reached	4/16/2011	
Date Well Completed	4/30/2011	
Hole Diameter	30 -in. from 0 to 28 ft bgs 17.5 -in. from 28 to 437 ft bgs 9.875 -in from 437 to 440	
Drilling Techniques	Auger from 0 to 27.5 ft bgs Conventional Mud Rotary Pilot from 27.5 to 440 ft bgs Ream from 27.5 to 437 ft bgs	
Drilling Fluid Materials Used	Quick -Gel (390 bags) Soda Ash (4.25 bags) EZ Mud Gold (25 cups)	QuiK Trol (7 buckets)
Drilling Fluid Properties	*Properties* Viscosity Range = 34 to 52 sec/qt Weight Range = 8.6 to 9.1 lbs Filtrate Range = 4.5 to 19.6 ml Filter Cake Range = 2/32 to4/32-in.	*Averages* 44.54 sec/qt 8.83 lbs 10.82 ml 3/32-in.
CASING DATA	20-in. MS Conductor Casing from 0 to 27.5 ft bgs 12.75-in. MS Completion Casing from +2 to 422 ft bgs	
WELL COMPLETION DATA	384 ft of blank MS 12.75-in. completion casing from +2 to 382 ft bgs 40 ft of 12.75-in. mill slot screen from 382 to 422 ft bgs. <u>Grout, Plug and Gravel Pack Depth</u> 0 to 28 ft bgs on outside of conductor casing (grout) 0 to 353 ft bgs between conductor casing/borehole and completion casing (grout) 353 to 358 ft bgs bentonite chips 358 to 360 ft bgs sand plug 360 to 430 ft bgs SRI^{TM} 6-9 gravel pack	
GROUNDWATER LEVEL	Static Water Level: 215.56 ft bgs (5/17/2011) Groundwater Elevation: 5,664 ft amsl	
DRILLING CONTRACTOR	WDC Exploration & Wells	
OVERSIGHT	Southern Nevada Water Authority	

4.2 DRILLING HISTORY

Monitor Well SPR7029M2 was drilled from April 1 to April 16, 2011 (Figure 9). Drilling commenced when WDC Drilling augered a 30-in. diameter borehole to 28 ft bgs and installed a 20-in. mild steel conductor casing. The conductor casing was centralized in the borehole, and grout was placed in the annulus between the casing and the borehole.

Conventional circulation drilling of a 9.875-in. diameter pilot borehole was started at a depth of 28 ft bgs on April 2, 2011. During advancement of the pilot borehole, several mechanical issues and borehole conditions created delays. Drilling was stopped to address plugged or worn out drill bits as large boulders were encountered during the advancement of the borehole. Drilling fluid loss and periods of no cuttings returns, occurred during drilling of the borehole and were addressed by adding additional amounts of Quik-Gel. The 9.875-in. pilot borehole reached a total depth of 440 ft bgs on April 5, 2011.

Reaming the borehole began on April 12, 2011 with a 9.875-in. pilot bit and a 17.5-in. ream bit. Reaming was slowed by the quartzite cobbles and boulders. On April 14, 2011 the pull down cable failed on the drill rig and caused a delay of approximately 24 hrs until a new cable to arrived onsite. The cable was repaired on April 15, 2011 and reaming continued from 205 ft bgs to the total depth of 437 ft bgs.

4.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7029M2 at 10-ft intervals during the drilling process. These samples were described using the SNWA Field Operating Procedures, and were correlated to the lithologic units described by Hose and Blake (1976).

The entire borehole was drilled within material that is very similar in composition and properties to Monitor Well SPR7029M. The alluvium encountered consisted of gravels with varying amounts of silt and trace clay. The gravel encountered was angular to subrounded. The gravels consist of varicolored quartzite and dark gray to black limestone. Interbedded with the gravel clasts are various amounts of tan sandy silt. 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)
- Pump Pressure
- Drill Bit Rotation
- Rotary Torque

Drilling parameter values are presented on Figure 11. Drilling data were collected from land surface to the total depth of the borehole at 440 ft bgs. The drilling parameter values are relatively constant and are similar to those of Monitor Well SPR7029M.

The Rate of Penetration log shows a low rate of penetration from 60 to 240 ft bgs varying from 4 to 21 min/ft. Lower ROP (21 min/ft) occur when the drill bit encountered cobble or boulder sized

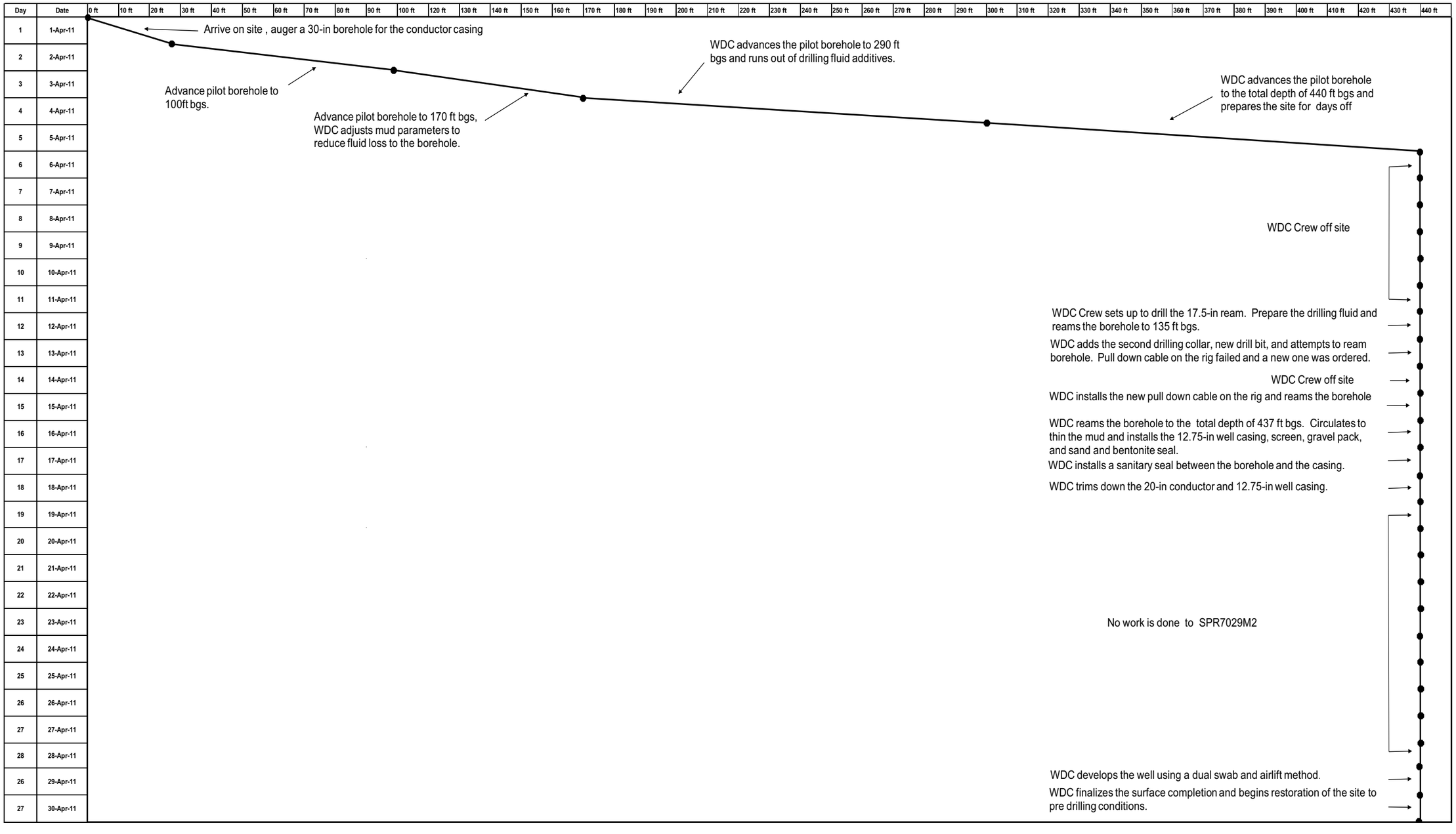


FIGURE 9
MONITOR WELL SPR7029M2 DRILLING HISTORY

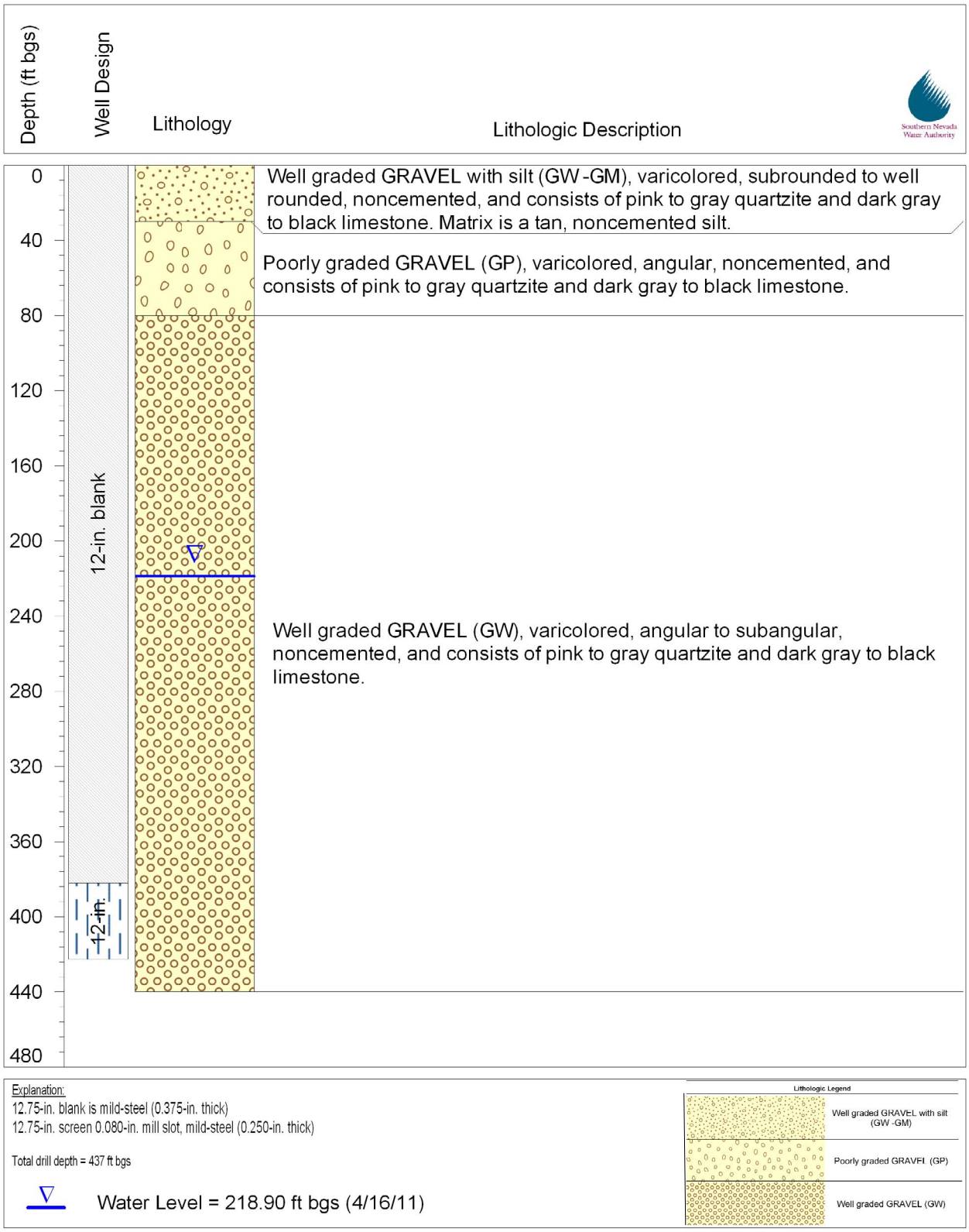


FIGURE 10
MONITOR WELL SPR7029M2 BOREHOLE STRATIGRAPHIC COLUMN

quartzite clasts. From 240 ft bgs to 260 ft bgs, the ROP increased to 3 min/ft. At 260 ft bgs, significant drilling fluid loss reduced the penetration rates to over 65 min/ft. Once the drilling fluid issues were addressed, the penetration rates increased and varied between 2 to 10 min/ft to the bottom of the borehole at 437 ft bgs.

The Weight on Bit log is a direct correlation with the weight of the drill string. During advancement of the borehole, only the weight of the drill string was used to advance the borehole. The log reflects the increase in WOB as additional drill pipe was added to the drill string.

The pump pressure was steady at approximately 2,500 psi from the bottom of the conductor casing to 80 ft bgs. Between 80 and 160 ft bgs the pump pressure was reduced to 1,500 psi in an attempt to slow the fluid loss to the borehole. The pump pressure remained at 1,500 psi to 285 ft bgs where it was increased slightly to 1,600 psi and remained at that pressure to the TD of the borehole.

The Drill Bit Rotation log only shows data from 55 to 115 ft bgs when the rate was increased from 75 to 116 rpm. The rest of the rotation data was of poor quality due to significant variation in rpm due to intermittent clogging and binding of the bit on large cobble and boulder clasts.

The Rotary Torque was constant at 2,000 psi from 27 to 75 ft bgs. Between 75 and 85 ft bgs, the torque increased to 3,000 psi in a zone of coarser grained alluvial material. Torque was decreased to 1,000 psi to reduce stress on the drill string between 85 and 240 ft bgs and then slowly increased to 1,800 due to borehole sloughing conditions between 240 ft bgs and the total depth of the borehole.

4.5 WELL COMPLETION

Installation of the 12.75-in. casing and screen was started and completed on April 30, 2011. A schematic diagram of the well completion is in Figure 12.

The 12.75-in. completion string was constructed of ASTM A503B mild steel and included 384 ft of blank casing starting at 2 ft ags to 382 ft bgs. A total of 40 ft of mill slot screen was installed from 382 to 422 ft bgs. The aperture size of the mill slot casing is .080-in. with 24 openings per linear foot. A gravel feed tube (tremie) for the installation of the gravel pack was installed on April 16, 2011.

With the 12.75-in. completion string finalized on April 16, 2011, completion operations continued with the emplacement of SRI™ Supreme 6-9 gravel pack. A total of 2 yards of gravel pack were placed in the annulus between the borehole and the 12.75-in. completion casing from 430 up to 360 ft bgs. Gravel pack installation progress went quickly as water was added into the mixing funnel/hopper. Chlorine and AquaClear PFD were also added intermittently during the installation of the gravel pack. The volume of gravel pack required exceeded estimations because of an enlarged borehole. Installation of the gravel pack from 360 to 430 ft bgs, a sand plug from 358 to 360, and a bentonite chip interval from 353 to 358 ft bgs was completed on April 16.

On April 29, 2011, airlifting and swabbing of the gravel pack was completed using a 20 ft double swab to develop the 40 ft slotted section. A locking wellhead cap was secured to the 12.75-in. casing on April 30, 2011.

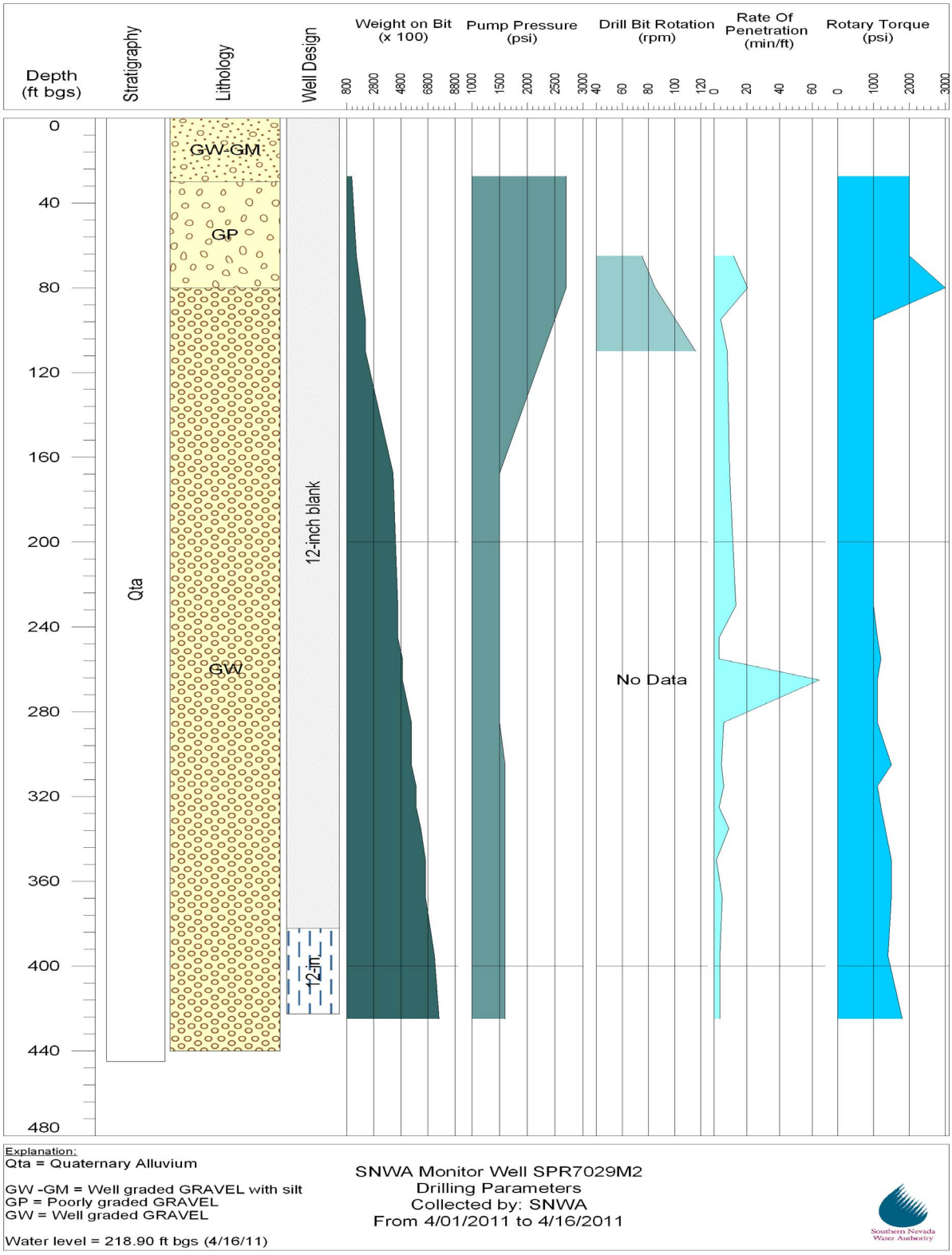


FIGURE 11
MONITOR WELL SPR7029M2 DRILLING PARAMETERS

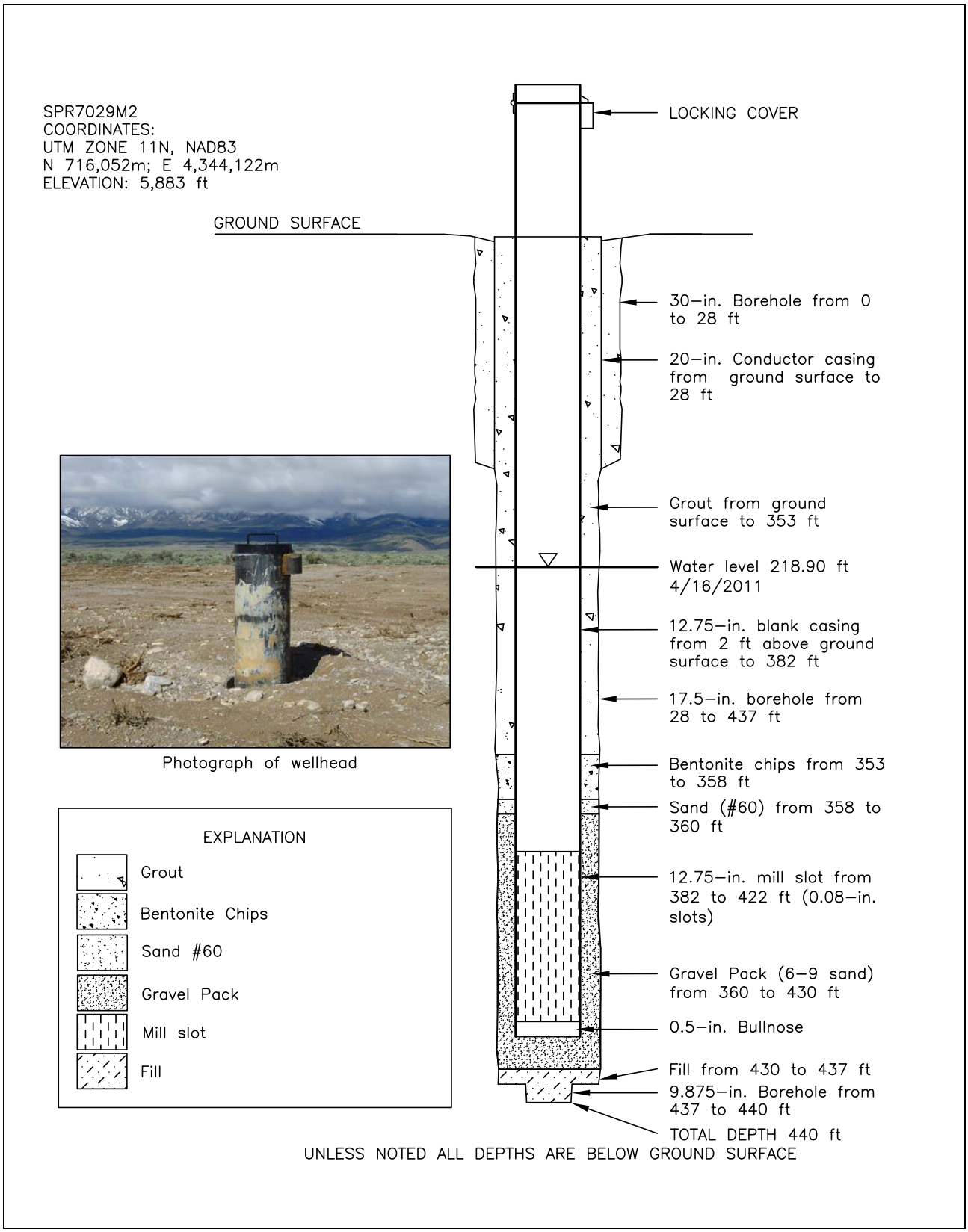


FIGURE 12
MONITOR WELL SPR7029M2 WELL COMPLETION DIAGRAM

4.6 WATER-LEVEL DATA

This section discusses depth-to-water measurements noted after well construction and aquifer testing. No measurements were noted during the drilling of Monitor Well SPR7029M2 because the borehole was drilled using a technique that created a wall cake on the borehole wall reducing hydraulic communication with the formation. A total of two depth-to-water measurements of 215.25 to 215.56 ft bgs were noted on May 17 and May 19, 2011 respectively. The average depth-to-water measurement is 215.40 ft bgs. The surface elevation at the well is approximately 5,883 ft amsl. The average groundwater elevation of 5,668 ft amsl.

5.0

SUMMARY

Monitor Wells SPR7029M and SPR7029M2 were drilled in April 2011 on the west side of Spring Valley. Monitor Well SPR7029M is located approximately 109 ft S5E of Monitor Well SPR7029M2. These wells 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 at Cleveland fan. Two monitor wells were completed at 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 the 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.

The 9.625-in. borehole for Monitor Well SPR7029M was drilled to a total depth of 275 ft bgs and was completed with 4.5-in. casing to 260 ft bgs with a slotted interval from 220 to 260 ft bgs. The 17.5-in. borehole for Monitor Well SPR7029M2 was drilled to a total depth of 437 ft bgs and completed with 12.75-in. casing to 422 ft bgs with a slotted interval from 382 to 422 ft bgs.

Both monitor wells encountered interbedded coarse grained gravels. The gravels consist of varicolored quartzite and dark gray limestone and are moderate to well rounded. Mixed with the limestone and quartzite clasts are various amounts of tan sand, silt and of clay.

Drilling parameters provided additional data for analysis. These logs were consistent with the geology encountered and were indicative of coarse alluvial material, which were also noted in the cuttings. Coarse alluvial material resulted in highly variable drilling rates and changes in rpm and changes in rpm and torque as the borehole was advanced through the alluvium.

There is a small difference between the preliminary groundwater elevation of the two monitor wells. Additional pressure data and a professional elevation survey will need to be collected to determine if a discernible vertical hydraulic gradient exists.

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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