



Southern Nevada Water Authority

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7024M and SPR7024M2 in Spring Valley



June 2011

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SOUTHERN NEVADA
WATER AUTHORITY

Well Completion and Geologic Data Analysis Report for Monitor Wells SPR7024M and SPR7024M2 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

CONTENTS

| | |
|---|-----|
| List of Figures | ii |
| List of Tables | iii |
| List of Acronyms and Abbreviations | iv |
| 1.0 Introduction | 1 |
| 1.1 Purpose and Scope | 1 |
| 1.2 Objectives of SPR7024M and SPR7024M2 | 1 |
| 2.0 Well Site Description | 3 |
| 2.1 Geologic Setting | 3 |
| 2.1.1 Geologic Units Encountered at the Wells | 3 |
| 2.1.2 Geologic Structures at the Wells | 3 |
| 3.0 Monitor Well SPR7024M | 5 |
| 3.1 SPR7024M Summary | 5 |
| 3.2 Drilling History | 5 |
| 3.3 Lithology | 8 |
| 3.4 Drilling Parameters | 8 |
| 3.5 Well Completion | 11 |
| 3.6 Water-Level Data | 11 |
| 4.0 Monitor Well SPR7024M2 | 14 |
| 4.1 SPR7024M2 Summary | 14 |
| 4.2 Drilling History | 14 |
| 4.3 Lithology | 17 |
| 4.4 Drilling Parameters | 17 |
| 4.5 Well Completion | 20 |
| 4.6 Water-Level Data | 20 |
| 5.0 Summary | 23 |
| 6.0 References | 24 |

FIGURES

| NUMBER | TITLE | PAGE |
|---------------|--|-------------|
| 1 | Location of Monitor Wells SPR7024M and SPR7024M2. | 2 |
| 2 | Surficial Geology at Monitor Wells SPR7024M and SPR7024M2. | 4 |
| 3 | View of Monitor Well SPR7024M Looking West. | 5 |
| 4 | Monitor Well SPR7024M Drilling History | 7 |
| 5 | Monitor Well SPR7024M Borehole Stratigraphic Column | 9 |
| 6 | Monitor Well SPR7024M Drilling Parameters | 10 |
| 7 | Monitor Well SPR7024M Well Completion Diagram. | 12 |
| 8 | View of Monitor Well SPR7024M2 Looking North East | 14 |
| 9 | Monitor Well SPR7024M2 Drilling History | 16 |
| 10 | Monitor Well SPR7024M2 Borehole Stratigraphic Column | 18 |
| 11 | Monitor Well SPR7024M2 Drilling Parameters | 19 |
| 12 | Monitor Well SPR7024M2 Well Completion Diagram. | 21 |

TABLES

| NUMBER | TITLE | PAGE |
|---------------|---|-------------|
| 1 | Monitor Well SPR7024M Borehole and Well Statistics | 6 |
| 2 | Monitor Well SPR7024M Water-Level Measurements | 13 |
| 3 | Monitor Well SPR7024M2 Borehole and Well Statistics | 15 |
| 4 | Monitor Well SPR7024M2 Water-Level Measurements | 22 |

ACRONYMS

| | |
|-------|---|
| ACEC | Area of Critical Environmental Concern |
| 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 |

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 SPR7024M and SPR7024M2 are located in eastern Spring Valley in Section 1, T12N, R67E, at an elevation of approximately 5,840 ft amsl (Figure 1). The site is approximately 34 mi southeast of Ely, Nevada, and is accessed from State Route 894 by an unimproved dirt road. This well site is on the west side of the Snake Range, just east of the Shoshone Ponds Area of Critical Environmental Concern.

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 SPR7024M and SPR7024M2. 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 SPR7024M AND SPR7024M2

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)

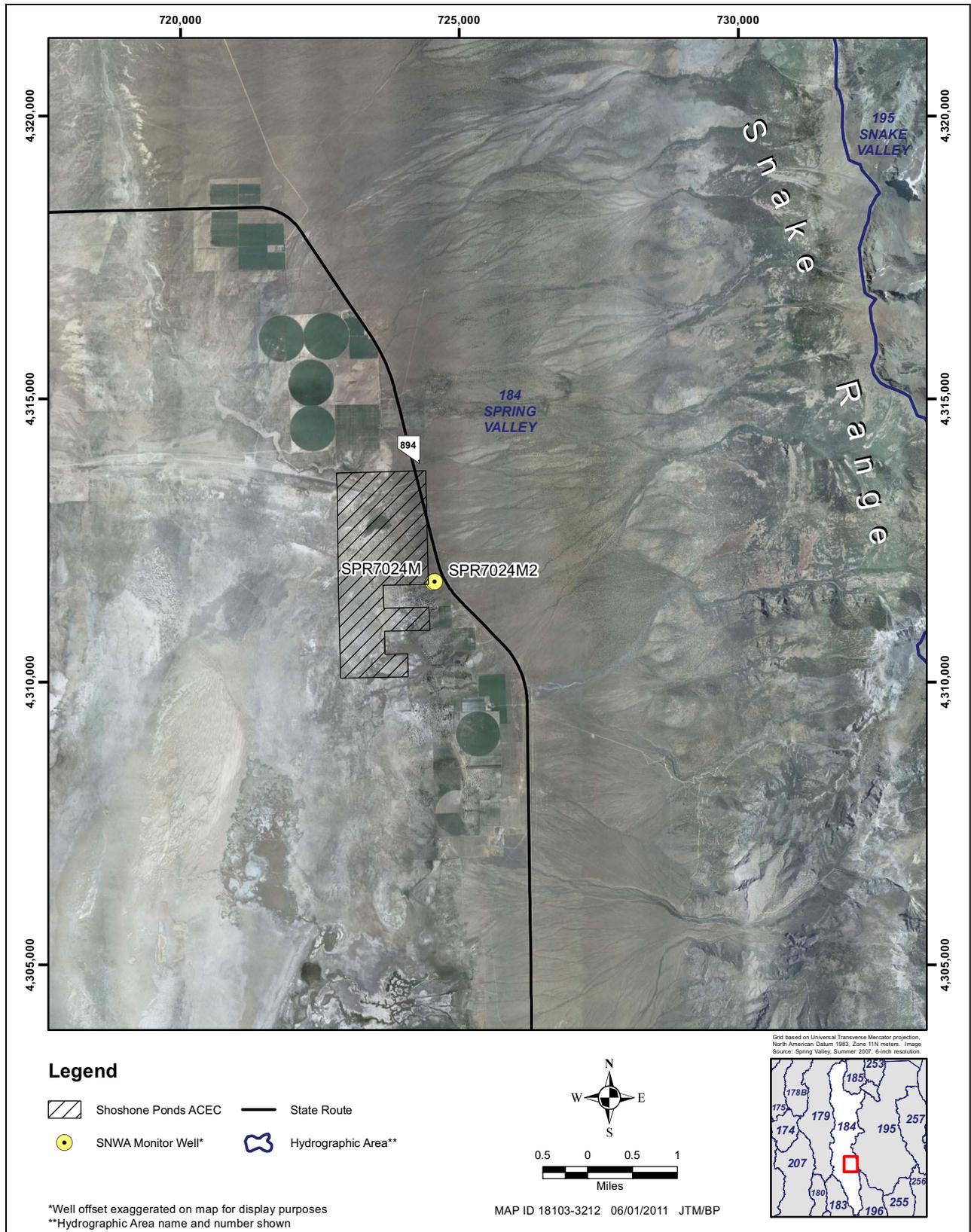


FIGURE 1
LOCATION OF MONITOR WELLS SPR7024M AND SPR7024M2

2.0

WELL SITE DESCRIPTION

This section discusses the surficial and structural geology in the vicinity of Monitor Wells SPR7024M and SPR7024M2 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 eastern margin of the valley is marked by regional north-trending range-front faults that are associated with extensional tectonics.

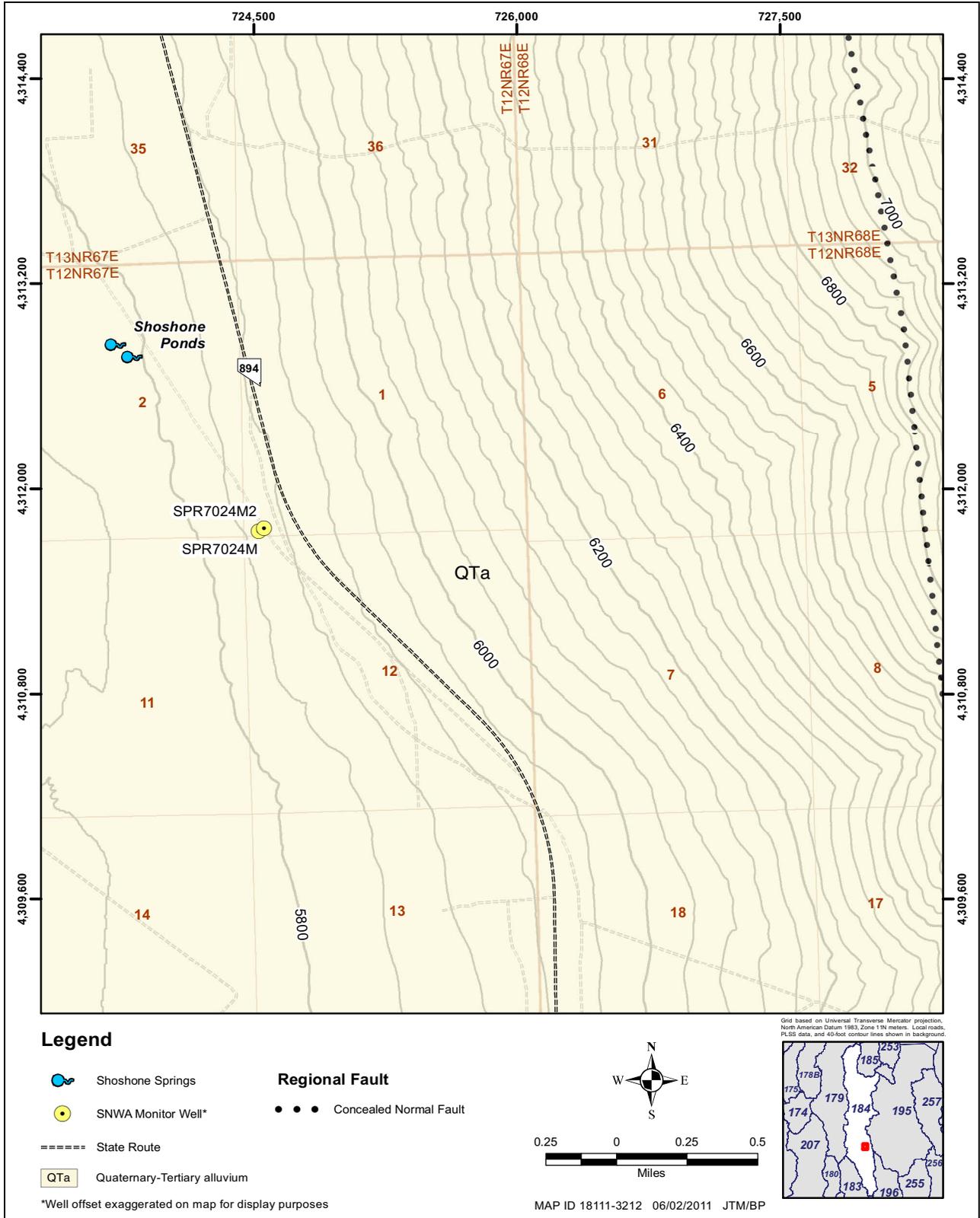
Monitor Wells SPR7024M and SPR7024M2 are situated near the eastern margin of Spring Valley (Figure 2). The surface geology at the well sites consists of Quaternary alluvium comprised of Paleozoic carbonates and clastics with occasional Tertiary volcanics making up the hills to the east (Hose and Blake, 1976).

2.1.1 GEOLOGIC UNITS ENCOUNTERED AT THE WELLS

The geologic unit encountered in Monitor Wells SPR7024M and SPR7024M2 consist of alluvium. The alluvium consists primarily of clastic detritus eroded from the Snake Range to the east (Figure 1). The alluvium is part of the surficial alluvium and basin fill (QTa) regional geologic unit (Dixon et al., 2007).

2.1.2 GEOLOGIC STRUCTURES AT THE WELLS

There are no mapped structures at the well site. The nearest structure is a major range bounding fault, described by Dixon et al. (2007), to the east 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 SPR7024M AND SPR7024M2

3.0

MONITOR WELL SPR7024M

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and water-level data for Monitor Well SPR7024M.

3.1 SPR7024M SUMMARY

Monitor Well SPR7024M was drilled and completed from March 27 to 30, 2011, to a depth of 260 ft bgs. A 11.75-in. temporary conductor casing was installed to a depth of 20 ft bgs and a 10.5-in. borehole was drilled using conventional mud drilling techniques. The monitor well was completed with 4.5-in. well casing from 2 ft ags to 249 ft bgs with a slotted interval from 209 to 249 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 SPR7024M
LOOKING WEST

3.2 DRILLING HISTORY

Monitor Well SPR7024M was drilled from March 27 to 28, 2011 ([Figure 4](#)). Drilling commenced when WDC Drilling utilized an Air Rotary Casing Hammer (ARCH) drilling method to advance a 11.75-in. diameter temporary conductor casing to 20 ft bgs. A 10.5-in. borehole was then advanced to a depth of 260 ft bgs using the conventional mud rotary method.

**TABLE 1
MONITOR WELL SPR7024M BOREHOLE AND WELL STATISTICS**

| | | |
|-------------------------------|--|--|
| LOCATION DATA | Universal Transverse Mercator (UTM), Zone 11, North American Datum of 1983 (NAD83), N 4,311,754 m; E 724,553 m | |
| Surveyed Coordinates | | |
| Ground Elevation | 5,851 ft amsl | |
| DRILLING DATA | 3/27/2011 | |
| Spud Date | | |
| Total Depth (TD) | 260 ft bgs | |
| Date TD Reached | 03/28/2011 | |
| Date Well Completed | 03/30/2011 | |
| Hole Diameter | 11.75 in. from 0 to 20 ft bgs 10.5 in. from 20 to 260 ft bgs | |
| Drilling Techniques | Air Rotary Casing Hammer from 0 to 20 ft bgs Conventional Mud Rotary from 20 to 260 ft bgs | |
| Drilling Fluid Materials Used | Gel (10 bags) EZ Mud (12 cups) Soda Ash (3.25 cups) EZ Mud Gold (4 cups) | |
| Drilling Fluid Properties | <i>Properties</i> Viscosity Range = 34 to 45 s/qt Weight Range = 9.7 lbs/gal Filtrate Range = 10 ml Filter Cake Range = 1/32 in. | <i>Averages</i> 41 sec/qt 9.7 lbs/gal 10 ml 1/32 in. |
| CASING DATA | 4.5-in. MS Completion Casing from +2 to 249 ft bgs | |
| WELL COMPLETION DATA | 211 ft of blank MS 4.5-in. completion casing from +2 to 209 ft bgs 40 ft of 4.5-in. Mill slot screen MS casing from 209 to 249 ft bgs. <u>Grout, Bentonite and Gravel Pack Depth</u> 0 to 190 ft bgs between borehole and completion casing (cement) 190 to 201ft bgs sand/bentonite plug 201 to 260 ft bgs Carmeuse 8-12 gravel pack | |
| GROUNDWATER LEVEL | Static Water Level: 20.19 ft bgs (3/29/2011) Groundwater Elevation: 5,831 ft amsl | |
| DRILLING CONTRACTOR | WDC Exploration & Wells | |
| OVERSIGHT | Southern Nevada Water Authority | |

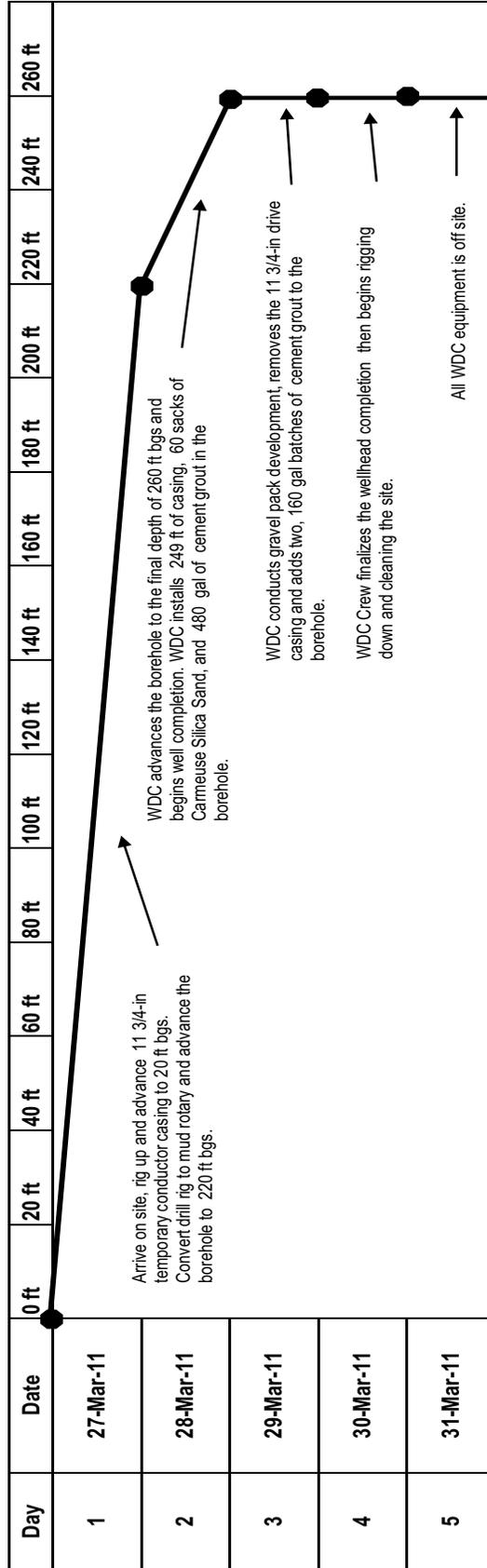


FIGURE 4
MONITOR WELL SPR7024M DRILLING HISTORY

Upon reaching the total depth of the borehole, WDC began circulating the borehole to reduce the mud viscosity to complete the well.

3.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7024M 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 consists of coarse grained gravels, sands, and two zones of clays. Clay is commonly present in the cuttings and is significant in the intervals from 50 to 60 and 250 to 260 ft bgs. The noncemented gravels are comprised of varicolored quartzites and volcanic intrusive units derived from the mountains to the east. The sands are tan, subrounded to rounded, quartzite and intrusive clasts.

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 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 260 ft bgs.

The Rate of Penetration log shows a high ROP from land surface to 260 ft bgs with spikes (down to 27 min/ft) at 25, 90, and 130 ft bgs. The peak ROP at 25 ft bgs occurred in a silty sand, while the peaks at 90 and 130 ft bgs occurred in gravels.

The Weight on Bit log is a direct correlation with the weight of the drill string. The driller allowed the full weight of the drill string on the bit. The log reflects the increase in WOB as additional drill pipe was added to the drill string and shows a gradual increase in string weight from 400 lbs to over 4,400 lbs at the total depth of the borehole.

The pump pressure was steady at approximately 300 psi from the bottom of the conductor casing to 100 ft bgs; it was then increased to a maximum of 360 psi from 100 to 200 ft bgs to assist with drill cuttings removal. From 200 ft bgs to the total depth of the borehole the pump pressure dropped back down to approximately 340 psi.

The Drill Bit Rotation log was reasonably consistent, varying from 120 to 140 rpm with the exception of a spike to 165 rpm between 5 to 15 ft bgs to clean out the bit in a zone of silty sand. A decrease to 90 rpm also occurred between 20 and 50 ft bgs as the driller attempted slowing the rotation to reduce the drill string from bouncing in the borehole.

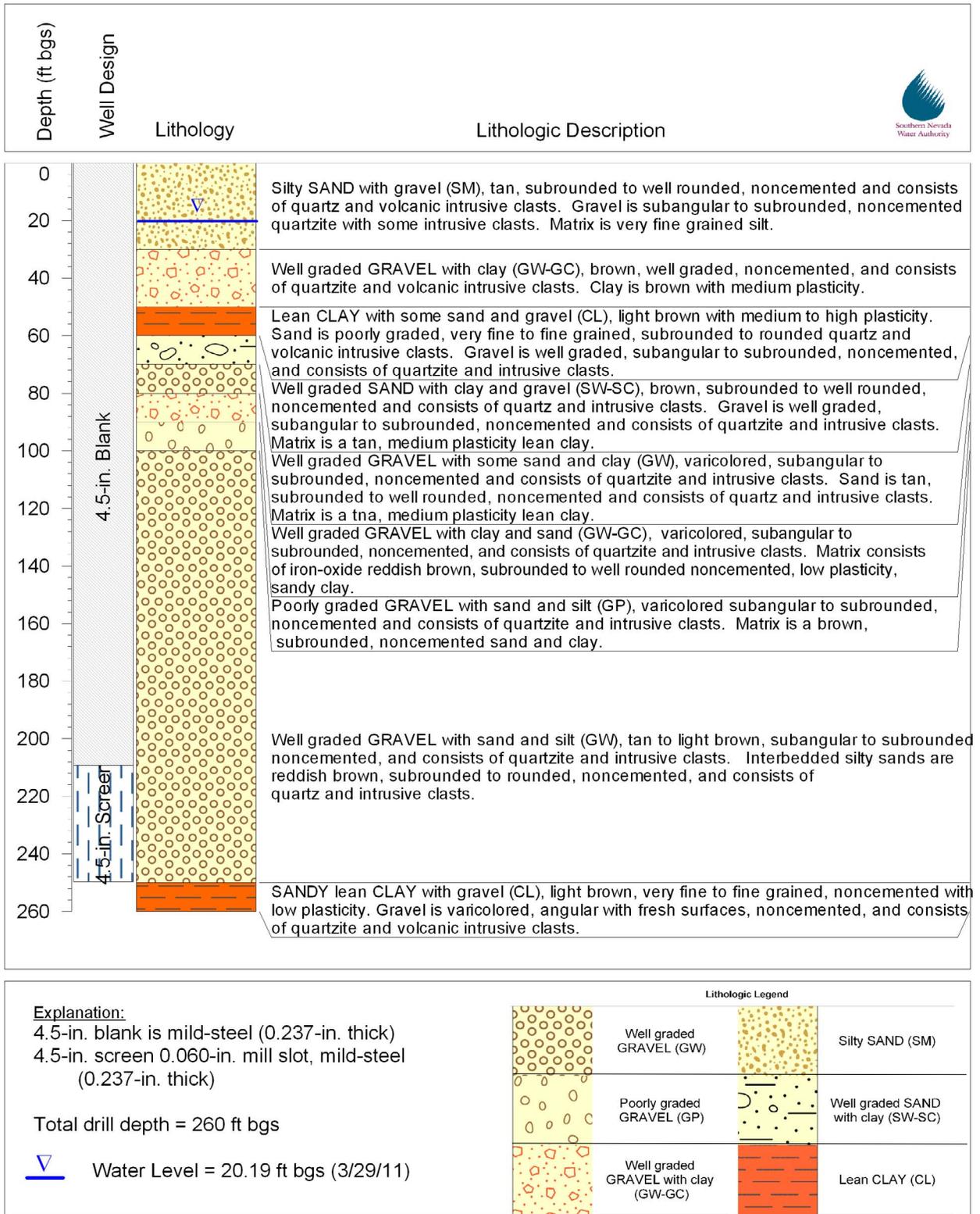
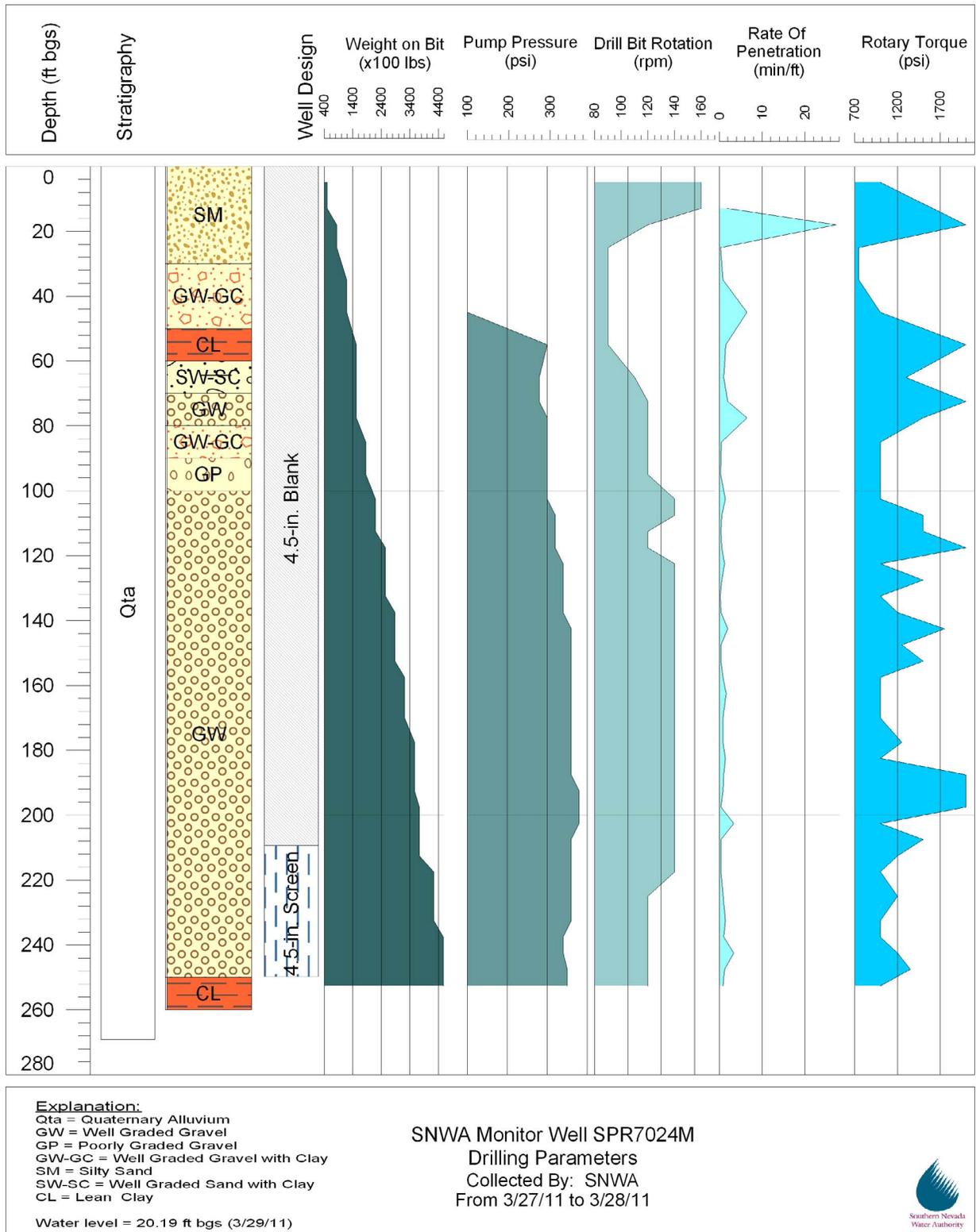


FIGURE 5
MONITOR WELL SPR7024M BOREHOLE STRATIGRAPHIC COLUMN



**FIGURE 6
MONITOR WELL SPR7024M DRILLING PARAMETERS**

The Rotary Torque log shows variable (750 to 2,000 psi) values from land surface to the bottom of the borehole due to changes in alluvial material and the bit binding intermittently on coarse grained gravels.

3.5 WELL COMPLETION

Installation of the 4.5-in. well casing was started and completed on March 28, 2011. A schematic diagram of the well completion is shown on [Figure 7](#).

The 4.5-in. completion string was constructed of schedule 40 mild steel and included 211 ft of blank casing starting at 2 ft ags to 209 ft bgs. A total of 40 ft of factory mill slot casing was installed from 209 to 249 ft bgs. The slot size of the casing is 0.060-in. with 8 openings per linear ft. A gravel feed tube (tremie) for the installation of the gravel pack was installed on March 28.

With the 4.5-in. completion string in place on March 28, completion operations continued with the emplacement of Carmeuse[™] Silica Sand 8-12 gravel pack. A total of sixty, 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 to the mixing funnel/hopper. Chlorine and AquaClear PFD were also added intermittently during the installation of the gravel pack. The gravel feed tube was removed as the gravel pack was emplaced in the borehole. The volume of gravel installed exceeded estimations because of an enlarged borehole diameter.

On March 29, airlift development of the gravel pack was performed on the well for 5.75 hours. Upon completion of development, an 11 ft section of sand/bentonite was placed on the outside of the casing from 190 to 201 ft bgs, the temporary conductor casing removed, and the borehole annulus was grouted to the surface. A locking wellhead cap and protective locking cover were installed over the 4.5-in. casing on March 30, 2011.

3.6 WATER-LEVEL DATA

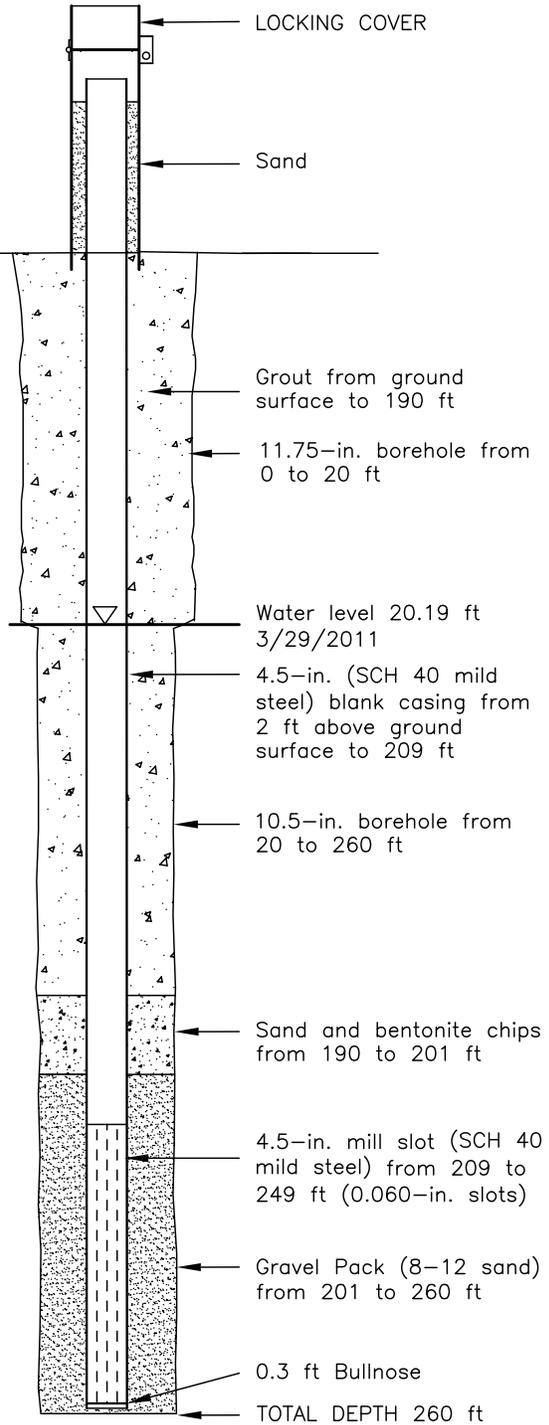
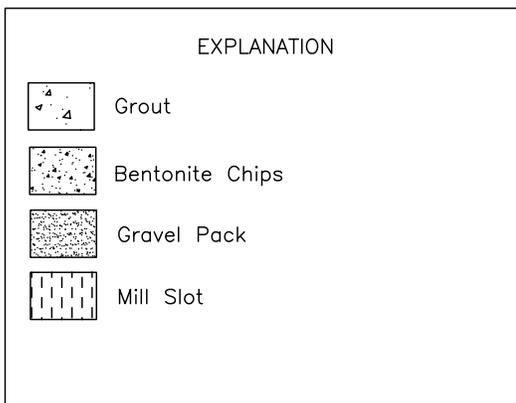
This section discusses depth-to-water measurements collected after well construction and development. No measurements were noted during the drilling of Monitor Well SPR7024M because the borehole was drilled using a technique that created a wall cake on the borehole wall reducing the hydraulic communication with the formation. A total of 4 measurements ranging from 19.97 to 20.40 ft bgs were noted between March 29 and May 10, 2011. These measurements vary 0.43 ft with an average depth-to-water of 20.21 ft bgs. The surface elevation at the well is approximately 5,851 ft amsl and the average groundwater elevation is 5,831 ft amsl. The depth-to-water measurements for Monitor Well SPR7024M are listed in [Table 2](#).

SPR7024M
 COORDINATES:
 UTM_ZONE 11N, NAD83
 N 724,553m; E 4,311,754m
 ELEVATION: 5,851 ft

GROUND SURFACE



Photograph of wellhead



UNLESS NOTED ALL DEPTHS ARE BELOW GROUND SURFACE

FIGURE 7
MONITOR WELL SPR7024M WELL COMPLETION DIAGRAM

TABLE 2
MONITOR WELL SPR7024M WATER-LEVEL MEASUREMENTS

| Date | Time | Depth (ft bgs) | Elevation^a (ft amsl) | Data Source |
|-------------|-------------|---------------------------|--|--------------------|
| 3/29/2011 | 6:36 | 19.97 | 5,831 | SNWA |
| 3/29/2011 | 8:26 | 20.19 | 5,831 | SNWA |
| 4/6/2011 | 9:32 | 20.27 | 5,831 | SNWA |
| 5/10/2011 | 18:40 | 20.40 | 5,831 | SNWA |

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

4.0

MONITOR WELL SPR7024M2

This section presents the history of the drilling operation, the lithology, drilling parameters, well completion, and water-level data for Monitor Well SPR7024M2.

4.1 SPR7024M2 SUMMARY

Monitor Well SPR7024M2 was drilled and completed from March 4 to March 27, 2011, to a depth of 720 ft bgs. A 11.75-in. O.D. temporary conductor casing was installed to a depth of 40 ft bgs using the ARCH drilling methods and a 10.5-in. borehole was drilled using conventional mud rotary drilling techniques to a depth of 720 ft bgs. The monitor well was completed with 4.5-in. well casing from 2 ft ags to 699 ft bgs with a slotted interval from 659 to 699 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 SPR7024M2
LOOKING NORTH EAST

4.2 DRILLING HISTORY

Monitor Well SPR7024M2 was drilled from March 4 to March 23, 2011 ([Figure 9](#)). Drilling commenced when WDC Drilling advanced a 11.75-in. diameter temporary casing to 40 ft bgs using an ARCH drilling method. WDC Drilling attempted to continue borehole advancement utilizing a 9.625-in. diameter driven casing but could not advance past 98 ft bgs on March 5, 2011. On March 8,

**TABLE 3
MONITOR WELL SPR7024M2 BOREHOLE AND WELL STATISTICS**

| | | | | | | | | | | | |
|---------------------------------------|---|-------------------|-----------------|-----------------------------------|-----------|-----------------------------------|-------------|-----------------------------|--------|---------------------------------------|-----------|
| LOCATION DATA | | | | | | | | | | | |
| Surveyed Coordinates | UTM, Zone 11, NAD83, N 4,311,765 m; E724,562 m | | | | | | | | | | |
| Ground Elevation | 5,841 ft amsl | | | | | | | | | | |
| DRILLING DATA | | | | | | | | | | | |
| Spud Date | 3/4/2011 | | | | | | | | | | |
| Total Depth (TD) | 720 ft bgs | | | | | | | | | | |
| Date TD Reached | 3/23/2011 | | | | | | | | | | |
| Date Well Completed | 3/27/2011 | | | | | | | | | | |
| Hole Diameter | 11.75 in. from 0 to 40 ft bgs 10.5 in. from 40 to 720 ft bgs | | | | | | | | | | |
| Drilling Techniques | Air Rotary Casing Hammer from 0 to 40 ft bgs Conventional Mud Rotary from 40 to 720 ft bgs | | | | | | | | | | |
| Drilling Fluid Materials Used | Gel (10) EZ Mud (12 cups) Soda Ash (3.25 cups) EZ Mud Gold (4 cups) | | | | | | | | | | |
| Drilling Fluid Properties | <table border="0"> <tr> <td><i>Properties</i></td> <td><i>Averages</i></td> </tr> <tr> <td>Viscosity Range = 32 to 60 sec/qt</td> <td>45 sec/qt</td> </tr> <tr> <td>Weight Range = 8.8 to 9.9 lbs/gal</td> <td>9.4 lbs/gal</td> </tr> <tr> <td>Filtrate Range = 3 to 11 ml</td> <td>6.3 ml</td> </tr> <tr> <td>Filter Cake Range = 1/32 to 2/32 -in.</td> <td>2/32 -in.</td> </tr> </table> | <i>Properties</i> | <i>Averages</i> | Viscosity Range = 32 to 60 sec/qt | 45 sec/qt | Weight Range = 8.8 to 9.9 lbs/gal | 9.4 lbs/gal | Filtrate Range = 3 to 11 ml | 6.3 ml | Filter Cake Range = 1/32 to 2/32 -in. | 2/32 -in. |
| <i>Properties</i> | <i>Averages</i> | | | | | | | | | | |
| Viscosity Range = 32 to 60 sec/qt | 45 sec/qt | | | | | | | | | | |
| Weight Range = 8.8 to 9.9 lbs/gal | 9.4 lbs/gal | | | | | | | | | | |
| Filtrate Range = 3 to 11 ml | 6.3 ml | | | | | | | | | | |
| Filter Cake Range = 1/32 to 2/32 -in. | 2/32 -in. | | | | | | | | | | |
| CASING DATA | 4.5-in. MS Completion Casing from +2 to 699 ft bgs | | | | | | | | | | |
| WELL COMPLETION DATA | 661 ft of blank MS 4.5-in. completion casing from +2 to 659 ft bgs 40 ft of 4.5-in. mill slot screen from 659 to 699 ft bgs. <u>Grout, Bentonite, and Gravel Pack Depths</u> 0 to 646 ft bgs between borehole and completion casing (cement) 646 to 650 ft bgs sand/bentonite plug 650 to 720 ft bgs 8-12 gravel pack | | | | | | | | | | |
| GROUNDWATER LEVEL | Static Water Level: 12.98 ft bgs (3/31/2011) Groundwater Elevation: 5,828 ft amsl | | | | | | | | | | |
| DRILLING CONTRACTOR | WDC Exploration & Wells | | | | | | | | | | |
| OVERSIGHT | Southern Nevada Water Authority | | | | | | | | | | |

2011, WDC converted to conventional circulation mud rotary and began drilling a 10.75-in. diameter borehole. Advancement of the borehole was slowed due to encountering quartzite boulders and cobbles. Drilling was also halted at times to make repairs to the drill rig and the mud system. On March 16, 2011, drilling was stopped due to a twisted off drill pipe at approximately 350 ft bgs. An overshot was used to extract the drill pipe and drilling continued on the same day. At 460 ft bgs the bit was replaced due to wear as significant clogging issues prevented borehole advancement for the day. On March 21, 2011, the mud system failed. WDC Drilling replaced the mud system on March 22, 2011 and the total depth of 720 ft bgs was reached on March 23, 2011.

4.3 LITHOLOGY

Lithologic samples from drill cuttings were collected for Monitor Well SPR7024M2 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 Quaternary Alluvium. The alluvium encountered consists of clay, sands and gravels. The gravel consists of varicolored quartzite and intrusive volcanic clasts. Interbedded with the gravels are varicolored sands and clays. 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

These drilling parameters are presented on [Figure 11](#). Drilling data were collected from land surface to the total depth of the borehole at 720 ft bgs.

The Rate of Penetration log shows variable rates (1 to 40 min/ft) from ground surface to 180 ft bgs that correlate to varying alluvial materials encountered. At 180 ft bgs the rate slowed down to 6 min/ft and stayed at that rate until 465 ft bgs where the rate was increased to 1 to 2 min/ft for the remainder of the borehole. This increase corresponded to a change in the drilling operator.

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 an increase in WOB as additional drill pipe was added to the drill string. The log shows a gradual increase in string weight from 1,340 lbs to 15,800 lbs at the total depth of the borehole.

The Pump Pressure log shows a low pressure at approximately 100 psi at the top of the borehole to 90 ft bgs. At 90 ft bgs, the drilling methodology changed to a mud based system instead of an air based system and the pump pressure increased to 1,600 psi. The pump pressure remained at 1,600 psi from 90 to 190 ft bgs where it then slowly increased to 3,200 psi at the bottom of the borehole as additional pressures were required to remove the drill cuttings.

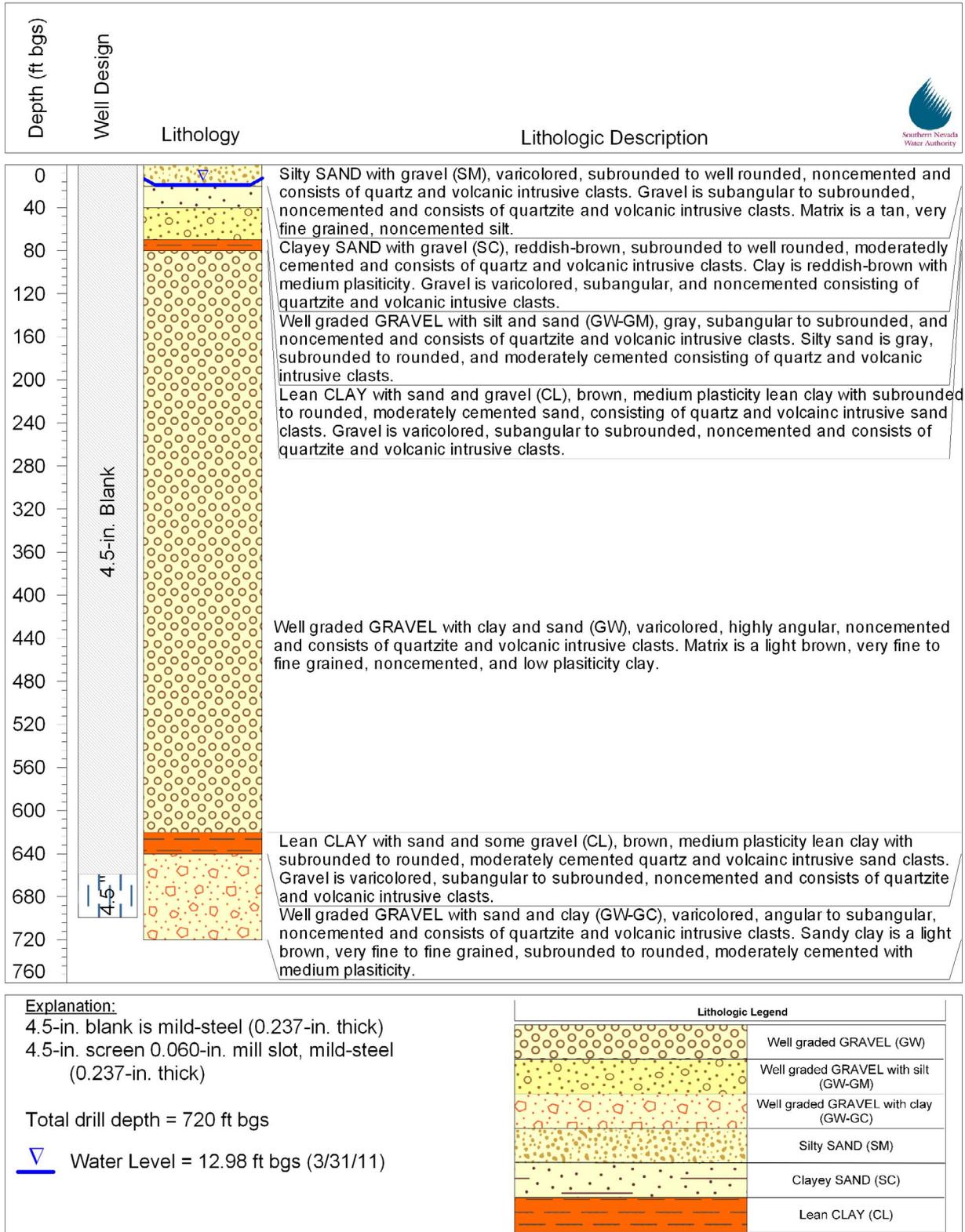
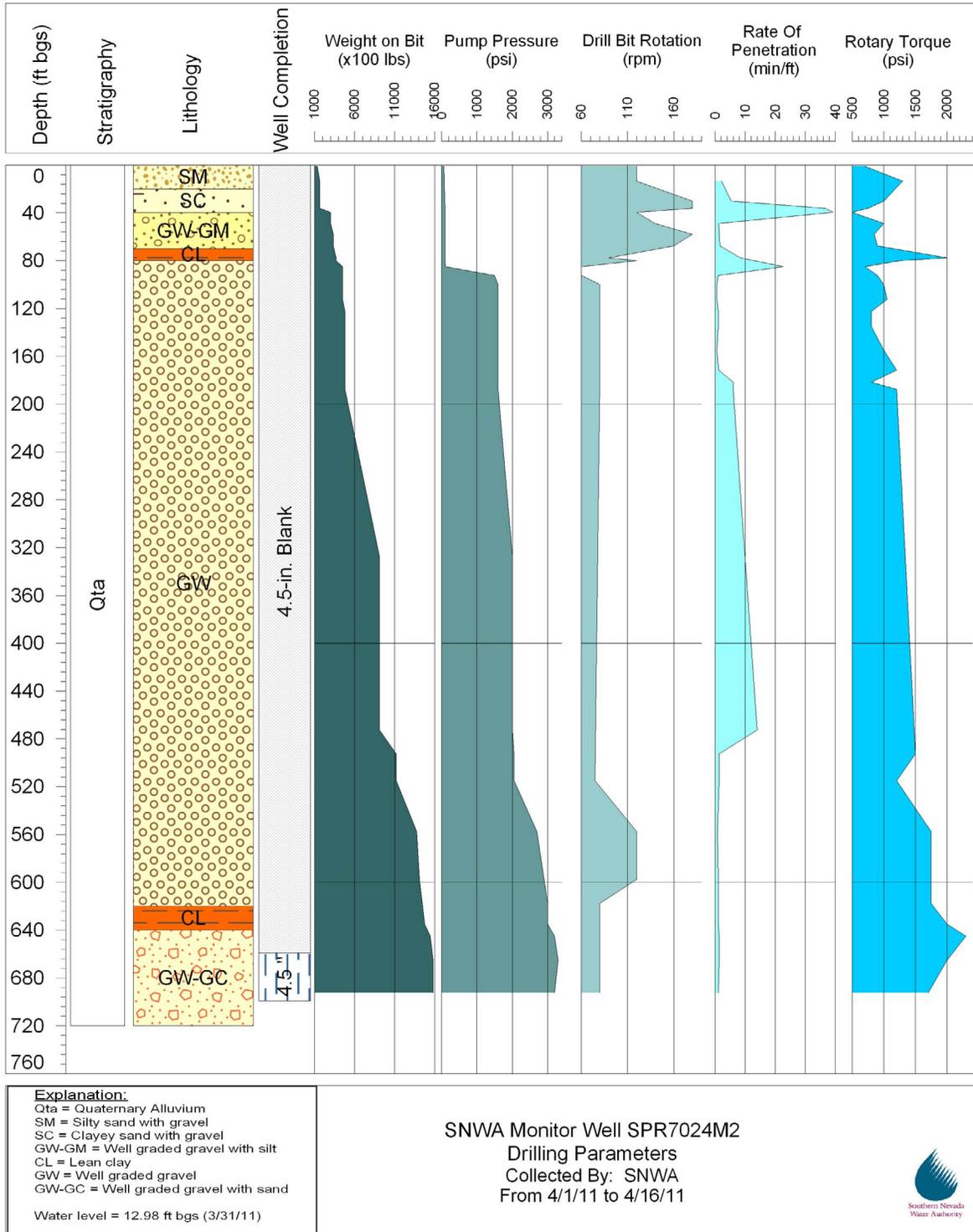


FIGURE 10
MONITOR WELL SPR7024M2 BOREHOLE STRATIGRAPHIC COLUMN



The Drill Bit Rotation log shows a variable rotation speed between 60 to 200 rpm from the top of the borehole to 90 ft bgs. At 90 ft bgs, the rotation was stabilized by the driller to approximately 60 rpm and remained at that rate to 525 ft bgs. At 525 ft bgs, a new driller arrived onsite and increased the rotation rate to 120 rpm in an attempt to increase penetrations rates. At 605 ft bgs, the driller set the rotation speed at 80 rpm where it remained to the bottom of the borehole at 720 ft bgs.

The Rotary Torque log shows variable (50 to 2,000 psi) values from land surface to 175 ft bgs due to varying alluvial materials. Between 175 and 620 ft bgs, the rotary torque steadily increased from 1,200 to 1,700 psi in a well graded gravel, with a dip in rotary torque (1,250 psi) at 525 ft bgs as a new driller attempted to increase penetration rates. From 620 ft bgs to 640 ft bgs, the torque spiked to 2,400 psi that corresponds to a clay interval. From 640 ft bgs to the bottom of the borehole, the torque steadily decreased to 1,700 psi.

4.5 WELL COMPLETION

Installation of the 4.5-in. well was started on March 25, 2011 and completed on March 27, 2011. A schematic diagram of the well completion [Figure 12](#).

The 4.5-in. completion string was constructed of ASTM A503B mild steel and included 661 ft of blank casing starting at 2 ft ags to 659 ft bgs. A total of 40 ft of mill slot casing was installed from 659 to 699 ft bgs. The slot size of the casing is 0.060-in. with 8 openings per linear ft. A gravel feed tube (tremie) for the installation of the gravel pack was installed on March 25.

With the 4.5-in. completion string finalized on March 25, 2011 completion operations continued with the emplacement of CarmeuseTM Silica 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 gravel feed tube was removed as gravel pack was emplaced in the borehole. The volume of gravel pack installed exceeded estimations because of an enlarged borehole.

On March 26, 2011 airlifting of the gravel pack was completed on the well for 4 hours. A 4 ft section of sand/bentonite was placed on the outside of the casing from 646 to 650 ft bgs. The temporary conductor casing was removed, and the annulus was grouted to the surface. A locking wellhead cap and protective locking cover were installed.

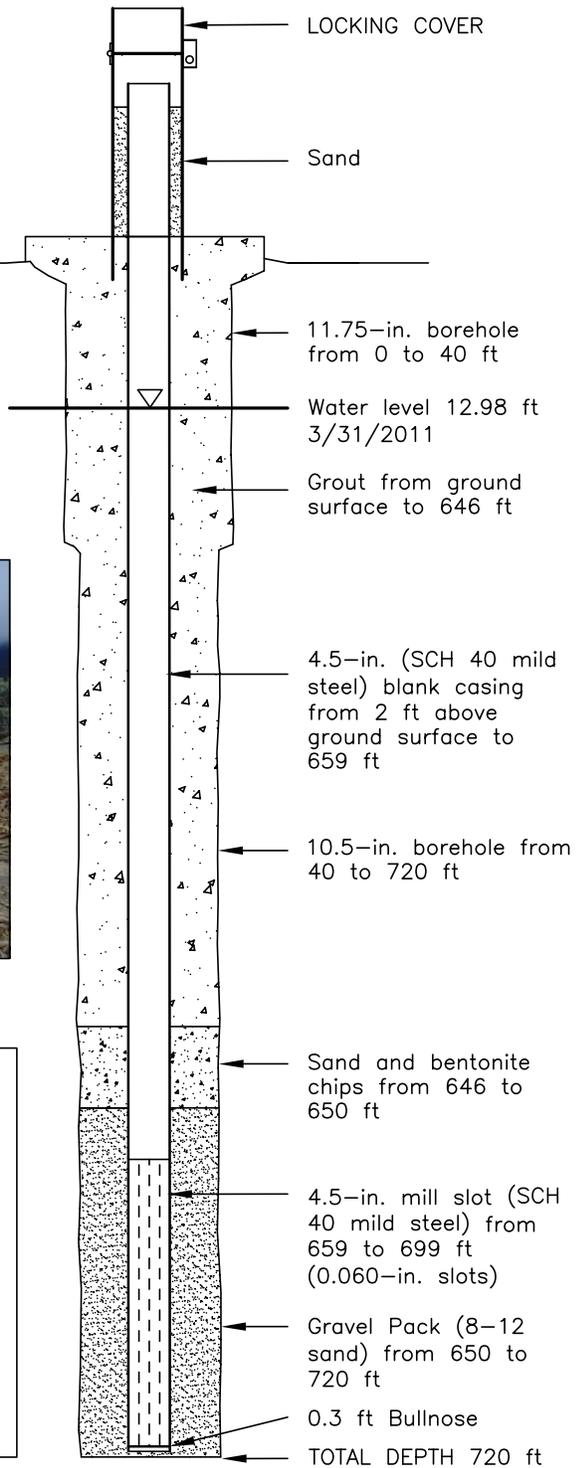
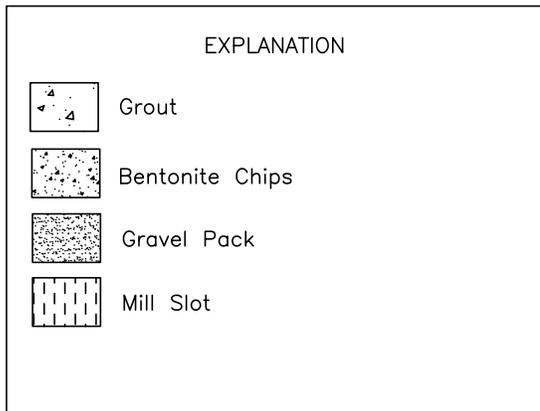
4.6 WATER-LEVEL DATA

This section discusses depth-to-water measurements noted after well construction. No measurements were noted during the drilling of Monitor Well SPR7024M because the borehole was drilled using a technique that created a wall cake on the borehole wall reducing the hydraulic communication with the formation. A total of 8 measurements ranging from 12.86 to 14.46 ft bgs were noted between March 27, 2011 and May 10, 2011. These measurements vary 1.60 ft with an average depth-to-water of 13.20 ft bgs. The surface elevation at the well is approximately 5,841 ft amsl. The average groundwater elevation is 5,828 ft amsl. The depth-to-water measurements for Monitor Well SPR7024M2 are listed on [Table 4](#).

SPR7024M2
 COORDINATES:
 UTM_ZONE 11N, NAD83
 N 724,562m; E 4,311,765m
 ELEVATION: 5,841 ft



Photograph of wellhead



UNLESS NOTED ALL DEPTHS ARE BELOW GROUND SURFACE

FIGURE 12
MONITOR WELL SPR7024M2 WELL COMPLETION DIAGRAM

TABLE 4
MONITOR WELL SPR7024M2 WATER-LEVEL MEASUREMENTS

| Date | Time | Depth (ft bgs) | Elevation^a (ft amsl) | Data Source |
|-------------|-------------|---------------------------|--|--------------------|
| 3/27/2011 | 6:32 | 14.46 | 5,827 | SNWA |
| 3/28/2011 | 10:45 | 12.86 | 5,828 | SNWA |
| 3/29/2011 | 7:20 | 12.99 | 5,828 | SNWA |
| 3/29/2011 | 12:08 | 12.97 | 5,828 | SNWA |
| 3/30/2011 | 6:36 | 12.99 | 5,828 | SNWA |
| 3/31/2011 | 8:29 | 12.98 | 5,828 | SNWA |
| 4/6/2011 | 9:38 | 12.95 | 5,828 | SNWA |
| 5/10/2011 | 18:45 | 13.42 | 5,828 | SNWA |

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

5.0

SUMMARY

Monitor Wells SPR7024M and SPR7024M2 were drilled in March 2011 on the east side of Spring Valley. Monitor Well SPR7024M is located approximately 47 ft S39W of Monitor Well SPR7024M2. 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 near the Shoshone Ponds. Two monitor wells were completed at different depths at the site approximately 0.75 miles from the Shoshone Pond Area of Critical Environmental Concern. 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.

A 10.5-in. borehole for Monitor Well SPR7024M was drilled to a total depth of 260 ft bgs and was completed with 4.5-in. casing to 249 ft bgs with a slotted interval from 209 to 249 ft bgs. The 10.5-in. borehole for Monitor Well SPR7024M2 was drilled to a total depth of 720 ft bgs and completed with 4.5-in. casing to 699 ft bgs with a slotted interval from 659 to 699 ft bgs.

Both monitor wells encountered Quaternary alluvium consisting of clay, sand, and gravels. The gravels consist of varicolored quartzite and intrusive volcanic clasts and are angular to sub rounded. Mixed with the quartzite and volcanic intrusive clasts are various amounts of silt and clay.

Drilling parameters provided additional data for analysis. These drilling logs were consistent with the coarse grained gravels and clay zones encountered, and were verified in the lithologic samples.

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.

6.0

REFERENCES

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