Drilling, Construction, Aquifer Testing, & Monitoring Plan for the
San Juan Spanish Valley Special Service District Well 1
Spanish Valley, Utah

April 2018

Prepared for:
San Juan Spanish Valley SSD &
The Utah Division of Water Rights

Prepared by:

CASCADE
WATER RESOURCES

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1.0 INTRODUCTION

From December 2017 to March 2018, a culinary well was drilled, constructed, developed, and aquifer tested in Spanish Valley, Utah for the San Juan Spanish Valley Special Service District (SJSVSSD). The well will be known as SJSVSSD Well 1 (Well 1). Before drilling the well, a Preliminary Evaluation Report (PER) and Engineering Specifications were submitted to Utah State Division of Drinking Water (DDW) which were approved by DDW. Approval from DDW is included in Appendix A.

The well is designed to provide culinary water for existing homes that are currently on private wells and potential new development in the San Juan County portion of Spanish Valley, Utah.

1.1 Water Right and Location

The well was drilled under the Utah State Division of Water Rights (DWRi) State Engineer’s approved change application a37400 on base water right 09-2349. The well was drilled by Beeman Drilling Services, Utah driller’s license number 824. The paperwork associated with the approval to drill the well from the State Engineers office is included in Appendix A.

The well is located in south of Moab, Utah at approximately north 200 feet and east 2,100 feet from the southwest corner of section 31, Township 26 South, Range 23 East, Salt Lake Base & Meridian, Location is shown on Figure 1.

1.2 Conditions of Memorandum Decision

The approval of the Change Application by DWRi, was a very complex Memorandum Decision in which 500 acre-ft were approved with numerous conditions. All of the conditions in the Memorandum Decision are included in Appendix A. This report will address the following aspects of each of the conditions;

Part of Condition 1. “A groundwater monitoring plan must be submitted and approved by the State Engineer before any water is diverted under this application.” It was agreed by the State Engineer, that it was best to drill and test a well and use information from this to custom fit the monitoring plan to the geographic location and aquifer parameters determined in testing.

Part of Condition 4. “No new or existing high volume (>50 gallons per minute) well development will be allowed closer than 1,000 feet from any existing well or spring and no new existing high volume well development will be allowed within 3,000 feet of any existing well or spring without a pump test to indentify whether or not there are interference issues
SJSVSSD Well 1 Location Map

Figure 1:
SJSVSSD Well 1 Location Map

1 inch = 11,500 ft

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig1.pdf
Cartography: maps@BluesunGeoGraphics.com

Grand County
San Juan County

Moab Industrial Park Well

SITLA Behind the Rocks Well

BLM (D-27-23)6cad-1

Shumway
Spielman
Johnston

SJSVSSD Well 1

SJSVSSD Monitored Wells
Wells added to the USGS monitoring plan by SJSVSSD
that may have to be addressed by the applicant. If there is evidence of interference resulting from the applicant’s activities, the applicant will be required to mitigate the impacts of the interference, provide replacement water for the uses being impaired or discontinue use of the well.”

Condition 5. “No new or existing high volume (>50 gallons per minute) well development will be allowed within 3,000 feet of Ken’s Lake dam or reservoir basin in order to mitigate concerns related to dam safety and reservoir operations.”

Figure 2 shows the location of the new well along with the zones mentioned in the “conditions” of the Memorandum Decision.

The logistics and planning prior to drilling this well was a dynamic process. There is one well within the 1,000-foot zone from Well 1. This well belongs to Melinda Elkin & Karl Spielman, and will be referred to as the Spielman Well in the remainder of this text. This well is approximately 320 feet from Well 1. Prior to drilling Well 1 attempts were made, but failed to pre-mitigate with the owners of the Spielman Well. At this time the SJSVSSD made the decision to go ahead with drilling a well at the same location as a “low volume” well or a well that would pump under 50 gallons per minute. This decision was based on the following:

1. Geographic and geologic location of the well was favorable,
2. Close proximity to a proposed storage tank
3. Close proximity of existing power infrastructure
4. High number (>100 connections) of existing property owners in the general vicinity that have chosen to hook into the new SJSVSSD system. It should be noted that many of these connections are on existing wells and production from these wells for culinary-use will cease and be provided by SJSVSSD. In other words, for these connections with existing wells there will be no net change in withdrawal from the local aquifers.
5. In this area even a “low volume” <50 gallon per minute well could provide enough water for approximately 90 domestic connections as per DDW calculations for use for domestic purposes.

After the plan for a low volume well was put into place, the owners of the Spielman Well agreed to allow their well to be monitored and also have gone back to the table on mitigation agreements. A signed agreement would allow the new Well 1 to be developed as a high volume (>50 gallon per minute) well. With this in mind, all drilling, design, well construction, and aquifer testing was completed as a “high volume” well.

1.3 Schedule of Drilling, Development and Aquifer Testing of Well 1

Below is the schedule of activities that took place on SJSVSSD Well 1.
SJSVSSD Well 1 Report

Figure 2: Zones from the Memorandum Decision Conditions

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig2.pdf
Cartography: maps@bluesunGeoGraphics.com
12/13/17 to 12/17/17 - An 8-inch pilot test hole is drilled to a depth of 527 feet. The hole was caving making drilling a test hole that water information could be collected any deeper impossible. A geophysical log was completed on the well on 12/17/17.

12/18/17 to 12/19/17-A 5-inch temporary sleeve is installed in the well to a depth of 420 feet and a 24-hour pump test was conducted at a flow of 70 to 80 gpm. At this point there was only approximately 14 feet of drawdown and the decision was made that that a higher flow pump could be installed in the well in order to stress the aquifer more than the 80 gpm pump. In order to do this a 7-inch sleeve would have to be installed to accommodate the larger pump.

1/2/18 to 1/15/18- A 7-inch temporary sleeve is installed to 420 feet and a 7-day pump test was conducted on Well 1. Pumping was followed by recovery. The Spielman and SJSVSSD Well 1 were monitored during this testing.

1/27/18 to 3/8/18- Well is reamed out and drilled to a final depth of 705 feet. Drillers experienced significant issues with drilling and construction of the well due to poor ground conditions above and below the groundwater table. Construction activities ended March 8th, 2018 with the installation of the DDW required sanitary seal.

3/21/18 to 3/26/24/18- Pump development on well. Well was developed at flows starting at 200 gpm and ending at 480 gpm. Water levels were monitored during this phase to determine the flow rate for the DDW required 24-hour aquifer test.

3/27/18 to 3/28/18- DDW Required 24-hour test. Flow rate for the 24-hour test was 480 gpm. The Spielman, Johnston, BLM, and Well 1 were all monitored for water level during the pumping and recovery portions of the test. As of 3/28/18, all activities on well construction, development, and aquifer testing are completed. Appendix B includes Well Driller’s log for Well 1 and the nearby wells.

### 2.0 WELL GEOLOGY

Figure 3 is a local geology map of the Well 1 area. The target of this well was the fractured sandstones of the Navajo, Keyenta, and Windgate Formations. Below is a summary of geology encountered in the borehole. The hole had essentially no productive saturation in the Navajo and was screened entirely in the Keyenta and Windgate Formations. The hole was drilled without injecting water to a depth of 257 feet.

<table>
<thead>
<tr>
<th>Depth in feet</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 235</td>
<td>Navajo Sandstone, locally highly fractured above and below the water table.</td>
</tr>
<tr>
<td>235 to 406</td>
<td>Highly faulted Keyenta, blocks of both Navajo and Windgate were present in this zone</td>
</tr>
<tr>
<td>406 to 705</td>
<td>Windgate Formation. Locally highly fractured.</td>
</tr>
</tbody>
</table>
**Geologic Units**

- Alluvial deposits (Qal/Qea)
- Younger alluvial gravel (Qagy)
- Older alluvial gravel (Qago)
- Terrace deposits (Qat)
- Eolian and alluvial deposits (Qae)
- Eolian sand (Qes)
- Slumps and Landslides (Qms)
- Burro Canyon Fm (Kbc)
- Morrison Fm, Brushy Basin (Jmb)
- Entrada Sandstone (Jes)
- Carmel Fm, Dewey Bridge (Jcd)
- Navajo Sandstone (Jn)
- Kayenta Fm (Jk)
- Wingate Sandstone (Jw)
- Collapse breccia (bx)

**SJSVSSD Well 1 Report**

- **Date:** March 2018
- **Project Manager:** John Files
- **File:** SJSVSSD_Fig3.pdf
- **Cartography:** maps@bluesunGeoGraphics.com
Figure 4 is the Well Construction, geology and geophysical log drawing for Well 1.

Data from this well was added to the existing UGS Cross section from Lowe et al. (2007). Modifications were made to the cross section to include data from Well 1. It should be noted that the geology of the Spielman and Johnston Well was interpreted from surface geology and Well 1 geology, because the actual formations were not called out in the Well Drillers Logs. Logs for the Spielman and Johnston Wells are included in Appendix B. Figure 5 is the modified cross section.

3.0 WELL DRILLING AND CONSTRUCTION

Beeman Drilling Services, drilled, constructed, developed, and pump/aquifer tested Well 1 from December 2017 to March 2018. Due to fracturing from faulting, there were some very difficult ground conditions. Caving zones above and below the water table made drilling, design, and construction of this well a dynamic process. The final well construction design was not the ideal for this formation, but was the safest design given the ground conditions.

3.1 Well Drilling

The plan for this well was to drill a small diameter hole to a depth of 700 feet then conduct an open-hole pump test to determine if the aquifer could be pumped at a minimum flow of 50 gpm. Due to ground conditions, only a depth of 527 feet could be drilled to without adding mud. For this reason, the open hole pump test was done after drilling to 527 feet. Below is a summary of drilling methods used in the hole;

<table>
<thead>
<tr>
<th>Depth in feet</th>
<th>Hole diameter and drilling method</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 527</td>
<td>8” Conventional air-water (flows and water quality collected)</td>
</tr>
<tr>
<td>0 to 705</td>
<td>13.25” Conventional Mud, reamed to 527, new hole to 705</td>
</tr>
<tr>
<td>0 to 274</td>
<td>18” Conventional mud. Had to ream hole to set casing to prevent caving in this zone</td>
</tr>
</tbody>
</table>

During drilling, flows and field parameters for water quality were collected to a depth of 527 feet. After each 20-foot rod was drilled, the injection water was turned off and flows and field parameters were measured. Due to some large cavities from fractures zones in the unsaturated portion of the hole, we were losing significant air. The maximum flow that could be airlifted was approximately 50 gpm due to this loss of air. It should be noted that water-quality samples were not taken until a depth of 317 feet due to low flow and the hole would dry up before water was clean enough to sample.
Figure 4: Well Construction, Borehole Geology and Geophysical Log
Figure 5: Geologic Cross Section

Geologic Units
- Qagy - Younger alluvial gravel
- Jn - Navajo Sandstone
- Jk - Kayenta Formation
- Jw - Wingate Sandstone

Static Water Table Elevation
24-hour Pump Test Drawdown Elevation Pumping at 480 gpm
10-year Estimates of Drawdown Elevation Pumping at 320 gpm

Modified from Lowe et al. (2007, section F-F')

SJSVSSD Well 1 Report
Date: March 2018
File: SJSVSSD_Fig5.pdf

Project Manager: John Files
Drawn By: maps@BluesunGeoGraphics.com

1 inch = 150 feet
<table>
<thead>
<tr>
<th>Depth(ft)</th>
<th>Flow (gpm)</th>
<th>Conductivity(us/sec)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>257</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>297</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>317</td>
<td>20</td>
<td>310</td>
<td>7.4</td>
</tr>
<tr>
<td>337</td>
<td>40</td>
<td>320</td>
<td>7.4</td>
</tr>
<tr>
<td>357</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>377</td>
<td>50</td>
<td>310</td>
<td>7.6</td>
</tr>
<tr>
<td>397</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>417</td>
<td>50</td>
<td>320</td>
<td>7.4</td>
</tr>
<tr>
<td>437</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>457</td>
<td>50</td>
<td>310</td>
<td>7.5</td>
</tr>
<tr>
<td>477</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>497</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>517</td>
<td>50</td>
<td>320</td>
<td>7.5</td>
</tr>
<tr>
<td>537</td>
<td>50</td>
<td>310</td>
<td>7.4</td>
</tr>
<tr>
<td>557</td>
<td>Not able to develop sample due to caving</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2 Well Construction

Well 1 was constructed as shown on Figure 4. As mentioned above, this was not the ideal construction, but what was felt to be the safest construction possible given the ground conditions.

4.0 DEVELOPMENT

The well was first developed by using the drill rig. Both dual surge blocks and air jetting method was used on the well for approximately 50 hours. After the rig development was complete, a pump without a check valve was installed to a depth of 420 feet in the screen section near the top of the Windgate. The well was then put through a series of surge and pump cycles (raw hiding). Flows started at 200 gpm and were slowly increased to 480 gpm. The well was surged from 1 to 3 times then allowed to pump for a minimum of 1 hour. During the pumping portion of the cycle, sand content was measured with a Rossum sand tester. Water levels at the end of each surge cycle were compared, if water level was higher, improvement was being made with communication with the well to the aquifer. Though we were still making progress at the end of the pump development, the increases were minimal and the decision was made to cease pump development on a cost vs. benefit. At the end of development, an estimate was made that at 480 gpm, approximately 30 feet of the total 91 feet of the drawdown is due to efficiency issues. Below is a plot of the water levels and flow during development.
5.0 AQUIFER TESTING

Three separate pumping/aquifer tests were performed on Well 1. In addition, a 24-hour pump test was conducted on the Spielman well during the 7-day 193 gpm test of Well 1. Below is a summary of the aquifer/pump tests that were conducted.

1. 24-hour, 70 gpm open hole test. This test was performed to establish if the well could produce a minimum 50 gpm, and to help size the pump for the 7-day test. Water levels in Well 1 and the Spielman well were monitored during this test.
2. 7-day, 187 gpm average flow test. This test was performed to establish any potential interference with nearby wells. Water levels were monitored in Well 1 and the Spielman Well. The final flow of for the last 6 days of the test was 193 gpm.
3. Spielman 24 hour 40 gpm test. This test was performed during the Well 1, 7-day test. The purpose of this test was to establish any influence pumping Well 1 might have on the Spielman Well’s ability to produce.
4. DDW Required 24.5-hour pump test. This test was performed at a flow of 480 gpm. The flow of 480 was chosen to stress the aquifer as much as possible during the 24.5-hour test. During this test, water levels were monitored in Well 1, the Spielman Well,
Johnston Well, and the BLM Well. The test ran an extra half hour due to a late arrival of the New Source sample bottles, not due to any aquifer related issues.

Below is a summary of each of the individual tests.

5.1 **24-Hour 70 gpm Test**

This test was performed simply to establish if Well 1 could produce a minimum 50 gallons per minute. A 5-inch sleeve was placed to a depth of 420 feet and the pump was set to a depth of 400 feet. During the test field parameters for conductivity, pH, and turbidity were measured.

Water levels were monitored in Well 1 and the Spielman Well. Below is a plot of the water levels in both wells during the test.

![Depth to Water in SJSVSSD Well 1 & Spielman Well During 24 Hour Test](image)

The maximum drawdown observed in Well 1 was 14 feet, and in the Spielman Well 0.20 feet.

During this test the conductivity of the water was consistently in the 280 to 330 us/sec range,
pH in the 7.4 to 7.6 range, and turbidity was clear except for brief periods of very turbid water due to caving of sandstone taking place in the open borehole.

5.2 7-Day Test

For this test a 7-inch sleeve was placed to a depth of 420 feet and the pump was placed at a depth of 400 feet in the open sleeved hole. Water levels were monitored in Well 1 and the Spielman Well. An attempt was made to also monitor the Johnston Well, but a monitoring agreement could not be reached between Mr. Johnston and the District as Mr. Johnston wished to be on site during the installation of a sounding tube and was out of town at the time of the test. In addition to the 7-day pumping portion of this test, the well was allowed to recover for 7 days after the pumping. The flow was slowly turned up in this test, as when testing an open hole, each time the flow was turned up some sandstone from the formation was brought into the well. The flow was increased slowly in order to minimize the impact on the hole integrity.

Below is a plot of the water level in Well 1 and the Spielman Well during the 7-day test.

Below is a plot of the drawdown and flow of Well 1 during the 7-day test.
Drawdown and Recovery in SJSVSSD Well 1 During 7 Day Open Hole Test

Flow at end of Test = 193 gpm

Below is a zoomed in plot the Spielman Well and Well 1 during the pumping and recovery.

Depth to Water in 7 Day Open Hole Aquifer Test, SJSVSSD Well 1 and Spielman Well

Date / Time

31-Dec-17  2-Jan-18  4-Jan-18  6-Jan-18  8-Jan-18  10-Jan-18  12-Jan-18  14-Jan-18  16-Jan-18  18-Jan-18

Depth to Water Well 1 (ft)

Depth to Water in Spielman Well
The maximum drawdown observed in Well 1 was 43.4 feet and the drawdown at the end of the test was 41.8. The maximum drawdown observed in the Spielman Well due to pumping Well 1 was approximately 1 foot.

During the test we did have some interesting open hole dynamic issues. The first night of the test, the water level rose approximately 9 feet and the flow increased from 155 to 165 gpm. No adjustments were made to the pump during this time. We attribute the change in level and flow to pumping out zones that had filled with sand from caving portions of the open hole (the hole had been sitting for over two weeks). Throughout the test there were other instances of changes in flow and level that can be attributed to open hole issues that were not aquifer related.

The only shutdown we had during the test was on 1/4/18, we shut down the test for approximately 8 minutes to replace a leaking hose.

### 5.3 Spielman 24-Hour 40 gpm Test

During the 7-day test of Well 1, a 24-hour pump test was performed on the Spielman Well. This test was conducted in order to test the ability of the Spielman Well to pump its capacity while Well 1 was pumping. Below is the water level plot of drawdown during this test. The maximum drawdown observed at a flow of 40 gpm was 11.7 feet.
This test did have approximately 5 minutes of shutdown time to repair a leaky valve.

Below is a plot of the Spielman water level with respect to the zones the well is screened.

![Depth to Water in Spielman Well (ft toc)](chart.png)

**5.4 DDW Required 24-Hour Test**

This test was conducted on the completed well. Data from development indicated the well could likely sustain and stabilize at the pump’s maximum flow-rate of 480 gpm. It should be noted that 480 gpm is not a recommended flow rate for the well (see Section 8.0 Safe Yield). The flow of 480 gpm was chosen for the 24 hour test to safely stress the aquifer to its maximum and still allow for stabilization of the pumping level. Secondary to the stressing of the aquifer is the DDW’s 2/3 rule. DDW R309-515-6(10)(B)(c) Safe Yield states, “If the aquifer drawdown test data show that the drawdown has stabilized, the Director will consider 2/3 of the pumping rate used in the constant-rate test as the safe yield of the well. The safe yield is used to determine the number of permanent residential connections or ERCs that a well source can support”. This rule is only a calculated safe yield and does not take into account the actual aquifer parameters or drawdown of a well. In this case the DDW assigned safe yield of Well 1 would be 2/3 of 480 gpm, or 320 gpm.

During the 24-hour test water levels were monitored in Well 1, Spielman Well, Johnston Well, and the BLM Well. Below is a table showing the distance from the pumping well and the maximum drawdown observed in the 24-hour test.
SJSVSSD Well 1 Report

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Distance from Well 1</th>
<th>Maximum Drawdown (ft)</th>
<th>Geology</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSVSSD Well 1</td>
<td>0</td>
<td>91</td>
<td>Keyenta/Windgage</td>
</tr>
<tr>
<td>Spielman Well</td>
<td>320</td>
<td>0.4</td>
<td>*Navajo(?) /Keyenta</td>
</tr>
<tr>
<td>Johnston Well</td>
<td>1,200</td>
<td>3.01</td>
<td>*Keyenta/Windgate</td>
</tr>
<tr>
<td>BLM Well</td>
<td>4,283</td>
<td>0</td>
<td>Drill log states Navajo</td>
</tr>
</tbody>
</table>

*Drill log does not state geology, geology is interpreted from surface and Well 1 geology.

Below is a composite plot of all of the groundwater elevations for all of the wells that were monitored during the 24 hour test.

---

Below is a zoomed in plot of water levels for wells that had observed drawdown;
Below is the zoomed in drawdown for the Spielman Well.

**Depth to Water in Spielman Well (ft.toc) during Well 1- 24 Hour Test**
Below is the zoomed in drawdown for the Johnston Well.

![Depth to Water in Johnston Well](image)

Figure 6 is the contoured observed drawdown from the 24 hour test.

### 6.0 AQUIFER TEST ANALYSIS

#### 6.1 Analysis Methods

Several different methods of calculating transmissivity for each well were used. For Well 1, AQTESOLV was used for both the 7-day and 24-hour data. The 7-day test would not be influenced by well efficiency issues that would cause more drawdown. As this aquifer is thought to be unconfined, the unconfined Theis and Cooper Jacob were both ran on the Well 1 data. The AQTESOLV plots are included in Appendix C.

For the analysis of the Spielman and Johnston Wells; backing into a Theis Distance Drawdown calculation was used. Time pumped, flow rate, distance from well, and drawdown were all known, so the knowns were inserted into the DWRi calculator and the transmissivity value was backed into. Data plots for calculation of the Johnston and Spielman Wells are also included in Appendix C.

Below is the data that was used for backing into the transmissivity of the Spielman and Johnston Wells. This method was also used simply for comparison purposes for Well 1.
SJSVSSD Well 1 Report

Figure 6:
Drawdown for 24-hour 480 gpm Pump Test

Wells added to the USGS monitoring plan by SJSVSSD

Drawdown Contours
- 0.1’ - 0.5’
- 0.5’ - 1.0’
- 1.0’ - 10’
- 10’ - 91’

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig6.pdf
Cartography: maps@BluesunGeoGraphics.com
Spielman Well
Well 1 Flow = 193 gpm
Distance from Well 1 = 320 feet
Aquifer Storativity (S) = .0002
Time = 7 days
Drawdown after 7 days = *1.42
Resulting Transmissivity = 20,000 ft²/day
*Actual drawdown was 1.0 feet.

Johnston Well
Well 1 Flow = 480 gpm
Distance from Well 1 = 1.200 feet
Aquifer Storativity (S) = .0001
Time = 24 hours
Drawdown after 24 hours = 3.10
Resulting Transmissivity = 12,500 ft²/day

Well 1
Well 1 Flow = 480 gpm
Distance from Well 1 = 0.000001 feet
Aquifer Storativity (S) = .0001
Time = 24 hours
Drawdown after 24 hours = 90.43
Resulting Transmissivity = 9,800 ft²/day

Below is a summary of the Transmissivity calculated for each well during the test.

<table>
<thead>
<tr>
<th>Well</th>
<th>Test</th>
<th>Method</th>
<th>Transmissivity (ft²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well 1</td>
<td>7-day AQTESOLV-Theis</td>
<td>10,400</td>
<td></td>
</tr>
<tr>
<td>Well 1</td>
<td>24-hour AQTESOLV-Theis</td>
<td>4,001</td>
<td></td>
</tr>
<tr>
<td>Well 1</td>
<td>24-hour AQTESOLV-Cooper-Jacob</td>
<td>10,400</td>
<td></td>
</tr>
<tr>
<td>Well 1</td>
<td>24-hour Calculated Theis</td>
<td>9,800</td>
<td></td>
</tr>
<tr>
<td>Spielman Well</td>
<td>7-day Theis Distance-Drawdown</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Johnston Well</td>
<td>24-hour Theis Distance-Drawdown</td>
<td>12,500</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>11,183</td>
</tr>
</tbody>
</table>

### 6.2 Discussion of Transmissivity Values

The purpose of calculation of transmissivity is for an estimation of transmissivity for the aquifer, not just an individual well. When using drawdown data from an individual pumping constructed well, all methods use the measured drawdown from the well. In a constructed well, a percentage of the drawdown is related to well efficiency and is not aquifer related.
Wells that are completed different distances away from the pumping well are always a better indicator of transmissivity of an aquifer than analysis of a pumping well.

In the case of the 24-hour 480 gpm test, the Spielman Well, which is 320 feet away from the pumping well, had less drawdown than the Johnston Well which is located 1,200 feet away. This indicates that the Spielman Well is screened in a zone that is more transmissive than the Johnston Well. The well log for the Spielman Well indicates the well is screened in a highly fractured zone, and in conversations with the driller of the well, he indicated the well could not be drilled any deeper with his methods due to caving issues. This data suggests that the Spielman well is screened only in a transmissive part of the aquifer.

Geologic data collected while drilling Well 1 indicated that there were very transmissive zones producing significant water as well as zones that are not as transmissive. This is not unusual for any aquifer. The Johnston Well, which was drilled deeper than the Spielman Well, is likely to also have a larger range of transmissivity in the hole, which when combined yields an overall drawdown of the aquifer for all zones. This in turn leads to a well location that is not as transmissive. If a well was drilled deeper at the location of the Spielman Well and screened in portion of the aquifer similar to those screened in the Johnston Well, the Spielman Well location would likely have a much higher observed drawdown.

7.0 PREDICTED DRAWDOWN

Two methods of predicting regional drawdown were used for this report, basic Theis calculations and an AQTESOLV forward modeling program. All calculations were done for only a 10-year time frame. Though the calculations can go as far into the future as desired, it is not reasonable or reliable to use any method for a longer time frame as many of the inputs can change over time. Both the Theis based calculations and the AQTESOLV modeling software used assumes the aquifer is homogeneous, isotropic, the base is horizontal and impermeable, and it does not account for recharge to the aquifer or discharges via leakage or other aquifer extractions. The model is based on the Theis Equation, which assumes these conditions. Actual conditions vary from these assumptions; though the bedrock aquifer and valley-fill aquifers are connected they likely share much different aquifer parameters.

7.1 Theis Predictive Calculations for Individual Wells

For this method, the individual transmissivity for each well was used and inputted into the Theis based predictive calculation. This calculation projects drawdown into the future based on the calculated transmissivity. The values for the predicted 10-year drawdown was then plotted on a map and hand contoured. This method will work best in predicting the drawdown for existing wells. Data from these plots are included in Appendix D. The data was also exported and plotted on a time series. Below is a plot of the predicted drawdown for the individual wells.
The contoured calculated predicted drawdown is presented in Figure 7.

### 7.2 AQTESOLV Forward Modeling

Using this method, the average transmissivity was inputted into the AQTESOLV forward modeling program. Below are the parameters used for the model.

\[
T = 11,183 \\
\text{Aquifer Thickness} = 560 \text{ feet-Estimated saturated thickness to bottom of Windgate used} \\
\text{Casing Radius of Pumping Well} = 0.6667 \text{ feet} \\
\text{Well Radius} = 1.10 \text{ feet} \\
\text{Flow} = 320 \text{ gpm.} \\
\text{10-year time frame}
\]

Using this method, the modeled drawdown exceeds the actual observed drawdown for the Spielman Well. This method is a good conservative estimate of the local extent of possible drawdown that may be observed over 10 years of pumping. The forward modeled contouring is presented in Figure 8.
Figure 7: Thies-based Predicted Drawdown Map

**SJSVSSD Well 1 Report**

**Drawdown Contours**
- 0.1' - 4.9'
- 5.0' - 24.9'
- 25' - 49.9'
- 50' - 64'

1 inch = 2,000 ft

- **SJSVSSD Well 1**
- **SJSVSSD Monitored Wells**
- **Wells added to the USGS monitoring plan by SJSVSSD**

**Date:** March 2018

**Project Manager:** John Files

**File:** SJSVSSD_Fig7.pdf

**Cartography:** maps@BluesunGeoGraphics.com
SJSVSSD Well 1 Report

Figure 8: 10-year AQTESOLV Predicted Forward Drawdown Model

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig8.pdf
Cartography: maps@BluesunGeoGraphics.com

SJSVSSD Well 1
SJSVSSD Monitored Wells
Wells added to the USGS monitoring plan by SJSVSSD
Area Wells

1 inch = 850 ft
7.3 Discussion of Predictive Methods

All methods of predictive calculations or modeling have limitations. Models or calculations cannot take into account real-life changes in climate, recharge, discharge from other wells, or how aquifer parameters change as levels drop due to natural or pump-induced influence. Boundaries may also be encountered that would accelerate or slow the rate of change of the local water-table. For these reasons, even though the methods used can predict as far into the future as desired, only a 10 year time frame was used.

The predictive flow used was 320 gallons per minute. This is a very conservative safe yield for Well 1 short term. However, this well will likely not be pumped at near that flow for many years in the future if ever. San Juan Spanish Valley SSD currently has no active hook-ups. An estimated 110 parties have signed on for use in the system. Using the DDW estimated calculation of indoor domestic use of 800 gallons per day, the maximum use when the well goes online would be approximately 61 gallons per minute on an annual basis. This is a very high estimate for use, but will be a good conservative estimate. For example, Grand County Water Conservancy District listed a total of 1,958 connections in 2017. The total use for 2017 was 960.5 acre-feet. This equates to an annual flow per connection of 438 gallons per day, much less than the 800 used in the calculation. Using the Grand County data, expected flow from Well 1 with the new hook-ups would be 33 gpm. Either way, the estimated flow from Well 1 for the first few years would be between 30 and 100 gpm, much less than the calculated and modeled 320 gpm.

This scenario will be ideal for refining the long-term drawdown predictions in the area. Instead of using a snapshot as was used for these calculations, actual data for years at lower flow rates can be used to help predict actual drawdown.

Models and calculations can be used only as a guide to what may happen in a local aquifer. These methods should not be taken as a hard prediction as to the actual drawdown in the future. There is no substitute for actual long-term water level data. It has been my experience with over 30 years of monitoring individual basins, that in basins experiencing increased extractions, that models and calculated drawdown always under-predict observed local drawdown.

In the case of Well 1, the modeled and actual observed drawdown is minimal and will not have any impact on the ability of the surrounding wells from producing the water right for each individual well. Given observed drawdown in area wells of 3 feet and under for all tests, production from this well will not interfere with any local wells to a point that impairs production of individual water rights. If, for example, the Spielman Well had seen drawdown greater than 10 feet, that would be a completely different scenario, and a lower safe yield would be recommended for Well 1 that would limit the drawdown in surrounding wells.

As noted above, the model and calculations have limitations. This section just looks at the impacts related only to Well 1. There are other outside factors that cannot be brought into
calculations using these predictive methods. Namely, increased discharge from the aquifer or decreased recharge due to climate or man-made influences. As the majority of land up-gradient from Well 1 is in the service area of Well 1 and the SJSVSSD, there are not thought to be any large producing wells that would be brought into the system. DWRi has in place a new appropriation policy that allows individual land owners to drill their own well with up to 5.73 acre-feet per home. Having a Public Water System to hook to will not increase or decrease the amount of water that would be pumped from the aquifer, it simply moves it from many small wells to one larger well.

The largest unknown is recharge to the aquifer from Kens Lake. When the lake was constructed in the early 1980’s, groundwater levels rose up to 30 feet from leakage. Since then, levels have declined some due to repairs which has slowed the leakage rates. Below is the USGS monitoring data of a well that is approximately 4 miles down gradient of Kens Lake.

The actual volume of leakage in the reservoir is not known, however if all leaks were repaired it is thought that it would have an impact on recharge to wells in the Well 1 area.
8.0 SAFE YIELD OF WELL 1

The DDW definition of safe yield is 2/3 the pump tested flow of a new well in a 24-hour test. With the test completed at 480 gpm this would put the safe DDW safe yield at 320 gpm. With all of the information available for this aquifer, 320 gpm is likely an accurate long-term safe yield for this well and aquifer. There are no other large volume wells screened in this aquifer in the area. The transmissivity estimated is very conservative and aquifer drawdown is much less than well drawdown due to efficiency issues with the well.

With the above in mind two safe yield estimates are made for the well.

1. Short term and long term, the short term being a flow the well can safely pump for the summer months on a high demand basis.
2. The long term would be the estimated safe yield on an annual basis.

The short-term safe yield would be 400 gpm. The short term means the well can be pumped for short durations, usually under 6 hours and would need to recover fully prior to pumping the well again. The long-term safe yield is 320 gpm.

This safe yield can be reviewed each year after pumping and water level information are analyzed. If adjustments to the long-term safe yield need to be made they can be completed after each year’s pumping and water level data is analyzed. Given the local hydrology, and also the actual required use for the small number of hook ups, it would be very safe to install a pump capable of 320 gallons per minute.

9.0 MONITORING PLAN

As required by the Memorandum Decision on the water right for this well, a monitoring plan is required for Well 1. Using the data from drilling, development, aquifer testing, and predicative drawdown methods, the monitoring plan can be tailor fit for extractions at this site.

9.1 SJSVSSD Well 1 Monitoring Plan Sites

Using the data collected from the nearby wells, a potentiometric map was constructed for this immediate area. This map is presented in Figure 9. All measuring point elevations were surveyed using RTK GPS with a vertical accuracy of +/- 0.03’ (3/8”). All water levels were taken under static conditions in March of 2018 with the exception of the Shumway Well which was taken on April 9th 2018.

For monitoring in the immediate area, transducers have been installed in a total of 4 wells which are;

1. SJSVSSD Well 1- Actual Production Well
2. BLM Well- Located 4,283 feet up gradient
3. Spielman Well- Located 320 feet away, adjacent Well 1
4. Shumway Well – Located 1,196 feet down gradient
SJSVSSD Well 1 Report

Figure 9: Potentiometric Map - March 2018

Date: March 2018
Project Manager: John Files
Cartography: maps@BluesunGeoGraphics.com

SJSVSSD Monitored Wells
- Shumway 4675'
- Spielman 4678'
- Johnston 4694'
- SJSVSSD Well 1 4681'
- BLM 4756'

Wells added to the USGS monitoring plan by SJSVSSD

1 inch = 650 ft

SJSVSSD Well 1
SJSVSSD Monitored Wells
Wells added to the USGS monitoring plan by SJSVSSD

File: SJSVSSD_Fig9.pdf
Currently, the minimum frequency for recording is every 6 hours. This interval was increased for testing and can be changed in the future if the need arises. Geologically, all of the wells are screened in the Glen Canyon Group. Refer to Figures 10 and 11 for the location of these wells.

In addition to the nearby wells SJSVSSD has installed transducers into for the Monitoring Plan; the United States Geological Survey (USGS) has recently started a monitoring plan that includes 23 wells in the Moab /Spanish Valley area. These wells are geographically from the Behind the Rocks & Pole Canyon Road area on the south extent to the Colorado River on the north. It should be noted that the USGS had slated the BLM well as part of their plan, but due to well construction issues it is not possible to measure the level in the well with the transducer in the well at the same time.

At the request of the SJSVSSD, the USGS added 3 additional wells into their plan, these wells are,
1. The Johnston Well
2. Moab Industrial Park Well
3. SITLA Behind the Rocks Well

Wells within the USGS plan have water levels taken annually in March, and then after QA/QC, are added to the USGS Utah water level database.

Refer to Figure 10 for the location of all of the wells included in the USGS Monitoring Plan that will be incorporated into the SJSVSSD Well 1 Monitoring Plan. Figure 11 is a zoomed in area near Well 1.

There are a total of 29 wells included in the Monitoring Plan for Well 1, 25 of the wells will be monitored by the USGS as part of their plan, and the remaining 4 are monitored by SJSVSSD. SJSVSSD has also granted the USGS access to the transducers and transducer data if they would like to include this data in their monitoring plan.

9.2 SJSVSSD Well 1 Monitoring Plan Reporting

As part of any monitoring plan, the reporting is a critical part. The USGS expects to have its monitoring completed and reported by the end of March each year. The SJSVSSD Wells can be downloaded at any time. The recommendation would be made that at least for the first 5 years of monitoring, that an annual report be submitted to the Division of Water Rights with the data collections time frame being the end of March, and the reporting time frame the end of June. Within the annual report will be the following data.
1. Time series plots for all water levels for wells in monitoring plan
2. A change in potentiometric elevation map that covers areas in Figure 10 and 11. An example of a change of potentiometric map is included in Appendix D.
SJSVSSD Well 1 Report

Figure 10: Groundwater Monitoring Plan Well Locations

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig10.pdf
Cartography: maps@BluesunGeoGraphics.com

1 inch = 11,500 ft
Figure 11: Groundwater Monitoring Plan Well Locations (zoomed in)

San Juan Spanish Valley Special Service District

Date: March 2018
Project Manager: John Files
File: SJSVSSD_Fig11.pdf
Cartography: maps@BluesunGeoGraphics.com

1 inch = 2,600 ft

- SJSVSSD Well 1
- USGS Monitored Wells
- SJSVSSD Monitored Wells
- Wells added to the USGS monitoring plan by SJSVSSD

- (D-26-22)15dca-1
- (D-26-22)22aab-1
- (D-26-22)22dad-1
- (D-26-22)23ccb-2
- (D-26-22)22ddc-2
- formerly (D-26-22)27aaa-1
- formerly (D-26-22)26ddb-1
- (D-26-22)23bbca-1
- Moab Industrial Park Well
- Shumway
- SJSVSSD Well 1
- Spielman
- Johnston
- BLM (D-27-23)6cad-1

Project:
- (D-26-22)1bbca-1
3. Discussion of results. This will provide discussion of any changes observed from the previous year’s data. It will also include any changes to the monitoring plan such as additions of new monitoring locations, changes in monitoring frequency, or observed trends that are not related to pumping of Well 1.

9.3 Discussion of Monitoring Plan

This monitoring plan is unique for Well 1. There is currently only 500 acre-feet approved on the change application Well 1 is associated with. 500 acre-feet equates to an annual flow of 310 gallons per minute. This plan is more than adequate for extraction of this volume at this location. If, in the future, other wells are added with different change application approvals or other wells drilled on the existing change application, the plan can be modified to take into account the new individual geographic location, geology, and aquifer parameters. In addition, the history from this plan can be used as a baseline for any new locations.

There are many other larger influences of water elevation between Well 1 and the seeps and springs along the Colorado River. Between Well 1 and the seeps and springs along the Colorado, there are many large used and unused approved underground water rights. The scope of this plan in conjunction with the USGS plan should be able to differentiate the changes that are due to the pumping of this well and the pumping of other wells in the area.

It is not disputed that a drop in groundwater elevation in proximity to the Colorado River and Matheson Wetlands Preserve will decrease the flow in seeps and springs along the Colorado River, including those in the Matheson Wetlands Preserve. What this plan will hopefully do is discriminate changes in groundwater elevation already taking place to changes, if any, associated with extractions from Well 1.

10.0 CONCLUSIONS AND RECOMMENDATIONS

There was no short-term interference monitored that would prevent any of the existing well owners in the area from producing their water right unimpaired while Well 1 was pumping 193 to 480 gallons per minute. In addition, there was no calculated or modeled drawdown that would prevent any existing well owners from producing their water right unimpaired when Well 1 is pumping 320 gallons per minute. As was stated above, it will be many years before the actual production of this well would reach 320 gallons per minute.

The majority of connections that will be serviced by this well for the first five years of use is made up of connections that already have a well or a water right. There will only be a slight net change in extractions from this aquifer as extractions will decrease from private wells and now be centralized in one well. Though the balance of paper water in the Valley will increase, the actual wet water extractions will be close to the same for the first few years of operation.
Current DWRi appropriation policy for this area, allow up to 5.73 acre-feet per home of new appropriations. In other words, if individual land owners wanted to build 50 individual homes (on 1 acre or more) they could legally apply for a total of 50 individual 5.73 acre-feet appropriations totaling 286.5 acre-feet, as was done with the development in the Mt. Peale Road area. The recommendation would be made to the DWRi that with the approval of water rights on Well 1 that a temporary moratorium be placed on all new domestic appropriations in the active service district of SJSVSSD. This moratorium could be reviewed after a few years of data collection and reporting on the monitoring plan.

Given the unknowns with long-term pumping in any aquifer, the strong recommendation would be made that no more than 500 acre-feet be approved for use on Well 1 on the existing change application. If SJSVSSD would desire to drill an additional well under the existing approved water right, at least five years of monitoring and reporting would need to be completed and this data would need to be reviewed by DWRi and all of the stakeholders in the area.

Transparency is critical in any monitoring plan; any of the stakeholders in the area will have access to all data collected at any time. In addition, stakeholders will have input to changes in the monitoring plan, production rates, or any other unforeseen circumstance. This plan will be circulated to all of the stakeholders for comments, and changes will be adopted that prove to be reasonable.
APPENDIX A:

Paperwork from DWRi and DDW for Well Drilling Approval

Conditions from DWRi in Memorandum Decision
December 29, 2017

Kelly Pehrson
San Juan Spanish Valley SSD
PO Box 9
Monticello, Utah 84535

Subject: Plan Approval, Well Drilling, SJSVSSD Well 1 (WS001), San Juan Spanish Valley Special Service District (SJSVSSD), System #19080, File #11081, SRF #3F275

Dear Mr. Pehrson:

The Division of Drinking Water (the Division) received the plans and specifications for the SJSVSSD Well 1 project from your consultant, John D. Files of Cascade Water Resources on November 9, 2017.

We understand that this project consists of a new single groundwater well to be located in San Juan County. The well will be drilled using a conventional rotary method with a minimum of 12-inch diameter that will allow for the annular space needed for the 8-inch casing. The drilling conditions will dictate actual sizes used, with a possibility of telescoping if caving conditions are encountered. The SJSVSSD Well 1 is identified as WS001 in the Division’s database.

We have received the following information for the SJSVSSD Well 1:
1. Plans and specifications for borehole and well drilling
2. Preliminary Evaluation Report
3. Bidding documents and Notice of Award

We have completed our review of the plans and specifications, stamped and signed by John D. Files, P.E., and dated November 8, 2017, and found they basically comply with the applicable portions of Utah’s Administrative Rules for Public Drinking Water Systems.
We hereby approve the proposed plans to construct the SJSVSSD Well 1 subject to the following conditions:

1. Approval from the Division of Water Rights to drill the well by obtaining a start card from the State Engineer’s Office.

Conditions of approval must be addressed to the satisfaction of the Director by March 1, 2018, or this approval is invalid.

This approval pertains to well drilling, development, aquifer testing, and disinfection of the SJSVSSD Well 1 only. Please be aware that discharge permits may be required by Utah Division of Water Quality for discharges generated during well drilling and aquifer drawdown testing.

After drilling is completed, you are required to submit additional information outlined in R309-515-6(5)(b) and (c) for review, and obtain an approval from the Director for equipping this well and constructing discharge piping and infrastructure necessary for introducing the well water into the distribution system. After obtaining the well equipping approval, you’ll then be required to obtain an Operating Permit before the SJSVSSD Well 1 may be put in service. A checklist outlining the well approval process, including the items required for well equipping and an Operating Permit, is enclosed for your information.

Please label the well water sample collected for new source chemical analysis with your water system number UTAH19080 and WS001 (for both the facility ID and sample point ID) on all laboratory forms for each individual source. This will ensure proper identification and entry of the new source chemical analysis results in our database.

We have also reviewed your submission of the Preliminary Evaluation Report (PER) for the proposed Spanish Valley Well. The Division of Drinking Water concurs with this report. This PER must be refined and a complete Drinking Water Source Protection (DWSP) Plan submitted within one year of the date of this letter. Refer to R309-600-13(6) and R309-600-7(1). You must submit proof that the final delineation has been submitted to San Juan Spanish Valley SSD to be covered under their Source Protection Ordinance, before the well can receive an operating permit. The proof of coverage under the ordinance may be submitted to the Division before the DWSP Plan is due. If you have any questions or concerns about source protection requirements please contact source protection staff at (801) 536-4200.

Approvals or permits from the local authority or county may be necessary before beginning construction of this project. As the project proceeds, notice of any changes in the approved design, as well as any change affecting the quantity or quality of the delivered water, must be submitted to the Division. We may also conduct interim and final inspections of this project. Please notify us when actual construction begins so that these inspections can be scheduled.
This approval must be renewed if construction has not begun or if substantial materials have not been ordered within one year of the date of this letter. If you have any questions regarding this approval, please contact Lisa Nelson, of this office, at (801) 536-4348 or Michael Grange at (801) 536-0069.

Sincerely,

Michael J. Grange, P.E.
Construction Assistance Manager

LCN/SP/mjg/dg/hb

Enclosure — Well Approval Checklist

cc: Rick Meyer, Environmental Health Director, San Juan Country Health Department, rmeyer@sanjuancounty.org
    Daniel Hawley, Jones & DeMille, Daniel.h@jonesanddemille.com
    Ryan Jolley, Jones & DeMille, ryanj@jonesanddemille.com
    Lisa Nelson, P.E., Division of Drinking Water, lcnelson@utah.gov
    Kate Johnson, Division of Drinking Water, katej@utah.gov
    Deidre Beck, Division of Drinking Water, dbeck@utah.gov
    Scott Hacking, P.E., District Engineer, shacking@utah.gov
    Gayle Gardner, Community Impact Board, ggardner@utah.gov
    Candace Powers, Community Impact Board, cpowers@utah.gov

DDW-2017-014170.docx
ORDER OF THE STATE ENGINEER
Permanent Change Application Number
09-2349 (a37400)
Page 12

The State Engineer believes that continued development of Utah’s share of the Colorado River can be achieved along with recovery of the endangered fish species native to the Colorado River system. The State Engineer is of the opinion that the natural stream environment, recreational opportunities, and endangered fish habitat through this stretch of the river will not unreasonably be impacted by this application.

Other Concerns - May Not Enlarge the Right

Some protestants question the quantification of Water Right Number 09-2349 and are concerned that this change application enlarges the original appropriation. The parent right 09-439 was originally approved in 1967 for the diversion of 25,000 acre-feet of water for 2,500 acres of irrigation, and storage in a 25,000 acre-feet reservoir with associated evaporation losses. Other non-depleting uses such as recreation were also listed as part of the application. Reservoir evaporation losses were defined from a projected surface area of 1,400 acres. Using an evaporation factor, taken from Dr. Robert W. Hill’s report, “Consumptive Use of Irrigated Crops in Utah”, of 3.5758 acre-feet per acre (Bluff Station) the resulting evaporative loss would equal 5,006.17 acre-feet. The applicant has represented that this application represents one half of the evaporative portion of approved application 09-439 with the remaining amount being diverted for use but not consumed. The State Engineer believes the applicant’s quantification is reasonable and does not represent an enlargement of the right.

It is the opinion of the State Engineer that this change application can be approved without adversely affecting existing rights. The applicant is put on notice that diligence must be shown in pursuing the development of this application which can be demonstrated by the completion of the project as proposed in the change application.

It is, therefore, ORDERED and Permanent Change Application Number 09-2349 (a37400) is hereby APPROVED subject to prior rights and the following conditions:

1) The potential annual diversion and depletion of water under this application is 5,000 acre-feet and 2,503 acre-feet respectively. The amount of water approved to be diverted based on this decision is 500 acre-feet of groundwater in Moab-Spanish Valley and 100 acre-feet of groundwater on Bridger Jack Mesa. A groundwater monitoring plan must be submitted and approved by the State Engineer before any groundwater is diverted under this application. After implementation of the groundwater monitoring plan, additional blocks of water may be approved to be diverted (up to 5,000 acre-feet) if monitoring data show no impairment of existing water rights, no impact to the regional groundwater table, no contamination issues, and no adverse effects to the natural environment including at the Matheson Wetlands Preserve.
2) The total rate of diversion directly from the Colorado River may not exceed 7 cubic feet per second or a total volume of water from the wells and surface diversion of 5,000 acre-feet annually. If the applicant desires to use surface water to recharge the ground water and utilize the wells to divert the recharged water, a separate application should be filed to comply with the Groundwater Recharge and Recovery Act under Utah Code Ann. §73-3b.

3) A comprehensive study of groundwater recharge and discharge for the purpose of establishing of a safe yield volume must be completed before approval of more than 1,000 acre-feet of groundwater under this application. In the event that the study finds groundwater withdrawal rates exceed the safe yield volume, the applicant will be required to enter into a groundwater management plan to reduce uses to safe yield volumes.

4) No new or existing high volume (>50 gallons per minute) well development will be allowed closer than 1,000 feet from any existing well or spring and no new or existing high volume well development will be allowed within 3,000 feet from any existing well or spring without a pump test to identify whether or not there are interference issues that may have to be addressed by the applicant. If there is evidence of interference resulting from the applicant’s activities, the applicant will be required to mitigate the impacts of the interference, provide replacement water for the uses being impaired or discontinue use of the well.

5) No new or existing high volume (>50 gallons per minute) well development will be allowed within 3,000 feet of Ken’s Lake dam or reservoir basin in order to mitigate concerns related to dam safety and reservoir operations.

6) The priority of Water Right Number 09-2349 is July 22, 1966. The priority of Change Application Number 09-2349 (a37400) is April 27, 2011. The 50 year period from the date of approval of the water right ends on August 31, 2017. The applicant should be aware that under current statutes, the holding of a water right by a public entity for 50 years from the date of approval is considered reasonable and due diligence in obtaining extensions of time to file proof pursuant to Utah Code Ann. §73-3-12. After this date, additional extensions of time to submit proof may be obtained only by filing a 40 year plan as outlined in §73-1-4(2)(f) or otherwise complying with the requirements of the statutes. Inasmuch as the works and infrastructure necessary to place water to beneficial use have not been constructed, the applicant is strongly encouraged to proceed expeditiously in order the retain this right.
7) The applicant shall install and maintain measuring and totalizing recording devices to meter all water diverted and shall annually report this data to the Division of Water Rights’ Water Use Program. Inasmuch as this application seeks to divert water from multiple points of diversion, it is necessary that detailed information be provided to the State Engineer to show which aquifers are actually developed and used and the extent of their usage under this application. Upon the submission of proof as required by Section 73-3-16, Utah Code, for this application, the applicant must identify every source of water (aquifer) used under this application and the amount of water used from that source.

8) Approval of this application for use of water from the Colorado River is conditioned on the requirement that the applicant successfully completes a Section 7 Consultation with the U.S. Fish and Wildlife Service and complies with any conservation measures required.

9) Prior to altering any natural channel or constructing new diversion structures from the Colorado River, the applicant must file and receive approval of a Stream Alteration Permit with the Division of Water Rights pursuant to the requirements of Utah Code Ann. §73-3-29 and Rule R655-13 of the Utah Administrative Code. Stream Alteration Permits are received and processed by the Dam Safety Section of the Division of Water Rights, which may be contacted at 801-538-7240. Additional information on permitting requirements for stream alteration activities can be obtained on the Division of Water Rights’ website at http://waterrights.utah.gov.

10) Approval of this change application does not grant any rights to use property not owned or controlled by the applicant or its agent. Acquisition of all necessary easements, rights of way or title to property must be made before construction is begun. No rights of trespass are inferred by this approval.

11) The applicant and its agents are required to comply with all applicable local, state, and federal statutes, ordinances, and rules required for construction of this project.

12) Although this approval does not exclude any of the points of diversion requested in the application, start cards for the wells applied for will not accompany this decision. The applicant must request a start card for each individual well as the applicant desires to construct it. Contact should be made with the Southeastern Regional Office of the Division, either in writing or by phone at (435) 613-3750, for issuance of the start card authorizing a licensed well driller to construct the well.
APPLICANT CARD for WELL#: a37400

IMPORTANT: THIS CARD MUST BE COMPLETED, SIGNED AND RETURNED BY THE WELL OWNER/APPLICANT AS SOON AS THE WELL IS DRILLED BY A LICENSED UTAH WATER WELL DRILLER.

OWNER/APPLICANT NAME: ________________________________

MAILING ADDRESS: ____________________________________

PHONE NUMBER: ____________________________

WELL LOCATION: N 290' E 600' from SW Cor. S31, T26S, R23E, SLBRM.

WELL UTM COORDINATES: Northing: 4261471 Easting: 636169

WELL ACTIVITY: NEW ( ) REPAIR ( ) REPLACE ( ) ABANDON ( ) CLEAN ( ) DEEPEN ( )

WELL COMPLETION DATE: ________________________________

NAME OF DRILLING COMPANY/LICENSEE: ________________________________

__________________________________________ ____________________________
Owner/Applicant Signature Date

***COMPLETE, SIGN AND RETURN THIS PORTION UPON FINAL WELL COMPLETION -
DO NOT GIVE THIS CARD TO LICENSED WELL DRILLER - YOU MUST RETURN IT.

STATE OF UTAH DIVISION OF WATER RIGHTS Phone No. 801-538-7416
Fax No. 801-538-7467

COMMENTS: ______________________________________________

_________________________________________________________________

START/APPLICANT CARD INSTRUCTIONS: First, for each well, you must give a Driller (Start) Card to the licensed driller with whom you contract to construct the well. Second, it is your responsibility to sign and return this Applicant Card to this office immediately after completion of the well. **CAUTION:** There may be local health requirements for the actual siting of your well. Please check with the proper local authority before construction begins. See the enclosed sheet addressing construction information.
DRILLER (START) CARD for WELL#: a37400

IMPORTANT: THIS CARD MUST BE RECEIVED BY THE DIVISION OF WATER RIGHTS PRIOR TO THE BEGINNING OF WELL CONSTRUCTION -- REQUIRED ONLY FOR WELLS DEEPER THAN 30 FT.

OWNER/APPLICANT NAME: ____________________________________________

PHONE NUMBER: ____________________________________________________

MAILING ADDRESS: __________________________________________________

WELL LOCATION: N 200’ E 800’ from SW Cor. S31, T26S, R23E, SL5&6M.

WELL UTM COORDINATES: Northing: 4261471 Easting: 6361660

WELL ACTIVITY: NEW ( ) REPAIR ( ) REPLACE ( ) ABANDON ( )

CLEAN ( ) DEEPEN ( )

For surface seals in unconsolidated formations (clay, silt, sand, and gravel), will you be using a temporary conductor casing or other formation stabilizer (e.g., drilling mud) in the surface seal interval to maintain the required annular space?

YES or NO (Circle one).

Answering ‘NO’ suggests that you will be placing the surface seal in an open and unstabilized annular space, which may require onsite inspection of seal placement by the State Engineer’s Office.

PROPOSED START DATE: ____________________________________________

PROJECTED COMPLETION DATE: ______________________________________

LICENSE #:_____________LICENSEE/COMPANY: _______________________

Licensee Signature ___________________________ Date _______________

NOTICE TO APPLICANT: THIS CARD IS TO BE GIVEN TO A UTAH LICENSED WATER WELL DRILLER FOR SUBMITTAL TO THE DIVISION OF WATER RIGHTS PRIOR TO WELL CONSTRUCTION.

STATE OF UTAH DIVISION OF WATER RIGHTS Phone No. 801-538-7416
Fax No. 801-538-7467

COMMENTS: _______________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________
APPENDIX B:

Drillers Log & Sanitary Seal Certification for Well 1
Well Drillers Logs for Spielman and Johnston Well
WELL DRILLER'S REPORT
State of Utah
Division of Water Rights
For additional space, use "Additional Well Data Form" and attach

Well Identification
Change Application: a37400 (09-2349) WIN: 441508

Owner
San Juan Spanish Valley Special Service District
117 South Main #202
PO Box 9
Monticello, UT 84535
Contact Person/Engineer: Ben Musselman

Well Location
N 200 E 800 from the SW corner of section 31, Township 26S, Range 23E, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #)

Drillers Activity
Start Date: Dec 14 2017 Completion Date: April 2 2018
Check all that apply: ☑ New ☐ Repair ☐ Deepen ☐ Clean ☐ Replace ☐ Public Nature of Use: Municipal
If a replacement well, provide location of new well: feet north/south and feet east/west of the existing well.

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>BOREHOLE DIAMETER (in)</th>
<th>DRILLING METHOD</th>
<th>DRILLING FLUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20'</td>
<td>26&quot;</td>
<td>Air Rotary</td>
<td>Air Mist/Water + Bentonite Gell</td>
</tr>
<tr>
<td>20'-274'</td>
<td>18 1/4&quot;</td>
<td>Air P Mud Rotary</td>
<td>Bentonite Gell</td>
</tr>
<tr>
<td>274'-600'</td>
<td>13 1/8&quot;</td>
<td>Mud Rotary</td>
<td>Bentonite Gell</td>
</tr>
<tr>
<td>600'-705'</td>
<td>12 1/4&quot;</td>
<td>Mud Rotary</td>
<td>Bentonite Gell</td>
</tr>
</tbody>
</table>

Well Log

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>WATER PERMEABILITY</th>
<th>UNCONSOLIDATED CONSOLIDATED</th>
<th>ROCK TYPE</th>
<th>COLOR</th>
<th>DESCRIPTION AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-235</td>
<td>High</td>
<td></td>
<td>Sandstone</td>
<td>Yellow Navajo Sandstone, Fractured zones</td>
<td></td>
</tr>
<tr>
<td>235-406</td>
<td>Low</td>
<td></td>
<td>Sandstone</td>
<td>Pink/Red Kayenta mixed with Blocks of Navajo Sandstone layers</td>
<td></td>
</tr>
<tr>
<td>406-705</td>
<td>High</td>
<td></td>
<td>Sandstone</td>
<td>Tan    Wingate Formation Consolidated</td>
<td></td>
</tr>
</tbody>
</table>

RECEIVED
APR 16 2018

Static Water Level
Date: 4/2/2018 Water Level: 237 feet Flowing? ☑ Yes ☐ No
Method of Water Level Measurement: Electric Well Sounder If Flowing, Capped Pressure: PSI
Point to Which Water Level Measurement was Referenced: Top of 8" Casing Elevation: 4921.39 Top of 8" Casing
Height of Water Level reference point above ground surface: feet Temperature: degrees C ☑ F

Well Log
### Construction Information

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>CASING TYPE AND MATERIAL/GRADE</th>
<th>WALL THICK. (in)</th>
<th>NOMINAL DIA. (in)</th>
<th>DEPTH (feet)</th>
<th>SCREEN SLOT SIZE OR PERF SIZE (in)</th>
<th>SCREEN DIAM OR PERF LENGTH (in)</th>
<th>SCREEN TYPE OR NUMBER PERF (per round/interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td>Caso 18202248 375.14 PO 15</td>
<td></td>
<td></td>
<td>FROM TO</td>
<td>348.368 .040 8&quot; wire wrap 304 SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 AGL</td>
<td>Caso 18202248 375.14 PO 15</td>
<td></td>
<td></td>
<td>389.549 .040 8&quot; wire wrap 304 SS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>360'</td>
<td>Same as above</td>
<td></td>
<td></td>
<td>570 670 .040 8&quot; wire wrap 304 SS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>549'</td>
<td>Same as above</td>
<td></td>
<td></td>
<td>670 695 .040 8&quot; wire wrap 304 SS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>690'</td>
<td>Same as above</td>
<td></td>
<td></td>
<td></td>
<td>Johnson</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Well Head Configuration: 24.5 AGL X 14" Wilding
Casing Joint Type: Wilded
Access Port Provided: NO

WATER RIGHTS
SALT LAKE

### Surface Seal / Interval Seal / Filter Pack / Packers Information

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>SEAL MATERIAL, FILTER PACK and PACKER TYPE AND DESCRIPTION</th>
<th>Quantity of Material Used (if applicable)</th>
<th>GROUT DENSITY (lbs/gal, # bag mix, gal/sack etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Poor cement Grout (14&quot; Surface Seal)</td>
<td>7 cubic Yards 153 lb/gal, 6 gal 23gal/yd</td>
<td></td>
</tr>
<tr>
<td>125'</td>
<td>Formation Stabilizer (14&quot; Surface Casing)</td>
<td>10 cubic Yards 15&quot; Sand/Gravel</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Filter Pack, Silica Resources</td>
<td>10 cubic Yards 15&quot; Gravel/Silica</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8&quot; Production Casing Annulus Ann.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Well Development and Yield Test Information

<table>
<thead>
<tr>
<th>DATE</th>
<th>METHOD</th>
<th>YIELD</th>
<th>UNITS</th>
<th>TIME PUMPED</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/12/18</td>
<td>Air Swab + Pump + Air Test</td>
<td>450+</td>
<td>GPM</td>
<td>30 hrs.</td>
</tr>
<tr>
<td>2-9/2018</td>
<td>Test Pump + 25Hp Submersible Pump</td>
<td>193</td>
<td>CFPS</td>
<td>168 hr/70 days</td>
</tr>
<tr>
<td>3/26/2018</td>
<td>Test Pump + 50Hp Submersible Pump</td>
<td>480</td>
<td>CFPS</td>
<td>24 hr/70 days</td>
</tr>
</tbody>
</table>

Pump Description: [Remarks]
Horsepower: [Remarks]
Pump Intake Depth: [Remarks]

Well Disinfected upon Completion: NO

Comments: We encountered several Baffle fracture zones while drilling. 75', 145', and 265', we had to remount Baffles + Install Deep 14" Surface Casing to resolve these Baffle zones. These zones were 15' and 16' circulation too but air and mud

### Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name: BEEMAN DRILLING SERVICES INC.
Signature: [Signature]
Date: April 13, 2018
WELL DRILLER'S REPORT
State of Utah
Division of Water Rights
For additional space, use “Additional Well Data Form” and attach

Well Identification
WATER RIGHT APPLICATION: 05-2729(A71831)

Owner
Melinda Elkin/Karl Spielman
10530 Culpeper Ct. N.W.
Seattle, WA 98177

Well Location
COUNTY: San Juan
SOUTH 584 feet EAST 895 feet from the NW Corner of
SECTION 6, TOWNSHIP 27S, RANGE 23E, SLB&M.

Contact Person/Engineer: WATERS RIGHTS

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #):

By Ken’s Lake - Lot 2

Drillers Activity
Check all that apply:
☑ New  ☐ Repair  ☐ Deepen  ☐ Abandon  ☐ Replace  ☐ Public  Nature of Use: RR, STK, DOM

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>BOREHOLE DIAMETER (in)</th>
<th>DRILLING METHOD</th>
<th>DRILLING FLUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20</td>
<td>12 1/4</td>
<td>Air Rotary</td>
<td>Air + Foamer</td>
</tr>
<tr>
<td>20 - 80</td>
<td>9 7/8</td>
<td>Mud Rotary</td>
<td>Bentonite + Water</td>
</tr>
<tr>
<td>80 - 365</td>
<td>7 1/8</td>
<td>Air Rotary</td>
<td>Air + Foamer</td>
</tr>
</tbody>
</table>

Well Log

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>WATERS</th>
<th>UNCONSOLIDATED</th>
<th>CONSOLIDATED</th>
<th>ROCK TYPE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td></td>
<td>CONSOLIDATED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 4</td>
<td>high</td>
<td>low</td>
<td>235</td>
<td>Limestone</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>4 - 40</td>
<td>high</td>
<td>low</td>
<td>1 1/8</td>
<td>L/T/Bn</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>40 - 67</td>
<td>high</td>
<td>low</td>
<td>3 1/22</td>
<td>R&amp;B/Bn</td>
<td>R&amp;B/Bn</td>
</tr>
<tr>
<td>67 - 820</td>
<td>high</td>
<td>low</td>
<td>320</td>
<td>Sandstone</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>320 - 325</td>
<td>high</td>
<td>low</td>
<td>325</td>
<td>Sandstone</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>325 - 350</td>
<td>high</td>
<td>low</td>
<td>350</td>
<td>Sandstone</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>350 - 360</td>
<td>high</td>
<td>low</td>
<td>360</td>
<td>Sandstone</td>
<td>L/T/Bn</td>
</tr>
<tr>
<td>360 - 365</td>
<td>high</td>
<td>low</td>
<td>365</td>
<td>Sandstone</td>
<td>L/T/Bn</td>
</tr>
</tbody>
</table>

Static Water Level

Date: 11-27-98
Water Level: 229 feet
Flowing?: ☐ Yes  ☐ No
Method of Water Level Measurement: Tape  If Flowing, Capped Pressure: PSI
Point to Which Water Level Measurement was Referenced: Surface
Height of Water Level reference point above ground surface: 0 feet  Temperature: ☐ °C  ☐ °F
### Construction Information

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>CASING TYPE AND MATERIAL/BRAND</th>
<th>WALL THICK (in)</th>
<th>NOMINAL G.A.M. (ft)</th>
<th>SCREEN □</th>
<th>PERFORATIONS □</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td></td>
<td></td>
<td></td>
<td>FROM TO</td>
<td>SLOT SIZE OR PERFOR SIZE (ft)</td>
</tr>
<tr>
<td>12 74</td>
<td>Steel</td>
<td>.250</td>
<td>8&quot;</td>
<td>305 365</td>
<td>6&quot; PVC casing Perfed</td>
</tr>
</tbody>
</table>

Well Head Configuration: Baker Well Cap  Access Port Provided? □ Yes ☒ No
Casing Joint Type: Weld + Glue  Perforator Used: Circular Saw

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>FILTER PACK / GROUT / PACKER / ABANDONMENT MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td>ANNULAR MATERIAL, ABANDONMENT MATERIAL</td>
</tr>
<tr>
<td></td>
<td>and/or PACKER DESCRIPTION</td>
</tr>
<tr>
<td>0 20</td>
<td>Bentonite Grout</td>
</tr>
<tr>
<td>20 80</td>
<td>Bentonite Drilling Fluid</td>
</tr>
<tr>
<td>300 365</td>
<td>1/4&quot; Gravel Pack</td>
</tr>
</tbody>
</table>

### Well Development / Pump or Bail Tests

<table>
<thead>
<tr>
<th>Date</th>
<th>Method</th>
<th>Yield</th>
<th>Units</th>
<th>Drawdown (ft)</th>
<th>Time Pumped</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-25-98</td>
<td>Air</td>
<td>100 +</td>
<td>GPM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pump (Permanent)

Pump Description:  
Horsepower:  
Pump Intake Depth: feet
Approximate maximum pumping rate:
Well disinfected upon completion? □ Yes ☒ No

### Comments

- **Highly Fractured Formations - Lost Circulation**

- **Pump Test Should Prove Higher G.P.M.**

### Well Driller Statement

This well was drilled or abandoned under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

Name: [Signature]
License No.: 610
Date: 11-27-98
**WELL DRILLER'S REPORT**

State of Utah  
Division of Water Rights  

**Well Identification**  
Water Right: 05-3223  

**Owner**  
Stephen Johnston  
27107 12th Avenue  
Hawley, MN 56549

**Well Location**  
S 84 W 605 from the N4 corner of section 06, Township 27S, Range 23E, SL B&M

**Location Description:** (address, proximity to buildings, landmarks, ground elevation, local well #)

**Drillers Activity**  
Start Date: **1-29-07**  
Completion Date: **2-14-07**

Check all that apply:  
- [x] New  
- [ ] Repair  
- [ ] Deepen  
- [ ] Clean  
- [ ] Replace  
- [ ] Public  
- [ ] Nature of Use:

If a replacement well, provide location of new well: __________________________ feet north/south and __________________________ feet east/west of the existing well.

**DEPTH (feet) FROM TO**  
**BOREHOLE DIAMETER (in)**  
**DRILLING METHOD**  
**DRILLING FLUID**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Diameter</th>
<th>Drilling Method</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30</td>
<td>10&quot;</td>
<td>Air Rotary</td>
<td>Air</td>
</tr>
<tr>
<td>30 - 41</td>
<td>6 1/4&quot;</td>
<td>Air Rotary</td>
<td>Air</td>
</tr>
<tr>
<td>41 - 420</td>
<td>6&quot;</td>
<td>Air Rotary</td>
<td>Air</td>
</tr>
</tbody>
</table>

**Well Log**

<table>
<thead>
<tr>
<th>Depth (feet) FROM TO</th>
<th>WATER PERMEABLE</th>
<th>WATER IMPERMEABLE</th>
<th>UNCONSOLIDATED</th>
<th>CONSOLIDATED</th>
<th>ROCK TYPE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Tan</td>
</tr>
<tr>
<td>35 - 120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Red/Brown</td>
</tr>
<tr>
<td>120 - 180</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Yellow/Brown + Red/Brown</td>
</tr>
<tr>
<td>180 - 190</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Brown</td>
<td></td>
</tr>
<tr>
<td>190 - 220</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yellow/Brown</td>
<td></td>
</tr>
<tr>
<td>220 - 250</td>
<td></td>
<td></td>
<td>Yellow/Red/Brown/White/Tan Layers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 - 280</td>
<td></td>
<td></td>
<td>White</td>
<td></td>
<td>Hard</td>
<td></td>
</tr>
<tr>
<td>280 - 290</td>
<td></td>
<td></td>
<td>Shell Rock</td>
<td></td>
<td>1-2 pm, 8-200'</td>
<td></td>
</tr>
<tr>
<td>290 - 315</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td></td>
<td>White</td>
<td>Hard - Hard</td>
</tr>
<tr>
<td>315 - 380</td>
<td></td>
<td></td>
<td>Sandstone White</td>
<td></td>
<td>Soft</td>
<td>5-10 gpm</td>
</tr>
</tbody>
</table>

**Static Water Level**

Date: **2-14-07**  
Water Level: 249 feet  
Flowing: [ ] Yes  
[ ] No  
Method of Water Level Measurement: Sonic  
Pressure: [ ] Flowing  
[ ] Capped  
Elevation: PSI  
Point to Which Water Level Measurement was Referenced: Top of Casing  
Height of Water Level reference point above ground surface: 2 feet  
Temperature: 58 degrees  
[ ] C  
[ ] F  

**Scanner**  
Well Log
### Construction Information

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>CASING</th>
<th>DEPTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM</td>
<td>TO</td>
<td>CASING TYPE AND MATERIAL/GRADE</td>
</tr>
<tr>
<td>+2</td>
<td>42</td>
<td>Steel A53B</td>
</tr>
<tr>
<td>8</td>
<td>268</td>
<td>P.U.C. Certilock</td>
</tr>
<tr>
<td>288</td>
<td>368</td>
<td>Blank</td>
</tr>
<tr>
<td>328</td>
<td>428</td>
<td>Blank</td>
</tr>
<tr>
<td>388</td>
<td>428</td>
<td>Blank</td>
</tr>
</tbody>
</table>

**Well Head Configuration**: Merrill Well Cap

**Access Port Provided?** Yes No

**Casing Joint Type**: Weld Steel / Certilock pup

**Perforator Used**: —

**Was a Surface Seal Installed?** Yes No

**Depth of Surface Seal**: 30 + feet

**Drive Shoe?** Yes No

**Surface Seal Material Placement Method**: Grant Pump

**Was a temporary surface casing used?** Yes No

**If yes, depth of casing**: 15 feet diameter: 10 inches

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>SURFACE SEAL / INTERVAL SEAL / FILTER PACK / Packer Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM</td>
<td>TO</td>
</tr>
<tr>
<td>0</td>
<td>30+</td>
</tr>
<tr>
<td>260</td>
<td>420</td>
</tr>
</tbody>
</table>

### Well Development and Well Yield Test Information

<table>
<thead>
<tr>
<th>DATE</th>
<th>METHOD</th>
<th>YIELD</th>
<th>UNITS CHECKED</th>
<th>DRAWDOWN</th>
<th>TIME TURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-2-07</td>
<td>Air shift</td>
<td>28</td>
<td>x</td>
<td>5hrs</td>
<td></td>
</tr>
<tr>
<td>2-14-07</td>
<td>Pump</td>
<td>25</td>
<td>x</td>
<td>13'</td>
<td>4hrs</td>
</tr>
</tbody>
</table>

**Pump (Permanent)**

**Pump Description**: Grundfos 1050E15-330

**Horsepower**: 1/2

**Pump Intake Depth**: 360 feet

**Approximate Maximum Pumping Rate**: 14 gpm

**Well Disinfected upon Completion?** Yes No

**Comments**: Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. Use additional well data form for more space.

**Well Driller Statement**: This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

**Name**: BALSLEY WELL SERVICE

**License No.**: 610

**Signature**: [Signature]

**Date**: 2-16-07
WELL DRILLER'S REPORT ADDITIONAL DATA FORM  
State of Utah  
Division of Water Rights

Well Identification
Water Right: 05-3223

Owner
Note any changes:
Stephen Johnston  
27107 12th Avenue  
Hawley, MN 56549

Contact Person/Engineer: 

Well Location
Note any changes:
S 4 W 605 from the N4 corner of section 06, Township 27S, Range 23E, SL B&M

<table>
<thead>
<tr>
<th>DEPTH (feet) FROM TO</th>
<th>PERMEABLE</th>
<th>UNCONSOLIDATED</th>
<th>CONSOLIDATED</th>
<th>ROCK TYPE</th>
<th>COLOR</th>
<th>DESCRIPTION AND REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>320 360</td>
<td>x</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Brn</td>
<td></td>
</tr>
<tr>
<td>360 385</td>
<td>x</td>
<td></td>
<td></td>
<td>Pipl/Brn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>385 390</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>Rd shale layers</td>
<td></td>
</tr>
<tr>
<td>390 425</td>
<td>x</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Brn</td>
<td>Hard - Hard</td>
</tr>
<tr>
<td>425 450</td>
<td>x</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>White w/Rd shale layers</td>
<td>HARD</td>
</tr>
<tr>
<td>450 453</td>
<td>x</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Rd/Brn</td>
<td>10+ g.p.m.</td>
</tr>
<tr>
<td>453 470</td>
<td>x</td>
<td></td>
<td></td>
<td>Sandstone</td>
<td>Brn w/Rd shale layers</td>
<td>HARD-HARD</td>
</tr>
</tbody>
</table>
# WELL DRILLER'S REPORT

**State of Utah**  
**Division of Water Rights**

For additional space, use "Additional Well Data Form" tab below.

**Well Identification**  
Water Right: 05-3067

**Owner**  
USA Bureau of Land Management  
82 East Dogwood  
Moab, UT 84532

Contact Person/Engineer: ____________________________

**Well Location**  
N 1635 W 196 from the S4 corner of section 06, Township 27S, Range 23E, SL B&M

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #)

**Drillers Activity**  
Start Date: **OCT 27-06**  
Completion Date: **NOV 3-06**

Check all that apply:  
[ ] New  [x] Repair  [ ] Deepen  [ ] Clean  [ ] Replace  [ ] Public  Nature of Use: **Fire Station**

If a replacement well, provide location of new well, ______ feet north/south and ______ feet east/west of the existing well.

<table>
<thead>
<tr>
<th>DEPTH (feet) FROM TO</th>
<th>BOREHOLE DIAMETER (in)</th>
<th>DRILLING METHOD</th>
<th>DRILLING FLUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-365</td>
<td>12-4</td>
<td>Mud Rotary</td>
<td>Get - Unspecified water</td>
</tr>
</tbody>
</table>

**Well Log**

<table>
<thead>
<tr>
<th>DEPTH (feet) FROM TO</th>
<th>WATER</th>
<th>UNCONSOLIDATED</th>
<th>CONSOLIDATED</th>
<th>ROCK TYPE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-90</td>
<td>PERMEABLE</td>
<td>LIMESTONE</td>
<td>BOULDER</td>
<td>D. Grey</td>
<td><strong>Sandstone Boulder set in course sand</strong></td>
</tr>
<tr>
<td>90-200</td>
<td>CLAY</td>
<td>CRY stall</td>
<td>BOULDER</td>
<td>Brown</td>
<td><strong>Boulders of cobbles of dark red Sandstone</strong></td>
</tr>
<tr>
<td>200-225</td>
<td></td>
<td></td>
<td>BOULDER</td>
<td>D. Red</td>
<td><strong>Sandstone</strong></td>
</tr>
<tr>
<td>225-290</td>
<td></td>
<td></td>
<td>BOULDER</td>
<td>Red</td>
<td><strong>Navajo Sandstone</strong></td>
</tr>
<tr>
<td>290-365</td>
<td></td>
<td></td>
<td>BOULDER</td>
<td>Red</td>
<td><strong>Sandstone w Fractured water from 305 to total depth</strong></td>
</tr>
</tbody>
</table>

**Static Water Level**  
Date: **NOV 3-06**  
Water Level **305** feet  
Flowing? [ ] Yes  [ ] No  
Method of Water Level Measurement: **Well Sounder**  
If Flowing, Capped Pressure PSI  
Point to Which Water Level Measurement was Referenced: **Ground Level Elevation**  
Height of Water Level reference point above ground surface: **0** feet  
Temperature: **55** degrees [ ] C  [ ] F

**Well Log**
### Construction Information

<table>
<thead>
<tr>
<th>DEPTH (feet)</th>
<th>CASING</th>
<th>DEPTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM TO</td>
<td>CASING TYPE AND MATERIAL/GRADE</td>
<td>FROM TO</td>
</tr>
<tr>
<td></td>
<td>WALL THICK (in)</td>
<td>SCREEN SLOT SIZE OR PERF SIZE (in)</td>
</tr>
<tr>
<td></td>
<td>NOMINAL DIAM (in)</td>
<td>SCREEN DIAM OR PERF LENGTH (ft)</td>
</tr>
<tr>
<td></td>
<td>SCREEN TYPE OR NUMBER PERF (per linear ft)</td>
<td>SCREEN TYPE OR NUMBER PERF (per linear ft)</td>
</tr>
<tr>
<td>0 - 365</td>
<td>A-538 steel .250</td>
<td>245 - 365</td>
</tr>
</tbody>
</table>

Well Head Configuration: **Pump Cup**
Access Port Provided? □ Yes □ No
Casing Joint Type: **welded**
Perforator Used: **Milled Slotted**
Was a Surface Seal Installed? □ Yes □ No
Depth of Surface Seal: 600 feet
Drive Shoe? □ Yes □ No
Surface Seal Material Placement Method: **Pumped via 2 in Trimm**
If yes, depth of casing: 13 feet
diameter: 16 inches

### Well Development and Well Yield Test Information

<table>
<thead>
<tr>
<th>DATE</th>
<th>METHOD</th>
<th>YIELD</th>
<th>DRAWDOWN (ft)</th>
<th>TIME PUMPED (hrs &amp; min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 1</td>
<td>Air Developed</td>
<td>80</td>
<td>✔</td>
<td>80 hrs</td>
</tr>
<tr>
<td>Nov 6</td>
<td>Test Pumped</td>
<td>35</td>
<td>✔</td>
<td>48 hrs</td>
</tr>
</tbody>
</table>

### Pump (Permanent)

Pump Description: 
Horsepower: 
Pump Intake Depth: _feet_
Approximate Maximum Pumping Rate: 
Well Disinfected upon Completion? □ Yes □ No
Comments: Description of construction activity, additional materials used, problems encountered, extraordinary circumstances, abandonment procedures. Use additional well data form for more space.

**Pumped Municipal Seal upon-site state inspector**

### Well Driller Statement

This well was drilled and constructed under my supervision, according to applicable rules and regulations, and this report is complete and correct to the best of my knowledge and belief.

**Name** MIDWAY DRILLING  
**License No.** 432  
**Signature** C. E. Epley  
**Date** Dec 15-06
March 26, 2018

Kelly Pehrson
San Juan Spanish Valley SSD
P.O. Box 9
Monticello, Utah 84535

Subject: Well Seal Certificate, San Juan Spanish Valley SSD Well #1 (WS001); San Juan Spanish Valley SSD Water System, System #19080, File #11159

Dear Mr. Pehrson:

On March 8, 2018, I witnessed the sealing procedure for the well referenced above. This letter is to certify that the well sealing procedure met the requirements of Utah Administrative Code (UAC), Rule R309-515-6(6)(i), Well Sealing Techniques and Requirements, and Rule R655-4-11.4, Surface Seals and Interval Seals.

The San Juan Spanish Valley SSD Well #1 was sealed from a depth of 125 feet below ground surface to the surface with a neat cement grout. The grout was delivered to the well site location via cement truck from LeGrand Johnson Ready Mix (now Kilgore Companies) and the grout was placed via grout pump. The grout was placed from the bottom of the seal to the top by means of a 1 ½-inch diameter tremie pipe, which was successfully removed after grout placement. The annular space grouted was between the 18-inch diameter borehole and the 14-inch diameter steel casing. Approximately 5.0 cubic yards of neat cement were placed as a permanent well seal.

Well Background Information

Well Name: San Juan Spanish Valley SSD Well #1
Water Right Number: a37400 (09-2349)
Well Owner Name: San Juan Spanish Valley SSD
Well Type: Proposed Public Drinking Water Well
Public Water System Name: San Juan Spanish Valley SSD
PWS Number: UTAH#19080
Water Source ID: WS001
DDW File Number: 11159
Consultant Name and Company: John Files, Cascade Water Resources
Well Location

County: San Juan County
Nearest Town: Moab
Local Health Department: Southeast Utah Health Department
Street Address:
Latitude/Longitude: 38° 29' 28.31", -109° 26' 19.59"
Method Used to Determine Latitude & Longitude: Handheld GPS Unit
Elevation at Well Head: 4,930 feet above sea level

Well Driller

License Number: 824
Company Representative’s Name: Todd Beeman
Company Name: Beeman Drilling Services Inc.
Mailing Address: 3400 S Hwy 191, Moab, UT 84532
Phone Number: 435-259-7281

Well Construction* (for the top portion of well only; well is still under construction, see finished well log and as-builts for complete well construction)

Casing Types Installed: 14-inch steel from 1’ above the surface to 274’ below surface
Casing Diameter: 14-inch
Casing Length: 275 feet
Casing Material: Steel
Annulus Size: 2 inches
Pitless Adapter: not proposed

Well Sealing Description

Description of the Well Sealing Process:
Grout Material: Neat Cement
Grout Volume: 5.0 cubic yards
Grout Density: 15.6 lbs/gal
Method of Placement: Grout pump and 1½ - inch diameter tremie pipe
Depth from Surface: 125 feet
Did Grout Come to the Surface? Yes

Issues Observed during Well Sealing
None
This well seal certification is not a Plan Approval to construct a public drinking water well, nor an Operating Permit to use the well as a public drinking water source. Such approval may only be granted by the Division of Drinking Water.

If you have any questions regarding this certificate, please contact me at 435-559-3825 or scotth@utah.gov.

Sincerely,

Scott D Hacking, P.E.
DEQ District Engineer, Southeast Utah

cc: Orion Rogers, Southeast Utah District Health Department, orogers@utah.gov
Todd Beeman, Beeman Drilling Services, 3400 S. Highway 191, Moab, UT 84532
Daniel Hawley, Jones and DeMille Engineering, daniel.h@jonesanddemille.com
John Files, Cascade Water Resources, john@cascadewaterresource.com
Scott Hacking, DEQ District Engineer, scotth@utah.gov
Lisa Nelson, Division of Drinking Water, lcnelson@utah.gov
Jim Goddard, Division of Water Rights, jimgoddard@utah.gov

DDW-2018-002941.docx
APPENDIX C:

AQTESOLV Plots
Theis Distance Drawdown Data for Johnston and Spielman Wells
WELL 1 - 24 HOUR TEST

Data Set:  
Date: 04/10/18  
Time: 10:14:09

PROJECT INFORMATION

Company: Cascade Water  
Client: San Juan Spanish Valley SSD  
Test Location: San Juan County  
Test Well: Well 1

AQUIFER DATA

Saturated Thickness: 500 ft  
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

<table>
<thead>
<tr>
<th>Pumping Wells</th>
<th>Observation Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Name</td>
<td>X (ft)</td>
</tr>
<tr>
<td>PW 1</td>
<td>0</td>
</tr>
</tbody>
</table>

SOLUTION

Aquifer Model: Unconfined  
Solution Method: Theis  
T = 4001 ft²/day  
S = 0.0001773
WELL TEST ANALYSIS

Data Set: 04/10/18
Date: 04/10/18
Time: 10:43:53

PROJECT INFORMATION

Company: Cascade Water
Client: San Juan Spanish Valley SSD
Test Location: San Juan County
Test Well: SJSVSSD Well 1

AQUIFER DATA

Saturated Thickness: 300 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA

<table>
<thead>
<tr>
<th>Pumping Wells</th>
<th>X (ft)</th>
<th>Y (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PW 1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observation Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Name</td>
</tr>
<tr>
<td>OW 1</td>
</tr>
</tbody>
</table>

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

\[ T = 1.04E+04 \text{ ft}^2/\text{day} \]
\[ S = 1.757E-41 \]
WELL TEST ANALYSIS

Data Set: 04/10/18
Time: 10:44:52

PROJECT INFORMATION

Company: Cascade Water
Client: San Juan Spanish Valley SSD
Test Location: San Juan County
Test Well: SJSVSSD Well 1

AQUIFER DATA

Saturated Thickness: 300 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA

<table>
<thead>
<tr>
<th>Pumping Wells</th>
<th>X (ft)</th>
<th>Y (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PW 1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Observation Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Name</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>OW 1</td>
</tr>
</tbody>
</table>

SOLUTION

Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

T = 1.04E+04 ft²/day
S = 1.757E-41
APPENDIX D:

Theis Based Calculations for Predicted Drawdown
Example of Change in Potentiometric Elevation Map
CALCULATED THEIS:

Given input: Johnatan Well 24 hr. 480 gpm Test

Constant pumping rate (Q): 1,069444 cfs
Aquifer transmissivity (T): 12500 ft²/day or 0.144676 ft²/second
Time since pumping began (t): 1 days
Radial distance from well (r): 1,200.00 feet
Aquifer storativity (S): .0001

\[ h_o - h = \frac{Q}{4\pi T} W(u) \quad u = \frac{r^2 S}{4Tt} \]

\[ h_o - h = \frac{Q}{4\pi T} \left[ -0.5772 - \ln u + u - \frac{u^2}{2 \cdot 2!} + \frac{u^3}{3 \cdot 3!} - \frac{u^4}{4 \cdot 4!} + \ldots \right] \]

Q is the constant pumping rate (L³/T; ft³/day or m³/day)
h is hydraulic head (L; ft or m)
h_o-h is the drawdown (L; ft or m)
T is aquifer transmissivity (L²/T; ft²/day or m²/day)
t is time since pumping began (T; days)
r is radial distance from the pumping well (L; ft or m)
S is aquifer storativity (dimensionless)
b is aquifer thickness (L; ft or m)

u: 0.002880
W(u) series: 5.27564291256067

Drawdown (h_o-h) at day 1: 3.10 ft using series calculation of W(u) to u²

**Drawdown over the course of a year from initial well drilling:**

Day 1: 3.10 ft
Day 4: 3.92 ft
Day 7: 4.25 ft
Day 10: 4.46 ft
Day 13: 4.61 ft
Day 16: 4.73 ft
Day 19: 4.83 ft
Day 22: 4.92 ft
Day 25: 5.00 ft
Day 28: 5.06 ft
Month 1: 5.11 ft
Month 2: 5.52 ft
Month 3: 5.76 ft
Month 4: 5.93 ft
Month 5: 6.06 ft
Month 6: 6.16 ft
Month 7: 6.26 ft
Month 8: 6.33 ft
Month 9: 6.40 ft
Month 10: 6.47 ft
Month 11: 6.52 ft
Month 12: 6.57 ft

**Drawdown over multiple years from initial well drilling:**

Year 1: 6.57 ft
Year 2: 6.98 ft
Year 3: 7.22 ft
Year 4: 7.39 ft
Year 5: 7.52 ft
Year 6: 7.63 ft
Year 7: 7.72 ft
Year 8: 7.80 ft
Year 9: 7.87 ft
Year 10: 7.93 ft
Year 11: 7.98 ft
Year 12: 8.03 ft
Year 13: 8.08 ft
Year 14: 8.12 ft

<table>
<thead>
<tr>
<th>Year</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>8.17</td>
</tr>
<tr>
<td>16</td>
<td>8.20</td>
</tr>
<tr>
<td>17</td>
<td>8.24</td>
</tr>
<tr>
<td>18</td>
<td>8.27</td>
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<tr>
<td>19</td>
<td>8.30</td>
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<tr>
<td>20</td>
<td>8.33</td>
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<td>21</td>
<td>8.36</td>
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<td>8.39</td>
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<tr>
<td>28</td>
<td>8.53</td>
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<tr>
<td>29</td>
<td>8.55</td>
</tr>
<tr>
<td>30</td>
<td>8.57</td>
</tr>
</tbody>
</table>
CALCULATED THEIS:

Given input:  
Johnston Well: Estimated 7-18-1963 4pm 7-31-

Constant pumping rate (Q): 0.430006 cfs
Aquifer transmissivity (T): 12500 ft²/day or 0.144676 ft²/second
Time since pumping began (t): 7 days
Radial distance from well (r): 1,200.00 feet
Aquifer storativity (S): .0001

\[ h_0 - h = \frac{Q}{4\pi T} W(u) \quad u = \frac{r^2 S}{4Tt} \]

\[ h_0 - h = \frac{Q}{4\pi T} \left[ -0.5772 - \ln u + u - \frac{u^2}{2} + \frac{u^3}{3!} \right] - \frac{u^4}{4!} + \ldots \]

\( Q \) is the constant pumping rate (L³/T; ft³/day or m³/day)
\( h \) is hydraulic head (L; ft or m)
\( h_0 \) is hydraulic head before pumping started (L; ft or m)
\( h_0 - h \) is the drawdown (L; ft or m)
\( T \) is aquifer transmissivity (L²/T; ft²/day or m²/day)
\( t \) is time since pumping began (T; days)
\( r \) is radial distance from the pumping well (L; ft or m)
\( S \) is aquifer storativity (dimensionless)
\( b \) is aquifer thickness (L; ft or m)

\( u = 0.000411 \)
\( W(u) \) series: 7.21908652014653

Drawdown (ho-h) at day 7: 1.71 ft using series calculation of Wo(u) to u^4:

**Drawdown over the course of a year from initial well drilling:**
Day 1: 1.25 ft
Day 4: 1.58 ft
Day 7: 1.71 ft
Day 10: 1.79 ft
Day 13: 1.85 ft
Day 16: 1.90 ft
Day 19: 1.94 ft
Day 22: 1.98 ft
Day 25: 2.01 ft
Day 28: 2.04 ft
Month 1: 2.06 ft
Month 2: 2.22 ft
Month 3: 2.31 ft
Month 4: 2.38 ft
Month 5: 2.44 ft
Month 6: 2.48 ft
Month 7: 2.52 ft
Month 8: 2.55 ft
Month 9: 2.57 ft
Month 10: 2.60 ft
Month 11: 2.62 ft
Month 12: 2.64 ft

**Drawdown over multiple years from initial well drilling:**
Year 1: 2.64 ft
Year 2: 2.81 ft
Year 3: 2.90 ft
Year 4: 2.97 ft
Year 5: 3.02 ft
Year 6: 3.07 ft
Year 7: 3.10 ft
Year 8: 3.13 ft
Year 9: 3.16 ft
Year 10: 3.19 ft
Year 11: 3.21 ft
Year 12: 3.23 ft
Year 13: 3.25 ft
Year 14: 3.27 ft

Year 15: 3.28 ft
Year 16: 3.30 ft
Year 17: 3.31 ft
Year 18: 3.33 ft
Year 19: 3.34 ft
Year 20: 3.35 ft
Year 21: 3.36 ft
Year 22: 3.37 ft
Year 23: 3.38 ft
Year 24: 3.39 ft
Year 25: 3.40 ft
Year 26: 3.41 ft
Year 27: 3.42 ft
Year 28: 3.43 ft
Year 29: 3.44 ft
Year 30: 3.45 ft
CALCULATED THEIS:

Given input: Spielman Well 1 flow - 193 gpm Test

Constant pumping rate (Q): 0.430006 cfs
Aquifer transmissivity (T): 20000 ft²/day or 0.231481 ft²/second
Time since pumping began (t): 7 days
Radial distance from well (r): 320.00 feet
Aquifer storativity (S): .0002

\[
h_0 - h = \frac{Q}{4\pi T} W(u) \quad u = \frac{r^2 S}{4Tt}
\]

\[
h_0 - h = \frac{Q}{4\pi T} \left[ -0.5772 \ln u + u - \frac{u^2}{2} + \frac{u^3}{3} - \frac{u^4}{4} + \ldots \right]
\]

Q is the constant pumping rate (L³/T; ft³/day or m³/day)
h is hydraulic head (L; ft or m)
h₀ is hydraulic head before pumping started (L; ft or m)
h₀−h is the drawdown (L; ft or m)
T is aquifer transmissivity (L²/T; ft²/day or m²/day)
t is time since pumping began (T; days)
r is radial distance from the pumping well (L; ft or m)
S is aquifer storativity (dimensionless)
b is aquifer thickness (L; ft or m)

u: 0.000037
W(u) series: 9.63907983363423

Drawdown (h₀−h) at day 7: 1.42 ft using series calculation of W(u) to u⁶

Drawdown over the course of a year from initial well drilling:
Day 1: 1.14 ft
Day 4: 1.34 ft
Day 7: 1.42 ft
Day 10: 1.48 ft
Day 13: 1.52 ft
Day 16: 1.55 ft
Day 19: 1.57 ft
Day 22: 1.59 ft
Day 25: 1.61 ft
Day 28: 1.63 ft
Month 1: 1.64 ft
Month 2: 1.74 ft
Month 3: 1.80 ft
Month 4: 1.85 ft
Month 5: 1.88 ft
Month 6: 1.91 ft
Month 7: 1.93 ft
Month 8: 1.95 ft
Month 9: 1.97 ft
Month 10: 1.98 ft
Month 11: 2.00 ft
Month 12: 2.01 ft

Drawdown over multiple years from initial well drilling:
Year 1: 2.01 ft
Year 2: 2.11 ft
Year 3: 2.17 ft
Year 4: 2.21 ft
Year 5: 2.25 ft
Year 6: 2.27 ft
Year 7: 2.30 ft
Year 8: 2.32 ft
Year 9: 2.33 ft
Year 10: 2.35 ft
Year 11: 2.36 ft
Year 12: 2.38 ft
Year 13: 2.39 ft
Year 14: 2.40 ft

Year 15: 2.41 ft
Year 16: 2.42 ft
Year 17: 2.43 ft
Year 18: 2.44 ft
Year 19: 2.44 ft
Year 20: 2.45 ft
Year 21: 2.46 ft
Year 22: 2.47 ft
Year 23: 2.47 ft
Year 24: 2.48 ft
Year 25: 2.49 ft
Year 26: 2.49 ft
Year 27: 2.50 ft
Year 28: 2.50 ft
Year 29: 2.51 ft
Year 30: 2.51 ft
CALCULATED THEIS:

Given input:
- Pumping rate (Q): 1.069444 cfs
- Aquifer transmissivity (T): 9800 ft²/day or 0.113426 ft²/second
- Time since pumping began (t): 1 days
- Radial distance from well (r): 0.00 feet
- Aquifer storativity (S): 0.0001

\[ b_0 - h = \frac{Q}{4\pi T} \left[ -0.5772 - \ln u + u - \frac{u^2}{2 \cdot 2!} + \frac{u^3}{3 \cdot 3!} - \frac{u^4}{4 \cdot 4!} + \ldots \right] \]

\[ u = \frac{r^2 S}{4 T t} \]

\[ h_0 - h = \frac{Q}{4\pi T} \]

\( Q \) is the constant pumping rate (L³/T; ft³/day or m³/day)
\( h_0 \) is hydraulic head before pumping started (L; ft or m)
\( h_0 - h \) is the drawdown (L; ft or m)
\( T \) is aquifer transmissivity (L²/T; ft²/day or m²/day)
\( t \) is time since pumping began (T; days)
\( r \) is radial distance from the pumping well (L; ft or m)
\( S \) is aquifer storativity (dimensionless)
\( b \) is aquifer thickness (L; ft or m)

\( u \): 0.000000

W(u) series: 120.523316489493

Drawdown (ho-h) at day 1: 90.43 ft using series calculation of W(u) to u⁶

**Drawdown over the course of a year from initial well drilling:**
- Day 1: 90.43 ft
- Day 4: 91.47 ft
- Day 7: 91.39 ft
- Day 10: 92.16 ft
- Day 13: 92.35 ft
- Day 16: 92.51 ft
- Day 19: 92.64 ft
- Day 22: 92.75 ft
- Day 25: 92.84 ft
- Day 28: 92.93 ft
- Month 1: 92.99 ft
- Month 2: 93.51 ft
- Month 3: 93.82 ft
- Month 4: 94.03 ft
- Month 5: 94.20 ft
- Month 6: 94.34 ft
- Month 7: 94.45 ft
- Month 8: 94.55 ft
- Month 9: 94.64 ft
- Month 10: 94.72 ft
- Month 11: 94.79 ft
- Month 12: 94.86 ft

**Drawdown over multiple years from initial well drilling:**
- Year 1: 94.86 ft
- Year 2: 95.38 ft
- Year 3: 95.68 ft
- Year 4: 95.90 ft
- Year 5: 96.06 ft
- Year 6: 96.20 ft
- Year 7: 96.32 ft
- Year 8: 96.42 ft
- Year 9: 96.50 ft
- Year 10: 96.58 ft
- Year 11: 96.66 ft
- Year 12: 96.72 ft
- Year 13: 96.78 ft
- Year 14: 96.84 ft

https://waterrights.utah.gov/wellinfo/theis/theis_output.asp?Q=480&qunit=GPM&lr=9800&i=1&r=000000000000000000000001&runit=f&S=0.0001
4/6/2018
Year 15: 96.89 ft
Year 16: 96.94 ft
Year 17: 96.98 ft
Year 18: 97.02 ft
Year 19: 97.07 ft
Year 20: 97.10 ft
Year 21: 97.14 ft
Year 22: 97.18 ft
Year 23: 97.21 ft
Year 24: 97.24 ft
Year 25: 97.27 ft
Year 26: 97.30 ft
Year 27: 97.33 ft
Year 28: 97.36 ft
Year 29: 97.38 ft
Year 30: 97.41 ft
CALCULATED THEIS:

Given input: John's Well - Projected Drawdown < 320 gpm

- Constant pumping rate (Q): 0.712963 cfs
- Aquifer transmissivity (T): 12500 ft²/day or 0.144676 ft²/second
- Time since pumping began (t): 7 days
- Radial distance from well (r): 1,200.00 feet
- Aquifer storativity (S): 0.001

\[ h_0 - h = \frac{Q}{4\pi T} W(u) \quad u = \frac{r^2 S}{4T} \]

\[ h_2 - h = \frac{Q}{4\pi T} \left[-0.5772 - \ln u + u - \frac{u^2}{2 \cdot 2!} + \frac{u^3}{3 \cdot 3!} - \frac{u^4}{4 \cdot 4!} + \ldots\right] \]

Q is the constant pumping rate (L³/T; ft³/day or m³/day)
h is hydraulic head (L; ft or m)
h₀-h is the drawdown (L; ft or m)
T is aquifer transmissivity (L²/T; ft²/day or m²/day)
t is time since pumping began (T; days)
r is radial distance from the pumping well (L; ft or m)
S is aquifer storativity (dimensionless)
b is aquifer thickness (L; ft or m)

u: 0.000411
W(u) series: 7.21908652014653

Drawdown (h₀-h) at day 7: 2.83 ft using series calculation of W(u) to u⁴

Drawdown over the course of a year from initial well drilling:
- Day 1: 2.07 ft
- Day 4: 2.61 ft
- Day 7: 2.83 ft
- Day 10: 2.97 ft
- Day 13: 3.07 ft
- Day 16: 3.16 ft
- Day 19: 3.22 ft
- Day 22: 3.28 ft
- Day 25: 3.33 ft
- Day 28: 3.37 ft
- Month 1: 3.41 ft
- Month 2: 3.48 ft
- Month 3: 3.84 ft
- Month 4: 3.95 ft
- Month 5: 4.04 ft
- Month 6: 4.11 ft
- Month 7: 4.17 ft
- Month 8: 4.22 ft
- Month 9: 4.27 ft
- Month 10: 4.31 ft
- Month 11: 4.35 ft
- Month 12: 4.38 ft

Drawdown over multiple years from initial well drilling:
- Year 1: 4.38 ft
- Year 2: 4.65 ft
- Year 3: 4.81 ft
- Year 4: 4.93 ft
- Year 5: 5.01 ft
- Year 6: 5.08 ft
- Year 7: 5.14 ft
- Year 8: 5.20 ft
- Year 9: 5.24 ft
- Year 10: 5.28 ft
- Year 11: 5.32 ft
- Year 12: 5.36 ft
- Year 13: 5.39 ft
- Year 14: 5.42 ft

<table>
<thead>
<tr>
<th>Year</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 15</td>
<td>5.44 ft</td>
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<td>Year 25</td>
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<td>Year 26</td>
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<td>Year 27</td>
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<td>Year 28</td>
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<tr>
<td>Year 29</td>
<td>5.70 ft</td>
</tr>
<tr>
<td>Year 30</td>
<td>5.72 ft</td>
</tr>
</tbody>
</table>
CALCULATED THEIS:

Given input: **Spelman Well - Estimated at 320 gpm**

- Constant pumping rate (Q): 0.712963 cfs
- Aquifer transmissivity (T): 20000 ft²/day or 0.231481 ft²/second
- Time since pumping began (t): 7 days
- Radial distance from well (r): 320.00 feet
- Aquifer storativity (S): .0002

\[
h_w - h = \frac{Q}{4\pi T} W(u) \\
u = \frac{r^2 S}{4T} \left[ -0.5772 + u + \frac{u^2}{2!} - \frac{u^3}{3!} + \frac{u^4}{4!} + \ldots \right]
\]

- \(Q\) is the constant pumping rate (L³/T; ft³/day or m³/day)
- \(h\) is hydraulic head (L; ft or m)
- \(h_o\) is hydraulic head before pumping started (L; ft or m)
- \(t\) is the drawdown (L; ft or m)
- \(T\) is aquifer transmissivity (L²/T; ft²/day or m²/day)
- \(u\) is time since pumping began (T; days)
- \(r\) is radial distance from the pumping well (L; ft or m)
- \(S\) is aquifer storativity (dimensionless)
- \(b\) is aquifer thickness (L; ft or m)

\[u: 0.000037\]
\[W(u)\] series: 9.63907983363423

Drawdown (\(h_o-h\)) at day 7: 2.36 ft using series calculation of \(W(u)\) to \(u^4\)

**Drawdown over the course of a year from initial well drilling:**

- Day 1: 1.89 ft
- Day 4: 2.23 ft
- Day 7: 2.36 ft
- Day 10: 2.45 ft
- Day 13: 2.51 ft
- Day 16: 2.57 ft
- Day 19: 2.61 ft
- Day 22: 2.64 ft
- Day 25: 2.67 ft
- Day 28: 2.70 ft
- Month 1: 2.72 ft
- Month 2: 2.89 ft
- Month 3: 2.99 ft
- Month 4: 3.06 ft
- Month 5: 3.12 ft
- Month 6: 3.16 ft
- Month 7: 3.20 ft
- Month 8: 3.23 ft
- Month 9: 3.26 ft
- Month 10: 3.29 ft
- Month 11: 3.31 ft
- Month 12: 3.33 ft

**Drawdown over multiple years from initial well drilling:**

- Year 1: 3.33 ft
- Year 2: 3.50 ft
- Year 3: 3.60 ft
- Year 4: 3.67 ft
- Year 5: 3.73 ft
- Year 6: 3.77 ft
- Year 7: 3.81 ft
- Year 8: 3.84 ft
- Year 9: 3.87 ft
- Year 10: 3.90 ft
- Year 11: 3.92 ft
- Year 12: 3.94 ft
- Year 13: 3.96 ft
- Year 14: 3.98 ft

Year 15: 4.00 ft
Year 16: 4.01 ft
Year 17: 4.03 ft
Year 18: 4.04 ft
Year 19: 4.05 ft
Year 20: 4.07 ft
Year 21: 4.08 ft
Year 22: 4.09 ft
Year 23: 4.10 ft
Year 24: 4.11 ft
Year 25: 4.12 ft
Year 26: 4.13 ft
Year 27: 4.14 ft
Year 28: 4.15 ft
Year 29: 4.16 ft
Year 30: 4.17 ft
CALCULATED THEIS:

Given input:

- Constant pumping rate (Q): 0.712963 cfs
- Aquifer transmissivity (T): 9800 ft²/day or 0.113426 ft²/second
- Time since pumping began (t): 1 days
- Radial distance from well (r): 0.00 feet
- Aquifer storativity (S): .0001

\[
h_0 - h = \frac{Q}{4\pi T} W(u) \quad u = \frac{r^2 S}{4 T t}
\]

\[
h_0 - h = \frac{Q}{4\pi T} \left[ -0.5772 - \ln u + u - \frac{u^2}{2} - \frac{u^3}{3} - \frac{u^4}{4} + \ldots \right]
\]

- \(Q\) is the constant pumping rate (L³/T; ft³/day or m³/day)
- \(h\) is hydraulic head (L; ft or m)
- \(h_0\) is hydraulic head before pumping started (L; ft or m)
- \(h_0 - h\) is the drawdown (L; ft or m)
- \(T\) is aquifer transmissivity (L²/T; ft²/day or m²/day)
- \(t\) is time since pumping began (T; days)
- \(r\) is radial distance from the pumping well (L; ft or m)
- \(S\) is aquifer storativity (dimensionless)
- \(b\) is aquifer thickness (L; ft or m)

\[u = 0.000000\]

\[W(u)\text{ series: } 120.523316499493\]

Drawdown (ho-h) at day 1: 60.29 ft using series calculation of W(u) to \(u^6\)

**Drawdown over the course of a year from initial well drilling:**

- Day 1: 60.29 ft
- Day 4: 60.98 ft
- Day 7: 61.26 ft
- Day 10: 61.44 ft
- Day 13: 61.57 ft
- Day 16: 61.67 ft
- Day 19: 61.76 ft
- Day 22: 61.83 ft
- Day 25: 61.90 ft
- Day 28: 61.95 ft
- Month 1: 61.99 ft
- Month 2: 62.34 ft
- Month 3: 62.54 ft
- Month 4: 62.69 ft
- Month 5: 62.80 ft
- Month 6: 62.89 ft
- Month 7: 62.97 ft
- Month 8: 63.03 ft
- Month 9: 63.09 ft
- Month 10: 63.15 ft
- Month 11: 63.19 ft
- Month 12: 63.24 ft

**Drawdown over multiple years from initial well drilling:**

- Year 1: 63.24 ft
- Year 2: 63.58 ft
- Year 3: 63.79 ft
- Year 4: 63.93 ft
- Year 5: 64.04 ft
- Year 6: 64.13 ft
- Year 7: 64.21 ft
- Year 8: 64.28 ft
- Year 9: 64.34 ft
- Year 10: 64.39 ft
- Year 11: 64.44 ft
- Year 12: 64.48 ft
- Year 13: 64.52 ft
- Year 14: 64.56 ft

https://waterrights.utah.gov/wellinfo/theis/theis_output.asp?Q=320&quini=500&tr=9800&ti=1&r=0.0000000000000000000000000001&runt=ft&S=.0001
Year 15: 64.59 ft
Year 16: 64.62 ft
Year 17: 64.65 ft
Year 18: 64.68 ft
Year 19: 64.71 ft
Year 20: 64.74 ft
Year 21: 64.76 ft
Year 22: 64.78 ft
Year 23: 64.81 ft
Year 24: 64.83 ft
Year 25: 64.85 ft
Year 26: 64.87 ft
Year 27: 64.89 ft
Year 28: 64.90 ft
Year 29: 64.92 ft
Year 30: 64.94 ft
Figure 4-17
Change in Regional Alluvial Aquifer Potentiometric Surface (1999-2016)