Idaho Department of Water Resources

RAFT RIVER BASIN MONITORING WELL INSTALLATION COMPLETION REPORT

Department of Energy Supplemental Environmental Project:
Raft River Basin Hydrogeologic Investigation Project

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IDAHO DEPARTMENT OF
WATER RESOURCES

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Introduction

The Idaho Department of Water Resources (IDWR) was awarded a Department of Energy (DOE) Supplemental Environmental Project (SEP) grant in July 2020 to conduct the Raft River Basin Hydrogeologic Investigation Project. The project duration is from October 1, 2020, through June 30, 2024. Goals of the 3.5-year, multi-agency hydrogeologic investigation are to: (1) collect data from the aquifer utilized for water supply; (2) update the conceptual hydrogeologic framework and water budget; (3) develop an understanding of surface water and groundwater interactions, and (4) define recharge and discharge mechanisms.

As part of this project, twelve monitoring wells were drilled and constructed across the Raft River Basin in the spring of 2022 (Table 1; Figure 1). Well locations and depths were chosen by geologists from the Idaho Geological Survey (IGS) in consultation with IDWR to provide lithologic information for use in updating the hydrogeologic framework, as well as provide dedicated, long-term water level and water quality monitoring locations in areas with little or no groundwater information.

Submersible pumps have been installed in the wells to facilitate water quality sampling, and all wells have been equipped with transducers/data loggers which continuously record water levels and temperatures (Table 1).

Table 1. Raft River Basin Monitoring Well Summary Table

Well Name	Completion Date	Total Depth (fbgs)[1]	Depth to Water (fbgs)	Pump Installed	Latitude	Longitude	PLSS
Well #1	03/09/2022	358	44	Yes	42.5910	-113.2350	09S 28E 31SWSW
Well #2	03/15/2022	768	59	Yes	42.5906	-113.2353	09S 28E 31SWSW
Well #3	05/20/2022	940	266	Yes	42.5692	-113.3937	10S 26E 11SWNW
Well #4	03/29/2022	510	90	Yes	42.3055	-113.0842	13S 29E 08NWSE
Well #5	03/26/2022	720	450	Yes	42.4744	-113.1466	11N 28E 11SESW
Well #6	04/04/2022	753	475	Yes	42.1450	-113.2060	15S 28E 05NESW
Well #7[2]	04/17/2022	471	7	NA	42.2736	-113.4247	13S 26E 21SESW
Well #8	04/08/2022	495	114	Yes	42.0894	-113.3196	15S 27E 29NWSE
Well #9	03/19/2022	300	154	Yes	42.2247	-113.3491	14S 27E 07NWNW
Well #10	04/30/2022	1,007	250	Yes	42.5028	-113.3243	10S 27E 32SESW
Well #11	04/20/2022	500	182	Yes	42.3790	-113.3598	12S 26E 13NESE
Well #12	05/17/2022	1,010	227	Yes	42.5649	-113.1746	10S 28E 10NWSW

[1]Feet below ground surface.

[2]The bottom hole temperature exceeded 85 ºF during drilling but was not constructed to meet IDWR low-temperature geothermal standards. Therefore, the well was abandoned.

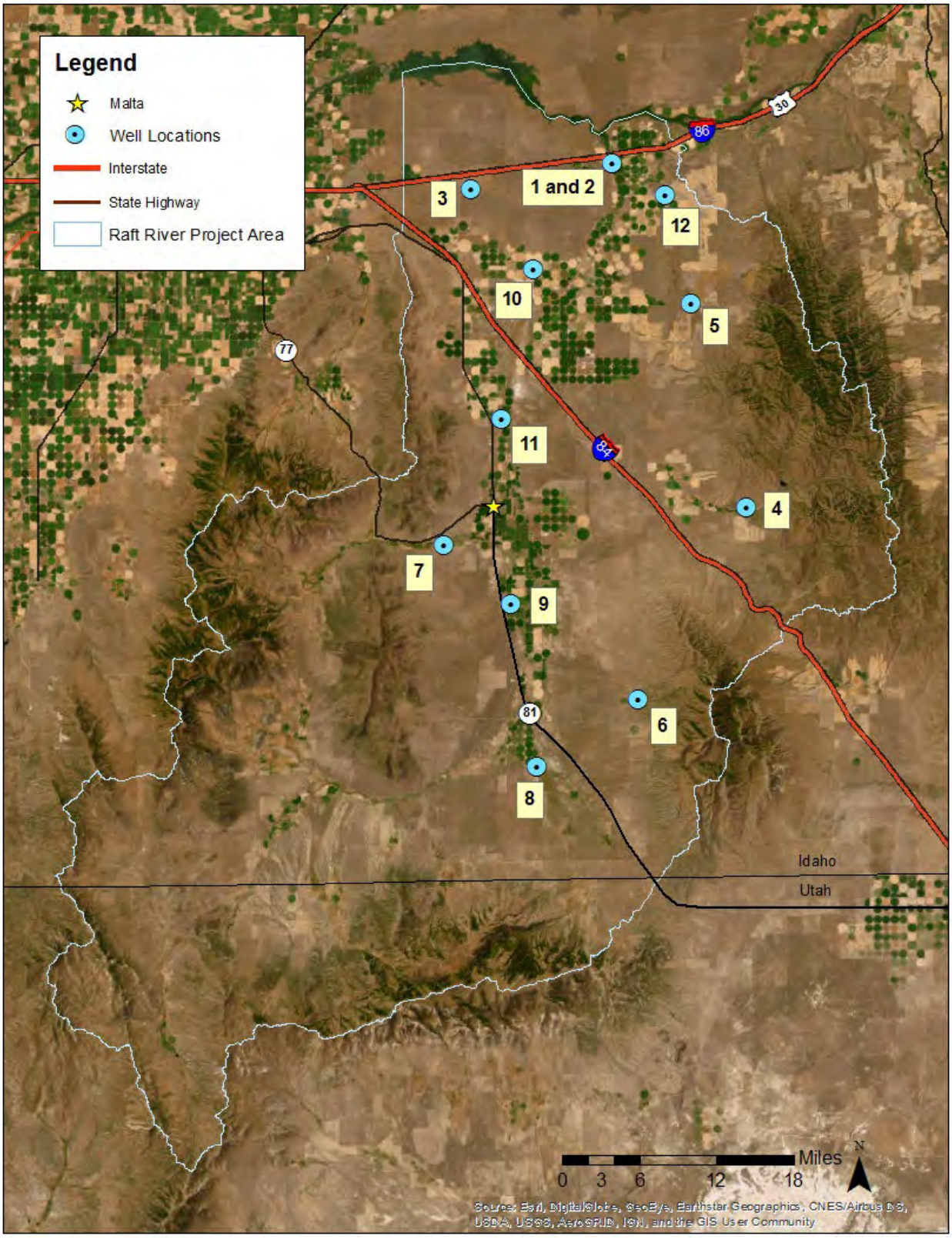


Figure 1. Map of Raft River Basin Monitoring Wells

Lithologic Description

Updating the hydrogeologic framework is one of the main goals of the Raft River Basin Hydrogeologic Investigation Project. The delineation of subsurface lithology is a key component of a hydrogeologic framework, and well drilling provides an opportunity to collect and describe subsurface lithologic samples.

Professional geologists and engineers from IDWR, geologists from the IGS, as well as contractors from Boise State University, provided drilling oversight and manually collected cuttings samples during drilling to provide detailed lithologic descriptions and identify water-bearing zones at each well location. The oversight team documented the color, texture, grain size, and mineral composition of the samples, as well as the presence/absence of water, and any other relevant features (e.g., fossils, wood fragments, cementation). The samples were collected every five feet, at observed lithologic changes, or when the driller noted a change in drilling conditions or water content.

The United States Geological Survey (USGS) was contracted to conduct downhole geophysical surveys to compliment the cuttings-based lithologic descriptions. The geophysical surveys are discussed in more detail in the section titled "Downhole Geophysics."

Completion Diagrams

Cold Steel Mechanical constructed all wells using a dual rotary drilling method. The following sections describe the construction details and lithology for each well. The lithologic descriptions presented below are based on rock and sediment samples taken manually during drilling.

Raft Well #1

Raft Well #1 is located 28.2 miles NNE of Malta, approximately 0.7 miles south of Interstate 86 near confluence of the Snake and Raft rivers (Figures 1 and 2). Drilling began March 7, 2022, and was completed on March 10, 2022, at a total depth of 358 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 47 fbgs. The well is open to the aquifer from 341 – 356 fbgs with a stainless steel, 0.01-inch slot size, wire-wound screen. The depth-to-water in the well was 47.38 fbgs on April 17, 2022 (Figure 3).

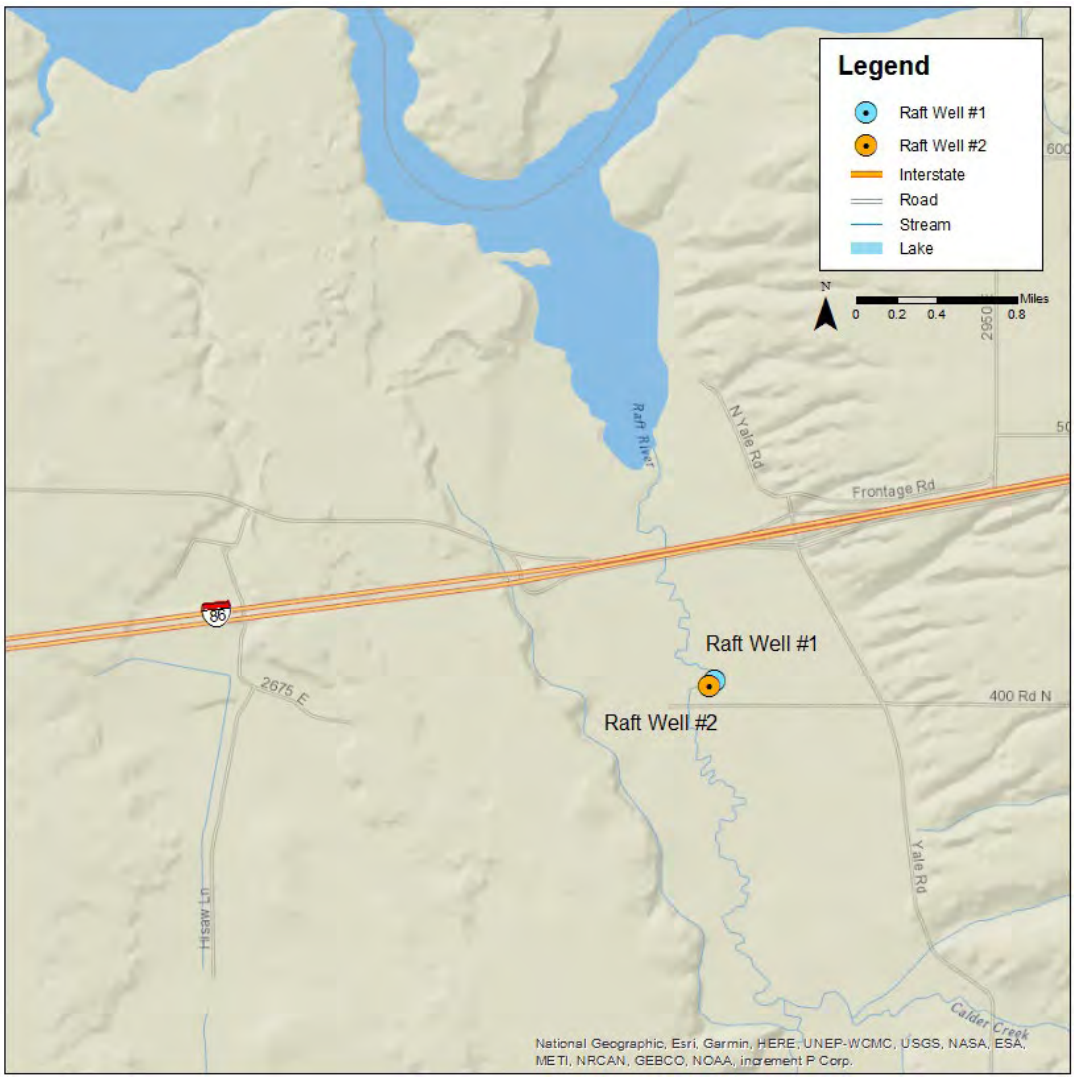


Figure 2. Location of Raft Wells #1 and #2

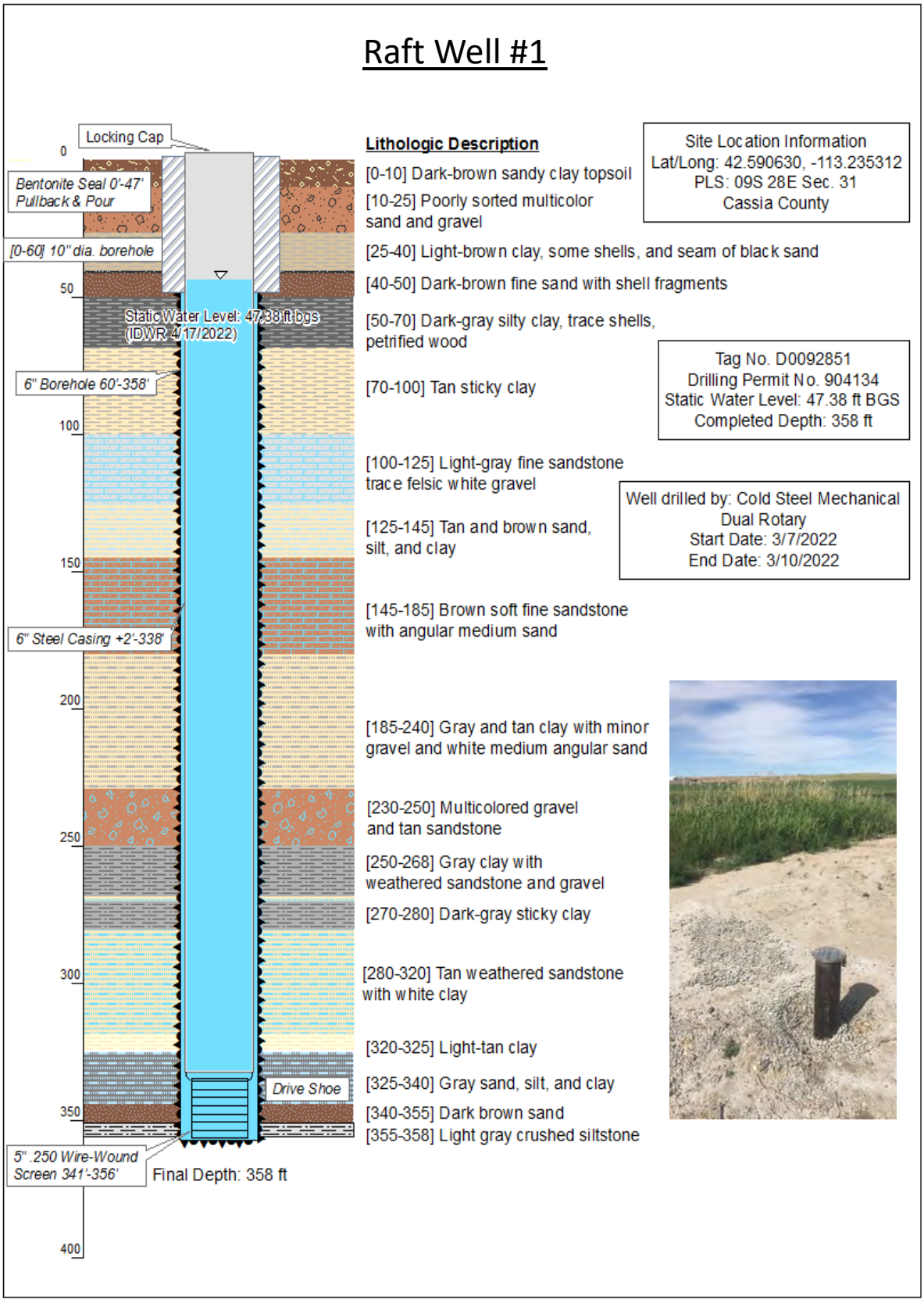


Figure 3. Construction and lithologic details for Raft Well #1.

Raft Well #2

Raft Well #2 is located 28.2 miles NNE of Malta, approximately 200 ft southwest of Raft Well #1 (Figures1, 2, and 4); both wells are within 75 ft. of the Raft River. Drilling began March 11, 2022, and was completed on March 16, 2022, at a total depth of 768 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 759 – 765 fbgs with a 0.18-mm slot size, perforated screen. The depth-to-water in the well was 59 fbgs at the time of completion (Figure 5).

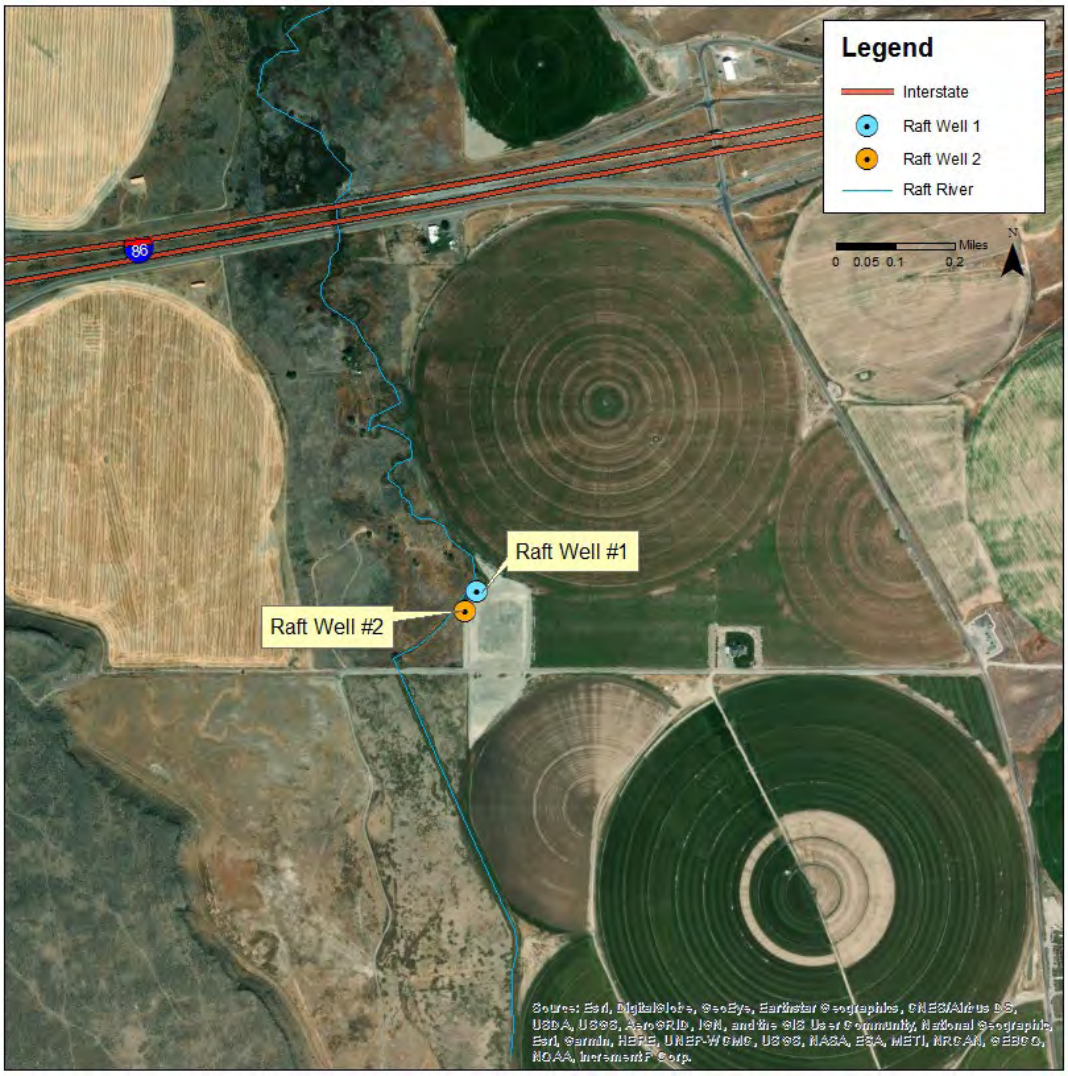


Figure 4. Location of Raft Wells #1 and #2.

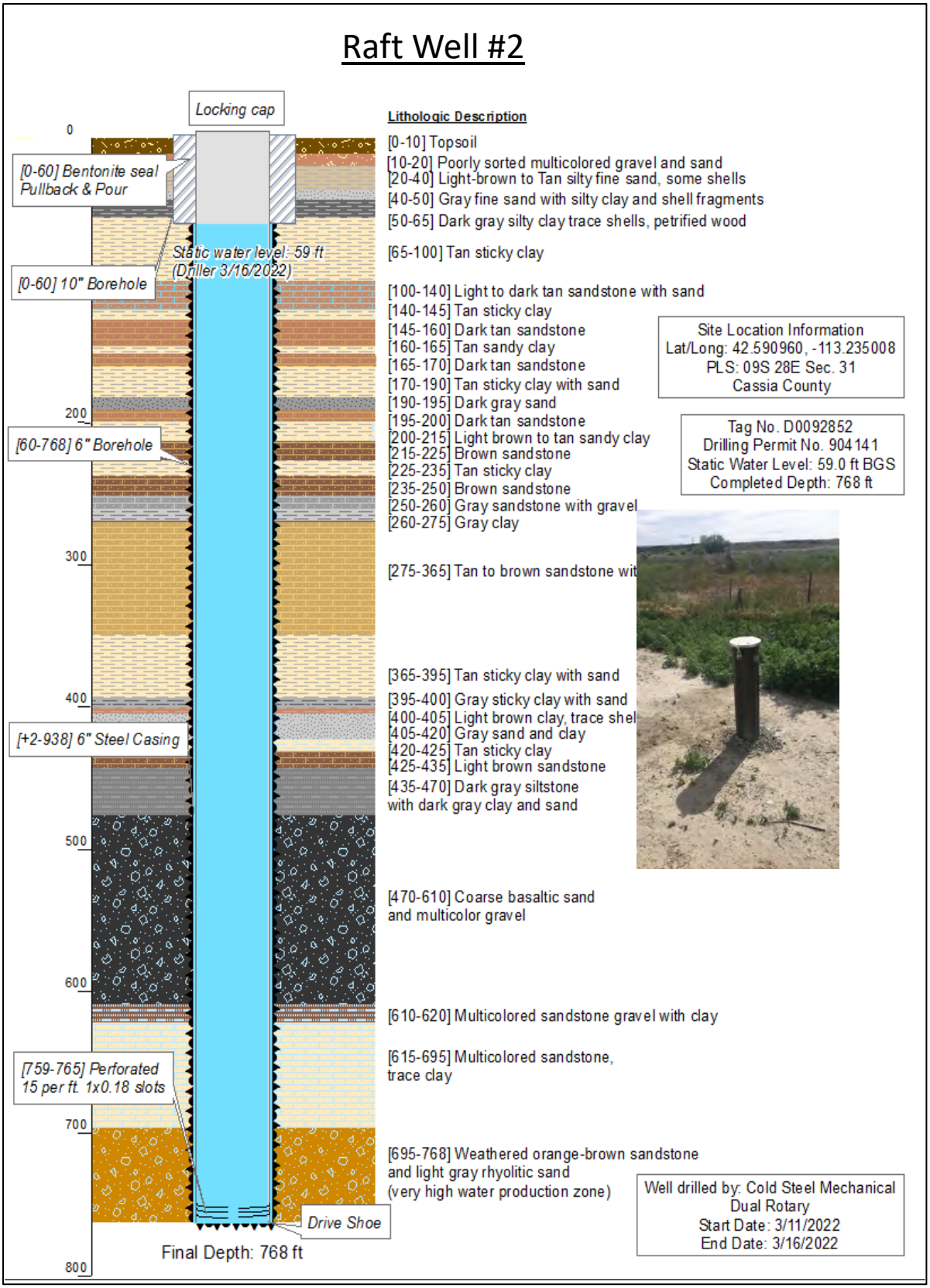


Figure 5. Construction and lithologic details for Raft Well #2

Raft Well #3

Raft Well #3 is located 24.7 miles north of Malta, approximately 8.5 miles east of the intersection of Interstate 86 and Interstate 84 (Figure 6). Drilling began May 18, 2022, and was completed on May 21, 2022, at a total depth of 940 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 933 – 938 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 266 fbgs at the time of completion (Figure 7).

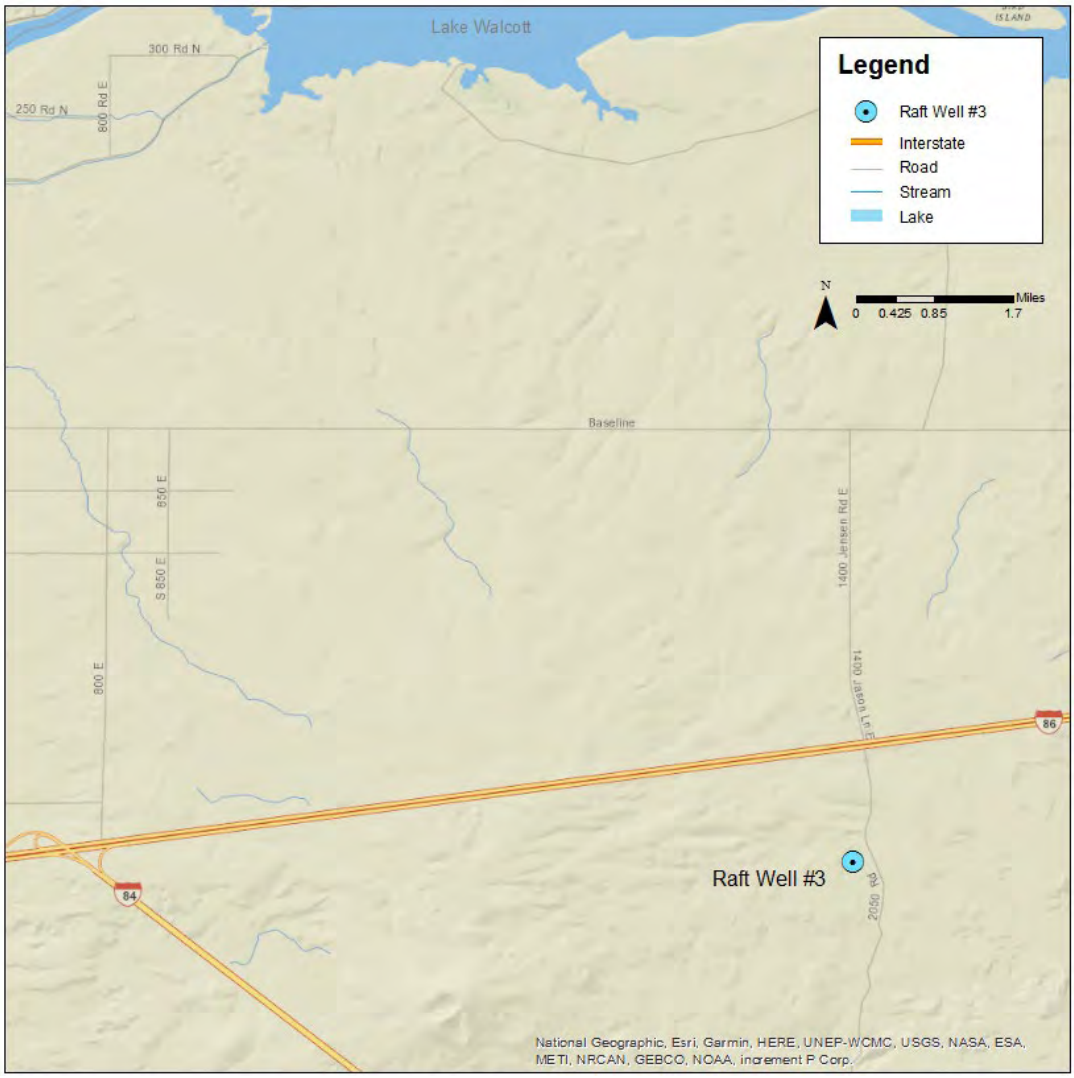


Figure 6. Map of Raft Well #3

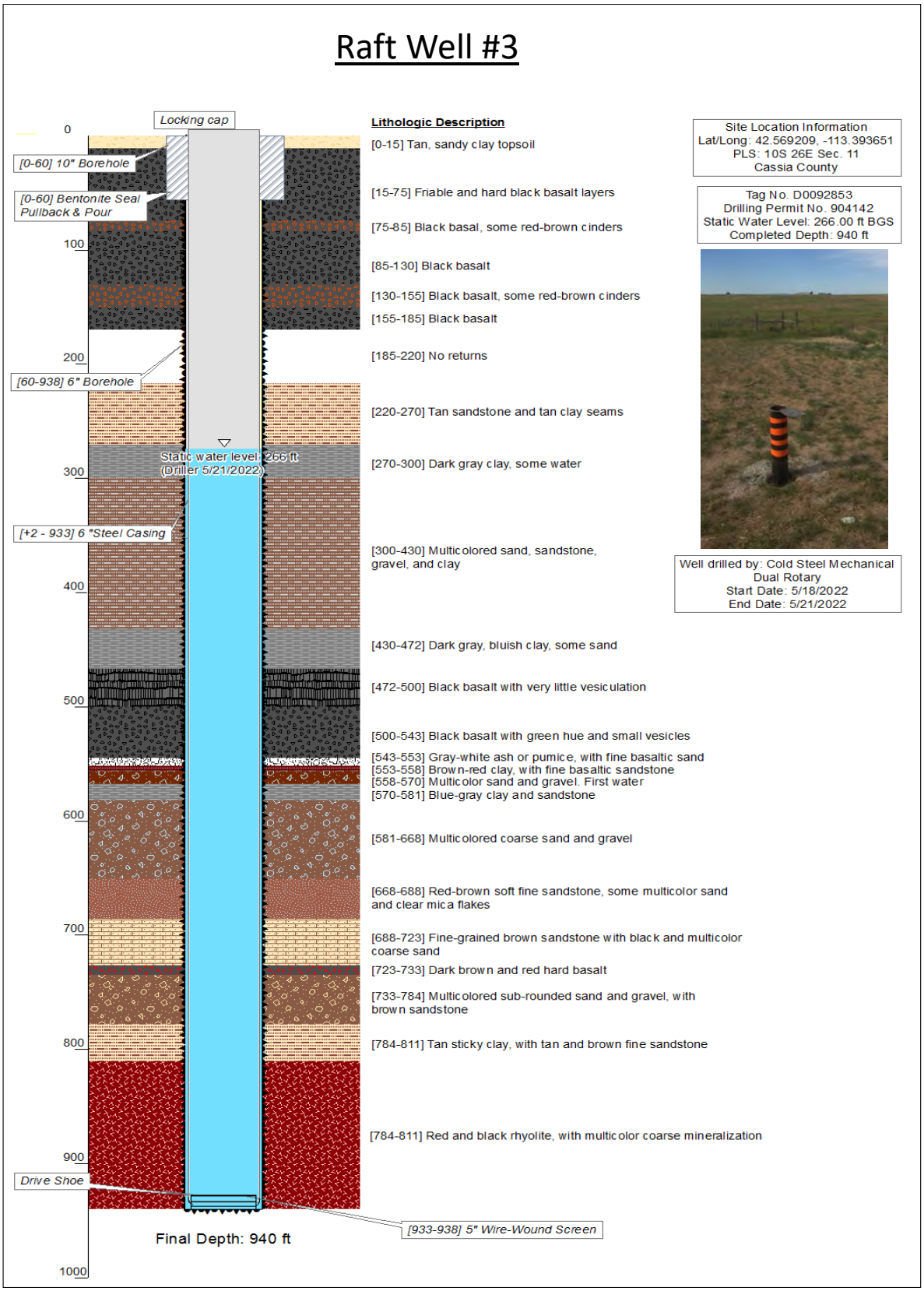


Figure 7. Construction and lithologic details of Raft Well #3

Raft Well #4

Raft Well #4 is located 19.7 miles east of Malta, approximately 9.4 miles east of Interstate 84 on Sublette Road (Figures 1 and 8). Drilling began March 28, 2022, and was completed on March 30, 2022, at a total depth of 510 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 498 – 508 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 90 fbgs at the time of completion (Figure 9).

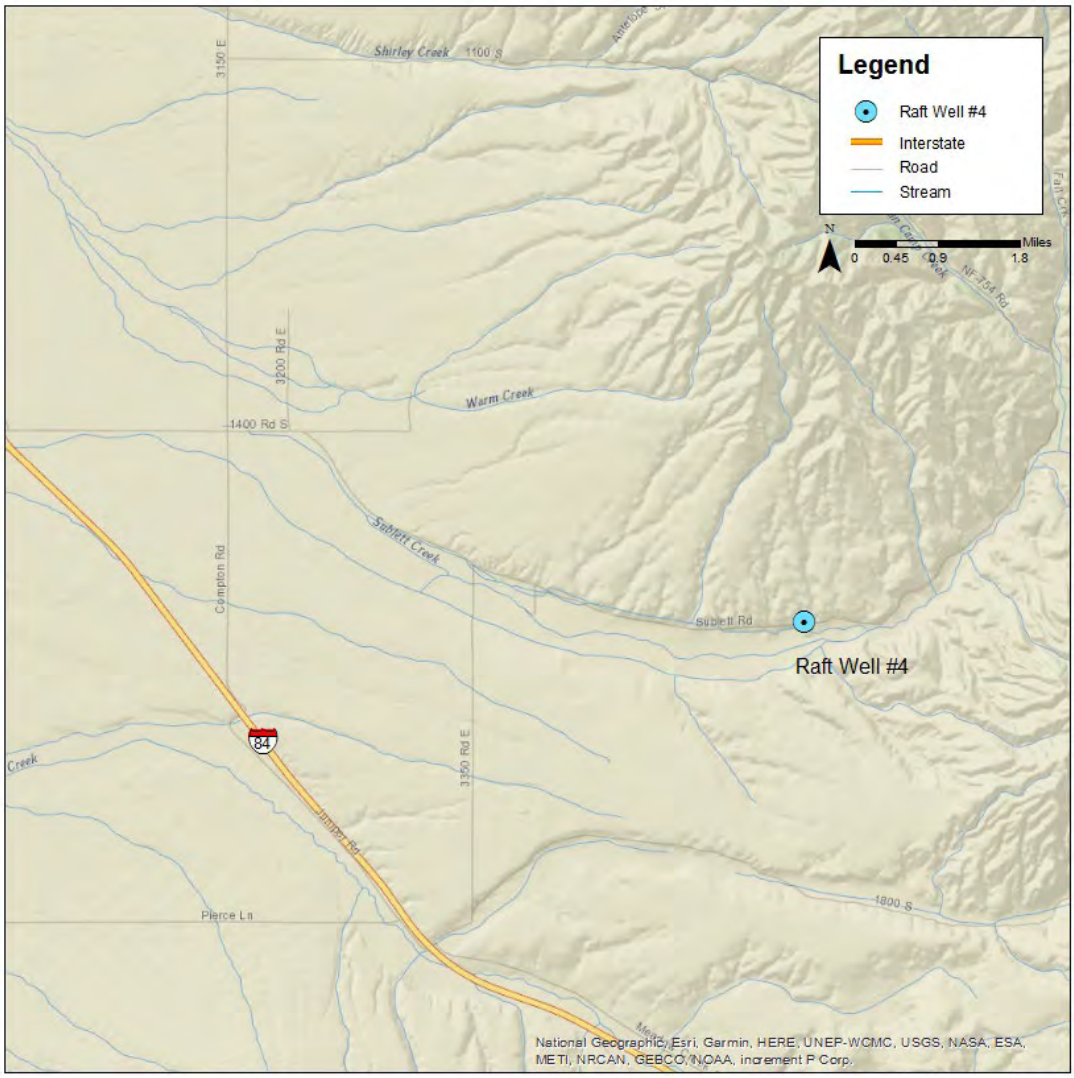


Figure 8. Map of SEP Well #4

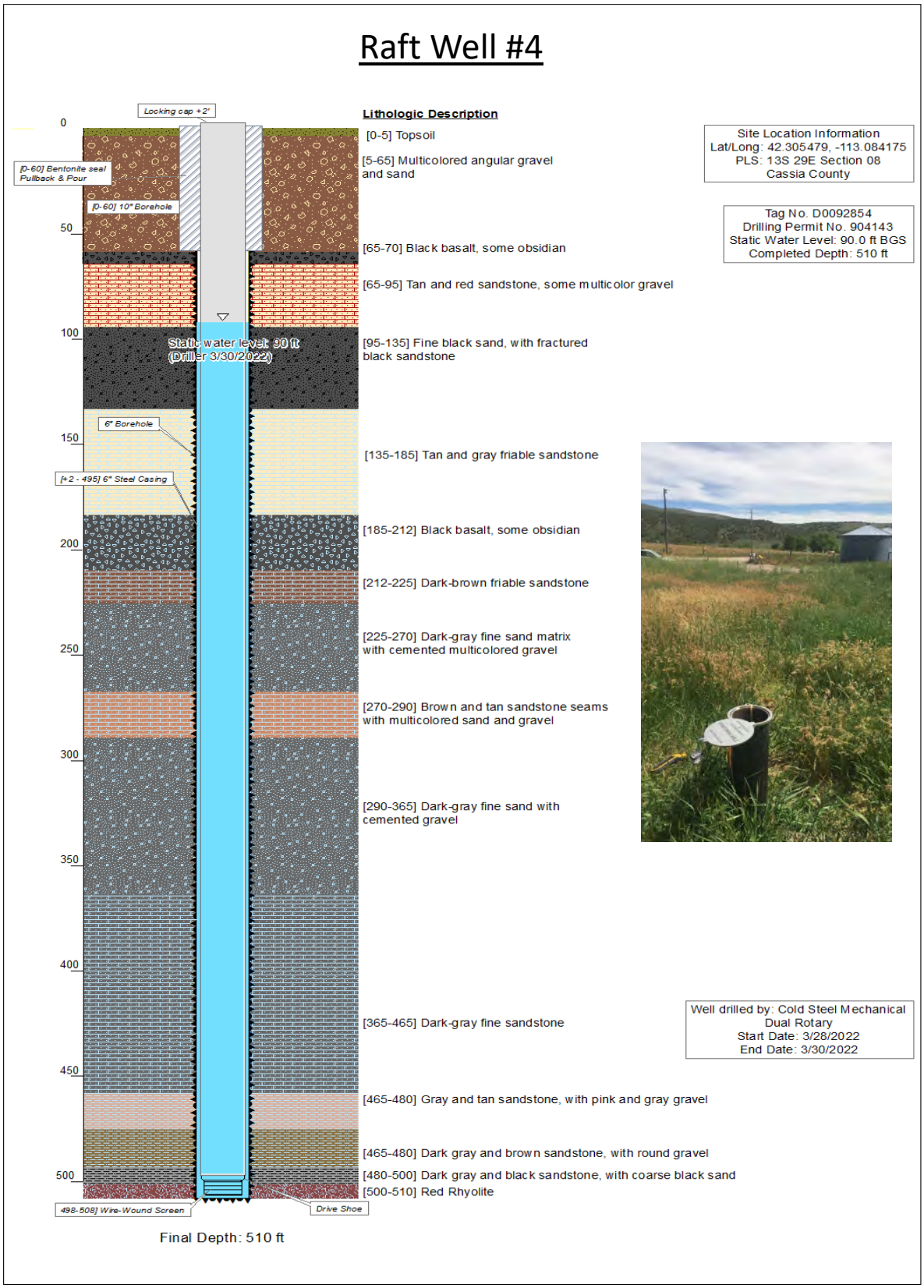


Figure 9. Construction and lithologic details for Raft Well #4

Raft Well #5

Raft Well #5 is located 22 miles NE of Malta, approximately 8.5 miles east of the Raft River (Figures 1 and 10). Drilling began March 23, 2022, and was completed on March 26, 2022, at a total depth of 720 fbgs. The well is cased to 450 fbgs with 6-inch steel casing, lined with a 4.5-inch PVC liner to 700 fbgs, and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 700 – 720 fbgs with a 0.02-inch slot size PCV screen. The depth-to-water in the well was 450 fbgs at the time of completion (Figure 11).

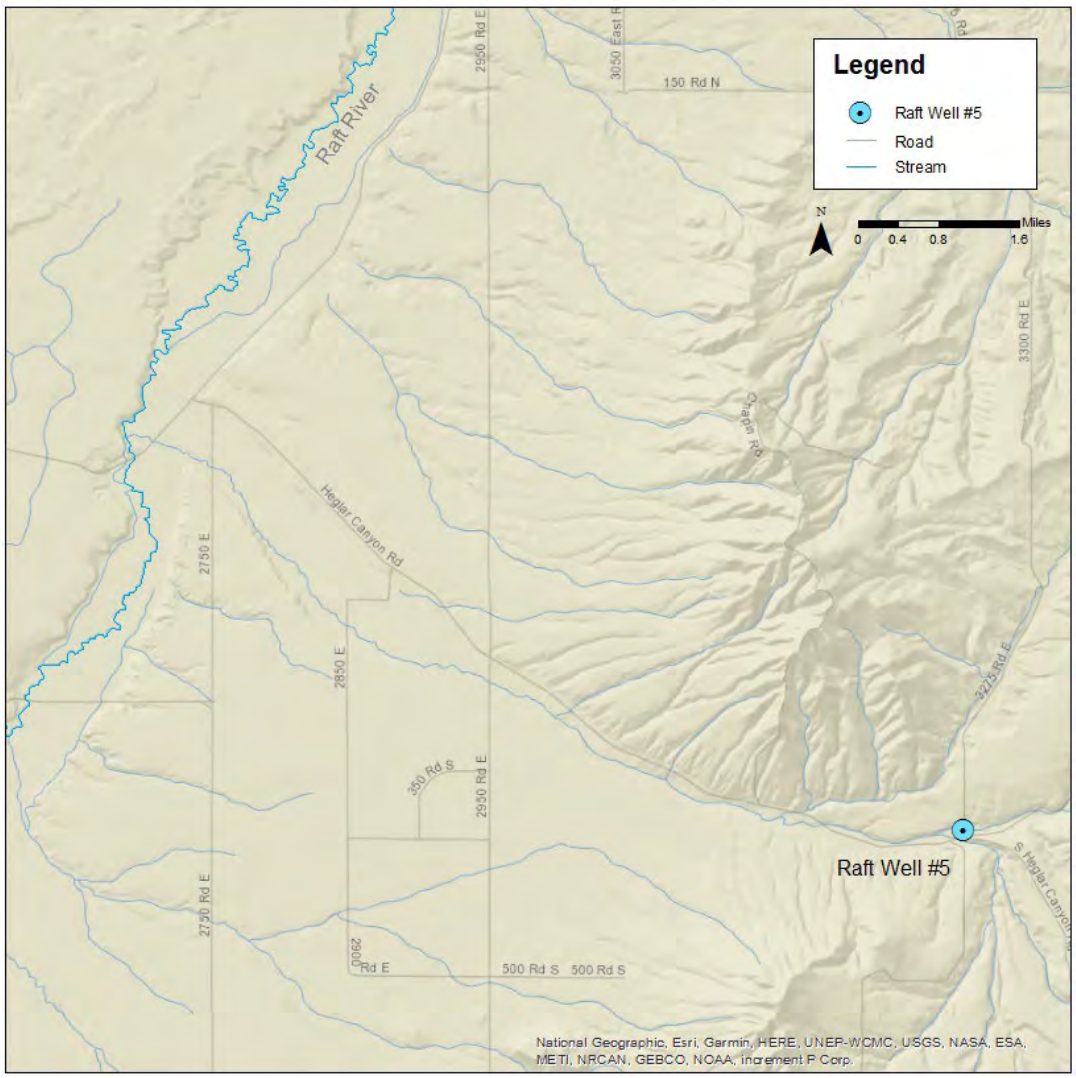


Figure 10. Map of Raft Well #5

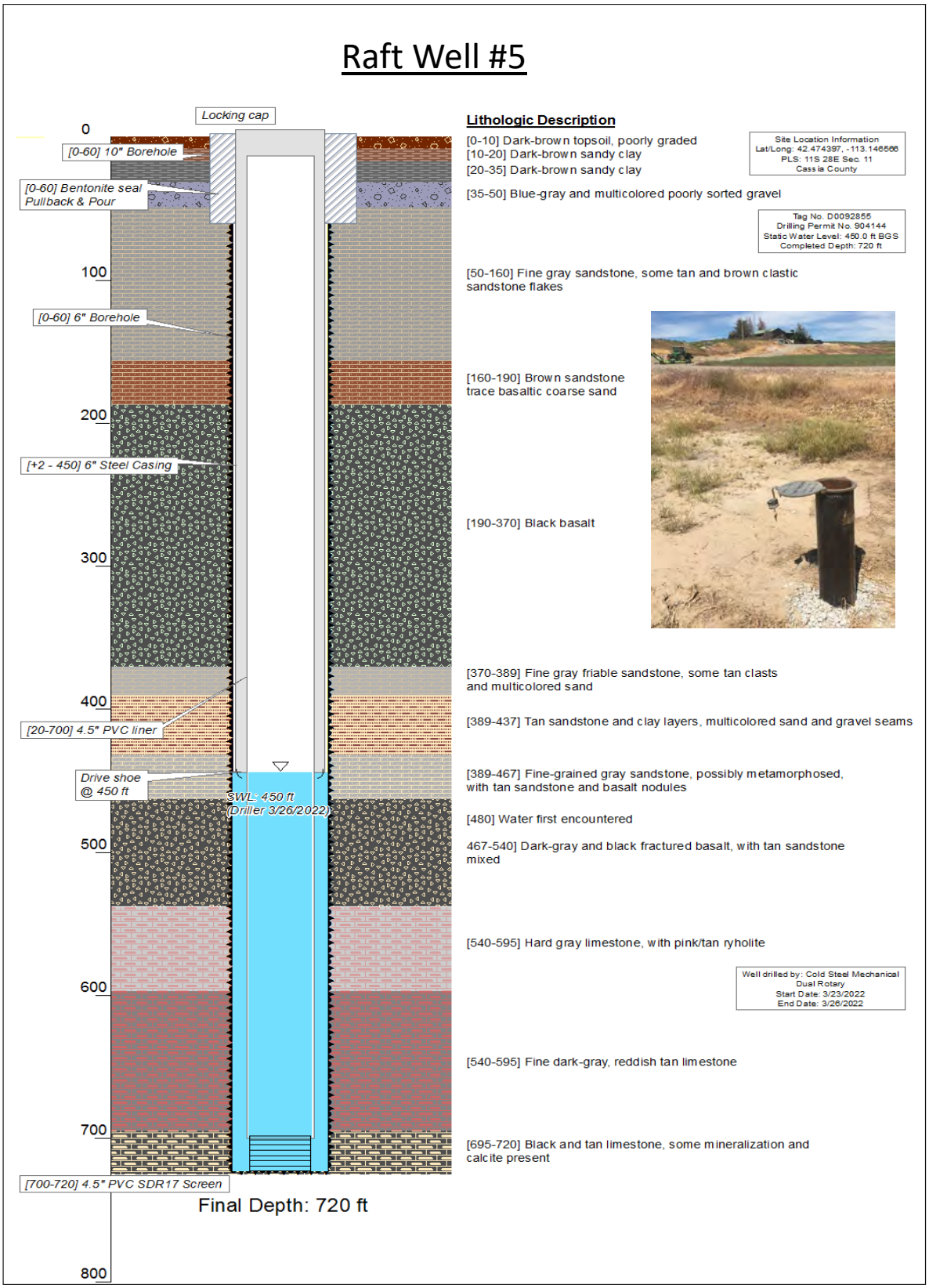


Figure 11. Construction and lithologic details of RAFT Well #5

Raft Well #6

Raft Well #6 is located 18.8 miles SE of Malta, approximately 9.0 miles east of Highway 81 (Figures 1 and 12). Drilling began March 31, 2022, and was completed on April 5, 2022, at a total depth of 753 fbgs. The well is cased to 450 fbgs with 6-inch steel casing, lined with a 4.5-inch PVC liner to 733 fbgs, and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 733 – 753 fbgs with a 0.02-inch slot size PCV screen. The depth-to-water in the well was 475 fbgs at the time of completion (Figure 13).

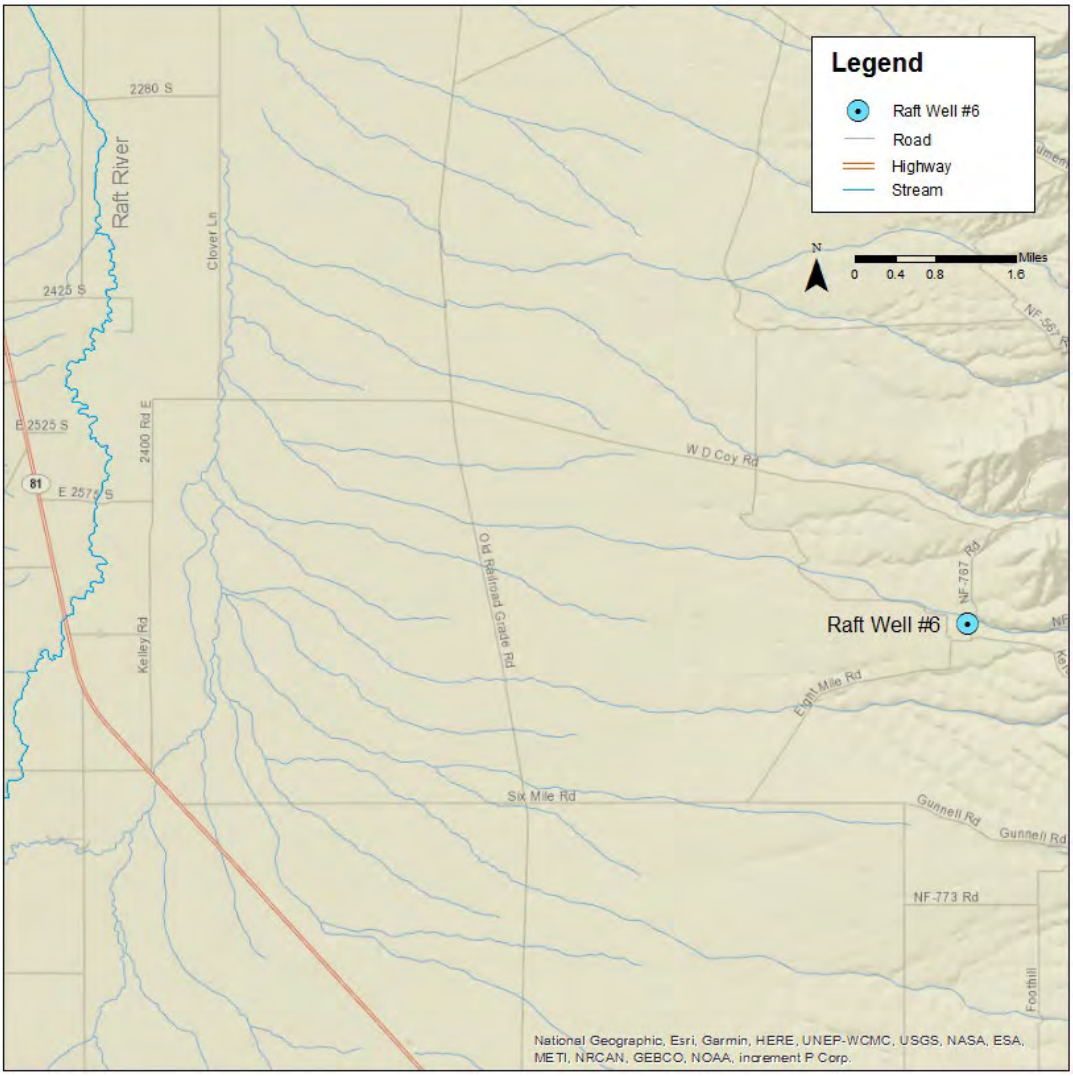


Figure 12. Map of Raft Well #6

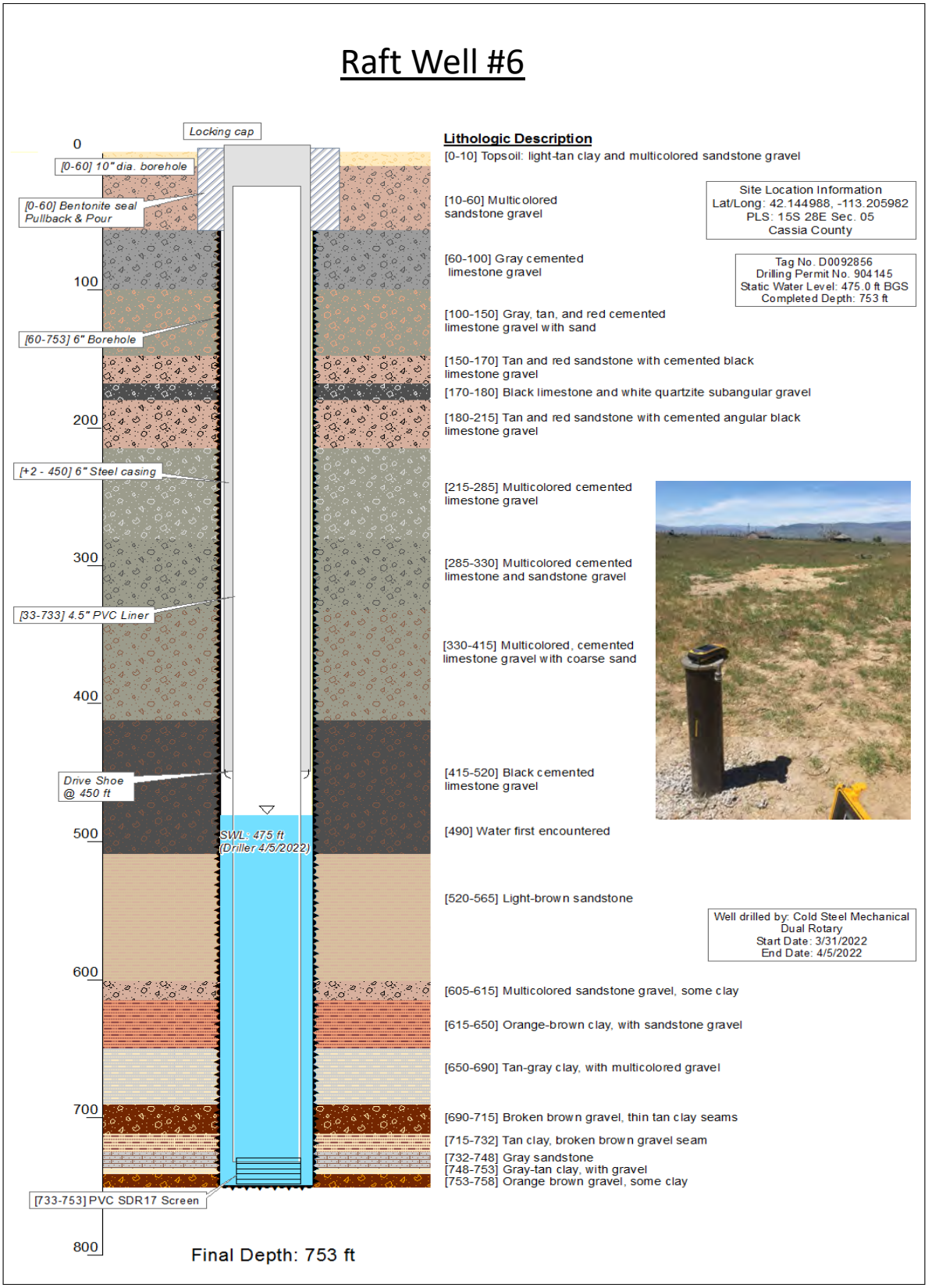


Figure 13. Construction and lithologic details of Raft Well #6

Raft Well #7

Raft Well #7 is located 4.9 miles southwest of Malta, approximately 1.3 miles south of Highway 77 (Figures 1 and 14). Drilling began April 15, 2022, and was completed on April 17, 2022, at a total depth of 471 fbgs. The well is cased to 460 fbgs with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 451 – 471 fbgs with a 0.02-inch slot size PCV screen. The depth-to-water in the well was 7.2 fbgs at the time of completion (Figure 15). The bottom-hole temperature exceeded 85 ºF. IDWR considers wells with bottom-hole temperatures of 85 ºF to and above be low-temperature geothermal wells, and requires they be constructed to meet standards that protect the geothermal resource (IDAPA, 37). The well was not constructed to meet the requirements and was abandoned on May 13, 2023.

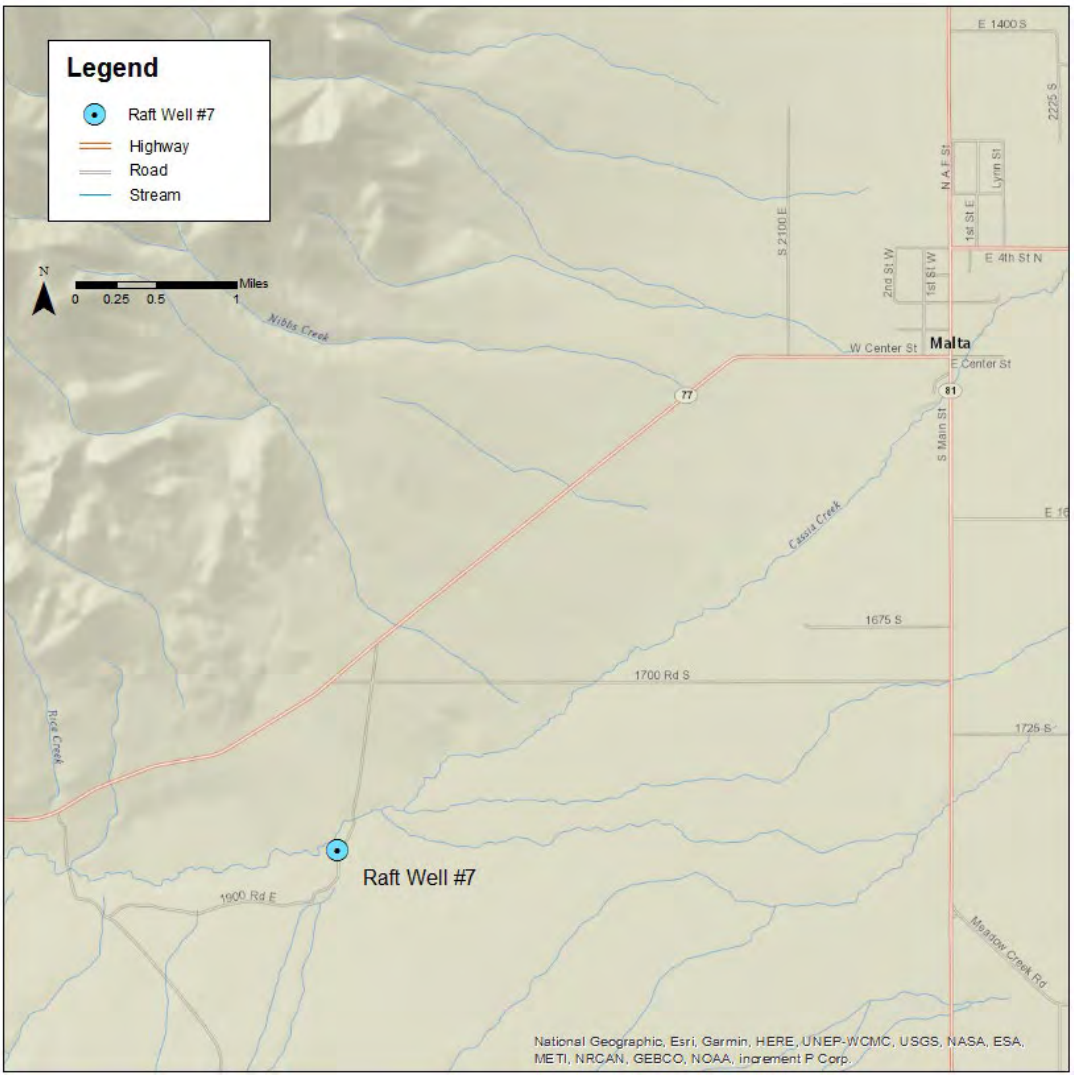


Figure 14. Map of Raft Well #7

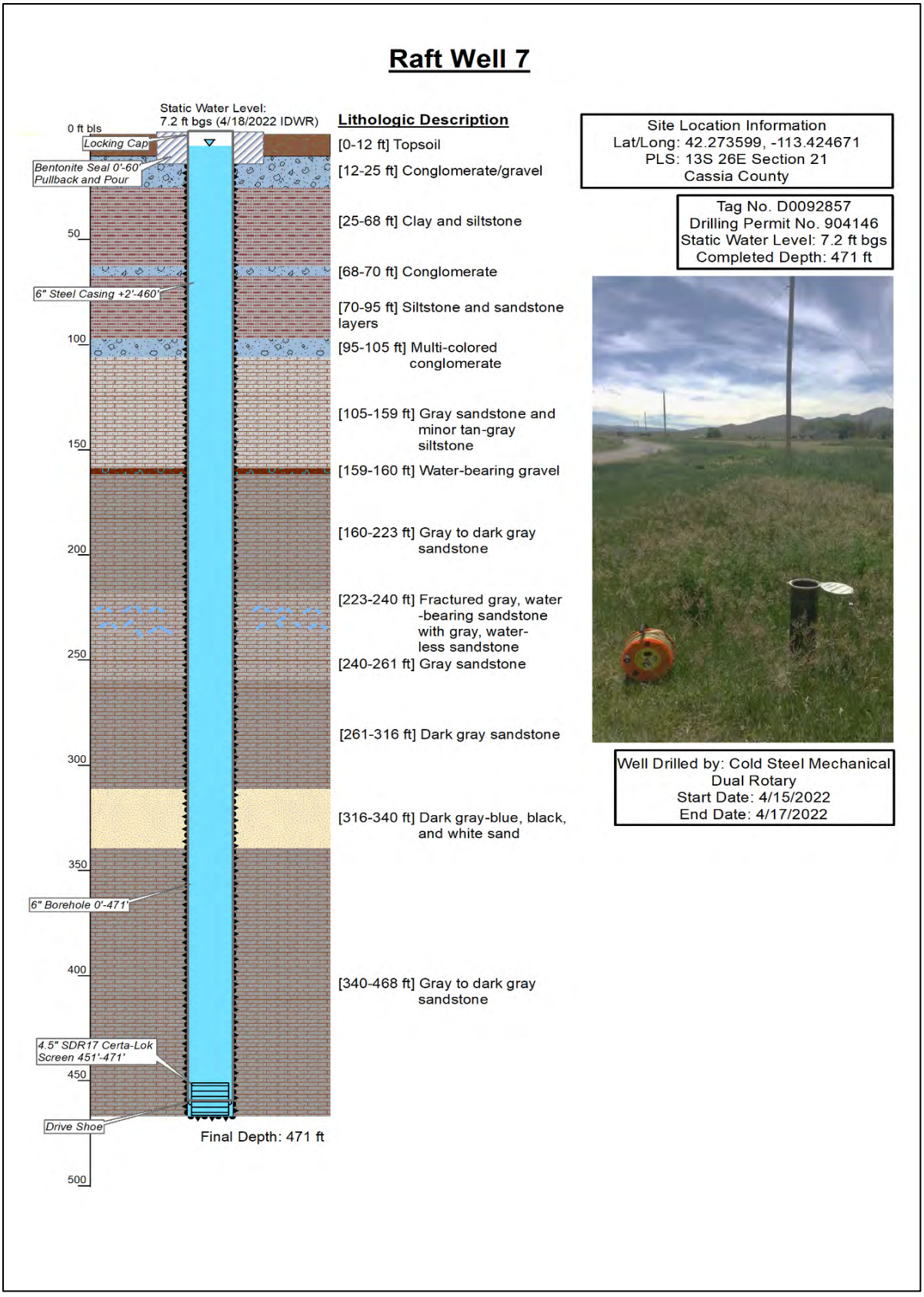


Figure 15. Construction and lithologic details of Raft Well #7

Raft Well #8

Raft Well #8 is located 20.5 miles south of Malta, approximately 2.3 miles southwest of Highway 81 (Figures 1 and 16). Drilling began April 7, 2022, and was completed on April 9, 2022, at a total depth of 495 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 478 – 493 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 114.45 fbgs on April 17, 2022 (Figure 17).

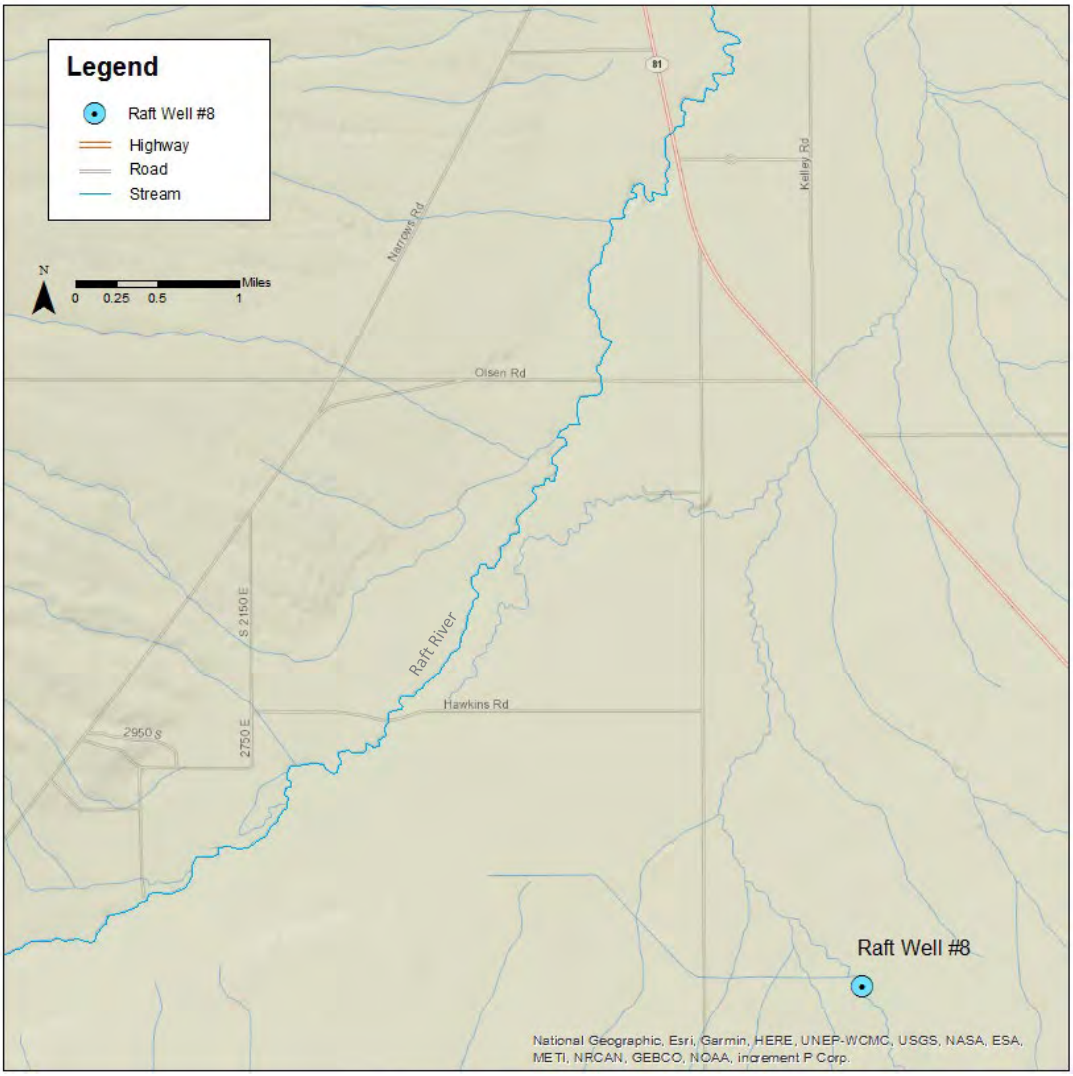


Figure 16. Map of Raft Well #8

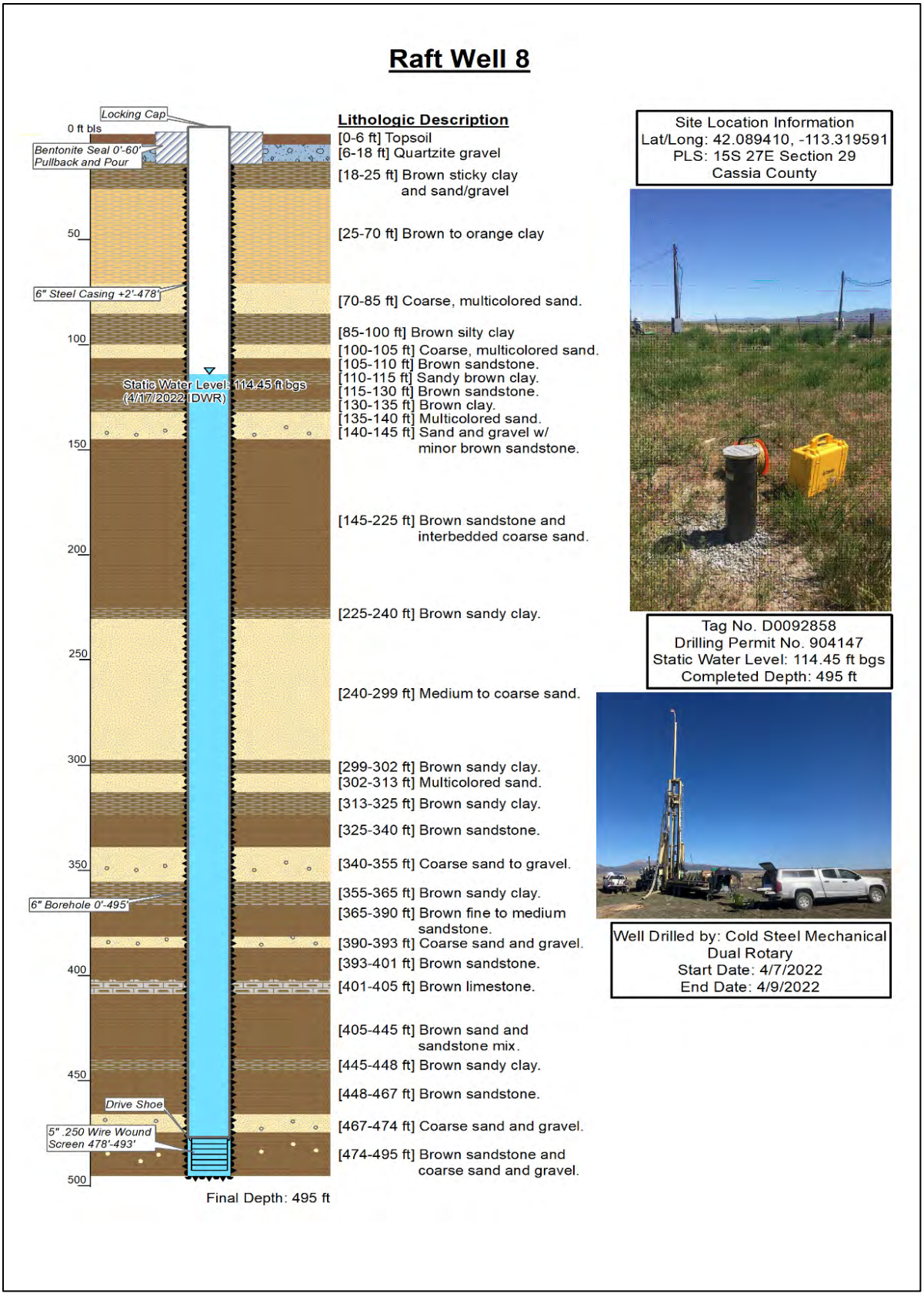


Figure 17. Construction and lithologic details of Raft Well #8

Raft Well #9

Raft Well #9 is located 7.7 miles south of Malta, approximately 0.7 miles east of Highway 81 (Figures 1 and 18). Drilling began March 19, 2022, and was completed on March 20, 2022, at a total depth of 300 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 288 – 298 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 153.52 fbgs on April 17, 2022 (Figure 19).

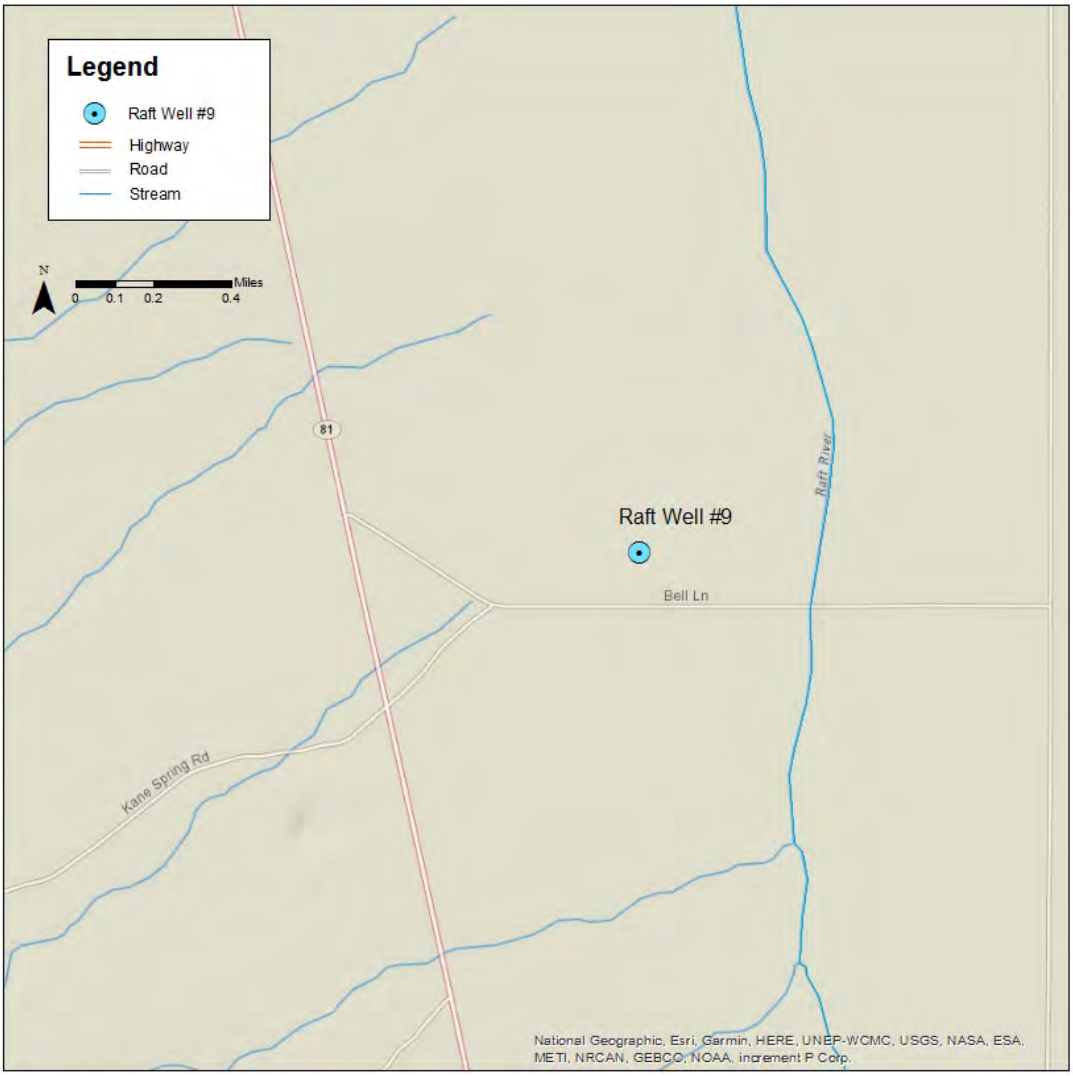


Figure 18. Map of Raft Well #9

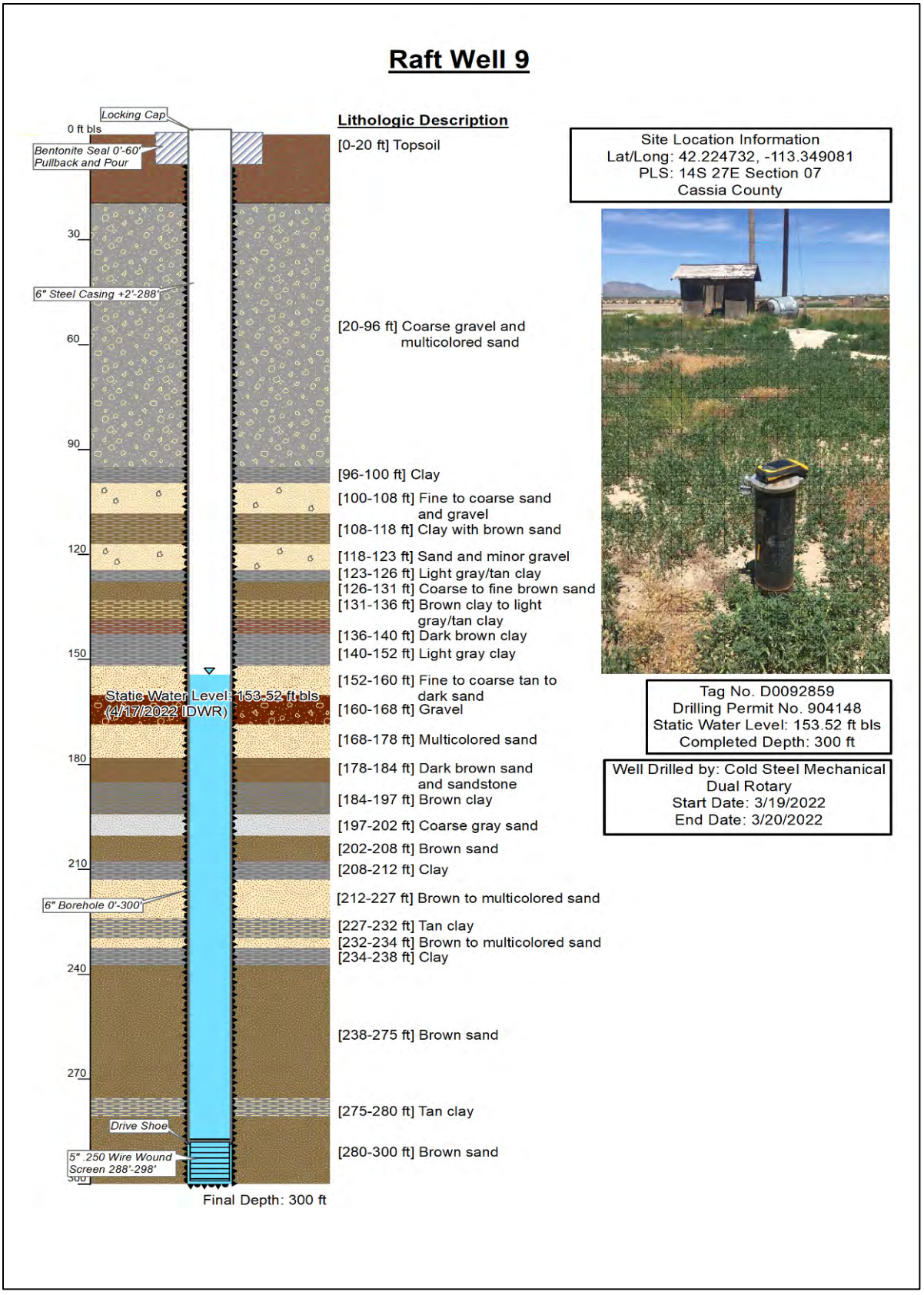


Figure 19. Construction and lithologic details of Raft Well #9

Raft Well #10

Raft Well #10 is located 18.7 miles north of Malta, approximately 1.3 miles south of Yale Road (Figures 1 and 20). Drilling began April 22, 2022, and was completed on April 30, 2022, at a total depth of 1,007 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 1,000 – 1,005 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 250.17 fbgs on June 10, 2022 (Figure 21).

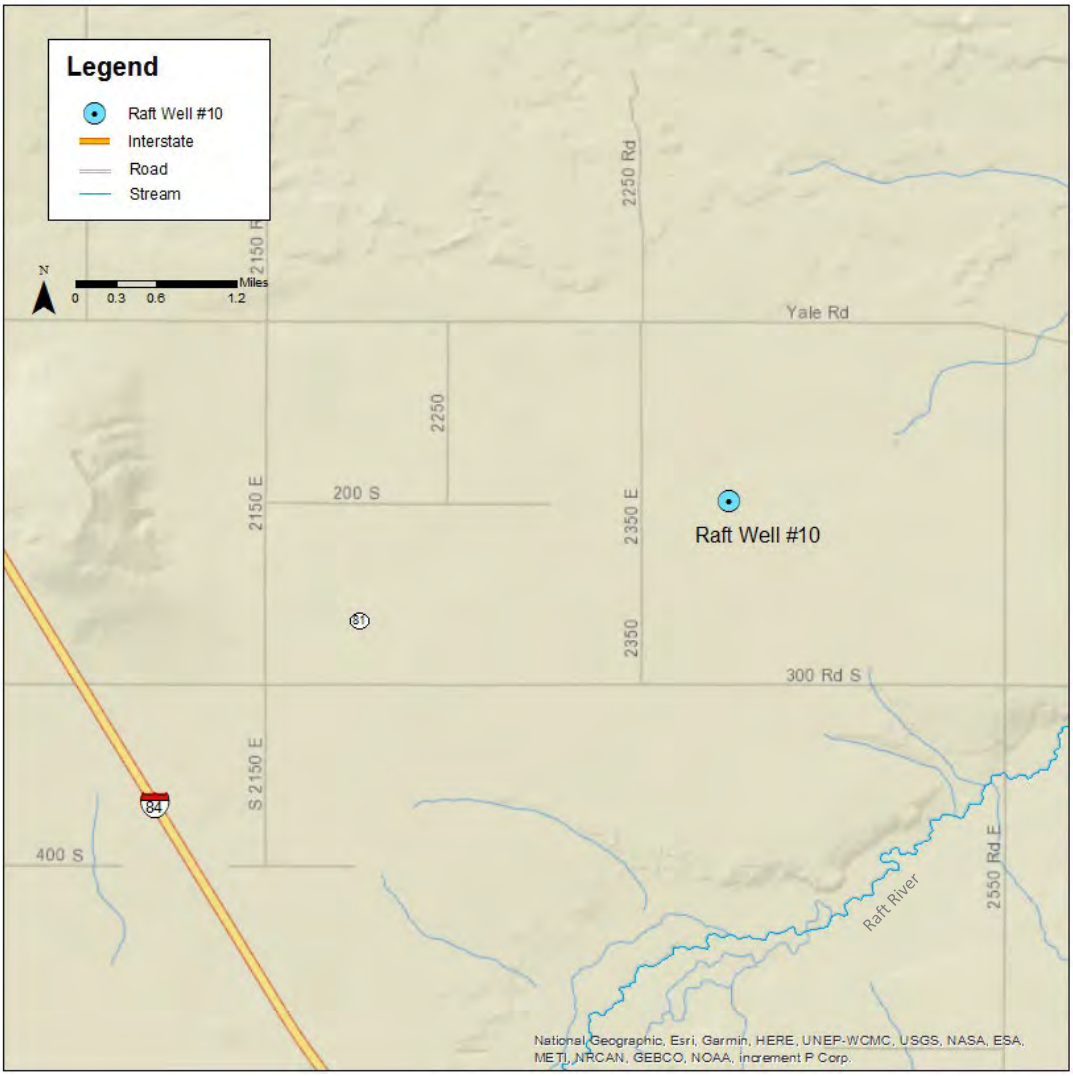


Figure 20. Map of Raft Well #10

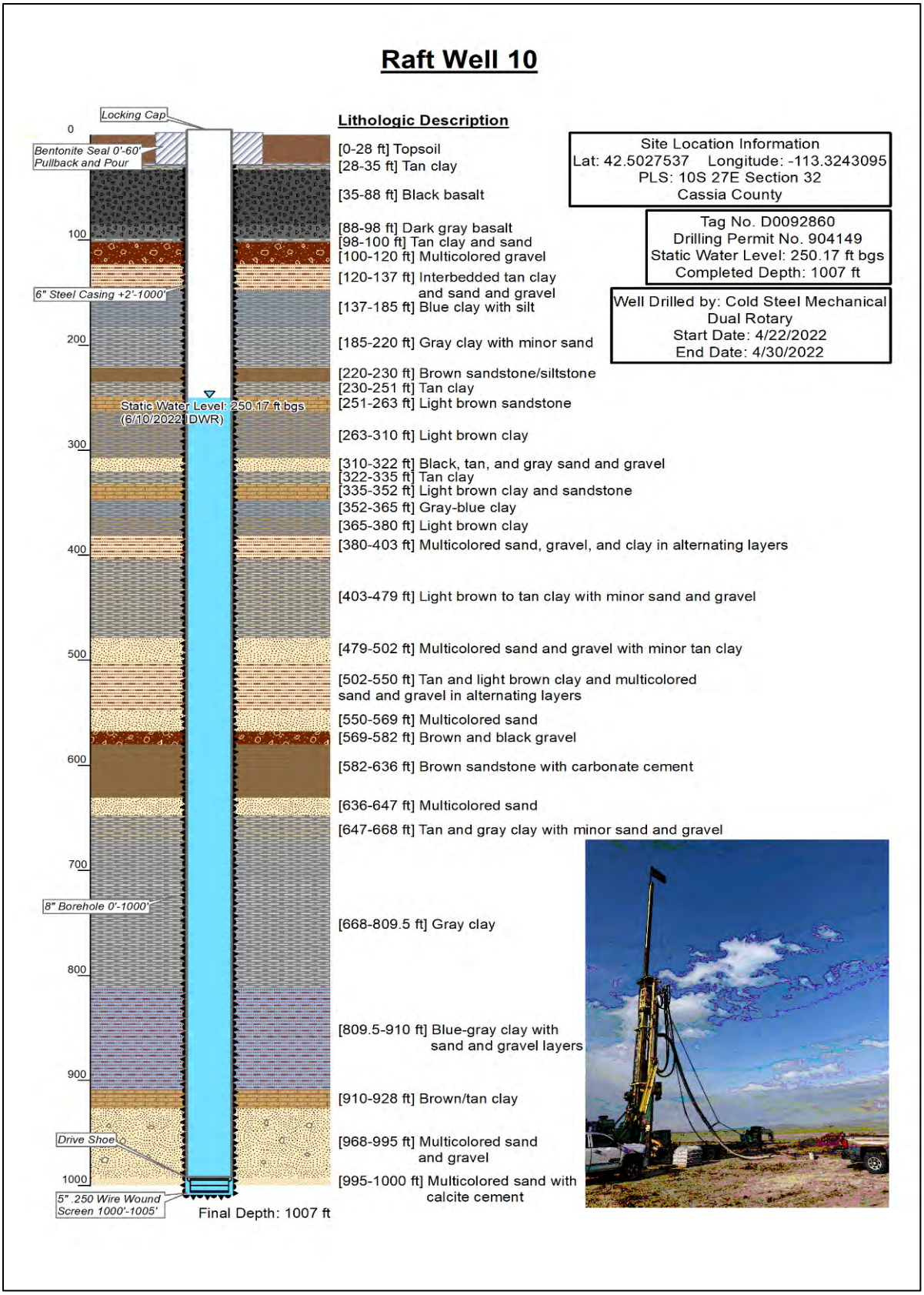


Figure 21. Construction and lithologic details of Raft Well #10

Raft Well #11

Raft Well #11 is located 6.8 miles north of Malta, approximately 1.0 mile east of Highway 81 (Figures 1 and 22). Drilling began April 18, 2022, and was completed on April 20, 2022, at a total depth of 500 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 478 – 498 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 182.45 fbgs on June 10, 2022 (Figure 23).

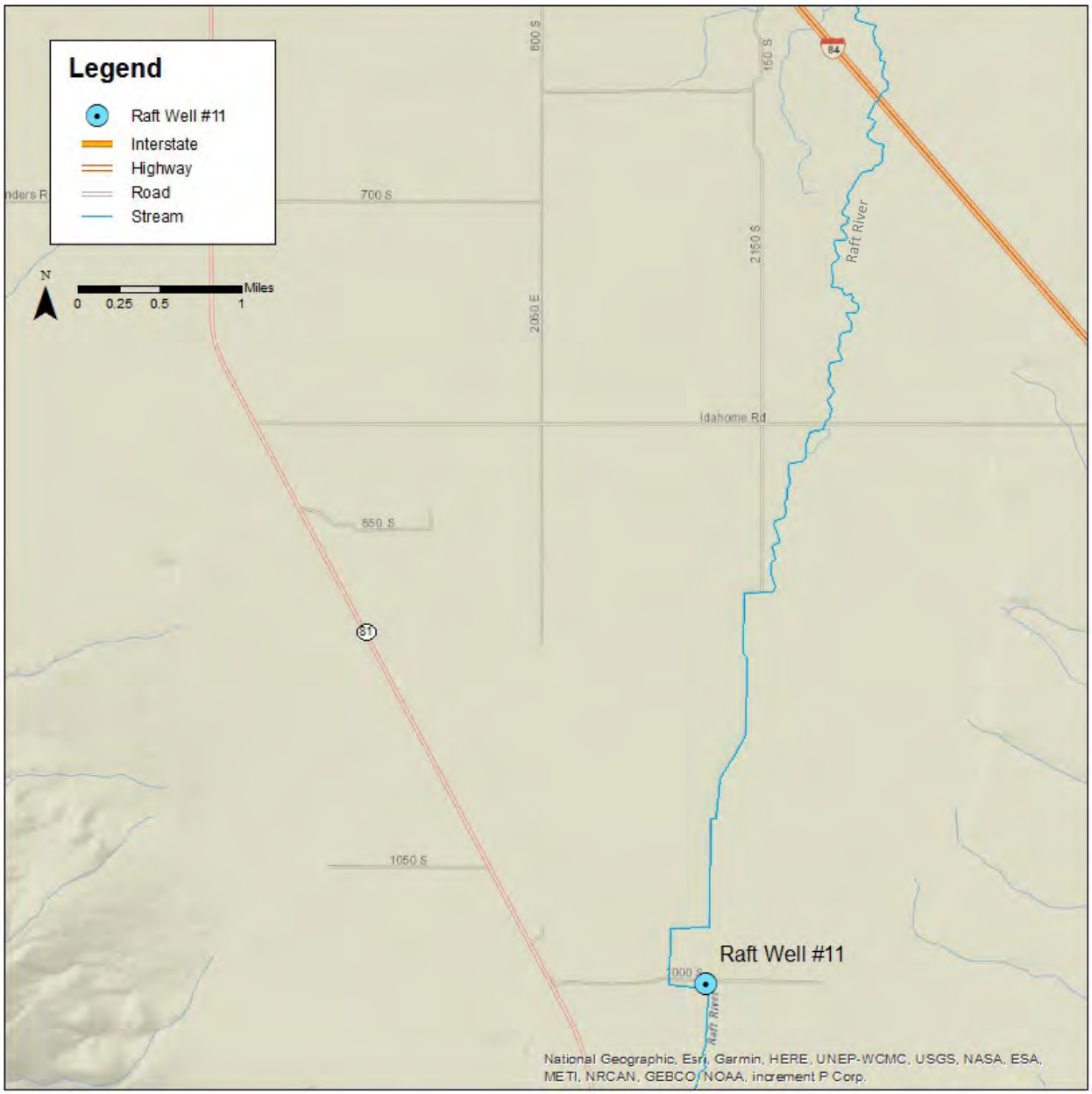


Figure 22. Map of Raft Well #11

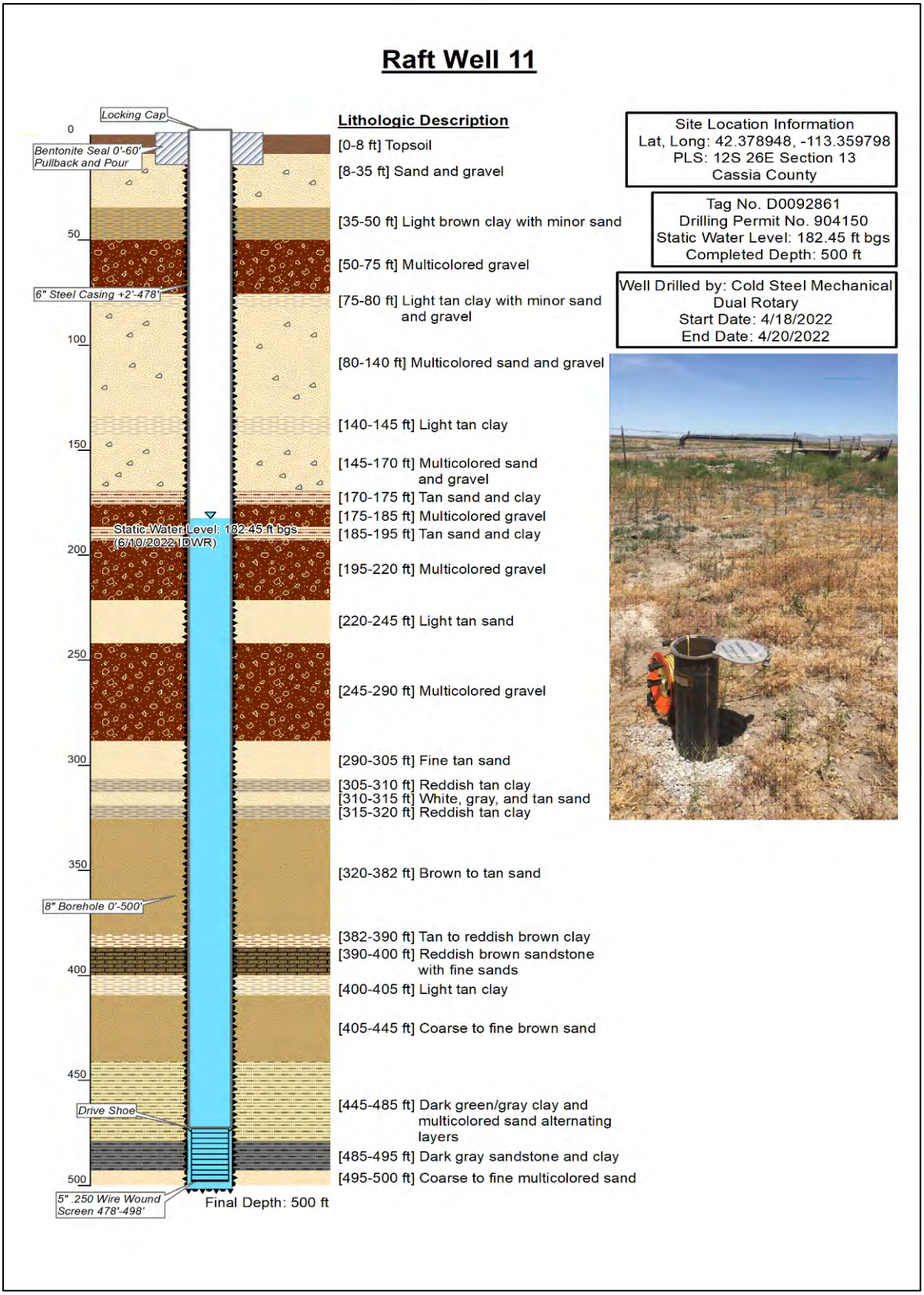


Figure 23. Construction and lithologic details of Raft Well #11

Raft Well #12

Raft Well #12 is located 27.7 miles northeast of Malta, approximately 2.8 miles east of Yale Road (Figures 1 and 24). Drilling began May 3, 2022, and was completed on May 17, 2022, at a total depth of 1,010 fbgs. The well is cased the entire length with 6-inch steel casing and is sealed with a bentonite surface seal to 60 fbgs. The well is open to the aquifer from 1,003 – 1,008 fbgs with a stainless steel, 0.012-inch slot size, wire-wound screen. The depth-to-water in the well was 227.07 fbgs on June 22, 2022 (Figure 25).

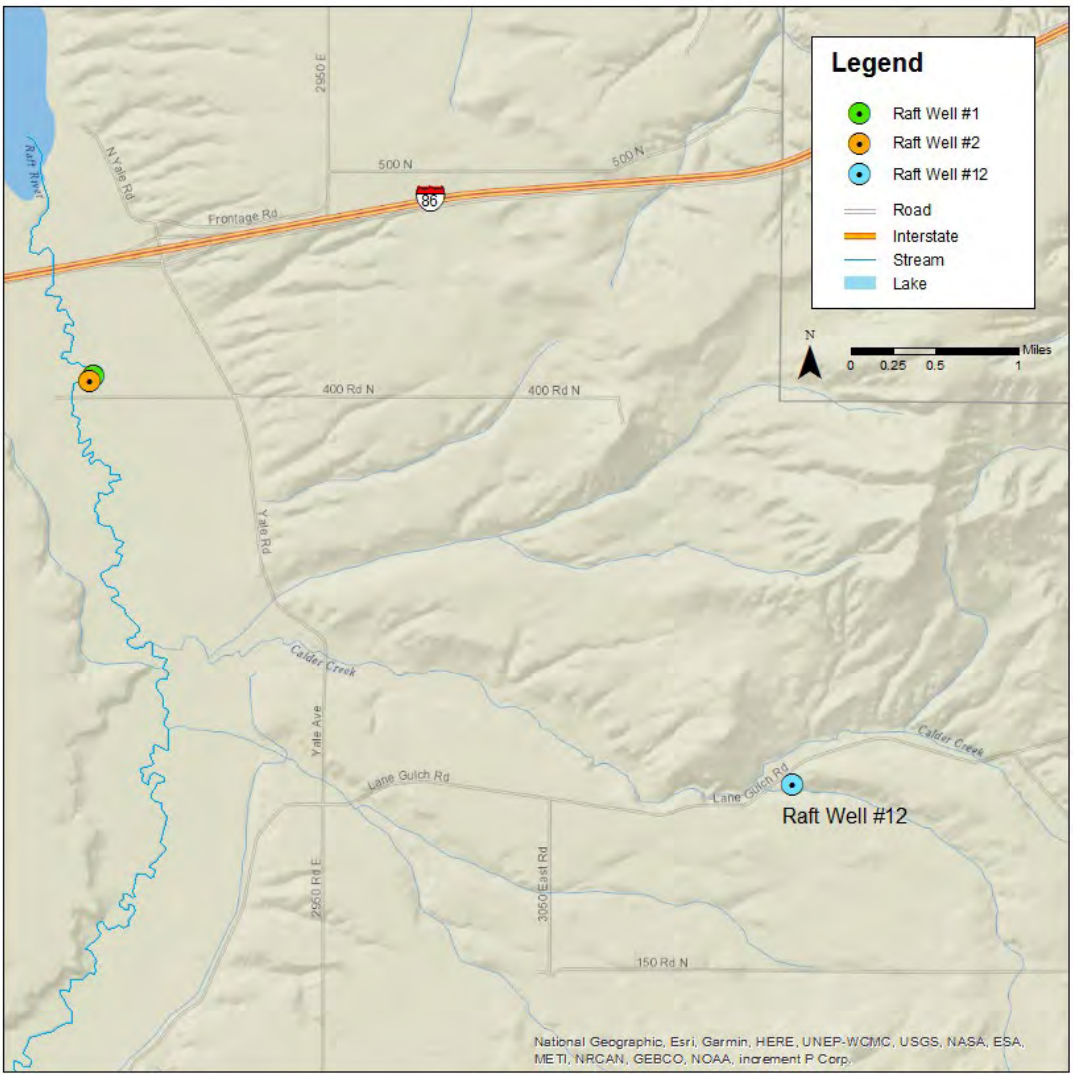


Figure 24. Map of Raft Well #12

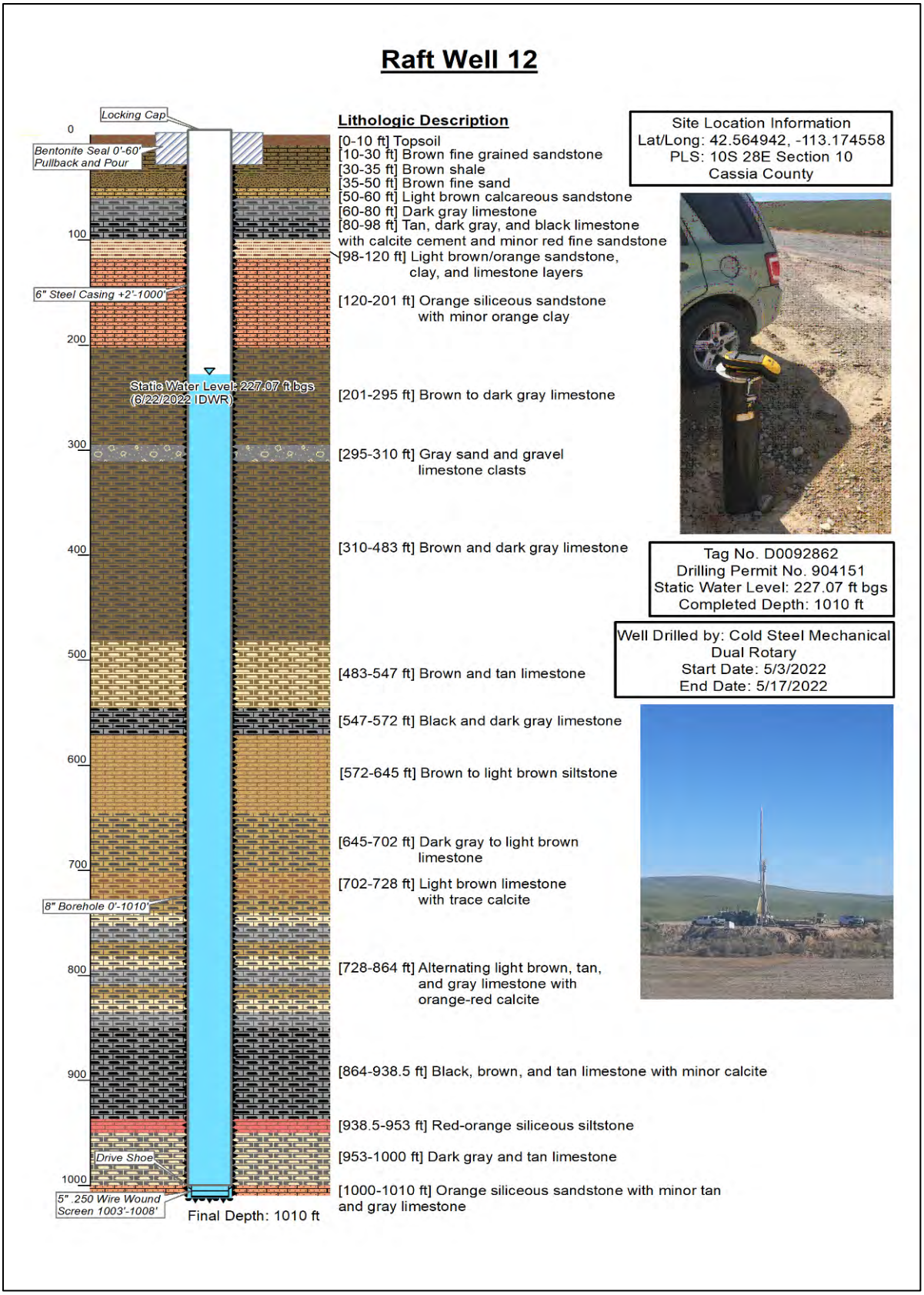


Figure 25. Construction and lithologic details of Raft Well #12

Downhole Geophysics

IDWR entered into a joint agreement with the USGS for them to conduct downhole geophysical surveys using tools that log natural gamma, neutron, gamma-gamma, temperature, and specific conductance. Each log is described below:

Natural Gamma – The natural gamma log is a measure of the natural gamma radiation emitted by decay of radioisotopes in subsurface materials. High gamma radiation levels can indicate the presence of shale or clay-rich formations, while low gamma radiation levels suggest the presence of sandstone or limestone.

Neutron – The neutron logging tool emits neutrons into the formation. Because the neutrons lose energy to hydrogen, the count of returning neutrons is used to quantify the hydrogen content of subsurface materials. High hydrogen content indicates the presence of water, while low hydrogen content suggests a drier formation with lower porosity.

Gamma-Gamma – Also known as bulk density logging, the gamma-gamma tool emits gamma radiation into the formation and detects the scattering of gamma rays. The amount of scattering is related to the density of the material. This log is especially useful for determining lithology and porosity. Higher bulk density indicates denser materials like limestone, while lower bulk density is characteristic of less dense materials such as sandstone or shale.

There are two detectors on the gamma-gamma tool, the short-spaced detector (SS) is placed a short distance from the radiation emitter, and the long-space (LS) detector is placed farther away. The SS detector is more sensitive to borehole irregularities and the LS detector investigates a larger formation volume; the SS data is typically used to correct LS data.

Temperature – The temperature probe records temperature with depth. Because these wells are cased from land surface to the screen, there is less circulation of water within the well as compared to an open borehole; therefore, the temperature profile generally reflects the geothermal gradient at the well location.

Specific Conductance – The specific conductance log is a measure of the electrical conductivity of subsurface water. However, because these wells are entirely cased, the specific conductance is not related to formation water and specific conductance is of limited usefulness.

The lithologic interpretations based on the downhole geophysical surveys are slightly different than those identified from cuttings samples. In general, these differences can be attributed to the nature of the measurement methods and the challenges associated with sampling in the subsurface. Here are some key factors that can lead to different interpretations:

Drilling and Sampling Errors – Although the dual rotary drilling method makes collecting representative cutting samples easier than with other methods, sampling from the drilling discharge introduces the possibility of mixing cuttings from multiple depths. Furthermore, it was discovered that the casing sections used by the driller were approximately 20.5 feet long, not exactly 20 feet. Although this discrepancy was tracked during logging, it introduced additional uncertainty to the recorded depths of sample collection.

Tool Response and Calibration – Downhole geophysical tools have varying responses to lithology changes, and variations in lithology may not be evident in all the logs. Furthermore, geophysical logs must be calibrated and interpreted, and different calibration methods may result in different lithologic interpretations.

Resolution and Scale – The downhole geophysics data are collected at a much smaller scale than the cutting samples, measuring properties of the formation in an almost continuous manner. Although the geophysical measurements are virtually continuous, the data are sensitive to the bulk properties of the rock and may not have captured the fine-scale heterogeneities that exist.

Conversely, cutting samples were collected every five feet, at observed lithologic changes, or when the driller noted a change in drilling conditions or water content, and sampling based on lithologic changes may identify heterogeneities that are obscured by the bulk-property nature of the geophysical interpretation. However, some changes occurred rapidly during the drilling, and all lithologic changes may not have been captured by the cuttings that were collected. Furthermore, some of the fine-scale lithologic differences identified in the cuttings were grouped based on similarities (e.g., grain size, cementation, chemical composition) to generate simplified lithologic logs.

Each method groups lithologies based on different criteria, and lithologic interpretations from both methods have been used in combination to develop a more accurate hydrogeologic framework. The following figures illustrate the logs generated during the geophysical surveys, as well as the lithologic interpretations for each well.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 423527113140601	**RAFT WELL #1**	**Other ID** Well Tag 92851
County Cassia	**State** Idaho	**Log date** 11/15/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 43.5909612	**Longitude** -113.2350078	**Lat/Long datum** NAD83
Altitude LMP 4212.98 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 1.75 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 358 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 358 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 57.06 feet	**at time** 13:09 on 11/15/2022

Hydrologic conditions Borehole completed 3/10/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

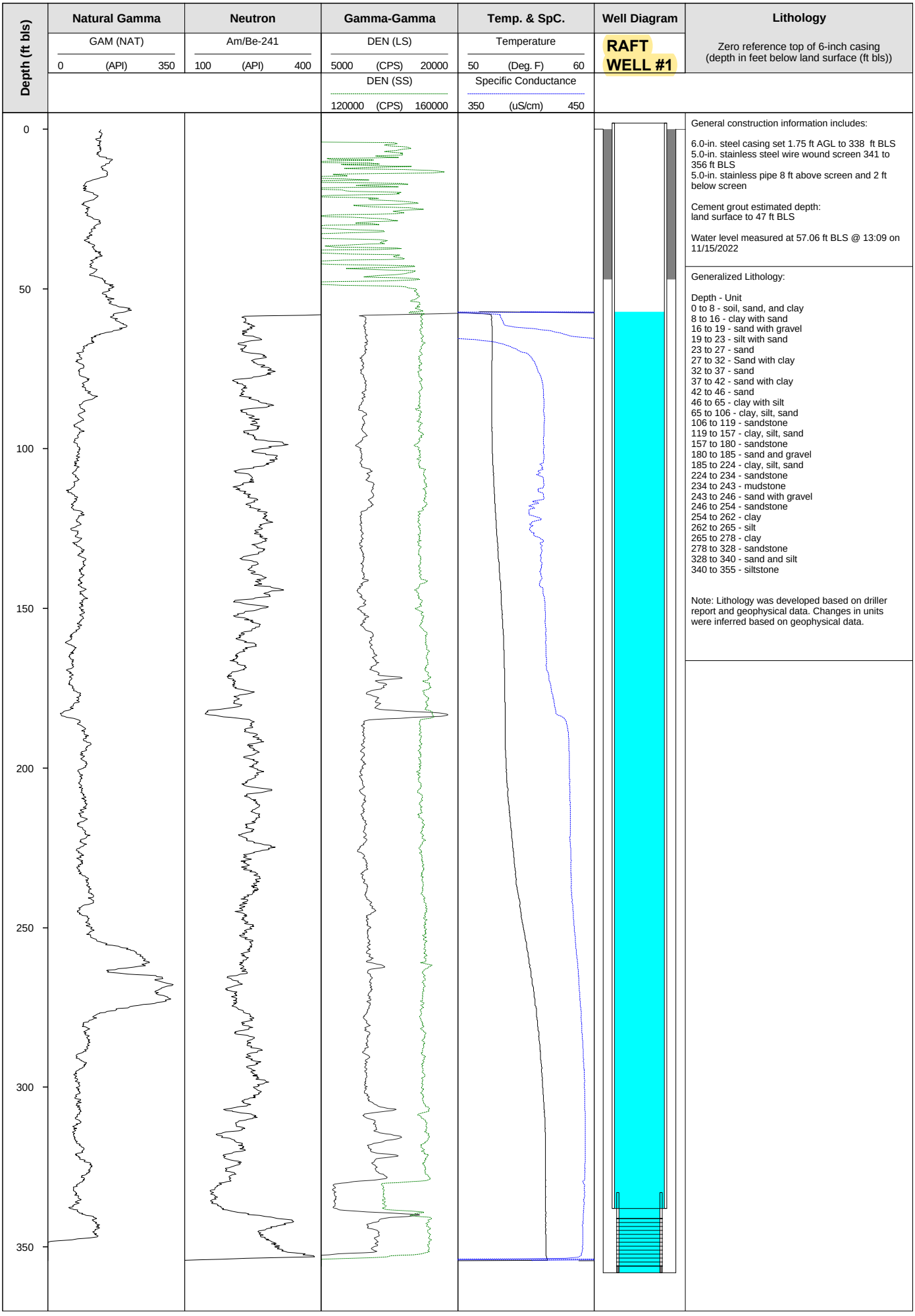
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature, and Natural Gamma. Log 9042A run inside of 6-in. casing. Down log run from land surface to 354 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron, Porosity (relative change) - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 354 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 356 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #1.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing set 1.75 ft AGL to 338 ft BLS
5.0-in. stainless steel wire wound screen 341 to 356 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 47 ft BLS

Water level measured at 57.06 ft BLS @ 13:09 on 11/15/2022

Generalized Lithology:

Depth - Unit
0 to 8 - soil, sand, and clay
8 to 16 - clay with sand
16 to 19 - sand with gravel
19 to 23 - silt with sand
23 to 27 - sand
27 to 32 - Sand with clay
32 to 37 - sand
37 to 42 - sand with clay
42 to 46 - sand
46 to 65 - clay with silt
65 to 106 - clay, silt, sand
106 to 119 - sandstone
119 to 157 - clay, silt, sand
157 to 180 - sandstone
180 to 185 - sand and gravel
185 to 224 - clay, silt, sand
224 to 234 - sandstone
234 to 243 - mudstone
243 to 246 - sand with gravel
246 to 254 - sandstone
254 to 262 - clay
262 to 265 - silt
265 to 278 - clay
278 to 328 - sandstone
328 to 340 - sand and silt
340 to 355 - siltstone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

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BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 423526113140701	**RAFT WELL #2**	**Other ID** Well Tag 92852
County Cassia	**State** Idaho	**Log date** 11/15/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.5906237	**Longitude** -113.2353128	**Lat/Long datum** NAD83
Altitude LMP 4210.84 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.13 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 768 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 768 feet BLS
Casing diameter 6-in.	**Casing type** Steel casing	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 71.77 feet	**at time** 10:10 on 11/17/2022

Hydrologic conditions Borehole completed 04/04/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

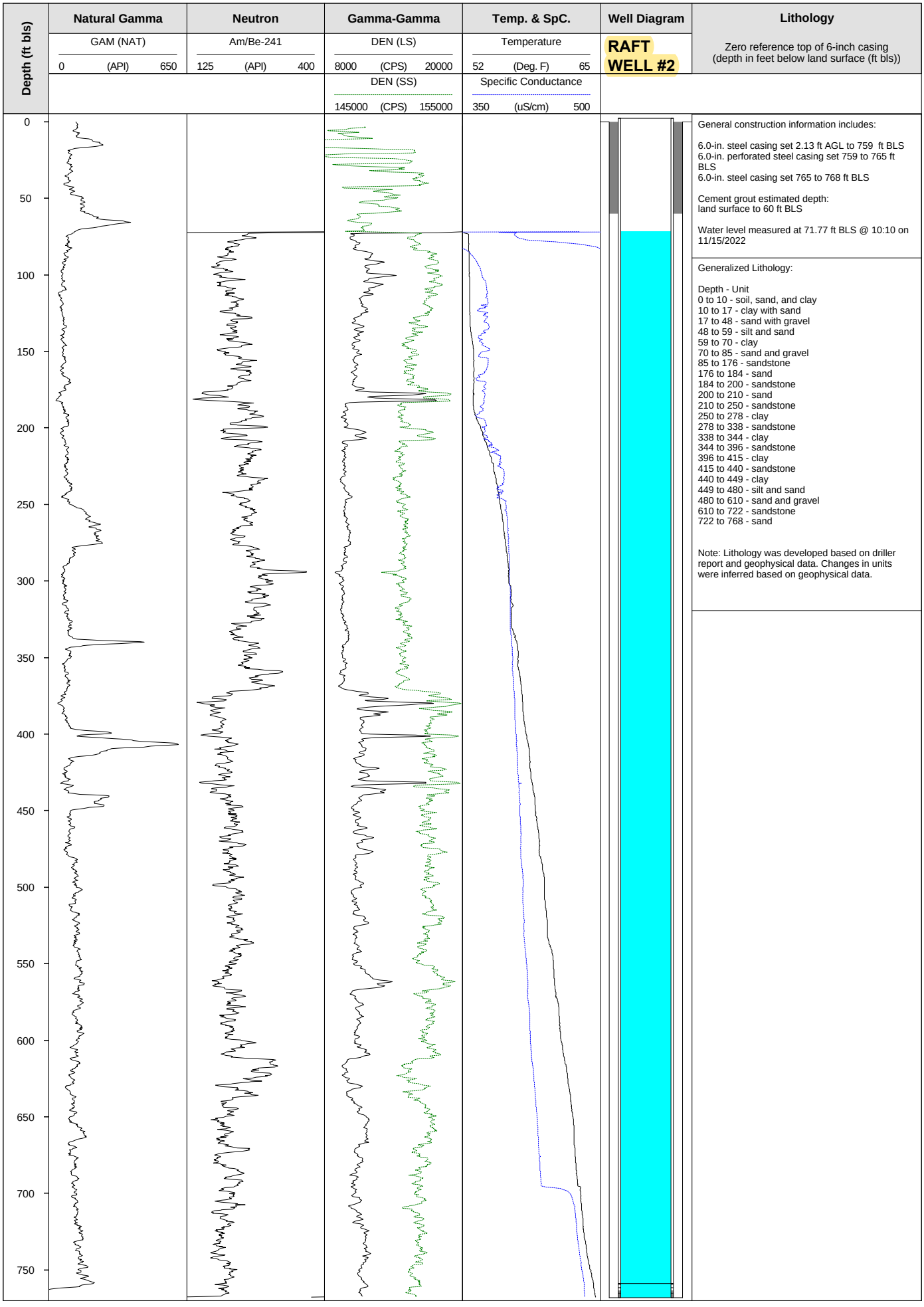
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 770 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 768 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 769 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #2.



General construction information includes:

6.0-in. steel casing set 2.13 ft AGL to 759 ft BLS
6.0-in. perforated steel casing set 759 to 765 ft BLS
6.0-in. steel casing set 765 to 768 ft BLS

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 71.77 ft BLS @ 10:10 on 11/15/2022

Generalized Lithology:

Depth - Unit
0 to 10 - soil, sand, and clay
10 to 17 - clay with sand
17 to 48 - sand with gravel
48 to 59 - silt and sand
59 to 70 - clay
70 to 85 - sand and gravel
85 to 176 - sandstone
176 to 184 - sand
184 to 200 - sandstone
200 to 210 - sand
210 to 250 - sandstone
250 to 278 - clay
278 to 338 - sandstone
338 to 344 - clay
344 to 396 - sandstone
396 to 415 - clay
415 to 440 - sandstone
440 to 449 - clay
449 to 480 - silt and sand
480 to 610 - sand and gravel
610 to 722 - sandstone
722 to 768 - sand

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 423409113233701	**RAFT WELL #3**	**Other ID** Well Tag 92853
County Cassia	**State** Idaho	**Log date** 11/16/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.5692103	**Longitude** -113.393651	**Lat/Long datum** NAD83
Altitude LMP 4418.55 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.15 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 940 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 938 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 271.30 feet	**at time** 14:44 on 11/16/2022

Hydrologic conditions Borehole completed 05/21/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

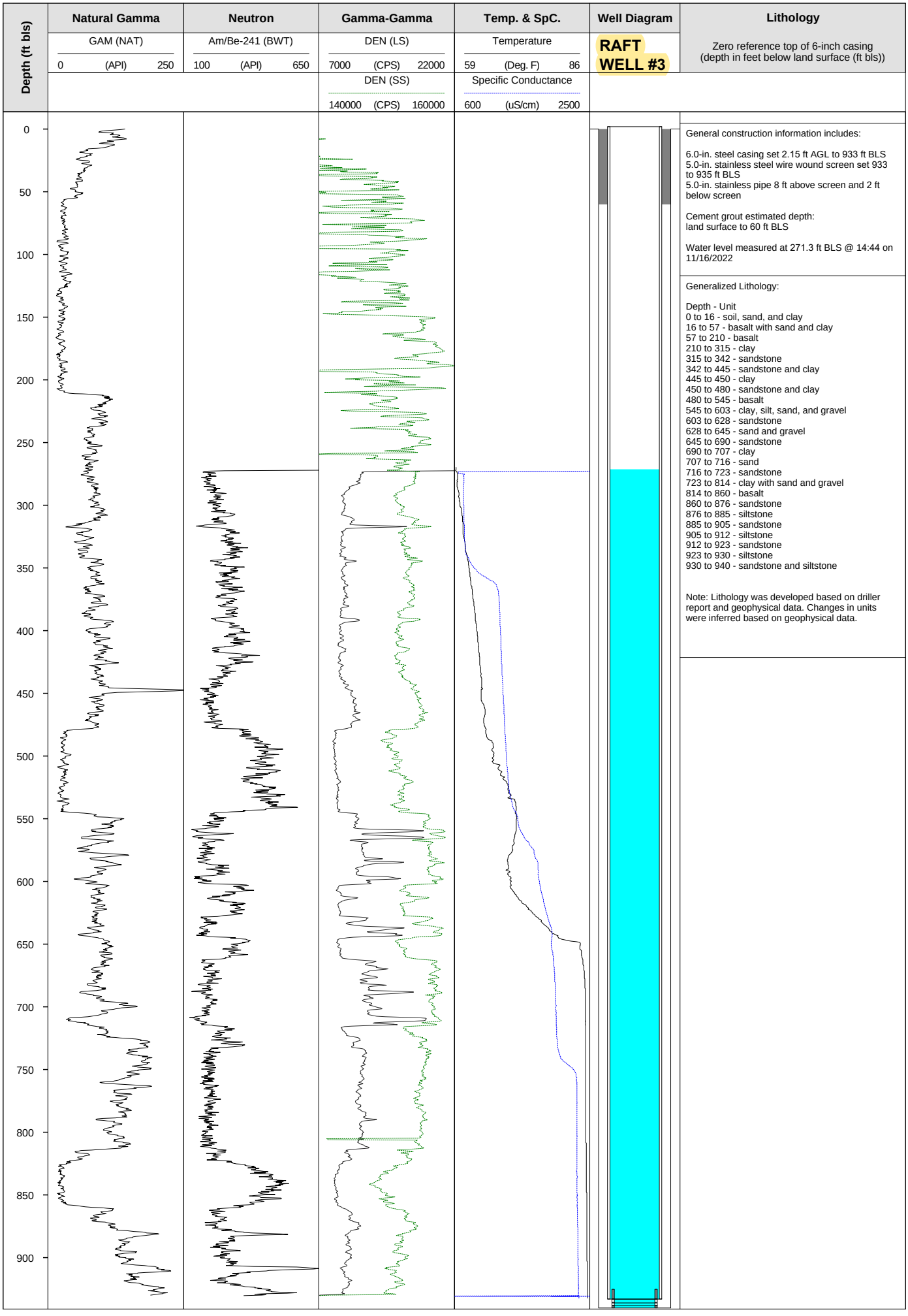
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 940.00 feet below land surface (ft BLS) (not shown). Repeat quality assurance up log run from 940.00 ft BLS to 271.30 ft BLS (shown below).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 940.80 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 932.90 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #3.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing set 2.15 ft AGL to 933 ft BLS
5.0-in. stainless steel wire wound screen set 933 to 935 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 271.3 ft BLS @ 14:44 on 11/16/2022

Generalized Lithology:

Depth - Unit
0 to 16 - soil, sand, and clay
16 to 57 - basalt with sand and clay
57 to 210 - basalt
210 to 315 - clay
315 to 342 - sandstone
342 to 445 - sandstone and clay
445 to 450 - clay
450 to 480 - sandstone and clay
480 to 545 - basalt
545 to 603 - clay, silt, sand, and gravel
603 to 628 - sandstone
628 to 645 - sand and gravel
645 to 690 - sandstone
690 to 707 - clay
707 to 716 - sand
716 to 723 - sandstone
723 to 814 - clay with sand and gravel
814 to 860 - basalt
860 to 876 - sandstone
876 to 885 - siltstone
885 to 905 - sandstone
905 to 912 - siltstone
912 to 923 - sandstone
923 to 930 - siltstone
930 to 940 - sandstone and siltstone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

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BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 421818113050301	**RAFT WELL # 4**	**Other ID** Well Tag 92854
County Cassia	**State** Idaho	**Log date** 11/18/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.3054794	**Longitude** -113.084175	**Lat/Long datum** NAD83
Altitude LMP 5188.59 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.25 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 510 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 510 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 87.19 feet	**at time** 08:16 on 11/18/2022

Hydrologic conditions Borehole completed 3/30/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

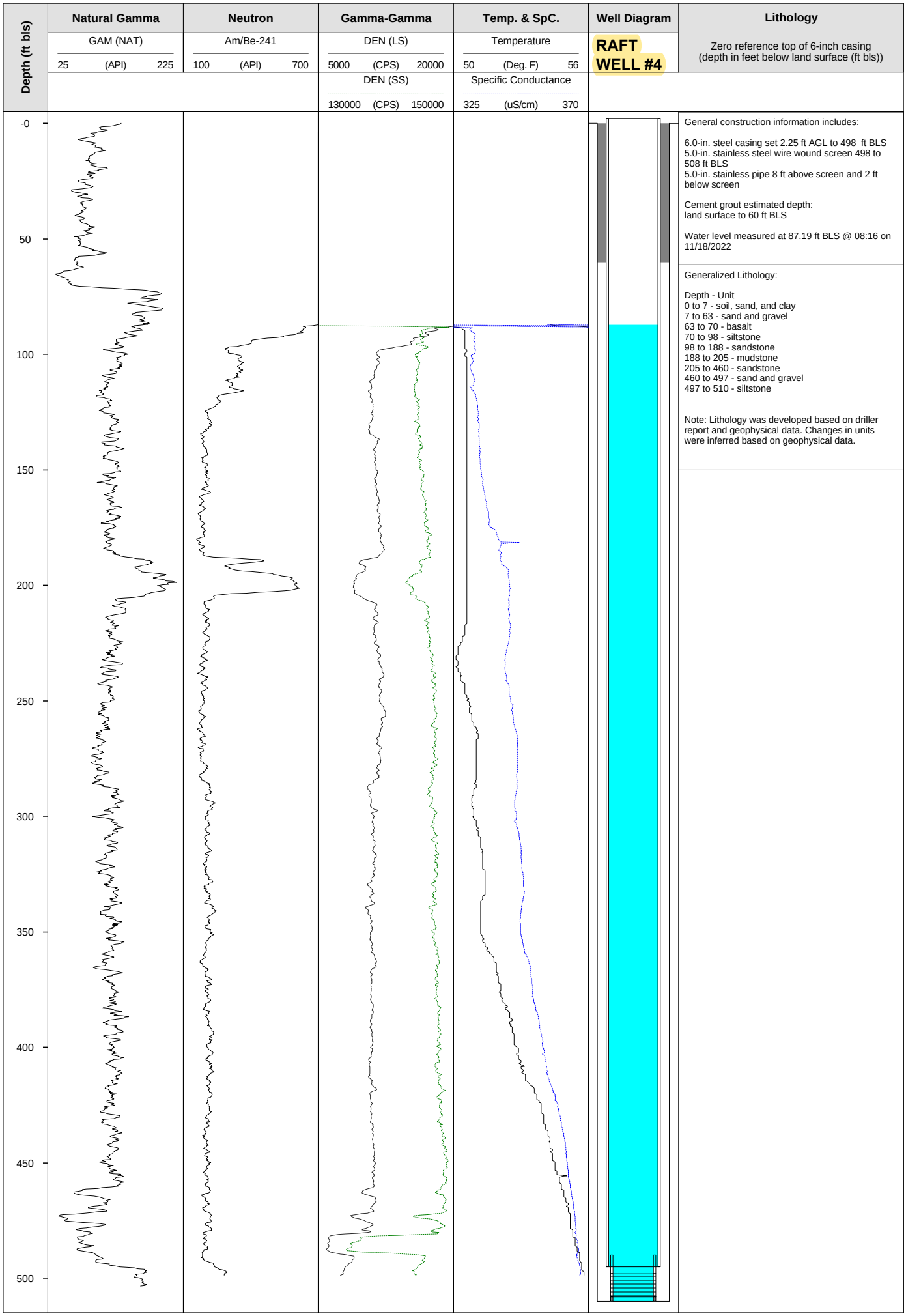
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Natural Gamma, Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 506.60 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Down log run from land surface to 500.60 ft BLS.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Down log run from land surface to 503.20 ft BLS.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #4.


Depth (ft bls)
Natural Gamma
GAM (NAT)
25 (API) 225
Neutron
Am/Be-241
100 (API) 700
Gamma-Gamma
DEN (LS)
5000 (CPS) 20000
DEN (SS)
130000 (CPS) 150000
Temp. & SpC.
Temperature
50 (Deg. F) 56
Specific Conductance
325 (uS/cm) 370
Well Diagram
RAFT
WELL #4
Lithology
Zero reference top of 6-inch casing
(depth in feet below land surface (ft bls))
-0
50
100
150
200
250
300
350
400
450
500
General construction information includes:
6.0-in. steel casing set 2.25 ft AGL to 498 ft BLS
5.0-in. stainless steel wire wound screen 498 to 508 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen
Cement grout estimated depth:
land surface to 60 ft BLS
Water level measured at 87.19 ft BLS @ 08:16 on 11/18/2022
Generalized Lithology:
Depth - Unit
0 to 7 - soil, sand, and clay
7 to 63 - sand and gravel
63 to 70 - basalt
70 to 98 - siltstone
98 to 188 - sandstone
188 to 205 - mudstone
205 to 460 - sandstone
460 to 497 - sand and gravel
497 to 510 - siltstone
Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 422828113084801	**RAFT WELL #5**	**Other ID** Well Tag 92855
County Cassia	**State** Idaho	**Log date** 11/16/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.4743982	**Longitude** -113.146565	**Lat/Long datum** NAD83
Altitude LMP 4725.28 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.0 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 720 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 720 feet BLS
Casing diameter 6-in., 4.5-in.	**Casing type** Steel casing / PVC Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 551.79 feet	**at time** 08:38 on 11/16/2022

Hydrologic conditions Borehole completed 3/26/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

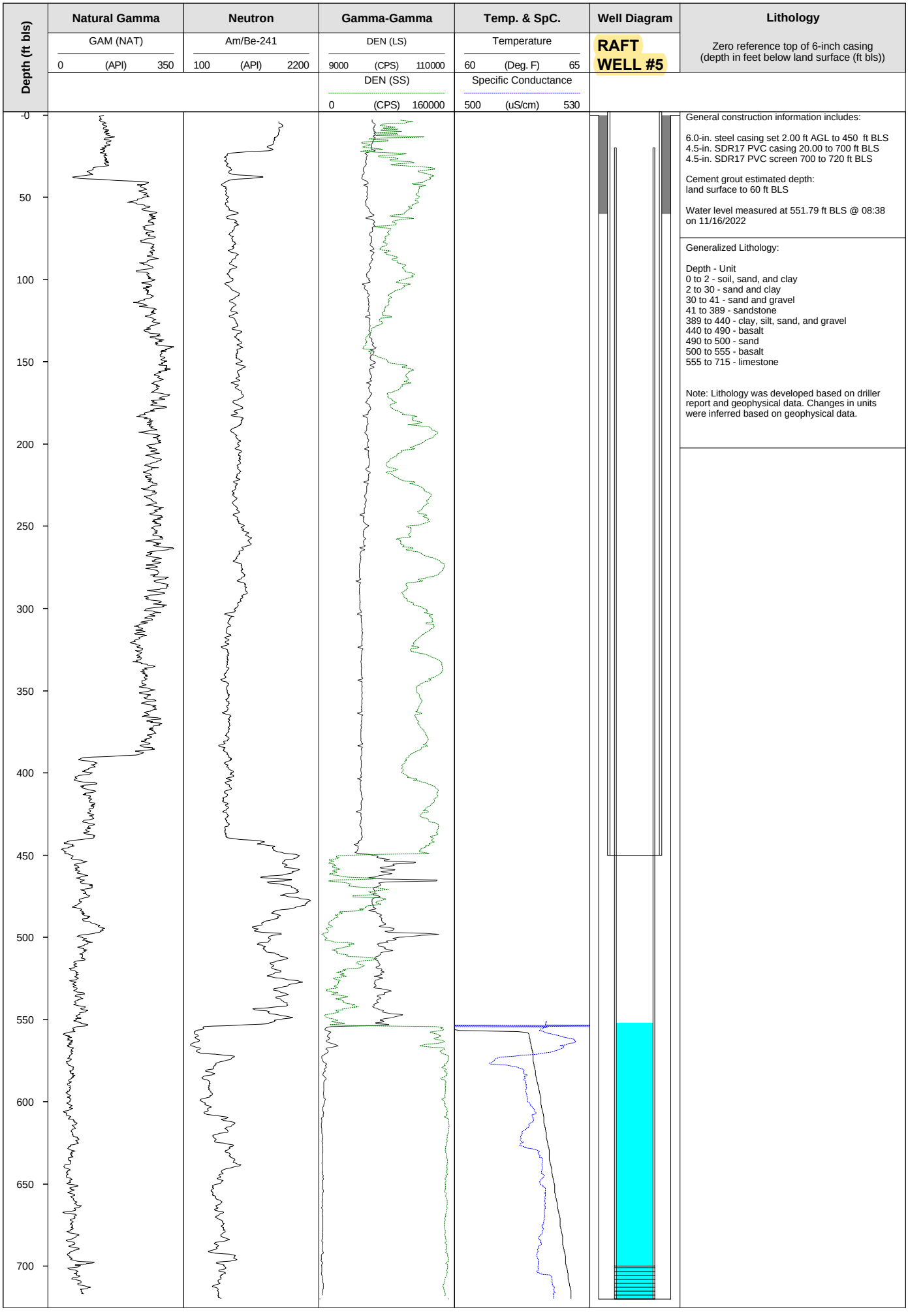
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 720 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 723.10 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 719.70 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #5.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing set 2.00 ft AGL to 450 ft BLS
4.5-in. SDR17 PVC casing 20.00 to 700 ft BLS
4.5-in. SDR17 PVC screen 700 to 720 ft BLS

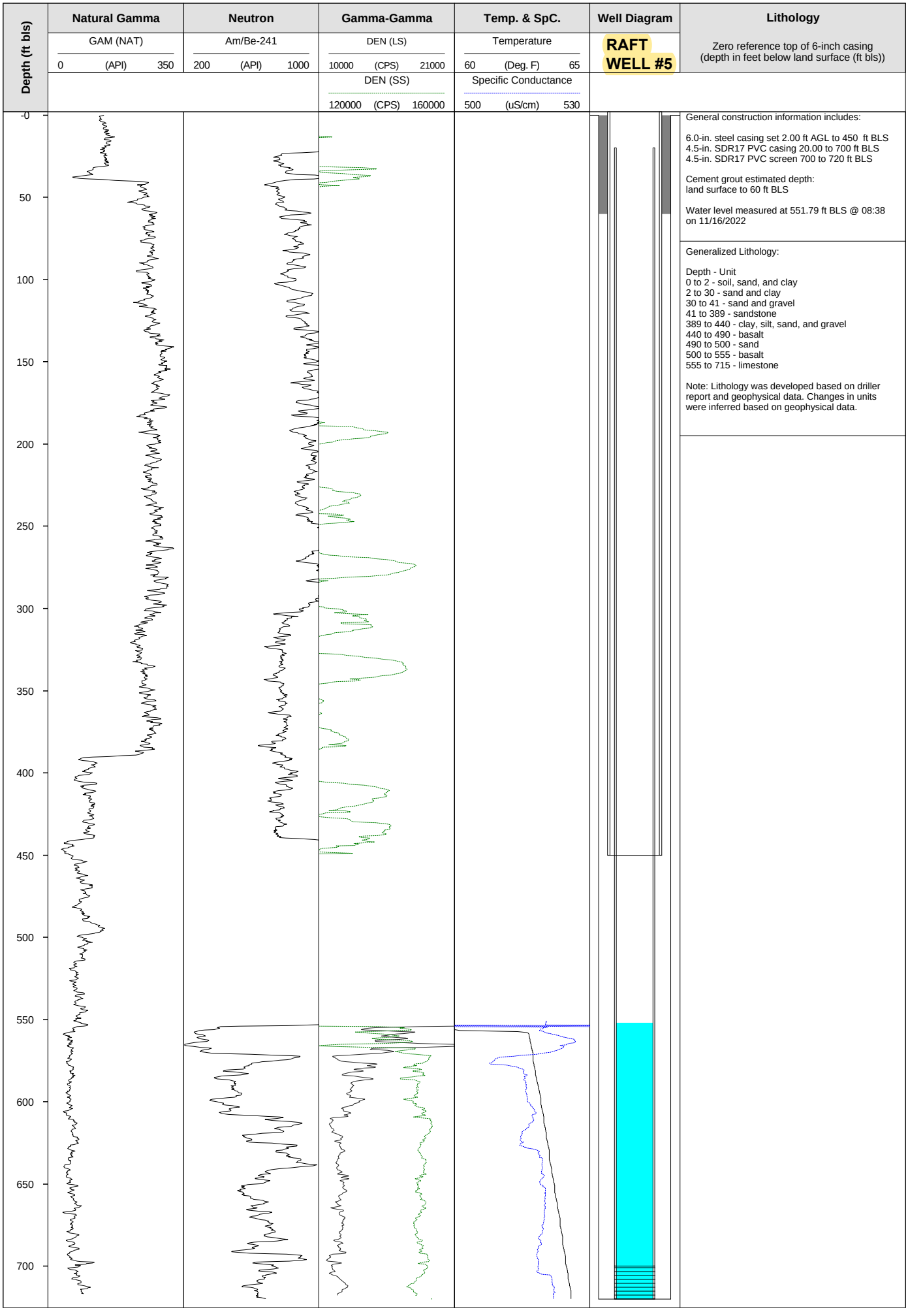
Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 551.79 ft BLS @ 08:38 on 11/16/2022

Generalized Lithology:

Depth - Unit
0 to 2 - soil, sand, and clay
2 to 30 - sand and clay
30 to 41 - sand and gravel
41 to 389 - sandstone
389 to 440 - clay, silt, sand, and gravel
440 to 490 - basalt
490 to 500 - sand
500 to 555 - basalt
555 to 715 - limestone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.



General construction information includes:

6.0-in. steel casing set 2.00 ft AGL to 450 ft BLS
4.5-in. SDR17 PVC casing 20.00 to 700 ft BLS
4.5-in. SDR17 PVC screen 700 to 720 ft BLS

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 551.79 ft BLS @ 08:38 on 11/16/2022

Generalized Lithology:

Depth - Unit
0 to 2 - soil, sand, and clay
2 to 30 - sand and clay
30 to 41 - sand and gravel
41 to 389 - sandstone
389 to 440 - clay, silt, sand, and gravel
440 to 490 - basalt
490 to 500 - sand
500 to 555 - basalt
555 to 715 - limestone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

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BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 420842113112201	**RAFT WELL #6**	**Other ID** Well Tag 92856
County Cassia	**State** Idaho	**Log date** 11/17/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 43.1449883	**Longitude** -113.2059821	**Lat/Long datum** NAD83
Altitude LMP 5490.54 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.55 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 753 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 753 feet BLS
Casing diameter 6-in., 4.5-in.	**Casing type** Steel casing / PVC Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 430.59 feet	**at time** 08:35 on 11/17/2022

Hydrologic conditions Borehole completed 4/5/2022. Water level measured prior to running logs. Two obstructions encountered; a constriction at ~590 feet below land surface (ft BLS) and bridge at ~713 ft BLS.

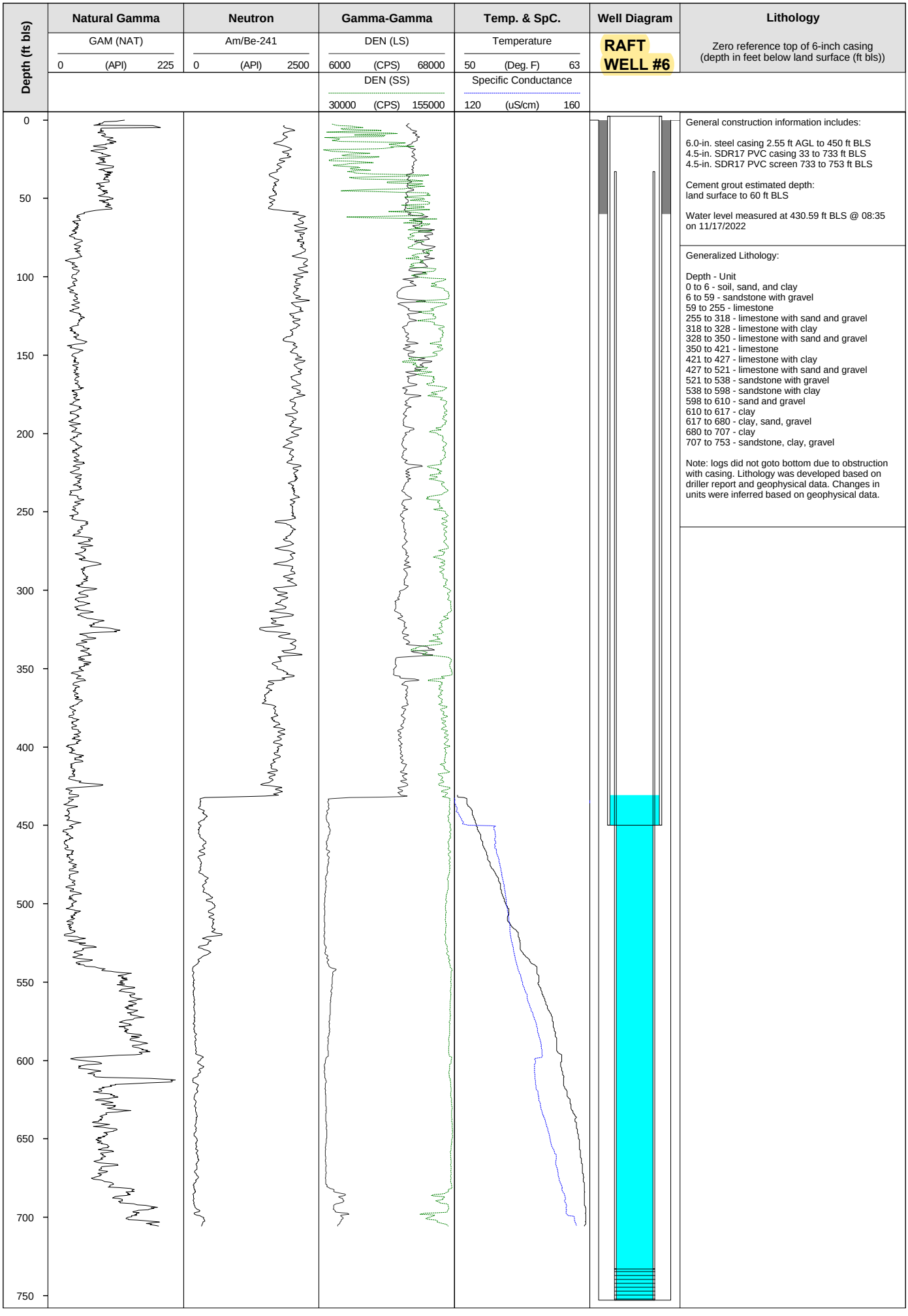
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Constriction at 590 ft BLS terminated down log tool advancement. Up log run from 713.30 ft BLs to land surface (shown below).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 712.40 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 713.20 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #6.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing 2.55 ft AGL to 450 ft BLS
4.5-in. SDR17 PVC casing 33 to 733 ft BLS
4.5-in. SDR17 PVC screen 733 to 753 ft BLS

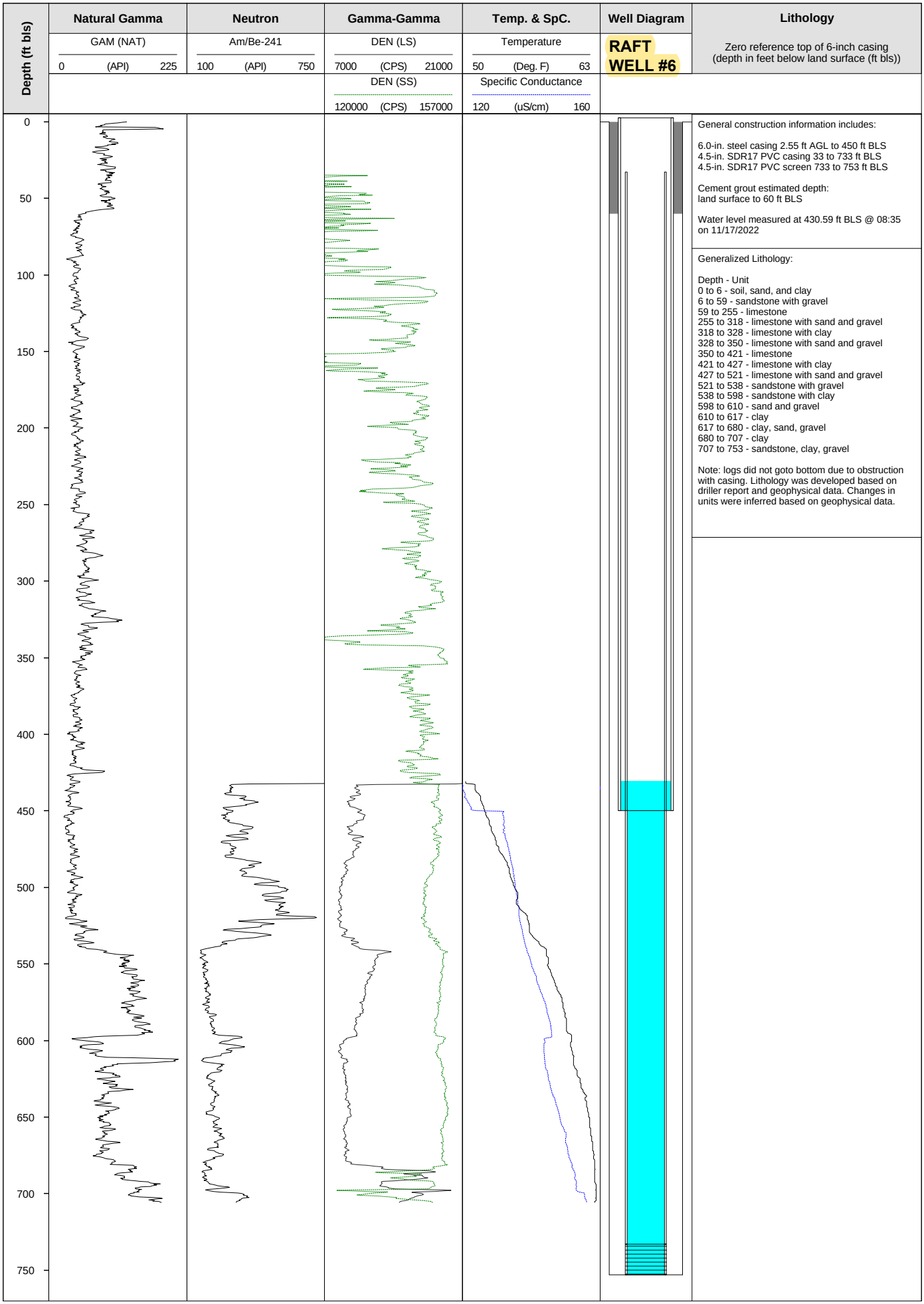
Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 430.59 ft BLS @ 08:35 on 11/17/2022

Generalized Lithology:

Depth - Unit
0 to 6 - soil, sand, and clay
6 to 59 - sandstone with gravel
59 to 255 - limestone
255 to 318 - limestone with sand and gravel
318 to 328 - limestone with clay
328 to 350 - limestone with sand and gravel
350 to 421 - limestone
421 to 427 - limestone with clay
427 to 521 - limestone with sand and gravel
521 to 538 - sandstone with gravel
538 to 598 - sandstone with clay
598 to 610 - sand and gravel
610 to 617 - clay
617 to 680 - clay, sand, gravel
680 to 707 - clay
707 to 753 - sandstone, clay, gravel

Note: logs did not goto bottom due to obstruction with casing. Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing 2.55 ft AGL to 450 ft BLS
4.5-in. SDR17 PVC casing 33 to 733 ft BLS
4.5-in. SDR17 PVC screen 733 to 753 ft BLS

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 430.59 ft BLS @ 08:35 on 11/17/2022

Generalized Lithology:

Depth - Unit
0 to 6 - soil, sand, and clay
6 to 59 - sandstone with gravel
59 to 255 - limestone
255 to 318 - limestone with sand and gravel
318 to 328 - limestone with clay
328 to 350 - limestone with sand and gravel
350 to 421 - limestone
421 to 427 - limestone with clay
427 to 521 - limestone with sand and gravel
521 to 538 - sandstone with gravel
538 to 598 - sandstone with clay
598 to 610 - sand and gravel
610 to 617 - clay
617 to 680 - clay, sand, gravel
680 to 707 - clay
707 to 753 - sandstone, clay, gravel

Note: logs did not goto bottom due to obstruction with casing. Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 421625113252901	**RAFT WELL #7**	**Other ID** Well Tag 92857
County Cassia	**State** Idaho	**Log date** 11/18/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.2735993	**Longitude** -113.4246717	**Lat/Long datum** NAD83
Altitude LMP 4676.69 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.00 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 471 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 471 feet BLS
Casing diameter 6-in., 4.5-in.	**Casing type** Steel casing / PVC Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 4.44 feet	**at time** 12:28 on 11/18/2022

Hydrologic conditions Borehole completed 4/5/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

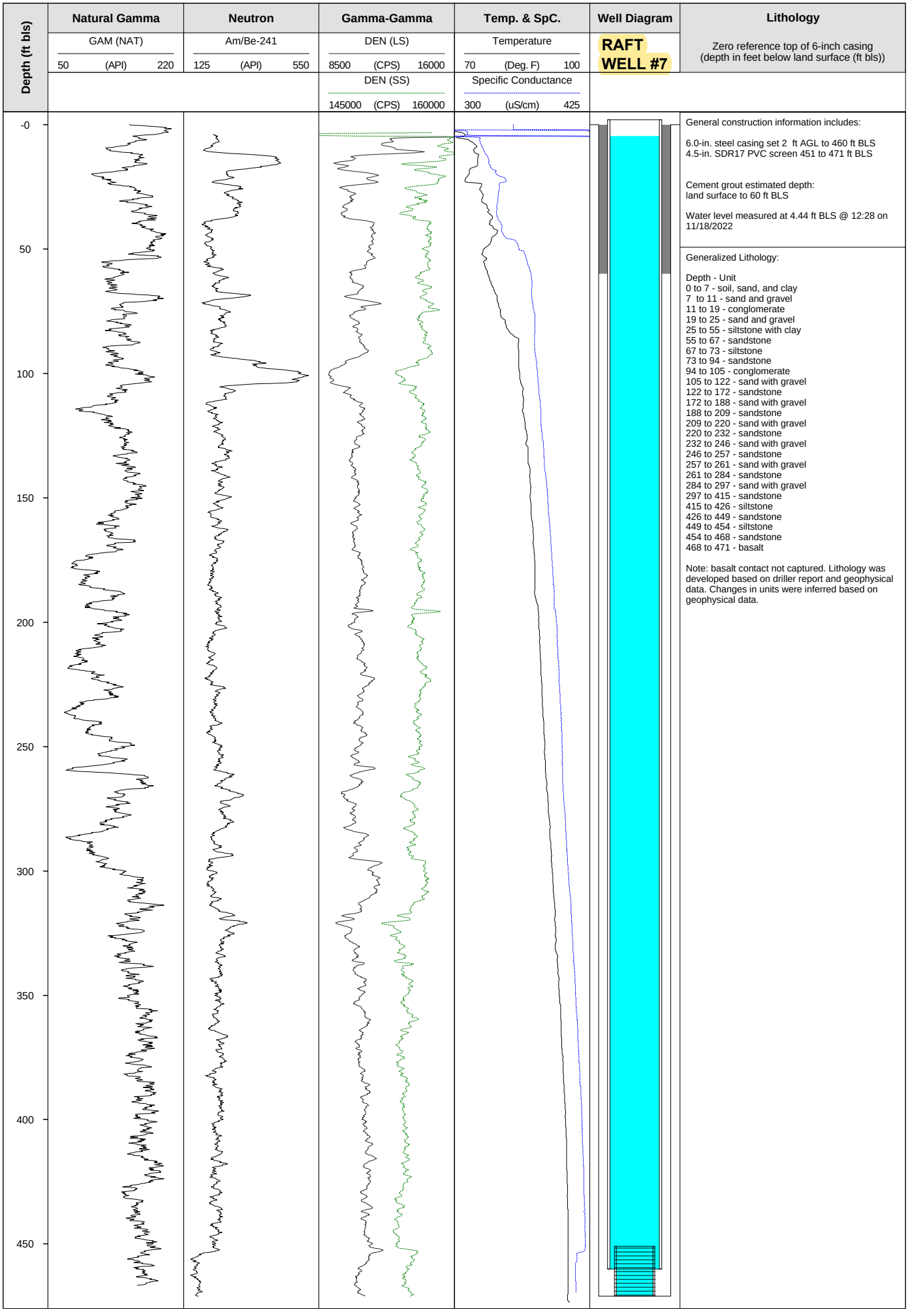
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 473.70 feet below land surface (ft BLS) (not shown). Repeat quality control up log run from 473.40 ft BLS to land surface (shown below).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 472.70 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 474.60 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Four LAS files generated for Well #7.



General construction information includes:

6.0-in. steel casing set 2 ft AGL to 460 ft BLS
4.5-in. SDR17 PVC screen 451 to 471 ft BLS

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 4.44 ft BLS @ 12:28 on 11/18/2022

Generalized Lithology:

Depth - Unit
0 to 7 - soil, sand, and clay
7 to 11 - sand and gravel
11 to 19 - conglomerate
19 to 25 - sand and gravel
25 to 55 - siltstone with clay
55 to 67 - sandstone
67 to 73 - siltstone
73 to 94 - sandstone
94 to 105 - conglomerate
105 to 122 - sand with gravel
122 to 172 - sandstone
172 to 188 - sand with gravel
188 to 209 - sandstone
209 to 220 - sand with gravel
220 to 232 - sandstone
232 to 246 - sand with gravel
246 to 257 - sandstone
257 to 261 - sand with gravel
261 to 284 - sandstone
284 to 297 - sand with gravel
297 to 415 - sandstone
415 to 426 - siltstone
426 to 449 - sandstone
449 to 454 - siltstone
454 to 468 - sandstone
468 to 471 - basalt

Note: basalt contact not captured. Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 420522113191101	**RAFT WELL #8**	**Other ID** Well Tag 92858
County Cassia	**State** Idaho	**Log date** 11/17/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.0894109	**Longitude** -113.3195916	**Lat/Long datum** NAD83
Altitude LMP 4811.28 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 1.80 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 495 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 495 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 126.47 feet	**at time** 12:15 on 11/17/2022

Hydrologic conditions Borehole completed 4/9/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

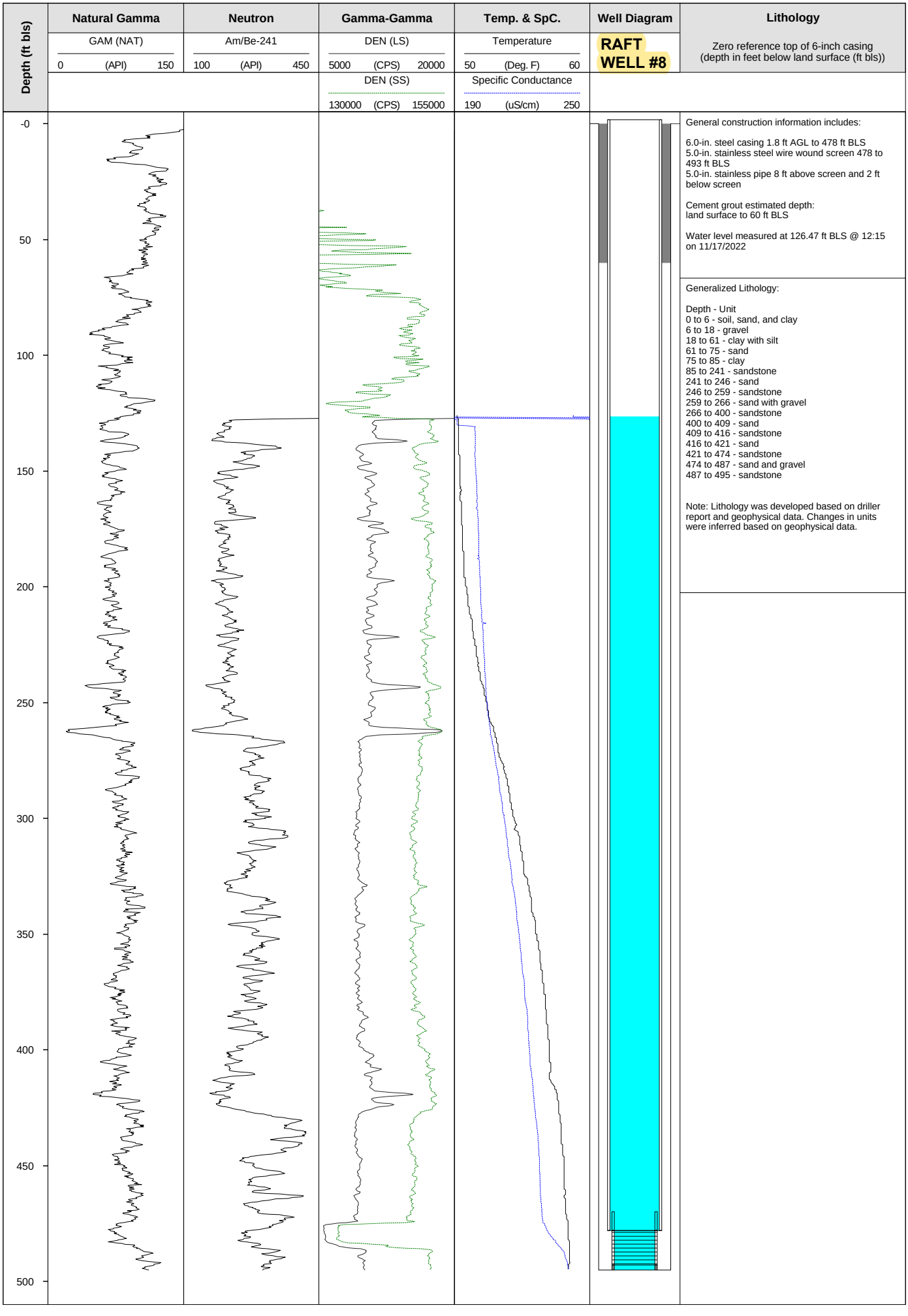
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 476.40 feet below land surface (ft BLS) (not shown). Repeat quality assurance up log run from 500.00 ft BLS to land surface (shown below).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 499.90 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 499.80 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Four LAS files generated for Well #8.


Depth (ft bls)
Natural Gamma
GAM (NAT)
0 (API) 150
Neutron
Am/Be-241
100 (API) 450
Gamma-Gamma
DEN (LS)
5000 (CPS) 20000
DEN (SS)
130000 (CPS) 155000
Temp. & SpC.
Temperature
50 (Deg. F) 60
Specific Conductance
190 (uS/cm) 250
Well Diagram
RAFT
WELL #8
Lithology
Zero reference top of 6-inch casing
(depth in feet below land surface (ft bls))
-0
50
100
150
200
250
300
350
400
450
500
General construction information includes:
6.0-in. steel casing 1.8 ft AGL to 478 ft BLS
5.0-in. stainless steel wire wound screen 478 to 493 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen
Cement grout estimated depth:
land surface to 60 ft BLS
Water level measured at 126.47 ft BLS @ 12:15 on 11/17/2022
Generalized Lithology:
Depth - Unit
0 to 6 - soil, sand, and clay
6 to 18 - gravel
18 to 61 - clay with silt
61 to 75 - sand
75 to 85 - clay
85 to 241 - sandstone
241 to 246 - sand
246 to 259 - sandstone
259 to 266 - sand with gravel
266 to 400 - sandstone
400 to 409 - sand
409 to 416 - sandstone
416 to 421 - sand
421 to 474 - sandstone
474 to 487 - sand and gravel
487 to 495 - sandstone
Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 421329113205701	**RAFT WELL # 9**	**Other ID** Well Tag 92859
County Cassia	**State** Idaho	**Log date** 11/17/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.2247318	**Longitude** -113.3490815	**Lat/Long datum** NAD83
Altitude LMP 4597.73 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.20 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 300 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 300 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 161.09 feet	**at time** 14:35 on 11/17/2022

Hydrologic conditions Borehole completed 4/9/2022. Water level measured prior to running logs. One casing joint or constriction obstruction located at ~270 feet below land surface (ft BLS).

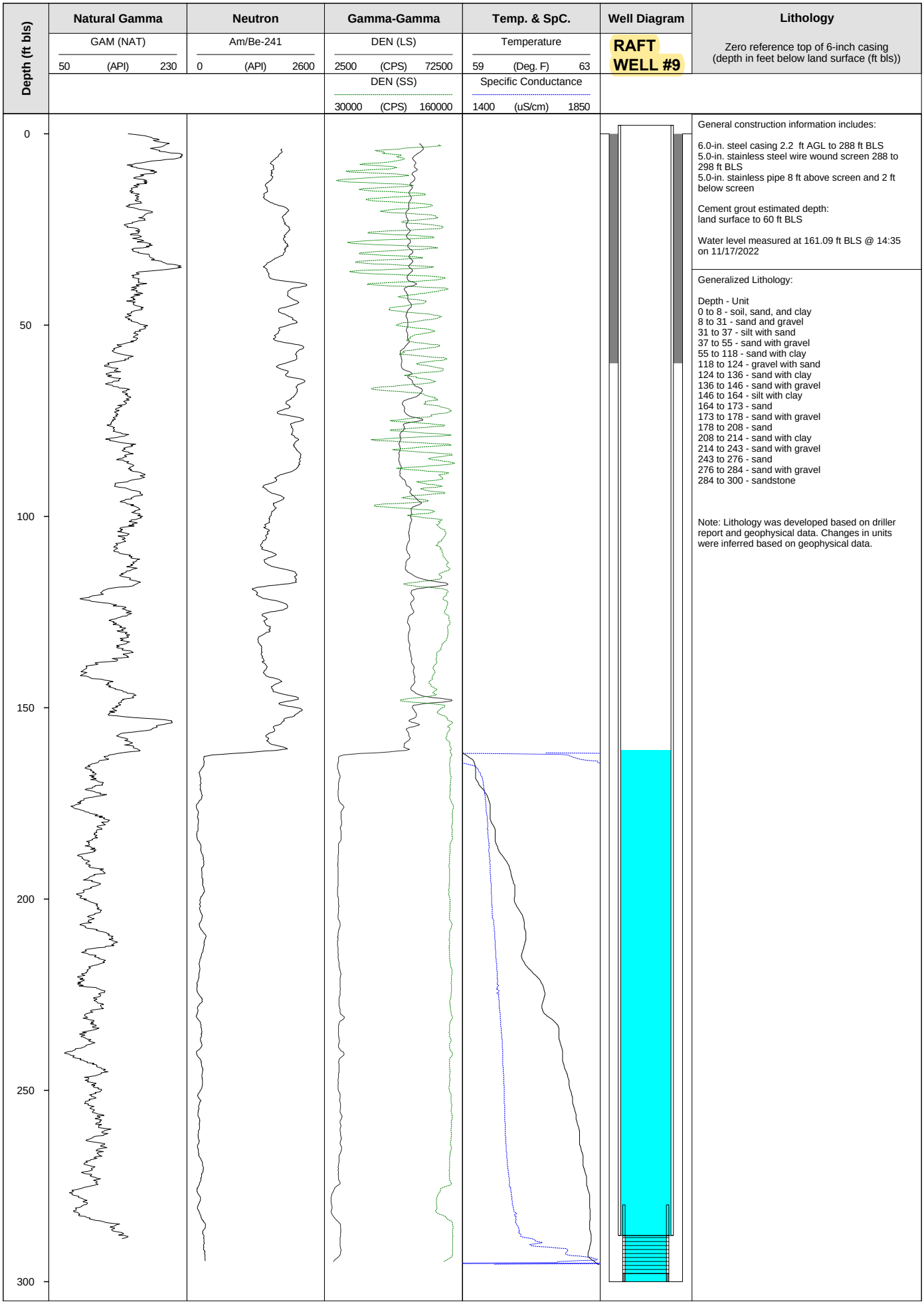
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Obstruction terminated down log advancement at ~270 ft BLS (not shown). Up log run from 295.60 ft BLS to land surface (shown below).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 499.90 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 499.80 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #9.



General construction information includes:

6.0-in. steel casing 2.2 ft AGL to 288 ft BLS
5.0-in. stainless steel wire wound screen 288 to 298 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

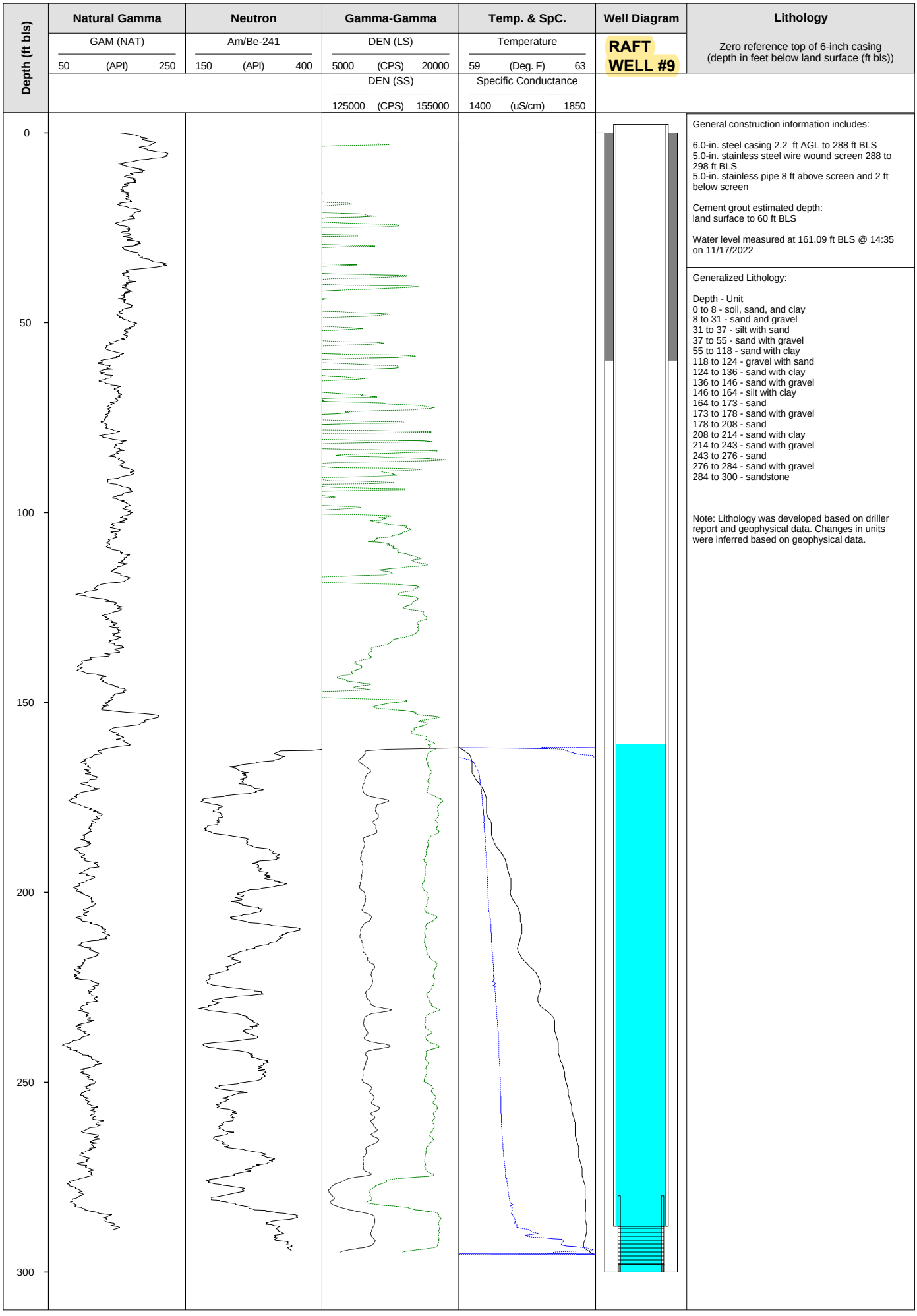
Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 161.09 ft BLS @ 14:35 on 11/17/2022

Generalized Lithology:

Depth - Unit
0 to 8 - soil, sand, and clay
8 to 31 - sand and gravel
31 to 37 - silt with sand
37 to 55 - sand with gravel
55 to 118 - sand with clay
118 to 124 - gravel with sand
124 to 136 - sand with clay
136 to 146 - sand with gravel
146 to 164 - silt with clay
164 to 173 - sand
173 to 178 - sand with gravel
178 to 208 - sand
208 to 214 - sand with clay
214 to 243 - sand with gravel
243 to 276 - sand
276 to 284 - sand with gravel
284 to 300 - sandstone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.



General construction information includes:

6.0-in. steel casing 2.2 ft AGL to 288 ft BLS
5.0-in. stainless steel wire wound screen 288 to 298 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 161.09 ft BLS @ 14:35 on 11/17/2022

Generalized Lithology:

Depth - Unit
0 to 8 - soil, sand, and clay
8 to 31 - sand and gravel
31 to 37 - silt with sand
37 to 55 - sand with gravel
55 to 118 - sand with clay
118 to 124 - gravel with sand
124 to 136 - sand with clay
136 to 146 - sand with gravel
146 to 164 - silt with clay
164 to 173 - sand
173 to 178 - sand with gravel
178 to 208 - sand
208 to 214 - sand with clay
214 to 243 - sand with gravel
243 to 276 - sand
276 to 284 - sand with gravel
284 to 300 - sandstone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

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BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 423010113192701	**RAFT WELL #10**	**Other ID** Well Tag 92860
County Cassia	**State** Idaho	**Log date** 11/16/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.5027537	**Longitude** -113.3243095	**Lat/Long datum** NAD83
Altitude LMP 4394.18 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 2.70 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 1007 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 1007 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 250.61 feet	**at time** 11:35 on 11/16/2022

Hydrologic conditions Borehole completed 4/30/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

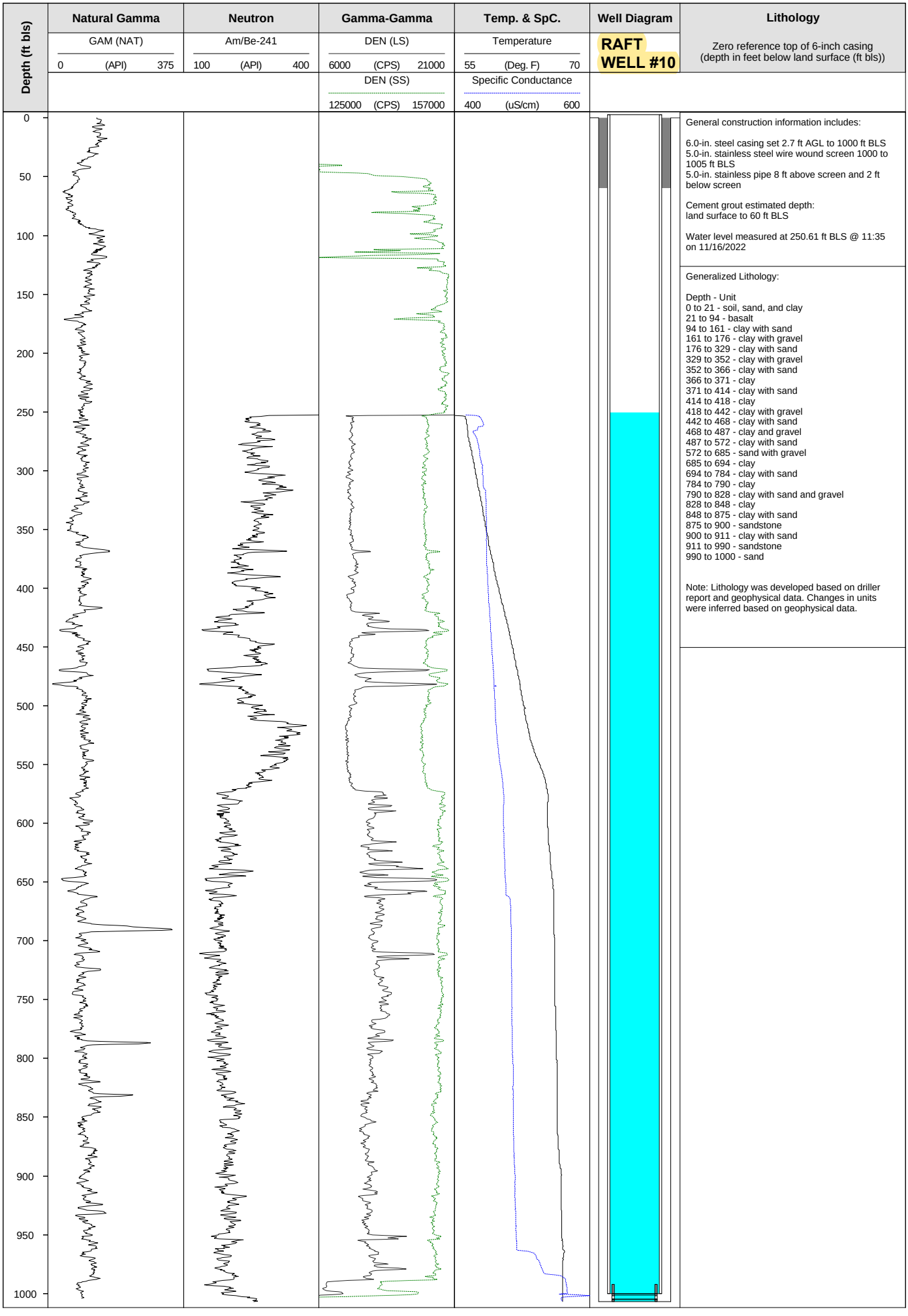
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 1,008.40 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 1,010.20 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 1,012.50 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #10.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing set 2.7 ft AGL to 1000 ft BLS
5.0-in. stainless steel wire wound screen 1000 to 1005 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 250.61 ft BLS @ 11:35 on 11/16/2022

Generalized Lithology:

Depth - Unit
0 to 21 - soil, sand, and clay
21 to 94 - basalt
94 to 161 - clay with sand
161 to 176 - clay with gravel
176 to 329 - clay with sand
329 to 352 - clay with gravel
352 to 366 - clay with sand
366 to 371 - clay
371 to 414 - clay with sand
414 to 418 - clay
418 to 442 - clay with gravel
442 to 468 - clay with sand
468 to 487 - clay and gravel
487 to 572 - clay with sand
572 to 685 - sand with gravel
685 to 694 - clay
694 to 784 - clay with sand
784 to 790 - clay
790 to 828 - clay with sand and gravel
828 to 848 - clay
848 to 875 - clay with sand
875 to 900 - sandstone
900 to 911 - clay with sand
911 to 990 - sandstone
990 to 1000 - sand

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 422246113213501	**RAFT WELL #11**	**Other ID** Well Tag 92861
County Cassia	**State** Idaho	**Log date** 11/18/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.3789491	**Longitude** -113.3597988	**Lat/Long datum** NAD83
Altitude LMP 4416.43 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 1.70 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 500 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 500 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 182.39 feet	**at time** 14:47 on 11/18/2022

Hydrologic conditions Borehole completed 4/20/2022. Water level measured prior to running logs. Well in good condition, no obstructions.

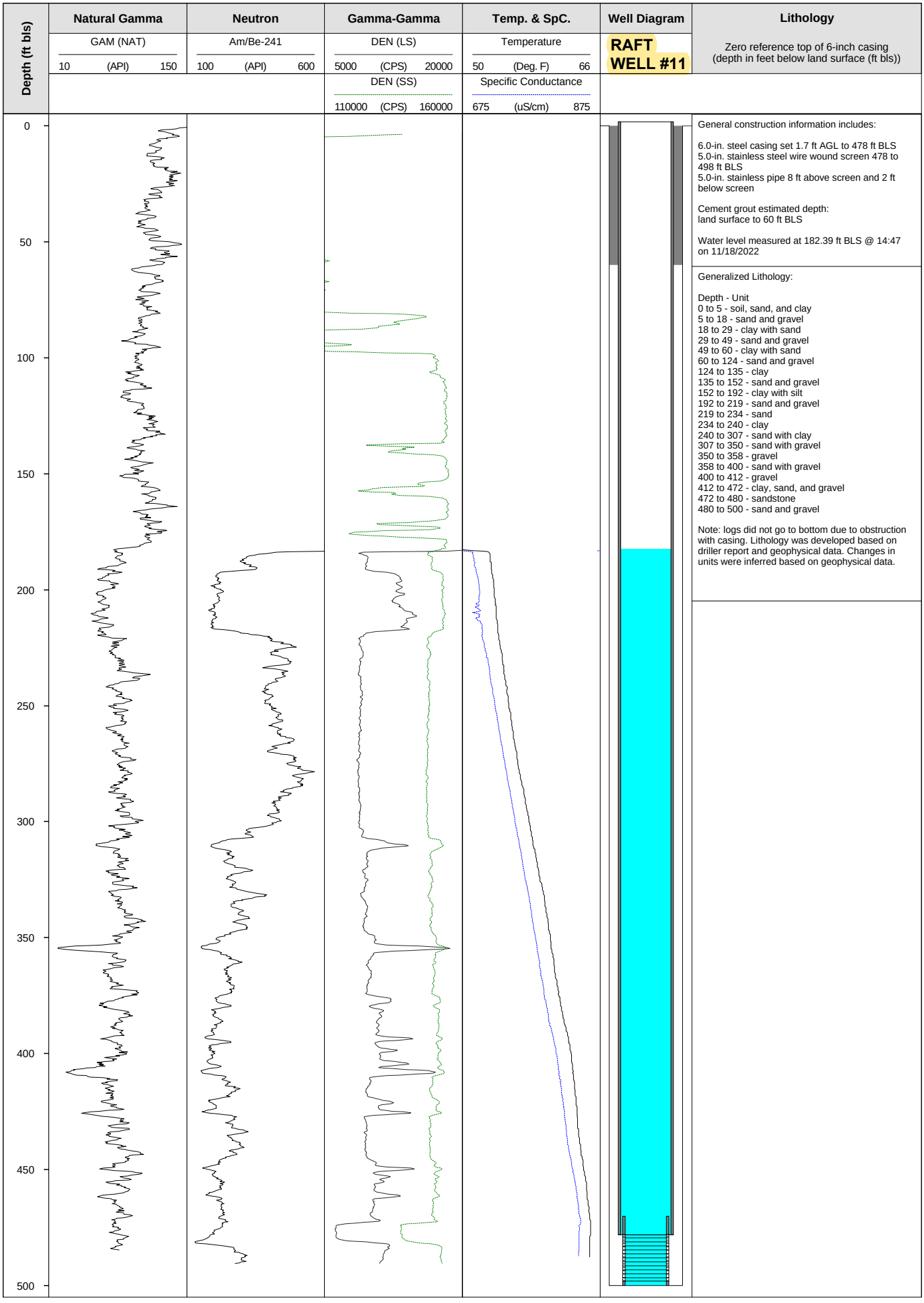
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Natural Gamma, Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 487.80 feet below land surface (ft BLS).

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 497.30 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 497.80 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #11.



General construction information includes:

6.0-in. steel casing set 1.7 ft AGL to 478 ft BLS
5.0-in. stainless steel wire wound screen 478 to 498 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 182.39 ft BLS @ 14:47 on 11/18/2022

Generalized Lithology:

Depth - Unit
0 to 5 - soil, sand, and clay
5 to 18 - sand and gravel
18 to 29 - clay with sand
29 to 49 - sand and gravel
49 to 60 - clay with sand
60 to 124 - sand and gravel
124 to 135 - clay
135 to 152 - sand and gravel
152 to 192 - clay with silt
192 to 219 - sand and gravel
219 to 234 - sand
234 to 240 - clay
240 to 307 - sand with clay
307 to 350 - sand with gravel
350 to 358 - gravel
358 to 400 - sand with gravel
400 to 412 - gravel
412 to 472 - clay, sand, and gravel
472 to 480 - sandstone
480 to 500 - sand and gravel

Note: logs did not go to bottom due to obstruction with casing. Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

USGS science for a changing world

BOREHOLE GEOPHYSICAL LOG

English/Metric units English

SiteID (C1) 423354113102801	**RAFT WELL #12**	**Other ID** Well Tag 92862
County Cassia	**State** Idaho	**Log date** 11/15/2022
Owner Idaho Department of Water Resources		**Project** Raft River
Location description Raft River Idaho		
Latitude 42.5649409	**Longitude** -113.1745583	**Lat/Long datum** NAD83
Altitude LMP 4402.07 feet	**Altitude datum** NAVD88	**Log measurement point (LMP)** 6-inch casing
Height LMP 3.50 feet	**Description of LMP** Top of 6-in. casing	
Borehole depth 1,010 feet BLS	**Borehole diameter** Not Available	**Casing bottom** 1,010 feet BLS
Casing diameter 6-in., 5-in.	**Casing type** Steel casing / Stainless Screen	**Source of data** Well Driller Report
Logging unit USGS	**Log orientiation** Not Available	**Magnetic declination** 12.5 deg.
Recorded by Coury Dorn and Brian Twining	**Observed by** Not Available	
Software non-ASCII logs Century	**Type of log** Century	
Fluid type Groundwater	**Fluid depth below LMP** 229.78 feet	**at time** 15:07 on 11/15/2022

Hydrologic conditions Borehole completed 5/3/2022. Water level measured prior to running logs. One well obstruction; bridged at ~959.3 feet below land surface (ft BLS).

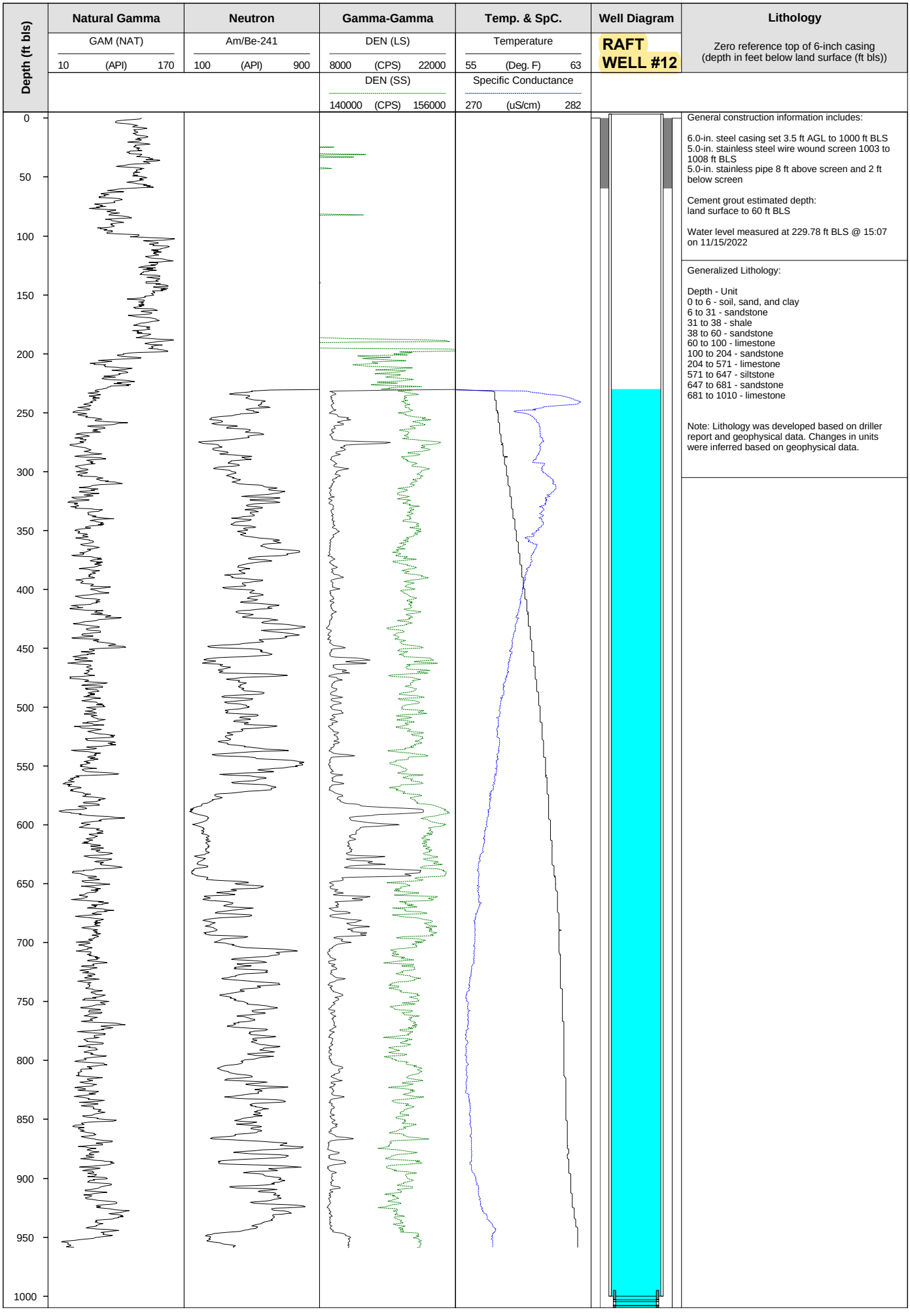
Tool manufacturer and model, tool serial number, log date and time, logging direction and speed, depth error after logging, log parameter(s) and date(s) of calibration check

Tool run 1 Tool ID: 9042A / Serial #: 864. Logs included: Specific Conductance, Temperature. Log 9042A run inside of 6-in. casing. Down log run from land surface to 992.70 ft BLS.

Tool run 2 Tool ID: 9057 / Serial #: 1077. Logs included: Natural Gamma, Neutron - 1.0 Curie Am/Be-241 source. Log 9057A run inside of 6-in. casing. Up log run from 966.20 ft BLS to land surface.

Tool run 3 Tool ID: 0024 / Serial #: 776. Logs incuded: Short Spaced (SS) Density, Long Spaced (LS) Density - 0.2 Curie Cs-137 source. Log 0024 run inside of 6-in. casing. Up log run from 969.9 ft BLS to land surface.

Remarks Logs shown below scaled to reflect response after entering groundwater. Three LAS files generated for Well #12.



Lithology

Zero reference top of 6-inch casing (depth in feet below land surface (ft bls))

General construction information includes:

6.0-in. steel casing set 3.5 ft AGL to 1000 ft BLS
5.0-in. stainless steel wire wound screen 1003 to 1008 ft BLS
5.0-in. stainless pipe 8 ft above screen and 2 ft below screen

Cement grout estimated depth:
land surface to 60 ft BLS

Water level measured at 229.78 ft BLS @ 15:07 on 11/15/2022

Generalized Lithology:

Depth - Unit
0 to 6 - soil, sand, and clay
6 to 31 - sandstone
31 to 38 - shale
38 to 60 - sandstone
60 to 100 - limestone
100 to 204 - sandstone
204 to 571 - limestone
571 to 647 - siltstone
647 to 681 - sandstone
681 to 1010 - limestone

Note: Lithology was developed based on driller report and geophysical data. Changes in units were inferred based on geophysical data.

References

IDAPA 37. Idaho Administrative Code 37.03.09, Department of Water Recourses, Well Construction Standards, Section 30. IDAPA 37 - Department of Water Resources.book (idaho.gov)