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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February 29, 2024

IDAHO DEPARTMENT OF
WATER RESOURCES

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*Acknowledgements: Special thanks to Jaxon and Brian Higgs of Water Well Consultants for facilitating access to many of the well locations, the various private landowners for allowing access to their property, IDWR staff (Dennis Owsley, Gus Womeldorph, Amy Steimke, and Blake Burkard) and Boise State University contractor Erin Murray for participating in drilling oversight and lithologic logging.*

# 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.

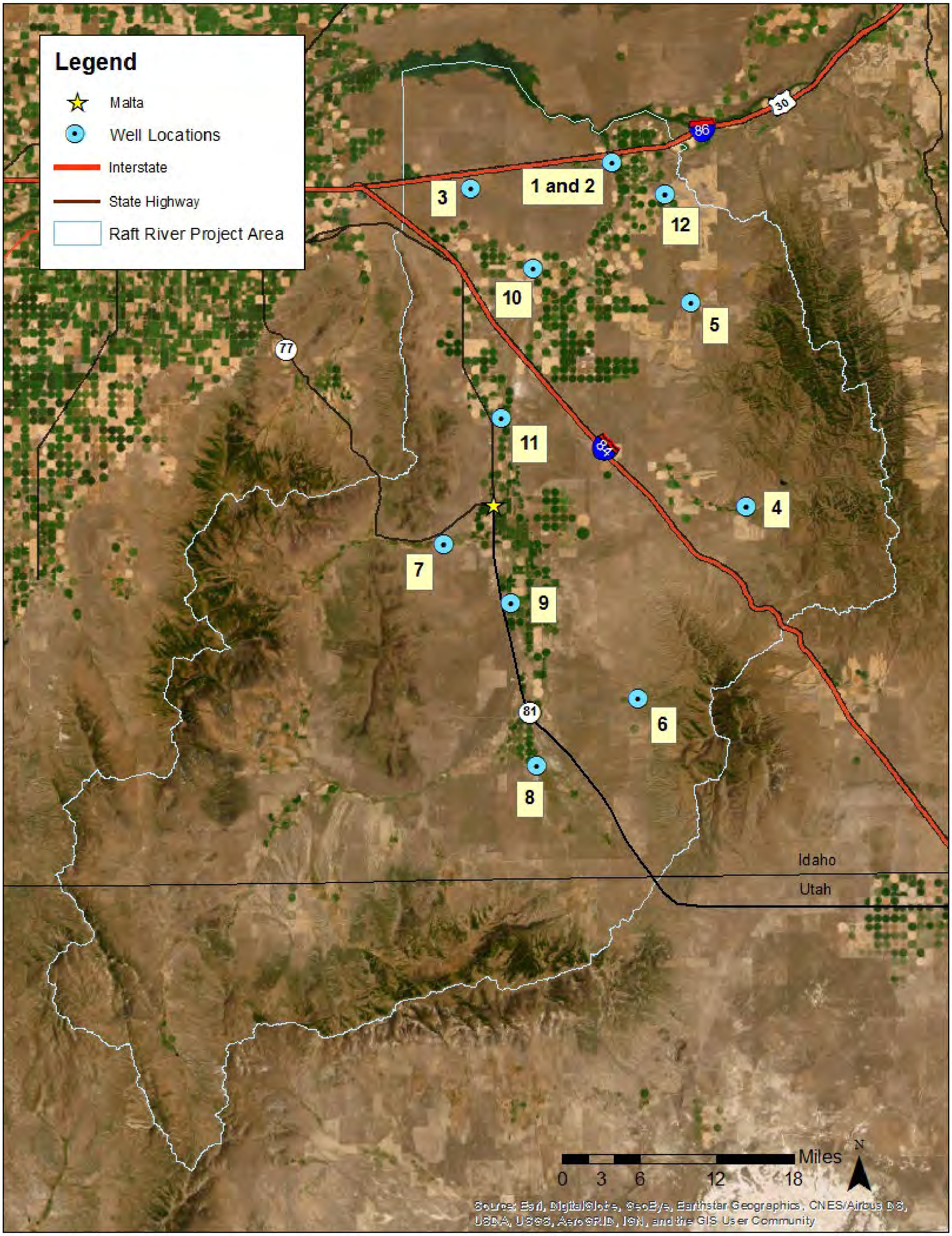


Figure 1. Map of Raft River Basin Monitoring Wells

# 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

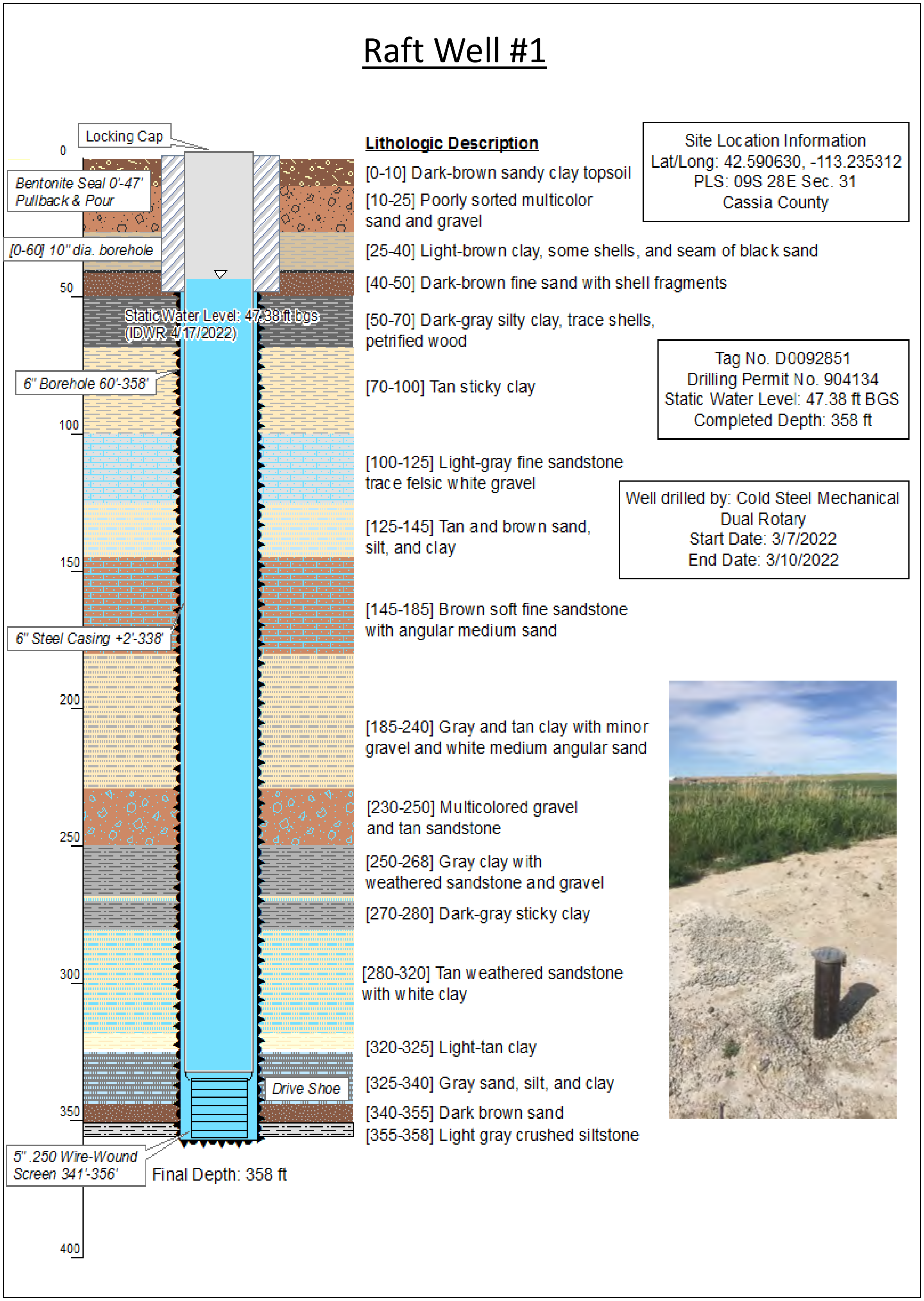


Figure 3. Construction and lithologic details for Raft Well #1.

**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).

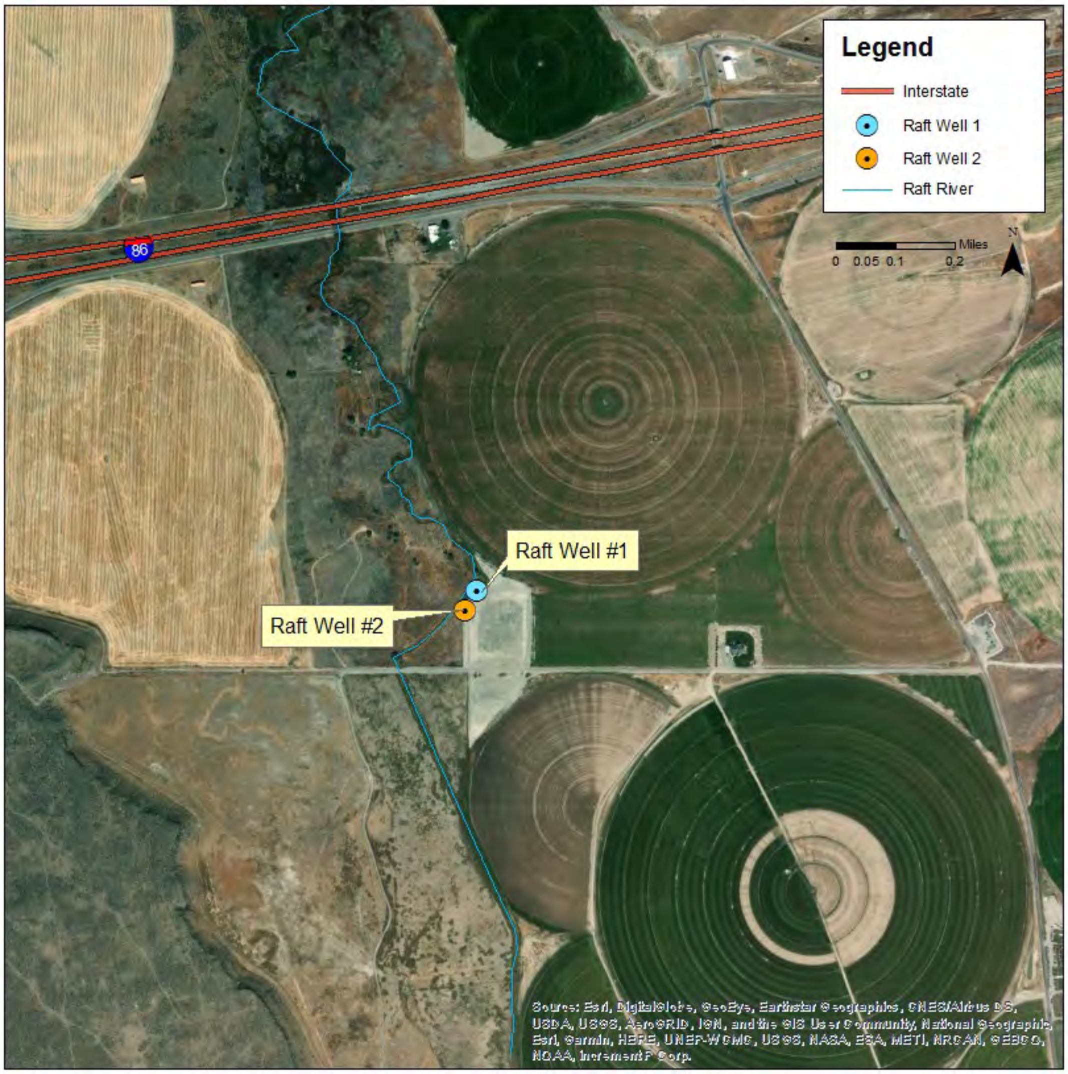


Figure 4. Location of Raft Wells #1 and #2.

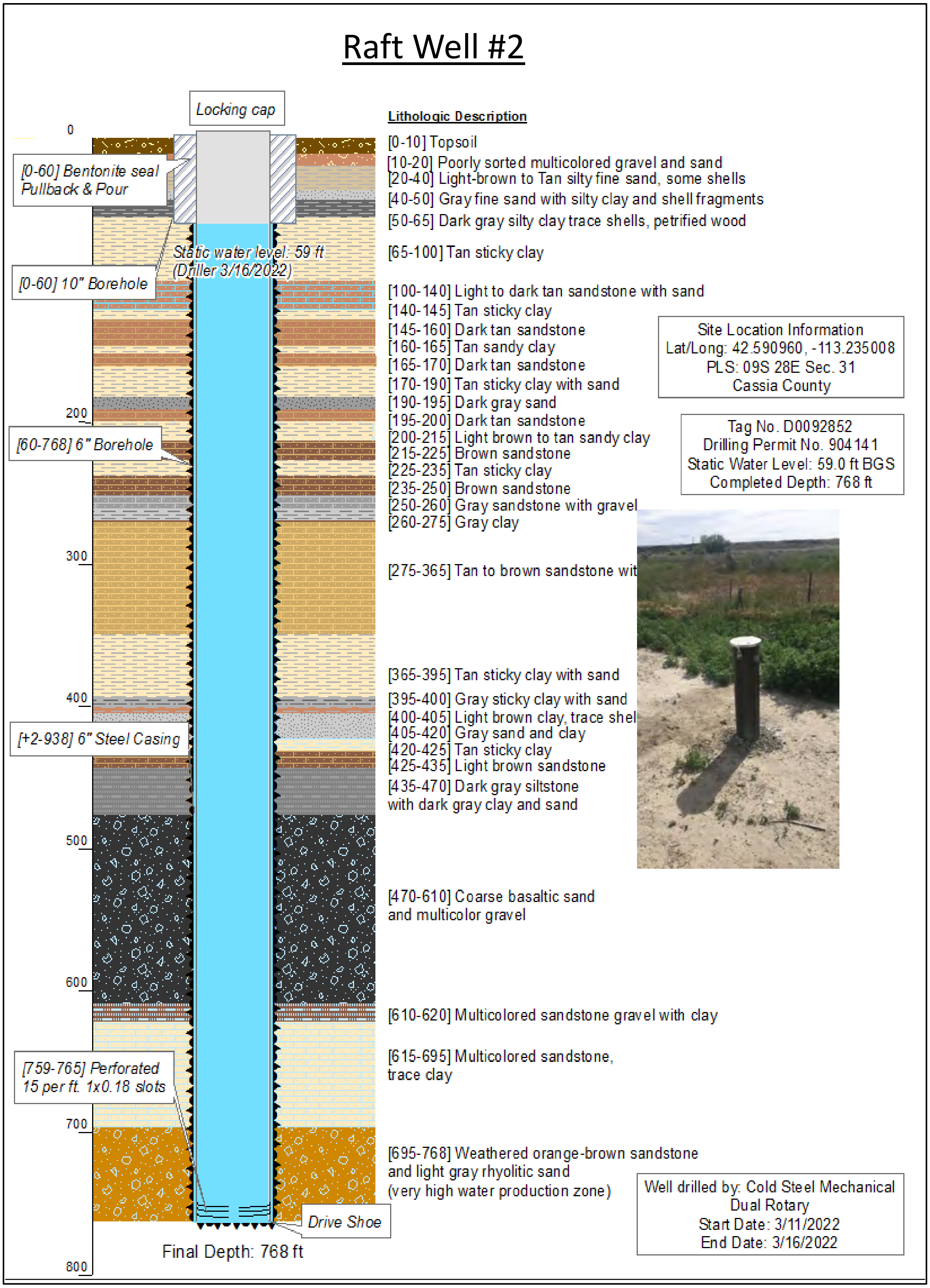


Figure 5. Construction and lithologic details for Raft Well #2

**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).

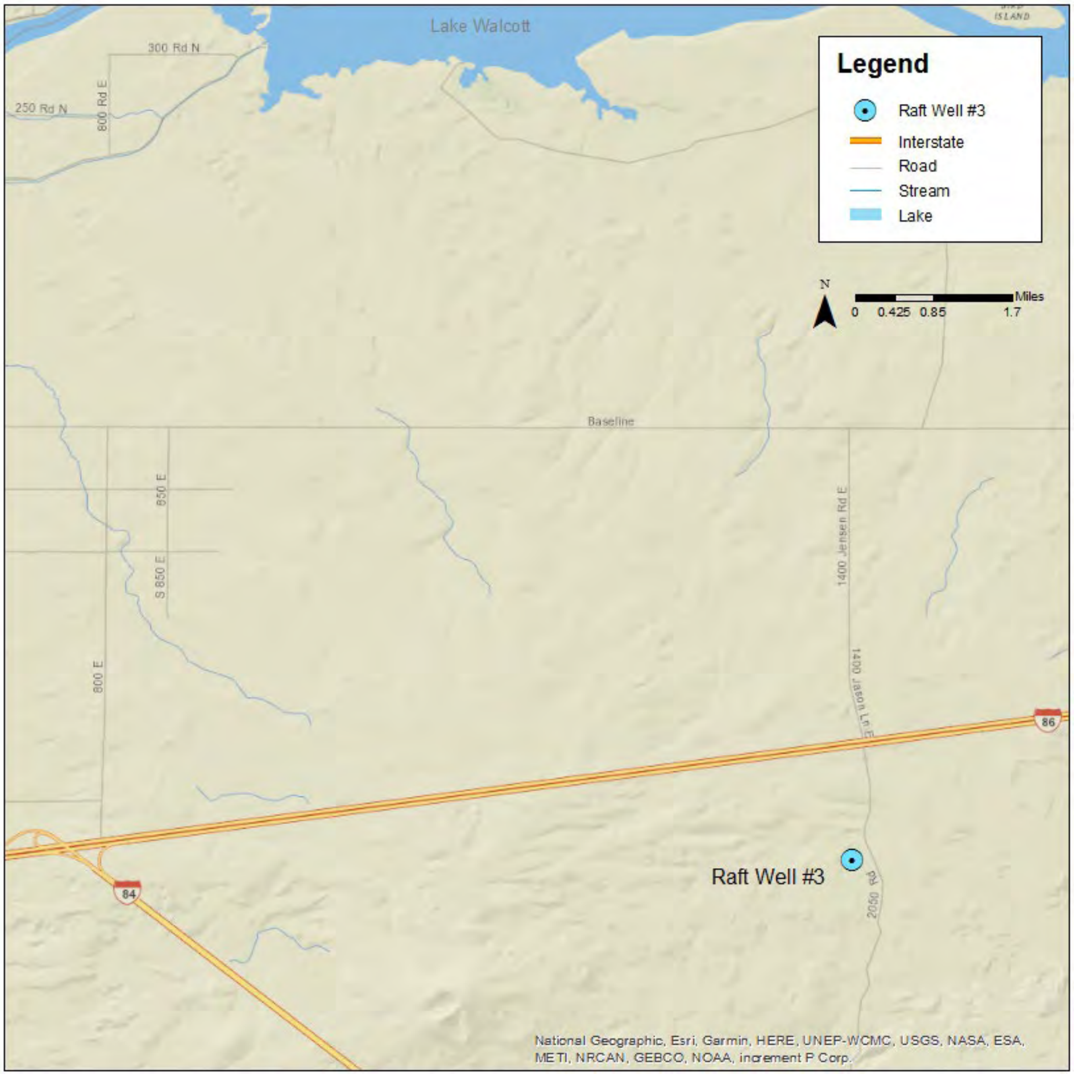


Figure 6. Map of Raft Well #3

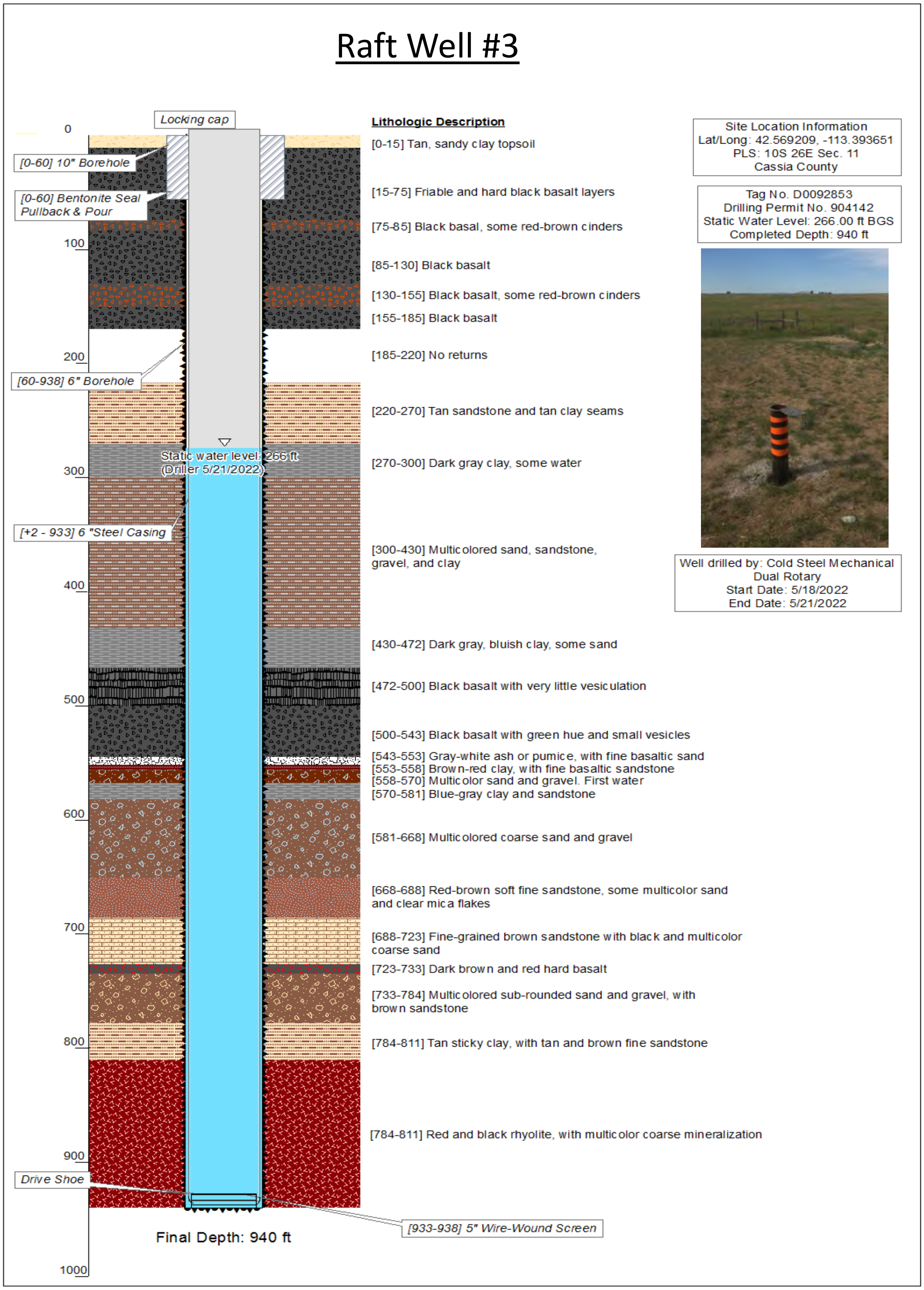


Figure 7. Construction and lithologic details of Raft Well #3

**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).

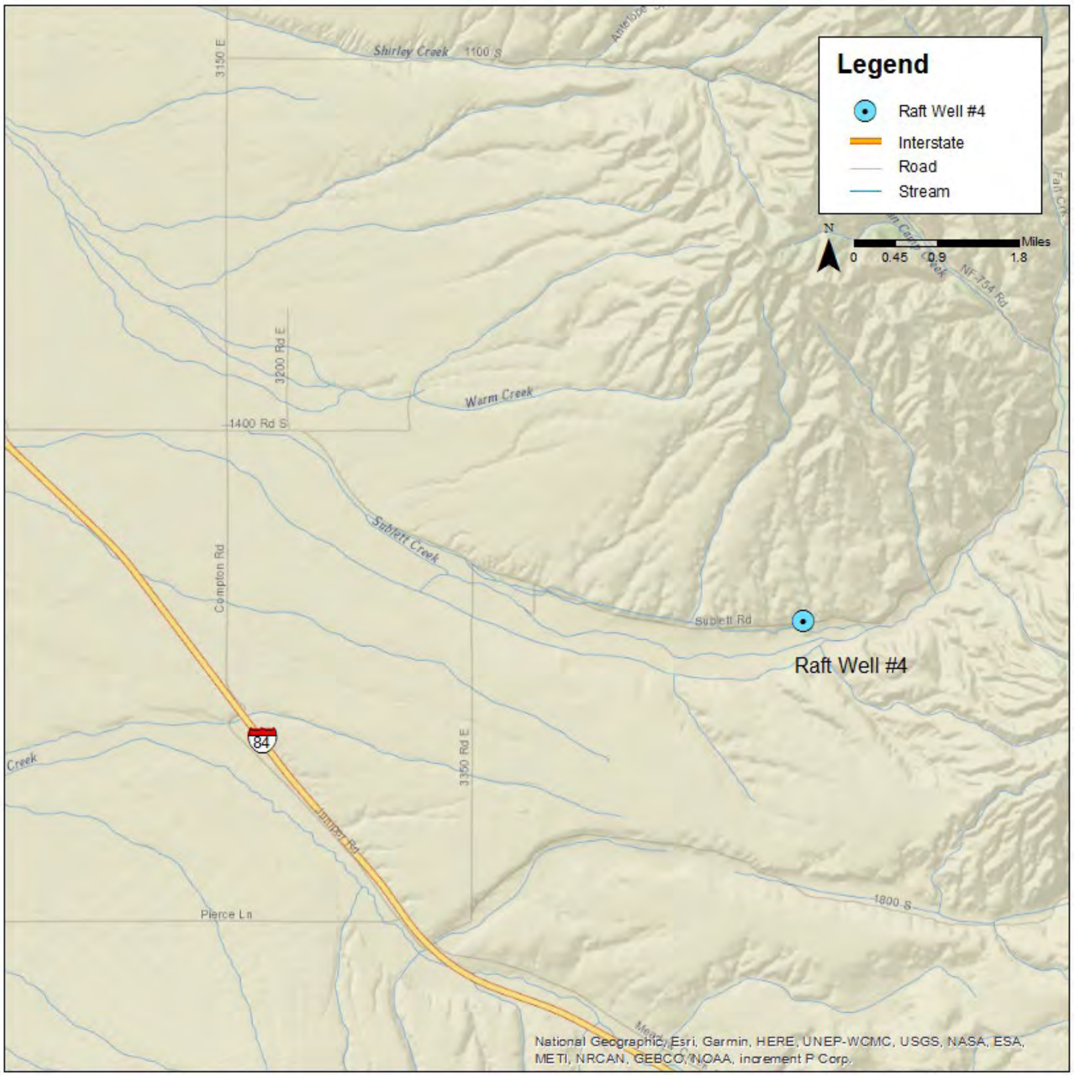


Figure 8. Map of SEP Well #4

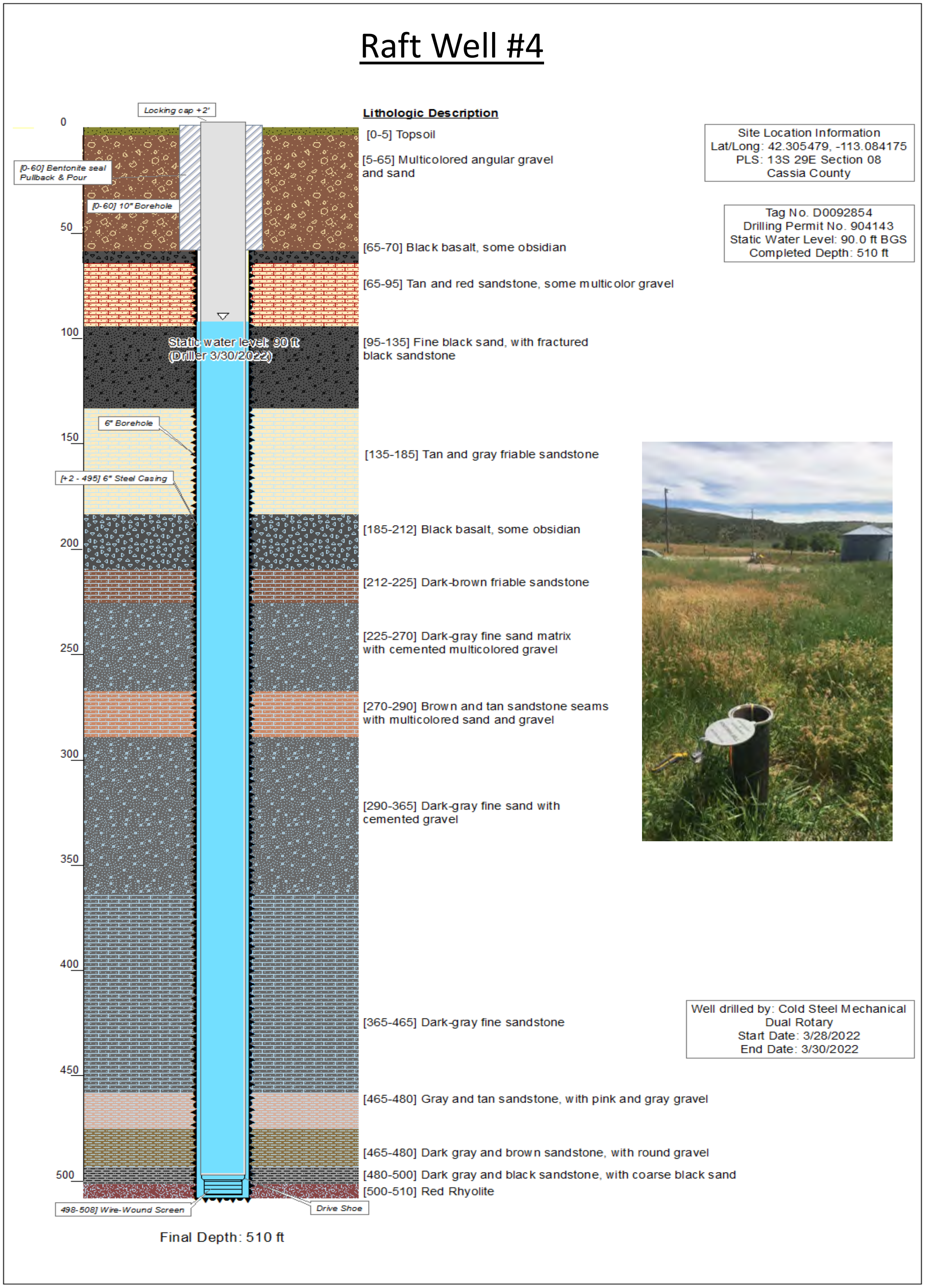


Figure 9. Construction and lithologic details for Raft Well #4

**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).

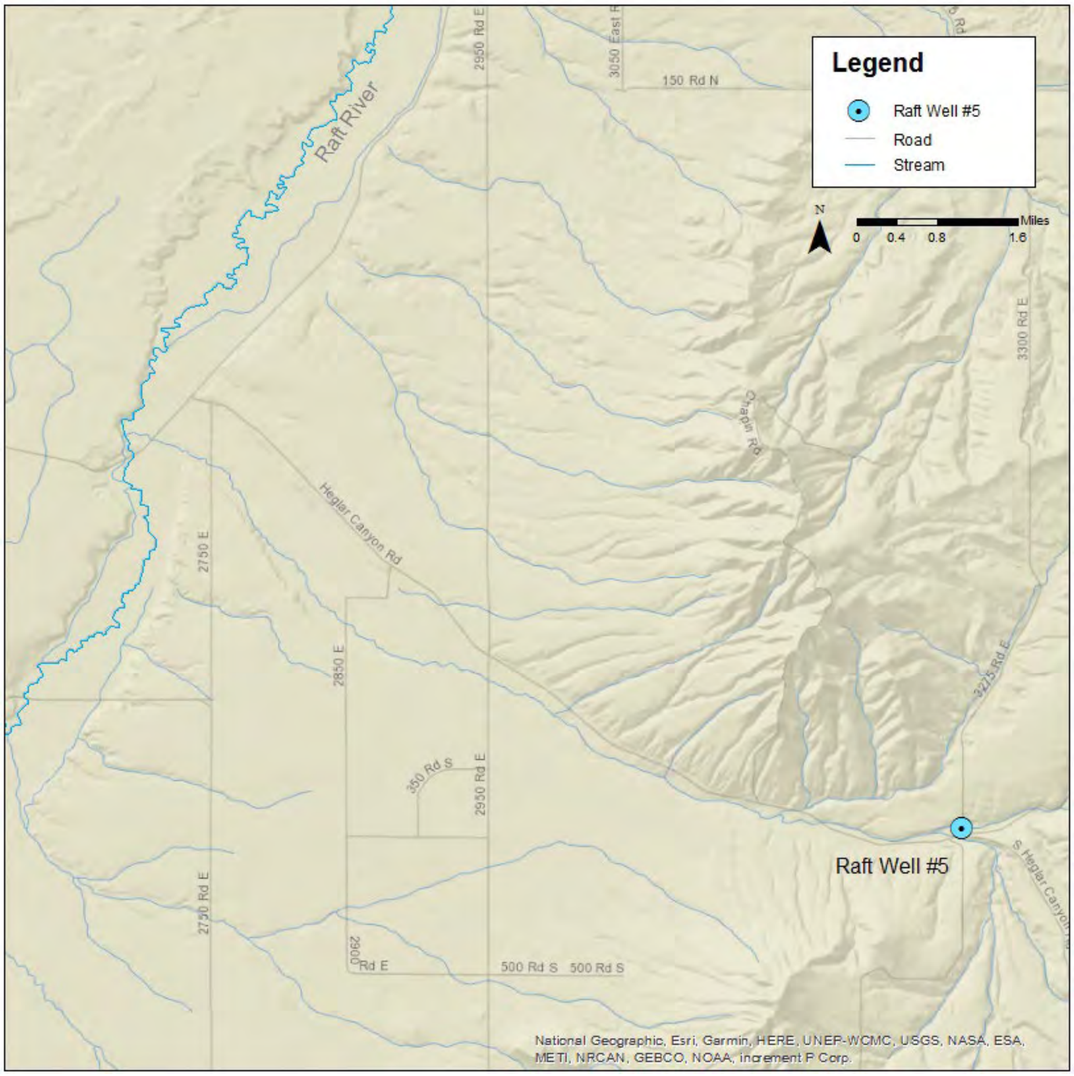


Figure 10. Map of Raft Well #5

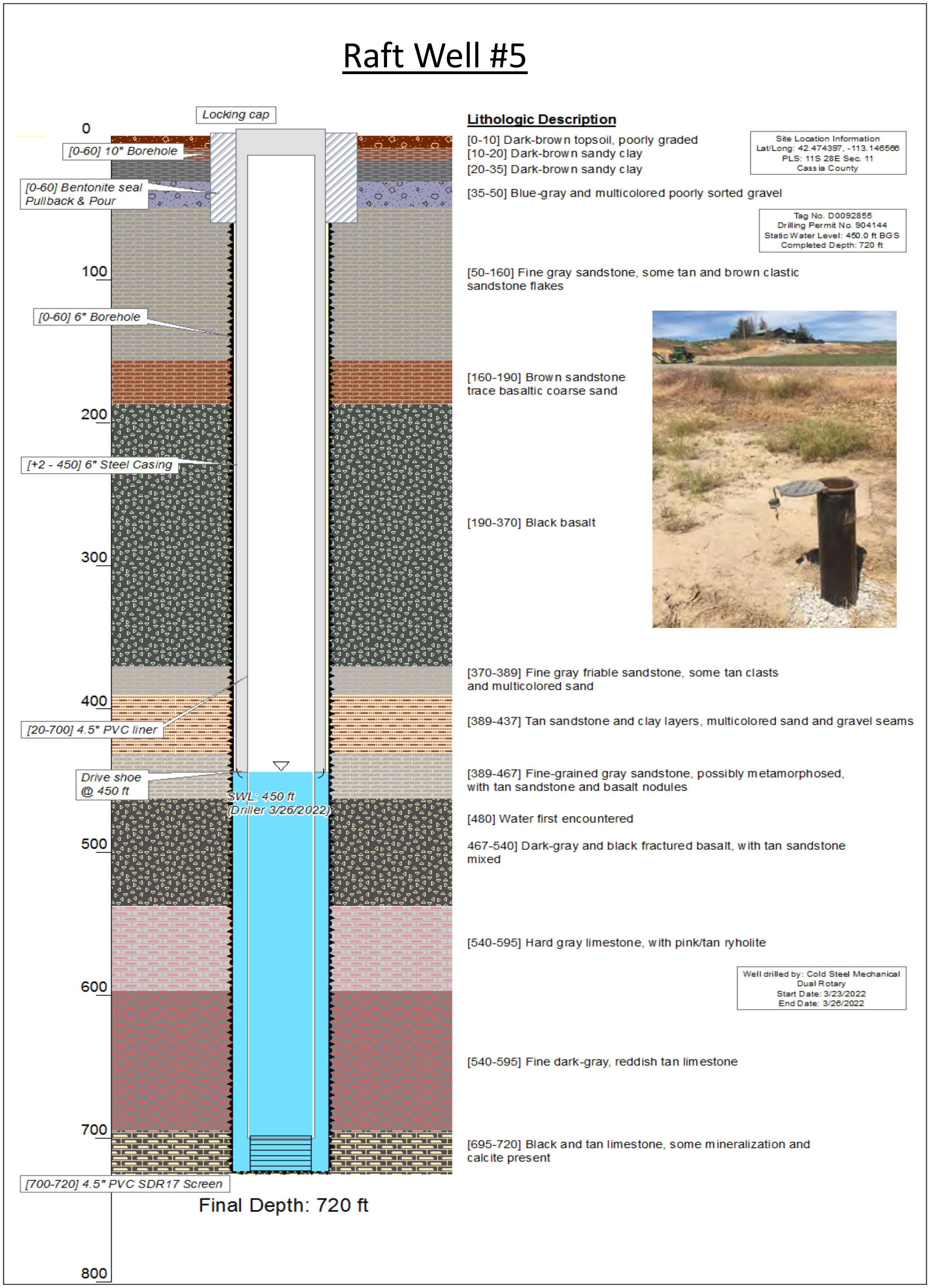


Figure 11. Construction and lithologic details of RAFT Well #5

**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).

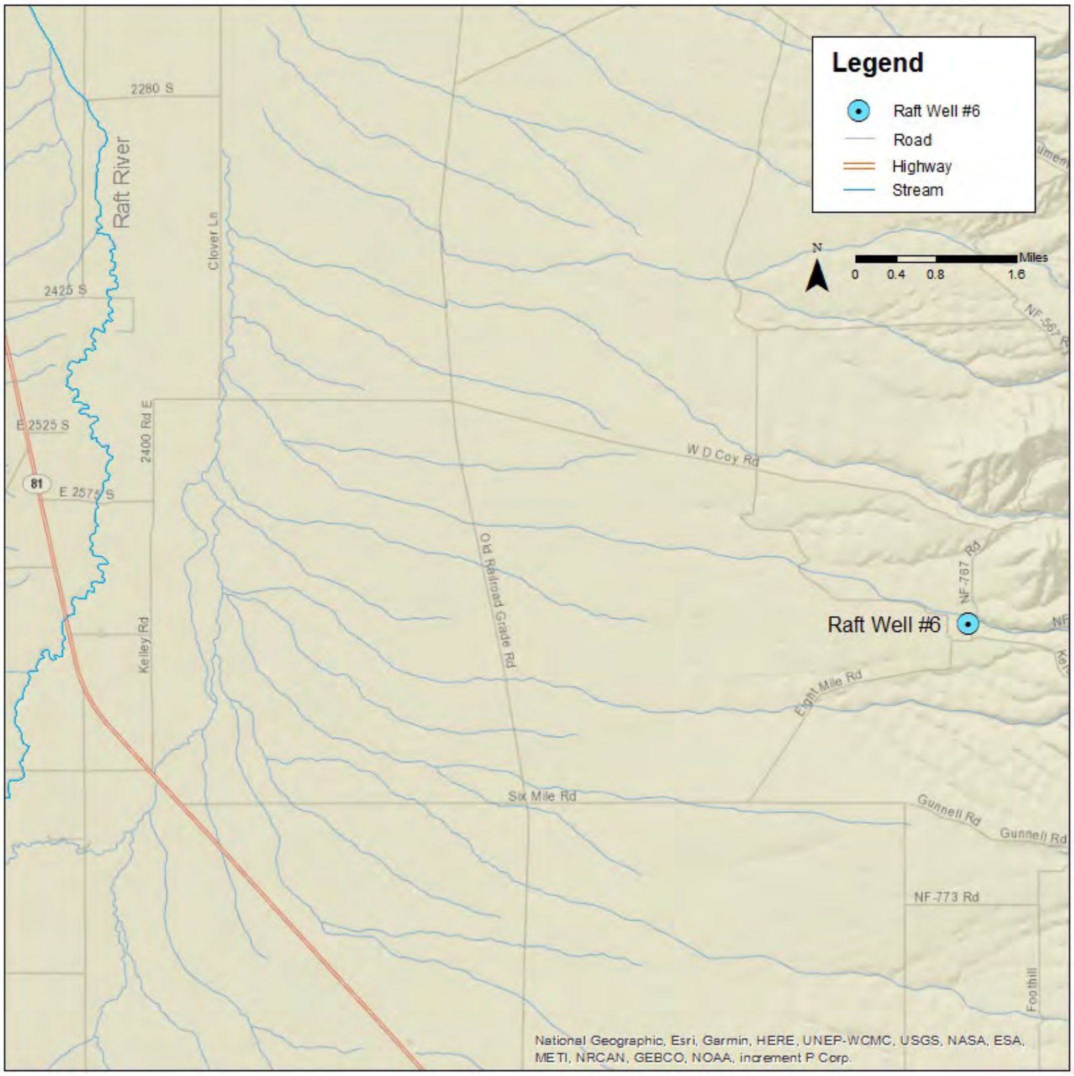


Figure 12. Map of Raft Well #6

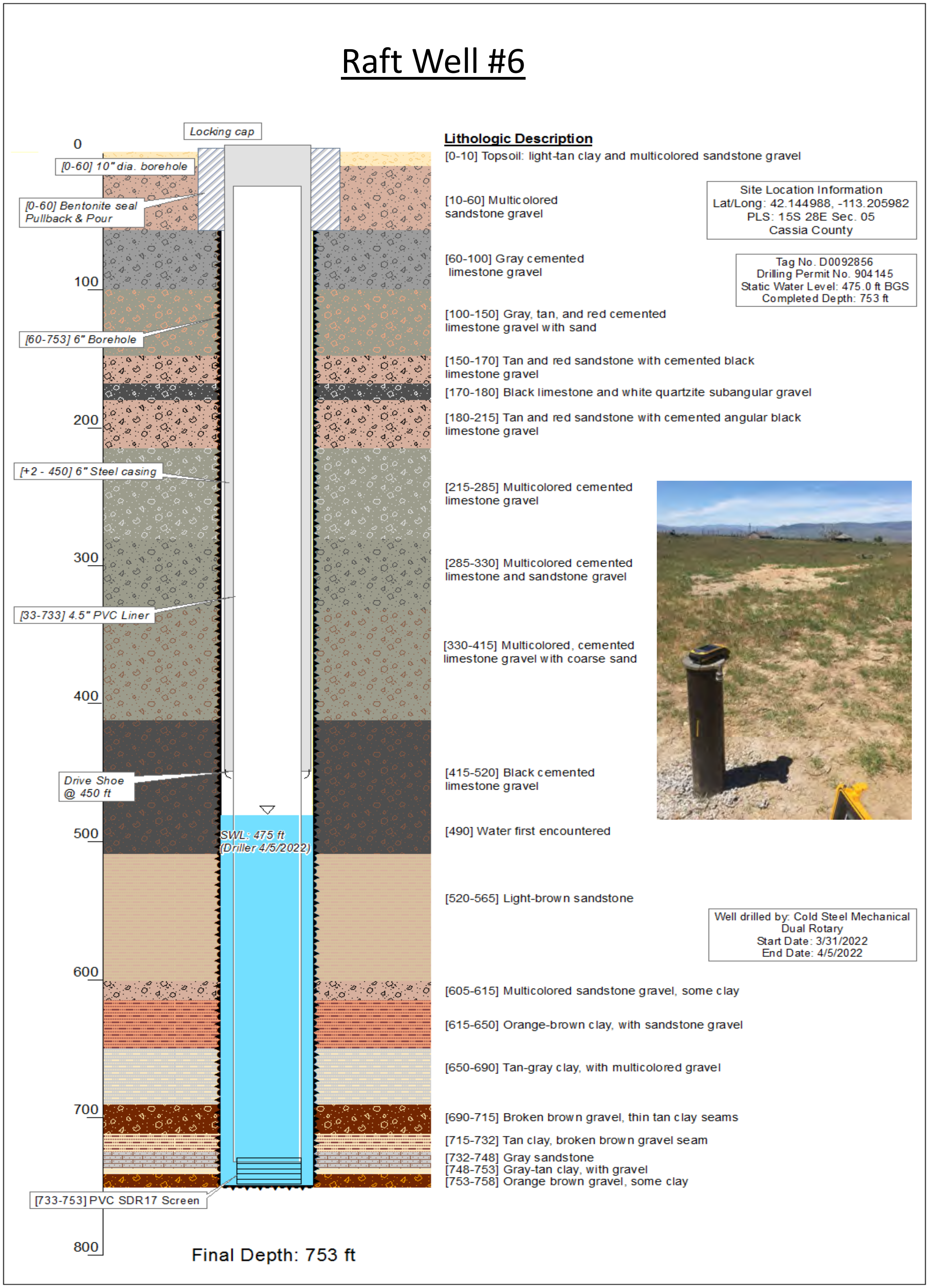


Figure 13. Construction and lithologic details of Raft Well #6

**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.

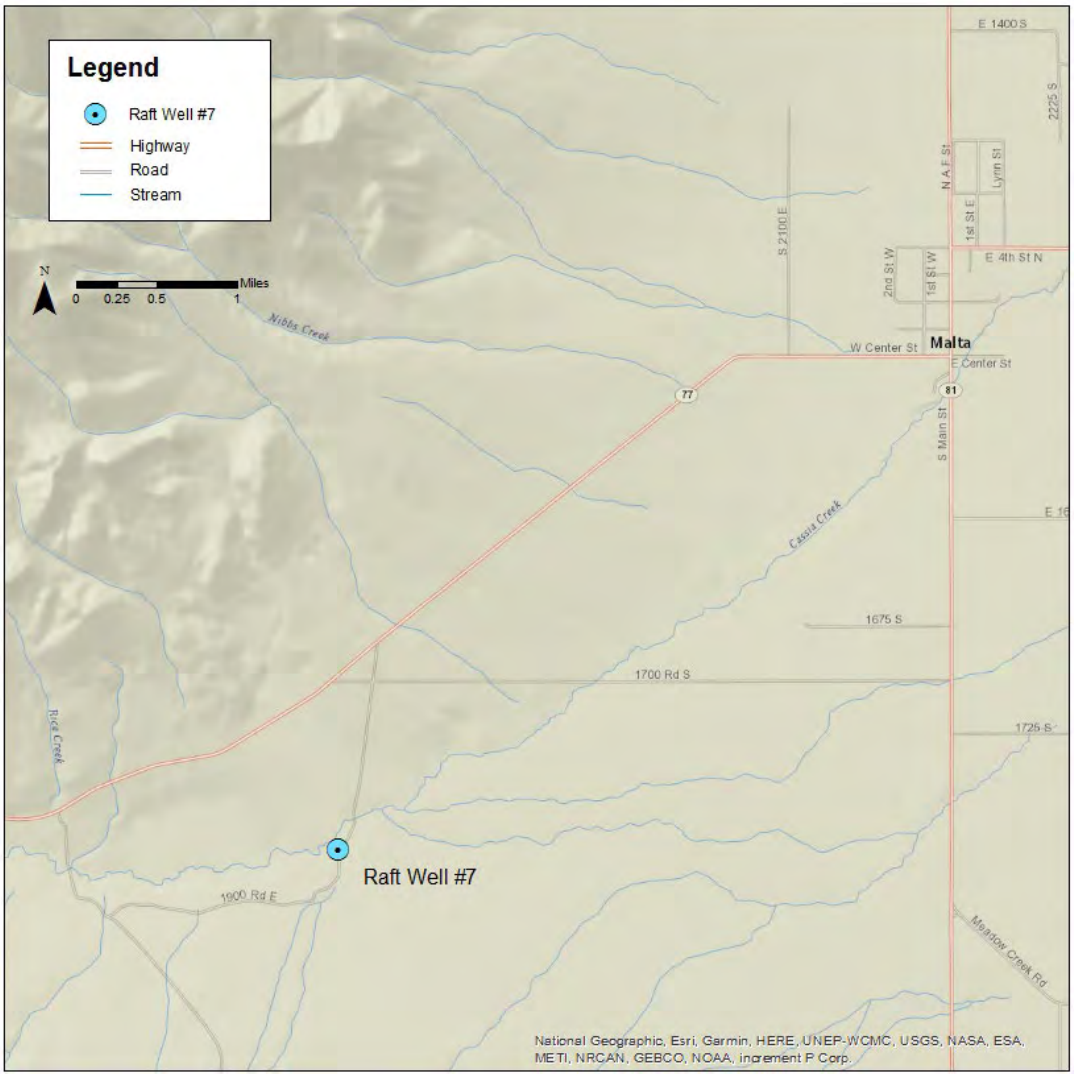


Figure 14. Map of Raft Well #7

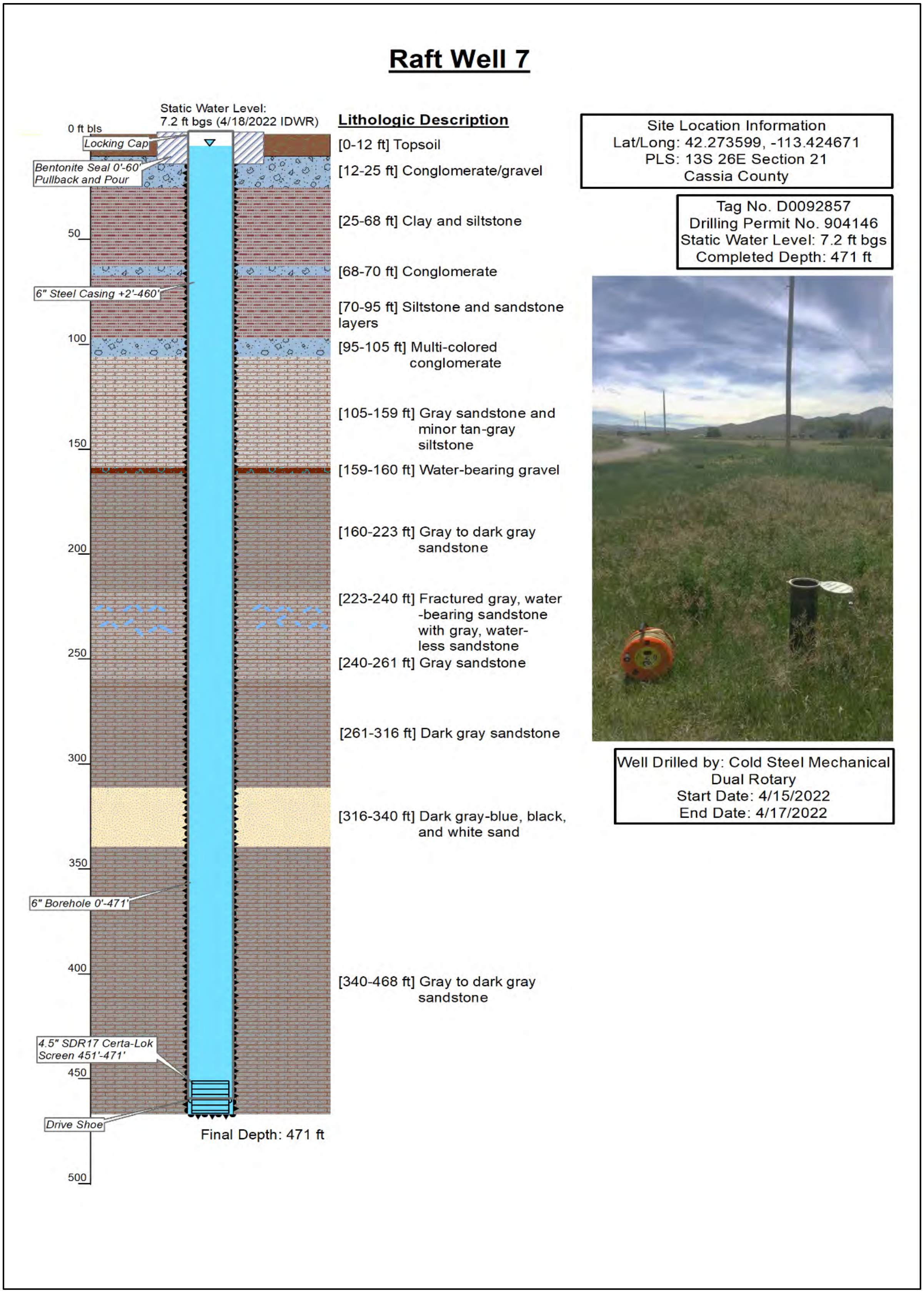


Figure 15. Construction and lithologic details of Raft Well #7

**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).

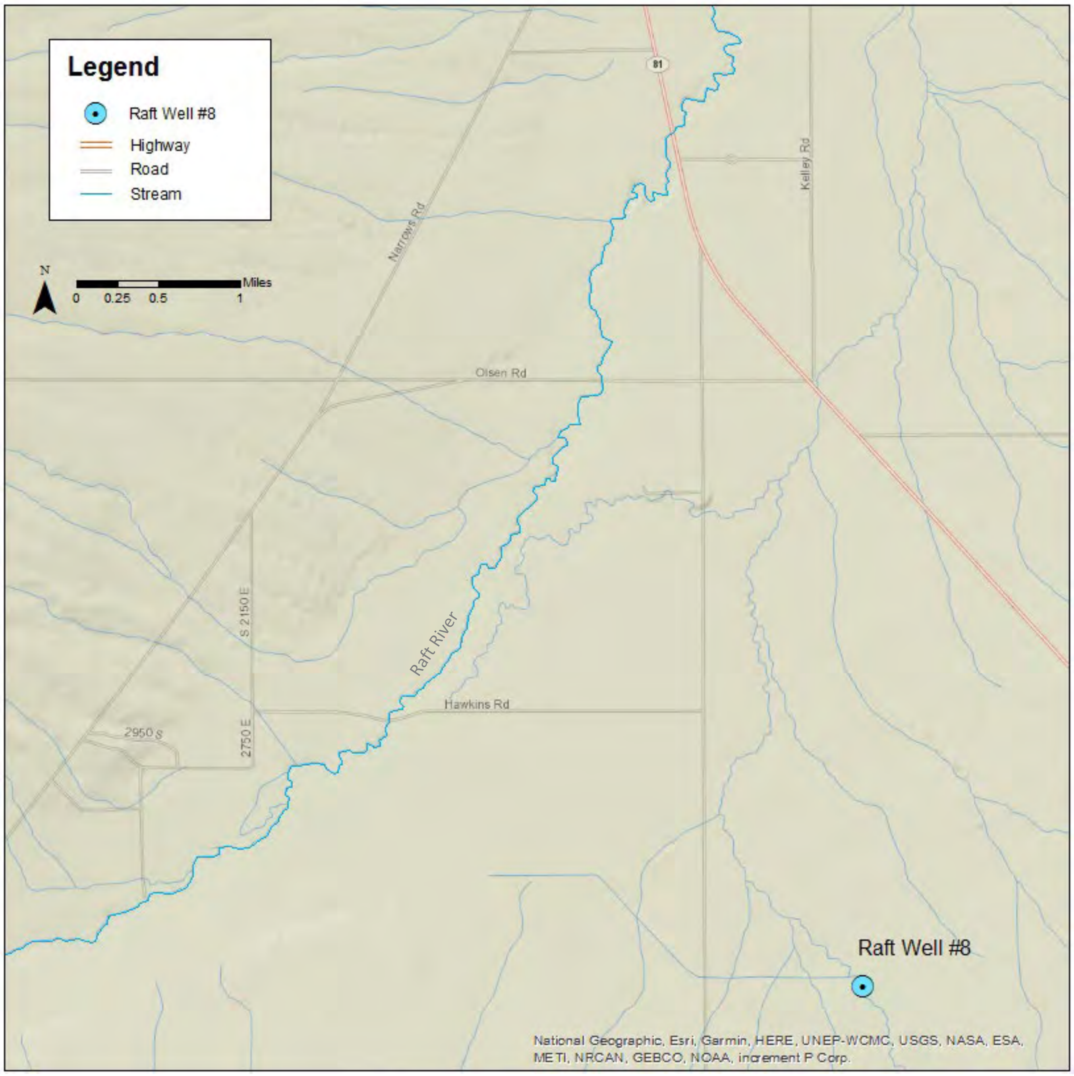


Figure 16. Map of Raft Well #8

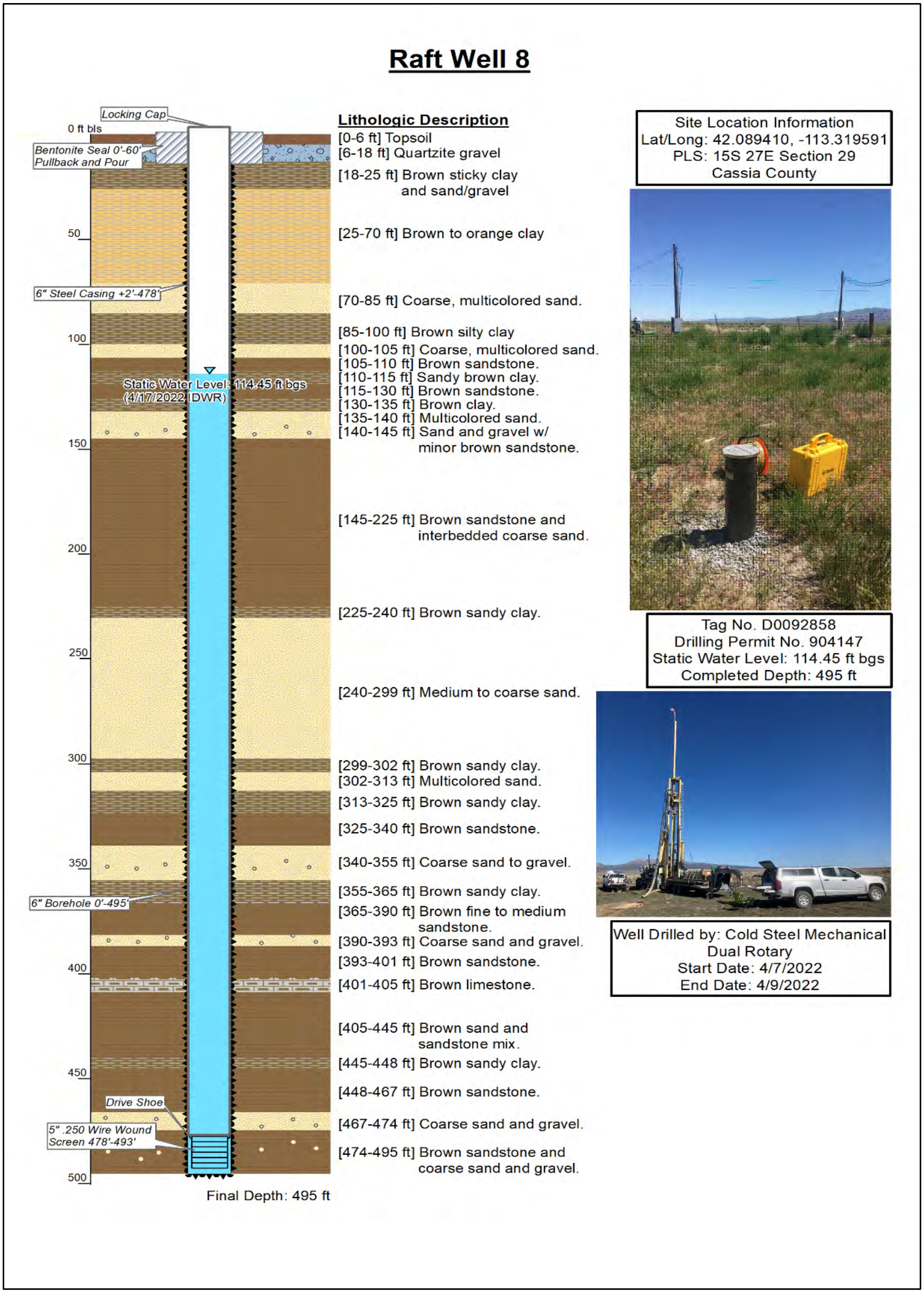


Figure 17. Construction and lithologic details of Raft Well #8

**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).

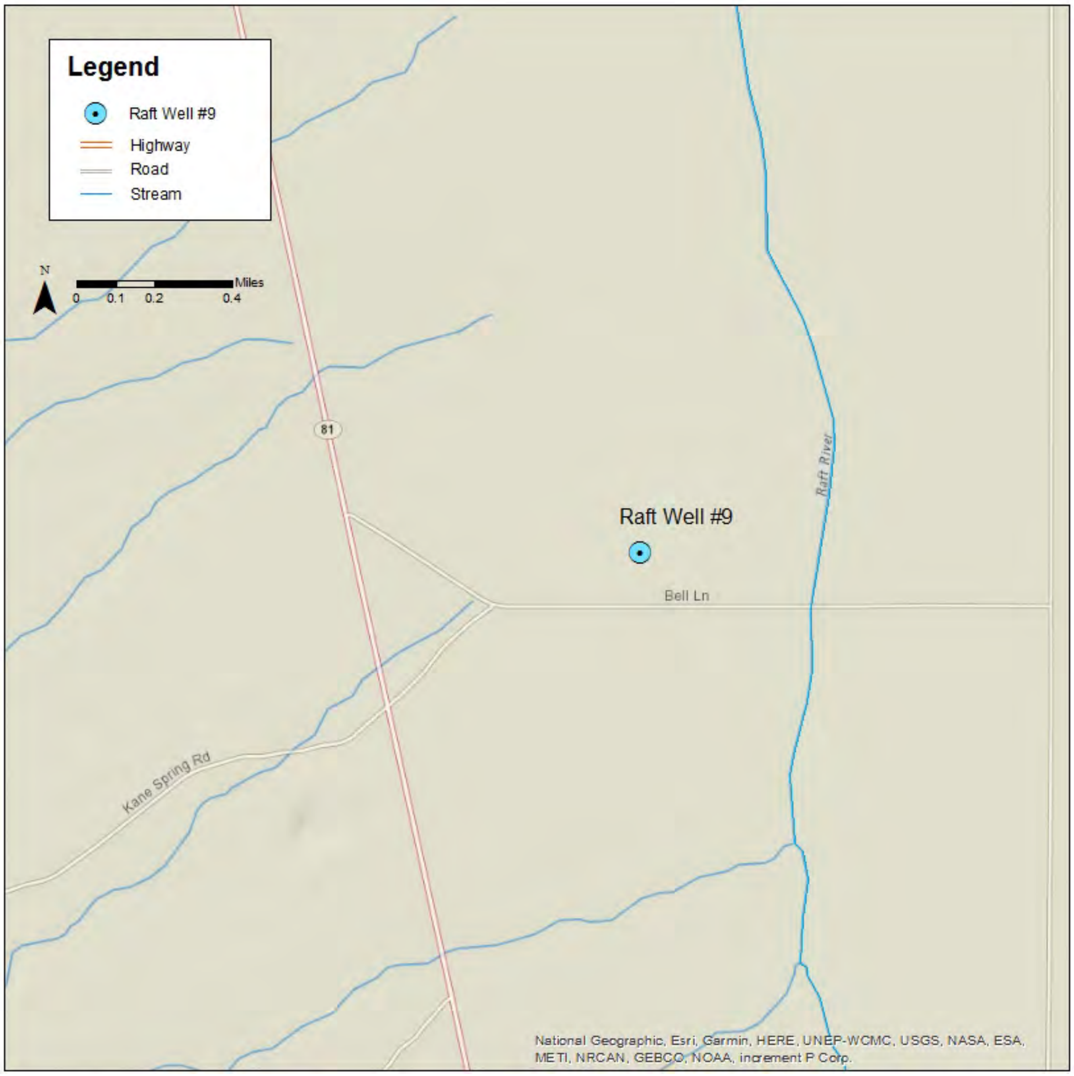


Figure 18. Map of Raft Well #9

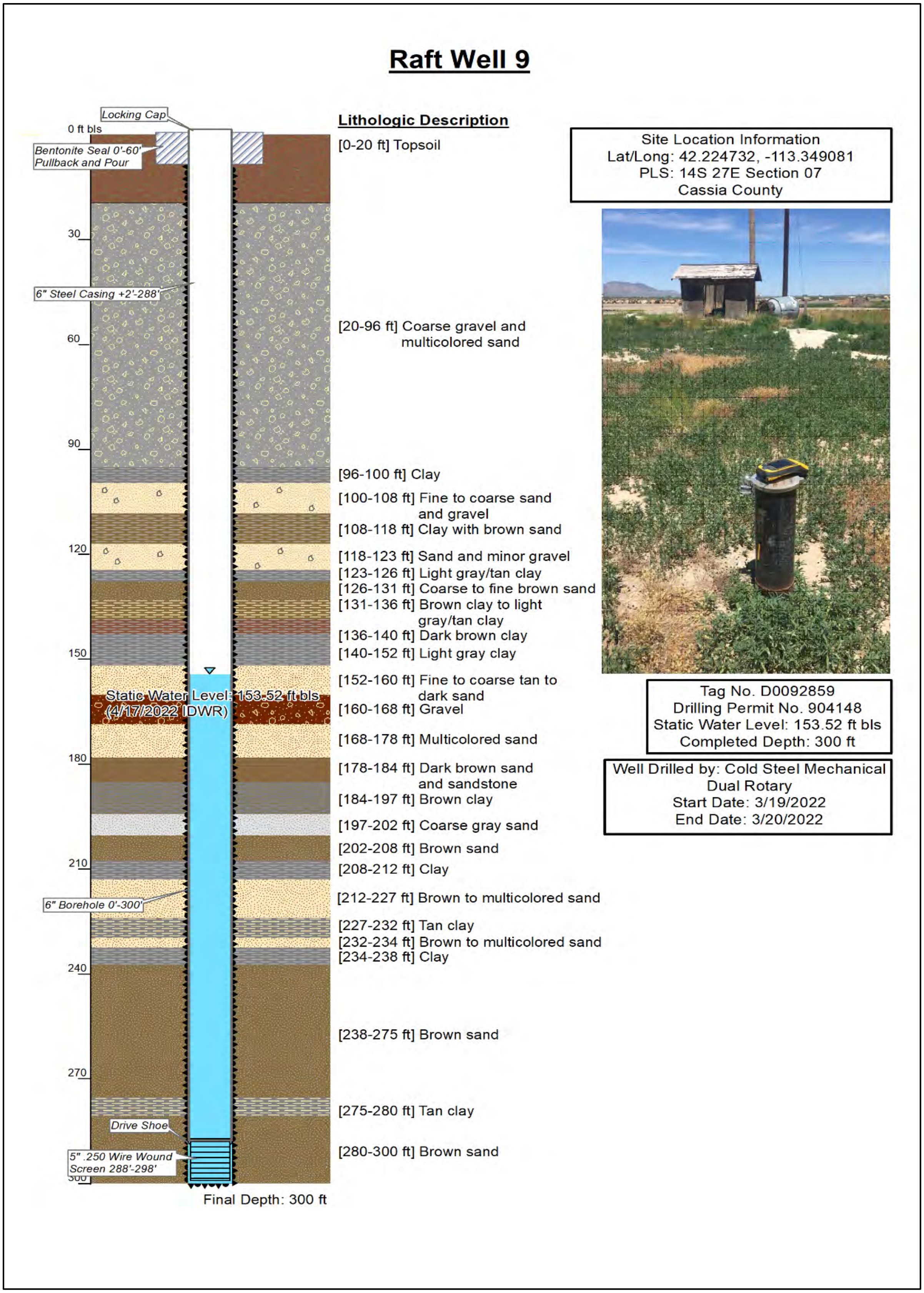


Figure 19. Construction and lithologic details of Raft Well #9

**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).

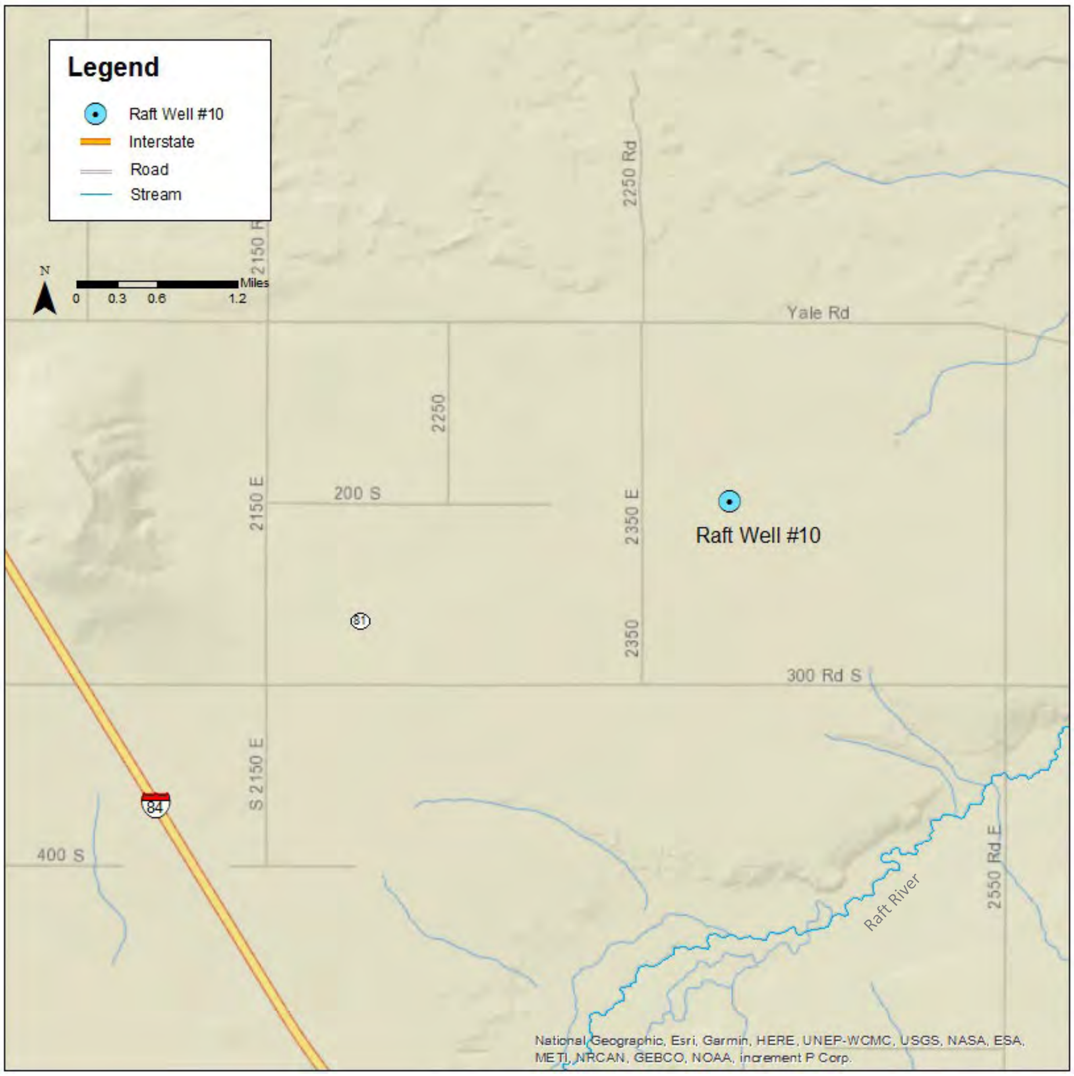


Figure 20. Map of Raft Well #10

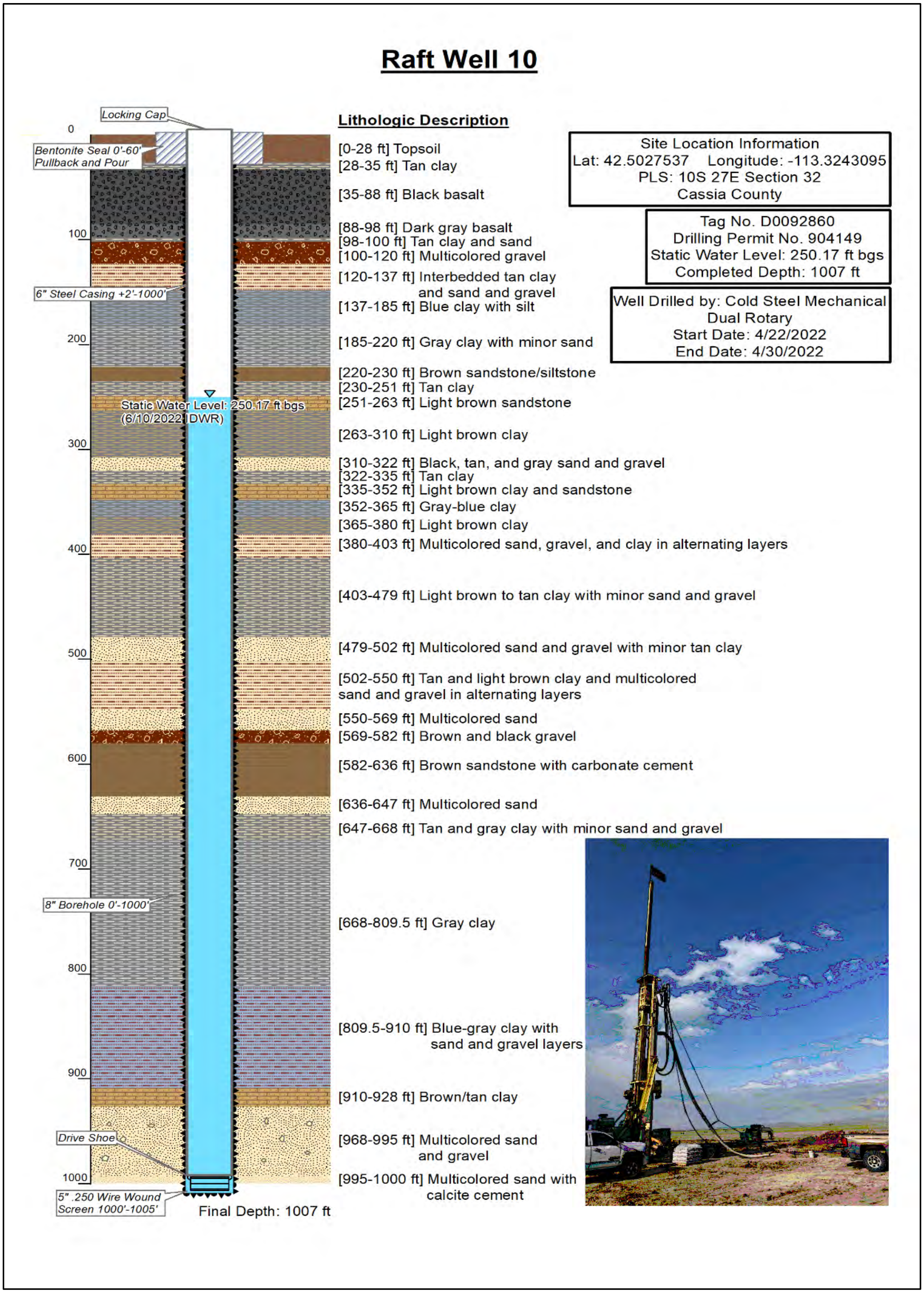


Figure 21. Construction and lithologic details of Raft Well #10

**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).

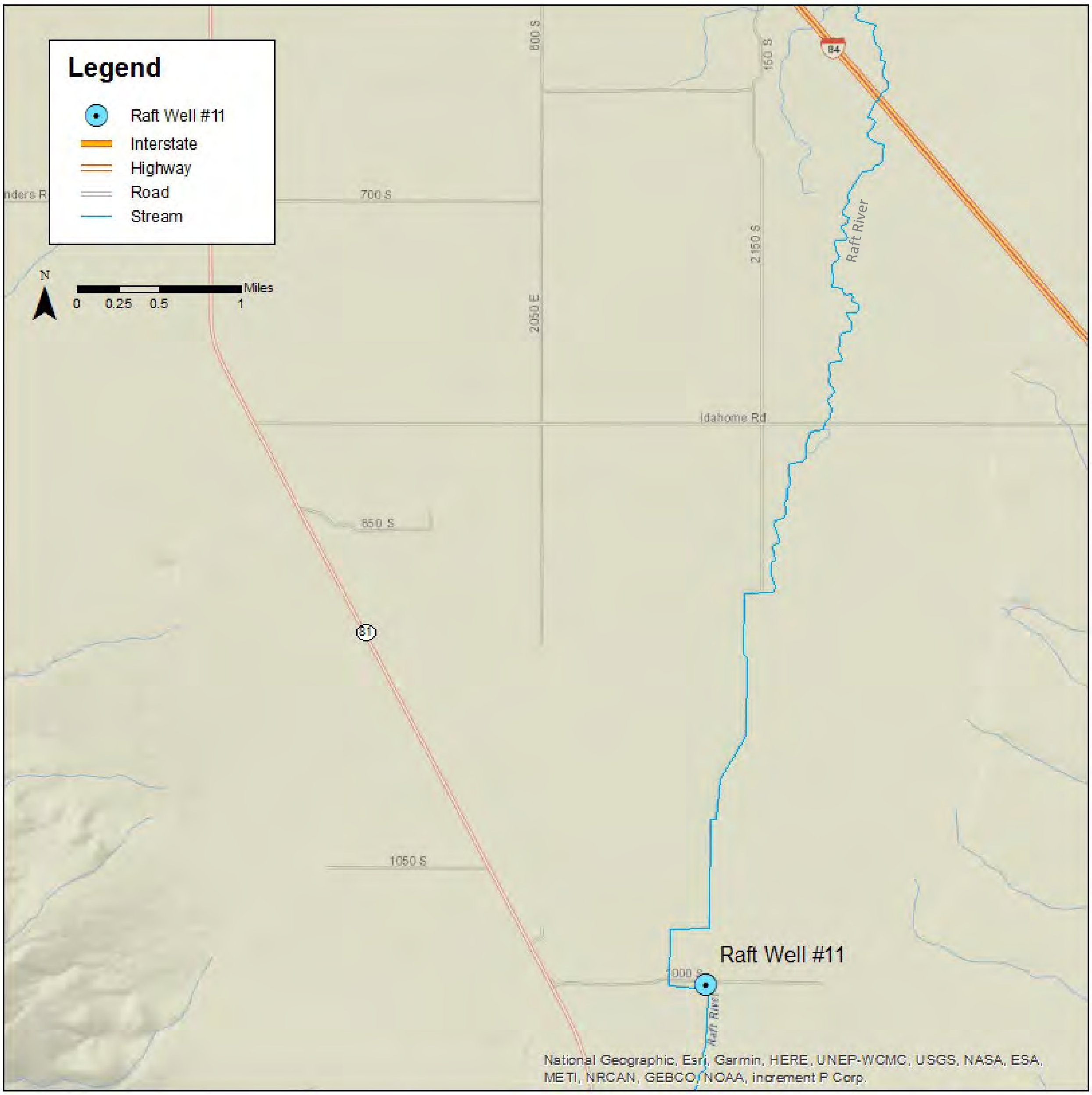


Figure 22. Map of Raft Well #11

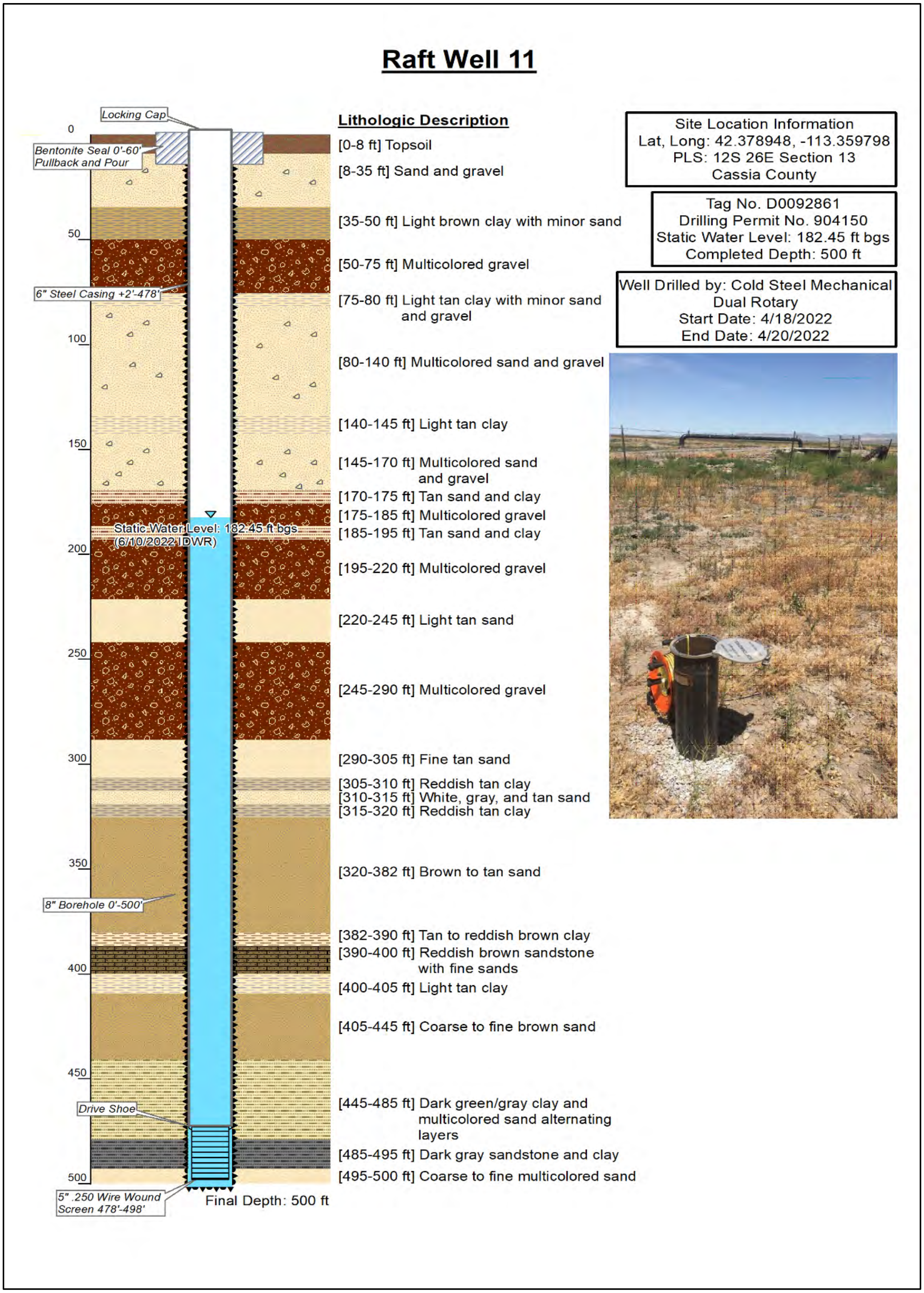


Figure 23. Construction and lithologic details of Raft Well #11

**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).

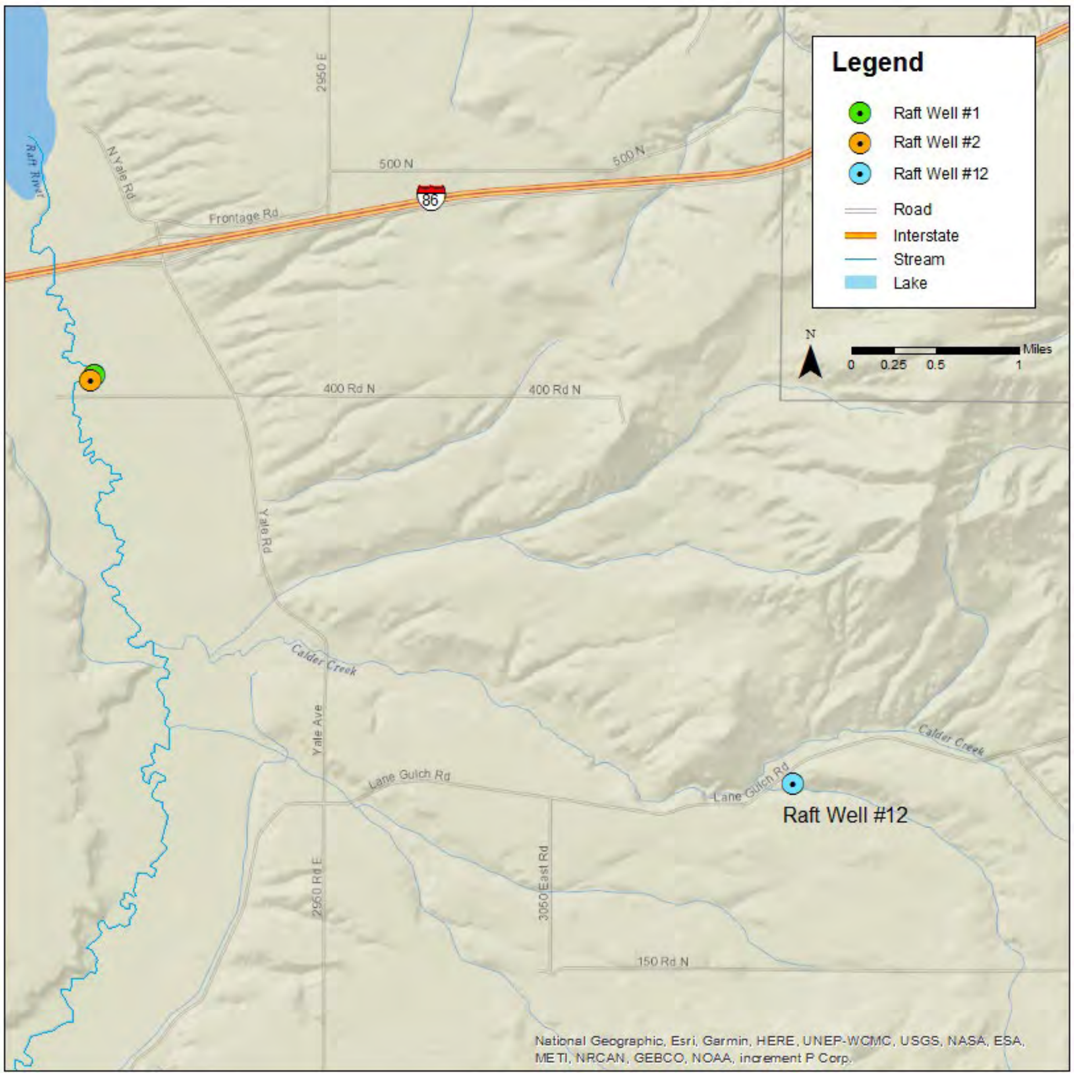


Figure 24. Map of Raft Well #12

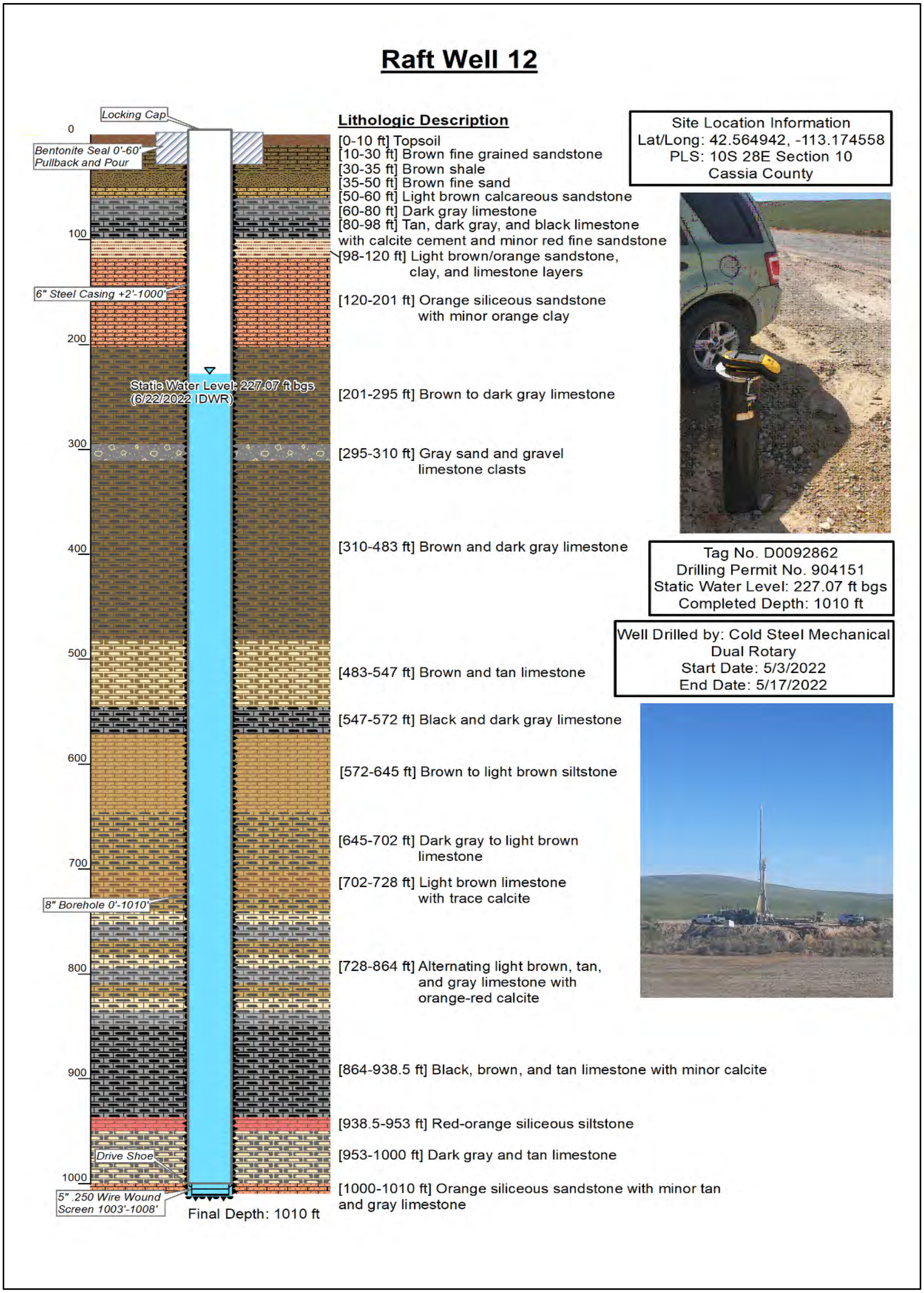


Figure 25. Construction and lithologic details of Raft Well #12

# 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.

# 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)