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DIXIE MEADOWS GEOTHERMAL PROJECT, AQUATIC RESOURCES MONITORING AND MITIGATION PLAN, DIXIE VALLEY, NEVADA

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Prepared for:

United States Department of the Interior
Bureau of Land Management
Carson City District – Stillwater Field Office

FINAL DRAFT DOCUMENT

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LIST OF ACRONYMS AND ABBREVIATIONS

af/yr – acre feet per year
AO – Authorized Officer
ARMMP – Aquatic Resources Monitoring and Mitigation Plan
BLM – Bureau of Land Management, Carson City District, Stillwater Field Office
DRI – Desert Research Institute
DVFZ – Dixie Valley Fault Zone
DO – dissolved oxygen
E – evaporation
EA – environmental assessment
EC – electrical conductivity
EGS – Engineered Geothermal Systems
ET – evapotranspiration
FNAS – Fallon Naval Air Station
ft amsl – feet above mean sea level
ft bgs – feet below ground surface
gpm – gallons per minute
GPS – Global Positioning System
LMWL – local meteoric water line
LPI – Line Point Intercept transects
mg/L – milligrams/liter
MW – monitoring well
NDOW – Nevada Division of Wildlife
NDWR – Nevada Division of Water Resources
NV – Nevada
P – precipitation
PVC – polyvinyl chloride
Q_{IN} – groundwater inflow
Q_{OUT} – groundwater outflow
SW_{IN} – surface water inflow
SW_{OUT} – surface water outflow
TDS – total dissolved solids
USFWS – Unites States Fish and Wildlife Service
USGS – United States Geological Survey
WARD – Water and Aquatic Resource Delineation
WRCC – Western Regional Climate Center

1.0 EXECUTIVE SUMMARY

ORNI 32, LLC, a subsidiary of Ormat Nevada, Inc., (referred to herein as Ormat) engaged McGinley & Associates, Inc. (McGinley) as an independent contractor (Contractor) to develop this aquatic resource monitoring and mitigation plan (ARMMP) for Dixie Meadows in Dixie Valley, Churchill County, Nevada. This ARMMP document is being prepared for the US BLM, as the lead NEPA compliance agency for the ORNI 32, LLC Dixie Meadows Geothermal Utilization Project. The goal of the ARMMP is to identify hydrologic and biologic resources, characterize hydrologic conditions, spring-dependent ecosystems, aquatic habitat, and special status species, and describe the plan that Ormat would implement to monitor and mitigate potential impacts to those resources and ecosystems associated with its future geothermal exploration and production/injection in the Dixie Meadows area.

The Dixie Meadows are a spring-supported riparian and meadow area situated at the base of the Stillwater Range to the west of the Dixie Valley playa. McGinley completed a water and aquatic resource delineation (WARD) to inventory these resources and identify potential monitoring locations within Dixie Meadows. In the spring and summer of 2019 during WARD development, McGinley identified and quantified 117 spring and seep features and eight distinct wetland communities, many of which support a variety of aquatic-dependent biological resources and special status species (i.e., Dixie Valley toad and springsnails). During 2020 springsnail monitoring, an additional five springs were found totaling 122 springs within Dixie Meadows. Warm and hot springs that line the western perimeter of the Dixie Meadows are believed to be geologically young features that formed from seismic events that created new faults or rejuvenated existing faults, which act as permeable conduits for geothermal groundwaters to ascend from depth. Thermal waters migrate upwards through these fault zones, discharge into basin-fill sediments and mix with shallow groundwater, then flow towards the Dixie Valley playa, and in some cases, discharge to the surface through the springs of Dixie Meadows.

Existing hydrology and chemistry data for surface water and groundwater resources in Dixie Meadows were analyzed to characterize these resources and assess the degree of connection between deep geothermal groundwater, basin-fill groundwater, and surface water resources. McGinley has monitored a subset of springs and monitoring wells since August 2018 for water chemistry, water levels, flow rates, and field parameters (water temperature, conductivity, and pH). Geothermal groundwater is characterized by elevated temperatures, high concentrations of silica, and low magnesium. Warm and hot springs in Dixie Meadows exhibit a chemical signature of mixed geothermal and shallow groundwater. Fresh groundwater and surface waters have low temperatures, high concentrations of magnesium, and low concentrations of silica. Water that is intermittently contained in two playa ponds in eastern Dixie Meadows are a sodium-chloride water type with elevated concentrations of lithium due to the dissolution of playa salts.

This ARMMP includes a hydrologic budget (water balance) that describes and quantifies inflows and outflows of water from Dixie Meadows, which are assumed to be in a state of dynamic equilibrium. Total spring discharge is estimated at approximately 900 acre-feet per year (af/yr), which is ultimately consumed by evapotranspiration (ET) from vegetation and evaporation from

the two playa ponds in eastern Dixie Meadows. The playa ponds are suspected seismic-liquefaction features that collect spring discharge during winter months when ET is low and spring discharge reaches the ponds, along with sporadic surface water runoff after significant precipitation events. Estimated annual ET of groundwater, spring discharge, and precipitation is 2,800 af/yr, and evaporation from the playa ponds is estimated to be approximately 15 af/yr, which is equal to the capacity of the two ponds. During winter months, an average of 45 af/yr of runoff from Dixie Meadows is also interpreted to reach the Dixie Valley playa. Total annual outflow from the Dixie Meadows is estimated at 2,860 af/yr.

The main source of inflow to Dixie Meadows is approximately 1,800 af/yr from direct precipitation, which is eventually lost to evaporation or ET. In average precipitation years, mountain-block runoff from the Stillwater Range to the Dixie Meadows is low and sporadic, estimated at approximately 20 af/yr. Runoff may not be present during dry years; however, the entire Dixie Meadows can be inundated following storm events (two-year and five-year flood discharges are approximately 30 and 340 acre-feet). Increases in spring discharge have been observed following storm events, suggesting an occasional input of meteoric water to the springs. Average groundwater recharge from infiltration in the mountain block and alluvial fan is estimated at approximately 270 af/yr, and geothermal inflow is estimated at 770 af/yr and may be in part derived from outside the tributary watershed to Dixie Meadows. The total average annual inflow to the Dixie Meadows equals the total outflow.

The BLM, McGinley, Ormat, and cooperating agencies (NDOW, USFWS, USGS, and FNAS) have developed this ARMMP based on the conceptual hydrogeologic model, water balance, and results of the WARD as well as the current scientific understanding of habitat requirements for special status species. The ARMMP was designed to ensure long-term flexibility in the monitoring plan and allow for triggers and mitigation to be adaptive to potential changes in sensitive-resource concerns throughout the life of the project. Twenty-three surface water monitoring locations have been established as locations where hydrologic changes may be identified and quantified during geothermal operations. Five of these would be equipped for continuous flow measurement using weirs or flumes. These locations would be monitored to quantify natural variations in hydrologic conditions. Four potential surface water “control sites” that are considered most likely to be outside the influence of geothermal operations are proposed to monitor natural conditions. McGinley has started collecting baseline data from 15 locations, while the remaining locations are yet to be established. Additional surface water monitoring locations may be added and/or existing monitoring locations may be changed as new information is gained throughout the life of the project and would be subject to approval by the BLM Authorized Officer (AO). A BLM approved third-party contractor (Contractor) would monitor surface water locations on a monthly basis for variations in flow, water stage, temperature, field water quality parameters, and biological parameters (habitat quality indices), and surface water quality samples would be collected on a quarterly basis for the life of the project (exploration, utilization, decommission, and reclamation phases).

It is proposed that the approved Contractor would monitor nine groundwater monitoring wells for potentiometric head on a continuous basis (maintained monthly), and for chemistry, and field

parameters on a monthly basis, transitioning to quarterly (to be approved by the BLM AO). Of these wells, seven are, or would be, completed in alluvium and two in bedrock. Monitoring of the geothermal resource would continue at 23A-8 and 24-8 for temperature, pressure and water chemistry and would include additional production/injection well sites determined during operations. For additional monitoring of shallow water table conditions within Dixie Meadows, the installation of fifteen drive-point piezometers is proposed. Installation of additional groundwater monitoring wells and monitoring of additional production/injection well sites would be added to the ARMMP as necessary to further establish and define monitoring triggers and site appropriate mitigation.

The health and function of the various spring-dependent ecosystems (wetland and aquatic habitat) and associated species will be monitored as part of the ARMMP. Several monitoring frameworks have been developed to monitor these sensitive biological resources for the life of the project. It is proposed that the approved Contractor would implement those frameworks as follows: 1) annually monitor the extent and composition of wetland communities (hydrophytic vegetation and hydric soils) throughout the WARD, 2) annually monitor wetland vegetation (cover and composition) and hydric soils at eight sites co-located with hydrological monitoring sites, and at least 13 sites elsewhere in the meadows (as determined by forthcoming data on special status species habitat preferences), and 3) monitor the distribution and abundance of special status species. Two of five springs known to harbor springsnails (*Pyrgulopsis* spp.), will be surveyed annually to monitor distribution and abundance. Surface water temperature will be monitored on a continual basis (summarized monthly) and water stage will be monitored monthly at these two springs. Dixie Valley toad (*Anaxyrus williamsi*) distribution and abundance will be monitored twice annually at locations to be determined by working groups (see below). Surface water temperature and stage will be monitored monthly during both the Dixie Valley toad reproductive season (March-May) and brumation (October-February) at eight sites co-located with hydrological monitoring sites, and elsewhere as determined by working groups (see below).

Technical working group meetings were held in September and October 2020 with the Contractor, BLM, Ormat, and cooperating agencies to develop and refine monitoring objectives and preliminary hydrologic and biologic baseline conditions and thresholds to complement the monitoring activities. The hydrologic and biologic baseline conditions and thresholds would continue to be refined though a baseline monitoring period extending to 2022, in concert with the technical working group reviews that include involved federal and state cooperating agencies. The ARMMP would be updated as those monitoring data are collected, and baseline conditions and thresholds are refined.

This ARMMP identifies a framework of proposed adaptive management actions and mitigation measures based on monitoring results, baseline conditions and triggers, as well as thresholds based on the current understanding of the natural variability of hydrological and biological conditions, and the potential importance to special status species in Dixie Meadows. Adaptive management and mitigation are tied to the parameter range identified for hydrologic conditions, special status species, and aquatic habitat sustainability. If potential changes are detected in

baseline conditions and threshold values are exceeded, a proactive set of adaptive management actions and mitigation would be implemented with the goal of preventing any potential impacts to hydrologic resources, special status species, or aquatic habitat. Management actions would initially concentrate on early detection of changes in baseline conditions, with concurrent consultations among the BLM and technical working group (cooperating agencies) for appropriate monitoring and tracking of conditions. In the event that changes to baseline conditions are occurring or thresholds are being exceeded, adaptive management and mitigation measures would be implemented to minimize potential impacts to hydrologic resources, aquatic habitat, and special status species, including geothermal reservoir pumping and injection adjustments, such as redistribution of injection between shallow and deep aquifers. If more aggressive actions are necessary, mitigation measures have been identified and may include augmenting impacted springs with geothermal fluids or fresh water at a quality and quantity sufficient to restore pre-production temperature, flow, stage, and water chemistry.

Furthermore, the ARMMP adopts an adaptive management approach, whereby monitoring attributes, frequencies, triggers, adaptive management, and mitigation measures may be refined as additional data are collected and in response to monitoring observations. Maintaining an adaptive management approach ensures potential impacts to hydrologic resources, special status species, and aquatic habitat would be reduced, minimized, and/or avoided.

2.0 INTRODUCTION

Ormat has proposed to construct and operate a geothermal facility within the Dixie Meadows lease area located approximately 45 miles northeast of Fallon, in Churchill County, Nevada. The Bureau of Land Management, Carson City District, Stillwater Field Office (BLM) completed a Draft Environmental Assessment (EA) for the Dixie Meadows Geothermal Development Project in May 2017 (EA #DOI-BOM-NV-C010-2016-0014-EA) (BLM, 2017a), as updated in 2020. The Draft EA included a mitigation measure that required the preparation of an ARMMP. The purpose of the ARMMP is to ensure that significant adverse effects on aquatic resources (water resources, riparian and wetland vegetation, and aquatic dependent special status species) do not occur as a result of the project. The BLM did not make a final decision on the Draft EA, pending the development of the ARMMP. In June 2017, the BLM provided Ormat with an outline of necessary components required in the ARMMP, which this document follows (BLM, 2017b).

3.0 LEASE AREA AND PROJECT INFORMATION

3.1. Final Environmental Assessment - Dixie Meadows Geothermal Exploration Project (2011)

A final EA (Dixie Meadows Geothermal Exploration Project EA [BLM 2011]) was issued to Ormat Technologies, Inc. in 2011 for conducting geothermal exploration activities in the Dixie Meadows. Under the EA, Ormat proposes to evaluate the geothermal resources that potentially exist within the Lease Area by constructing up to 20 well pads and drilling one of each of the three different types of geothermal exploration wells on each pad: temperature gradient wells, observation wells, and production wells. Therefore, a total of 60 geothermal exploration wells may be drilled as part of the Proposed Action.

In support of the geothermal exploration drilling activities, Ormat also proposes to construct new gravel access roads and utilize and repair existing roads for access to the Project Area. Gravel would be obtained from an existing mineral material site that Ormat would expand and from a new mineral material site that Ormat would construct. Additionally, Ormat proposes to drill up to two groundwater wells on one or two of the proposed well pads or at the proposed new gravel source area. Therefore, a total of 62 wells may be drilled, including 60 geothermal exploration wells and 2 groundwater wells. All geothermal exploration activities would occur within the Project Area, including any disturbance necessary for construction and drilling operations. The Project Area is approximately 970 acres in size and consists of a 20-acre block centered on each proposed well pad location, a 10-acre area at the existing and proposed mineral material sites, and a 400-foot-wide corridor centered on all proposed access roads. The entire Project Area would not be disturbed; instead, only the areas where the existing and proposed gravel sources would be expanded or constructed and those areas ultimately developed with a well pad and associated access roads would be disturbed.

Under the Dixie Meadows Geothermal Exploration Project EA (2011), Ormat has to date drilled eight core holes / monitoring wells / full-size wells under this EA, including 22-8B (shallow core hole and monitoring well, 2012), 22D-8 (slim hole, injection test well, 2012), 23-8 (deep core hole, monitoring well, 2012), 23A-8 (production well, 2016), 24(13)-8ST2 (injection well, 2017), 24A-8

(shallow core hole, monitoring well, 2016), 75-4 (full-size well, monitoring well, 2017), and 86-7 (shallow core hole, monitoring well,2012). In 2011, Prior to the Ormat 2011 EA, Terragen Power completed one full size well (42[12]-9) and one small diameter monitoring well (21-9/MW-1) under a Utilization Plan (UP) and subsequent FONSI in 2010. Ormat additionally conducted flow testing included the April-June 2017 pumping (23A-8) and injection (24-8 and 75-4) test, along with other short-duration flow tests. The drilling and testing under the EA have informed the geologic framework and hydrogeologic interpretations presented in Sections 6 and 8, and the details of the 2017 flow testing are provided in Section 8.4. Complementing these exploration and testing activities have been miscellaneous spring discharge and physical properties measurements, including monthly spring pool stage and field parameter measurements at select spring locations commencing in 2015, and quarterly spring chemistry and physical properties monitoring at select locations commencing in 2018.

3.2. Draft Environmental Assessment - Dixie Meadows Geothermal Utilization Project (2017, updated October 2020)

3.2.1. Proposed Action

The Proposed Action for the Draft EA includes the following five components (Figure 1A):

- Construction and operation of up to two 30-MW net rated geothermal power plant facilities and associates electrical substations;
- Construction of up to 18 production and injection well pads for proposed deep core hole / full size wells (Figure 1B);
- Construction of up to 8 core hole well pads (permitted, not drilled - see Figure 1B);
- Construction and operation of geothermal production and injection wells, pipelines, access roads, and support facilities; and,
- Construction and operation of a 120-kV gen-tie to Ormat's Jersey Valley power plant.

Further details of the Proposed Action can be found in Section 2.1 of the Draft Final EA ORNI 32, LLC Dixie Meadows Geothermal Utilization Project (DOI-BLM-NV-C010-2016-0014-EA).

3.2.2. Alternatives

Under Alternative 1, ORNI 32 would construct and operate the proposed project as described in the Proposed Action. The only differences would be a different gen-tie route and associated facilities. Under Alternative 1, the gen-tie would extend about 31 miles to the south from substations at the proposed Dixie Meadows Geothermal power plants to NV Energy's Fort Churchill to Gonder 230-kV transmission line. Throughout its length, the gen-tie would run parallel to the existing Oxbow power line (Figure 1A).

Two gen-tie alignments adjacent to the Oxbow line are possible. Both alignment options are located on BLM-administered land and Navy lands. No private property would be affected. For either alignment, a switching station would be required at the terminus site to connect the gen-tie to the NV Energy line. Depending on the gen-tie alignment, this substation would be located on Navy lands on either the west side or east side of the Dixie Valley Road. The amount of

permanent ground disturbance associated with the switching station and access roads would be 8 to 10 acres in size.

Further details of the Proposed Action can be found in Section 2.2 of the Draft Final EA ORNI 32, LLC Dixie Meadows Geothermal Utilization Project (DOI-BLM-NV-C010-2016-0014-EA).

3.3. Lease Parcel Information

A map showing the extent of the lease area, Study Area, and project infrastructure is included as Figure 1A. The extent of the Study Area is defined by the Water and Aquatic Resources Delineation (WARD) boundary as determined by the BLM and includes mapped springs, seeps, and wetland community types (Figure 1B). Project infrastructure is defined by locations of existing and permitted wells and an existing gravel pit authorized under the Ormat Technologies, Inc., Dixie Meadows Geothermal Exploration Project EA (BLM 2011) and locations of proposed wells, power plants (phase I and II), a 120-kV generation tie line (Proposed Action), and a 230-kV generation tie line (Alternative I) as described under the Draft EA (BLM 2017a). As shown on Figure 2, land status within the Study Area includes BLM-administered land, a segment of United States Navy lands that have mineral rights owned by Ormat, and private parcels.

3.4. Lease Stipulations and Conditions of Approval

The Combined Dixie Meadows Geothermal Unit Area (NVN-89456X) was created by combining the Dixie Hope and Dixie Meadows geothermal lease units. It also contains mineral rights to 760 acres of Department of Defense/United States Navy land known as the Lamb Mineral interests. Ormat acquired the Dixie Hope leases from Terra-Gen Power, LLC in December 2010 and on February 1, 2012, those portions of the Dixie Meadows and Dixie Hope lease blocks that remain of interest to Ormat were consolidated into the Dixie Meadows Unit Agreement NVN-89456X. Ormat obtained two additional geothermal lease areas (N-92479 and N-92717) on December 1, 2013, on the western side of the lease blocks, which extend up to the boundary of the Stillwater Range Wilderness Study Area that is present west of the Dixie Valley road (Figure 1A).

Stipulations are included in the federal geothermal leases issued to or acquired by Ormat in the Dixie Meadows Unit Agreement. Most leases in the Study Area contain a stipulation to protect riparian areas and threatened, endangered, or other special status species and their habitats. The riparian area stipulation states that no surface occupancy or disturbance would be allowed within either 500 or 650 feet (horizontal measurement), depending on the lease, from any surface water bodies, riparian areas, wetlands, playas, or 100-year floodplains. This stipulation would protect the integrity of these resources, which would be delineated by the presence of riparian vegetation and not actual water. Exceptions may be considered on a case-by-case basis if the BLM determines at least one of the following conditions applies:

- Additional development is proposed in an area where current development has shown no adverse impacts;
- Suitable off-site mitigation would be provided if habitat loss is expected (i.e., replacement of resources that are of the same type as those being impacted, replacement of resources

that are of equal or greater value to public lands as those being impacted, or payment of funds to the BLM or other appropriate organization for performance of mitigation that addresses impacts of the project); or,

- The BLM determines development proposed under any plan of operations would ensure adequate protection of these resources.

The endangered species act section 7 consultation stipulation states lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or other special status species. BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activity that will contribute to a need to list such a species or their habitat. BLM may require modifications to or disapprove proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modifications of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act, 16 USC Section 1531 et seq., as amended, including completion of any required procedure for conference or consultation.

If future operations appear to have adverse impacts on aquatic resources or habitat, Ormat would implement additional adaptive management actions and/or mitigation measures to avoid, minimize, or reverse those potential impacts. Mitigation techniques are proposed in the 2017 Draft EA (BLM, 2017a) Section 2.1.6, and are discussed in Section 9.7 of the ARMMP document.

A complete list of geothermal lease stipulations can be found in Appendix A of the Draft Final EA ORNI 32, LLC Dixie Meadows Geothermal Utilization Project (DOI-BLM-NV-C010-2016-0014-EA).

4.0 BASIN CHARACTERISTICS AND HYDROLOGIC SETTING

4.1. Physiography

Dixie Valley is located in north-central Nevada within the Great Basin Physiographic Province. Dixie Valley is an endorheic basin (i.e., the basin retains water and allows no outflow to other basins) between the Stillwater Range to the west and the Clan Alpine Range to the east. The basin floor consists of alluvial fans with a relatively flat valley bottom. A 70-square-mile playa with an internal brine pool, referred to as the Humboldt Salt Marsh, exists in the west-central segment of the basin, which is periodically flooded following storm events. The Humboldt Salt Marsh has the lowest elevation in the basin and no surface outlet. Land-surface elevations in Dixie Valley range from approximately 3,380 feet above mean sea level (ft amsl) at the Humboldt Salt Marsh to 9,900 ft amsl in the Clan Alpine Range (Huntington et al., 2014). The total area of the Dixie Valley hydrographic basin is approximately 1,301 square miles (NDWR, 2019).

The Study Area is located in west-central Dixie Valley, at the base of the Stillwater Range and southwest of the Humboldt Salt Marsh. The Study Area is characterized by alluvial fan deposits in the west and lacustrine (i.e., playa) deposits in the east and a wetland area, referred to as Dixie

Meadows, that is fed primarily by groundwater discharge from seeps and springs and periodic stormwater runoff from the Stillwater Range. Discharge from seeps and springs at and near Dixie Meadows is a mixture of shallow alluvial groundwater and deeper derived geothermal fluid. Two ephemeral ponds, which are believed to be seismically created land features, exist in the northeast segment of the Study Area to the east of Dixie Hot Spring within the Dixie Meadows.

4.2. Climate

The climate of Dixie Valley is typical for valleys within the Great Basin. The basin floor is arid, characterized by low annual precipitation and high evaporation rates. Precipitation increases with elevation at Dixie Valley as a result of orographic effects. The region generally experiences hot summers with little precipitation and cold winters with moderate amounts of precipitation, which is predominantly snowfall. The majority of precipitation falls from December through May.

Garcia et al. (2014) reported 5-8.6 inches of precipitation on the playa (elevation 3383 ft amsl) floor between 2010 and 2011, while the valley floor weather station at the Navy Centroid Facility (elevation 4235 ft amsl) reported an average of 8.97 inches per year between 2006 and 2015 (WRCC, 2020). The Paris Ranch weather station in northern Dixie Valley reports average annual precipitation at this location of 8.99 inches from 1966 to 1991 (WRCC, 2020), while the Middlegate Lowery weather station to the southeast of Dixie Valley indicates average precipitation of 5.68 inches from 1988 to 2013 (WRCC, 2020). Data collected in the mountain ranges by Interflow (2016) from 2010-2015 indicate average annual precipitation of 18.0 inches at 8,210 ft amsl in the Clan Alpine Range and 15.0 inches at 6,015 ft amsl in the Stillwater Range (Interflow, 2016).

4.3. Hydrology

In Dixie Valley, most streams are ephemeral and fed by significant precipitation events or snowmelt (Interflow and Mahannah, 2013). A few perennial and intermittent streams exist in the mountain blocks, such as Horse Creek and Cottonwood Creek, flows from which infiltrate rapidly and are consumed by ET at the base of mountains. Short perennial stream flow reaches occur downgradient of the major spring discharges in Dixie Meadows. These water course tend to be poorly defined and diffuse through wetland areas. Springs and seeps exist in the mountain-blocks, along fault scarps at the mountain block-valley floor interface, and where shallow groundwater breaches the surface on the valley floor. Typically, cool and fresh water discharges from mountain-block springs at less than one gallon per minute (gpm) (Interflow, 2012). Valley-floor spring discharge rates range from less than one to 300 gpm and temperatures range from 4°C to more than 60°C (Interflow, 2012). High temperature spring discharge indicates a geothermal-source component.

Sources of surface water and groundwater recharge to Dixie Valley include precipitation, mountain block runoff, surface water inflow from adjacent basins, and groundwater inflow from adjacent basins. Adjacent basins that contribute recharge in Dixie Valley include Fairview, Stingaree, Cowkick, and Eastgate to the south, and Pleasant and Jersey Valleys to the north (Interflow, 2016). The extent of these basins is indicated on Figure 3. The area of the entire Dixie

Valley tributary watershed is approximately 2,380 square miles (Harrill and Hines, 1995). Because Dixie Valley is a terminal basin, surface water and groundwater outflow to adjacent basins is considered negligible.

In an average year, minimal surface water in Dixie Valley is observed to reach the playa, as the majority of runoff infiltrates along alluvial fans; however, major precipitation events are known to have the ability to cause surface water flow and flooding of ephemeral channels (Interflow and Mahannah, 2013). Estimated average total annual runoff to the playa was estimated by Interflow (2016) at 500 af/yr.

The primary natural groundwater discharge types in the basin are ET from phreatophytic vegetation along the playa perimeter and evaporative discharge at the playa. Groundwater also discharges from springs, which exist primarily in northern and west-central Dixie Valley. Many of these springs have a geothermal-source component. Groundwater is also discharged by wells used for agricultural and geothermal pressure augmentation, primarily in the northern part of Dixie Valley. Artesian and pumped wells used in the Settlement Area south of the playa are now mostly abandoned.

5.0 WELL AND SURFACE WATER INVENTORIES

5.1. Well Inventory

Information on existing wells within and adjacent to the Study Area have been compiled from data obtained from Ormat and the Nevada Division of Water Resources (NDWR). Locations of existing wells and boreholes are shown on Figure 4, and well completion details are provided in Table 1. Copies of available well drillers reports (well logs) from the NDWR are provided in Appendix A.

5.2. Surface Water Inventory

In accordance with the BLM-approved workplan titled *Dixie Meadows Water and Aquatic Resource Delineation Workplan* (Workplan), dated July 2018, McGinley conducted an inventory of springs, seeps, and previously established monitoring control sites (collectively referred to as the "spring inventory") to be used for establishing baseline monitoring and control sites. The spring inventory was conducted in two phases; 1) a desktop inventory, and 2) field-verification.

McGinley developed the desktop inventory using the following sources of data:

- United States Geological Survey (USGS) Topographic Quadrangle Maps;
- Publicly available Aerial Photographs;
- USGS Geographic Names Information System;
- USGS National Hydrography Dataset; and
- Available data provided by Ormat.

These data sources were reviewed to establish a preliminary inventory of springs and seeps. All springs and seeps identified from these sources were digitized in a geographic information

system to create a preliminary inventory. The preliminary inventory was then uploaded to a global positioning system (GPS) device to aid in ground-truthing. McGinley visited in the field each preliminary spring/seep location identified during the desktop inventory and adjusted or removed locations if found to be erroneous. Additional spring/seep features identified in the field were GPS-surveyed and added to the database, regardless of whether they were identified during the desktop inventory. In total, McGinley field-verified 117 spring and seep features. Locations of field-verified springs and seeps are presented in Figure 5. A Table summarizing spring locations and detailed figures of spring locations are included Appendix E. Wetland or meadow areas that contain multiple seeps and springs are referred to as "spring complexes.".

5.3. Spring-Dependent Ecosystems and Aquatic Habitat Delineation

In accordance with the Workplan, McGinley delineated spring-dependent ecosystems and aquatic habitat within the Study Area to be used for establishing baseline monitoring and control sites. It conducted the delineation in two phases: 1) a pre-field desktop assessment and 2) field investigations (vegetation surveys, hydric soil pits, and wetland delineation).

5.3.1. Pre-field Desktop Assessment

The desktop assessment utilized available GIS data resources to describe the ecological setting in terms of soil associations, ecological sites, and associated vegetation communities (including wetlands). Pre-field assessment data are provided in Appendix B.

5.3.2. Vegetation Surveys

Eight distinct wetland communities were identified and quantified within the Study Area: 1) Wetland Boundary, 2) Bulrush Wetland, 3) Cattail Wetland, 4) Reed Canarygrass Wetland, 5) Saltgrass and Alkali Bulrush Wetland, 6) Wet Meadow, 7) Field Sedge Meadow, and 8) Woody Riparian. Each community is characterized by the dominance of one to several plant species. The Wet Meadow and Field Sedge Meadow wetland types were generally closely coupled, often occurring as large mosaics of meadow habitat. These meadow areas graded gently between both wetland types, resulting from the microtopography of the landscape and changes in soil saturation. An additional wetland type, Meadow, would occasionally be used to collectively reference these wetland types. For the purposes of delineating the boundary between wetlands and non-wetlands, three upland communities that commonly bordered wetland communities were characterized: 1) Shrub Upland, 2) Saltgrass Upland, and 3) Forb Upland. Summaries of the data gathered within each community type listed above can be found in Tables 3 and 4, with Table 2 providing species names and codes. Photos of each plant community can be found in Appendix C.

5.3.3. Soil Pits

To survey for hydric soils, soil pits were excavated per the protocols outlined by the ACOE (2008). Soil pits were excavated to a depth of approximately 50cm with a sharpshooter style shovel, and hand auger (when necessary). The soil was removed from the pit and photographed. Soil profiles

were characterized beginning immediately below the A-horizon or at a depth of 10" (whichever was shallower). Each layer of the profile was characterized in terms of its color (including redoximorphic features) and texture. Colors of moist soil were determined with a Munsell Soil Color Chart. Surveys for hydric soils occurred concurrently with plant surveys. As wetland plant communities were identified, soil pits were excavated within that community to confirm hydric soil. Additional soil pits were characterized within the adjacent upland community.

A total of fifteen soil pits were characterized. Eleven of these were characterized as hydric soils, and four were characterized as non-hydric soils. Hydric soil indicators observed include: a positive reaction to alpha, alpha-dipyridyl, loamy gleyed matrix, sandy gleyed matrix, depleted matrix, and sandy redox. Additional pits were evaluated, but not recorded, in boundary plant communities to hone the wetland/non-wetland break for the purposes of delineation. Photos of soil pits and soil data can be found in Appendix D.

5.3.4. Wetland Delineation

The wetland areas in the Study Area were grouped into six spring complexes. The wetlands in each of these complexes were delineated as separate units, and the results are presented in Figures 6-12. Uplands were only delineated and mapped when present within wetland community map units. A summary of each plant community is below. The acreage of each wetland community, and the percentage of the entire delineated area represented by that wetland community, are also provided. Summaries of the data gathered within each community type can be found in Tables 3 and 4, with Table 2 providing species names and codes. Photos of each plant community can be found in Appendix C.

5.3.4.1 Upland Communities

5.3.4.1.1 Shrub Upland

The driest community encountered in the project area was dominated by two shrub species tolerant of alkaline soils, Torrey's saltbush (*Atriplex torreyi*) and greasewood (*Sarcobatus vermiculatus*), and the exotic annuals cheatgrass (*Bromus tectorum*) and fivehorn smotherweed (*Bassia hyssopifolia*).

5.3.4.1.2 Saltgrass Upland

Large stretches of the project area were dominated by stands of inland saltgrass, with scattered shrubs (*A. torreyi* and *Chrysothamnus nauseosus*). A variety of FACW species occurred in the low-lying areas of saltgrass stands, while FACU species prevailed in drier areas.

5.3.4.1.3 Forb Upland

The wettest upland community was often encountered at the border with wetland communities. Much like the wetland boundary community (above), this community was species rich given its occurrence at the wetland and non-wetland boundary. A total of 13 unique species were identified in the forb upland community, comprised of a variety of facultative upland (FACU) and facultative wetland (FACW) species. This community was dominated by one FACW (*Carex preagracilis*) and one FACU (*Helianthus annuus*) species and is thus problematic in terms of a

hydrophytic vegetation determination (dominance test = 50%). A calculated prevalence index of 2.8 (LPI method) and 3.0 (Daubenmire method) provides positive indicators of hydrophytic vegetation. However, this community is considered an upland community due to a negative hydric soil indicator.

5.3.4.2 Wetland Communities

5.3.4.2.1 Wetland Boundary

The wetland boundary is a species rich community occurring at the interface between upland and wetland communities and shares many species in common with both. The community is dominated by inland saltgrass (*Distichlis spicata*), annual rabbitsfoot grass (*Polypogon monspeliensis*), and chairmakers bulrush (*Schoenoplectus americanus*). The community is also characterized by the presence of wetland obligates such as *Eleocharis* spp. and facultative wetland species such as clustered field sedge (*Carex praegracilis*) and Baltic rush (*Juncus balticus*). A total of 8.1 acres of wetland boundary occurs in the project area (representing 3.4% of all delineated wetland communities). Sixteen unique species were identified within this community (1 exotic).

5.3.4.2.2 Bulrush Wetland

The interior of most spring complexes was dominated by nearly impenetrable stands of bulrush (*Schoenoplectus* spp.). This community prevailed in areas with saturated soils or standing water and was dominated by chairmakers bulrush (*Schoenoplectus americanus*). Hardstem bulrush (*Schoenoplectus acutus*) was dominant in small patches, distributed widely throughout this community type. Indian hemp (*Apocynum cannabinum*) occurred in thick stands, intermixed with *Schoenoplectus* spp., at the boundary between this community and the 'wetland boundary' community. Several northern harriers (*Circus hudsonius*) were noted nesting in this community. A total of 116.7 acres of bulrush wetland occurs in the project area (representing 48.9% of all delineated wetland communities). Six unique plant species were identified within this community.

5.3.4.2.3 Cattail Wetland

This wetland community is characterized by nearly monotypic stands of southern cattail (*Typha domingensis*), occurring in small (<20m wide) to medium sized stands (0.5 acres). Red-winged blackbirds (*Agelaius phoeniceus*) were commonly encountered denizens of this community type. A total of 1.8 acres of cattail wetland occurs in the project area (representing 0.8% of all delineated wetland communities). Three unique species were identified within this community.

5.3.4.2.4 Reed Canarygrass Wetland

This community is characterized by nearly monotypic stands of reed canarygrass (*Phalaris arundinacea*), occurring in widely distributed patches. A total of 9.1 acres of reed canarygrass wetland occur in the project area (representing 3.8% of all delineated wetland communities). Two unique species were identified within this community.

5.3.4.2.5 Saltgrass and Alkali Bulrush Wetland

The last wetland community to occur before the unvegetated playa was a sparsely vegetated community dominated by inland saltgrass (*Distichlis spicata*). Of note was the presence of many

patches of alkali bulrush (*Scirpus maritimus*) in this community type occurring in the highly alkaline soils on the fringes of the Humboldt Sink. A total of 12.5 acres of saltgrass and alkali bulrush wetland occurs in the project area (representing 5.2% of all delineated wetland communities). Two unique species were identified within this community.

5.3.4.2.6 Meadows

Wet Meadow

Wet Meadows occurred on the fringes of bulrush wetlands, and in other areas of standing or flowing water. This community was dominated by Baltic rush (*Juncus balticus*), common spikerush (*Eleocharis palustris*) and clustered field sedge (*Carex praegracilis*). Wet meadows generally had a hard boundary with adjacent and drier community types. Dixie Valley toads (*Anaxyrus williamsi*) were commonly encountered in this community type. A total of 3.7 acres of wet meadow occurs in the project area (representing 1.6% of all delineated wetland communities). Seven unique species were identified within this community.

Field Sedge Meadow

This community type can be characterized as a drier version of the wet meadow, where clustered field sedge (*Carex praegracilis*) dominated and OBL species such as *E. palustris* rarely occurred. This community type was commonly the boundary between wetlands and non-wetlands and was defined by either hard boundaries or subtle gradients into meadows dominated by FACU species (e.g., *Poa secunda*). Of note was the extensive cover of common sunflower (*Helianthus annuus*) seedlings within the drier parts of this community type. Dixie Valley toads were commonly encountered in this community type. A total of 37.4 acres of field sedge meadow occurs in the project area (representing 15.7% of all delineated wetland communities). Eight unique species were identified within this community (1 exotic).

Meadow

In various parts of the project area, a heterogeneous mixture of Wet Meadow and Field Sedge Meadow community types occurred. These communities generally had fuzzy boundaries (unlike the hard boundaries between the above meadow communities), differentiated due to microtopographic features in the wetland. Therefore, an additional sub-habitat type (Meadow) was recognized for the delineation of large patches of meadows in which the Wet Meadow and Field Sedge Meadow community types dominated but graded indistinguishably into each other. A total of 46.5 acres of Meadow habitat occurs in the project area (representing 19.5% of all delineated wetland communities).

5.3.4.2.7 Woody Riparian

The last community type recognized in the project area consisted of woody species, generally rooted in areas adjacent to flowing water. Though this community was dominated by chairmakers bulrush and common sunflower, the presence of various exotic woody species such as saltcedar (*Tamarix* spp.), Russian olive (*Eleaeagnus angustifolia*), and native species such as willow (*Salix* spp.) resulted in a unique and structurally rich community type. Various species of birds were noted nesting in this community type including red-winged blackbirds (*Agelaius phoeniceus*), kingbirds (*Tyrannus* spp.), common yellowthroat (*Geothlypis trichas*), and song

sparrow (*Melospiza lincolnii*). A total of 2.8 acres of woody riparian habitat occurs in the project area (representing 1.2% of all delineated wetland communities). Ten unique species were identified within this community (4 exotics).

5.4. WARD Geodatabase

After completion of WARD field activities, the seep and spring locations and plant communities were uploaded in a geographic information system and stored as a file geodatabase. The geodatabase has been copied to a USB hard drive and is attached to this report in Appendix E. The attached geodatabase contains all of the georeferenced historical aerial images and historical topographic maps that were used to delineate the seep/spring locations as well as the final inventory of seeps/springs and plant communities. The geodatabase would continue to be updated as needed.

5.5. Existing Water Rights

Active water rights within and near the Study Area are illustrated by source and manner of use in Figure 13. An inventory of active water rights near the Dixie Meadows study area is presented as Table 5 (NDWR data source, July 2019).

The perennial yield of the Dixie Valley hydrographic area (Hydrographic Area No. 128, Hydrographic Region No. 10) is estimated to be 15,000 af/yr (NDWR, 2020; Cohen and Everett, 1963). NDWR has determined that current groundwater appropriations (November 2020) total 15,218.28 af/yr, as differentiated by manner of use as summarized below:

- 5,856.34 af/yr for industrial uses (geothermal energy production);
- 8,770.38 af/yr for irrigation uses;
- 218.00 af/yr for quasi-municipal uses;
- 111.96 af/yr for stockwater uses; and
- 261.60 af/yr for wildlife uses.

Geothermal groundwater appropriations are categorized separately for appropriations listed above, which are consumptive in nature, as they are managed differently by NDWR with required return of pumped geothermal groundwater back to the aquifer (non-consumptive). Total geothermal water rights appropriated in Dixie Valley are 12,704.00 af/yr (NDWR, November 2020).

The Dixie Valley hydrographic basin is designated for preferred uses (State Engineer Order 715), generally indicating that the basin is fully appropriated for consumptive groundwater uses.

Groundwater pumpage within Dixie Valley in 2015 is estimated at 16,906 acre-feet (NDWR, 2017) which includes geothermal pumping, although not differentiated as consumptive and non-consumptive, and was distributed as follows:

- 20 af/yr for domestic use;

- 11,030 af/yr for industrial use (geothermal);
- 5,341 af/yr for irrigation;
- 218 af/yr for quasi-municipal;
- 35 af/yr for stockwater; and
- 262 af/yr for wildlife.

Spring (SPR) and stream (STR) water rights differentiated from underground (UG), i.e., groundwater sources, for purposes of water right administration. Occasionally, a water surface water source may not clearly fit into either a stream or spring source type and may be idented as "other surface water" (OWS). In the Dixie Meadows study area, there are no underground water rights, but three water rights on spring sources (V10057, V10058, and V10065) and one OWS source (V10066), as shown in Figure 13. The springs and OWS water rights are vested claims (claims filed for water uses that pre-date 1905) for stockwatering uses.

5.6. Jurisdictional Waters

Waters of the United States are defined in Title 40 Code of Federal Regulations 230.3. Based on a review of the United States Environmental Protection Agency Clean Water Act Approved Jurisdictional Determinations website and United States Army Corps of Engineers Jurisdictional Determinations and Permit Decisions website, approved jurisdictional determinations are not available within the Study Area. Dixie Valley is an endorheic basin (Cohen and Everett, 1963), and the surface water resources in Dixie Meadows appear to be isolated from any Waters of the United States; therefore, there appear to be no jurisdictional waters within the Study Area.

5.7. Existing Authorized Land Uses

Authorized land uses within and adjacent to the Study Area include a right-of-way associated with State Route 121 (Dixie Valley Road), a transmission line right-of-way operated by Terra-Gen, livestock grazing, geothermal leases (geothermal exploration and development), and Navy-owned lands used for training. The Study Area lies within the Boyer Ranch Cottonwood Valley, Mississippi Canyon, and Dixie Valley grazing allotments.

Other land and resource use within the Study Area includes active grazing by wildlife, cattle, and horses that may utilize springs, seeps, or other water resources and aquatic habitat within and surrounding the Study Area.

6.0 GEOLOGIC AND HYDROGEOLOGIC SETTING

This section discusses the regional geologic and hydrogeologic setting of Dixie Valley, with a particular focus on the geology of the Stillwater Range and basin, as the Study Area is located along the western-central periphery of Dixie Valley at the base of the Stillwater Range. Detailed descriptions of the geology and hydrogeology of the Study Area are included in Section 8.0.

6.1. Basement Geology

The oldest units in the Stillwater Range are early Triassic pelites, quartz arenites, clastic and micritic limestones, and dolomites (Nimz et al., 1999). The late Triassic section of the Stillwater Range is a thick sequence of pelitic rocks that are overlain by Triassic-Jurassic calcareous pelites (Nimz et al., 1999). Deformed lower Jurassic carbonates, calcarenites, and pelitic rocks overlay these rocks or are in thrust fault contact. The Jurassic Humboldt Lopolith (coarse-grained gabbros, picrites, anorthosites) overlies the Triassic section of the Stillwater Range at a thrust-fault contact (Speed, 1976). Cretaceous granodioritic bodies have intruded the Mesozoic sequence of the Stillwater Range (EGS, 2014a). Mid-Cenozoic silicic tuffs occur in both the Stillwater and Clan Alpine Ranges, and each range is capped by Late-Cenozoic basalts (Nimz et al., 1999).

6.2. Basin Geology

The Dixie Valley basin-fill is composed of Quaternary-Tertiary sediments derived from the surrounding mountain ranges, and Tertiary volcanic rocks. The thickness of the basin-fill reaches up to 8,200 feet towards the center of the basin (EGS, 2014a).

The basin-fill includes coarse colluvial and alluvial fan deposits, sandy and silty eolian deposits, lacustrine, and playa deposits. The alluvial fans consist of near-surface deposits of unconsolidated silt, sand, gravel, cobbles, and boulders. The basin-fill sediment become progressively consolidated with increasing depth. Eastward, the basin-fill sediments thicken to 5,000 feet at well 42-9. Basin lowlands include interbedded clay, silt, sand, and gravel (Huntington et al., 2014). Lacustrine and playa deposits are made up of fine-grained clays and silts (EGS, 2014a).

Tertiary volcanic rocks, including rhyolitic pyroclastic deposits and basalt flows, generally underlie the alluvial materials except along the moderately dipping Dixie Valley Fault where the alluvial sediments are juxtaposed against Triassic slate and siltstone. The Oligocene rhyolitic pyroclastic deposits include ash flow tuffs and air-fall deposits, which correlate to welded silicic tuffs exposed in the Stillwater and Clan Alpine Ranges. Miocene basalt flows and lacustrine volcaniclastic deposits overlie the Oligocene section (EGS, 2014a).

6.3. Structural Geology

The Dixie Meadows area is located adjacent to and east of the northern segment of the northeast-striking Dixie Valley Fault Zone (DVFZ), a complex system of subparallel moderate to steeply dipping normal faults along the eastern flank of the Stillwater Range and western part of Dixie Valley. There are also several younger faults in Dixie Meadows that vary in strike from northeast to southeast. As discussed in greater detail in Section 8.1, data collected during recent exploration activities suggest that the older reactivated east-northeast trending structures are the conduits and primary source of geothermal fluids at the Dixie Meadows geothermal field.

The Dixie Valley Fault Zone is the producing reservoir at the existing Terra-Gen Dixie Valley geothermal power plant, located about 16 miles northeast of Dixie Meadows. At that site, the DVFZ ranges in width from approximately two to four kilometers and incorporates the range-bounding Dixie Valley Fault, a piedmont fault, and associated intra-basin faults (EGS, 2014b). The width of the DVFZ expands to approximately five kilometers in width to the south of Dixie Meadows where there is a western bend in the mountain front (Bell and Katzer, 1987). The Dixie Valley Fault is the primary range-front normal-fault separating the bedrock of the Stillwater range from the Cenozoic basin-fill sediments. Results from recent drilling and geophysical surveys near Dixie Meadows indicates that the Dixie Valley Fault at and near Dixie Meadows has a moderate dip of approximately 47° southeast. This is contrary to findings along other portions of the DVFZ, where the fault plane is a higher angle feature normal fault (EGS, 2014a, 2014b; Blackwell, 2005). A vertical displacement of 3,000 meters along the Dixie Valley Fault is based on Late Miocene basaltic ash-flow tuffs observed in both the Stillwater Range and beneath the basin-fill alluvium (EGS, 2014a).

At the Dixie Valley geothermal power plant, geophysical and drilling data suggest significant normal displacement along a piedmont fault plays a crucial role in the geothermal producing field (EGS, 2014b). EGS (2014a) states that geothermal fluids derived from the piedmont structure are known to occur at deeper levels, but that the piedmont fault does not appear to contribute hot fluids to the shallow thermal regime. At Dixie Meadows, geothermal reservoir exploration has not identified that the Dixie Valley Fault (range front fault), or piedmont fault(s) contributes to significant geothermal fluid flow. Rather, the cross-cutting east-northeasterly faults (Figure 16) constitute the primary geothermal reservoir (Omat, 2020, verbal communications).

At Dixie Meadows, piedmont faults likely exist east of the Dixie Valley Fault Zone, also concealed by Quaternary alluvium. An apparent fault scape bounding the west side to the Dixie Meadows may be a piedmont fault, or may be a shallow listric fault. Ormat exploratory drilling has not, to date, encountered evidence of a deep-rooted piedmont fault associated with this apparent fault scape (Ormat, 2020, verbal communications). For purposes of identification of the fault on the geologic mapping, it is labeled as a piedmont fault on Figure 15.

The Dixie Valley Fault Zone is considered one of the most active faults in the Basin and Range Province (EGS, 2014a). The 1954 Dixie Valley earthquake (magnitude 6.8) created range-front and piedmont fault scarps extending south of the Dixie Meadows area (Bell and Katzer, 1987). The epicenter of the 1954 earthquake was at the mouth of Hare Canyon, directly west of the Dixie Meadows area (Page, 1965). The effect of the 1954 earthquake on the Dixie Meadows springs has not been determined; however, Smith (2001) believes that the event probably rejuvenated or even initiated the Dixie Meadows spring flow.

To the west of the playa, and south of Dixie Meadows, liquefaction-induced scarps and fissures have been documented, including lurch and collapse features up to 3-6 feet in depth. A thin veneer of fine sand and silt is present in the liquefaction zones, which is believed to be related to expelled-water phenomena along these features (Bell and Katzer, 1987). The ponds on the east side Dixie Meadows are likely associated with liquefaction that is known to have occurred during

the 1954 earthquake, or perhaps earlier tectonic events along the active fault zone (Wesnousky, 2003).

An earthquake with an estimated magnitude of 7.3 (Wesnousky, 2003) occurred in the area approximately 2,400 to 3,000 years ago (Pearthree, 1990). This event has been bracketed in age between 1,500 and 6,860 years by paleoseismic studies along the southern part of the Dixie Valley fault (Caskey et al., 2000). The mid- to late-Holocene age of this event may also be responsible for rejuvenation of permeability and hydrothermal fluid transport in the producing geothermal reservoir and at several fumaroles along the range front fault between Dixie Hot Springs and the north end of the Dixie Valley. The earthquake resulted in a linear zone of compression parallel to and east of the piedmont fault and Dixie Meadows. The compressed zone along the playa margin is strongly developed east of Spring Complex 2 (Wesnousky, 2003). The effect of the seismic events on the springs themselves, if in existence at the time, has not been determined; however, the compression folds east of the springs were caused by eastward, soft sediment slumping and low-angle imbricate thrusts (Wesnousky, 2003). Trenching completed by Wesnousky (2003) north of Dixie Meadows suggests a minimum of 27 meters of shortening across the compressed zone at this location; the amount of shortening should approximately equal the amount of spreading directly upslope from the playa. Although lateral spreads formed across the entire area between the playa margin and the large graben at the trench site, the greatest spreading probably occurred across the largest graben. At the trench site, the graben width is approximately 43 meters. The 27 meters of shortening across the playa margin suggests that a significant portion of the graben width was produced by down-slope movement of the "detached" alluvium. The areal extent of severe ground failure related to liquefaction along the 30-kilometer-long disrupted zone is estimated at 20-30 square kilometers. Wesnousky (2003) believes the playa ponds to the east of Dixie Meadows likely formed this way during the seismic event from approximately 2,500 years ago.

6.4. Thermal Spring Formation

The origin of the springs in Dixie Meadows is unknown; as stated above, Smith (2001) believes that the 1954 Dixie Valley earthquake possibly initiated the Dixie Meadows spring flow as new fault movements rearranged geothermal passageways, while Interflow (2019) suggests that the springs may be geologically young features, forming after the recession of Pleistocene Lake Dixie. The warm and hot springs along the western side of the Dixie Meadows appear to originate from relatively shallow lateral groundwater flow of geothermal waters (mixed source or convectively heated), based on temperature-gradient data from exploration drilling (Ormat, 2020, verbal communications). The geothermal waters are interpreted to move up the east-northeast striking fault structures to mix with shallower cool groundwater, which then flows laterally to the east in the down-gradient direction toward the valley floor and Dixie Meadows (see Figure 16). The east-northeast fault structures are located within the DVFZ, but pre-date the active structural features of the DVFZ. Periodic fault movement along the DVFZ is interpreted to cause reactivation or dilation of fractures which enhances the permeability and enables permeable conduits for geothermal water to ascend along fault zones that would otherwise have been sealed off over time by mineral precipitation from the hot waters (Ormat, 2020, verbal communications).

As summarized by Interflow (2019), during the most recent glacial epoch, the Pleistocene Lake Dixie high stand peaked at an elevation of 3,600 ft amsl approximately 13,000 years before present. What is now the Dixie Meadows area was inundated by up to 190 feet of water. Inundation extended from approximately 35,000 to 8,000 years before present. Spring water chemistry in Dixie Meadows is similar to other thermal springs in Dixie Valley that were submerged by Pleistocene Lake Dixie, such as Hyder and Seven Devils Springs (Interflow, 2012); however, while significant tufa mounds were formed Hyder and Seven Devils Springs, they have not formed at Dixie Meadows. This may suggest that the Dixie Meadows springs formed post Pleistocene Lake Dixie, after approximately 8,000 years before present. Additionally, the geographical relationship between Dixie Meadows springs and the piedmont fault scarp supports that the springs may have been formed during the earthquake event that occurred between 2,400 to 3,000 thousand years ago.

6.5. Geophysics

A variety of geophysical data have been collected throughout Dixie Valley and were detailed by Blackwell et al. (2005). Negative magnetic anomalies may result from the alteration of magnetic minerals along geothermal fluid pathways that intersect mafic-dominated sediments (EGS, 2014a); negative magnetic anomalies are present near Dixie Meadows and Hyder Springs in northern Dixie Valley. A high geothermal gradient in the Study Area suggests a high temperature and long-standing geothermal system that has removed a large volume of magnetic minerals (EGS, 2014a).

6.6. Hydrogeology

Groundwater in Dixie Valley occurs in alluvial aquifers and bedrock fractures. Groundwater is most prevalent within the alluvial aquifers, where flow occurs through the pores of unconsolidated sediment. The thickness of the alluvium that makes up the basin-fill increases towards the center of the valley, reaching depths upward of 8,000 feet below ground surface (ft bgs). Shallow groundwater is stored in unconfined, semi-confined, and confined (i.e., artesian) aquifers. Artesian aquifers in Dixie Valley are pressurized from recharge occurring in higher elevation alluvial fans and mountains. Monitoring well MW-1, completed to a depth of 451 feet, is located near the alluvium-playa interface in Dixie Meadows and flows under artesian conditions.

Groundwater flow in consolidated bedrock and in some instances consolidated alluvium is controlled by secondary permeability, or faults and fractures. Drill core data from the Study Area shows that the alluvium is densely consolidated or cemented at depths as shallow as 100 feet (Ormat, 2020, personal communications) in the Dixie Meadows geothermal area, which may be associated with heat and mineral deposition. The deep basin-fill in Dixie Valley is expected to be indurated, which is a lowering of permeability due to cementation and compaction. These materials have little to no remaining primary porosity and, therefore, transmit water primarily along fractures and fault zones.

Deep groundwater within consolidated rock has been located in several geothermal aquifer systems (Benoit, 2011) up to 20,000 ft bgs (Blackwell et al., 2003). The regional groundwater flow direction follows the topographic gradient from the surrounding mountains toward the Humboldt Salt Marsh, where groundwater levels are near the land surface.

Geothermal aquifers are present in Dixie Valley in both the alluvium and underlying bedrock. The targeted high-temperature geothermal resource at the Dixie Meadows is expected to occur within the fractured bedrock (Jurassic shales) at depths ranging from 4,000 to 10,000 ft bgs. This geothermal resource is expected to be confined by low-permeability clay, shale, siltstone, and clay-altered volcaniclastic rocks. Alluvial materials overlying the resource are locally clay-altered, carbonate cemented, or silicified and behave similar, hydraulically, to consolidated, altered volcanic rocks, as fluid movement is predominantly along fractures and faults. In some cases, geothermal groundwater migrates upward along permeable fault structures, interpreted to be primarily the east-northeast faults at the Dixie Meadows area, and discharging and mixing with cooler groundwater in the basin-fill sediments then flowing laterally towards the center of the basin in the shallow subsurface (EGS, 2014a; Ormat, 2020, verbal communications; refer to Section 6.4).

Geothermal gradients measured in wells throughout the valley and geochemical and isotopic data from shallow wells indicate considerable input of geothermal fluids into shallow alluvial aquifers. The main chemical indicators of geothermal water in Dixie Valley identified by Huntington et al. (2014) are high concentrations of lithium, boron, and silica.

7.0 BACKGROUND HYDROLOGIC INFORMATION

7.1. Existing Monitoring Locations

Current or recent monitoring site details are summarized in Table 6, locations are shown on Figure 14, and photographs of each site are provided in Appendix F. Monitoring to date has been focused on field parameters including temperature, height of pooled water, and chemistry for a select set of springs in Dixie Meadows, per monitoring requirements under the Final Dixie Meadows Geothermal Exploration Project EA (BLM 2011). Periodically, spring discharge measurements using open channel flow measurement techniques have been made to glean supplemental information for development of the ARMMP. The proposed monitoring plan for the ARMMP would substantially expand the hydrologic monitoring throughout the Dixie Meadows spring complexes, as discussed in Section 9, including monitored parameters, frequency, and data collection methods.

Data collection to date for spring and monitoring well sources have included field parameters such as water temperature, conductivity, total dissolved solids, dissolved oxygen, pH, and oxidation-reduction potential. Pooled water depths are measured using staff gages. Chemistry samples have been collected and analyzed for a broad suite of minerals, ionic compounds, stable isotopes and geothermal tracers.

Ormat sampled well MW-1, and collected field parameters at three springs (NDOWSS-1, USGS-101, and USGS-301 North) on four occasions between 2011 and 2016 (Ormat, 2012; Ormat, 2016). Field parameters were measured at five springs (NDOWSS-1, USGS-101, Spring 2, Spring 4 and Spring 5A) by Ormat in 2017 associated with flow testing of geothermal test wells (see Section 8.4). Pool stage and water temperature data were measured by Rubicon Environmental Consulting from 2015 to 2019 at spring sites USGS-101, Spring 2, NDOW-SS1, USGS-301 North, and West Playa Pond. McGinley has monitored spring locations USGS-101, NDOWSS-1, USGS-301 North, USGS-301 Salt Cedar, and monitoring well MW-1 on a quarterly basis since August 2018, for reporting of field parameters and chemistry to the BLM per monitoring requirements under the final exploration EA (BLM 2011). In 2018 and 2019, McGinley also measured field parameters and discharges at select spring locations to inform development of the hydrogeologic conceptual model (Spring 2, Spring 4, Spring 5A, Spring 5B, Spring 6, Spring 7, Spring 8, Complex 2 Confluence and the East and West Playa Ponds). A summary of filed parameter measurements can be found in Table 7 and a summary of water chemistry data can be found in Table 8.

Other entities have occasionally measured spring discharge and chemical parameters of select springs in Dixie Meadows, including the USGS (Huntington et al, 2014), and Interflow Hydrology (2012).

7.2. Water Chemistry and Geothermal Indicators

Water samples are divided into three field-temperature classes based on studies performed by Huntington et al. (2014) and Schafer et al. (2005); a water temperature of <68°F is considered cold water with low potential of geothermal influence, 68-122°F is considered warm water indicating potential geothermal influence, and >122°F is considered hot water that is influenced by geothermal water.

Analytical results for water samples collected in the Study Area are summarized in Table 8 and includes geothermal samples taken from wells 23A-8 and 24-8. Major ion concentrations were plotted in a Piper diagram, indicating a sodium-potassium-chloride water type for all surface water and groundwater samples (Appendix G), which is indicative of geothermal mixing (EGS, 2014a) and evaporite-rich playa water. Chemistry data were also assessed to determine chemical indicators of geochemical end-members (i.e., waters that have a discrete source or evolutionary end point). Reported concentrations of potential geothermal indicators (identified by Goff et al., 2002; Zehner et al., 2006; and EGS, 2014a) versus temperature (water temperature is a key geothermal indicator) are discussed below. Plots are included in Appendix G.

- Concentrations of arsenic were less than the analytical detection limit in 19 of the 34 collected spring samples. Detectable concentrations of arsenic range from 0.01 to 0.15 milligrams/liter (mg/L). Overall, samples with the highest reported concentrations of arsenic were collected at locations with cool to warm water; concentrations were below the analytical detection limit in all but one hot water sample.

- Reported boron concentrations are greater than the analytical detection limit in all spring samples and range from 0.9 to 2.1 mg/L. Overall, boron concentrations decrease with increasing water temperature.
- Reported fluoride concentrations range from 4.2 to 24 mg/L. Overall, fluoride concentrations increase with water temperature; however, the highest reported concentration of fluoride is from a cool water sample collected from USGS-301 Salt Cedar.
- Reported lithium concentrations range from 0.20 to 0.68 mg/L. Overall, lithium concentrations increase with temperature.
- Reported silica concentrations range from 29 to 180 mg/L. A direct correlation exists between increasing silica concentrations and increasing temperature, with exception of one outlier (180 mg/L in a 78.3°F sample collected from USGS-101).
- Concentrations of antimony are less than the analytical detection limit in 25 of the 27 collected samples.
- There is no observed correlation between water temperature and concentrations of bromide or strontium.
- Overall, concentrations of iron and aluminum are observed to decrease with increasing water temperature.
- With exception to the sample collected at Spring 6, calcium, magnesium, and sodium concentrations appear to decrease with increasing water temperature. There is no observed correlation between water temperature and other major ion concentrations.

In summary, relationships between water temperature and constituent concentrations (Table 8) suggest that key indicators of geothermal water include high concentrations of silica and low concentrations of magnesium. A summary of geochemical indicators of endmembers (i.e., evaporite-rich playa water, geothermal brine, fresh groundwater/surface water) and mixing is presented as Table 9.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL

McGinley developed a conceptual hydrogeologic model of the Study Area based on available data obtained from field research, information assimilated during a literature review, and generally accepted principles of groundwater and surface water flow in the Basin and Range Province.

8.1. Hydrogeologic Conditions

A geologic map of the Study Area is provided as Figure 15, and a hydrogeologic cross section through the Study Area is provided as Figure 16. The alignment of the cross section is indicated on Figure 15.

The Dixie Meadows are a spring-supported riparian and meadow area situated between the toe of the alluvial fan from the Stillwater Range and an extensive playa that occupies the Dixie Valley floor. As indicated in Section 5.2, 117 springs and seeps were identified within the Study Area, many of which are clustered in spring complexes. Monitored discharge points and spring-supported streams are included on Figure 14. Springs that discharge from the higher and intermediate elevations flow to the meadow area. During some times of the year when

evaporation and plant transpiration are low, spring discharge water reaches and collects in pools at the playa edge, approximately 0.5-mile from the meadows, notably in the topographic depressions (suspected seismic-liquefaction features) that constitute the playa ponds to the east of Spring Complex 2.

Groundwater in the vicinity of Dixie Meadows can be characterized into two main aquifer types: an alluvial aquifer with shallower, mixed thermal and non-thermal groundwater, and a deeper, locally thermal, bedrock aquifer (Karst, 1987). Groundwater in the alluvial aquifer exists primarily under confined aquifer conditions, and the shallowest groundwater is unconfined. Localized semi-confined to confined conditions exist due to interfingering and laterally discontinuous layers of thin permeable layers of sand or gravel (unconsolidated alluvium) separated by thicker, low-permeability confining layers of silt and clay (lacustrine deposits) (BLM, 2017a). These conditions are represented at MW-1, which exhibits artesian flowing conditions. The upper boundary of the confined aquifer is defined by the extent of confining clay layers, which vary in depth, thickness, and lateral extent.

The uppermost shallow groundwater in Dixie Meadows occurs as an unconfined water table, which is locally recharged by infiltration of spring discharge and upward vertical gradients from underlying confined aquifers. The shallow water table aquifer supports riparian and phreatophyte vegetation, with roots that tap into the shallow groundwater. The depth to the water is interpreted to be shallow, within 10 feet of land surface in the meadow areas and within 30-40 feet in the surrounding phreatophyte shrub areas.

Quaternary lacustrine sediment deposits are composed mostly of clay and minor silt and have an estimated hydraulic conductivity of 6.5 x 10-4 ft/day (Huntington, et al, 2014). As indicated in Table 1 and Appendix A, lithology logs for wells to the east of Dixie Meadows (Wells 109435, 109491, 108770, 108771, 109574) suggest that lacustrine deposits extend to at least 50 ft bgs to the southeast of the Study Area. Deeper geothermal well logs document that lacustrine deposits extend to a depth of approximately 1,450 ft bgs near the west-central edge of the Dixie Valley playa and to greater depths towards the center of the playa (Huntington et al., 2014).

The playa is the terminal boundary to the easterly flow of groundwater from the Stillwater Range to the Dixie Meadows and valley floor. The Stillwater Range is a regional groundwater flow divide that acts as the hydrographic boundary to the west. The playa deposits limit groundwater flow due to their low permeability and the high density of saline groundwater (brine) that is contained within the playa deposits (Huntington et al., 2014). A steep gradient of groundwater salinity concentrations beneath at the edges of the playa has the potential to produce density-driven convection cells, which may force fresh (i.e., low-density) basin-fill groundwater upward, forming perched shallow freshwater aquifers (Fan et al., 1997).

Total groundwater discharge from the entire 35,825-acre playa in Dixie Valley is estimated at 1,800 af/yr (Garcia et al, 2014) and from the Humboldt Salt Marsh brine area is estimated to be 0-100 af/yr, both being a small component of the overall basin groundwater budget of 23,000 af/yr. Most fresh groundwater derived from precipitation in watershed discharges along the playa edge in a zone where the depth to groundwater becomes shallow, and groundwater is

consumed by phreatophyte vegetation. Delineation and characterization of the phreatophyte area surrounding the playa is presented in Garcia et al. (2014).

In areas of the valley floor where playa sediments and other fine-grained, consolidated units are not present, generally, an unconfined aquifer exists within Quaternary alluvial sediments. The upper boundary of the unconfined alluvial aquifer is defined by the groundwater table. Basin-fill alluvium consists of unconsolidated deposits of silt, sand, gravel, cobbles, and boulders in the alluvial fans and interbedded clay, silt, sand, and gravel in basin lowlands (Huntington et al., 2014). The main control on groundwater movement in the shallow unconsolidated sediments is the hydraulic conductivity and potentiometric gradient. Hydraulic conductivity of the unconsolidated alluvial deposits tends to decrease from the mountain front to the center of the basin as grain size reduces, with values ranging from approximately 2.2x103 ft/day to 2x10-4 ft/day (Huntington et al., 2014). The bottom of this unconsolidated layer is poorly defined, but in the Study Area, the alluvium becomes consolidated, densely compacted (potentially cemented), and/or hydrothermally altered to clay materials at relatively shallow depth (approximately 100 feet) in some locations. This consolidated alluvium may have fracture permeability and hydraulic behavior similar to the underlying tuffaceous volcanic rocks. The alluvium thickness increases from the Stillwater Range towards the center of the valley, with a thickness of approximately 3,400 ft bgs in the vicinity of core holes 24-8RD2, 23-8, and 23A-8 and 4,900 ft bgs at 42-9RD (Figure 16). The alluvium in these holes is reported to have virtually no primary permeability, and fluid flow is along fractures and fault zones predominantly. In general, the consolidated alluvium acts as a cap to the deeper, hotter geothermal system, although some hot fluid locally migrates upward through fractures and into the very shallow unconsolidated alluvium. From there, the water migrates laterally, mixes with shallow cold groundwater, and eventually discharges at the springs or is consumed by phreatophyte vegetation, with a small amount of bare-soil/playa evaporation.

Groundwater movement in the consolidated aquifer (consolidated alluvium and bedrock) is controlled by secondary porosity from open spaces along faults and fractures. Constrained, inferred, and concealed faults within the Study Area are illustrated on Figure 15. The degree of faulting and fracturing typically decreases with depth; therefore, permeability of the bedrock aquifer at Dixie Meadows may decrease with depth. While the depth to bedrock varies in Dixie Meadows, based on exploration drilling, there is at least 3,100 feet of consolidated, low-permeability alluvium above the geothermal reservoir in the Study Area.

The geothermal reservoir is expected to be in fractured pre-tertiary bedrock along the DVFZ. As noted in Section 6.3 above, the DVFZ consists of a northeast-trending range-front fault zone that extends along much of the base of the Stillwater Range, a Piedmont Fault, and several younger faults in Dixie Meadows that vary in strike from northeast to southeast. The Dixie Meadows geothermal field is located at this zone of structural complexity. At Dixie Valley geothermal plant, the conceptual geologic model assumes the northeast-trending faults exhibit normal slip and the northwest-trending faults exhibit strike-slip motion (EGS, 2014a). This stress regime produces a dilatational zone within Dixie Meadows, which is conducive to the upward transmission of geothermal fluid (Faulds et al., 2011). As discussed in Section 6.3, geologically recent seismic

events resulted in seismically induced liquefaction in a shallow zone of lateral spreading beginning at the scarp immediately west of the Dixie Meadows springs. This spreading resulted in a down-gradient zone of compression and soft-sediment deformation near the edge of the playa (Wesnousky et. al, 2003). The location of the zone of extension and compression relative to thermal springs in Dixie Meadows is indicated on Figure 16. It is uncertain if the fault responsible for these features surfaces along the scarp or is located near the eastern extent of the wetlands.

Based on this stress regime, existing hydrologic data, and spatial trends of gravity anomalies, thermal gradients, and magnetic lows (Ormat, 2019), the east-northeast trending structures of Dixie Meadows are largely responsible for the main permeability encountered in the system and are likely the conduits for geothermal fluids entering the Dixie Meadows hydrologic domain. The discharge of geothermal water from these east-northeast trending structures does not preclude the discharge of geothermal water from the same reservoir up other faults within the DVFZ, namely the range-front and piedmont faults; however, the piedmont fault does not appear to contribute geothermal fluid to the shallow thermal regime (EGS, 2014a), making it an unlikely source of geothermal fluid to the Dixie Meadows area.

Geochemical and stable isotope data suggest that there is not a direct hydraulic connection between the geothermal reservoir and the springs, but rather, geothermal fluid migrates upward through permeable segments of the east-northeast trending faults and reaches the shallow basin-fill alluvium, where it then mixes with alluvial groundwaters and migrates laterally to the east and down-gradient toward Dixie Meadows. Temperature data from exploration drilling has identified this shallow lateral flow path at relatively shallow depths below approximately 170 ft.

The majority of the shallow mixed geothermal flow is eventually lost to evapotranspiration within and near the Dixie Meadows, with a portion discharging to the surface as hot and warm springs. Younger subsidiary faults related to expansion and compression of the shallow sediments near the playa edge produce both higher permeability conduits (expansion zone) and partial barriers to lateral flow (compression zone) of shallow groundwater. All significant springs in the Dixie Meadows up-well in the zone of expansion, with the hottest springs situated on the west side of the expansion zone and immediately down-gradient of an apparent piedmont fault scrap. Of note, the apparent piedmont fault may be a shallow listric fault rather than a deep-rooted normal fault, as there has been no evidence of a deep piedmont fault at this location in geothermal exploration drilling that crosses the hypothetical fault plane (Ormat, 2020, verbal communications).

Because the springs in Dixie Meadows are situated on an active fault/scarp zone, changes in the occurrence and magnitudes of discharge are likely to have occurred in geologically recent times, associated with earthquake events. As reviewed in Section 6.4, limited tufa or sinter deposition at the Dixie Meadows springs may suggest a relatively young age for the Dixie Meadows springs, or perhaps very little flow during the Pleistocene when the Dixie Meadows area was submerged by Pleistocene Lake Dixie.

8.2. Hydrologic Budget

The hydrologic budget is the summation of the inflows and outflows of water from the hydrologic domain of the Study Area, including both groundwater and surface water. The extent of the hydrologic domain is defined by the watershed tributary to Dixie Meadows, which is shown on Figure 17. The Study Area hydrologic system is assumed to be in a state of dynamic equilibrium, with changes in groundwater storage (and groundwater levels) due only to short-term variabilities in climate. If pumping and injection occur for geothermal production, then a transient condition would be introduced and the change in storage in the aquifer may occur, adding or changing components in the water balance. However, the geothermal pumping and injection are intended to be balanced in magnitude.

Assuming steady-state (equilibrium) conditions within the Study Area, total inflows equal total outflows, and the steady-state hydrologic budget can be expressed as:

$$\sum \text{Inflows} - \sum \text{Outflows} = \Delta S \ (\Delta S \text{ is equal to zero, no change in Storage}),$$

with components as follows:

$$[P + SW_{IN} + Q_{IN}] - [ET + E + SW_{OUT} + Q_{OUT}] = 0,$$

where,

P is precipitation falling directly on the Study Area,

SW_{IN} is surface water inflow to the Study Area,

Q_{IN} is subsurface inflow to the Study Area,

ET is evapotranspiration by vegetation within the Study Area,

E is open water and bare-soil evaporation in the Study Area,

SW_{OUT} is surface water discharging from the Study Area,

Q_{OUT} is subsurface outflow from the Study Area.

Each of these variables is discussed in the following subsections, and the estimated inputs and outputs are summarized in Table 10. Variables that represent an exchange of flow between surface and groundwater within the Study Area (i.e., spring discharge - QS) are internal to the water budget and are fully accounted for in other components (principally E and ET); therefore, they are not included in the water budget equation. However, spring discharges are important to the understanding of the flow system and Dixie Meadows ecology and will be expanded upon in this report section.

8.2.1. Precipitation (P)

In the tributary watershed to the Study Area (Figure 17), precipitation increases with elevation. Precipitation recorded on the Dixie Valley playa at two micrometeorological stations in water

years (WY) 2009-2011 indicates average annual precipitation of 5.0 to 5.3 inches (Garcia et al, 2014). Direct precipitation falling on the Study Area is assumed to be approximately 5 inches (0.4 ft) in an average year, amounting to approximately 1,800 af/yr. This precipitation occurs predominately in the November to May timeframe. Generally, direct precipitation infiltrates soils and is consumed (returned to the atmosphere) by evaporation from bare soils or vegetation transpiration. After high-intensity storm events, direct precipitation along with run-on supports accumulation of water in the playa ponds.

8.2.2. Mountain-Block Runoff (SW_{IN})

Estimates of mountain-block runoff within the Dixie Meadows watershed during an average year and storm events are provided in a technical memorandum prepared by McGinley (2020a). In summary, the average annual runoff tributary to the Dixie Meadows is estimated at approximately 20 af/yr, with 2-year and 5-year flood discharge of approximately 30 and 340 acre-feet, respectively. The presence of surface water runoff to Dixie Meadows is sporadic and may not be present in dry years.

8.2.3. Groundwater Inflow/Recharge (Q_{IN})

Subsurface inflow to the Study Area is derived from precipitation falling on the tributary mountain block and alluvial fan and the resultant groundwater recharge. Estimates of recharge can be made using relationships between precipitation magnitudes, topographic elevations of the mountain range, and empirical relationships. The Maxey-Eakin (Eakin et al., 1951) method was developed to estimated recharge on a basin scale and has been applied throughout Nevada. The Maxey-Eakin method produces 6,000 af/yr of estimated recharge to Dixie Valley (Cohen and Everett, 1963). A modified version of the method using more modern precipitation-altitude relationships produces 11,600 af/yr of recharge for Dixie Valley (Harrill and Hines, 1995). On the smaller watershed scale, the method of Harrill and Hines (1995) produces approximately 270 af/yr for Dixie Meadows, which represents groundwater inflow from recharge on the tributary mountain block and alluvial fan. It should be noted that the Maxey-Eakin method was not specifically developed for smaller watershed-scale estimates, and the magnitude of error by using the method on a watershed-scale is unknown.

It is also likely that the deep geothermal groundwater inflow to the Study Area is occurring from a broader tributary area along the Dixie Valley Fault Zone and Stillwater Range. The magnitude of geothermal inflow from outside the watershed has not been documented but could be in the order of hundreds of acre-feet per year. A preliminary estimate of geothermal inflow is calculated by difference in the water balance. In order for the estimated inflows to equal the estimated outflows, a value of geothermal groundwater inflow of 770 af/yr is required.

8.2.4. Evapotranspiration (ET)

Evapotranspiration is a primary mechanism for water discharge from the hydrologic system. Evapotranspiration occurs via plants that intercept soil moisture and surface-water infiltration

(i.e., xerophytes) and plants that derive water in part from the saturated zone (i.e., phreatophytes).

Phreatophytes in the Study Area comprise much of the vegetation, including the riparian and meadow areas at the springs and the surrounding greasewood and rabbitbrush shrub vegetation. These plants, in part, consume precipitation falling directly on the Study Area but also consume groundwater during the summer season when the soil moisture has been depleted. The ET of phreatophytes in Dixie Valley has been extensively studied by Garcia et al. (2014).

Within the Study Area, there are approximately 350 acres of grassland vegetation, as delineated by Garcia et al. (2014). The mean annual groundwater ET (ETGW) rate for grasslands of Dixie Valley is 1.7 ft/yr (Garcia et al., 2014), equaling an average annual ETGW of 600 af/yr. As stated previously, the primary source of water to meadow and riparian areas, which make up a significant portion of the grasslands, is spring discharge. The remainder of the vegetation in the Study area is within the phreatophyte shrub vegetation area delineated by Garcia et al. (2014), occupying approximately 1,800 acres, 40 percent of which is considered sparse shrubland and 60 percent of which is moderate to dense shrubland. Applying an average ETGW rate of 0.1 ft/yr to sparse shrubland and 0.3 ft/yr to moderate to dense shrubland (Garcia et al., 2014), approximately 400 af/yr of groundwater is consumed by phreatophyte vegetation outside the meadow areas within the Study Area.

The total ET of groundwater and spring discharge (ETGW), above direct precipitation falling on the Study Area, is approximately 1,000 af/yr. ET of precipitation by xerophytes, phreatophytes, and evaporation from bare soils is estimated to be approximately equal to the average annual direct precipitation falling on the Study Area, or approximately 1,800 af/yr. Total ET from the Study Area is estimated to be 2,800 af/yr.

8.2.5. Evaporation (E)

Evaporation occurs in the Study Area from open water and from bare soils. The bare-soils evaporation is incorporated in the ET values above.

Surface water in the Study Area flows towards the edge of the playa, seasonally contributing to two intermittent “playa” ponds (eastern pond and western pond). During the winter when ET is very low, spring discharge from Dixie Meadows has been observed to reach the ponds and the edge of the main playa.

The NDWR shallow open-water annual evaporation rate for Dixie Valley is 4.9 feet/year. The net evaporation rate is 4.3 feet/year after offsetting direct precipitation. But since the “playa” ponds dry out each summer, the total annual evaporation from the ponds is assumed to be less than this rate and may be correlated with the pond depths and volume of water held. Using Lidar land surface topography data for the site, the east pond has an area of 4.7 acres, a maximum depth of 1.5 ft, and a volume of approximately 3.7 acre-feet. The west pond has an area of 11.3 acres, maximum depth of 2.0 ft, and an approximate volume of 10.9 acre-feet. The total estimated

open-water evaporation from the ponds after accounting for direct precipitation is approximately 15 af/yr.

8.2.6. Spring Discharge (Q_S) and Surface Water Outflow (SW_{OUT})

Spring discharge represents groundwater discharge within the Study Area that feeds other water budget components, principally E and ET. Spring discharge rates at measured locations ranged from 15 to 146 gpm in May 2019, as summarized in Table 11 at locations shown in Figure 14. The total discharge for Dixie Meadows is estimated to be between 400 and 700 gpm (Interflow, 2012). This equates to 645 to 1130 af/yr and equals a large portion of the total water budget outflow for the Study Area. A mid-range value of approximately 900 af/yr is assumed, which then becomes discharge by ET from vegetation and evaporation from the terminal "playa" ponds (spring discharge is accounted for by ET and evaporation in water balance calculations). During winter months, when evaporation rates are reduced, some of the runoff infiltrates back to the shallow water table becoming secondary recharge, and some runs off to the playa ponds or the Dixie Valley playa. The amount that runs off from Complex 2 is preliminarily estimated to be at least 25-50 af/yr (sufficient to fill the playa ponds in the winter). Small drainages and pools can be observed at the playa edge below the primary spring groups, but the extent of the pools is small, suggesting the that unconsumed or infiltrated winter runoff from the springs to the playa is relatively small. Surface water runoff to the main Dixie Valley playa is assumed to be about 5% of the total spring discharge, or approximately 45 af/yr.

8.2.7. Subsurface Outflow (Q_{OUT})

The hydraulics of groundwater flow near the playa edge are examined in Huntington et al. (2014). Low hydraulic conductivity of playa sediments and high density of saline groundwater contained in the playa "aquifer" cause the fresh groundwater (both mountain-block recharge and geothermal) to migrate upwards and discharge at the playa periphery, with minimal subsurface outflow into the playa sediments. For purposes of the water balance, it is assumed the subsurface outflow from the Study Area to the Dixie Valley playa is effectively zero.

8.2.8. Water Balance Summary

Inflows to the Study Area include direct precipitation, mountain-block runoff, recharge derived from tributary watershed precipitation and entering as subsurface inflow, and geothermal inflow that may have a larger contributing area. During years of average precipitation, surface water runoff into and out of the Study Area is small, though, runoff is significant after infrequent storm events and during years of higher-than-average precipitation. Direct precipitation falling on the Study Area is assumed to be fully consumed by vegetation or evaporation and does not contribute significantly to recharge of groundwater.

Discharge of water from the Study Area is primarily by evapotranspiration from plants, in particular by riparian, meadow, and phreatophyte vegetation that consumes spring discharge and groundwater inflow to the Study Area. Total ET is estimated at 2,800 af/yr.

Evaporation of spring discharge and runoff that collects in the ephemeral playa ponds comprises about 15 af/yr. Surface water and spring discharge runoff to the playa is assumed to be low, estimated at 45 af/yr. Subsurface outflow to the playa is assumed to be negligible, due to the low hydraulic conductivity of the playa sediments and the high density of playa groundwater (brine), which in effect prevents inflow of the fresh groundwater.

Total discharge is estimated at 2,860 af/yr, which is assumed to be in balance with the total water inflow to the Dixie Meadows area. Groundwater inflow to the deep geothermal aquifer that is derived from outside the local watershed is computed by difference in the water budget to be approximately 770 af/yr.

8.3. Groundwater Flow Paths

Flow directions in the Study Area are controlled by gradients in hydraulic head including those created by differences in temperature and water density. Summaries of groundwater elevations and spring water elevations are provided in Tables 1 and 6, respectively. At wells where the static groundwater level is below ground surface, the groundwater elevations are calculated by subtracting the depth to water from the land surface elevation. Artesian flowing conditions (i.e., where the potentiometric surface is above ground surface) occur at well locations where confined aquifer conditions are present. To determine the potentiometric head at these locations, recorded gauge pressures at the well head were converted to hydraulic head using the equation:

$$h = 2.31 \times P/\rho$$

where h equals head in feet, P equals pressure in psi units, and ρ equals density. The calculated hydraulic head was then added to the approximate elevation of the top of the well casing to determine groundwater potentiometric elevation. Spring stage elevations are set to approximate land surface elevation at the spring orifice, although the true potentiometric head is greater than land surface.

As indicated in Table 1, groundwater elevations in bedrock wells 23-8 (3,724.8 ft amsl) and 42(12)-9 (3,662.1 ft amsl) exceed groundwater elevations in all playa and alluvium wells. This suggests an upward hydraulic gradient and that the bedrock aquifer is under confined conditions, which is supported by artesian flowing conditions.

Figure 18A shows groundwater elevations in bedrock wells, deep and shallow alluvium wells, and springs. Figure 18B illustrates the potentiometric surface of the shallow aquifer, including water elevations in alluvium, playa, and spring locations. Water elevations decrease to the east overall, which is consistent with the regional flow direction toward the Dixie Valley playa.

Water densities were determined using a water density calculator (McCutcheon et al., 1993), which takes into consideration water temperature and salinity. A summary of water densities is provided as Table 12. Overall, the lowest water densities are at hot spring locations due to high temperatures and low total dissolved solids (TDS) concentrations. Cool to warm temperature

springs and groundwater are characterized by relatively greater TDS concentrations and densities. Water at the western pond, eastern pond, and MW-1 have relatively high densities as a result of high salinity. TDS concentrations of 184,000 to 310,000 mg/L have been measured in shallow playa groundwater (Huntington et al., 2014). As examined in Huntington et al. (2014), the sharp density contrast between fresh basin-fill water and playa groundwater may force the basin-fill groundwater upward. Very little mixing is expected to occur at this density-interface.

8.4. Flow and Injection Testing

Ormat performed a flow and injection test from April 27 to June 11, 2017. Locations of test wells, observation wells, springs, and faults are shown in Figure 15. Plots of production rates over time and injection rates over time are provided in Appendix H.

Water was flowed from Well 23A-8, with discharge rates decreasing over time from approximately 2,075 to 1,600 gpm. Production Well 23A-8 was drilled through densely compacted and cemented alluvial materials extending to 3,400 ft bgs and is completed in Triassic slate and siltstone in the footwall of the range-front fault at 4,733 ft bgs. Permeable fractures associated with an east-northeast-striking fault zone were recorded in 23A-8 at depths of approximately 4,580 and 4,640 ft bgs (Ormat Fault Model, 2017).

Discharge water was reinjected at Wells 24-8 and 75-4, which are completed in mineralized and fractured alluvium at depths 3,060 ft bgs and 2,493 ft bgs, respectively (Table 1). Injection rates decreased over time at Well 24-8 from approximately 2,500 to 1,300 gpm, while the injection rate was relatively constant at Well 75-4 at an average of 165 gpm.

Observation wells 23-8, 24A-8, 42-9, 86-7, and 22-8B were monitored for hydraulic head responses during testing activities to determine the degree of hydraulic connectivity between bedrock and alluvial aquifers and qualitatively assess fault permeabilities. Plots of pressure head versus time are also included in Appendix H and a summary of hydraulic responses are summarized in Table 13.

Observation wells 86-7 and 22-8B are completed in densely compacted and cemented alluvium. Decreases in pressure head in wells 86-7 and 22-8B during the flow test indicate a hydraulic and structural interconnection between the Pre-Tertiary bedrock and consolidated alluvium. The response observed at 86-7 suggests that the range-front fault and east-northeast trending faults between 86-7 and 23A-8 are permeable. With limited antecedent data at well 24A-8, it is unclear whether the reduction in pressure head at this observation well was a response to the flow test.

Well 42-9 exhibited the greatest reduction in absolute pressure during the flow test, decreasing from 118.4 to 104.95 psi. Well 42-9 is separated from test well 23A-8 by the regional range-front Dixie Valley and Piedmont faults and associated intra-basin faults; the hydraulic response observed at 42-9 suggests that these structures have permeability across the fault plane.

Select spring locations were monitored for temperature, electrical conductivity (EC), and spring pool stage during flow testing activities to further assess the degree of hydraulic connectivity

between groundwater and associated surface water expressions. Monitoring locations are shown in Figure 14. At USGS-101, temperature and EC remained relatively constant over time, while water depth reduced slightly from early June to the end of August, which is likely due to decreased precipitation and increased evaporation during the summer months. Increased water temperature at Spring 2 during testing is attributed to increased ambient temperature during the summer months, while increased EC is attributed to enhanced evapotranspiration from elevated temperatures and increased vegetation cover during the monitoring period. Temperature and water level increases recorded in August 2017 at NDOWSS-1 are likely a response to the cessation of flow testing activities. At Spring 4, temperature and EC remained relatively constant during the monitoring period. Temperature, water levels, and EC appeared to be constant over time at Spring 5A.

Return curves of tracers 2-ns and 2,6-nds—which were injected into Wells 24-8 and 75-4, respectively, during flow/injection testing operations—are included in Appendix H. Tracer 2-ns injected into Well 24-8 was injected into compacted/cemented alluvial materials up to 3,060 ft bgs. Tracer 2,6-nds was injected into 75-4, a well completed in both dense compacted/cemented alluvium up to 2,493 ft bgs and granodiorite and gabbro to 5,000 ft bgs.

A valid tracer response typically maintains at measurable concentrations for a period of time that depends on the amount and duration of tracer injected and the hydrogeologic conditions. The observed 2-ns returns at Production Well 23A-8 indicate some injection fluid return to production due to a hydraulic connection between the alluvium and bedrock, which may have been induced during flow testing activities. Return curves of both 2-ns and 2,6-nds concentrations at Spring 2 from May 26 to June 3 are likely the result of contamination during sampling or in the laboratory.

In summary, it appears that there is a hydraulic connection between the bedrock and alluvium in the Dixie Meadows area, and that many faults and fractures in the Dixie Meadows area, including the regional Dixie Valley and Piedmont faults do not function as horizontal barriers to groundwater flow. An increase in temperature at spring NDOWSS-1 at the end of the flow test illustrates the connection between the bedrock aquifer and surface water expressions of Spring Complex 2. Existing tracer results cannot be used to make any conclusive determination of hydraulic properties or connections between aquifers and surface water expressions, however changes to hydrologic conditions at some of the springs during production may be expected.

8.5. Water Source Chemical Characterization and Mixing

8.5.1. Spring Locations

8.5.1.1 Temperature

Water temperature is one indicator of potential geothermal input at seeps and springs. A summary of historical water temperatures at existing monitoring locations is presented in Table 7. Springs with the highest water temperatures in Dixie Meadows are within Spring Complex 2, indicating significant geothermal input in this area. Overall, water temperature decreases to the north, east, and south of this location (Figure 19A and 19B). As stated in Section 6, Spring Complex

2 is found along strike of east-northeast trending faults that are believed to act as conduits for geothermal water. The geothermal water loses heat over time as it migrates through the shallow alluvium and/or mixes with cool basin-fill groundwater before reaching controlling faults that are barriers to lateral shallow groundwater flow and cause groundwater to discharge to the ground surface; this increase in travel time and potential mixing with cool groundwater may explain the spatial trend of decreasing spring water temperatures moving away from Spring Complex 2.

8.5.1.2 Chemistry

Results of previous water geochemistry studies in Dixie Valley (EGS, 2014a; Huntington et al., 2014; Benoit, 2011) suggest that multiple geothermal systems exist in Dixie Valley and that each system is geochemically unique with groundwater chemistry evolving along distinct flow paths with varying rock types. A summary of water chemistry data for samples collected in Dixie Meadows since August 2018 is provided in Table 8. Relatively constant ratios of conservative chemical elements and ionic compounds, such as boron-to-chloride and lithium-to-chloride, in the spring samples collected in Dixie Meadows suggest that the fluids are derived from a common regional geothermal resource and that they interact with similar lithologies along their flow paths.

As discussed in Section 7.2, concentrations of silica and magnesium, and water temperature, are key indicators of geothermal fluid and can be used to determine the degree of mixing between geothermal and other water sources, including meteoric and basin-fill groundwater. Samples collected from hot springs in Dixie Meadows have high concentrations of silica and low concentrations of magnesium, while samples from cool to warm springs have lower concentrations of silica and elevated magnesium (Appendix G).

Lithium concentrations have been useful in determining geothermal-fresh water mixing ratios at other geothermal sites; however, elevated lithium concentrations in Dixie Meadows may result from mixing with geothermal waters or evaporite-rich waters from playa deposits. Due to this fact, it is difficult to make mixing interpretations based on lithium concentrations alone; however, assuming linear mixing, Huntington et al. (2014) concluded that 27 of 51 sampled basin-fill wells and springs in Dixie Valley have an average mixing of 13 percent, reaching up to 46 percent, and that, overall, mixing increases with water temperature.

Relative mixing interpretations can be made by comparing lithium, magnesium, and silica concentrations. Hot spring water in the Study Area is represented by low magnesium-to-lithium molar ratios and high silica concentrations, while cooler waters have higher magnesium-to-lithium molar ratios and lower silica concentrations (Appendix G). This corroborates the interpretation made by Huntington et al. (2014) that warm and hot springs in Dixie Valley (and in this case, Dixie Meadows) experience greater percentages of geothermal mixing.

8.5.1.3 Stable Isotopes

Stable isotopic signatures of oxygen-18 and deuterium can be used to characterize surface water and groundwater and assess possible sources. The mean oxygen-18 and deuterium signatures for samples collected from springs and seeps for this study were -15.8 and -125.8 per mil,

respectively. These signatures are 0.3 and 7.9 per mil lighter (more negative) in oxygen-18 and deuterium, respectively, than winter mountain-block precipitation signatures reported by Huntington et al. (2014), which may indicate that spring water in Dixie Meadows was recharged under cold climate conditions (Rademacher et al., 2002).

Huntington et al. (2014) developed a local meteoric water line (LMWL) using signatures of oxygen-18 and deuterium from mountain-block and valley-floor precipitation samples collected by Interflow Hydrology and USGS personnel from May 2009 to May 2011. Isotopic signatures of water samples collected from cool, warm, and hot springs from the valley floor were plotted against the LMWL to provide insight on the extent of geothermal water mixing (Appendix G). All spring samples collected run parallel to the LMWL but are more enriched (approximately 1 per mil more positive) in oxygen-18 relative to equal deuterium values on the LMWL. The observed positive shift in oxygen-18 signatures of spring water from the LMWL likely indicates input of geothermal fluid. Oxygen-18 becomes enriched in geothermal groundwater due to isotopic exchange when groundwater interacts with minerals containing oxygen, such as quartz and calcite (Clark and Fritz, 1997). This isotopic shift has been observed in a previous study by Huntington et al. (2014), who found that geothermal samples and non-geothermal samples had similar deuterium values, but geothermal samples were enriched in oxygen-18.

8.5.2. Western and Eastern Playa Ponds

The extent of the local watershed that may contribute to the western and eastern playas is shown on Figure 20. Surface water runoff and outflow in adjacent watersheds contribute to surface water of the Dixie Meadows area (see Figure 17 for extent of Dixie Meadows watershed); however, runoff from these adjacent areas is not believed to contribute to the playa ponds. Field observations and a review of Landsat imagery suggest that the playas typically begin collecting water by October or November; the western playa collects water first because of its proximity to the drainage channels of Spring Complex 2. Water discharging from the spring complex continues migrating to the east as sheet flow, with a portion infiltrating and returning water to the shallow water Table aquifer and a portion reaching the playa ponds. During the warmer summer months, all spring discharge is consumed by ET, and there is no excess flow to the playa ponds. During the cooler winter months, there is little to no ET, and the spring discharge provides a source of water to the playa ponds. Occasional storm events produce runoff that contributes significant water to the Study Area and the playa ponds; however, these events are sporadic (McGinley, 2020).

Water of the western and eastern ponds is characterized by a sodium-potassium-chloride water type (Appendix G) and high concentrations of total dissolved solids and lithium due to the dissolution of playa salts and evapo-concentration during evaporation. Water of the playas is enriched in oxygen-18 and deuterium as a result of evaporation (Appendix G).

8.5.3. Alluvial Groundwater Samples

MW-1 is located at the southwestern edge of the Humboldt Salt Marsh, and the lithology log indicates that it was drilled through a mixture of lacustrine (playa) and basin-fill deposits and is

representative of the shallow basin-fill groundwater with little to no mixing with geothermal fluid.

Groundwater chemistry at MW-1 (Table 8) is more consistent with playa water quality than basin-fill chemistry described by Huntington et al. (2014). Elevated concentrations of lithium at MW-1 are likely the result of the dissolution of playa salts, rather than input of geothermal fluid. This is supported by the relatively high concentrations of total dissolved solids, ranging from 2,700 mg/L to 3,100 mg/L, in samples collected at MW-1 from August 2018 to May 2019.

Temperatures of discharge water from MW-1 were relatively constant from August 2018 to May 2019, ranging from 71.3 to 73.5°F, indicating that the groundwater is not impacted significantly by ambient temperature fluctuations.

In August 2018, oxygen-18 and deuterium values were -16.2 and -129, respectively. In May 2019, values were -16.1 and -128, respectively. These are some of the lightest (most negative) values of oxygen-18 and deuterium recorded in all samples collected for this study and plot relatively close to the LMWL (Appendix G). This suggests that the groundwater in the vicinity of MW-1 was recharged under cooler climate conditions and has not been impacted significantly by geothermal fluids.

8.6. Summary

A conceptual hydrogeologic model has been constructed to represent the groundwater flow system in Dixie Meadows, Churchill County, Nevada and to aid in development of a monitoring program to establish background hydrologic conditions and determine potential hydrologic impacts caused by future geothermal exploration and development. There are two main aquifers identified in the Dixie Meadows area: a shallow unconsolidated alluvial aquifer and a deeper aquifer consisting of consolidated and chemically altered alluvium and bedrock. High-temperature geothermal fluid has an origin in the deep bedrock aquifer. Hydrologic, geochemical, and geophysical data indicate that some of the geothermal fluid migrates upward through east-northeast trending fault structures discharging out into the shallow, unconsolidated alluvial basin-fill. The mixed groundwater then moves laterally through basin-fill deposits towards the Dixie Valley playa and discharges as springs along fault discontinuities in the alluvium. The degree of geothermal mixing appears to increase with increasing spring temperature. The majority of this water is then lost to evapotranspiration and evaporation.

Groundwater movement in unconsolidated sediments is controlled by hydraulic conductivity of the materials, which tends to have a horizontal preference, while groundwater in consolidated bedrock is controlled by structures; geothermal fluid has a vertical flow preference along the plane of the fault. Results of flow test data suggest that faults in Dixie Meadows have varying degree of permeability and influence on the flow system and that there is a hydraulic connection between the bedrock and alluvial aquifers. Flow directions are determined by the local hydraulic gradient, which follows topography, but are also governed by potentiometric gradients caused by temperature differences (hotter water has a lower density than cool water) and TDS concentrations (high TDS water has a higher density than low TDS).

Temperature, chemistry, and isotope data suggest that spring discharge within Dixie Meadows consists of a mixture of modern recharge water from precipitation and geothermal water. The western and eastern ponds fill with a mixture of spring discharge from Spring Complex 2, mixed occasionally with runoff from storm events. The persistent source of water to the ponds is spring discharge that is not consumed by meadow vegetation in the winter. The ponds are ephemeral and exhibit dry conditions each summer.

In order to preserve the natural environment of Dixie Meadows, including warm spring discharges and the seasonal "playa" ponds, a carefully implemented production and injection program would need to be developed, which could maintain the water balance of the springs and the shallow aquifer system. Additional exploration drilling and flow/injection tests are anticipated in the Project area, and as such, the production and injection program would be developed and refined upon completion of these activities and additional data are collected. Theoretically, no water would be consumed by the project as the facility would use air-cooled, binary technology, and therefore, the total water balance for the system would be preserved (geothermal production flow would equal injection return to the hydrologic system). The challenge to geothermal resource development would be finding an acceptable geographic distribution for injection that would meet reservoir requirements while maintaining the environmental balance.

9.0 AQUATIC RESOURCES MONITORING AND MITIGATION PLAN

The conceptual model and information obtained from the WARD has been used to develop this draft ARMMP. The actions outlined in the ARMMP, including additional data collection and identification and/or refining of baseline conditions and thresholds, would begin immediately upon signing of the Record of Decision for the Final Dixie Meadows Geothermal Utilization Plan EA. The proposed monitoring network has been developed primarily in response to the proposed Phase I geothermal powerplant development, and in concert with the adaptive management approach, and may be modified or expanded to meet monitoring objectives for subsequent phases or implementation of alternatives for geothermal reservoir development, subject to BLM approval.

The baseline hydrologic conditions established upon implementation of the ARMMP monitoring network would build upon existing background data collection to define seasonal variations but may not be sufficient in duration to define long-term climate driven variance resulting from prolonged drought or wet cycles. As discussed in Section 7.0, background monitoring has been ongoing for several years contributing to the baseline dataset. As detailed in Sections 9.1 to 9.3, baseline data collection under the ARMMP monitoring network would take place for 1-2 years before production activities commence to further define the range of natural variability in hydrologic and biologic parameters. Because long-term climate variance can require multiple decades to define, climate trends would additionally need to be factored into consideration during development of baseline conditions and associated thresholds for adaptive management actions and mitigation measures.

The BLM would implement this ARMMP using an adaptive management approach to accommodate undefined variances, and address uncertainties in hydrologic and biologic system responses. Using this approach, baseline conditions, thresholds, management actions, and mitigation measures would be adapted throughout the life of the project to respond to the needs of the hydrologic and biologic resources. In consultation with BLM, Ormat may add monitoring sites and/or temporarily adjust sampling parameters and durations to monitor for site-specific project actions. Modifications to the ARMMP may occur as additional data are collected and as the development and operations of the project progress. The adaptive management approach would follow the U.S. Department of the Interior's Technical Guide to Adaptive Management (Williams et al., 2009) to the degree possible.

To the extent practicable, the draft ARMMP was developed pursuant to the requirements outlined in the BLM-issued Guidance Document. The Guidance Document is still considered a draft and is under review by cooperating agencies. All details of the proposed ARMMP described below would be reviewed and finalized in coordination with the BLM and cooperating agencies.

Proposed monitoring locations included in the ARMMP are considered locations where hydrologic or biologic changes may be identified and quantified during development phases of the project based on their location, ground conditions, and potential connectivity to the geothermal reservoir. Changes do not necessarily equate to negative impacts. For example, increases in spring flow or stage and decreases in TDS during geothermal production may be viewed as a positive effect for the spring-dependent ecosystem and aquatic resources.

Control sites are defined in the Guidance Document as sites that are "within the same or similar hydrologic or hydrogeologic conditions as the project area," but are "outside the influence of project operations," which are established to "monitor natural and seasonal variations of water resources" and "to ensure potential impacts to water and aquatic resources that may be influenced by project operations are adequately captured." The control sites identified herein are considered "most likely" control sites based on the conceptual hydrogeologic model presented herein.

Proposed surface water monitoring locations and control sites were selected based on the following criteria:

- representativeness of the hydrologic and geochemical conditions of the Study Area;
- potential for measurable flow and/or water stage measurements;
- potential to collect water quality samples and measure field parameters;
- spatial and thermal coverage (i.e., ability to characterize multiple spring complexes that cover a range of water temperatures over a broad area);
- known presence of aquatic-dependent biological resources (i.e., springsnails, based on past surveys) and the potential presence of aquatic-dependent biological resources (i.e., Dixie Valley toads, based on preferred habitat type); and
- site access.

Proposed groundwater monitoring locations were selected based on the following criteria:

- potential to monitor early evidence of hydrologic changes during power plant operations;
- potential to use existing monitoring wells rather than drilling new monitoring wells;
- representativeness of the hydrogeologic conditions that influence ground and surface water resources in the Study Area;
- potential to measure hydraulic head;
- potential to collect water quality samples and measure field parameters; and
- site access.

Proposed biological monitoring locations were selected based on the following criteria:

- co-location of vegetation and hydric soil monitoring locations with tier 1 hydrological monitoring locations;
- additional vegetation and hydric soil monitoring locations will be identified based on DVT habitat preference research currently underway by USGS; and
- springs which harbor populations of springsnail populations (*Pyrgulopsis* spp.).

9.1. Surface Water Monitoring

9.1.1. Monitoring Locations

To quantify the natural variability of hydrologic conditions in the Dixie Meadows area, 23 surface water monitoring locations, including four control points are proposed. Of the monitoring locations, 20 are seep/springs, two are channels, and one is a pond. The surface water monitoring network locations are illustrated in Figure 21. The degree of natural variability in hydrologic parameters varies by spring and by spring complex, and as such, it is proposed that each spring complex be represented in the monitoring program. It is proposed that each surface water monitoring location be monitored for water quality, flow/stage, and field parameters (temperature, pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity). A summary of the proposed surface water monitoring locations and control sites, monitoring frequencies, and monitoring parameters are provided in Table 14A. Each proposed surface water monitoring location and control point meet the selection criteria outlined above and each location has a specific monitoring objective. Characteristics and monitoring objectives of each location are summarized in Table 14B, and photographs illustrating site conditions are provided in Appendix F. Additional surface water monitoring locations may be added and/or existing monitoring locations may be modified as new information is gained throughout the life of the project. Monitoring parameters, and the timing and frequency of data collection may also increase or decrease as necessary to complement objectives of the monitoring plan and adaptive management approach for the ARMMP, of which are subject to prior approval by the BLM Authorized Officer (AO).

Of the 23 monitoring locations proposed in the monitoring network, background / preliminary baseline data collection has occurred at 15 locations (Table 6). Background hydrologic conditions at these locations is discussed in Section 7.0. Field parameters and analytical results for these

locations are summarized in Table 7 and Table 8, respectively. A summary of flow measurements is provided in Table 11.

9.1.2. Water Quality Sampling

A summary of surface water sampling locations, sampling frequency, and monitoring parameters is included in Table 14A. The Contractor would measure field parameters, including temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), reduction-oxidation (redox) potential, and turbidity at each surface water monitoring location prior to sample collection using a calibrated multimeter. Chemical analytes, test types, analytical methods, container requirements, preservation requirements, and holding times are provided in Table 15. Analytes include potential geothermal indicators identified from initial water sampling results described in Section 7.2, including major ions and select trace metals. To aid in quantification of mixing contributions of meteoric and geothermal input in surface water and groundwater at the Study Area, stable isotope samples would be collected.

USGS and EPA sampling protocols (USGS, 2018; EPA, 2016) would be followed to the degree practicable. Field instruments would be calibrated per manufacturer's recommendations to the degree practicable. Laboratory provided sampling bottles will be filled manually to the bottom of the neck (no positive meniscus – allow for a small amount of air space) from the surface water channel or discharge location. Containers do not need to be rinsed with sample water prior to sample collection, as sterile containers would be provided by the laboratory. All sampling equipment would be thoroughly decontaminated after each sampling event. Samples would be placed into appropriate containers, labeled, and preserved with acid and/or on ice pending delivery to the laboratory. The water samples would be delivered under chain-of-custody protocol to a Nevada-certified laboratory for analysis.

9.1.3. Flow Rates

To assess flow conditions, the Contractor would monitor flow rates, water pool stage, and contributions of meteoric water input at the locations indicated in Table 14A. Permit applications would be submitted to the appropriate landowners (US Navy) to install water discharge structures within Dixie Meadows.

Continuous discharge measurements are proposed at five spring locations distributed in four spring complexes (USGS-101, NDOWSS-1, Complex 2 Confluence, Spring 5A/5B Confluence, and USGS-301 Salt Cedar). The central location at Complex 2 Confluence represents the combined thermal spring discharge from the Dixie Hot Spring complex, and accounts for approximately one-half of the total spring discharge from the entire Dixie Meadows area. In order to provide accurate and high-frequency flow measurement at this location, a Parshall flume is proposed to be installed. A properly installed Parshall flume would have a measurement accuracy of $\pm$5%. This flume site would become a key monitoring location to establish thresholds and triggers.

In addition, the discharge of thermal waters on the western side of Complex 2 is proposed to be monitored at NDOWSS-1, more commonly known as Dixie Hot Spring. A V-notch weir is an

appropriate control structure to measure flow at this location. The USGS-301 Salt Cedar in Complex 5 is also suitable for a similar V-notch weir for continuous discharge monitoring.

Two smaller spring discharge sites are proposed for V-notch weir installation and continuous flow measurement, at sites USGS-101 in Complex 1A, and Spring 5A/5B confluence in Complex 3. The weirs would require volumetric measurements to confirm accuracy of standard rating tables, and if necessary, refine a rating Table for site-specific conditions. Once the rating Table is established, a measurement accuracy of $\pm$ 5% should be achieved.

The Parshall flume at Complex 2 Confluence is proposed to be a pre-fabricated steel insert, approximately 2 ft in width at the broadest point, and 5 ft in length, that would be placed in the current channel with minimal disturbance. Cement would be used to secure the insert in place and to prevent by-pass flow. V-notch weirs are smaller plate steel control structures that may require some concrete on the wings and base to prevent by-pass flow. Upon completion of installation, surface water discharge measuring structures would not alter natural surface flow patterns or cause increased erosion at the spring outflow point.

These continuous spring discharge measurement sites have been selected based on the following criteria:

- measurable flow quantities,
- a reasonably straight channel with parallel stream flow lines,
- the streambed is stable and generally free of large rocks and other obstructions,
- the channel cross-section is parabolic, trapezoidal, or rectangular.

Continuous flow measurements are collected by measurement of the height of water flowing through the control structure, at 15-minute measurement frequency. A water stage recorder (pressure transducer or sonic water height recorder) would be used to relate to discharge rate by a rating table or curve. The sensors would also record water temperature and electrical conductivity.

Seven additional sites are proposed to have monthly open channel measurements of flow, using current-velocity methods and include the following locations: Spring 4, Spring 6, Spring 9, Spring 10, Spring 11, Spring 12, and Spring 13 (Figure 21). Equipment includes a top-setting wading rod, tag line, and velocity meter, with velocity measurements acquired along a cross-section of the channel to compute total discharge. Measurement methods are detailed in the document prepared by the USGS in 2010 entitled *Discharge Measurements at Gaging Station*. Flow measurement records would be made on USGS Form 9-0275-G “Discharge Measurement Notes” or similar.

The remainder of spring monitoring sites are pooled water recordings, as described below in section 9.1.4.

9.1.4. Water Stage Readings

Water stage (pool height) would be measured using a staff gage at eleven proposed locations where discharge cannot be directly measured due to unsuitable conditions, such as pooling, where flow is too low, or where access is limited by vegetation and ground conditions. These sites include Spring 2, Spring 7, Spring 8, Spring 14, Spring 31, Spring 32, Spring 33, Spring 118, USGS-301 North, and the Western Playa Pond (Figure 21). Staff gages have one-hundredth of a foot increments. Manual readings of water levels via staff gages would be recorded on a form prepared prior to sampling/monitoring at frequencies summarized in Table 14A.

9.1.5. Monitoring Schedule

The Contractor would perform a monthly site visit to inspect field equipment and to collect/download field parameters from the surface water monitoring locations and control points. Water samples would be collected for chemical analysis on a monthly basis during the baseline period and for the first 1-2 years of power plant operation to define seasonal variability. Upon power plant start-up the monitoring frequency may be adjusted to weekly or biweekly at some locations, and for some specific parameters, to aid in providing early warning data. Assuming stable hydrologic conditions under plant operations, water samples then may be reduced to a quarterly basis, provided it is consistent with the goals of the adaptive management approach, as approved by the AO. A summary of the proposed monitoring schedule and data logging frequencies are provided in Table 14A.

Continuous flow and temperature data would be recorded at USGS-101, NDOWSS-1, USGS-301 Salt Cedar, and Spring 5A/5B Confluence. These data would be downloaded during each monthly site visit. Manual measurements of pH, EC, DO, ORP, and turbidity would be made at these locations during each monthly site visit. Field parameter measurement and flow/stage measurement frequency at all other surface water monitoring locations is proposed to be monthly.

Baseline data collection would continue up to the time of production, which is currently anticipated to be early to late in 2022, dependent on obtaining all permits and scheduling of equipment orders (construction of power plants and well field facilities would require 12 to 24 months). The frequency of monitoring would continue into the initial production years but may be adjusted in consultation with cooperating agencies based on the range of variabilities observed, trends observed, and potential operational responses observed, consistent with the proposed adaptive management approach.

Monitoring would continue throughout the life of the project at locations and frequencies determined to be appropriate by the BLM, in consultation with cooperating agencies.

9.2. Groundwater and Geothermal Reservoir Monitoring

9.2.1. Monitoring Locations

Groundwater monitoring is proposed at nine wells, including two geothermal bedrock wells, one fresh water bedrock well, and four alluvial wells, along with two monitoring wells completed in alluvium between Complex 2 and 3 and the geothermal facilities (MW-2 and MW-3). Locations are shown in Figure 22. Groundwater wells are proposed to be monitored for chemistry, field parameters, and hydraulic head; geothermal reservoir wells are proposed to be monitored for temperature, pressure, and water chemistry.

Additionally, fifteen drive point piezometers are proposed to monitor the shallow water table at each of the spring complexes within Dixie Meadows (Figure 22). Data collection at the drive point piezometers would include depth to groundwater and shallow groundwater temperature.

A summary of the groundwater monitoring locations and control sites, monitoring frequencies, and monitoring parameters are provided in Table 16A. Characteristics and monitoring objectives of each location are summarized in Table 16B. Monitoring wells MW-1 and 75-4 are control points as they are considered the least likely to be impacted by future project-related activities. Field parameters and analytical results of samples previously collected at MW-1, 23A-8, and 24-8 are summarized in Table 7 and Table 8, respectively. Well details and groundwater levels at each groundwater monitoring location are summarized in Table 1. Additional groundwater and geothermal monitoring locations and control sites may be added/installed and adjusted as the final project design is formulated, as consistent with the adaptive management approach for the ARMMP and approved by the AO.

In addition to regularly proposed monitoring sites and data collection listed above, site specific monitoring would also occur at identified springs and seeps during pumping tests, flow tests, injection tests, and tracer tests (referred collectively as “geothermal testing”). Geothermal testing would occur from 3 to 7 days but could last up to 29 days (see Section 3.2.6.1, Appendix I [BLM 2017a]). Monitoring would occur prior to, during, and after geothermal testing with timing and duration to be determined by the BLM and cooperating agencies. Monitoring could last from approximately 14 to 28 consecutive days, or longer. Standard monitoring of field parameters, temperature, and water flow/pond stage would occur to aid in determining if there are any potential changes or influences to surface waters via geothermal testing and to help refine baselines, thresholds, and general monitoring requirements under the ARMMP. Reporting would occur concurrently with monthly reporting requirements and submitted to the BLM and cooperating agencies as defined in Section 9.5.

9.2.2. Water Sampling

A summary of proposed groundwater sampling locations, sampling frequency, and monitoring parameters is included in Table 16A. Locations of the groundwater monitoring locations are indicated on Figure 22. It is proposed that the Contractor would sample monitoring wells on a quarterly basis, including MW-1, MW-2, MW-3, 75-4, 22-8B, 24A-8, 24-8, and 23-8. Drive point

piezometers are not proposed for sampling for chemical analyses but may be added if determined to provide meaningful data for management objectives, under the adaptive management approach.

Geothermal wells 23A-8 and 42(12)-9 would be sampled during flow/injection testing activities. Discharge water from geothermal wells would be routed to an approved sump and sampled midway through the planned discharge for chemical constituents listed in Table 15. This sampling would allow the Contractor to characterize geothermal fluids, compare geothermal fluid chemistry to shallow thermal and non-thermal water, and further understand the degree of mixing. In addition, temperature and pressure would be monitored as well.

Prior to field parameter measurement and groundwater sample collection, each well would be purged of approximately three casing volumes using a submersible pump (if well is not flowing under artesian conditions) or by allowing the well to discharge (if flowing under artesian conditions) to ensure groundwater samples are representative of aquifer water. Purge equipment would be cleaned before use at each well.

Field parameters, including temperature, pH, electrical conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity, would be measured at each groundwater monitoring location prior to sample collection using a calibrated multimeter.

At non-artesian locations, groundwater samples would be collected using a stainless steel or disposable polyethylene bailer at each well, or pump system, applicable for conditions and sampling constituents (peristaltic or positive displacement pump). At flowing-artesian locations, samples would be collected by collecting discharge water in sample bottles. Analytes, test types, analytical methods, container requirements, preservation requirements, and holding times are provided in Table 15. Analytes include potential geothermal indicators identified from initial water sampling results described in Section 7.2, including major ions and select trace metals. To quantify mixing contributions of meteoric input in groundwater at the Study Area, stable isotope samples would be collected from groundwater monitoring locations; results would be compared to isotope results of meteoric fluids near the Study Area.

USGS and EPA sampling protocols (USGS, 2018; EPA, 2016), would be followed to the degree practicable. Field instruments would be calibrated per manufacturer's recommendations to the degree practicable. Laboratory provided sampling bottles would be filled manually to the bottom of the neck (no positive meniscus – allow for a small amount of air space) from the monitoring wells. Containers do not need to be rinsed with sample water prior to sample collection, as sterile containers would be provided by a Nevada-certified laboratory. All sampling equipment would be decontaminated after each sampling event. Samples would be placed into appropriate containers provided by a Nevada-certified laboratory, labeled, and preserved with acid and/or on ice pending delivery to the laboratory. The groundwater samples would be delivered under chain-of-custody protocol to the laboratory for analysis.

9.2.3. Hydraulic Head Measurements

The Contractor would measure hydraulic head from all proposed groundwater monitoring locations, including eight non-geothermal wells (MW-1, MW-2, MW-3, 75-4, 22-8B, 24A-8, 24-8, 23-8) and fifteen drive point piezometers (DP-01 to DP-15). Locations of these groundwater monitoring locations are shown on Figure 22. The groundwater monitoring locations would be converted to continuous water level recorders during the baseline monitoring period. Hydraulic head measurements at the geothermal wells would be made during flow/injection testing activities and measured during power plant operations. At monitoring wells where the potentiometric surface is below ground surface, groundwater levels would also be measured with an electronic tape sounder prior to sample collection to calibrate pressure transducer readings to depth to groundwater. Depth to water measurements would be made from the surveyed top of the well casing. If the well is flowing artesian (i.e., the potentiometric surface is above ground surface), a pressure gauge and/or pressure transducer would be used to determine hydraulic head. The height of the measuring point above ground surface would be recorded and all water levels reported as depth below ground surface or elevation. Water elevations and pressure readings would be reported to an accuracy of one-tenth of one foot. Pressure transducers would record on an hourly interval.

9.2.4. Monitoring Schedule

It is proposed that the Contractor conduct groundwater monitoring activities (manual measurements and recorder downloads) on a monthly basis for the remainder of the baseline monitoring period, for a minimum of the first year of power plant operation. Monitoring would continue throughout the life of the project; however, the monitoring frequency and locations may vary depending on observed responses, in accordance with the adaptive management approach. In addition, the timing, frequency, and duration of groundwater monitoring may be subject to temporary changes during specific project activities (e.g., increase site specific monitoring frequency to daily hydraulic head and temperature measurements during production-injection well flow testing). Any alterations to monitoring site locations and/or the timing, frequency, and/or duration of monitoring data collection is subject to prior approval by the BLM AO.

9.2.5. Hydraulic Properties

Upon completion of additional production or injection wells, the Contractor would estimate hydraulic properties of the local aquifer (hydraulic conductivity, transmissivity, storativity, etc.) by monitoring water levels in the new well and surrounding wells during well development or aquifer testing. Additional hydrogeologic conditions would be assessed, including vertical and horizontal boundaries and aquifer type (confined, unconfined, etc.). Vertical aquifer boundaries would be noted from the lithology logs. Horizonal boundaries would be noted if indicated on time-drawdown plots produced during testing. Borehole geophysical surveys would be conducted for the depth of the borehole. The temperature of penetrated aquifers would be noted, and when feasible, water quality would be tested.

9.3. Biological Monitoring

To ensure that significant adverse effects to special status species, and the aquatic and wetland habitats on which they depend, do not occur as a result of geothermal testing and production activities, the Draft Dixie Meadows Geothermal Utilization Project EA (2017) specifies that the ARMMP include a monitoring framework for detecting and avoiding adverse impacts to these biological resources. Monitoring frameworks have been developed for several parameters indicative of aquatic and wetland habitat functionality and health, as follows:

- Hydrology—hydrological conditions that foster and maintain aquatic and wetland habitats would be monitored during the surface water monitoring program (as described in Section 9.1), and at additional locations which provide habitat to special status species;
- Extent of wetland vegetation and hydric soils;
- The distribution and abundance of special status species throughout Dixie Meadows; and,
- Habitat quality indices—known parameters of preferred habitat (e.g., water temperature) would be monitored during the surface water monitoring program (as described in Section 9.1), and at additional locations which provide habitat to special status species.

To further refine the monitoring frameworks for these biological resources and establish appropriate monitoring objectives and management triggers (see Section 9.6.2), technical working group meetings (comprised of Ormat, BLM, FNAS, USGS, USFWS, and NDOW) were held in September and October 2020; with USFWS only attending the first working group meeting due to scheduling conflicts. Biologic baseline conditions, thresholds and management actions would continue to be refined though a baseline monitoring period extending to 2022 at a minimum, in concert with the technical working group reviews that include involved federal and state agencies. The ARMMP would be updated as those monitoring data are collected and thresholds are refined. Technical working group meetings would continue past the baseline monitoring period so as if newly collected data, technical reports, or published literature suggests adaptations to baseline conditions, thresholds, and/or mitigation measures are necessary, those would be incorporated into the ARMMP under adaptive management.

9.3.1. Wetland Vegetation

The Contractor would monitor wetland vegetation in terms of percent cover and species composition using qualitative (photo points) and quantitative (Line Point Intercept [LPI] transect) monitoring methods. Wetland vegetation monitoring locations are co-located with each of the tier-1 hydrological monitoring locations (Figure 24) and additional monitoring locations will be identified based on DVT habitat monitoring findings by the USGS that are currently underway. The Contractor would analyze and report the data per Section 9.5 (Reporting Requirements).

9.3.1.1 Photo points (Qualitative monitoring)

To qualitatively monitor wetland vegetation cover over time, the Contractor would identify permanent photo points, informed by the U.S. Department of Agriculture protocol entitled

Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems (Herrick et al. 2005), at fifteen locations (Figure 21). For the life of the project, the Contractor would use quarterly photographs gathered at photo points to detect changes in vegetation structure (percent cover by functional group) and to visually document any quantifiable changes to wetland vegetation, should they be identified during quantitative monitoring (see below).

9.3.1.2 Line Point Intercept transects (Quantitative monitoring)

To quantitatively monitor wetland vegetation percent cover and plant species composition over time, permanent 50m LPI transects would be co-located with the tier-1 hydrological monitoring locations (Figure 24). In addition, 13 additional transects would be randomly placed within the predominant wetland habitats (e.g. bulrush and meadow) of each spring complex. Locations of these sites would be established with forthcoming toad distribution data from USGS and NDOW.

Line-point intercept is a rapid, accurate method for quantifying vegetation and ground surface cover, including litter, soils, and water. These measurements are related to vegetation composition, site hydrology, soil alteration, and the ability of the site to resist and recover from disturbance. Field methodology would follow the LPI protocol outlined in the AIM National Aquatic Monitoring Framework: Field Protocol for Lentic Riparian-Wetland Systems (BLM, In Progress). Transects would be monitored annually during peak flowering season (June-July) for proper identification. The Contractor would summarize and report these data per Section 9.5 (Reporting Requirements).

9.3.1.3 Aerial imagery

Drone

Should it be approved for use, a drone would be flown annually over the wetland communities of Dixie Meadows (during peak productivity) to document and monitor their extent and species composition (using red-green-blue imagery). Prior to the initial flight, reference plots (1x1m PVC frames) would be placed over plant species most representative of each wetland community, as identified during the wetland delineation (Section 5.3.3), and visually characterized in the field. Reference plots would be captured in the imagery to inform interpretations of plant species composition in subsequent imagery. The Contractor would analyze drone imagery to monitor both the overall extent and species composition of the wetland plant communities available to spring-dependent special status species (Section 9.3.3).

Satellite Imagery

The wetland delineation (Section 5.3.3) represents a snapshot of a single season in terms of wetland vegetation extent within Dixie Meadows. In addition, the mapped extent of wetland vegetation may not be representative of the variability of this resource given that the delineation was conducted in a year with above average precipitation (2.3" above average). Additional analysis is therefore needed for establishing a baseline range in variability of wetland vegetation extent in response to climate (e.g. the degree to which wetland vegetation contracts or expands due to precipitation) for the development and application of appropriate triggers for corrective action. The variability in wetland vegetation extent in response to climate, would be determined through review of historical satellite imagery (i.e. Landsat). The Normalized Difference

Vegetation Index (NDVI) would be used as a quantitative measure of wetland vegetation extent for each spring complex. NDVI data would be compared to the climatic conditions when the imagery was collected. Climatic data would be sourced from a report recently submitted to the BLM (McGinley 2020a), and from Google Earth Engine.

9.3.2. Hydric Soils

To monitor the extent of hydric soils throughout Dixie Meadows, soils would be co-located with the tier-1 hydrological monitoring sites and characterized on an annual basis using the Army Corps of Engineers Wetland Delineation Manual (ACOE 2008) and reported per Section 9.5 (Reporting Requirements). Proposed hydric soil monitoring locations are shown on Figure 24.

9.3.3. Special Status Species

Several special status species occur in the aquatic and wetland habitats of Dixie Meadows, including the Dixie Valley toad (*Anaxyrus williamsi*) and springsnails (*Pyrgulopsis* sp.). These species require stable habitat conditions and, in the case of *A. williamsi*, access to a variety of habitats throughout their lifecycle.

Available literature sources on these species were collected and reviewed as an initial step in developing monitoring frameworks for these species. This literature is summarized under each species' section below. In addition, on-going research on the Dixie Valley toad (USGS, NDOW) and springsnail monitoring (Ormat) endeavors are underway for these species. These monitoring frameworks are designed to complement this previous and on-going work and would be adaptively modified in response to the best available science (e.g., forthcoming USGS publications) and agency recommended best practices. The Contractor would analyze and report data per Section 9.5 (Reporting Requirements). Additional information on the special status species with potential to occur in the Dixie Meadows can be found in Section 3.8 (BLM Special Status Species) of the Environmental Assessment (BLM, 2017a).

9.3.3.1 Dixie Valley Toad (DVT)

Gordon et al. (2017) recently described, with genetic and morphological evidence, a new species of toad belonging to the *Anaxyrus boreas* species complex. The Dixie Valley toad (*Anaxyrus williamsi*) is restricted in range to the spring-dependent ecosystems of Dixie Meadows and is ranked as a BLM sensitive species. Forrest et al. (2013) conducted mark-recapture surveys for this species between 2009 and 2012 as part of a PhD dissertation. Recapture rates were not sufficient to accurately estimate abundance. Toads and bullfrogs (*Rana catesbeiana*) within Dixie Valley were sampled for the chytrid fungus (*Batrachochytrium dendrobatidis*). Chytrid was not found on samples taken from toads, while it was prevalent in bullfrog samples. Given the paucity of population and habitat preference data on this species, a monitoring protocol was developed by a group of stakeholders (including USGS, USFWS, BLM, NDOW, and FNAS) and implemented in 2018 (Halstead et al. 2019). Additional research into habitat preference for this species has been conducted by USGS and is set to be published by USGS in 2021. In addition to these peer-reviewed literature, there are unpublished monitoring and distribution data previously collected

by NDOW. These data are currently being curated by NDOW and will be provided to BLM in the near future for analysis and use in the ARMMP.

The monitoring framework proposed for the DVT in this document was informed primarily by technical working group discussions in September and October 2020 and by the 2019 USGS report (discussed above) titled *Monitoring Protocol Development and Assessment for Narrowly Endemic Toads in Nevada* (Halstead et al. 2019). The framework would be adaptively modified into the future in consultation with NDOW, USGS, USFWS, and BLM.

During working group discussions, USGS and NDOW specified the need for additional data collection on *A. williamsi* towards establishing a population baseline. FNAS will fund these ongoing research efforts by the USGS currently underway at least through 2021. Given current and continued research (USGS) and monitoring (NDOW) efforts underway on the distribution and habitat utilization of *A. williamsi* within Dixie Meadows, no additional monitoring surveys are being proposed for this species as part of this ARMMP. Rather, agency consultation and analysis of forthcoming agency data and habitat quality indices collected during the surface water (Section 9.1) and wetland vegetation (Section 9.3.1) monitoring programs would provide the core of this monitoring framework.

The USGS (Halstead et al. 2019) suggests using the proportion of wetland area cumulatively utilized by *A. williamsi* for reproduction (as evidenced by pre-metamorphic life stages) and occupied by adults as a metric of population health. Prior to project activities, Ormat would consult with BLM, NDOW, USFWS, USGS, and FNAS to develop a baseline and establish appropriate thresholds (Section 9.6.2, Table 19) of this metric for *A. williamsi* within the WARD. The ARMMP would be updated to reflect this agency consultation. Once project activities commence, quarterly (four times per year) consultation with cooperating agencies and analysis of their most recent data would inform whether changes over time in the proportion of area occupied by pre-metamorphic and adult life stages occur to an extent that corrective action is required (Section 9.6.2). Monitoring the extent of wetland vegetation (Section 9.3.1) would serve as an important component of this analysis by quantifying the amount of available habitat.

The USGS (Halstead et al. 2019) determined the distribution of Dixie Valley toads within the WARD to be a function of water temperature and availability of wet habitats, and that significant changes in these parameters could affect the proportion of area suitable for Dixie Valley toads. These parameters, in addition to other habitat quality indices of importance to amphibians (e.g., electrical conductivity, temperature, pH, etc.), would be gathered during the surface water monitoring program. In addition, the extent of the wetland communities (i.e. wet habitats) would be monitored (as outlined in Section 9.3.1). The Contractor would analyze these data in light of the best available science for this species, which would inform determining thresholds and triggers for corrective action in consultation with NDOW, USFWS, USGS, FNAS, and BLM (Table 19). The ARMMP would be updated to reflect this agency consultation.

The fungal pathogen *Batrachochytrium dendrobatidis* (Bd) can be lethal to amphibians. This fungus is present in many aquatic systems and has been identified in Dixie Valley associated with bullfrogs (*Rana catesbeiana*) (Forrest et al. 2013). Bd is of growing concern to cooperating

agencies and the public and monitoring efforts would be discussed with the BLM, USGS, USFWS, NDOW, and Ormat. The USGS has collected Bd samples within the Dixie Meadows (B. Halstead, personal communication, November 13, 2019). The results are unavailable for inclusion into the ARMMP at this time. However, these data may serve as a baseline for future monitoring efforts. Should the agencies deem additional monitoring efforts are warranted, the ARMMP would be updated to reflect this agency consultation. In addition to monitoring efforts, several best management practices to minimize the spread of Bd within the Dixie Meadows are included within Table 18.

9.3.3.2 Springsnails

Two hot springs located within the WARD were sampled for springsnails (*Pyrgulopsis* spp.) by Dr. Don Sada in 1991 (Dr. J. Umek, personal communication, September 2020). Springsnails were not found to be present during this survey. As part of the baseline data collection effort for this ARMMP, a springsnail survey was conducted by Ormat in October 2018 (Stantec 2019; Table 24). Two species of springsnail, representing three populations, were identified within three small and isolated springs (Spring Complex 1b) (Figure 24) after an inventory of 46 springs within the WARD. Snail collections were submitted for deoxyribonucleic (DNA) analysis. Genetic sequences for two specimens were found to be most similar to three previously described species including the Pleasant Valley pyrg (*Pyrgulopsis aurata*) (no difference in base pairs), the Cortez Hills pebblesnail (*Pyrgulopsis bryantwalkeri*) (difference of two base pairs out of 658 base pairs) and the Ovate Cain Spring pyrg (*Pyrgulopsis pictilis*) (no difference in base pairs). Currently, these three species are not considered to be genetically unique (Liu 2018a and 2018b). Genetic sequences for two other specimens indicate similarity to the Surprise Valley pyrg (*Pyrgulopsis gibba*) with a difference of three base pairs out of 658 base pairs (Liu 2018a).

During review of a preliminary ARMMP draft, BLM and USFWS requested a second springsnail survey throughout the WARD to collect additional baseline data on abundance, distribution, and habitat characteristics. A second springsnail survey was conducted in September 2020 by McGinley biologists to quantify abundance, distribution, and to document physical characteristics of occupied springs (McGinley 2020b). The 2020 survey implemented the USFWS recommended protocol titled: Appendix B - Springsnail Inventory, Monitoring, and Collecting Protocols (Sada 2019). All 117 springs identified during the surface water inventory (Section 5.2) were surveyed for springsnails. *Pyrgulopsis* spp. were encountered in the same three springs as in 2018, plus an additional two springs within spring complex 1B (Figures 24 and 25). Note that five new springs were encountered during the 2020 springsnail survey that were not identified during the surface water inventory, including spring 118. Detailed distribution, abundance, temperature, habitat, and stage data were collected at all five occupied springs (McGinley 2020b; Tables 25 and 26).

Habitat quality indices of importance to springsnails that would be monitored are maintaining consistent water quantity (flow or pool stage) and temperature. These data (water temperature and flow or pool stage) would be analyzed monthly and adaptive management and mitigation measures would be implemented in accordance with the hydrologic thresholds outlined in Section 9.6.

The Contractor would conduct springsnail abundance and distribution surveys every year at Springs 14 and 32, applying protocol consistent with Sada (2019) to permit comparative analyses of the data. Surveys would be conducted in October. Thresholds for adaptive management actions and mitigation measures, based on survey findings, are outlined in Section 9.6.

9.4. Meteorological Monitoring

A weather station would be installed to collect meteorological data, including air temperature, atmospheric pressure, humidity, wind speed, solar radiation, and precipitation. The location of the weather station is proposed to be adjacent to Complex 6. To the degree practicable, it would be installed at a secure location that is representative of natural conditions and far enough away from proposed project facilities to avoid microclimate conditions. The weather station would include soil moisture probes to the characterize the soil moisture regime of the site. The Contractor would maintain the station monthly and analyze collected data in parallel with surface water levels, spring flow rates, groundwater levels, and water chemistry to assess the degree of meteoric water input to surface water and groundwater resources. The weather station would log at a predefined frequency. The selected site would be subject to NASF permitting for installation.

9.5. Reporting Requirements

Reporting requirements described in the Guidance Document are summarized below:

- A BLM-approved third-party contractor would gather raw data, perform quality assurance and quality control tasks, analyze and interpret the compiled data, and prepare reports to be submitted to the BLM, CCDO-SFO and cooperating agencies;
- The third-party contractor would submit reports to BLM and cooperating agencies at a duration and frequency to compliment implementation of the ARMMP and would include monthly data up-loads to a data sharing portal, with flags for parameters showing trends of values near to threshold triggers; quarterly update reports for associated quarterly monitored attributes, and an annual data summary and review report;
- Reporting requirements, frequency, and/or duration may be subject to change if site-specific monitoring or adaptive management is required.

Provision of data to the BLM and cooperating agencies during the baseline monitoring period is proposed to be monthly and accomplished via database uploads to an accessible portal. The BLM and all cooperating agencies would have access to the portal for inspection and download of the data. Monthly data would be posted as provisional, to accelerate data access to the BLM and cooperating agencies. The data would go through QC review, and provisional data would be replaced with reviewed and approved data on a quarterly frequency. Each quarter, key observations would be summarized in report format, and a comprehensive report would be prepared at the conclusion of the baseline monitoring period. The baseline monitoring report would present a review of baseline conditions and thresholds and make recommendations for proposed updates to baseline conditions and thresholds based on the range of variances

observed in the flow, temperature, chemistry, and biological parameters. Any deficiencies in data collection and monitoring would be highlighted, with recommendations made for changes or augmentation.

Cooperating agency technical meetings would be scheduled on an as requested basis by the BLM, but are anticipated to a minimum of monthly meetings during power plant start-up and quarterly meetings during the pre-startup baseline data collection period. The technical (working group) meetings would be used to vet preliminary observations and interpretations, and if needed, advise the BLM on changes to the ARMMP monitoring or management activities. The technical working group would also advise the BLM on adequacy of thresholds and triggers that are implemented for monitoring objectives and for protection of hydrologic/aquatic resources and special status species.

After the baseline monitoring period, monitoring and reporting is proposed to be quarterly for a minimum of two years, with possible reduction in frequency to semi-annual or annual once monitoring indicates impacts from production are negligible. Possible reduction in monitoring and reporting is subject to consultation with cooperating agencies and approval by the BLM AO. Quarterly reports would present new monitoring data from the respective quarter and updated data tables and plots containing all monitoring data. An annual report would present data analysis and interpretations.

9.6. Identification of Potential Changes, Impacts, Thresholds, and Triggers

9.6.1. Hydrological Conditions

9.6.1.1 Potential Impacts

Potential impacts to water and aquatic resources within and adjacent to the Study Area may occur as a result of future project activities, including drilling, well development, flow/injection tests, tracer tests, aquifer tests, and geothermal power plant operations. There would be no surface disturbance in the meadows area, and the gen-tie has been relocated to the existing Dixie Valley road as part of the current proposed action for the power plant. The Proposed Actions covered under the 2017 Draft EA are discussed in Section 3.2. As described in the 2017 Draft EA (BLM, 2017a; updated October 2020), potential project impacts to water resources include:

- degradation of surface water quality by increasing erosion and sedimentation or altering spring-discharged water chemistry;
- alteration of groundwater or spring discharge water quality by changing the proportion of geothermal and fresh groundwater mixing;
- alteration of water quantity by reducing (or augmenting) spring discharge rates, decreasing groundwater supply, or interfering substantially with groundwater recharge;
- alteration of surface water temperatures;
- alteration to surface water flow paths; and,
- contamination of surface or groundwaters from spills or construction activities.

Monitoring parameters for each potential impact identified above are summarized in Table 17. The parameters listed in Table 17 would be monitored according to the program outlined in Section 9.1 and 9.2 during the continuation of the baseline monitoring period for up to 1-2 years before production activities commence. Data from the baseline monitoring period would be used to continue to evaluate the range of natural variability. Surface water and groundwater monitoring locations would be monitored for the life of the project following an adaptive management approach to adjust frequency, locations, and attributes.

9.6.1.2 Baseline Conditions and Thresholds

To establish specific high and low-end hydrologic values that would trigger a specific management response or mitigation, the baseline data collection period would ideally span over dry and wet climatic conditions. Until sufficient hydrologic data have been collected that accurately represent wet and dry periods, over seasonal and annual scales, the hydrologic baseline conditions and thresholds may be refined to best reflect hydrologic and meteorological conditions for the period of record. Initially, the baseline conditions and thresholds would be conservatively developed to account for uncertainties. Baseline conditions and thresholds are to be established in concert with cooperating agencies, and preliminary values are presented in Section 9.8. The method of establishing thresholds would be variable-specific, would reflect the natural variability of hydrological and biological conditions, and would be tied to the parameter range identified for hydrologic resources, special status species and habitat sustainability, or particular sensitivities. The purpose for development of baseline conditions and thresholds is to have specific indicators and baselines to tie threshold values to in order to determine if a management response or mitigation is required. If threshold values are exceeded during a specific timing period, the exceedance would trigger a management action or mitigation response (as described in Section 9.8, Table 18, and Table 19).

9.6.2. Biological Resources

9.6.2.1 Potential Impacts

Potential adverse impacts to spring-dependent biological resources (wetland and riparian areas and special status species), as a result of project activities and the above-mentioned potential hydrological impacts, as described in the 2017 Draft EA (BLM, 2017a), include:

- Surface disturbance during construction in upland areas could increase erosion and sedimentation to nearby springs and decrease groundwater infiltration and recharge rates in these areas. This could reduce wetland vegetation coverage in affected areas.
- The withdrawal of groundwater from the geothermal reservoir may indirectly impact wetland and riparian habitat by altering species composition or reducing wetland plant cover from reduced surface or subsurface water levels in wetland areas. Additional indirect impacts on wetland and riparian habitat would include potential for increased weed establishment and spread from soil disturbance and reduced productivity from fugitive dust generated during construction that settles on vegetation.

- Impacts on hydric soils could occur due to reductions or loss of soil saturation resulting from soil compaction, reduction in water quantity, or altered natural surface flow patterns.
- Construction activities, such as site preparation, vegetation clearing, and grading, could result in direct mortality to special status species.
- If water quality, quantity, or temperature were to be altered by geothermal utilization, this could reduce habitat suitability for certain special status species.
- Temporary effects from noise, human presence, and heavy equipment present during construction activities may lead to displacement of special status species from suitable habitat.
- Weed spread may alter habitat conditions, resulting in less suitable habitat for special status species.
- Direct impacts on sensitive plants that grow in wetland and riparian habitat are not anticipated, because construction would not occur in these areas. Indirect impacts on these plants or their habitat would be possible if geothermal utilization were to decrease wetland vegetation extent or degrade vegetation condition in the Dixie Meadows. This could reduce habitat quality for sensitive plants by altering soil moisture conditions, community composition, and increasing competition with nonnative, invasive plants.
- Direct impacts on the Dixie Valley toad in its terrestrial habitat could occur during construction of the power plants, well pads, and gen-tie line in terrestrial habitat that is near breeding habitat in Dixie Meadows. This is because toads may use terrestrial habitat to forage. They may use rodent burrows for overwintering or thermal refuge during high temperatures. There is a high likelihood that toads use terrestrial habitat near breeding habitat in Dixie Meadows; therefore, surface grading could crush or bury toads using burrows in the construction area. Moreover, toads dispersing into or through terrestrial habitat in the construction area to reach overwintering or thermal refuge areas could be crushed by vehicles or machinery.
- The project could indirectly impact Dixie Valley toad and its habitat, and suitable habitat for Dixie Valley pyrg and northern leopard frog. This would be the case if geothermal utilization or consumptive groundwater extraction for construction water were to alter suitable aquatic habitat in the Dixie Meadows by altering spring-discharged water quantity or quality or degrading surface water quality. If water quality (including temperature) or quantity were to be altered, this could reduce habitat suitability for these species. If construction water resulted in reduced spring discharges during critical breeding or egg-laying times for Dixie Valley toad, there could be substantial disruptions to life history cycles.

9.6.2.2 Baseline Conditions and Thresholds

Baseline conditions for the extent of wetland vegetation (and associated hydric soils) would continue to be established through the monitoring and adaptive management plan outlined above. Preliminary values are described in Section 9.8.

Baseline conditions have been established for the distribution and abundance of springsnails throughout the WARD (Stantec 2019; McGinley 2020b). Threshold values for management actions were established during working group sessions. Preliminary values are described in Section 9.8.

As described in Section 9.3.3, baseline conditions for the proportion of wetland area occupied by the Dixie Valley toad (pre-metamorphic and adult life stages) and hydrological parameters of importance (e.g. temperature and salinity) would be established by the BLM in consultation with NDOW, USFWS, USGS, FNAS, Ormat, and the Contractor. Baseline conditions and thresholds for management actions would likewise be refined from continued collection of baseline data. Preliminary baseline conditions and thresholds are discussed in Section 9.8.

9.7. Potential Avoidance, Management Actions, and Mitigation Measures

Table 18 lists potential avoidance, management actions and mitigation measures included in the 2017 Draft Environmental Assessment (BLM, 2017a). All avoidance measures in Table 18 have been followed since the commencement of exploration activities and would continue to be followed during pre-project construction and throughout the life of the project. BLM and Ormat may identify and agree upon other avoidance and mitigation measures beyond those listed in Table 18. Specific mitigation and action procedures would be determined as additional baseline data is collected and reviewed by technical working groups consisting of the BLM, cooperating agencies, Ormat, and the Contractor. These procedures would be devised in a hierarchical fashion such that each potential impact has mitigation options identified by degree of anticipated effectiveness. If, based on the established baseline conditions and thresholds, operations have adverse impacts on water and aquatic resources and special status species, Ormat would implement mitigation measures agreed upon by the BLM, Ormat, and cooperating agencies to reverse the impacts.

9.8. Goals & Objectives

In addition to the required monitoring described in Sections 9.1-9.3, avoidance, minimization, and mitigation measures outlined in the 2017 Draft Environmental Assessment (BLM, 2017a), the BLM would also require progress towards meeting associated goals and objectives created for the Proposed Action. Refer to Table 19 for a detailed outline of goals and objectives, baseline conditions, thresholds, and management actions/mitigation. Achievement of goals and objectives would be required to ensure project activities would not significantly impact hydrologic resources (groundwater, and thermal and cool springs and seeps), aquatic habitat (wetlands, meadows, and vegetation), or known special status species and their habitat within the Dixie Meadows area (Dixie Valley toad [DVT], springsnails, etc.). Adaptive and flexible management approaches aimed at achieving outlined goals and objectives are necessary for successful project management. Outlining clear, specific objectives, and timing of monitoring and management responses for the associated ARMMP is imperative to determine whether project actions are meeting acceptable standards; and if not, modifying project activities and

management approaches to ensure objectives are met.

Goals and objectives were formulated using multiple resources including NEPA documents (BLM and USFS 2008), established monitoring protocols and guides (BLM and ARS 2020), manuals (BLM 2008, BLM 2015), interdisciplinary team (IDT) review, and professional input and expertise with cooperating agencies. Objectives outlined for this Proposed Action may consist of a specific baseline or threshold, however, flexibility to adaptively change baseline data and thresholds would be maintained as new information from monitoring and surveys are collected throughout project operations (exploration, development, decommission, and reclamation activities). The need for changes to project operations may stem from the results of ongoing monitoring data collection and surveys, or may also stem from changes in climatic conditions, resource conditions, or other events (grazing management, flooding, wildfire, etc.). Adaptive management within the monitoring plan would be utilized to allow for changes, additions, and/or modifications of objectives, baseline conditions, and monitoring/critical thresholds to suit the goals of the project and ensure compliance with the Draft EA.

Monitoring sites applicable to achievement of these objectives were identified using specific criteria to stratify sites into two categories: tier-1 and tier-2 (Tables 20-23). Figures 24 and 25 present the locations and monitoring types proposed for tier-1 and tier-2. Criteria utilized for establishing tier-1 sites includes those sites with measurable flow, representative temperatures of spring complexes, areas of known DVT and/or springsnail populations and occurrence, areas of importance for breeding/reproduction and brumation of DVT, and dominant vegetation habitat representative of spring complexes and/or DVT populations. Tier-2 sites are those previously proposed monitoring sites described in Section 7.0 of the ARMMP as well as randomly generated locations that represent each spring complex (complexes 1-6) and associated wetland habitat types (tier-2 sites, tables 20-23). Tier-1 sites would be used as representative spring complex sites to establish baseline conditions, thresholds and evaluate exceedances of thresholds for hydrologic objectives. Tier-1 sites for aquatic habitat and/or special status species objectives would further be revised based on available information of springsnail and DVT populations and habitat occurrence from NDOW and USGS surveys. If an objective is not being achieved within the established monitoring timeframe and a threshold is exceeded at a tier-1 site, then a more detailed look at the spring complex level (tier-2 sites) would occur to determine if additional tier-2 monitoring sites within the same spring complex are also exceeding thresholds, or not achieving the objective(s). Tier-2 sites may also be revised as needed upon receipt of available information based on NDOW and USGS surveys. If a monitoring threshold or critical threshold is exceeded at a tier-1 and/or tier-2 site, then consultation between the BLM, Contractor, Ormat, and cooperating agencies would occur. Consultation, adaptive management, and mitigation would include one of three categories (see management action and critical mitigation in Table 19):

> Code A – Discuss and re-evaluate within 10 days of exceeding a threshold the monitoring indicators, baseline conditions, thresholds, and timing of monitoring to determine if additional adaptive management or mitigation is required.

Code B – Discuss and determine within 5 days the appropriate adaptive management or mitigation action to be taken.

Code C – Discuss and determine within 24 to 48 hours the appropriate adaptive management or mitigation action to be taken immediately.

Data collected for all objectives would occur on a continuous, monthly, or quarterly basis as described in Table 19 for the life of the project. Objectives would be evaluated concurrently with the timing of monitoring data collection and reporting of results (monthly, quarterly, and/or annually). The frequency, duration and timing of monitoring and reporting may increase or decrease dependent upon exceedances of thresholds as a result of meeting or not meeting monitoring objectives as determined by BLM. Monitoring objectives, indicators, baseline conditions, thresholds, and other aspects of data collection (e.g. monitoring locations), as well as management actions and mitigation measures, may be subject to modifications at any time during project operations, including exploration, utilization, decommissioning, and reclamation phases. Any changes to monitoring objectives, indicators, baselines, thresholds, locations, or the ARMMP would require prior approval from the BLM Authorized Officer (AO).

The following hydrology, aquatic habitat, and SSS goals and objectives are further delineated in Table 19. Each objective has been assigned tier-1 and tier-2 monitoring sites with representative baseline conditions, monitoring and/or critical thresholds, adaptive management, and mitigation measures. Thresholds have been established with consideration of values and ranges within the natural variation of each site during baseline data collection. Some monitoring sites do not have established baseline indicator conditions and are identified in Table 19 as “currently unknown”. Baseline conditions labeled “currently unknown” would be established upon further data collection as previously described in Section 9. In addition, critical thresholds have been established with specific consideration to SSS (springsnail and DVT thermal tolerances and populations/habitat occurrence). Adaptive management and mitigation reflect the above-mentioned categories (codes A, B, and C) and include those described in section 9.9 (Adaptive Management & Mitigation Measures).

Hydrologic, aquatic habitat, and SSS objectives are as follows:

9.8.1. Hydrology (Ground/Surface Water)

Goal 1 – Gain a clear understanding of the local hydrogeology, including areas of groundwater discharge and recharge and their potential relationships with surface water bodies, to maintain water quantity at Dixie Meadows.

Objective 1 – Maintain surface water flow and stage within ±10% or ±15gpm/20mm (whichever is less) outside the natural range of baseline conditions for 90% of tier-1 monitoring sites.

Objective 2 – Maintain hydraulic head within ±15% outside the natural range of baseline

conditions for 90% of tier-1 groundwater monitoring wells.

Goal 2 – Maintain current groundwater and surface water quality conditions at Dixie Meadows.

Objective 3 – Maintain water temperatures within ±10% or ±10°F (whichever is less) outside the natural range of baseline conditions at all tier-1 monitoring sites.

Objective 4 – Maintain field parameters within ±10% outside the natural range of baseline conditions at 85% of tier-1 monitoring sites.

Objective 5 – Maintain key geothermal indicator values* within ±15% outside the natural range of baseline concentrations at 85% tier-1 monitoring sites.

*Key geothermal indicators: SiO_2 and Mg (other geothermal constituents may apply as appropriate for site-specific locations).

9.8.2. Aquatic Habitat/Special Status Species

Goal 3 – Maintain special status species populations and life cycle diversity within Dixie Meadows.

Objective 6 – Maintain Dixie Valley toad populations (all life stages) at a minimum of >80% from baseline for 85% of USGS monitoring areas.

Objective 7 – Maintain seasonal distribution of Dixie Valley toad populations (of all life stages) at ±10% from baseline within 85% of occupied habitat of Dixie Meadows.

Objective 8 – Maintain springsnail populations (average abundance within springbrook) at >80% from baseline for tier-1 monitoring sites.

Goal 4 – Maintain appropriate hydrologic conditions (habitat quality indicators) at surface water locations occupied by springsnails and Dixie Valley toad.

Objective 9 – Maintain surface water temperature within ±1.0°C outside the natural range of springsnail thermal tolerance (as defined by the range of temperatures measured throughout the occupied spring brook at Dixie Meadows) at all springsnail occupied sites.

Objective 10 – Maintain surface water stage within ±10% outside the natural range of baseline conditions at springsnail occupied springs.

Objective 11 – Maintain surface water temperature within ±2.0°C outside the natural range of Dixie Valley toad thermal tolerance (as defined by the range of temperatures measured during population/HQI surveys at Dixie Meadows) at 85% of Dixie Valley toad occupied

springs.

Objective 12 – Maintain surface water stage within ±10% or 20mm (whichever is less) outside the natural range of baseline conditions at 85% of Dixie Valley toad occupied habitat (USGS monitoring sites).

Goal 5 – Ensure the continuity of aquatic habitats is maintained, with respect to vegetative composition, cover, hydric soils, and habitat extent.

Objective 13 – Maintain total vegetative cover and species composition (key riparian indicator species*) within ±10% outside the natural range of baseline ecological (aquatic habitat) potential for 85% of tier-1 monitoring sites.

Objective 14 – Maintain aquatic habitat extent (sum of all wetland communities in the WARD by acreage) within natural climatic variations for all habitat types within Dixie Meadows.

Objective 15 – Maintain hydric soil indicators at 85% of tier-1 monitoring sites (Table 22).

*Key riparian indicator species include those from Army Corps of Engineers (ACOE) wetland survey indicators listed in Table 2.

9.9. Adaptive Management & Mitigation Measures

Adaptive management or mitigation measures may be triggered if an indicator has exceeded a monitoring/critical threshold. The following is a general list of proposed adaptive management actions and mitigation measures that may implemented during, or following, project operations. This is not a complete list and additional adaptive management actions, or mitigation measures may be developed by the BLM, Ormat, Contractor, and/or cooperating agencies as needed to ensure goals and objectives are being achieved. Additional management actions and/or mitigation measures may be proposed throughout the life of the project (exploration, utilization, decommissioning, and reclamation phases) and would require prior approval from the BLM AO before implementation.

9.9.1. Mitigation Measures Outlined in the Proposed Action

1. Providing geothermal fluids to the affected hot springs of a quality and quantity to approximately restore the pre-production temperature; flow, stage or equivalent; and basic thermal water chemistry of the hot springs; and/or

2. Implementing appropriate geothermal reservoir management techniques to adjust the geothermal reservoir pressure regime and reduce and/or reverse these adverse effects to the springs. Such geothermal reservoir management techniques may include:

a. Modifying the volume (and/or pressure) of geothermal fluids produced from one or more production wells within the geothermal unit area field and monitor the reservoir and hot spring response; and/or

b. Modifying the volume (and/or pressure) of geothermal fluids injected into one or more injection wells within the geothermal unit area field to balance injection throughout the system either vertically or laterally and monitor the reservoir and hot spring response; and/or

c. Relocating one or more injection well(s) within the geothermal unit area*.

3. Any other measure as directed by the BLM AO which, pursuant to the lease stipulations, may include shutting down the operation.

*Relocation of production wells could prove to be difficult and not feasible/plausible; however new injection wells could also be drilled in other areas to supplement additional areas of injected water.

9.9.2. Additional Proposed Adaptive Management Actions and Mitigation Measures

Hydrology (Ground/Surface Water):

1. Increase the frequency, duration and/or timing of monitoring specific parameters at defined monitoring locations to determine if other applicable adaptive management actions or mitigation measures need to be implemented.

2. Modify (increase and/or decrease) pumping and/or injection rates of geothermal fluid until maintenance of pre-operation conditions is achieved.

3. Alter the location(s) of pumping and/or injection of geothermal fluid (into specific geological units) until maintenance of pre-operation conditions is achieved.

4. Install spring boxes and pipeline to pipe spring water directly to a discharge point while controlling flow rates.

5. Install a temporary injection pipeline from injection well(s) to spring(s) to supplement losses in water volume.

6. Install a temporary pipeline from production well(s) to spring(s) to supplement losses in water temperature.

7. Install shallow injection wells to maintain shallow groundwater levels, and indirectly support spring flows.

8. Temporary cessation of pumping and/or injection at site-specific well locations until maintenance of pre-operation conditions is achieved.

Aquatic Habitat/Special Status Species:

9. Work with cooperating agencies/partners to develop a Conservation Agreement/Conservation Strategy to assist in the management and conservation of the Dixie Valley toad (See Relict Leopard frog and Amargosa toad examples). This should be completed prior to USFWS species status review for listing under the Endangered Species Act.

10. Continue population monitoring program to better establish a population baseline and initial population trends where there are existing data research gaps. Studies could also allow for a better understanding of life history, genetics, and ecological requirements for the Dixie Valley toad. Funding would allow for a minimum of 2 additional years of baseline surveys.

11. Implement habitat manipulation and improvement projects for Dixie Valley toad as needed by direction from the NDOW and USFWS. Experimental habitat manipulation and improvement projects (e.g. modifying breeding pools, vegetation thinning, re-seeding, etc.) would be developed and implemented to enhance reproduction, recruitment, survival, and dispersal of the Dixie Valley toad.

12. Work with the BLM and the Navy to reduce the threats of grazing and/or grazing during critical periods for Special Status Species. Examples could include changes to grazing rotation, additional water troughs or supplements away from wetland habitats, and additional fencing.

13. Work with the Navy to determine if fencing of springsnail populations and associated spring sources is feasible to reduce impacts from grazing within Dixie Meadows.

14. Conduct tamarisk and other noxious and non-native weed treatments in conformance with the BLM and Navy and approved aquatic methods in the Project Weeds Management Plan to improve habitat for Special Status Species within Dixie Meadows.

15. In coordination with the NDOW, investigate predation and disease threats from non-native species (e.g. bullfrogs, crayfish, fish, etc.) for the Dixie Valley toad and springsnails and develop a program to reduce these threats within Dixie Meadows.

16. Work with the Navy to develop a public outreach and education program for Dixie Valley toad.

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TABLES

Table 1. Details for Existing Wells Near Dixie Meadows

Well ID**	Well Owner	Completion Date	Easting (m)	Northing (m)	TOC Elevation (ft amsl)	Borehole Depth (ft bgs)	Cased Depth (ft bgs)	Borehole Diameter (in.)	Well Diameter (in.)	Top of screen (ft bgs)	Bottom of Screen (ft bgs)	Well Completion Geology	SWL (ft bgs)	GW Elevation (ft amsl)
MW-1 (21-9)	-	7/27/2011	409,583.8	4,405,672.2	3,396.3	472	451	9.875	4	333 385 410	343 395 430	Quaternary alluvium and playa	24.9*	3,421.2
108770	USGS	9/15/2009	410,472.9	4,400,461.4	3,383.4	50	50	6.625	2	45	50	Quaternary playa	14.4	3,369.0
108771	USGS	9/16/2009	410,472.9	4,400,461.4	3,383.4	15	15	6.625	2	10	15	Quaternary playa	7.4	3,376.0
109435	USGS	3/19/2009	412,051.3	4,402,339.5	3,383.1	9.625	9.625	4	1	5.625	9.625	Quaternary playa	2.8	3,380.3
109491	USGS	3/17/2009	410,176.1	4,400,776.2	3,384.4	10	10	4	1	5	10	Quaternary playa	4	3,380.4
109574	USGS	3/10/2009	408,538.8	4,398,347.5	3,384.4	24.5	24.5	6.625	2	19.5	24.5	Quaternary alluvium and playa	0	3,384.4
21832	Phillips Petroleum Company	4/15/1978	-	-	-	200	200	4.75	1	N/A	N/A	Quaternary alluvium and playa	UNK	-
21833	Phillips Petroleum Company	4/1/1978	-	-	-	200	200	5.125	1	N/A	N/A	Quaternary alluvium and playa	UNK	-
23087	Nufuels Corps.	6/30/1981	-	-	-	1,460	151	UNK	UNK	N/A	N/A	Quaternary alluvium	105	-
23748	Nufuels Corps.	7/19/1981	-	-	-	500	160	8.75	6.625	N/A	N/A	Quaternary alluvium and playa	8	-
21834	BLM	n/a	-	-	-	300	300	5.625	1.25	N/A	N/A	Quaternary alluvium	UNK	-
22-8B	Ormat	7/27/2012	407,743.9	4,405,476.7	3,473.0	1,000	274	3.895	4.5	-	-	Quaternary alluvium	8.75	3,464.3
22D-8	Ormat	8/1/2019	407,755.0	4,405,482.0	3,481.6	4,010	1,342	8.5	7	N/A	N/A	Quaternary alluvium	40	3,441.6
23-8	Ormat	10/20/2015	407,916.9	4,405,313.3	3,462.8	4,700	829	3.895	4.5	-	-	Triassic siltstone	262.0*	3,724.8
23A-8	Ormat	3/2/2016	407,890.7	4,405,290.2	3,458.1	4,758	2,095	14.75	16	-	-	Triassic slate and siltstone	139	3,331.0
24(13)-8ST2	Ormat	9/21/2017	407,734.1	4,404,987.9	3,477.2	4,800	3,394	8.5-13	9.625-13.375	-	-	Triassic slate and Jurassic granodiorite	92	3,404.0
24A-8	Ormat	04/2016	407,729.0	4,404,984.4	3,483.1	750	151	3.895	4.5	-	-	Quaternary alluvium	142.9*	3,626.0
86-7	Ormat	8/9/2012	407,325.9	4,404,624.4	3,535.6	1,000	293	3.895	4.5	-	-	Quaternary alluvium	174.1*	3,709.7
42(12)-9	Ormat	10/26/2011	410,009.1	4,405,383.9	3,388.6	7,442	3,721	12.25	13.375	-	-	Tertiary tuff	273.5*	3,662.1
75-4	Ormat	1/21/2017	410,548.9	4,406,436.8	3433.0	5,476	2,493	12.25	13.375	-	-	Jurassic granodiorite and gabbro	142	3291

Data Source for well completion information: Nevada Division of Water Resources, Well Logs and Well Log Database, 2019; and Ormat (2019)
Coordinates in NAD 1983 UTM Zone 11N

* Indicate water level in feet above ground surface. Calculated from gauge pressure.

** NDWR Well Log ID Number, or Ormat ID Numaber

ft amsl feet above mean sea level
ft bgs feet below ground surface
in. inches
m meters
N/A No screened interval or information not provided in Driller's Report
SWL static water level
TOC top of casing
UNK Information not provided in Driller's Report

Table 2: Plant Species Encountered During Vegetation Surveys					
Species Code	**Species name**	**Common name**	**Functional Group**	**ACOE Wetland Indicator Status**	**Status**
APCA	*Apocynum cannabimum*	Indian hemp	Forb	FAC	Native
ATTO	*Atriplex torreyi*	Torrey's saltbush	Shrub	FACU	Native
BAHY	*Bassia hyssopifolia*	Fivehorn smotherweed	Forb	FACU	Exotic
BEER	*Berula erecta*	Cutleaf water parsnip	Forb	OBL	Native
BRTE	*Bromus tectorum*	Cheatgrass	Graminoid	UPL	Exotic
CAMI	*Castilleja minor*	Alkali Indian paintbrush	Forb	OBL	Native
CAPR	*Carex praegracilis*	Clustered field sedge	Graminoid	FACW	Native
CAPU	*Cardaria pubescens*	Hairy whitetop	Forb	UPL	Exotic
CHNA	*Chrysothamnus nauseosus*	Rubber rabbitbrush	Shrub	UPL	Native
CRRU	*Crepis runcinata*	Fiddleleaf hawksbeard	Forb	FACU	Native
DEPI	*Descurainia pinnata*	Tansy mustard	Forb	UPL	Native
DISP	*Distichlis spicata*	Inland saltgrass	Graminoid	FAC	Native
ELPA	*Eleocharis palustris*	Common spikerush	Graminoid	OBL	Native
ELRO	*Eleocharia rostellata*	Beaked spikerush	Graminoid	OBL	Native
HEAN	*Helianthus annuus*	Common sunflower	Forb	FACU	Native
HOJU	*Hordeum jubatum*	Fox-tail barley	Graminoid	FAC	Native
JUBA	*Juncus balticus*	Baltic rush	Graminoid	FACW	Native
LASE	*Lactuca serriola*	Prickly lettuce	Forb	FACU	Exotic
MELI	*Melilotus spp.*	Sweet clover	Forb	FACU	Exotic
MIGU	*Mimulus guttatus*	Seep monkey flower	Forb	OBL	Native
NIOC	*Nitrophila occidentalis*	Boraxweed	Forb	FACW	Native
PHAR	*Phalaris arundinacea*	Reed canarygrass	Graminoid	FACW	Native
POMO	*Polypogon monspeliensis*	Annual rabbitsfoot grass	Graminoid	FACW	Exotic
POSE	*Poa secunda*	Sandberg bluegrass	Graminoid	FACU	Native
SAVE	*Sarcobatus vermiculatus*	Greasewood	Shrub	FACU	Native
SCAC	*Schoenoplectus acutus*	Hardstem bulrush	Graminoid	OBL	Native
SCAM	*Schoenoplectus americanus*	Chairmakers bulrush	Graminoid	OBL	Native
SCMA	*Schoenoplectus maritimus*	Alkali bulrush	Graminoid	OBL	Native
SOSP	*Solidago spectabilis*	Nevada goldenrod	Forb	FACW	Native
SPER	*Spergularia spp.*	Sandspurry	Forb	?	Native
TRMA	*Triglochin maritima*	Seaside arrowgrass	Graminoid	OBL	Native
TYDO	*Typha domingensis*	Southern cattail	Forb	OBL	Native

Army Corp of Engineers (ACOE) Wetland Indicator Status codes:

OBL	Obligate Wetland Species (almost always occur in wetlands)
FACW	Facultative Wetland (usually occurs in wetlands, but may occur in non-wetlands)
FAC	Facultative (occurs in wetlands and non-wetlands)
FACU	Facultative Upland (usually occurs in non-wetlands, but may occur in wetlands)

Table 3. Summary of Vegetation Surveys - Wetlands

Habitat Type	# of Line Point Intercept transects	# of Daubenmire plots	Dominant Species	% Cover	ACOE Indicator	Dominance test	Prevalence Index	Hydrophytic Vegetation?	Species Richness	Other Species (% cover)
Wetland boundary	4	0	DISP	24.0	FAC	3/3 = 100%	NA	Yes	13	ELPA (10.2), CAPR (9), JUBA (7.5), HEAN (5.7), ELRO (2.7), BEER (1.5), SOSP (1.5), HOJU (1.5), ATTO (1.2), SPER (0.3)
			POMO (e)	21.3	FACW					
			SCAM	13.8	OBL					
Wetland boundary	0	20	POMO (e)	31.5	FACW	2/2 = 100%	NA	Yes	15	SCAM (15.2), CAPR (8), HEAN (6.7), ELPA (4), JUBA (3.5), ATTO (1.9), ELRO (1.8), CHNA (1.5), HOJU (1.4), BEER (1.1), POSE (0.9), MIGU (0.8), SOSP (0.3)
			DISP	15.8	FAC					
Bulrush Wetland	0	18	SCAM	70.6	OBL	1/1 = 100%	NA	Yes	6	SCAC (15.8), APCA (9.2), BEER (5.7), MIGU (1.4), SOSP (1.1)
Cattail Wetland	0	5	TYDO	31.0	OBL	2/2 = 100%	NA	Yes	3	SCAM (4.0)
			DISP	10.0	FAC					
Reed Canarygrass Wetland	0	5	PHAR	55.0	FACW	1/1 = 100%	NA	Yes	2	SCAM (2.6)
Saltgrass and Alkali Bulrush Wetland	0	10	DISP	36.0	FAC	1/1 = 100%	NA	Yes	2	SCMA (5.8)
Wet Meadow	0	15	JUBA	19.5	FACW	3/3 = 100%	NA	Yes	7	DISP (8.0), HEAN (2.4), SCAM (0.9), HOJU (0.1)
			ELPA	18.1	OBL					
			CAPR	13.3	FACW					
Field Sedge Meadow	0	10	CAPR	66.5	FACW	1/2 = 50%	2.7	Yes	8	DISP (6.7), JUBA (3.0), ELPA (2.0), HOJU (2.0), POMO (0.9 [e]), POSE (0.4)
			HEAN	33.9	FACU					
Woody Riparian	0	6	SCAM	23.8	OBL	1/2 = 50%	2.2	Yes	10	POMO (7.2 [e]), TACH (4.4 [e]), BAHY (2.6 [e]), APCA (0.8), TRMA (0.6), MELI (0.2 [e]), SOSP (0.2), TYDO (0.2)
			HEAN	11.9	FACU					

Table 3: Summary of the data collected at the eight wetland plant communities identified at Dixie Meadows. The calculation in the dominance test column is as follows: total number of dominant species across all strata / number of dominant species that are FAC or wetter. A prevalence index value was calculated only for problematic communities. An 'e' next to a species code indicates it as an exotic species to the region. See Table 2 for plant species codes.

Army Corp of Engineers (ACOE) Wetland Indicator Status codes:

OBL	Obligate Wetland Species (almost always occur in wetlands)
FACW	Facultative Wetland (usually occurs in wetlands, but may occur in non-wetlands)
FAC	Facultative (occurs in wetlands and non-wetlands)
FACU	Facultative Upland (usually occurs in non-wetlands, but may occur in wetland
UPL	Obligate Upland (almost never occurs in wetlands)

Table 4: Summary of Vegetation Surveys - Uplands										
Habitat Type	**# of Line Point Intercept transects**	**# of Daubenmire plots**	**Dominant Species**	**% Cover**	**ACOE Indicator**	**Dominance test**	**Prevalence Index**	**Hydrophytic Vegetation?**	**Species Richness**	**Other Species (% cover)**
Shrub Upland	1	0	ATTO	32.3	FACU	0/4 = 0%	NA	No	6	DISP (9.7), CHNA (6.5)
			BAHY (e)	19.4	FACU					
			BRTE (e)	16.1	UPL					
			SAVE	16.1	FACU					
Saltgrass Upland	4	0	DISP	71.6	FAC	1/3 = 33%	NA	No	12	JUBA (4.5), POSE (4.5), CRRU (2.0), CAPR (2.0), HEAN (1.5), SAVE (1.5), TRMA (1.0), PHAR (0.5), POMO (0.5 [e])
			ATTO	5.5	FACU					
			CHNA	5.0	UPL					
Saltgrass Upland	0	15	DISP	51.3	FAC	1/4 = 25%	NA	No	12	NIOC (7.3), POSE (2.1), CRRU (1.7), BAHY (0.3 [e]), CAPR (0.3), CAMI (0.2), JUBA (0.2), TRMA (0.2)
			ATTO	7.0	FACU					
			SAVE	6.7	FACU					
			CHNA	5.7	UPL					
Forb Upland	1	0	CAPR	40.0	FACW	1/2 = 50%	2.8	Yes	11	SOSP (8.9), POMO (8.9 [e]), JUBA (6.7), MELI (4.4 [e]), BRTE (4.4 [e]), CAPU (2.2 [e]), CRRU (2.2), DEPI (2.2), LASE (2.2 [e])
			HEAN	17.8	FACU					
Forb Upland	0	5	HEAN	19.4	FACU	1/2 = 50%	3.0	Yes	13	POMO (8.0 [e]), SOSP (4.6), MELI (3.0 [e]), CRRU (2.4), CAPU (1.6 [e]), BRTE (1.4 [e]), LASE (1.4 [e]), DISP (1.0), CAMI (0.6), DEPI (0.2), JUBA (0.2)
			CAPR	15.6	FACW					

Table 4: Summary of the data collected at the three upland plant communities identified at Dixie Meadows. The calculation in the dominance test column is as follows: total number of dominant species across all strata / number of dominant species that are FAC or wetter. A prevalence index value was calculated only for problematic communities. An 'e' next to a species code indicates it as an exotic species to the region. See Table 2 for plant species codes.

Army Corp of Engineers (ACOE) Wetland Indicator Status codes:

OBL	Obligate Wetland Species (almost always occur in wetlands)
FACW	Facultative Wetland (usually occurs in wetlands, but may occur in non-wetlands)
FAC	Facultative (occurs in wetlands and non-wetlands)
FACU	Facultative Upland (usually occurs in non-wetlands, but may occur in wetlands)
UPL	Obligate Upland (almost never occurs in wetlands)

Table 5. Summary of Active Water Rights near Dixie Meadows

Basin	App	App Status	Src	Qtr-Qtr	Qtr	Sec	Twn	Rng	Div Rate (CFS)	Type of Use	Priority Date	Duty (AFA)	Owner of Record
128	13267	CER	UG	NE	SW	14	22N	36E	0.00	STK	2/16/1950	1.1	ROSENLUND, JUDY
128	13269	CER	UG	NE	NE	24	21N	35E	0.00	STK	2/16/1950	1.1	ROSENLUND, JUDY
128	17272	CER	UG	SW	SW	1	21N	34E	0.10	IRR	5/14/1957	18.4	NAVAL AIR STATION -FALLON
128	21690	CER	UG	SW	NE	8	21N	35E	1.78	IRR	12/17/1963	360	NAVAL AIR STATION-FALLON
128	34303	CER	UG	NW	SW	9	21N	35E	0.13	IRR	11/29/1971	52	BARTLETT, WILLIAM S.
101	3859	CER	STR	SW	SE	2	23N	34E	0.00	STK	4/4/1916	1.44	JAMES C. ESTILL
101	52786	PER	UG	SW	SE	6	22N	34E	0.45	MM	12/20/1988	72.8	FISK/ROBERTSON MINING
128	72059	PER	UG	SW	NE	36	21N	34E	1.53	IRR	3/5/1982	1107.7	NAVAL AIR STATION-FALLON
128	72061	PER	UG	SW	SW	36	21N	34E	1.08	IRR	2/3/1955	620	NAVAL AIR STATION-FALLON
128	72062	CER	UG	SE	SE	9	21N	35E	0.04	WLD	2/3/1955	20	NAVAL AIR STATION-FALLON
128	7553	CER	STR	NW	SW	35	21N	36E	0.02	IRR	10/22/1925	6.7	STARK, CLYDE B.
128	80652	CER	UG	SE	SW	9	21N	35E	0.06	WLD	5/5/1949	29.2	NAVAL AIR STATION FALLON
128	80653	CER	UG	NE	NE	17	21N	35E	0.00	WLD	5/5/1949	0.8	NAVAL AIR STATION FALLON
128	80654	CER	UG	NE	SE	17	21N	35E	0.00	WLD	5/5/1949	2	NAVAL AIR STATION FALLON
128	80655	CER	UG	SW	SW	18	21N	35E	0.08	WLD	5/5/1949	38.4	NAVAL AIR STATION FALLON
128	80656	CER	UG	NW	NE	19	21N	35E	0.01	WLD	5/5/1949	2.4	NAVAL AIR STATION FALLON
128	80657	CER	UG	NW	NE	19	21N	35E	0.02	WLD	5/5/1949	7.6	NAVAL AIR STATION FALLON
128	80658	CER	UG	SW	NE	20	21N	35E	0.06	WLD	5/5/1949	27.6	NAVAL AIR STATION FALLON
128	80659	CER	UG	NE	NE	8	21N	35E	0.29	WLD	3/5/1982	11.2	NAVAL AIR STATION FALLON
128	80660	CER	UG	SW	NW	9	21N	35E	0.19	WLD	3/5/1982	7.2	NAVAL AIR STATION FALLON
128	80661	CER	UG	NW	NW	16	21N	35E	1.88	WLD	3/5/1982	72.8	NAVAL AIR STATION FALLON
128	80662	CER	UG	SW	NE	17	21N	35E	0.18	WLD	3/5/1982	6.8	NAVAL AIR STATION FALLON
128	80663	CER	UG	SE	NE	17	21N	35E	0.50	WLD	3/5/1982	19.2	NAVAL AIR STATION FALLON
128	80664	CER	UG	NW	NE	20	21N	35E	0.22	WLD	3/5/1982	8.4	NAVAL AIR STATION FALLON
128	80665	CER	UG	SW	NW	8	21N	35E	0.21	WLD	3/5/1982	8	NAVAL AIR STATION FALLON
128	8673	CER	SPR	NW	SW	12	23N	34E	0.00	STK	8/24/1928	1.26	MCKAY, CHARLES A.
128	8674	CER	SPR	NW	SE	11	23N	34E	0.00	STK	8/24/1928	2.88	MCKAY, CHARLES A.
128	87877	PER	SPR	NE	SE	31	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87878	PER	SPR	NW	SW	6	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87879	PER	SPR	SW	NW	7	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87881	PER	SPR	SW	SE	1	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87882	PER	SPR	SW	SE	2	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87883	PER	SPR	SW	NE	10	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87884	PER	SPR	NE	SW	20	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87885	PER	SPR	NE	SW	20	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87886	PER	SPR	NE	SW	31	22N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87887	PER	SPR	SW	NW	18	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87888	PER	SPR	NW	SW	18	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87889	PER	SPR	NW	NW	19	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87890	PER	SPR	NW	NW	29	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	87891	PER	SPR	SE	SE	30	21N	34E	0.02	STK	4/24/2018	11.96	BENCH CREEK RANCH CO, LLC
128	8896	CER	SPR	SE	NE	1	21N	34E	0.03	STK	4/3/1929	20.25	KENT LAND & LIVESTOCK CO
101	9594	CER	SPR	SW	NE	8	22N	34E	0.01	STK	6/1/1932	2.98	FISK, WILLIAM L.
101	9804	CER	SPR	SE	NE	6	22N	34E	0.03	DOM	9/17/1934	18.81	FONDAWAY GOLD MINING COMPANY
128	V04587	VST	UG	W2	SW	5	21N	35E	1.50	IRR	12/31/1904	0	TSCHETTER, RODNEY L.
101	V09823	VST	SPR	SW	SW	9	23N	34E	0.00	STK	1/1/1881	0	ESTILL, JIM
101	V09825	VST	SPR	SE	NE	8	23N	34E	0.00	STK	1/1/1881	0	ESTILL, JIM
101	V09829	VST	SPR	SW	NE	14	23N	34E	0.00	STK	1/1/1881	0	ESTILL, JIM
128	V10057	VST	SPR	SW	SE	5	22N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10058	VST	SPR	NE	SW	4	22N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10059	VST	STR	NW	NE	33	23N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10060	VST	OSW	SE	SW	14	23N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10061	VST	STR	NW	NW	2	23N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10065	VST	SPR	SW	NW	17	22N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10066	VST	OSW	NW	NE	19	22N	35E	0.01	STK	1/1/1880	0	STREMLER, MIKE AND BARBARA
128	V10206	VST	UG	SW	SE	16	21N	35E	0.05	STK	1/1/1878	0	CASEY, MICHAEL A AND CLAUDIA C

Source: Nevada division of Water Resources, Water Rights Database, July 2019.

Abbreviations:

APP = application, CER = certificated, DEC = decreed, PER = permitted, RES = reserved, RFA = ready for action, RFP = ready for action - protested, VST = claim of vested right

OSW = other surface water, SPR = spring, STR = stream, UG = underground

COM = commercial, DEC = decreed, DOM = domestic, IND = industrial, IRR = irrigation, MM = mining & milling, MMD = mining, milling & dewatering, STK = livestock watering

SUP = corresponding water right is supplemental, in whole or in part, to other water right(s)

AFA = acre-feet annually

Src Water source

Qtr Quarter

Sec Section

Twn Township

Rng Range

Div Rate Diversion Rate

CFS Cubic feet per second

Table 6. Current Monitoring Sites in Dixie Meadows				
Site ID	**Type**	**Easting (m)**	**Northing (m)**	**Elevation (ft amsl)**
MW-1	Monitoring Well	409,584.8	4,405,671.6	3,396.3
USGS-101	Spring	409,863.0	4,406,470.0	3,421.2
Spring 2	Spring	409,871.0	4,406,306.0	3,407.5
NDOWSS-1	Spring	408,476.0	4,405,816.0	3,422.5
Spring 4	Spring	408,480.0	4,405,694.0	3,421.8
Spring 5A	Spring	408,362.0	4,405,027.0	3,424.6
Spring 5B	Spring	408,372.0	4,404,969.0	3,422.5
Spring 6	Spring	408,703.0	4,406,020.0	3,419.8
Spring 7	Spring	408,336.0	4,404,172.0	3,411.3
Spring 8	Spring	408,080.0	4,403,234.0	3,408.0
USGS-301 North	Spring	407,910.2	4,403,440.4	3,413.5
USGS-301 Salt Cedar	Spring	407,867.0	4,403,375.0	3,413.1
Western Playa	Pond	409,494.0	4,405,645.0	3,397.8
Eastern Playa	Pond	409,604.0	4,405,499.0	3,395.3
Complex 2 Confluence	Channel	408,594.0	4,405,627.0	3,415.6

Coordinates in NAD 1983 UTM Zone 11N

m meters

ft amsl feet above mean sea level

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-101	6/24/2015	0900	90	67.10	-	-	-	-	-
USGS-101	6/30/2015	-	100	66.56	-	-	-	-	-
USGS-101	7/21/2015	1008	90	68.72	-	-	-	-	-
USGS-101	7/27/2015	0947	90	70.52	-	-	-	-	-
USGS-101	8/6/2015	1058	90	70.70	-	-	-	-	-
USGS-101	8/13/2015	1202	90	70.52	-	-	-	-	-
USGS-101	8/27/2015	1215	96	69.98	-	-	-	-	-
USGS-101	9/3/2015	1103	94	70.16	-	-	-	-	-
USGS-101	9/10/2015	1045	94	70.16	-	-	-	-	-
USGS-101	9/17/2015	1205	87	70.52	-	-	-	-	-
USGS-101	9/24/2015	1132	85	70.52	-	-	-	-	-
USGS-101	10/1/2015	1138	88	71.24	-	-	-	-	-
USGS-101	10/8/2015	1147	90	70.88	-	-	-	-	-
USGS-101	10/15/2015	1144	84	71.06	-	-	-	-	-
USGS-101	10/22/2015	1315	85	70.52	-	-	-	-	-
USGS-101	10/29/2015	1238	81	70.52	-	-	-	-	-
USGS-101	11/4/2015	1217	85	71.24	-	-	-	-	-
USGS-101	11/12/2015	1411	85	71.06	-	-	-	-	-
USGS-101	11/19/2015	1150	86	71.06	-	-	-	-	-
USGS-101	11/24/2015	1010	83	71.06	-	-	-	-	-
USGS-101	12/5/2015	1307	82	71.06	-	-	-	-	-
USGS-101	12/13/2015	1152	80	72.14	-	-	-	-	-
USGS-101	12/17/2015	1305	85	71.06	-	-	-	-	-
USGS-101	12/22/2015	1100	82	71.60	-	-	-	-	-
USGS-101	12/31/2015	1300	82	71.06	-	-	-	-	-
USGS-101	1/14/2016	1132	70	71.78	-	-	-	-	-
USGS-101	2/12/2016	1202	65	72.14	-	-	-	-	-
USGS-101	3/11/2016	1308	60	71.06	-	-	-	-	-
USGS-101	4/19/2016	1211	65	71.42	-	-	-	-	-
USGS-101	5/11/2016	1227	55	70.16	-	-	-	-	-
USGS-101	6/19/2016	1118	55	69.08	-	-	-	-	-
USGS-101	7/15/2016	1427	55	69.62	-	-	-	-	-
USGS-101	8/14/2016	1251	55	69.44	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-101	9/18/2016	1219	50	71.24	-	-	-	-	-
USGS-101	9/27/2016	-	-	67.20	860	-	-	-	8.1
USGS-101	10/20/2016	1138	60	71.24	-	-	-	-	-
USGS-101	11/18/2016	1038	63	70.34	-	-	-	-	-
USGS-101	12/21/2016	1045	64	71.06	-	-	-	-	-
USGS-101	1/19/2017	1055	52	70.84	-	-	-	-	-
USGS-101	2/17/2017	1226	58	70.92	-	-	-	-	-
USGS-101	3/21/2017	1153	60	70.45	-	-	-	-	-
USGS-101	4/12/2017	1117	62	69.90	996	-	-	-	-
USGS-101	4/13/2017	1230	62	69.60	1003	-	-	-	-
USGS-101	4/21/2017	1221	60	69.55	-	-	-	-	-
USGS-101	5/26/2017	1155	50	69.30	-	-	-	-	-
USGS-101	6/24/2017	1013	49	71.24	-	-	-	-	-
USGS-101	7/12/2017	1240	50	68.90	-	-	-	-	-
USGS-101	8/31/2017	1303	50	-	-	-	-	-	-
USGS-101	9/30/2017	1245	45	76.82	-	-	-	-	-
USGS-101	10/29/2017	1252	48	70.88	-	-	-	-	-
USGS-101	11/30/2017	1313	48	71.06	-	-	-	-	-
USGS-101	12/15/2017	1343	49	71.42	-	-	-	-	-
USGS-101	1/25/2018	1310	52	71.60	-	-	-	-	-
USGS-101	2/20/2018	1127	54	72.68	-	-	-	-	-
USGS-101	3/31/2018	1305	51	70.70	-	-	-	-	-
USGS-101	4/30/2018	1152	49	69.98	-	-	-	-	-
USGS-101	5/28/2018	0:00	0:00	71.42	-	-	-	-	-
USGS-101	6/25/2018	0:00	65	69.98	-	-	-	-	-
USGS-101	8/1/2018	0:00	63	70.34	-	-	-	-	-
USGS-101	8/28/2018	10:20		68.70	965	688	53.5	4.81	7.83
USGS-101	8/28/2018	10:20	0:00	71.06	-	-	-	-	-
USGS-101	9/25/2018	0.454861111	104	70.70	-	-	-	-	-
USGS-101	10/30/2018	0.576388889	96	71.42	-	-	-	-	-
USGS-101	10/30/2018	0.576388889		71.42	752	374	NM	NM	8.01
USGS-101	11/30/2018	0:00	0:00	71.06	-	-	-	-	-
USGS-101	12/11/2018	0:00	61	70.88	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-101	1/23/2019	0:00	0:00	71.06	-	-	-	-	-
USGS-101	2/22/2019	11:02		78.30	715	358	NM	NM	8.03
USGS-101	2/22/2019	10:35	0:00	71.78	-	-	-	-	-
USGS-101	5/29/2019	13:00		70.20	815	408	NM	NM	8.18
USGS-101	8/23/2019	11:11	-	68.99	985	640	NM	NM	8.06
USGS-101	12/18/2019	0	-	64.22	993	683	NM	NM	8.36
USGS-101	3/12/2020	0.479166667	-	70.40	1024	512	NM	NM	7.91
USGS-101	6/29/2020	0.489583333	-	68.30	1151	576	NM	NM	7.83
USGS-101	8/28/2020	1010	-	68.80	1001	501	NM	NM	8.03
Spring 2	6/24/2015	0915	75	67.10	-	-	-	-	-
Spring 2	6/30/2015	-	100	66.56	-	-	-	-	-
Spring 2	7/21/2015	1013	75	67.64	-	-	-	-	-
Spring 2	7/27/2015	0953	68	69.26	-	-	-	-	-
Spring 2	8/6/2015	1103	73	70.16	-	-	-	-	-
Spring 2	8/13/2015	1211	71	78.80	-	-	-	-	-
Spring 2	8/27/2015	1220	80	73.94	-	-	-	-	-
Spring 2	9/3/2015	1108	81	69.08	-	-	-	-	-
Spring 2	9/10/2015	1050	84	62.96	-	-	-	-	-
Spring 2	9/17/2015	1210	84	66.56	-	-	-	-	-
Spring 2	9/24/2015	1138	88	61.34	-	-	-	-	-
Spring 2	10/1/2015	1142	89	62.78	-	-	-	-	-
Spring 2	10/8/2015	1150	91	61.34	-	-	-	-	-
Spring 2	10/15/2015	1150	90	60.44	-	-	-	-	-
Spring 2	10/22/2015	1320	93	57.38	-	-	-	-	-
Spring 2	10/29/2015	1240	91	54.86	-	-	-	-	-
Spring 2	11/4/2015	1221	93	48.02	-	-	-	-	-
Spring 2	11/12/2015	1416	95	45.86	-	-	-	-	-
Spring 2	11/19/2015	1154	96	45.68	-	-	-	-	-
Spring 2	11/24/2015	1015	97	38.84	-	-	-	-	-
Spring 2	12/5/2015	1313	95	37.04	-	-	-	-	-
Spring 2	12/13/2015	1154	92	42.62	-	-	-	-	-
Spring 2	12/17/2015	1310	95	33.80	-	-	-	-	-
Spring 2	12/22/2015	1106	96	42.80	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
Spring 2	12/31/2015	1305	105	32.18	-	-	-	-	-
Spring 2	1/14/2016	1136	104	34.16	-	-	-	-	-
Spring 2	2/12/2016	1206	100	44.96	-	-	-	-	-
Spring 2	3/11/2016	1314	105	56.48	-	-	-	-	-
Spring 2	4/19/2016	1216	107	64.04	-	-	-	-	-
Spring 2	5/11/2016	1232	105	61.34	-	-	-	-	-
Spring 2	6/19/2016	1124	0	-	-	-	-	-	-
Spring 2	7/15/2016	1431	0	-	-	-	-	-	-
Spring 2	8/14/2016	1257	0	-	-	-	-	-	-
Spring 2	9/18/2016	1223	0	-	-	-	-	-	-
Spring 2	10/20/2016	1140	0	-	-	-	-	-	-
Spring 2	11/18/2016	1045	85	36.79	-	-	-	-	-
Spring 2	12/21/2016	1050	95	31.98	-	-	-	-	-
Spring 2	1/19/2017	1103	85	32.50	-	-	-	-	-
Spring 2	2/17/2017	1230	0	-	-	-	-	-	-
Spring 2	3/21/2017	1158	0	-	-	-	-	-	-
Spring 2	4/12/2017	1145	89	50.00	1150	-	-	-	-
Spring 2	4/13/2017	1247	95	47.10	1169	-	-	-	-
Spring 2	4/21/2017	1225	90	54.03	-	-	-	-	-
Spring 2	5/26/2017	1200	94	61.52	-	-	-	-	-
Spring 2	6/24/2017	1020	90	67.28	-	-	-	-	-
Spring 2	7/12/2017	1251	75	78.44	-	-	-	-	-
Spring 2	8/31/2017	1309	85	111.38	-	-	-	-	-
Spring 2	9/30/2017	1252	93	76.28	-	-	-	-	-
Spring 2	10/29/2017	1300	98	46.22	-	-	-	-	-
Spring 2	11/30/2017	1319	100	40.28	-	-	-	-	-
Spring 2	12/15/2017	1348	-	-	-	-	-	-	-
Spring 2	1/25/2018	1315	95	35.78	-	-	-	-	-
Spring 2	2/20/2018	1134	109	34.34	-	-	-	-	-
Spring 2	3/31/2018	1309	102	45.68	-	-	-	-	-
Spring 2	4/30/2018	1155	103	47.84	-	-	-	-	-
Spring 2	5/28/2018	1215	150	59.72	-	-	-	-	-
Spring 2	6/25/2018	1255	125	67.10	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
Spring 2	8/1/2018	1255	126	75.02	-	-	-	-	-
Spring 2	8/28/2018	1040	135	66.02	-	-	-	-	-
Spring 2	9/25/2018	1100	175	60.62	-	-	-	-	-
Spring 2	10/30/2018	0:00	0:00	56.48	-	-	-	-	-
Spring 2	11/30/2018	0:00	0:00	39.56	-	-	-	-	-
Spring 2	12/11/2018	0:00	0:00	38.48	-	-	-	-	-
Spring 2	1/23/2019	1050	180	34.34	-	-	-	-	-
Spring 2	2/22/2019	1040	182	34.34	-	-	-	-	-
Spring 2	8/28/2018	0.444444444	-	63.28	1728	1313	17.2	1.54	6.34
Spring 2	2/22/2019	0.451388889	-	32.90	921	461	NM	NM	8.02
Spring 2	5/29/2019	0.574305556	-	80.90	928	NM	NM	NM	7.81
NDOW-SS1	6/24/2015	1002	64	143.60	-	-	-	-	-
NDOW-SS1	6/30/2015	-	67	142.52	-	-	-	-	-
NDOW-SS1	7/21/2015	1030	71	141.26	-	-	-	-	-
NDOW-SS1	7/27/2015	1013	71	142.16	-	-	-	-	-
NDOW-SS1	8/6/2015	1050	72	142.70	-	-	-	-	-
NDOW-SS1	8/13/2015	1225	72	143.24	-	-	-	-	-
NDOW-SS1	8/27/2015	1238	70	147.56	-	-	-	-	-
NDOW-SS1	9/3/2015	1122	74	144.14	-	-	-	-	-
NDOW-SS1	9/10/2015	1108	75	145.94	-	-	-	-	-
NDOW-SS1	9/17/2015	1226	73	142.16	-	-	-	-	-
NDOW-SS1	9/24/2015	1157	75	145.76	-	-	-	-	-
NDOW-SS1	10/1/2015	1153	75	143.96	-	-	-	-	-
NDOW-SS1	10/8/2015	1202	75	144.14	-	-	-	-	-
NDOW-SS1	10/15/2015	1203	74	143.96	-	-	-	-	-
NDOW-SS1	10/22/2015	1331	38	142.52	-	-	-	-	-
NDOW-SS1	10/29/2015	1310	39	141.44	-	-	-	-	-
NDOW-SS1	11/4/2015	1300	30	140.18	-	-	-	-	-
NDOW-SS1	11/12/2015	1433	34	138.56	-	-	-	-	-
NDOW-SS1	11/19/2015	1234	37	138.56	-	-	-	-	-
NDOW-SS1	11/24/2015	1028	40	138.20	-	-	-	-	-
NDOW-SS1	12/5/2015	1332	40	137.12	-	-	-	-	-
NDOW-SS1	12/13/2015	1210	44	130.82	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
NDOW-SS1	12/17/2015	1341	44	135.68	-	-	-	-	-
NDOW-SS1	12/22/2015	1125	43	132.98	-	-	-	-	-
NDOW-SS1	12/31/2015	1327	44	132.26	-	-	-	-	-
NDOW-SS1	1/14/2016	1149	45	134.78	-	-	-	-	-
NDOW-SS1	2/12/2016	1223	45	136.94	-	-	-	-	-
NDOW-SS1	3/11/2016	1404	55	136.58	-	-	-	-	-
NDOW-SS1	4/19/2016	1231	41	140.00	-	-	-	-	-
NDOW-SS1	5/11/2016	1250	41	140.36	-	-	-	-	-
NDOW-SS1	6/19/2016	1137	44	141.62	-	-	-	-	-
NDOW-SS1	7/15/2016	1444	51	142.34	-	-	-	-	-
NDOW-SS1	8/14/2016	1315	49	147.02	-	-	-	-	-
NDOW-SS1	9/18/2016	1240	48	145.94	-	-	-	-	-
NDOW-SS1	9/27/2016	-	-	>120	1320	-	-	-	-
NDOW-SS1	10/20/2016	1200	41	142.13	-	-	-	-	-
NDOW-SS1	11/18/2016	1105	40	138.33	-	-	-	-	-
NDOW-SS1	12/21/2016	1112	40	135.82	-	-	-	-	-
NDOW-SS1	1/19/2017	1120	45	135.43	-	-	-	-	-
NDOW-SS1	2/17/2017	1216	45	136.71	-	-	-	-	-
NDOW-SS1	3/21/2017	1145	45	137.91	-	-	-	-	-
NDOW-SS1	4/12/2017	1239	65	140.40	1196	-	-	-	-
NDOW-SS1	4/13/2017	1312	65	139.20	1201	-	-	-	-
NDOW-SS1	4/21/2017	1210	67	139.28	-	-	-	-	-
NDOW-SS1	5/26/2017	1145	70	140.25	-	-	-	-	-
NDOW-SS1	6/24/2017	1036	70	144.14	-	-	-	-	-
NDOW-SS1	7/12/2017	1234	75	145.22	-	-	-	-	-
NDOW-SS1	8/31/2017	1328	75	147.38	-	-	-	-	-
NDOW-SS1	9/30/2017	1307	75	142.70	-	-	-	-	-
NDOW-SS1	10/29/2017	1315	88	145.94	-	-	-	-	-
NDOW-SS1	11/30/2017	1334	90	140.36	-	-	-	-	-
NDOW-SS1	12/15/2017	0:00	0:00	138.02	-	-	-	-	-
NDOW-SS1	1/25/2018	1325	91	136.94	-	-	-	-	-
NDOW-SS1	2/20/2018	1157	95	137.66	-	-	-	-	-
NDOW-SS1	3/31/2018	0:00	0:00	134.60	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
NDOW-SS1	4/30/2018	1258	110	141.26	-	-	-	-	-
NDOW-SS1	5/28/2018	1306	80	147.02	-	-	-	-	-
NDOW-SS1	6/25/2018	1310	95	145.04	-	-	-	-	-
NDOW-SS1	8/1/2018	1345	95	148.10	-	-	-	-	-
NDOW-SS1	8/28/2018	0.486111111	-	160.54	2,717	937	4.7	0.18	8.52
NDOW-SS1	8/28/2018	0:00	0:00	148.46	-	-	-	-	-
NDOW-SS1	9/25/2018	0:00	0:00	145.76	-	-	-	-	-
NDOW-SS1	10/30/2018	10:40	-	143.24	-	-	-	-	-
NDOW-SS1	10/30/2018	0:00	0:00	143.24	-	-	-	-	-
NDOW-SS1	11/30/2018	0:00	0:00	139.46	-	-	-	-	-
NDOW-SS1	12/11/2018	0:00	0:00	137.84	-	-	-	-	-
NDOW-SS1	1/23/2019	1215	0:00	136.76	-	-	-	-	-
NDOW-SS1	2/22/2019	0:00	0:00	136.04	-	-	-	-	-
NDOW-SS1	2/22/2019	13:00	-	134.80	976	487	-	-	7.85
NDOW-SS1	5/29/2019	14:55	-	138.70	1,020	510	-	-	8.19
NDOW-SS1	8/23/2019	11:40	-	159.71	1,399	909	-	-	7.87
NDOW-SS1	12/18/2019	11:35	-	133.30	1,313	908	-	-	8.33
NDOW-SS1	3/12/2020	12:00	-	156.20	2,888	1444	-	-	7.55
NDOW-SS1	6/29/2020	12:10	-	159.30	3,376	1,688	-	-	7.52
NDOW-SS1	8/28/2020	0915	-	158.20	2,896	1,448	-	-	7.68
Spring 4	4/12/2017	1300	0:00	165.20	954	-	-	-	-
Spring 4	4/13/2017	1331	0:00	164.70	956	-	-	-	-
Spring 4	8/28/2018	12:43	-	163.61	2,147	727	1.4	0.05	9.17
Spring 4	2/22/2019	12:30	-	163.76	939	469	-	-	7.97
Spring 4	5/29/2019	15:40	-	158.70	920	-	-	-	8.47
Spring 5A	4/12/2017	0:00	448	129.10	1,007	-	-	-	-
Spring 5A	4/13/2017	0:00	450	125.60	1,012	-	-	-	-
Spring 5A	8/28/2018	13:28	-	139.77	1,089	425	17.9	0.78	9.18
Spring 5A	2/22/2019	13:28	-	114.00	924	465	-	-	7.9
Spring 5A	5/30/2019	10:09	-	129.56	1,106	-	-	-	9.03
Spring 5B	8/28/2018	0.572916667	-	123.99	1,820	787	107	6	9
Spring 5B	2/22/2019	0.566666667	-	104.80	867	433	-	-	8
Spring 5B	5/30/2019	0.409722222	-	112.64	1,126	-	-	-	9

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
Spring 6	8/28/2018	0.511111111	-	140.55	4,985	1,936	50	2	8
Spring 6	2/22/2019	0.509027778	-	105.10	1,870	917	-	-	7
Spring 6	5/29/2019	0.607638889	-	126.00	1,760	-	-	-	8
Spring 7	8/28/2018	0.5875	-	115.19	2,785	1,291	22	1	8
Spring 7	2/22/2019	0.579861111	-	108.20	1,113	568	-	-	8
Spring 7	5/30/2019	0.545833333	-	112.46	1,475	-	-	-	8
Spring 8	8/28/2018	0.625	-	69.57	1,539	1,085	11	1	7
Spring 8	2/22/2019	0.614583333	-	34.30	1,391	677	-	-	7
Spring 8	5/30/2019	0.48125	-	60.80	1,481	-	-	-	8
USGS-301 North	6/24/2015	1015	1124	86.90	-	-	-	-	-
USGS-301 North	6/30/2015	-	1127	86.90	-	-	-	-	-
USGS-301 North	7/21/2015	1110	1118	88.52	-	-	-	-	-
USGS-301 North	7/27/2015	1045	1095	88.88	-	-	-	-	-
USGS-301 North	8/6/2015	1128	1095	88.70	-	-	-	-	-
USGS-301 North	8/13/2015	1256	1095	90.86	-	-	-	-	-
USGS-301 North	8/27/2015	1308	1090	90.68	-	-	-	-	-
USGS-301 North	9/3/2015	1150	1089	89.96	-	-	-	-	-
USGS-301 North	9/10/2015	1132	1089	89.60	-	-	-	-	-
USGS-301 North	9/17/2015	1255	1080	89.42	-	-	-	-	-
USGS-301 North	9/24/2015	1223	1080	90.14	-	-	-	-	-
USGS-301 North	10/1/2015	1215	1080	89.78	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-301 North	10/8/2015	1224	1080	89.96	-	-	-	-	-
USGS-301 North	10/15/2015	1421	1080	90.14	-	-	-	-	-
USGS-301 North	10/22/2015	1400	1074	89.42	-	-	-	-	-
USGS-301 North	10/29/2015	1339	1074	89.78	-	-	-	-	-
USGS-301 North	11/4/2015	1336	1080	89.06	-	-	-	-	-
USGS-301 North	11/12/2015	1502	1067	89.06	-	-	-	-	-
USGS-301 North	11/19/2015	1304	1054	89.24	-	-	-	-	-
USGS-301 North	11/24/2015	1053	1060	88.16	-	-	-	-	-
USGS-301 North	12/5/2015	1417	1054	89.24	-	-	-	-	-
USGS-301 North	12/13/2015	1302	1054	88.16	-	-	-	-	-
USGS-301 North	12/17/2015	1517	1060	88.52	-	-	-	-	-
USGS-301 North	12/31/2015	1422	1060	87.98	-	-	-	-	-
USGS-301 North	1/14/2016	1225	1060	88.34	-	-	-	-	-
USGS-301 North	2/12/2016	1258	1048	88.52	-	-	-	-	-
USGS-301 North	3/11/2016	1444	1060	89.78	-	-	-	-	-
USGS-301 North	4/19/2016	1327	1092	88.34	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-301 North	5/11/2016	1330	1092	88.16	-	-	-	-	-
USGS-301 North	6/19/2016	1221	1092	89.24	-	-	-	-	-
USGS-301 North	7/15/2016	1515	1073	89.78	-	-	-	-	-
USGS-301 North	8/14/2016	1352	1066	90.50	-	-	-	-	-
USGS-301 North	9/18/2016	1329	1066	90.14	-	-	-	-	-
USGS-301 North	9/27/2016	-	-	77.10	1,240	-	-	-	8
USGS-301 North	9/27/2016	-	-	86.70	1,280	-	-	-	8
USGS-301 North	10/20/2016	1245	1066	87.08	-	-	-	-	-
USGS-301 North	11/18/2016	1147	1066	86.72	-	-	-	-	-
USGS-301 North	2/17/2017	1055	1048	86.16	-	-	-	-	-
USGS-301 North	3/21/2017	1102	1035	87.37	-	-	-	-	-
USGS-301 North	4/21/2017	1055	1035	86.76	-	-	-	-	-
USGS-301 North	5/26/2017	1046	1041	87.40	-	-	-	-	-
USGS-301 North	6/24/2017	0:00	1041	89.06	-	-	-	-	-
USGS-301 North	7/12/2017	1128	1041	90.86	-	-	-	-	-
USGS-301 North	8/31/2017	1406	1105	90.32	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-301 North	9/30/2017	1433	1143	88.88	-	-	-	-	-
USGS-301 North	10/29/2017	0:00	0:00	89.06	-	-	-	-	-
USGS-301 North	11/30/2017	1443	1137	80.96	-	-	-	-	-
USGS-301 North	12/15/2017	1520	1118	87.44	-	-	-	-	-
USGS-301 North	1/25/2018	1414	1143	84.92	-	-	-	-	-
USGS-301 North	2/20/2018	1320	1105	82.04	-	-	-	-	-
USGS-301 North	3/31/2018	0:00	2:24	88.88	-	-	-	-	-
USGS-301 North	4/30/2018	0:00	2:24	88.34	-	-	-	-	-
USGS-301 North	5/28/2018	1345	0:00	90.32	-	-	-	-	-
USGS-301 North	6/25/2018	1401	19:12	90.14	-	-	-	-	-
USGS-301 North	8/1/2018	1427	1:12	91.22	-	-	-	-	-
USGS-301 North	8/28/2018	0.614583333	-	87.99	1,621	944	44	3.25	7.78
USGS-301 North	8/28/2018	1451	9:36	90.86	-	-	-	-	-
USGS-301 North	9/25/2018	0:00	0:00	90.86	-	-	-	-	-
USGS-301 North	10/26/2018	0:00	0:00	89.96	-	-	-	-	-
USGS-301 North	10/30/2018	12:00	-	89.40	1,010	500	NM	NM	8.14

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-301 North	11/30/2018	0:00	0:00	90.68	-	-	-	-	-
USGS-301 North	12/11/2018	0:00	0:00	90.32	-	-	-	-	-
USGS-301 North	1/23/2019	0:00	0:00	90.14	-	-	-	-	-
USGS-301 North		0:00	0:00	89.24	-	-	-	-	-
USGS-301 North	2/22/2019	14:10	-	87.70	1,040	520	NM	NM	7.89
USGS-301 North	5/30/2019	0.459027778	-	88.34	1,342	671	NM	NM	8.74
USGS-301 North	8/23/2019	12:45	-	89.55	1,363	885	NM	NM	8.16
USGS-301 North	12/18/2020	13:05	-	66.56	1,335	934	NM	NM	8.5
USGS-301 North	3/12/2020	12:55	-	89.50	1,744	872	NM	NM	7.89
USGS-301 North	6/29/2020	13:40	-	89.90	1,991	996	NM	NM	7.91
USGS-301 North	8/28/2020	0:00	-	87.20	1,594	797	NM	NM	7.88
USGS-301 Salt Cedar	8/28/2018	14:00	-	76.55	1,505	983	74.2	6.14	8.15
USGS-301 Salt Cedar	10/30/2018	12:35	-	90.32	1,060	530	NM	NM	7.73
USGS-301 Salt Cedar	2/22/2019	14:21	-	74.20	1,090	545	NM	NM	7.33
USGS-301 Salt Cedar	5/30/2019	0.488194444	-	77.18	1,442	721	NM	NM	7.99
USGS-301 Salt Cedar	8/23/2019	0.541666667	-	76.80	1,419	922	NM	NM	7

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
USGS-301 Salt Cedar	12/18/2019	0.545138889	-	66.56	1,442	1,029	NM	NM	8
USGS-301 Salt Cedar	3/12/2020	0.545138889	-	75.10	1,520	760	NM	NM	7
USGS-301 Salt Cedar	6/29/2020	0.5625	-	62.30	1,666	833	NM	NM	7
USGS-301 Salt Cedar	8/28/2020	1100	-	66.50	1,433	717	NM	NM	7
MW-1	8/28/2018	0.463194444	-	73.24	5,988	4,054	51	4	8
MW-1	10/30/2018	0.458333333	-	71.30	>3999	>2000	NM	NM	8
MW-1	2/22/2019	0.477083333	-	72.10	>3999	>2000	NM	NM	8
MW-1	5/29/2019	0.496527778	-	73.50	3,040	1,520	NM	NM	8
MW-1	8/23/2019	0.506944444	-	73.71	5,786	3,764	NM	NM	8
MW-1	12/18/2019	0.5	-	68.00	5,684	4,588	NM	NM	8
MW-1	3/12/2020	0.513888889	-	73.20	6,129	3,065	NM	NM	8
MW-1	6/29/2020	0.527777778	-	72.80	7,045	3,523	NM	NM	8
MW-1	8/28/2020	1150	-	73.30	6,129	3,065	NM	NM	8
Western Playa	6/24/2015	1215	91	79.16	-	-	-	-	-
Western Playa	6/30/2015	-	29	78.62	-	-	-	-	-
Western Playa	7/21/2015	1055	0	-	-	-	-	-	-
Western Playa	7/27/2015	1029	0	-	-	-	-	-	-
Western Playa	8/6/2015	1230	0	-	-	-	-	-	-
Western Playa	8/13/2015	1243	0	-	-	-	-	-	-
Western Playa	8/27/2015	1256	0	-	-	-	-	-	-
Western Playa	9/3/2015	1142	0	-	-	-	-	-	-
Western Playa	9/10/2015	1123	0	-	-	-	-	-	-
Western Playa	9/17/2015	1239	0	-	-	-	-	-	-
Western Playa	9/24/2015	1210	0	-	-	-	-	-	-
Western Playa	10/1/2015	1210	0	-	-	-	-	-	-
Western Playa	10/8/2015	1206	0	-	-	-	-	-	-
Western Playa	10/15/2015	1210	0	-	-	-	-	-	-
Western Playa	10/22/2015	1335	0	-	-	-	-	-	-
Western Playa	10/29/2015	1325	0	-	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites									
Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
Western Playa	11/4/2015	1320	210	49.46	-	-	-	-	-
Western Playa	11/12/2015	1450	255	51.80	-	-	-	-	-
Western Playa	11/19/2015	1248	284	48.56	-	-	-	-	-
Western Playa	11/24/2015	1040	288	40.64	-	-	-	-	-
Western Playa	12/5/2015	1356	299	41.18	-	-	-	-	-
Western Playa	12/13/2015	1227	297	43.52	-	-	-	-	-
Western Playa	12/17/2015	1410	308	34.88	-	-	-	-	-
Western Playa	12/22/2015	1151	337	43.88	-	-	-	-	-
Western Playa	12/31/2015	1357	330	33.62	-	-	-	-	-
Western Playa	1/14/2016	1203	-	-	-	-	-	-	-
Western Playa	2/12/2016	1237	334	50.18	-	-	-	-	-
Western Playa	3/11/2016	1426	339	57.38	-	-	-	-	-
Western Playa	4/19/2016	1248	332	69.26	-	-	-	-	-
Western Playa	5/11/2016	1309	335	73.04	-	-	-	-	-
Western Playa	6/19/2016	1205	0	-	-	-	-	-	-
Western Playa	7/15/2016	1500	0	-	-	-	-	-	-
Western Playa	8/14/2016	1336	0	-	-	-	-	-	-
Western Playa	9/18/2016	1310	0	-	-	-	-	-	-
Western Playa	10/20/2016	1230	0	-	-	-	-	-	-
Western Playa	11/18/2016	1128	278	42.49	-	-	-	-	-
Western Playa	12/21/2016	1138	320	37.76	-	-	-	-	-
Western Playa	1/19/2017	1142	345	41.25	-	-	-	-	-
Western Playa	2/17/2017	1152	334	53.31	-	-	-	-	-
Western Playa	3/21/2017	1127	340	59.83	-	-	-	-	-
Western Playa	4/21/2017	1145	350	62.67	-	-	-	-	-
Western Playa	5/26/2017	1125	285	69.40	-	-	-	-	-
Western Playa	6/24/2017	1130	0	-	-	-	-	-	-
Western Playa	7/12/2017	1215	0	-	-	-	-	-	-
Western Playa	8/31/2017	1350	0	-	-	-	-	-	-
Western Playa	9/30/2017	1400	0	-	-	-	-	-	-
Western Playa	10/29/2017	1315	0	-	-	-	-	-	-
Western Playa	11/30/2017	1356	190	49.64	-	-	-	-	-
Western Playa	12/15/2017	1505	320	38.84	-	-	-	-	-

Table 7. Summary of Field Parameter Measurements at Current Monitoring Sites

Site ID	Date	Time	Water Depth (mm)	Temp (°F)	EC (uS/cm)	TDS (mg/L)	DO (%)	DO (mg/L)	pH
Western Playa	1/25/2018	0:00	0:00	45.14	-	-	-	-	-
Western Playa	2/20/2018	0:00	0:00	44.24	-	-	-	-	-
Western Playa	3/31/2018	0:00	0:00	67.46	-	-	-	-	-
Western Playa	43220	1327	338	64.76	-	-	-	-	-
Western Playa	43248	1333	338	82.04	-	-	-	-	-
Western Playa	43276	1330	0	-	-	-	-	-	-
Western Playa	43313	1412	0	-	-	-	-	-	-
Western Playa	43340	1135	0	-	-	-	-	-	-
Western Playa	43368	1205	0	-	-	-	-	-	-
Western Playa	43403	1125	0	-	-	-	-	-	-
Western Playa	43434	1135	309	42.98	-	-	-	-	-
Western Playa	43445	1140	336	40.64	-	-	-	-	-
Western Playa	43488	1150	352	41.72	-	-	-	-	-
Western Playa	43518	1230	354	44.06	-	-	-	-	-
Western Playa	43614	0.482638889	-	73.50	2300	NM	NM	NM	9.56
Eastern Playa	43614	0.506944444	-	76.00	3450	NM	NM	NM	9.2
Dixie Spring Complex Confluence	43614	0.680555556	-	117.90	880	NM	NM	NM	8.52

°F	degrees fahrenheit	EC	electircal conductivity
uS/cm	microsiemens per centimeter	TDS	total dissolved solids
mg/L	milligrams per liter	mm	millimeters
%	percentage		
ORP	oxidation-reduction potential		
>	greater than		

Data sources:

McGinley	Data collected by McGinley & Associates, Inc.
Rubicon	Data collected and reported by Rubicon Environmental Consulting (Rubicon, 2018)

ORP	**Data source**
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Table 8. Summary of Water Chemistry Data

Site ID	Sample Date	TDS	Aluminum	Antimony	Arsenic	Boron	Bromide	Iron	Lithium	Strontium	Silica	Calcium	Magnesium	Sodium	Potassium	Fluoride	Sulfate	Chloride	Bicarbonate (HCO3)	Source
Valley-Floor Springs																				
USGS-101	8/28/2018	520	<0.050	<0.0025	0.0210	0.94	<0.50 D	0.02	0.21	0.26	46	20	4.2	180	1.4	12	120	150	110	Mcginley
	10/30/2018	550	0.14	<0.0025	0.0230	1.1	N/A	0.15	0.24	0.28	52	21	4.8	250	1.6	9.4	110	140	110	Mcginley
	2/22/2019	540	66	0.0075	0.1500	1.4	N/A	77	0.55	1.1	180	57	40	210	15	11	99	130	110	Mcginley
	5/30/2019	540	<0.050	<0.0025	0.0210	0.92	N/A	<0.10	0.20	0.25	44	17	4	160	1.3	10	110	150	110	Mcginley
	8/23/2019	570	0.09	<0.0025	0.022	0.96	N/A	<0.10	0.21	0.25	43	18	3.9	170	1.5	11	120	150	110	Mcginley
	12/18/2019	580	<0.050	NA	0.022	0.96	NA	<0.10	0.21	0.26	44	19	3.9	210	1.4	11	110	140	110	Mcginley
	3/12/2020	590	<0.050	<0.0025	0.021	0.98	NA	<0.10	0.19	0.25	41	19	4	150	1.4	10	120	140	110	Mcginley
	6/29/2020	640	0.062	<0.0025	0.021	0.92	NA	<0.10	0.2	0.27	42	19	4	160	1.3	11	130	150	110	Mcginley
	8/28/2020	540	<0.050	<0.0025	0.022	0.99	NA	<0.10	0.23	0.28	46	20	4.2	180	1.5	9.2	110	140	110	Mcginley
Spring 2	8/28/2018	1,200	6.10	<0.0025	0.0480	2.1	0.71	9.9	0.58	N/A	90	52	15	530	6.3	24	160	380	310	Mcginley
	5/29/2019	600	4.7	<0.0025	0.0530	1.5	<0.75	3.8	0.26	0.39	29	26	6.6	250	2.7	11	120	160	140	Mcginley
NDOWSS-1	8/28/2018	760	0.99 M	0.0028	<0.0050	0.91	<1.0 D	0.98	0.45	0.52	100	17	0.73	270 SC	7.9	13	110	260	77	Mcginley
	10/30/2018	670	0.78	<0.0025	<0.0050	0.92	N/A	0.73	0.49	0.54	110	17	0.81	270	8	10	95	240	76	Mcginley
	2/22/2019	690	<0.050	<0.0025	<0.0050	0.9	N/A	<0.020	0.43	0.26	96	13	<0.50	210	5.8	11	110	200	57	Mcginley
	5/29/2019	630	0.053	<0.0025	<0.0050	0.89	N/A	<0.10	0.40	0.25	97	11	<0.50	190	5.7	11	110	210	65	Mcginley
	8/23/2019	760	0.85	<0.0025	<0.0050	0.92	N/A	0.67	0.45	0.38	98	14	0.59	260	7.8	13	130	240	79	Mcginley
	12/18/2019	750	0.14	NA	<0.0050	0.85	NA	<0.10	0.41	0.48	79	16	<0.50	270	7	11	130	250	73	Mcginley
	3/12/2020	890	<0.050	<0.0025	<0.0050	0.9	NA	<0.10	0.41	0.47	87	16	<0.50	220	7.1	4	170	230	72	Mcginley
	6/29/2020	770	0.089	<0.0025	<0.0050	0.83	NA	<0.10	0.40	0.49	88	15	<0.50	270	7	12	140	270	69	Mcginley
	8/28/2020	780	0.095	<0.0025	<0.0050	0.94	NA	<0.10	0.49	0.54	99	17	<0.50	250	8.3	10	130	250	73	Mcginley
Spring 4	11/30/2011	560	<0.045	0.00	<0.0050	0.96	<0.50	<0.01	0.34	<0.10	100	4	<0.50	170	6.1	11	86	130	66	Ormat
	8/28/2018	600	0.12	<0.0025	<0.0050	0.92	0.26	0.08	0.39	N/A	89	4.1	<0.25	240 SC	6.1	14	110	150	64	Mcginley
	5/29/2019	570	0.35	<0.0025	<0.0050	0.87	<0.75	0.33	0.37	<0.10	110	3.9	<0.50	170	5.8	11	95	150	56	Mcginley
Spring 5A	8/28/2018	560 QD	0.17	<0.0025	<0.0050	0.93	0.31	0.14	0.40	N/A	100	5.0	<0.25	240	2.7	13	130	160	45	Mcginley
	5/30/2019	570	0.47	<0.0025	<0.0050	1.1	<0.75	0.20	0.39	<0.10	88	7.4	0.52	260	2.8	13	120	160	52	Mcginley
Spring 5B	8/28/2018	670	0.62	<0.0025	<0.0050	0.95	<0.50 D	0.41	0.40	N/A	120	8.0	<0.25	280	4.7	13	130	180	56	Mcginley
	5/30/2019	640	0.24	<0.0025	<0.0050	0.88	<1.5	0.12	0.32	<0.10	110	6.3	<0.50	170	3.9	12	110	180	50	Mcginley
Spring 6	11/30/2011	1400	<0.045	<0.0025	<0.025	0.98	0.96	<0.01	0.53	4.9	61	70.0	0.80	420	10	6.7	140	670	56	Ormat
	8/28/2018	1,300	<0.25 D	<0.0025	0.0058	1.20	0.94	0.05	0.68	N/A	88	87	<1.2 D	550	12	9	160	720	54	Mcginley
	5/29/2019	1,300	0.15	<0.0025	<0.0050	0.96	<1.5	<0.10	0.62	5.7	66	70	0.85	620	11	7	140	630	50	Mcginley
Spring 7	8/23/2019	790	<0.045	<0.0025	<0.0050	1.0	<0.5	<0.01	0.44	<0.1	90	15	<0.5	250	6.3	9.6	98	300	77	Mcginley
	8/28/2018	900	1.10	<0.0025	<0.0050	1.0	0.52	0.92	0.57	N/A	100	22	0.58	290	8.9	11	130	360	78	Mcginley
	5/30/2019	760	0.60	<0.0025	<0.0050	1	<0.75	0.29	0.50	0.10	85	15	<0.50	330	7.3	11	110	290	67	Mcginley
Spring 7 Duplicate	5/30/2019	780	0.86	<0.0025	<0.0050	1.1	<0.75	0.42	0.50	0.11	86	16	<0.50	330	7.2	10	110	290	73	Mcginley
Spring 8	8/28/2018	850	<0.10 D	<0.0025	0.0120	1.0	0.63	0.49	0.42	N/A	63	62	3.5	280	4.8	9	130	280	180	Mcginley
	5/30/2019	790	0.22	<0.0025	<0.0050	1.2	<0.75	0.30	0.40	0.33	45	40	2.4	320	4.3	7.6	120	240	140	Mcginley
USGS-301 Salt Cedar	8/28/2018	790	0.12	<0.0025	<0.0050	0.91	<1.0	0.11	0.31	0.51	44	62	3.5	290	2.9	5	160	240	140	Mcginley
	10/30/2018	740	<0.050	<0.0025	0.0053	0.99	N/A	<0.04	0.52	0.13	67	19	<0.50	250	4.1	7.3	78	210	77	Mcginley
	2/22/2019	800	0.2	<0.0025	<0.0050	0.93	N/A	0.18	0.28	0.48	45	58	3.4	220	3.1	4.4	160	240	150	Mcginley
	5/30/2019	800	<0.050	<0.0025	<0.0050	0.90	N/A	<0.10	0.28	0.44	43	52	2.6	200	2.7	4.2	150	240	130	Mcginley
	8/23/2019	760	0.17	<0.0025	<0.0050	0.87	N/A	0.20	0.28	0.43	41	54	2.8	270	2.8	5.0	170	250	130	Mcginley
	12/18/2019	800	0.10	<0.0025	<0.0050	0.88	NA	<0.10	0.25	0.5	38	55	2.7	220	2.5	4.5	160	230	140	Mcginley
	3/12/2020	790	0.40	<0.0025	<0.0050	0.90	NA	0.37	0.25	0.43	41	59	3.4	240	2.6	10.0	140	230	140	Mcginley

Table 8. Summary of Water Chemistry Data

Site ID	Sample Date	TDS	Aluminum	Antimony	Arsenic	Boron	Bromide	Iron	Lithium	Strontium	Silica	Calcium	Magnesium	Sodium	Potassium	Fluoride	Sulfate	Chloride	Bicarbonate (HCO3)	Source
Valley-Floor Springs, cont.																				
USGS-301 Salt Cedar	6/29/2020	800	<0.050	<0.0025	<0.0050	0.86	NA	<0.10	0.27	0.45	39	55	2.9	240	2.5	4.7	180	250	130	Mcginley
	8/28/2020	810	<0.050	<0.0025	<0.0050	0.94	NA	<0.10	0.33	0.46	46	56	2.9	230	2.7	4.3	170	240	130	Mcginley
Ponds																				
Western Playa	5/29/2019	1,900	0.31	<0.0025	0.0064	3.1	<1.5	0.2	1.2	0.7	86	19	2	840	18	17	240	770	89	Mcginley
Eastern Playa	5/29/2019	3,100	0.068	0.0031	0.0097	7.5	<1.5	<0.10	2.4	0.83	120	12	0.67	1,600	44	33	550	1,500	290	Mcginley
Stream Channel																				
Dixie Spring Complex Confluence	5/29/2019	590	0.16	<0.0025	<0.0050	0.93	<1.5	0.16	0.39	<0.10	100	6.6	<0.50	170	5.2	12	110	150	80	Mcginley
Groundwater																				
MW-1	8/23/2011	3,000	0.17	<0.0025	<0.0050	1.90	N/A	3.00	0.59	0.84	20	25.00	2.1	1,200	11.0	10.0	230	1,700	160	Ormat
	8/23/2011	2,800	0.07	<0.0025	<0.0050	2.00	N/A	1.50	0.58	0.82	31	24.00	2.2	1,200	11.0	10.0	240	1,600	170	Ormat
	5/22/2012	2,900	0.19	<0.0025	0.0110	N/A	N/A	0.57	N/A	N/A	N/A	N/A	2.1	1,200	N/A	8.8	220	1,600	160	Ormat
	9/27/2016	3,100	0.085	<0.0025	0.0140	1.70	N/A	0.25	0.48	N/A	41	27.00	2.2	1,300	7.1	6.2	170	1,600	130	Ormat
	8/28/2018	2,800	<0.10 D	<0.0025	0.01	1.60	2.10	0.13	0.58	N/A	46	32	2.4	1,700	9.5	9.7	250	1,700	120	Mcginley
	10/30/2018	3,100	<0.10	<0.0025	0.012	1.9	N/A	0.17	<2.0	N/A	60	38	<10	1,500	13	7.7	210	1,600	120	Mcginley
	2/22/2019	3,100	<0.10	<0.0025	0.018	1.7	N/A	0.13	0.58	N/A	47	30	2.3	1,400	8.6	8	230	1,500	130	Mcginley
	5/29/2019	2,700	<0.050	<0.0025	0.011	1.6	N/A	0.11	0.54	N/A	43	28	2.1	1,200	9	8.3	240	1,700	120	Mcginley
	8/23/2019	3,000	<0.10	<0.0050	0.016	1.8	N/A	<0.20	0.60	1.1	46	28	2.2	1,400	8.8	9.5	240	1,600	120	Mcginley
	12/18/2019	2,900	<0.10	<0.0050	0.016	1.6	NA	<0.20	0.48	NA	40	27	2.2	1,100	7.1	8.7	240	1,600	120	Mcginley
	3/12/2020	3,100	<0.10	<0.0025	0.013	1.8	NA	<0.20	0.57	NA	48	30	2.4	1,100	8.7	8	240	1,600	120	Mcginley
	6/29/2020	3,200	<0.10	<0.0025	0.013	1.8	NA	<0.20	0.58	NA	46.1	31	2.4	1,400	7.8	8	240	1,600	120	Mcginley
	8/28/2020	2,800	<0.10	<0.0025	0.013	1.8	NA	<0.20	0.67	1.2	51.2	32	2.3	1,200	9	7.6	240	1,700	120	Mcginley
23A-8	5/1/2017	960	0.28	0.0058	N/A	0.96	N/A	<0.02	0.53	2.6	180	22	0.1	350	17	<1.0	98	390	73	Ormat
	5/1/2017	960	0.28	0.01	<0.0050	0.96	0.56	<0.02	0.53	2.60	180	22	0.10	350	17	<1.0	98	390	73	Ormat
	6/2/2017	930	0.34	0.00	<0.0050	1.0	-0.50	<0.02	0.46	3.00	190	23	0.14	310	15	11	87	340	66	Ormat
24-8	1/3/2016	7,000	ND	N/A	N/A	2.5	N/A	N/A	1.9	N/A	188.21	800	6.3	2,200	64	12	140	3,800	160	Ormat

All units are milligrams/liter (mg/L), except bicarbonate is units of mg/L of calcium carbonate.

TDS	Total Dissolved Solids
N/A	Not analyzed
QD	The sample duplicate or matrix spike duplicate analysis demonstrated sample imprecision. The reported result should considered an estimate.
D	Due to the sample matrix dilution was required in order to properly detect and report the analyte. The reporting limit has been adjusted.
M	The matrix spike/matrix spike duplicate (MS/MSD) values for the analysis of this parameter were outside acceptance criteria due to probable matrix interference. The reported result should be considered an estimate.
SC	Spike recovery not calculated. Sample concentration >4X the spike amount; therefore, the spike could not be adequately recovered.
<	Concentration is less than detection limit. Value after "<" is the detection limit.
ND	Concentration is less than detection limit.

Table 9. Chemical Indicators of Geochemical End-members				
End-member	**Representative Sampling Locations**	**Elevated Value**	**Mixed Value**	**Low Value**
Geothermal brine	23A-8	SiO_2, Temp	-	Mg
Fresh groundwater/surface water North	Complex 1	Mg	F	Cl, Li, SO_4, SiO_2, B, Temp
Fresh groundwater/surface water South	Complex 5	Mg	Li	SO_4, F, SiO_2, B, Temp
Playa/evaporite-rich waters	MW-1, Eastern and Western Playa	Cl, Na, B, Li	SiO_2	Temp
Mixed/modified Geothermal hot springs	Complex 2, 3, 4	SiO_2, Temp	SO_4, Cl, Li, B, F	Mg
Mixed playa + Geothermal + Freshwater	Complex 2 (after storm events)	-	Na, Cl, B, Li	-

Table 10. Water Balance Summary for Dixie Meadows		
Water Balance Component	**Estimated Average Annual Amount (af/yr)**	**Notes and References**
Inflows		
Direct Precipitation	1,800	Direct precipitation is lost to evaporation and evapotranspiration. Precipitation data from Garcia et al., 2014.
Runoff	20	Estimated using methods by Hedman and Osterkamp (1982), Riggs and Moore (1965), and data from Interflow Hydrology (2013, 2016), Garcia et al. (2014), and Oregon State University PRISM Climate Group.
Groundwater Recharge (mountain block and alluvial fan)	270	Esimated using method by Harrill and Hines, 1995.
Groundwater Recharge (geothermal inflow)	770	Estimated by difference.
TOTAL ANNUAL INFLOW	**2,860**	Sum of all inflows.
Outflows		
Evapotranspiration	2,800	Total estimated for grassland vegetation, phreatophytes, xerophytes, and evporation from bare soil. ET values from Garcia et al., 2014.
Evaporation (open water)	15	Includes evaporation from open water after accounting for direct precipitation, using evaporation values from the Nevada Division of Water Resources and playa pond depths and volumes from Lidar data.
Runoff to playa	45	During winter months, runoff that does not infiltrate soils or impound in the playa ponds.
Groundwater Outflow to Playa	0	Outflow of fresh groundwater is negligible due to low hydraulic conductivity of playa sediments and high density playa groundwater.
TOTAL ANNUAL OUTFLOW	**2,860**	Sum of all outflows.

af/yr acre-feet per year

Table 11. Discharge Measurements at Select Monitoring Locations			
Site ID	**Type**	**Date**	**Discharge (gpm)**
USGS-101	Spring	29-May-19	15.3
NDOWSS-1	Spring	23-Oct-09	191[a]
		8-Mar-11	177[a]
		24-Jun-11	107[a]
		29-May-19	146
Spring 4	Spring	29-May-19	40.7
Spring 6	Spring	29-May-19	26.2
Western Playa	Pond	29-May-19	132
Dixie Spring Complex Confluence	Channel	26-Oct-11	162[a]
		4-May-12	237[a]
		29-May-19	144

gpm gallons per minute
a Source: Interflow Hydrology, 2013

Table 12. Summary of Water Densities

Location ID	Water Temperature at Land Surface (°F)	TDS (mg/L)*	Water Density (kg/m^3)
USGS-101	70.2	540	1.0019
Spring 2	80.9	600	1.0004
NDOWSS-1	138.7	630	0.9859
Spring 4	158.7	570	0.9784
Spring 5A	129.6	570	0.9888
Spring 5B	112.6	640	0.9937
Spring 6	126.0	1,300	0.9906
Spring 7	112.5	760	0.9939
Spring 8	60.8	780	1.0032
USGS-301 North	88.3	790	0.9993
USGS-301 Salt Cedar	77.2	800	1.0012
Western Playa	73.5	1,900	1.0028
Eastern Playa	76.0	3,100	1.0037
Dixie Spring Complex Confluence	117.9	590	0.9923
MW-1	73.5	2,700	1.0037

°F degrees fahrenheit
mg/L milligram per liter
kg/m^3 kilogram per cubic meter
TDS total dissolved solids
*TDS concentrations used to calculate water density are from analytical results of samples collected in May 2019.

Table 13. Summary of Hydraulic Responses during Flow Testing								
Well ID	**Pressure (psi)**				**Depth to Water (fbgs)**			
	P_O	**Min P**	**ΔP**	**P_F**	**SWL**	**Max DTW**	**ΔDTW**	**DTW_F**
23-8	113.4	105	8.4	112.85	-	-	-	
24A-8	61.8	59.65	2.15	61.1	-	-	-	
42-9	118.49	104.95	13.54	116.2	-	-	-	
86-7	75.35	67.15	8.2	68.5	-	-	-	
22-8B	-		-	-	8.75	16	7.25	14.15

P_O	Original pressure = pressure recorded prior to flow testing
Min P	Minimum pressure recorded during flow testing
ΔP	Difference between Po and Min P
P_F	Final pressure = pressure recorded after completion of flow testing
SWL	Static water level = water level recorded prior to flow testing
Max DTW	Maximum depth to water measured during flow testing
ΔDTW	SWL - Max DTW
DTW_F	Final DTW = depth to water recorded after completion of flow testing

Table 14A. Proposed Surface Water Monitoring Program

Monitoring Location Details						Field Parameters				Water Chemistry
Site ID	**Easting (m)**	**Northing (m)**	**Feature**	**Tier**	**Monitoring/Control**	**Measurement Frequency**	**Field parameters**	**Flow**	**Stage**	**Sampling Frequency**
USGS-101	409,863	4,406,470	Spring	1	Monitoring Site	Continuous[a]	X[b]	X[b]	-	Quarterly
Spring 2	409,871	4,406,306	Spring	2	Monitoring Site	Monthly	X		X	Quarterly
NDOWSS-1	408,476	4,405,816	Spring	1	Monitoring Site	Continuous[a]	X	X	-	Quarterly
Spring 4	408,480	4,405,694	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Complex 2 Confluence	408,594	4,405,627	Channel	1	Monitoring Site	Continuous[a]	X[b]	X[b]	-	Quarterly
Spring 5A	408,362	4,405,027	Spring	2	Monitoring Site	Monthly	X	-	-	No Sampling[c]
Spring 5B	408,372	4,404,969	Spring	2	Monitoring Site	Monthly	X	-	-	No Sampling[c]
Spring 5A/5B Confluence	408,407	4,404,981	Channel	1	Monitoring Site	Continuous[a]	X[b]	X[b]	-	Quarterly
Spring 6	408,703	4,406,020	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 7	408,336	4,404,172	Spring	2	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 8	408,080	4,403,234	Spring	2	Control Site	Monthly	X	-	X	Quarterly
Spring 9	408,217	4,403,818	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 10	408,370	4,404,236	Spring	1	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 11	408,549	4,404,575	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 12	408,469	4,404,625	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 13	408,410	4,404,691	Spring	2	Monitoring Site	Monthly	X	X	-	Quarterly
Spring 14	409,080	4,406,124	Spring	1	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 31	409,144	4,406,111	Spring	2	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 32	409,157	4,406,140	Spring	1	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 33	409,209	4,406,127	Spring	2	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 118	409,292	4,406,173	Spring	2	Monitoring Site	Monthly	X	-	X	Quarterly
Spring 15	406,965	4,402,276	Spring	1	Control Site	Monthly	X	-	X	Quarterly
USGS-301 North	407,910	4,403,440	Spring	2	Control Site	Monthly	X	-	X	Quarterly
USGS-301 Salt Cedar	407,867	4,403,375	Spring	1	Control Site	Continuous[a]	X	X[b]	-	Quarterly
Western Playa	409,494	4,405,645	Pond	N/A	Monitoring Site	Monthly	X	-	X	Quarterly

Coordinates in NAD 1983 UTM Zone 11N

[a] Continuous measurement frequency for surface water flow measurement is every 15-minutes to one hou

[b] Field parameters collected continuously include temperature and flow. Remaining field parameters are measured monthly (pH, EC, DO, ORP, and turbidity)

[c] Samping to be conducted at Spring 5A/5B Confluence

- equals not measured

Table 14B. Characteristics of Proposed Surface Water Monitoring Locations

Complex	No. of discharge points identified in complex	Estimated cumulative spring discharge (gpm)	Site ID	Geochemical end-member	Location description	Flow description	Water temperature	Location Objective
1a and 1b	15	n/a	USGS-101	Fresh water	Located within a meadow outside of of eastern fence of a corral; subject to trampling from livestock; aquatic-dependent biological resources have been identified	Flow emerges into an open pool of water and becomes channelized; low discharge	Cool to warm	Identify triggers in spring likely fed by shallow alluvial aquifer and where aquatic-dependent biological resources have been identified.
			Spring 2	Fresh water	Marshy and wet meadow	No discrete source of water; diffuse and neglibible flow	Cool to warm	Identify triggers in spring likely fed by shallow alluvial aquifer.
			Spring 14	Fresh water	Marshy and wet meadow	Open pool of water, minimal outflow	Cool to warm	Identify pooled water and temperature, springsnail habitat
			Spring 31	Fresh water	Marshy and wet meadow	Open pool of water, minimal outflow	Cool to warm	Identify pooled water and temperature, springsnail habitat
			Spring 32	Fresh water	Marshy and wet meadow	Open pool of water, minimal outflow	Cool to warm	Identify pooled water and temperature, springsnail habitat
			Spring 33	Fresh water	Marshy and wet meadow	Open pool of water, minimal outflow	Cool to warm	Identify pooled water and temperature, springsnail habitat
			Spring 118	Fresh water	Marshy and wet meadow	Open pool of water, minimal outflow	Cool to warm	Identify pooled water and temperature, springsnail habitat
2	21	400-700[1]	NDOWSS-1	Mixed/modified hot spring	Accessible from Dixie Valley Road; aquatic-dependent biological resources are prevalent in the area; downstream area becomes heavily vegetated	Flow emerges into a defined channel; high discharge	Hot	Identify triggers in spring complex with most significant geothermal input and where aquatic-dependent biological resources have been identified.
			Spring 4	Mixed/modified hot spring	Located beneath a tree; aquatic-dependent biological resources are prevalent in the area; downstream area becomes heavily vegetated	Flow emerges into a defined channel; moderate discharge	Hot	Identify triggers in spring complex with most significant geothermal input and where aquatic-dependent biological resources have been identified.
			Complex 2 Confluence	Mixed/modified water	A stream channel, not a discharge point; aquatic-dependent biological resources are prevalent in the area; heavily vegetated	Channelized flow from NDOW-SS1, Spring 4, and other Complex 2 springs merge and form a channel; high discharge	Warm to hot	Identify flow triggers in spring complex with most significant geothermal input and where aquatic-dependent biological resources have been identified.
			Spring 6	Mixed/modified hot spring	Accessible from Dixie Valley Road; aquatic-dependent biological resources are prevalent in the area; downstream area becomes heavily vegetated	Flow emerges into a defined channel; low to moderate discharge	Warm to hot	Identify triggers in spring complex with most significant geothermal input and where aquatic-dependent biological resources have been identified.
			Western and Eastern Playas	Evaporite-rich water	Playas are terminus for spring discharge and runoff in vicinity of Complex 2; typically fill with water during late fall and winter when ET is low and after storm events, attracts wildlife	No flow	Cool to warm	Identify triggers by monitoring water stage in ponds where biological resources have been identified.
3	25	n/a	Spring 5A	Mixed/modified hot spring	Discharge point surrounded by thick grass and shrubs; downstream area becomes heavily vegetated	Dischage is pooled at discharge point and then forms a defined channel; low discharge	Warm to hot	Identify triggers at hot spring location with significant geothermal input.
			Spring 5B	Mixed/modified hot spring	Minimal vegetation at spring; downstream area becomes heavily vegetated	Moderate velocity with minimal water depth at discharge point; flow becomes channelized	Warm to hot	Identify triggers at hot spring location with significant geothermal input.
			Spring 5A/5B Confluence	Mixed/modified water	Stream channel; heavily vegetated.	Channelized flow from Spring 5A, Spring 5B, and other Complex 3 springs merge and form a channel; high discharge	Warm to hot	Identify flow triggers in spring complex with significant geothermal input.
			Spring 11	Mixed/modified	Heavily vegetated	Discrete source with channelized flow	Warm[2]	Identify triggers at hot spring location with geothermal input.
			Spring 12	Mixed/modified	Heavily vegetated	Discrete source with channelized flow	Warm to hot[3]	Identify triggers at hot spring location with geothermal input.
			Spring 13	Mixed/modified	Heavily vegetated	Discharge is pooled at surface, then flows through defined channel	Warm to hot[3]	Identify triggers at hot spring location with geothermal input.
4	33	n/a	Spring 7	Mixed/modified	Heavily vegetated	Discharge is pooled at surface; low discharge	Warm	Identify triggers at hot spring location with geothermal input.
			Spring 9	Mixed/modified	Low-lying area with moderate vegetation	Discharge is pooled at surface, then flows through defined channel, then disprses through low-lying vegetation; moderate discharge	Warm[2]	Identify triggers at hot spring location with geothermal input.
			Spring 10	Mixed/modified	Heavy vegetation; immediately north of elevated and dry strip of land	Discrete source with channelized flow through heavy vegetation; high discharge	Hot[2]	Identify triggers at hot spring location with geothermal input.
5	7	n/a	Spring 8	Fresh water	Marshy and wet meadow	No discrete source; diffuse flow; minimal discharge	Cool to warm	Identify triggers in cold spring location with little to no geothermal input.
			USGS-301 North	Fresh water	Relatively deep water in channel; aquatic-dependent biological resources identified	Channelized flow; moderate discharge	Cool to warm	Identify triggers in cold spring location with little to no geothermal input where aquatic-dependent biological resources have been identified.
			USGS-301 Salt Cedar	Fresh water	Located beneath a Salt Cedar tree and surrounded by heavy vegetation, discharge location on southeast side of reed filled pond (proposed wier location)	Channelized flow; minimal discharge; flow can be heard beneath surrounding reeds	Cool to warm	Identify triggers in cold spring location with little to no geothermal input.
6	10	n/a	Spring 15	n/a	Located in the southern-most spring complex within the Dixie Meadows project area.	Discharge is standing and flow is very diffuse.	Cool to warm	Identify triggers at cold spring location with little to no geothermal input at periphery of project area.
n/a	n/a	n/a	Spring 14	Fresh water	Located between Spring Compex 1 and 2; aquatic-dependent biological resources identified; heavily vegetated	Discrete source; diffuse flow	Cool to warm	Identify triggers in cold to warm spring location with little to no geothermal input where aquatic-dependent biological resources have been identified.

1 Interflow, 2012.
2 Schwering et al., 2013
3 Based on qualitative field observations (i.e., steam)
n/a Indicates that a spring is not a part of spring complex or that the cumulative spring discharge of a complex is unknown.

Table 15. Proposed Analytes and Sampling Requirements

Analyte	Test Type	Analytical Method	Volume (mL)/ Container	Preservation	Holding Time
Temperature	Field	NA	NA	NA	NA
pH	Field/Laboratory	EPA 150.1	NA	NA	NA
Electrical conductivity (EC)	Field	NA	NA	NA	NA
Dissolved oxygen	Field	NA	NA	NA	NA
Oxidation-reduction potential	Field	NA	NA	NA	NA
Turbidity	Field	NA	NA	NA	NA
Total Dissolved Solids (TDS)	Laboratory	SM 23540C	500/poly	6 °C	7 days
Calcium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Magnesium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Sodium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Potassium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Bicarbonate	Laboratory	SM 2320B	250/Poly	6 °C	14 days
Sulfate	Laboratory	EPA 300	250/Poly	6 °C	28 days
Chloride	Laboratory	EPA 300	250/Poly	6 °C	28 days
Fluoride	Laboratory	EPA 300	500/Poly	None	28 days
Silica	Laboratory	EPA 200.7	500/Poly	6 °C	7 days
Boron	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Lithium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Strontium	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Iron	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Aluminum	Laboratory	EPA 200.7	250/Poly	HNO_3, pH <2	6 months
Arsenic	Laboratory	EPA 200.8	250/Poly	HNO_3, pH <2	6 months
Stable Isotopes (oxygen-18 and deuterium)	Laboratory	NA	10*	NA	NA

NA	not applicable
Poly	polyethylene container
SM	standard method
mL	milliliter
°C	degrees celsius

* Any bottle that can be tightly capped to prevent evaporation

Table 16A. Proposed Groundwater Monitoring Locations

	Coordinates				Monitoring Frequency			
Site ID	**Easting (m)**	**Northing (m)**	**Geology**	**Monitoring/ Control**	**Temperature**	**Other Field Parameters**	**Chemistry**	**Hydraulic Head**
MW-1	409,584.8	4,405,671.6	Shallow alluvium	Control	Daily	Quarterly	Quarterly	Daily
MW-2	408,078.0	4,405,558.0	Shallow alluvium	Monitoring	Daily	Quarterly	Quarterly	Daily
MW-3	408,078.0	4,405,035.0	Shallow alluvium	Monitoring	Daily	Quarterly	Quarterly	Daily
75-4	410,548.9	4,406,436.8	Bedrock	Control	Daily	Quarterly	Quarterly	Daily
22-8B	407,743.9	4,405,476.7	Shallow alluvium	Monitoring	Daily	Quarterly	Quarterly	Daily
24A-8	407,729.0	4,404,984.4	Shallow alluvium	Monitoring	Daily	Quarterly	Quarterly	Daily
24-8	407,734.1	4,404,987.9	Deep alluvium	Monitoring	Daily	Quarterly	Quarterly	Daily
23-8	407,916.9	4,405,313.3	Bedrock	Monitoring	Daily	Quarterly	Quarterly	Daily
23A-8	407,890.7	4,405,290.2	Bedrock (geothermal)	Monitoring	During drilling/testing	During drilling/testing	During drilling/testing	During drilling/testing
42(12)-9	410,009.1	4,405,383.9	Bedrock (geothermal)	Monitoring	During drilling/testing	During drilling/testing	During drilling/testing	During drilling/testing
DP-01	409,904.0	4,406,390.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-02	408,821.0	4,405,940.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-03	408,510.0	4,405,714.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-04	409,262.0	4,405,505.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-05	408,368.0	4,405,033.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-06	408,407.0	4,404,661.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-07	408,853.0	4,404,737.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-08	408,363.0	4,404,218.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-09	408,700.0	4,404,117.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-10	408,226.0	4,403,815.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-11	407,892.0	4,403,423.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-12	407,863.0	4,403,376.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-13	408,582.0	4,403,112.0	Shallow alluvium	Monitoring	Daily	-	-	Daily
DP-14	406,975.0	4,402,179.0	Shallow alluvium	Control	Daily	-	-	Daily
DP-15	409,051.0	4,406,109.0	Shallow alluvium	Monitoring	Daily	-	-	Daily

Coordinates in NAD 1983 UTM Zone 11N.

Other Field Parameters include pH, EC, DO, ORP, and turbidity.

m meters

Wells and piezometers to be equipped with pressure transducers for daily head and temperature measurements.

Table 16B. Characteristics of Proposed Groundwater Monitoring Locations					
Site ID	**Geology**	**Type**	**Geochemical end-member**	**Location description**	**Location objective**
MW-1	Shallow alluvium	Monitoring Well	Non-geothermal	Downgradient of main spring discharge area and potential future production zone	Monitor natural variability if outside area of influence. If inside area of influence, identify triggers downgradient of potential future production zone within shallow alluvial aquifer.
MW-2	Shallow alluvium	Monitoring Well	Anticipated to be mixed thermal	Mid-distance between proposed power plant facilities and spring Complex 2	Identify early triggers upgradient of spring discharge area within shallow alluvial aquifer.
MW-3	Shallow alluvium	Monitoring Well	Anticipated to be mixed thermal	Mid-distance between proposed power plant facilities and spring Complex 2	Identify early triggers upgradient of spring discharge area within shallow alluvial aquifer.
75-4	Bedrock	Monitoring Well	Non-geothermal	Crossgradient/downgradient of main spring discharge area and potential future production zone	Monitor natural variability if outside area of influence. If inside area of influence, identify triggers crossgradient/downgradient of potential future production zone in bedrock aquifer.
22-8B	Shallow alluvium	Monitoring Well	Non-geothermal	Upgradient of main spring discharge area	Identify early triggers upgradient of spring discharge area within shallow alluvial aquifer.
24A-8	Shallow alluvium	Monitoring Well	Non-geothermal	Upgradient of main spring discharge area	Identify early triggers upgradient of spring discharge area within shallow alluvial aquifer.
24-8	Deep alluvium	Monitoring Well	Non-geothermal	Upgradient of main spring discharge area; potential future injection well	Identify early triggers upgradient of spring discharge area within alluvial aquifer.
23-8	Bedrock	Monitoring Well	Non-geothermal	Upgradient of main spring discharge area	Identify early triggers upgradient of spring discharge area within bedrock aquifer.
23A-8	Bedrock	Geothermal	Geothermal	High temperature bedrock well; potential future production well; located upgradient of main spring discharge area	Identify early triggers upgradient of spring discharge area within deep bedrock aquifer.
42(12)-9	Bedrock	Geothermal	Geothermal	Warm to high temperature well intersecting multiple faaults; Downgradient of main spring discharge area	Identify triggers downgradient of potential future production zone within deep bedrock aquifer.
DP-01 to DP-15	Shallow alluvium	Drive Point Piezometer	Non-geothermal	Located in the meadows area, downgradient of spring discharge points.	Monitor shallow alluvial water table and identfy triggers downgradient of potential future production zone.

Table 17. Hydrologic Trigger Parameters	
Potential Impact	**Primary Measurement Parameter**
Erosion/Sedimentation	Water Turbidity
Water Chemistry Change	TDS, EC
Surface Water Discharge Change	Discharge Rate
	Water Pool Stage
Groundwater Level Change	Depth to Water
	Pressure Head (Artesian)
Temperature Change	Water Temperature

Table 18. Mitigation and Avoidance Measures		
Mitigation/Avoidance Measure	**Comment/Recommendation**	**Feasibility Level**
Providing geothermal fluids or fresh water (depending on mitigation objectives) to the affected springs of a quality and quantity sufficient to restore pre-production temperature, flow stage or equivalent, and basic water chemistry of the springs	It is anticipated that geothermal production would potentially affect hot springs, while cooler springs and groundwater would remain unaffected. If spring flow reduction occurs or water chemistry is impacted, spring discharge would be augmented with cooled geothermal fluid or fresh water. This could be accomplished by surface discharge, rapid infiltration basins, or shallow injection wells.	High
Modifying the volume or pressure of geothermal fluids injected into one or more injection wells within the geothermal unit area field and monitoring the reservoir, surface water, and groundwater response	This could be accomplished through shallow injection wells.	High
Modifying the volume or pressure of geothermal fluids produced from one or more production wells within the geothermal unit area field and monitoring the reservoir, surface water, and groundwater response	Affected water and aquatic resources would be augmented with cooled geothermal fluid via surface discharge, rapid infiltration basins, or shallow injection wells before exercising this mitigation option.	Low
Relocating one or more production or injection wells within the geothermal unit area	Affected water and aquatic resources would be augmented with cooled geothermal fluid via surface discharge, rapid infiltration basins, or shallow injection wells before exercising this mitigation option.	Low
Changing the depth of geothermal fluid injection in one or more geothermal unit area injection wells	Affected water and aquatic resources would be augmented with cooled geothermal fluid via surface discharge, rapid infiltration basins, or shallow injection wells before exercising this mitigation option.	Low
Temporarily suspending geothermal reservoir utilization or reinjection until the adverse impacts on water quality, quantity, and/or temperature are no longer observed or return to pre-production conditions.	Affected water and aquatic resources would be augmented with cooled geothermal fluid via surface discharge, rapid infiltration basins, or shallow injection wells before exercising this mitigation option.	Low
The 500 or 650-foot buffer outlined in the lease stipulation (Section 2.2) would ensure adequate protection of Wetlands and Riparian sources	-	-
Transmission towers would be sited to span identified hydric soils and Wetland and Riparian areas identified by the delineation. String sites and other temporary work areas would be sited outside of identified hydric soils and Wetland and Riparian areas	-	-
Surface grading or vegetation clearing would not occur on specific hydric soils, near springs, seeps, or sensitive resource areas as identified by the BLM from the wetland delineation	-	-
If surface grading or vegetation removal is necessary within pre-identified hydric soils or Wetland and Riparian areas, Ormat would notify and acquire authorization from the BLM Authorized Officer prior to project activity	-	-
If overland travel is necessary within pre-identified hydric soils and Wetland and Riparian areas, Ormat would notify and acquire authorization from the BLM Authorized Officer prior to project activity	-	-
If overland travel were required on hydric soils and Wetland and Riparian areas, every effort would be made to limit overland travel to the late fall or early winter. This is when most plant and wildlife species are dormant and water levels are low	-	-
ROW construction activities would be designed to not inhibit natural surface water flow patterns.		
To mitigate the impacts of fugitive dust on plant productivity, dust control measures during construction would be implemented	-	-

Table 18. Mitigation and Avoidance Measures		
Mitigation/Avoidance Measure	**Comment/Recommendation**	**Feasibility Level**
To minimize weed establishment and spread, environmental protection measure outlined in Section 2.1.6 of the EA would be implemented. In addition, an invasive plant management plan would be developed prior to construction, noxious weed infestations would be reported to the BLM, and certified weed-free seed would be used during reclamation activities	-	-
The Bird and Bat Conservation Strategy (BBCS) described in the EA would be followed to reduce potential of injury or mortality to migratory birds from project construction and operation, to ensure adequate monitoring is in place to determine if mortalities are occurring, and to provide a mechanism to implement adaptive management as needed to reduce injury or mortality	-	-
The spread of *Batrachochytrium dendrobatidis* (Bd) as a result of project activities and operation will be avoided by implementing the following best management practices: 1) Any equipment used for conducting work within wetland habitats (i.e. hand tools, scientific equipment, etc.) will be cleaned of all organic matter and sanitized (with quaternary ammonium or bleach solution), at least 100 feet from the edge of any water sources, prior to and after use within a wetland, 2) employees and contractors will receive instruction on the threats of Bd to amphibians and the need to minimize its spread, and 3) employees and contractors will not be permitted to handle or translocate amphibians, except by permission from the appropriate agencies. In addition, a written plan outlining specific cleaning and sanitizing measures will be produced and provided to contractors and employees.	-	-
Full preconstruction surveys for all known and potential occurrence of BLM Sensitive and NNHP plant species would be conducted within suitable habitat of the Project Area footprint by qualified botanists and protocols approved by the BLM	-	-
If sensitive plant species are identified within the project work area, impacts would be avoided by flagging/fencing and by applying an appropriate buffer determined by the qualified botanist and the BLM. If avoidance is not feasible, mitigation would be determined by the BLM to ensure no net loss of sensitive plants	-	-
Potential impacts to Special Status invertebrate species would be minimized by using existing routes for construction access in sensitive meadow vegetation and by avoiding and minimizing ground disturbance and vegetation removal in this area to the extent possible	-	-
Exclusion fencing approved by the BLM would be installed around all work areas near habitat for wetland dependent Special Status aquatic Species, as defined by the wetland delineation. Areas within the exclusion fencing would be cleared of Special Status aquatic Species (i.e. Dixie Valley toad) prior to construction activities to avoid direct impacts to those species (e.g. crushing, burying, etc.).	-	-

Table 19. Monitoring Goals and Objectives

Objective	Monitoring Indicators	Baseline Conditions	Monitoring Site	Monitoring Timing	Objective Threshold	Threshold Period	Management Action	Critical Timing	Critical Threshold	Critical Period	Critical Mitigation
Hydrology (Ground/Surface Water)											
Objective 1 - Maintain surface water flow and stage within ±10% or ±15gpm/20mm (whichever is less) outside the natural range of baseline conditions for 90% of tier-1 monitoring sites.	Flow (Continuous)	15.3 gpm	USGS-101	Continuous, year-round	±10% or ±15 gpm	2 consecutive monitoring events (monthly evaluation)	Code A	See Objectives 9-12			
		107 - 237 gpm	Complex 2 Confluence								
		Currently unknown	Spring SA/SB Confluence								
			USGS-301 Salt Cedar								
		15.3 gpm (30 - 110mm)	NDOWSS-1			3 consecutive monitoring events (monthly evaluation)	Code B or C				
	Flow (Current-Velocity)	Currently unknown	Spring 10	Monthly							
	Water Stage/Pool Height (Staff Guage)	See Objective 10	Spring 14								
			Spring 32								
		Currently unknown	Spring 15								
Objective 2 - Maintain hydraulic head within ±15% outside the natural range of baseline conditions for 90% of tier-1 groundwater monitoring wells.	Hydraulic Head	Currently unknown	MW-1 (75-4)	Monthly	±15%	2 consecutive monitoring events (monthly evaluation)	Code A	Currently Unknown or N/A			
			MW-2								
			MW-3								
			DP-01								
			DP-03			3 consecutive monitoring events (monthly evaluation)	Code B or C				
			DP-05								
			DP-10								
			DP-12								
			DP-14								
Objective 3 - Maintain water temperatures within ±10% or ±10°F (whichever is less) outside the natural range of baseline conditions at all tier-1 monitoring sites.	Temperature	66 - 78 F	USGS-101	Continuous	±10% or ±10°F	2 consecutive monitoring events (monthly evaluation)	Code A	See Objectives 9-12			
		117.9 F	Complex 2 Confluence								
		Currently unknown	Spring SA/SB Confluence								
			USGS-301 Salt Cedar								
		74 - 90 F	NDOWSS-1			3 consecutive monitoring events (monthly evaluation)	Code B or C				
		130 - 148 F	Spring 10	Monthly							
		Currently unknown	Spring 14								
		See Objective 12	Spring 32								
			Spring 15								
		Currently unknown	DP-01								
			DP-03								
			DP-05								
			DP-10								
			DP-12								
			DP-14								

Table 19. Monitoring Goals and Objectives

Objective	Monitoring Indicators	Baseline Conditions	Monitoring Site	Monitoring Timing	Objective Threshold	Threshold Period	Management Action	Critical Timing	Critical Threshold	Critical Period	Critical Mitigation
Hydrology (Ground/Surface Water), continued											
Objective 4 - Maintain field parameters within ±10% outside the natural range of baseline conditions at 85% of tier-1 monitoring sites.	pH, EC, TDS, DO, redox potential, turbidity	Currently unknown	USGS-101	Continuous	±10%	2 consecutive monitoring events (monthly evaluation)	Re-evaluate monitoring indicators, benchmarks, and timing; and/or Code A	Currently Unknown or N/A			
			Complex 2 Confluence								
			Spring SA/SB Confluence								
			USGS-301 Salt Cedar								
			NDOWSS-1			3 consecutive monitoring events (monthly evaluation)	Code B or C				
			Spring 10	Monthly							
			Spring 14								
			Spring 32								
			Spring 15								
			MW-1 (75-4)								
			MW-2								
			MW-3								
			DP-01								
			DP-03								
			DP-05								
			DP-10								
			DP-12								
			DP-14								
Objective 5 - Maintain key geothermal indicator values* within ±15% outside the natural range of baseline concentrations at 85% tier-1 monitoring sites.	SiO2, Mg	Currently unknown	USGS-101	Continuous	±15%	2 consecutive monitoring events (monthly evaluation)	Re-evaluate monitoring indicators, benchmarks, and timing; and/or Code A	Currently Unknown or N/A			
			Complex 2 Confluence								
			Spring SA/SB Confluence								
			USGS-301 Salt Cedar								
			NDOWSS-1			3 consecutive monitoring events (monthly evaluation)	Code B or C				
			Spring 10	Monthly							
			Spring 14								
			Spring 32								
			Spring 15								
			MW-1 (75-4)								
			MW-2								
			MW-3								
			DP-01								
			DP-03								
			DP-05								
			DP-10								
			DP-12								
			DP-14								

*Key geothermal indicators: SiO2 and Mg (other geothermal constituents may apply as appropriate for site-specific location

Table 19. Monitoring Goals and Objectives

Objective	Monitoring Indicators	Baseline Conditions	Monitoring Site	Monitoring Timing	Objective Threshold	Threshold Period	Management Action	Critical Timing	Critical Threshold	Critical Period	Critical Mitigation
Aquatic Habitat and Special Status Species											
Objective 6 - Maintain Dixie Valley toad populations (all life stages) at a minimum of >80% from baseline for 85% of USGS monitoring areas.	Population Abundance	Currently unknown (will be determined in consultation with Working Groups)	USGS monitoring sites	Biannual (spring and fall)	-20%	2 monitoring events (biannual evaluation)	Code A	Currently unknown or N/A			
Objective 7 – Maintain seasonal distribution of Dixie Valley toad populations (of all life stages) at ±10% from baseline within 85% of occupied habitat of Dixie Meadows.	Population Distribution				-10%						
Objective 8 – Maintain springsnail populations (average abundance* within spring brook) at >80% from baseline for tier-1 monitoring sites.	Population Abundance	Currently unknown (will be determined in consultation with Working Groups)	Spring 14	Annually	-20%	1 monitoring event (annual evaluation)	Code A	Weekly - during project activities which may influence water stage or temperature at Spring Complex 1b.	-10%	1 monitoring event (one-week evaluation)	Code B or C
			Spring 32								
*Springsnail abundance categories (per FWS protocol); abundant (>20); common (6-20); scarce (<6); or based on forthcoming dat											
Objective 9 – Maintain surface water temperature within ±1.0°C outside the natural range of springsnail thermal tolerance (as defined by the range of temperatures measured throughout the occupied spring brook) at all springsnail occupied sites.	Water Temperature	17.8 - 20.1°C (2020: 17.8 - 18.7) (2018: 20.1)	Spring 14	Continuous (HOBO temp loggers)	±1.0°C	2 consecutive monitoring events (monthly evaluation)	Code B or C	During project activities which may influence water stage or temperature at Spring Complex 1b.	±1.0°C	1 monitoring event (two-week evaluation)	Code B or C
		17.7 - 19.7°C (2020: 17.8 - 18.8) (2018: 17.7 - 19.7)	Spring 32								
Objective 10 – Maintain surface water stage within ±10% outside the natural range of baseline conditions at springsnail occupied springs.	Water Stage	5mm (2020) - 19mm (2018)	Spring 14	Monthly (staff gauge)	±10%				±10%		
		15mm (2020) - 22mm (2018)	Spring 32								
Objective 11 – Maintain surface water temperature within ±2.0°C outside the natural range of Dixie Valley toad thermal tolerance (as defined by the range of temperatures measured during population/HQI surveys) at 85% of Dixie Valley toad occupied springs.	Water Temperature	Currently unknown	Tier-1 surface water monitoring sites; and USGS monitoring sites	Monthly, March-May (reproduction)	±2.0°C	2 consecutive monitoring events (monthly evaluation)	Code B or C	During project activities which may influence water stage or temperature at Spring Complex 1b.	Currently unknown	1 monitoring event (two-week evaluation)	Code B or C
				Monthly, October-February (brumation)							
Objective 12 – Maintain surface water stage within ±10% or 10gpm/15mm (whichever is less) outside the natural range of baseline conditions at 85% of Dixie Valley toad occupied habitat (USGS monitoring sites).	Water Stage			Monthly, March-May (reproduction)	±5% or 10gpm/15mm						
				Monthly, October-February (brumation)							
Objective 13 – Maintain total vegetative cover and species composition (key riparian indicator species*) within ±10% outside the natural range of baseline ecological (aquatic habitat) potential for 85% of tier-1 monitoring sites.	Total Vegetation Cover and Species Composition	Currently unknown (will be established during summer 2021 surveys)	Tier-1 monitoring sites	Annually (June-July)	±10%	1 monitoring event (annual evaluation)	Code A	Currently unknown or N/A			
*Biannual qualitative photo points will be collected for reference and have have no associated trigger or management actio											

Table 19. Monitoring Goals and Objectives

Objective	Monitoring Indicators	Baseline Conditions	Monitoring Site	Monitoring Timing	Objective Threshold	Threshold Period	Management Action	Critical Timing	Critical Threshold	Critical Period	Critical Mitigation
Aquatic Habitat and Special Status Species, continued											
Objective 14 – Maintain aquatic habitat extent (sum of all wetland communities in the WARD by acrage) within natural climatic variations for all habitat types within Dixie Meadows.	Wetland Habitat Extent (Acres)	Currently unknown (the baseline # of acres will be established from review of historical satellite imagery)	Co-located with Objective 13 monitoring sites; and all habitat areas identified in WARD	Annually (June-July)	±5%	1 monitoring event (annual evaluation)	Code A	Currently unknown or N/A			
Objective 15 – Maintain hydric soil indicators at 85% of tier-1 monitoring sites.	Hydric Soil Indicators	Currently unknown (will be established during 2021 surveys)	Co-located with Objective 13 monitoring sites.	Annually (June-July)	±15%	1 monitoring event (annual evaluation)	Code A	Currently unknown or N/A			

Table 20. Tier-1 and Tier-2 Surface Water Monitoring Locations					
Complex 1A/1B	**Complex 2**	**Complex 3**	**Complex 4**	**Complex 5**	**Complex 6**
Tier-1					
USGS-101	Complex 2 Confluence	Spring 5A/5B Confluence	Spring 10	USGS-301 Salt Cedar	Spring 15
Spring 14	NDOWSS-1				
Spring 32					
Tier-2					
Spring 2	Spring 4	Spring 5A	Spring 7	USGS-301 North	None Present
Spring 31	Spring 6	Spring 5B	Spring 9	Spring 8	
Spring 33		Spring 11			
Spring 118		Spring 12			
		Spring 13			

Table 21. Tier-1 and Tier-2 Groundwater Monitoring Wells					
Complex 1A/1B	**Complex 2**	**Complex 3**	**Complex 4**	**Complex 5**	**Complex 6**
Tier-1					
MW-1 (75-4)	MW-2		DP-10	DP-12	DP-14
DP-01	DP-03	MW-3			
		DP-05			
Tier-2					
	22-8B		DP-08	DP-11	None Present
	23-8		DP-09	DP-13	
	DP-02	24A-8			
	DP-04	24-8			
		DP-06			
		DP-07			

Table 22. Tier-1 and Tier-2 Vegetation and Hydric Soil Monitoring Sites					
Complex 1A/1B	**Complex 2**	**Complex 3**	**Complex 4**	**Complex 5**	**Complex 6**
Tier-1					
USGS-101	Complex 2 Confluence	Spring 5A/5B Confluence	Spring 10	USGS-301 Salt Cedar	Spring 15
Spring 14	NDOWSS-1				
Tier-2					
Tier-2 sites would be determined prior to summer 2021 surveys; 13 sites will be randomly placed within the predominant wetland habitats (e.g. bulrush and meadow) of each spring complex. Locations of these sites will be established with forthcoming toad distribution data from USGS and NDOW.					

Table 23. Tier-1 and Tier-2 Springsnail and DVT Monitoring Sites					
Complex 1A/1B	**Complex 2**	**Complex 3**	**Complex 4**	**Complex 5**	**Complex 6**
Tier-1					
Spring 14	Springsnails currently not present within these spring complexes. Tier-1 Dixie Valley toad monitoring sites would be determined based on forthcoming USGS and NDOW data/protocol.				
Spring 32					
Tier-2					
Spring 31	Springsnails currently not present within these spring complexes. Tier-2 Dixie Valley toad monitoring sites would be determined based on forthcoming USGS and NDOW data/protocol.				
Spring 33					
Spring 118					

Table 24. 2018 Springsnail Survey Data

Spring ID	Easting	Northing	Type[1]	Spring Run Wetted Length (meters)[2]	Average Width (meters)	Average Depth (centimeters)	Flow (est.)[3]	Temperature (ºC)	pH	Conductivity (µS/cm)	Dominant Vegetation (% Cover)[4]	Substrate Composition (% Cover)[5]
DM20	409079	4406122	L	23.0 (Total) <0.20 (Occ.)	2.0	1.9	Low	20.1	8.27	1345.0	35 (watercress)	100 (silt)
DM21	409114	4406107	H	1.0 (Total) 1.0 (Occ.)	3.0	1.4	Low	17.7	8.54	552.0	85 (common threesquare)	100 (silt)
DM22	409159	4406137	L (SH)	43.6 (Total) 15.9 (Occ.)	3.0	2.2	Low	19.3	8.58	1129.0	30 (watercress)	100 (silt)
			MID		0.5	3.8	Low	19.7	7.97	1085.0	5 (watercress)	100 (silt)
			EOL		0.6	0.7	Low	18.7	7.51	1093.0	25 (artic rush)	100 (silt)
			+25		6.8	3.5	Low	10.0	6.21	1152.0	60 (artic rush)	100 (silt)

[1]H = Helocrene spring (pool); L = Limnocrene spring (pool which flows into a channel). SH = Springhead; MID = midpoint of occupied length; EOL = End of occupied length; +25 = point which is 25 m below EOL.

[2]Total = total length of wetted run; Occ. = Length of wetted run determined to be occupied by springsnails.

[3]Low = Little/no flow, mostly stagnant.

[4]Ocular estimate of canopy cover of dominant vegetation across transect.

[5]Ocular estimate of dominant substrate type across transect. Silt/clay = <0.1mm.

Coordinates: NAD 1983 UTM Zone 11N

Table 25. 2020 Springsnail Survey Data - Tier 3 Transect Data Summary										
Spring ID	**Transect Number**	**Distance from spring source (m)**	**Water temperature (°C)**	**Catch Per Unit Effort (CPUE)**	**Substrate Composition**	**Wetted width of springbrook (m)**	**Water depth (cm)**	**Water column velocity (m/sec)**	**Emergent vegetation cover (%)**	**Vegetated bank cover (%)**
29	**1**	24.4	14.6	0	100% fines (<1mm)	8.9	0.1	0	100	100
	2	17.0	15.1	0	100% fines (<1mm)	0.1	0.1	0	100	100
	3	10.6	20.2	0	100% fines (<1mm)	0.1	2.0	0	90	10
	4	6.1	23.7	0	100% fines (<1mm)	4.7	3.0	0	70	10
	5	2.3	22.9	0	100% fines (<1mm)	4.3	3.0	0	70	10
	6	1.8	22.6	1	100% fines (<1mm)	3.6	3.0	0	70	10
	7	0.9	23.6	2	100% fines (<1mm)	3.2	3.0	0	60	10
31	**1**	8.5	20.2	0	100% fines (<1mm)	1.5	3.0	0	90	50
	2	8.0	20.8	0	100% fines (<1mm)	1.0	0.5	0	90	50
	3	6.0	17.8	10	100% fines (<1mm)	0.9	3.0	0	90	70
	4	3.0	18.4	13	100% fines (<1mm)	3.3	0.5	0	100	80
	5	1.5	18.7	21	100% fines (<1mm)	1.3	0.5	0	100	100
32	**1**	42.4	14.6	1	100% fines (<1mm)	4.2	2.6	0	100	100
	2	37.9	16.3	1	100% fines (<1mm)	10.6	3.5	0	100	90
	3	26.4	18.2	0	100% fines (<1mm)	14.1	2.9	0	70	80
	4	16.0	23.6	0	100% fines (<1mm)	5.5	3.2	0.01	100	100
	5	7.0	22.0	0	100% fines (<1mm)	2.0	4.8	0.02	90	80
	6	2.0	20.7	0	100% fines (<1mm)	4.4	5.0	0.02	40	50
33	**1**	13.4	21.8	0	100% fines (<1mm)	2.4	7.3	0	60	50
	2	8.5	18.1	11	100% fines (<1mm)	5.6	4.5	0.01	100	100
	3	2.2	18.8	6	100% fines (<1mm)	1.1	1.9	0	60	50
	4	1.3	18.8	12	100% fines (<1mm)	0.9	0.9	0	50	50
	5	0.0	17.8	21	100% fines (<1mm)	0.7	1.5	0	50	50
118	**1**	10.4	18.3	0	100% fines (<1mm)	7.5	0.4	0	100	100
	2	8.5	20.2	0	100% fines (<1mm)	7.2	1.7	0	100	100
	3	5.3	20.4	0	100% fines (<1mm)	4.6	2.5	0	100	100
	4	2.7	19.9	14	100% fines (<1mm)	0.5	2.0	0	100	100
	5	0.0	19.9	21	100% fines (<1mm)	0.6	0.8	0	90	100

Table 25: Summary of springsnail (*Pyrgulopsis* spp.) abundance and distribution data at occupied springs, as calculated via tier 3 transects. Transects are oriented perpendicular to the springbrook, and begin at the furthest downstream location of springsnails (as determined during tier 2 sampling). Habitat parameters collected along each transect are also included. Catch per unit effort (CPUE) is calculated here as the average number of individuals encountered along the occupied springbrook length.

°C	degrees celsius
cm	centimeter
CPUE	Catch Per Unit Effort
m	meter
m/sec	meters per second
mm	millimeter

Table 26. 2020 Springsnail Survey Data - Springsnail Location Summary

Spring ID	Alternate Spring ID	Easting	Northing	New Springsnail Locality?	Mean CPUE	Abundance Category[3]	Springbrook Length (m)	Occupied Springbrook Length (m)	Temp along occupied length (min-max, °C)	Depth along occupied length (min-max, cm)	Temp at Spring Source (°C)	DO (%)	DO (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Spring Type	Disturbance
29	Spring 14[1], DM20[2]	409082	4406125	No	1.5	Scarce	27.0	1.8	22.6 - 23.6	3.0	23.3	9.1	0.77	1723	7.17	65.4	Helocrene	Moderate
31	N/A	409145	4406110	Yes	14.7	Common	9.9	6.0	17.8 - 18.7	0.5 - 3.0	18.4	25.1	2.34	1508	7.75	108.4	Helocrene	Moderate
32	DM22[2]	409159	4406139	No	0.3	Scarce	43.5	42.4	14.6 - 23.6	2.6 - 5.0	21.5	13.1	1.14	1354	8.11	31.0	Helocrene	High
33	N/A	409210	4406126	Yes	12.5	Common	16.6	8.5	17.8 - 18.8	0.9 - 4.5	17.6	73.5	7.00	1361	7.84	12.5	Rheocrene	Moderate
118	N/A	409293	4406172	Yes	17.5	Common	15.5	2.7	19.9	0.8 - 2.0	21.5	67.1	5.90	1329	8.08	25.8	Rheocrene	Moderate

Table 26: Summary of springsnail (*Pyrgulopsis* spp.) abundance and distribution data at occupied springs. Water quality parameters collected at the spring source are also included.

[1]ARMMP Surface Water Monitoring Spring ID (McGinley)

[2]2018 Springsnail Survey Spring ID (Ormat)

[3]Abundance Categories:
Abundant: > 20 CPUE
Common: 6-20 CPUE
Scarce: <6 CPUE

°C	degrees celsius
µS/cm	microsiemens per centimeter
cm	centimeter
CPUE	Catch Per Unit Effort
DO	Dissolved Oxygen
m	meter
mg/L	milligrams per liter
mL	milliliter

Coordinates: NAD 1983 UTM Zone 11N

FIGURES

23N 34E

23N 35E

23N 36E

22N 34E

22N 35E

22N 36E

21N 36E

NVN 86885

NVN 83941

NVN 83937

Lamb Mineral Interest

NVN 91823

NVN 83934

NVN 98644

NVN 92479

NVN 83939

NVN 60685

NVN 83935

NVN 92717

NVN 60686

NVN 83936

Legend

- Wilderness Study Area
- WARD Boundary
- 120kV Generation Tie Line (Proposed Action)
- 230kV Generation Tie Line (Alternative 1)
- Proposed Power Plant (Phase 1)
- Additional Power Plant Locations Analyzed (Phase 2)
- Existing Gravel Pit
- Proposed Deep Core Hole/Full-Size Well

Previously Permitted - Not Drilled

Well Type (By Symbol)

- Core Hole
- Deep Core Hole/Full-Size Well
- Full-Size Well

Existing Wells

Well Type (By Symbol)

- Core Hole
- Deep Core Hole/Full-Size Well
- Full-Size Well
- Monitoring Well

Dixie Meadows Unit Agreement - NVN 089456X

- (Labeled by Geothermal Lease Serial Number)
- Lamb Mineral Interest (Navy Lease)

Public Land Survey System

- Township
- Section

0 1 Miles

FIGURE 1A

TITLE:

SITE MAP
-SHOWING-
ORMAT GEOTHERMAL LEASES AND FACILITIES
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
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FILE: Fig 1A - Lease Areas

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
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		DRAWN	HC	APPROVED	DS		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 1A - Lease Areas.mxd

N

0 2,000

Feet

Legend

- Proposed Deep Core Hole/Full-Size Well
- Seep/Spring
- 120 kV Generation-Tie Line
- 230kV Generation Tie Line (Alternative 1)
- Existing Gravel Pit
- Proposed Power Plant
- Additional Power Plant Locations Analyzed (Phase 2)
- WARD Boundary

Existing Wells

Well Type (By Symbol)

- Core Hole
- Deep Core Hole/Full-Size Well
- Full-Size Well
- Monitoring Well

Permitted - Not Drilled

Well Type (By Symbol)

- Core Hole
- Deep Core Hole/Full-Size Well
- Full-Size Well

Wetland Communities

- Bulrush Wetland
- Cattail Wetland
- Field Sedge Meadow
- Forb Upland
- Meadow
- Reed Canarygrass Wetland
- Saltgrass & Alkali Bulrush Wetland
- Saltgrass Upland
- Shrub Upland
- Wet Meadow
- Wetland Boundary
- Woody Riparian

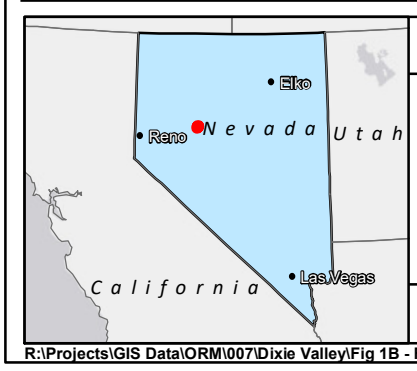

FIGURE 1B

TITLE:

SITE MAP

-SHOWING-

ORMAT GEOTHERMAL FACILITIES, SEEP/SPRING INVENTORY, AND WETLAND COMMUNITIES

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

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FILE: **Fig 1B - Facilities & Water Resources**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.: **ORM007**

DATE: **11/13/2020**

REF.					REVISION:
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	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 1B - Facilities & Water Resources.mxd

Legend

WARD Boundary

Land Ownership Boundaries*

Bureau of Land Management

Department of Defense

Private Lands

* Source - Bureau of Land Management
National Surface Management Agency, 2016

N

0 1
Miles

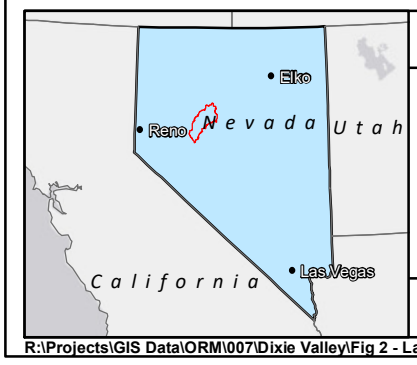

FIGURE 2

TITLE:

SITE MAP
-SHOWING-
LAND OWNERSHIP BOUNDARIES
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: Fig 2 - Land Ownership Boundaries

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	DS	CHECKED	DS		-
		DRAWN	HC	APPROVED	DS		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 2 - Land Ownership Boundaries.mxd

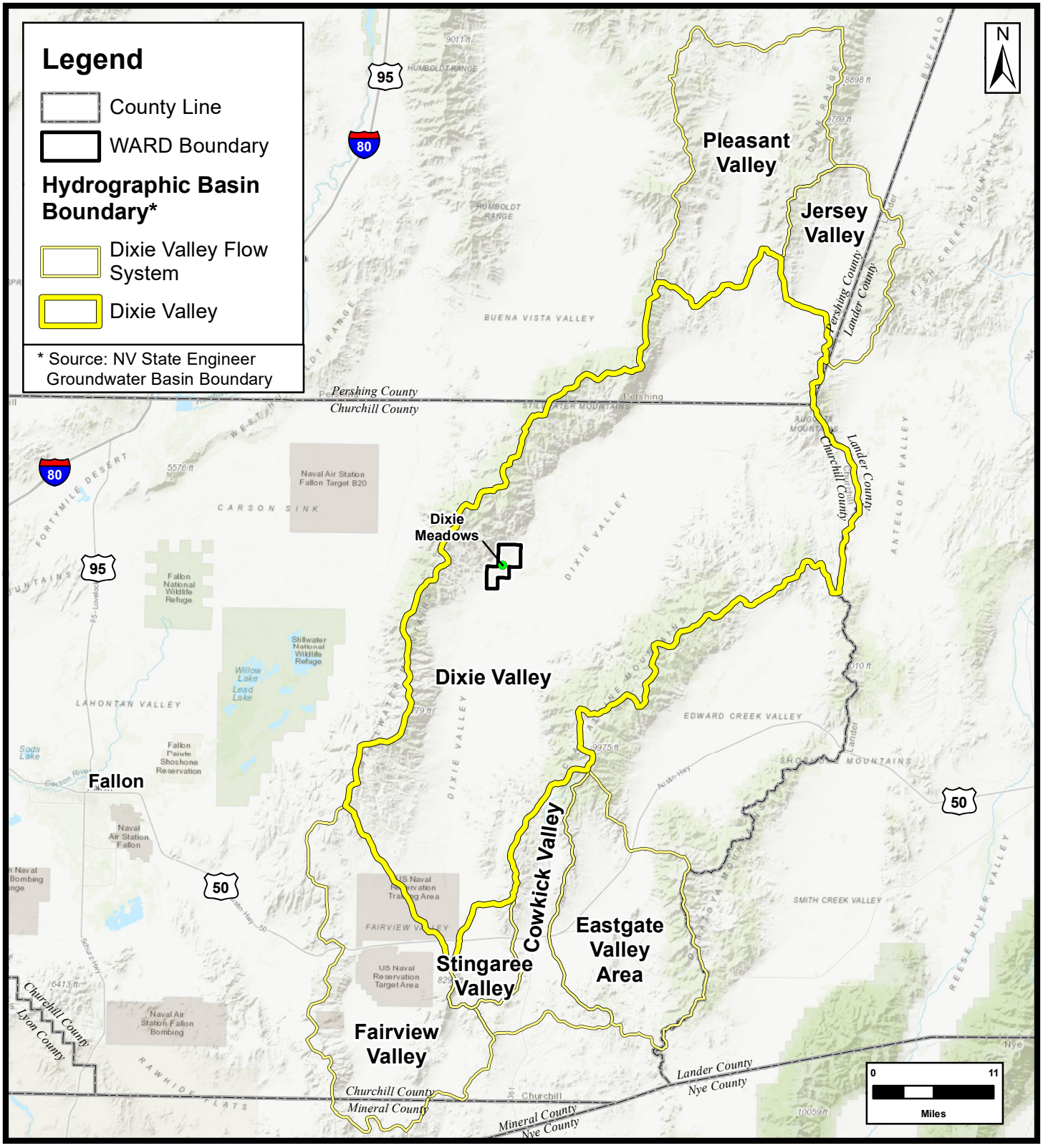

FIGURE 3

TITLE: **PROJECT LOCATION MAP**
-SHOWING-
DIXIE MEADOWS AND HYDROGRAPHIC BASINS IN DIXIE VALLEY FLOW SYSTEM
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
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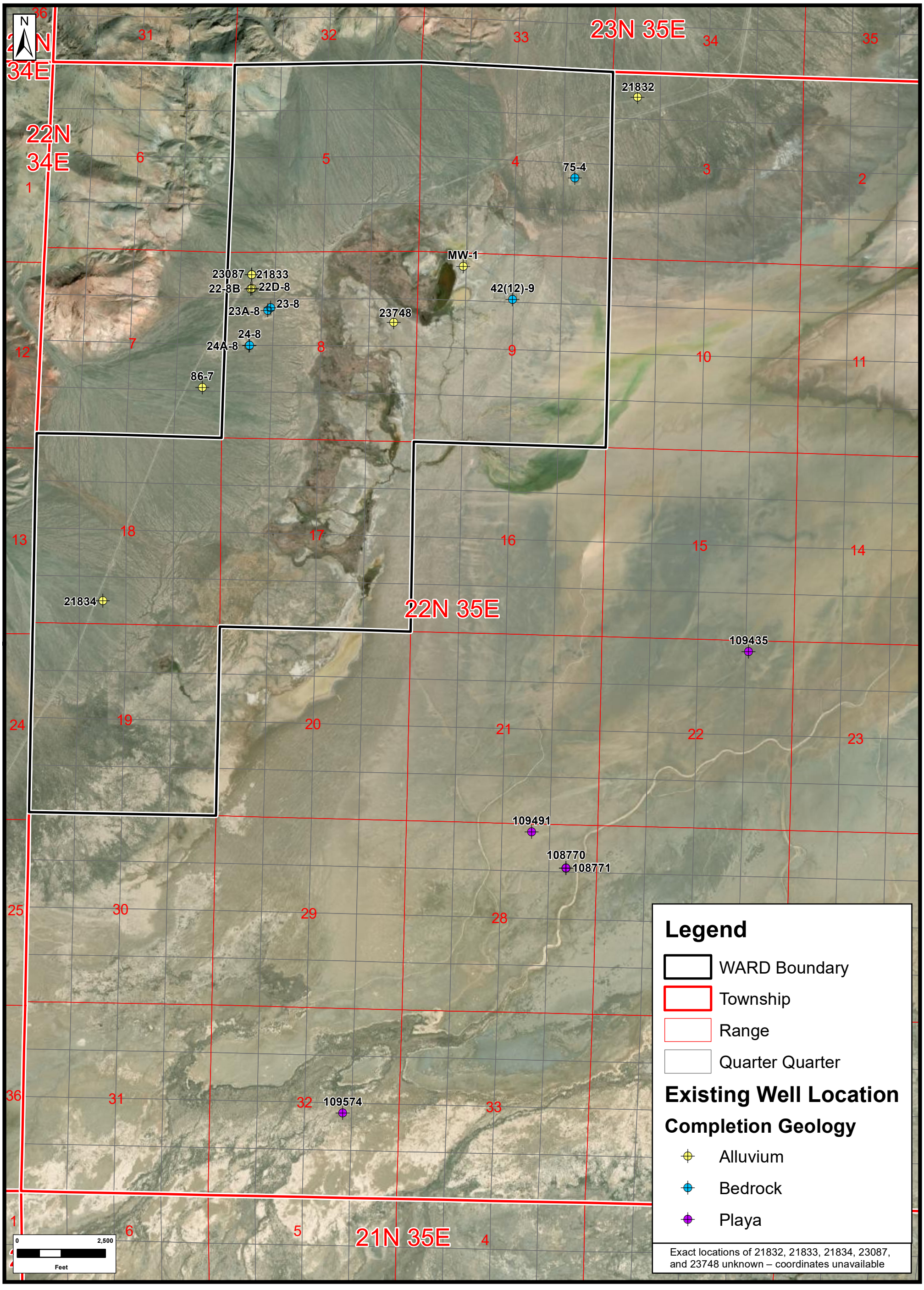
JOB NO.:	DATE:
ORM007	11/13/2020

FILE: Fig 3 - Hydrographic Basins

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 3 - Hydrographic Basins.mxd



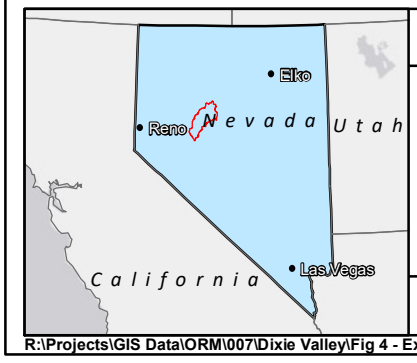


FIGURE 4

TITLE:

SITE MAP
-SHOWING-
EXISTING WELLS
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: **Fig 4 - Existing Well Sites**

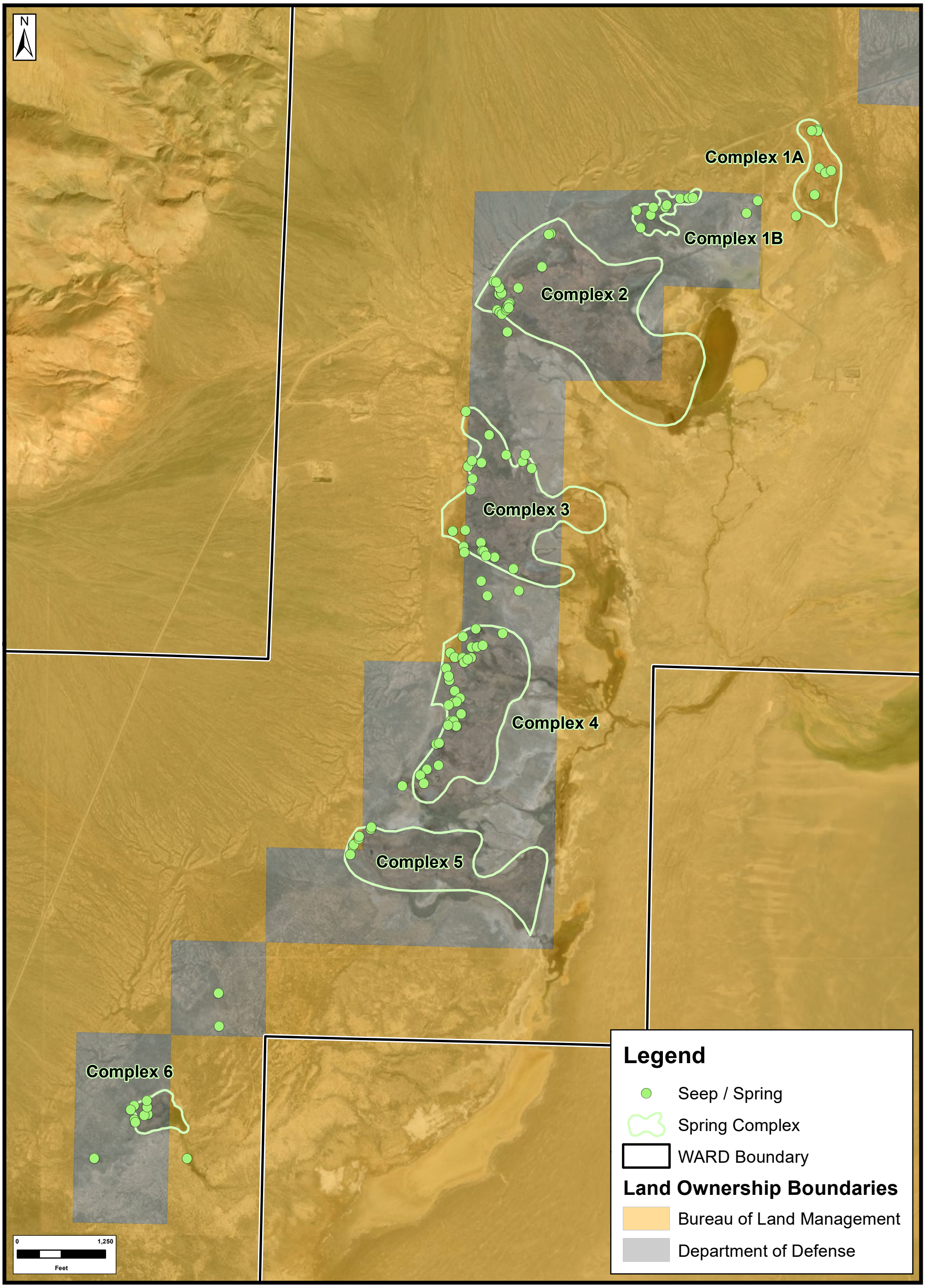
COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.: **ORM007**

DATE: **11/13/2020**

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 4 - Existing Well Sites.mxd



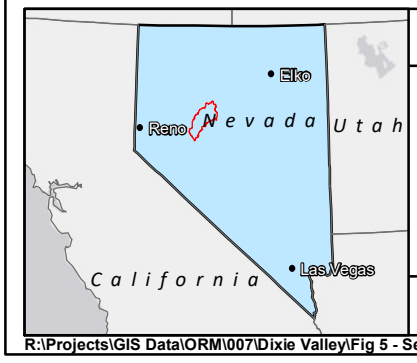


FIGURE 5

TITLE:

SITE MAP
-SHOWING-
SEEPS AND SPRINGS
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: Fig 5 - Seeps and Springs

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.: ORM007

DATE: 11/13/2020

REF.

DESIGNED	DS	CHECKED	DS	REVISION: -
DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 5 - Seeps and Springs.mxd

N

Figure 7

Figure 8

Complex 1A

Complex 1B

Complex 2

Figure 9

Complex 3

Figure 10

Complex 4

Figure 11

Complex 5

Figure 12

Complex 6

0 1,500

Feet

WARD Boundary

Spring Complex

Perennial Stream

Springs

Proposed Deep Core Hole/Full-Size Well

Previously Permitted - Not Drilled

Well Type (By Symbol)

Core Hole

Deep Core Hole/Full-Size Well

Full-Size Well

Existing Wells

Well Type (By Symbol)

Core Hole

Deep Core Hole/Full-Size Well

Full-Size Well

Monitoring Well

Wetland Communities

Bulrush Wetland

Cattail Wetland

Field Sedge Meadow

Forb Upland

Meadow

Reed Canarygrass Wetland

Saltgrass & Alkali Bulrush Wetland

Saltgrass Upland

Shrub Upland

Wet Meadow

Wetland Boundary

Woody Riparian

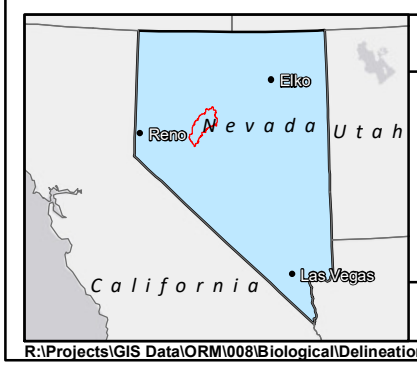

FIGURE 6

TITLE:

SITE MAP

-SHOWING-

DIXIE MEADOWS WETLAND COMMUNITIES

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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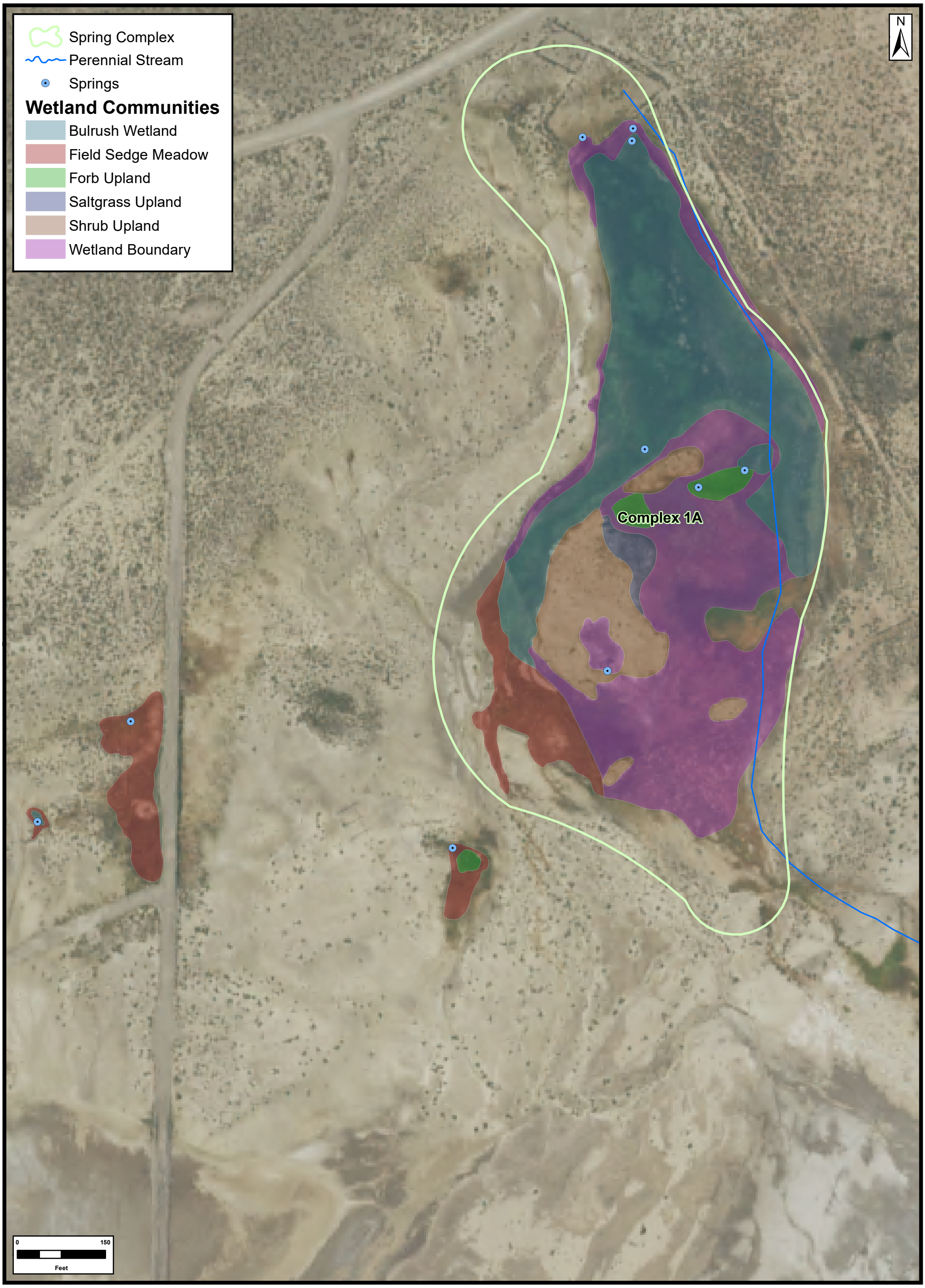
FILE: **Figure 6 - Dixie Meadows Wetland Communities**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	GB	CHECKED	BP		-
		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 6 - Dixie Meadows Wetland Communities.mxd



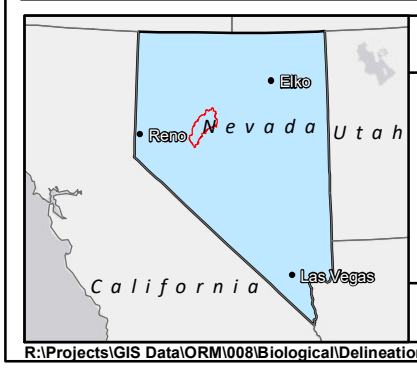


FIGURE 7

TITLE:

SITE MAP

-SHOWING-

DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 1A

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: Figure 7 - Dixie Meadows Wetland Communities SC 1A

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	GB	CHECKED	BP		-
		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 7 - Dixie Meadows Wetland Communities SC 1A.mxd

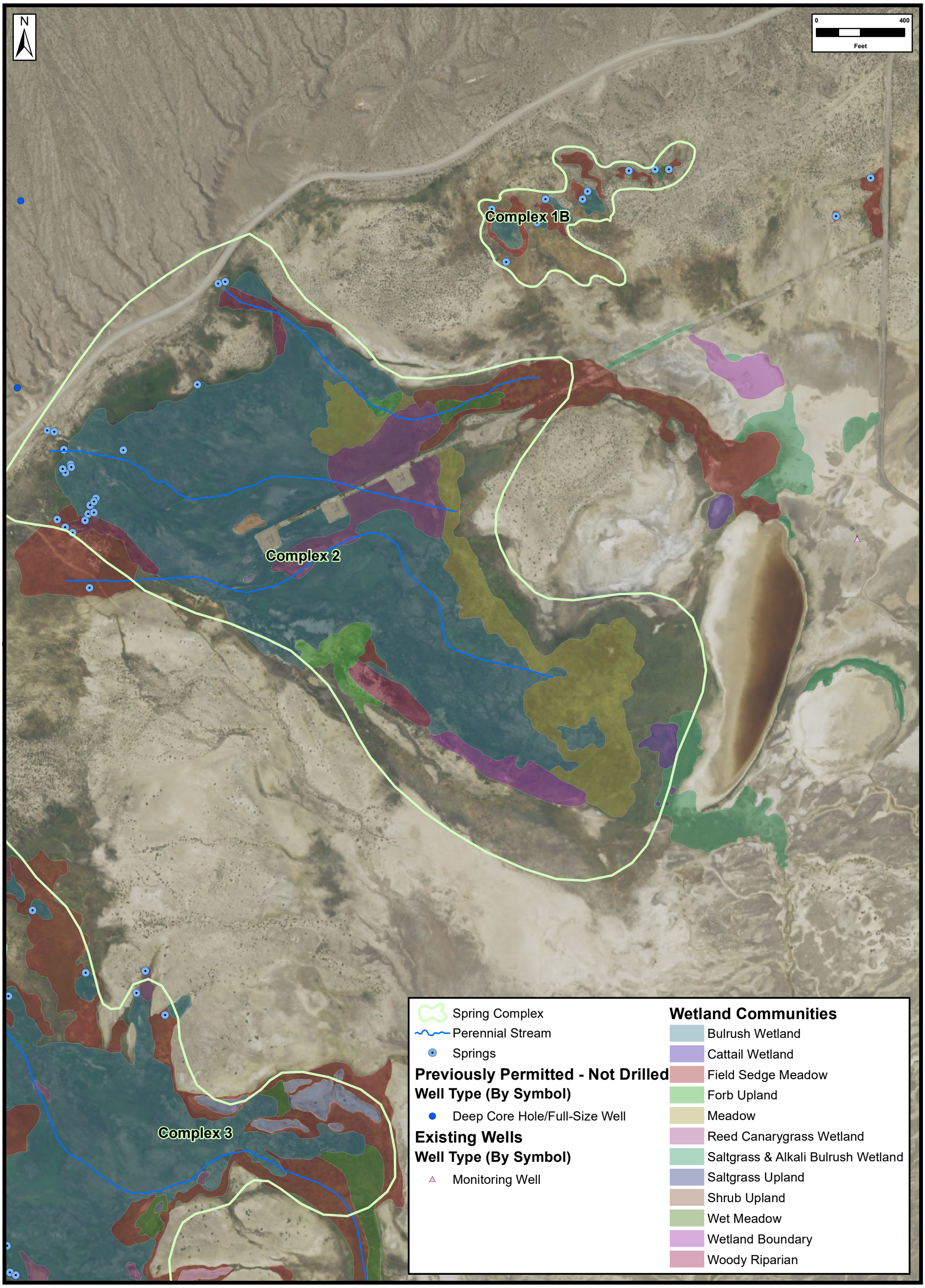

FIGURE 8

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 1B AND 2
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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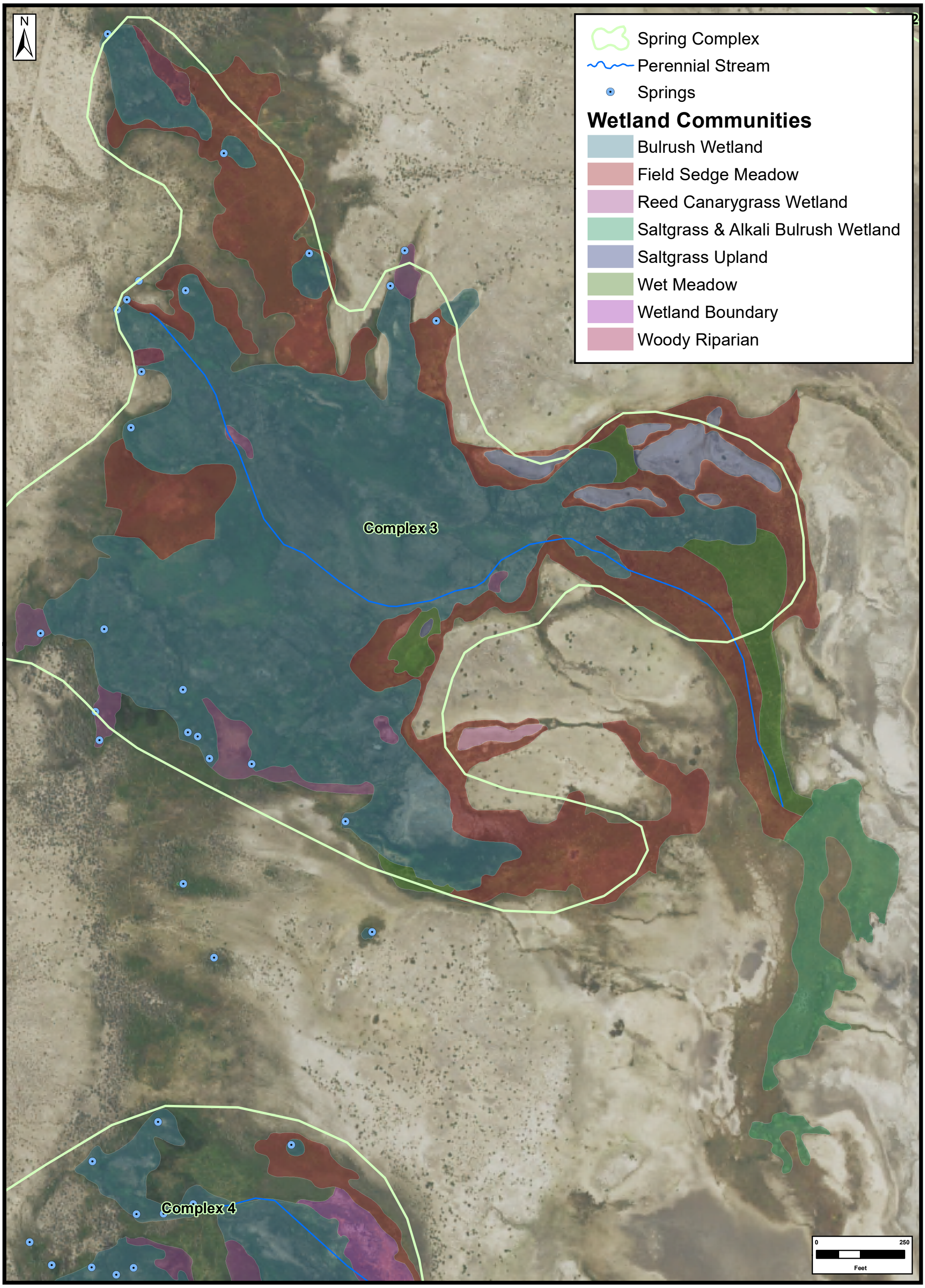
FILE: Figure 8 - Dixie Meadows Wetland Communities SC 1B and 2

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	GB	CHECKED	BP		-
		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 8 - Dixie Meadows Wetland Communities SC 1B and 2.mxd



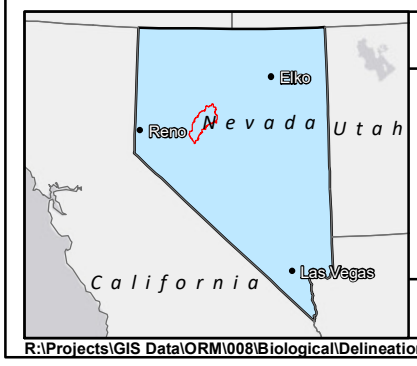


FIGURE 9

TITLE:

SITE MAP

-SHOWING-

DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 3

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

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FILE: Figure 9 - Dixie Meadows Wetland Communities SC 3

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

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		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 9 - Dixie Meadows Wetland Communities SC 3.mxd

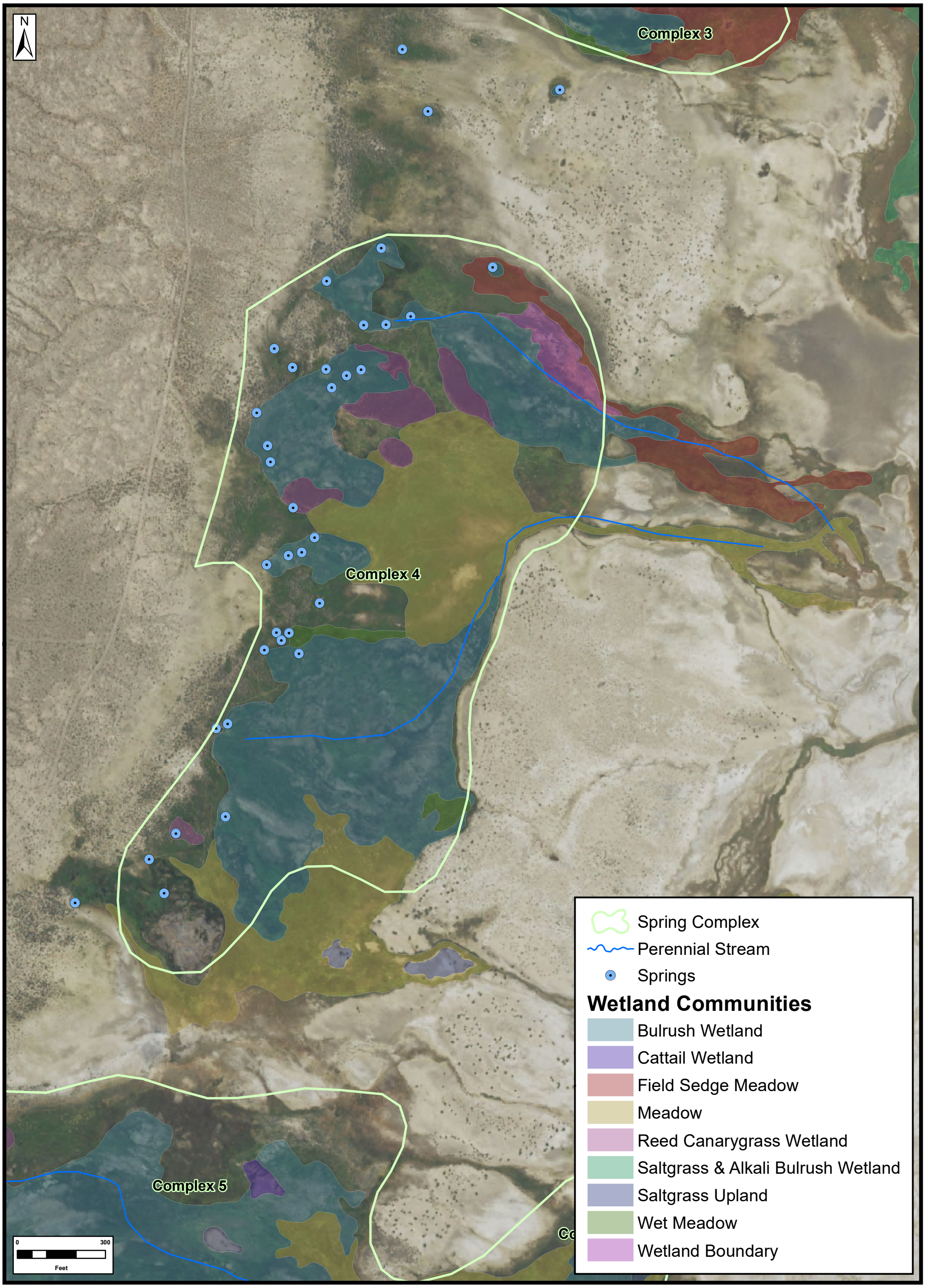

FIGURE 10

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 4
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: Figure 10 - Dixie Meadows Wetland Communities SC 4

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF:					REVISION:
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		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 10 - Dixie Meadows Wetland Communities SC 4.mxd

N

Complex 4

Complex 5

WARD Boundary
Spring Complex
Perennial Stream
Springs

Wetland Communities

Bulrush Wetland
Cattail Wetland
Forb Upland
Meadow
Reed Canarygrass Wetland
Saltgrass & Alkali Bulrush Wetland
Saltgrass Upland
Wet Meadow
Woody Riparian

0 350
Feet

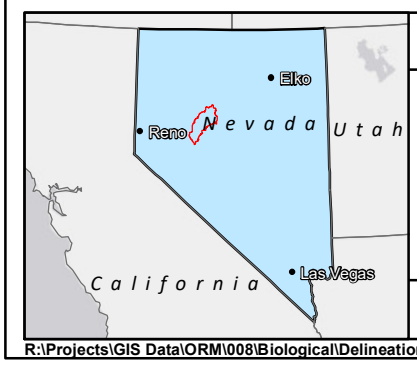

FIGURE 11

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 5
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
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FILE: Figure 11 - Dixie Meadows Wetland Communities SC 5

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.: ORM007

DATE: 11/13/2020

REF:

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DRAWN	GB	APPROVED	BP	

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 11 - Dixie Meadows Wetland Communities SC 5.mxd

N

Complex 6

0 250
Feet

Spring Complex
Springs
Proposed Deep Core Hole/Full-Size Well

Wetland Communities

Bulrush Wetland
Field Sedge Meadow
Wetland Boundary

FIGURE 12

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS WETLAND COMMUNITIES - SPRING COMPLEX 6
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
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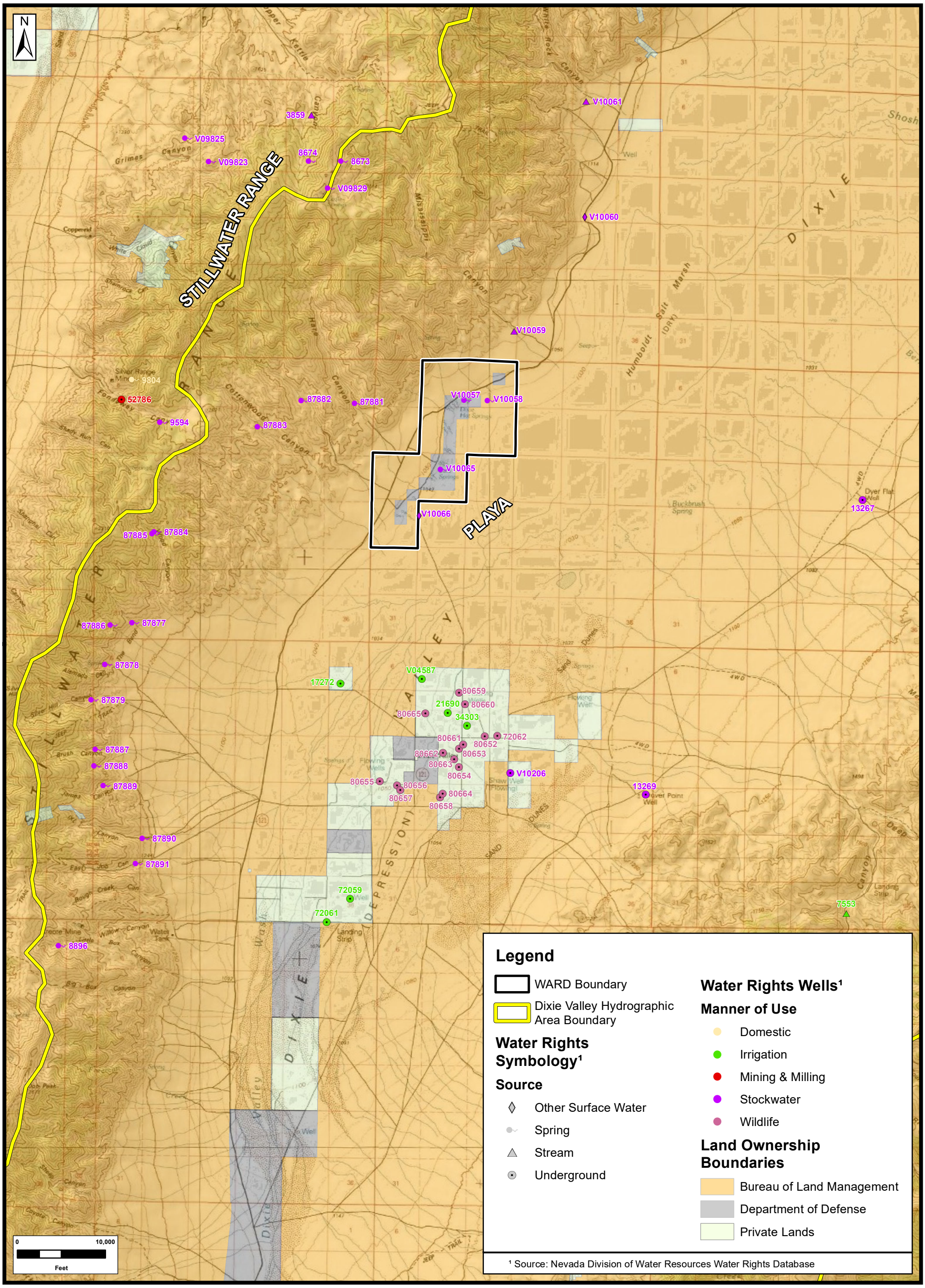
FILE: Figure 12 - Dixie Meadows Wetland Communities SC 6

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	GB	CHECKED	BP		-
		DRAWN	GB	APPROVED	BP		

R:\Projects\GIS Data\ORM\008\Biological\Delineation\Figure 12 - Dixie Meadows Wetland Communities SC 6.mxd



Legend

- WARD Boundary
- Dixie Valley Hydrographic Area Boundary

Water Rights Symbology[1]

Source

- Other Surface Water
- Spring
- Stream
- Underground

Water Rights Wells[1]

Manner of Use

- Domestic
- Irrigation
- Mining & Milling
- Stockwater
- Wildlife

Land Ownership Boundaries

- Bureau of Land Management
- Department of Defense
- Private Lands

[1] Source: Nevada Division of Water Resources Water Rights Database

FIGURE 13

TITLE:

SITE MAP
-SHOWING-
ACTIVE WATER RIGHTS NEAR DIXIE MEADOWS
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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JOB NO.:	ORM007
DATE:	11/13/2020
FILE:	Fig 13 - Active Water Rights
COORDINATE SYSTEM:	NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 13 - Active Water Rights.mxd

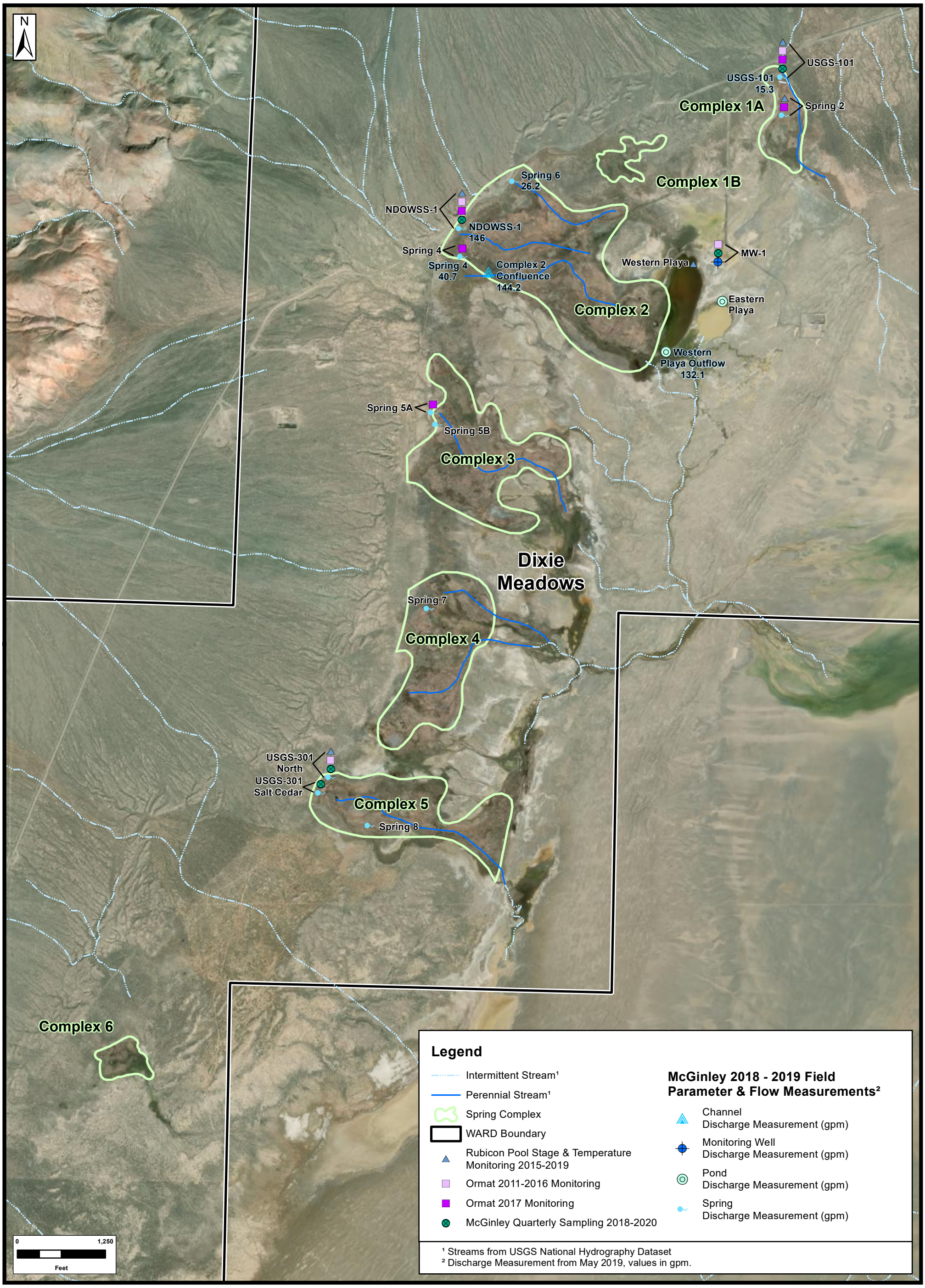

FIGURE 14

TITLE:

SITE MAP

-SHOWING-

CURRENT / RECENT MONITORING LOCATIONS AND FLOW MEASUREMENTS

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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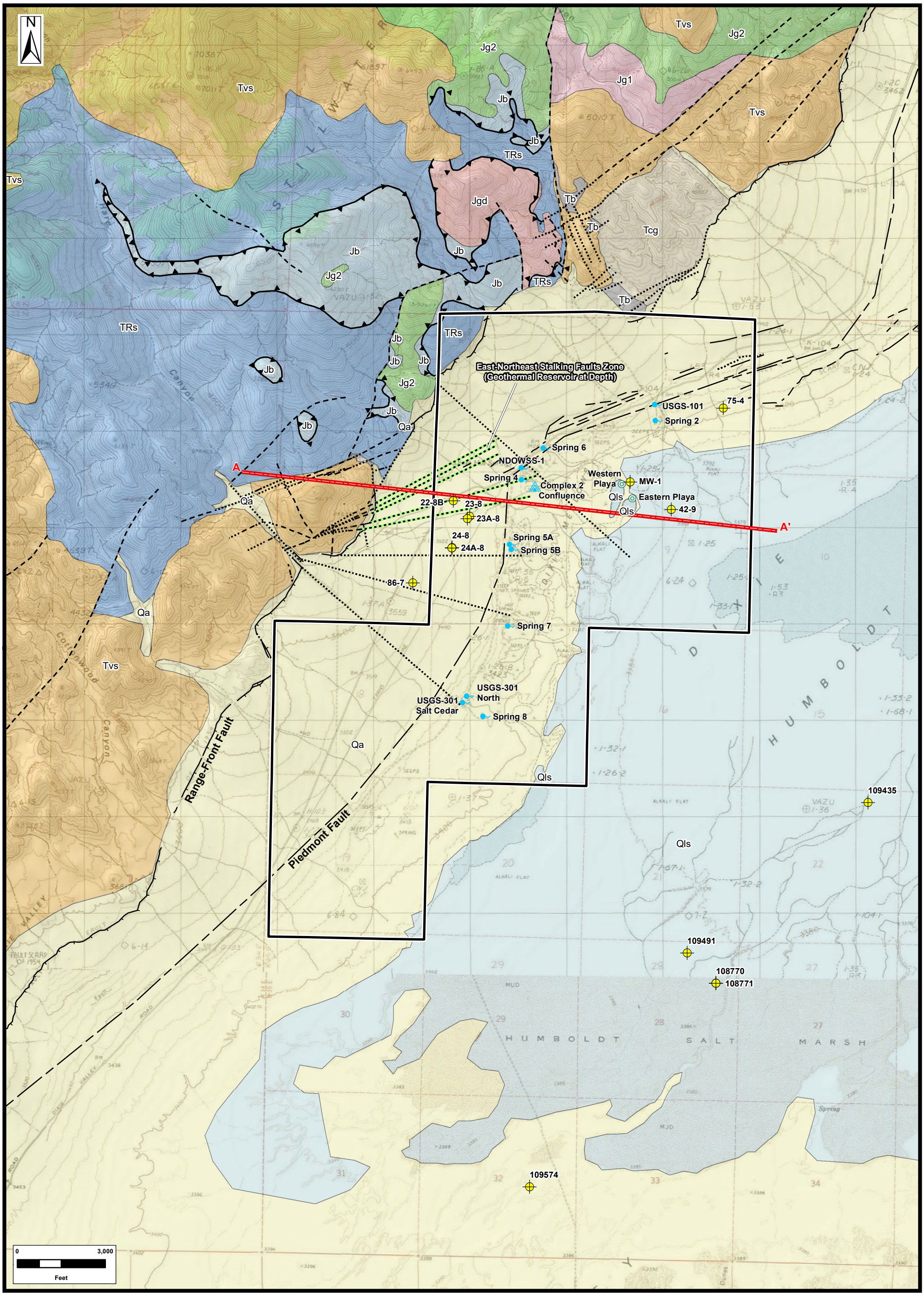
FILE: Fig 14 - Current Recent Monitoring Locations

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	DS	CHECKED	DW		-
		DRAWN	HC	APPROVED	DW		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 14 - Current Recent Monitoring Locations.mxd



Legend

- Existing Well Location
- Cross Section
- WARD Boundary

Current Monitoring Sites

- Channel
- Pond
- Spring

Faults

- Concealed Fault
- Concealed Fault Projected to Land Surface
- Holocene Fault Scarp
- Inferred Fault
- Thrust Fault
- Lineament

Geologic Unit

- Jb — Jurassic Boyer Ranch Formation
- Jg1 — Jurassic Gabbro, unfoliated
- Jg2 — Jurassic Gabbro, mod foliated
- Jgd — Jurassic Granodiorite
- Jvm — Jurassic Volcanic Rock
- Qa — Quaternary Alluvial Sediment
- Qls — Quaternary Lacustrine Sediment
- Qs — Quaternary Landslide Deposits
- TRs — Triassic Slate & Siltstone
- Tb — Tertiary Basalt
- Tcg — Tertiary Conglemerate
- Tvs — Tertiary Ash-Flow Tuff & Sediment

Sources:
Geologic Units (Speed, 1976)
Regional Faults (Speed 1976; EGS, 2014)
Local Dixie Meadows Fault (Speed 1976, Ormat 2017)

FIGURE 15

TITLE: **SITE MAP**
-SHOWING-
GEOLOGIC MAP OF DIXIE MEADOWS AREA
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
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FILE: **Fig 15 - Geologic Map**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.:	DATE:	REF.				
ORM007	11/13/2020	DESIGNED	DS	CHECKED	DS
		DRAWN	HC	APPROVED	DS

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 15 - Geologic Map.mxd

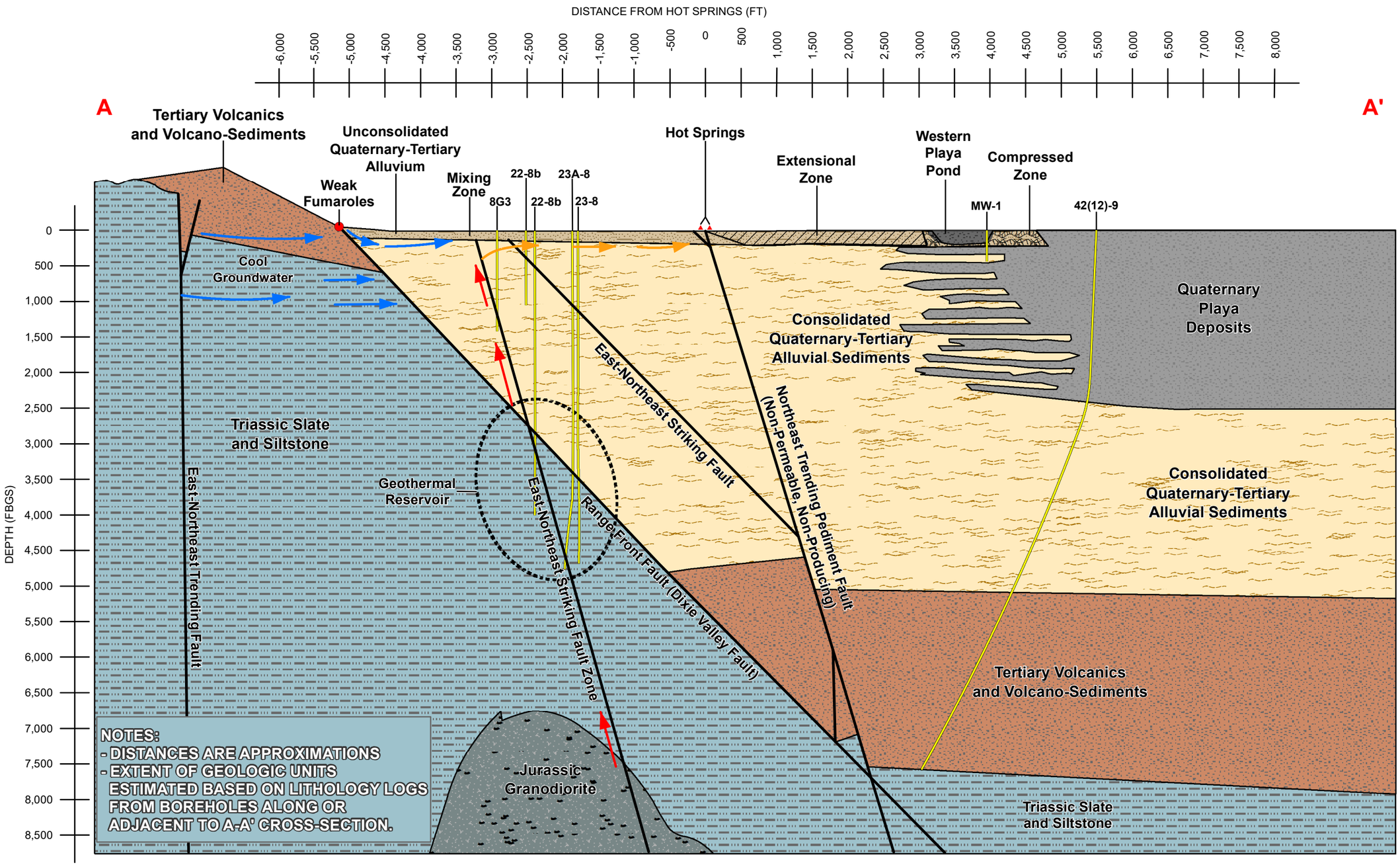

FIGURE 16

TITLE:

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

JOB NO.:

ORM007

DATE:

11/13/2020

FILE:

Fig 16 - Conceptual Model

REF.

DESIGNED	DS
DRAWN	HC
CHECKED	DW
APPROVED	DW

REVISION:

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R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 16 - Conceptual Model.mxd

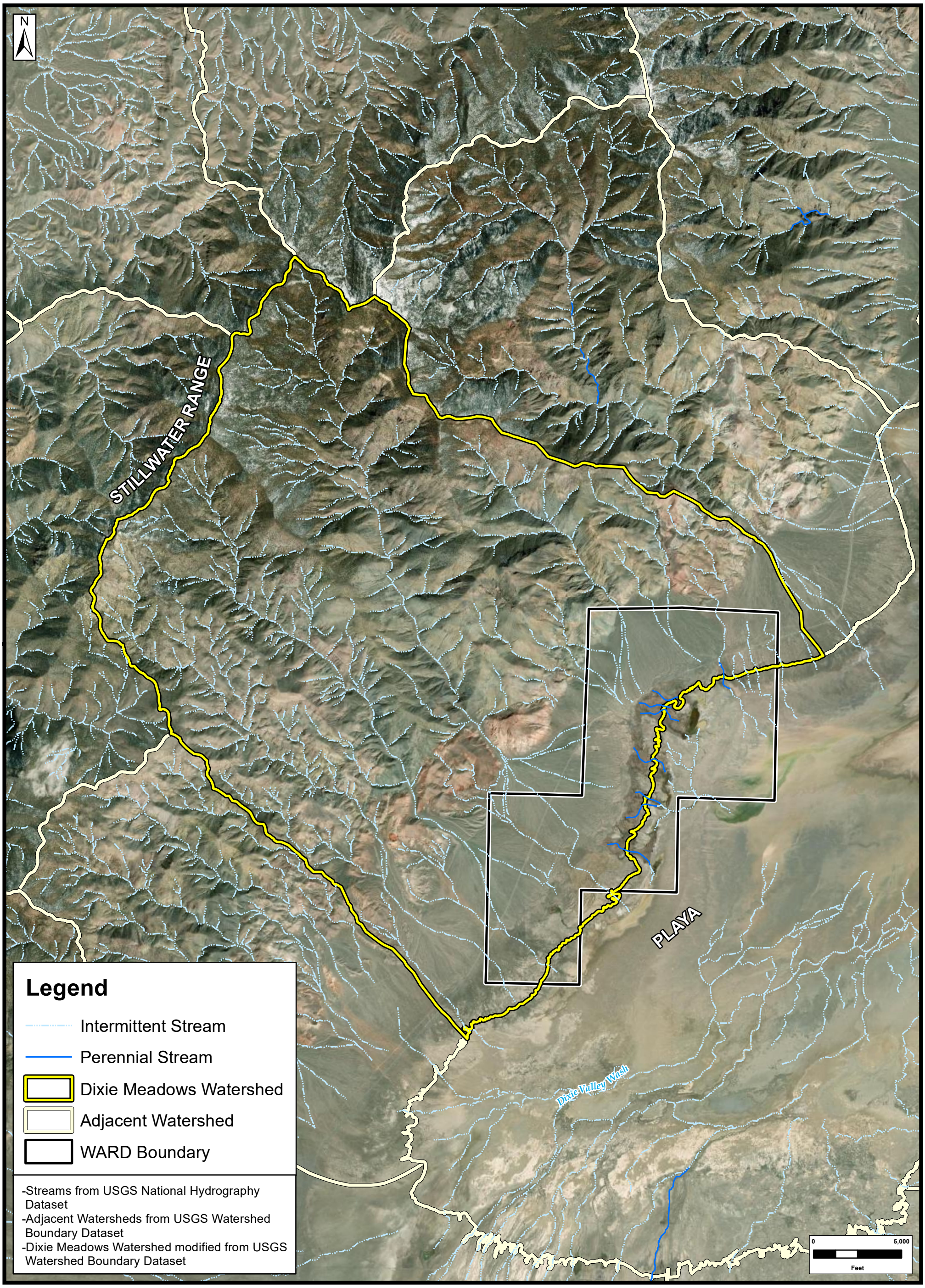


FIGURE 17

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS TRIBUTARY WATERSHED
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

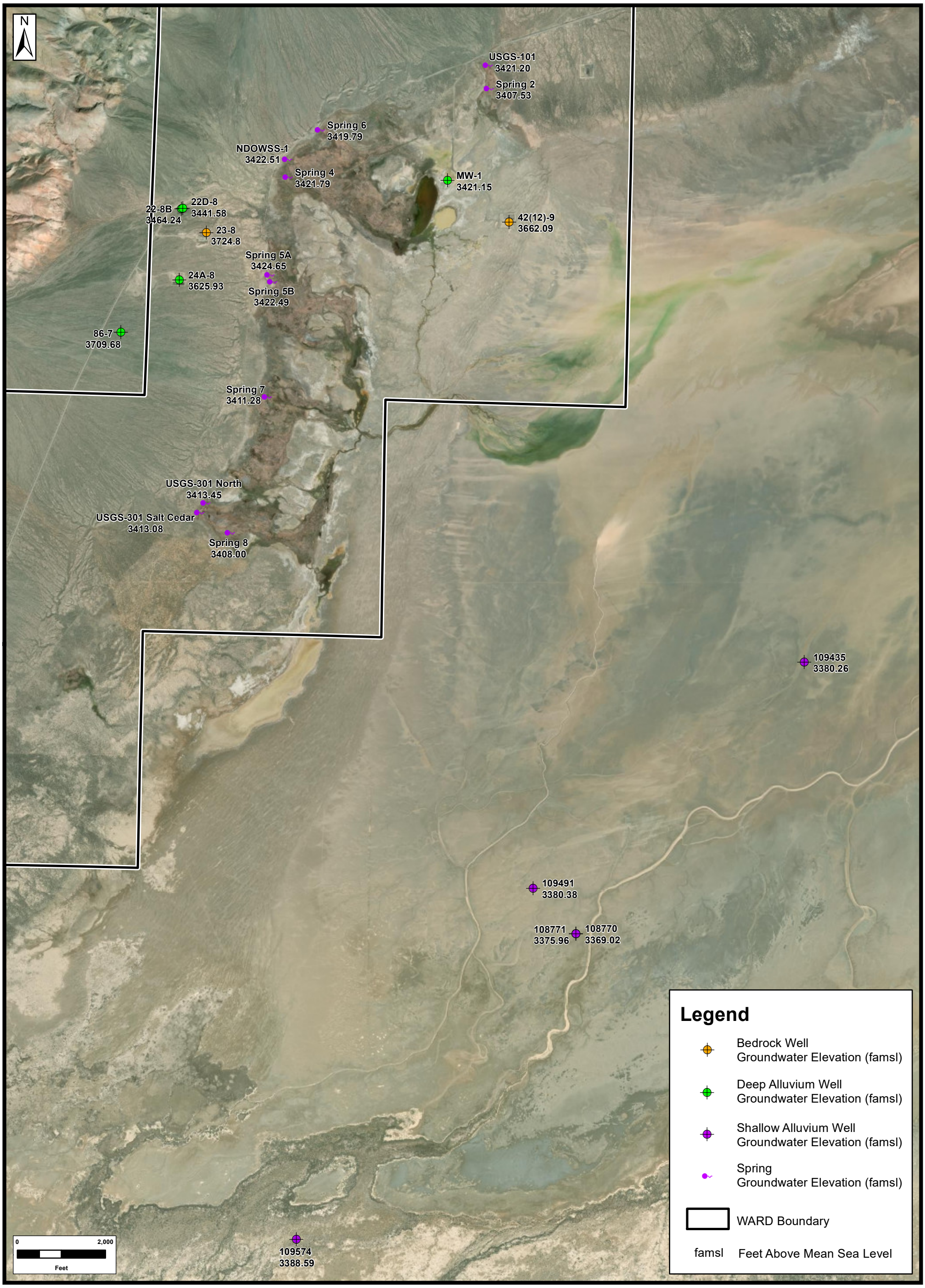
McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: Fig 17 - Dixie Meadows Watershed

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	DS	CHECKED	DS		-
		DRAWN	HC	APPROVED	DS		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 17 - Dixie Meadows Watershed.mxd



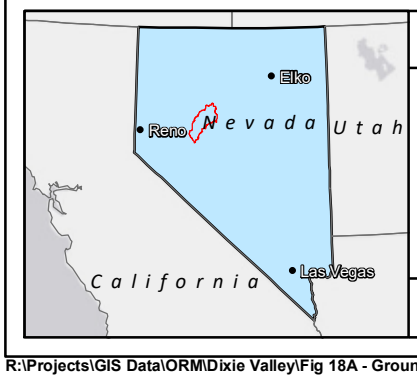


FIGURE 18A

TITLE:

SITE MAP

-SHOWING-

GROUNDWATER AND SPRING WATER ELEVATIONS

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Fig 18A - Groundwater Elevations**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.: **ORM007**

DATE: **11/13/2020**

REF.

DESIGNED	DS	CHECKED	DS	REVISION: -
DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\Dixie Valley\Fig 18A - Groundwater Elevations.mxd

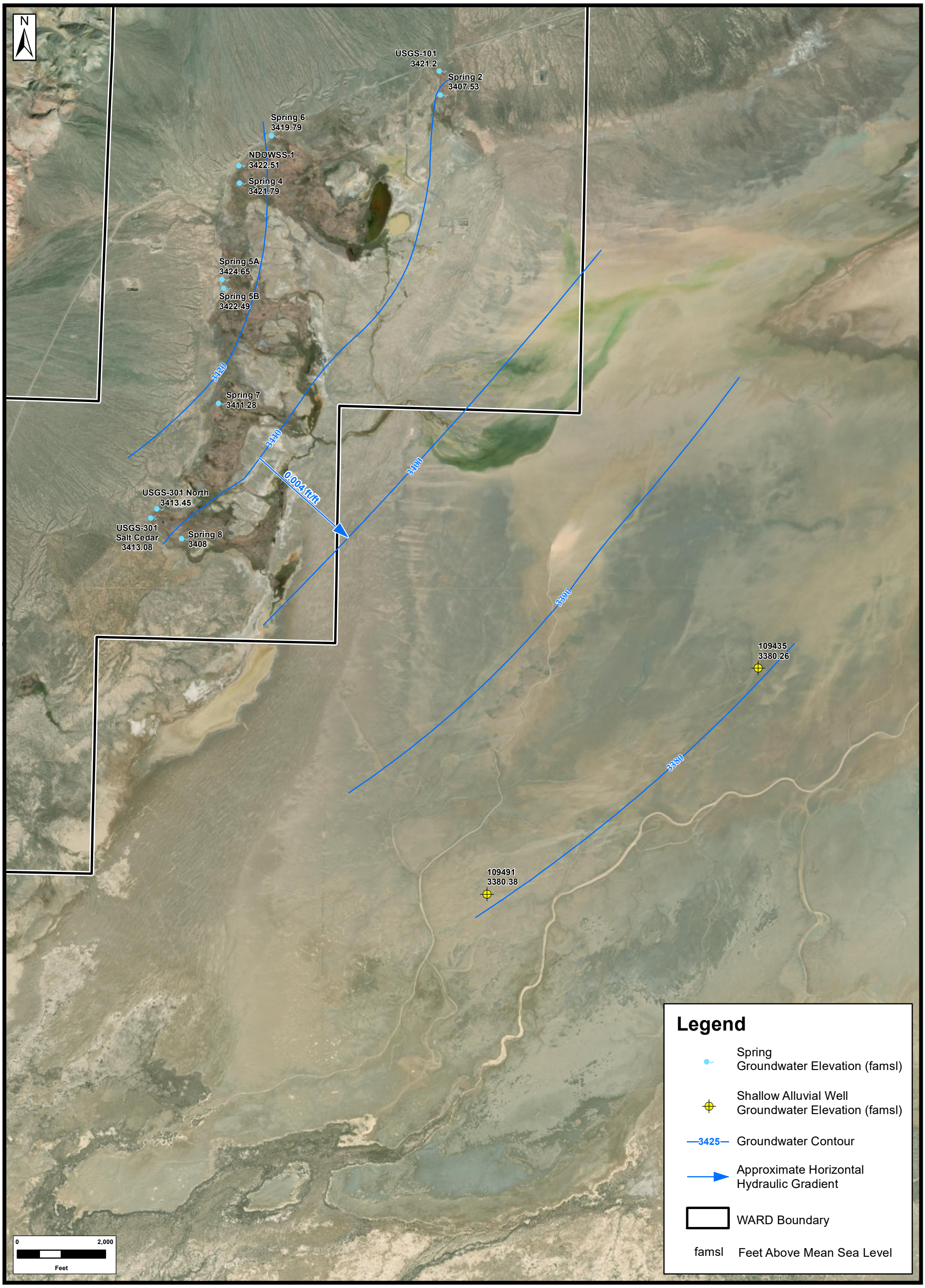


FIGURE 18B

TITLE:

SITE MAP
-SHOWING-
POTENTIOMETRIC SURFACE
(SHALLOW ALLUVIAL AQUIFER)
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Fig 18B - Potentiometric Surface**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

JOB NO.: **ORM007**

DATE: **11/13/2020**

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\Dixie Valley\Fig 18B Potentiometric Surface Map.mxd

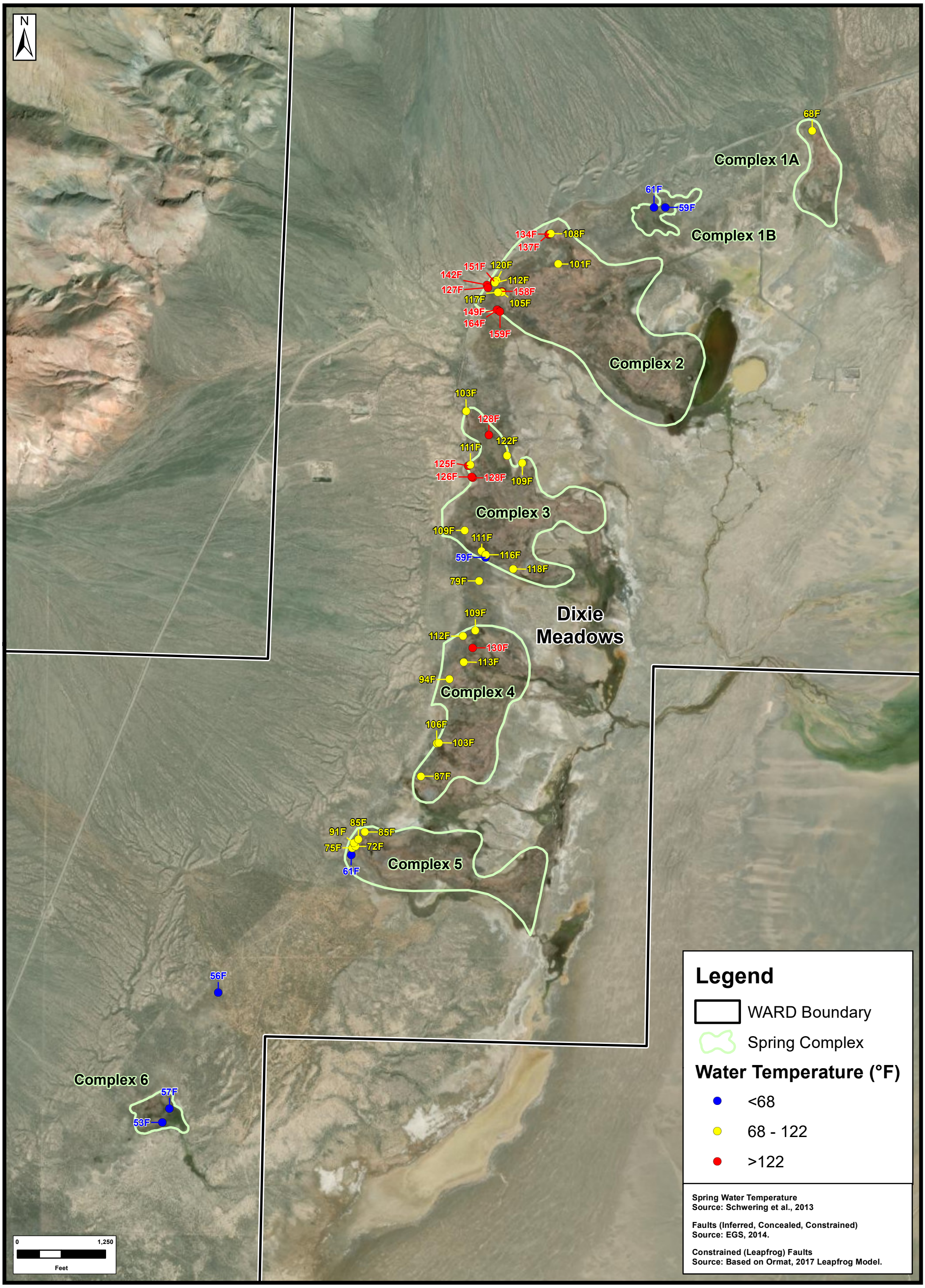


FIGURE 19A

TITLE:

SITE MAP
-SHOWING-
SPRING WATER TEMPERATURE
(MAY 2012)
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: Fig 19A - 2012 Water Temperatures

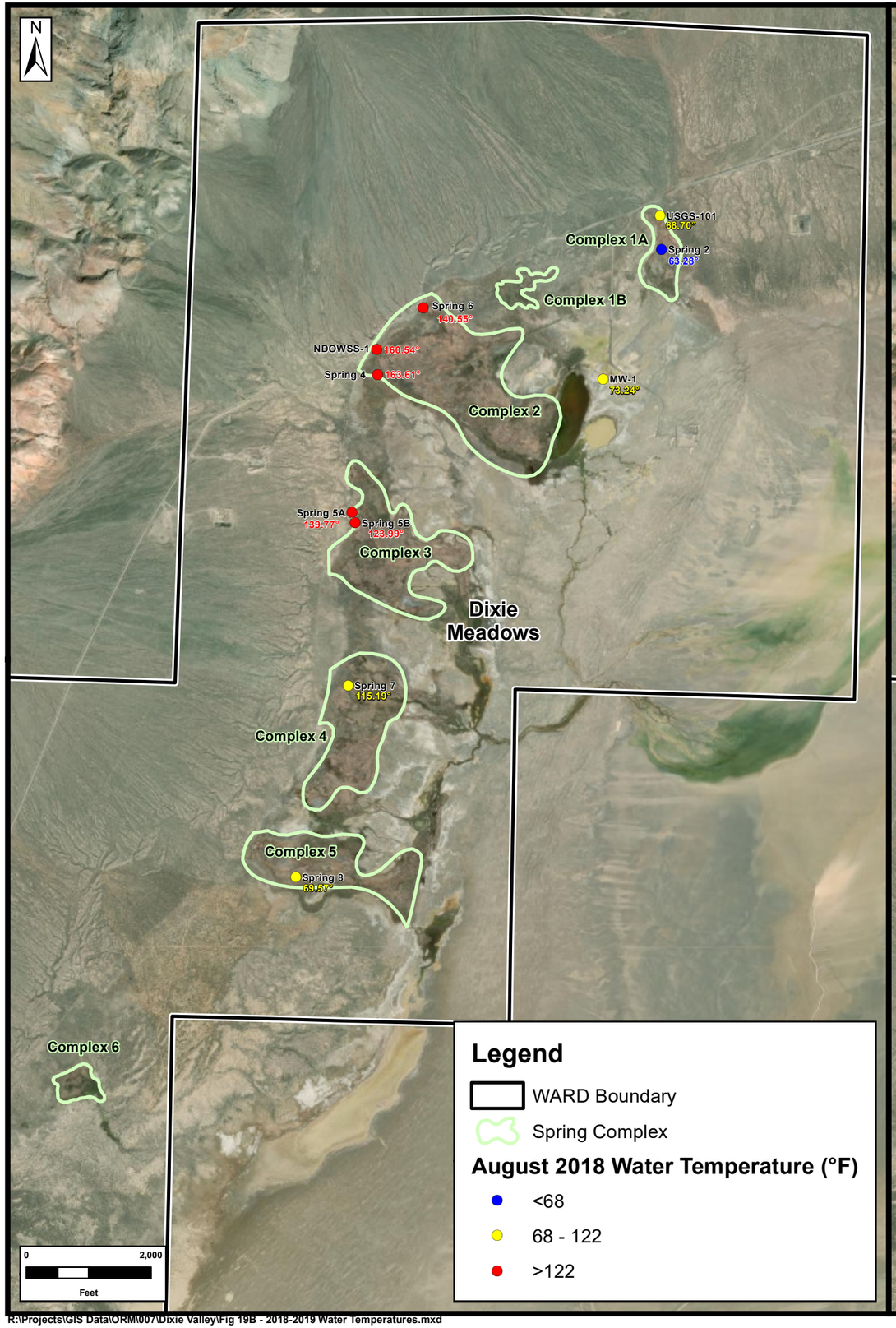
COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

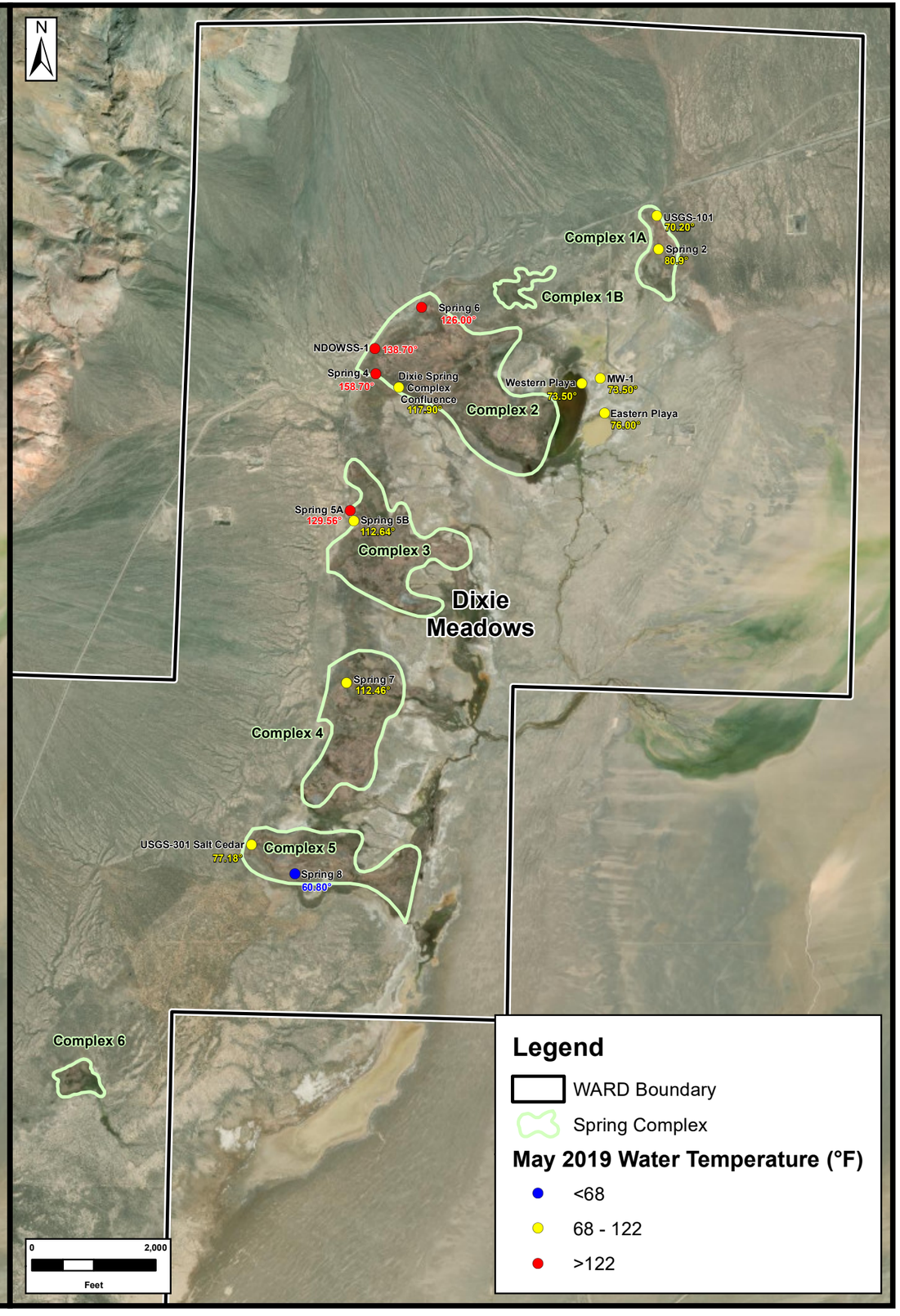
JOB NO.: ORM007

DATE: 11/13/2020

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 19A - 2012 Water Temperatures.mxd





R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 19B - 2018-2019 Water Temperatures.mxd

FIGURE 19B

TITLE:

SITE MAP
-SHOWING-
WATER TEMPERATURE
(AUGUST 2018 AND MAY 2019)
ORNI 32, LLC
DIXIE MEADOWS
GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

JOB NO.:

ORM007

DATE:

11/13/2020

FILE:

Fig 19B - 2018-2019 Water Temperatures

COORDINATE SYSTEM:

NAD 1983 UTM Zone 11N

REF.

DESIGNED	DS
DRAWN	HC
CHECKED	DS
APPROVED	DS

McGinley & Associates
Environmental Engineering and Science
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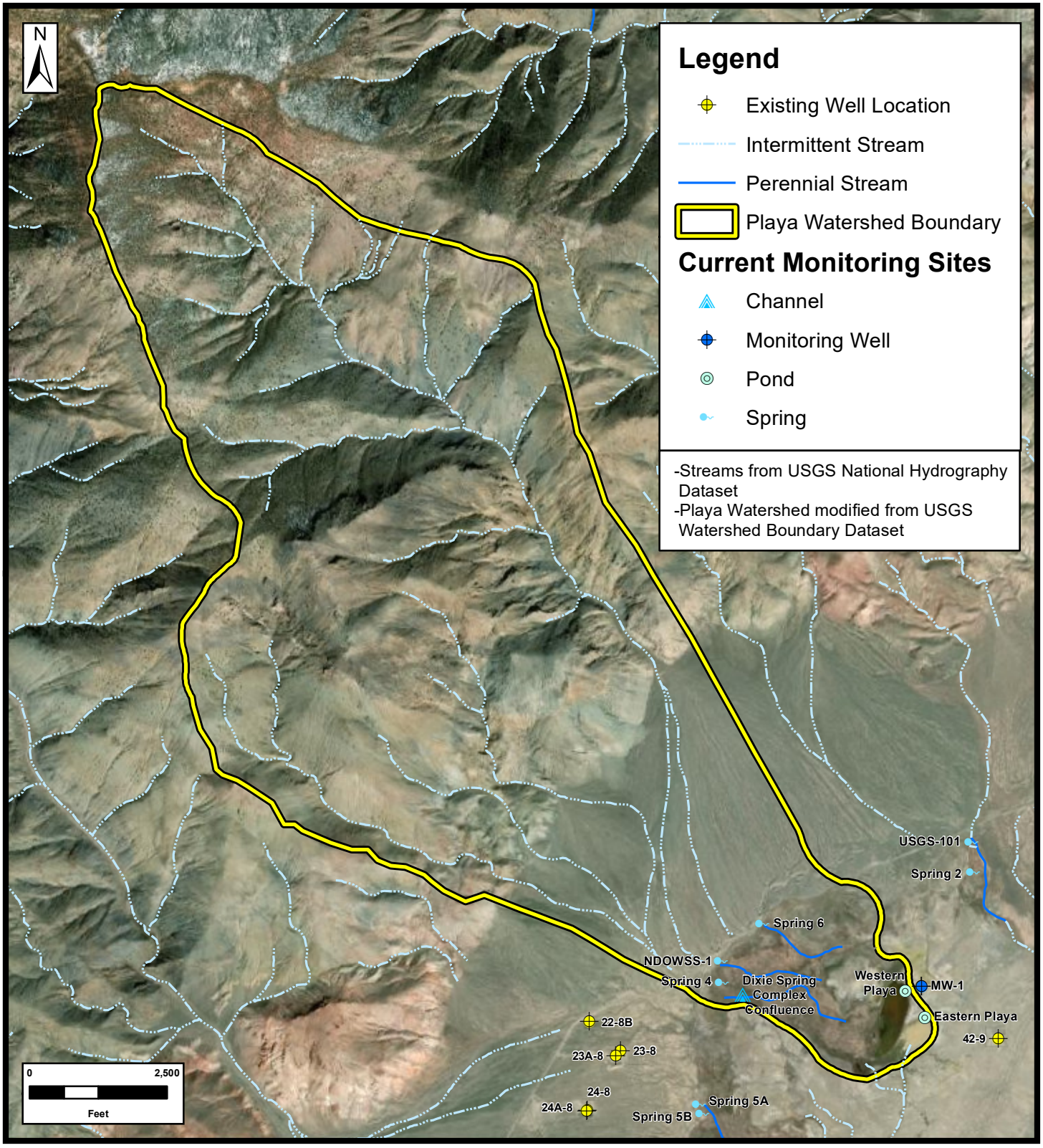


FIGURE 20

TITLE: **SITE MAP**
-SHOWING-
LOCAL WATERSHED OF WESTERN AND EASTERN PLAYAS
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM007**

DATE: **11/13/2020**

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Fig 20 - Playa Watershed Boundary**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 20 - Playa Watershed Boundary.mxd

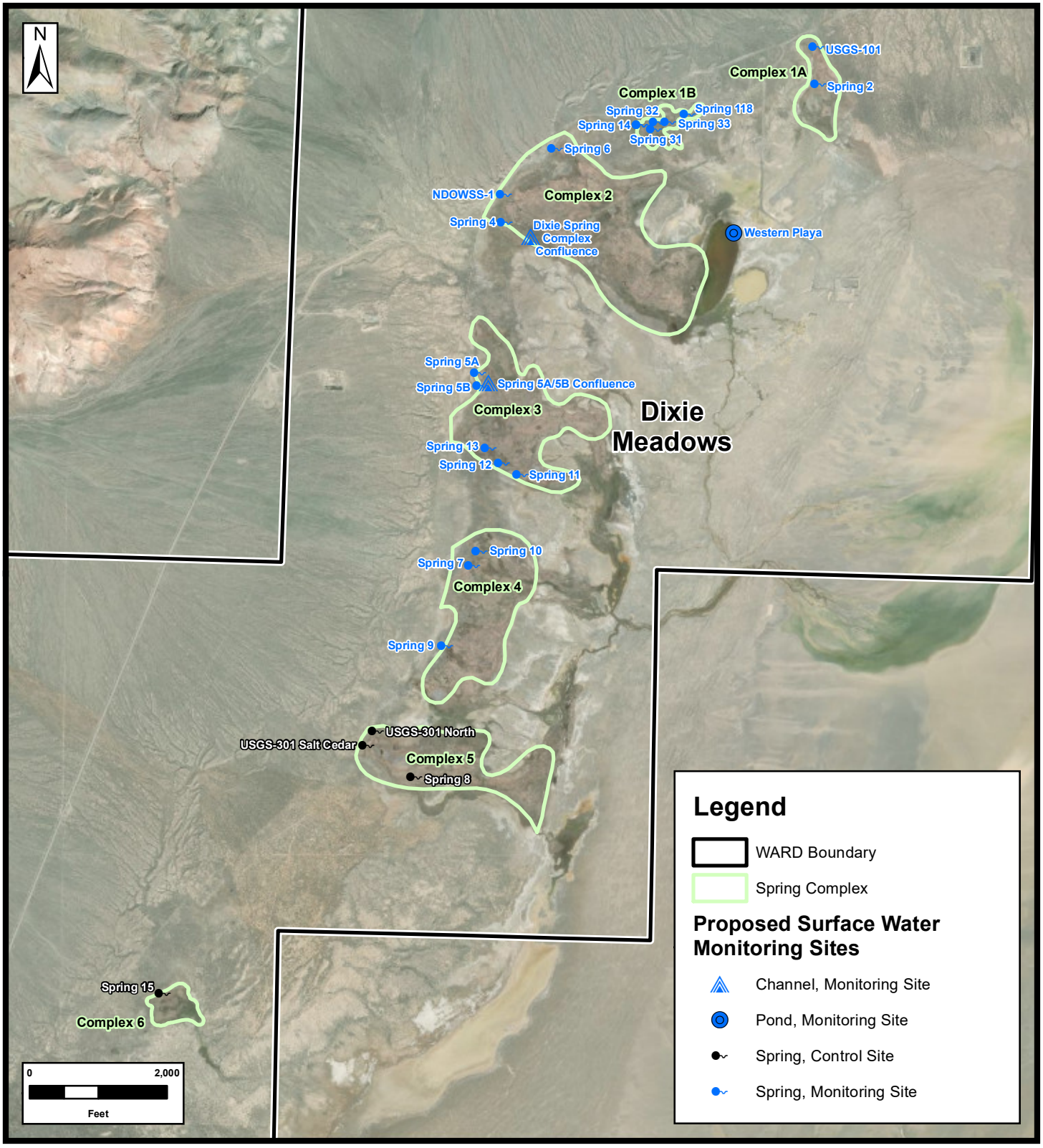


FIGURE 21

TITLE:

SITE MAP
-SHOWING-
PROPOSED SURFACE WATER MONITORING SITES
ORNI 32, LLC
DIXIE MEADOWS
GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM007**

DATE: **11/13/2020**

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Fig 21 - Proposed Surface Water Monitoring Sites**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 21 - Proposed Surface Water Monitoring Sites.mxd

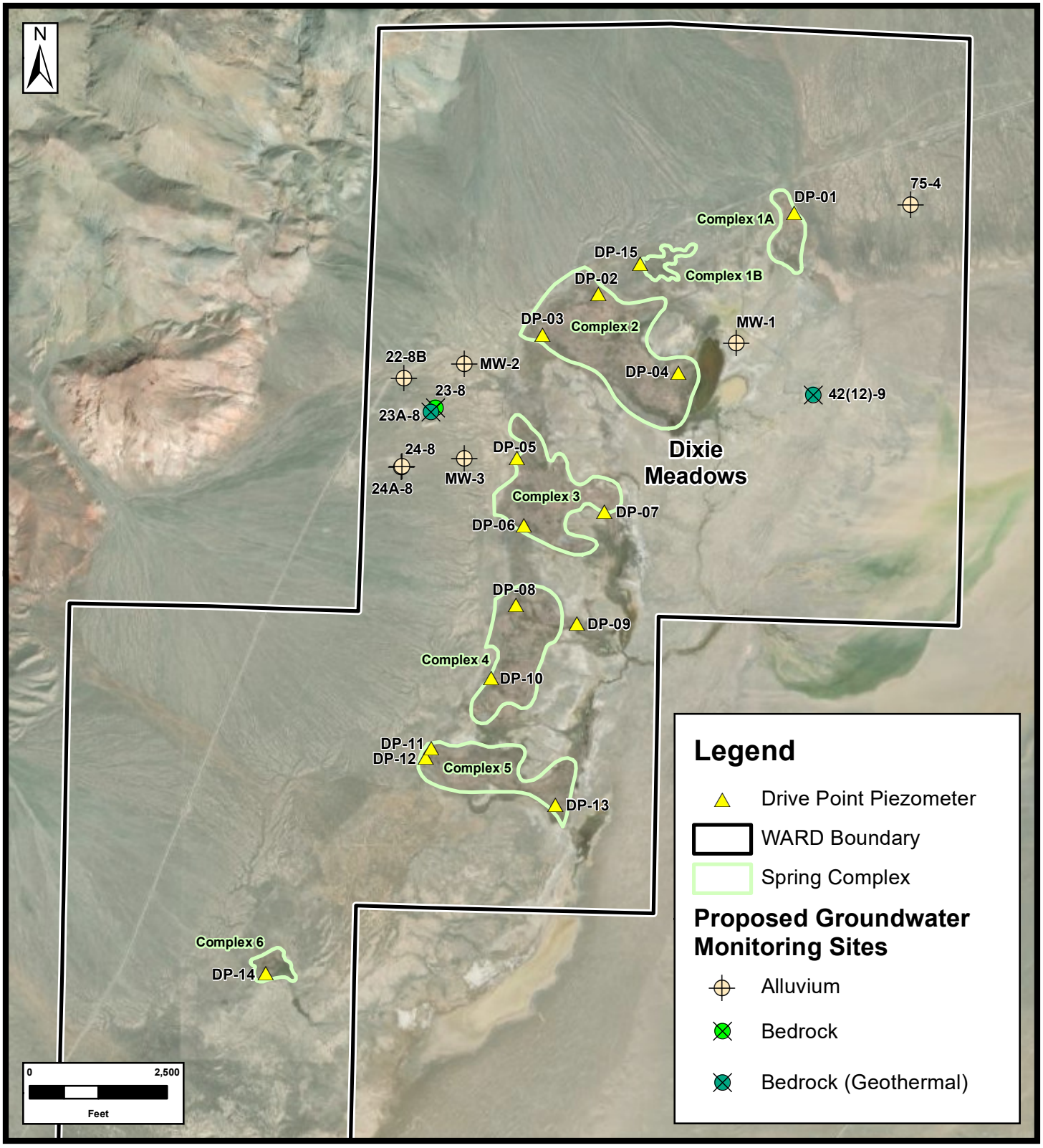


FIGURE 22

TITLE:
SITE MAP
-SHOWING-
PROPOSED GROUNDWATER MONITORING SITES
ORNI 32, LLC
DIXIE MEADOWS GEOTHERMAL PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM007**

DATE: **11/13/2020**

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Fig 22 - Proposed Groundwater Monitoring Sites**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	DS	CHECKED	DS	-
	DRAWN	HC	APPROVED	DS	

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 22 - Proposed Groundwater Monitoring Sites.mxd

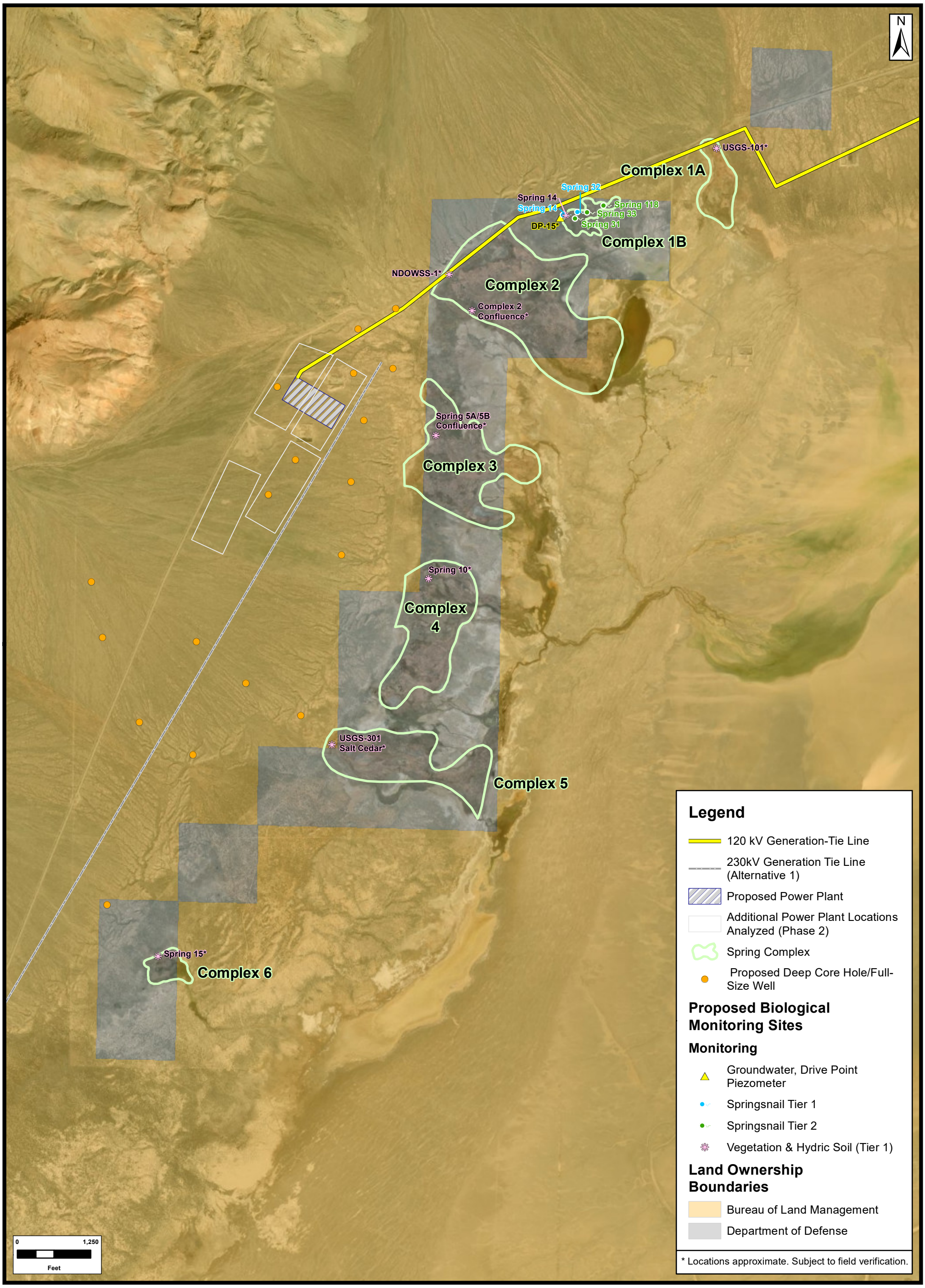


FIGURE 23

TITLE:

SITE MAP

-SHOWING-

AQUATIC HABITAT / SPECIAL STATUS SPECIES MONITORING SITES

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

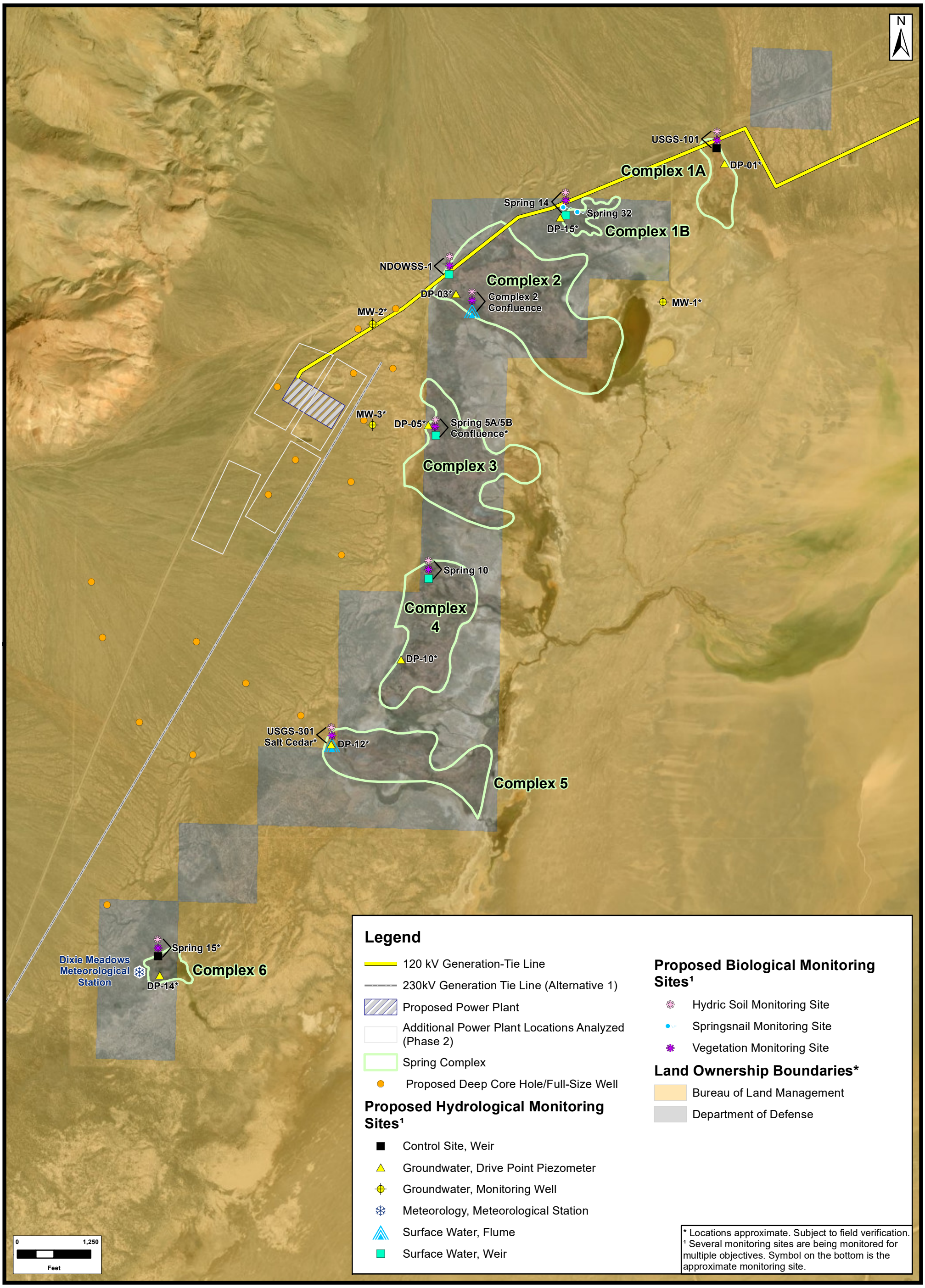
McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: Fig 23 - Aquatic Habitat - Special Status Species Monitoring Sites

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF:					REVISION:
ORM007	11/13/2020	DESIGNED	GB	CHECKED	GB		-
		DRAWN	HC	APPROVED	GB		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 23 - Aquatic Habitat - Special Status Species Monitoring Sites.mxd



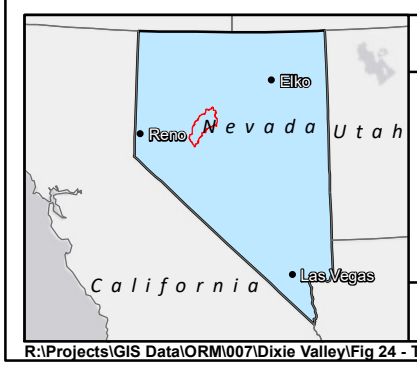


FIGURE 24

TITLE:

SITE MAP

-SHOWING-

PROPOSED LOCATIONS FOR TIER 1 MONITORING SITES (HYDROLOGICAL AND BIOLOGICAL)

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: Fig 24 - Tier 1 Monitoring Sites (Hydrological & Biological)

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	DW	CHECKED	DW		-
		DRAWN	HC	APPROVED	DW		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 24 - Tier 1 Monitoring Sites (Hydrological & Biological).mxd

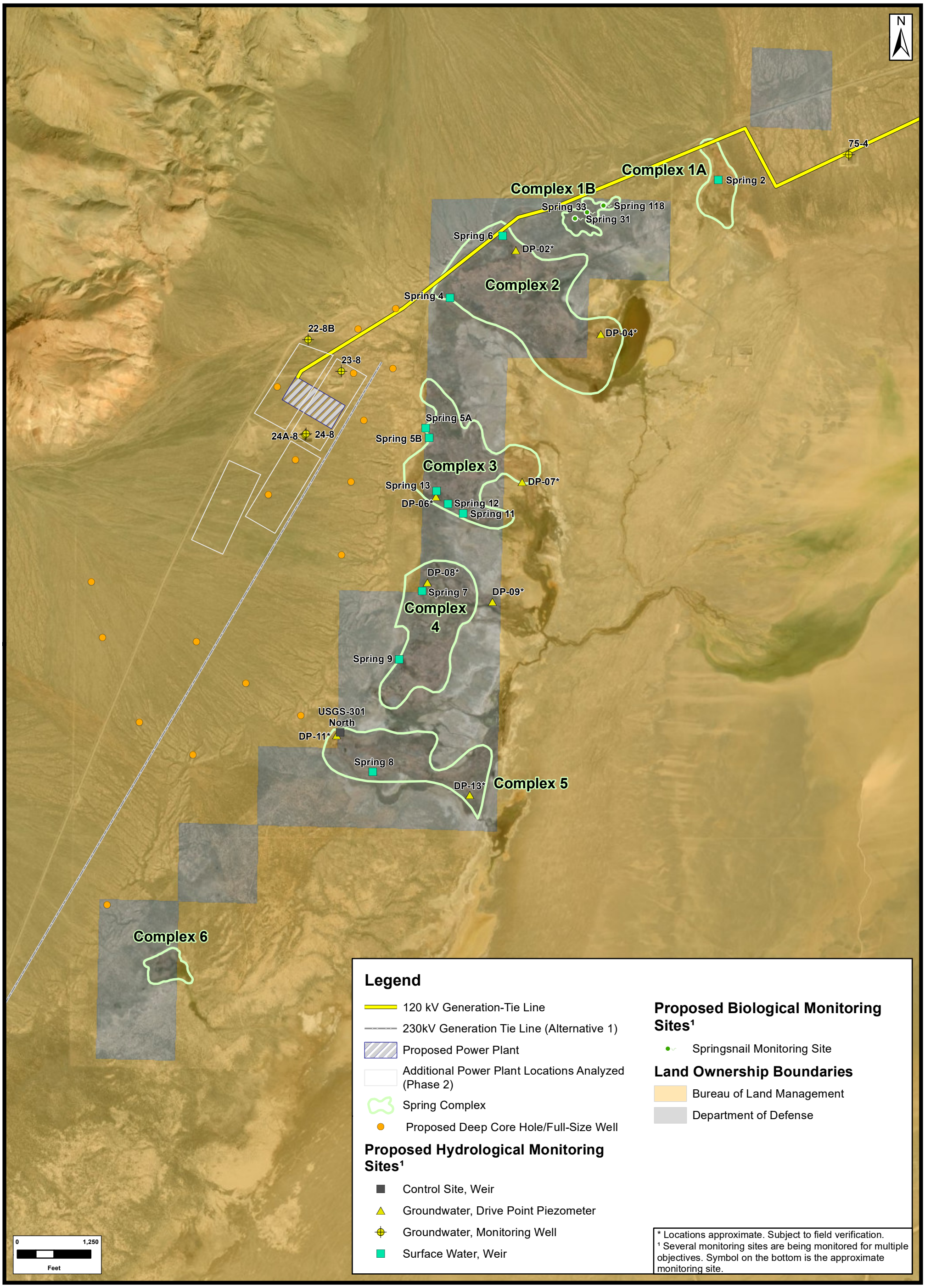


FIGURE 25

TITLE:

SITE MAP

-SHOWING-

PROPOSED LOCATIONS FOR TIER 2 MONITORING SITES (HYDROLOGICAL AND BIOLOGICAL)

ORNI 32, LLC

DIXIE MEADOWS GEOTHERMAL PROJECT

CHURCHILL COUNTY, NV

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: Fig 25 - Tier 2 Monitoring Sites (Hydrological & Biological)

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

JOB NO.:	DATE:	REF.					REVISION:
ORM007	11/13/2020	DESIGNED	DW	CHECKED	DW		-
		DRAWN	HC	APPROVED	DW		

R:\Projects\GIS Data\ORM\007\Dixie Valley\Fig 25 - Tier 2 Monitoring Sites (Hydrological & Biological).mxd

APPENDIX A

Well Driller's Reports and Lithology Logs

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

OFFICE USE ONLY
Log No. 21832
Permit No.
Basin

WELL DRILLERS REPORT

Please complete this form in its entirety

1. OWNER Phillips Petroleum Company ADDRESS P. O. Box 10566 Reno, Nevada 89510

2. LOCATION NE ¼ NW ¼ Sec. 3 T. 22 N/S R. 35 E. Churchill County
PERMIT NO.

3. TYPE OF WORK
New Well ☐ Recondition ☐
Deepen ☐ Other ☒

4. PROPOSED USE
Domestic ☐ Irrigation ☐ Test ☒
Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL
Cable ☐ Rotary ☒
Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Sand and gravel		0	60	
Gravel, sand, silt and clay		60	80	
Sand and gravel		80	120	
Coarse gravel		120	170	
Sand and silt		170	200	

Date started April 10, 19 78
Date completed April 15, 19 78

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

BAILER TEST
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours

8. WELL CONSTRUCTION
Diameter hole 4 3/4 inches Total depth 200 feet
Casing record 200 feet of 1" PVC
Weight per foot ..... Thickness .....

Diameter	From	To
1 inches	0 feet	200 feet
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet

Surface seal: Yes ☒ No ☐ Type Cement
Depth of seal 1 foot feet
Gravel packed: Yes ☐ No ☐
Gravel packed from ..... feet to ..... feet

Perforations:
Type perforation None
Size perforation
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet

9. WATER LEVEL
Static water level unknown Feet below land surface
Flow ..... G.P.M.
Water temperature ..... ° F. Quality .....

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name Willis Hines
Address P. O. Box 10566 Reno, Nevada 89510

Nevada contractor's license number

Nevada driller's license number 874

Signed Willis Hines

Date

USE ADDITIONAL SHEETS IF NECESSARY

5471

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

OFFICE USE ONLY
Log No. 21833
Permit No.
Basin

WELL DRILLERS REPORT

Please complete this form in its entirety

1. OWNER Phillips Petroleum Company ADDRESS P. O. Box 10566, Reno, Nevada 89510

2. LOCATION NW ¼ NW ¼ Sec. 8 T. 22 N/S R. 35 E. Churchill County
PERMIT NO.

3. TYPE OF WORK: New Well ☐ Recondition ☐ Deepen ☐ Other ☒

4. PROPOSED USE: Domestic ☐ Irrigation ☐ Test ☒ Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL: Cable ☐ Rotary ☒ Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Gravel, sand and brown silt and clay		0	30	
Gray gravel, sand and silt		30	80	
Light greenish-gray greenstone		80	160	
Light gray gravel, sand and silt		160	200	

Date started March 31, 19 78
Date completed April 1, 19 78

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

BAILER TEST
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours

8. WELL CONSTRUCTION
Diameter hole 5 1/8 inches Total depth 200 feet
Casing record 200 feet of 1" PVC
Weight per foot ..... Thickness .....

Diameter	From	To
1 inches	0 feet	200 feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet

Surface seal: Yes ☒ No ☐ Type Cement
Depth of seal One foot feet
Gravel packed: Yes ☐ No ☒
Gravel packed from ..... feet to ..... feet

Perforations:
Type perforation None
Size perforation
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet

9. WATER LEVEL
Static water level unknown Feet below land surface
Flow ..... G.P.M.
Water temperature ..... ° F. Quality

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name Willis Hines
Address P. O. Box 10566, Reno, Nevada 89510

Nevada contractor's license number
Nevada driller's license number 874

Signed Willis Hines

Date

USE ADDITIONAL SHEETS IF NECESSARY

5471

DIVISION OF WATER RESOURCES

#1

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLERS REPORT

Please complete this form in its entirety

OFFICE USE ONLY
Log No. 21834
Permit No.
Basin

1. OWNER BLM ADDRESS 801 N. Plaza St. Carson City Nev.

2. LOCATION SE ¼ SW ¼ Sec. 18 T. 22 N/S R. 35 E. Churchill County
PERMIT NO.

3. TYPE OF WORK
New Well ☐ Recondition ☐
Deepen ☐ Other ☒

4. PROPOSED USE
Domestic ☐ Irrigation ☐ Test ☐
Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL
Cable ☐ Rotary ☒
Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Gravel & sand		0	300	300
making water from 180 ft.				

Date started ....., 19....
Date completed ....., 19....

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

BAILER TEST
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours

8. WELL CONSTRUCTION
Diameter hole 5 5/8 inches Total depth 300 feet
Casing record 4" Plastic
Weight per foot ..... Thickness .....

Diameter	From	To
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet
..... inches	..... feet	..... feet

Surface seal: Yes ☒ No ☐ Type cement
Depth of seal 10 ft. feet
Gravel packed: Yes ☐ No ☒
Gravel packed from ..... feet to ..... feet

Perforations:
Type perforation .....
Size perforation .....
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet

9. WATER LEVEL
Static water level ..... Feet below land surface .....
Flow ..... G.P.M. .....
Water temperature ..... ° F. Quality .....

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Lester Millard
Address Box 648 Yerington, Nev.
Nevada contractor's license number 11089
Nevada driller's license number 579
Signed Lester Millard
Date 11-5-76

USE ADDITIONAL SHEETS IF NECESSARY

5471

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

OFFICE USE ONLY
Log No. 23087
Permit No.
Basin

WELL DRILLERS REPORT

Please complete this form in its entirety

1. OWNER NUFUELS CORP. ADDRESS BOX 5444 DENVER, COLO. 80217

2. LOCATION NW ¼ NW ¼ Sec. 8 T. 22 N/S R. 35 E. County
PERMIT NO.

3. TYPE OF WORK: New Well ☒ Recondition ☐ Deepen ☐ Other ☐

4. PROPOSED USE: Domestic ☐ Irrigation ☐ Test ☒ Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL: Cable ☐ Rotary ☒ Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
ALLUVIUM 0-120	✓	105	120	15
SANDSTONE 120-1460	✓	1120	1150	30

Date started 6/15, 19 81
Date completed 6/30, 19 81

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump
	N/A		

BAILER TEST
G.P.M. N/A Draw down feet hours
G.P.M. Draw down feet hours
G.P.M. Draw down feet hours

8. WELL CONSTRUCTION
Diameter hole 5 5/8" inches Total depth 1460 feet
Casing record 6 5/8" FROM 0-151'
Weight per foot 21# Thickness .328"

Diameter	From	To
9.0 inches	0 feet	170 feet
inches	feet	feet
5 5/8" inches	170 feet	1460 feet
inches	feet	feet
inches	feet	feet
inches	feet	feet

Surface seal: Yes ☒ No ☐ Type NEAT CEMENT
Depth of seal 50' feet
Gravel packed: Yes ☐ No ☒
Gravel packed from feet to feet

Perforations:
Type perforation N/A
Size perforation
From feet to feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

9. WATER LEVEL
Static water level 105 Feet below land surface 20
Flow G.P.M.
Water temperature 164 ° F. Quality

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name JOSEPH F. LEISEK
Address BOX 52 - CENTRAL, UTAH
Nevada contractor's license number 013697
Nevada driller's license number 864
Signed Joseph F. Leisek
Date 9/3/81

USE ADDITIONAL SHEETS IF NECESSARY

O-627

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

OFFICE USE ONLY
Log No. 3778
Permit No.
Basin

WELL DRILLERS REPORT

Please complete this form in its entirety

1. OWNER NUFUELS CORP. ADDRESS DENVER, COLO.

2. LOCATION SE ¼ NE ¼ Sec. 8 T. 22N N/S R. 35E E. CHURCHILL County
PERMIT NO.

3. TYPE OF WORK
New Well ☒ Recondition ☐
Deepen ☐ Other ☐

4. PROPOSED USE
Domestic ☐ Irrigation ☐ Test ☒
Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL
Cable ☐ Rotary ☒
Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
CLAY / SAND	✓	8	40	32
ARTESIAN FLOW CEMENTED				
CLAY / SAND		40	500	460

Date started 7/8, 19 81
Date completed 7/19, 19 81

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump
	NO TEST		

BAILER TEST
G.P.M. NO TEST Draw down feet hours
G.P.M. Draw down feet hours
G.P.M. Draw down feet hours

8. WELL CONSTRUCTION
Diameter hole 6 inches Total depth 500 feet
Casing record 160' X 6 5/8 OD
Weight per foot 12.0 Thickness .250

Diameter	From	To
8 3/4 inches	0 feet	165 feet
inches	feet	feet
6 inches	165 feet	500 feet
inches	feet	feet
inches	feet	feet
inches	feet	feet

Surface seal: Yes ☒ No ☐ Type CEMENT
Depth of seal 165' feet
Gravel packed: Yes ☐ No ☒
Gravel packed from feet to feet

Perforations:
Type perforation
Size perforation N/A
From feet to feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

9. WATER LEVEL
Static water level 8 Feet below land surface
Flow NO TEST GPM
Water temperature ° F. Quality

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name Joseph F. Leisek
Address Southwest Drilling & Exploration, Inc.
1199 West 980 North
St. George, Utah 84770

Nevada contractor's license number
Nevada driller's license number 0854
Signed Joseph F. Leisek
Date 5/21/82

USE ADDITIONAL SHEETS IF NECESSARY

O 627

WHITE–DIVISION OF WATER RESOURCES
CANARY–CLIENT'S COPY
PINK–WELL DRILLER'S COPY
PRINT OR TYPE ONLY
DO NOT WRITE ON BACK

Playa Ø1 Deep

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No. 108770
Permit No.
Basin 128 Ø91

NOTICE OF INTENT NO. 64615

1. OWNER U.S. Geological Survey
MAILING ADDRESS 2730 N. Deer Run Rd. Carson City Nv 89701
ADDRESS AT WELL LOCATION HA 128. Dixie Valley Playa – Humboldt Salt Marsh

2. LOCATION NE ¼ NE ¼ Sec. 28 T. 22 N/S R. 35 E/W Churchill County
PERMIT NO. M0-1533 A (Issued by Water Resources) Parcel No. N/A Subdivision Name N/A

3. WORK PERFORMED
☑ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Abandon ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☑ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC
☐ Air ☑ Other Auger

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Surface-Dry thin Salt Crust				
Moist brn Clay-Some Silt		0	3.5	3.5
Very Moist brn Clay		3.5	7.5	4
Wet brn Clay		7.5	12.2	4.7
Wet brown/green Clay		12.2	12.5	0.3
Wet brn, green black Clay (organics)		12.5	15.5	3
Wet black Clay-Sulfur Smell		15.5	32	16.5
Wet Sloppy black Clay With little Silt, High Sulfur Smell	X	32	47	15
Brown Clay		47	50	3

39.749459°N
118.044040°W
NAD 27 (TA)

RECEIVED 2009 SEP 22 AM 10:56 STATE ENGINEER'S OFFICE

Date started September 15, 2009
Date completed September 15, 2009

7. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)
GPS Local		
39 44 57.7 NAD 83		
118 02 42.0 ± 17'		

8. WELL CONSTRUCTION
Depth Drilled 50 Feet Depth Cased 50 Feet

HOLE DIAMETER (BIT SIZE)

	From	To
6.625 Inches	0 Feet	50 Feet
Inches	Feet	Feet
Inches	Feet	Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
2		0.154	0	50

Schedule 40-Flush Threads

Perforations:
Type perforation Slot
Size perforation 0.010
From 45 feet to 50 feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

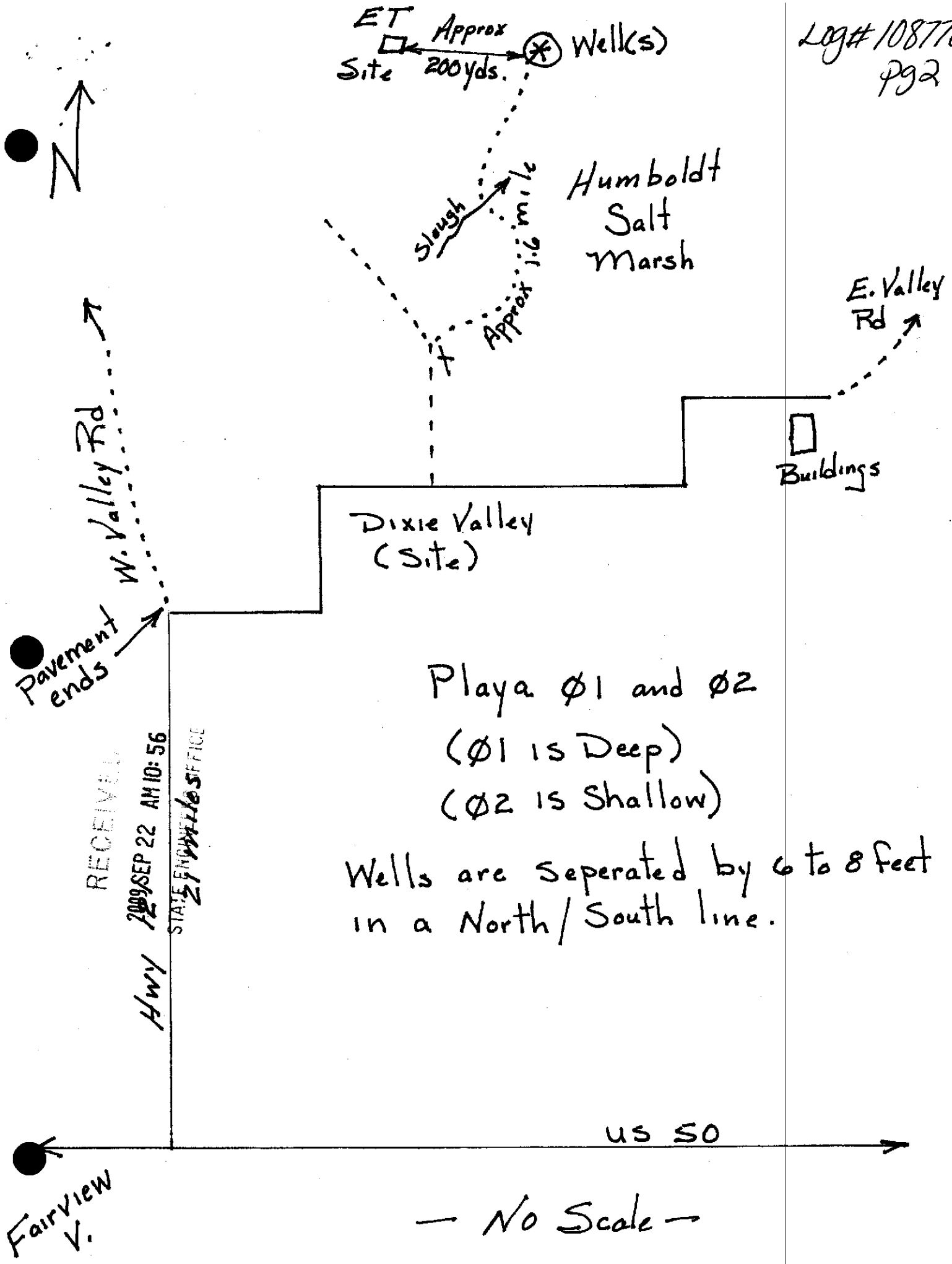
Surface Seal: ☑ Yes ☐ No
Depth of Seal 0 to 1.5
Placement Method: ☐ Pumped ☑ Poured
Seal Type: ☑ Neat Cement ☐ Cement Grout ☐ Concrete Grout
Gravel Packed: ☑ Yes ☐ No
From 27.5 feet to 50 feet

9. WATER LEVEL
Static water level 14.38 feet below land surface
Artesian flow No G.P.M. P.S.I.
Water temperature °F Quality

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Robert N. Pennington
Address (Contractor) 2730 N. Deer Run Rd. Carson City Nv 89701
Nevada contractor's license number issued by the State Contractor's Board
Nevada driller's license number issued by the Division of Water Resources, the on-site driller FP-1857
Signed R.N. Pennington (By driller performing actual drilling on site or contractor)
Date 9-21-09

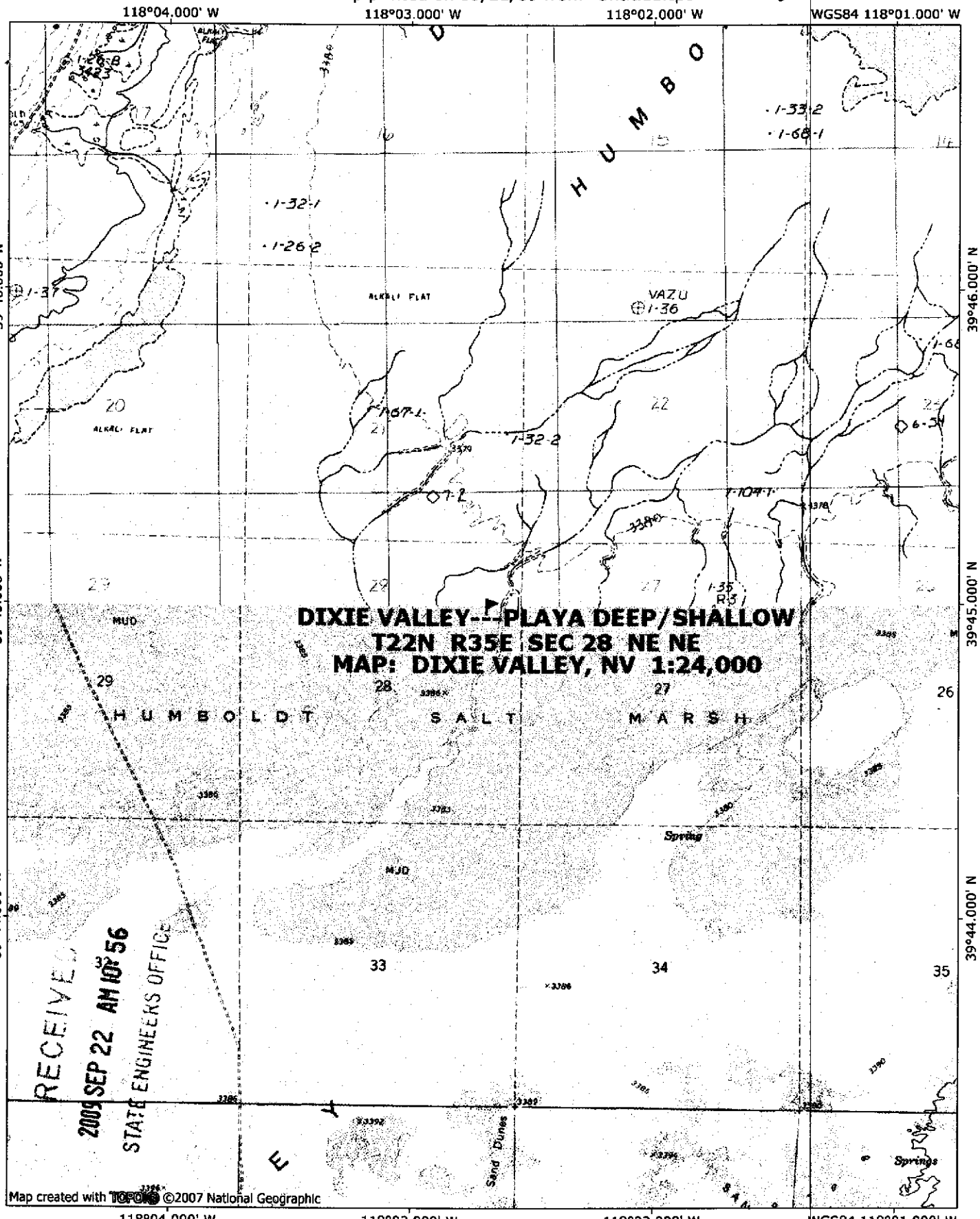
(Rev. 12-01) USE ADDITIONAL SHEETS IF NECESSARY (O)-627

Log# 108770
Pg2



Log#108770 #93

TOPO! map printed on 09/21/09 from "Untitled.tpo"



DIXIE VALLEY---PLAYA DEEP/SHALLOW
T22N R35E SEC 28 NE NE
MAP: DIXIE VALLEY, NV 1:24,000

RECEIVED
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WHITE—DIVISION OF WATER RESOURCES
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PINK—WELL DRILLER'S COPY
Playa · Ø2 Well
PRINT OR TYPE ONLY
DO NOT WRITE ON BACK Shallow

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY 10877
Log No.
Permit No.
Basin 128 PQ1

NOTICE OF INTENT NO 64615

1. OWNER U.S Geological Survey
MAILING ADDRESS 2730 N. Deer Run Rd Carson City Nv 89701
ADDRESS AT WELL LOCATION If A 128, Dixie Valley Playa - Humboldt Salt Marsh

2. LOCATION ~~NE~~ SE ¼ NE ¼ Sec. 28 T. 22 N N/S R. 35 E. Churchill County
PERMIT NO MO-1533 A Issued by Water Resources | N/A Parcel No. | N/A Subdivision Name

3. WORK PERFORMED
☑ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Abandon ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☑ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC
☐ Air ☑ Other Auger

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Surface - Salt Crust evaporite				
Brown Friable Sandy Clay, Increases To Dense, moist Brown Clay		0	6½	6½
Wet Brown Clay		6½	9	2½
Greenish Black moist Clay. Organic layer	*	9	15	

RECEIVED 2009 SEP 22 AM 10:56 STATE ENGINEER'S OFFICE

39.744959°N
118.044040°W
NAD 27 TD

Date started September 16, 2009
Date completed September 16, 2009

7. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)
GPS	Local	
39 44 57.6	WAD 83	
118 02 42.1	±	17 Feet

8. WELL CONSTRUCTION
Depth Drilled 15 Feet Depth Cased 15 Feet

HOLE DIAMETER (BIT SIZE)

	From	To
6.625 Inches	0 Feet	15 Feet
Inches	Feet	Feet
Inches	Feet	Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
2		0.154	0	15

Schedule 40 - Flush Threads

Perforations:
Type perforation Slot
Size perforation 0.010
From feet to feet
From 10 feet to 15 feet
From feet to feet
From feet to feet
From feet to feet

Surface Seal: ☑ Yes ☐ No
Depth of Seal 0 To 1½'
Placement Method: ☐ Pumped ☑ Poured
Seal Type: ☑ Neat Cement ☐ Cement Grout ☐ Concrete Grout
Gravel Packed: ☑ Yes ☐ No
From 8.7 feet to 15 feet

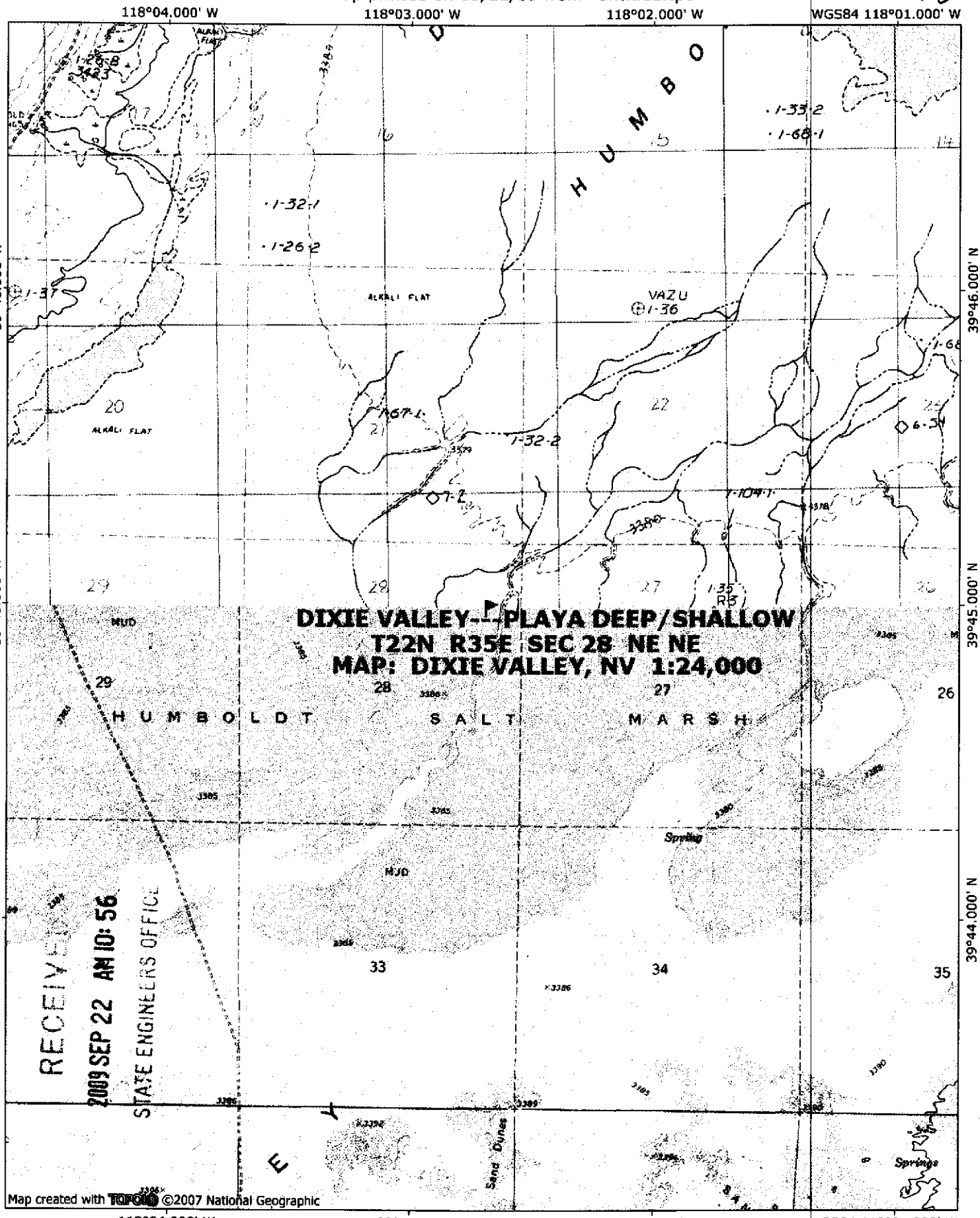
9. WATER LEVEL
Static water level 7.44 feet below land surface
Artesian flow NO G.P.M. P.S.I.
Water temperature °F Quality

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Robert N. Pennington Contractor
Address 2730 N. Deer Run Rd. Contractor
Carson City Nv 89701
Nevada contractor's license number issued by the State Contractor's Board
Nevada driller's license number issued by the Division of Water Resources, the on-site driller FP-1857
Signed R.N. Pennington By driller performing actual drilling on site for contractor
Date 9-21-09

(Rev. 12-01) USE ADDITIONAL SHEETS IF NECESSARY (O)-627

Log# 108771
pg2

TOPO! map printed on 09/21/09 from "Untitled.tpo"



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STATE ENGINEERS OFFICE

NATIONAL GEOGRAPHIC

MILES 0 5
FEET 1000 0 1000 2000 3000 4000 5000
KILOMETERS 5 0
METERS 1000 0 1000

TN MN
14°
09/21/09

Log#108771
pg3

Playa Ø1 and Ø2

(Ø1 is Deep)

(Ø2 is Shallow)

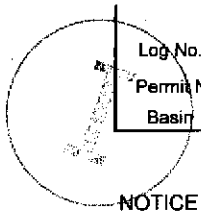
Wells are Seperated by 6 to 8 feet in a North/South line.

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

PRINT OR TYPE ONLY
DO NOT WRITE ON BACK

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340



OFFICE USE ONLY
Log No. 109435
Permit No.
Basin 128 pg 1 of 5

NOTICE OF INTENT NO. 58246

1. OWNER U.S. Geological Survey
MAILING ADDRESS 2730 N. Deer Run Rd.
CARSON CITY NV 89701

ADDRESS AT WELL LOCATION U.S. BLM Land, Dixie Valley, NV
HA 128
Subdivision Name: NA County: Churchill

2. LOCATION NE ¼ NE ¼ Sec 22 T 22N N/S R 35 E
PERMIT/WAIVER No. M/O 1533 (Issued by Water Resources) NA (Parcel No.)

Latitude 39 45 59.19929 Longitude -118 01 36.59187
UTM E 412051.254 N 4402339.477
☐ NAD 27 ☒ NAD 83/WGS 84

3. WORKED PERFORMED
☒ New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test ☐ Municipal/Industrial ☒ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC ☐ Air ☒ Other Hand Auger

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
very moist brown clay		0	0.66	1
slightly less moist brown clay		0.66	1.25	1
very moist brown clay		1.25	5.58	4
thicker, denser brown clay		5.58	6.58	1
greenish black dense moist clay		6.58	7.33	1
dark green and grey clay		6.58	7.67	1
thick, dense moist brown clay		7.67	7.83	0
thick, dense unsaturated clay		7.83	9.17	1
thick dense moderately saturated clay		9.17	9.625	0

39.776528°N
118.025867°W
N90 27 (TO)

Date started: 18-Mar , 20 09
Date completed: 19-Mar , 20 09

9. WELL CONSTRUCTION
Depth Drilled 9.625 Feet Depth Cased 9.625 Feet

HOLE DIAMETER (BIT SIZE)

		From		To	
4	Inches	0	Feet	9.625	Feet
	Inches		Feet		Feet
	Inches		Feet		Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
1		Schedule 40	0	5.625

Perforations:
Type of perforation: Machined Slot
Size of perforation: .02
From 5.625 feet to 9.625 feet
From ____ feet to ____ feet
From ____ feet to ____ feet
From ____ feet to ____ feet
From ____ feet to ____ feet

Annular Seal: ☐ Yes ☐ No

☐ Neat Cement	to	☐ Pumped	☐ Poured
☐ Cement Grout	to	☐ Pumped	☐ Poured
☐ Concrete Grout	to	☐ Pumped	☐ Poured
☐ ≥30% Bentonite Grout	to	☐ Pumped	☐ Poured

Gravel Pack: ☒ Yes ☐ No 3.375 to 9.625 ☐ Pumped ☐ Poured
Type: Fine-grained sand #30
Bentonite Chips: ☒ Yes ☐ No 0 to 3.375 ☐ Pumped ☐ Poured
Type: 3/8 betonite chips

7. Water Level
Static water level: 2.8 feet below land surface
Artesian Flow: G.P.M. P.S.I.
Water Temperature: Cold °F
Quality:

8. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)

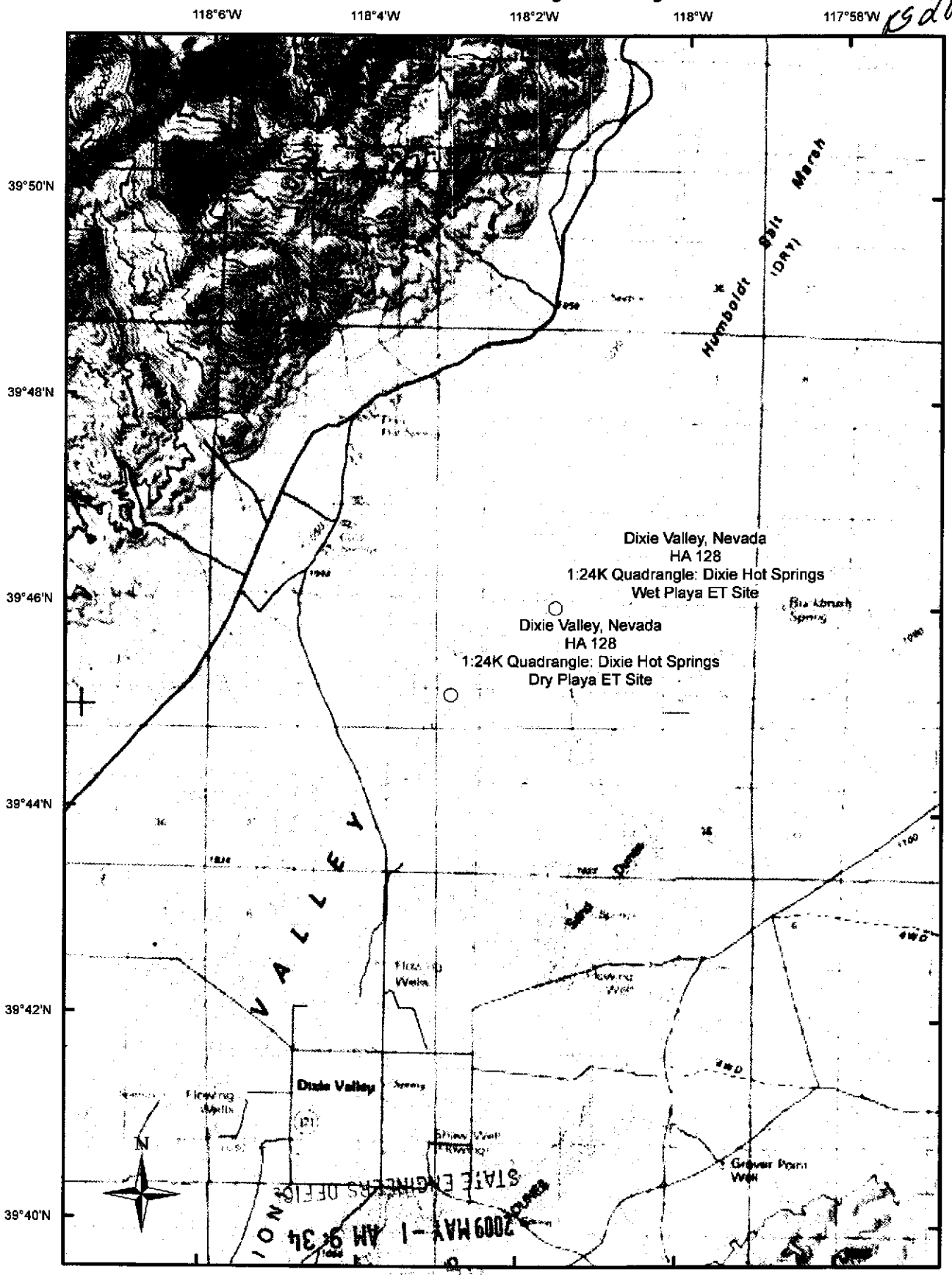
STATE ENGINEERS OFFICE
2009 MAY -1 AM 9:34
RECEIVED

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name JAMES L WOOD (Contractor)
Address 2730 N DEER RUN ROAD (Contractor)
CARSON CITY NV 89701
Nevada contractor's license number issued by the *State Contractor's Board*
Nevada driller's license number issued by the Division of Water Resources, the *on-site driller* FP-2178
Signed (By driller performing actual drilling on site or contractor)
Date 4/30/09

(Rev. 05-06) USE ADDITIONAL SHEETS IF NECESSARY

Log #109435
2 of 5

USGS Dixie Valley Playa Wells



Base sourced USGS 1:24,000-scale Quadrangles. Universal Transverse Mercator Projection, Zone 11N, NAD83.

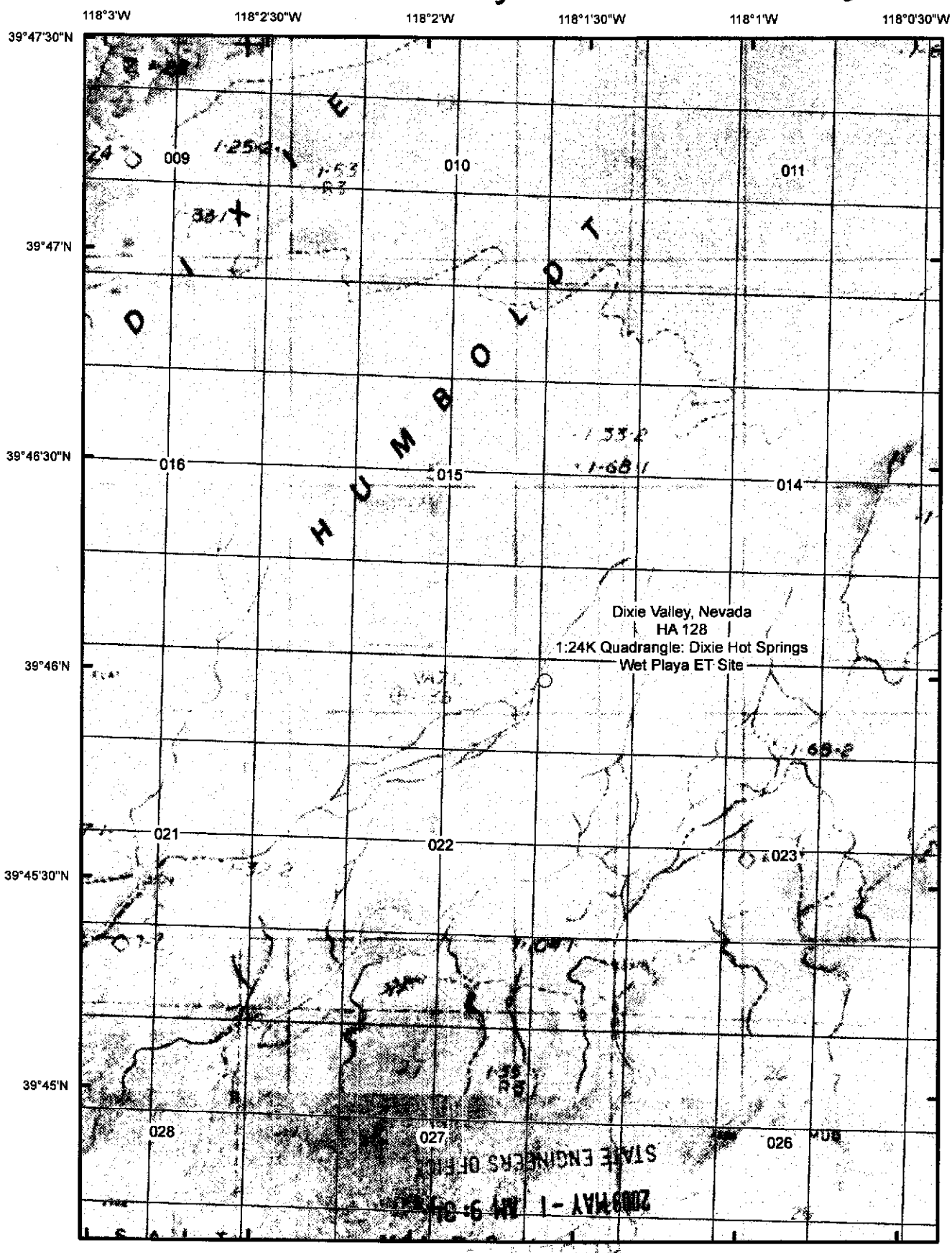
0 1.25 2.5 5 Miles

0 1.25 2.5 5 Kilometers

1:100,000

Wet Playa ET Site

Log #109435
3 of 5



Base sourced from 1:24,000-scale USGS quadrangle with 60 percent transparency overlaid on National Agricultural Imagery Program 1m Natural Color Imagery, August 12, 2008. PLSS sourced from BLM Land Survey Information System, 2009. Universal Transverse Mercator Projection, Zone 11N, NAD83.

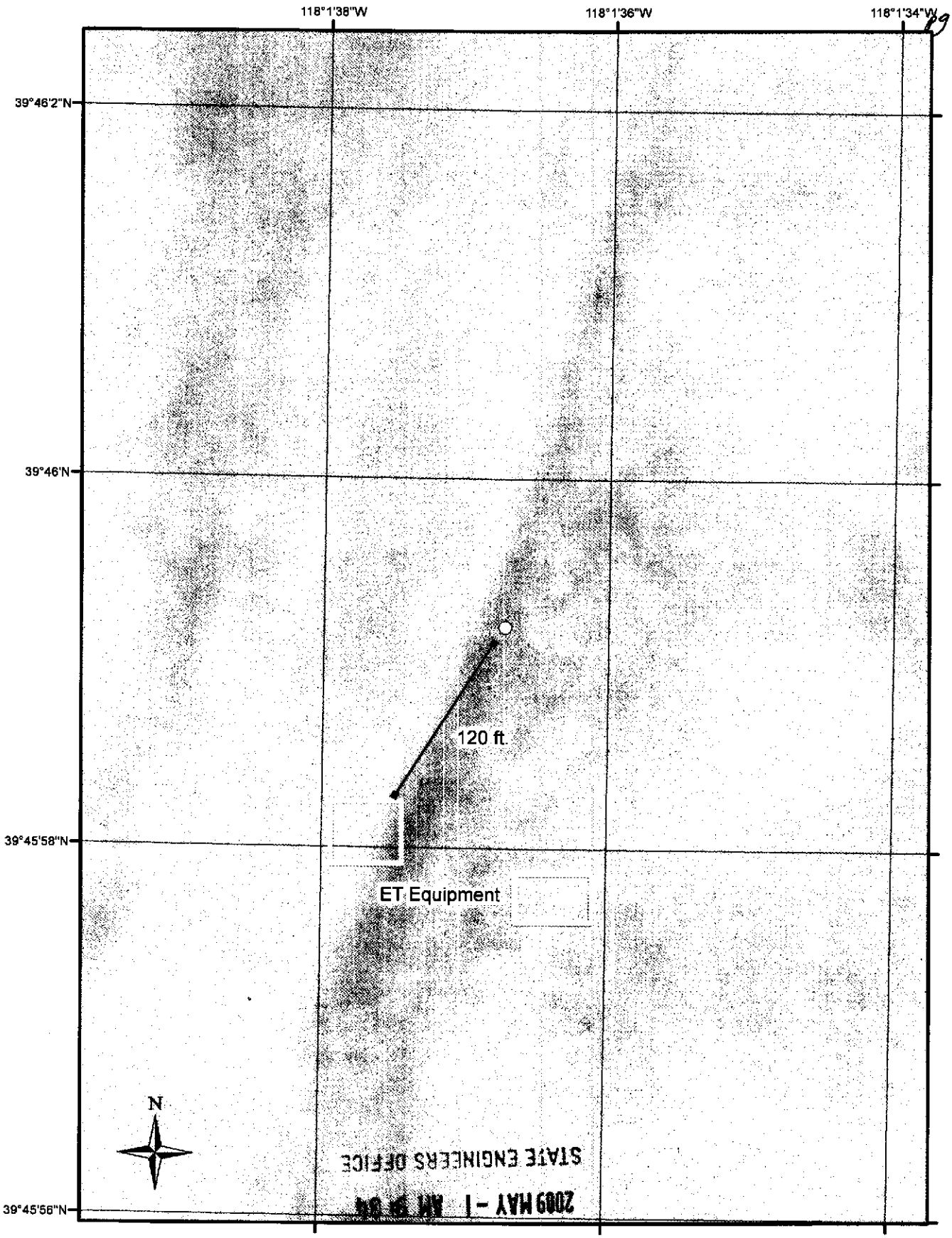
0 0.25 0.5 1 Miles

0 0.25 0.5 1 Kilometers

1:24,000

Wet Playa ET Site Sketch

Log # 109435
4 of 5



Base sourced from National Agricultural Imagery Program
1m Natural Color Imagery, August 12, 2008.
Universal Transverse Mercator Projection, Zone 11N, NAD83.

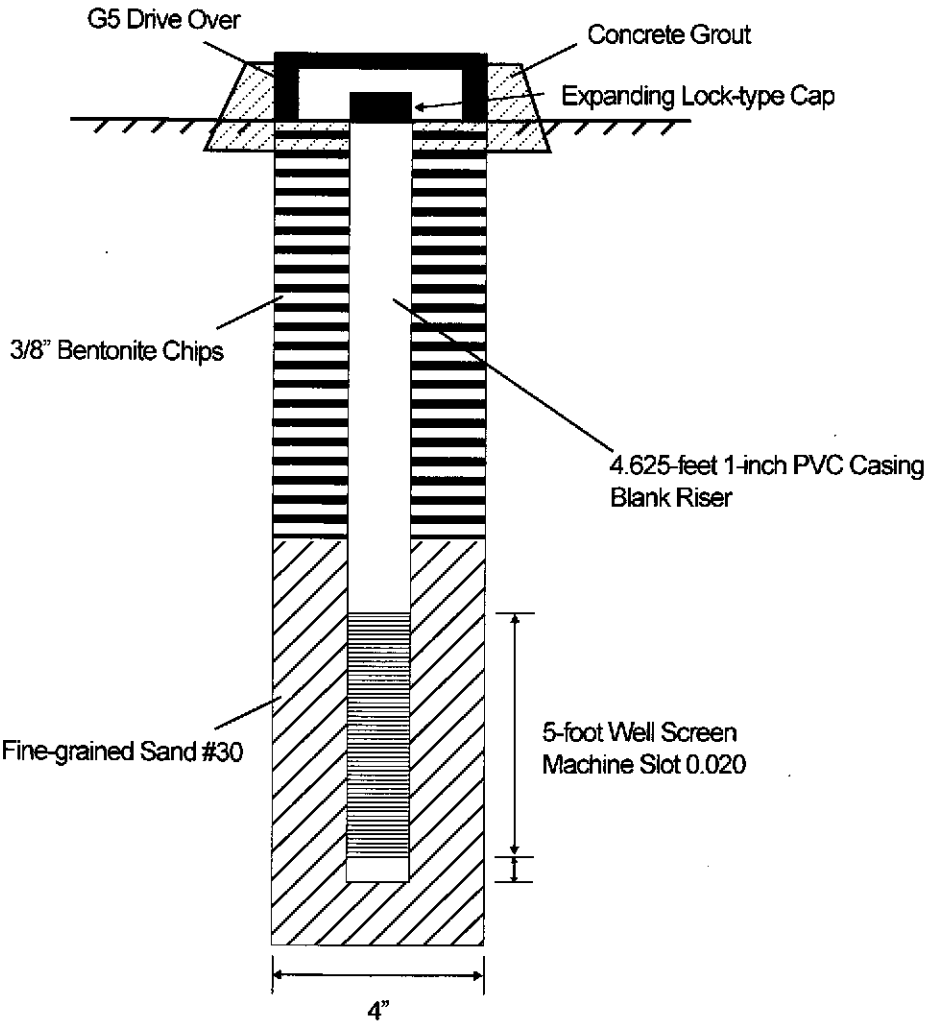
0 50 100 200 Feet

1:900

Log# 109435 5 of 5

Well Construction Diagram

Wet Playa ET Site



STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

PRINT OR TYPE ONLY
DO NOT WRITE ON BACK

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No. 109491
Permit No.
Basin [redacted] 128

NOTICE OF INTENT NO. [redacted]

1. OWNER U.S. Geological Survey
MAILING ADDRESS 2730 N. Deer Run Rd.
Carson City Nv 89701

ADDRESS AT WELL LOCATION U.S. BLM Land, Dixie Valley, NV
HA 128
Subdivision Name: NA County: Churchill

2. LOCATION NW ¼ NE ¼ Sec 28 T 22N N/S R 35 E
PERMIT/WAIVER No. M/O 1533 NA
Issued by Water Resources Parcel No.

Latitude 39°45'07.79621" UTM E 410176.069 ☐ NAD 27
Longitude -118°02'54.62690" N 4400776.217 ☒ NAD 83/WGS 84

3. WORKED PERFORMED
☒ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☒ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC
☐ Air ☒ Other Hand Auger

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
salt crust on surface, brown dry clay		0	1.33	1
dark brown moist clay		1.33	2	1
moist, moldable brown clay		2	2.25	0
brown clay, higher moisture content		2.25	4	2
saturated brown clay	W	4	4.33	0
dark green and grey clay		4.33	5.08	1
less saturated brown clay		5.08	6.83	2
drier, brown clay with green clay lenses		6.83	7.25	0
deep aqua-green tight clay		7.25	7.75	1
black clay, sulfuric smell		7.75	10	2

39.752249°N
118.047543°W
NAD 27 (TA)

Date started: 17-Mar , 20 09
Date completed: 17-Mar , 20 09

9. WELL CONSTRUCTION
Depth Drilled 10 Feet Depth Cased 10 Feet

HOLE DIAMETER (BIT SIZE)

		From		To	
4	Inches	0	Feet	10	Feet
	Inches		Feet		Feet
	Inches		Feet		Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
1		Schedule 40	0	5

Perforations:
Type of perforation Machined Slot
Size of perforation .02
From 5 feet to 10 feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

Annular Seal: ☒ Yes ☐ No

☐ Neat Cement	to	☐ Pumped	☐ Poured
☐ Cement Grout	to	☐ Pumped	☐ Poured
☐ Concrete Grout	to	☐ Pumped	☐ Poured
☐ ≥30% Bentonite Grout	to	☐ Pumped	☐ Poured

Gravel Pack: ☒ Yes ☐ No 2.5 to 10 ☐ Pumped ☐ Poured
Type: Coarse Sand #6
Bentonite Chips: ☒ Yes ☐ No 0 to 2.5 ☐ Pumped ☒ Poured
Type: 3/8 Bentonite

7. Water Level
Static water level: 4.0 feet below land surface
Artesian Flow: G.P.M. P.S.I.
Water Temperature: Cold °F
Quality:

8. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)

STATE ENG. WATERS OFFICE
2009 MAY -1 AM 9:34

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name JAMES L WOOD Contractor
Address 2730 N DEER RUN ROAD Contractor
CARSON CITY NV 89701
Nevada contractor's license number issued by the *State Contractor's Board*
Nevada driller's license number issued by the Division of Water Resources, the *on-site driller* FP-2178
Signed J L Wood By driller performing actual drilling on site or contractor
Date 4/30/09

(Rev. 05-09)

USE ADDITIONAL SHEETS IF NECESSARY

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

PRINT OR TYPE ONLY
DO NOT WRITE ON BACK

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No. 109574
Permit No.
Basin 128 pg 1 of 3

NOTICE OF INTENT NO. 58426

1. OWNER U.S. Geological Survey
MAILING ADDRESS 2730 N. Deer Run Rd
Carson City, Nv 89701
ADDRESS AT WELL LOCATION U.S.B.L.M Land.
Dixie V. Nv. HA 128 T 22N R 35E
Sec. 32 NWSE

2. LOCATION NW ¼ SE ¼ Sec. 32 T 22N N/S R 35 E Churchill County
PERMIT NO. M/O 1533 (Issued by Water Resources) Parcel No. N/A Subdivision Name N/A

3. WORK PERFORMED
☑ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Abandon ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☑ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC
☐ Air ☑ Other Auger

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Salty Alkali Flat Tan Surface		Surface		
Light Brown fine Silty Sand		0	4	4
Medium Brown fine Silty Sandy Clay in 1/4 inch balls		4	5	1
Silty Sandy Clay in 1/2 inch balls		5	9	4
Brown Silty Clay Easy Soft drilling at 9-Feet		9	10	1
Brown Silty Clay		10	13.5	3.5
Moist Blue/Green Clay		13.5	14	0.5
Black moist Clay - Anerobic layer. Strong Sulfur Smell		14	17	3
Creamy Black Silty moist Clay		17	18	1
Fine (#18-20 mesh) XXX Black Saturated Sand		18	24.5	6.5

Date started 3-10, 2009
Date complated 3-10, 2009

7. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)
GPS Location		
39 43 48.4		NAD 83
118 04 02.2		± 16 Feet

39.730194°N, 118.066313°W N0822 (TN)

8. WELL CONSTRUCTION
Depth Drilled 24.5 Feet Depth Cased 24.5 Feet

HOLE DIAMETER (BIT SIZE)

	From	To
6.625 Inches	0 Feet	24.5 Feet
Inches	Feet	Feet
Inches	Feet	Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
2-inch		0.154	0	24.5

Sch 40 PVC Flush Threads

Perforations:
Type perforation Factory Slot
Size perforation 0.020 inch
From feet to feet
From 19 1/2 feet to 24 1/2 feet
From feet to feet
From feet to feet
From feet to feet

Surface Seal: ☑ Yes ☐ No
Depth of Seal 6
Placement Method: ☐ Pumped ☑ Poured 3/8" Bentonite Chips Hydrated
Gravel Packed: ☑ Yes ☐ No
From 6 feet to 24 1/2 feet

Seal Type:
☐ Neat Cement
☐ Cement Grout
☐ Concrete Grout

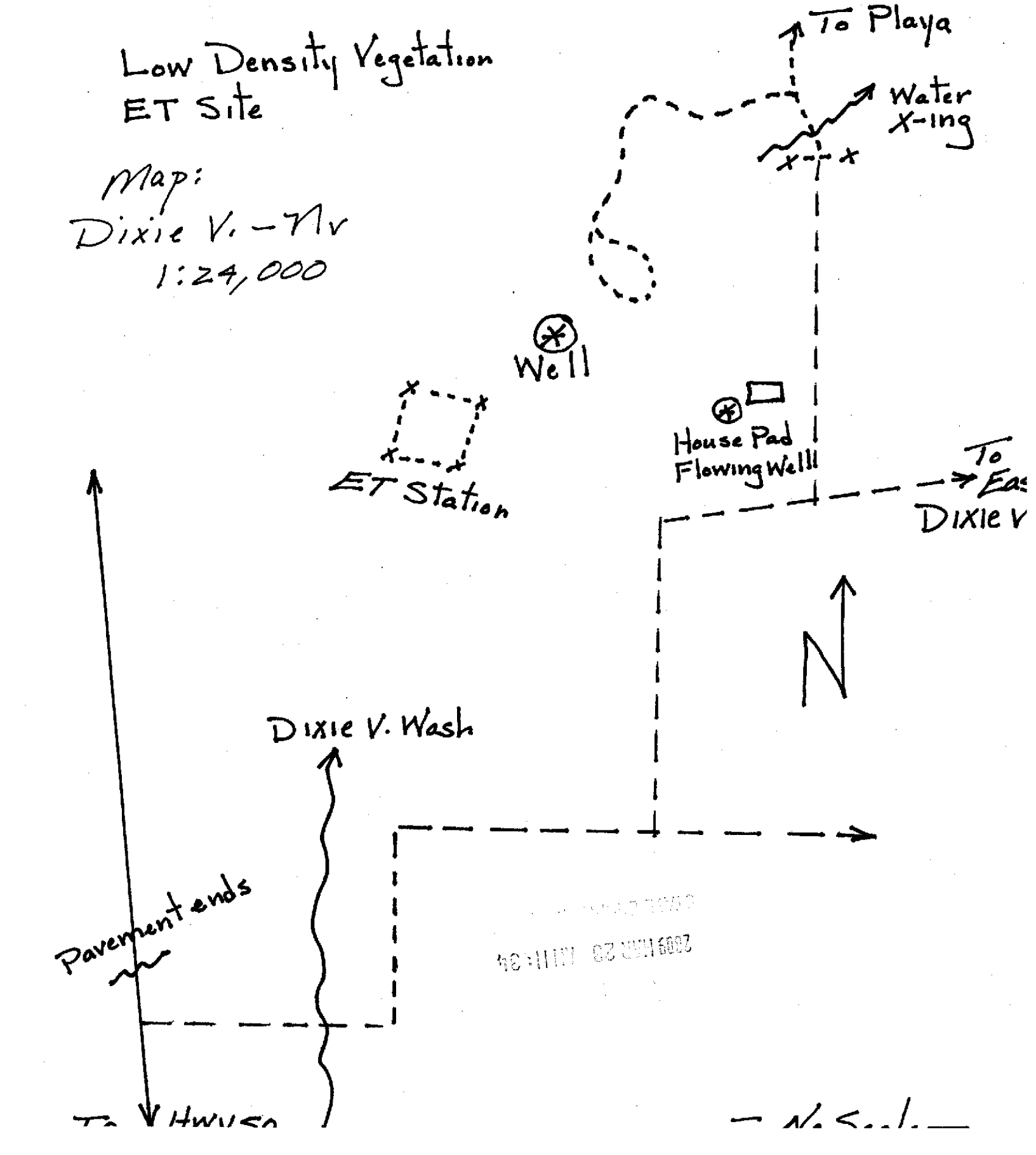
9. WATER LEVEL
Static water level +0.2 feet above below land surface
Artesian flow No G.P.M. P.S.I.
Water temperature °F Quality T.B.D

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Robert N. Pennington - USGS
Contractor
Address 2730 N. Deer Run Rd.
Contractor
Carson City Nv 89701
Nevada contractor's license number issued by the State Contractor's Board
Nevada driller's license number issued by the Division of Water Resources, the on-site driller EP-1857
Signed R.N. Pennington
By driller performing actual drilling on site of contractor
Date 3-17-09

(Rev. 12-01) USE ADDITIONAL SHEETS IF NECESSARY (O)-627

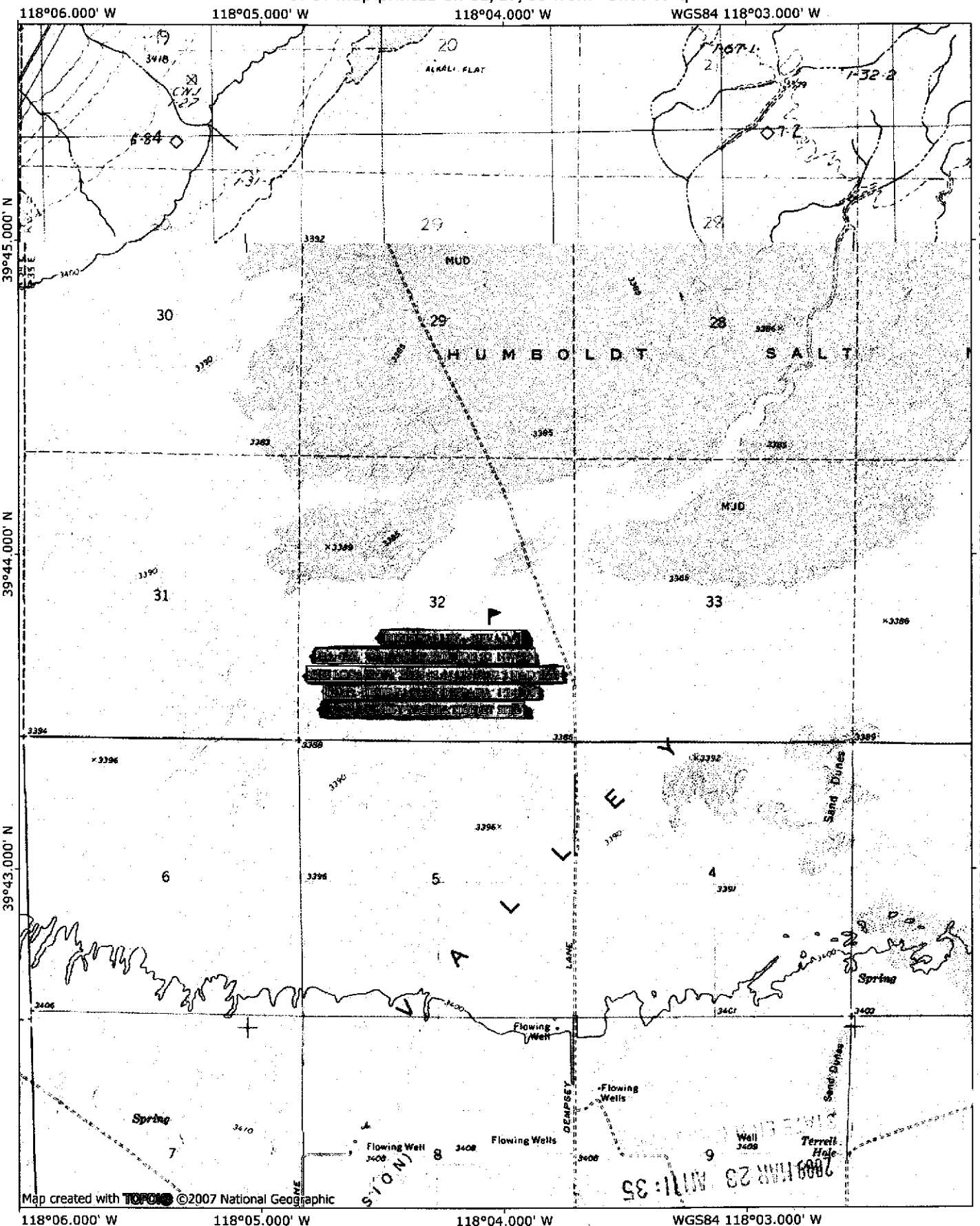
Dixie Valley – Nv. HA 128 T 22 N R 35 E Sec 32 NWSE

GPS Location 39 43 48.4 / 118 04 02.2 NAD83



Log# 109574 pg 3053

TOPO! map printed on 03/17/09 from "Untitled.tpo"



NATIONAL GEOGRAPHIC

MILES 0 5
FEET 1000 0 1000 2000 3000 4000 5000
KILOMETERS 1 5 0 1
METERS 1000 0 1000

TN MN 14°

03/17/09

STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

OFFICE USE ONLY
Log No. 114350
Permit No.
Basin 128

PRINT OR TYPE ONLY
DO NOT WRITE ON BACK

Please complete this form it its entirety in accordance with NRS 534.170 and NAC 534.340

1. OWNER Bureau of Land Management / ORMAT NV INC.
MAILING ADDRESS Carson City, Nevada
NE

NOTICE OF INTENT NO. 64460
ADDRESS AT WELL LOCATION Dixie Hope Prospect Township 22
N. Range 35 East MDB&M Section 9

2. LOCATION NW¼ ~~NW~~ ¼ Sec 9 T 22 N/S R 35 E
PERMIT/WAIVER No. See Attached | 04-211-01
Issued by Water Resources Parcel No.

Latitude
Longitude
Subdivision Name:

UTM E 409994.2 ☐ NAD 27
N 4405393.8 ☐ NAD 83/WGS 84
County: Churchill

3. WORKED PERFORMED
☑ New Well ☐ Replace ☐ Recondition
☐ Deepen ☐ Other...

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☑ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☑ Rotary ☐ RVC
☐ Air ☐ Other...

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Top Soil		0	15	15
Sticky Gray Clay		15	105	90
Blue Clay With Sand Layer		105	140	35
Sticky Blue Clay		140	240	100
Brittle Blue Clay W/		240	285	45
Volcanic Layers				
Sticky Blue Clay		285	327	42
Blue Clay With Corse		327	365	38
Sand Layers				
Blue Clay (Sort)		365	380	15
Volcanics (Red) With		380	400	20
Sand Layers				
Corse Sand with		400	460	60
Brittle Blue Clay Layers				
Sticky Blue Clay		460	472	12

RECEIVED
2011 AUG 18 PM 1:12
STATE ENGINEER'S OFFICE

Date started July 19, 2011 , 20
Date completed July 27, 2011 , 20

7. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

	G.P.M.	Draw Down (Feet Below Static)	Time (Hours)
N/A			

8. WELL CONSTRUCTION
Depth Drilled 472 Feet Depth Cased 100 Feet

HOLE DIAMETER (BIT SIZE)

		From		To	
9 7/8	Inches	105	Feet	472	Feet
10"	Inches	0	Feet	105	Feet
	Inches		Feet		Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
4"			0	451
10			0	105

Perforations:
Type of perforation Mill Slot
Size of perforation 0.1

From	333	feet to	343	feet
From	385	feet to	395	feet
From	410	feet to	430	feet
From		feet to		feet
From		feet to		feet

Surface Seal: ☑ Yes ☐ No
Depth of Seal 50'
Placement Method: ☑ Pumped ☐ Poured
Gravel Packed: ☑ Yes ☐ No
From 50 feet to.. 472 feet

Seal Type:
☑ Neat Cement
☐ Cement Grout
☐ Concrete Grout

9. WATER LEVEL
Static water level feet below land surface
Artesian flow 3 to 4 G.P.M P.S.I
Water temperature 84 °F Quality

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Western Strata Exploration, Inc.
Contractor
Address P.O. Box 657
Contractor
Clarksburg, CA 956125
Nevada contractor's license number issued by the *State Contractor's Board* #03369A
Nevada driller's license number issued by the Division of Water Resources, the *on-site driller* M1978
Signed
By driller performing actual drilling on site or contractor
Date 8/10/11

(Rev. 06/10)

USE ADDITIONAL SHEETS IF NECESSARY

39.793828° N
118.050298° W
NAD27

page 2 of 3
log # 114350
basin 128

Form 3260-3
(August 2007)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
GEOTHERMAL SUNDRY NOTICE

FORM APPROVED
OMB NO 1004-0132
Expires July 31, 2010

The Bureau of Land Management (BLM) requires this form or other BLM approved forms to be prepared and filed in triplicate with requisite attachments. The BLM must approve this permit prior to any lease operations.

6 Lease Serial No.
N-60685

7 Surface Manager ☑ BLM ☐ FS ☐ Other

8 Unit Agreement Name
Proposed Dixie Meadows Unit

1a Well Type ☐ Production ☐ Injection ☐ Heat Exchange ☑ Observation ☐ Other

9 Well No.
MW 21-9

10 Permit No.

1b Well Status:
New

11 Field or Area
Dixie Meadows

2 Name of Lessee/Operator
TGP Dixie Development Company, LLC

12 Sec., T., R., B. & M.
Sec. 9, T22N, R35E, MDB&M

3 Address of Lessee/Operator
6580 Prototype Court, Suite 200, Reno, NV 89521

13 County
Churchill

4 Location of Well or Facility
UTM11, NAD83: approx. 409586E 4405670N

14 State
NV

5 Type of Work

☐ Change Plans	☐ Convert to Injection	☐ Pull or Alter Casing
☐ Site and Road Construction	☐ Fracture Test	☐ Multiple Complete
☐ Construct New Production Facilities	☐ Shoot or Acidize	☐ Abandon
☐ Alter Existing Production Facilities	☐ Repair Well	☑ Other

15 Describe Proposed Operations *(Use this space for well activities only. See instructions for current well conditions on page 2.)*

Drill groundwater monitor well as part of Groundwater Monitor Plan to be completed through first aquifer, not to exceed 1,000' depth. Well is expected to be above 300' depth given presence of surface water such as ponds, seeps and springs in the area. Well will consist of 4" diameter PVC or metal pipe, screened through production zone. A downhole pump may be installed if needed. Overland travel to and from the proposed monitoring well location is in accordance with the plan submitted on 12/1/10 and attached Figure 1.

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16 Describe Proposed Operations *(Use this space for activities other than well work.)*

Use existing and new two track trail for access, as shown on Figure 1.

17 I hereby certify that the foregoing is true and correct

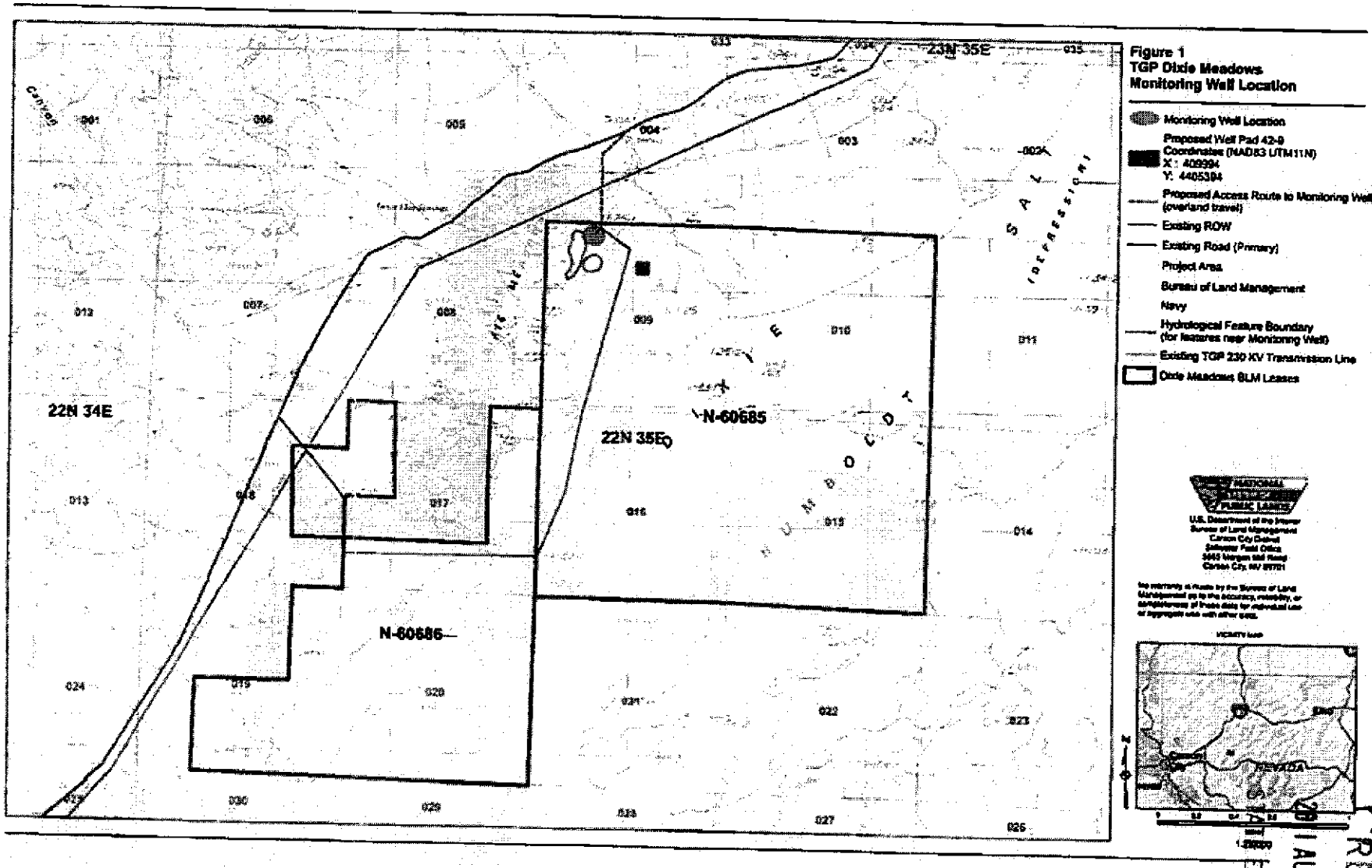
Signed Missy Miller Title Sr. Compliance Coordinator Date 12/03/2010

(This space for Federal use)

Approved by Loren Francis Title Acting for Field Manager Date 12/3/10
Conditions of Approval, if any:

Title 18 U.S.C. Section 1001 and Title 43 U.S.C. Section 1212 make it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

(Continued on page 2)



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Contractor
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By driller performing actual drilling on site or contractor
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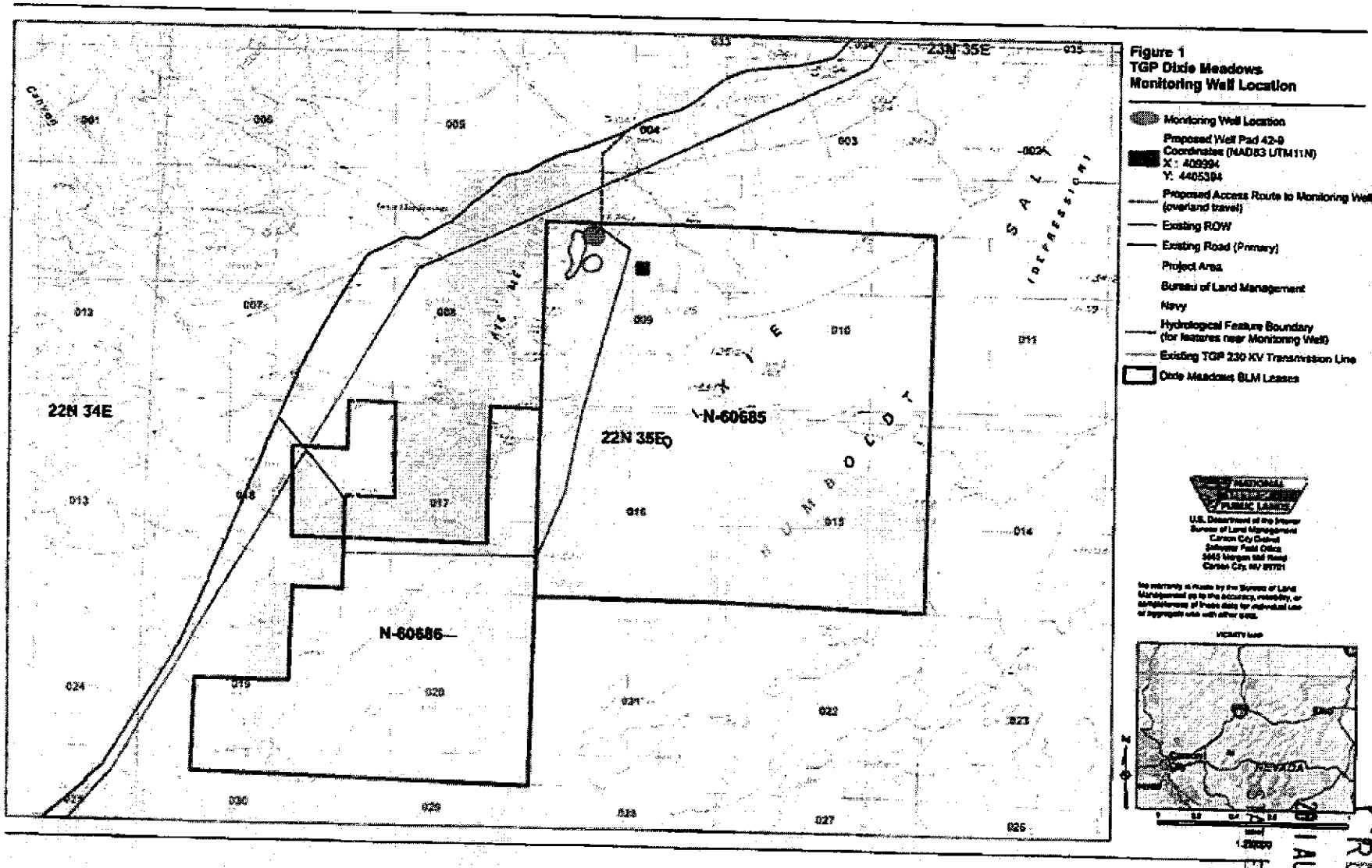
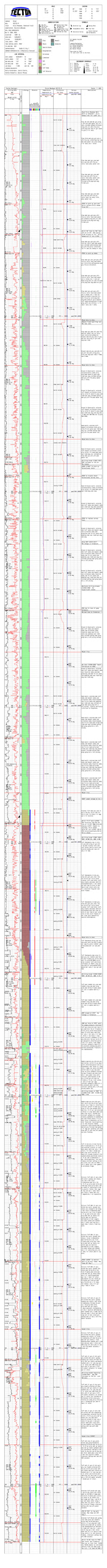
(Continued on page 2)





DH 22-8B

Geothermal
MD Mudlog

HORIZON WELL LOGGING, INC.

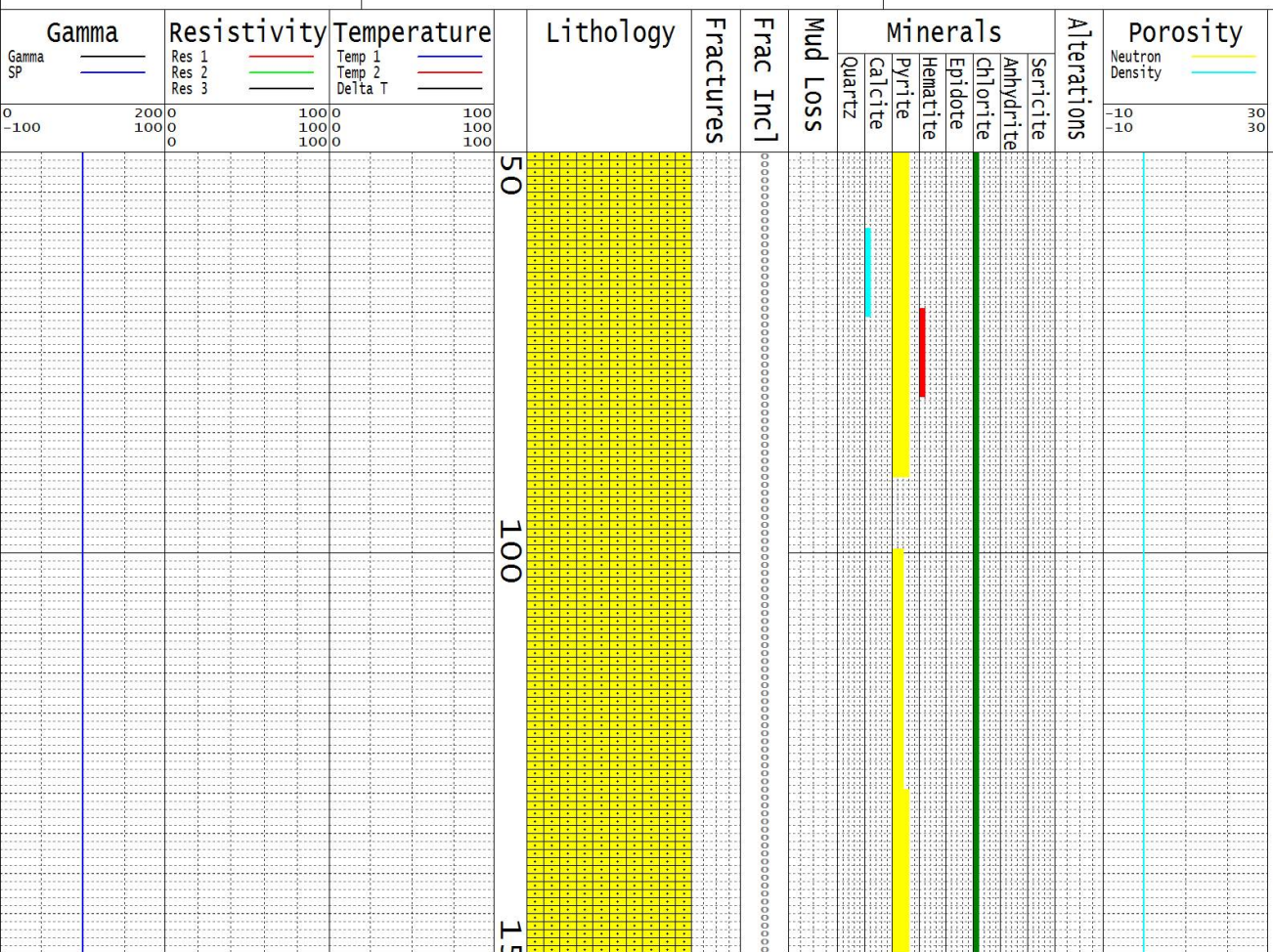
711 Saint Andrews Way
Lompoc, California 93436
805-733-0972
Fax 805-733-0992
http://www.horizon-well-logging.com

COMPANY	ORMAT Nevada, Inc.
WELL	DH 22-8B
LOCATION	~975 ft South & 700 ft East of NW corner Section 8, T22N R35E MDB&M
ELEVATION	~3475 ft MSL (GL)
FIELD	Dixie Hope
COUNTY & STATE	Churchill, NV
API No.	
SPUD DATE	2012.07.16
LOGGING DATES	2012.07.17-2012.07.27
LOGGING DEPTHS	10-1000 ft (GL)
CO. GEOLOGIST	Ben Delwiche
COMPANY MAN	
CONTRACTOR	GeoDrill
RIG	6
MUD COMPANY	Geo Drilling Fluids
TYPE	Gels
LOGGING GEOLOGISTS	Jay Zlotkowski
BIT SIZE	8" t/8.5' 5.75" t/277' HQ 3.895" t/1000'
CASING	7" 23#/ft t/8.5' 4.5" 11.6#/ft t/274'

Abbreviations

Symbols

RHYOLITE TUFF
ALLUVIUM



Descriptions

NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM GROUND LEVEL (GL) AND ARE BASED ON DRILLERS PIPE TALLY; ALPHA ANGLES OF GEOLOGIC STRUCTURES (E.G. BEDDING PLANES, FRACTURES, JOINTING ETC.) ARE MEASURED RELATIVE TO THE CORE AXIS; MRT DEPTHS ARE ~17 FT HIGHER THAN RECORDED DEPTHS; COLORS ARE DESCRIBED WHILE CORES ARE WET UNLESS OTHERWISE NOTED, AND ARE REFERENCED FROM THE GSA ROCK COLOR CHART.

ALLUVIUM: ABD OXIDZD, WELL RDD RHYOLITE TUFF; ABD FRM, PL GRN BLEACHED/CHLORTZD XL-ASH TUFF W/ V FN DISSM PYR - WK SUCC TXT; R TRNSL BLK CRS GR SS W/SILISC CMT; R SILICFD ASH TUFF; R LIMONITE SEAMS; R V THIN HMT SEAMS; V R V THIN CHLORT SEAMS; R WHT CHALCEDONY.

ABD RHYOLITE TUFF W/ UNALTRD BIOT, WELL RDD T/ SB-ANG; THIN QTZ VNG; R CHALCDNY

MUD TEMP @ 140' : 130° F

R EPID STNG @ 180'; XLN EPID @ 190'

ABD TRNSL BLK CRS GR SS W/ SILISC CMT

COM FRM, BLEACHED ASH TUFF

PRD PL GRN, BLEACHED, RXTLZD XL-ASH TUFF

R V THIN HMT VNG

R EPID STNG; R TRNSL BLK SS

MUD TEMP @ 245' : 125° F

PRD FRM-HD, BLEACHED XL-ASH TUFF; V R XLN EPID

MUD TEMP @ 255' : 127° F

PRD HD-V HD, TRNSL PL GRN CRS GR SS; ABD LT GRNSH GRY SILTSTONE; V THIN QTZ VNG; V R EPID STNG

MUD TEMP @ 265' : 135° F

PRD PL GRN, SBRDD, RXTLZD XL TUFF; R THIN PYR VNG; TR TRNSL BLK CRS GR SS W/ SILISC CMT

MUD TEMP @ 275' : 148° F

BOTTOMS UP TEMP = 185° F

DRILL T/277' (GL) ON 2012.07.18; SET/CMT 4.5" CSG T/274'; CORE AHEAD W/ HQ ASSEMBLY ON 2012.07.20.

ALLUVIUM/CONGLOMERATE: LT GRNSH GRY; FRM - PRD COMPTNT, OCC IN-COMPTNT; PRLY SRTD - ANG, MD GR T/ SMALL BLOCKS; ABD CHLORTZD SILTSTN, COM QUARTZITE, TR BLEACHED RHYOLITE TUFF; TR OXDZD BASALT; BLEACHED WKLY CHLORTZD LT GRNSH GRY SANDY FN GR MATRX W/TR DISMM PYR; TR CALCT PF.

MRT @ 303' : 155° F

MRT @ 313' : 155° F

SBHD CALCT/GYPSUM @ 322'; V R DETRITAL EPID

MRT @ 323' : 155° F

TR V FN PORES

MRT @ 333' : 130° F

35° OPEN FRAC @ 339' W/CALCT AND SBHD GYPSUM

MRT @ 343' : 135° F

MRT @ 353' : 138° F

MRT @ 363' : 139° F

HIGH ANGLE FRAC (4°) @ 360-61'; PRESUMED TO BE MECHANICAL; COM CALCT/GYPSUM PF

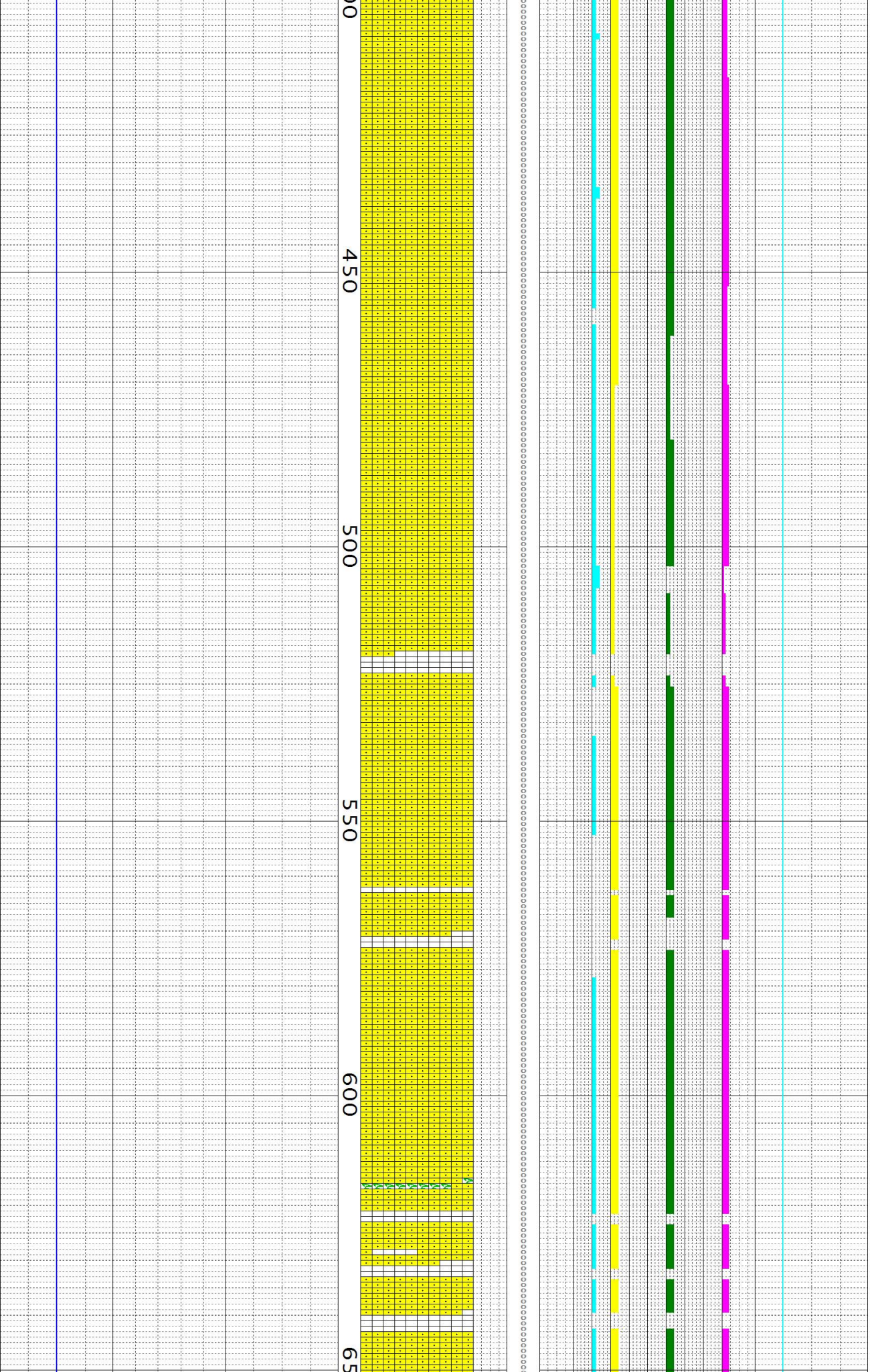
BCMNG V FRM

MRT @ 373' : 142° F

MRT @ 383' : 145° F

ALLUVIUM/CONGLOMERATE: LT GRNSH GRY, MD GRY; V FRM, FRM; PRLY SRTD, ANG T/ SB-RDD, MD GR T/ SMALL BLOCKS; ABD CHLORTZD SILTSTONE, COM BLK QUARTZITE, TR OXIDZD BASALT; WKLY CHLORTZD SANDY FN GR MATRX W/TR DISM PYR; TR CALCT/GYPSUM PF.

MRT @ 393' : 145° F



MRT @ 403' : 158° F

MRT @ 413' : 161° F

MRT @ 423' : 174° F

V FN PORES

MRT @ 433' : 181° F

MRT @ 443' : 182° F

MRT @ 453' : 182° F

MRT @ 461' : 184° F

COHSV CLAY MATRX

BIT TRIP @ 463'

MRT @ 473' : 181° F

MRT @ 483' : 166° F

ALLUVIUM/CONGLOMERATE: MD GRY, LT GRNSH GRY; V FRM T/ INCOMPTNT; PRLY SRTD - ANG T/ WELL RDD, MD GR T/ SMALL BLOCKS; ABD BLK APHAN BASALT, ABD CHLORTZD SILTSTONE, TR TRNSL GRY QUARTZITE; BLEACHED, WKLY CHLORTZD SANDY FN GR MATRX W/ R DISM PYR; R-TR CALCT/ GYPSUM PF.

TR CALCT CMT

MRT @ 503' : 184° F

MRT @ 493' : 174° F

MRT @ 513' : 180° F

NO RECOVERY

MRT @ 523' : 177° F

MRT @ 533' : 185° F

MRT @ 543' : 178° F

MRT @ 553' : 178° F

MRT @ 563' : 179° F

ABD V FN XLN GYPSUM PF

NO RECOVERY

NO RECOVERY

MRT @ 573' : 179° F

MRT @ 583' : 182° F

MRT @ 593' : 180° F

MRT @ 603' : 197° F

ALLUVIUM/CONGLOMERATE: MD GRY, LT GRNSH GRY; V FRM T/ INCOMPTNT; PRLY SRTD - ANG T/ WELL RDD, MD GR T/ SMALL BLOCKS; ABD CHLORTZD SILTSTONE, TR BLK APHAN BASALT, TR TRNSL GRY QUARTZITE, R TONALITE; BLEACHED, WKLY CHLORTZD SANDY FN GR MATRX W/ R DISM PYR; R BLEACHED RHYOLITE TUFF FLOW; R-TR CALCT/ GYPSUM PF; R-TR V FN XLN GYPSUM PF.

NO RECOVERY

MRT @ 613' : 189° F

NO RECOVERY

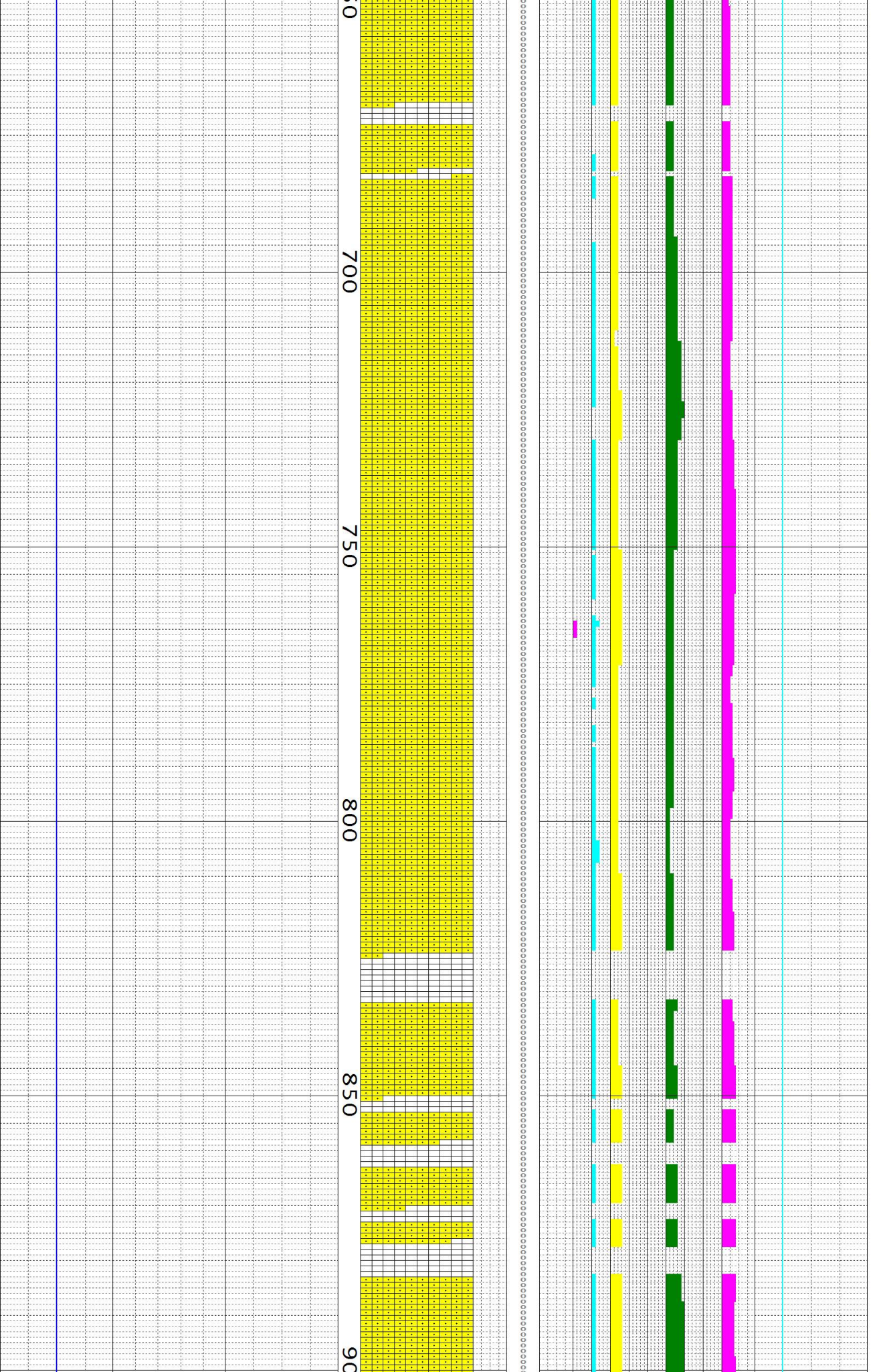
MRT @ 623' : 194° F

MRT @ 628' : 191° F

NO RECOVERY

MRT @ 637' : 192° F

MRT @ 643' : 196° F



MRT @ 653' : 197° F

MRT @ 663' : 202° F

STRLY BLEACHED FN GR MATRX

NO RECOVERY

MRT @ 673' : 200° F

SHORT TRIP @ 673'

NO RECOVERY

MRT @ 675' : 212° F

MRT @ 683' : 218° F

MRT @ 693' : 220° F

STRLY BLEACHED, MOD CHLORTZD FN GR MATRX W/ TR V FN DISM PYR

MRT @ 703' : 228° F

MRT @ 713' : 220° F

FLUVIAL BDDING F/711-12'; MOD WELL SRTD W/ THIN X-BDDNG

MRT @ 723' : 230° F

MRT @ 733' : 225° F

MRT @ 739' : 225° F

BIT TRIP @ 739'

MRT @ 743' : 240° F

ABD V FN XLN GYPSUM PF

MRT @ 753' : 238° F

MRT @ 763' : 240° F

MRT @ 773' : 238° F

ALLUVIUM/CONGLOMERATE: LT GRNSH WHT, LT GRNSH GRY; FRM, BRTTL; PRLY SRTD - FN GRS T/SMALL BLOCKS, SB-ANG T/ ANG; ABD CHLORTZD SILTSTONE, COM BLK APHAN BASALT; STRLY BLEACHED, WKLY-MOD CHLORTZD SANDY FN GR MATRX W/MNR V FN DISM PYR; R-TR LOC CALCT/GYPSUM PF; LOC QTZ PF; ABD V FN XLN GYPSUM PF THROUGHOUT.

MRT @ 783' : 242° F

V FRM T/ HD

MRT @ 793' : 236° F

MRT @ 803' : 236° F

DUMP MUD/ADD FRESH WATER

51° JNT @ 811'

MRT @ 813' : 224° F

MRT @ 823' : 224° F

MRT @ 833' : 224° F

NO RECOVERY

CLOGGED CORE BARREL, TOH @ 833'; RIH, TIGHT @ 280'; TOH T/SHOE; CIRC; RIH, WASH/REAM F/803-833', TAKING WEIGHT.

FRM T/ INCOMPTNT; V R DETRITAL (?) EPIDOTE

MRT @ 843' : 228° F

NO RECOVERY

MRT @ 853' : 220° F

NO RECOVERY

MRT @ 863' : 228° F

MRT @ 873' : 234° F

NO RECOVERY

STRLY RXTLZD GRANTOID BLOCK W/ ABD EPIDOTE PSEUDOMRPH @ 874'

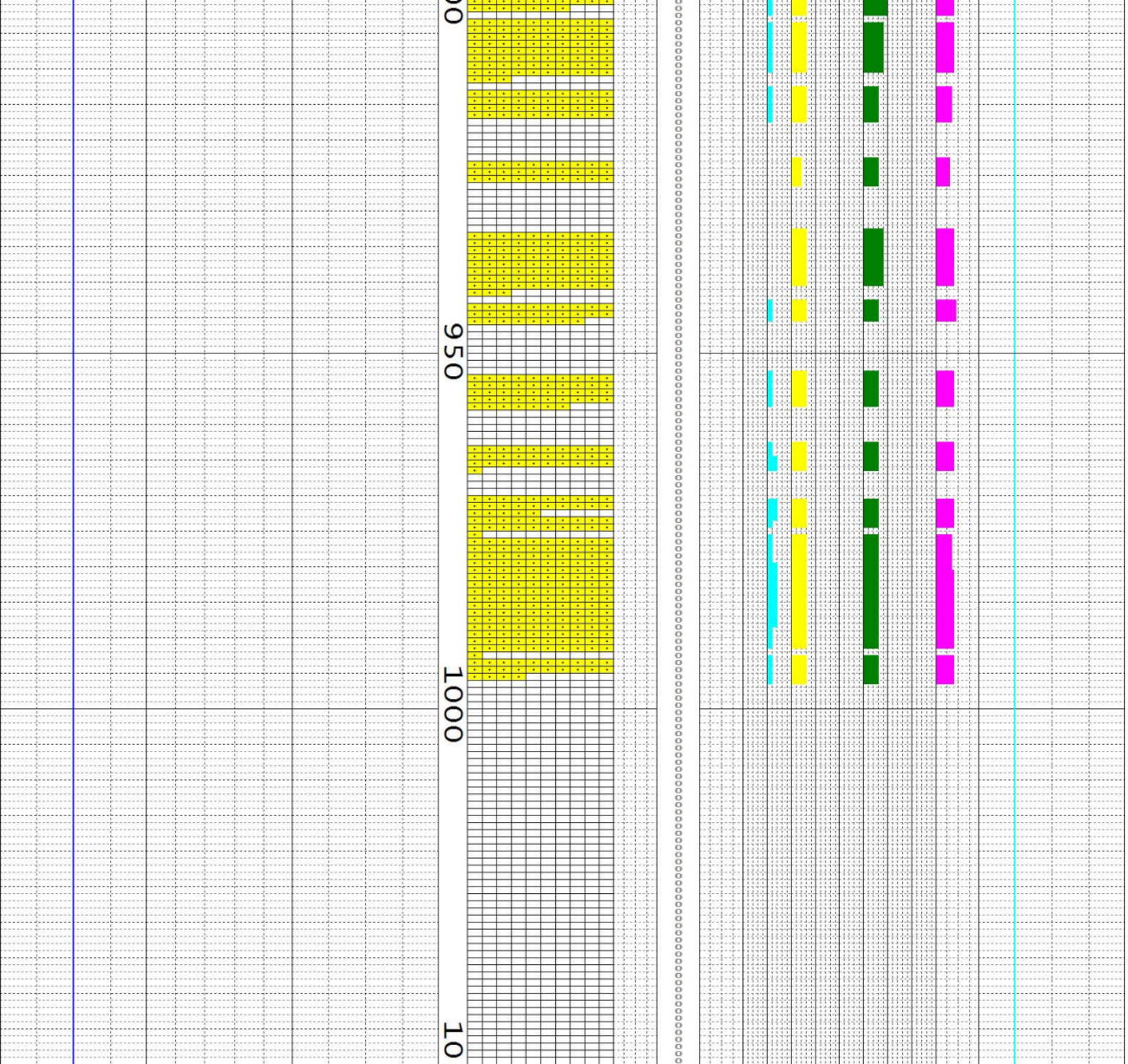
NO RECOVERY

MRT @ 883' : 240° F

COM DETRITAL EPIDOTE

CONDITION MUD/ADD WATER/CIRC

MRT @ 893' : 218° F



NO RECOVERY

MRT @ 913' : 238° F

MRT @ 923' : 238° F

NO RECOVERY

BIT TRIP @ 923'

NO RECOVERY

MRT @ 933' : 235° F

MRT @ 943' : 235° F

NO RECOVERY

NO RECOVERY

NO RECOVERY

STRLY BLEACHED/MOD CHLORTZD/ STRLY PYRTZD FN GR MATRX; FRM T/ INCOMPTNT FM.

NO RECOVERY

MRT @ 1000' : 234° F

TD DIXIE HOPE 22-8B @ 1000' (GL) ON 2012.07.27; RUN WIRELINE LOGS ON 07/27.

Dixie Hope 23-8

Geothermal
MD Mudlog

HORIZON WELL LOGGING, INC.

711 Saint Andrews Way
Lompoc, California 93436

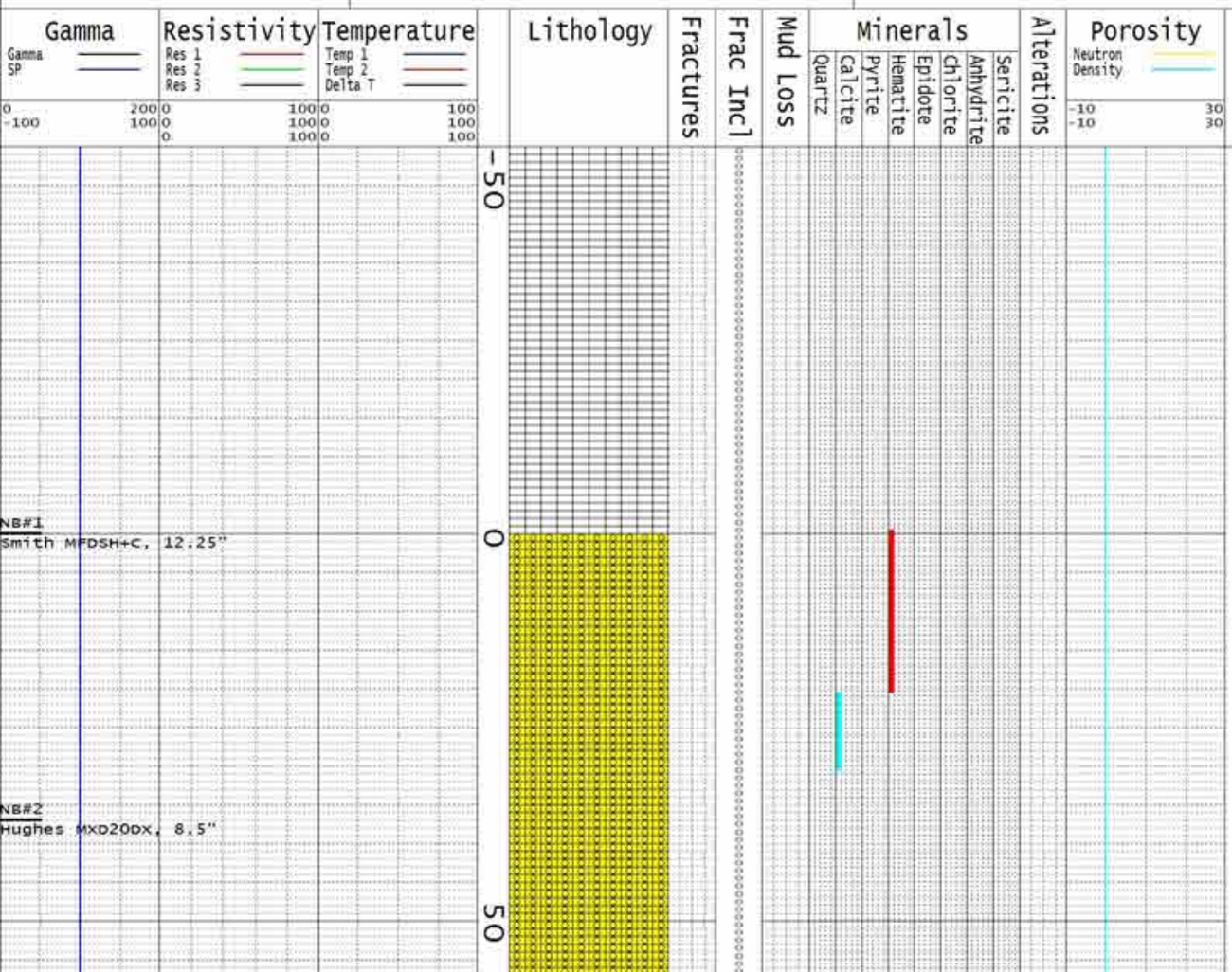
805-733-0972
Fax 805-733-0992

http://www.horizon-well-logging.com

COMPANY	ORMAT Nevada, Inc.
WELL	Dixie Hope 23-8
LOCATION	SW1/4 NW1/4 of Section 8 T22N-R35E MDB&M
ELEVATION	3457'(GL) ; 3467.5'(KB)
FIELD	Dixie Hope
COUNTY & STATE	Churchill, NV
API No.	
SPUD DATE	2015.08.23
LOGGING DATES	2015.08.29-2015.10.20
LOGGING DEPTHS	0-4700'(GL)
CO. GEOLOGIST	Ben Delwiche
COMPANY MAN	
CONTRACTOR	GeoDrill, Inc.
RIG	4 & 6
MUD COMPANY	Newpark
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	Jay Zlotkowski
BIT SIZE	12.25" t/36' 8.5" t/308'(GL) HQ t/4700'(GL)
CASING	9.625" t/36' 7" t/299'(GL) 4.5" t/829'(GL) 2.375" t/4692'(GL)

Abbreviations

Symbols



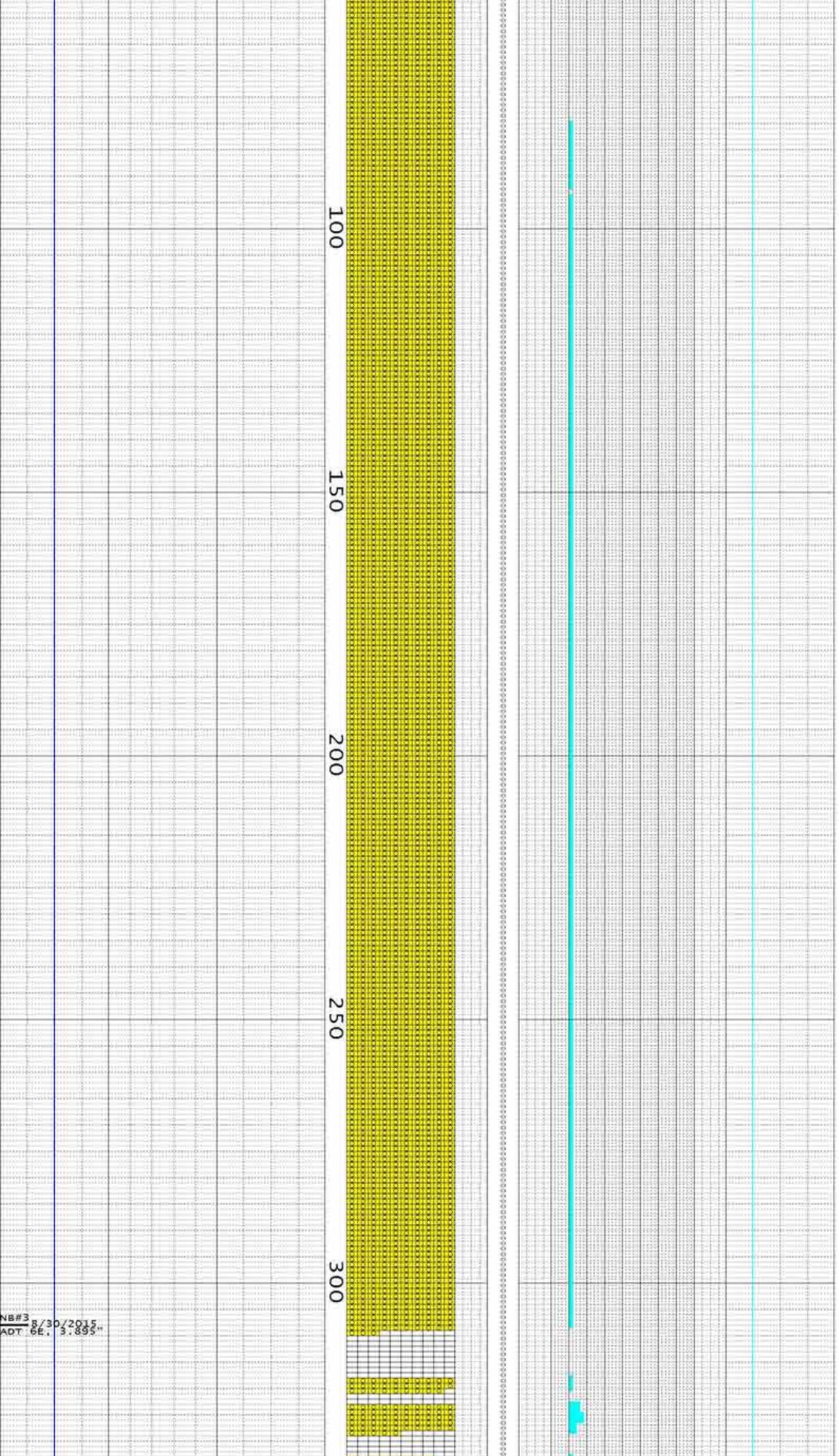
Descriptions

NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM GROUND LEVEL; ALPHA ANGLES OF GEOLOGICAL STRUCTURES ARE MEASURED RELATIVE TO CORE AXIS; COLORS ARE DESCRIBED WHILE CORES ARE WET AND ARE BASED ON THE GSA ROCK COLOR CHART.

SPUD DIXIE HOPE 23-8 ON 2015.08.23 W/GEODRILL #4; ROTARY CHIPS COLLECTED BY GEODRILL PERSONNEL.

ALLUVIUM: PL RD, PL PNK, PURP, GRN, PL GRN, RDDSH YEL; MD-SML BLCKS; ANG-SBRDD; PRED OXDZD WELDED XL-TUFF LITH FRAG, TR PL GRN RXLZD SLTSTN LITH FRAG, RR FN SB-RDD VOLC GLASS; RR LIMONITE STNG ON LITH FRAG F/0-20' (LOGGED AS HMT); MAJ OF MATRX WASHED PRIOR TO LOGGING; RR CALC MATRX @30'; ABD BLK RXLZD SLTSTN LITH FRAG F/30'.

SET/CMT 9-8/8" 40#/FT CSG T/36.5'; D/O W/8.5" BIT.



RR LRG CTTGS, PRD CRS SD F/60'

ALLUVIUM: MD-DRK GRY (BULK SPL); FN-CRS, WELL RDD-SBANG GRS; PRED LT GRY XL-TUFF LITH FRAG, RR PL GRN + PL RD XL-TUFF; COM VOLC GLASS + PLAG XL FRAG, COM BRN BIOT, RR DETRITAL CUBIC PYR; RR CALCT PF.

PRED V FRIA WHT XL-TUFF, MNR PLAG XL FRAG.

TR CRS SBANG XL-TUFF LITH FRAG

ALLUVIUM: MD GRY (BULK SPL); LT-MD GRY, RR PL GRN, RR PL RD; MD-V CRS GRS, ANG-SBRDD; PRED DK GRY RXLZD SLTSTN, MNR LT GRY WELDED RHYLT XL-TUFF, V RR TRNSL PL RD QTZT LITH FRAG; TR PLAG XL FRAG, RR BRN BIOT, RR VOLC GLASS/QTZ FRAG, V RR DETRITAL CUBIC PYR; V RR CALCT PF.

COM V FRIA WHT XL-TUFF LITH FRAG; WHT FRIA ALLUV MATRX; TR CALCT PF

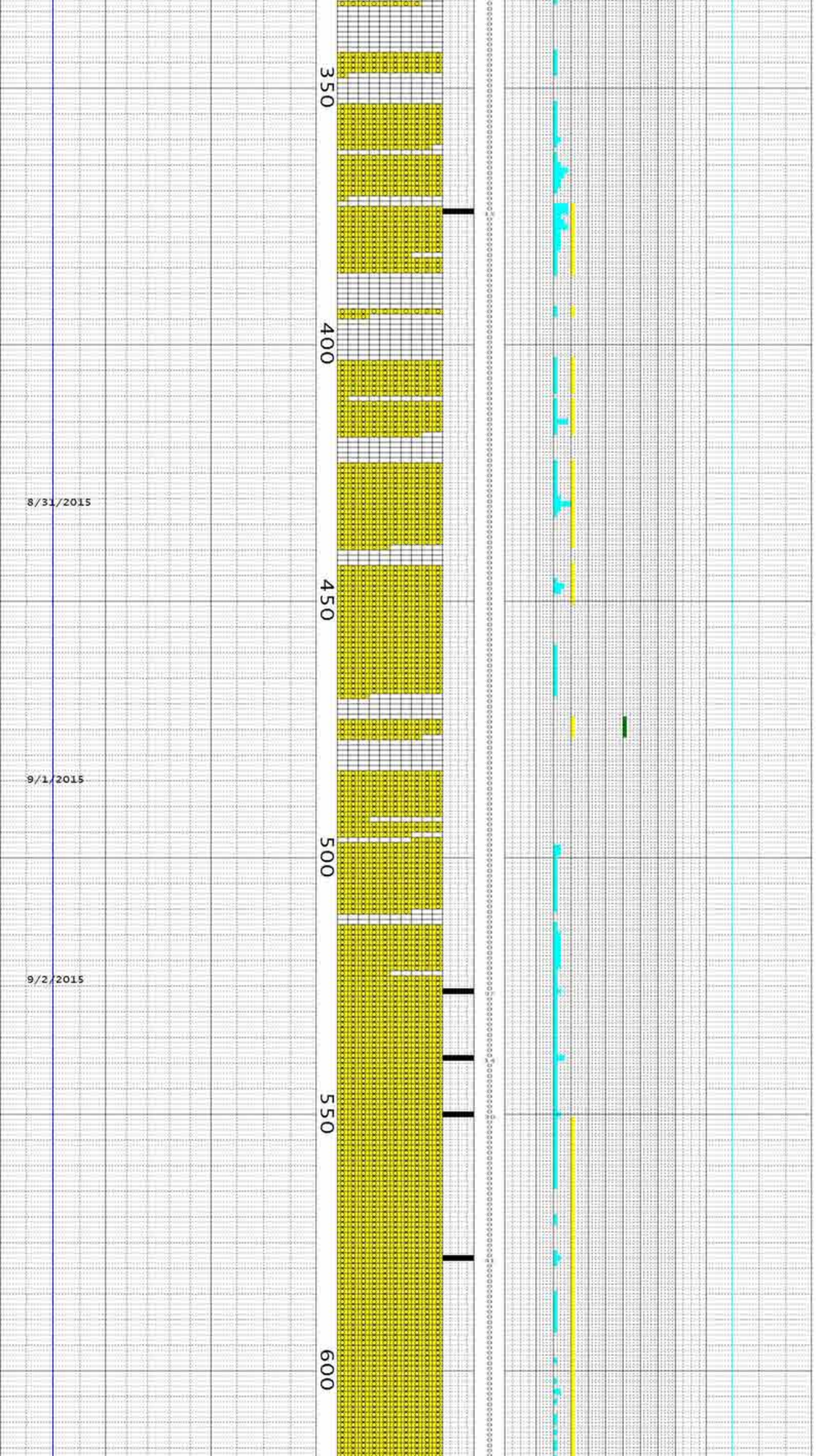
COM PL GRN SLTSTN LITH FRAG, RR TRNSL WHT QTZTE LITH FRAG, V RR EPID XL FRAG @300'

DRILL 8.5" HOLE T/308'(GL); SET/CMT 7" CSG T/299'(GL); R/D GEODRILL #4, R/U GEODRILL #6; NIPPLE UP/TEST ANNULAR BOPE T/500PSI - PASSED; D/O CMT W/6.25" MILL-TOOTH BIT F/264' T/298'; RUN 4" CSG T/298'; CORE-OUT CMT/FLOAT/SHOE T/300'; TEST SHOE T/60PSI - PASSED; CORE AHEAD W/HQ (3.895").

ALLUVIUM: LT-MD GRY; SFT/FRIA-FRM/BRTL; FN-V CRS (2-90MM), ANG LITH FRAG - PRD LT GRY WKLY RXLZD SILTSTN, MNR LT GRY RHYOLT XL-TUFF, PL GRN PORPH RHYOLT; LT-MD GRY SLT/CLY FN GR MATRX, LOC WHTTSH/MOD BLEACHD; RR-ABD CALCT PF/CMT.

MRT @323' : 130°F

MRT @333' : 130°F



MRT @343' : 125°F

15° 3MM CALCT VN @360'

MRT @363' : 135°F

BLEACHD/CALCFD FN GR MATRX @366'

15° OPEN FRAC @374'

~6° 5MM IRRG CALCT VN @377'; V RR SBHD PYR

MRT @383' : 135°F

MRT @403' : 138°F

FRIA SILTY MATRX

ABD CACLT PF/CMT @415'

MRT @423' : 137°F

WHTTSH SANDY SLT MATRX W/V FN DISSM PYR (DETRITAL?); V FNT CHLOR ALTRTN

MNR COHSV CLY

MRT @443' : 139°F

FRIA LT GRY SANDY SILT MATRX W/MNR COHSV CLY; SML RHYLT XL-TUFF BLCKS

MRT @463' : 140°F

WKLY CHLORTZD MATRX, V FN DISSM PYR

MRT @483' : 145°F

COM MD GRY COHSV CLY

TR-RR CALCT PF/CMT

MRT @503' : 141°F

HD/DENSE CORES F/502'

3X5CM, 2X1CM PORES W/EUHD CALCT @515-16'

MRT @523' : 151°F

NOTE: INSTALL MUD COOLER @523'

37° 2MM CALCT VN/FRAC @526'

SURVEY @533': 127° 0.5° INC

14° OPEN FRAC @539', MNR CALCT VNG

MRT @543' : 140°F

30° CALCT VN W/SBHD XLS @550'

V FN CUBIC PYR W/IN MATRX; RR SCAT CALCT BLEBS/PF

MRT @563' : 145°F

TR CALCT CMT @570'

41° FRAC/CALCT VN @578'

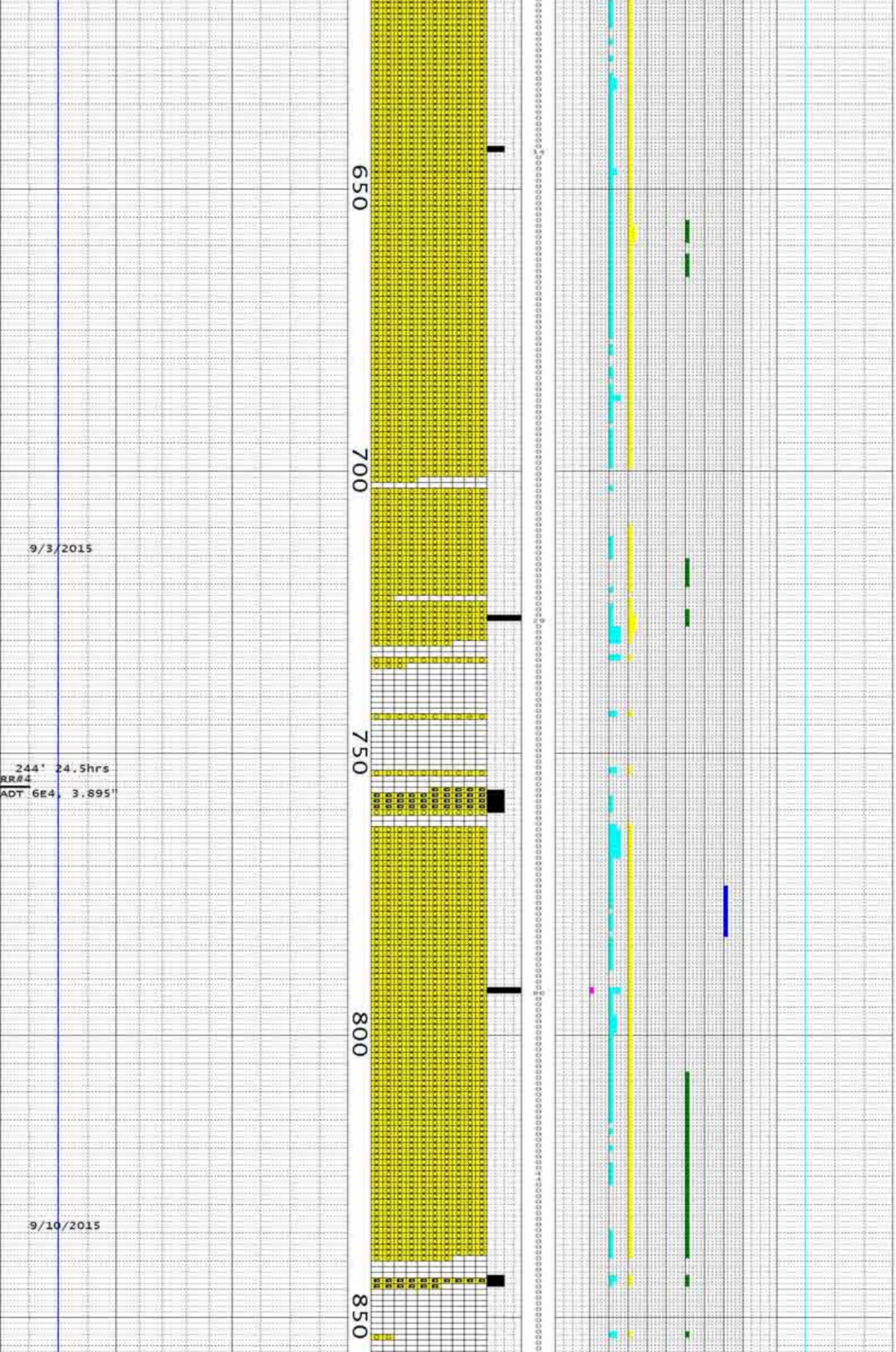
MRT @583' : 158°F

ALLUVIUM: MD GRY; PRD V FRM, SLI BRTL, OCC SFT/FRI; PRD ANG 1-8CM MD GRY/GRYSH PURP, HD WELDED XL-TUFF LITH FRAG, COM PL GRNSH GRY SLTSTN W/DISSM PYR, COM BLK SHALE W/DISSM PYR, TR BRN BIOT, TR VOLC GLASS; HYDRTD LT GRY/WHTSH SANDY/CLY SLT MATRX W/V FN CUBIC PYR - RR V FN STRIA PRISMTC PRECIP W/IN V FN PORES; LOC CALCT CMT/BLEBS.

MRT @603' : 150°F

SURVEY @603': 100° 0.2°INC

MNR SBANG-WELL RDD GRAVEL



MRT @623' : 158°F

TR V FN FRAGILE TRNSP STRIA PRISMTC XLN PRECIP IN MATRX PF.

LOC CALCT CMT

POSSBLE 70° THRUST @642', OFFSET MICRITE BLOCK+CALCT VNS; DISPLCMNT DOES NOT CONTINUE INTO ALLUV MATRX.

14° NORMAL @643' W/1MM CALCT FF

MRT @643' : 160°F

FRIA, WKLY CHLOR SILTY SAND MATRX W/TR V FN CUBIC PYR

MRT @663' : 158°F

BLEACHD V LT GRY MATRX

MRT @683' : 155°F

25° 0.5-1CM CALCT VN @687 ALNG LT GRY BRN-BIOT DOM XL-TUFF BLOCK; NO PERM.

MRT @703' : 162°F

HYDRTD SANDY CLY MATRX

ALLUVIUM: LT-MD GRY; FRM, SLI FRIA, BRTL; PRED PL GRNSH GRY SILTSTN, BLK/DRK GRY SHALE, MNR LT GRY BRN-BIOT RICH XL-TUFF, RR PL GRN CHLORTZD XL-TUFF; LT-MD GRY SANDY SILTY CLY MATRX - WKLY CHLORTZD F/716-21'; LOC RR CALCT PF; RR-TR V FN CUBIC DISSM PYR.

MRT @723' : 170°F

POSSBL 29° BRCCTD FRAC SURFACE @726'; STRLY BLEACHD, WKLY CHLORTZD MATRX F/726-30'; COM CALCT CMT, TR CUBIC PYR.

GRY-BRN DHYDRTD SLTY CLY FLT GOUGE? @743'

MRT @743' : 172°F

NOTE: POOH @756.5' T/INSPECT CORE BARREL; SET CORE BARREL; P/U RR#4.

BRCCTD F/757-60', ~6° NON-PLNR FRAC CUT F/MATRX INTO XL-TUFF BLOCK; 3X1CM PORE W/BLADDED CALCT @765', COM CALCT CMT.

MRT @763' : 190°F

SURVEY @773'; 152.9° 0.8°INC

COM WHT SERCT CLY W/IN MATRX

MRT @783' : 170°F

86° (LOW ANGLE) FRAC @792' W/SBHD QTZ ONTOP BLADD CALCT

MNR CALCT PF

MRT @803' : 160°F

PL GRN, GRNSH WHT MATRX, WK CHLOR ALTRTN; RR LOC CALCT PF

MRT @823' : 155°F

4° (HIGH ANGLE) 2MM CALCT VN @824-25'

SURVEY @833'; 45.3° 0.4°INC

CORE HQ T/833'(GL); OPEN HOLE T/6-1/8"; RUN E-LOGS; SET/CMT 4.5" 10.5#/FT J-55 BTC CSG T/829'(GL); NIPPLE UP/TEST 4.5" BOPE T/300PSI & 1000PSI - PASSED; CORE AHEAD W/HQ.

MRT @843' : 168°F

RR EPID XL FRAG @835', DETRITAL? BRCCTD @843-44', MNR CALCT PF, WK CHLOR ALTRTN

HD WHT, SB-SUCC TXT MATRX

126' 38.5hrs
NB#5
ADT 2A0, 3.895"

9/11/2015

900

950

1000

1050

1100

MRT @863' : 167°F

PR RECOVERY F/840' T/882'; NO FLUID LOSS; POOH, CHANGE CORE BARREL LATCH, RE-SET CORE BARREL; P/U NB#5.

MRT @883' : 178°F

HD WHT RXLZD MATRX, RR EPID XL FRAG/PSEUDMRPH OF XL-TUFF, LOC COM V FN XLN PYR

V RR QTZ BLEBS

23CM ~39° CALCT VN @893-94' W/BLADD XLS @894'

MRT @903' : 190°F

SURVEY @903' : 115.4' 1.0°INC

WHT-LT GRY CLY MATRX W/ FN DISSM PYR; RR V FN TRNSP FRAGL STRIA PRISMTC PRECIP W/IN FN MATRX PORES.

MRT @923' : 188°F

BLADD CALCT W/IN PORES @924'

ALLUVIUM: MD GRY, GRNSH GRY; V FRM-HD, BRTL, OCC FRIA; PRD ANG FN GRVL-SML BLCKS WKLY CHLORTZD SLTSTN LITH FRAG, TR BLK ARGLT, TR LT GRY QTZITE, RR CHLORTZD XL-TUFF; TR QTZ/PLAG/BIOT XL FRAG; WHT-LT GRY SLTY CLY MATRX W/V FN CUBIC DISSM PYR; TR-MNR CALCT PF.

MRT @943' : 184°F

COM CALCT PF @950'

MRT @963' : 189°F

SURVEY @963' : 190.0' 0.3°INC

MRT @983' : 182°F

3MM 16° CALCT VN @988'

V FRM WHT-LT GRY SANDY SLT MATRX

MRT @1003' : 186°F

MRT @1023' : 188°F

SURVEY @1023' : 137.6' 1.1°INC

NO RECOVERY F/1025-29'

SFT/FRIA MD GRY SLTY MATRX @1033'; GRDDNG T/LT GRY-WHT V FRM/BRTL

MRT @1043' : 192°F

HD/DENSE MATRX, TR CALCT CMT

MRT @1063' : 196°F

4MM 41° CALCT+QTZ VN @1076'
1CM 20° CALCT VN @1077'

MRT @1083' : 192°F

V RR EPID XL FRAG/PSEUDMRPH, DETRITAL?; V RR QTZ BLEBS

SURVEY @1083' : 139.7' 0.9°INC

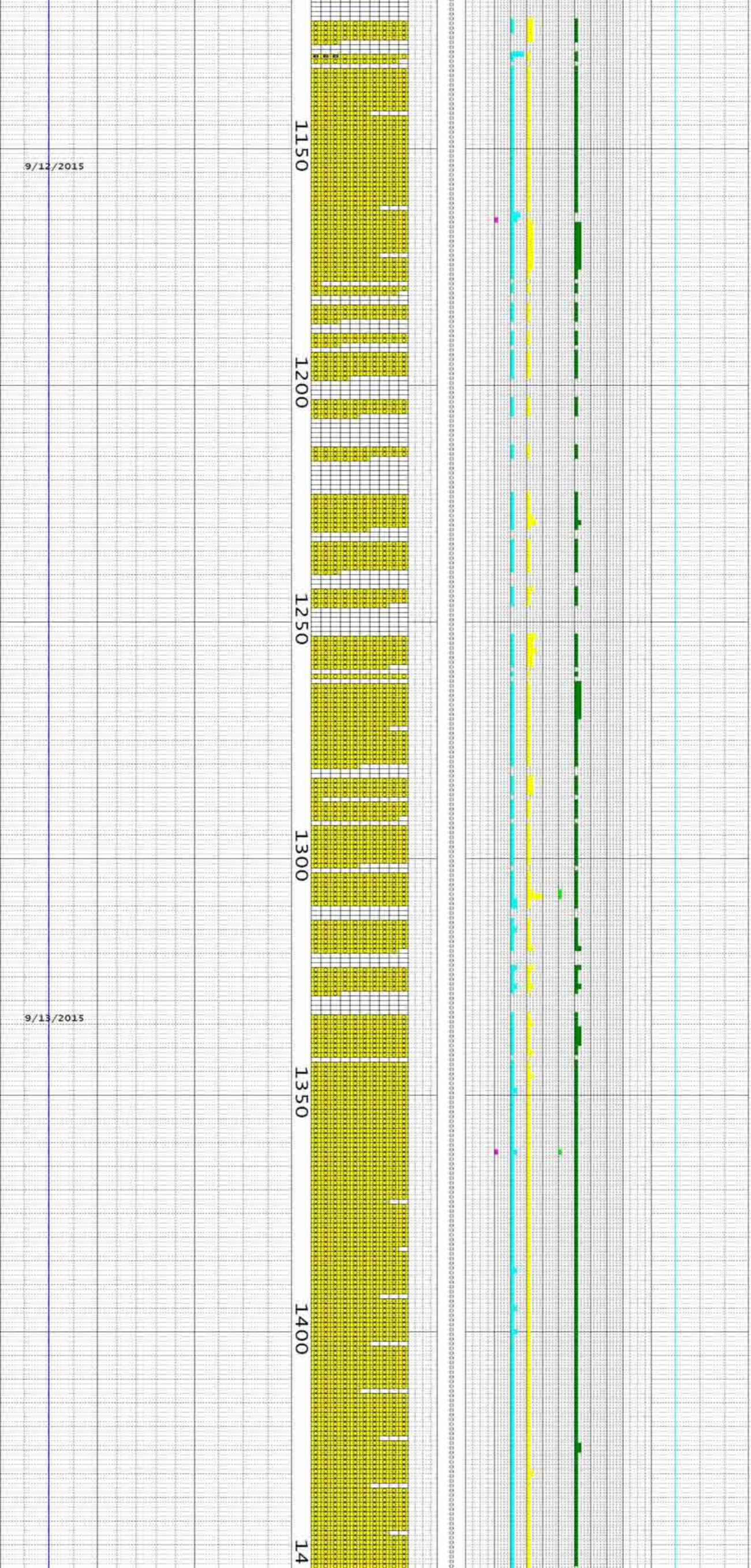
V FRM WHT MATRX W/SUCC TXT

4MM 35° QTZ/CALCT/QTZ VN @1095'

MRT @1103' : 190°F

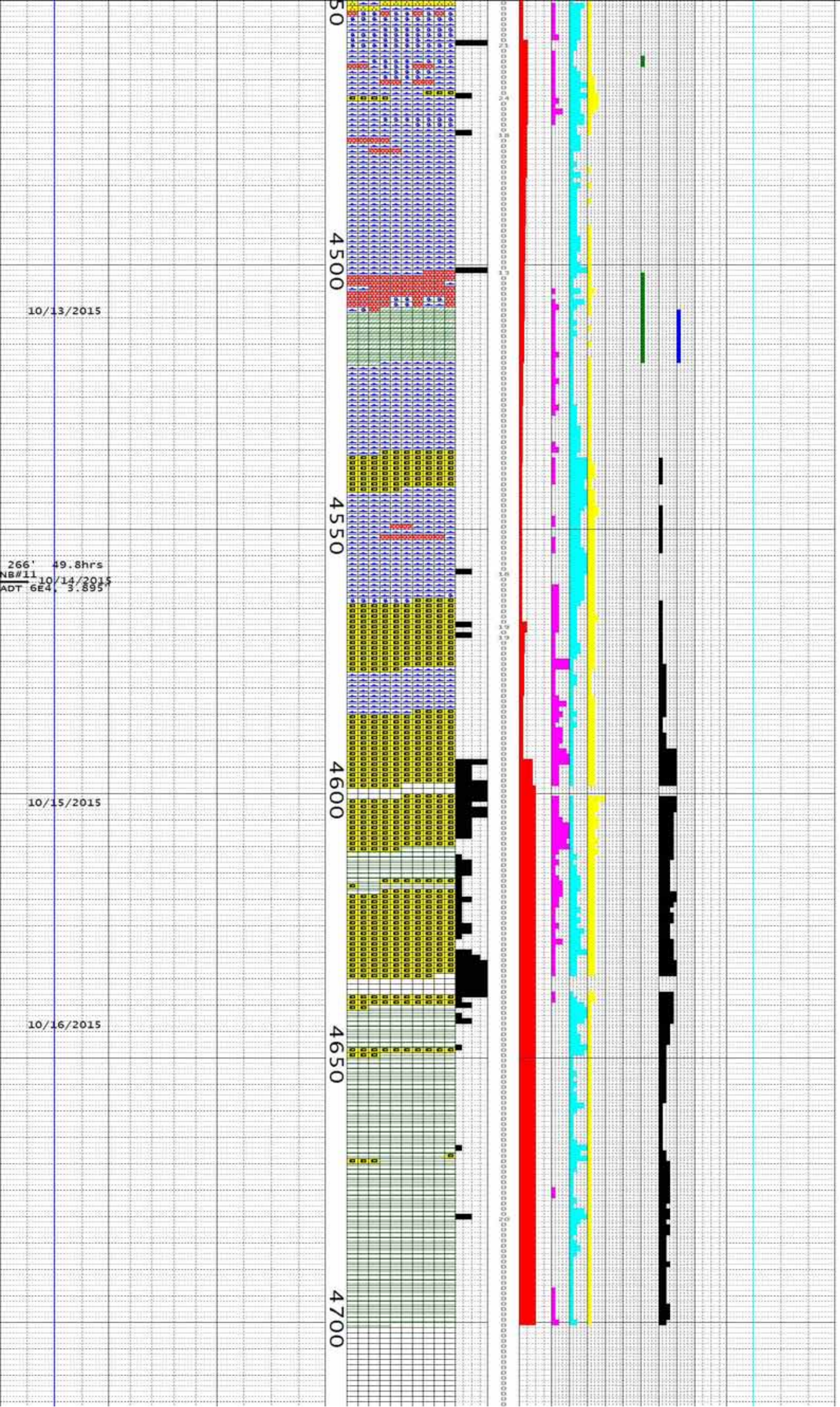
SFT/FRI PL GRN-LT GRY SLTY MATRX F/1112', RR CALCT PF

NO RECOVERY F/1117.7-23'



15BBL LOSS F/1123-30'
MRT @1123' : 190°F
10BBL LOSS F/1130-33'
NO RECOVERY F/1127.3-30'
BRCCTD/CALCFD @1130'
NO RECOVERY F/1131.9-33'
5BBL LOSS @1137'
SFT HYDRTD PL GRN GRY MATRX W/RR-TR V FN CUBIC DISSM PYR
MRT @1143' : 190°F
SURVEY @1143 : 179.0' 1.2°INC

MRT @1163' : 190°F
CALCT CMT @1164', RR TRNSP QTZ CMT @1165'
SFT PL GRNSH GRY, WKLY-MOD CHLORTZD SLTY CLY MATRX W/TR V FN DISSM CUBIC PYR
LOSING ~2BBLS ON CNXS
NO RECOVERY @1178', F/1180.9' T/1183'
MRT @1183' : 200°F
NO RECOVERY F/1186.3' T/1189'
NO RECOVERY F/1191.3' T/1193'
SFT/HYDRTD PL GRNSH GRY SLTY CLY MATRX
NO RECOVERY F/1198.4' T/1203'
MRT @1203' : 198°F
NO RECOVERY F/1206.5' T/1213'
NO RECOVERY F/1215.6' T/1223'
MRT @1223' : 198°F
NOTE: PR RECOVERY; SLOW RPM + SPM, LUBE INNER CORE BARREL.
NO RECOVERY F/1230.6' T/1233'
WKLY-MOD CHLORTZD MATRX, RR-TR DISSM PYR; RR V FN TRNSP FRAGL STRIA PRISMTC PRECIP
NO RECOVERY F/1239.3' T/1243'
MRT @1243' : 208°F
NO RECOVERY F/1246.8' T/1253'
SFT/FRIA HYDRTD PL GRNSH GRY SLTY CLY MATRX, TR-COM V FN CUBIC PYR, RR CALCT PF
MRT @1263' : 200°F
MOD CHLORTZD MATRX
27CM ARGLLT BLCK
SURVEY @1273' : 180.5' 1.6°INC
NO RECOVERY F/1280.5' T/1283'
MRT @1283' : 214°F
SFT/FRIA HYDRTD LT GRY-PL GRNSH GRY SNDY SLTY CLY MATRX W/RR-TR DISSM PYR; RR CALCT PF
MRT @1303' : 208°F
ABD V FN CUBIC PYR @1308', V RR DETRITAL? EPID, BLEACHD WHT MATRX
NO RECOVERY F/1310' T/1313'
5BBL LOSS @1313' & 1323'
NO RECOVERY F/1319.9' T/1323'
MRT @1323' : 218°F
NO RECOVERY F/1328.3' T/1333'
SURVEY @1333' : 180.5' 0.7°INC
3BBL LOSS @1333' & 1343'
MRT @1343' : 215°F
CALCT/QTZ/CALCT CMT @1362', V RR XLN EPID ALNG CMT MARGNS
MRT @1363' : 208°F
5BBL LOSS @1373'
MRT @1383' : 210°F
SURVEY @1393' : 87.9' 1.5°INC
FRM SLI HYDRTD LT GRNSH GRY SNDY SLT MATRX; WKLY CALCFD; RR-TR CALCT PF
MRT @1403' : 210°F
MRT @1423' : 212°F
FRM PL GRNSH WHT DEHYDRTD SLTY CLY MATRX, NON-CALC, RR V FN CUBIC PYR, WKLY CHLORTZD; RR CALCT PF
MRT @1443' : 208°F
SURVEY @1453' : 166.0' 1.4°INC



~8° CALCT+QTZ VN @4452'

SURVEY @4453': 222.1° 3.3°INC

21° OPEN FRAC @4458'

RXLZD MD GRY SLTSTN
MRT @4463' : 318°F

24° CALCT+QTZ+PYR+BRCC VN @4466'

24° FRAC @4468', BRCCTD W/ABD CALCT IN FOOTWALL

NOTE: LOSING ~26 BBLS/HR

18° R-OBLQ NRML @4475', 44° RAKE

RXLZD DRK GRY SLTSTN

2MM 24° CALCT VN @4485'

IRRG HIGH ANGLE JNTNG

STRLY RXLZD DRK GRY SLTSTN

~13° R-OBLQ NRML @4501', 30°RAKE

22° JNT/CALCT+QTZ+PYR VN @4505'

INTRUSV CNTC, MNR LT GRY QTZ PF HYPABYSSAL ANDESITE: MD GRY; APHAN, V FN GR; ALLOTRMRPHC GRAN; ABD V FN BLK ACICLR HRNBLDN PHENOS W/IN TRNSL ANHD PLAG GRNDMS; 47° CALCT VEIN BASAL CNTC.

SURVEY @4513': 163.9° 2.4°INC

MRT @4513' : 298°F

RXLZD DRK GRY-BLK SLTSTN

40° SHEAR @4527', PORES W/V FN PRSMTC GYPSM

DAMAGED/DISORDERED CORES ON CORE RUN 4523-33'(GL).

24° JNT @4537', NO SLICKS STRLY BRCCT, LRG CALCT+QTZ BLEBS W/IN GRAPH MATRX; COM PORES W/BLADD CALCT+PRSMTC GYP

MRT @4543' : 300°F

0.5CM ~4°,BLADD CALCT VN F/4553-54'; 1CM ~2° BRCCTD CALCT VN F/4556-58', 1.5CM 18° BLADD CALCT VN @4558' TR QTZ PF, RR V FN PRSMTC GYP.

NOTE: WASH-OUT; POOH @4560'; P/U NB+NEW OUTER CORE BARREL.

BRCCTD/RXLZD SLTSTN+QRTZITE, TR QTZ PF/VNG, MNR CALCT VNG, RR ANHYDRT VNG, VUGGY W/FN PRMTC GYP; 19° FRACS @4568' & @4570', 26° BLADD CALCT VNS @4573' 4574' LT GRY/OPAQ QTZ F/4575-76' W/RR TRMNTD XLS W/BLADD CALCT. RXLZD/BRCCTD DRK GRY SLTSTN, HEALD W/ANHYDRT+LT GRY/OPAQ QTZ PF/BLEBS.

SURVEY @4573': 204.5° 3.8°INC

MRT @4573' : 280°F

NOTE: LOSING ~48BPH F/4594', LOST CIRC (>50BPH) @4598'; COND MUD; HIGH TORQ @4590', REAM W/PARTL RTRNS WHILE PUMPING ON BACKSIDE.

STRLY RXLZD BLK PORPHYROBLSTC METAPELT BLCKS, RR V CRS QTZITE. COM-ABD OPAQ QTZ BLEBS, TRNSP DRUSY QTZ VUG/FRACS, ABD PRSMTC GYPSM XLS; SHARP 30° BASAL CNTC. ~10° JNT/CALCT VN @4614'; HIGH ANGLE PORES W/DRUSY QTZ @4617-19

VUGGY W/ABD FN PRMTC GYP XLS, RR DRUSY QTZ, TR-MNR CALCT PF

RXLZD/BRCCTD GRYWKE

10° R-OBLQ NRML @4630'; 69° RAKE STRLY BRCCTD, ABD ANHYDRT NO RECOVERY F/4634.8' T/4638' 30° CALCT VN @4640'

PORPHYROBLSTC SLATE/METAPELITE: BLK, HD, SLI BRCCTD; ABD FN EUHD ANDALUST? PORPHYRBLSTS ALTRD T/SERCT? PSUEDMRPHS SET IN BLK, SHINY, WKLY FOL MATRX; RR FN SBHD PYR: MNR CALCT FF.

VUGGY W/BLADD CALCT+PRSMTC GYP

30° CALCT+GYP VN @4660'

24° TIGHT SHEAR @4660-61', MNR CALCT+FN-CRS BRCC

~4° BLADD CALCT VN @4667'

37° SHEAR @4669' W/ABD CALCT, BLADD IN PART, TR CRS BRCC

HD/DENSE CORES, RXLZD; TR ANHYDRT VNG; TR GYP VUG FILL. SLI BRCCTD, HEALD W/GYP+CALCT. 19° R-OBLQ NRMAL @4680', 50°RAKE 19° CALCT VN @4683'

ABD POIKILOBASTS, MD GRY SLTY INCLSNS W/IN EUHD PORPHYROBLSTS

~39° FOL FABRIC

RR-TR WHT-LT GRY OPAQ QTZ PF

TD DIXIE HOPE 23-8 ON OCTOBER 16TH, 2015 T/4700'(GL) MD; RUN ACCUSTIC LOG; HANG 2-3/8" TUBING T/4692'(GL), SLOTTED F/3083'(GL) T/4692'(GL); RUN P/T SURVEY; PERFORM INJECTVTY TEST; RELEASE HORIZON ON OCT 20TH, 2015.

DH 86-07

Geothermal
MD Mudlog

HORIZON WELL LOGGING, INC.

711 Saint Andrews Way
Lompoc, California 93436
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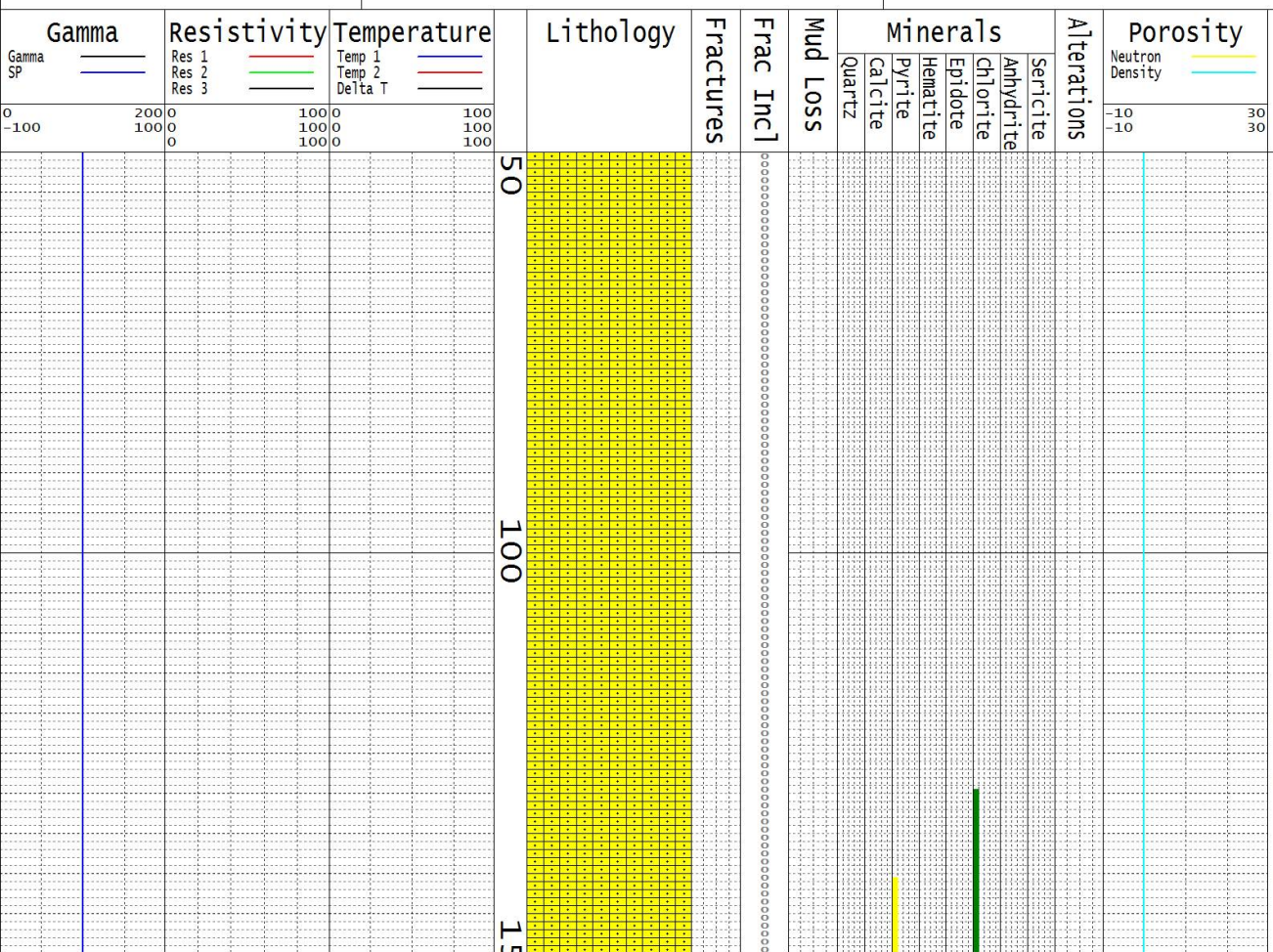
Fax 805-733-0992
http://www.horizon-well-logging.com

COMPANY	ORMAT Nevada, Inc.
WELL	DH 86-07
LOCATION	
ELEVATION	
FIELD	Dixie Hope
COUNTY & STATE	Churchill, NV
API No.	
SPUD DATE	2012.08.01
LOGGING DATES	2012.08.02-2012.08.09
LOGGING DEPTHS	10-1000'
CO. GEOLOGIST	Ben Delwiche
COMPANY MAN	
CONTRACTOR	GeoDrill
RIG	6
MUD COMPANY	Geo Drilling Fluids
TYPE	Gels
LOGGING GEOLOGISTS	Jay Zlotkowski
BIT SIZE	8" t/8' 5.75" t/294' HQ 3.895" t/1000'
CASING	7" 23#/ft t/8' 4.5" 11.6#/ft t/293'

Abbreviations

Symbols

ALLUVIUM



Descriptions

NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM GROUND LEVEL (GL) AND ARE BASED ON DRILLERS PIPE TALLY; ALPHA ANGLES OF GEOLOGIC STRUCTURES (E.G. BEDDING PLANES, FRACTURES, JOINTING ETC.) ARE MEASURED RELATIVE TO THE CORE AXIS; MRT DEPTHS ARE ~17 FT HIGHER THAN RECORDED DEPTHS; COLORS ARE DESCRIBED WHILE CORES ARE WET UNLESS OTHERWISE NOTED, AND ARE REFERENCED FROM THE GSA ROCK COLOR CHART.

SPUD DIXIE HOPE 86-07 ON 2012.08.01

MUD TEMP @ 80' : 114°

ALLUVIUM: PRLY SRTD, MD - V CRS, WELL RDD T/ SB-ANG; ABD LT RD RHYOLITE TUFF W/ LIMONITE STNG, ABD LT OLIV BRN SLTSTN, TR CHLORTZD WKLY RXLTZD ASH TUFF; R RXLTZD BLK APHAN BASALT; R DRK GRY/TRNSP CRS GR SS, R QTZ SD; V R CALCT.

MUD TEMP @ 90' : 76°

MUD TEMP @ 100' : 114°

MUD TEMP @ 110' : 117°

MUD TEMP @ 120' : 118°

MUD TEMP @ 130' : 118°

MUD TEMP @ 140' : 115°

ABD BLK BASALT; ABD CHLORTZD XL-ASH TUFF W/ V FN DISM PYR F/130'

MUD TEMP @ 150' : 115°

MUD TEMP @ 160' : 112°

V R CALCT; R QTZ SD W/FN XLN PYR

MUD TEMP @ 170' : 114°

MUD TEMP @ 180' : 114°

ABD CHLORTZD/BLEACHED RHYOLITE TUFF, UN-ALTRD BIOT

MUD TEMP @ 190' : 116°

TR QTZ/CHALCDNY - DETRITAL (?)

MUD TEMP @ 200' : 116°

MUD TEMP @ 210' : 116°

MUD TEMP @ 220' : 116°

ABD SLUFF

MUD TEMP @ 230' : 125°

CIRC @ 234', WAIT ON CSG PARTS

MUD TEMP @ 240' : 132°

WKLY RXTLZD, MOD CHLORTZD, OCC SILICFD ASH/ XL-ASH TUFF W/TR DISM PYR; R QTZ W/PYR INCLUSIONS (FN TRMNTD XL @ 250')

MUD TEMP @ 250' : 132°

MUD TEMP @ 260' : 130°

MUD TEMP @ 270' : 130°

MUD TEMP @ 280' : 130°

TR QTZ/CHALCDNY; R CHLORTZD BIOT

MUD TEMP @ 290' : 130°

MUD TEMP @ 295' : 132°

TD 5.75" WELL T/294' ON 08/03; REAM WELL ON 08/04; SET/CMT 4.5" CSG T/293' ON 08/05; CORE AHEAD W/ HQ 3.895" BIT ON 08/06.

MUD TEMP @ 313' : 114°

MRT @ 323' : 220°

NO RECOVERY

STRAIN FOL MATRX @ 328', MNR CALCT + QTZ PF

MRT @ 333' : 220°

MRT @ 343' : 220°

ALLUVIUM: PL GRN, LT GRN; FRM T/ INCMPTNT; PRLY SRTD - FN T/ SMALL BLOCKS, WLL RDD T/ ANG; ABD CHLORTZD SILTSTN, COM STRLY RXTLZD DIORT/GABRO, COM QUARTZITE, COM RHYOLITE TUFF; BLEACHED/CHLORTZD FN GR MATRX W/COM V FN DISM PYR; LOC R-TR CALCT/GYPSUM PF.

MRT @ 353' : 215°

R QTZ PF @ 354-55'

MRT @ 363' : 215°

MRT @ 373' : 215°

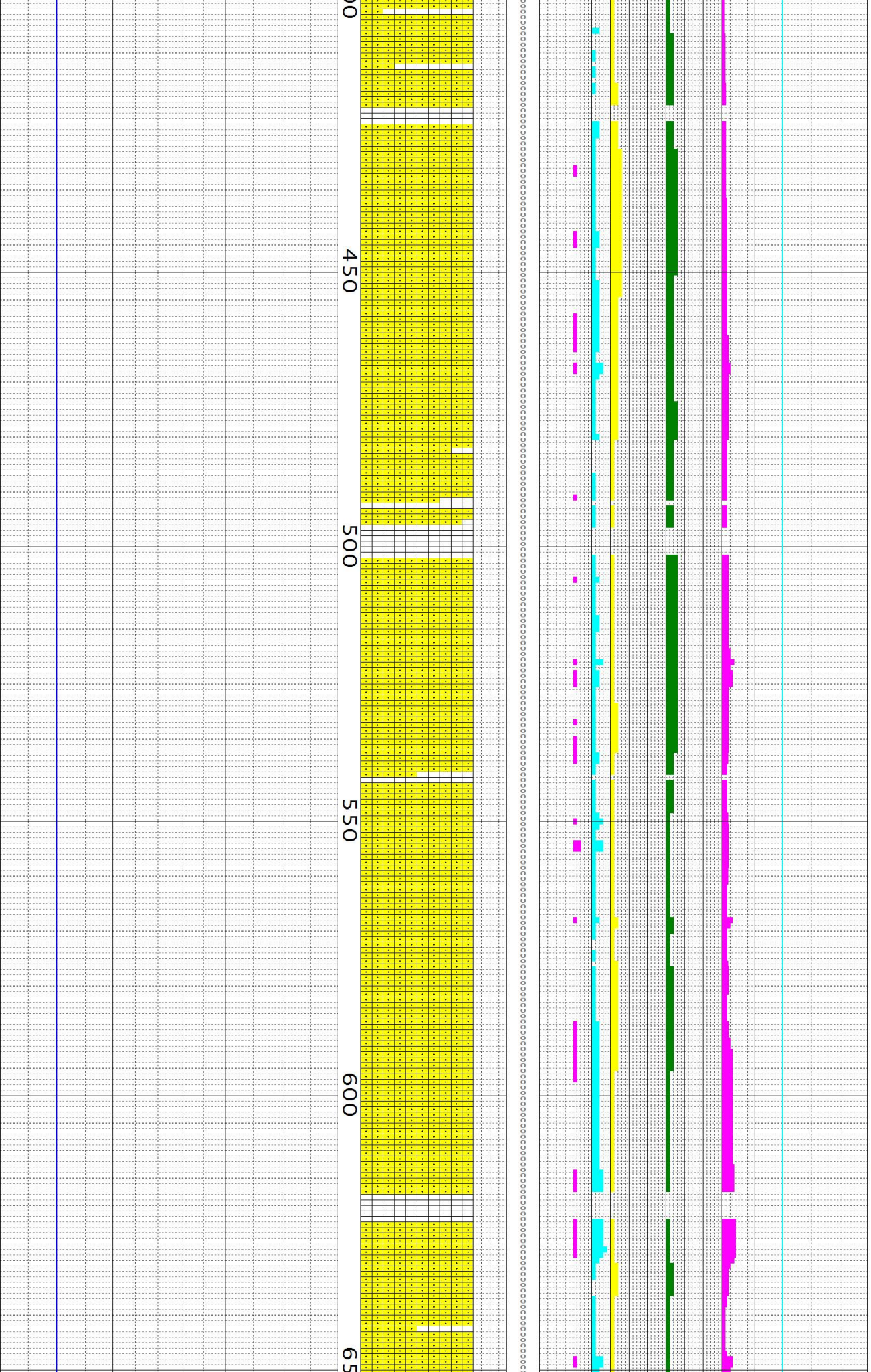
R QTZ, TR CALCT PF @ 368'

NO RECOVERY

MRT @ 383' : 215°

MRT @ 393' : 220°

MRT @ 403' : 210°



WKLY CHLORTZD MATRX, R DISM PYR

MRT @ 413' : 210°

MRT @ 423' : 210°

NO RECOVERY

FRM CALCT CMT

MRT @ 433' : 200°

MRT @ 443' : 208°

MRT @ 453' : 205°

MRT @ 463' : 200°

ALLUVIUM/CONGLOMERATE: LT GRYSH GRN; FRM - V FRM; PRLY SRTD, FN T/SMALL BLOCKS, WELL RDD T/AGN; ABD CHLORTZD META-SILTSTONE, ABD RXTLZD GABRO/DIORITE, COM CRS GR WELL SRTD QUARTZITE, COM OXIDZD RHYOLITE TUFF; MOD CHLORTZD SANDY FN GR MATRX W/COM V FN DISM PYR; LOC CALCT/GYPSUM PF/CMT OCC W/ V R QTZ.

MRT @ 473' : 205°

MRT @ 483' : 201°

MRT @ 493' : 207°

NO RECOVERY

V FRM CALCT CMT

MRT @ 502' : 200°

MRT @ 512' : 203°

MRT @ 523' : 200°

HD CALCT/QTZ CMT @ 521-24'

MRT @ 533' : 210°

R CACLT/V R QTZ PF

NO RECOVERY

MRT @ 543' : 200°

CALCT/QTZ CMT @ 554-55'

MRT @ 553' : 190°

MRT @ 563' : 205°

LOC HD CALCT/QTZ CMT

MRT @ 573' : 220°

MRT @ 583' : 225°

ABD V FN XLN GYPSUM

HD CALCT/QTZ CMT

2 CM OBLONG PORES W/SBHD CALCT/ANHD QTZ @ 592'

MRT @ 593' : 230°

V FN PORES W/ V FN XLN GYPSUM F/599-602'; MOD BLEACHED MATRX

MRT @ 603' : 225°

DENSE, DEHYDATED FN GR MATRX

NO MRT'S TAKEN

LOC CALCT CMT W/R QTZ PF

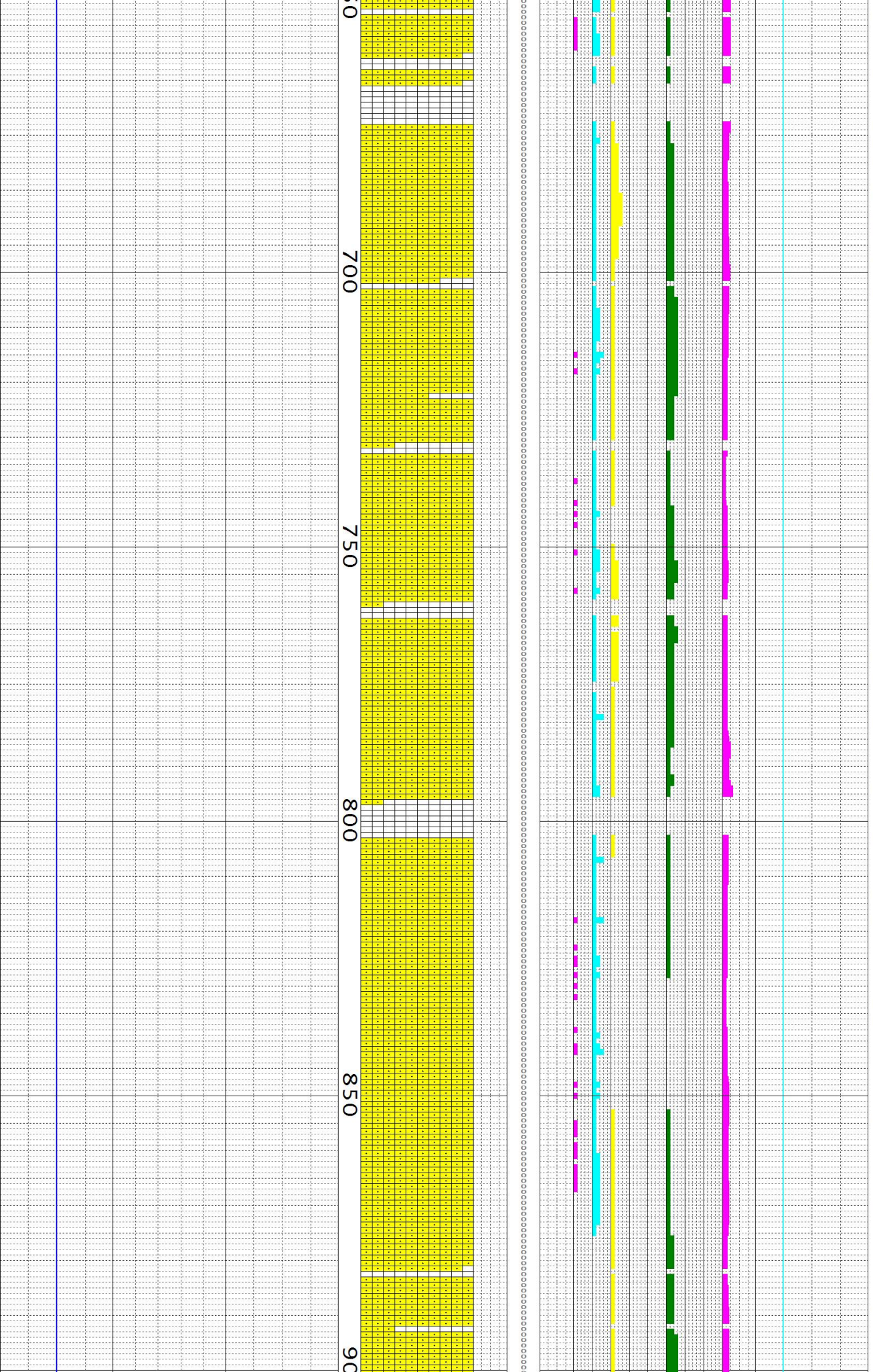
NO RECOVERY

C/O DRILLING FLUID

MRT @ 633' : 152°

MECHANICALLY DAMAGED CORES DUE T/DRILLER PACKING OFF CORE BARREL; DOWN-HOLE DIRC NOT PRESERVED.

MRT @ 643' : 225°



MRT @ 653' : 150°

STRLY BLEACHED MATRX; TR CALCT/R QTZ PF

MRT @ 663' : 150°

NO RECOVERY

MRT @ 673' : 150°

MRT @ 683' : 171°

MRT @ 693' : 171°

ALLUVIUM/CONGLOMERATE: LT GRYSH GRN; FRM; PRLY SRTD - FN T/SMALL BLOCKS, WELL RDD T/ANG; ABD CHLORTZD SILTSTONE, COM OXIDZD RHYOLITE, TR QUARTZITE, TR GABRO; WKLY BLEACHED, MOD CHLORTZD SANDY FN GR MATRX W/TR V FN DISM PYR; LOC TR-R CALCT PF; ABD V FN XLN GPYPSUM.

MRT @ 703' : 172°

TR CALCT/GYPSUM PF

MRT @ 713' : 172°

V R QTZ PF

MRT @ 723' : 172°

NO RECOVERY

MRT @ 733' : 172°

V R QTZ PF; WKLY ALTRD MATRX

MRT @ 743' : 174°

MRT @ 753' : 170°

MRT @ 763' : 174°

NO RECOVERY

MRT @ 773' : 174°

MRT @ 783' : 178°

LOC STR CALCT CMT @ 781'; R FN PORE SPACE W/ V FN XLN GYPSUM; MOX CHLORTZD FN GR MATRX W/ R-TR DISM PYR.

LOC HD DEHYDRTD CLY MATRX F/786-90'

MRT @ 793' : 178°

NO RECOVERY

MRT @ 803' : 178°

BIT TRIP @ 803'

MRT @ 813' : 178°

MRT @ 823' : 180°

LOC TR CALCT/GYPSUM PF, V R QTZ

HD DEHYDRTD LT-MD GRY FN GR MATRX

MRT @ 833' : 180°

22° FRAC @ 838' - PRESUMED TO BE MECHANICAL

FN PORES W/ BLADDED CALCT @ 841'

LOC STR CALCT CMT; V R PYR, V WK CHLORT ALTN

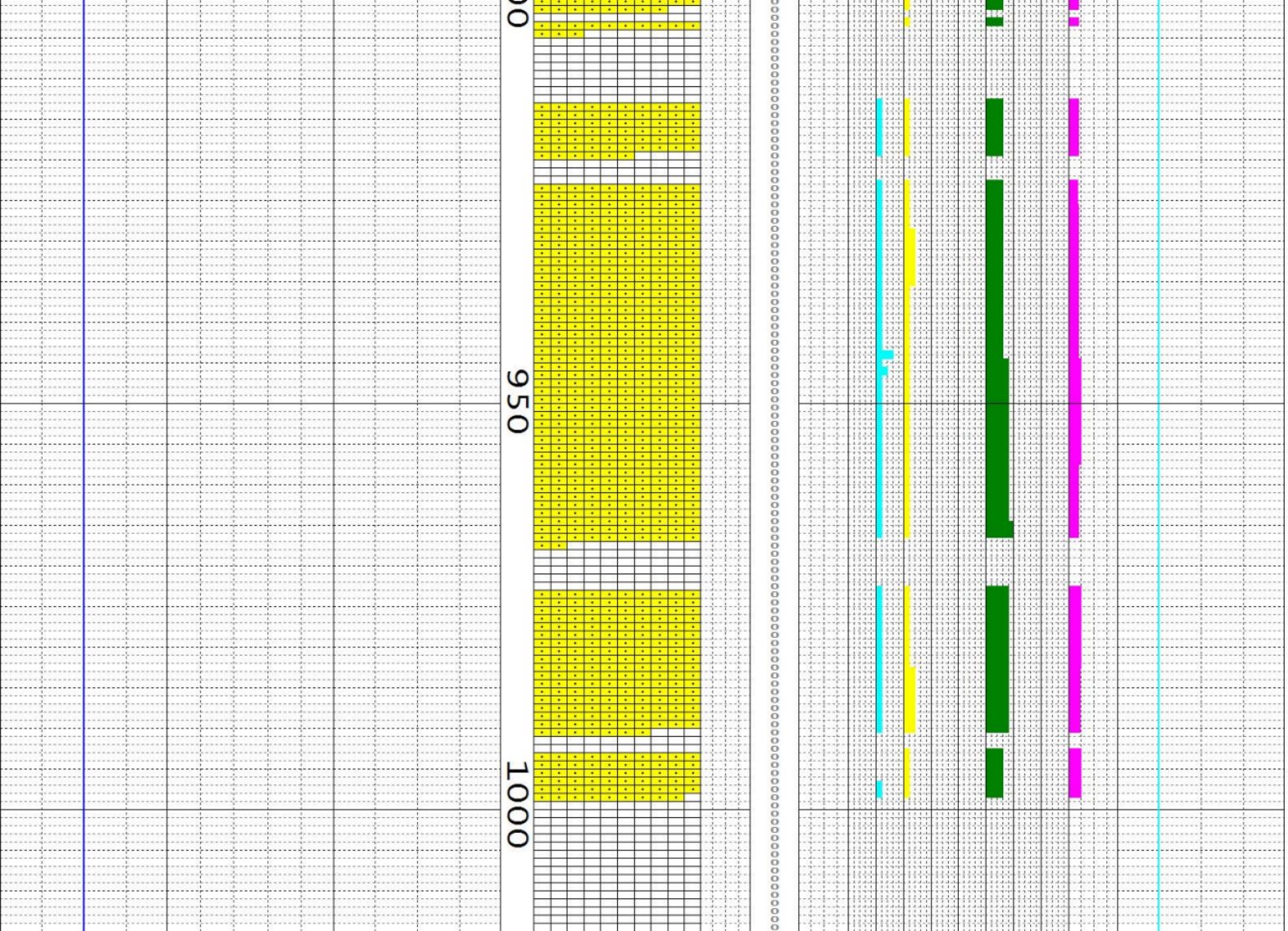
NO MORE MRT'S (I.E. ALL BROKEN)

V FN PORES W/ BLADDED CALCT/ GYPSUM; MNR CALCT CMT

FRM HYDRTD MATRX F/876', MOD CHLORT ALTN

NO RECOVERY

WKLY BLEACHED MATRX W/V FN DISM PYR



NO RECOVERY

NO RECOVERY

FRM T/INCOMPTNT, HYDRATED, MOD CHLORTZD MATRX W/ABD V FN XLN

NO RECOVERY

TR GYPSUM/CALCT PF, R FN PORES

MNR CALCT @ 944', FN PORES W/ SBHD CALCT/GYPSUM

R CALCT/GYPSUM CMT, STRLY CHLORTZD MATRX W/V R FN DISM PYR, R FN PORES

NO RECOVERY

V FRM CHLORTZD MATRX W/LOC R CALCT/GYPSUM CMT

NO RECOVERY

V FN PORES

NO RECOVERY

TD DIXIE HOPE 86-07 T/1000' (GL) ON 2012.08.09; R/U TIGER LOGGING UNIT.

Dixie Meadows 22D-8

Geothermal
MD Mudlog
1:600 Scale

HORIZON WELL LOGGING, INC

3769 Constellation Road
Lompoc, California 93436
Phone 805-733-0972 Fax 805-733-0992
AK Phone 907-563-7002
Online Real-Time Well Data:
horizonwells.com
horizon-well-logging.com

COMPANY	Ormat Nevada Inc
WELL	Dixie Meadows 22D-8
LOCATION	407755 mE 4405482 mN Lat: 39.794250, Long: -118.077440 Twn 22N, R 35E, Sec 8
ELEVATION	GL: 3471', RF: 3481.58'
FIELD	Dixie Meadows
COUNTY & STATE	Churchill, NV
API No.	27-001-90542
SPUD DATE	2019.07.12
LOGGING DATES	2019.07.12-2019.08.01
LOGGING DEPTHS	69' t/4025'
CO. GEOLOGIST	Ryan Libby
DRILL SITE MANAGER	Manuel Barros
CONTRACTOR	Welsco Drilling
RIG	T130XD
MUD COMPANY	Sinclair
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	Will Starrett, Tom Shaver
BIT SIZE	12.25" t/323' 8.5" f/323 t/1350' 6.125" t/4025'
CASING	9.625" Set @ 317' 7" Set @ 1342'

Abbreviations

CO	Circulate Out
LAT	Logged After Trip
CG	Connection Gas
WG	Wiper Gas
TG	Trip Gas
SG	Survey Gas
NR	No Returns
NB	New Bit
WR	Wiper Run
WOB	Weight On Bit
PP	Pump Pressure
SPM	Strokes Per Minute
POOH	Pull Out Of Hole
LC	Lost Circulation

Symbols

OBSIDIAN, TUFF-ASH, RHYOLITE, BASALT, VOLCANICS, ANDESITE, DACITE, FELSIC/SIL DIKE, PYROCLASTICS, TUFF-CRYSTAL, TUFF-LITHIC, MONZONITE, QUARTZ DIORITE, GRANODIORITE, DIORITE, GABBRO, PHYLLITE, SLATE, CARBONATES, ANHYDRITE, CLAY, SILTSTONE, CEMENT, SANDSTONE, FINE SAND, BRECCIA, PEBBLE/ GRAVEL, METAMORPH SDST, MEDIUM SAND, COARSE SAND

Descriptions

NOTE: ALL SAMPLES DESCRIBED WET; COLORS REFERENCED TO GSA (MUNSELL) ROCK COLOR CHART; ALL DEPTHS TAKEN FROM DRILLERS' PIPE TALLY WITH RIG FLOOR = 0'

NOTE: COMMENCE DRILLING F/69' ON 07.12.2019 @ 14:45 HRS.

ALLUVIUM: LT GRY-MED LT GRY BULK SPL; GRS V LT GRY-MED GRY, WHT, DRK GRY-BLK, GRNSH GRY; FN- >7MM, CONG DOM T/110', INCRSNG MED-FN SD F/110; ANG-SBRND; V PRLY SRTD; LSE; PRED RHYOLITE & FELSIC VOLCS; TR ANDESITE & TUFF; PRED QTZ DOM IN FINES; COM FN-CR SDST W/ABD CLAY MTRX F/120'; LCLY COM CALCT; COM V FN-FN GR SDST W/ABD CLAY MTRX F/130', OCC GRDS T/GRTY MUDST.

SANDSTONE: LT GRY-MED LT GRY IN BULK; GRS, CLR, TRANSL WHT-LT GRY, MED GRY, OPAQ WHT; V FN-MED L, FN DOM; MOD WLL SRTD; ANG-SBRND; MOD-WLL CEMENTED; PRED BRTL, OCC CRNCHY, RR FRIA; COM V LT GRY CLAY MTRX, OCC SLI CALC; OCC GRDS T/GRTY CLAYST, FSPR, QTZ DOM, COM FELSIC VOLCS & BIOT.

ALLUVIUM: BULK SPLS DOM LT BLUSH GRY W/MXD MED T/DK GRYS, RR GRYSH BLK; DOM ANG FRAGS OF WL RNDD PBBL/ GRVL/ LRGR W/LOW SPHER; V PRLY SRTD; AP LSE & UNCONSOL; MSTLY DIVRS LT BLUSH GRY ASH TUFFS, COM MOD ORNG PNK RHYOLITE & MULTI COLRD SILIC FRAGS, OCC TR SCHIST; COM SFT LT BLUSH GRY CLY AP DERIVD F/ HYDRTD &/OR BIT CRHSD VOLC ASH CLASTS; SLI-MOD HCL RXN THRU NOT AP 2NDRY CMT/ FRAC FILL

NOTE: DRILL 12.25" HOLE T/323'; CLEAN OUT HOLE; RUN 9.625" CASING T/317'

ALLUVIUM: LT GRY-MED GRY BULK SPL; GRS V LT GRY-MED GRY, WHT, LT OLV GRY, DRK GRY-BLK, GRNSH GRY; MED- >10MM, CONG DOM , COM SHATTRD FRAGS F/POSS COBBLES >25MM; ANG-RNDD; V PRLY SRTD; LSE; PRED RHYOLT & TUFFS W/SCAT META FRAGS; COM PYR GRS IN VOLCS; LCLY COM CALCT; COM MOD SOL LT GRY CLAY; RR QTZ ON SHATTRD FRAGS; RR SHATRD EPIDOTE FRAGS.

DEV SURVEY @ 390' 0.9° INC

CLAY: WHT-V LT GRY; SFT; PASTY-SLI TOUGH LUMPS; SLI STKY; MOD-WLL HYDRTD; MOD SOL, 10-15% EZLY WASH F/SPLS; DLL LSTR; COM SLI GRTY TEX; COM AP AS THIN COATINGS ON RNDD PEBBLES; COM CALCT MTRX; MOD XPNSV; MOD COHES & ADHES.

ALLUVIUM: LT GRY-MED GRY OVERALL; CLASTS PRED V LT GRY-MED GRY & WHT, COM DRK GRY-BLK, SCAT LT OLV GRY, LT BLUSH GRY; FN- >10MM, SHATRD CLASTS DOM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; PRED TUFFS & RHYOLITE FRAGS, INCRSNG DRK VOLCS, POSS ANDESITE, COM META FRAGS; SCAT CLAY VENEERS ON RNDD SURFS; SCAT CALCT, OCC AP AS COATINGS ON WORKED SURFS; COM GRAN PYR IN RHYOLT FRAGS; TR LSE EPIDOTE FRAGS IN SPLS.

DEV SURVEY @ 520' 0.6° INC

ALLUVIUM: LT GRY-MED BLUSH GRY IN BULK; GRS V LT GRY-MED GRY & WHT DOM, COM DRK GRY-BLK, SCAT LT BLUSH GRY, OCC LT GRNSH GRY; FN- >10MM; V PRLY SRTD; ANG-RNDD W/ABD SHATRD CLASTS; LOW-HI SPHER; LSE; PRED TUFFS & RHYOLITE FRAGS, COM DRK VOLCS & COM META FRAGS; OCC WHTSH CLAY COATINGS; SCAT-LCLY COM CALCT, OCC AP AS FROSTING ON WORKED SURFS; COM GRAN PYR IN RHYOLT.

ALLUVIUM: LT GRY-MED GRY IN BULK; GRS V LT GRY-MED GRY, WHT, LT OLV GRY-BLUSH GRY, DRK GRY-BLK, GRNSH GRY; PRED MED- >10MM, CONG DOM , TR-SCAT FN SD; ANG-RNDD; V PRLY SRTD; LOW-HI SPHER ; LSE; PRED VOLC W/COM META FRAGS; COM QTZITE; COM PYR GRS IN VOLCS, TR LSE GRAN IN SPLS ; COM CALCT, OCC SBHED SPAR; TR V LT GRY CLAY.

SURVEY @ 690' INC 1.0°

ALLUVIUM: LT GRY-MED GRY IN BULK; GRS V LT GRY-MED GRY, WHT, PL OLV GRY, LT BRNSH GRY, DRK GRY-BLK; FN- >10MM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; SCAT-COM CALCT COATINGS, OCC AP AS FROSTING ON PEBBLES; PRED RHYOLT & TUFF, PL FELSIC VOLCS & STNNG; PRED VOLCS W/COM META QTZITE.

ALLUVIUM: LT GRY-LT BLUSH GRY BULK SPLS W/DIST SCAT NEAR BLACK CLASTS; PRLY SRTD MED SD T/ PBBL, GRVL & LRGR; MSTLY ANG FRAGS OF LRGR CLASTS, TYP W/1 WL RNDD SIDE; VARIOES F/ UNCONSOL T/MOD CONSOL W/LT BLU GRY PRTLY CALCIC CLY MTRX AP MSTLY DERIVD F/ALTRD TUFFACEOUS COMPONENTS; GRS DOM XL ASH TUFF W/COM NEAR BLACK, BIOT RICH TUFF & ORNG RHYOLITE; FRR EUHED DOGTOOTH CALCT + PYR GROWTHS F/ CLY MTRX; INCRSNG CLY ALT OVERALL W/DEPTH THRU SECTION

WIPE T/SHOE @ 823'

MW 8.8 VIS 48 PV 22 YP 20 GELS 9/14/17 PH 8.5 CL 1000 CA 140

NOTE: BLOWN HYDRAULIC LINE ON CXN @ 883'; CIRC @ 46 SPM & WAIT ON PARTS

ALLUVIUM: LT BLUSH GRY-MED GRY IN BULK; PRED PL BLUSH GRY-MED GRY & WHT W/COM-ABD DRK GRY-BLK; MED- >10MM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; DECRS SHATTRD FRAGS; SCAT-COM GRAN CALCT; COM PYR IN RHYOLTS & TUFFS; RR-TR CHLOR ALTN & STNNG; TR LSE GRN PYR, RR SML EPIDOTE FRAGS; COM PL BLUSH WHT SFT MOD SOL CLAY; PRED VOLCS W/COM META QTZITE, TR CHALCDNY.

CLAY: BLUSH WHT T/WHT; SFT; PASTY-TOUGH; RNDD BALLS 3-8MM COM; MOD-WL HYDRTD; MOD SOL, MOD EFFORT T/WSH AWAY; DL LSTR; GRTY TEX; SLI-MOD TACKY; COM AP AS COATING ON PEBBLES; MOD CALC; MOD COHES & ADHES; EXPANSV, SHRINKAGE FRACS AP WHEN DRYING; COM FNT CHLOR STNNG

DEV SURVEY @ 990', 1.1° INC

ALLUVIUM: LT BLUSH GRY-MED GRY OVERALL; CLASTS PRED LT BLUSH GRY-MED LT GRY & WHT, COM DK GRY-BLK, PL GRNSH GRY; FN- >7MM, V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; COM THN MOD SOL CLAY VENEERS ON PEBBLES; COM PYR IN FELSIC VOLCS; FNT CHLOR STNNG IN CLY & TUFF CLASTS; COM-LCLY ABD CALCT, PRED ANHED GRAN, TR SBHED-EUHED FF; TR LSE GRAN PYR; RR EPIDOTE FRAGS, OCC AP AS ALTN IN FSPR.

CLAY: BLUSH WHT-WHT; SFT; CREAMY-TOUGH, SECTL; RND LUMPS 3-10; MOD-WL HYDRTD; MOD-HILY SOL, SIG VOL EZLY WASHD AWAY; DL LSTR; SMTH-GRTY TEX; MOD TACKY; COM MTRX IN CNGLMTC SDS; MOD-LOCLY HILY CALC; MOD COHES & ADHES; XPNSV; TOUGH LUMPS COM; MALIBL; COM FNT CHLOR STNG

DEV SURVEY @ 1150', 1.9° INC

ALLUVIUM: LT BLUSH GRY-MED GRY BULK SPL; LT BLUSH GRY-MED GRY DOM W/ABD WHT, COM DK GRY-BLK, GRNSH GRY; FN- >5MM, CRS-CONG DOM BY VOL; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; SIG DECRS IN RHYOLT, INCRSNG QTZITE & TUFFS; ABD CLY MTRX, INCRSGLY SOL F/1170', COM CREAMY-PASTY W/LUMPS OCC>10MM; LOW POR DUE TO ABD CLAYS; TR PYR IN VOLCS, RR-TR LSE GRAN PYR; RR LSE EPIDOTE, COM ASSOC W/FSPRS; RR-TR FNT CHLOR STNNG, COM ASSOC W/VOLC CLASTS.

CLAY: LT BLUSH GRY; TYP 4-20 MM RNDD BLLS; MOD ADHES; LOW COHES F/RNDD SD & CRSR CLSTCS; SECTL T/FRIA; SLICK EXTRR; AP MTRX T/ ALLUVIUM DERVD F/ALTRTN OF ASHY VOLC CLASTS; HA CALC CONTENT & RR-TR V FN CUBIC PYR W/IN; LIKLEY PRTLY DERIVD F/BIT ACTION

ALLUVIUM: LT BLUSH GRY OVERALL; LSE T/PRLY CONSOL W/CLY MTRX; V PRLY SRTD; V FN SD T/PBBL+GRVL+ CRSR; SD DOM SBANG W/OCC WL RNDD INTACT PBBLS, MSTLY ANG FRAGS W/1 WL RNDD SIDE; DOM PRTLY CLY ALTRD FELSIC ASHY VOLCNCS W/COM DK GRY META QTZITE; HI CALC CONTENT T/CLY MTRX & SLI-MOD HCL RXN F/SURFS OF MST GRS; TR CUBIC PYR LSE & W/IN CLY MTRX

DRILL T/1350' & POOH FOR 7" CSG POINT; SET SHOE AT 1342'

DEV SURVEY @ 1350', 2.7° INC

ALLUVIUM: LT BLUSH GRY-LT GRY IN BULK; LT BLUSH GRY-MED GRY, WHT, PL GRNSH GRY, MED DRK GRY-BLK; FN- >6MM, CRS-CONG DOM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; COM W/MNR CLAY MTRX; COM SHATTERED GRAVELS & RNDD PEBBLES; PRED VOLCS & META CLASTS; COM CALCT, PRED ANHED, RR SBHED; TR LSE GRAN PYR; RR EPIDOTE FRAGS; TR WEAK CHLOR STNNG.

ALLUVIUM: V LT GRY-LT BLUSH GRY IN BULK; GRS WHT-LT GRY, LT BLUSH GRY, PL GRNSH GRY, MED-DRK GRY-BLK; FN- >5MM, CRS-AP DOM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL; MNR CLAY CONT IN SPLS; ABD EPIDOTE @ 1480', POSS TRANSPORT CLASTS; COM V WEAK CHLOR STNNG ASSOC W/ FELSIC VOLCS; DECRSG META CONT, MNR MAFICS; RR-TR LSE GRAN PYR; COM ANHED CALCT, RR AP SUBHED.

DEV SURVEY @ 1500, 3.8° INC

ALLUVIUM: LT BLUSH GRY-MED GRY OVERALL; GRS PRED LT GRY-MED GRY & WHT, COM PL BLUSH-GRNSH GRY & DRKR HUES; FN U- >5MM, CRS AP DOM; V PRLY SRTD; ANG-RNDD; LOW-HI SPHER; UNCONSOL, ABD PEBBLES; LSE; OCC THIN CLAY VENEERS ON GRS AS POS MTRX; COM-LOCLY ABD ANHED CALCT; PRED VOLCS W/COM META CLASTS, SIGN INCRS IN DRK VOLCS 1540'-1550'; RR-TR LSE GRAN PYR; TR PL CHLOR STNNG COM IN FELSIC VOLCS; RR LSE EPIDOTE & CHLOR ALTN; TR LSE BIOT.

ALLUVIUM: BULK SPL LT BLUSH T/ GRNSH GRY; PRED RETRND LSE, AP HS MOD ANT HI CALC CLY MTRX; V PRLY SRTD, DOM ANG SHTTRD SHRDS OF AP MOD-WL RNDD PBBL, GRVL & LRGR W/ABD CRS & MED SD; PRTLY CLY ALTRD ASH TUFF & QTZITE; COM ANHED CALCT RHINDS+ RR LSE AGGRGTS CALCT+PYR+CHLOR+EPIDT

ALLUVIUM: LT BLUSH GRY BULK SPLS W/DIST FNT GRNSH HUE; DOM RETRND LSE BUT INCRSNG AMTS CALCT CMT (COM LUMPY/CRNCHY AGGRGTS CALC CLY OCC W/FN CUBIC PYR + TR ANHED/PRLY DRUSY SUBHED CALCT RHINDS ON CLASTS & LSE FRAGS V PURE CALCT; COM DOM FRAGS ASH TUFF & QTZITE PBBLS LRGR; 1ST OBSERVED EUHED TERM QTZ PORE FILL ~1700'. INCRSD CHLOR STNNG & RR CHLOR VISBL W/IN 2NDRY AGGRGTS; V RR EPID.

MW 8.7 VIS 45 PV 7 YP 36 GELS 18/24/27 PH 9.5 CL 900 CA 80

CALCITE FILL: @ 1748'; CLR-MLKY WHT SPL DOM LRG 1-2 CM FRAGS/FLAKES OF SPARRY CALCT VNNG/FRAC FILL W/DIST RHOMBHDRL CLEAVG/DBBL REFRCTV INDX; COM ACIC, SPLINTERD FLAKES <.5 MM THICK; OCC V FN EUHED T/DRUSY QTZ GRTHS ON CALCT; FN ZEOLITES AP NATROLITE, POSS STILBITE(?); RR OCTAHDRL V FN CLR NODULE MNRL ON CALCT AP FLUORITE.

NOTE: DRILL T/1809' POOH DUE TO LOW ROP; P/U NEW BIT; RIH

ALLUVIUM: LT GRY-LT BLUSH GRY BULK SPL; GRS WHT-LT GRY, LT BLUSH GRY, PL GRNSH GRY; MED-DRK GRY, BLK; FN U- >5MM W/CRS AP DOM; ANG-RNDD, ANG-SBANG DOM; LSE; RR TR CLAY, POS WASHED OUT BY H2O DRILLING FLUID; COM-LCLY ABD ANHED CALCT, RR SBHED-EUHED SPAR; RR-TR LSE GRAN PYR; RR EPIDOTE; TR CHLOR STNNG & ALTN, RR HEMTT; CLASTS PRED VOLC W/ABD META & SCAT INTRUSIVES, TR PLATY SILTST.

SURVEY @ 1860'; 6.2° INC 154.8° AZI

ALLUVIUM: LT GRY-LT BLUSH GRY OVERALL; GRS PRED WHT-LT GRY, COM BLUSH GRY-MED GRY, SCAT DRK GRY-BLK, TR GRNSH GRY; FNU- >5MM; ANG-RNDD, SBANG DOM; UNCONSOL; COM SHATTERED F/BIT; SOL CLAYS WASHED F/CTNGS & COLRNG FT H2O, MINOR IN SPLS; COM-LCLY ABD ANHED CALCT, RR SBHED; RR-TR LSE GRAN PYR; RR LSE EPIDOTE; RR-TR CHLOR STNNG & ALTN; RR HEMTT STNNG;

SURVEY @ 1990' 6.9° INC 162.5° AZI

NOTE: SURVEYS BEFORE 1990' REF'D T/MAGNETIC N; F/ 2115' SURVEYS CRCTD T/GRID N

NOTE: DRILL T/2012'; CIRC & POOH FOR DIR TOOLS (MUD MTR).

ALLUVIUM: LT GRY-LT BLUSH GRY IN BULK; GRS PRED V LT GRY-LT BLUSH GRY & WHT W/COM DRKR GRY HUE & BLK; FN- >4MM, CRS DOM; ANG-RNDD; SBANG DOM; RRETRND UNCONSOL; COM THN LT GRY CLAY RIMS/ABD IN CLAY RICH CRNCHY CLY AGGRGTS; HI CALC CONTENT T/CLASTICS; FN HI HI CALC PYR; RR V FN Q AB AS ZEOLITE &/OR NATROLITE ON EDGES OF GRS OR F/CALC CLY MTRX.

ALLUVIUM: MED T/MED BLUSH GRY OVERALL; DOM RTRND LSE AS ANG SHARDS/FRAGS F/MED T/LRGR THN V CRS; MSTLY XL ASH TUFF & QTZITE CLASTS; MOD AMT LT GRY HI SOL CLY MTRX RDLY WSHS F/SPLS; COM CRUSTY WHT HI CALC CLY-CALCT AGGRGTS W/INCRSNGLY COM GRTHS OF NATROLITE/QTZ F/ MTRX INTO POR SPACES; TR CUBIC PYR, ANHED EPIDT, & HEMTT & CHLOR STNG; TR LSE ACICULAR AGGRGTS NATROLITE OCC W/QTZ.

SURVEY @2135'MD, INC 4.8°, AZI 169.03°

Mw 8.4 VIS 36 PV 6 YP 18 GELS 9/12/15 PH 7.0 CL 800 CA 120

ALLUVIUM: MED T/MED GRNSH GRY BULK SPLS; INDIV GRS MOSTLY MED LT GRY/MED BLUSH GRY OR MED GRNSH GRY ASH TUFFS W/COM NEAR CLR T/V DK GRY NEAR BLCK META QTZITES W/SCT MED PNK RHYOLITE; V PRLY SRTD OVERALL; FN SD (<10%) T/MSTLY CRS SD & LRGR SZD PBBL & GRVL FRAGS; ABD AMTS LT GRY HI SOL CLY MTRX EZLY WSHS F/SPLS; DEC ALTRD/REXLZD OCCX RHINDS ON CLASTS THRU SPL OVERALL INDRY ALTRTN-->TYP V CALCIC W/ FN SB-EUHEDRL NATROLITE +/- V FN EUHED TERMNTD QTZ +/- CUBIC PYR & V RRLY EPIDT; COM LRG 2MM-1CM TRANSL T/CLR FRAGS OF PURE CALCT SCAT THRU SPLS W/DIST RHOMBHDRL CLEAVG (AP MACRO-POR FILL); FNT CHLOR STNG THRU & V RR LOCAL HEMTT STNG.

SURVEY @2285'MD, INC 1.17°, AZI 166.58°

CLAY: LT GRY; ABD F/FRSH SPL, WSHS AWAY QUICKLY; V WL HYDRTD; HI XPNSV; LIKELY DERIVED F/BIT PULVRZTN OF MTRX MTRL; OCC LOCAL RNDD BALLS REMAIN INTACT AFTR WSHNG; INTACT CLAY BALLS TYP HV MOD ADHES, LOW COHES, AND MOD T/HI CALC CONTENT.

ALLUVIUM: MED T/MED BLUSH GRY BULK SPLS; INDIV GRS DOM BED MED BLUSH T/ MED GRY W/COM NEAR BLK, SCAT MOD REDDSH ORNG F/HEMTT STNNG & WHT WHERE MTRX IS PRESERVED; V PRLY SRTD, TR FN-DOM ANG PBBL & GRVL FRAGS W/ LOW SPHER; MSTLY CLASTIC ASH TUFF & QTZITE; COM CALCT; RR-TR NATRLT, QTZ, & PYR AS POR FILL (OCC OPEN); FNT HEMTT & CHLOR STNNG THRU

SURVEY @2375'MD, INC 1.04°, AZI 78.69°

ALLUVIUM: LT BLUSH GRY-LT GRY IN BULK; GRS PRED LT BLUSH GRY-LT GRY, COM WHT & DRK GRY-BLK; FN- >5MM, CRS AP DOM; ANG-RNDD, SBANG DOM; UNCONSOL; COM-LCLY ABD WHTSH HILY SOL CLAY THROUGHOUT SPLS; COM-ABD CALCT, PRED ANHED, OCC SBHED-EUHED; RR-TR LSE GRAN PYR; RR-TR WEAK HEMTT STNNG & CHLOR ALTN; RR LSE EPIDOTE; OCC TR OF EUHED ZEOLITES, COM NATROLITE.

SURVEY @ 2495' 0.92° INC 150.3 ° AZI

CLAY: WHT-V LT GRY; SFT; RNDD PASTY LUMPS COM >5MM; WLL HYDRTD; HILY SOL, EZLY WASHED AWAY; SLI TACKY; DLL LSTR; SLI GRTY TEX F/INCLD FN SD; SLI CALC; COM MTRX IN CONG; LOW COHES & ADHES; AP WEAKLY XPANSV.

ALLUVIUM: LT BLUSH GRY-LT GRY IN BULK; GRS PRED LT GRY HUES, COM WHT, SCAT DRKR GRYS-BLK; FN- >5MM, MED U-CRS AP DOM; ANG-RNDD; LSE IN SPLS W/COM-LCLY ABD HILY SOL CLAY AS MTRX; COM-ABD ANHED CALCT, TR SBHED-EUHED; RR-TR LSE GRAN PYR; TR WEAK HEMTT STNNG; RR-TR CHLOR STNNG & ALTN; V RR-RR LSE EPIDOTE & ZEOLITES; RR QTZ.

SURVEY @ 2645' 0.78° INC 59.6° AZI

ALLUVIUM: LT BLUSH GRY-LT GRY IN BULK; GRS V LT GRY-LT BLUSH GRY DOM, COM WHT & DRKR GRY HUES, SCAT DRK GRY-BLK; PRED DRK GRY-BLK @ 2650'(DACITE FRAGS??); FN- >5MM; ANG-RNDD; COM-ABD ANHED CALCT, TR SBHED; TR HEMTT & CHLOR; RR QTZ, ZEOLITES & EPIDOTE; RR-TR LSE GRAN PYR; ABD HILY SOL CLAY THROUGHOUT SPLS.

SURVEY @ 2705' 0.81° INC 149.5° AZI

NOTE: DRILL T/2750' @ 18:00 HRS ON 2019.07.24 TD PER GEOLOGIST; PERFORM INJECTIVITY TEST (INJECT ~4 BBL/HR); EXTEND TD.

GRANODIORITE: BY 2770', V DIST COLOR CHANGE T/DK GRNSH GRY W/TRANSTN INTO HVLY CHLORTZD DIORITIC INTRUSION; PHAN; PLAG AP PRTLY CLY ALTRD; MAFICS (AP AUGITE & BIOT) LRGLY CHLORTZD &/OR ALTRD T/EPID; SCAT ORTHCLS & TR ANHED QTZ PHENOS; BY 2790', XLN FRAGS CALCT VNNG COM; (POSS RAPID CHANGE IN SED COMPOSITION, BUT AP INTRUSIVE).

PHYLLITE: A SILVERY MED DK GRY W/PROM MICACEOUS SHEEN; THN FOLIA; PARTS INTO THN WVY LYRS AP F/GRPHT; SILTY T/SMTH WXY TEX; DECRSNG PHYLTC CHRCTR W/INCR DPTH BCMNG SBPHYLTC BY 2860-70'; COM CALCT VNNG THRU.

MW 8.4 VIS 35 PV 6 YP 11 GELS 9/11/15 PH 7.0 CL 800 CA 80

SLATE: DK GRY T/GRYSH BLK W/FNT MICACEOUS SHEEN; V BRTTL & SNAPPY, EZLY SCORED; TYP 2-5 MM BLKY CTGS; SILTY TEX OVERALL, RRLY SLI GRTY F/REMNT V FN SD; NON-SOL/ DOES NOT HYDRT; COM VAGUE FOLI & SLATY CLEAVG; RR-V RR TYP SBHED PYR PORPHYBLSTS; FREQ SBPHYLITC & GRDNG T/ PHYLLT; COM-ABD CALCT VNNG THRU, OCC W/PYR; TR SLICKEN-SIDED CTGS IN ALL SPLS; NO AP OPEN FRACS/OPEN CALCT FRAC FILL.

SURVEY @ 2915', INC 0.86, AZI 231.7, TVD 2910', 115'S, 17'E

SLATE: DK GRY T/GRYSH BLK; 2-OCC 10MM TAB-BLKYV CTGS; V FRM; V BRTTL & SNAPPY; DENS; NON-SOL, OCC RTRND PRTLY BIT PULVRZD T/CLY; TYP SMTH SILTY TEX; OCC FNTLY VISBL FOLI; COM SLATY CLEAVG; TR (&CRNSD) MSTLY CUBIC PYR PORPHYBLSTS; CONTINUED TR SLICKENSIDED CTGS IN MST SPLS; DECRSD BUT STILL COM CALCT VNNG/ FRAC FILL THRU (NO AP OPEN FRACS); SINGLE CALCT VN W/EPIDT @ 2990'.

SURVEY @ 3035', INC 1.39, AZI 161.6, TVD 3030', 117'S, 16'E

SLATE: DRK GRY-GRYSH BLK; FRM; BRTL; BLKY-BLDD CTNGS T/8MM; IREG-UNEVEN FRAC; COM AP PULVERIZED, SCAT CLAY WLL HYDRTD LUMPS IN SPLS; GRTY SILTY TEX; DLL-PEARLY LSTR; COM MICRO CALCT VNNG, OCC VNNG >2MM; IP AP BREC W/CALCT FF; OCC WEAK REMNANT BEDDING, OCC WEAK FOLI ZONES; TR-SCAT PYR, OCC EUHED IN CALCT VNNG, TR LSE CUBES, F/CRUSHED CTNGS.

SLATE: DRK GRY-GRYSH BLK; FRM; BRTL, FREG-SBTAB CTNGS PRED <3MM, OCC BLDD EDGES; DLL-RSNS LSTR; SILTY GRTY TEX; PRED UNEVEN-IREG FRAC, TR STAIRSTEPPED FRAC; DENSE; SCAT FNT REMNANT BEDDING; IP WEAKLY FOLI; TR SLICKS 3145'-3150'; COM-LCLY ABD CALCT FRAC FILL; SCAT AP MICRO BREC W/CALCT FF; SCAT-COM PYR, PRED SBHED, RR EUHED IN SLATES, TR LSE, PRED SBHED, RR-TR CUBES; DRILL BREAK F/3156'-3160'.

SURVEY @ 3185', INC 2.47, AZI 5.3, TVD 3180', 117'S, 16'E

SLATE: DRK GRY-GRYSH BLK; FRM; PRED BRTL, OCC V CRNCHY W/GD SNAP; DLL-PEARLY LSTR; SILTY GRTY TEX; UNEVEN-IREG FRAC; TR SLICKS IN SPLS; COM MICRO BREC W/COM-LCLY ABD ANHED CALCT FRAC FILL; RR SBHED-EUHED; COM SBHED PYR IN SLATE, RR EUHED; V RR CHLOR ALTN.

SURVEY @ 3275', INC 2.24, AZI 36.1, TVD 3270', 112'S, 18'E

SLATE: DRK GRY-GRYSH BLK; FRM; BRTL; IREG-SBTAB CTNGS, OCC BLDD EDGES; PRED DLL-RSNS LSTR, SCAT PEARLY ON SLICKS & WEAK FOLI ZONES;; SILTY GRTY TEX; UNEVEN-IREG FRAC; TR FNT REMNANT BEDDING; DENSE; TR SLICKS THROUGHOUT SPLS; COM-LCLY ABD CALCT FRAC FILL; COM MICRO BREC W/CALCT VNNG; TR-SCAT PYR, PRED GRAN-SBHED, TR CUBES.

SLATE: DRK GRY-GRYSH BLK; FRM; PRED BRTL, OCC V CRNCHY; PRED BLKY-IREG CTNGS, OCC SBTAB W/BLDD EDGES; DLL-RSNS LSTR; GRTY SILTY TEX; RR WEAK FOLI; ABD MICRO BREC W/ANHED CALCT FRAC FILL, FILL OCC >3MM, RR SBHED; DENSE; TR SLICKS; TR-COM PYR IN SLATE, OCC IN CALCT VNNG.

SURVEY @ 3395', INC 0.64, AZI 113.6, TVD 3390', 111'S, 20'E

SLATE: DK GRY T/GRYSH BLK; V FRM; SNAPPY & BRTTL; VAGUE FOLI AP INCRSNG W/DEPTH; F/3440-50' APRS HVLY FRAC'D W/PERV MXD CALCT+QTZ VNNG W/RR-TR OPEN QTZ FRAC FILL; F/3460-70', DECRSNG FRAC FILL OVERALL BUT INCRSNG PROPRTN OF OPEN QTZ/CALCT FRAC FILL VS VNNG & RR AP OPEN NATROLITE; BY 3480' CONT'D AP DECRS IN FRAC FILL, NOTICEABLY MORE COM, BUT SLATE HS DISTCNTLY MORE MICACEOUS SHEEN GRDNG T/SBPHYLLITIC; TR CUBIC PYR PORPHYBLSTS THRU.

NEPHELINE MONZONITE (?): BULK COLOR V LT GRNSH GRY; 1-5MM HOMOGENOUS IRREG FRAGS; GREASY LSTR DRY; GELS IF CRUSHD IN HCL; TR INCLUD RND CLR GLASSY BLEBS; NO AP PRIMARY QTZ; ABD V FN NEAR WHT PLAG W/FIGHT PLYSYNTHC TWINING; ACCSY INDIST CHLOR ALTRD MAFCS; COM LRG EUHED QTZ FRAC FILL (XLS UP T/1MM) & TR CALCT SHEETS LSE IN SPL @ 3490' OCC W/QTZ &/OR NATRLT; SLI CALC THROUGHOUT SPLS

NOTE: @ 3500' (PLANNED TD)', POOH & P/U NEW BIT; EXTEND TD; RIH DRILL AHEAD.

SLATE: DRK GRY-GRYSH BLK; V FRM TYP W/SLI-MOD MICACEOUS SHEEN; PRED V BRTTL & SNAPPY, SCAT V CRNCHY, OCC RTRND BIT PULVRZD AS SML BLLS OF CLY W/INTACT FRAGS W/IN; SBBLKY-IRREG CTGS, SCAT-OCC BLADED EDGES; DLL-PRLY LSTR OVERALL, DOM SILTY, OCC SLI GRTY TEX F/REMNANT V FN SD; WKLY DISC FOLI; SLATY CLVG OCC DIST; COM MICRO BREC W/ANHED CALCT VNNG/FILL; RR-TR PYR, COM PORPHYBLASTS, OCC IN CLACT VNNG; RR QTZ; RR NATROLITE & CHLOR ALTN; CALCT VNNG THRU.

SURVEY @ 3665', INC 1.04, AZI 243.8, TVD 3660', 115'S, 22'E

SLATE: V DK GRY T/GRYSH BLK TYP W/PROM MICEAOUS SHEEN; IRREG MTTLD (OCC APPRS SLI SHEERED) T/GRDLY BLKY CTGS; TYP V FRM & BRTTL; SNAPPY; RELTVLY EAZY T/SCORE; OVERALL RTHY LSTR; TYP SILTY, OCC SLI GRTY TEX F/ REMNANT V FN SD; TYP HS V FNTLY VISBL FOLI; OCC GRDS T/SBPHYLTC W/INCRSD WVY FOLI + SILVERY MICACEOUS SHEEN; SLATY CLEVG OCC DIST WHERE NOT HVLY FRACTD &/OR ALTRD; COM-ABD MOSTLY CALCT HEALED FRACS THRU; RR-TR QTZ VNNG; LOCALLY HS MNR AMTS INTRUSV RK TYP ASSOC W/GRTR DEGREE OF FRACTURING/VNNG.

MW 8.4 VIS 36 PV 5 YP 17 GELS 11/13/16 PH 7.0 CL 800 CA 120

SURVEY @ 3785', INC 0.85, AZI 62.34, TVD 3780', 115'S, 21'E

SLATE: V DK GRY T/GRYSH BLK; FROM MICACEOUS SHEEN AP F/SCAT V FN MICAS THRU; V FRM; TYP BRTTL & SNAPPY; OCC RTRND MUSHY F/BIT ACTION; INCRSNGLY MTTLD APPRNC, AP MICR-BRACCIATED-->OCC CRMBLY; EARTHY LSTR OVERALL; FOLI V FNTLY DISCRNBL (AP DECRSD); RR-TR PYR PORPHYBLSTS THRU; COM MSTLY CALCT MICR-VNNG THRU, RRLY QTZ MICR-VNNG; RR OPEN FRAC FILL ~3835 AND OCC-COM BY 3890'--> TYP CALCT & NATROLITE, OCC W/V FN OPEN QTZ; RR PYR W/IN CALCT FRAC FILL

SURVEY @ 3905', INC 1.65, AZI 44.3 , TVD 3900', 114'S, 23'E

SLATE: DOM AS ABOVE; CONTINUED ABD CALCT VNNG; CONTINUED INCRS IN OPEN FRAC FILL 3935-3955'--> EUHED SHEET CALCT, OPEN TERMINATED QTZ, OPEN NATROLITE &/OR POSS OTHER CLR ZEOLITES, PYR OCHS MRE PROM & OCCRS IN LRGR CUBIC XLS; SHEET CALCT FREQ HS QTZ +/- NATROLITE GROWTH; SLI INCRSD DOWN HOLE LOSSES AP ASSOC W/OPEN FRAC FILL F/3835 T/3963'.

SURVEY 3935'MD, INC 1.58, AZI 35.6, TVD 3930', 113'S, 23'E

NOTE: LOST CIRC @ 3963'; PARTIAL RETURNS BY 3983' (CALCULATED LOSS RATE ~250 BBL/HR OR ~67% LOST CIRC W/PRTL RETRNS); NO VIABLE SAMPLES 3955-4000'; DRILLER'S DEPTH 4000' AT TD @ 06:35 HRS ON 7.30.2019; RUN E-LOGS & INJECTIVITY TEST; RIH, CLEAN OUT FILL & DRILL T/4025' TD ON 8.1.2019; RUN 4.5" PROD LINER SET @ 4010'.

Dixie Meadows 23A-8

Geothermal
MD Mudlog
1:600 Scale

27-001-90518|GEO

HORIZON WELL LOGGING, INC

3769 Constellation Road
Lompoc, California 93436
Phone 805-733-0972 Fax 805-733-0992
AK Phone 907-563-7002
Online Real-Time Well Data:
horizonwells.com
horizon-well-logging.com

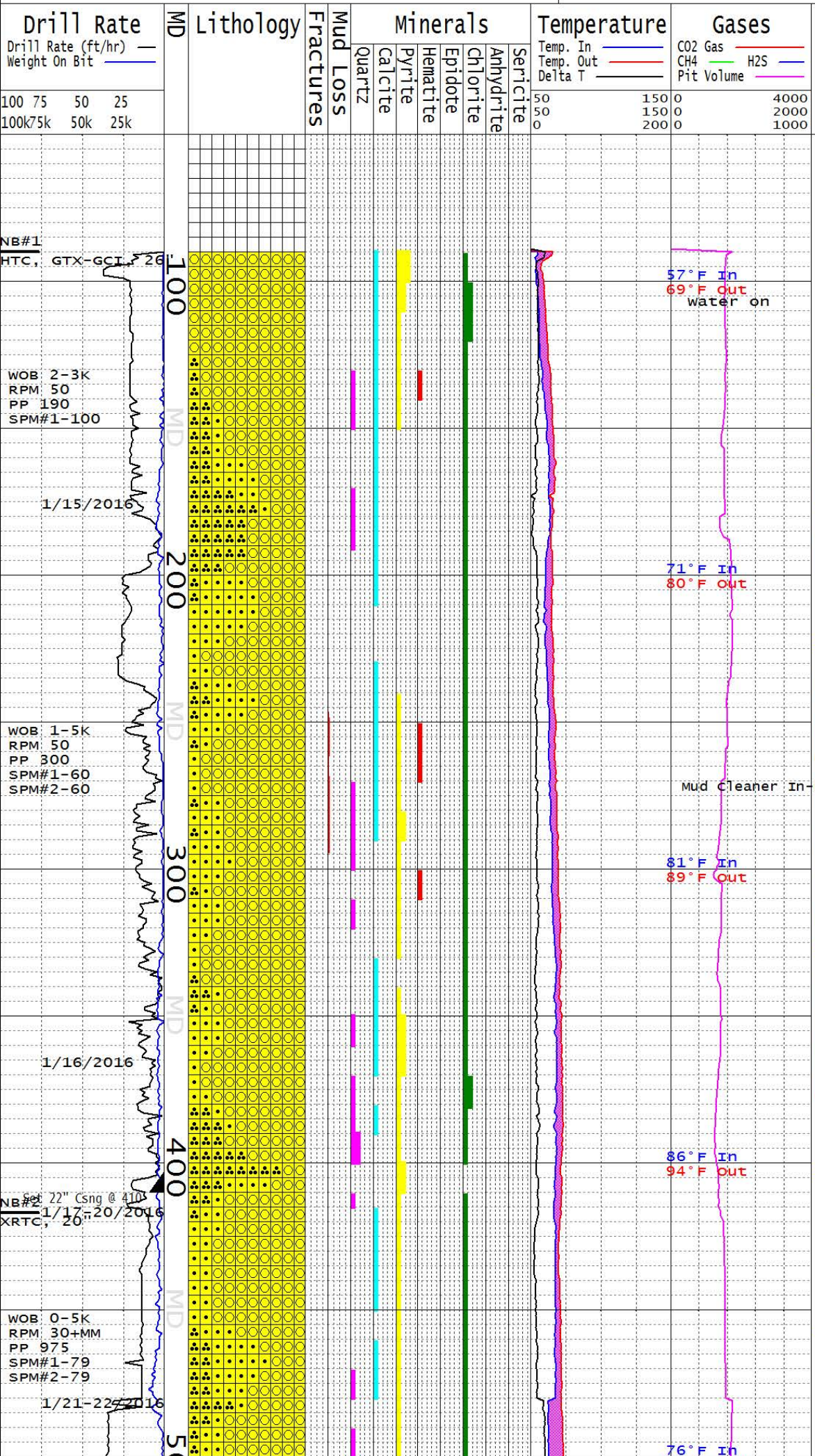
Abbreviations

CO	Circulate Out
LAT	Logged After Trip
CG	Connection Gas
WG	Wiper Gas
TG	Trip Gas
SG	Survey Gas
NR	No Returns
NB	New Bit
WR	Wiper Run
WOB	Weight On Bit
PP	Pump Pressure
SPM	Strokes Per Minute
POOH	Pull Out Of Hole
LC	Lost Circulation

Symbols

- TUFF-ASH
- ARGILLIC ALT
- TUFF-CRYSTAL
- DIORITE
- PHYLLITE
- MARBLE
- SLATE
- QUARTZITE
- LIMESTONE
- DOLOSTONE
- MARL
- ANHYDRITE
- CLAYSTONE
- CLAY
- SILTSTONE
- CEMENT
- SANDSTONE
- SAND
- BRECCIA
- CONGLOMERATE
- MEDIUM SAND
- COARSE SAND

COMPANY	Ormat Nevada, Inc.
WELL	Dixie Meadows 23A-8
LOCATION	SW1/4 NW1/4 OF Section 8 T22N R35E
ELEVATION	GL 3470' KB 3491'
FIELD	Dixie Meadows
COUNTY & STATE	Churchill , NV
API No.	27-001-90518
SPUD DATE	2016.01.14
LOGGING DATES	2016.01.14-2016.03.02
LOGGING DEPTHS	90'-4758'
CO. GEOLOGIST	Ben Delwiche
DRILL SITE MANAGER	Bruce Case, Brian Oliver
CONTRACTOR	GeoDrill
RIG	3
MUD COMPANY	Geo Drilling Fluids, Inc.
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	David Baldazzi, Bradley Ring, William Starrett
BIT SIZE	26" t/415' 20" t/2098' 14.75" T/4758'
CASING	9 5/8" Liner Set @ 4733'



NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM K.B. AND ARE BASED ON DRILLER'S PIPE TALLY; SAMPLES ARE DESCRIBED WHILE WET UNLESS OTHERWISE NOTED; COLORS ARE BASED ON THE GSA ROCK COLOR CHART; ALL GAS EQUIPMENT IS CALIBRATED TO SPWLA STANDARDS.

SPUD DIXIE MEADOWS 23A-8 ON JAN 14TH 2016 @ 16:45 HRS.

NOTE: LAGGED CUTTINGS SAMPLED BY GEODRILL PERSONEL, IN PART.

SURVEY @126' : 0.4°INCL

VALLEY FILL: PL GRNSH GRY IN BULK SPL; FN TO V CRS, COM CLASTS TO 8MM; SBRND TO ANG FRAGS, V PRLY SRTD; OFTN TABULAR; COM LT GRY ASH TUFF COATING; DOM TUFF FRAGS, OCC VITRIC; LESSER RHYLT; <15% VARIABLE LITHICS OCC W/PRIMARY QTZ VEING; MNR CHLRTZTN; MOD CALC; PYR & BIOTT AS COMPONENTS OF RHY.

MW 8.5 VIS 62 PV 14 YP 28
FL 12.4 PH 9.4 CL-100PPM

SURVEY @215' : 0.4°INCL

ALLUVIUM: MED-MED DK GRY IN BULK, WHT, MOD GRN, BLK; V FN-V CRS; SME GR <5MM; V PRLY SRTD; PRED ANG-SBANG; PRED ASH & LITHIC TUFF FRAG; MIN AMNTS FN-MED GR SS; COM DISSEM PYR W/RR SBHD XLS; SCAT ANHD-SBHD CALCT; RR CHLOR STNNG; V RR BIOT FLKS; V RR AP QTZ FRAC FILL W/ABD DISSEM PYR 270'-280'.

ALLUVIUM: MED LT GRY-MED GRY; FN-V CRS GR; PRLY SRTD; SBANG-SBRND; V RR SUC TEX; PRED ASH TUFF; SCAT WELDED & LITHIC TUFF; COM RHYOLITE FRAG; COM DISSEM PYR; RR QTZ FRAC FILL; V RR LOC STRNGLY CHLRTZD CTGS.

SURVEY @322' : 0.6°INCL

ALLUVIUM: MED LT GRY IN BULK SPL; FN TO V CRS, DOM CLASTS 2-10MM; SBRND TO ANG, DOM SBANG; SBDISCOIDAL; DOM WHOLE CLSTS OCC ANG FRAGS; DOM ASH & LITHIC TUFFS, COM RHYLT; COM LT GRY, SDY HD ASH COATINGS; SL CHLORTZD; SL CALC; PYR & BIOTT W/I RHYLT CLSTS.

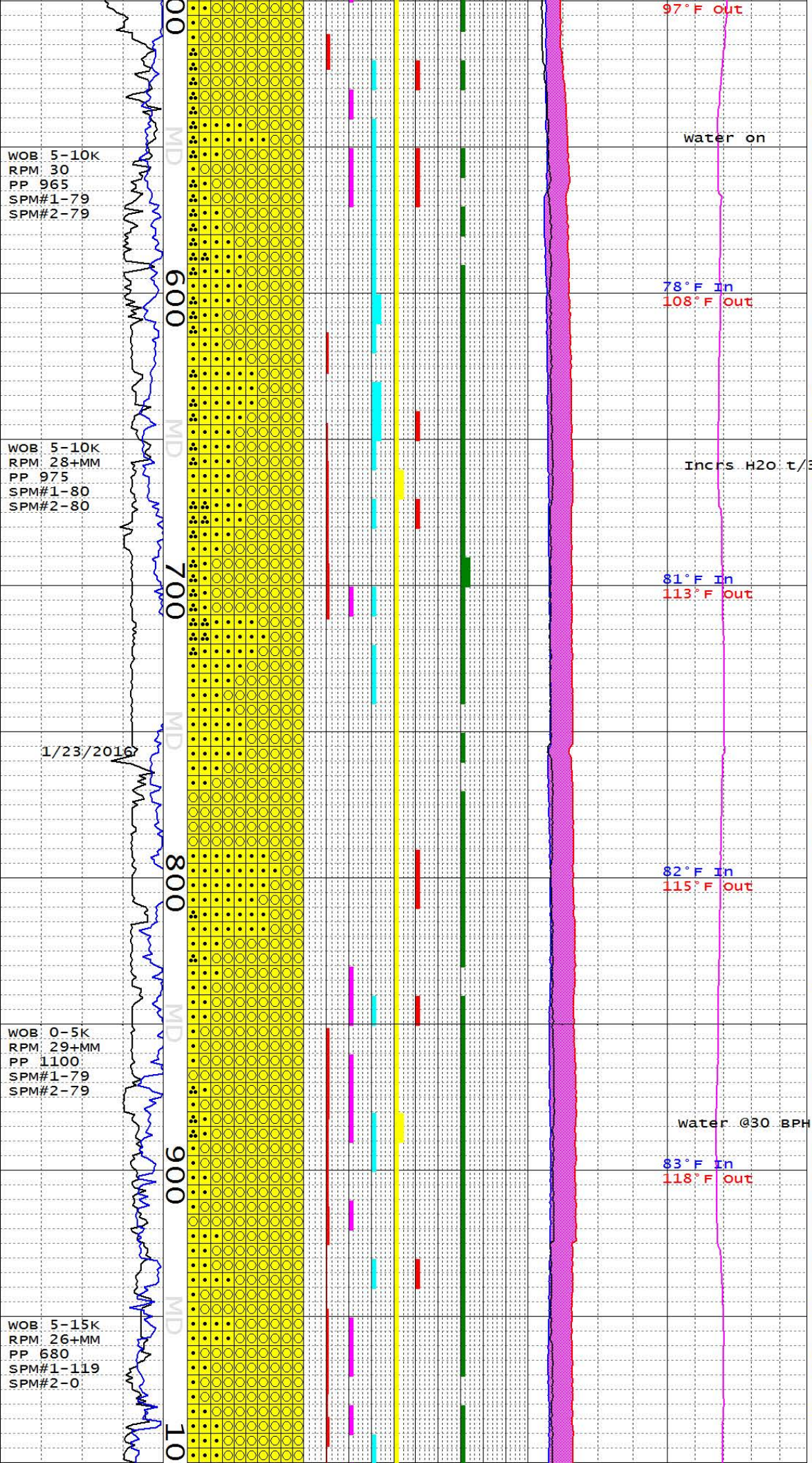
MW 8.9 VIS 57 PV 15 YP 29
FL 9.4 PH 9.2 CL-60PPM

SURVEY @415' : 0.3° INCL

NOTE: DRILL 26" HOLE T/415'; WIPE HOLE; POOH; RUN 410' OF 22" WALL GRADE B LINEPIPE; CMT T/SURFACE; TEST BOP; TAG CMT @364'; D/O CMT T/411'; TEST SHOE T/54PSI W/8.6 MW; DRILL AHEAD W/20" SLICK ASSMBLY.

SURVEY @467' : 0.7°INCL

NOTE: DRILL T/480'; CO; POOH; CHANGE OUT 2 8"DC & XO; M/U NEW BHA W/MUD MOTOR; RIH T/411 TAG FILL; CLEAN OUT FILL; CO; POOH; CHANGE STABS; RIH; CLEAN OUT T/480'; DRILL AHEAD.



ALLUVIUM: MED GRY-DK GRY IN BULK, WHT, MED BLUSH GRY, RR GRYSH ORNG PNK, RR LT BLU GRN; FN-V CRS, PRED V CRS T/540' & MED AFT; ANG-SBRND, PRED SBANG; PRED XL & LITHIC TUFF; SCAT RHYOLITE FRAG; OCC CRS GR QTZITE LITHIC FRAG; COM PYR, PRED DISSEM; COM CHLOR ALTN DECRS W/DEPTH; OCC CALCT; RR QTZ VNNG; V RR HEMTT VNNG.

SURVEY @538' : 0.3°INCL

MW 8.7 FV 60 PV 15 YP 27
PH 11.6 GEL 11/26 CL 320 CA 40

ALLUVIUM: LT GRY-MED DK GRY IN BLK; FN-VR CRS, <12MM; V PRLY SRTD; ANG-SBANG, PRED SBANG; PRED LITHIC FRAG COMPRISED OF ASH & LITHIC TUFF, RHYOLITE, COM VOL GLASS, AND SCAT SS; SCAT CALCT BCMS COM F/600'-610'; SCAT PYR, PRED DISSEM; RR WK CHLOR ALTN.

SURVEY @642' : 0.1°INCL

ALLUVIUM: LT-MED GRY; FN-V CRS, PRED SD SZ GR; PRLY SRTD; ANG-SBANG CTGS & GR; PRED IRREG FRAC; PRED V FIRM-HD; PRED TUFF & RHYOLITE FRAG; OCC WELL CMNTD FN-MED GR SS; OCC VOL GLASS; COM CALCT DECRS W/DEPTH; PYR PRED DISSEM INCRS TO COM 660'-670'; TR WK CHLOR ALTN.

NOTE: INCREASED RHYOLITE & QUARTZITE 690'-700'

SURVEY @724' : 0.3°INCL

ALLUVIUM: MED DK GRY-DK GRY, WHT, LT GRY, GRYSH GRN, FN-10MM GR; PRLY SRTD; PRED ANG-SBANG, OCC SBRND; FIRM-V HD; PRED ASH TUFF & RHYOLITE T/760'; RHYOLITE BCMS MOST PRED 760'-770'; MNR AMNTS VOL GLASS; SME AP SILIC SLTST; COM PYR, PRED DISSEM; SCAT CALCT; RR-SCAT CHLOR, PRED WK ALTN.

NOTE: RHYOLITE CONTINUES TO BE MOST PREDOMINAT PORTION OF SAMPLE WITH QUARTZITE BECOMING ABUNDANT 770'-790'.

SURVEY @809' : 0.5°INCL

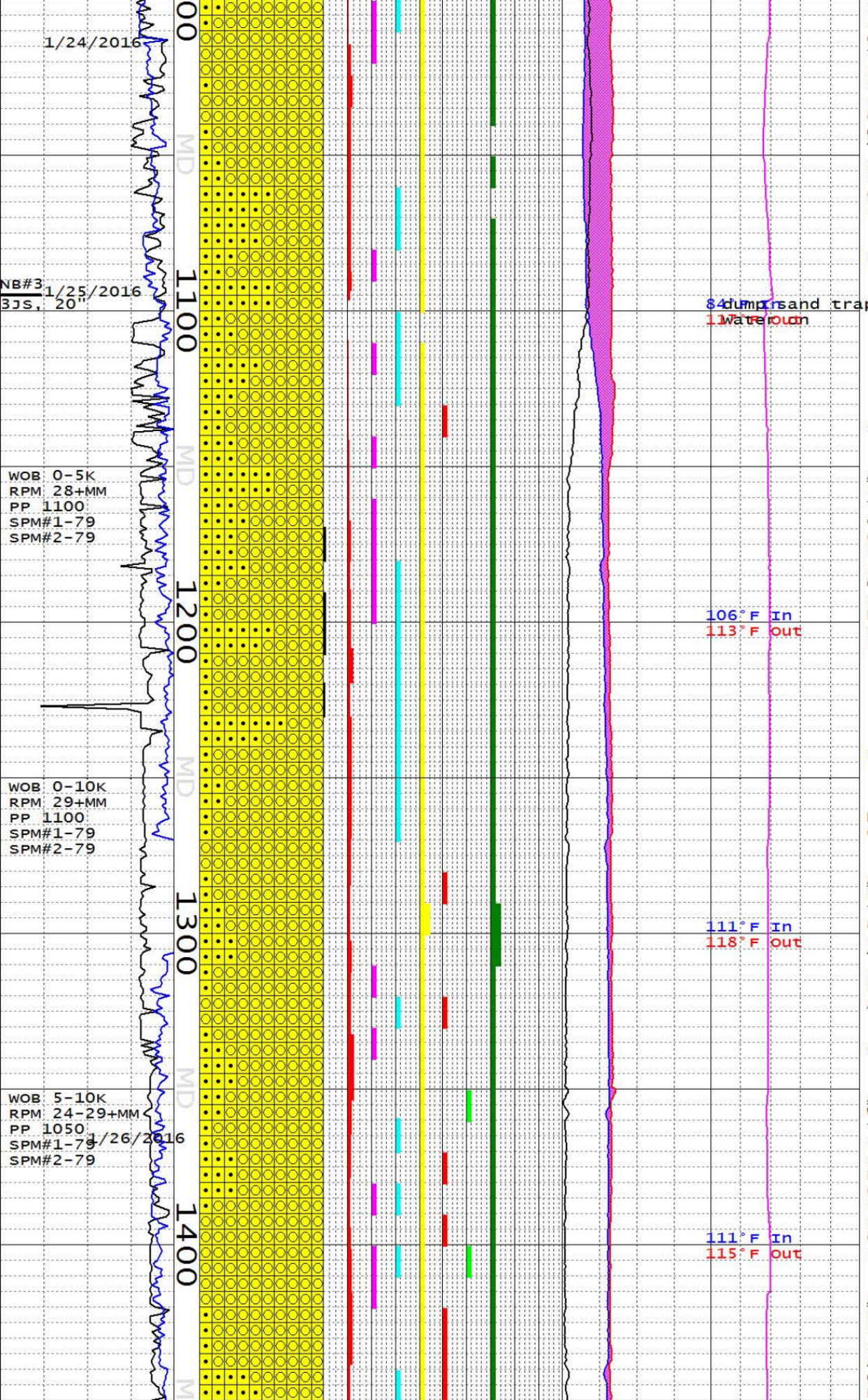
ALLUVIUM: MED DK GRY IN BULK, DK GRY, BLK, WHT, OCC LT BRN-MOD RDSH BRN, OCC PL GRNSH YEL, OCC DK YELSH GRN; PRED >2MM CTGS; PRLY SRTD; PRED ANG-SBANG, OCC SBRND; PRED IREG HCKLY FRAC, V RR CONCH FRAC PRED ASSOC W/VOL GLASS FRAG; OVERALL HD-V HD; SME CTGS BRTL; PRED ASH TUFF, RHYOLITE, & QUARTIZTE; COM PYR PRED DISSEM, OCC SBHD XL & RR FRAC FILL; SCAT CHLOR ALTN; RR QTZ & CALCT FRAC FILL; V RR HEMTT STNNG & FRAC FILL.

SURVEY @899' : 0.4°INCL

MW 8.9 FV 53 PV 15 YP 25
GEL 10/24 PH 10.5 SOL 5 CL 240

SURVEY @980' : 0.2°INCL

ALLUVIUM: MED LT GRY-MED DK GRY



IN BULK, DK GRY, BLK, WHT, OCC LT BRN-MOD RDSH BRN, OCC PL GRNSH YEL, OCC DK GRNSH YEL-DK YELSH GRN, RR MOD ORNG PNK; FN-V CRS, OCC>10MM; V PRLY SRTD; ANG-SBANG, PRED SBANG; PRED IREG HCKLY FRAC, V RR CONCH FRAC; OVERALL HD-V HD, OCC BRTL OR CRUMBLY; PRED ASH TUFF, RHYOLITE, & QUARTIZTE; RR SD, SS & AP SLTST; SCAT-COM PYR PRED DISSEM, RR SBHD XL; SCAT CHLOR ALTN; RR QTZ & CALCT FRAC FILL; V RR HEMTT STNNG.

SURVEY @1065' : 0.3°INCL

NOTE: DRILL T/1096'; CIRC; SURVEY; L/D MM & BIT; BUILD VOLUME; INSPECT PUMPS; M/U NEW BHA; RIH T/1096', NO FILL; DRILL AHEAD F/1096'.

SURVEY @1153' : 0.5°INCL

ALLUVIUM: MED LT GRY-MED DK GRY IN BULK, BLK, WHT, OCC PL GRNSH YEL, OCC DK GRNSH YEL-DK YELSH GRN, RR MOD ORNG PNK; U FN-V CRS; V PRLY SRTD; ANG-SBRND, PRED SBANG; COM IREG HCKLY FRAC, HD-V HD; PRED ASH TUFF & QUARTIZTE; OCC RHYOLITE FRAG; SCAT-COM SS; SCAT-COM PYR PRED DISSEM, RR SBHD XL, V RR EUHD; SCAT-COM CHLOR ALTN; V RR QTZ FRAC FILL.

NOTE: RR SBHD-EUHD PYR XL <1MM W/ABD TWINNING 1190'-1210'.

SURVEY @1243' : 0.5°INCL

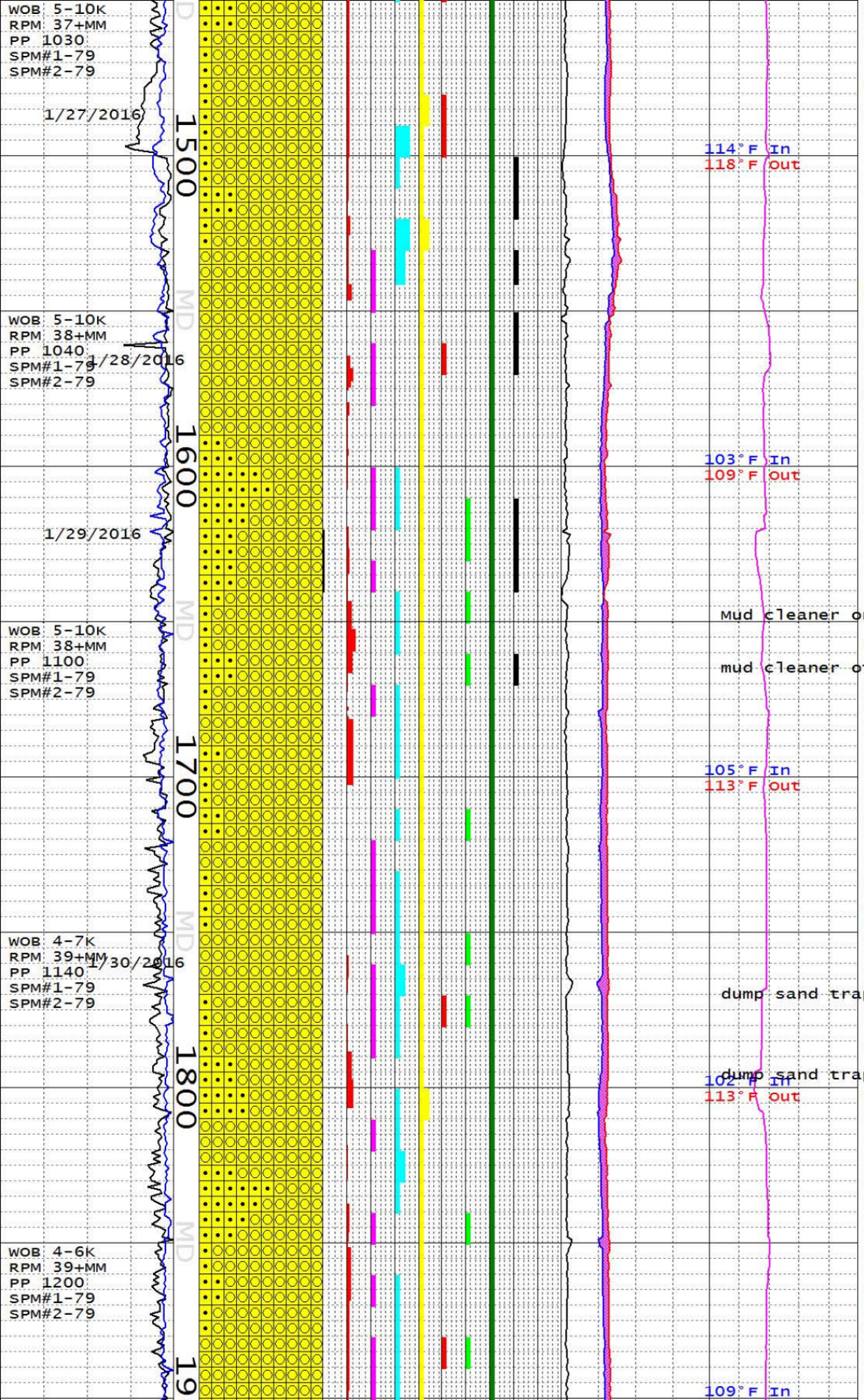
MW 8.8 FV 47 PV 14 YP 19
GEL 4/10 PH 9.4 CL 540

ALLUVIUM: MED LT GRY IN BULK, BLK, WHT, OCC DK GRNSH YEL-DK YELSH GRN; FN-V CRS, PRED CRS-V CRS; V PRLY SRTD; ANG-SBRND, PRED SBRND; HD-V HD; PRED ASH TUFF & QUARTIZTE; OCC RHYOLITE FRAG; RR-SCAT PYR PRED DISSEM, RR SBHD XL; SCAT-COM CHLOR ALTN; V RR CALCT FRAC FILL.

SURVEY @1324' : 0.3°INCL

ALLUVIUM: MED-LT GRY IN BULK; WHT, BLK, PL GRNSH YEL-DK GRNSH YEL; FN-V CRS, <15MM CTGS; V PRLY SRTD; SBANG-SBRND, PRED SBRND; LOW SPHERE; PRED HD-V HD, OCC BRTL; PRED QUARTZITE; COM ASH TUFF; RR RHYOLITE; COM PYR, PRED DISSEM; COM CHLOR STNNG & OCC ALTN; RR CALCT COATING & FRAC FILL; V RR QTZ, EPIDOTE & HEMTT.

ALLUVIUM: MED-LT GRY IN BULK, BLK, WHT, DSKY GRN; FN-V CRS; PRED CRS-V CRS; PRLY SRTD; SBANG-SBRND; PRED PLL YELSH GRN ASH TUFF & CLR-TRANSL, BLCK QUARTZITE; RR-SCAT PYR, PRED DISSEM, RR <1MM SBHD XL;



RR-SCAT CHLOR ALTN; RR CALCT FRAC FILL & SME SURF COATING; V RR HEMTT STNNG.

SURVEY @ 1440' : 0.5°INCL

SURVEY @1476' : 0.9°INCL

NOTE: DRILL T/1485'; POOH DO TO DROP IN PUMP PRESSURE @1455'; POOH T/357'; GO THROUGH PUMPS; POOH; BREAK BIT; M/U BIT; M/U BHA; RIH; DRILL AHEAD F/1485'.

SURVEY @1514' : 0.7°INCL

SURVEY @1564' : 0.6°INCL

ALLUVIUM: LT GRY TO MED-LT GRY IN BULK, CLR-TRANS, WHT, BLK, GRNSH GRY; FN-V CRS, PRED V CRS W/SME CTGS >10MM, BCMS FN-MED AFT 1580'; PRED V PRLY SRTD; SBANG-SBRND; PRED QUARTZITE; COM ASH TUFF W/LESS AMNTS OF LITHIC TUFF; COM PYR, PRED DISSEM, OCC SBHD-EUHD XL <2MM; COM CHLOR ALTN; SCAT TAB ANHYDRITE; SCAT QTZ & CALCT.

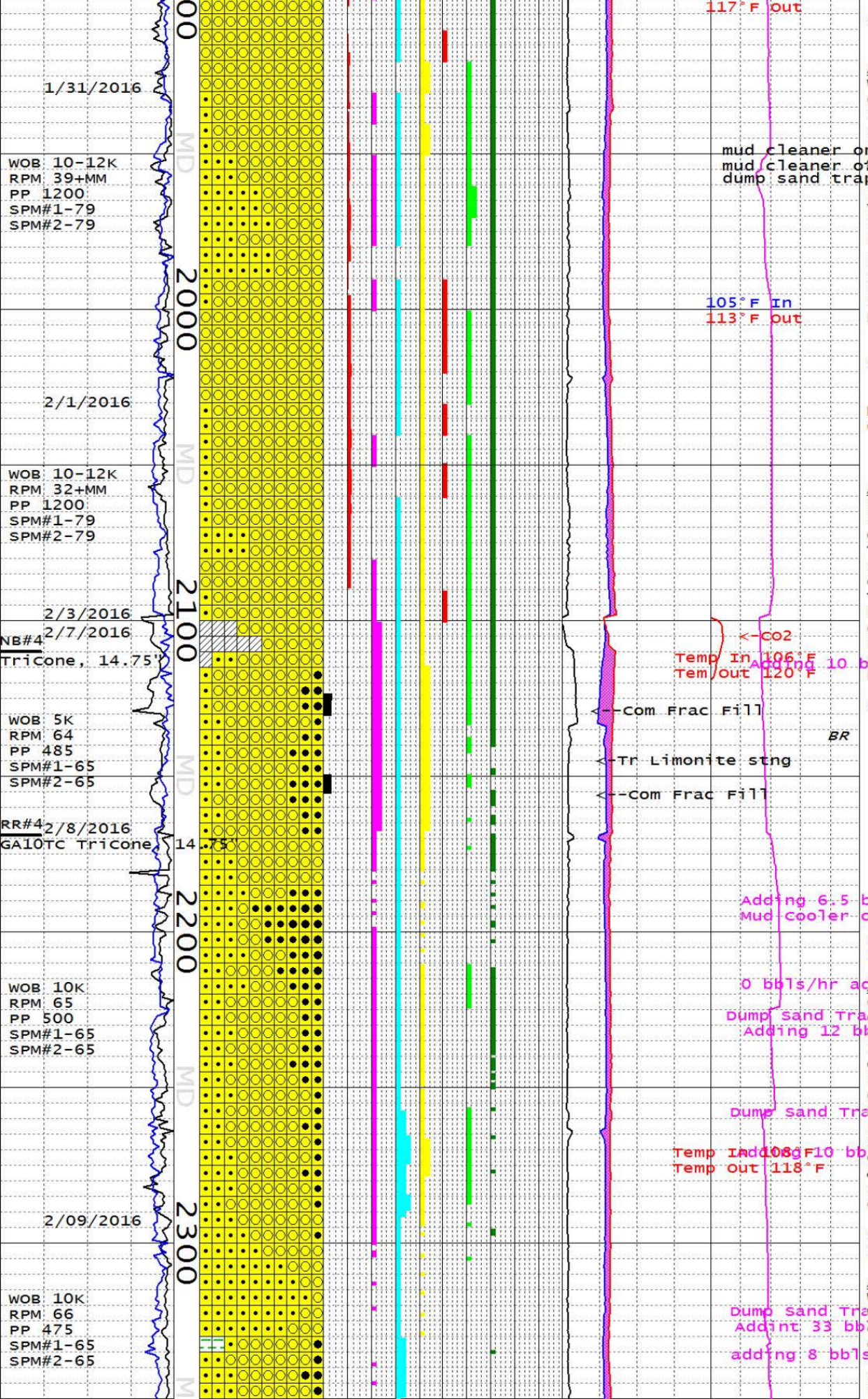
DRILL T/1620'; CO; POOH; L/D MOTOR; P/U NEW MOTOR; M/U BHA; RIH T/1595'; REAM 1595'-1620' DRILL AHEAD F/1620'.

SURVEY @1646' : 0.7°INCL

ALLUVIUM: MED-LT GRY IN BULK, DRK YELSH GRN, WHT, CLR-TRANSL, BLK, V RR GRYSH YEL; FN-V CRS, PRED CRS-V CRS W/SCAT CTGS T/9MM; CTGS SLI LRG & MORE SILIC IP 1670'-1680'; V PRLY SRTD; SBANG- SBRND, PRED SBRND, V RR ANG CTGS W/IREG HCKLY FRAC; PRED HD-V HD, BCMS PRED CRUMBLY F/AP ALTN 1680'-1690'; PRED DRK YLSH GRN ASH TUFF & TRANSL-BLK QUARTZITE; ASH TUFF AP FRAC W/CALCT FILL & V RR CHLOR FRAC FILL 1670'-1680'; RR LT GRY-TRANS RHYOLITE, SME W/ABD BIOT; SCAT-COM V FN DISSEM PYR, V RR INTGRWN W/V FN XLN CALCT; V RR ANHD-SBHD GRYSH YEL EPIDOTE; V RR CUBIC CALCT XL; V RR 1MM TAB ANHYDRITE 1660'-1670'; V RR YELSH GRY COATING 1670'-1680' POSS LIMONITE.

SURVEY @1814' : 1.0°INCL

ALLUVIUM: MED-LT GRY IN BULK, WHT, BLK, GRYSH YEL GRN; MED-V CRS, BCMS PRED V FN-CRS 1830'-1840' ; V PRLY SRTD; PRED SBRND, SME ANG CTGS 1760-1770'; PRED HD-V HD, COM BRTL & CRUMBLY 1810'-1820' & 1850'-1860'; PRED TRANSL-BLK QUARTZITE & GRYSH YEL GRN ASH TUFF, PRED WHT-LT GRY 1800'-1810'; RR RHYOLITE & LITHIC TUFF; RR-COM CALCT, PRED <1MM FRAC FILL & SURF COATING, V RR SBHD XL T/4MM; COM PYR, PRED DISSEM, RR 1-2MM CLSTR OF TWND XLS; COM CHLOR ATLN, & V RR FRAC FILL; SCAT QUARTZ FRAC FILL, V RR 1/2 MM NRLY EUHD LSE QTZ XL; V RR WK HEMTT STNNG; V RR FN SBHD EPIDOTE XL.



SURVEY @1904' : 1.2°INCL

ALLUVIUM: MED DK GRY IN BULK, WHT, BLK, GRYSH YEL GRN; MED-V CRS, PRED V CRS, FN-MED 1960'-1970'; PRLY SRTD; PRED SBRND; HD-V HD; POSS SLICK 1900'-1910'; PRED QUARTZITE & ASH TUFF; PERV PYR & CHLOR; RR-SCAT CALCT SURF COATING & FRAC FILL & V RR SBHD XL T/4MM, V RR >1MM THK SHEET 1950'-1960'; RR QTZ FRAC FILL, V RR EUHD XLS IN OPEN SPACE IN <2MM FRAC IN QUARTZITE FRAG 1890'-1900', LSE EUHD XL 1960'-1970'; RR ANHD EPIDOTE, ABD SBHD XLS 1960'-1970'; V RR HEMTT STNNG.

SURVEY @1956' : 1.2°INCL

MW 8.8 FV 55 PV 17 YP 27
GEL 9/15 FIL 7.8 PH 8.5 CL 560

ALLUVIUM: PRED MED DK GRY IN BULK, MED GRY IN BULK 2050'-2060', CLR-TRANSL, GRYSH YEL GRN, GRYSH BLK; FN-V CRS, UP T/8MM CTGS; PRED V PRLY SRTD; SBANG-SBRND; PRED HD-V HD; PRED GRYSH YEL GRN ASH TUFF & CLR-TRANSL QUARTZITE, OCC GRYSH BLK; PERV PYR & CHLOR; SCAT CALCT FRAC FILL & SURF COATING, RR SBHD XL; RR QTZ FRAC FILL; RR ANHD-SBHD EPIDOTE; V RR-RR HEMTT STNNG.

SURVEY @2031' :1.4°INCL

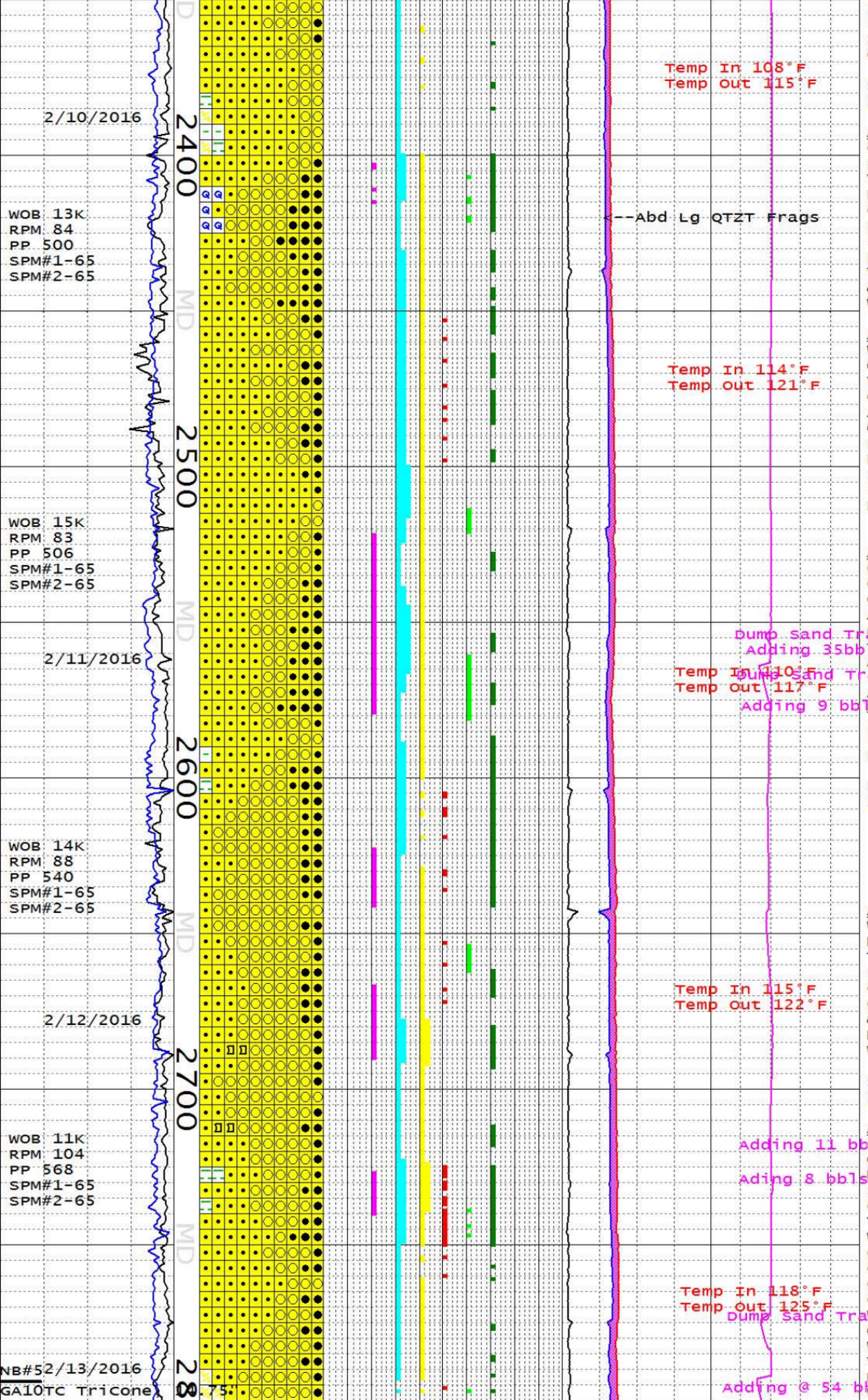
DRILL T/2098'; CO; WIPE HOLE; REPAIR RIG; RIH T/2098 NO FILL; CIRC; POOH; L/D BHA; RUN 16" CASING T/2095'; NU/ND BOP; R/U MUFFLER & FLOWLINE; PRESSURE TEST BOP; RIH; DRILL OUT CMT; PREFORM LEAK OFF TEST; DRILL AHEAD F/2095' T/2170'; RUN DEVIATIONAL SURVEY; POOH; L/D MONEL & BHA; P/U DRILLING BHA; RIH R/2170; DRILL AHEAD F/2170'..

SURVEY@ 2162' MD 1.0° INC 124.8 AZI

ALLUVIUM: PRED BLEACHED WHT, COM LT-DK GRN, OCC LT YELSH GRN, RR MTLC GLD, V RR BLUSH GRY; CONSOL OVERALL; V HD, WL IND; MOD-PRLY SRTD; LO-HI CRS GR, V RR PBL SZ GRS; PRED REXLZD-REWRKD ASH MTRX, SLI CALC IP; SLI FRACTD, FRAC AP HEALED W/SILICIS & OCC CALC FRAC FILL; RR PRIM QTZ, TR SECNDARY EUHED EPIDOTE XL GROWTH, TR CUBIC PYR; V RR QTZT & IGN FRAGS CMTD IN MTRX; ABD SECNDRY QTZ, COM SLI BLEACHED CHLOR ALTN ASSOC W/MTRX.

SURVEY@ 2259' MD 1.3° INC 133.7 AZI 130°F MRT

ALLUVIUM: ABD BLEACHED WHT-LT WHTSH GRN, COM CLR-TRANSL, MLKY WHT, OCC DK GRN, BLK, RR MTLC GLD, PNK-ORNG, TR YELSH GRN; CONSOL-WL IND; V HD, OCC BRTL; PRLY SRTD; V FN CLASTS-OCC PBL SZ CLASTS; CLASTS APR HILY ANG; REXLZD ASH MTRX; ABD IGNEOUS



FRAGS, RR QTZT; COM BLDD CALCT FRAC FILL; RR CHLOR ALTN, TR SECNDRY CUBIC PYR; V FNT CHLORIC ALTN ASSOC W/MTRX.

SURVEY@ 2348' MD 1.4° INC 130.8 AZI 120°F MRT

ALLUVIUM: PRED LT GRNSH WHT, COM BLUSH GRN, OCC YELSH ORNG, RR MTLC GLD, BLK, DK GRN; V HD; V WL IND; REXLZD TUFCS MTRX; DECR-COM ANG CLASTS, PRED QTZT, COM BASALT,, OCC IG FRAGS; RR BLEACHED CHLORIC ALTN, V RR V FN CUBIC PYR IN FRAC SURFS; ABD BLDD CALCT FRAC FILL, FRACS & VNGG APRS HEALED; RR V THN CLAY & CLAYSTN LAMS, COM ARGIL ALTN W/ASSOC CLAY LAMS.

ALLUVIUM: ABD CLR-TRANS, MLKY WHT, COM BLUSH GRN, OCC YELSH ORNG, RR MTLC GLD, BLK, DK GRN; V HD; V WL IND; U CRS-RR MED FN GR, OCC PEB-CBL SZ GRS; REXLZD ASH MTRX; PRED ANG CLASTS, PRED QTZT, COM BASALT, OCC IG FRAGS; RR BLEACHED CHLORIC ALTN, V RR HEMTT ALTN; V RR V FN CUBIC PYR IN FRAC SURFS; ABD BLDD CALCT FRAC FILL, FRACS & VNGG APRS HEALED; RR ARGIL ALTN.

ALLUVIUM: PRED BLEACHED WHT, CLR-TRANSL, ABD TRANSL EDGE, COM BLYSH GRY, LT GRN, RR MTLC GLD, BLK, DK GRN; V HD; INCR LG ANG CBL & PBL FRAGS, PRED MED-U CRS W/ V RR MED FN GR; HLIY SILICIS REXLZD ASH MTRX; ABD LG ANG QTZT & BRECCIATED IGNEOUS FRAGS; RR BLEACHED CHLORIC ALTN ASSOC W/ASH MTRX, V RR HEMTT ALTN; V RR V FN CUBIC PYR IN FRAC SURFS; ABD CALCT FRAC FILL, FRACS & VNGG APRS HEALED; RR ARGIL ALTN.

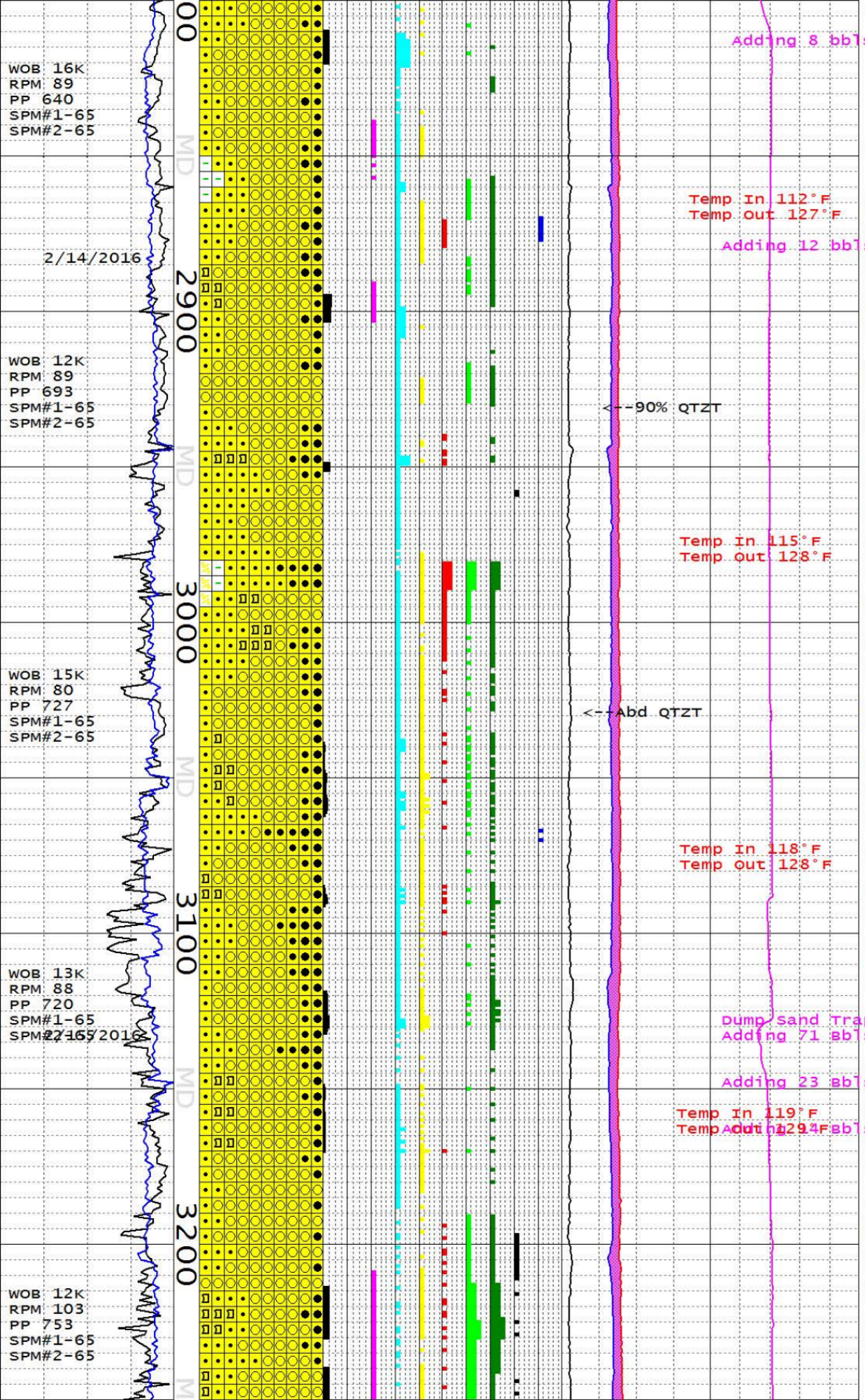
SURVEY @ 2603' 1.4° INC 148.8° AZI 130°F MRT

NOTE: DRILL T/2642'; CIRC BTMS UP; POOH F/WIPER RUN T/SHOE; RIH T/2642'; DRILL AHEAD F/2642'.

ALLUVIUM: PRED CLR-TRANSL, MLKY WHT, ABD BLEACHED LT GRN, V RR MTLC GLD; V HD, WL IND; V RR THN CLAY LAMS W/AP ARGIL ALTN; PRLY SRTD; MED-FN-U CRS, OCC CBL-PBL SZ GRS; NO VIS PERM, COM CALCT FILLED FRACS, ALL VNS & FRACS AP HEALED; COM CALC MICRO VNG; RR CUBIC PYR ASSOC W/FRAC SURF.

SURVEY @ 2688' 1.8° INC 136.9° AZI 130°F MRT

ALLUVIUM: ABD CLOUDY MLKY WHT, CLR, COM DK GRN, MED GRYSH BLU, OCC LT GRN, RR PNKSH RD, TR MTLC GLD; V HD; HILY CALC; PRLY SRTD; MED FN-U CRS, OCC PBL & CBL SZ GRS; HILY ANG THROUGHOUT, APRS SLI BRCCIATED; WL CMTD W/REXLZD ASH MTRX; ABD CHLORIC ALTN ASSOC MTRX; ABD CALC & SILICIS FILLED VNG, COM CALCT HEALED FRAC FILL; RR CUBIC PYR XLN GROWTH ASSOC W/HEALED FRACS; ABD LG HILY ANG QTZ FRAGS, POSS IP OF LARGER WHOLE BLDR SZ CLAST W/IN MTRX, V RR HEMTT ALTN ASSOC W/FN GRN MTRX; V RR V THN LAMS OF CLYSTN W/HVY CHLORIC ALTN W/ASSOC



RE-WORKED ASH MTRX..

NOTE: CIRC BTMS UP @ 2793'; POOH; L/D BIT; P/U NEW BIT & MOVE STAB; RIH T/2730' REAM F/2730'-2793'; DRILL AHEAD F/2793'.

MW 9.0 VIS 44

ALLUVIUM: PRED CLR-TRANSL, MLKY WHT, COM BLEACHED LT GRN, V RR MTLC GLD; V HD, WL IND; LOW CRS-CBL-PBL SZ GRS; PRLY SRTD; HILY ANG-OCC BLDD OVERALL; NO VIS PERM, COM CALCT FILLED FRACS, ALL VNS & FRACS AP HEALED; ABD SILICIS & CALC MICRO VNG; RR V FN CUBIC PYR ASSOC W/FRAC SURF.

SURVEY @ 2942' 1.2° INC 155.6° AZI 145°F MRT

ALLUVIUM: PRED CLR, OCM MLKY WHT, ABD DK BLK-TRANSL, OCC LT TRANSL GRY W/SLI BLU HUES, RR DK ORNGSH RD, DK GRN, RR MTLC GLD; V HD-BRTL; PRLY SRTD; MED FN GR-U CRS, RR PBL-CBL SZ; HILY ANG OVERALL; HILY CALC, ABD BLDD-SBRND CALCT FRAC FILL; AP FRACS APR HEALED; ABD LG ANG QTZTT FRAGS, OCC LG DIORITE FRAGS, HILY BRECCIATED; SLTY T/FN GR SD SZ MTRX, RE-WRKD & RE-XLZD ASH TUFF MTRX W/OCC SUCC TEX; RR FNT CHLORIC ALTN, SLI HEMTT ALTN ASSOC W/MICRO VNGG, TR V FN PYRIC & POSS CHALC XLN GROWTH ASSOC W/FRAC SURFACES.

SURVEY @ 3030' 1.6° INC 146.6° AZI 142°F MRT

ALLUVIUM: PRED CLR & MLKY WHT, ABD DK-MOD GRY (OCC BLK)-TRANLS, RR DK GRN (OCC SPKLD W/RD) & MTLC GLD; V HRD & BRTL; PRLY SRTD; UPPR FN T/>UPPR CRS; TYP V ANG; HI CALC OVERALL; OCC MED GR CALCT FRAC FILL; FRACS TYP AP HEALED; ABD V CRS ANG QTZTT FRAGS & OCC DIORITE FRAGS, V BRECCIATED; PRED SLTY RE-WRKD & RE-IND ASH TUFF MTRX; COM V FN PYR (OCC EUHEDRAL) W/IN CHALC MCR-FRAC FILL; OCC FNT CHLOR ALTN, TR-OCC SCAT HEMTT W/IN INCR SILIC MCR-VNNG.

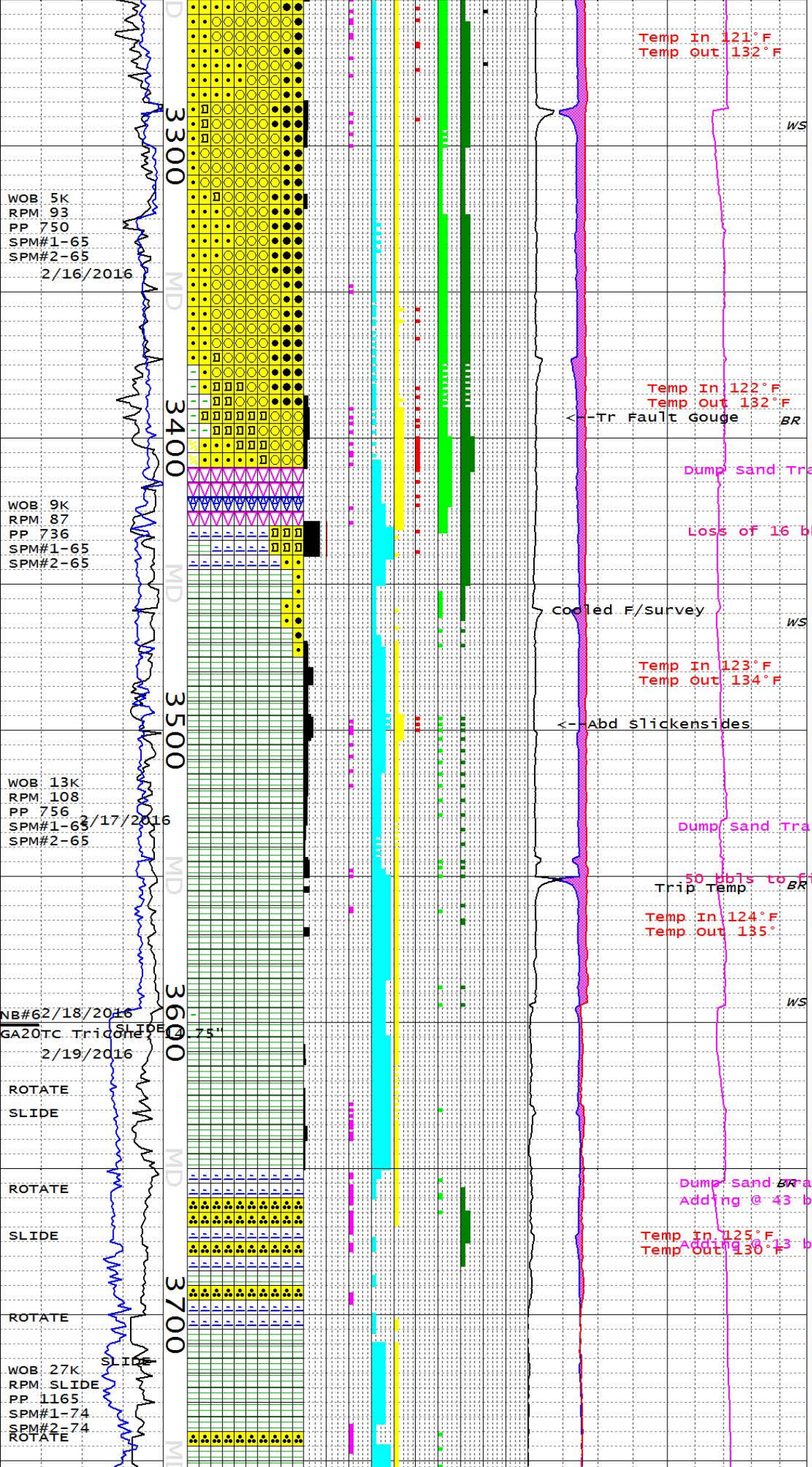
SURVEY @ 3115' 1.6° INC 155° AZI 140°F MRT

MW 8.9 VIS 46

ALLUVIUM: PRED CLR, MLKY WHT & DK T/MOD TRANSL GRY; OCC MOD ORNGSH RD; RR DK GRNSH GRY; V RR MTLC GLD; V HRD & BRTL W/MXD CALCTC & SILIC RE WRKD SLTY ASH TUFF MTRX; V PRLY SRTD; UPPR FN T/GRTR THN UPPR V CRS; TYP V ANG W/COM THN SHRD-LIKE FRAGS; MOD T/V CALC OVERALL; COM THN MXD CALC/SILIC MCR FRACS W/V FN SBHDRL T/EUHDRL PYR; ALL FRACS AP HEALED; ABD LRG QTZT FRAGS; OCC T/COM CHLOR ALT; SCAT RR EPIDOTE.

SURVEY @ ' 1.2° INC 155.6° AZI 145°F MRT

NOTE: ABD CHALC ASSOC W/LG HILY ANG DIRITE FRAGS.



NOTE: CIRC BTMS UP @ 3285'; POOH T/SHOE F/WIPER RUN; SLIP CUT 40' OF DRILL LINE; RIH T/3285'; REAM F/3244'-3285'; DRILL AHEAD F/3285'.

SURVEY @ 3286' 2° INC 157.7°AZI MRT 142°

ALLUVIUM: PRED MLKY WHT, CLR-TRANSL & MOD (COM BLUSH) GRY, OCC DK YELSH ORNG, SCAT DK GRNSH GRY, RR MTLC GLD; HD & BRTL; PRLY SRTD; UPPR FN-UPPR V CRS W/COM PBBL & CBL; TYP V ANG; ABD DIORITE FRAGS; HI CALC & OCC BLDD CALCT FRAC FILL; FRAC SURFS AP HEALED; COM (DECR) SHRP ANG GRY QTZT FRAGS; COM LSE MED EPIDOTE GRS & EPIDOTE ALTN OF PLAG & CHLOR ALTN OF AMPHBLS; COM CHALC FRAC FILL W/V FN PYR; V RR CUBIC PYR.

SURVEY @3369' 1.6° INC 159.1° AZI MRT 144°

MW 9.0 VIS 48

ASH TUFF/FAULT BRECCIA: PRED PNKSH CHALKY WHT, COM BRNSH GRY, OPAQ WHT, LT YELSH GRN, DK GRN, LT ORNG, DK GRN, RR DK BLUSH GRY, V TR MTLC GLD; V HD-SLI BRTL; ABD REXLZD ASH TUFF W/ABD BLEACHED-CHLORTZD PLAG PHENOS, RR BLK XL TUFF MDLD W/GABBRO FRAGS; ABD V LG (10-20MM) FRAGS OF THNLY LAMD, HILY CALC, SLI CHLORITZD SLTSTN, ABD LG SLATE W/V GD VIS FISS, W/ABD CALC MICRO VNG; HILY BRECCIATED W/ABD THN LAMS OF CLAY & WL IND CLYSTN; IMED DECR IN EPIDOTE & CHLOR; V LG BULKY CALCT FRAGS, DECR PYR.

SURVEY @ 3459' 1.7° INC 181.8° AZI

SLATE: MED DK T/DK GRY SBTAB-TAB CTGS W/SCAT WHT FRAC FILL; HRD & BRTL W/PROM FISS; FNLY SDY IP; COM CUBIC PYR W/IN, & RR FN T/MED GR LSE CUBIC MTLC GLD PYR IN SPL; PERV CALC-HEALED MICR VNNG; COM SHINY SLICKS; OCC EPIDOTE/ CHLOR/PYR & RRLY QTZ & HEM GRWTH ON LRGR FRAGS OF CALCT FRAC FILL TYP ASSOC W/LOCAL INCR SLICKS.

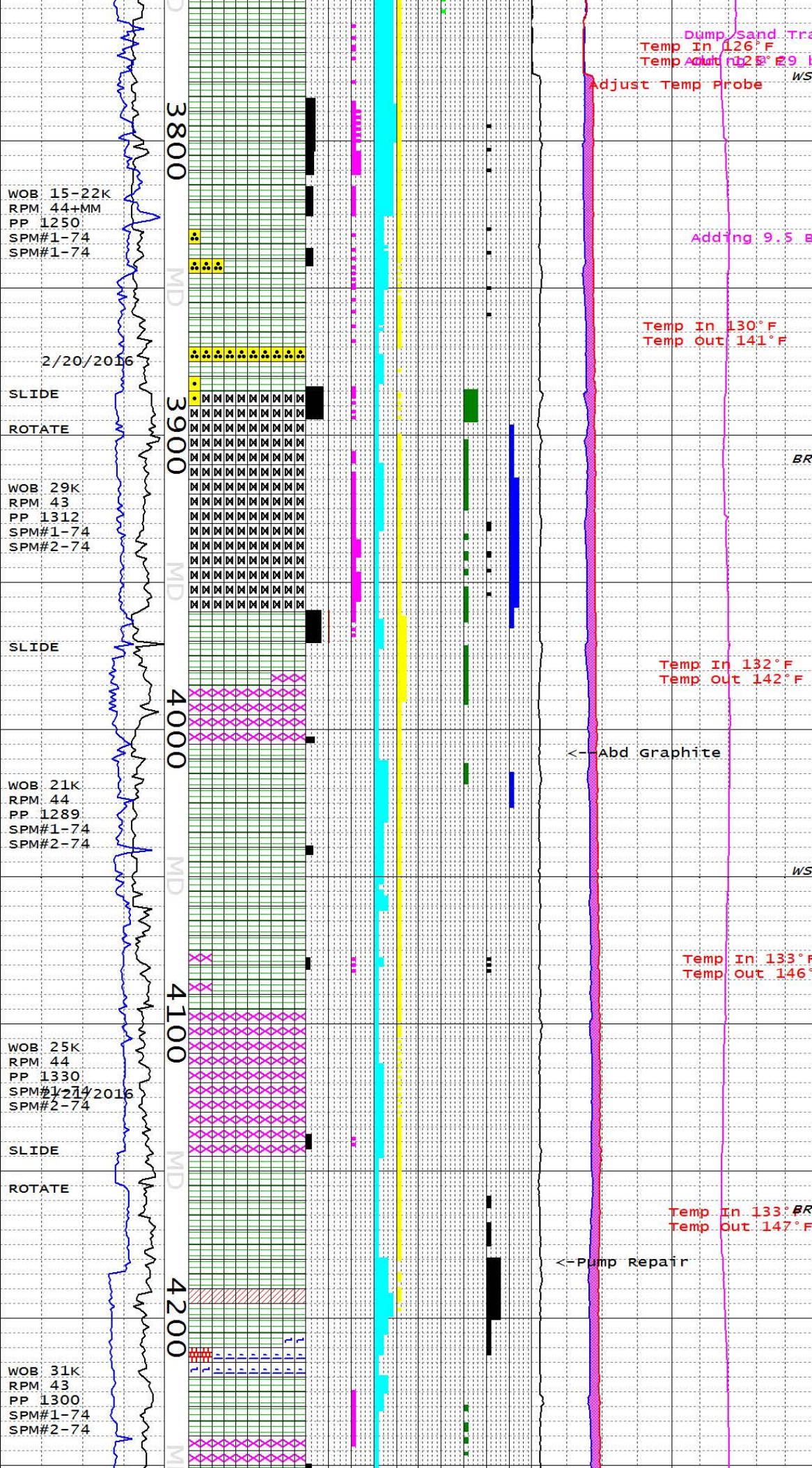
SURVEY @ 3539' 1.0° INC 126.4° AZI MRT 150°F

NOTE: DRILL T/3550', CIRC B/U & POOH T/1240'; RIH T/3550'; DRILL AHEAD F/3550' T/3595'; CIRC B/U & POOH; L/D BHA; WAIT ON WEATHER; P/U BHA W/MOTOR AND DIRECTIONAL TOOLS; RIH; SURVEY EVERY 80' WITH MWD F/SHOE; DRILL AHEAD.

SURVEY @ 3564' 0.77° INC 155.02 AZI MRT 133°F

SURVEY @ 3649': 1.5° INC 323.3° AZI 3648' TVD

SANDSTONE/METASANDSTONE: LT GRY BULK SPL, PRED CLR-TRANSL, OCC LT-DK GRN, BLK-DK GRY, V RR OPQ WHT; V HD, OCC BRTL; NON FOLIATED; SLI META, W/RR FUSED GRS; ARENIC OVERALL, W/V RR AP FSPR GRS, V COM MNR CALCT MICRO VNG; GRANOBLASTIC TEX; RR DISSEM MED FN-LOW CRS SD; COM SILICIS MICRO VNG; COM SURFICIAL CHLORIC ALTN; V RR DRUSSY PYR ASSOC W/MICRO FRACS & VNS; DECR, HILY CALC, INTRBEDDED SILICIS SLTSTN W/DECR METAMORPHSM F/SLATE W/FN APHAN NON FOLIATED TEX.



SLATE: PRED BLK-DK GRY W/COM WHT, V RR Y ELSH GRN, TR DK GRN; V HD-BRTL; APANIC; NON FOLIATED; NO VIS MICA; SLTY MTRX; WXY LSTR; V DNS; ANG-BLKY FRAC; RR FISS; RR CUBIC PYR & DRUSSY PYR MICRO VNG; COM BRECCIATED SS INTRBDS; ABD HEALED CALCT VNG THROUGHOUT.

SURVEY @ 3820' 6.0° INC 331.9° AZI 3819' TVD 42'S 17'E

MW 8.9 VIS 48

SLATE: TYP V DK GRY W/COM WHT FRAC FILL; V HD & BRTL; RR PR FISS; NON FOLIATED; V ANG, BRECCIATED, AND IRREG OVERALL; OCC THN, GRANOBLASTIC WELDED SDSTN BEDS; DECR OCC CUBIC PYR; ABD FUSED CALCT MCRVNNG THROUGHOUT; COM THN OPEN FRACS W/EUHEDRAL QTZ, CALCT, & GYPSUM (3790-3820'); TR ANHYDRITE; MST FRACS AP HEALED.

DIORITIC INTRUSION: LT GRY OVERALL; ABD WHT, CLR, OLV GRN, OCC MTLC GLD; V HD; HOLOXLN IP, OCC FRAGS APR HYPOXLN; PHAN-PEGMATIC; HYPIDIOMORPHIC GRANULAR TEX; ABD TAB HRNBLND, ANHED SERICITE & BIOT, ABD FSPR QTZ; OCC EUHED & ANHEDRAL PYR; COM LOCALZD LG BLDD CALCT FRAC FILL.

SLATE: PRED BLK-DK GRY W/COM WHT, TR DK GRN; V HD-BRTL; APANIC; V FNT FOLIATION T/RR PHYL TEX; RR V FN MIICA; SLI SLTY MTRX IP; WXY LSTR; V DNS; ANG-BLKY FRAC; RR VIS FISS; INCR CUBIC PYR & DRUSSY PYR MICRO VNG; RR DIORITE FRAGS POSS SLOUGH, APRS SHARP CONTACT; ABD HEALED CALCT VNG THROUGHOUT.

SLATE: PRED BLK-DK GRY, COM LT GREY, W/COM WHT, TR DK GRN; V HD; SLI FISS, APANIC-CRYPTOXLN OVERALL; RR SLI FOLIATION, RR PHYL TEX; RR V FN MIICA; WXY-GRSY LSTR; SLI SLTY MTRX IP; SB-BLKY-SBHKLY FRAC; ABD GRAPHITE, COM EUHED PYR.

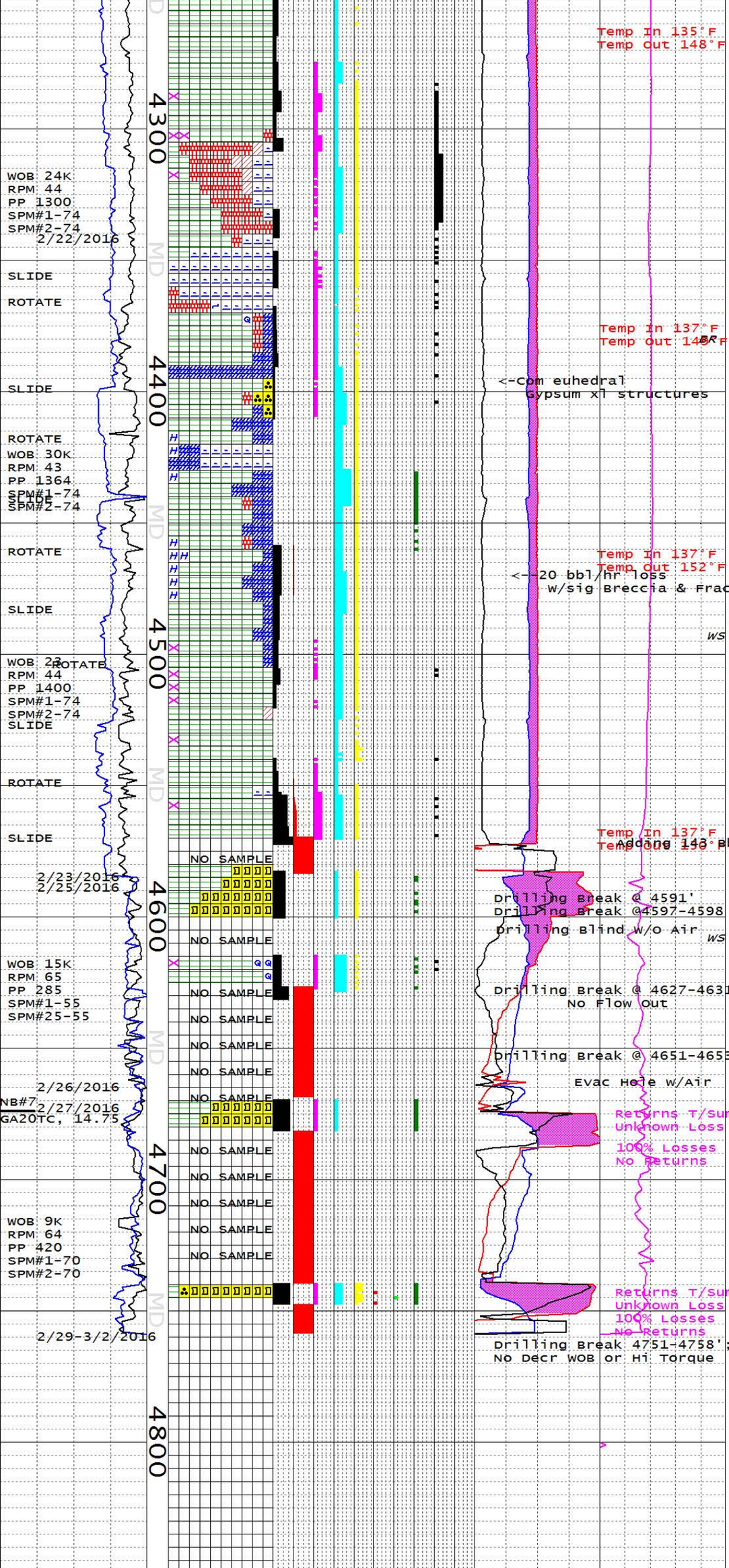
SLATE: TYP DK GRY W/COM WHT FRAC FILL; HD & BRTL; DENS; IRREG & ANG; TR PR FISS; APHNC-CRYPTOXLN; PRED V FNTLY FOLI, RR PHYLITIC TEX W/V FN CREN & INCR MICACEOUS SHEEN, PRED SBPHYLITIC; V RR VIS MICA W/10X MAGNIF; DL LSTR; IRREG FRAC, COM ALONG FN CREN; COM GRAPHITE & CUBIC PYR; ABD CALC MCR VNNG.

SURVEY @ 4076' 3.58° INC 342.46° AZI 4074' TVD

PHYLLITE: DK GRY T/GRYSH BLK W/COM WHT FRAC FILL; HD & BRTL; IRREG, COM BRECCIATED CTGS; PERV FN CREN & PHYLITIC TEX; TR V PR CREN CLEAVAGE; PERV SLI FOLI; ABD MICACEOUS SHEEN; DL EARTHY T/WXY LSTR; PRED CRYPTXLN W/OCC VIS MICA PHENOS; TR V THN CALCT & PYR BNDNG; ABD GRAPHITE & OCC EUHD PYR; TR V FN EUHD QTZ IN RR THN OPEN FRACS; ABD CALCT MCR VNNG.

SURVEY @ 4161' 4.28° INC 333.89° AZI 4159' TVD

SLATE: PRED BLK-DK GRY, COM LT GREY, W/COM WHT; V FRM-HD, BRTL; SLI FRIAB; SLI FISS, APANIC-CRYPTOXLN OVERALL; DECR FOLI CTNGS, RR PHYL TEX; RR V FN MICA; WXY-GRSY LSTR; INCR SLTY MTRX; DECR GRAPHITE, COM EUHED & DRUSSY PYR, COM ANHYD, RR MARL-LIMESTN INTRBDS.



MW 9.0 VIS 45

SLATE: DK GRY T/GRYSH BLK W/COM WHT FRAC FILL; HRD & BRTL; TR PR FISS; TYP APHNC, ABD VIS MICAS IP; INCRSNGLY SBPHYLITIC, TYP V SLI FOLI; DL ERTHY T/WXY LSTR; COM CUBIC & DRUSY PYR; OCC GRAPHITE; RR EUHED QTZ & SBHEDRAL ANHYD W/IN THN OPEN FRACS; TR ACTINOLITE F/4310 SPL.

LIMESTONE: PL OLV T/LT BLUSH GRY, OCC WHT; HRD; FN GR; COM SBSUCROSIC TEX; COM V SLI TRANSL; FNLY SDY IP; LIKLEY HI MAG CNTNT INF F/SLI DELAYED HCL RXN; AP THNLY INTR-BDD W/ CALC SILTSTN; ABD PNKSH GRY T/ PL BRN ANHYD.

SURVEY @ 4289' 4.96° INC 325.6° AZI 4286' TVD

SLATE: PRED BLK-DK GRY, COM LT GREY, WHT, LT OLV GN, RR MTLC GLD; V FRM-HD, BRTL; OCC SLI FRIAB; RR FISS, APHANIC-CRYPTOXLN, COM SLTY TEX; TR FOLI CTNGS W/PHYLIC TEX; RR V FN MICA; WXY-GRSY LSTR; ABD OLV GRN MICRITIC OLV GRN DOLOSTN, W /TR LOW GRD META LIMESTON INTRBDS; INCR LOW GRD META AERNIC SS W/INCR FUSED GRS & SILICIS CMT; COM EUHED & DRUSSY PYR, COM CHLORIC ALTN.

SLATE: S&P LT-DK GRYSH BLK OVERALL; COM WHT, PNK, OCC OLV GRN, RR MTLC GLD; V FRM-HD, OCC BRTL; LG SB-BLKY CTNGS; SLI FRIAB; RR FISS, APHANIC-CRYPTOXLN, WXY LSTR; RR V FN MICA W/FLOI TEXS; COM OLV GRN MICRITIC OLV GRN DOLOSTN, W /TR LOW GRD META LIMESTN INTRBDS, RR PNK-WHT V HD MARBLE FRAGS SCATT; COM EUHED & DRUSSY PYR, COM CHLORIC ALTN.

SLATE: S&P DK GRY T/GRYSH BLK OVERALL; PRED DK GRY & GRSH BLK W/ABD WHT, RR PL BRN & PL OLV; V FRM T/HD; BRTL T/CRNCHY; IRREG, AP BRECCIATED & REXLZD CTGS; V RR PR FISS; PRED APHNC W/ABD MICACEOUS SILT SZD SPRKLS; COM SBPHYLITIC TEX W/RR FNT FOLI; ABD V FN SD CMPNTS; AP SLI MM FNLY SDY SLTSTN; HILY CALC OVERALL & ABD CALC MCR VNNG; COM EUHED QTZ IN AP THN, BUT INCRSNGLY PERV FRACS; COM CUBIC & DRUSY PYR; RR ANHYD & V THN SML EUHED NATROLITE XLS.

NOTE: INCR DN HOLE LOSSES @ 4554' (50 BBLS/HR); LSNG 130 BBLS/HR BY 4568', 190 BBLS/HR BY 4582'; @4583' BLEW POP OFF, ENCOUNTERED TIGHT HOLE, LOST CIRCULATION; POOH; R/D DIRECTIONAL; R/U AIR JAMMERS; M/U BHA W/O DIRECTIONAL & RIH; DRILL AHEAD W/AIR F/4583-4604'.

NOTE: DRILL BLIND F/4604'; DIVERT PITS T/SUMP; DRLNG AHEAD W/UNKNOWN LOSSES; PRTL RTRNS 4615- 4627'; DRILL BLIND 4627-4674'.

NOTE: DECREASED ROP F/4665'-4674'; POOH FOR BIT; P/U NEW BIT #7; RIH T/4649', CIRC W/AIR + MUD T/DISCHARGE WELL, MAX TEMP @ 255°F; DRILL AHEAD W/AIR+MUD F/4674'-4689'; DRILL AHEAD BLIND F/4689'.

DRILL BLIND T/4737'; ATTEMPT T/DISCHARGE WELL W/AIR & MUD, NO FLOW OUT, EXHAUSTED ALL AVAILABLE MUD/ H2O; POOH T/3619'; BUILD VOLUME; RIH & TAG @ 4733'; DISCHARGE WELL W/AIR & MUD; DRILL AHEAD W/AIR T/4758' (TD); NO RTRNS AFTR 4747' (LAG).

PULL 3 JNTS; RIH T/BTTM & CIRC W/O RTRNS; POOH T/4460'; RIH & TAG FILL (9'); POOH & L/D BHA; R/R WIRELINE LOGS; M/U BHA & RIH (TAG @ 4743', 15' FILL); POOH T/3421'; RIH T/ 4587'; PUMP AWAY SUMP DN HOLE; RIH & TAG @ 4741 (17'FILL); POOH; L/D BHA; R/R 9 5/8" LINER T/4753'; RIH OPEN ENDED T/1748'; RUN STATIC LOGS & FLOW TEST WELL.

NOTE: TD @ 4758'

Dixie Meadows 24(13)-8 ST2

Geothermal
MD Mudlog
1:600 Scale

HORIZON WELL LOGGING, INC

3769 Constellation Road
Lompoc, CA 93436
Phone 805-733-0972
Fax 805-733-0992
http://www.horizon-well-logging.com

AK Phone 907-563-7002
Online Real-Time
Well Data Access:
www.horizonwells.com

COMPANY	ORMAT Nevada, Inc.
WELL	Dixie Meadows 24(13)-8 ST2
LOCATION	T22N-R35E MDB&M 39.78984611 -118.077598611 (NAD83)
ELEVATION	3517' (KB); 3496' (GL)
FIELD	Dixie Meadows
COUNTY & STATE	Churchill, NV
API No.	27-001-90516
SPUD DATE	2015.11.18
LOGGING DATES	2015.11.18-2017.09.21
LOGGING DEPTHS	100'-4800'
CO. GEOLOGIST	Ben Delwiche
DRILL SITE MANAGER	Bruce Case Brian Oliver
CONTRACTOR	GeoDrill, Inc.
RIG	3
MUD COMPANY	GEO Drilling Fluids/Sinclair
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	Dave Baldazzi, Don Thompson, Jay Zlotkowski
BIT SIZE	42" t/101', 26" t/505' 17.5" t/3060', 12.25" t/3400' 8.5" t/4800' 8.25"x13" Opener 3410'-4795'
CASING	30" Conductor t/101' 20" 94# K-55 t/495' 13.375" 61# K-55 t/2813' 9.625" 40# K-55 2710'-3394'

Abbreviations

CO	Circulate Out
LAT	Logged After Trip
CG	Connection Gas
WG	Wiper Gas
TG	Trip Gas
SG	Survey Gas
NR	No Returns
NB	New Bit
WR	Wiper Run
WOB	Weight On Bit
PP	Pump Pressure
SPM	Strokes Per Minute
POOH	Pull Out Of Hole
LC	Lost Circulation

Symbols

CATACLASITE, APLITE DIKE, QUARTZ DIORITE, GRANODIORITE, PHYLLITE, SLATE, GNEISS, QUARTZITE, SILTSTONE, CEMENT, SANDSTONE, BRECCIA, ALLUVIUM

Drill Rate	MD	Lithology	Fractures	Mud Loss	Minerals (Quartz, Calcite, Pyrite, Hematite, Epidote, Chlorite, Anhydrite, Sericite)	Temperature	Gases	Descriptions

Descriptions

NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM K.B. AND ARE BASED ON DRILLER'S PIPE TALLY. SAMPLES ARE DESCRIBED WHILE WET UNLESS OTHERWISE NOTED; COLORS ARE BASED ON THE GSA ROCK COLOR CHART; ALL GAS EQUIPMENT IS CALIBRATED TO SPWLA STANDARDS.

SPUD DIXIE MEADOWS 24-8 ON NOV 18TH 2015 @ 23:55 HRS.

NOTE: LAGGED CUTTINGS SAMPLED BY GEODRILL PERSONEL, IN PART.

NOTE: RIG NOV HOOKLOAD TRANSDUCER INOPERABLE; POOH @149' FOR REPAIR.

ALLUVIUM: LT BLU GRY (BULK), PL GRN, RR PL RD; FRM-WLD; MD SD-V CRS GRVL; ANG-SBANG; PRD CHLORTZD STRLY WELDD RHYLT XL TUFF W/DISSM PYR, V RRLY OXDZD; RR CHLORTZD XL-ASH TUFF; V RR TRNSL CRS GR QTZITE FRAG; V RR HRNBLND GABBRO FRAG; V RR BLK SLTSTN; RR VOLC GLASS+PLAG XL FRAG; RR CALCT VNG; RR CALC SLTY MD GR SND MATRX.

SURVEY @190' : 1.0°INCL
SURVEY @215' : 1.0°INCL
SURVEY @265' : 0.8°INCL

ALLUVIUM: GRNSH GRY, MD BLU GRY (BULK SPL), LT BLU GRY, V PL RD; FRM-V HD/DENSE; FN-CRS GR SD, FN-MD GR GRVL; ANG-SBANG; PRD WKLY CHLORTZD WELDD RHYLT XL TUFF LITH FRAG W/ V FN DISSM PYR; TR V FN CRS GR QTZITE FRAG; MNR BLK SLTSTN; TR V FN GR QTZITE LITH FRAG; SLT MATRX W/RR CLY; RR CALC CMT VNG; TR RD BLU OPAL @290'; TR CALCT CMT BLEBS F/310-50'; V RR WHT QTZ CMT @330'.

SURVEY @355' : 0.8°INCL

ALLUVIUM: PRD PL GRN, RR BLKSH RD, DUSKY RD; PRD V HD/DENSE SBANG-RNDD MOD CHLORTZD WELDD BIOTI-SANDN XL TUFF LITH FRAG, RRLY OXDZD; V RR WHT ANG-SBANG CRS GR QTZITE LITH FRAG; TR PL GRN V HD/DENSE MD GR QTZITE LITH FRAG F/420'; MNR PL GRN SLTSTN LITH FRAG F/430'; COM VOLC GLASS; HD WHT/BLEACHD-PL GRN/WKLY CHLORTZD SLTSTN LITH FRAG F/360'; TR-MNR CALCT PF/CMT, V RR WHT QTZ BLEBS (TRNSP)CMT F/392-430'; RR WKLY CHLORTZD XL TUFF (SCT TXT) MATRX W/V FN DISSM PYR F/440'; RR FN XLN PYR.

MW 9.0 FV 56 PV 15 YP 27 PH 8.7 GEL 6/17 SOL 5 CL 150 CA 56

SURVEY @447' : 0.6°INCL

NOTE: LOSING 178 BPH F/483'. PUMP LCM, LOSING 100 BPH; LOSS RATE INCREASE T/234 BPH; STOP CIRC, PUMP/SPOT LCM SLUG; LOSING 47 BPH; MNR SBHD CALCT +TR CUBIC PYR THRU ZONE, HD BLEACHD WHT/OPAQUE SNDY SLT MATRX; ABD CALCT PF, BLADD IN PART @500'; RR QTZ BLEBS.

DRILL 26" HOLE T/505'; WIPER TRIP; CIRC; SPOT LCM; POOH; RUN 20" 94#/FT K-55 BTC CSG T/495'. CMT T/SURFACE; TEST BOPE; TAG CMT @463'; D/O CMT/ SHOE/CMT T/496'; TEST SHOE T/292PSI W/8.9 MW; DRILL AHEAD W/17.5" SLICK ASSEMBLY.

SURVEY @560' : 1.4°
SURVEY @592' : 0.7°

MW 8.8 FV 40 PV 16 YP 11 PH 11 GEL 3/8 SOL 5 CL 320 CA 72

NOTE: P/U STABS @592'

ALLUVIUM: LT-MD LT GRY (BULK SPL) V LT GRN, HD; PRLY SRTD, MD GR SD-GRVEL/COBBLE; PRD PL RD, LT BRNSH GRY, PL GRN, WHT, ANG-SBANG V HD/DENSE WELDD RHYLT TUFF; TR-MNR V HD/DENSE FN-CRS GR QTZITE LITH FRAG; PL GRN WKLY CHLORTZ/BLEACHD ANG V FN CRS GR QTZITE W/DISTNCT GR BNDRS+TR V FN FRAG; TR MNR WHT PL FN GR QTZITE LITH FRAG; RR MOD GRN HRNBLND GABBRO; MNR TRNSP VOLC GLASS+ WHT PLAG XL FRAG; WHT BLEACHD LITH FRAG DEHYDRTD; RR CMT/FRAG; TRNSP QTZ CMT F/700-10'; V RR RXLZD SLTSTN MATRX F/720-30'; V RR TRNSL QTZ BLEBS; RR V FN CUBIC PYR.

SURVEY @613' : 1.4°
SURVEY @705' : 1.4°

ALLUVIUM: MD LT GRY (BULK SPL); PRLY SRTD, CRS GR SD-GRVLS/COBBLS; ANG-WELL RDD FRAG; PRD HD/V FRM STRLY-MOD WELDD RHYLT GRN/MOD RDDSH ORNG/GRYSH RD RHYLT XL-ASH FLOW TUFF LITH FRAG; LOC RR-TR TRNSL WHT-V PL GRN CRS GR QTZITE FRAG; RR GRN SLTSTN; V RR BLK ANGLLS MDSTN/ PELITE; WHT CLY MATRX W/CRS GR SD, PRD CALCT/ DHYRTD, SFT/HYDRTD @ DRILNG BRKS; LOC RR CALCT CMT; RR CALCT PF; V RR CUBIC PYR.

SURVEY @760' : 1.6°

POOH @793': KICK-OUT NEAR BIT, PONY DC & STAB #1, REPLACE W/STAB #2.

MW 9.0 FV 51 PV 19 YP 15 PH 10 GEL 3/7 SOL 6 CL 292 CA 80

SURVEY @853' : 1.1°

POOH F/895' T/STAB, MOVE STAB +SHOCK SUB UP 90'; RIH, TAG @877', REAM T/BTTM.

ALLUVIUM: LT OLV GRY (BULK SPL); FNNR CTTGS F/880', MD-V CRS GR SD, FN CRVL, ANG-SBANG; PRD V FRM PL GRN/WKLY CHLORTZD/BLEACHD FN-CRS GRVL GRD WELDD RHYLT TUFF, ABD VOLC GLASS, RR SBHD QTZ PHENO XL FRAG, MNR PLAG, TR BIOT, V RR LAB; WHT/BLEACHD FRM/FRIA WKLY INDRTD SLTY CLAY-FN GR SD; RR CALCT/FRAG CMT-SBHD FN IN PART; RR-TR V FN CUBIC PYR.

SURVEY @938' : 0.7°,1.8°,0.9°
MW 9.2 FV 48 PV 19 YP 14 PH 9.5 GEL 3/6 SOL 7 CL 200 CA 80
SURVEY @980' : 0.7°, 0.5°, 1.0°

POOH @980': P/U NEAR BIT, PONY DC, & STAB.

SURVEY @1006' : 2.1°,2.1°,0.6°

ALLUVIUM: LT GRY, LT OLV GRY (BULK SPL); V FRM; MD-V CRS GR, FN-CRS GR SD, <2MM; PRL SRTD, FN-CRS GR SD, RE V FN GRVL; ANG-WELL RDD FRAG; PRD PL GRN/WKLY CHLORTZD/BLEACHD SLTSTN LITH FRAG W/V SKT ALTRTN+V FN DISSM PYR; COM WHT/PL RD/ PL HRDSH HRN MOD-DENSLY WELDD RHYLT TUFF FRAG; V RR TRNSL WHT CRS GR QTZITE FRAG; ABD VOLC GLASS; SR BIOT XL FRAG; RR FN MOD CALC CMT; MNR WHT SFT TRNSPT BLACHD CLY FRM/FRIA CLAYY SS MATRX; TR-RR CALCT PF; RR V FN TRNSP QTZ XLS; RR V FN TRANSP DRUZY QTZ @1050'; RR WHT QTZ PF @1100'.

SURVEY @1048' : 0.6°,0.5°,1.6°
MW 9.2 FV 51 PV 22 YP 15 PH 6 GEL 3/6 SOL 7 CL 200 CA 80
SURVEY @1133' : 0.8°,0.6°,0.8°

ALLUVIUM: GRNSH GRY, PL BLU GRY (BULK SPL); MOD SRTD, PRLY SRTD F/1178'; PRD V HD TRNSL WHT QTZITE, RR BLK CRS GR QTZITE LITH FRAG; MD GRY PL GRN SBANG-WELL RDD FRAG; RR WKLY-STRLY WELDD SLTY SNDSTN/SND SLTSTN LITH FRAG; MNR TR V FN PYR; COM WHT, PL RD, DUSKY RD, PL NON-DENSLY WELDD RHYLT LITH FRAG; LOC ABD VOLC GLASS GRS, RR QTZ/BIOT XL FRAG; LOC CALCT PF, SBHD IN PART; LOC V RR WHT QTZ PF; RR V FN XLN PYR.

SURVEY @1218' : 0.7°,0.6°,0.8°

ALLUVIUM: GRNSH GRY (BULK SPL); PRLY SRTD, MD GR SD-FN GRVLS; ANG-WELL RDD GRS; ABD WELDD PL RD PORPH RHYLT XL-ASH FLOW TUFF LITH FRAG; PL GRN CHLORTZD SNDY SLTSTN FRAG; ABD VOLC GLASS/QTZ PHENO FRAG; RR BIOT; TR FRM/SLT BRTL WHT/BLEACHD CLYD SD MATRX; TR-MNR CALCT PF; CMT @1220'; RR WHT QTZ BLEBS; V RR V FN XLN PYR.

MW 9.0 FV 55 PV 20 YP 10 PH 9.3 GEL 4/8 SOL 6 CL 120 CA 56

SURVEY @1303' : 0.6°,0.6°,0.7°

NOTE: CLOGGED JET F/1303' SWEEP, 910 PSI @100 SPM.

ALLUVIUM: GRNSH GRY, MD BLU GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-FN GRVL; ANG-RDD; ABD WELDD RHYLT TUFF LITH FRAG, COM -ABD FRM-HD PL GRN-MSTD FN-CRS GR QTZITE FRAG; V RR BLK SLTSTN W/WK SERCT ALTRN; MNR WHT, TRNSL, MD GRN, PL RD, FN GR + CRS GR QTZT LITH FRAG; V RR STRLY CHLORTZD GABBRO FRAG; ABD VOLC GLASS, ABD BRKN QTZ PHENO FRAG (SBHD IN PART) RR-MNR ANORTHCL XL FRAG W/PL BLU RFRCTN; V FRM-HD WHT/PL GRN SNDY CLY MATRX; RR-TR CALCT PF/ VNG, RR CMT @1390'; V RR V FN TRMNTD QTZ XL @1330'; V RR WHT QTZ PF @1370'; V RR SBHD PYR.

SURVEY @1389' : 0.8°

ALLUVIUM: LT OLV GRY, GRNSH GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-FN GRVL; ANG-SBANG ABD TRNSL, WHT, PL GRN, QTZITE LITH FRAG; ABD PNK, PL RD HD/DENSE WELDD RHYLT TUFF LITH FRAG; COM FRM/ BRTLL PL GRN WKLY RXLZD SLTSTN FRAG W/V FN DISSM PYR; LOC ABD VOLC GLASS, COM BIOT XL FRAG, RR ANORTHCL; HD/ BRTL DHYDRTD WHT CLYY SND MATRX W/RR CALCT CMT, RR WHT QTZ CMT; RR-MNR CALCT PF; RR RD BLU OPAL @1470'; RR WHT CHALCDNY @1490'; RR-TR V FN PYR; RR V FN TRNSP PRSMTC LAUMNT XLS.

SURVEY @1475' : 1.1°

NOTE: LOWER WOB INCRS RPM

ALLUVIUM: LT OLV GRY, GRNSH GRY (BULK SPL); HD; FN-CRS, <2MM, MOD SRTD CTTGS T/ADLY SRTD, ANG-RDD GRS; ABD TRNSL WHT QTZITE FRAG; MNR PL GRN SLTY SNDSTN/ SNDY SLTSTN LITH FRAG; MNR PL RD/WHT WELDD RHYLT TUFF FRAG; RR QTZITE FRAG; ABD VOLC GLASS; MNR BRKN SBHD QTZ/ANORTHCL PHENO FRAG; TR GRN BIOT; HD WKLY RXLZD (SUCC TXT) WHT CLYY SD MATRX; RR TR ANHD-SBHD CALCT PF/PF; RR TRNSL WHT CHALCDNY, V RR MLKY WHT PL BLU OPAL; V RR V FN CUBIC-SBHD PYR.

SURVEY @1559' : 1.4°,1.2°

NOTE: INCRS WOB T/1605'

MW 9.0 FV 49 PV 25 YP 21 PH 8.8 GEL 5/11 SOL 6 CL 160 CA 54

NOTE: NO SAMPLES F/1600-40'

SURVEY @1645' : 1.1°

ALLUVIUM: MD BLU GRY, MD GRY (BULK SPL); HD; FN CTTGS <4MM; PRLY SRTD, MD GR SD-FN GRVL; ANG-WELL RDD; PRD PL GRN, WHT, RR DRK GRY FN-CRS GR QTZITE/DENSE SS LITH FRAG; COM WHT/BLEACHD RHYLT W/LLGD TUFF OF DOGSKIN MTN, RR PL RD DENSLY WELDD RHYLT LITH FRAG; TR GRN SNDY SLTSTN LITH FRAG; ABD VOLC GLASS; ABD BRKN SBHD QTZ PHENO; MNR TR DRK BRN BIOT, TR SBHD ANORTHCL XL FRAG; RR DEHYDRTD WHT CLYY SD MATRX; TR-MNR CALCT PF/FF; RR TRNSL QTZ; RR V RR SUCC CHALCDNY PF; RR V FN CUBIC PYR; V RR V FN PYR; V RR SLT XLS @1760'; EPID STN + TRNSL WHT QTZ BLEBS @1780'.

SURVEY @1729' : 1.2°

MW 9.0 FV 48 PV 23 YP 24 PH 8.9 GEL 5/10 SOL 6 CL 350 CA 68

SURVEY @1815' : 1.3°

NOTE: CLOGGED JET AFTER 1816' CONNCTN, 1500 PSI @109 SPM; CIRC, SURVEY, POOH; L/D BHA; P/U NB#3 + NEAR BIT, 2-NEW STABS, SHOCK SUB.

ALLUVIUM: MD LT GRY, PL BLU GRY (BULK SPL); MOD SRTD, MD GR SD-CRS GR-COBBLES/SML BOULDRS; ANG-SBANG; ABD WHT/PL GRN/MOD GRN WKLY CHLORTZD, ABD RHYLT TUFF LITH FRAG; COM PL GRN/RD/OLV GRY WELDD RHYLT TUFF LITH FRAG; MNR FRM/BRTL PL GRN SLTSTN/RD SLTY SNDSTN LITH FRAG; TR WELL RNDD V RR CHLORTZD GABBRO FRAG; MNR QTZ PHENO FRAG; TR BRN BIOT; V FRM/ BRTL PL GRN SLTY SS MATRX; TR-ABD CALCT PF/ FF; RR MLKY WHT/ PL BLU CHALCDNY/OPAL; RR FN CUBIC PYR.

SURVEY @1903' : 1.1°

MW 9.0 FV 48 PV 20 YP 22 PH 9.1 GEL 5/10 SOL 6 CL 320 CA 64

SURVEY @1987' : 1.2°

ALLUVIUM: LT GRY, LT BLU GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-CRS GR COBBLES; ANG-WELL RDD; PRED V HD/DENSE TRNSL WHT CRS GR QTZITE LITH FRAG; COM PL GRN WKLY CHLORTZD FN GR SNDY SLTSTN LITH FRAG; COM V HD/DENSE WELDD RHYLT TUFF LITH FRAG; MNR VOLC GLASS; TR SANDN PHENO FRAG; MNR BRKN SBHD QTZ PHENO FRAG; TR BIOT; MNR FRM/FRIA CLYY SD MATRX; RR-MNR CALCT VNG, CMT @2025'; RR WHT QTZ CMT @2030'; V RR WHT/PL GRN FRM/FRIA CLYY SS MATRX; RR-MNR CALCT PF/FF; LOC RR TRNSL MLKY WHT CHALCDNY PF/BLEBS; V RR CUBIC PYR.

SURVEY @2071' : 1.4°

ALLUVIUM: MD LT GRY, PL BLU GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-GRVL/COBBLS; ANG-WELL RDD GRS; ABD PL GRN/MOD RD, WKLY RXLZD SS LITH FRAG; ABD TRNSL WHT/ GRN QTZITE LITH FRAG; RR TRNSL MD GRN HD/SLI BRTL CRS GR QTZITE; RR V FRM/SLI FRI WHT SS; MNR PL RD/MOD ORNG WELDD RHYLT TUFF; V RR CHLORTZD GABBRO FRAG; V RR V HD PNK PHANRTC QTZ MONZNT/PLAGT (ROTATE) FRAG; V FRM/HD WHT/PL GRN SLTY SD MATRX; TR-MNR CALCT PF/FF; LOC V RR PL BLU/WHT OPAL/CHALCDNY, OCC W/SCAT HMT STNG, DETRITAL?; RR-TR V FN CUBIC PYR.

SURVEY @2158' : 1.6°

MW 9.2 FV 49 PV 24 YP 23 PH 8.8 GEL 6/12 SOL 7 CL 400 CA 64

SURVEY @2244' : 1.8°

ALLUVIUM: MD LT GRY, LT BLU GRY, MD GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-GRVL/COBBL+ SML BLOCKS; ANG-WELL RNDD; PRD V HD/DENSE TRNSL WHT QTZITE LITH FRAG; COM V FRM/BRTL PL GRN/ LT GRY SNDY SLTSTN LITH FRAG; MNR PL GRN HD/DENSE FN-CRS GR QTZITE LITH FRAG; MNR V FRM/BRTL GRN/ WELDD RHYLT TUFF LITH FRAG; SLTY CHLORTZD RXLZD PSEUDMORPH ALTRTN; ABD QTZ PID PSEUDMORPH ALTRTN; ABD QTZ; RR SANDN PHENO FRAG, V RR PRSMTC WHT APATITE PHENO FRAG W/ BIOT ADULRSCNC; RR TRNSP VOLC GLASS; V RR ANORTHCL; RR GRN BIOT; MNR WHT/PL GRN SLTY RXLZD MATRX; SLTY CLY SD; TR-MNR CALCT PF/ FF @2244'; V RR CALCT CMT @2270'; RR CALCT PF/FF.

SURVEY @2329' : 1.6°

MW 9.1 FV 47 PV 19 YP 20 PH 8.9 GEL 5/11 SOL 6 CL 320 CA 56

ALLUVIUM: MD LT GRY, MD BLU GRY (BULK SPL); HD; PRLY SRTD, MD GR SD-FN GRVL; ANG-WELL RDD; ABD TRNSL WHT, PL GRN CRS GR QTZITE LITH FRAG; MNR LT GRN/ MOD GRN CHALC/MRLNG OXDZD WELDD RHYLT ASH-FLOW TUFF LITH FRAG; MNR V FRM/BRTL PL GRN SLTY SS; MNR PL GRN GRY GRN CHLORTZD/ZEOLTD SS LITH FRAG; SR GRN/ HD WKLY BLEACHD LITH FRAG, OCC WHT/BLEACHD +PL GRN/WKLY CHLORTZD/CHLORTZD SLTSTN FRAG; V RR MOD GRN HD/DENSE WHT-PL GRN GRANODIORT FRAG; MNR SBHD QTZ/FLDSP PHENO FRAG; TR BIOT; ABD VOLC GLASS/ QTZ/FLDSP/ PHENO XL FRAG; TR BIOT; MNR WHT-PL GRN CLYY SD MATRX; TR-MNR CALCT PF/FF; LOC V RR PL BLU/GRN/ WHT OPAL/CHALCDNY; RR-TR FN CUBIC PYR; RR V FN CTTGS/ORS SD W/MNR CALCT PF/2410-30'.

SURVEY @2410' : 1.7°

MW 9.1 FV 48 PV 19 YP 20 PH 8.7 GEL 5/12 SOL 7 CL 360 CA 64

SURVEY @2495' : 2.0°

ALLUVIUM: LT-MD LT GRY, MD GRY (BULK SPL); HD; PRLY SRTD, MD-CRS GR SD-FN GRVL; ANG-SBANG; ABD HD/DENSE WHT/TRNSL WHT MD-CRS GR QTZITE GRVL FRAG; TR PL GRN FN GR QTZITE LITH FRAG; RR TRNSL CRS GR QTZITE LITH FRAG; MNR PL GRN WKLY CHLORTZD RR WHT/PL GRN WELDD RHYLT TUFF FRAG; V RR BLK/DRK GRY MUDSTN FRAG; COM SBANG QTZ SD GRS; MNR CHLORTZD GABBRO FRAG; RR FRM/FRIA CLYY SLTY SS MATRX; TR-MNR CALCT PF; RR CMT; LOC TR TRNSL WHT CHALCDNY W/V FN SUCC TXT; RR WHT CUBIC PYR; V RR XLN EPID @2500'.

SURVEY @2584' : 2.1°

NOTE: LOSING 17 BPH F/2610'. INCRS T/26 BPH; PUMP LCM.

SURVEY @2665' : 1.7°

ALLUVIUM: LT GRNSH GRY, LT BLU GRY (BULK SPL); HD; MOD GRNSH GRN (BULK SPL); ANG-SBANG; PRD V HD TRNSL WHT/DKR GRY/PL GRN QTZITE LITH FRAG; COM FN-CRS GR QTZITE FRAG; COM RD BRN/PL BRN/ PL GRN RHYLT ASH-FLOW TUFF FRAG W/COM DRTD TXT; ABD VOLC GLASS; CHLORTZD GABBRO FRAG W/COM BT PSDMRPH ALTRTN; SFT-FRM WHT RXLZD CLY-SD MATRX; TR XLN EPID F/2627'; TR RR CALCT PF; RR FRAG WEATHRD F/CASCADED @2627'; RR TRNSL WHT SUCC CHALCDNY; RR TRNSL WHT QTZ BLEBS @2705'; RR V FN XLN PYR; V RR SBHD PYR F/2710'; V RR FN CUBIC PYR.

NOTE: 20 PSI PP DROP NOTED @2618'; INFORM RIG PERSONNEL; TWIST OFF @2713'-ENNZ'N; POH/RECOVER ALL FISH; ONE DAMAGED BIT THREADS; P/U NB #4, NEAR BIT, PONY, 2-STABS.

SURVEY @2755' : 1.7°

ALLUVIUM: LT-MD DRK GRY, PL RD (BULK SPL); HD; PRLY SRTD, MD-CRS GR SD-FN GRVL; ANG-WELL RNDD; PRED TRNSL/TRNSL WHT/PL GRN HD/DENSE CRS GR QTZITE W/PRLY DISTINCT GR BOUNDRS +RR FN XLN PYR; ABD DRK GRN LG GR QTZ W/DISTINCT GR BOUNDRS; COM PL GRN/RDSH/WHT WELDD RHYLT ASH-FLOW TUFF; V RR SHT/LT GRYSH GRN RHYLT XL TUFF-FRAG; V RR V FN CHLORTZD GABBRO FRAG; W/SCT EPID ALTRTN; RR MOD ORNG RHYLT FRAG; RR WHT QTZ FRAG; W/EPID PSEUDMRPH; FRM/FRIA WHT/BLEACHD LITHIC FRAG W/GREEN CLAY SEMI MATRX; SFT-FRM RR SD LS MTRX; TR-MNR CALCT PF; RR TRNSL WHT CHALCDNY PF W/V FN SUCC TXT; RR WHT CUBIC PYR.

SURVEY @2840' : 1.8°

NOTE: DRILL T/3060' ON 12/17/2016; RUN FMI & TP LOGS; PERFORM INJECTIVITY TEST; SAND BACK; RUN SURVEY TOOL TO TAG SAND LOST TOOL; SAND BACK; RUN 13.375" CASING T/2813'; CEMENT; CLEAN OUT SAND T/3057'; POOH; RE-ENTER WELL ON 8/17/2017; RIH OPEN ENDED TAG @ 3013'; CLEANOUT WITH AIR AND UNLOAD WELL W/700 CFM; SET 3 CEMENT PLUGS; POOH; P/U TOP TOOLS; RIH T/2821'; TAG CMT; DRILL OUT CMNT T/2883'; CONTROL DRILL F/2883' T/2925'; START SIDE TRACK @ 2930'; STUCK PIPE @ 3098'; JAR ON STUCK PIPE; FREE POINT FISH; REMOVE PARTIAL BHA; CMT 2 PLUGS OVER UBHO/STAB/MWD/BIT; TAG CMT @2924' ON 8/30/2017; POOH; CLEAN CEMENT T/2950'; CONTROL DRILL F/2950' T/2991'.

ALLUVIUM: MED-DK GRY IN BULK, WHT, CLR-TRANS, PL PNK; MED-V CRS; PRLY SRTD; ANG-SBANG; OCC SBRND; LOW SPHERE; MOD CALC; PRED QTZ & FSPR(PLAG & ORTHCLA); SCAT VOLCANIC LITHICS; COM DISSEM PYR, RR WHT COAL; OCC SCAT ANHD-SBHD CALCT; RR HEMTT STNG; RR CHLORT ALTN.

ALLUVIUM: LT-MED GRY IN BULK; TRANS-TSL, PL PNK; VF-CRS GR; PRLY SRTD; PRED LSE QTZ GRS W/ABNT VF GR SS FRAGS, MNR AMTS FSPR; TR V F GR DISSEM PYR.

ALLUVIUM: LT-MED GRY IN BULK, WHT; MNR AMTS PL PNK; WHT; UNCONS; VF-CRS GRS, PRLY SRTD; ANG-SBRND, ELONG-SBSPHER; PRED QTZ W MNR AMTS FLDSPR, MNR AMTS VF GR SS, SL CALC, TR VF GR INTXLN DIS PYR.

NOTE: POOH T/SHOE @ 3096'; BUILD VOLUME; RIH DRILL AHEAD.

NOTE: LOST RETURNS @ 3149'; DRILL T/3151' BLIND; REGAIN RETURNS DRILL T/3153'; PARTIAL RETURNS T/3159'; SPOT PILL ON BOTTOM; POOH T/SHOE.

ALLUVIUM: MED GRY IN BULK, WHT, CLR-TRANS; MED-V CRS; PRLY SRTD; ANG-SBANG, OCC SBRND; LOW SPHERE; MOD CALC; DULL-SBVIT LSTR; RR SUC TEX; PRED QTZ & FSPR; INCRS AMNT QTZ FRAC FILL & OCC V FN EUHD XL ON SURF & IN OPEN FRAC; COM CALCT; PRED ANHD-SBHD, OCC FRAC FILL; SCAT DISSEM & ANHD-SBHD PYR, RR SBHD PYRITOHEDRON; RR CHLORT ALTN; RR HEMTT STNG; V RR LT BLUE CHALCDNY.

NOTE: 3190'-3215' & 3230'-3240' CTGS AP BREC W/COM-ABD QTZ FRAC FILL & OCC CALCT FRAC FILL; COM ASSOC WITH CTGS THAT EXHT FLAME STRUC; POSS GNEISS.

SLATE: DK GRY, BLK; SFT-FIRM, OCC HD; PRED V FRIA, OCC BRTL; IRREG SBBLKY CTGS; OCC HCKLY FRAC; V FN-CRS XLN; DULL-EARTHY LSTR; CRMBLY; MATT; PRED QTZ & FSPR; V RR QTZ & CALCT; SCAT PYR FRAC FILL & ANHD XL; V RR HEMTT STNG; V RR CHLORT ALTN.

SLATE: MD GRY, DK GRY, BLK; PRED FIRM, BRTL, OCC FRIA; SBBLKY; OCC IRREG HCKLY FRAC; RR FISS; PEARLY LSTR; COM-ABD CALCT FRAC FILL; SCAT ANHD-SBHD PYR; V RR HEMTT VNG; MNR AMNT CONT ALLUVIUM LIKELY F/ABOVE.

SLATE: MD-DK GRY, GRDG TO BLK; V FRM TO V HD, BRTL; MASV, BLKY, SL EARTHY IP; ARG, SILIC IP; LOC V FN CALCT MICR VNNG IP; TR V F GR SDST; R DISM PYR.

SANDSTONE: V LT - MD GRY; V HD, V V IND, BRTL, SL FRIA IP; V F-F GR; MOD W SRTD; PRED QTZ GRS, SILIC CMT IP; NON - V SL CALC; NO VIS POR; GEN SBRND.

DRILL T/3400' POOH; L/D DIR TOOLS; P/U LOCKED ASSEMBLY; RIH; REAM 3360'-3400'; OPEN HOLE T/3400' W/OPENER; CIRC; POOH; RUN CSG T/3362'-3400'; CIRC B/U; SPOT PILL; WIPE T/SHOE; RIH TAG; CIRC B/U; POOH; SET 9-5/8" CSG @3394' (LAP TEST FAILED) SQUEEZE CMNT; TAG @2678'; POLISH CMT T/2710'; DRILL OUT 3' PERFORM LAP TEST; RIH TAG CMT @3338'; DRILL CMT T/3395'; PERFORM SHOE TEST; D/O CMT; DRILL AHEAD.

SLATE: MD-V DRK GRY, DRK GRY BLK; V HD; PRED MASSV, COM LAMS; BLKY CTTNGS; SL ARG, SILIC IP, INTRBDD QTZ STRGRS, MOD PYR.

QUARTZITE: LT GRY, MD-DRK GRY; V HD, BRTL; WELL SRTD/V FN GR W/INDISTNCT GR BNDRS; TR CALCT, CHLOR.

MWD FAILURE, POOH @3514'

QUARTZITE: MED-V DK GRY, GRY BLK, OCC LT GRY-TRANSL; V FN GR; WELL SRTD; FIRM-V HD; PRED BRTL; OCC FRIA; PRED IRREG SBBLCKY CRGS; SLI GRTY TEX; DULL-OCC SBVIT LSTR; OCC SUC TEX; SL CALC; PRED QTZ & FSPR; SCAT-COM PYR FRAC FILL & RR SBHD-ANHD XL; RR MUSC FLKS.

SILTSTONE: DK GRY, GRYSH BLK, FIRM; BRTL; SBBLKY; SL GRTY; EZLY SCAPBD; COM WHT COATNG; AP ESPR CSY ALTN; ABD V FN FSPR PRENOS; SCAT QTZ & CALCT FRAC FILL; RR SBHD CALCT XL; RR ANHD PYR.

PHYLLITE: MED LT GRY, MED GRY; FIRM-V HD; OCC FRIA; PRED V FN GR; WELL SRTD; PRED IRREG SBBLKY CTGS; PRED QTZ, OCC LAM; COM CALCT FRAC FILL; SCAT DISSEM & ANHD PYR; V RR CHLORT ALTN.

PHYLLITE: DK GRY, GRYSH BLK; V HD; BRTL, BLKY; MASV, V SL-MOD CALC, TR V TRN CALC VNG, TR PYR BLEBS.

PHYLLITE: DK GRY, GRY BLK; V FRM-HD; SL CRMBLY - BRTL, CRNCHY IP; BLKY, MASV; V SL-MOD CALC; TR AMTS PHL-CALCT-PYR BREC FRAGS.

PHYLLITE: MED GRY, DK GRY, GRY BLK; V FRM-HD; SL CRMBLY - BRTL, CRNCHY IP; BLKY; MASV; V SL-MOD CALC, TR AMTS PHL-CALCT-PYR BREC FRAGS.

QUARTZITE: V LT GRY, TSP, FRM, V HD, FRIA IP-BRTL, V F-F GR, W SRTD, SB ANG-SBRND GRS, SILICA CMT, SL CALC.

PHYLLITE: MED GY- DK GY BLK, V FRM-V HD, SL CRMBLY - BRTL, V HD IP; BLKY; WKLY DISM CALC - V THN CALC VNNG IP, TR DISM PYR.

PHYLLITE: DK GRY, DK GRYISH BLK, MOD HD, MASS, BLKY, DECR PYR, DECR QTZ.

ALTERED DIKE: LT OLV GRY, LT GRY; SFT-MOD FRM, CRMBLY-BRTL; GRAN; CHLITZD + KAOLIN GRNDMAS;

PHYLLITE: MED GRY, DK GRY; V FRM-V HD; SL CRMBLY - BRTL, V HD IP; BLKY; WKLY DISM CALC - V THN CALC VNNG IP, TR DISM PYR.

QUARTZITE: V LT V SL OLIV GRY; V HD, BRTL, AMORPH APP, SL CALC, (25% OF SMPL).

PHYLLITE: BLK, V DRK GRY, RR PHT GRAPHT SHEEN; HD/BRTTL, OCC FISSL, LAM; RR DIAGNC PYR; RR LT OLV GRY, V HD FN GR QTZITE; V RR BRECC W/CALCT CMT @3910'; V RR WHT/OPAQ SUCC CHALCDNY @3910'; DB 3943'-3947', V RR DRK GRY CALCLST, V RR BRECC W/CALC CMT, OLV GRN QTZITE FRAG; V RR ARAG; ABD CALCT @3960'; V RR CATACLST.

SLATE: BLK, V DRK GRY; HD/V HD, BRTL W/IRREG FRAC; PR FISS, LAM, PR DIAGNC PYR; QTZ PSEUDOMRPH; ABD-MNR CALCT FF; RR V FN TRNSL STRIA, PRSMTC NATROLT? XLS ON CALCT @3980'; V RR FN BRECC W/CALCT CMT @3985'; MNR THIN CALCT VNG 3980'-4000'.

SLATE: BLK, V DRK GRY W/GRAPH; HD-V HD, BRTL; BLKY CTTGS W/PR IRREG FRAC; PRD MASSV, RR LAMS W/PR FISS; TR DIAGNC PYR; ABD SCT-ABD CALCT FF; RR CALCT BLADS; V RR VUGGY CHALCDNY @4010'; RR-MNR LT OLV- GRNSH GRY V HD FN GR QTZITE-ARGLL QTZITE @4010'-4030'; RR V FN TRNSP STRIA/PRSMTC NATROLT? XLS @4040'; DECRS CALCT.

SLATE: DRK GRY W/SILVRY GRAPHT SHEEN; HD/BRTL, FRIA; SLI PHYLTC; BLKY, WKLY FOL/SCALED; OCC BLK; V HD; MASSV; RR DIAGNC PYR; RR MD-DRK GRY ARGLL QTZITE; TR PL GRN FN GR QTZITE; TR QTZ FF; TR-COM CALCT FF; V RR V FN TRNSP STRIA/FLUID NATRLT @4080' & @4120'; @4100'; V RR TRNSP QTZ; V RR CHALCPYR @4110'; V HD MASSV/WKLY FOL SLATE F/4105'; RR V FN TRNSL GRNSH GRY QTZITE/ARGLL QTZITE @4130'; V RR COVELT? @4140'.

MW 9.0 FV 40 PV 16 YP 12 PH 10 GEL 5/8/13 SOL 7 CL 1000

SLATE: MED-DK GRY, SHINY GRY; V FRM-HD; MASS-LOCALY LAM; MNR QTZ VNS; LOCAL SLI BREC, SCAT PY; INCRSNG CALC F/ 4190'-4200'

SLATE: MED-DK GY, SHINY GRY; FRM-V HD; BLKY, MASS, V THIN LAMS IN PT, BRECTD CTGS W/PYR-CALCT-SLATE FRAGS; 2NDY QTZT: V LT GRY; V HD, BRTL.

SLATE: MED-DK GY, SHINY GRY; FRM-V HD; BLKY, MASS, V THIN LAMS IN PT, BRECTD CTGS W/PYR-CALCT-SLATE FRAGS.

QUARTZITE: V LT GRY, V LT SL TAN GRY; V HD, BRTL, MASS, BLKY, SL ARG, TR CALCT, TR - MNR DISSM DIAGEN PYR.

SLATE: DK GRY-V SL GRN GRY IN PT, GEN V HD, BRTL, MASS, CHNKY, V FN LAMS IN PT, TR AMTS IREG DISSEM PYR

QUARTZITE/SANDSTONE: V LT GY, WHT, TRNSP, CLR; V HD, BRTL, FRIA IN PT; VF-MED GR, INDISTINCT GRS, LOOSE-W CMTD, PRLY SRTD, ANG-SBRND, ELONG-SBSPHER, RR AMTS DISM PYR.

WIPE HOLE @4321'

GRANODIORITE/TONALITE: (CNTC @4323' W/MNR SUCC CHALCDNY); WHT, V LT GRY (BULK SPL); V HD/SLI BRTL; PHAN, ABD FN EUHD-SBHD RDDSH BRN-DRK GRN BIOT PHEN, ABD TRNSP ANHD QTZ, COM WHT ANHD-SBHD PLAG; V RR CALCT FF; TR BLK SLATE+PHYLLT SLOUGH/ SIDEWALL.

GRANODIORITE/TONALITE: WHT, V LT GRY (BULK SPL); V HD/SLI BRTL; PHAN ABD FN EUHD-SBHD RDDSH BRN-SILVER GRN BIOT PHEN, ABD WHT-TRNSL WHT SBHD PLAG, COM TRNSP ANHD QTZ; RR CALCT FF.

NOTE: JARS ACTUATED PREMATRLY AFTER SLIDE; POOH @4447'; P/U NEW BIT & JARS.

GRANODIORITE/TONALITE: WHT, V LT GRY (BULK SPL); V HD, SL BRTL; PHAN, ABD WHT-TRNSL SBHD-EUHD PLAG PHEN W/POLYSYNTH TWNNG, COM TRNSP ANHD QTZ, COM FN SILVERY GRN-RDDSH BRN SBHD-EUHD BIOT PHEN; RR CALCT FF.

GRANODIORITE/TONALITE: WHT, V LT GRY (BULK SPL); V HD, BRTL; PHAN, ABD WHT-TRNSL SBHD-EUHD PLAG W/POLYSYNTH TWNNG, COM TRNSP ANHD QTZ, COM FN DRK SILVER GRN-RDSH BRN SBHD-EUHD BIOT PHEN.

GRANODIORITE/TONALITE: WHT, V LT GRY, WHT (BULK SPL); V HD, BRTL; FN-CRS XLN CTTGS; PHAN, ABD WHT-TRNSL WHT SBHD-EUHD PLAG, COM TRNSP ANHD QTZ, COM FN SILVERY GRN-RDDSH BRN SBHD BIOT; RR CALCT FF; TR BLK SLATE SLOUGH; TR WHT FRM/FRIA CONCV BIT GOUGE.

GRANODIORITE/TONALITE: V LT GRY, WHT (BULK SPL); V HD, BRTL; PHAN, ABD WHT-TRNSL WHT SBHD-EUHD PLAG, COM TRNSP ANHD QTZ, COM FN DRK RDDSH BRN-SILVERY GRN SBHD-EUHD BIOT PHEN; RR WHT FRM/FRIA CONCV BIT GOUGE.

MW 8.9 FV 42 PV 15 YP 18 PH 10 GEL 6/11/17 SOL 4 CL1000

GRANODIORITE/TONALITE: WHT, TRNSP, PEARLY LSTR IN PT; GEN V HD, BRTL; INDIST XLN STRUC, APRX 1% V FN RDSH BRN MICROXLN GRN FLAT-CC SL CRBN BIOT BOOKS-PTLY-COMPLTLY ALTD TO CHLOR; MOD AMTS V TRNSP QTZ, SL CALC; OCC PHAN TWIN STRIA.

GRANODIORITE/TONALITE: WHT, TRNSP, PEARLY LSTR IN PT; GEN V HD, BRTL; INDIST XLN STRUC, APRX 1% V FN BRN MICROXLN GRN FLAT-CC SL CRBN BIOT BOOKS-PTLY-COMPLTLY ALTD TO CHLOR; MOD AMTS V TRNSP QTZ, SL CALC; OCC PHAN TWIN STRIA.

DRILL 8.5" T/4800'; POOH; P/U LOCKED BHA, REAM F/3480'-4800'; CIRC/SWEEP; POOH; RUN ACOUSTIC LOG; RIH OPEN-ENDED T/3360'; FLOW WELL W/500-860 CFM AIR; RUN PTS LOG; PERFORM INJECTIVITY TEST; P/U 9.25" X 13" WIDER OPENER, UNDER-REAM 3410'-4383'; POOH; RE-TOOTH HOLE OPENER; UNDER-REAM 4383'-4795'; RIH OPEN ENDED T/3360'; FLOW WELL W/280-573 CFM; RUN PTS LOG; INJECTIVITY TEST; RELEASE HORIZON 2017.09.21.

Dixie Meadows 75-4

Geothermal
MD Mudlog
1:600 Scale

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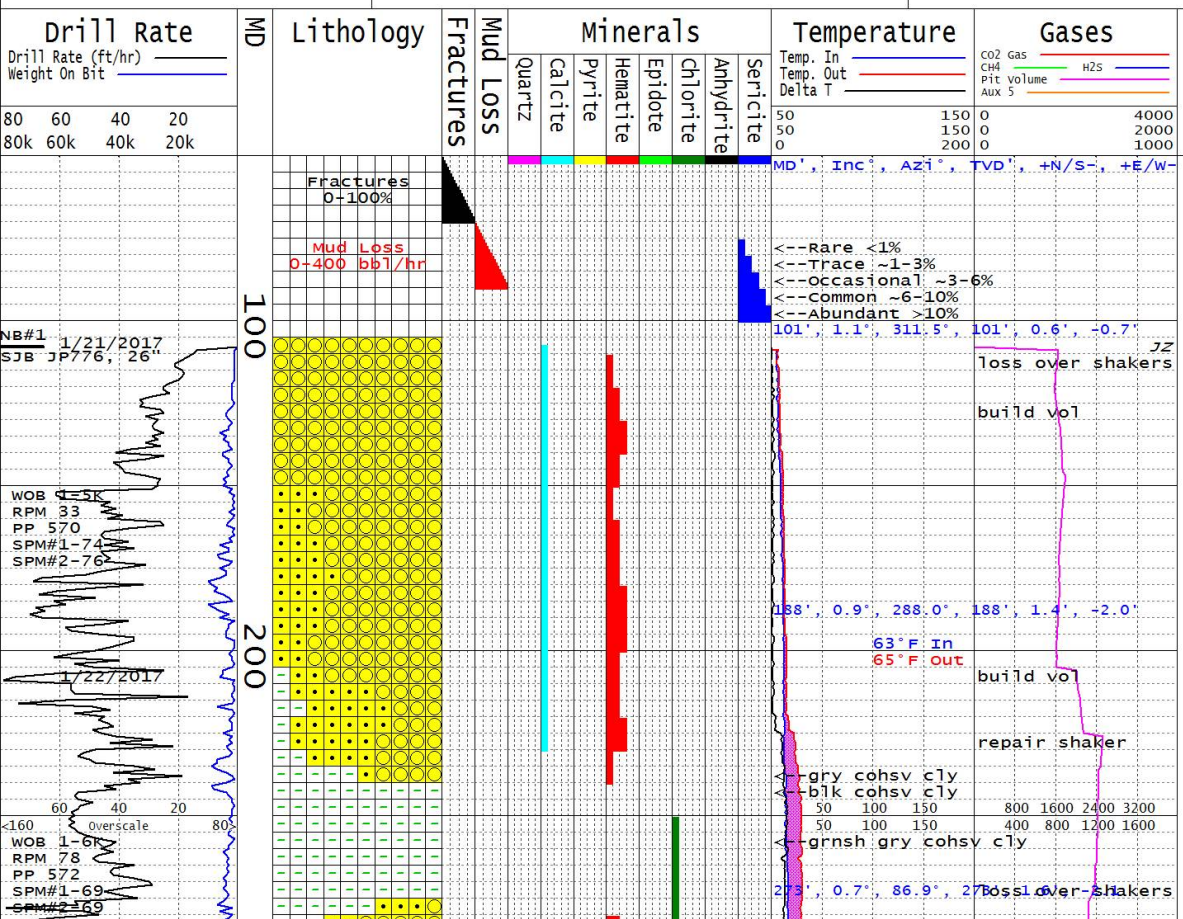
COMPANY	ORMAT Nevada, Inc.
WELL	Dixie Meadows 75-4
LOCATION	S4-T22N-R35E MDB&M 39.803198 -118.044926 NAD(83)
ELEVATION	3433' (GL) ; 3460' (KB)
FIELD	Dixie Meadows
COUNTY & STATE	Churchill, NV
API No.	
SPUD DATE	2017.01.21
LOGGING DATES	2017.01.21-
LOGGING DEPTHS	108'-5000'
CO. GEOLOGIST	Ben Delwiche
DRILL SITE MANAGER	Joe Bunce Bob Mueller
CONTRACTOR	GeoDrill, Inc.
RIG	1
MUD COMPANY	Sinclair
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	J. Zlotkowski, W. Starrett, D. Baldazzi
BIT SIZE	42" t/108' 26" t/600' 17.5" t/2500' 12.25" t/5000'
CASING	30" Conductor t/108' 20" 94# K-55 BTC t/593' 13.375" 68# K-55 BTC t/2493'

Abbreviations

CO	Circulate Out
LAT	Logged After Trip
CG	Connection Gas
WG	Wiper Gas
TG	Trip Gas
SG	Survey Gas
NR	No Returns
NB	New Bit
WR	Wiper Run
WOB	Weight On Bit
PP	Pump Pressure
SPM	Strokes Per Minute
POOH	Pull Out Of Hole
LC	Lost Circulation
TT	Trip Temperature
CT	Connection Temperature

Symbols

CATACLASITE
ANDESITE
GRANODIORITE
GABBRO
CLAYSTONE
CLAY
SILTSTONE
SAND
BRECCIA
GRAVEL
COARSE SAND



Descriptions

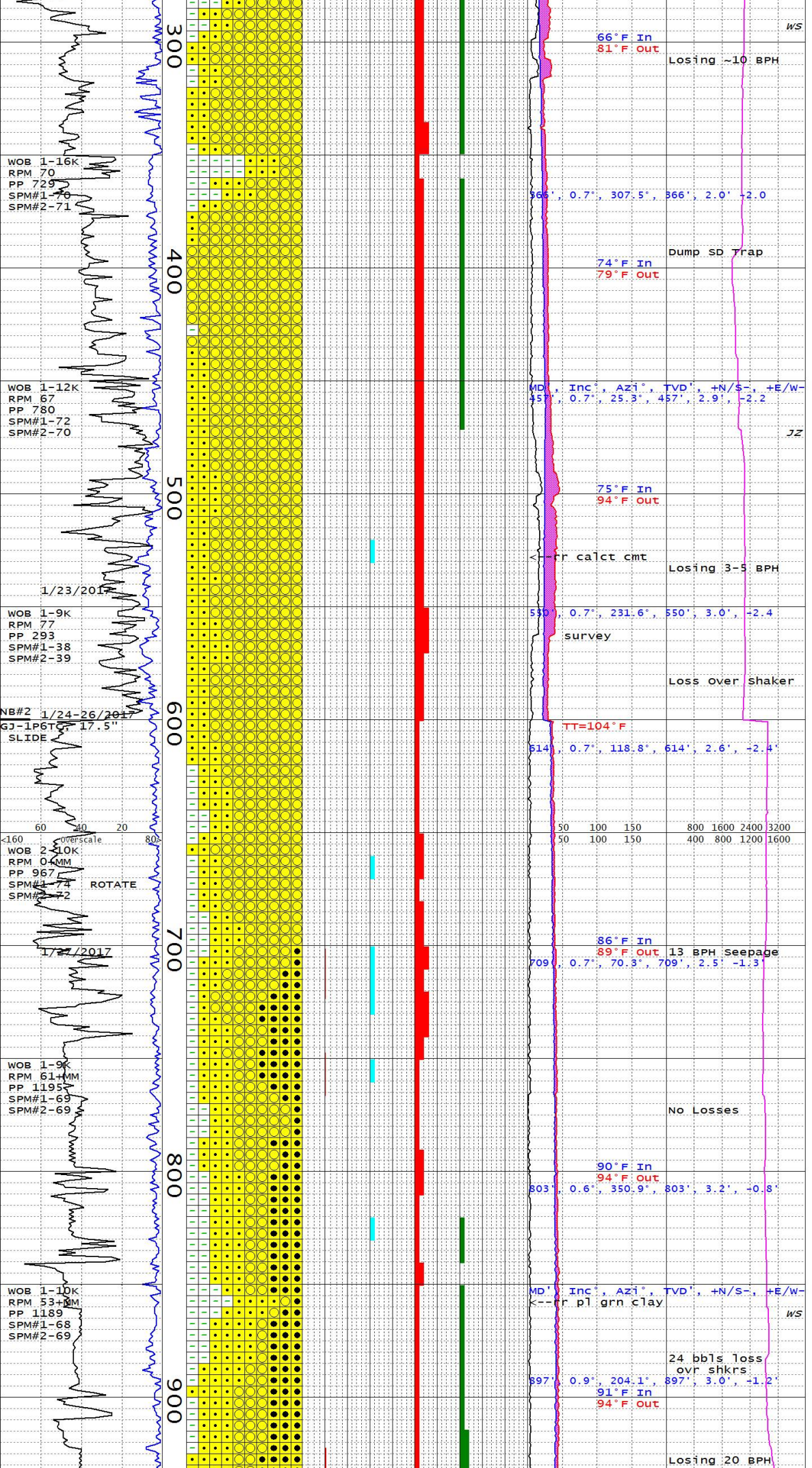
NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM K.B. AND ARE BASED ON DRILLERS' PIPE TALLY; SAMPLES ARE DESCRIBED WHILE WET UNLESS OTHERWISE NOTED; COLORS ARE REFERENCED FROM THE GSA ROCK COLOR CHART; ALL GAS EQUIPMENT IS CALIBRATED TO SPWLA STANDARDS.

NOTE: 30" CONDUCTOR SET @108' (KB); SPUD 75-4 ON JAN 21, 2017 w/26" MILLTOOTH BIT.

ALLUVIUM: DUSKY BLU, MOD YEL BRN, DRK GRNSH GRY (BULK SPLS); PRLY SRTD, MD GR SD-FN GRVL; SBRDD-WELL RDD; PRED WKLY OXIDZD-RR WKLY CHLORTZD-V RR BLEACHD RHYOLITC XL-TUFF LITH FRAG W/RR-TR LIMONIT STNG; MNR-TR DRK GRY-BLK VITROPHYRE; RR-TR GABBRO & ANORTHOST LITH FRAG W/ALBT ALTRTN OF PLAG, CHLORTZD IN PART W/V RR EPID STNG; RR DRK GRY SLATE; COM VOLC GLASS, MNR ADULARSCNT SANDN XL FRAG, TR SBHD + BYPYRAMDL TRNSP QTZ XL FRAG, V RR WELL RDD SUCC DETRITAL CHALCDNY; V RR FN BLK BIOT FRAG; FRM LT BRN DEHYDRTD CLY F/210-230'.

MW 8.8 VIS 55 PV 16 YP 24 GELST 10S-9 10M-22 PH 9.5 CL 600 CA 40

CLAY: GRY, BLK, GRNSH GRY; FRM; STRLY COHSV/ADHSV; HYDRTD; V FNT ORGNC ODOR W/IN BLK CLAY; GRDS T/ DK GRNSH GRY T/MED BLUSH GRY, WL HYDRTD, MOD SOL, HI COHES, HI PLASTICITY, SLI STIFF CLY (STILL PLSTC WHEN DEHYDRTD & V STIFF).



ALLUVIUM: MOD T/DSKY BRN BULK SPLS W/ABD MXD DSKY REDS, DK GRNSH GRYS, MOD BRNS, & LT T/DK GRYS; MED SD (TYP SBANG) T/FN GRVL & PBBLS (TYP SBRND-RND OR FRAGS W/RND SIDE); ABD DIVRS IGN LITHS: RED OXDZD ANDSIT, CHLOR ALT DIORITE, CLY ALTRD & BLEACHD XL TUFF, WL RNDD BASALT, TR GRABRO; TR VOLC GLASS; TR DK VITROPHYRE; RR AGATINE BANDD CHALDY; COM LSE DBL TERM QTZ; TR ADULARSCNT KSPRS; COM LRG FRAGS SODIC PLAG (FREQ LIMONIT STND); ABD SLI TACKY T/SLI FRIA PL BRN SOL CLY MTRX 350-370'; INCR GR SZ F/380'

ALLUVIUM: PRED MOD GRYSH BRN BUK SPLS W/ABD DIVRS DSKY T/PL REDS/BRNS, GRYSH T/DK YELSH ORNGS, & GRNSH T/DK GRNSH GRYS; AP INCR CLAST SZ, PRED CR SD T/MED GRVL & LRGR; PRED WLDD XL/ ASH/ RHYOLITIC TUFFS (COM VITROPHYRE); OCC DIORT & RR GABBRO; COM AP SILIC ALT OF TUFFS; COM SUCR CHALDY & JASP; COM SCAT BLUE SCHILLER (LSE KSPRS OCC W/IN RHYOLITE); HEMTT ALT, CHLOR ALT, LIMONT STNNG SCAT THRU; LSE BIPYR QTZ.

MW 8.9 FV 54 PV 13 YP 16 PH 9.2 GEL 10/18 SOL 4 CL 3300; (520')

ALLUVIUM: MOD RDSH BRN, GRYSH RD PURP (BULK SPL); PRLY SRTD, CRS GR SD-FN GRVL; SBRDD-WELL RDD; PRED MOD RDSH ORNG-PL RD RHYOLITIC XL-TUFF LITH FRAG; MNR STRLY CHLORTZD GABBRO FRAG W/RR EPID STNNG; RR DIORITE FRAG W/PRTLY CHLORTZD MAFICS; V RR DRK GRY META-SLTSTN FRAG; COM CRS GLASS SD; TR ADULARSCNT SANIDINE XL FRAG; RR TRANSP, OCC SMOKEY SBHD-BYPRYMDL QTZ XL FRAG W/V FN OXDZD INCLSNS; RR V FN BLK BIOT XL FRAG; V RR TRNSL WHT FN SUCC DETRITAL? CHALCDNY; SILT MATRX COMPLTLY WASHED-OUT F/SPL; V RR CALCT CMT @530'; TR LIMONT STNNG.

DRILL 26" WELL T/600'; SWEEP/ CIRC; WIPE HOLE; TAG @590'; SWEEP/CIRC, TAG @593'; SWEEP/ CIRC, TAG @599'; POOH.

RUN 20" 94# K-55 BTC CSG T/593', CMT T/SURFACE; NU/ TEST 21" 2M BOPE; M/U 17.5" BHA W/MUD MOTOR, TAG CMT @545', D/O CMT & SHOE T/593'; TEST SHOE W/0.54 GRADIENT & 8.8 MW; SLIDE-OUT F/SHOE.

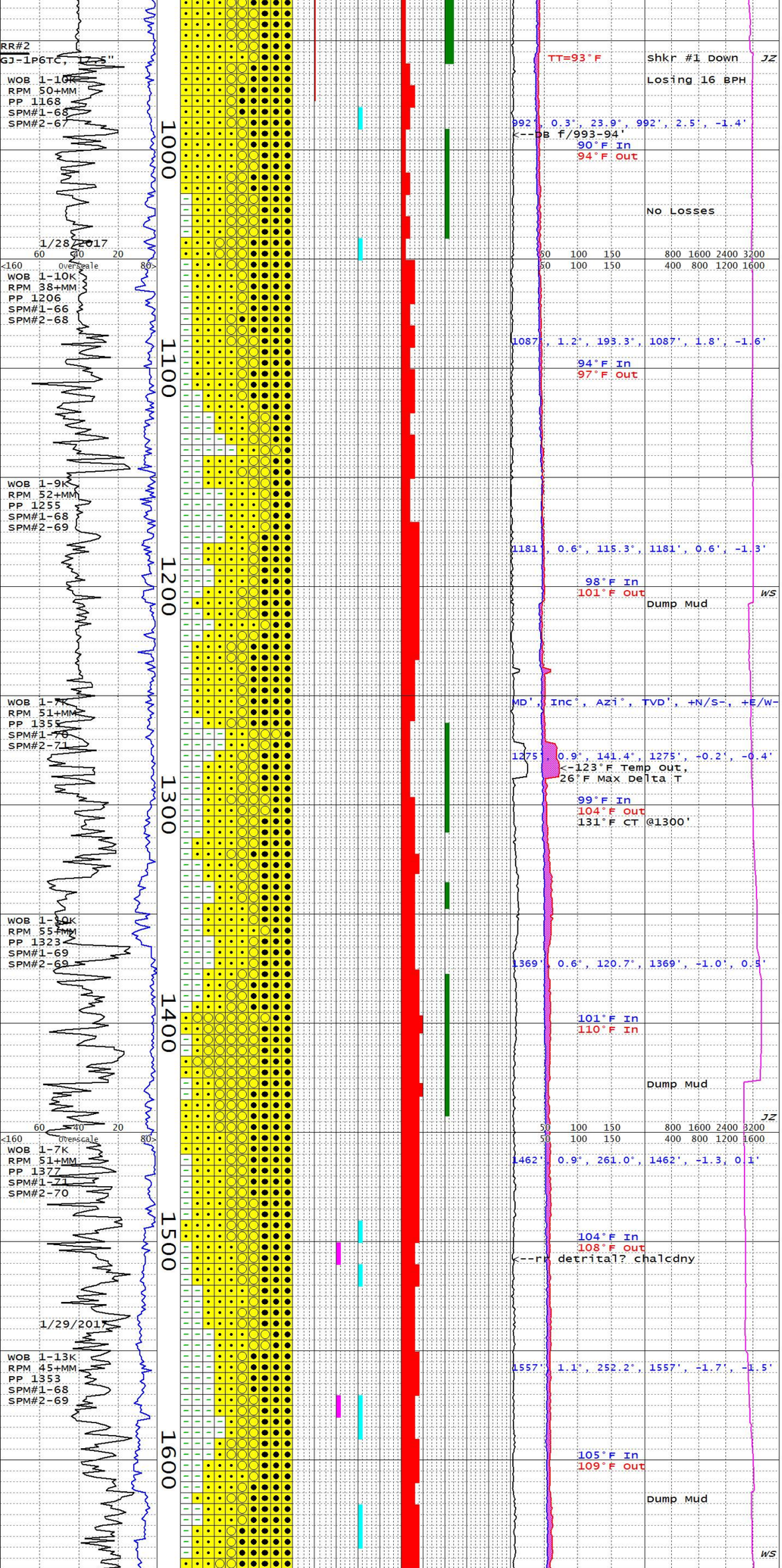
ALLUVIUM: MOD RDDSH ORNG-DRK YELLSH ORNG (BULK SPL); PRLY SRTD, CRS GR SD-FN GRVL; SBRDD-WELL RDD; PRED NON-STRLY WELDD RHYOLTC XL-TUFF LITH FRAG W/TR LIMONITE STNG; TR GABBRO FRAG W/ALBITE ALTRD PLAG & PRTLY CHLORTZD MAFICS; TR DIORITE FRAG; V RR RDSH VIOLT BRN APHAN BASALT FRAG; V RR PL GRNSH WHT FN GR QTZITE; V RR PL OLV META-SLTSTN; V RR BLK SLATE; COM GLASS SD, MNR ADULARSCNT SANIDINE XL FRAG, TR SBHD-EUHD BYPYRMDL QTZ PHENO FRAG, V RR BLK BIOT; RR-TR PL YELLSH BRN MOD COHSV CLY MATRX; LOC V RR CALCT PF.

MW 8.8 FV 46 PV 7 GEL 10/18/23 YP 12 SOL 4 PH 11 CL 3300

ALLUVIUM: DRK YELLSH BRN (BULK SPL); PRLY SRTD, OCC MOD SRTD; MD-CRS SD W/MNR FN GRVLS; ANG -WELL RDD; PRED RHYOLITIC XL-TUFF LITH FRAG - PL YELLSH ORNG-PL RDSH BRN WKLY-NON WELDD W/LIMONITE STNNG; RR PL GRN-WHT WELDD XL-ASH TUFF; MNR CHLORTZD GABBRO FRAG W/RR EPID STNNG +PSUEDMRPH; RR DIORITE FRAG; V RR BLKSH RD APHAN BASALT FRAG; V RR BLK SLATE FRAG; V RR LT OLV BRN META-SLTSTN; ABD SBHD ADULARSCNT SANIDINE XL FRAG; ABD QTZ XL FRAG, TR SBHD-EUHD BYPYRMDL; PL YELLSH BRN ADHSV, WKLY-MOD COHSV CLY MATRX; LOC RR SBHD CALCT PF.

NOTE: INCRS TORQ F/838-842'.

ALLUVIUM: BRNSH T/OLV BLK OR DSKY BRN BULK SPLS; PRED DK GRYS W/ABD DSKY REDS & DK GRNSH GRY INDIV GRS; TYP SBANG MED & CRS SD T/FN GRVL FRAGS & OCC RNDD PBBLS; PRED WLDD XL & ASH TUFF (PRED RHYOLITIC) W/OCC LITHIC TUFF; TR ALBITZD GABBRO/MICROGABBRO; V RR RNDD APHAN BASALT; COM KSPAR W/BLU SCHILLER & BIPYRMDL QTZ LSE & W/IN TUFFS; VARBL AMTS OF MOD T/DK YELSH BRN MOD SOL SILTY CLY MTRX; SCAT RED OX STNNG & CHLOR STNNG & ABD LIMONT STNNG.



NOTE: DRILL T/955'; ATTMEPT T/SURVEY, 20' OF FILL, REAM T/BTTM; SURVEY, TAG 13' OF FILL, HIGH PUMP PRESS; POOH; BIT PACKED OFF W/GRVL.

ALLUVIUM: DRK GRNSH GRY (BULK SPL); PRLY SRTD, MD-CRS GR SD-FN GRVL; AND-WELL RDD; PRED RHYOLT XL-TUFF, ABD OXDZD ORNG NON-WELDD TUFF, MNR CHLORTZD PL GRN- WHT DENSLY WELDD XL-TUFF, RR V DUSKY PURP NON-WELDD XL-TUFF W/ABD SANIDINE; MNR CHLORTZD/ALBITZD GABBRO LITH FRAG; V RR OLV-BRNSH BLK BASALT LITH FRAG; V RR GRNSH-MD GRY META-SLTSTN; V RR WHT FN GR QTZITE; COM FN ADULRSCNT SANIDINE PHENO FRAG; ABD TRNSP GLASS SD, TR TRNSP SBHD TRMNTD QTZ PHENO FRAG W/ORNG OXID STNNG; RR BLK BIOT FRAG; LOC V RR WKLY-MOD COHSV PL YELLSH BRN CLY MATRX; RR-TR LIMONT STNNG; LOC V RR CALCT PF.

MW 8.8 FV 48 PV 8 YP 12 PH 10.5
GEL 9/19/24 SOL 4 CL 5000

ALLUVIUM: DRK YELLSH BRN, OLV BRN (BULK SPL); PRLY SRTD, MD-CRS GR SD-TR FN GRVL; ANG-WELL RDD; PRED RHYOLITC XL-TUFF, ABD MOD RDDSH ORNG-PL RD NON-WELDD TUFF, RR LT GRY MOD WELLD TUFF, TR PL GRNSH WHT STRLY WELDD TUFF; COM CHLORTZD GABBRO W/RR FN EPID PSUEDMRPH; TR PL-GRYSH PURP DACITC? XL-TUFF FRAG; V RR BRNSH GRY WELL RDD APHAN BASALT LITH FRAG; V RR WHT FN GR QTZITE FRAG W/LIMONT STNNG; ABD SANIDINE PHENO FRAG, TR TRMNTD QTZ PHENO FRAG, COM TRNSP GLASS, RR FN BLK BIOT; TR-ABD PL YELLSH BRN MOD COHSV CLAY MTRX; MNR LIMONT STNNG ON TUFF FRAG.

ALLUVIUM: DK YELSH BRN T/OLV BRN BULK SPLS W/DSKY REDS, MOD T/DK YELSH BRNS, DK GRNSH GRYS, DK GRYS, & OCC BLUSH GRY GRS; MSTLY MED T/CRS SD W/MOD AMT FN GRVL/RNDD PBBL & MOD YELSH BRN CLY MTRX; PRED DIVRS WLDD XL & ASH TUFFS; COM LSE SBANG BYPYRMDL QTZ; COM RED OX STNNG.

NOTE: 10 BBL DOWN HOLE GAIN 1287-1296' (LAG DEPTH 1272-1288') W/INCR TEMP OUT & FLOW

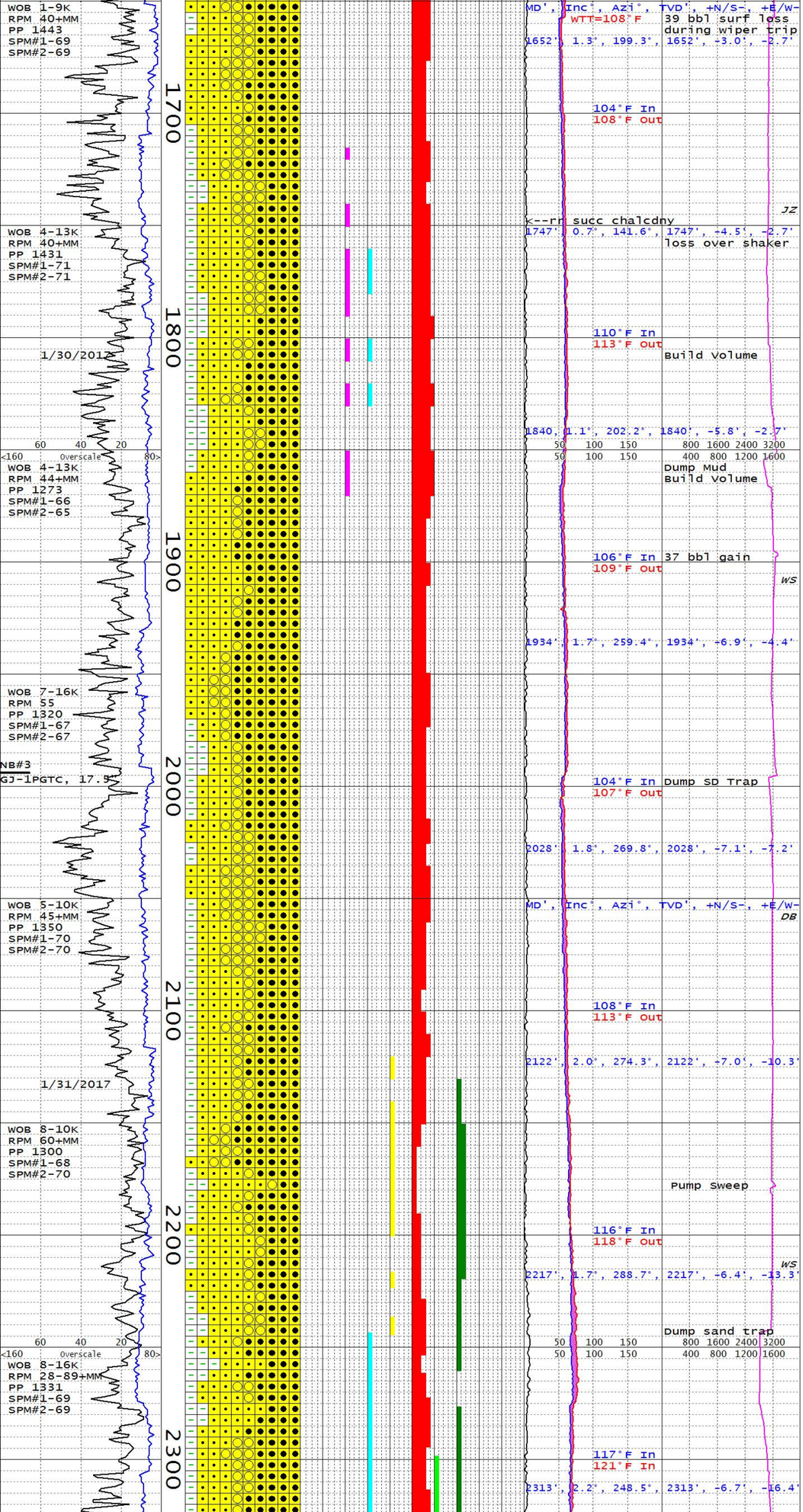
ALLUVIUM: DK YELSH BRN OVERALL; MOD YELSH BRN, DK GRY, MED BLUSH GRY, DSKY RED, & DK YESLH ORNG GRS; PRED MED T/CRS SBANG-ANG SD W/COM FN GRVL/ PBBL FRAGS, LOCAL ZONES MSTLY PBBL; MSTLY WLDD XL & ASH TUFF (COM RHYOLITIC, RRLY VITROPHYRC); TR APHAN BASALT; DIST INCR T/COM SILIC CLYSTN (TYP RNDD) OCC W/DIST FISS F/1290' ON; COM LSE QTZ GRS (FREQ DIPYRMDL & TYP SBRND), RR ADULARSCNT KSPARS; COM RED OX STNNG/ ALT & LIMONT STNNG & TR CHLOR ALT THRU.

ALLUVIUM: DK YEKLSH BRN BULK SPLS; ABD MOD YELSH BRN, MED T/DK GRY, GRYSJH ORNG T/DK YELSH ORNG, MED BLUSH GRY, OCC DK GRNSH GRY GRS; PRLY SRTD; PRED MED T/CRS SBANG T/ANG SD W/MOD AMT MOD YELSH BRN CLY MTRX GRDNG T/PRED GRVL FRAGS & SBRNDD PBBLS BY 1400' W/TR CLY MTRX; PRED MXD MULTI-COLR WLDD XL & ASH TUFF W/OCC T/ MNR TAB GRY T/BLUSH OR GRNSH GRY, HD, BRTL, SBRND T/RND SILIC CLYSTN CMPNTS; INCRSNG RED OXDTN & LIMONT STNNG; MNR CHLOR STNNG.

ALLUVIUM: DRK YELLSH ORNG-DRK YELLSH BRN (BULK SPL); PRLY SRTD, MD-CRS GR SD-FN GRVL; ANG-WELL RDD; PRED PL RDDSH BRN NON-WELDD RHYOLTC XL-TUFF LITH FRAG, COM PL RD-WHT WELDD XL-TUFF FRAG; MNR GRANODIORTE FRAG, RR CHLORTZD GABBRO FRAG W/EPID STNNG/PSUEDMRPH; V RR MD GRY META-CLAYSTN; COM GLASS SD, RR SBHD TRMNTD PHENO FRAG, RR ADULARSCNT SANIDINE PHENO FRAG, V RR BLK BIOT; RR-TR WKLY COHSV CLAY MATRX; COM PL YELLSH ORNG LIMONT STNNG; V RR LOC SBHD CALCT PF; V RR DETRITAL TRNSL WHT SUCC CHALCDNY @1510'.

MW 9.1 FV 51 PV 12 YP 16 PH 10
GEL 8/17/26 SOL 6 CL 6000

ALLUVIUM: DRK-PL YELLSH ORNG, GRYSH ORNG (BULK SPL); PRLY-MOD SRTD, MD-CRS GR SD W/TR-COM FN GRVL; ANG-WELL RDD; PRED OXDZD NON-WELDD RHYOLTC XL-TUFF, TR WHT-PL GRNSH WHT WELDD XL-TUFF, MNR V DUSKY RD APHAN BASALT, TR GRANOD FRAG, RR CHLORTZD GABBRO FRAG, TR MD GRY SILIC CLAYSTN; COM GLASS SD, TR SBHD QTZ PHENO FRAG, V RR SANIDINE PHENOS FRAG; TR-ABD MOD COHSV PL YELL BRN CLAY MATRX; COM LIMONT STNNG ON LITH FRAG; LOC V RR SBHD CALCT PF; V RR WHT SUCC CHALCDNY @1580'.



NOTE: WIPE T/SHOE F/1657'; SERVICE RIG.

ALLUVIUM: TYP DK YELSH BRN BULK SPL; ABD DSKY RDDSH BRN & MOD YELSH BRN, COM DSKY RED, PL YLESH T/GRYSH ORNG &* MNR DK GRY GRS; PRED ANG CRS SD & SBANG T/ANG MED SD, & COM SBANG PBBL FRAGS; PRED WLDD XL TUFFS W/ABD RED OX STNNG & LIMONT STNNG (TYP RHYOLITIC, TR PUMICY TEX, TR VITRS); TR ASH TUFF; TR FNLY SUCR CHALDNY (RR TRANLS/ MLKY & VITRS); TR GRNODRT FRAGS & AP HEMTT ALT V DSKY RD BASALT; V RR PINK FLOW BRECCIA.

MW 9.1 FV 52 PV 13 YP 24 PH 9.6 GEL 8/19/25 SOL 5 CL 6000

ALLUVIUM: GRYSH ORNG, PL YELLSH BRN (BULK SPL); PRLY SRTD; MD-V CRS GR SD T/RR FN GRVL; ANG-WELL RDD; ABD LT RD, MOD RDDSH ORNG NON-WELDD RHYOLT XL-TUFF LITH FRAG; ABD WHT STRLY WELDD XL-ASH TUFF FRAG; COM OXDZD PL RDSH BRN, GRYSH RD BASALTIC ANDST FRAG; RR GRANODRT FRAG; V RR LT BLU GRY META-CLYSTN FRAG; COM VOLC GLASS SD, V RR ADULARSCNT SANIDINE PHENO FRAG, V RR BLK BIOT FRAG; V RR PL RD FN GR QTZITE FRAG; PL YELLSH BRN WKLY COHSV CLAY MATRX; COM-ABD LIMONITE STNNG; LOC RR TRNSL WHT SUCC CHALCDNY PF; LOC V RR CALCT PF, OCC SBHD.

ALLUVIUM: GRYSH ORNG MOD YELLSH BRN; PRLY SRTD, MD-V CRS GR SD T/RR FN GRVL; ANG-WELL RDD; PRED WLDD (TYP RHYOLTC) XL TUFFS (ABD DSKY RDDSH BRN, DSKY RED, MOD BRN, OCC DK BRNSH GRYS, & MOD PINKS); COM NON-WELDD GRYSH PNK, YELSH GRY & V PL ORNG XL TUFF TYP W/SME LIMONT STNNG; TR MOD YELSH BRN SILTY, HI SOL, LOW COHES CLY MTRX; TR GRYSH OLV FNLY SUCR CHALDNY; COM LSE QTZ & KSPARS (OCC ADULARSCNT); ABD RED OX STNNG & YEL LIMONT STNNG THRU;

NOTE: BIT TRIP @ 1994'

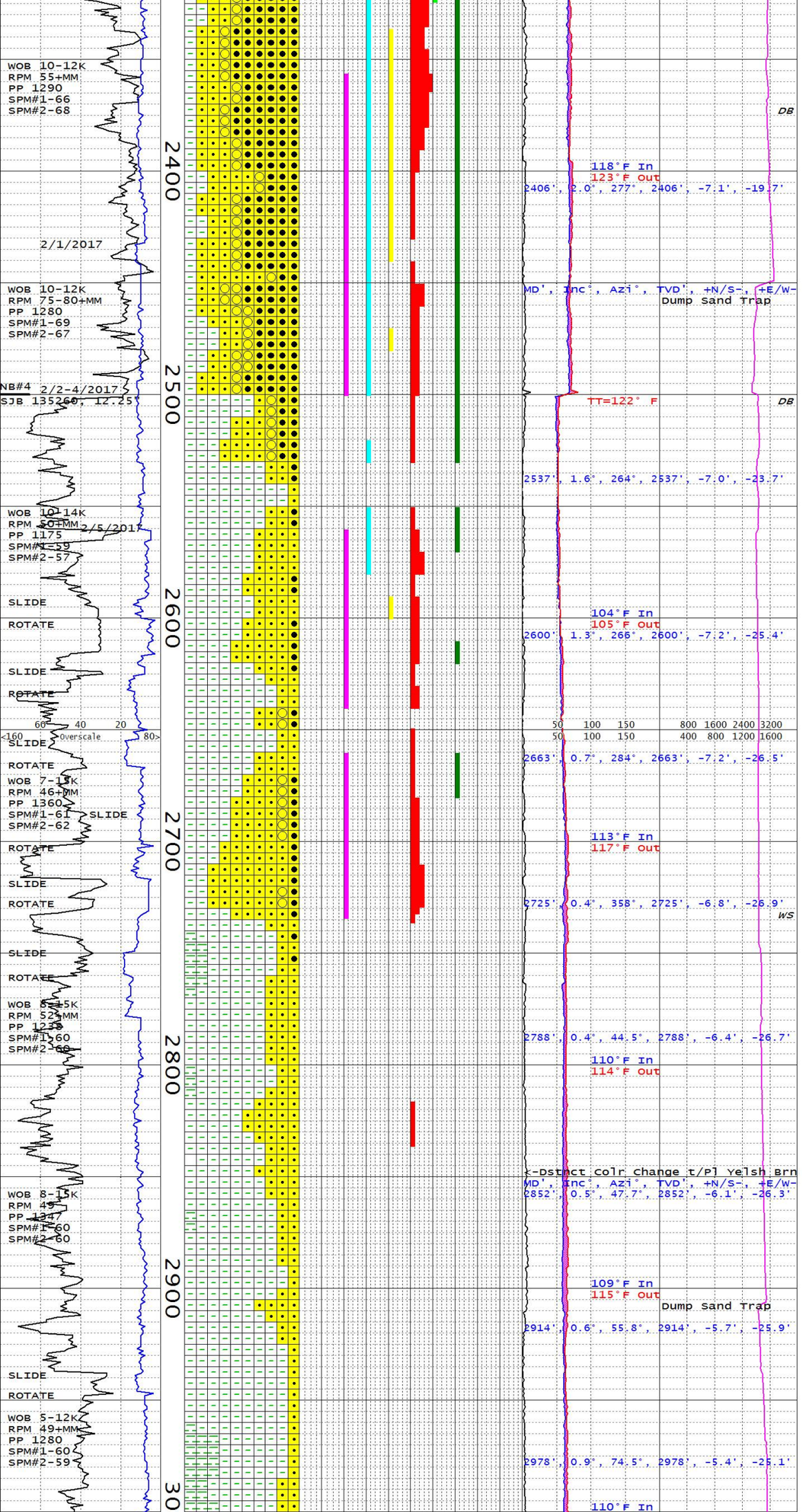
ALLUVIUM: MOD YELSHBRN T/DK YELSH BRN BULK SPL; PRLY SRTD; MED T/V CRS SD W/COM MED PBBL & MNR FN GRVL FRAGS; PRED ANG T/SBANG, OCC SBRND T/RND;PRED DSKY RED T/DSKY RDDSH BRN, GRYSH BRN, & PL YELSH BRN T/GRYSH ORNG WLDD XL TUFFS; COM GRYSH YEL T/V PL ORNG NO WLDD XL TUFF (TYP W/LIMONT STNNG); TR HI SOL, V LOW COHES, MOD YELSH BRN CLY MTRX;

ALLUVIUM: MOD YELSH BRN-DK YELSH BRN IN BULK; PRLY SRTD; SBANG-SBRND; MED-V VRS SD & GRVL FRAG; PRED WLDD XL TUFFS, OFF WHT, MOD RDSH ORNG, & PL OLV; RR QTZ FRAGS PRED SBRND W/OCC CONCH FRAC; COM MOD YELSH GRY LIMONT STNNG; V RR BIOT FLKS 2090'-2100'.

ALLUVIUM: MOD YELSH BRN T/DK YELSH BRN IN BULK; FN-V CRS SD; SBANG-SBRND, OCC RND; V PRLY SRTD; PRED UNCONS; ABD LITHIC WLDD & XL TUFF, MOD PNK, GRYSH RD, DSKY YELSH GRN & V LT GRY FRAGS; COM GRYSH ORNG-MOD RDSH ORNG LIMONT STNNG; V RR SBHD BIOT FLKS; V RR ANHD PYR; V RR SBHD MAGNTT 2120'-2130'.

CLAY: GRYSH ORNG PNK; SFT; GRTY; WELL HYDRD; PR ADHES/COHES; NON CACL; ABD FN-MED CONSOL SD; COM-ABD WLDD XL TUFF FRAGS; SCAT CHLOR ALTN; RR LIMONT STNNG; V RR DISSEM & SBHD XL PYR; V RR TUFF FRAG W/CALCT FRAC FILL.

ALLUVIUM: DK YELSH BRN BULK SPLS BCMNG OLV BLK T/BRNSH BLK W/INCR DEPTH; PRLY SRTD TYP SBANG T/ANG MED SD T/PBBL W/TR FN GRVL FRAGS; PRED MXD DSKY RED, DSKY RDDSH BRN, DK GRNSH GRY, MED GRY & DK YELSH BRN WLDD XL TUFF W/COM LT GRNSH GRY T/PL YELSH ORNG NONWLDD XL TUFF; ABD RHYLTC (OCC VITRIC); SCAT LSE BIPYRMDL QTZ, ADULR-SCNT KSPAR, & BIOT; TR SCAT FNLY SUCR CHALDNY; COM T/ABD RD OX STNNG & INCR CHLOR STNNG+ALT OVRALL; SLI DECR LIMONT STNNG; MOD AMT EVNLY DISSEM MOD YELSH BRN SILTY CLY MTRX (V HI SOL, EZLY WSHS F/SPLS); LOCAL TR CALCT PF; TR EPDT STNNG F/2300



ALLUVIUM: DK T/DSKY YELSH BRN BULK SPLS; PRLY SRTD; PRED MED SD T/FN PBBLS W/TR GRVL; TYP SBANG T/ANG; ABD DSKY RED T/DK REDDSH BRN WELDD RHYLTC XL TUFF, MED T/DK GRY & DK YELSH BRN WELDD XL TUFF; TR CHLOR STNNG; V RR <1MM CUBIC PYR XL.

ALLUVIUM: MOD BRN-MOD RDSH BRN IN BULK; FN-V CRS SD, COM FN PBBL SZ GR; PRLY SRTD; SBANG-SBRND; PRED WLDD & XL TUFF FRAG, LT GRY, DSKY RD, & YELSH GRY-PL OLV; RR LITHIC TUFF FRAG; V RR ANDESITE; ABD ANHD-SBHD QTZ, APP ASSOC W/XL TUFF, SME W/INCL; ABD MOD RDSH BRN HEMTT; SCAT MOD YELSH BRN LIMONT; V RR ANHD-SBHD CUBIC PYR XL.

NOTE: BCMS MED LT GRY-MED GRY IN BULK @2400'.

ALLUVIUM: V LT GRY-LT GRY IN BULK, WHT, PL OLV, MOD BRN, MOD RDSH BRN; SBANG-SBRND; PRLY SRTD; PRED XL TUFF; RR LITHIC TUFF; ABD ANHD-SBHD QTZ XL; COM HEMTT STNNG; SCAT CHLOR ALTN.

DRILL T/2500'; CIRC; WIPE HOLE; POOH; R/R 13.375" #68 K-55 CASING T/2493'; CEMENT; NIPPLE DOWN/UP; TEST BOP; TAG CMT @ 2433'; PERFORM SHOE TEST; DRILL OUT CEMENT; DRILL AHEAD F/2500' W/DIR ASSMBLY.

CLAY: GRYSH ORNG PNK; STIFF; THCK & PSTY; PRED RNDD OCC PLTY; GD ADHES/COHES; PR SOL; RR-SCAT FN-MED GR SD, OCC CRS; V RR GRVL; NON CALC.

ALLUVIUM: LT BRN, PL BRN; FN-MED GR, OCC CRS GR; PRLY SRTD; SBANG-SBRND; PRED QTZ/FSPR; SCAT MOD RDSH PNK, LT BRN TUFF FRAG; ABD PL YELSH ORNG-MOD RDSH BRN HEMTT STNNG; ABD GRTY MOD ORNG PNK CLAY W/GD ADHES & COHES, SLI MORE SOL.

CLAY: GRYSH ORNG PNK; FIRM; THCK & PSTY; OCC GRTY; PRED RNDD OCC PLTY; MOD-GD ADHES/COHES; PR-MOD SOL; RR-SCAT FN-MED GR SD, V RR CRS; NON CALC; SCAT HEMTT STNNG; RR CHLOR ALTN; COM QTZ GR ASSOC W/SD.

ALLUVIUM: LT BRN, PL BRN; MED-CRS GR SD; OCC GRVL FRAG; PRLY SRTD; SBANG-SBRND; ABD QTZ & LITHICS; SCAT MOD RDSH PNK, LT BRN TUFF FRAG; V RR SCORIA; ABD PL YELSH ORNG-MOD RDSH BRN HEMTT STNNG; V RR CHLOR ALTN; ABD GRTY MOD ORNG PNK CLAY W/MOD-HI ADHES/COHES.

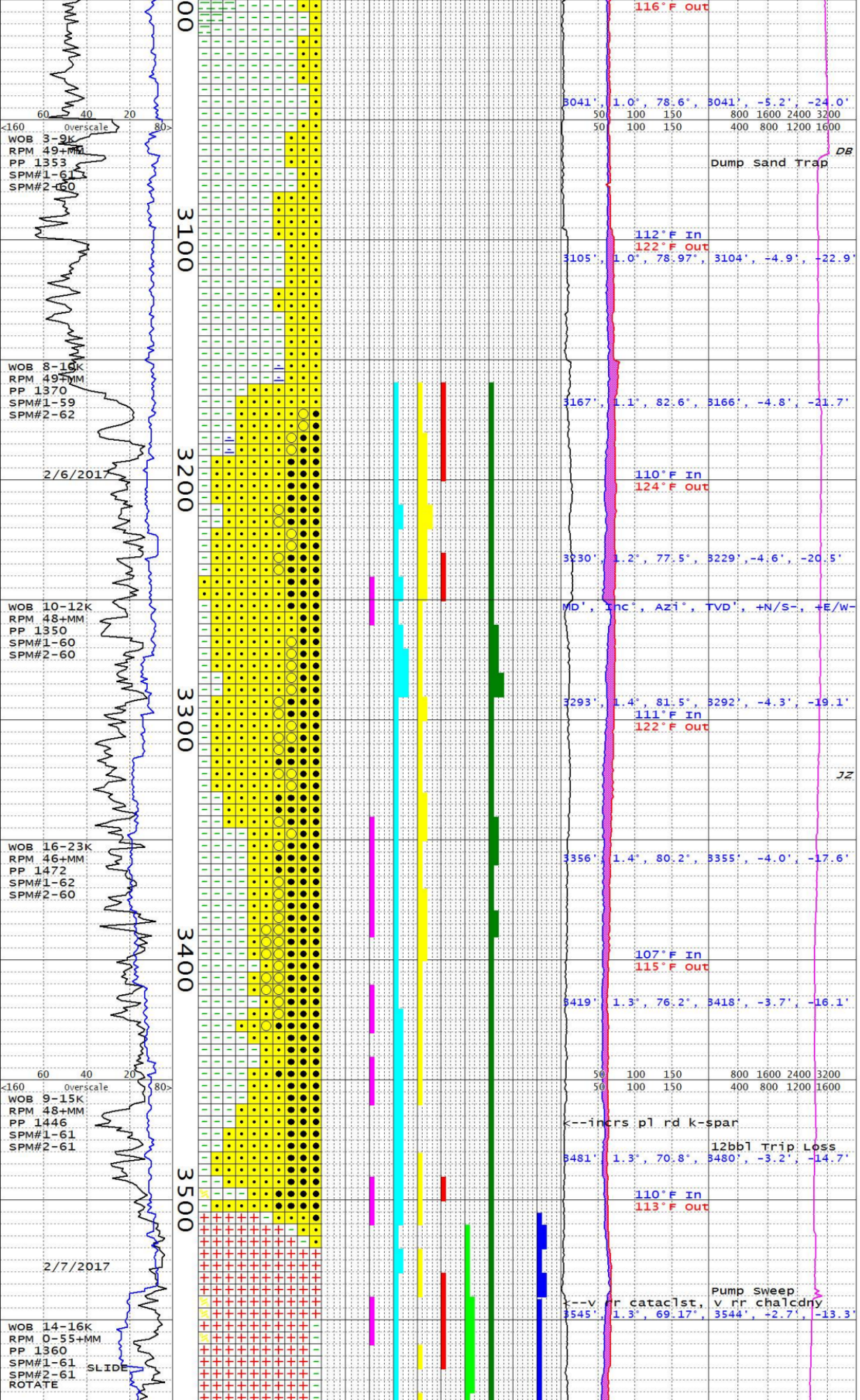
CLAY: V PL ORNG T/LT BRN; TYP MOD T/V STIFF LRG TAB CTGS OR RND BALLS; MOD SOL; V WXY; MOD HYDRTD W/WL HYDRTD SLICK EXTRR SURF; 20-30% EVNLY DISSEM WL RNDD T/SBRND MED SD W/IN (QTZ, TUFF FRAGS, WHT T/LT GRY CLAY ALTRD FSPRS, TR BIOT); LOW PLASTICITY; NONCALC; MNR SCAT LT BRN, TAB, NONHYDRTD, NONCALC, CRMBLY MUDSTONE CTGS (GRTY TEX, ABD MED GR, SBRNDD T/WL RNDD SD GRS, >50% CLY MTRX)

SAND: DISSEM W/IN CLAY; LOWR MED T/LOWR V CRS; WL RNDD T/SBANG; CLR QTZ FRAGS (PHENOS WTHRD F/TUFFS); DK GRNSH GRY, DSKY RED, V PL ORNG T/GRYSH YEL, & BRN TUFF FRAGS; BLEACHED FSPRS; TR LSE BIOT; SCAT RED OX STNNG & TR LIMONT STNNG.

CLAY: COLOR CHNGE T/PL YELSH BRN @ 2850'; MOD STIFF & WL HYDRTD W/INCR SD T/V STIFF & PRLY HYDRTD ABS SD; COM 1-2" TAB CTGS (POSS SLOUGH) INDIC SME FISS/ LAMNTN; SMTH SLICK TEX; V WXY; MOD SOL; HI ADHES/COHES; V PSTY & STKY WHERE HYDRTD; LOW PLASTICITY; COM T/ABD EVNLY DISSEM MED T/CRS RNDD T/SBANG SD (MSTLY QTZ, FSPRS, & TUFF FRAGS); NON CALC/ NO AP CALC SD CMPNTS; TR RED OX STNNG ON SD GRS (NOT AP F/IN SITU ALTERATION)

NOTE: WIPE HOLE @ 2968'

MUDSTONE: MOD BRN; TYP 4MM T/2" SLI WVY TAB T/PLATY CTGS; MOD FRM; GRTY TEX F/DISSEM MED SD; SLI BRTL T/CRMBLY; CTG HBT INDIC FISS/ LAMTN; DL RTHY LSTR; NONCALC; EVNLY DISSEM MED T/CRS RNDD T/SBANG SD (QTZ, FSPR, TUFF FRAGS, TR BIOT.



CLAY: GRYSH ORNG PINK; SFT T/ V STIFF; SMTH SLICK TEX; WXY WHERE SCORED, V PSTY WHERE HYDRTD; INCR AP SOL, MOD-HI; LOW AP PLASTICITY; COM EVNLY DISSEM, WL RNDD T/SBANG MED SD CMPNTS (PRED QTZ, FSPRS, & TUFF FRAGS); TR MOD BRN, 1CM -2" PLATY/ TAB MUDSTONE CTGS (POSS SLOUGH)

CLAY: GRYSH ORNG PNK, YELSH GRY; SFT; GRTY; OCC FIRM; MOD-GD ADHES/COHES; SLI SOL; SCAT MED-CRS GR SD, PRLY SRTD.

CLAY: GRYSH ORNG PINK; SFT-FIRM; GRTY TEX; WXY WHEN SCORED, V PSTY WHERE HYDRTD; INCR AP SOL, MOD-HI; LOW AP PLASTICITY; MOD ADHES/COHES; COM EVNLY DISSEM, WL RNDD T/SBANG MED SD CMPNTS (PRED QTZ, FSPRS, & TUFF FRAGS); V RR MOD BRN TAB MUDSTONE CTGS.

CLAY: GRYSH ORNG PNK, MED GRY, BCMS DK GRY @3150'; THCK; PSTRY; SLI GRTY TEXT; PRED LMPY, OCC PLTY HBT; GD ADHES/COHES; PR-MOD SOL; LOW-MOD HYDRTD; WAXY WHEN SCORED; SCAT MED-CRS GR SD BCMS ABD AFT 3150', PRED QTZ & TUFF FRAG, COM HEMTT AND SCAT CHLOR ALTN OF SD; SLI CALC, V RR ANHED PYR.

NOTE: BCMS V LT GRY-WHT @3190'; PRED SBANG-SBRND QTZ FRAG W/SCAT TUFF, ANHED-SBHED PYR, & CALCT; RR CHLOR ALTN & POSS PHLOGOPITE; ABD FSPR AFT 3240'.

ALLUVIUM: LT GRY IN BULK, CLR-TRANSL, WHT, MOD ORNG PNK, DSKY YELSH GRN; MED-CRS GR; PRLY SRTD; PRED SBANG-SBRND; DULL LSTR; PRED DEVIT; PRED QTZ FSPR; COM DSKY YELSH GRN DIORITE FRAGS; RR SFT SLTSTN FRAG; COM CHLOR ALTN; SCAT-COM FN DISSEM & SBHED PYR; SCAT CALCT; RR ALTD BIOT.

ALLUVIUM: PL BLU GRN-PL GRN (BULK SPL); PRLY-MOD SRTD, MD-CRS GR SD T/FN GRVL; PRED SBANG, OCC WELL RDD; PRED (>95%) WKLY-MOD CHLORTZD GRANODIORTE FRAG W/ABD RDSH BRN BIOT, RR BLK HRNBLND, V RR F FN BLK ANHD OXIDES, RR-MNR YELLSH GRN EPID PSUEDMRPH; V RR (5-10%) BLK BASALT FRAG & GLASS SD; ABD RDSH BRN BIOT XL FRAG; TR-ABD LT GRY WKLY COHSV, MOD ADHSV LT GRYSH WHT T/WHT CLAY; RR TRNSL WHT V FN SUCC CHALCDNY BLEBS; V RR CALCT PF; TR ANHD-SBHD PYR.

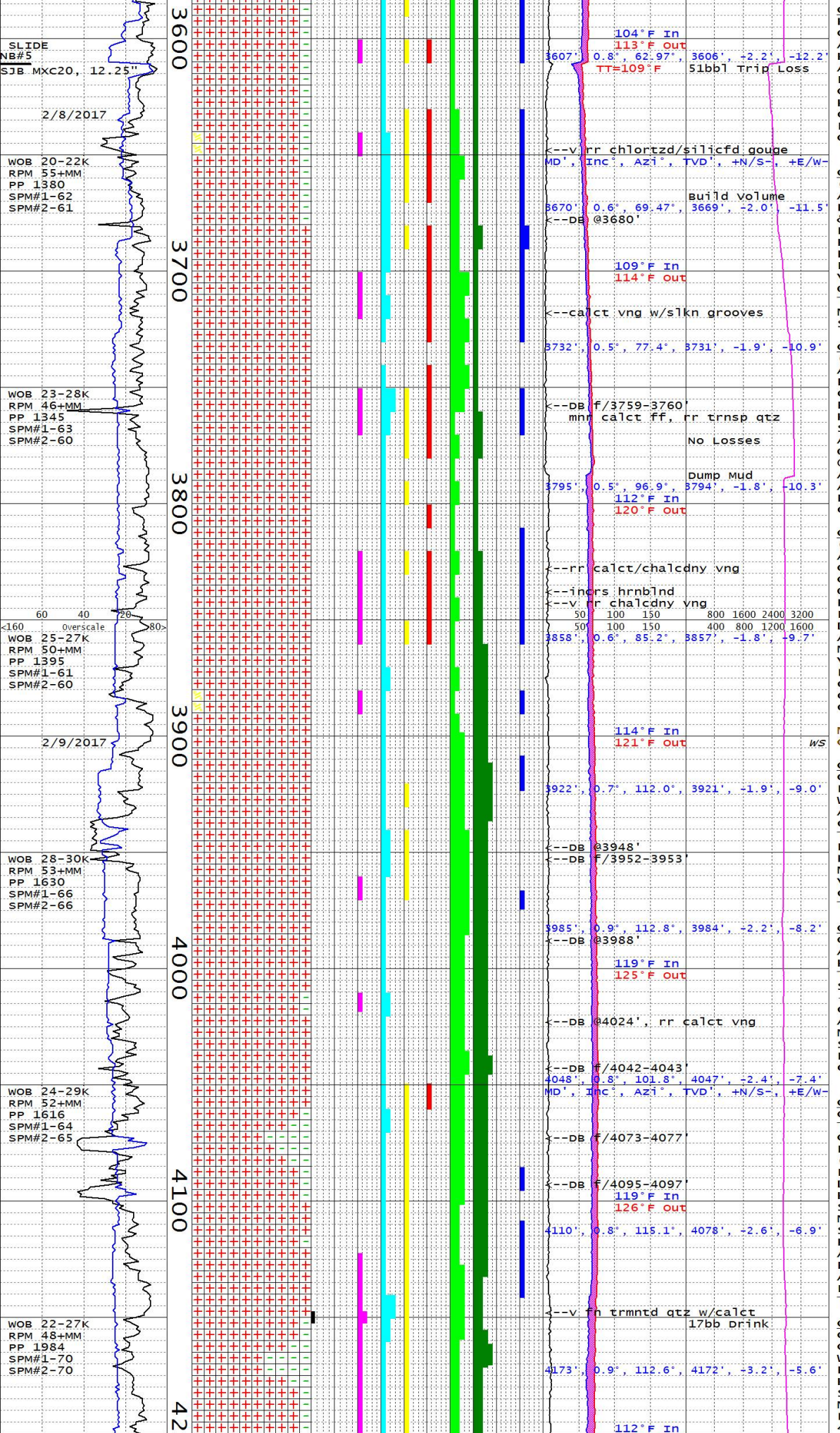
ALLUVIUM: GRYSH GRN (BULK SPL); PRLY-MOD SRTD, MD-CRS GRS SD T/FN GRVL; PRED (98%) MOD CHLORTZD GRANODRT LITH FRAG COURSE FRACTION W/ABD RDSH BRN BIOT, RR WKLY CHLORTZD HRNBLND, COM EPID PSUEDMRPH; MNR VOLC GLASS SD; V RR GRYSH RD XL-TUFF FRAG; ABD BIOT XL FRAG; COM V FN BLK ANHD OXID FRAG; ABD LT GRY-LT GRYSH WHT-PL GRNSH WHT MOD COHSV CLY MATRX; RR-TR CALCT PF; RR TRNSL WHT V FN SUCC CHALCDNY BLEBS; RR PYR.

WIPE T/SHOE F/3474', NO FILL.

NOTE: RR CATACLST @3500', RR BLK & RD (HMT) SLICKS; RR TRNSL WHT SUCC CHALCDNY.

GRANODIORITE: WHT, RR GRYSH ORNG PNK; V HD/DENSE; PHAN, ALLOTRMRPHC GRAN; ABD SBHD BIOT PHENOS, RR PRTLY ALTRD T/CHLORT OR SERCT; ANHD PLAG & K-SPAR; TR ANHD QTZ; TR GRNSH YELL EPID PSUEDMRPH AFTER PLAG; V RR CATACLST @3550' W/CHLORT, CHALCDNY, HMT VNG; TR CALCT VNG; TR CRS GR WELL RDD VOLC SD SLOUGH, V RR PL RD/LT BRN SANDY CLAYSTN SLOUGH.

POOH @3610'; P/U BUTTON BIT; ABD GRANDRT SD, MOD RDSH ORNG CLAYSTN SLOUGH AFTER TRIP.



GRANODIORITE: WHT, GRYSH PNK; V HD/DENSE; PHAN, ALLOTRMRPHC GRANLR; ABD BIOT PHENS, OCC ALTRD T/SERCT, CHLORT; V RR HRNBLND; ANHD PLAG & K-SPAR; TR ANHD QTZ; TR EPID PSUEDMRPH OF PLAG; V RR CHLORTZD/ SILCFD GOUGE @3650' W/PYR VNG & RD HMT; RR LT GRY- WHT SOL/WKLY COHSV CLAY; RR CALCT FF; V RR FN SBHD PYR; MNR GRANODRT SD/ GRVL & PL RD CLAYSTN SLOUGH.

GRANODIORITE: PL GRN, GRYSH GRN (BULK SPL); V HD/DENSE; PHAN, ALLOTRMRPHC GRANLR; ABD BLK BIOT PHENOS, RRLY ALTRD T/SERCT & CHLORT; ANHD-SBHD PLAG W/MNR EPID PSUEDMRPH; TR ANHD PL RD K-SPAR; RR ANHD QTZ; RR V FN BLK MTTLC OXIDES; RR FN SBHD PYR; RR RD HMT STNNG; TR CALCT VNG, SLICKN GROOVES @3720'; RR QTZ/CALCT/CHORT/HMT VNG @3720'; TR WELL RDD ALLUVL SD & LT BRN/ MOD RDDSH ORNG SANDY CLAYSTN SLOUGH, DECR F/3700'.

GRANODIORITE: GRYSH GRN, PL GRN (BULK SPL); V HD/DENSE; PHAN, ALLOTRMRPHC GRANLR; ABD DRK BRN-BLK SBHD BIOT PHEN, CHLORTZD IN PART; RR FN SBHD BLK MTLLC OXIDS; V RR DRK GRN HRNBLND @3800'; OPAQ WHT ANHD-SBHD PLAG; RR PNK K-SPAR; RR ANHD QTZ; MNR CALCT FF, TRNSP QTZ, TRNSL WHT SUCC CHALCDNY @3760' W/INCRS RD HMT & CHLORT ALTRTN, RR FN XLN PYR; TR-MNR ALLUVL SD/FN GRVL & LT BRN/MOD RDDSH ORNG/OLV GRY SANDY CLAYSTN SLOUGH THROUGHOUT.

GRANODIORITE: GRYSH GRN, PL GRN (BULK SPL); V HD/DENSE; PHAN ALLOTRMRPHC GRANLR, HYPIDMRPHC GRANLR F/3830'; INCRS BLK-DRK GRN SBHD HRNBLND PHENS F/3830', OCC CHLORTZD W/PRTL RD HMT RPLCMNT; EUHD-SBHD TRNSL WHT PLAG; TR FN BLK MTTLC OXIDS; TR DRK BRN/DRK GRN BIOT, RR SERTC ALTRTN; RR PNK ANHD K-SPAR; TR-MNR EPID PSUEDMRPH AFTER PLAG; V RR TRNSL WHT SUCC CHALCDNY F/3820-3860'; V RR CHLORTZD CATACLST @3890'; RR-TR THIN CALCT FF; RR-TR ALLUVL SD & CLAYSTN SLOUGH.

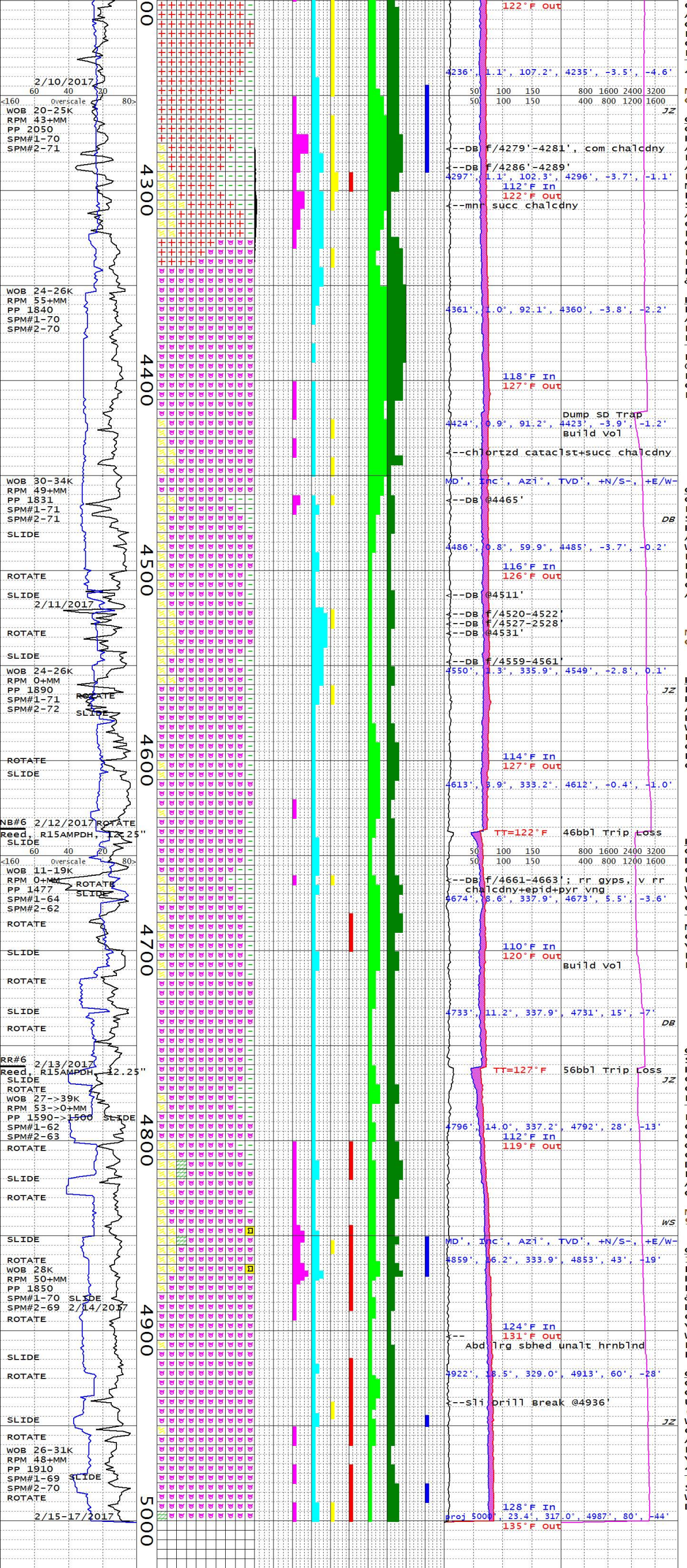
MW 8.9 FV 47 PV 15 YP 20 PH 9.7
GEL 11/19/30 SOL 4 CL 2500

GRANODIORITE: GRYSH GRN T/PL GRN BULK SPLS; V HD & DENS; PHAN, PRED HYPIDMRPHC GRNLR W/SBHDRL HRNBLND, OCC ALLOTRRMRPHC GRNLR W/AP ANHDRAL CHLOR ALTRD HRNBLND; PRED TRANLS WHT PLAG; COM SBHDRL T/ EUHED BIOT; TR GRYSH ORNG ANHED KSPAR; TR HI LSTR SB-SPHRCL BLK MTLC OXIDS; COM EPID RPLCMNT & V RR PRTL PSEUDMRPH AFTR MRE CALCIC INTRIOR OF ZONED PLAG; TR LOCAL SERCT ALT; TR CALCT FF.

GRANODIORITE: GRYSH GRN T/PL GRN BULK SPLS; HD & DENS; PRED ANG BLDD CTGS; PHAN & TYP HYPIPMRPHC GRNLR (LRG AP EUHED T/SBHED TRANSL WHT PLAG W/ SBHDRL PRED CHLOR ALTRD HRNBLND -OCC BRNSH BLK ABS CHLOR ALT); COM SBHDRL T/EUHED BIOT; TR ANHED GRYSH ORNG KSPR; TR BLK MTLC OXIDS; LOCAL TR PRTLY SILIC AP GOUGE; LOCAL SLI DECR EPID ALTRTN 3990-4050'; TR THN CALCT FF; MNR KAOLIN ALTRD PLAG

GRANODIORITE: PL GRN T/GRYSH GRN BULK SPLS (GRN ATTR MSTLY T/CHLOR ALT); PHAN, HYPDMRPHC GRNLR, TR IDMRPHC GRNLR; PRED EUHED T/SBHED TRANSL WHT PLAG (RRLY W/VIS V THNLY SPACED PLYSYNTHTC TWINS) & SBHED-EUHED DK GRNSH GRY OR BRNSH BLK T/BLK HRNBLND; MNR BLK T/BRNSH BLK SBHDRL BIOT (AP SLI DECR) & MNR MTLC OXIDS (AP SLI INCR, FREQ SBSPHERCL); TR GRYSH ORNG KSPAR; LOCAL AP INCR KAOLIN ALTRD PLAG ~4050'; TR PYR RPLCMNT (AP OF OXIDS?) & V RRLY AS SBHDRL FF; COM EPID ALT OF PLAG & CHLOR ALT OF HRNBLND THRU; TR THN CALCT FF THRU.

GRANODIORITE: PL GRN T/GRNSH GRY BULK SPLS; PHAN, HYPDMRPHC GRNLR W/EUHED T/SBHED TRANSL WHT PLAG & SBHED-EUHED BLK, BRNSH BLK, OR DK GRNSH GRY HRNBLND; COM BLK T/BRNSH BLK SBHED BIOT (RRLY EUHED); TR BLK MTLC OXIDS & GRYSH ORNG KSPAR; LOCAL DECR CHLOR ALT OF MAFICS 4140-4160' & 4180-4200', TYP



COM; COM EPID RPLCMNT OF PLAG; ABD KAOLIN ALT OF PLAG & AP GOUGE ~4170', MNR KAOLIN ALT OF PLAG THRU; TR V FN OPEN QTZ & CALCT ~4150'; TR TRANSL CHALDY FF & TR THN CALCT FF; INCR T/ABD SBHDRL T/EUHED HORNBLND 4180-4200'.

MW 9.1 FV 49 PV 15 YP 24 PH 9.4 GEL 13/19/31 SOL 5 CL 2500

GRANODIORITE/TONALITE: GRYSH GRN, DUSKY GRN (BULK SPL); V HD; PHAN, HYPIDMRPHC GRANLR; ABD BLK EUHD-SBND HRNBLND PHENOS, V RR ALTRD T/CHLORT; ABD TRNSL WHT ANHD- SBHD PLAG PHENOS; MNR V FN SBHD BLK METLLC OXIDE MICRO-PHENOS; V RR BIOT, V RRLY ALTRD T/CHLORT-SERCT; MNR-ABD EPID PSUEDMRPH AFTER PLAG; RR-MNR CHLORTZD CATACLST 4275'-4325' W/MNR-ABD LT GRY-GRNSH GRY WKLY COHSV CLAY; RR-COM V FN SUCC CHALCDNY FF; RR-MNR CALCT FF THRU; RR-TR FN SBHD PYR; LOC V RR RD HMT; V RR MOD RDDSH ORNG SANDY CLAYSTN & ALLUVL SD SLOUGH.

HORNBLENDE GABBRO: DRK GRN, BRLLNT GRN; V HD/DENSE; PHAN, ABD BLK EUHD-SBHD HRNBLND PHENOS, ABD-COM CHLORTZD ANHD PLAG PHENOS, RR-ABD WHT/ALBTZD TAB EUHD-SBHD PLAG PHENOS, ABD EPID PSUEDMRPH; V RR MUSCV @4410', INCRS T/MNR @4420'; LESS CHLORT ALTRTN F/4410'; RR CALCT VNG; LOC V RR CHALCDNY F/4410-4440'.

NOTE: ANORTHOSTC HRNBLND GABBRO W/OPAQ WHT TAB PLAG PHENOS & MNR EPID PSUEDMRPH F/4400'; RR-TR CATACLST/ CHLORTZD GOUGE? W/V FN PYR & SUCC CHALCDNY F/4430-4450'.

GABBRO: GRNSH GRY, WHT, LT BLSH GRY; FIRM-HD, COM BRTL, OCC FRIAB; MD-CRS GR CTGS; SBANG-SBRND; PHAN; SCAT BLK EUHD-SBHD HRNBLND PHENOS; COM CHLORTZD ANHD PLAG PHENOS; RR-ABD WHT/ALBTZD TAB EUHD-SBHD PLAG PHENOS; ABD BRT YEL-YELSH GRY EPID PSUEDMRPH; RR ANHED-SBHED PYR XL; V RR MUSC SME W/WK CHLOR ALTN; V RR CALCT VNNG, ABD F/4520'-4522'.

MW 9.0 FV 47 PV 13 YP 20 PH 9.3 GEL 8/20/34 SOL 4 CL 2000

HORNBLENDE GABBRO: BLK&WHT, BRLLNT GRN&WHT; HD/SLI BRTL-V HD/DENSE; PHAN, ABD BLK/UN-ALTRD T/ GRN/STRLY CHLORTZD HRNBLND PHENOS, ABD WHT-TRNSL WHT/ALBTZD PLAG PHENOS, TR-MNR EPID PSUEDMRPH; LOC RR CHLORTZD CATCALST & MOD COHSV WHT CLAY; RR THIN CALCT VNG; V RR SUCC CHALCDNY @4630'.

POOH @4637'; P/U NB #6, NEW MUD MOTOR, GAP SUB, & JARS; ABD PL RD, MNR MOD BRN SNDY CLAYSTN SLOUGH AFTER TRIP.

HORNBLENDE GABBRO: PL GRN, GRYSH GRN (BULK SPL); V HD/ DENSE-HD/SLI BRTL; PHAN, ABD CHLORTZD CRS TAB SBHD HRNBLND PHENOS, RR BLK UNALTRD; ABD WHT/TRNSL WHT SBHD PLAG PHENOS, V RR SBHD-ANHD BLK OXIDES; MNR-COM GRNSH YELL EPID PSUEDMRPH; TR CATACLST F/4660-4675' W/TR-MNR LT GRYSH WHT-PL GRNSH WHT CLAY; RR CALCT VNG; RR GYPSUM & V RR CHALCDNY VNG W/V FN XLN PYR @4662'; V RR RD HMT STNNG F/4680-4700'.

POOH @4761'; L/D GAP SUB; CHANGE-OVER TO MUD PULSE SURVEY TOOL; ABD PL RD, COM BRNSH GRY, MNR MOD BRN SNDY CLAYSTN AFTER TRIP, POSSBL DRAG-SLOUGH FROM 1.75° MM.

GABRRO: PL GRN, GRNSH GRY (BULK SPL); PRED HD/SLI BRT, OCC V HD/DENSE; PHAN, ABD STRLY CHLORTZD SBHD HRNBLND PHENOS, COM WHT/TRNSL WHT SBHD PLAG PHENOS, RR V FN BLK OXIDES; RR-TR EPID PSUEDMRPH; TR CATACLST F/4810' W/V RR CHALCDNY VNG, RR CALCT VNG, V RR RD HMT & INCRS CHLORT ALTRTN; RR-TR WHT/LT GRYSH WHT/PL GRN WKLY COHSV CLAY; THIN HYPABYSSAL ANDESITE DIKE F/4800-4820' W/V FN FRM EUHD WKLY CHLORTZD/WKLY CLAY ALTRD PLAG PHENOS & OPAQ LT GRYSH PURPL GRNDMS.

MW 8.9 VIS 50 PV 14 YP 27 PH 9.4GEL 14/23/36 SOL 4 CL 2000

GABBRO: PL GRN BULK SPL W/ABD & INCRSNG SCAT WHT; HD; PHAN; ANG BLDD CTGS; ABD CHLOR ALT SBHED HRNBLND & CHLOR STNND PLAG; TR BLK OXIDES; COM CATACLSTC CTGS & TR BRCCIA IN SILIC FF & VNNG; DCER CHLOR ALT W/DPTH GRDNG T/V CLEAN HRNBLND BY 4900' W/DECR VNNG (COM VIS WHT PLAG INCLDD W/IN HRNBLND INDIC SODIC ALT OF PLAG--ANRTHT T/ALBT); COM EPID RPLCMNT THRU; TR CALCT FF.

GABBRO: PL GRN BULK SPL (MXD GRNSH GRY, GRYSH BLK & DK GRNSH GRY); V HD/DENSE; PHAN, ABD BLK UN-ALTRD TAB SBHD HRNBLND PHENO (OCC ALTRD T/CHLORT), ABD OPAQ WHT-TRNSL WHT PLAG PHENOS (V RR CHLORT STNNG), V RR FN SBHD-ANHD BLK OXIDES; MNR EPID PSUEDMRPH OF PLAG; V RR CHLCDNY VNG W/RD HMT STNNG @4960' & 4980'; TR CALCT VNG, V RR TRMNTD CALCT XLS @4960'; V RR SERCT ALTRTN OF HRNBLND; V RR WKLY CHLRTZD/BLEACHD ANDESITE DIKE @5000'.

DRILL 12.25" WELL T/5000'; RUN FMI LOGS.

Dixie Meadows 75-4ML

Geothermal
MD Mudlog
1:600 Scale

HORIZON WELL LOGGING, INC

3769 Constellation Road
Lompoc, CA 93436
Phone 805-733-0972
Fax 805-733-0992

AK Phone 907-563-7002
Online Real-Time
Well Data Access:
www.horizonwells.com

http://www.horizon-well-logging.com

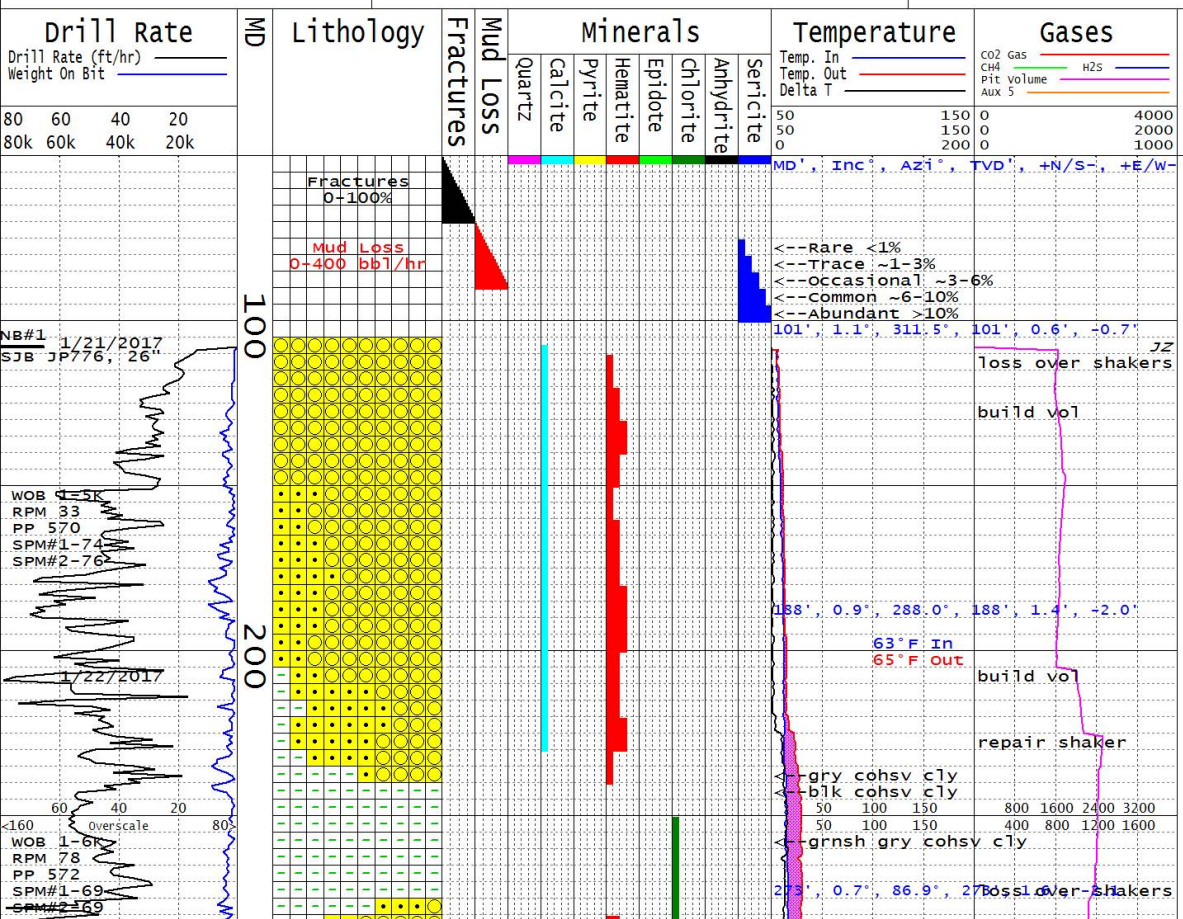
COMPANY	ORMAT Nevada, Inc.
WELL	Dixie Meadows 75-4ML
LOCATION	S4-T22N-R35E MDB&M 39.803198 -118.044926 NAD(83)
ELEVATION	3433' (GL) ; 3460' (KB)
FIELD	Dixie Meadows
COUNTY & STATE	Churchill, NV
API No.	
SPUD DATE	2017.01.21
LOGGING DATES	2017.01.21-
LOGGING DEPTHS	108'-
CO. GEOLOGIST	Ben Delwiche
DRILL SITE MANAGER	Joe Bunce, Bob Mueller, Randy Baldwin
CONTRACTOR	GeoDrill, Inc.
RIG	1
MUD COMPANY	Sinclair
TYPE	Gel/Polymer
LOGGING GEOLOGISTS	J. Zlotkowski, W. Starrett, D. Baldazzi
BIT SIZE	42" t/108' 26" t/600' 17.5" t/2500' 12.25" f/2292'-
CASING	30" Conductor t/108' 20" 94# K-55 BTC t/593' 13.375" 68# K-55 BTC t/2493'

Abbreviations

CO	Circulate Out
LAT	Logged After Trip
CG	Connection Gas
WG	Wiper Gas
TG	Trip Gas
SG	Survey Gas
NR	No Returns
NB	New Bit
WR	Wiper Run
WOB	Weight On Bit
PP	Pump Pressure
SPM	Strokes Per Minute
POOH	Pull Out Of Hole
LC	Lost Circulation
TT	Trip Temperature
CT	Connection Temperature

Symbols

CATACLASITE
ANDESITE
KERATOPHYRE
QUARTZ DIORITE
GRANODIORITE
DIORITE
GABBRO
CLAYSTONE
CLAY
CEMENT
SANDSTONE
SAND
GRAVEL
GRANITE
COARSE SAND



Descriptions

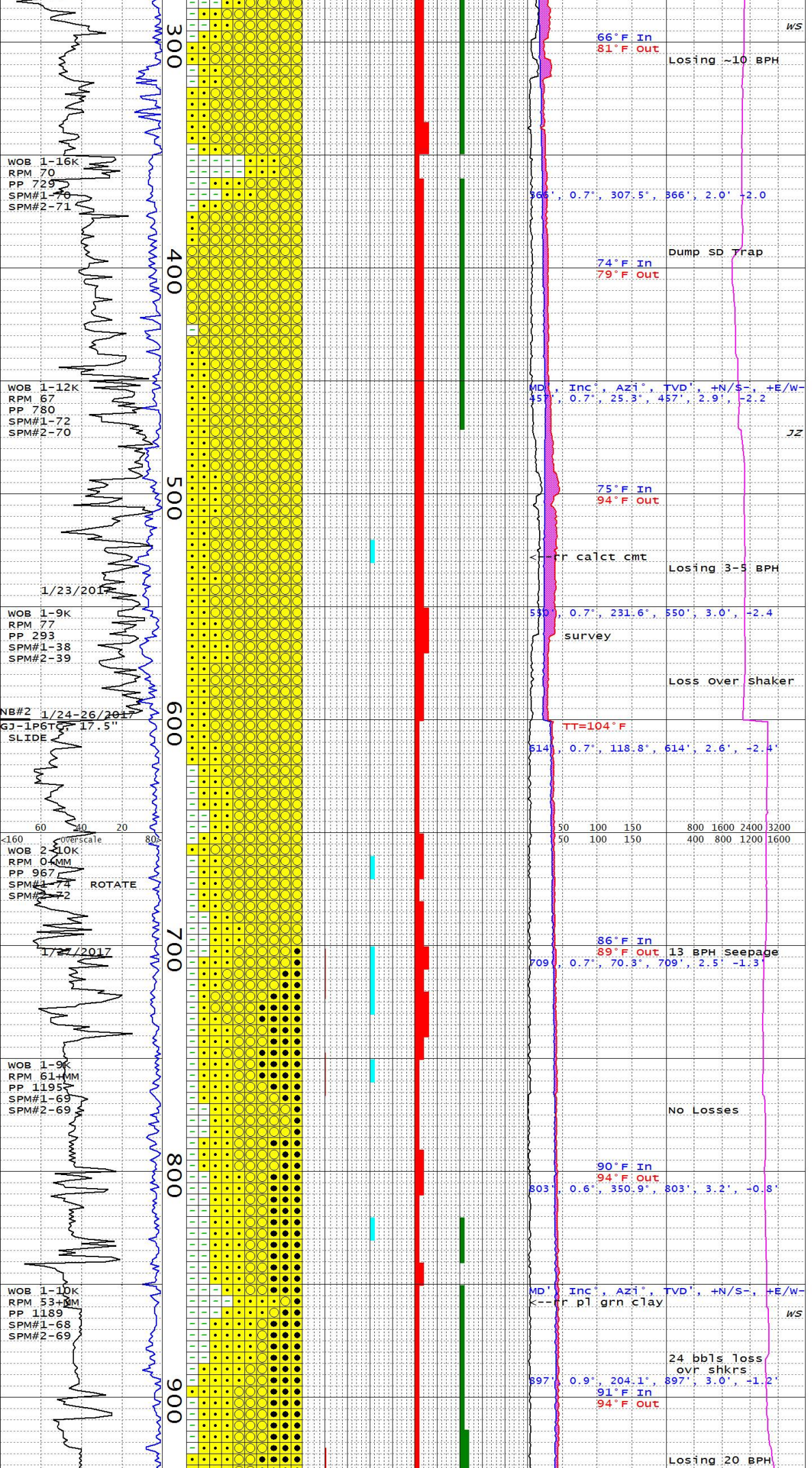
NOTE: ALL DEPTH MEASUREMENTS ARE REFERENCED FROM K.B. AND ARE BASED ON DRILLERS' PIPE TALLY; SAMPLES ARE DESCRIBED WHILE WET UNLESS OTHERWISE NOTED; COLORS ARE REFERENCED FROM THE GSA ROCK COLOR CHART; ALL GAS EQUIPMENT IS CALIBRATED TO SPWLA STANDARDS.

NOTE: 30" CONDUCTOR SET @108' (KB); SPUD 75-4 ON JAN 21, 2017 w/26" MILLTOOTH BIT.

ALLUVIUM: DUSKY BLU, MOD YEL BRN, DRK GRNSH GRY (BULK SPLS); PRLY SRTD, MD GR SD-FN GRVL; SBRDD-WELL RDD; PRED WKLY OXIDZD-RR WKLY CHLORTZD-V RR BLEACHD RHYOLITC XL-TUFF LITH FRAG W/RR-TR LIMONIT STNG; MNR-TR DRK GRY-BLK VITROPHYRE; RR-TR GABBRO & ANORTHOST LITH FRAG W/ALBT ALTRTN OF PLAG, CHLORTZD IN PART W/V RR EPID STNG; RR DRK GRY SLATE; COM VOLC GLASS, MNR ADULARSCNT SANDN XL FRAG, TR SBHD + BYPYRAMDL TRNSP QTZ XL FRAG, V RR WELL RDD SUCC DETRITAL CHALCDNY; V RR FN BLK BIOT FRAG; FRM LT BRN DEHYDRTD CLY F/210-230'.

MW 8.8 VIS 55 PV 16 YP 24 GELST 10S-9 10M-22 PH 9.5 CL 600 CA 40

CLAY: GRY, BLK, GRNSH GRY; FRM; STRLY COHSV/ADHSV; HYDRTD; V FNT ORGNC ODOR W/IN BLK CLAY; GRDS T/ DK GRNSH GRY T/MED BLUSH GRY, WL HYDRTD, MOD SOL, HI COHES, HI PLASTICITY, SLI STIFF CLY (STILL PLSTC WHEN DEHYDRTD & V STIFF).



ALLUVIUM: MOD T/DSKY BRN BULK SPLS W/ABD MXD DSKY REDS, DK GRNSH GRYS, MOD BRNS, & LT T/DK GRYS; MED SD (TYP SBANG) T/FN GRVL & PBBLS (TYP SBRND-RND OR FRAGS W/RND SIDE); ABD DIVRS IGN LITHS: RED OXDZD ANDSIT, CHLOR ALT DIORITE, CLY ALTRD & BLEACHD XL TUFF, WL RNDD BASALT, TR GRABRO; TR VOLC GLASS; TR DK VITROPHYRE; RR AGATINE BANDD CHALDY; COM LSE DBL TERM QTZ; TR ADULARSCNT KSPRS; COM LRG FRAGS SODIC PLAG (FREQ LIMONIT STND); ABD SLI TACKY T/SLI FRIA PL BRN SOL CLY MTRX 350-370'; INCR GR SZ F/380'

ALLUVIUM: PRED MOD GRYSH BRN BUK SPLS W/ABD DIVRS DSKY T/PL REDS/BRNS, GRYSH T/DK YELSH ORNGS, & GRNSH T/DK GRNSH GRYS; AP INCR CLAST SZ, PRED CR SD T/MED GRVL & LRGR; PRED WLDD XL/ ASH/ RHYOLITIC TUFFS (COM VITROPHYRE); OCC DIORT & RR GABBRO; COM AP SILIC ALT OF TUFFS; COM SUCR CHALDY & JASP; COM SCAT BLUE SCHILLER (LSE KSPRS OCC W/IN RHYOLITE); HEMTT ALT, CHLOR ALT, LIMONT STNNG SCAT THRU; LSE BIPYR QTZ.

MW 8.9 FV 54 PV 13 YP 16 PH 9.2 GEL 10/18 SOL 4 CL 3300; (520')

ALLUVIUM: MOD RDSH BRN, GRYSH RD PURP (BULK SPL); PRLY SRTD, CRS GR SD-FN GRVL; SBRDD-WELL RDD; PRED MOD RDSH ORNG-PL RD RHYOLITIC XL-TUFF LITH FRAG; MNR STRLY CHLORTZD GABBRO FRAG W/RR EPID STNNG; RR DIORITE FRAG W/PRTLY CHLORTZD MAFICS; V RR DRK GRY META-SLTSTN FRAG; COM CRS GLASS SD; TR ADULARSCNT SANIDINE XL FRAG; RR TRANSP, OCC SMOKEY SBHD-BYPRYMDL QTZ XL FRAG W/V FN OXDZD INCLSNS; RR V FN BLK BIOT XL FRAG; V RR TRNSL WHT FN SUCC DETRITAL? CHALCDNY; SILT MATRX COMPLTLY WASHED-OUT F/SPL; V RR CALCT CMT @530'; TR LIMONT STNNG.

DRILL 26" WELL T/600'; SWEEP/ CIRC; WIPE HOLE; TAG @590'; SWEEP/CIRC, TAG @593'; SWEEP/ CIRC, TAG @599'; POOH.

RUN 20" 94# K-55 BTC CSG T/593', CMT T/SURFACE; NU/ TEST 21" 2M BOPE; M/U 17.5" BHA W/MUD MOTOR, TAG CMT @545', D/O CMT & SHOE T/593'; TEST SHOE W/0.54 GRADIENT & 8.8 MW; SLIDE-OUT F/SHOE.

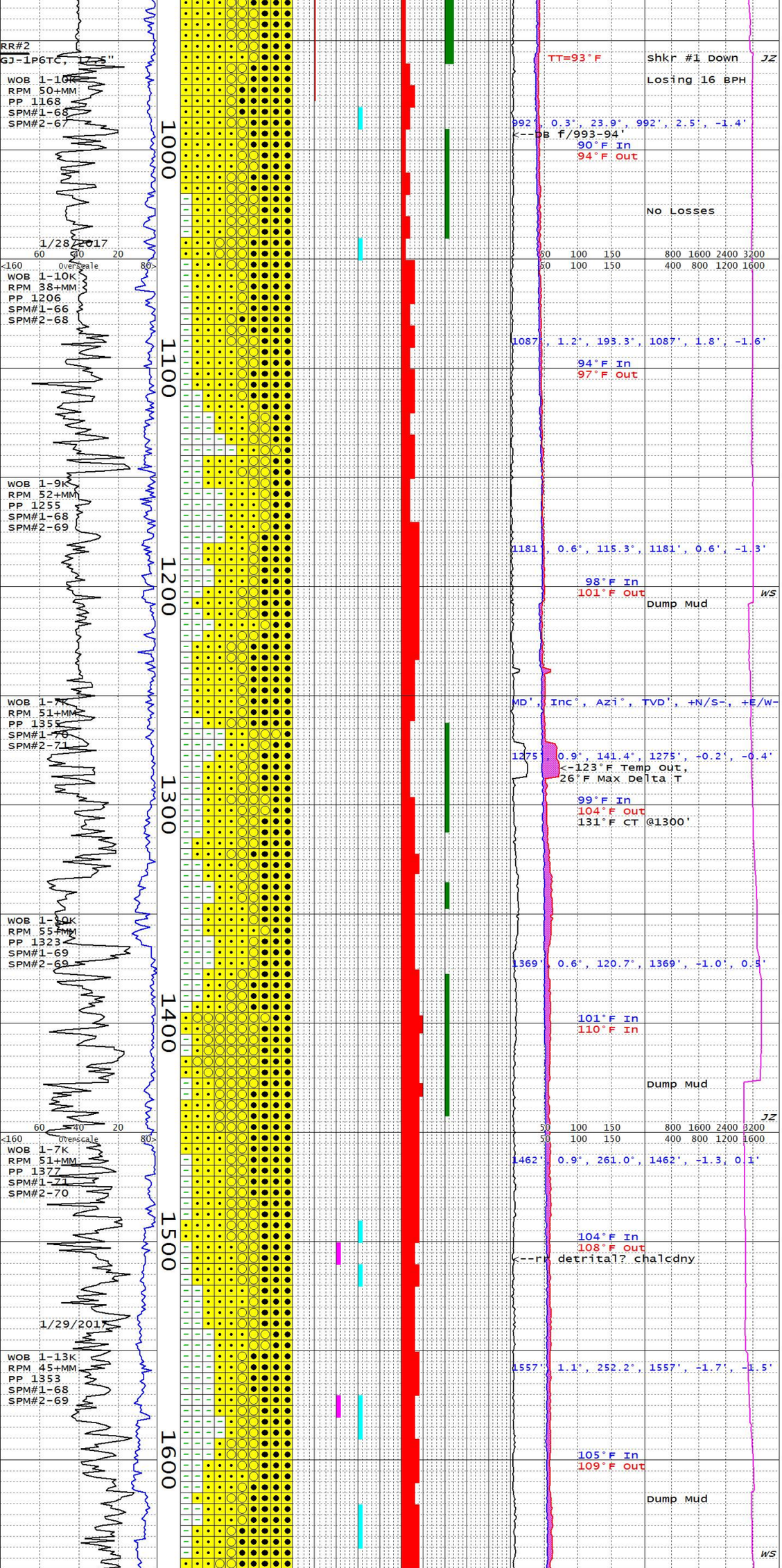
ALLUVIUM: MOD RDDSH ORNG-DRK YELLSH ORNG (BULK SPL); PRLY SRTD, CRS GR SD-FN GRVL; SBRDD-WELL RDD; PRED NON-STRLY WELDD RHYOLTC XL-TUFF LITH FRAG W/TR LIMONITE STNG; TR GABBRO FRAG W/ALBITE ALTRD PLAG & PRTLY CHLORTZD MAFICS; TR DIORITE FRAG; V RR RDSH VIOLT BRN APHAN BASALT FRAG; V RR PL GRNSH WHT FN GR QTZITE; V RR PL OLV META-SLTSTN; V RR BLK SLATE; COM GLASS SD, MNR ADULARSCNT SANIDINE XL FRAG, TR SBHD-EUHD BYPYRMDL QTZ PHENO FRAG, V RR BLK BIOT; RR-TR PL YELLSH BRN MOD COHSV CLY MATRX; LOC V RR CALCT PF.

MW 8.8 FV 46 PV 7 GEL 10/18/23 YP 12 SOL 4 PH 11 CL 3300

ALLUVIUM: DRK YELLSH BRN (BULK SPL); PRLY SRTD, OCC MOD SRTD; MD-CRS SD W/MNR FN GRVLS; ANG -WELL RDD; PRED RHYOLITIC XL-TUFF LITH FRAG - PL YELLSH ORNG-PL RDSH BRN WKLY-NON WELDD W/LIMONITE STNNG; RR PL GRN-WHT WELDD XL-ASH TUFF; MNR CHLORTZD GABBRO FRAG W/RR EPID STNNG +PSUEDMRPH; RR DIORITE FRAG; V RR BLKSH RD APHAN BASALT FRAG; V RR BLK SLATE FRAG; V RR LT OLV BRN META-SLTSTN; ABD SBHD ADULARSCNT SANIDINE XL FRAG; ABD QTZ XL FRAG, TR SBHD-EUHD BYPYRMDL; PL YELLSH BRN ADHSV, WKLY-MOD COHSV CLY MATRX; LOC RR SBHD CALCT PF.

NOTE: INCRS TORQ F/838-842'.

ALLUVIUM: BRNSH T/OLV BLK OR DSKY BRN BULK SPLS; PRED DK GRYS W/ABD DSKY REDS & DK GRNSH GRY INDIV GRS; TYP SBANG MED & CRS SD T/FN GRVL FRAGS & OCC RNDD PBBLS; PRED WLDD XL & ASH TUFF (PRED RHYOLITIC) W/OCC LITHIC TUFF; TR ALBITZD GABBRO/MICROGABBRO; V RR RNDD APHAN BASALT; COM KSPAR W/BLU SCHILLER & BIPYRMDL QTZ LSE & W/IN TUFFS; VARBL AMTS OF MOD T/DK YELSH BRN MOD SOL SILTY CLY MTRX; SCAT RED OX STNNG & CHLOR STNNG & ABD LIMONT STNNG.



NOTE: DRILL T/955'; ATTMEPT T/SURVEY, 20' OF FILL, REAM T/BTTM; SURVEY, TAG 13' OF FILL, HIGH PUMP PRESS; POOH; BIT PACKED OFF W/GRVL.

ALLUVIUM: DRK GRNSH GRY (BULK SPL); PRLY SRTD, MD-CRS GR SD-FN GRVL; AND-WELL RDD; PRED RHYOLT XL-TUFF, ABD OXDZD ORNG NON-WELDD TUFF, MNR CHLORTZD PL GRN- WHT DENSLY WELDD XL-TUFF, RR V DUSKY PURP NON-WELDD XL-TUFF W/ABD SANIDINE; MNR CHLORTZD/ALBITZD GABBRO LITH FRAG; V RR OLV-BRNSH BLK BASALT LITH FRAG; V RR GRNSH-MD GRY META-SLTSTN; V RR WHT FN GR QTZITE; COM FN ADULRSCNT SANIDINE PHENO FRAG; ABD TRNSP GLASS SD, TR TRNSP SBHD TRMNTD QTZ PHENO FRAG W/ORNG OXID STNNG; RR BLK BIOT FRAG; LOC V RR WKLY-MOD COHSV PL YELLSH BRN CLY MATRX; RR-TR LIMONT STNNG; LOC V RR CALCT PF.

MW 8.8 FV 48 PV 8 YP 12 PH 10.5
GEL 9/19/24 SOL 4 CL 5000

ALLUVIUM: DRK YELLSH BRN, OLV BRN (BULK SPL); PRLY SRTD, MD-CRS GR SD-TR FN GRVL; ANG-WELL RDD; PRED RHYOLITC XL-TUFF, ABD MOD RDDSH ORNG-PL RD NON-WELDD TUFF, RR LT GRY MOD WELLD TUFF, TR PL GRNSH WHT STRLY WELDD TUFF; COM CHLORTZD GABBRO W/RR FN EPID PSUEDMRPH; TR PL-GRYSH PURP DACITC? XL-TUFF FRAG; V RR BRNSH GRY WELL RDD APHAN BASALT LITH FRAG; V RR WHT FN GR QTZITE FRAG W/LIMONT STNNG; ABD SANIDINE PHENO FRAG, TR TRMNTD QTZ PHENO FRAG, COM TRNSP GLASS, RR FN BLK BIOT; TR-ABD PL YELLSH BRN MOD COHSV CLAY MTRX; MNR LIMONT STNNG ON TUFF FRAG.

ALLUVIUM: DK YELSH BRN T/OLV BRN BULK SPLS W/DSKY REDS, MOD T/DK YELSH BRNS, DK GRNSH GRYS, DK GRYS, & OCC BLUSH GRY GRS; MSTLY MED T/CRS SD W/MOD AMT FN GRVL/RNDD PBBL & MOD YELSH BRN CLY MTRX; PRED DIVRS WLDD XL & ASH TUFFS; COM LSE SBANG BYPYRMDL QTZ; COM RED OX STNNG.

NOTE: 10 BBL DOWN HOLE GAIN 1287-1296' (LAG DEPTH 1272-1288') W/INCR TEMP OUT & FLOW

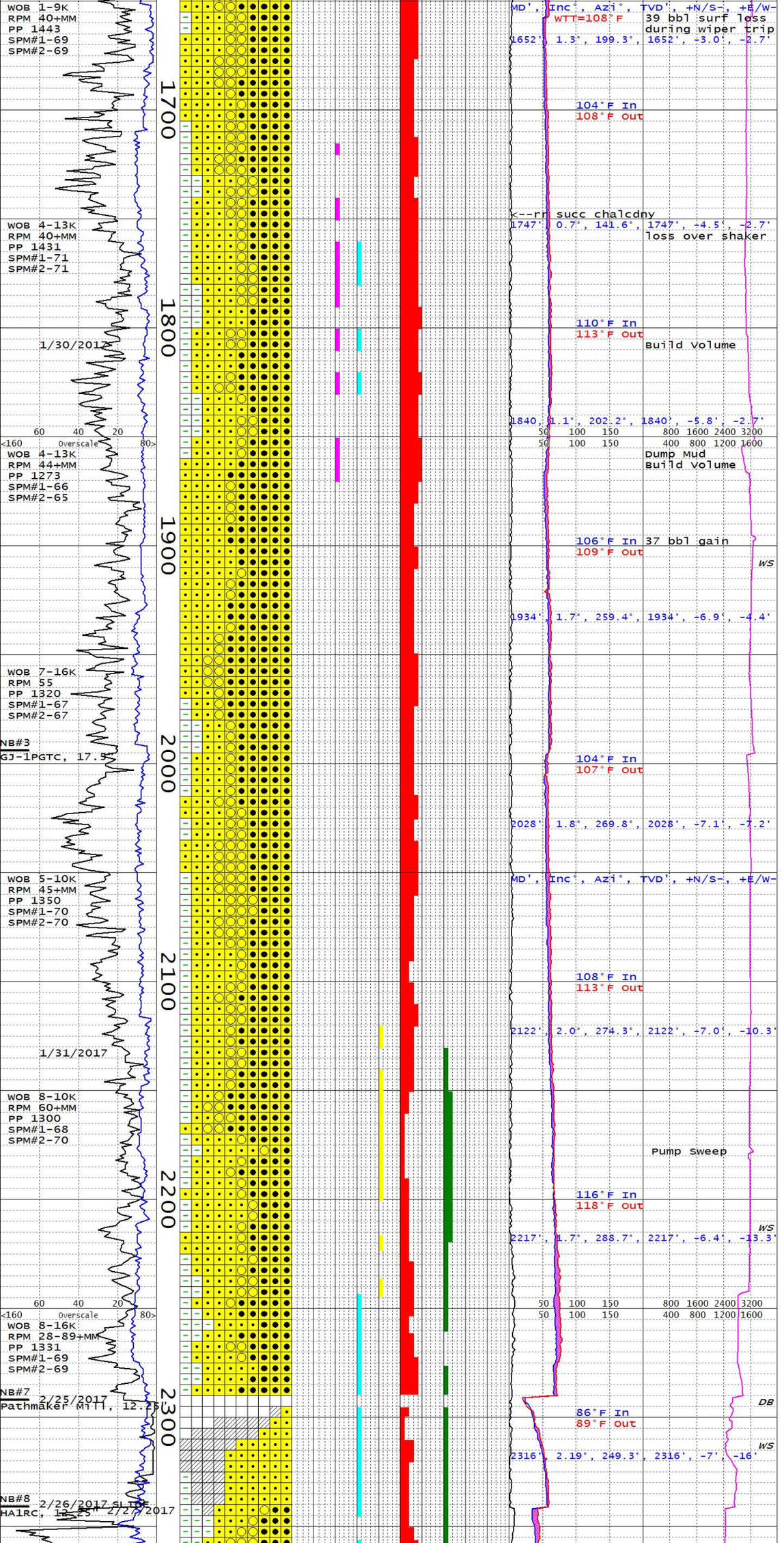
ALLUVIUM: DK YELSH BRN OVERALL; MOD YELSH BRN, DK GRY, MED BLUSH GRY, DSKY RED, & DK YESLH ORNG GRS; PRED MED T/CRS SBANG-ANG SD W/COM FN GRVL/ PBBL FRAGS, LOCAL ZONES MSTLY PBBL; MSTLY WLDD XL & ASH TUFF (COM RHYOLITIC, RRLY VITROPHYRC); TR APHAN BASALT; DIST INCR T/COM SILIC CLYSTN (TYP RNDD) OCC W/DIST FISS F/1290' ON; COM LSE QTZ GRS (FREQ DIPYRMDL & TYP SBRND), RR ADULARSCNT KSPARS; COM RED OX STNNG/ ALT & LIMONT STNNG & TR CHLOR ALT THRU.

ALLUVIUM: DK YEKLSH BRN BULK SPLS; ABD MOD YELSH BRN, MED T/DK GRY, GRYSJH ORNG T/DK YELSH ORNG, MED BLUSH GRY, OCC DK GRNSH GRY GRS; PRLY SRTD; PRED MED T/CRS SBANG T/ANG SD W/MOD AMT MOD YELSH BRN CLY MTRX GRDNG T/PRED GRVL FRAGS & SBRNDD PBBLS BY 1400' W/TR CLY MTRX; PRED MXD MULTI-COLR WLDD XL & ASH TUFF W/OCC T/ MNR TAB GRY T/BLUSH OR GRNSH GRY, HD, BRTL, SBRND T/RND SILIC CLYSTN CMPNTS; INCRSNG RED OXDTN & LIMONT STNNG; MNR CHLOR STNNG.

ALLUVIUM: DRK YELLSH ORNG-DRK YELLSH BRN (BULK SPL); PRLY SRTD, MD-CRS GR SD-FN GRVL; ANG-WELL RDD; PRED PL RDDSH BRN NON-WELDD RHYOLTC XL-TUFF LITH FRAG, COM PL RD-WHT WELDD XL-TUFF FRAG; MNR GRANODIORTE FRAG, RR CHLORTZD GABBRO FRAG W/EPID STNNG/PSUEDMRPH; V RR MD GRY META-CLAYSTN; COM GLASS SD, RR SBHD TRMNTD PHENO FRAG, RR ADULARSCNT SANIDINE PHENO FRAG, V RR BLK BIOT; RR-TR WKLY COHSV CLAY MATRX; COM PL YELLSH ORNG LIMONT STNNG; V RR LOC SBHD CALCT PF; V RR DETRITAL TRNSL WHT SUCC CHALCDNY @1510'.

MW 9.1 FV 51 PV 12 YP 16 PH 10
GEL 8/17/26 SOL 6 CL 6000

ALLUVIUM: DRK-PL YELLSH ORNG, GRYSH ORNG (BULK SPL); PRLY-MOD SRTD, MD-CRS GR SD W/TR-COM FN GRVL; ANG-WELL RDD; PRED OXDZD NON-WELDD RHYOLTC XL-TUFF, TR WHT-PL GRNSH WHT WELDD XL-TUFF, MNR V DUSKY RD APHAN BASALT, TR GRANOD FRAG, RR CHLORTZD GABBRO FRAG, TR MD GRY SILIC CLAYSTN; COM GLASS SD, TR SBHD QTZ PHENO FRAG, V RR SANIDINE PHENOS FRAG; TR-ABD MOD COHSV PL YELL BRN CLAY MATRX; COM LIMONT STNNG ON LITH FRAG; LOC V RR SBHD CALCT PF; V RR WHT SUCC CHALCDNY @1580'.



NOTE: WIPE T/SHOE F/1657'; SERVICE RIG.

ALLUVIUM: TYP DK YELSH BRN BULK SPL; ABD DSKY RDDSH BRN & MOD YELSH BRN, COM DSKY RED, PL YLESH T/GRYSH ORNG &* MNR DK GRY GRS; PRED ANG CRS SD & SBANG T/ANG MED SD, & COM SBANG PBBL FRAGS; PRED WLDD XL TUFFS W/ABD RED OX STNNG & LIMONT STNNG (TYP RHYOLITIC, TR PUMICY TEX, TR VITRS); TR ASH TUFF; TR FNLY SUCR CHALDNY (RR TRANLS/ MLKY & VITRS); TR GRNODRT FRAGS & AP HEMTT ALT V DSKY RD BASALT; V RR PINK FLOW BRECCIA.

MW 9.1 FV 52 PV 13 YP 24 PH 9.6 GEL 8/19/25 SOL 5 CL 6000

ALLUVIUM: GRYSH ORNG, PL YELLSH BRN (BULK SPL); PRLY SRTD; MD-V CRS GR SD T/RR FN GRVL; ANG-WELL RDD; ABD LT RD, MOD RDDSH ORNG NON-WELDD RHYOLT XL-TUFF LITH FRAG; ABD WHT STRLY WELDD XL-ASH TUFF FRAG; COM OXDZD PL RDSH BRN, GRYSH RD BASALTIC ANDST FRAG; RR GRANODRT FRAG; V RR LT BLU GRY META-CLYSTN FRAG; COM VOLC GLASS SD, V RR ADULARSCNT SANIDINE PHENO FRAG, V RR BLK BIOT FRAG; V RR PL RD FN GR QTZITE FRAG; PL YELLSH BRN WKLY COHSV CLAY MATRX; COM-ABD LIMONITE STNNG; LOC RR TRNSL WHT SUCC CHALCDNY PF; LOC V RR CALCT PF, OCC SBHD.

ALLUVIUM: GRYSH ORNG MOD YELLSH BRN; PRLY SRTD, MD-V CRS GR SD T/RR FN GRVL; ANG-WELL RDD; PRED WLDD (TYP RHYOLTC) XL TUFFS (ABD DSKY RDDSH BRN, DSKY RED, MOD BRN, OCC DK BRNSH GRYS, & MOD PINKS); COM NON-WELDD GRYSH PNK, YELSH GRY & V PL ORNG XL TUFF TYP W/SME LIMONT STNNG; TR MOD YELSH BRN SILTY, HI SOL, LOW COHES CLY MTRX; TR GRYSH OLV FNLY SUCR CHALDNY; COM LSE QTZ & KSPARS (OCC ADULARSCNT); ABD RED OX STNNG & YEL LIMONT STNNG THRU;

NOTE: BIT TRIP @ 1994'

ALLUVIUM: MOD YELSHBRN T/DK YELSH BRN BULK SPL; PRLY SRTD; MED T/V CRS SD W/COM MED PBBL & MNR FN GRVL FRAGS; PRED ANG T/SBANG, OCC SBRND T/RND;PRED DSKY RED T/DSKY RDDSH BRN, GRYSH BRN, & PL YELSH BRN T/GRYSH ORNG WLDD XL TUFFS; COM GRYSH YEL T/V PL ORNG NO WLDD XL TUFF (TYP W/LIMONT STNNG); TR HI SOL, V LOW COHES, MOD YELSH BRN CLY MTRX;

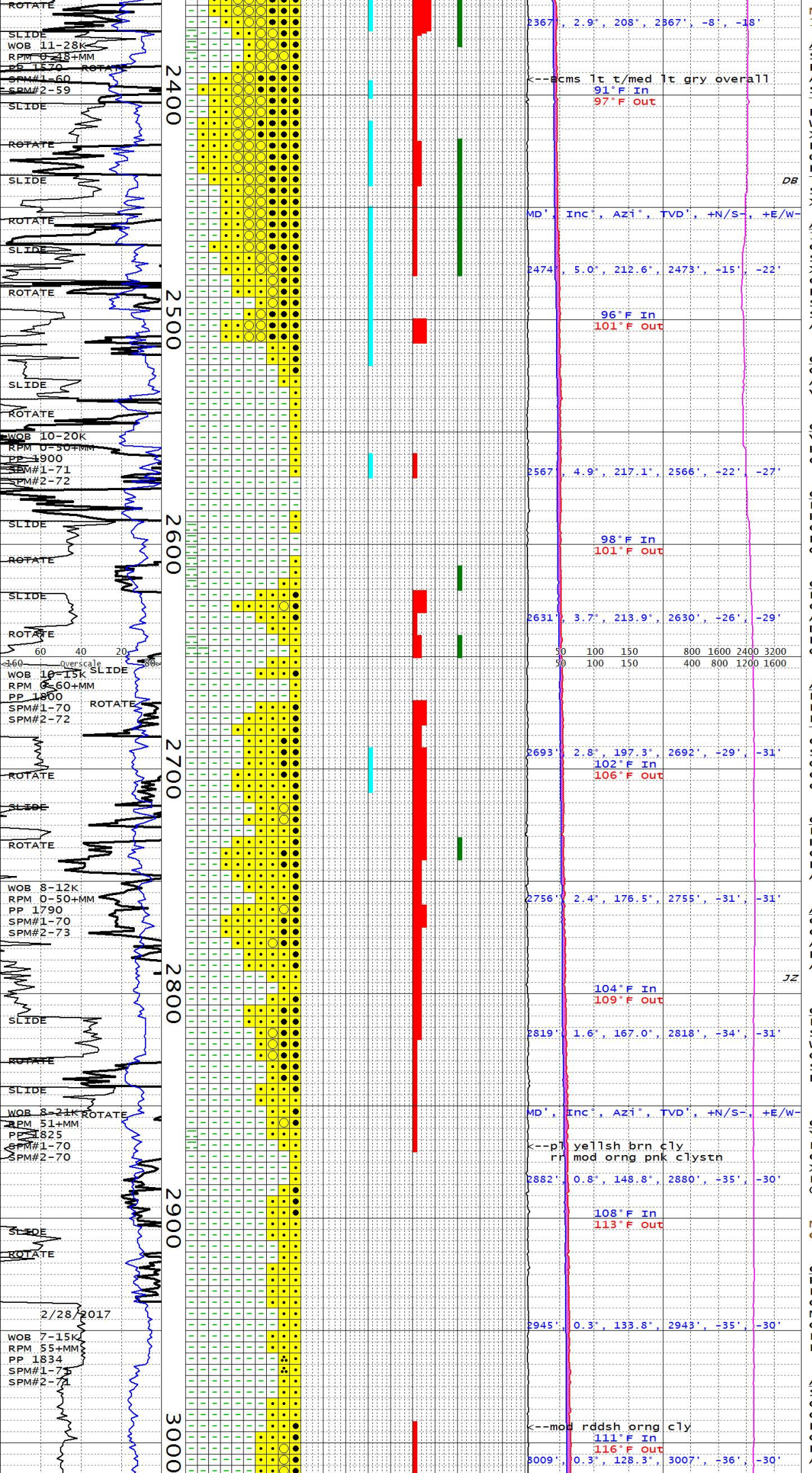
ALLUVIUM: MOD YELSH BRN-DK YELSH BRN IN BULK; PRLY SRTD; SBANG-SBRND; MED-V VRS SD & GRVL FRAG; PRED WLDD XL TUFFS, OFF WHT, MOD RDSH ORNG, & PL OLV; RR QTZ FRAGS PRED SBRND W/OCC CONCH FRAC; COM MOD YELSH GRY LIMONT STNNG; V RR BIOT FLKS 2090'-2100'.

ALLUVIUM: MOD YELSH BRN T/DK YELSH BRN IN BULK; FN-V CRS SD; SBANG-SBRND, OCC RND; V PRLY SRTD; PRED UNCONS; ABD LITHIC WLDD & XL TUFF, MOD PNK, GRYSH RD, DSKY YELSH GRN & V LT GRY FRAGS; COM GRYSH ORNG-MOD RDSH ORNG LIMONT STNNG; V RR SBHD BIOT FLKS; V RR ANHD PYR; V RR SBHD MAGNTT 2120'-2130'.

CLAY: GRYSH ORNG PNK; SFT; GRTY; WELL HYDRD; PR ADHES/COHES; NON CACL; ABD FN-MED CONSOL SD; COM-ABD WLDD XL TUFF FRAGS; SCAT CHLOR ALTN; RR LIMONT STNNG; V RR DISSEM & SBHD XL PYR; V RR TUFF FRAG W/CALCT FRAC FILL.

ALLUVIUM: DK YELSH BRN BULK SPLS BCMNG OLV BLK T/BRNSH BLK W/INCR DEPTH; PRLY SRTD TYP SBANG T/ANG MED SD T/PBBL W/TR FN GRVL FRAGS; PRED MXD DSKY RED, DSKY RDDSH BRN, DK GRNSH GRY, MED GRY & DK YELSH BRN WLDD XL TUFF W/COM LT GRNSH GRY T/PL YELSH ORNG NONWLDD XL TUFF; ABD RHYLTC (OCC VITRIC); SCAT LSE BIPYRMDL QTZ, ADULR-SCNT KSPAR, & BIOT; TR SCAT FNLY SUCR CHALDNY; COM T/ABD RD OX STNNG & INCR CHLOR STNNG+ALT OVRALL; SLI DECR LIMONT STNNG; MOD AMT EVNLY DISSEM MOD YELSH BRN SILTY CLY MTRX (V HI SOL, EZLY WSHS F/SPLS); LOCAL TR CALCT PF; TR EPDT STNNG F/2300

DRILL T/5000'; HANG 8" LINER F/2395'-3490'; FLOW WELL AND PERFORM INJECTIVITY TESTS; SET BRIDGE PLUG @2328'; SET WHIPSTOCK W/TOP @2292'; MILL WINDOW IN 13.375" CASING F/2292'-2341' ON 2/26/2017.



MW 8.8 FV 49 PV 12 YP 26 PH 10.2 GEL 7/14/20 SOL 3 CL 1200

ALLUVIUM: DK RDDSH BRN BULK SPLS W/LOCAL ABD V PL BLU T/PL BLU GRN CLY (AP BIT PLVRZD CLY ALTRD ASH TUFF GRVL); PRLY SRTD, MED SD T/GRVL; SBANG T/ANG; PRED V DSKY RED WLDD RHYLTC XL TUFF (OCC VTRPHYR) W/ABD RED OXDTN, MED GRY WLDD XLL TUFF, & GRYSH BLU GRN T/PL BLU GRN VARBLY WLDD ASH TUFF; OCC-COM LSE BIPYR QTZ/ADLRSCNT KSPAR WTHRD F/RHYLT; BCMS LT T/MED LT GRY OVERALL W/DECR OX STNNG BY 2400' (PRED MED LT GRY XL TUFF); TR CALCT PF.

ALLUVIUM: MOD BRN-MOD RDSH BRN IN BULK, WHT, LT GRY; FN-V CRS, COM PBBL SZ GR; PRLY SRTD; SBANG-SBRND CTGS; PRED WLDD & XL TUFF; RR LITHIC TUFF FRAG; COM ANHD-SBHD QTZ SD; ABD MOD RDSH BRN CLY, WELL HYDRTD, V SOL, PR ADHES, COHES; RR HEMTT STNNG; RR CHLORT ALTN; V RR ANHED PYR.

CLAY: LT BRN, MOD BRN; SFT; GRTY; MOD SOL; WELL HYDRTD; MOD ADHES/COHES; SCAT FN-MED GR SD; V RR CRS GR SD; NON CALC.

CLAY: LT BRN; THCK; LMPY; PSTY; V SLI GRTY; LOW SOL; PRLY HYDRTD; GD ADHES/COHES; NON CALC; MINR AMNT V FN-FN GR SD.

CLAY: LT BRN; THCK; PSTY; PRED FIRM; LOW-MOD SOL; BCMS MOD HYDRTD @2580'; MOD-GD ADHES-COHES; NON CALC; V RR WLDD MED BLUSH GRY TUFF FRAG; RR V FN-FN GR SD.

CLAY: LT BRN; FIRM, OCC SFT; PRED THCK/PSTY; OCC SLI GRTY; COM LMPY; PRED MOD SOL; MOD-GD ADHES/COHES; NON CALC; SCAT DSKY YELSH GRN CLYSTN, BLKY, BRTL; SCAT-COM FN-MED GR SD, RR GVL SZ; RR STRNG HEMTT STNNG.

ALLUVIUM: LT BRN IN BULK, WHT, LT GRY, MOD RDSH BRN; FN-V CRS; PRLY SRTD; SBANG-SBRND; PRED V LT GRY & MOD RDSH BRN WLDD & XL TUFF; V RR MOD BRN LITHIC TUFF; COM ANHD QTZ XL; ABD HEMTT STNNG; V RR BIOT; V RR YELSH GRN EPID PSUEDMRPH; ABD LT BRN CLAY, PRED MOD SOL, GD ADHES-COHES, PR-MOD HYDRTD, NON CALC.

CLAY: PL YELSH BRN IN BULK; FIRM; GRTY; LMPY; OCC PSTY; MOD HYDRTD; PR-MOD SOL; GD ADHES-COHES; NON CALC; ABD MOD RDSH BRN-MOD YELSH BRN HEMTT STNNG; ABD FN-V CRS SD.

ALLUVIUM: LT BRN IN BULK; FN-V CRS; PRLY SRTD; SBANG-SBRND; COM WLDD & XL TUFF; ABD ANHD-SBHD QTZ XL; ABD MOD YELSH BRN-MOD RDSH BRN HEMTT STNNG; ABD MOD SOL CLAY.

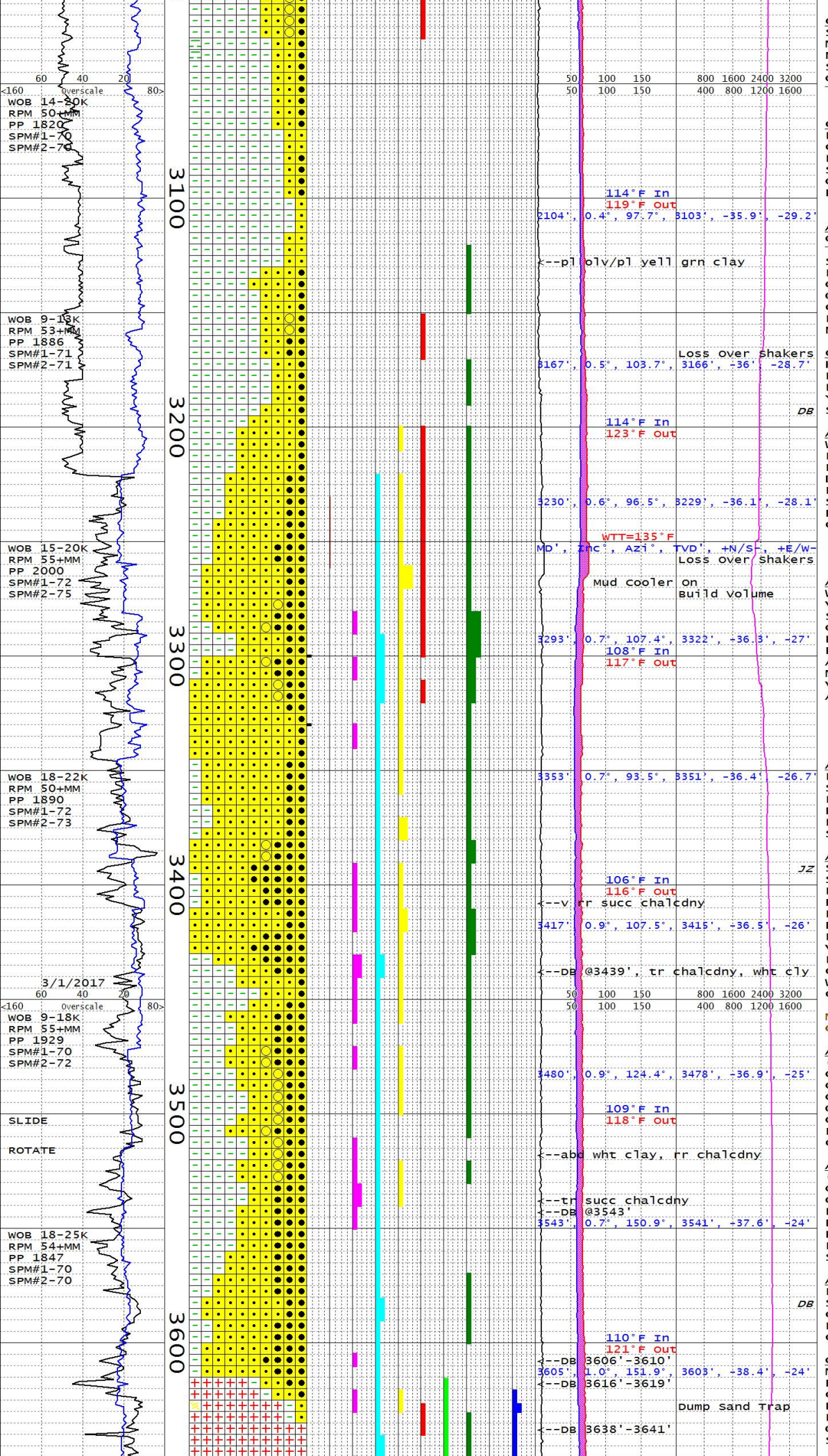
CLAY: LT BRN-GRYSH ORNG PNK; FRM; HYDRTD; STRLY ADHESV, MOD-STRLY COHESV; NON-CALC; INTRBDD W/PRLY SRTD WELL RDD SD, FN-CRS GR, PRED XL-TUFF SD, TR GLASS SD, V RR OXDIZD BASALTC SD; V RR FN SBANG XL-TUFF GRVL.

CLAY: LT BRN-GRYSH ORNG PNK, PL YELLSH BRN-YELLSH GRY F/2870'; FRM-HD; HYDRTD; STRLY ADHSV/ COHSV; STR PLASTCTY; THIN PRLY XL-TUFF/VOLC GLASS SD BDS; V RR FRM MOD RDDSH ORNG SNDY CLAYSTN @2870'.

MW 8.8 FV 45 PV 19 YP 16 PH 9.8 GEL 3/6/10 SOL 3 CL 1500

CLAY: PL YELLSH BRN; V FRM; HYDRTD; STRLY ADHSV/ COHSV; STR PLASTCTY; NON-CALC; GRDNG T/FRM GRYSH ORNG PNK W/STR COHSHN; TR MOD WELL SRTD, SBANG-WELL RDD GLASS/WKLY OXIDZD VOLC SD; V RR FRM/FRIA/NON-INDRTD/GR SPPRTD PL YELLSH BRN CLAYEY SS @2970'.

ALLUVIUM: MOD RDDSH ORNG (BULK SPL); ABD PRLY SRTD SD +V FN GRVL, FN-CRS GRS; PRED VOLC GLASS, COM XL-TUFF, V RR DRK RDDSH BRN BASALT GRVL; ABD GRYSH ORNG PNK CLAY MATRX, REWRKD BY BIT, STR COHSHN/ ADHSHN, NON-CALC.



CLAY: GRYSH ORNG-PL YELLSH BRN; SLI FRM-V FRM; HYDRTD, SLI SOL; MOD ADHSHN/COHSHN; WK PLASTCTY; NON-CALC; INTRBDD W/MOD-PRLY SRTD SD, FN-CRS GR, ABD VOLC GLASS, RR BLEACHD & OXDZD XL-TUFF, V RR V FN RDD BASALT GRVL.

CLAY: V PL ORNG, GRYSH ORNG PNK; FRM-V FRM, OCC HD; V STR COHSHN, STRLY ADHSV; STR PLASTCTY; NON-CALC; TR MOD-PRLY SRTD SD, FN-CRS GR; PRED VOLC GLASS, TR TUFF, RR DRK BRN BASALT GRS.

ALLUVIUM: PL OLV, PL YELLSH GRN, GRDNG T/GRNSH GRY @3150', T/MOD ORNG PNK @3160'; COM PRLY SRTD SD, FN-CRS GR, LOC V RR V FN RDD GRVL; PRED VOLC GLASS GRS, V RR SANIDN, RR FN GR QTZITE, V RR BLK SLATE; WKLY CHLORTZD CLY MATRX REWRKD T/ABD FRM-V FRM, STRLY COHSV/ADHSV, NON-CALC CLAY;

CLAY: DRK GRNSH GRY; FRM; GRTY; HYDRTD; STRLY COHSV/ADHSV; MOD PLASTICTY; MNR MOD WELL SRTD SD PRED VOLC GLSS, TR TUFF; RR MOD YELSH BRN & MOD RDSH BRN GRVL SZ SD W/HEMTT STNNG; NON CALC.

ALLUVIUM: OLV GRY, BRNSH GRY, WHT, MOD BRN; PRLY SRTD V FN-CRS GR SD, SME GRVL SZ FRAG; PRED VOLC LITHICS & GLASS; COM DK YLSH BRN BIOT; SCAT ANHED PYR, SME SBHED CUBIC PYR; SCAT-COM MOD YELSH BRN-MOD RDSH BRN HEMTT; RR CHLOR ALTN; V RR CALCT FRAC FILL.

WHIPE HOLE T/2400' @3249'

ALLUVIUM: MED LT GRY IN BULK, WHT, CLR-TRANS, MOD RDSH ORNG; V FN-V CRS SD W/SME GRVLS; PRLY SRTD; SBANG-SBRND; PRED GRANODIORITE FRAG W/COM RDSH BRN BIOT & SCAT CHLOR ALTN; V RR YLSH GRN EPID PSUDMRPH; COM ANHD-SBHD PRY, OCC DISSEM; SCAT MOD RDSH BRN HEMTT STNNG; V RR V LT GRY TUFF LITHICS; DECRS AMNTS V SOL LT GRY CLAY.

NOTE: V RR <1MM TRMNTD QTZ XLS 3300'-3310' & 3330'-3340'; POSSBL DETRITL.

ALLUVIUM: LT GRY, MED LT GRY; FN-V CRS SD; PRLY SRTD; SBANG-SBRND; PRED GRANODIORITE FRAG W/COM-ABD RDSH BRN BIOT, RR CHLOR ALTN, RR YLSH GRN EPID PSUEDMRPH; MNR AMNTSV LT GRY V SOL CLAY; R-COM ANHD-SBHED PYR.

ALLUVIUM: DRK GRNSH GRY (BULK SPL); PRLY SRTD, FN-CRS GR SBANG-SBRDD SD, RR FN RDD GRVL; PRED MOD CHLORTZD GRANODRT W/ RDSH BRN BIOT PHENS, TR EPID PSUEMRPH; TR CRS OXDZD RDDSH BRN BASALTIC SD @3430'; RR BY-PYRMDL QTZ XL-TUFF PHENO FRAG; V RR ADULRCNT SANIDN PHENO FRAG; DB @3440' W/TR V FN SUCC CHALCDNY/TR CALCT/GYPSUM, ABD WHT SOL CLAY; ABD LT GRY SOL CLAY @3450'; RR V FN SBHD PYR.

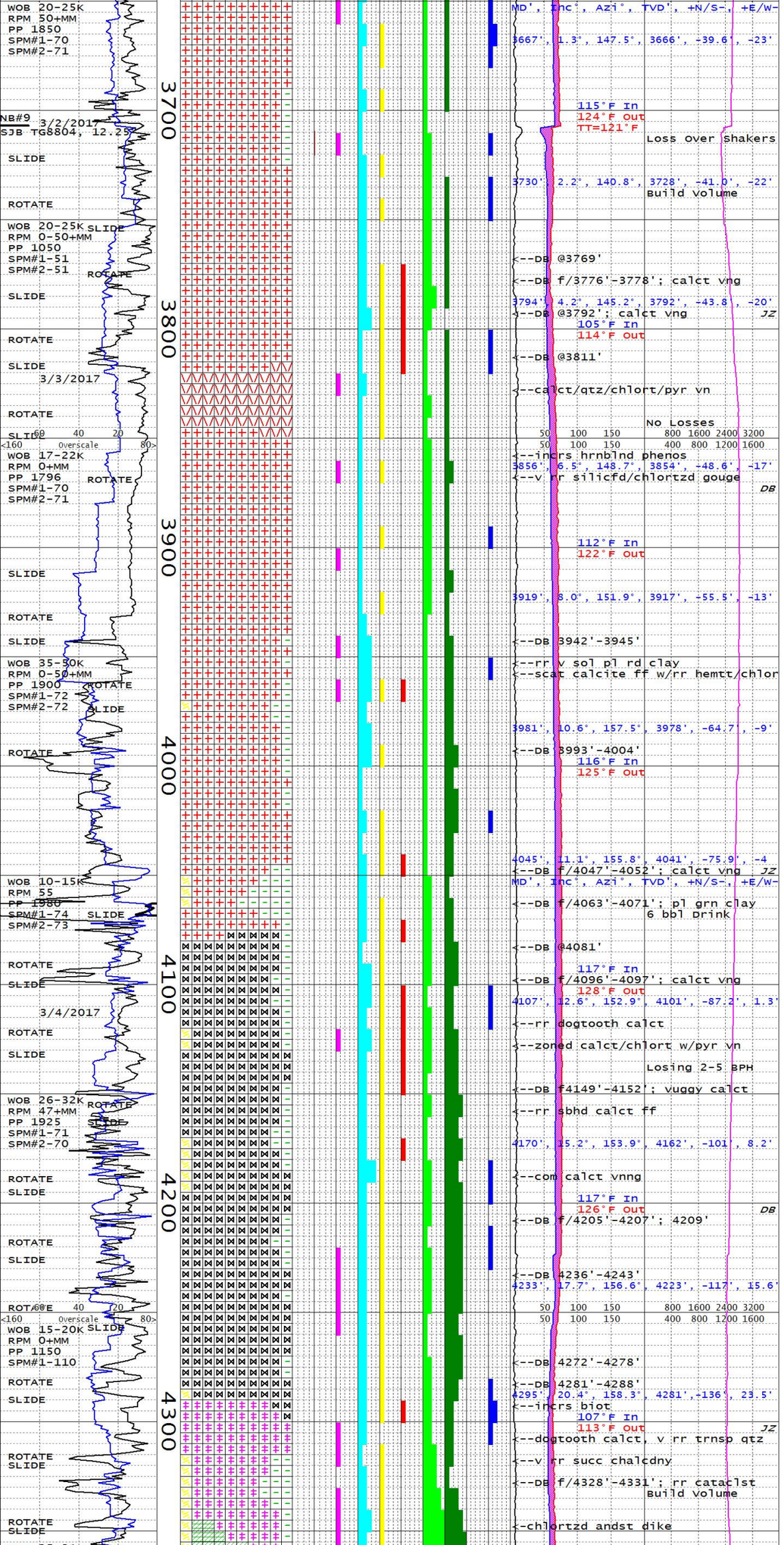
MW 8.8 FV 48 PV 17 YP 18 PH 9.4 GEL 5/14/20 SOL 3 CL 1400

ALLUVIUM: GRNSH GRY, MD GRY (BULK SPL); PRLY SRTD, FN-CRS GR SBANG-SBRDD SD, RR FN RDD GRVL; PRED WKLY CHLORTZD GRANODRT FRAG; V RR MOD RDDSH ORNG SNDY CLAYSTN; ABD WHT-LT GRYSH WHT WKLY-MOD COHSV CLAY; LOC RR V FN SUCC CHALCDNY; RR CALCT PF; RR V FN SBHD PYR.

ALLUVIUM: GRNSH GRY, MD LT GRY (BULK SPL); PRLY SRTD, FN-CRS GR SD, V RR FN GRVL; SBAN-RDD GRS; PRED GRANODRT FRAG W/RR EPID PSUEDMRPH; V RR RDDSH BRN BASALT GRS; V RR VOLC GLASS; RR-TR RNDD DETRITL? CHALCDNY F/3530-3550'; RR CALCT PF; RR SBHD PYR.

ALLUVIUM: MED LT GRY IN BULK; FN-V CRS SD; PRLY SRTD; SBANG-SBRND; PRED GRNODRT FRAG; COM EPID PSUEDMRPH; SCAT PYR PRED ANHD, V RR VNNG; SCAT CALCT; RR CHLOR ALTN.

GRANODIORITE: LT OLV GRY, WHT, MOD ORNG PNK, GRY; FIRM-HD; OCC BRTL; PHAN; PRED IRREG SBBLKY CTGS; ABD EPID PSUEDMRPH; COM BLK BIOT PHENOS; TR ANHD-EUHD PYR; RR HEMTT STNNG; V RR EUHD QTZ XLS; SCAT LT BRN CLY; RR V SFT DK GRY CATACLASITE.



GRANODIORITE: LT OLV GRY, GRNSH GRY; HD/DENSE, OCC BRTL; PRED SBBLKY CTGS; OCC IRREG HCKLY FRAC; PHAN; ABD K-FSPR; ABD YELSH GRN PSUEDMRPH; COM BIOT PHENOS, BCMS INCRNGLY RDSH BRN W/V RR CHLOR ALTN; SCAT CHLOR ALTN; RR-V RR ANHD PYR, OCC VNG.

P/U BUTTON INSERT BIT, NEW MUD MOTOR, STRING STAB & SHOCK SUB @3707', L/D UBHO.

GRANODIORITE: GRNSH GRY IN BULK; PRED 1-3MM IRREG SBBLKY CTGS, SCAT BLDD CTGS W/HCKLY FRAC; HD/DENSE; GRSY-SBVIT LSTR; PHAN; PLAG & K-SPAR; ABD ANHD EPID PSUEDMRPH, V RR APP AS EUHD PSUEDMRPH OF PLAG; COM RDSH BRN BIOT; SCAT SBHD BLKY & TAB CHLOR, V RR W/CHLOR ALTN; RR <1MM ANHD-SBHD BLK MTTLC OXIDES; RR ANHD PYR, V RR SBHD CUBIC XL; V RR WHT SERICITE, SFT W/FIBRS TEX WHEN DRY.

MW 8.9 FV 45 PV 16 YP 17 PH 9.3 GEL 4/9/16 SOL 4 CL 1300

SYENO-GRANITE: GRNSH GRY, DRK GRNSH GRY (BULK SPL); V HD/DENSE; PHAN, HYPDIOMRPHC GRANLR; COM BRN SBHD-EUHD BIOT PHENOS, MNR ALTRTN T/CHLORT & SERCT; MNR V FN OLV-BRNSH GRY HRNBLND PHENOS, RRLY ALTRD T/CHLORT; TR V FN BLK/METLLC OXIDES; ABD MOD ORNG PNK SBHD K-SPAR; TR WHT SBHD-ANHD PLAG; TR ANHD QTZ; RR SBHD PYR; RR CALCT/CHLORT/TRNSP QTZ W/V FN PYR INCLSNS VEIN @3830'.

GRANODIORITE: GRNSH GRY IN BULK, WHT, BLK, MOD YELSH GRN; HD/DENSE; PRED IRREG BLKY CTGS; SCAT BRTL IRREG PLTY CTGS; PHAN; FSPR PRED SBHD PLAG, V RR ANHD K-SPAR; ABD GRNSH BLK HRNBLND PHENOS; ABD YLSH GRN EPID PSUEDMRPH; SCAT RDSH BRN BIOT, SME W/V MNR CHLOR ALTN, BCMS COM & PRED BLK AFT 3910' ; SCAT WK CHLOR ALTN OF BULK SMPL; TR FN BLK/METLLC OXIDES; RR CALCT; RR ANHD PYR & V RR OCCUR MICR VNG; V RR ANHD-SBHD QTZ XL, PRED SBVIT, OCC W/WHT & OR PNKSH GRY INCLS 3900'-3910'.

NOTE: INCRS K-SPAR ALONG WITH MNR AMNTS CLAY AND SCAT CALCT/PYR/QTZ/CHLOR/HEMTT FRAC FILL 3960-3670'; DECR CTGS SZ AFT 3960'.

GRANODIORITE: GRNSH GRY, WHT, MOR YELSH GRN; PRED HD/DENSE, OCC FIRM; OCC BRTL, RR FRIA; PRED IRREG SBBLKY CTGS, COM BLDD W/HCKLY FRAC; PHAN; ABD ANHD-SBHD WHT PLAG, V RR EUHD TAB XL, RR-SCAT K-SPAR; ABD CHLOR ALTN; SCAT YELSH GRN EPID PSUEDMRPH; COM GRNSH BLK HRNBLND, SME CHLOR ALTN TO GRYSH OLV GRN; COM CALCT FRAC FILL; SCAT BIOT PHENOS.

ABD PL GRN SOL CLAY F/4050'-4070', RR CATACLST @4060'.

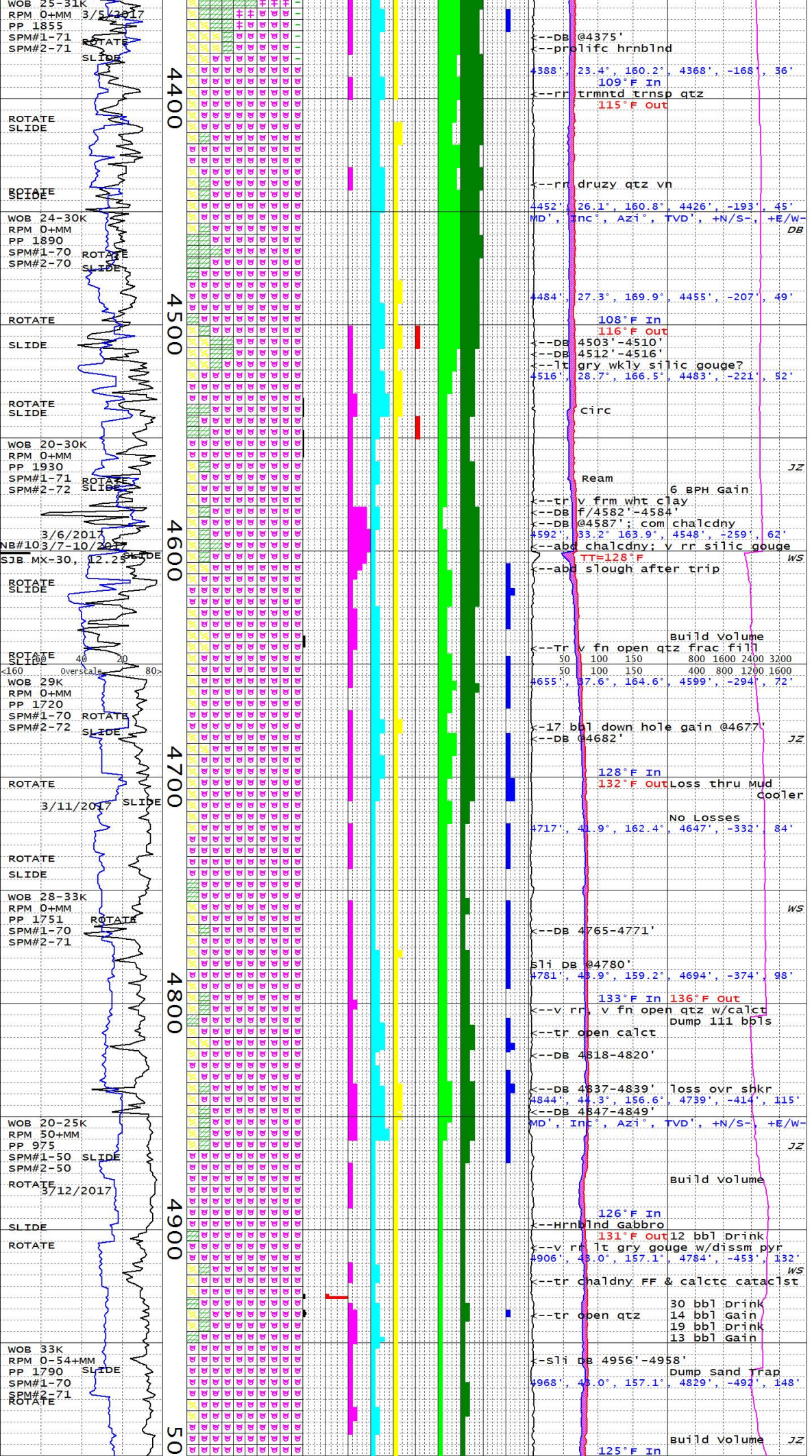
DIORITE: GRYSH GRN (BULK SPL); HD/DENSE; PHAN, HYPIDIOMRPHC GRNLR; ABD DRK GRN CHLORTZD EUHD HRNBLND PHEN, MNR SBHD-ANHD BLK/METTLC OXID PHEN, V RR DRK BRN EUHD-SBHD BIOT PHEN (OCC ALTRD T/SERCT), ABD SBHD-ANHD WHT-TRNSL WHT PLAG; TR EPID PSUEDMRPH AFTER PLAG; TR-MNR CALCT VNG, ZONED W/CHLORT+ PYR & HMT @4130'; V RR TRNSP QTZ W/PYR INCLSNS & CALCT 4130'; RR DOGTOOTH CALCT 4120'; RR VUGGY CALCT @4150'.

DIORITE: GRYSH GRY, DUSKY GRY; V HD/DENSE; PHAN, HYPIDIOMRPHC GRNLR; ABD FN DRK GRN CHLORTZD HRNBLND PHEN, OCC BLK/UNALTRD; MNR V FN ANHD-SBHD BLK/METLLC OXID, RRLY W/RD HMT OXD; ABD WHT WHT SBHD PLAG; V RR V FN RDDSH SILVERY BRN BIOT PHEN, OCC ALTRD T/CHLORT OR SERCT; TR EPID PSUEDMRPH AFTER PLAG, RRLY AFTER HRNBLND; TR-MNR CALCT VNNG; LOC CATACLST W/V FN XLN PYR; TR PL GRN CLY.

WIPE HOLE 4223'-3600', NO FILL

DIORITE: GRYSH GRN IN BULK; HD/DENSE, OCC BRTL; IRREG ANG-SBRND BLKY CTGS, OCC SPLNTRY; PHAN; HYPIDIOMRPHIC GRANLR; ABD DSKY GRN STRNGLY CHLORTZD HRNBLND PHENOS; COM CALCT, V RR APP TAB FRAC FILL; SCAT YELSH GRN EPID PSUEDMRPH; TR <1MM BLK METLLC OXIDE, W/ V RR MOD RDSH BRN HMT; RR ANHD PYR; V RR ANHD-SBHD QTZ XL; INCRS AMNTS DK YLSH BRN SERCT AFT 4270'.

QUARTZ DIORITE: GRYSH GRN, DUSKY GRN (BULK SPL); PHAN, HYPIDIOMRPHC GRAN; ABD BLK EUHD HRNBLND PHEN (CHLORTZD IN PART); COM SILVERY RDDSH BRN BIOT PHEN; ABD WHT EUHD-SBHD PLAG; RR TRNSP ANHD QTZ; COM EPID PSUEDMRPH AFTER PLAG; COM V LT GRY CLAY F/4320', RR CATACLST; DOGTOOTH & BLADDED CALCT @4310', TR CALCT VNNG THRU; V RR SUCC CHALCDNY @4320'.



ANDESITE DIKE: LT GRN, LT BLU GRN; FRM, BRTTL; APHAN, COM SFT TRNSL GRYSH YELL GRN EUHD PLAG MICRO-PHEN; CRYPTXLN GRNDMS; ABD EPID PSUEDMRPH IN HOST; RR-TR CATACLST; RR SUCC CHALCDNY.

HORNBLENDE GABBRO: DUSKY GRN (BULK SPL); PHAN; ABD BLK/ UNALTRD HRNBLND PHEN, V RRLY ALTRD T/RDDSH BRN BIOT ALTRD T/SILVERY GRN SERCT; COM FN SBHD/ANHD BLK/METLLC OXID; PL GRN/CHLORTZD EUHD-SBHD PLAG, OCC TRNSL WHT; ABD XLN EPID; V RR CHLORTZD ANDST DIKE @4420'; RR CATACLST/TECTONIC BRECC THRU; TR CALCT VNNG; RR XLN PYR.

HORNBLENDE GABBRO: DSKY GRN, DK GRNSH GRY, BLK, YLSH GRN; HD/DENSE, OCC FIRM AFT 4460'; PHAN; ABD BLK UNALTRD SBHD HRNDBLND, SME CHLORTZD AFT 4460'; SCAT EUHD WHT/TRANSL WHT PLAG; ABD XLLN EPID PSUEDMRPH; RR-TR CALCT FF; RR ANHD PYR; TR CHLORTZD CATACLST 4500'-4520', LT GRY WKLY SILICFD GOUGE? @4520'; V RR SILVERY MUSCV?; V RR SUCC CHALCDNY; GRNSH GRY CRYPTOXLN ANDST DIKE W/SFT PL YELL GRN EUHD PLAG MICRO-PHEN, OCC BLK & MOD BRN METLLC OXDS.

NOTE: SLIDE T/4567', PULL 245K-LBS @4542' BIT DEPTH; REAM TIGHT-HOLE; INCRS TEMP IN & 6 BPH GAIN AFTER REAMNG; ABD V FN SUCC CHALCDNY 4580'-4600', TR-MNR V FRM WHT CLAY, RR LT GRY SILICFD GOUGE; RR FN RADIAL/ TRMNTD QTZ ON CHALCDNY VN 4590'.

TWIST OFF @4600'; TOP OF FISH @4362'; RIH W/OVERSHOT, TAG @3207'; M/U SLICK ASSEMBLY, REAM 2442'-3714', WASH-IN 4279'-4363'; RECOVER FISH.

HORNBLENDE GABBRO: GRYSH GRN T/DK GRNSH GRY BULK SPLS; PRED HD ANG, IRREG, PHAN FRAGS, OCC FRM, CRMBLY T/CRNCHY, & CATACLASTIC; ABD GRYSH GRN T/ GRYSH BLU GRN OR WHT SBHED & RRLY EUHED PLAG (COM CHLOR STNND); ABD TYP SBHED BLK HRNBLND (FREQ ALTD T/MTLC BRN BIOT &/OR SERICT); COM QTZ & CALCT VNNG; COM EPID RCPLCMNT OF PLAG; TR SBHED BLK MTLC OX OCC EUHED PLAG INCLDD IN HRNBLND

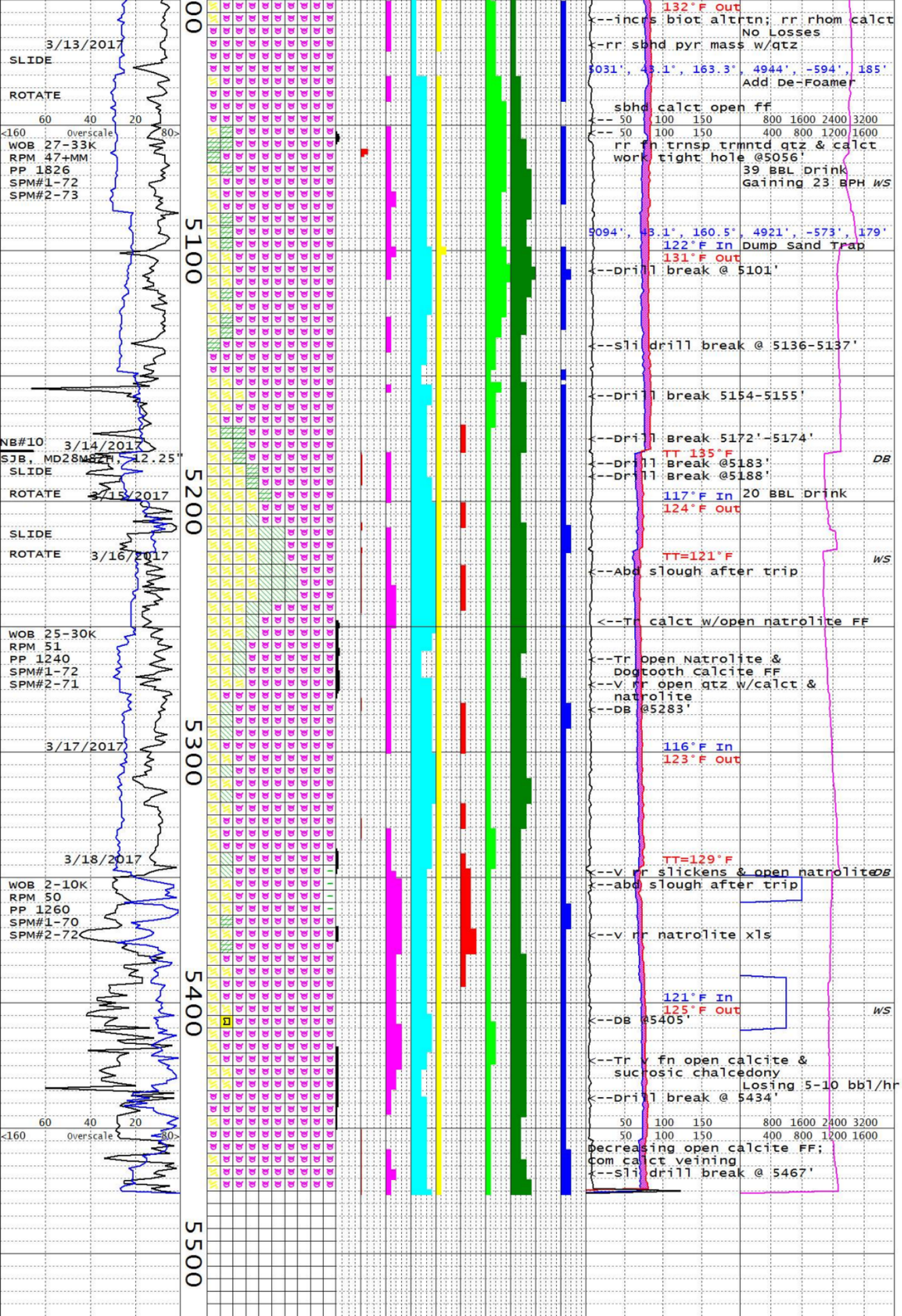
HORNBLENDE GABBRO: DUSKY YELL GRN, GRYSH GRN (BULK SPL); V HD/DENSE; PHAN, HYPIDIOMRPHC GRNLR; ABD BLK/UNALTRD HRNBLND PHEN, V RRLY ALTRD T/DRK RDDSH BRN BIOT, OCC STRLY ALTRD T/CHLORT W/IN CATACLSTC ZONE; ABD HD WT SBHD-EUHD PLAG, WK CHLOR ALTRTN @4740'; RR V FN SBHD BLK METTLC OXID; TR-MNR EPID PSUEDMRPH AFTER PLAG; TR-RR WHT CALCT VNG, OCC TRNSP/ SBHD; V RR V LT GRY FN SUCC CHALCDNY; LOC V RR SERCT ALTRTN W/IN CATACLST; V RR SBHD PYR.

HORNBLENDE GABBRO: PRED GRYSH GRN T/DK GRNSH GRY OVERALL; PHAN; HYPDMRPHC GRNLR; HD IRREG FRAGS; PRED WHT SBHD PLAG (COM GRSH GRN T/GRYSH BLU GRN WHERE CHLOR STNND) & BLK SBHD HRNBLND (OCC T/RRLY ALT T/RDDSH BRN BIOT & SILVERY BRNSH CHLOR); COM PRTLY REXLZD CATACLST/ GOUGE FREQ W/TR ANDST ; MNR CALCT VNNG (RRLY TRANSP) & V RR OPEN CALCT FF THRU; TR CHALDNY FF; COM EPID RPLCMNT OF PLAG; SCAT ANHED PYR & TR EUHED PYR IN CATACLST; TR SERCT ALT OF PLAG & & CATACLST (COM W/ CHLOR); TR SBHED BLK MTLC OX.

ANORTHOSITIC HORNBLENDE GABBRO: PL GRN, GRYSH GRN (BULK); V HD/ DENSE; PHAN, HYPIDIOMRPHC GRNLR; ABD (70%) HD TRNSL WHT EUHD-SBHD TAB PLAG PHEN W/POLYSYNTH TWINS, OCC W/V WK CHLORT ALTRTN; COM BLK/V DRK BRN BRTLL SBHD HRNBLND PHEN; RR BLK V FN OXD; RR EPID PSUEDMRPH AFTER PLAG; V RR SILVERY GRN SERCT; RR CALCT VNG; V RR FN SUCC CHALCDNY VNG; V RR XLN PYR.

HORNBLENDE GABBRO: GRYSH GRN T/DK GRNSH GRY BULK SPLS; HD & DENS ANG FRAGS; PHAN; HYPDMRPHC GRNLR; PRED SBHED WHT T/GRNSH GRY PLAG; ABD (DECR) BLK T/DK BRN HRNBLND (RR-OCC ALT T/BIOT); MNR DK BRN T/BLK NON STRIATED PYRXN; TR V FN BLK MTLC OXD; OCC-COM EPID REPLCMNT OF PLAG; MNR CALCT VNNG (OCC CLR) & TR CHALDNY VNNG; V RR OPEN TERMNTD QTZ @ 4937'; TR PYR & V RR DODECHDRL PYR W/IN CALCT REXLZD GOUGE & CATACLST.

NOTE: ADD DE-FOAMER T/SUCTN



PITS @5032', STABLZD PUMP PRESS, 12 BBL DROP IN PVT.

HORNBLENDE GABBRO: GRYSH GRN, DUSKY GRN (BULK); V HD; PHAN, HYPIDIOMRPHC GRNLR; ABD BLK, DRK RDDSH BRN SBHD HRNBLND PHEN, RRLY ALTRD T/BIOT; ABD EUHD-SBHD PLAG; RR BLK METLLC OXD; V RR SBHD-ANHD TRNSP/PL YEL APPAT?; INCRS SILVERY RDDSH BRN BIOT BOOKS F/5010'; RR-MNR CALCT VNG THRU, OCC TRNSP W/ PRFCT CLEAVG; RR SBHD PYR MASS W/CHALCDNY @5020'; V RR LOC CHALCDNY VNG; RR SERTC ALTRTN.

HORNBLENDE GABBRO: GRYSH GRN, DSKY GRN (BULK SPL); HD, IRREG FRAGS; PHAN; PRED SBHED WHT T/GRNSH GRY (W/CHLOR STNNG) PLAG & DK RDDSH BRN T/BLK HRNBLND (VARBLY ALTRD T/BIOT); V RR BLK MTLC OXD; LCLY COM SLVRY SERCT; COM-ABD CALCT FF (OCC CLR W/GD CLVG, V RRLY OPEN); RR LCL CHLDNY VNNG; COM CHLOR/ CHLOR ALT; COM EPID ALT OF PLAG & V RR EUHED EPID @ 5110 (AP GRWNG INTO VUG, POSS PLAG GHOST); COM CALCT REXLZD CATACLST/ GOUGE & MNR ANDCT DIKE

NOTE: BIT TRIP @ 5179'; REAM 5072'-7179'

NOTE: TORQUING UP 5180'-5195'

HORNBLENDE GABBRO: GRNSH GRY; HD; PRED IRREG BLKY CTGS; PHAN; PRED ANHED-SBHED WHT T/GRNSH GRY PLAG; SCAT HRNBLND; V RR BLK MTLC OXD, OCC W/HEMTT ALTN; ABD CALCT FF; RR PYR VNNG & ANHD XL; RR EPID PSUEDMRPH; V RR QTZ XL; ABD GRNSH GRY T/WHT CATACLST, SFT-FIRM, FRIA; V RR SLICK 5210'-5220'; BCMS INCRSNGLY SHEARD W/DECR MAFICS, INCRSD CHLOR/SERCT/CALCT FF.

DRILL T/5220'; POOH; L/D DIR TOOLS; M/U BHA; RIH; TAG @3825'; REAM F/3793'-3869'; RIH; TAG @4169'; REAM 4131'-4239'; RIH T/4508'; REAM 4508'-5220'.

MW 8.8 FV 45 PV 15 YP 17 GEL 8/16/23 PH 9.6 SOL 3 CL 7000

HORNBLENDE GABBRO: DK GRNSH GRY, WHT, GRNSH GRY; HD/DENSE; PHAN; IRREG 1-2MM SBBLKY CTGS; PRED ANHED-SBHED WHT T/GRNSH GRY PLAG; ABD BLK T/GRNSH BLK SBHD HRNBLND; ABD CALCT, V RR SBHD XL; COM CHLOR ALTN; RR EPID PSUEDMRPH; V RR PYR VNNG & FN ANHD-SBHD XLS; SCAT GRNSH GRY T/WHT CATACLST; TR-SCAT V HD POSS KERATOPHYRE, WHT-GRNSH GRY GRNDMSS W/COM PLAG PHENOS.

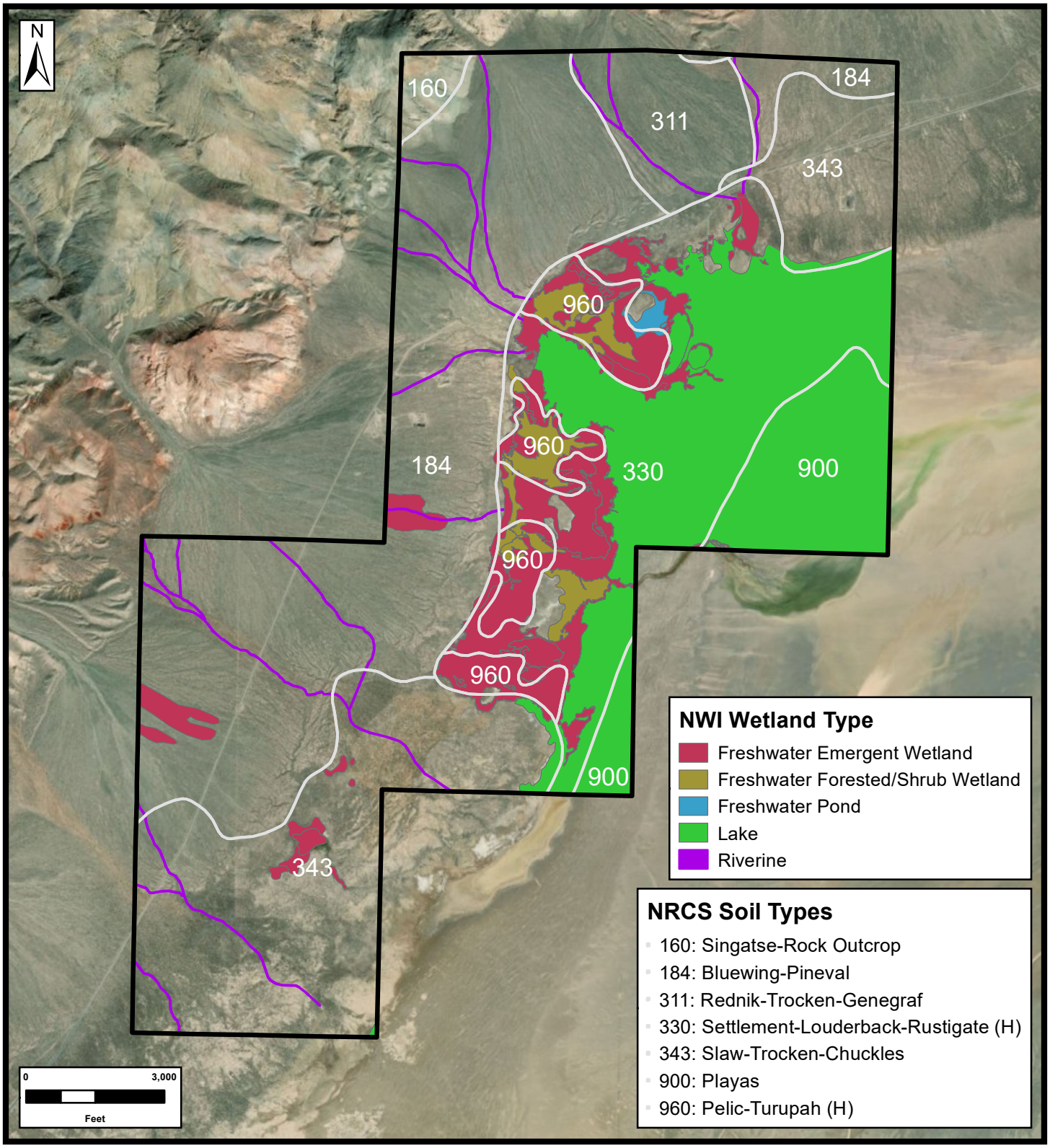
DRILL T/5348'; 200PSI DROP IN PUMP PRESSURE; SURVEY; POOH LOOKING FOR WASH; L/D 2 8"DC'S, STAB, NEAR BIT; P/U 2 8"DC'S; RIH W/SLICK BHA; REAM F/5222'-5348'; DRILL AHEAD.

HORNBLENDE GABBRO: GRYSH BLU GRN T/GRYSH GRN BULK SPL; PHAN IRREG ANG FRAGS; HYPDMRPHC GRNLR; PRED SBHED SLI TRANSL WHT T/GRNSH GRY OR PL GRN PLAG (COM W/DIST THN PLYSYNTHTC TWINS) & BRNSH BLK T/DSKY BRN ANHED T/SBHED HRNBLND (ABD ALTRN T/BRN BIOT); TYR BLK MTLC OXDS; COM SHEARED & REXLZD T/ CATACLST; ABD CALCT VNNG & TR T/RR OPEN CALCT FF; TR T/RR CLR OR CLDY CHALDY VNNG; ABD CHLOR & TR SERCT ALT; GRDS T/MRE ANRORTHSITIC GABBRO F/5430' W/DECR HORNBLND.

NOTE: HIGH TORQUE STALLING OUT ROT TABLE F/5400'--CALL TD; TD @ DRILLER'S DEPTH 5476' @ 16:40 HRS ON 3/18/2017; PUMP SWEEP; POOH; P/U NEAR BIT STAB; RIH & REAM F/3590-

APPENDIX B

Pre-Field Assessment Data - Spring Dependent Ecosystems and Aquatic Habitat



TITLE:

SITE MAP
-SHOWING-
NWI WETLANDS AND NRCS SOIL TYPES
ORMAT TECHNOLOGIES INC.
DIXIE MEADOWS GEOTHERMAL DEVELOPMENT PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM008**

DATE: **7/22/2019**

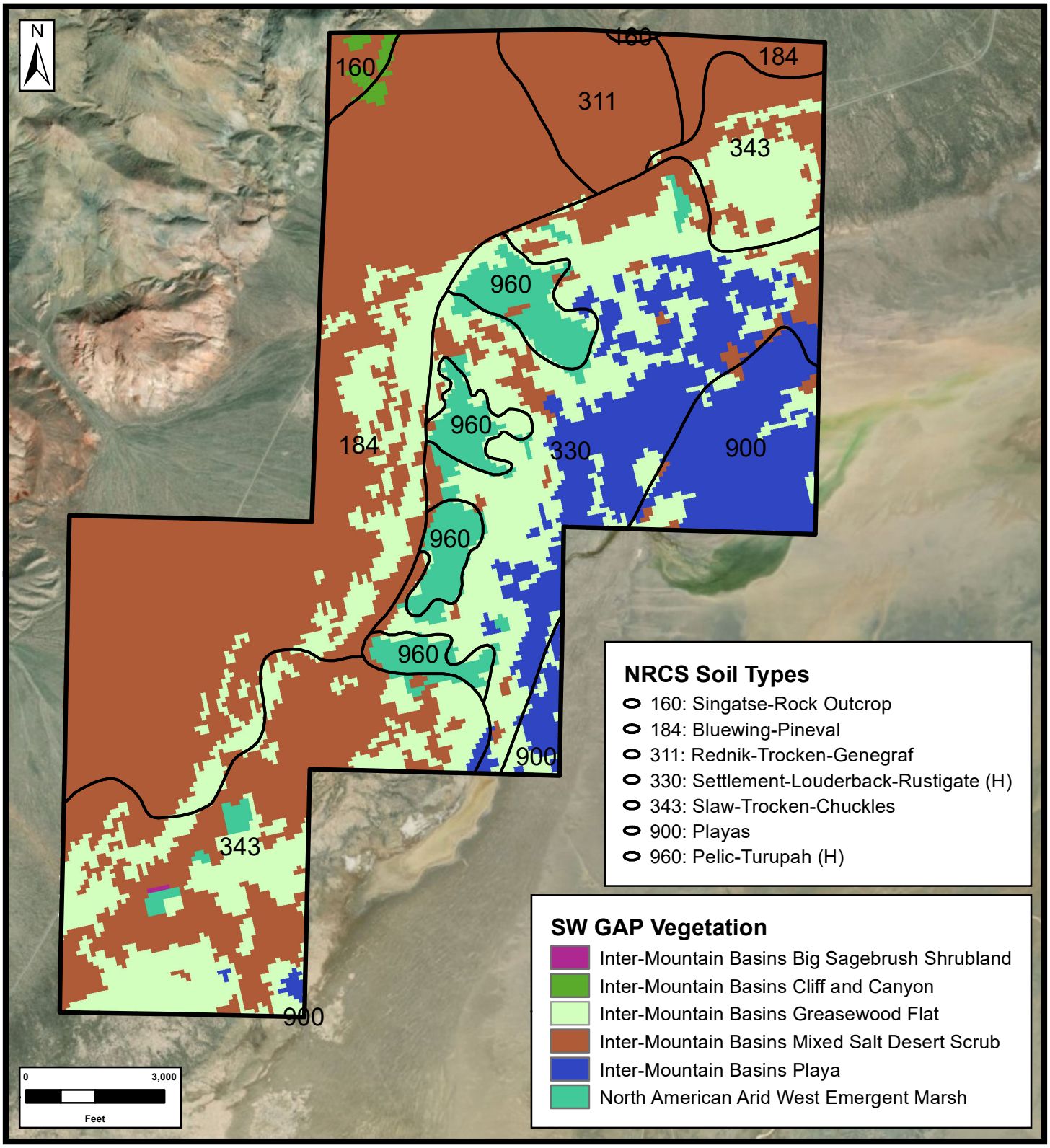
McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Wetlands and Soils Map**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	GB	CHECKED	BP	-
	DRAWN	GB	APPROVED	BP	

R:\Projects\GIS Data\ORM\008\Biological\Wetlands and Soils Map.mxd



TITLE:
SITE MAP
-SHOWING-
SWReGAP VEGETATION
AND NRCS SOIL TYPES
ORMAT TECHNOLOGIES INC.
DIXIE MEADOWS GEOTHERMAL
DEVELOPMENT PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM008**

DATE: **7/22/2019**

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Vegetation and Soils Map**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	GB	CHECKED	BP	-
	DRAWN	GB	APPROVED	BP	

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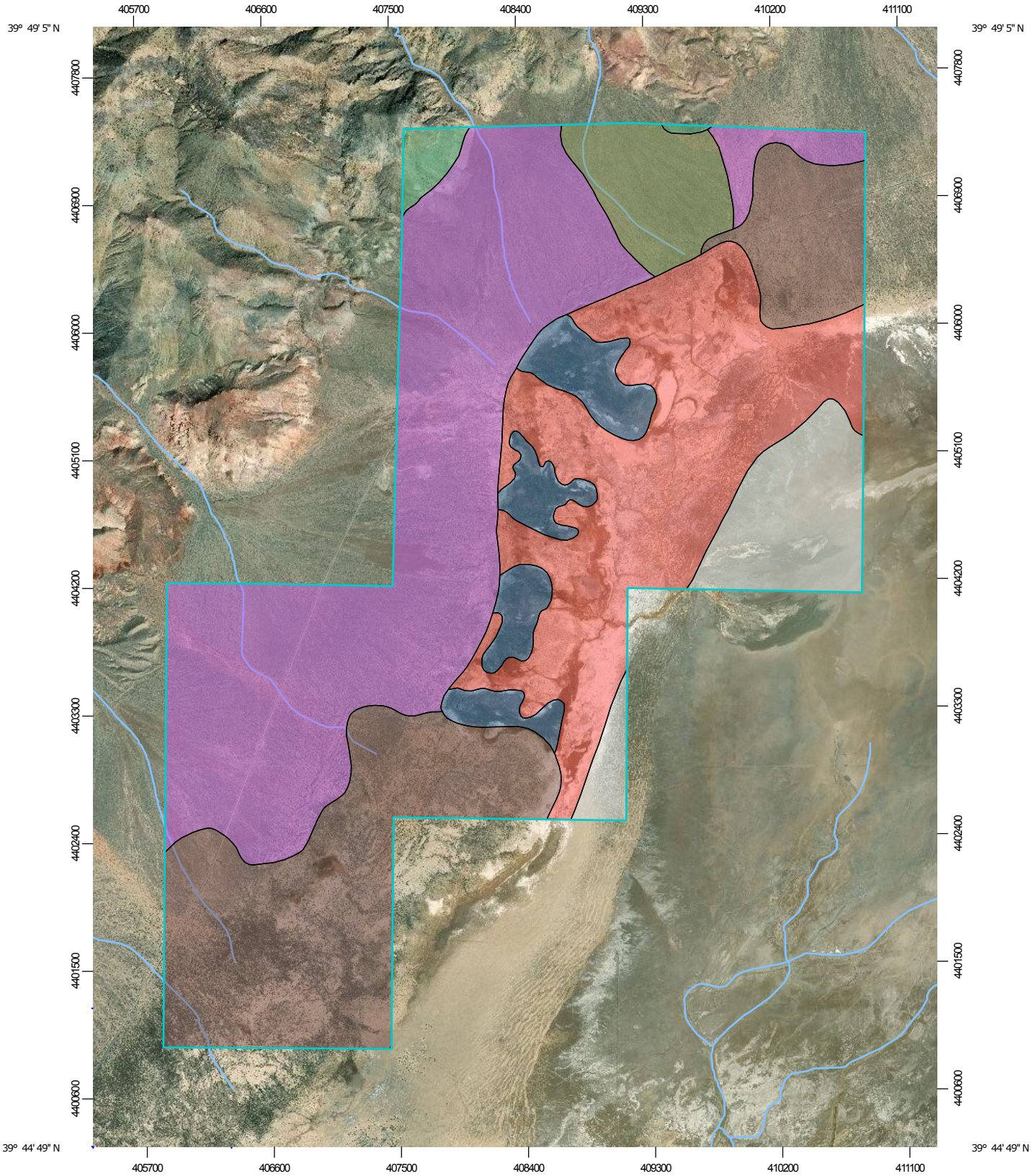
All Ecological Sites -- Rangeland—Churchill County Area, Nevada, Parts of Churchill and Lyon Counties
(Ward_boundary)



Map Scale: 1:38,500 if printed on A portrait (8.5" x 11") sheet.

N

0 500 1000 2000 3000 Meters

0 1500 3000 6000 9000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- R027XY001NV
- R027XY005NV
- R027XY018NV
- R027XY022NV
- R027XY027NV
- R027XY041NV
- Not rated or not available

Soil Rating Lines
- R027XY001NV
- R027XY005NV
- R027XY018NV
- R027XY022NV
- R027XY027NV
- R027XY041NV
- Not rated or not available

Soil Rating Points
- R027XY001NV
- R027XY005NV
- R027XY018NV
- R027XY022NV
- R027XY027NV
- R027XY041NV
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Churchill County Area, Nevada, Parts of Churchill and Lyon Counties
Survey Area Data: Version 13, Sep 13, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 11, 2015—Oct 6, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

All Ecological Sites — Rangeland

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
160	Singatse-Rock outcrop association, very steep	Singatse (65%)	R027XY027NV — BARREN GRAVELLY SLOPE 4-8 P.Z.	47.6	1.0%
		Rock outcrop (25%)			
		Theon (5%)	R027XY019NV — STONY SLOPE 4-8 P.Z.		
		Old camp (3%)	R027XY007NV — LOAMY SLOPE 8-10 P.Z.		
		Theon (2%)	R027XY017NV — SOUTH SLOPE 4-8 P.Z.		
184	Bluewing-Pineval association	Bluewing (50%)	R027XY022NV — VALLEY WASH	1,636.8	35.3%
		Bluewing (20%)	R027XY050NV — COARSE GRAVELLY LOAM 4-8 P.Z.		
		Pineval (15%)	R027XY008NV — DROUGHTY LOAM 8-10 P.Z.		
		Isolde (8%)	R027XY016NV — SODIC DUNES		
		Trocken (5%)	R027XY024NV — SODIC TERRACE		
		Defler (2%)	R027XY014NV — COARSE SILTY 4-8 P.Z.		
311	Rednik-Trocken-Genegraf association	Rednik (45%)	R027XY018NV — GRAVELLY LOAM 4-8 P.Z.	217.2	4.7%
		Trocken (25%)	R027XY050NV — COARSE GRAVELLY LOAM 4-8 P.Z.		
		Genegraf (15%)	R027XY018NV — GRAVELLY LOAM 4-8 P.Z.		
		Bluewing (6%)	R027XY022NV — VALLEY WASH		

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
		Bluewing (6%)	R027XY050NV — COARSE GRAVELLY LOAM 4-8 P.Z.		
		Xeric Torriorthents (3%)	R027XY029NV — GRAVELLY FAN 8-10 P.Z.		
330	Settlement-Louderback-Rustigate association	Settlement (40%)	R027XY006NV — SALINE BOTTOM	1,051.9	22.7%
		Louderback (30%)	R027XY005NV — SALINE MEADOW		
		Rustigate (15%)	R027XY005NV — SALINE MEADOW		
		Slaw (6%)	R027XY041NV — DEEP SODIC FAN		
		Kolda (5%)	R027XY001NV — WETLAND		
		Water (4%)			
343	Slaw-Trocken-Chuckles association	Slaw (40%)	R027XY041NV — DEEP SODIC FAN	1,089.4	23.5%
		Trocken (30%)	R027XY041NV — DEEP SODIC FAN		
		Chuckles (20%)	R027XY025NV — SODIC FLAT		
		Bluewing (6%)	R027XY022NV — VALLEY WASH		
		Bluewing (2%)	R027XY050NV — COARSE GRAVELLY LOAM 4-8 P.Z.		
		Mazuma (2%)	R027XY025NV — SODIC FLAT		
900	Playas	Playas (95%)		330.4	7.1%
		Parran (5%)	R027XY025NV — SODIC FLAT		
960	Pelic-Turupah complex, 0 to 1 percent slopes	Pelic (50%)	R027XY001NV — WETLAND	268.5	5.8%
		Turupah (35%)	R027XY090NV — DRY SALINE MEADOW		
		Water (8%)			
		Parran (7%)	R027XY025NV — SODIC FLAT		

Map unit symbol	Map unit name	Component name (percent)	Ecological site	Acres in AOI	Percent of AOI
Totals for Area of Interest				**4,641.9**	**100.0%**

Hydric Soil List - All Components

This table lists the map unit components and their hydric status in the survey area. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; Hurt and others, 2002).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2). Definitions for the codes are as follows:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
   A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
   B. Show evidence that the soil meets the definition of a hydric soil;
3. Soils that are frequently ponded for long or very long duration during the growing season.
   A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
   B. Show evidence that the soil meets the definition of a hydric soil;
4. Map unit components that are frequently flooded for long duration or very long duration during the growing season that:
   A. Based on the range of characteristics for the soil series, will at least in part meet one or more Field Indicators of Hydric Soils in the United States, or
   B. Show evidence that the soil meets the definition of a hydric soil;

Hydric Condition: Food Security Act information regarding the ability to grow a commodity crop without removing woody vegetation or manipulating hydrology.

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. Doc. 2012-4733 Filed 2-28-12. February, 28, 2012. Hydric soils of the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

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Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

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Report—Hydric Soil List - All Components

Hydric Soil List - All Components–NV770-Churchill County Area, Nevada, Parts of Churchill and Lyon Counties					
Map symbol and map unit name	**Component/Local Phase**	**Comp. pct.**	**Landform**	**Hydric status**	**Hydric criteria met (code)**
160: Singatse-Rock outcrop association, very steep	Singatse	65	Hills	No	—
	Rock outcrop	25	Ridges	No	—
	Theon	5	Hills	No	—
	Old camp	3	Hills	No	—
	Theon	2	Hills	No	—
184: Bluewing-Pineval association	Bluewing	50	Drainageways	No	—
	Bluewing	20	Inset fans	No	—
	Pineval	15	Fan remnants	No	—
	Isolde	8	Dunes	No	—
	Trocken	5	Beach terraces	No	—
	Defler	2	Inset fans	No	—
311: Rednik-Trocken-Genegraf association	Rednik	45	Fan remnants	No	—
	Trocken	25	Beach terraces	No	—
	Genegraf	15	Fan remnants	No	—
	Bluewing	6	Drainageways	No	—
	Bluewing	6	Inset fans	No	—
	Xeric Torriorthents	3	Channels	No	—
330: Settlement-Louderback-Rustigate association	Settlement	40	Lake terraces	Yes	2
	Louderback	30	Lake terraces	No	—
	Rustigate	15	Lake terraces	No	—
	Slaw	6	Lake terraces	No	—
	Kolda	5	Lake terraces	Yes	2,3
	Water	4	Depressions	No	—
343: Slaw-Trocken-Chuckles association	Slaw	40	Stream terraces	No	—
	Trocken	30	Inset fans	No	—
	Chuckles	20	Lake terraces	No	—
	Bluewing	6	Drainageways	No	—
	Mazuma	2	Lake terraces	No	—
	Bluewing	2	Inset fans	No	—
900: Playas	Playas	95	Playas	No	—
	Parran	5	Lake plains	No	—

Hydric Soil List - All Components–NV770-Churchill County Area, Nevada, Parts of Churchill and Lyon Counties					
Map symbol and map unit name	**Component/Local Phase**	**Comp. pct.**	**Landform**	**Hydric status**	**Hydric criteria met (code)**
960: Pelic-Turupah complex, 0 to 1 percent slopes	Pelic	50	Flood plains	Yes	2,3,4
	Turupah	35	Flood plains	No	—
	Water	8	Streams	No	—
	Parran	7	Lake plains	No	—

Data Source Information

Soil Survey Area: Churchill County Area, Nevada, Parts of Churchill and Lyon Counties
Survey Area Data: Version 13, Sep 13, 2018

APPENDIX C

Plant Community Photographs

Photograph 1:
Wetland boundary plant community.

Photograph 2:
Bulrush wetland community.

Photograph 3:
Cattail wetland.

Photograph 4:
Reed canarygrass wetland.

Photograph 5:
Saltgrass and alkali bulrush wetland.

Photograph 6:
Wet meadow.

Photograph 7:
Field sedge meadow.

Photograph 8:
Woody riparian community.

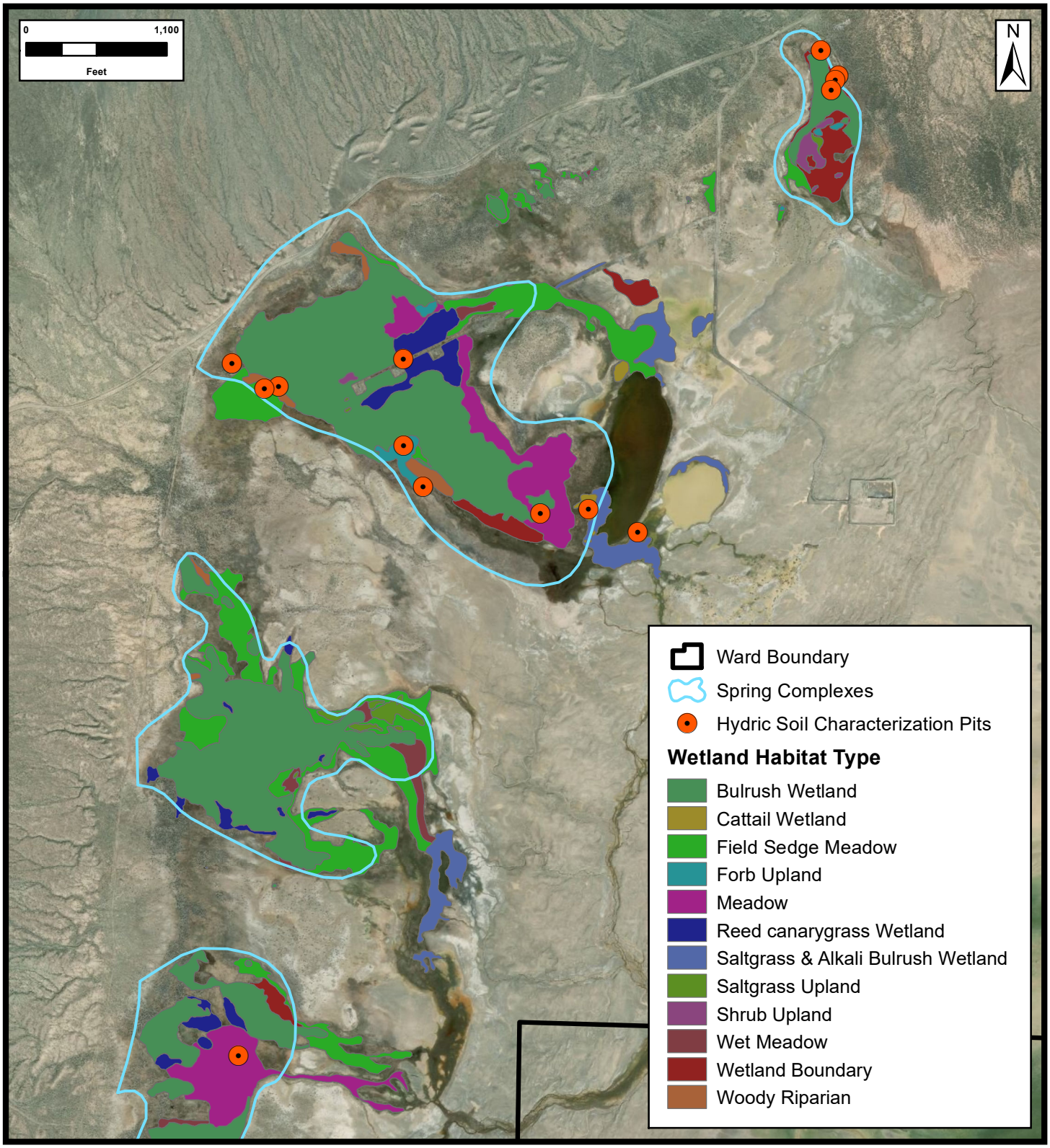
Photograph 9:
Shrub upland community.

Photograph 10:
Saltgrass upland community.

Photograph 11:
Forb upland community.

APPENDIX D

Soil Pit Photographs and Data



TITLE:
SITE MAP
-SHOWING-
HYDRIC SOIL CHARACTERIZATION PITS
ORMAT TECHNOLOGIES INC.
DIXIE MEADOWS GEOTHERMAL DEVELOPMENT PROJECT
CHURCHILL COUNTY, NV

JOB NO.: **ORM008**

DATE: **2/2/2020**

McGinley & Associates
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FILE: **Hydric Soil Pits**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	GB	CHECKED	BP	-
	DRAWN	GB	APPROVED	BP	

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Photograph 1:
Wetland boundary soil pit.

Photograph 2:
Bulrush wetland soil pit.

Photograph 3:
Cattail wetland soil pit.

Photograph 4:
Reed canarygrass wetland soil pit.

Photograph 5:
Saltgrass and alkali bulrush wetland.

Photograph 6:
Wet meadow soil pit.

Photograph 7:
Field sedge meadow soil pit.

Photograph 8:
Woody riparian soil pit.

Photograph 9:
Shrub upland soil pit.

Photograph 10:
Saltgrass upland soil pit.

Soil Profile Description Plant Community: Shrub upland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-7	10YR 4/2						Sandy loam	
7-14	2.5Y 2.5/1						Silty loam	

Hydric Soil Indicator: None

Soil Profile Description Plant Community: Forb upland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-22	2.5Y 5/2						Sandy clay loam	

Hydric Soil Indicator: None

Soil Profile Description Plant Community: Saltgrass upland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-16	2.5Y 5/2						Sandy clay loam	
16-24	10YR 4/2						Sandy clay loam	

Hydric Soil Indicator: None

Soil Profile Description Plant Community: Saltgrass upland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-5	2.5Y 4/1						Sandy clay loam	Effervescent
5-12	10YR 5/3						Clay loam	Effervescent
12-28	2.5Y 6/2						Silty clay	Effervescent

Hydric Soil Indicator: None

Soil Profile Description Plant Community: Wetland boundary

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-4	2.5Y 3/1						Silty clay loam	
4-6	5Y 2.5/1						Silty loam	
6-7	2.5Y 3/1						Silty clay	
7-14	2.5Y 2.5/1						Silty clay loam	

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Wetland boundary

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-4	10YR 4/1						Clay loam	
4-5	10YR 2/1						Loam	
5-6	5Y 3/1						Sandy clay loam	
6-12	Gley 1 4/N						Loam	
12-16	5Y 4/1						Sandy loam	
16-24	5Y 5/2	85	10YR 6/8	15	C	M	Sandy loam	

Hydric Soil Indicator: F2 - Loamy gleyed matrix; Positive reaction to alpha, alpha-dipyridyl
Type: C = Concentration. Location: M = Matrix.

Soil Profile Description Plant Community: Bulrush wetland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-2	2.5Y 2.5/1						Sandy loam	Effervescent
2-12	Gley 1 5/10GY						Sandy clay loam	
12-20	Peat							

Hydric Soil Indicator: S4 - Sandy gleyed matrix; Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Bulrush wetland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-6	10YR 2/1						Sandy loam	
6-7	Peat							
7-14	10YR 2/1						Sandy loam	

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Cattail wetland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-6	5Y 3/1						Sandy clay loam	
6-8	2.5Y 3/1						Sandy loam	Effervescent
8-12	5Y 5/2						Loamy sand	

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Reed canarygrass wetland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-5	5Y 3/1						Sandy clay loam	
6-12	Peat							

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Saltgrass and alkali bulrush wetland

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-4	10YR 2/1						Sandy loam	Effervescent
4-14	2.5Y 5/2						Loamy sand	Effervescent

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Wet meadow

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-4	10YR 2/1						Clay loam	
4-5	5Y 5/1						Clay loam	
5-14	Gley 2 2.5/5B						Sandy clay loam	

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Field sedge meadow

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-1	2.5Y 2.5/1						Clay loam	
1-10	2.5Y 5/1	98	7.5YR 5/8	2	C	M	Sandy clay loam	Effervescent
10-20	10YR 3/1						Clay loam	Effervescent
20-28	2.5Y 5/2	96	7.5YR 5/8	4	C	M	Sandy clay loam	

Hydric Soil Indicator: F3 - Depleted matrix

Type: C = Concentration. Location: M = Matrix.

Soil Profile Description Plant Community: Woody riparian

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-8	2.5Y 4/2						Loamy sand	Effervescent
8-13	Gley 1 3/N						Sandy clay loam	Effervescent
13-20	5Y 4/1						Sandy loam	Effervescent

Hydric Soil Indicator: Positive reaction to alpha, alpha-dipyridyl

Soil Profile Description Plant Community: Woody riparian

	Matrix		Redox Features					
Depth (in)	Color (moist)	%	Color (moist)	%	Type	Loc	Texture	Remarks
0-9	2.5Y 5/2	90	10YR 6/8	10	C	M	Loamy sand	Effervescent
9-13	5Y 5/2							Effervescent

Hydric Soil Indicator: S5 - Sandy redox

Type: C = Concentration. Location: M = Matrix.

APPENDIX E

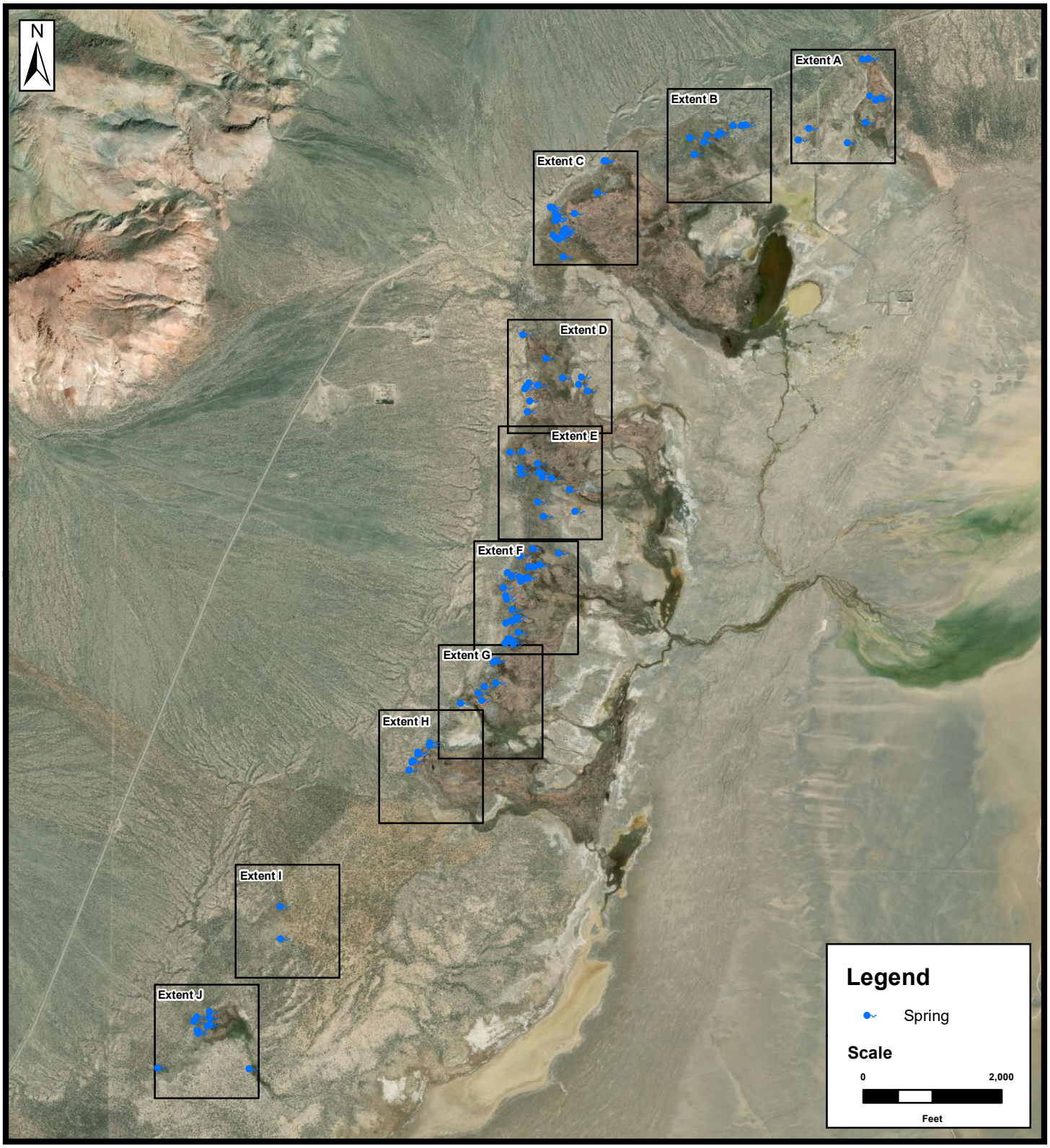
WARD Geodatabase

Appendix E. Surface Water Inventory		
Site ID	**Easting (m)**	**Northing (m)**
USGS-101	409864.78	4406468.57
NDOWSS-1	408475.30	4405816.01
USGS-301	407857.19	4403376.22
Spring 1	409865.45	4406475.08
Spring 2	409871.49	4406308.55
Spring 3	409839.19	4406470.53
Spring 4	408479.20	4405695.30
Spring 5A	408361.16	4405027.70
Spring 5B	408373.77	4404965.13
Spring 6	408701.84	4406021.70
Spring 7	408336.40	4404171.58
Spring 9	408216.53	4403817.92
Spring 10	408369.58	4404236.39
Spring 11	408550.04	4404576.16
Spring 12	408469.08	4404625.86
Spring 13	408409.62	4404690.02
Spring 14	409080.47	4406124.08
Spring 15	408517.89	4405693.89
Spring 16	408521.99	4405702.91
Spring 17	408524.78	4405714.88
Spring 18	408490.64	4405759.73
Spring 19	408487.21	4405764.98
Spring 20	408498.08	4405771.32
Spring 21	408498.79	4405767.24
Spring 22	408488.51	4405791.97
Spring 23	408465.47	4405818.20
Spring 24	406911.82	4402192.89
Spring 25	408570.90	4405791.04
Spring 26	408673.30	4405881.56
Spring 27	408711.62	4406023.89
Spring 28	409899.38	4406288.89
Spring 29	408523.85	4405600.65
Spring 30	409100.45	4406051.34
Spring 31	409142.93	4406105.77
Spring 32	409154.56	4406138.52
Spring 33	409205.96	4406138.46
Spring 34	409212.83	4406148.90
Spring 35	409270.04	4406177.99
Spring 36	409306.35	4406179.35
Spring 37	409325.61	4406180.04
Spring 38	408344.70	4405257.42
Spring 39	408445.04	4405153.97
Spring 40	408628.55	4405009.27
Spring 41	408589.04	4405039.50
Spring 42	408601.41	4405070.07

Appendix E. Surface Water Inventory		
Site ID	**Easting (m)**	**Northing (m)**
Spring 43	408518.81	4405067.75
Spring 44	408411.78	4405035.38
Spring 45	408500.32	4405676.66
Spring 46	408352.70	4405018.61
Spring 47	406895.81	4402236.32
Spring 48	408364.68	4404916.83
Spring 49	408371.51	4405043.91
Spring 50	408532.90	4405724.23
Spring 51	408530.19	4405719.81
Spring 52	408530.30	4405704.62
Spring 53	409604.78	4406167.32
Spring 54	408490.11	4405684.63
Spring 55	409556.55	4406115.08
Spring 56	408331.37	4404282.12
Spring 57	406915.64	4402182.25
Spring 58	408392.95	4404236.86
Spring 59	408418.43	4404245.24
Spring 60	408286.53	4404739.12
Spring 61	408341.43	4404742.49
Spring 62	408334.03	4404671.30
Spring 63	408337.39	4404646.40
Spring 64	408413.84	4404653.06
Spring 65	408422.20	4404649.60
Spring 66	408432.38	4404630.65
Spring 67	408409.85	4404522.47
Spring 68	408573.24	4404480.75
Spring 69	408436.46	4404458.24
Spring 70	408503.43	4404296.42
Spring 71	408388.03	4404316.17
Spring 72	408277.13	4404212.13
Spring 73	408296.00	4404192.53
Spring 74	408258.57	4404145.57
Spring 75	408330.50	4404190.56
Spring 76	409923.37	4406297.54
Spring 77	408366.83	4404190.13
Spring 78	408352.05	4404184.00
Spring 79	408272.89	4404094.25
Spring 80	408269.83	4404111.04
Spring 81	408296.61	4404046.77
Spring 82	408318.86	4404016.03
Spring 83	408291.47	4403997.19
Spring 84	408305.24	4404000.44
Spring 85	408268.92	4403987.77
Spring 86	408323.85	4403947.79
Spring 87	408279.20	4403917.16

Appendix E. Surface Water Inventory		
Site ID	**Easting (m)**	**Northing (m)**
Spring 88	408284.25	4403909.25
Spring 89	408292.17	4403916.99
Spring 90	408302.61	4403895.64
Spring 91	408266.56	4403899.26
Spring 92	409852.18	4406193.49
Spring 93	408228.56	4403822.57
Spring 94	408226.33	4403726.04
Spring 95	408174.80	4403708.87
Spring 96	408147.04	4403681.95
Spring 97	408070.29	4403636.84
Spring 98	408162.56	4403646.66
Spring 99	407932.84	4403449.64
Spring 100	407934.71	4403459.51
Spring 101	406910.34	4402253.37
Spring 102	407860.81	4403382.83
Spring 103	407882.31	4403408.09
Spring 104	407883.83	4403418.83
Spring 105	407844.81	4403339.20
Spring 106	407275.05	4402739.89
Spring 107	407277.44	4402597.79
Spring 108	406737.26	4402026.78
Spring 109	407139.63	4402025.11
Spring 110	406968.43	4402217.41
Spring 111	406953.37	4402211.92
Spring 112	406966.36	4402247.32
Spring 113	406964.64	4402276.20
Spring 114	409771.93	4406101.67

Coordinates in NAD 1983 UTM Zone 11N



TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS EXTENTS A-J
DIXIE VALLEY, NV

JOB NO.: **ORM007**

DATE: **1/30/2020**

McGinley & Associates
Environmental Engineering and Science
RENO | LAS VEGAS | www.mcgin.com

FILE: **Springs Inventory Map Extent**

COORDINATE SYSTEM: **NAD 1983 UTM Zone 11N**

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
	DRAWN	MH	APPROVED	DS	

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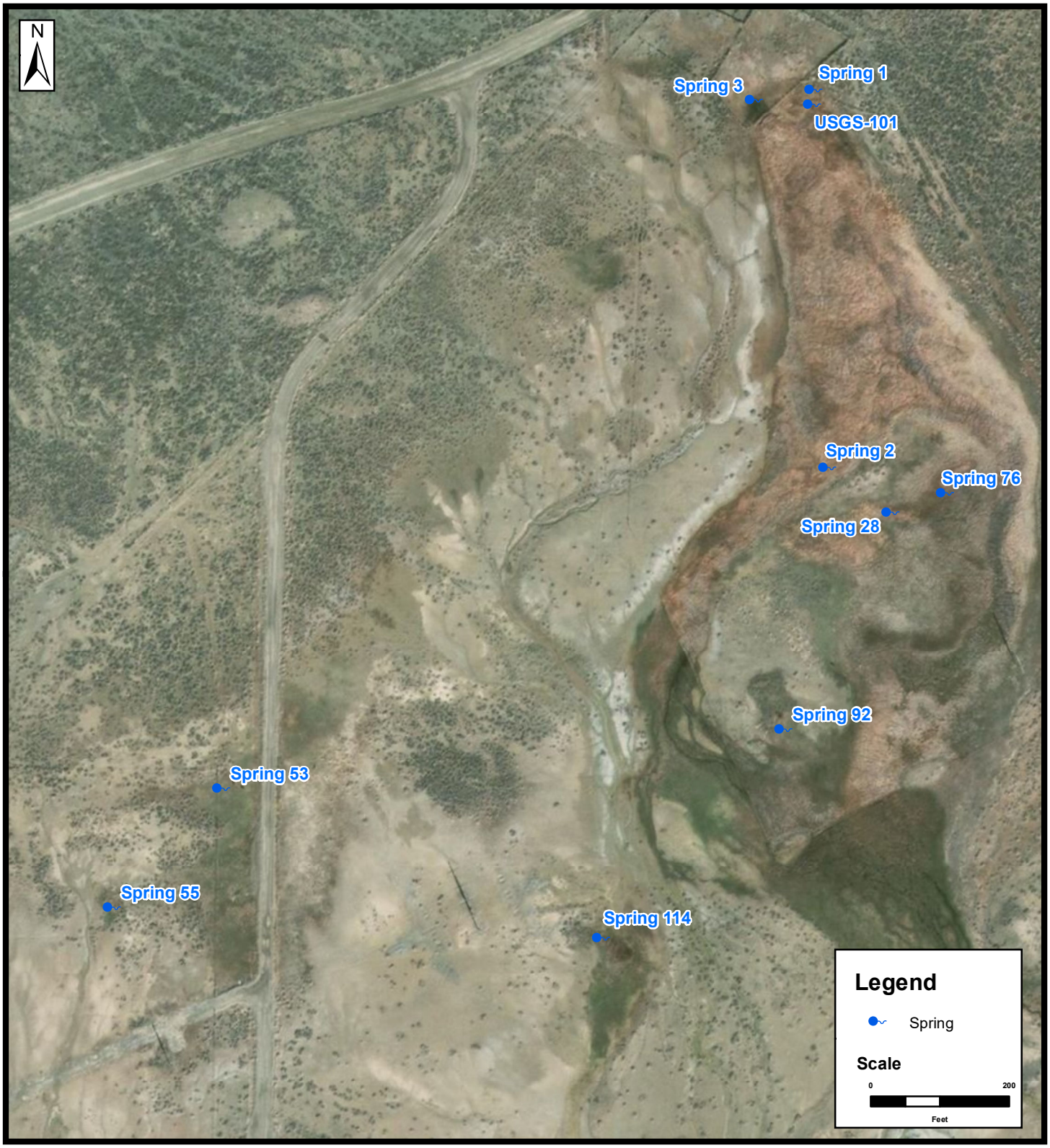

EXTENT A

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT A
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
DESIGNED	MH	CHECKED	DS		-
DRAWN	MH	APPROVED	DS		

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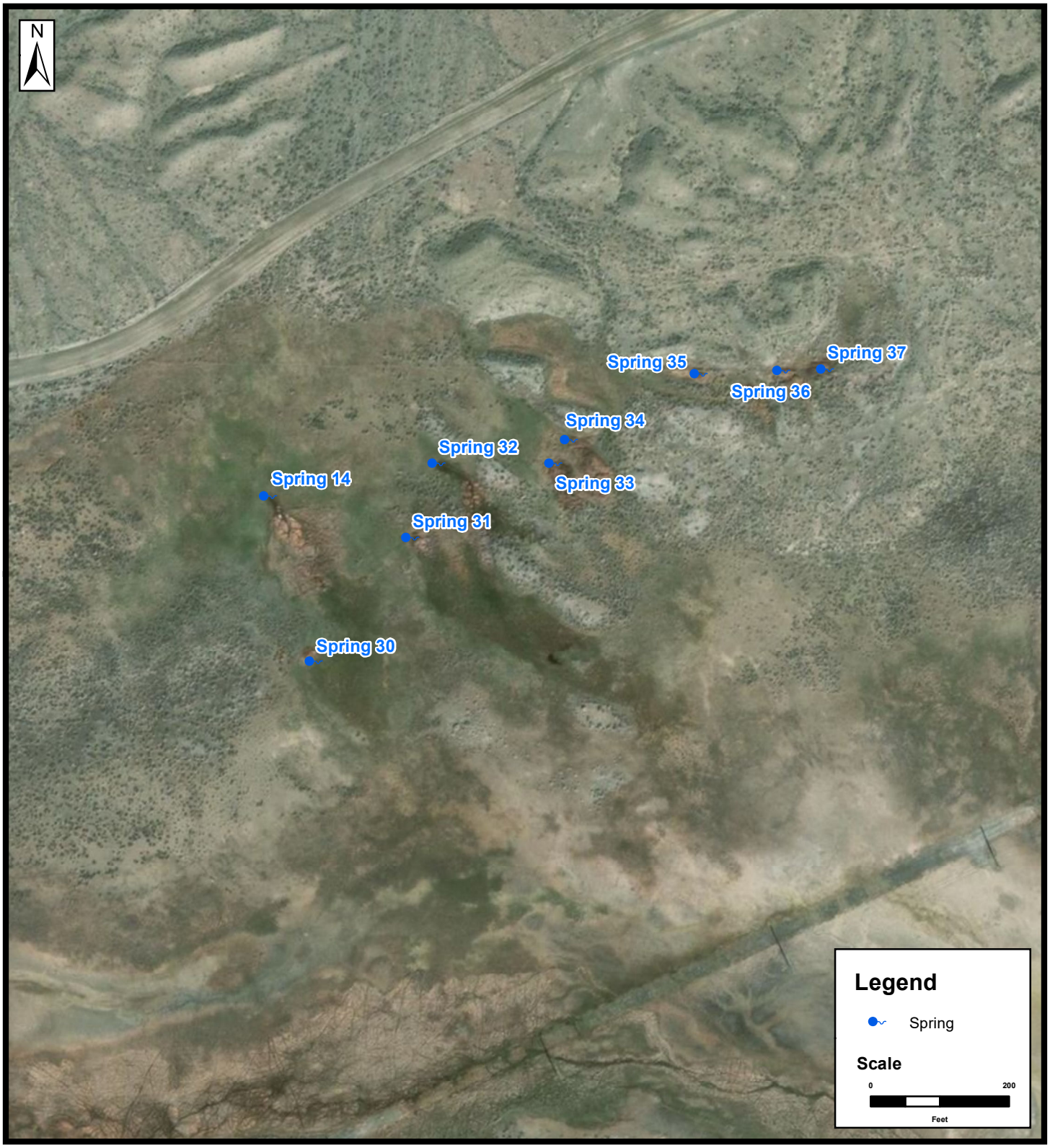

EXTENT B

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT B
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
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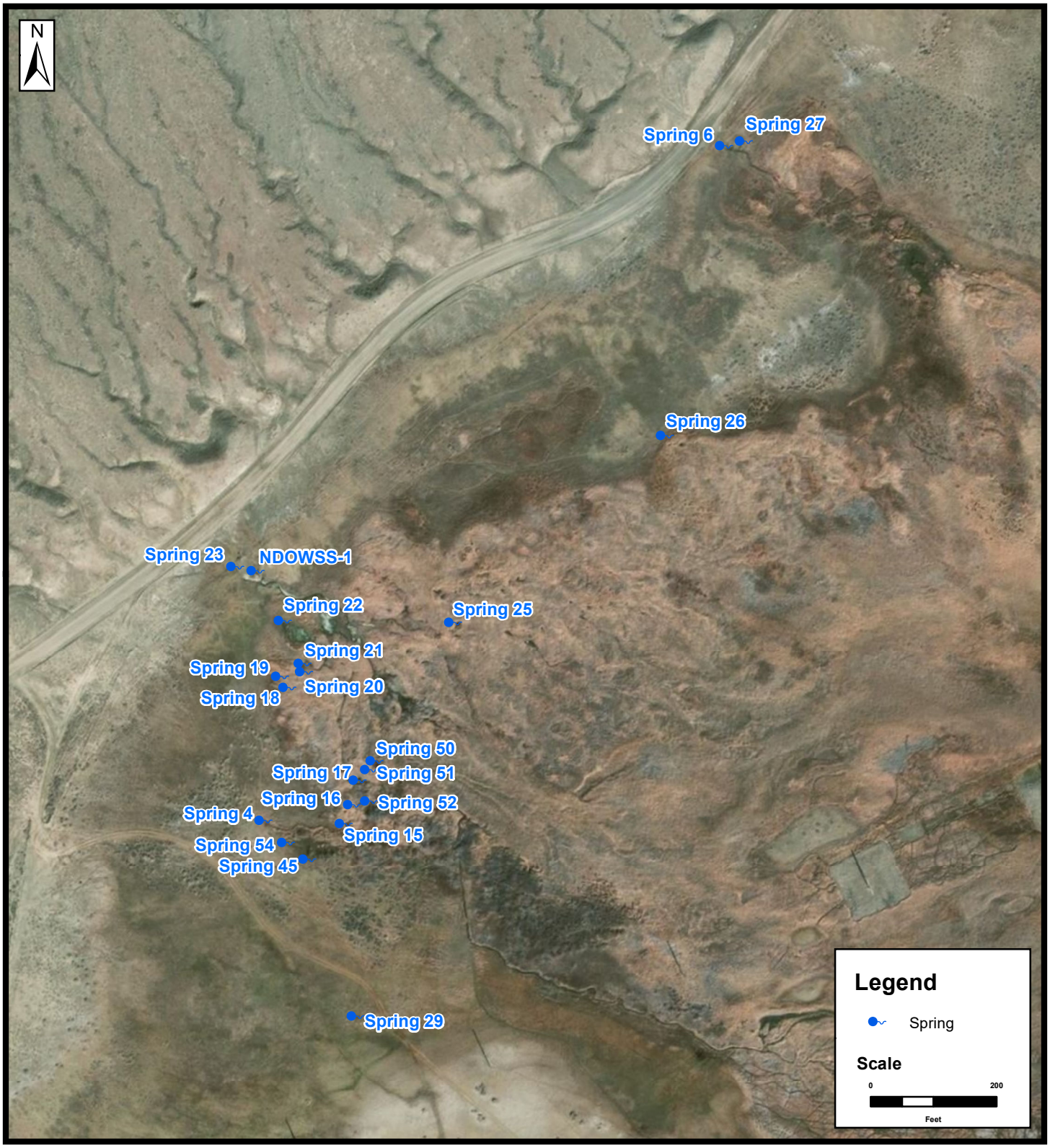

EXTENT C

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT C
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

McGinley & Associates
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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

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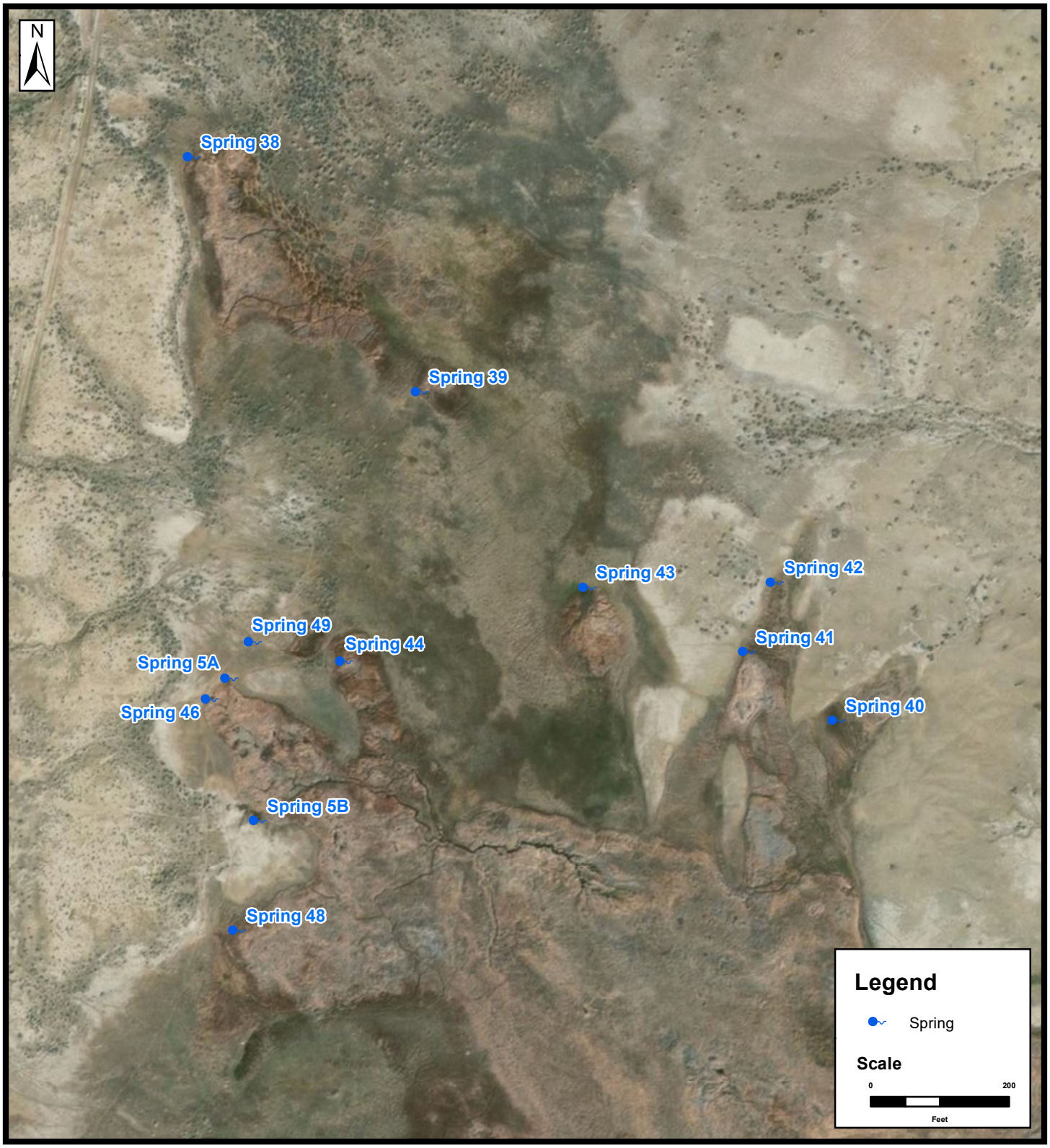

EXTENT D

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SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT D
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

McGinley & Associates
Environmental Engineering and Science
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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
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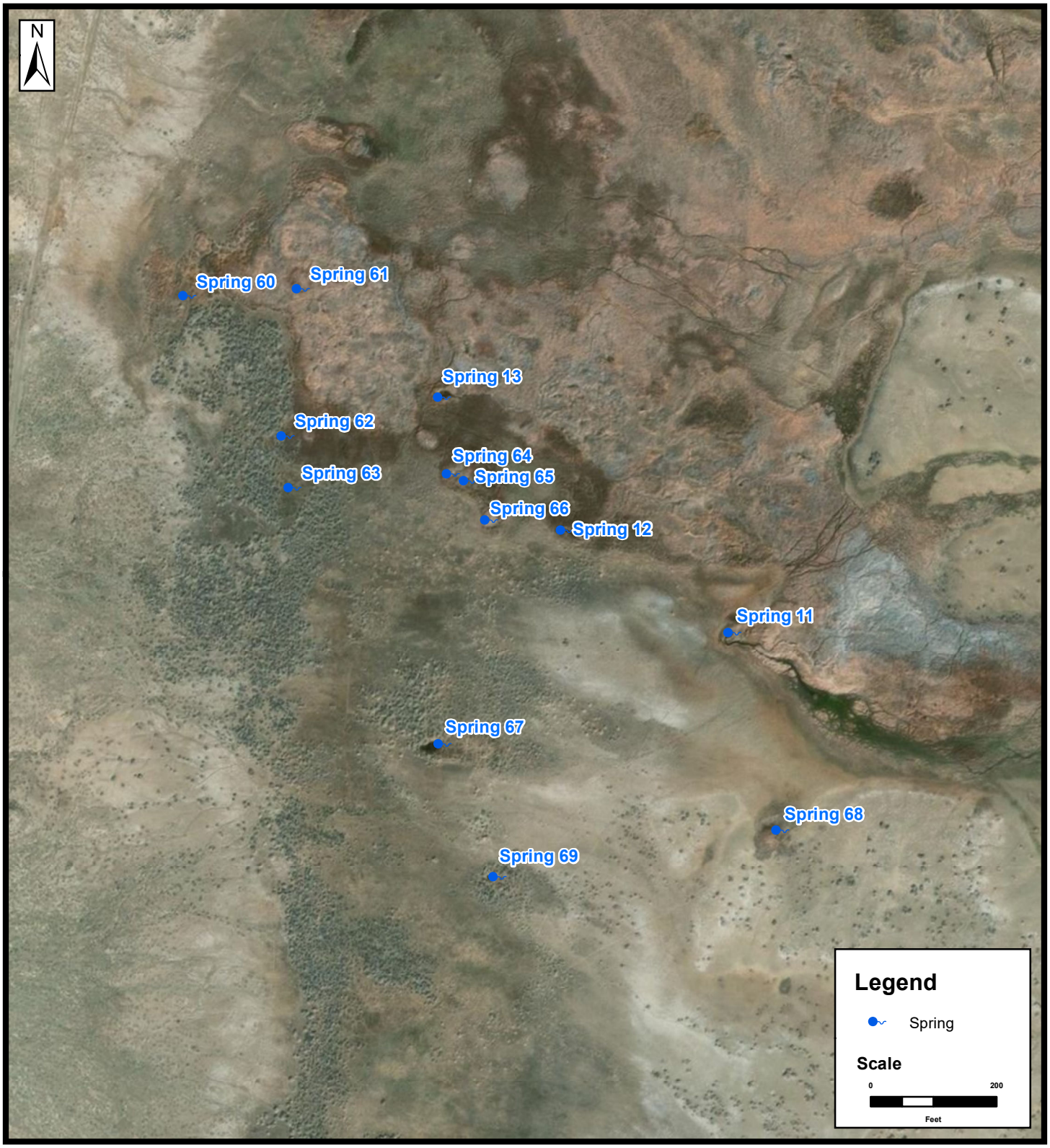

EXTENT E

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SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS EXTENT E
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
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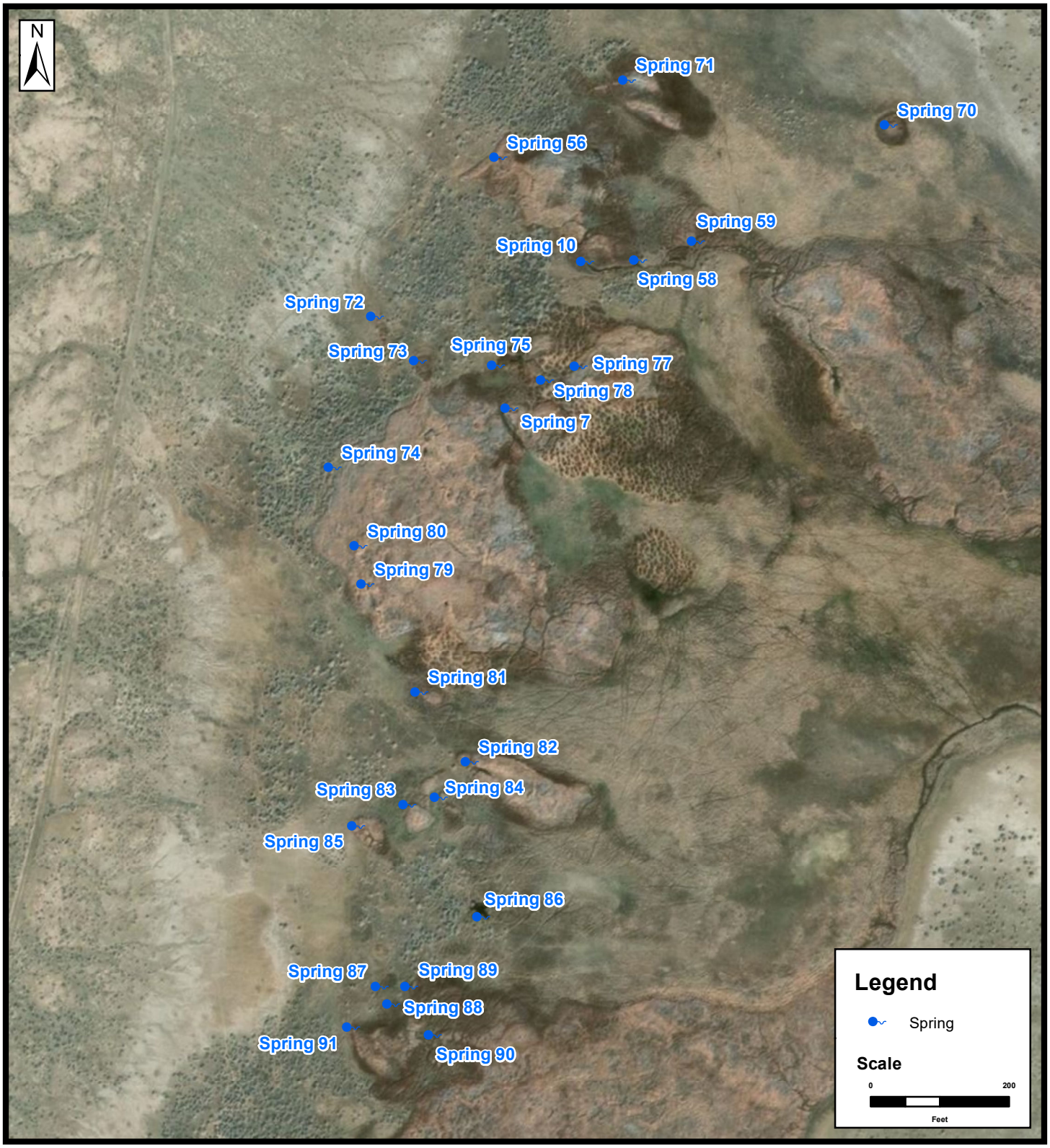

EXTENT F

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT F
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
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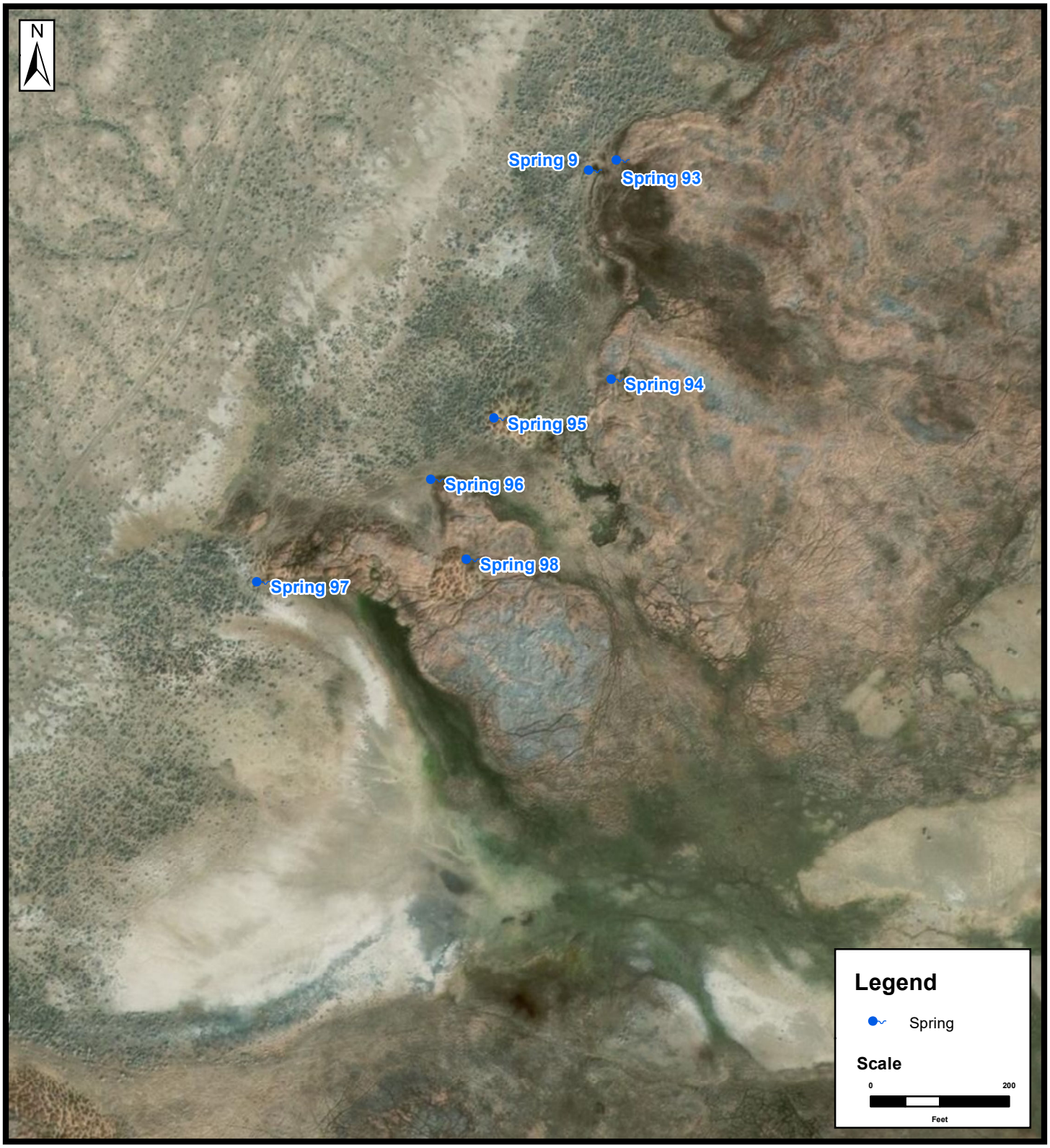

EXTENT G

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT G
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

McGinley & Associates
Environmental Engineering and Science
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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
	DRAWN	MH	APPROVED	DS	

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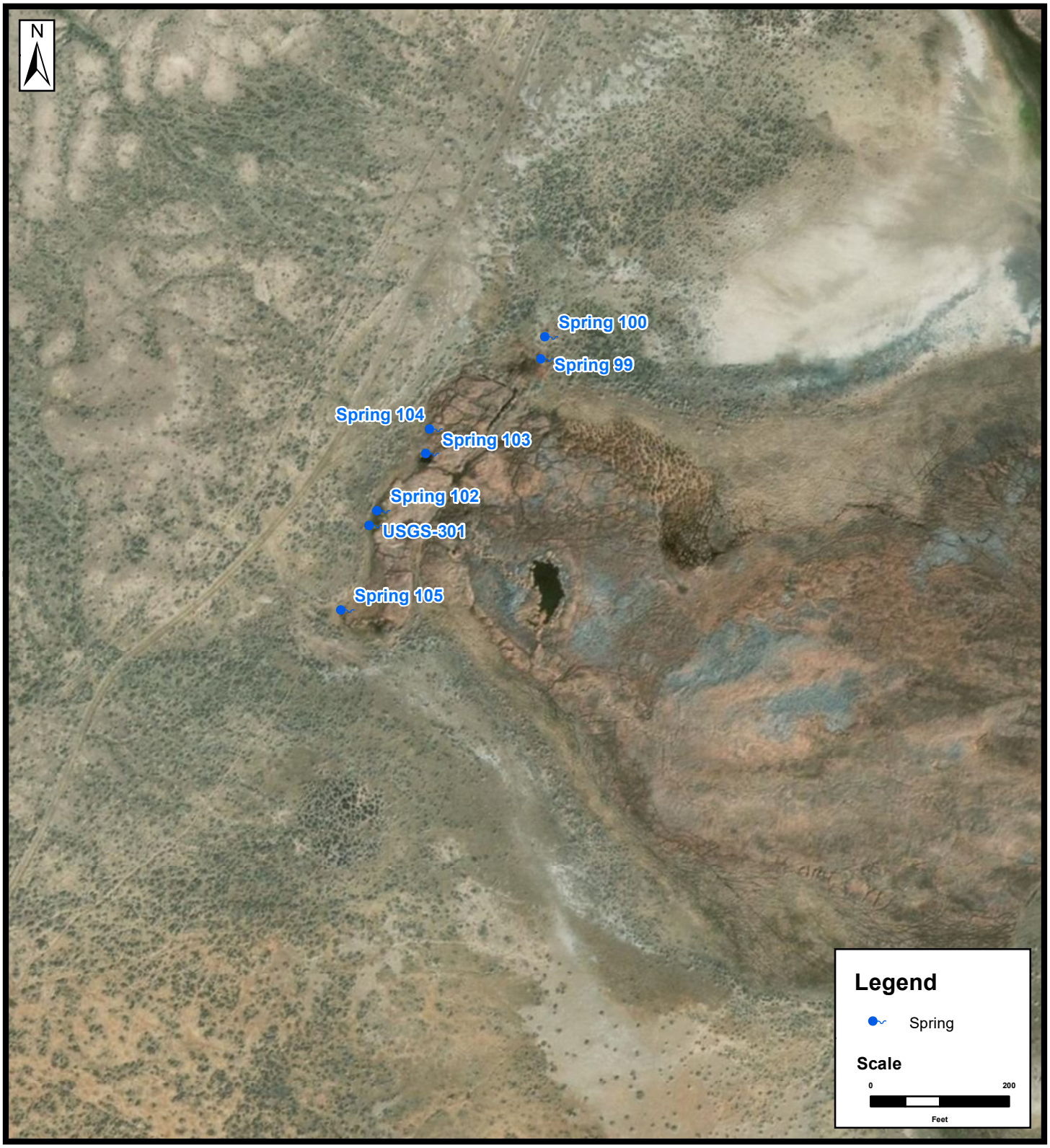

EXTENT H

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT H
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
	DRAWN	MH	APPROVED	DS	

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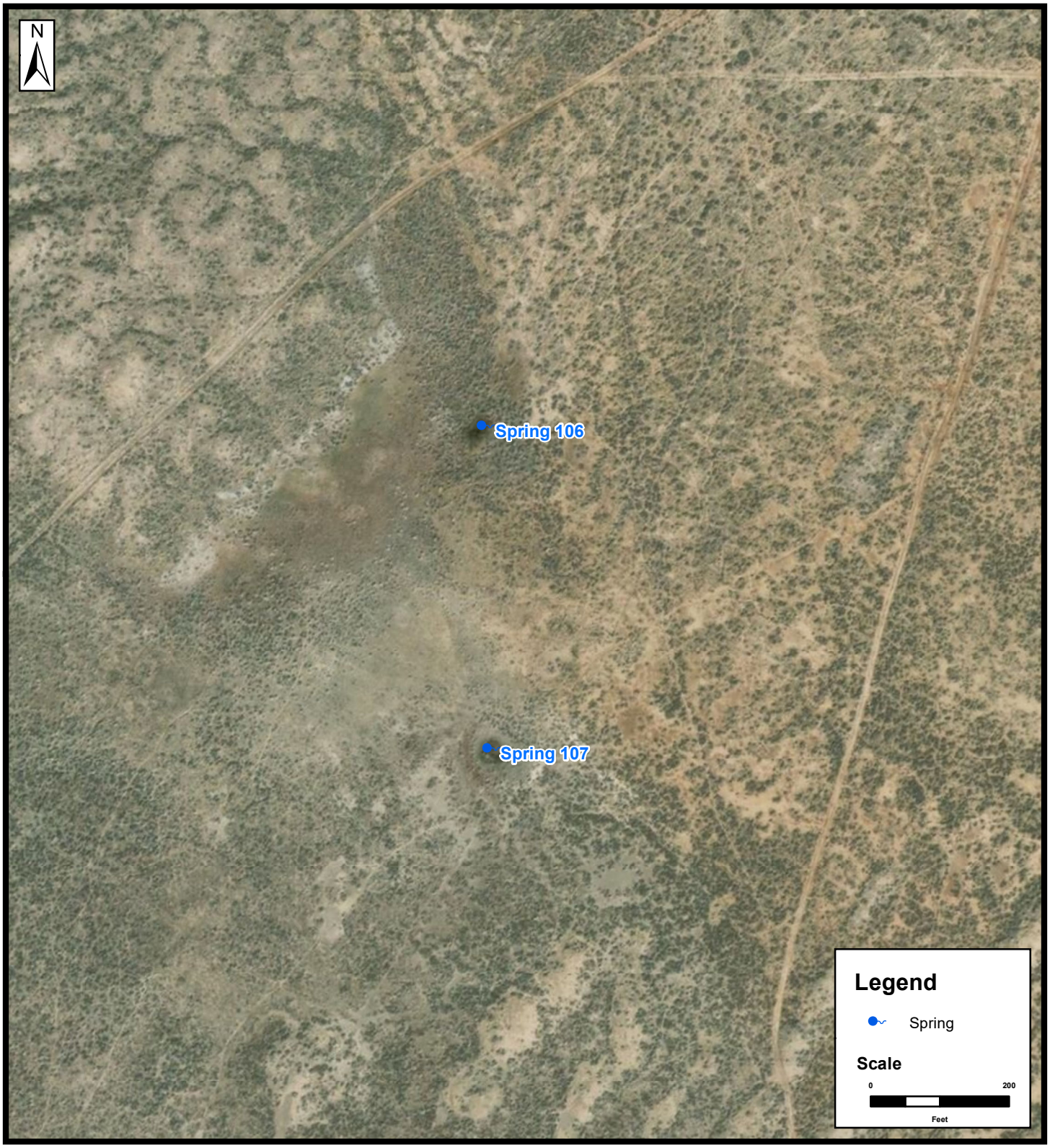

EXTENT I

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT I
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
	DRAWN	MH	APPROVED	DS	

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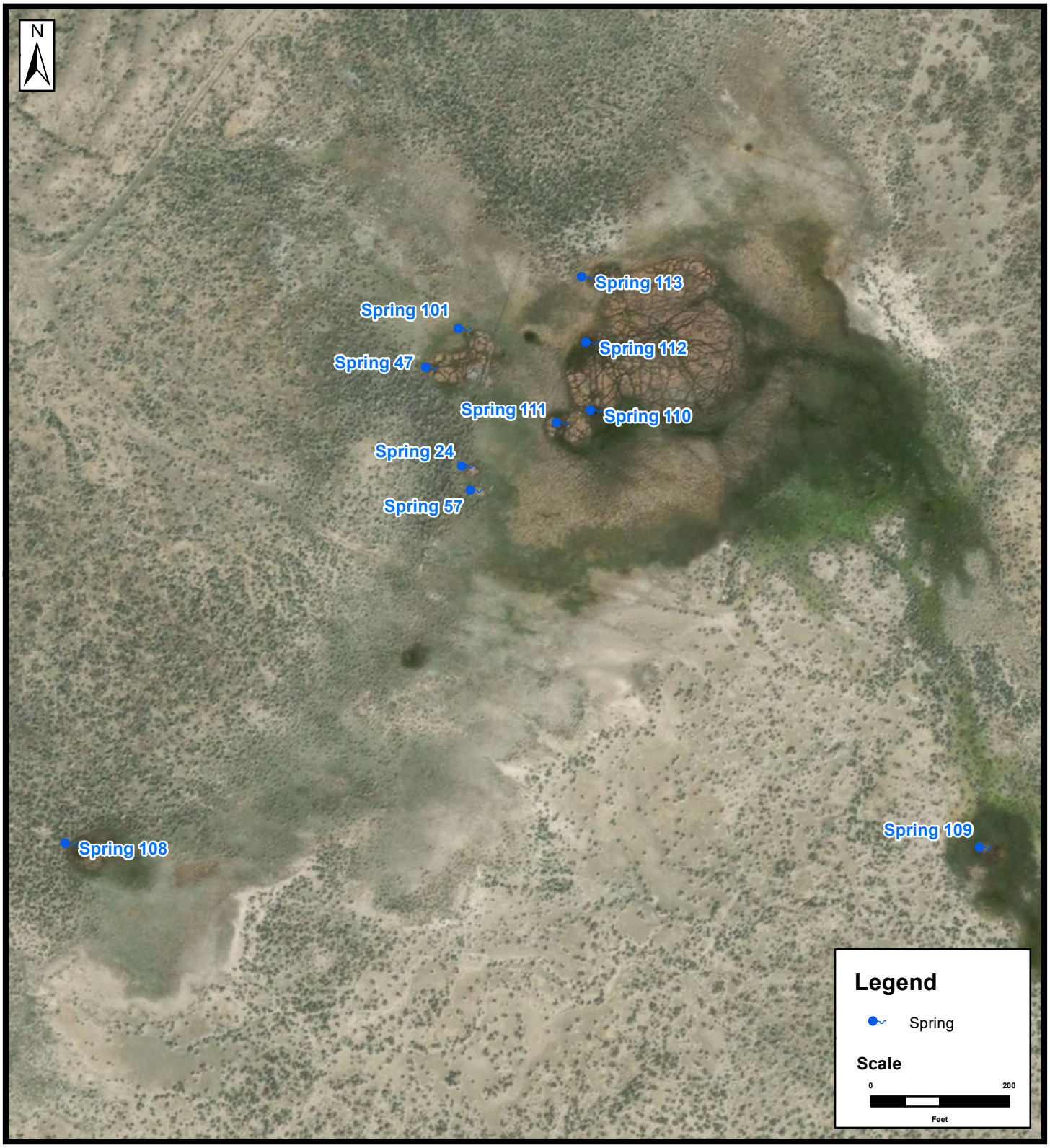

EXTENT J

TITLE:

SITE MAP
-SHOWING-
DIXIE MEADOWS SPRINGS
EXTENT J
DIXIE VALLEY, NV

JOB NO.: ORM007

DATE: 1/30/2020

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FILE: Springs Inventory Extents A-J

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

REF.					REVISION:
	DESIGNED	MH	CHECKED	DS	-
	DRAWN	MH	APPROVED	DS	

R:\Projects\GIS Data\ORM\008\2019 Spring Inventory\Springs Inventory Extents A-J.mxd

APPENDIX F

Photographs of Proposed Monitoring Locations

Photograph 1:
View of the proposed monitoring location MW-1.

Photograph 2:
View of the proposed monitoring location USGS-101.

Photograph 3:
View of the proposed monitoring location Spring 2.

Photograph 4:
View of channelized flow from proposed monitoring location NDOWSS-1.

Photograph 5:
Additional view of the proposed monitoring location NDOWSS-1.

Photograph 6:
View of the proposed monitoring location Spring 4.

Photograph 7:
View of the proposed monitoring location Spring 5A.

Photograph 8:
Additional view of the proposed monitoring location Spring 5A.

Photograph 9:
View of the proposed monitoring location Spring 5B.

Photograph 10:
View of the proposed monitoring location Spring 6.

Photograph 11:
View of the proposed monitoring location Spring 7.

Photograph 12:
View of the proposed monitoring location Spring 8.

Photograph 13:
View of the proposed monitoring location USGS-301 North.

Photograph 14:
Additional view of the proposed monitoring location USGS-301 North.

Photograph 15:
View of the proposed monitoring location USGS-301 Salt Cedar.

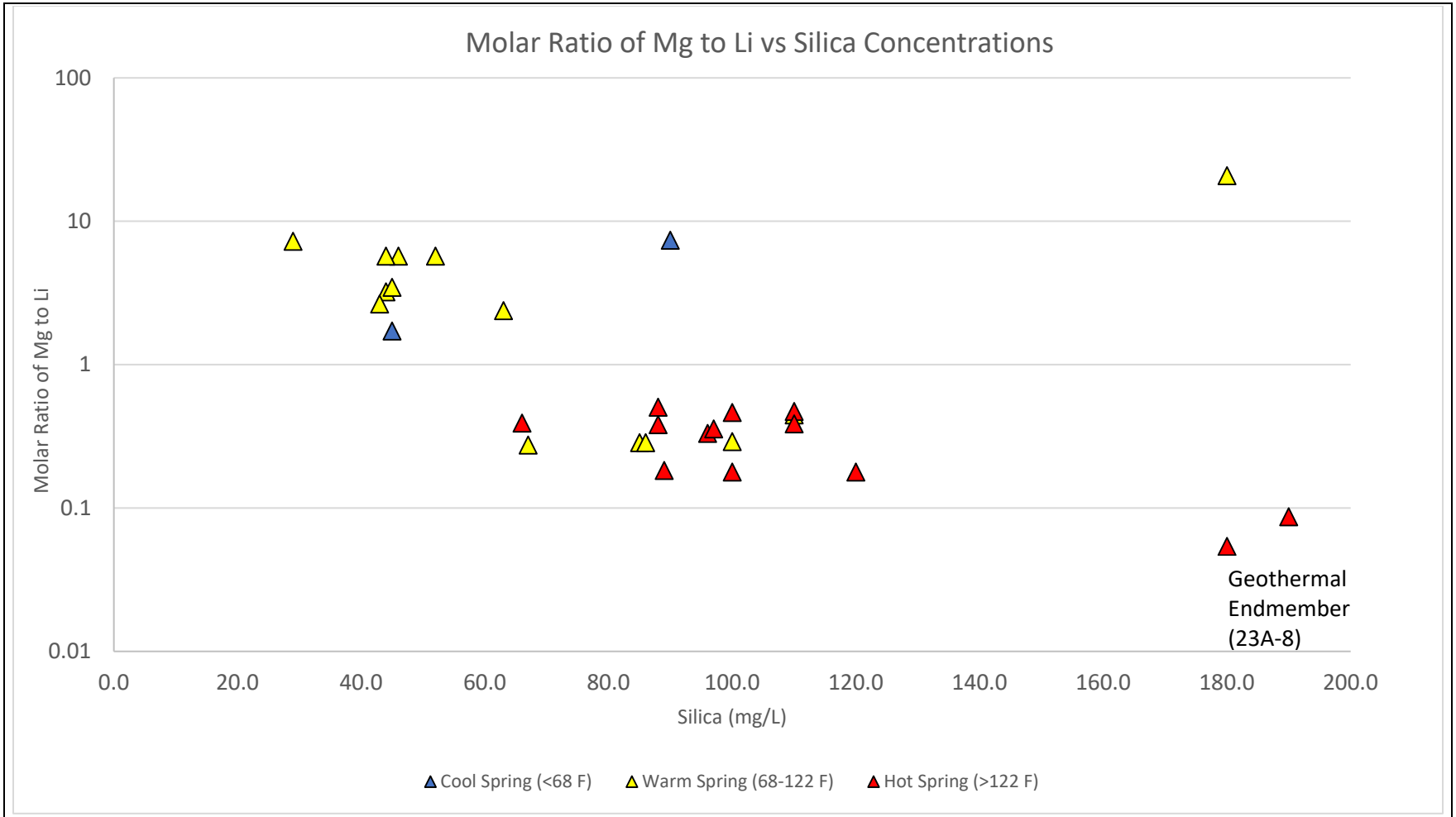
Photograph 16:
View of the proposed monitoring location Western Playa Pond on May 29, 2019.

Photograph 17:
View of the proposed monitoring location Eastern Playa Pond on May 29, 2019.

Photograph 18:
View of the proposed monitoring location Complex 2 confluence.

APPENDIX G

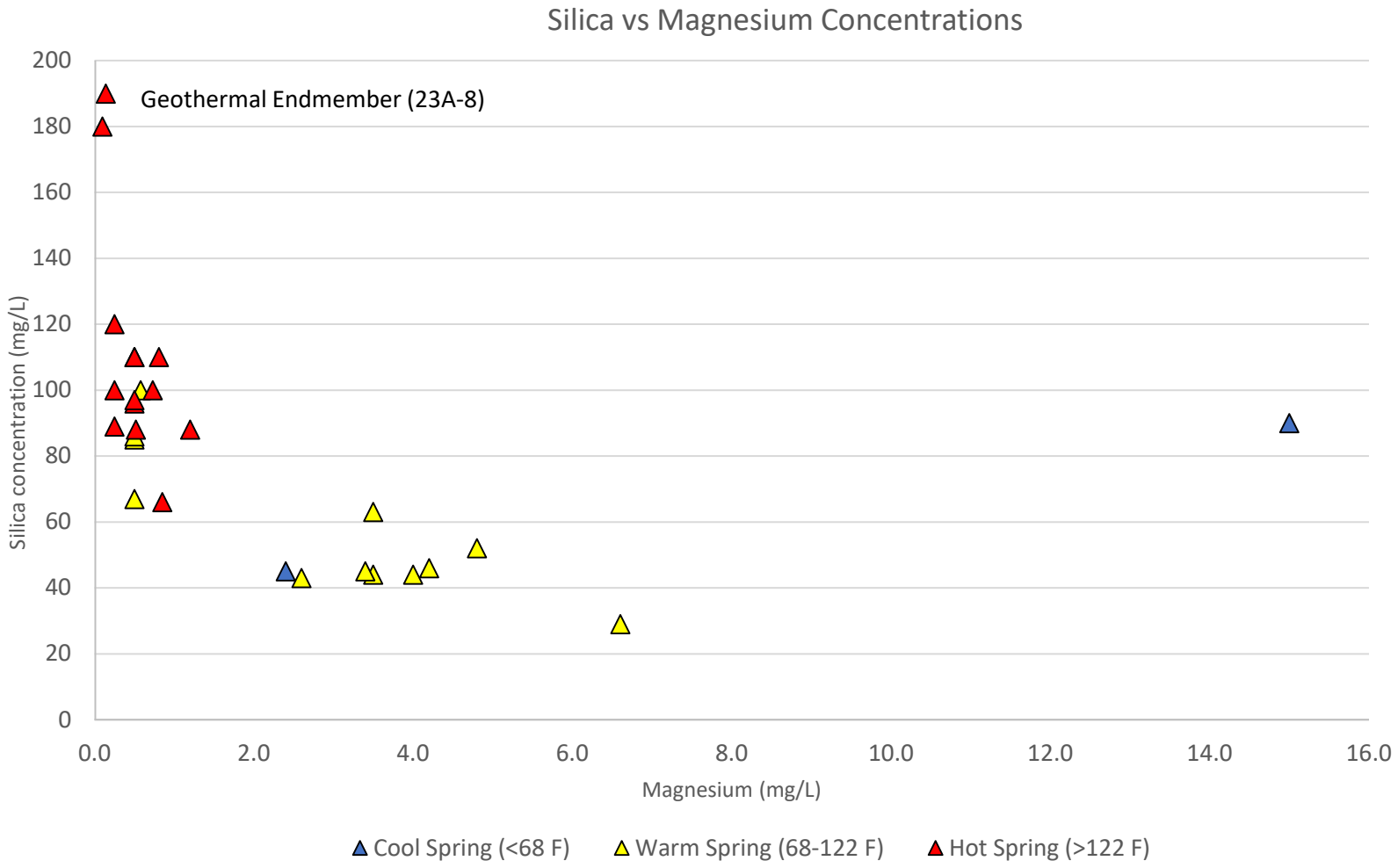
Chemistry and Isotope Plots



McGinley & Associates
Environmental Engineering and Science

Title
Mg to Li Molar Ratio vs Silica Concentration for Spring Samples and Geothermal Endmember

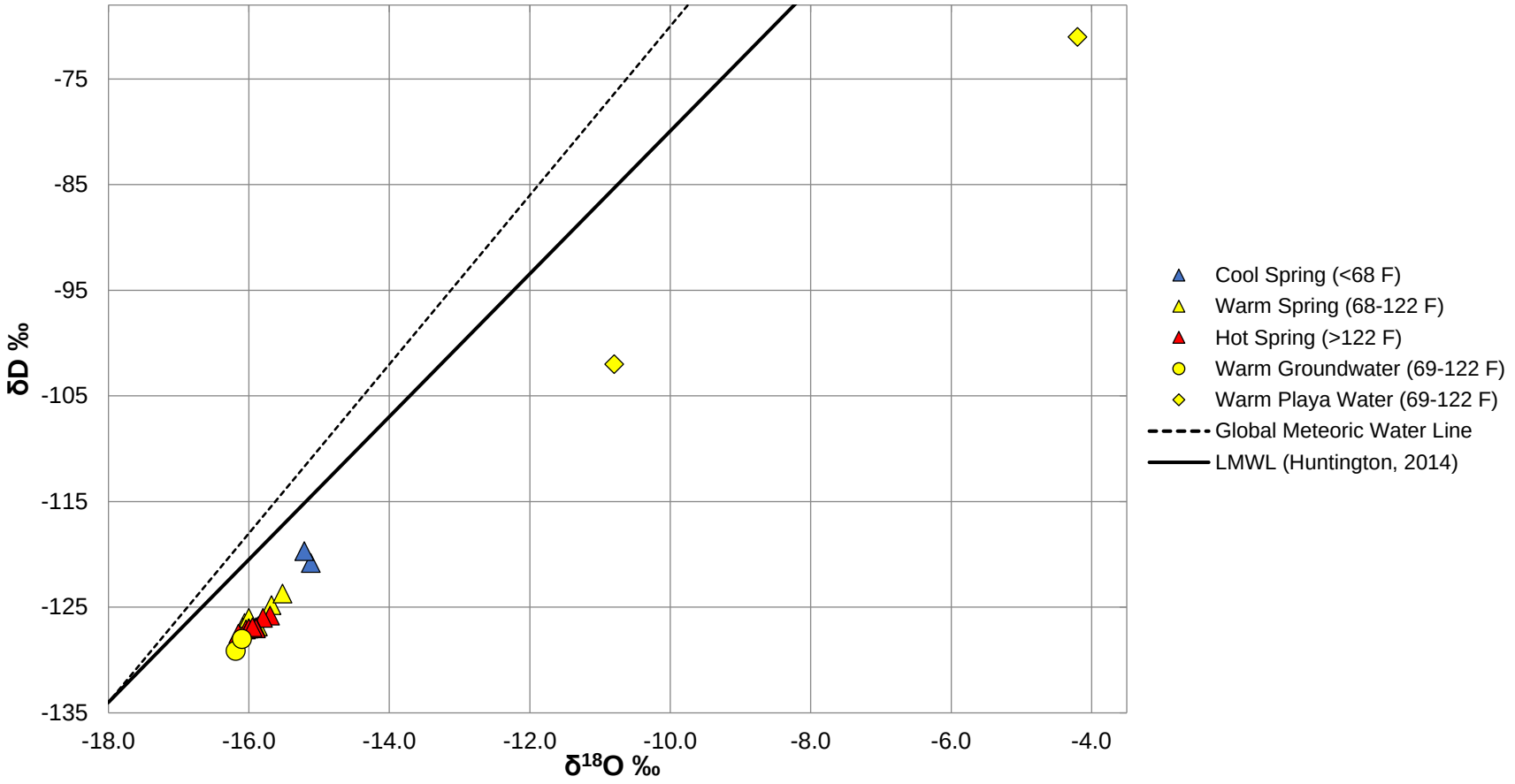
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	10/10/19



McGinley & Associates
Environmental Engineering and Science

Title	**Silica vs Magnesium Concentrations for Spring Samples and Geothermal Endmember**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	10/10/19

Oxygen-18 vs Deuterium

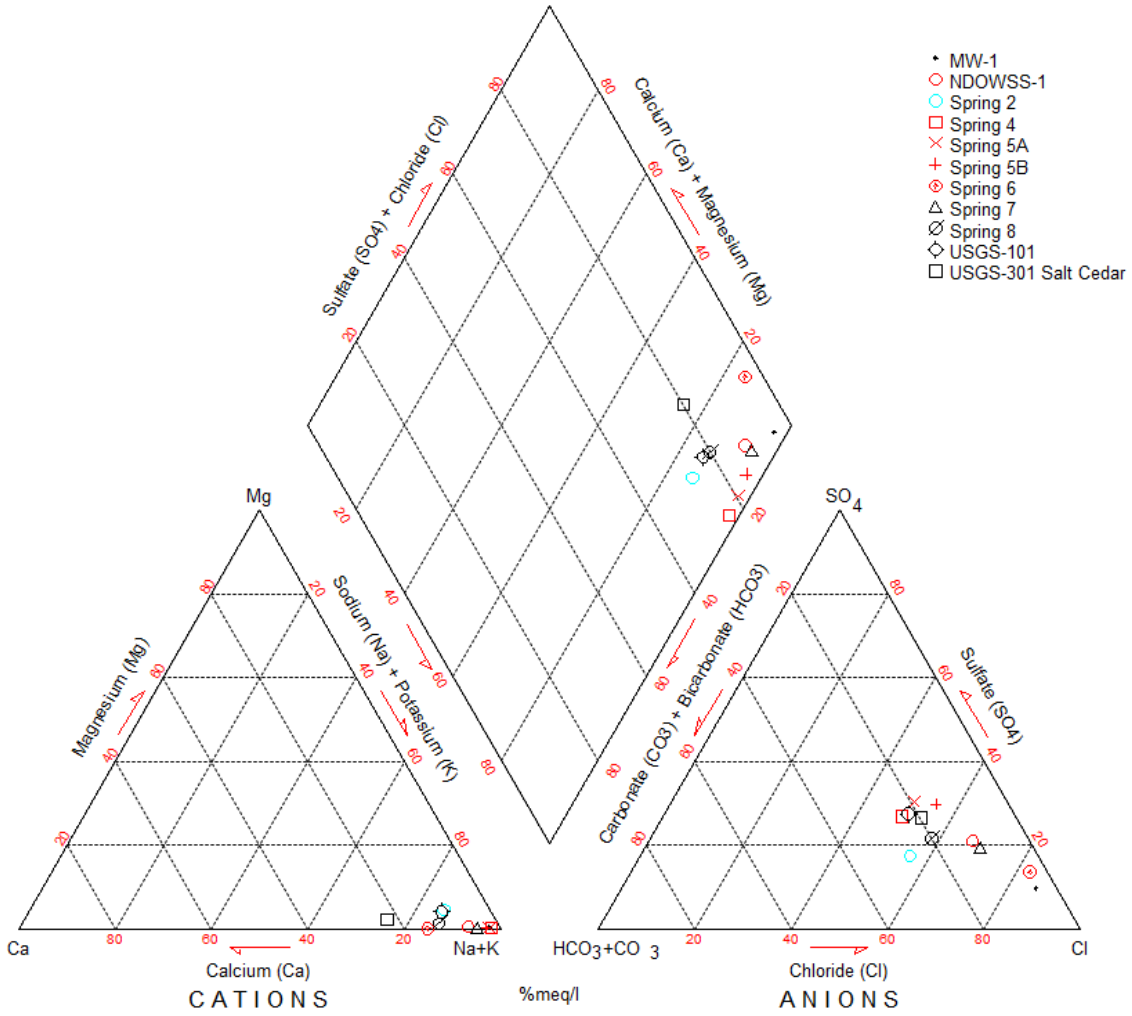


McGinley & Associates
Environmental Engineering and Science

Title	**Oxygen-18 vs Deuterium Plot**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	7/8/2019

Piper Diagram

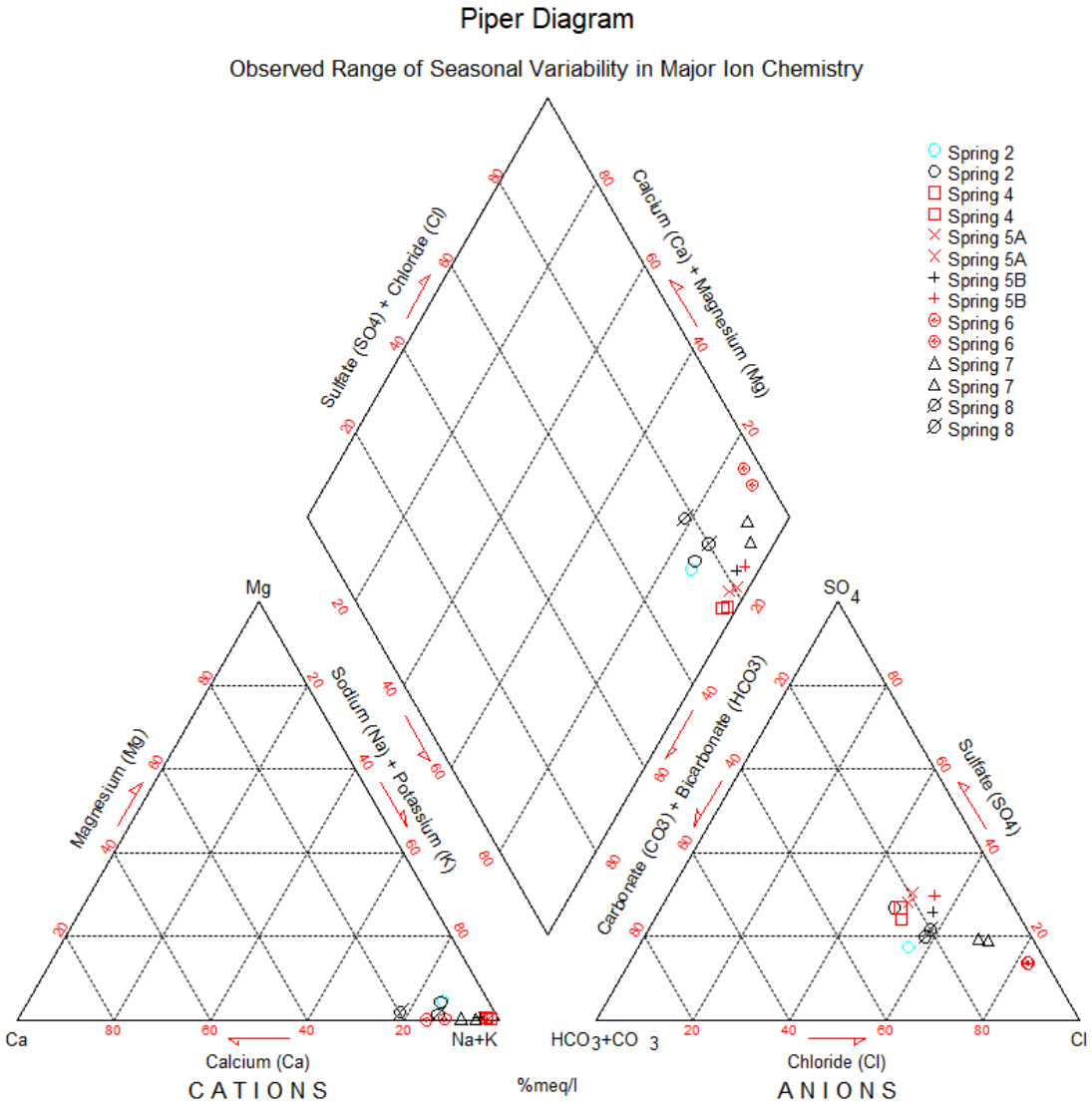
Typcial Chemistry of Individual Springs



Key:
Blue circles – cold water
Black circles – warm water
Red circles – hot water

McGinley & Associates
Environmental Engineering and Science

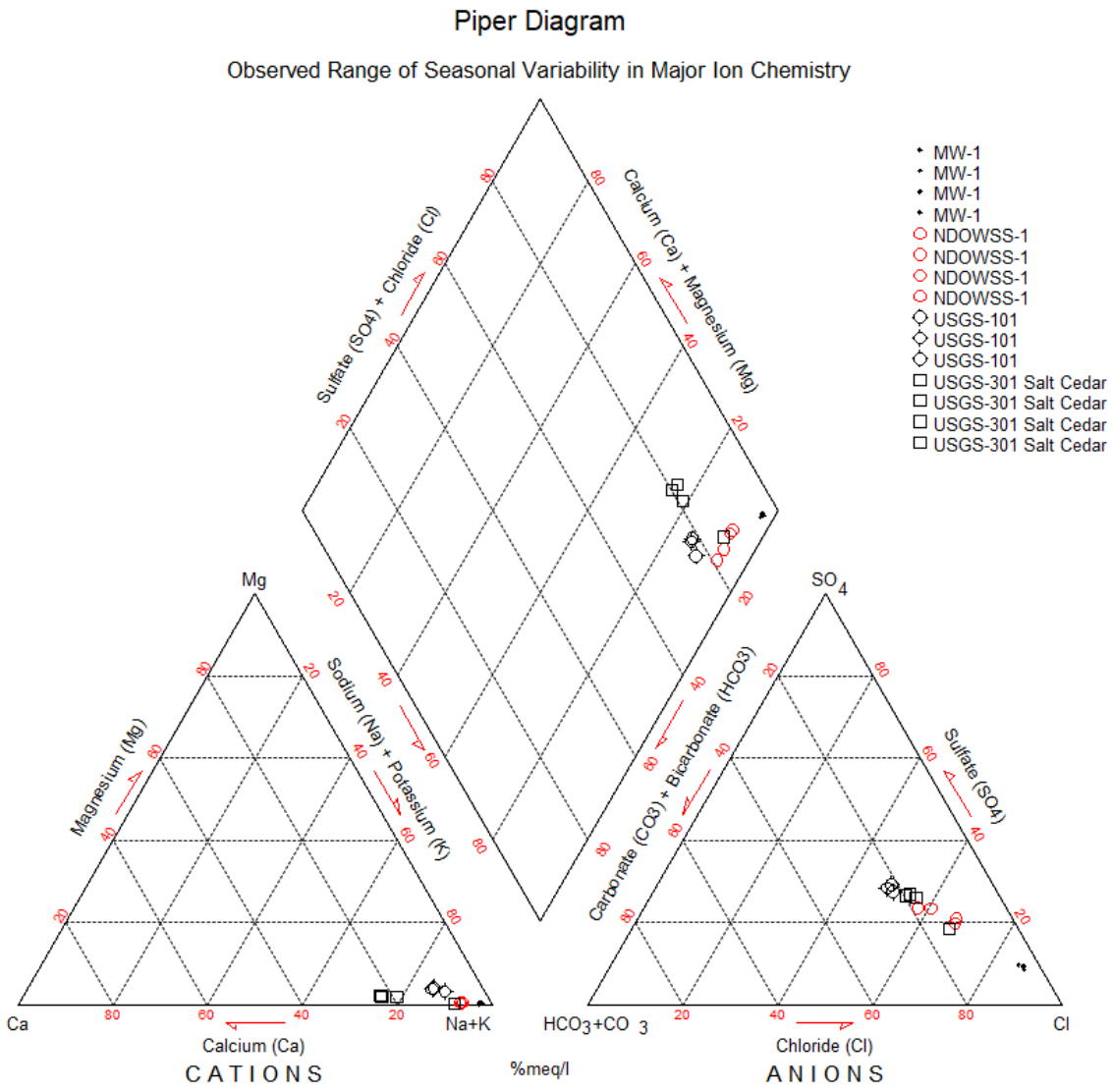
Title: **Piper Diagram for Samples collected in Dixie Meadows**		
Project Name: Dixie Meadows	Project Number: ORM007	Figure **G-1**
Client Name: Ormat	Date: 12/23/20	



Key:
Blue circles – cold water
Black circles – warm water
Red circles – hot water

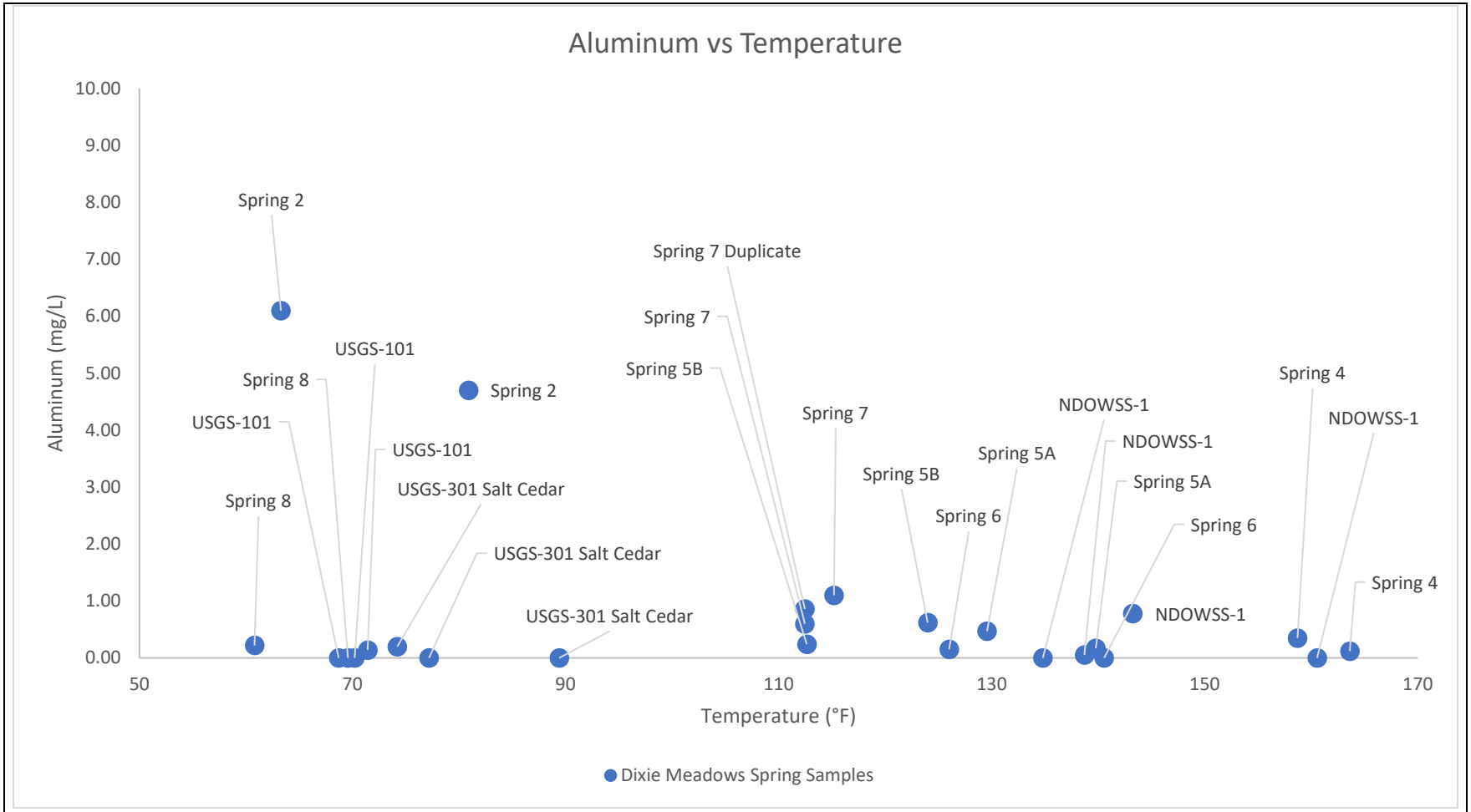
McGinley & Associates
Environmental Engineering and Science

Title: **Piper Diagram for Samples collected in Dixie Meadows**		
Project Name: Dixie Meadows	Project Number: ORM007	Figure **G-2a**
Client Name: Ormat	Date: 12/23/20	



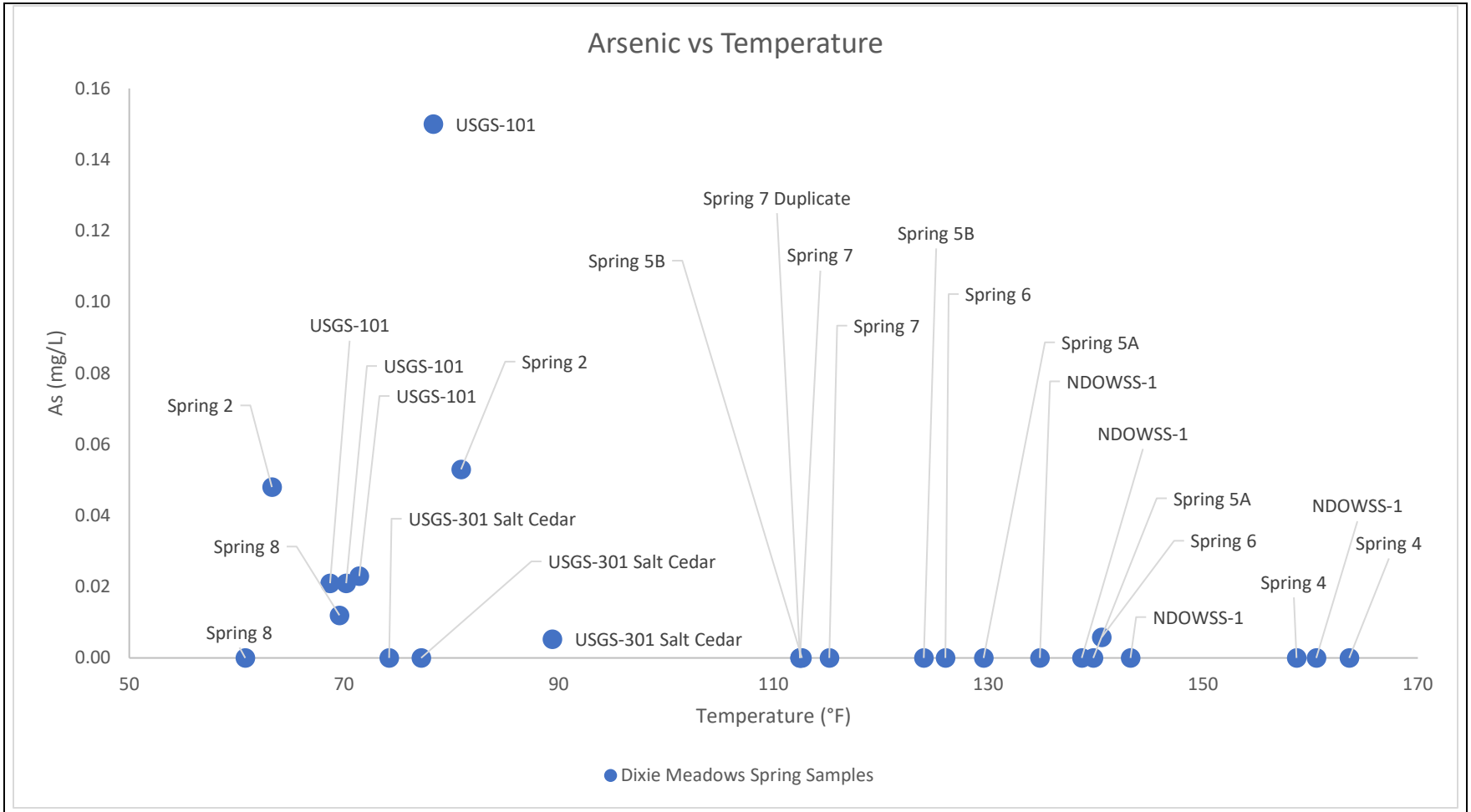
Key:
Black circles – warm water
Red circles – hot water

McGinley & Associates Environmental Engineering and Science	Title: **Piper Diagram for Samples collected in Dixie Meadows**		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure **G-2b**
	Client Name: Ormat	Date: 12/23/20	



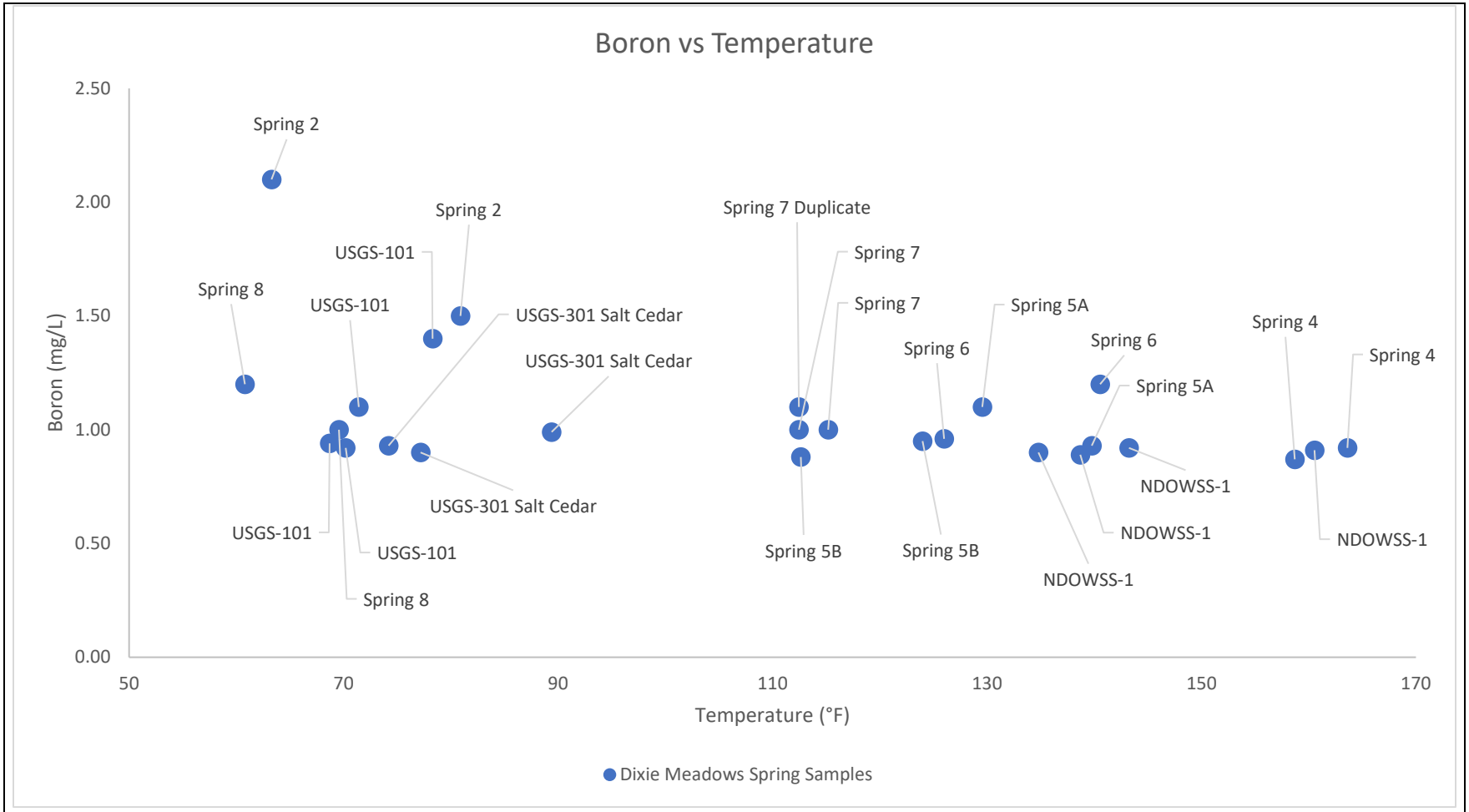
McGinley & Associates
Environmental Engineering and Science

Title:	Concentration vs Temperature Plots		
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	



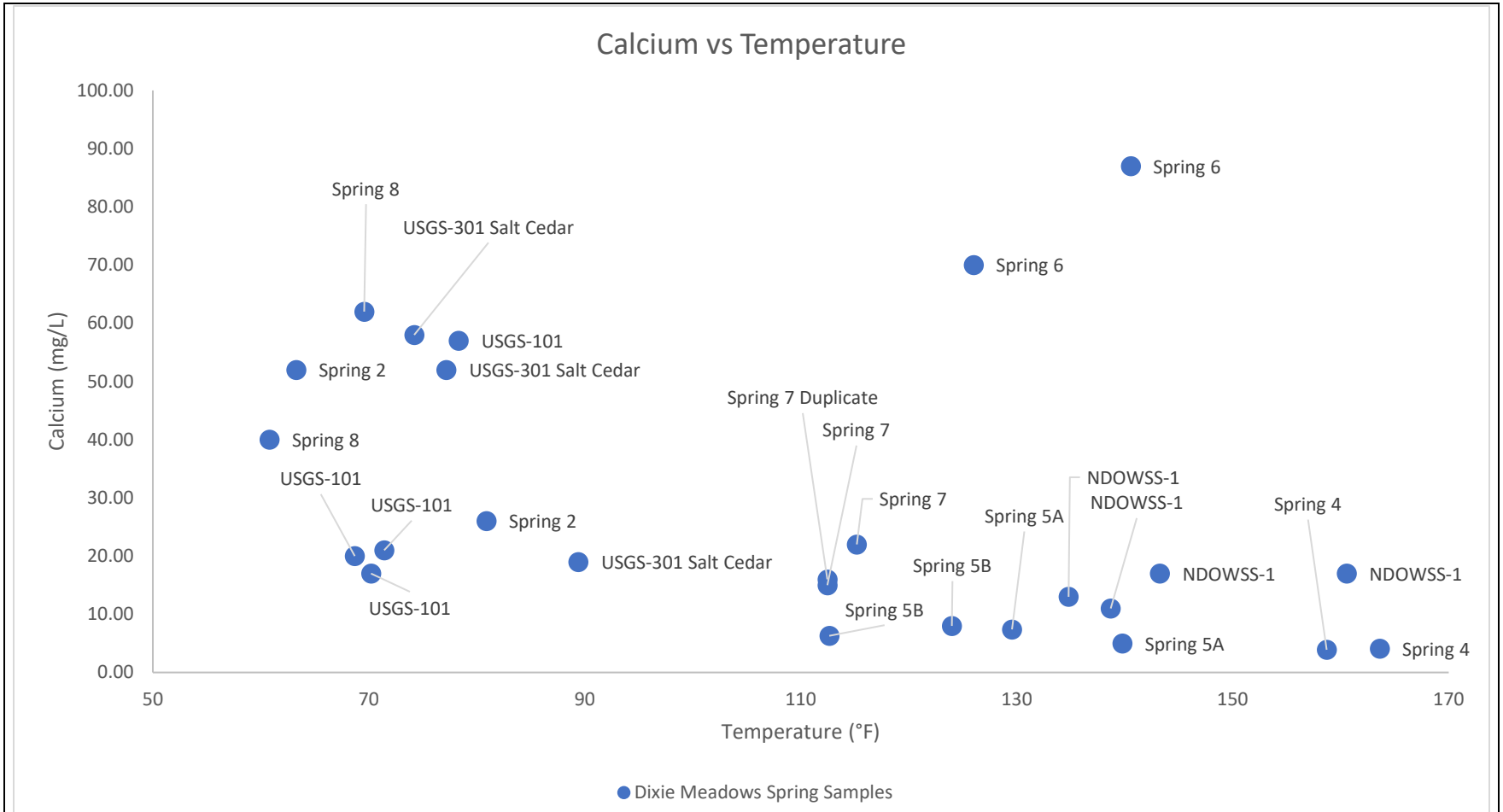
McGinley & Associates
Environmental Engineering and Science

Title:	Concentration vs Temperature Plots		
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	

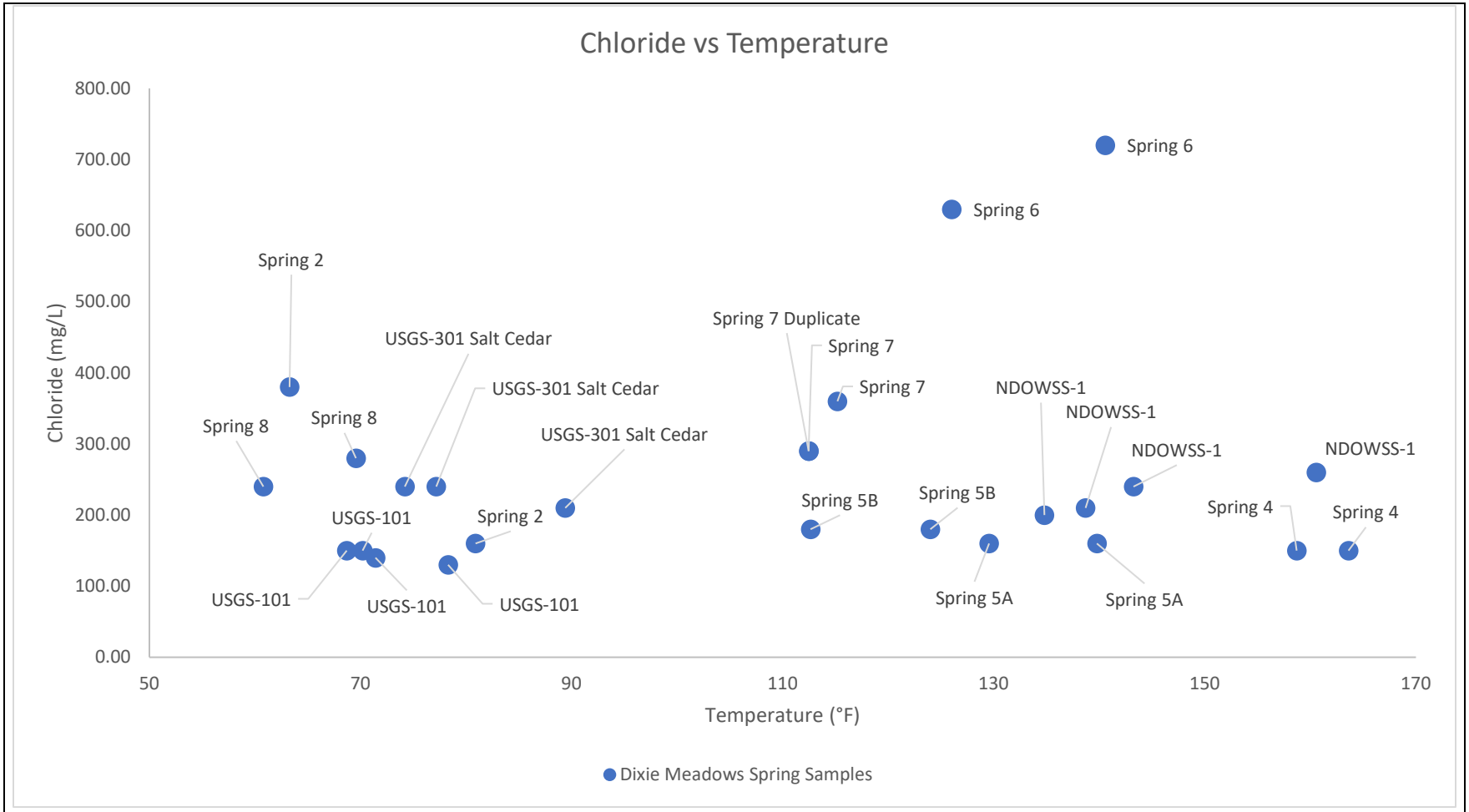


McGinley & Associates
Environmental Engineering and Science

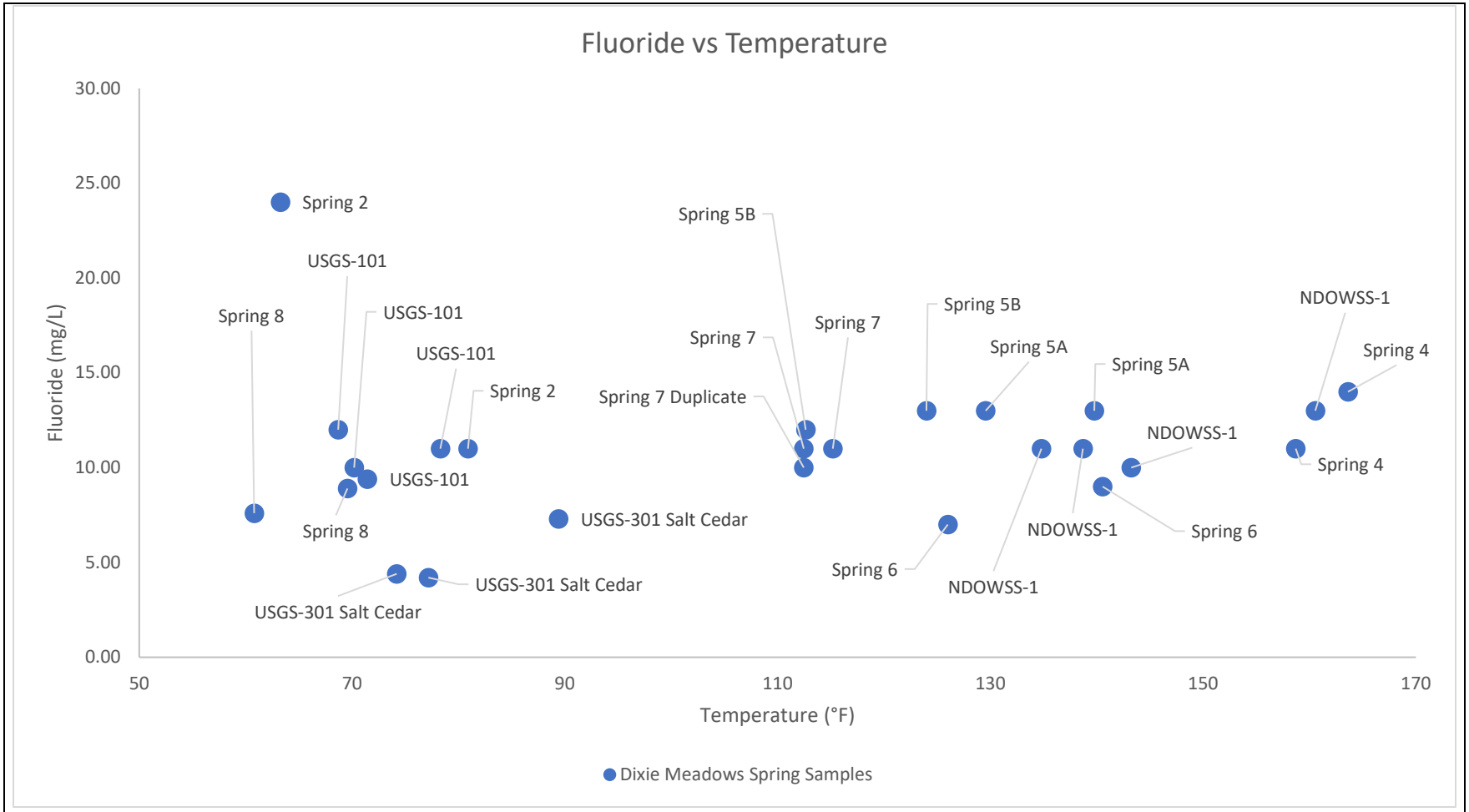
Title:	Concentration vs Temperature Plots		
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	



McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	

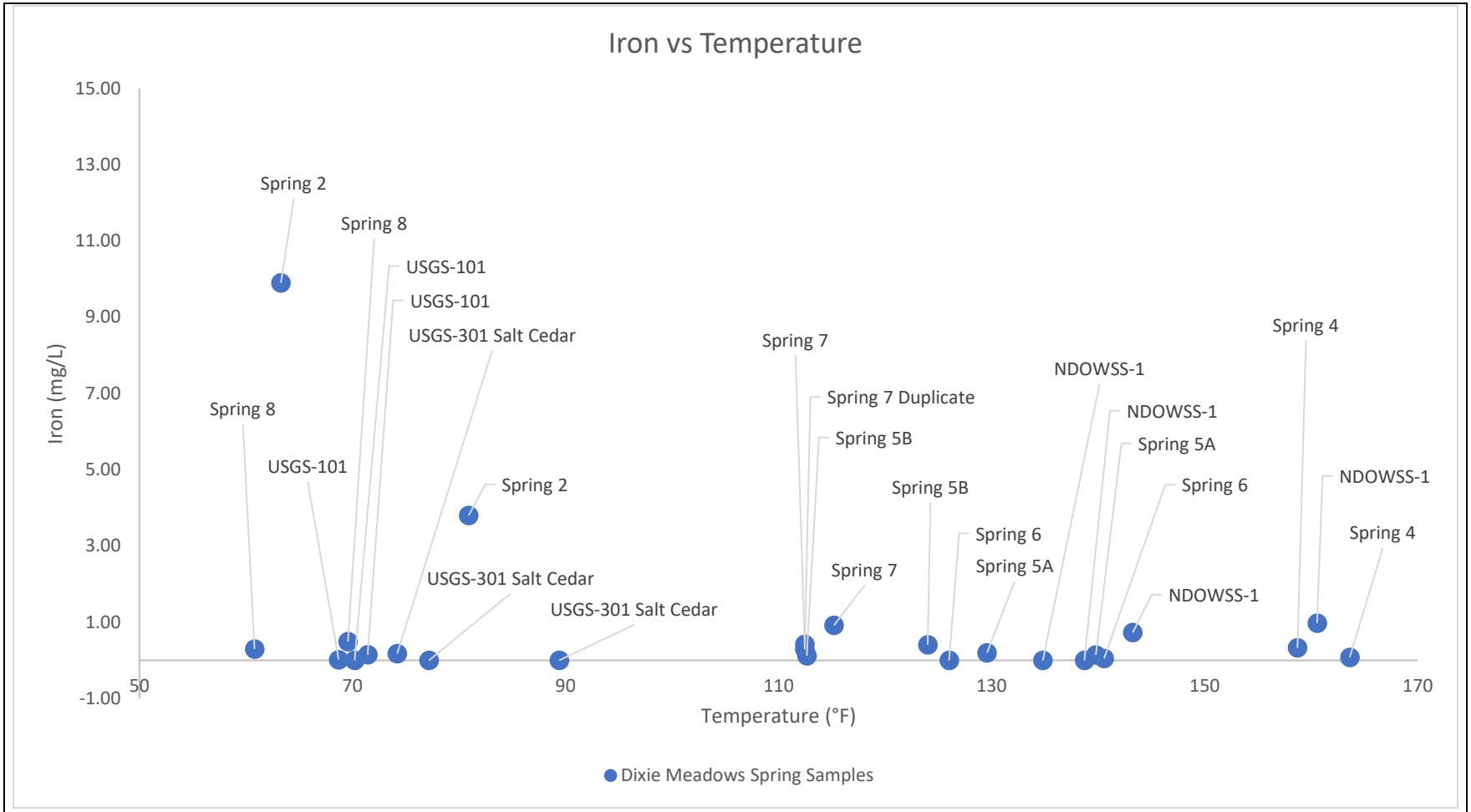


McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	



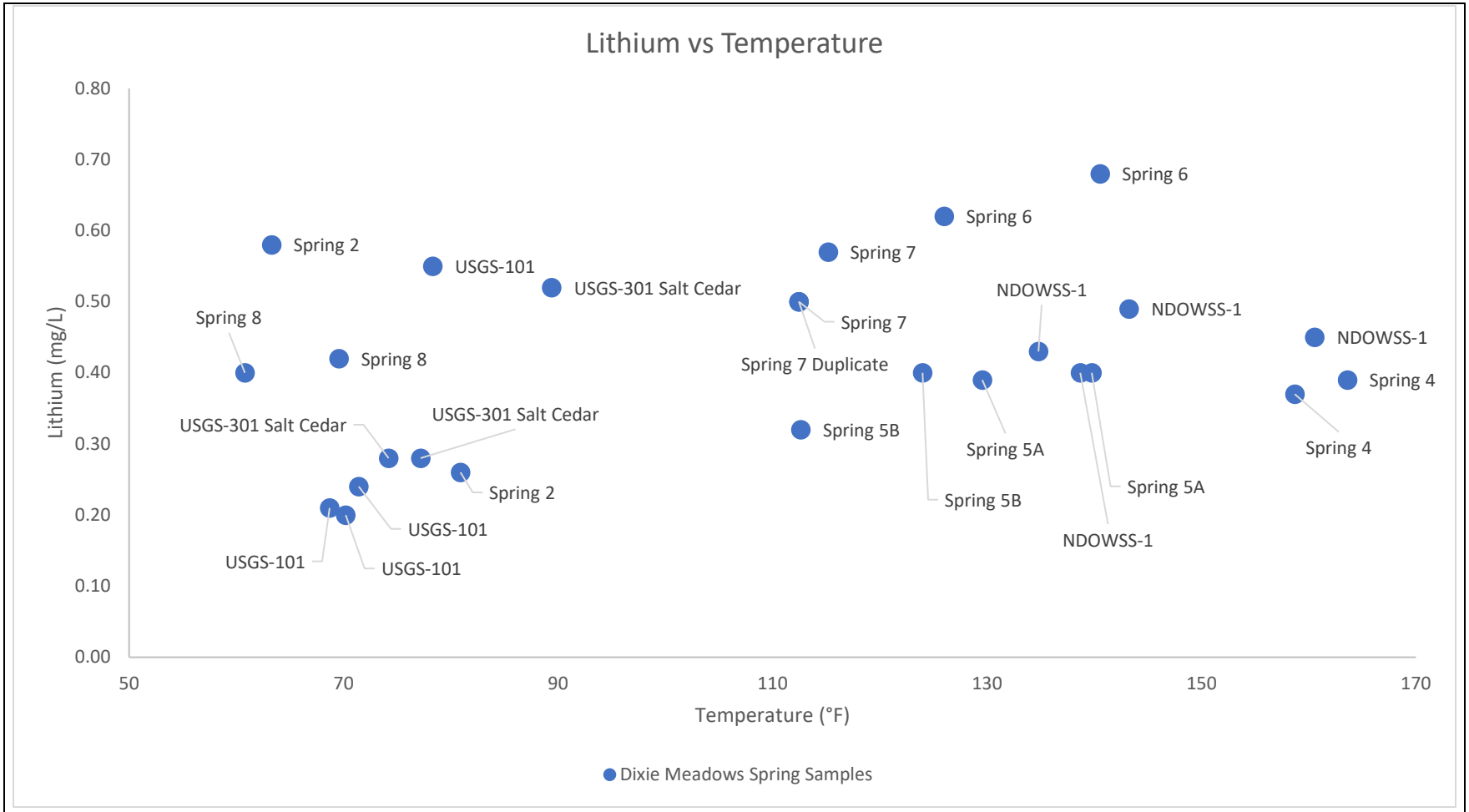
McGinley & Associates
Environmental Engineering and Science

Title: Concentration vs Temperature Plots			
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	

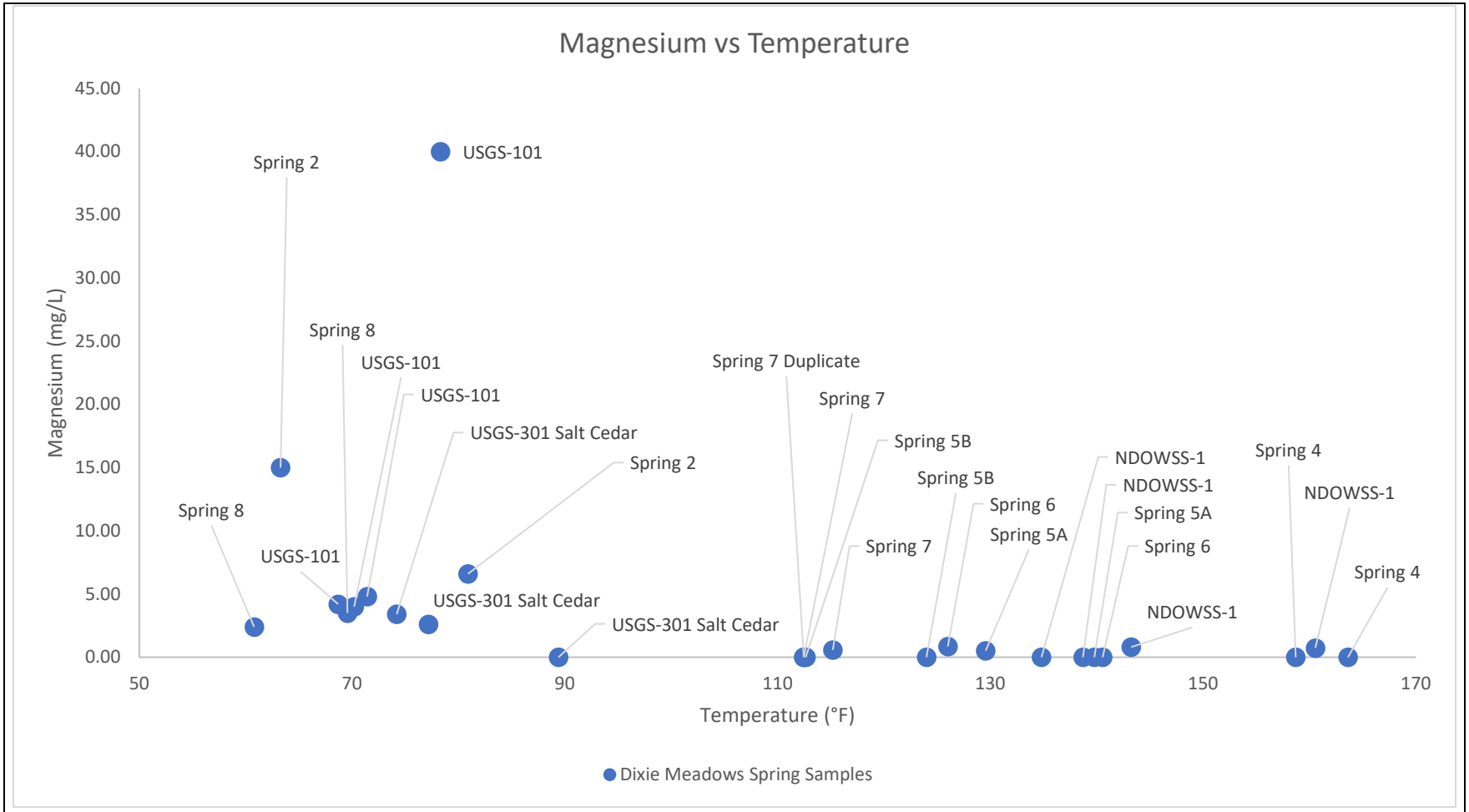


McGinley & Associates
Environmental Engineering and Science

Title: Concentration vs Temperature Plots			
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	

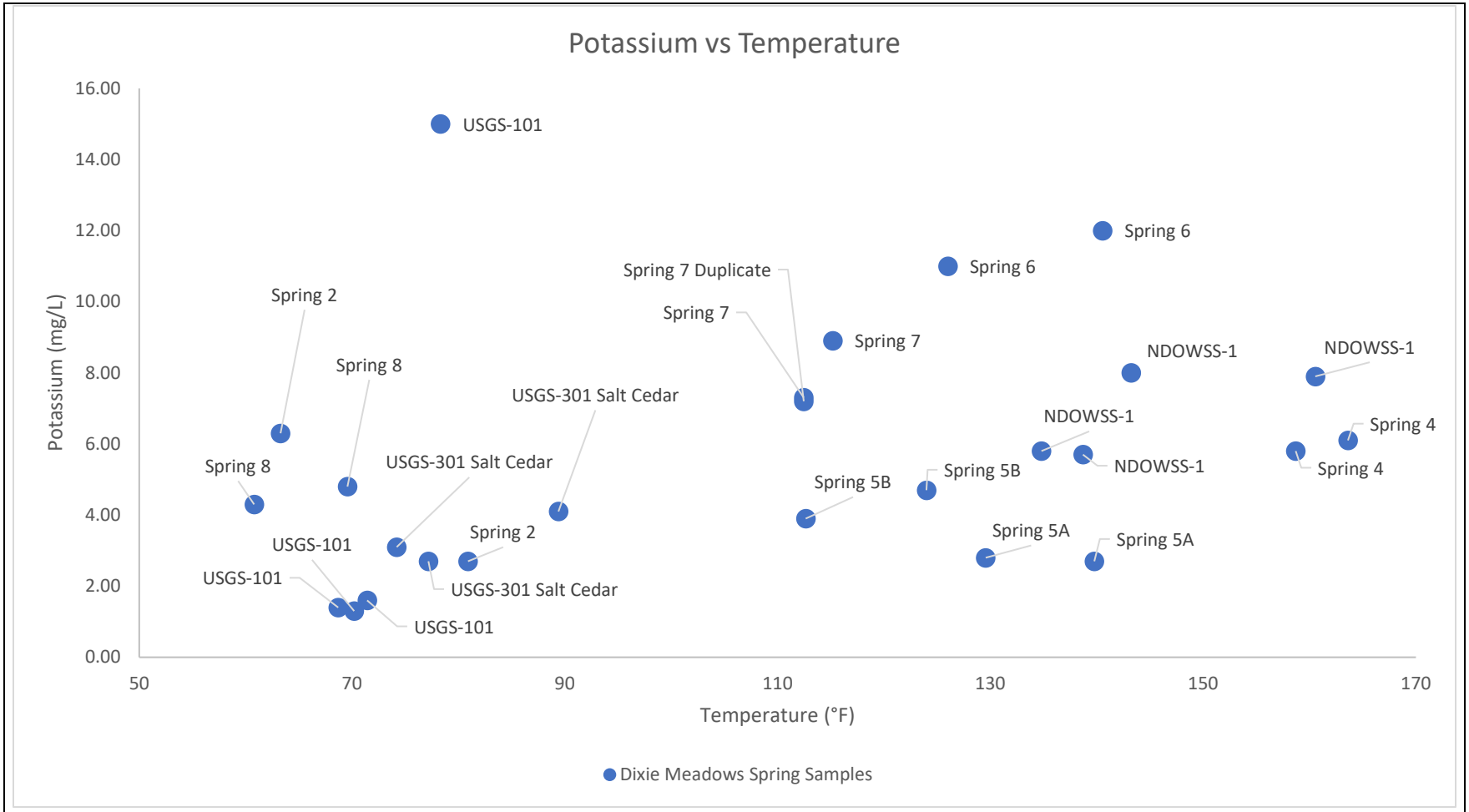


McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	

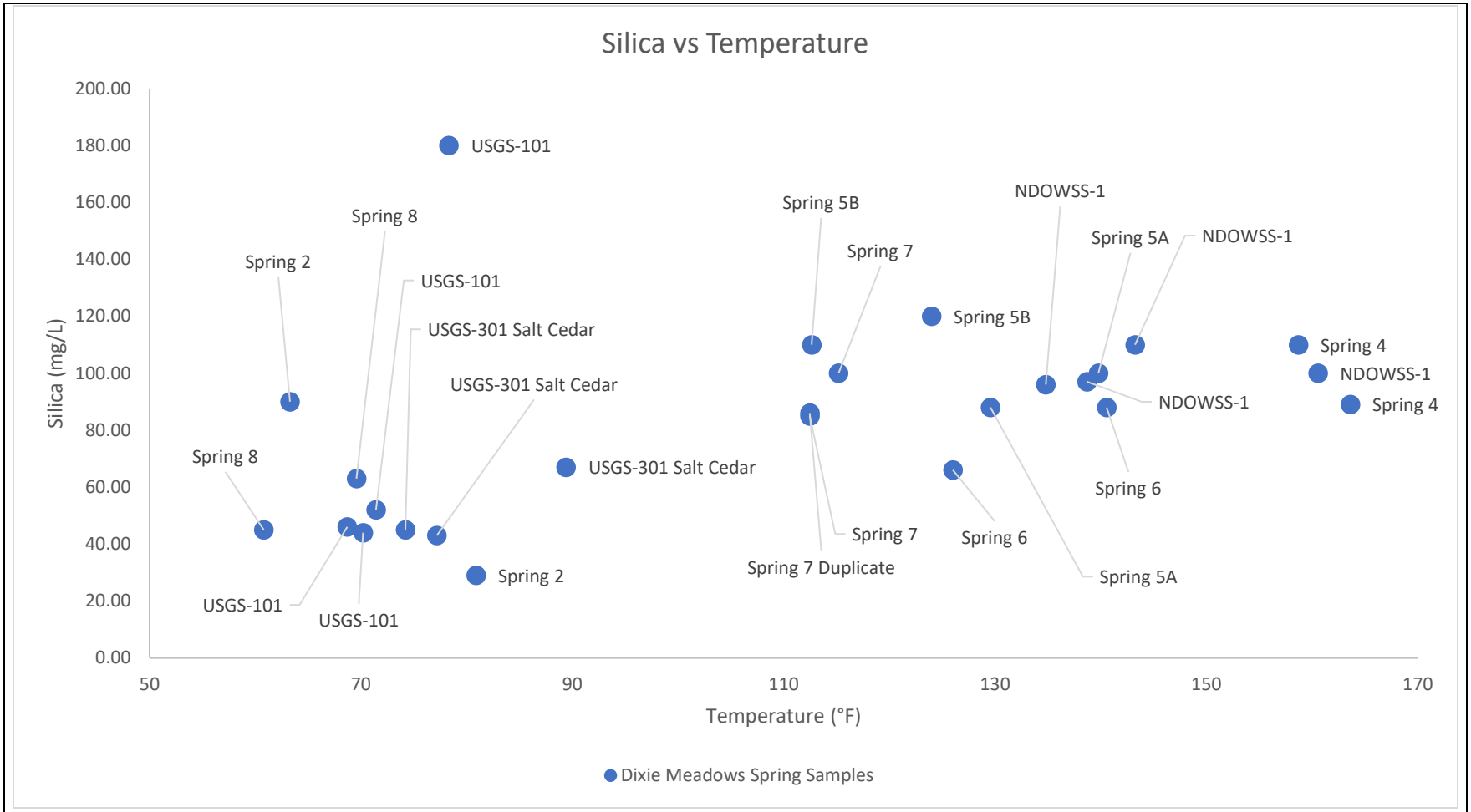


McGinley & Associates
Environmental Engineering and Science

Title:	Concentration vs Temperature Plots		
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	

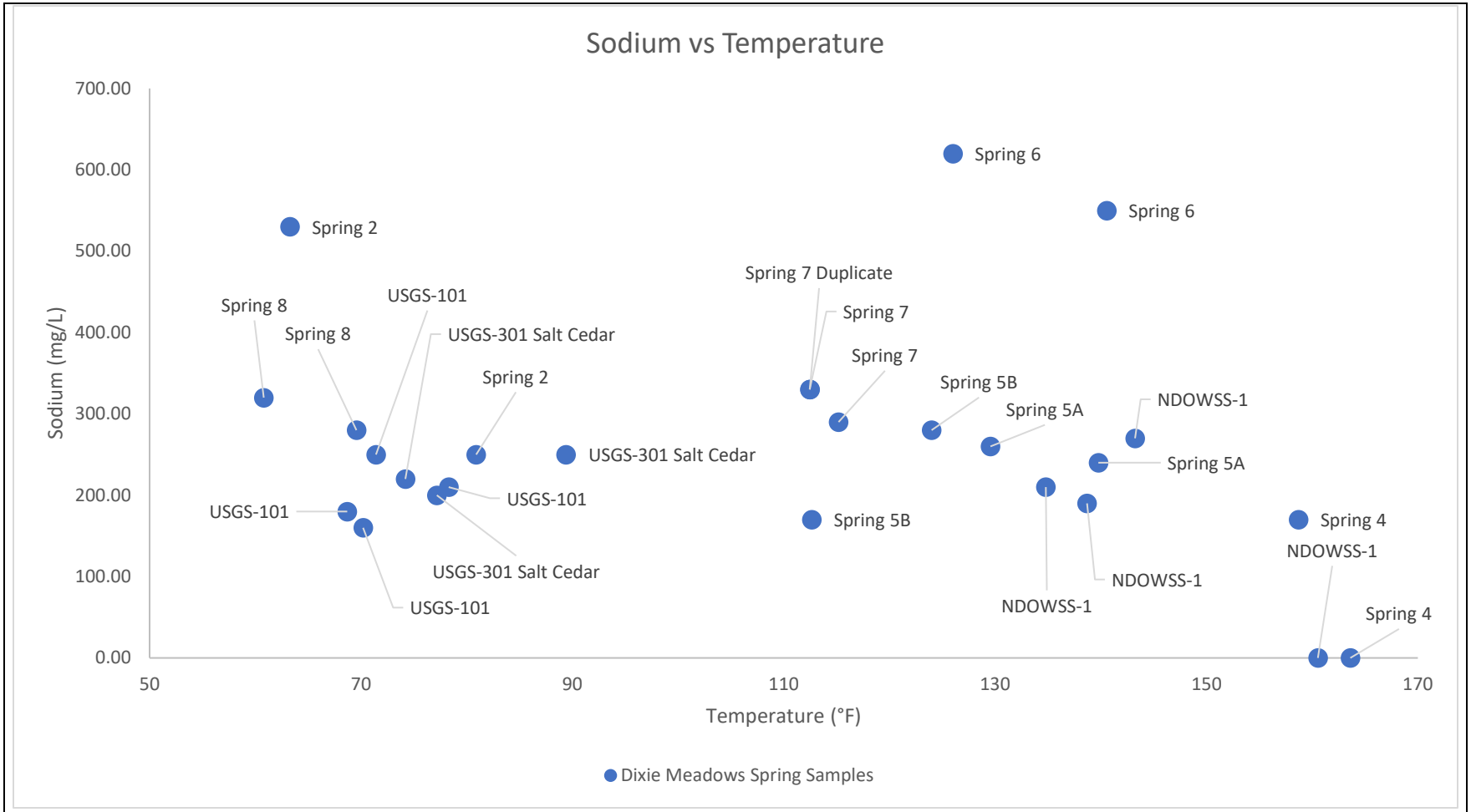


McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	



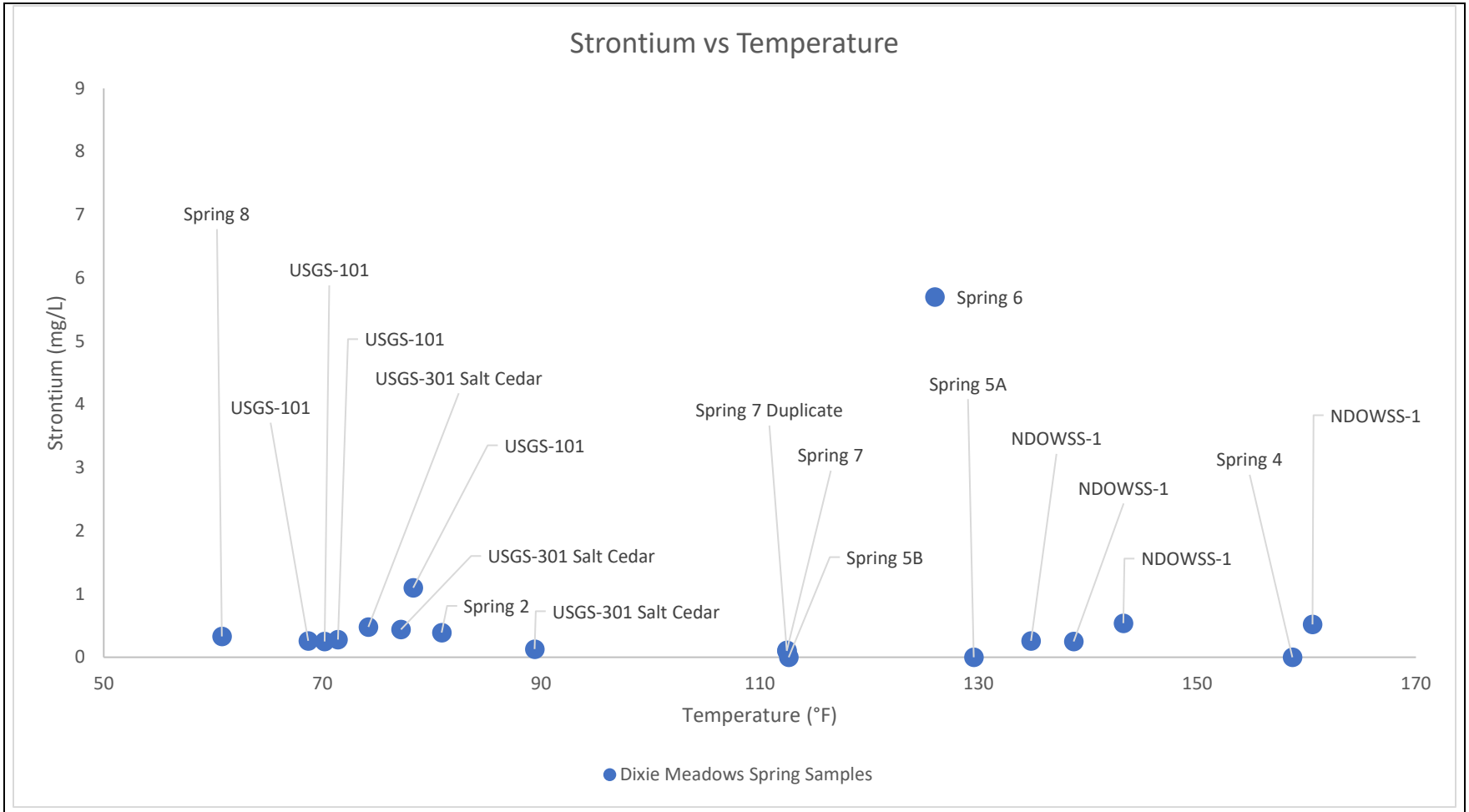
McGinley & Associates
Environmental Engineering and Science

Title: Concentration vs Temperature Plots			
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	

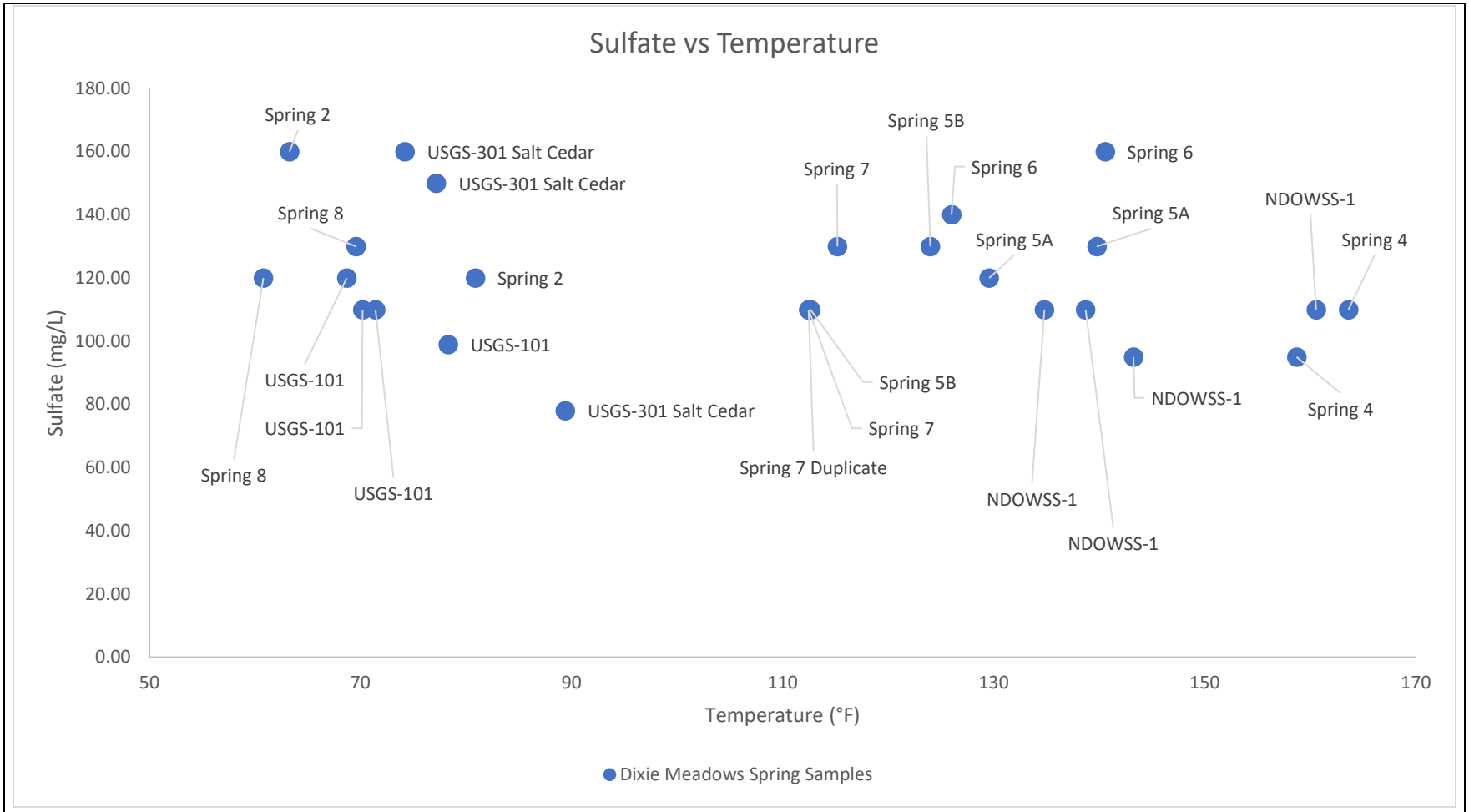


McGinley & Associates
Environmental Engineering and Science

Title:	Concentration vs Temperature Plots		
Project Name: Dixie Meadows		Project Number: ORM007	Figure
Client Name: Ormat		Date: 12/23/2020	



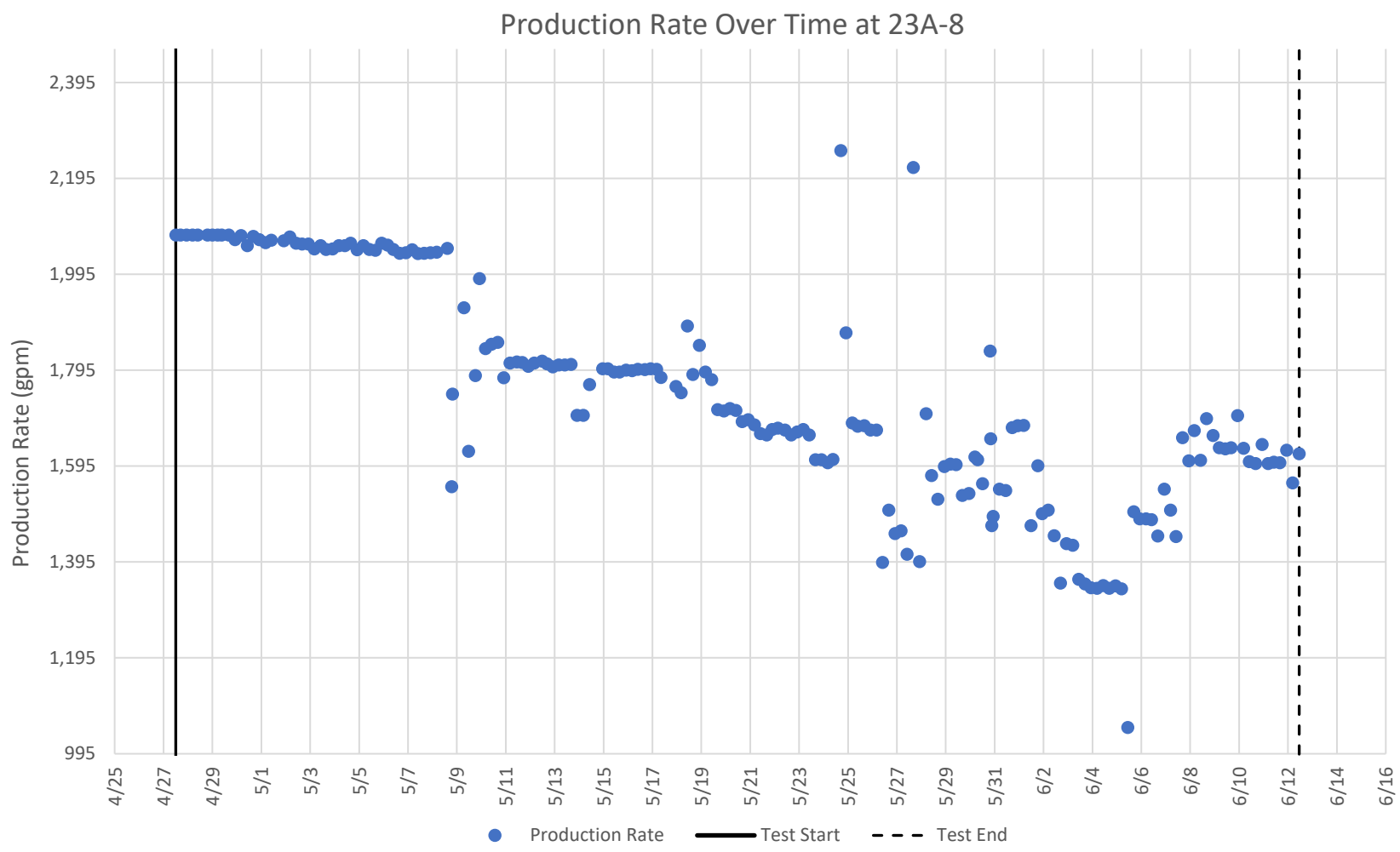
McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	



McGinley & Associates Environmental Engineering and Science	Title: Concentration vs Temperature Plots		
	Project Name: Dixie Meadows	Project Number: ORM007	Figure
	Client Name: Ormat	Date: 12/23/2020	

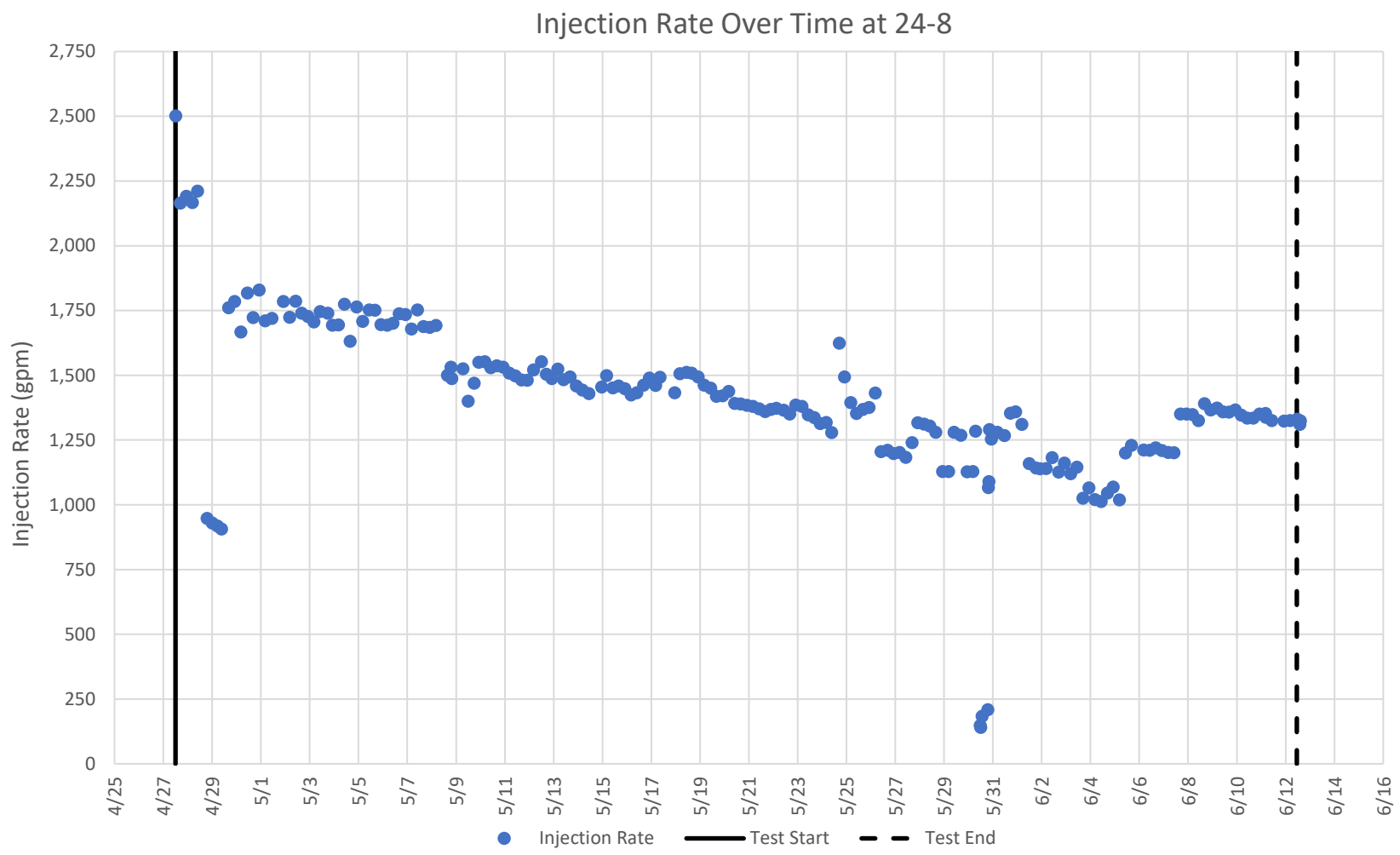
APPENDIX H

Flow/Injection Test Plots



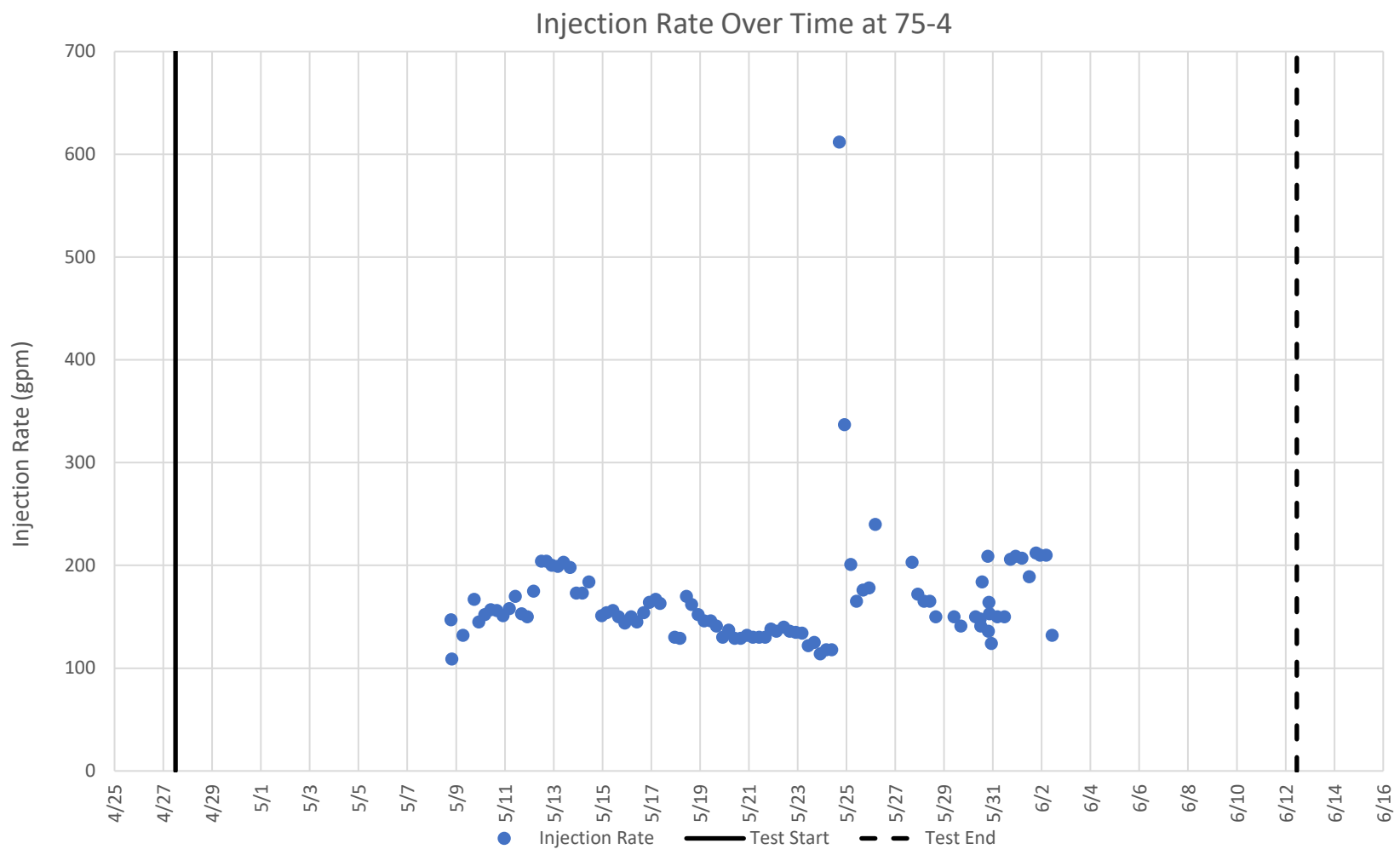
McGinley & Associates
Environmental Engineering and Science

Title	**Production Rate Over Time at 23A-8 During Flow Testing Operations**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	10/2/19



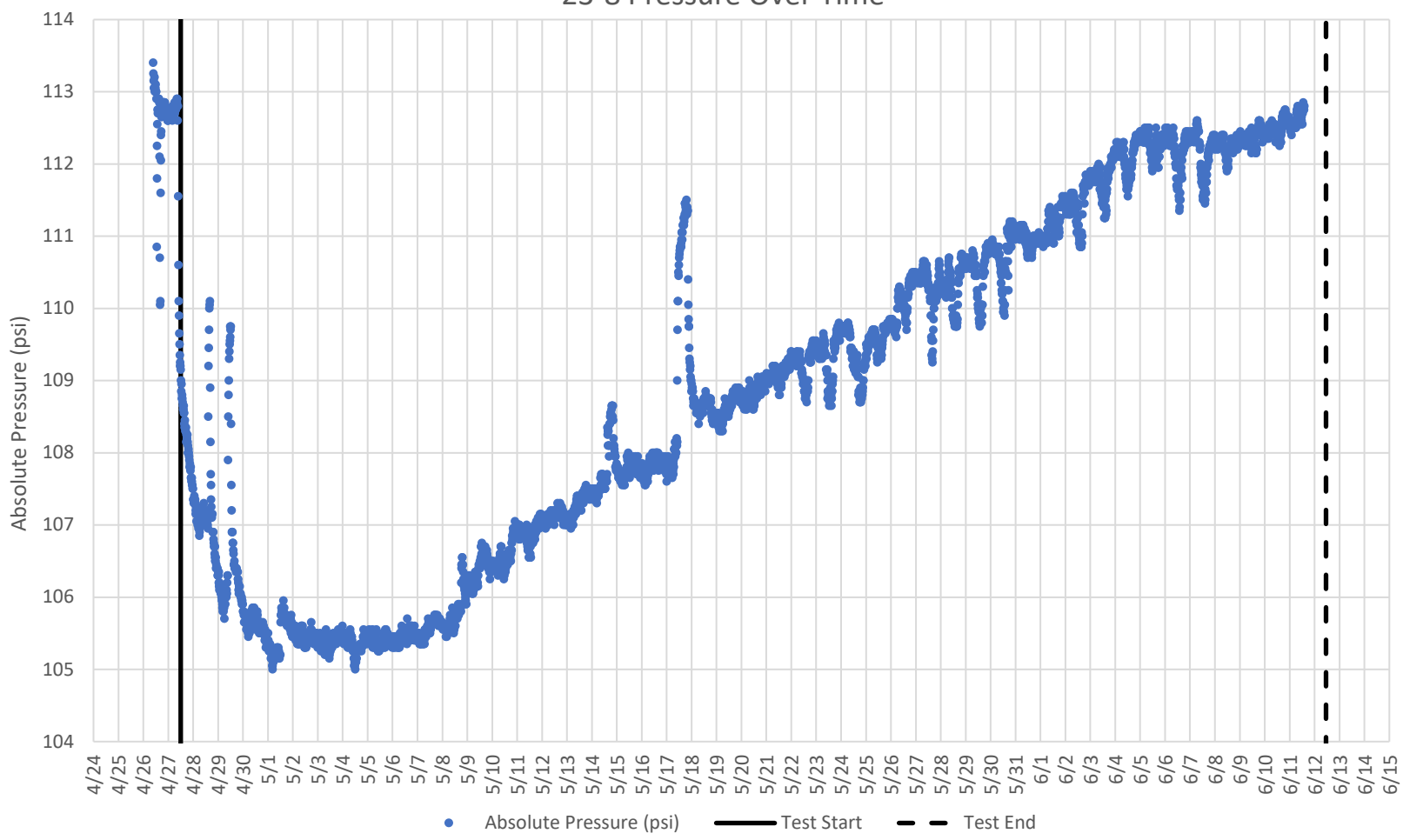
McGinley & Associates
Environmental Engineering and Science

Title	**Injection Rate Over Time at 24-8 During Flow Testing Operations**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	8/20/19



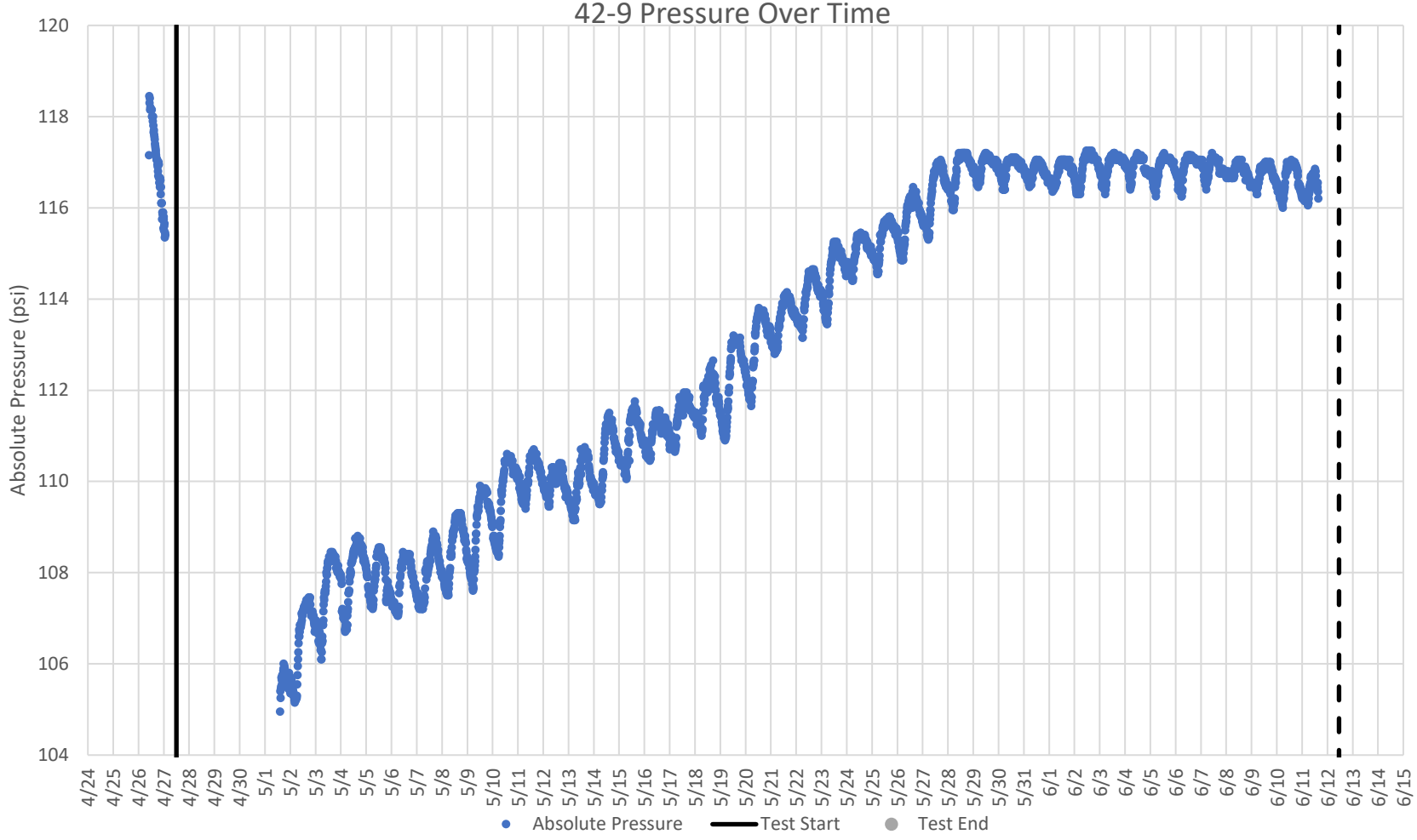
McGinley & Associates
Environmental Engineering and Science

Title	**Injection Rate Over Time at 75-4 During Flow Testing Operations**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	8/20/19



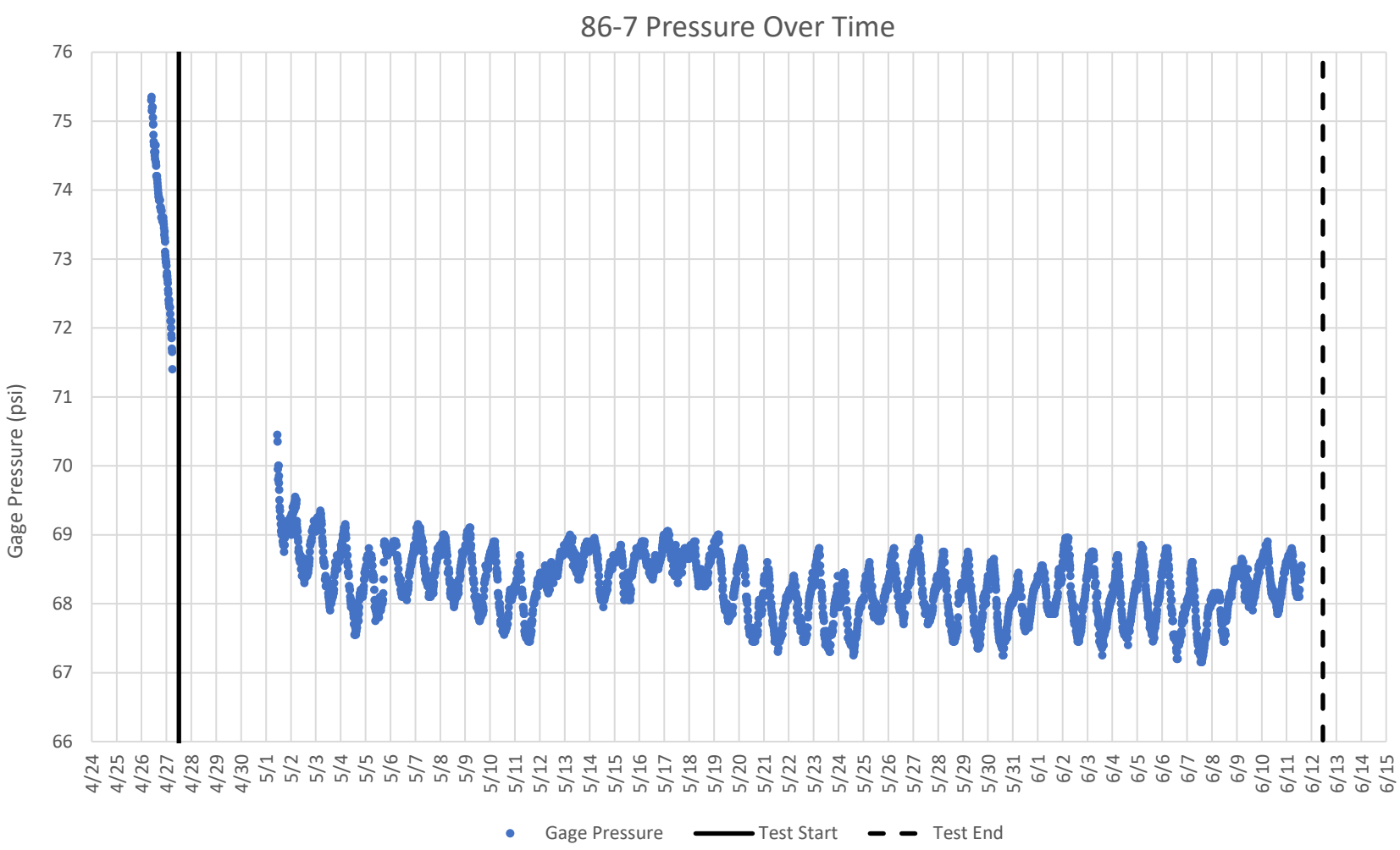
McGinley & Associates
Environmental Engineering and Science

Title	**Pressure Over Time at 23-8 During Flow Testing Operations**			
Project Name	Dixie Meadows	Project Number	ORM007	Figure
Client Name	Ormat	Date	7/8/2019	



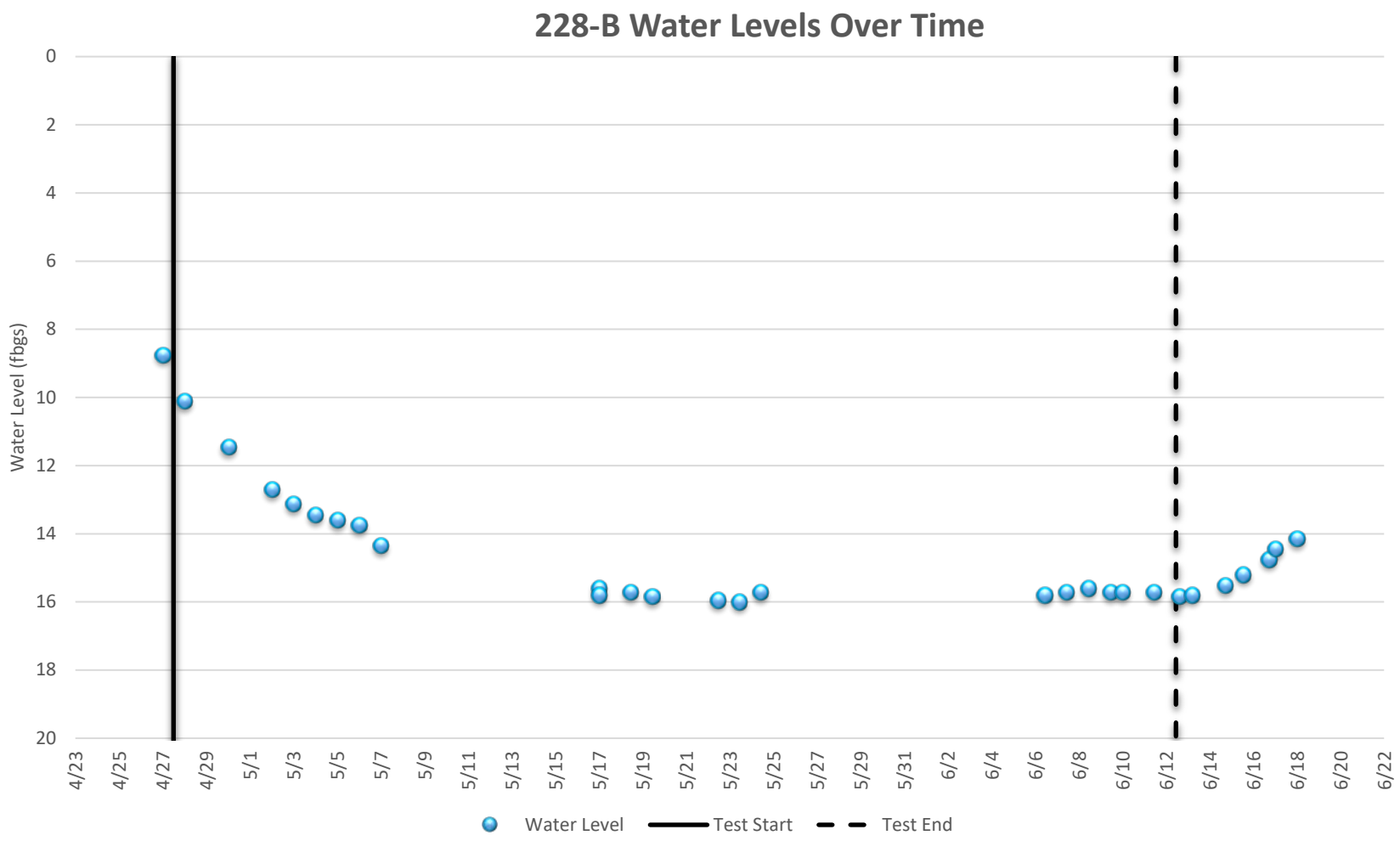
McGinley & Associates
Environmental Engineering and Science

Title	**Pressure Over Time at 42-9 During Flow Testing Operations**			
Project Name	Dixie Meadows	Project Number	ORM007	Figure
Client Name	Ormat	Date	7/8/2019	



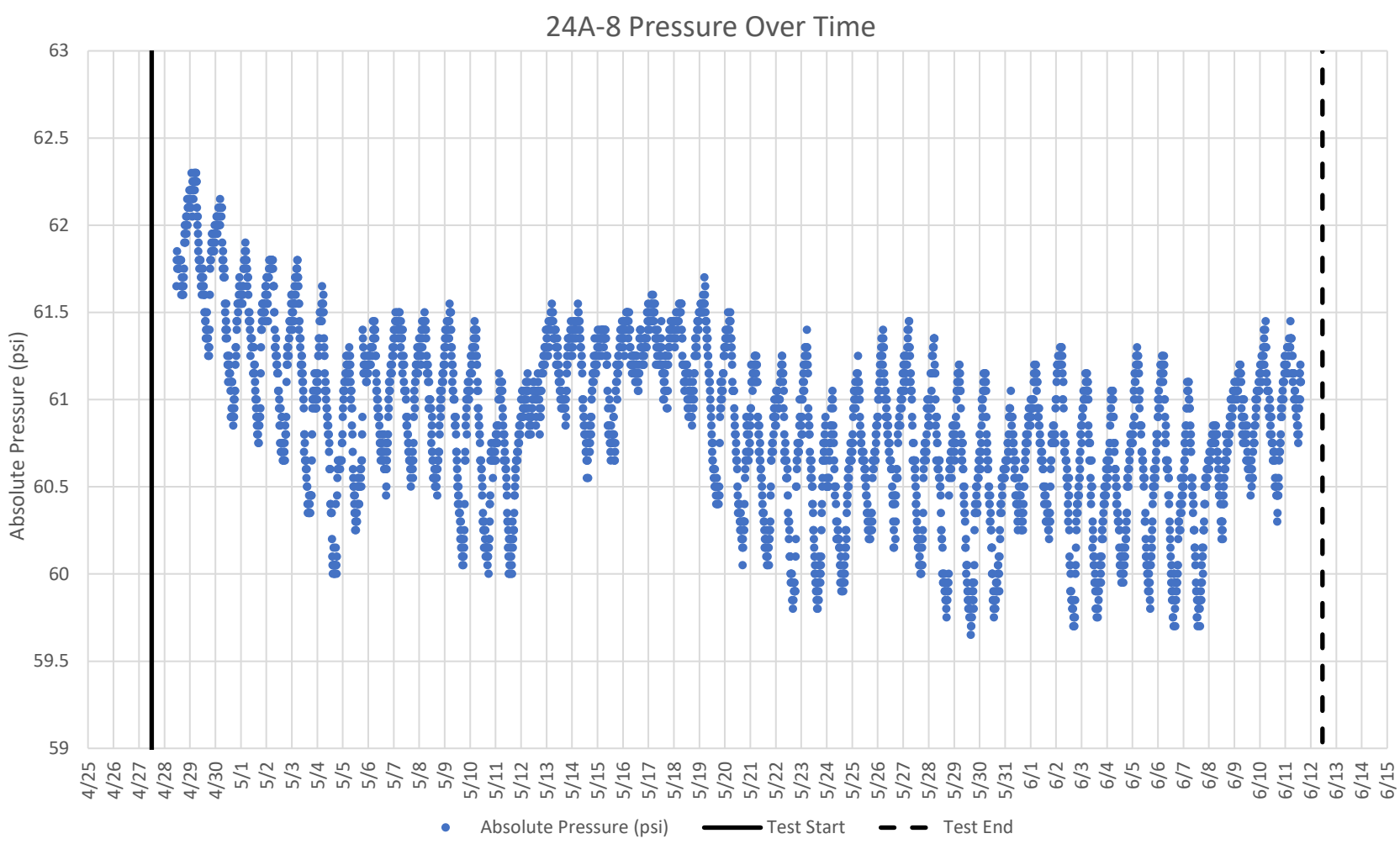
McGinley & Associates
Environmental Engineering and Science

Title	**Pressure Over Time at 86-7 During Flow Testing Operations**			
Project Name	Dixie Meadows	Project Number	ORM007	Figure
Client Name	Ormat	Date	7/8/2019	



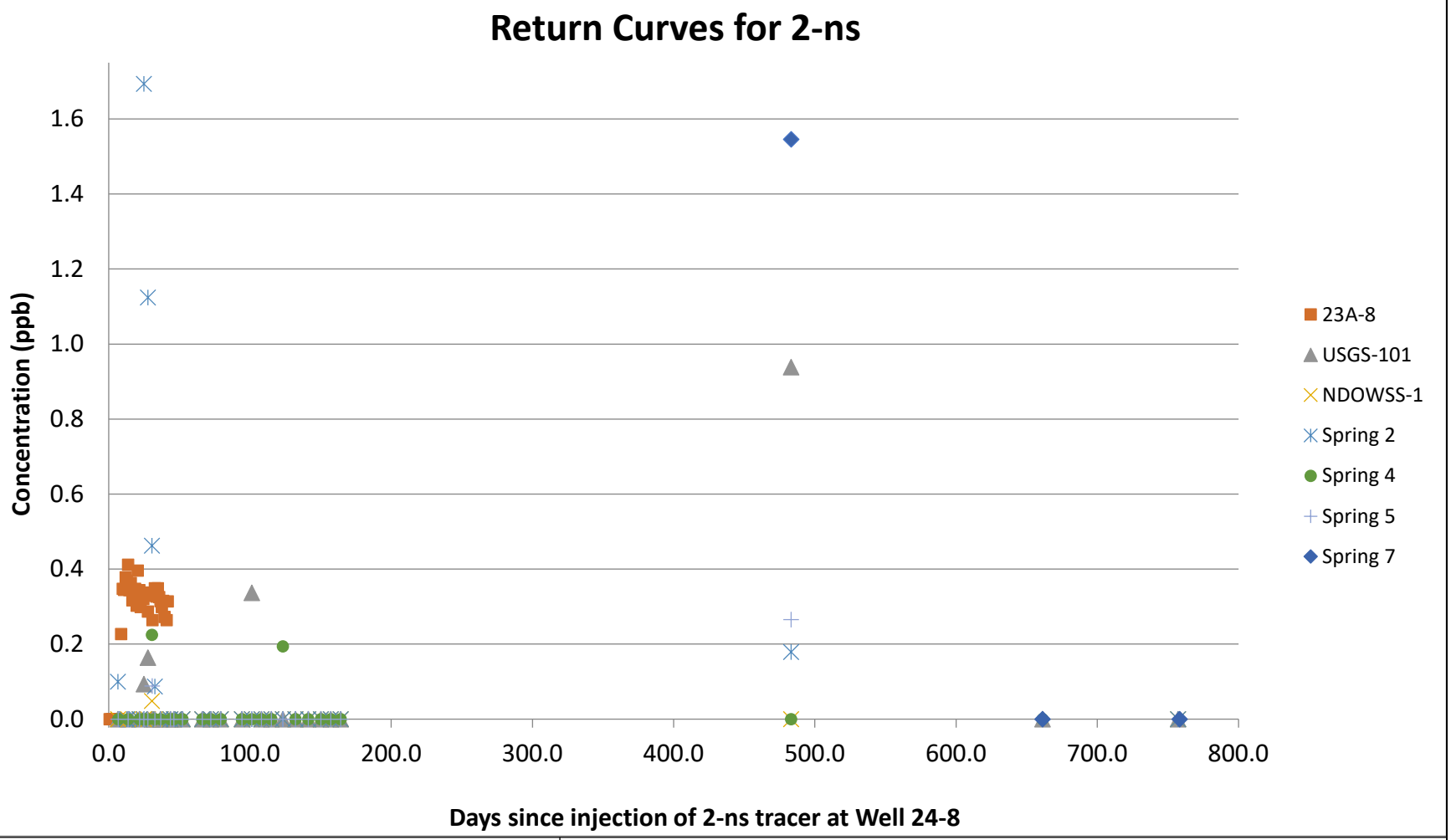
McGinley & Associates
Environmental Engineering and Science

Title	**Hydrograph for 22-8B During Flow Testing Operations**			
Project Name	Dixie Meadows	Project Number	ORM007	Figure
Client Name	Ormat	Date	7/8/2019	



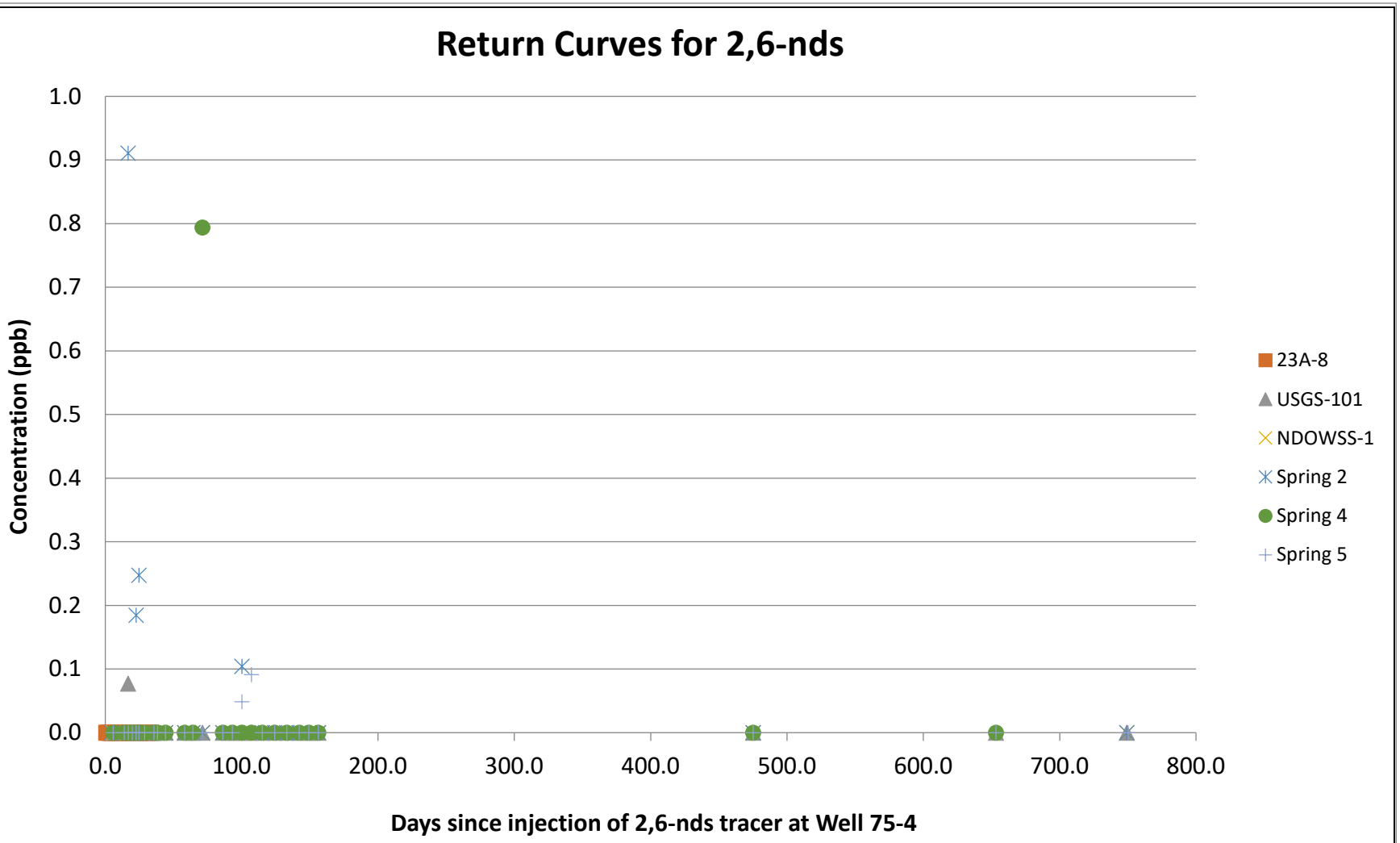
McGinley & Associates
Environmental Engineering and Science

Title	**Pressure Over Time at 24A-8 During Flow Testing**			
Project Name	Dixie Meadows	Project Number	ORM007	Figure
Client Name	Ormat	Date	7/8/2019	



McGinley & Associates
Environmental Engineering and Science

Title	**Return Curves for 2-ns**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	8/20/2019



McGinley & Associates
Environmental Engineering and Science

Title	**Return Curves for 2,6-nds**		
Project Name	Dixie Meadows	Project Number	ORM007
Client Name	Ormat	Date	8/20/2019