NUCLA TOWN RESERVOIR ENLARGEMENT

FEASIBILITY INVESTIGATIONS AND ANALYSIS

PREPARED FOR:

MONTROSE COUNTY, COLORADO
317 SOUTH 2ND STREET
MONTROSE, COLORADO 81401

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DEERE & AULT
CONSULTANTS, INC.
600 South Airport Road, Suite A-205
Longmont, CO 80503
(303) 651-1468 • Fax (303) 651-1469
www.deereault.com

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1.0 GENERAL

1.1 Existing Conditions

The Nucla Town Reservoir site is located in the west end of Montrose County, Colorado along the CC Ditch, approximately two miles east of the Town of Nucla and about one-mile north of the San Miguel River and the Nucla Pump Site (**Figure 1**). The reservoir is in Section 10 and the pump site is in Section 15, Township 46 North, Range 15 West of the New Mexico Prime Meridian. The reservoir is situated within the arid farmland surrounding the town. The typical vegetation in the land around the reservoir consists of low brush and scattered juniper and piñon trees with sparse grass and other low vegetation. Water consuming vegetation including cottonwood and Russian olive trees have become established along the CC Ditch. East of the existing reservoir is a small, intermittent ravine tributary to the San Miguel River. It is characterized by colluvial slopes and ribs of sandstone bedrock outcrops forming low cliffs, with some isolated wetlands in the bottom. For the enlarged reservoir, the contributing drainage area is approximately 217 acres.

The existing Nucla Town Reservoir is the main raw water supply for the Town of Nucla. It stores up to 135 acre-feet of water and is primarily filled using a diversion structure on the CC Ditch. The diversions are measured using a broad-crested weir and the discharge enters the northern end of the reservoir. Additionally, an eight-inch water supply pipeline from the Nucla Pump Site enters the site from the southeast and discharges into the northern end of the reservoir. Currently the pump site consists of an infiltration gallery beneath the river and a pumping system designed to yield up to 1,200 gallons per minute (gpm) to the Town Reservoir. However, the existing system can only be operated at about 50 percent capacity and during high river flows the gallery fills with sediment, which requires frequent back-flushing.

The stored water is released through a low-level outlet works, consisting of an eight-inch conduit, and then treated at the onsite treatment facility by the Mustang Water Authority. The conduit passes through at the maximum section of the existing dam and then runs east to the treatment plant. The proposed enlargement will leave the outlet works in place. Overhead electrical utility lines run west to east from Road 3050 along the southern property boundary to the treatment facility. The existing reservoir is entirely on land owned by the Town of Nucla, but the enlarged reservoir would occupy a portion of the adjacent property to the east, owned by the U.S. Bureau of Land Management (BLM); and to the north, a privately owned parcel.

1.2 Proposed Dam and Reservoir Enlargement Project

The proposed enlargement project considered for the site includes a 50-foot high embankment dam across the ravine. A new 50-foot wide spillway would be built on the left abutment. The project entails removing approximately 300 feet of the left (northeast) side of the existing embankment dam and extending it approximately 800 feet to the east. The portion of the embankment that is removed will be stockpiled as borrow material, in conjunction with soil and shale material excavated from within the enlarged reservoir basin to build the larger dam. This would be a 122-acre-foot enlargement (90 percent), allowing a total storage of approximately

257 acre-feet. A total storage capacity of 300 acre-feet has been decreed as the Nucla Town Reservoir First Enlargement in Colorado Water Court Case No. 10CW164.

Additionally, the Nucla Pump Site will be rehabilitated to allow it to operate at full capacity. A new 100-foot long infiltration gallery along the San Miguel River would be plumbed into the existing gallery and into the existing wet well. The additional infiltration capacity is expected to provide higher flows into the wet well, thereby allowing both pumps to operate. Isolation valves would be installed on each line to allow operational flexibility and provide for a more efficient means of backflushing any accumulated sediment from the gallery.

1.3 Purpose and Work Completed

This report has been prepared to document Deere & Ault Consultants (D&A) 2016 feasibility investigations and analysis for Nucla Town Reservoir in Montrose County, Colorado. The field work and laboratory testing were completed in the fall of 2016. The scope of that work included:

1. Review of existing published data and site specific data
2. Topographic mapping and base map preparation
3. Engineering geologic mapping of the dam site and reservoir basin
4. Drilling foundation exploratory core borings and Packer permeability testing
5. Excavation of exploratory test pits in the reservoir basin to investigate for potential soil borrow
6. Laboratory testing of the soils and bedrock samples obtained from the exploratory borings and test pits

The data obtained from the field investigations at the Town Reservoir site and the laboratory testing were summarized and analyzed in 2016 and 2017. The scope of these studies included:

1. Engineering analysis of:

    a. Geologic and geotechnical conditions
    b. Stability and seepage
    c. Hydrologic and hydraulic conditions and requirements
    d. Dam layout, quantities and materials
    e. Feasibility costs

2. Preparation of this feasibility report summarizing the investigations, the data gathered, the various analysis completed, and our conclusions regarding the project technical feasibility and the project estimated feasibility level costs.

2.0 GEOLOGIC AND GEOTECHNICAL CONDITIONS

2.1 Geologic Setting

The reservoir site is near the eastern margin of the Canyon Lands Division of the Colorado Plateau Physiographic Province. The Canyon Lands Division is characterized by flat-topped mesas separated by rugged, steep sided canyons that have been cut by rivers. The site is also situated near the axis of the Nucla Syncline, a broad downwarp, or flexure in the sedimentary strata (**Figure 1**).

Based on published regional geology and our site specific mapping of the dam site and reservoir basin, the near surface bedrock at the site consists of beds of the Cretaceous Age Dakota Formation. This unit contains sandstone and shale strata deposited by mainly non-marine, fluvial (river deposited) processes. The Dakota Formation consists of gray and yellow-brown quartz sandstones with interbeds of gray to black carbonaceous shales and beds of impure coal. The sandstone beds are generally massive and moderately well cemented, although some units are thinly bedded and flaggy.

2.2 Site Geology

The engineering geologic mapping was started for the initial studies described in the report entitled, "*Facility Feasibility and Cost Estimates, Montrose County, Colorado, Case No. 10CW164, 10CW165, 10CW166, and 10CW167*," dated March 5, 2012. Additional geologic mapping was completed in 2016, focusing on the area subject to reservoir enlargement. This area encompasses the ravine situated to the east of the existing reservoir. The mapping work included field mapping and digital mapping using the Lidar survey and the orthophoto of the site.

The site is about two miles northeast of the northwest-trending axis of the Nucla Syncline, so the sedimentary beds at the site are generally very gently dipping to the south and southwest. Northeast of the site, the beds have been flexed upward by the Uncompahgre Uplift, resulting in the southwestward dip toward the syncline axis (**Figure 1**). Southwest of the site, the beds are warped upward in the Hamilton Creek Anticline and therefore dip northeastward toward the synclinal axis.

The bedrock exposures and outcrops along the ravine are relatively continuous. In general, the more resistant sandstone beds crop out as narrow ribs of rock and low cliff sections along the steeper slopes. Less resistant beds of shale, typically underlie the shallow soils between the sandstone outcrops. Between the sandstone rock outcrops, the shale beds are typically blanketed by thin colluvial soils which contain mainly pieces of sandstone colluvium, slope wash soils and residual soils. Two sandstone beds were observed outcropping in the ravine. The upper one is about 15 feet thick and the lower one is about five feet thick. Based on GPS positions on the upper outcrop, the approximate strike and dip of the strata is nearly flat, estimated to be striking North 84° East, and dipping 2° South. The approximate outcrop patterns are shown on the geologic map on **Figure 2** along with the conceptual reservoir enlargement. These outcrops extend beneath the proposed borrow area in the enlarged reservoir basin.

The local structure includes three sets of master joints. There appears to be two sets of near vertical joints at near right angles to each other. One set strikes roughly parallel to the ravine, and one strikes perpendicular to it. The other major joint set is the near horizontal bedding joints. Near vertical joints in the hard sandstone beds are sometimes open several inches. This is probably a stress relief phenomenon created by the erosion of the bedrock forming the steep ravine slopes, which allows the horizontal stresses to be relieved towards the ravine axis. Large blocks of the upper sandstone bed were observed to have slid on the underlying shale up to five feet towards the ravine axis. The spacing of the bedding joints ranges from widely jointed and near massive in some of the sandstone beds to closely jointed. Additionally, some of the shale beds have thin bedding laminations. The jointing combined with the bedding results in near rectangular blocks of sandstone talus in the colluvium, ranging from gravel to boulder size depending on the spacing of the joints and bedding where the talus originated.

2.3 Site Soils

Soils at the dam site and in the proposed enlarged reservoir basin are fairly sparse and locally thin. The main soil types onsite include fill materials and natural colluvial soils. These both consist primarily of sandy clays to clayey sands with gravel, cobble, and boulder size sandstone fragments. The colluvium also includes slope wash soils and residual soils, the latter of which results from the in-place weathering of the fine-grained shale beds. The colluvial soils occur in those areas shown on **Figure 2** that have not been mapped as either bedrock outcrop/subcrop or fill soils. A large stockpile of artificial fill soils is present onsite between the existing reservoir and the ravine.

3.0 SITE FIELD GEOTECHNICAL INVESTIGATIONS

3.1 General

The proposed reservoir enlargement plan, as well as a profile of the embankment maximum section, and an area/elevation/storage capacity curve for the reservoir basin are shown on **Figure 3**. The enlarged dam will have a maximum structural height of approximately 50 feet. The property boundaries at the reservoir site are also shown on **Figure 3**. The dam plan and longitudinal profile is presented on **Figure 4**. The plan shows the proposed infrastructure and the locations of our exploratory borings. The profile shows our interpretation of the subsurface geology and the estimated extent of a foundation cutoff key.

The project also includes improvements to the Nucla Pump Site adjacent to the San Miguel River. **Figure 5** is a plan showing the proposed improvements to the Nucla Pump Site and the location of two profiles, which show the proposed subsurface improvements on **Figure 6**. The improvements include an additional 12-inch diameter, 100-foot long slotted intake pipe bedded in filter gravel running along the river channel connecting to the existing infiltration gallery and wet well.

The site field investigations included an aerial survey and geotechnical investigations. On May 4th, 2016, an aerial survey was performed by Mapmart for the Nucla Town Reservoir site. The survey did not cover the Nucla Pump Site. The survey resulted in a topographic surface represented by 2-foot contours and a digital terrain model. Mapmart also provided a site-wide aerial orthophotograph with 6-inch pixel resolution. On-site surveying was performed by Mountain West Land Surveying in 2011 and by Delmont in 2016 to further develop the base map. On-site surveying included surveyed sections across the CC Ditch, shots on the diversion headgate and on the flume leading into the reservoir; and setting seven ground control panels prior to the aerial survey. The vertical datum for the project is NAVD 88 and the horizontal datum is NAD 83 Colorado State Plane South Coordinate System.

The geotechnical conditions at the dam site were investigated by drilling eleven exploratory borings and excavating six exploratory test pits at the site. Three deep borings (NR-5, NR-7 and NR-10) were drilled using HQ core methods to allow Packer permeability testing and monitoring well installation. Eight auger borings were drilled using 4.25-inch I.D. hollow-stem augers. The drill sites were accessed using an all-terrain track-mounted CME 850 drilling rig. Water for drilling was obtained from the reservoir. The deep borings were located along the proposed enlarged dam axis, and the auger borings and test pits were generally located in the proposed enlarged reservoir basin as shown on **Figure 3**. Additionally, two test pits were dug at the Nucla Pump Site. **Table 1** summarizes all the geotechnical investigations.

A geologic profile showing our interpretation of the geology and stratigraphy of the dam foundation is shown on **Figure 4**. It depicts a rough correlation of beds between borings and outcrops observed during geologic mapping of the ravine. By their very nature, fluvial sedimentary strata like the Dakota Formation are complexly interbedded and have numerous facies changes both vertically and horizontally. The Dakota Formation sandstones are frequently

interbedded with dark carbonaceous shales that make up about 50 percent of the Dakota stratigraphic section.

3.2 Exploratory Core Borings

The three core borings (NR-5, NR-7 and NR-10) were drilled along the proposed enlarged dam alignment to 40 to 44-feet deep. The core retrieved from borings was carefully logged as the drilling progressed. The core samples were placed in wooden boxes for long-term storage at the Montrose County Road and Bridge shops in Nucla. Detailed logs of the exploratory core borings are provided in **Appendix A**, and summary logs of the core borings are shown on **Figure 7**. Photographs of the core boxes are provided in **Appendix C**.

Dakota Formation sandstone bedrock was encountered at relatively shallow depths below the surficial soils and extended to the depth of the borings allowing observation of about 36 to 38 feet of the Dakota section per boring. The Dakota Formation beds consist of well cemented buff to gray sandstones interbedded with gray clay shales. The shales are locally black carbonaceous shales with thin zones of impure coal. A bentonitic ash bed was encountered in borings NR-5 and NR-7.

Packer permeability tests were completed as the drilling progressed to provide a measure of the permeability of the foundation bedrock. The calculated permeabilities ranged from very low, 0.10 feet/year (0.01 Lugeons) to low, 51 feet/year (5.1 Lugeons). The geometric mean for the Packer Tests is 2.9 feet/year (0.3 Lugeons), which is a low value of permeability, indicating good rock mass that may only require local grouting. Because permeability exhibits a log-normal distribution, the geometric mean is the appropriate method to use to obtain an average value. The Packer test results are summarized on **Table 3** and **Figure 7**, and details of the individual tests are provided in **Appendix E**. Histograms of the Packer tests performed in the Dakota Formation are presented with **Table 3**. These histograms show that the Dakota Formation at this site is generally characterized by a low permeability, with all eight tests resulting in permeability values less than 10 Lugeons.

Groundwater monitoring wells were installed in each of the three cored borings. The wells are open standpipe piezometers consisting of two-inch diameter, Schedule 40 PVC with 20-foot screened sections. The well screen intervals are shown on **Figure 7** along with measured groundwater pressures. The groundwater levels in NR-5 and NR-7 are relatively shallow, at about 4 feet and 8 feet deep, respectively. The groundwater level in NR-10 was measured at about 34.5 feet deep. The monitoring well permits and construction reports submitted to the State Engineer's Office (SEO) are included in **Appendix F**.

3.3 Exploratory Auger Borings and Test Pits

The main purpose for the eight auger borings and six test pits was to explore for potential soil borrow for the enlarged dam embankment. Each auger boring and test pit was logged and samples were collected for laboratory testing of the potential borrow soils. The results of the laboratory tests are shown on **Table 2**, and in **Appendix B**. The feasibility level investigations concluded that a zoned embankment dam appeared to be most suitable for the geotechnical

conditions at the site. The existing dam is a homogeneous compacted clay embankment dam, and because part of it will need to be removed, its soils were targeted for borrow. The area east of the existing reservoir has been used to stockpile fill materials, so these materials were also investigated as sources of borrow for the enlarged dam.

The auger borings were drilled using hollow stem, or solid stem auger methods. The summary logs of the auger borings are included on **Figure 8**. Each auger boring was drilled two samples into bedrock or to refusal, which commonly occurred on a massive sandstone bed. Borings NR-4 and NR-6 were drilled into the engineered dam fill. All other borings encountered fill materials overlying Dakota bedrock units. Dakota bedrock was encountered in each boring, ranging from 16 to 35.5 feet deep under the dam, and 4.5 to 14 feet deep elsewhere. Boring NR-8 encountered 14 feet of fill in the stockpile onsite. Groundwater was only encountered by observing wet soils in the drive samples in the dam borings. All other borings were dry. Samples from borings NR-6 and NR-8 were used to characterize the onsite soils.

All the test pits were excavated on October 24, 2016 using a track-mounted excavator. The test pits were carefully logged as they were excavated and samples of the various soils and bedrock encountered were taken for laboratory testing. Logs of the test pits are shown on **Figure 9**, and photographs of the test pits are provided in **Appendix D**. Of the six exploratory test pits (TP-1 through TP-6) excavated at the reservoir site, four were located in the proposed enlarged reservoir basin where fine-grained soils appeared to be present (see **Figure 3**). The other two pits (TP-7 and TP-8) were excavated at the Nucla Pump Site (see **Figure 5**). Groundwater was not encountered in the test pits at the reservoir site. Four of the test pits encountered bedrock at relatively shallow depths of less than five feet; and three met refusal on sandstone. TP-4 was excavated in the fill stockpile and encountered bedrock at a depth of 11 feet. Test pits TP-7 and TP-8, excavated at the Nucla Pump Site, encountered relatively clean, saturated alluvial sand and gravel deposits at a depth of four feet, but did not encounter bedrock.

4.0 LABORATORY TESTING

4.1 General

Samples of soil from the exploratory borings and the test pits were tested in the laboratory for various physical and engineering properties. **Table 2** provides a summary of the laboratory test results and details of the laboratory test results are provided in **Appendix B**.

4.2 Soils

The soils at the dam site were tested for particle size distribution (gradation and hydrometer), Atterberg Limits, Standard Proctor moisture/density relationships, remolded consolidation properties, dispersity, water soluble sulfates, and electrical resistivity. Samples from the pump site borings were only tested for gradation. Since bedrock is so shallow in test pits TP-5 and TP-6, borrowing soils for dam construction from the areas represented by these test pits is probably not practical.

The fill materials found in borings NR-6 and NR-8, and in test pit TP-3 appear promising as sources for fine grained borrow. Additionally, the shale tested in TP-2 also appears to be suitable for fine grained borrow. The soils from these test pits classify mainly as lean sandy clays or lean clay (**Table 2**). The silt and clay content (-200) of tested samples ranged from 57 to 79 percent. The Plasticity Indices range from 11 to 22. The soils exhibit low swelling characteristics, and are non-dispersive (ND-1). In general, the soil properties indicate the borrow materials have properties suitable for a Zone 1 low permeability zone in an embankment dam. Standard Proctor tests indicate the optimum moisture content is of the order of 13 to 15 percent and the maximum dry density of 112 to 115 pounds per cubic foot (pcf).

The gradation tests of the alluvium at the Nucla Pump Site suggest that the fines content (-200) is between 2 and 10 percent, while the gravel fraction is on the order of 60 to 70 percent. Based on the Unified Soils Classification System, these soils classify as well-graded gravel (GW) or well-graded gravel with silt (GW-GM).

4.3 Bedrock Core

The Dakota bedrock core sampled at the Town Reservoir site was not tested for physical or engineering properties. Instead, we referred to our testing of the Dakota bedrock units encountered at the Maverick Draw Reservoir No. 1 dam site. The sandstone strata there are suitable as rockfill embankment material. Based on our observation of the sandstone at both sites, there appears to be no significant difference in character. For Maverick No. 1, samples of bedrock core were tested for moisture content, dry density, gradation and Atterberg Limits of the shale samples, Unconfined Compressive Strength, Modulus of Deformation, and Brazilian Indirect Tensile Strength. Unconfined Compressive Strength values for the sandstones averaged about 10,000 psi, indicating that the sandstones are typically moderate strength rock. The Brazilian Tensile Strength for the sandstone ranged from 157 psi to 454 psi, and the Modulus of Deformation for the sandstone ranged from 1.1×10^6 psi to 5.8×10^6 psi. Therefore, the onsite sandstone appears suitable as rockfill shells for the enlarged Town Reservoir concept.

5.0 HYDROGEOLOGY

Groundwater levels were measured in each boring during drilling and then in the three wells in December 2016. These water levels are shown on the summary logs (**Figures 7-9**). Shallow groundwater was measured in boring NR-5 at four feet deep and in NR-7 at eight feet deep. The groundwater level measured in well NR-10 was 34.5 feet deep. All of these water levels are within the Dakota bedrock.

The geologic profile on **Figure 4** shows our interpretation of the groundwater table. There appears to be a shallow bedrock water table that is in hydraulic connection with the existing reservoir and the wetlands in the ravine. This aquifer exists within the fractures and pore space in the Dakota Formation, and is likely tributary to the alluvial aquifer of the San Miguel River. The bedrock aquifer is recharged by precipitation, reservoir seepage and ditch leakage. The lower permeability shale layers in the Dakota Formation likely restrict the flow of groundwater. While the groundwater appears to drain into the ravine, the lack of a live stream in the bottom of the ravine suggests the aquifer may be a perched system.

6.0 SEISMICITY

6.1 General

Colorado has had a relatively quiet recorded seismic history and is generally not considered to be very seismically active. However, earthquakes do occur in Colorado, and the historical record is too short to be considered an accurate prediction of the potential for future seismic activity.

The state has been divided into seven seismic tectonic providences based on structure, fault characteristics, historical earthquakes, and interpreted earthquake potential. The Colorado Plateau Physiographic Province where the site is located roughly corresponds with the Colorado Plateau Seismotectonic Province. Except for the Uncompahgre Uplift north and of the site, the province appears to be fairly tectonically stable (Kirkham and Rogers, 1981). Faults that are considered to have had a recent activity are relatively rare in this province. The Uncompahgre Uplift, however, has been interpreted to have been recurrently active and has evidence of recent activity.

A series of faults associated with collapsed salt anticlines in the Paradox Basin west of the site also show evidence of considerable recent movement. However, because they are non-tectonic in origin, renewed movement on these faults is judged to be unlikely to generate major earthquakes. General estimates for the Maximum Credible Earthquake for the Colorado Plateau Seismic Tectonic Province range from magnitude 5.5 to 6.5.

6.2 Earthquake History and Potentially Active Faults

In order to better define the seismotectonic conditions that need to be considered for the Town Reservoir Enlargement project, we prepared **Figure 10** showing recorded and reported earthquake epicenters and faults considered potentially active within a radius of 200 miles. The nearest tectonic related faults considered potentially active are northeast of the site, associated with the Uncompahgre Uplift.

The results of a historical earthquake search using the U.S. Geological Survey's Earthquake Search database (USGS, 2016) and the Colorado Geological Survey's Late Cenezoic earthquake database, which includes earthquake epicenters with MM intensity ratings, show that 1,031 earthquakes have occurred within a 200-mile radius of the reservoir site between May 12, 1882 and November 11, 2016. These include 959 earthquakes with published magnitudes greater than 2.0 and 72 earthquakes with MM Intensities between F (felt) and VI. The earthquakes with published magnitudes ranged from 2.0 to 5.5, with a mean magnitude of 2.8.

According to the earthquake database, the nearest major earthquake to the reservoir site, was also the largest: a magnitude 5.5 event that occurred on October 11, 1960. This earthquake was located by seismographs about 44 miles east of the site near the Uncompahgre River valley (**Figure 11)**. It was felt across west-central Colorado, including in the towns of Montrose, Ridgeway, Telluride, Ouray and Placerville, causing intensity VI effects (Kirkham and Rogers, 2000). In this same area, four earthquakes with M>4 occurred in the mid- to late-1960s and two occurred in 1994. The most recent earthquake within 50 miles of the site had a magnitude of 2.6

and occurred on November 11, 2016 about 45 miles northeast of the site near the Red Rocks and Cimmaron faults. Additionally, in 2013 four earthquakes occurred exhibiting magnitudes of 2.7 and 2.9 near the epicenter of the large 1960 event.

The Late Cenezoic Fault and Fold Database (Widmann et al., 2003), documents faults in Colorado that have experienced movement since the Miocene Epoch (approximately 23.7 million years ago). These data were used to show that about 42 faults are present within 50 miles of the project area that are considered potentially active. These faults are shown along with the near field earthquake epicenters on **Figure 11**. The nearest potentially active faults include the Paradox Valley graben, located about six miles west of the site; unnamed faults along the margins of the Uncompahgre Uplift, roughly seven to ten miles east of the site. The seven aforementioned earthquakes near the Uncompahgre River valley with magnitudes greater than 4.0 are in close proximity to the Ridgway fault and the Busted Boiler fault, which have been studied in detail, and may be considered to be the nearest capable faults.

6.3 Feasibility Level Seismic Analysis

The SEO Dam Safety Rules and Regulations have requirements for the seismic stability design analysis for dams. The requirements are based, in part, on the hazard classification of the dam. A hazard classification study has not been completed for the proposed enlarged dam at the Town Reservoir site. However, a 50-foot high dam at this site would likely be classified as High Hazard.

For a High Hazard dam with a height greater than 30 feet, the Rules and Regulations require the dam has a Factor of Safety greater than the following:

Loading Conditions	Calculated Factor of Safety
Full Reservoir, Steady State Seepage	1.5
Full Reservoir with Design Earthquake	1.0
End of Construction	1.3
Rapid Drawdown	1.2

For the feasibility analysis, the site was analyzed for the earthquake with a 5,000-year return frequency (1 percent chance in 50 years, or an annual probability equal to 2.0×10^{-4}) using the USGS calculation for Probabilistic Hazard Curves based on 2002 earthquake data. Based on these calculations, the design earthquake should be based on a horizontal acceleration of 0.21 G. This number should be used for evaluating the dam stability. Additional data on the site seismicity are provided in **Appendix F**.

7.0 ANALYSIS

7.1 Proposed Dam and Ancillary Facilities

As concluded in the initial analysis of the dam site, we found no conditions that would render construction of an enlarged dam and reservoir at the Town Reservoir site technically infeasible. The information collected from the 2016 field investigations support the conclusion that a zoned earthfill embankment dam is the most suitable dam type for the site conditions. This is because of the limited quantities of fine grained borrow available for use as a low permeability core, and the presence of sandstone in the enlarged reservoir basin that can be used for rockfill shell material.

The general footprint of a zone earthfill dam at the site required to impound a reservoir of approximately 257 acre-feet is shown on **Figure 3** along with a conceptual maximum dam embankment section showing probable embankment zoning, the site topography and normal water line, and the area/elevation/capacity curves for the reservoir. The main dam embankment will be approximately 50 feet high with a crest elevation of 5940 feet. The normal water line for the reservoir will be 5935 feet with the dam embankment providing five feet of freeboard. A water surface limiting spillway will be provided on the left abutment of the enlarged dam. The spillway will have a 50-foot wide concrete crest and will discharge into the tributary gulch downstream of the abutment. Approximately 1,050 feet of the existing eight-inch intake pipeline, encased in a 12-inch steel pipe, from the Nucla Pump Site will be replaced with a roughly 470-foot realigned pipeline.

The entire dam foundation will be stripped to sound bedrock. The dam embankment will have a relatively simple zonation as shown on **Figure 3**. A minimum five-foot deep cutoff key will be excavated into sound bedrock along the dam centerline. Zone 1 will consist of low permeability clayey materials borrowed from the enlarged reservoir basin. These materials will be the water barrier for the dam. They would be compacted to 95 percent of Proctor in six- to eight-inch lifts. The outside slopes of the core will be 0.5:1 (horizontal to vertical). The embankment shells will be Zone 2 rockfill material, consisting of quarried sandstone. Zone 3 will be a two-foot thick transition zone consisting of granular material. Zone 3 will act as a filter between Zone 1 and Zone 2 to prevent piping (internal erosion) of the fine-grained soils out of the core and through the voids in the rockfill.

7.2 Spillway Analysis

The spillway has been sized based on the basin hydrology by analyzing both the general and local PMP storms assuming the reservoir is full to the normal water line at elevation 5935 feet. Based on these analyses, the local storm controls the spillway design. We have assumed the spillway will be designed as a 50-foot bottom width reinforced concrete, trapezoidal broad crested weir founded on the bedrock on the left (east) dam abutment. The side slopes of the spillway will be 3:1 (horizontal to vertical). The local PMP storm was calculated to result in peak inflows to the reservoir of about 1,400 cfs and to result in a peak discharge through the spillway of 1,000 cfs. This storm will result in a spillway surcharge of nearly 4 feet at elevation

5938.9 feet. With the dam crest at elevation 5940 feet, this will result in at least one-foot of residual freeboard on the dam during the local PMP storm.

These local storms have a short duration. However, the shape and size of the reservoir does not significantly attenuate the flows. The local storm events result in high, but short-term, peak spillway flows.

The general PMP storm analysis resulted in a lower peak inflow to the reservoir of about 300 cfs and a spillway discharge of 180 cfs. The maximum water surface for the general PMP storm was calculated to be 5936.5, which results in 3.5 feet of residual freeboard.

7.3 Outlet Works Hydraulic Analysis

The SEO requires dam outlet works to be capable of discharging reservoir water at a rate that will lower the reservoir level from normal water line five vertical feet in five days. The existing outlet works installed in 2007 will remain in place following reservoir enlargement. The existing outlet works consists of an eight-inch diameter HDPE pipe inside a 12-inch diameter corrugated steel pipe (CSP). There are three outlet gates: a low level gate at elevation 5910, a secondary gate at elevation 5916.5, and a tertiary gate at elevation 5925.5. The outlet gates are controlled from the top of the dam. Flow is metered into the treatment plant.

With the enlarged normal water line reservoir pool at elevation 5935 feet, the maximum discharge through the conduit is calculated to be 5.6 cfs. The calculated discharge with the reservoir drawn down five feet to elevation 5930, is 5.2 cfs. The analysis indicates that using the existing outlet works, the reservoir can be drawn down five feet in about 6.4 days, which does not meet the required SEO design criteria. To achieve the SEO threshold, a flow of about 7 cfs is needed. This can be achieved if the 8-inch outlet pipe is replaced with a 10-inch pipe. To replace the outlet works would require removing nearly the entire existing dam during reservoir enlargement construction. Alternatively, a waiver could possibly be obtained from the SEO to allow the five-foot drawdown to occur in 6.4 days rather than five. This would allow the existing outlet works to be left in place. In our opinion, the likelihood of receiving a waiver is high: therefore, for the feasibility analysis, costs for replacing the outlet works are not included. However, costs have been included for modifying the gate operator stems to accommodate the higher dam crest.

7.4 Embankment and Foundation

7.4.1 General

There are three main properties that impact the engineering suitability of a dam foundation. These are strength, deformability, and permeability. The entire embankment foundation will be stripped down to unweathered bedrock, so the bedrock properties are the focus for the dam feasibility.

7.4.2 Foundation Bedrock Strength

Embankment dams by their very nature induce relatively low foundation loads. For this proposed dam, approximately 50 feet high, we estimate the maximum foundation loads will be around 6,000 psf, or 42 psi. The weakest sample of Dakota bedrock tested for the feasibility studies at the Maverick Draw No. 1 site had an Unconfined Compressive Strength of more than 1,500 psi. Extrapolating that data to the Town Reservoir site, the sedimentary sandstone and shale beds that form the dam foundation will have more than adequate strength to support the proposed zoned earthfill embankment dam.

7.4.3 Foundation Bedrock Deformability

The estimated maximum embankment loads are approximately 6,000 psf, or 42 psi. The minimum Deformation Modulus of the bedrock core tested in the laboratory from the Maverick No. 1 site was 1.1×10^6 psi. Since the Deformation Modulus represents the slope of the stress versus strain plot for the bedrock, the maximum embankment load will result in very minor deformation in the bedrock foundation, most likely too small to be measured accurately. The deformation should occur mainly as elastic deformation that will occur as the embankment is constructed.

7.4.4 Permeability

The permeability of the dam foundation appears to be a minor concern for this dam and reservoir. Field Packer permeability testing in the abutment core borings indicated a relatively narrow range of bedrock permeabilities, ranging from low to very low. In general, the Dakota Formation beds in borings NR-7 and NR-10 have slightly higher permeabilities, averaging about three Lugeons, compared to an average of about one Lugeon in boring NR-5 (**Table 3**). One Lugeon is equal to 10 feet per year.

One potential concern for the reservoir enlargement is that the groundwater elevation on the left abutment (well NR-10) is deep. As shown on the geologic profile on **Figure 4**, it still appears to be higher than the level of the wetlands in the bottom of the ravine. This suggests that the groundwater is discharging from the left abutment into the ravine. However, the ultimate groundwater discharge point is the San Miguel River, which is about 340 feet lower in elevation. The groundwater regime at the Town Reservoir site may therefore represent a perched system above a more regional groundwater level.

The slightly higher permeabilities measured in borings NR-7 and NR-10, the deep groundwater level measured in NR-10, and the stress relief observed at the ravine suggest that local grouting may be necessary in the sandstone beds forming the foundation of the enlarged dam, especially on the left abutment.

We completed a seepage analysis at the dam site using the average values from the abutment boring Packer tests to estimate bedrock permeability. For the rock in the foundation, we used a permeability value of 2.9×10^{-6} cm/second (0.3 Lugeons), which is the geometric mean for all of

the data (**Table 3**). Additionally, typical permeability values were input for the zoned earth materials in the dam as summarized below:

Material	Permeability K (cm/s)
Zone 1	1E-06
Zone 2	1
Zone 3	1E-01
Foundation Bedrock	2.9E-06

The relatively low value of bedrock permeability appears to limit seepage for the enlarged dam to approximately 2.4 gpm, or 3.9 acre-feet per year. This equates to 1.5 percent of the proposed storage.

We did not simulate a grout curtain in our seepage analysis because bedrock permeabilities of this magnitude appear sufficiently low enough to mitigate reservoir seepage with a cutoff key. However, prior to design, additional investigations should be performed to confirm the permeability values, especially near the ravine where open fractures are more likely to exist in the foundation.

7.4.5 Dam Embankment Stability

Properly designed and constructed, zoned earth embankment dams typically hold excess pore water in the low permeability Zone 1 material. This water needs to be drained from the downstream slope to ensure dam stability. Draining is typically accomplished using sand drains, filter zones and permeable shells. The downstream Zone 2 rockfill shell for the Town Reservoir enlargement should freely drain seepage through the Zone 1 and Zone 3 materials, keeping the phreatic level in the downstream embankment relatively low.

Additionally, rockfill is generally strong and will have a relatively high friction angle, in the range of 40 to 45 degrees, which typically allows relatively steep embankment slopes. However, for a safer zoned earthfill dam, our preliminary design calls for both upstream and downstream slopes of 3:1 (horizontal to vertical). The flatter slopes also take into account the potential variability of the quality of the sandstone beds. We expect there will be a considerable amount of breakdown during compaction of the weaker sandstone beds.

We completed a preliminary stability analysis of the dam embankment using the limit equilibrium finite element program SlopeW. The analysis assumed an embankment phreatic surface developed with the SeepW seepage analysis. We also used typical Zone 1 and rockfill unit weights and strengths. The unit weights and strength parameters used in the slope stability analysis for the embankment zones shown on **Figure 1** are summarized below:

Embankment Zone and Foundation	Unit Weight γ (pcf)	Effective Cohesion C' (psf)	Effective Friction Angle Φ' (degrees)
1	γ_{SAT} = 113	0	24
2	γ_{M} = 143	0	45
3	γ_{M} = 115	0	34
Foundation Bedrock	γ_{M} = 145	2,000	36

The analysis considered the following scenarios:

1) Downstream slope stability for a full reservoir with steady state seepage.
2) Downstream slope stability for a full reservoir with steady state seepage and the design earthquake.
3) Upstream slope stability for rapid drawdown of the reservoir.

The factors of safety calculated for the cases are summarized below:

Condition	Calculated Factor of Safety	
	Upstream Slope	Downstream Slope
Full Reservoir, Steady State Seepage	3.11	2.91
Full Reservoir, Steady State Seepage with Design Earthquake Loading of 0.21 G	1.69	1.82
Rapid Drawdown, Upstream	1.72	

The stability model results for these four conditions are included in **Appendix H**. In our opinion, these analyses demonstrate that a properly designed zoned earth/rockfill embankment dam should have a suitable factor of safety for anticipated loading conditions.

7.4.6 Borrow Materials

The feasibility level drilling and mapping indicates that the quantities of fine grained clayey borrow soils at the site are limited. Our laboratory testing program indicates that the existing dam embankment, the stockpiled fill soils and the Dakota shale beds will make suitable Zone 1 borrow. All of these materials classify either as lean sandy clays or lean clays (CL). The average Proctor values of maximum dry density and optimum moisture content for these soils are 113 pcf and 13.9 percent, respectively.

Borrowing from the Dakota Formation will be necessary to provide both Zone 1 and Zone 2 materials. The sandstone beds can be quarried for suitable Zone 2 rockfill, and the interbedded shale layers can be used for Zone 1 material. The Zone 2 shell material can accommodate the lower quality materials. Selective quarrying processes will add costs to the embankment construction.

Figure 3 shows a cut to elevation 5910 within the existing and enlarged reservoir basins that will supply the borrow material. Using this geometry, we estimated the various quantities of material that the cut in the reservoir basin will generate. Our analysis indicates that the cut will yield a total of about 30,000 cubic yards (yards) of Zone 1 materials and about 85,000 yards of Zone 2 rockfill. Approximately half of the sandstone to be used as Zone 2 material will come from the existing reservoir basin, and half will come from the enlarged reservoir basin. Based on our initial volume estimates the borrow volume is approximately sufficient for the dam construction. We estimate the enlarged dam will need about 27,000 yards of Zone 1 material and 75,000 yards of Zone 2 material. Additionally, we estimate that the dam will need about 4,000 yards of Zone 3 filter material. During the design phase, filter compatibility calculations should be performed

to design the gradation of the granular Zone 3 material. This material will likely have to be imported.

For design level investigations, several core borings should be completed in the proposed borrow area of the enlarged basin, and detailed analysis of quarry design and operation planned. In our opinion, suitable rockfill is likely onsite. The efficiency of the quarry operation, could have significant cost impacts on constructing an enlarged Town Reservoir.

7.5 Nucla Pump Site

The Nucla Pump Site was built in its current configuration about 10 years ago. It is designed to pump 1200 gpm to the Town Reservoir. There are two 600 gpm line-shaft turbine pumps with 125 horsepower motors. The pumps each have seven-inch, 11-stage shafts to lift the water from a wet well. The wet well consists of a 10-foot diameter corrugated metal pipe sunk approximately 18 feet deep. The existing infiltration gallery is about 15 feet deep and runs from the wet well straight out into the San Miguel River. The pipe diameter and length and type of perforations in the pipe are unknown. The pump station is typically operated once a year for about 30 days using just one of the pumps. This pump can generally operate approximately six hours at a time before the wet well is emptied. Additionally, when the river is carrying a high sediment load, the gallery must be backflushed after about 30 minutes of pumping.

The current pump station operation indicates that the existing infiltration gallery does not supply sufficient water to the wet well. This is likely because the length of the perforated pipe is insufficient and/or the perforations are plugged. The fact that the system must be flushed when the river carries a high sediment load suggests that the water is not sufficiently filtered before entering the pipe.

The conceptual design for improving the capacity of the Nucla Pump Site includes the installation of an additional 100-foot long infiltration gallery (see **Figures 5** and **6**). The new gallery would be installed parallel to the San Miguel River and about 20 to 25 feet away. The gallery would consist of a 40-foot and a 60-foot length of 12-inch diameter slotted pipe bedded in a filter pack. Based on the gradations performed on samples of alluvium from TP-7 and TP-8, normalized to the #4 sieve, the pipe would have 0.080-inch perforations, and would be bedded in a filter pack consisting of 8/12 sand. The extra capacity from the expanded gallery should allow the wet well to fill faster, which would allow higher pumping rates. The new gallery would be plumbed into the existing gallery, and isolation valves would be installed on each of the three intakes. This would allow the old gallery to be shut off during times when the sediment load is high in the river. Similarly, if the system needed to be backflushed, each line could be isolated and individually backflushed allowing more efficient sediment removal.

7.6 Land and Environmental Considerations

The reservoir enlargement would require acquisition of, or an easement through the parcel of BLM land to the east. A land exchange would necessitate environmental and cultural resources studies on the BLM parcel. Because the end project is a reservoir, the BLM would likely consider the project a connected action, thereby requiring the same studies on Town land. In

anticipation of these conditions, environmental and cultural studies should be performed during the design phase.

During our geologic reconnaissance, we observed several areas of potential wetlands in the bottom of the ravine. These wetlands appear to be isolated from the San Miguel River because there isn't a live stream in the ravine. Dam construction across the ravine would eliminate these wetlands. For the project to be feasible, the potential wetlands would need to be determined to be non-jurisdictional by the U.S. Army Corps of Engineers. A Natural Resources Assessment would identify these potential wetlands, and inform a request for non-jurisdictional determination by the Corps. If a non-jurisdictional determination is made, such a determination is effective for five years before expiring. If a jurisdictional determination is made, a Section 404 permit from the Corps would be required for the project.

8.0 COST ANALYSIS

A cost analysis was originally completed as part of the 2012 feasibility studies for the Montrose County alternative reservoir sites. Those analyses indicated that a 165-acre-foot enlargement for the Nucla Town Reservoir site would have a cost estimated to be approximately $1,800,000. We have updated those costs based on information from the 2016 field investigations and analysis, site specific topography, more accurate volume estimates, and changes in construction cost since 2012.

Based upon the adjustments described above, we estimate that the enlargement project would allow an additional 122 acre-feet of storage at the Nucla Town Reservoir site at a cost of approximately $3,300,000. This amounts to $27,000 per acre-foot of additional storage. The estimated costs are summarized on **Table 4**. Water delivery infrastructure, including modification of the Nucla pump station will cost an estimated $130,000 bringing the total project cost to approximately $3,430,000.

The individual estimated costs that we have increased significantly include the embankment cost because of the necessity to build a zoned earth dam rather than a homogeneous dam. Additionally, the estimated Zone 1 unit cost has doubled since 2012 based on increased construction costs in the last five years, the limited quantity of suitable onsite material, and extra processing required. The volumes have been adjusted based on the new topographic mapping and change in the feasibility level design.

A cost savings could potentially be realized during the design phase if the dam can be built at 2:1 (horizontal to vertical) slopes considering the higher strength rockfill shells. This would result in a smaller dam due to the decrease in the requisite volume of rockfill material.

9.0 SUMMARY AND CONCLUSIONS

After the completion of the 2016 feasibility level field investigations and our engineering analysis we have the following conclusions:

1. Design and construction of an enlarged dam and reservoir designed to store an additional 122 acre-feet of water at the Nucla Town Reservoir site is technically feasible.

2. The major technical challenges at the site are:

    a. The available quantity of onsite borrow materials. Typically, borrow sources are designed to yield 1.5 to 2 times the volume required for dam construction. This conceptual design indicates a roughly balanced cut-fill project.

    b. The necessity to process sandstone and shale at the site for borrow will require the quarry operation to be selective, which could result in the generation of waste materials unsuitable for dam embankment construction.

    While these two items will not render the project technically infeasible, they could have a significant impact on project costs.

3. Based on the results of these feasibility level studies, we estimate a 122-acre-foot enlargement of the Nucla Town Reservoir, will cost approximately $3,300,000, or $27,000 per acre-foot of additional storage. This assumes that the State Engineer's Office will allow a waiver for the existing outlet works capacity.

4. Water delivery for the enlargement is available from the CC Ditch and from the Nucla Pump Site. The yield of the Nucla Pump Site can likely be improved by installing a 100-foot long infiltration gallery along the San Miguel River.

5. The modification to the Nucla Pump Site costs approximately $130,000, bringing the overall total project cost to $3,430,000.

6. Design level investigations should focus on investigating the quantity and suitability of potential borrow materials for project construction, and on additional investigations of the stability of cut slopes in the reservoir basin. The embankment design should also be further refined to make the most efficient use of the on-site construction materials (soil and bedrock).

7. An easement, or land exchange with the BLM for the eastern part of the enlargement will be required to pursue reservoir enlargement.

8. Environmental studies need to be performed as part of the permitting process for the enlargement, including a likely request to the U.S. Army Corps of Engineers for non-jurisdictional determination for the wetlands in the ravine.

10.0 REFERENCES

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TABLES

TABLE 1

GEOTECHNICAL EXPLORATION SUMMARY

NUCLA TOWN RESERVOIR ENLARGEMENT

Name	Location	Coordinates (NAD83 Colorado State Plane South Coordinate System)		Ground Surface Elevation (feet)	Exploration Type(s)	Exploration Depth (feet)	Bedrock Depth (feet)	Groundwater Depth (feet)	Dates of Exploration
		Northing (feet)	Easting (feet)						
NR-1	Dam Foundation	1,593,023	2,136,111	5940.4	Auger Boring	16.5	8.0	Not Encountered	October 25 - 29, 2016
NR-2	Dam Foundation	1,592,886	2,136,148	5935.6	Auger Boring	17.3	8.0	15.1	October 25 - 29, 2016
NR-3	Dam Foundation	1,592,737	2,136,308	5920.8	Auger Boring	16.3	4.5	Not Encountered	October 25 - 29, 2016
NR-4	Dam Crest	1,592,854	2,136,585	5939.4	Auger Boring	40.0	35.5	29.0	October 25 - 29, 2016
NR-5	Dam Foundation	1,592,774	2,136,644	5903.6	HQ Core Boring, Packer, Piezometer	44.0	7.0	4.1	October 25 - 29, 2016
NR-6	Dam Crest	1,592,995	2,136,866	5938.0	Auger Boring	25.5	16.0	Not Encountered	October 25 - 29, 2016
NR-7	Dam Foundation	1,592,852	2,137,000	5914.4	HQ Core Boring, Packer, Piezometer	40.0	3.6	7.0	October 25 - 29, 2016
NR-8	Reservoir Basin	1,593,008	2,137,194	5936.9	Auger Boring	16.0	14.0	Not Encountered	October 25 - 29, 2016
NR-9	Dam Foundation	1,592,796	2,137,215	5917.6	Auger Boring	15.8	5.0	Not Encountered	October 25 - 29, 2016
NR-10	Dam Foundation	1,592,914	2,137,544	5942.8	HQ Core Boring, Packer, Piezometer	40.0	2.0	34.4	October 25 - 29, 2016
NR-11	Spillway	1,592,821	2,137,618	5943.2	Auger Boring	7.1	4.5	Not Encountered	October 25 - 29, 2016
TP-1	Reservoir Basin	1,593,149	2,137,017	5933.7	Test Pit	6.0	4.0	Not Encountered	October 24, 2016
TP-2	Reservoir Basin	1,593,126	2,137,137	5933.6	Test Pit	5.0	3.0	Not Encountered	October 24, 2016
TP-3	Reservoir Basin	1,592,967	2,137,208	5938.7	Test Pit	7.5	Not Encountered	Not Encountered	October 24, 2016
TP-4	Reservoir Basin	1,593,068	2,137,237	5938.5	Test Pit	11.5	11.0	Not Encountered	October 24, 2016
TP-5	Reservoir Basin	1,592,768	2,137,132	5911.0	Test Pit	1.5	1.0	Not Encountered	October 24, 2016
TP-6	Reservoir Basin	1,592,609	2,137,132	5911.0	Test Pit	2.0	1.0	Not Encountered	October 24, 2016
TP-7	Nucla Pump Site	1,588,428	2,137,074	5568.9	Test Pit	6.0	18.0	4.0	October 24, 2016
TP-8	Nucla Pump Site	1,588,394	2,137,133	5566.6	Test Pit	6.5	18.0	4.0	October 24, 2016

Table 2 - Lab Test Results
Nucla Town Reservoir
Job No. 0410.004.00

DEERE & AULT CONSULTANTS, INC.

Sample Location		Sample Collected	Field Classification	Natural Moisture Content (ASTM D 2216) (%)	Natural Dry Density (ASTM D 2166) (pcf)	Gradation (ASTM D 422)		Hydrometer (ASTM D 422)		Percent Passing No. 200 Sieve (ASTM D 1140)	Atterberg Limits (ASTM D 4318)		Standard Proctor Method C (ASTM D 698)		Swell/Settlement Consolidation (ASTM D 4546) @ 1.0 KSF (%) (-Value = Consol)	Pin Hole Dispersivity (ASTM D 4647)	Unified Soil Classification (Symbol)
Hole	Depth (ft)					Gravel (%)	Sand (%)	Silt (%)	Clay (%)		Liquid Limit (%)	Plasticity Index (%)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)			
NR-6	0-5	Bulk	Dam Fill - Clay			6	32			62	29	17	12.7	114.8			Lean sandy clay (CL)
	5-6	California	Dam Fill - Clay	12.6	109.2			44	15	59	37	22			0.0	ND-1	Lean sandy clay (CL)
	10-11	Bag	Dam Fill - Clay							69	32	16					Lean sandy clay (CL)
	15-16	California	Dam Fill - Clay	18.9	106.0					73	29	14					Lean clay (CL)
NR-8	4	California	Fill - Clay	9.1	104.7	5	27	42	25	67	27	11			1.8	ND-1	Lean sandy clay (CL)
	9	California	Fill - Clay	12.3	112.6	7	25			68	36	18					Lean sandy clay (CL)
TP-2	3.5-5	Bulk	Kd - Shale			10	11			79	35	16	15.0	111.8			Lean clay (CL)
TP-3	3-7	Bulk	Fill - Clay			22	21			57	29	13	14.1	112.3			Lean gravelly clay (CL)
TP-7	3-4.5	Bulk	Sand & Gravel			63	27			10							Well graded gravel with silt (GW-GM)
TP-8	5-6.5	Bulk	Sand & Gravel			70	28			2							Well graded gravel (GW)

Table 3
Packer Test Summary Table
Nucla Town Reservoir
Job No. 0410.004.00

Boring	Test Number	Depth Interval (feet)			Geologic Formation†	Average Permeability Data (K)			Average Lugeons
						ft/year	cm/sec	Lugeons	
NR-5	1	9.0	-	19.0	Kd	20.5	2.0E-05	2.1	0.7
	2*	19.0	-	29.0	Kd	0.1	1.0E-07	0.01	
	3*	29.0	-	44.0	Kd	0.1	1.0E-07	0.01	
NR-7	1	9.0	-	20.0	Kd	3.5	3.3E-06	0.3	2.9
	2	20.0	-	30.0	Kd	31.4	3.0E-05	3.1	
	3	30.0	-	40.0	Kd	50.7	4.9E-05	5.1	
NR-10	1*	11.0	-	19.0	Kd	0.1	1.0E-07	0.01	2.5
	2	20.0	-	40.0	Kd	50.2	4.8E-05	5.0	
					Geometric Mean =	2.9	2.9E-06	0.3	

Notes: †Kd - Dakota Formation

*K is too low to measure, therefore assumed to be 1.0E-07 cm/s

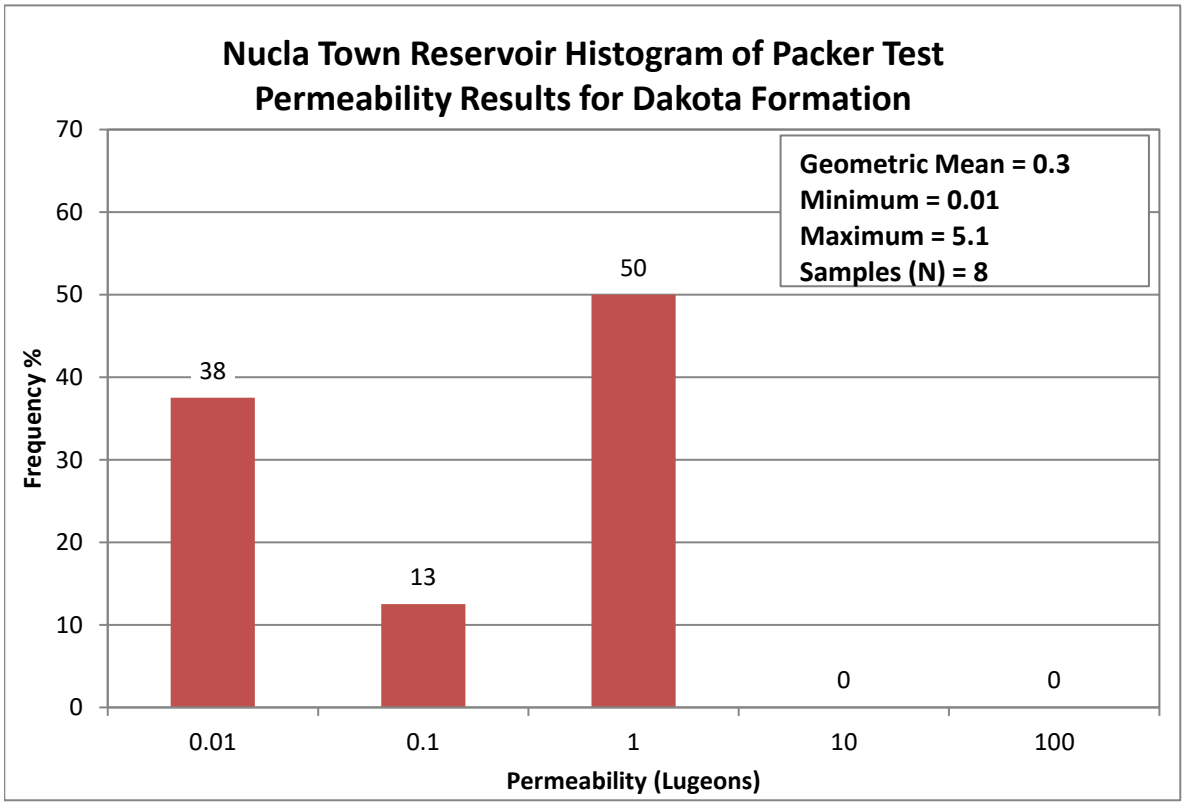


TABLE 4

Nucla Town Reservoir Enlargement
Addition of 122 Acre-Feet
ENGINEER'S OPINION OF COSTS
February 2017

Construction Item	Quantity	Unit	Cost	Extension
Reservoir Construction				
1. Mobilization / Demobilization @ 10%	1	LS	$180,000	$180,000
			Subtotal	$180,000
2. Dam Embankments				
a. Clearing and Grubbing	15	Acres	$3,500	$53,000
b. Dewatering and Water Handling	1	LS	$50,000	$50,000
c. Foundation Excavation	3,000	CY	$10	$30,000
d. Foundation Preparation	1	LS	$60,000	$60,000
e. Foundation Grouting	1	LS	$50,000	$50,000
f. Zone 1 Embankment	25,000	CY	$6	$150,000
g. Zone 2 Embankment	75,000	CY	$6	$450,000
h. Zone 3 (Filter Zone)	4,100	CY	$25	$103,000
i. Riprap	3,400	CY	$45	$153,000
j. Bedding	1,100	CY	$25	$28,000
k. Realign Intake Pipeline with Rundown	500	LF	$180	$90,000
l. Dam Crest Roads	1,800	LF	$25	$45,000
m. Instrumentation & Electrical	1	LS	$80,000	$80,000
			Subtotal	*$1,342,000*
3. Spillway and Spillway Channel	1	LS	$250,000	$250,000
			Subtotal	*$250,000*
4. Outlet Works				
a. Modify Existing Gate Operator and Stem	1	LS	$60,000	$60,000
			Subtotal	*$60,000*
5. Site Development				
a. Dam Access Roads	2,000	LF	$25	$50,000
b. Culverts	10	EA	$4,000	$40,000
c. Erosion Control & BMPs	1	LS	$100,000	$100,000
d. Fencing	2,000	LF	$6	$12,000
e. Seeding	10	AC	$1,000	$10,000
			Subtotal	*$212,000*
			Subtotal Construction Items	***$2,044,000***
			Contingency @ 25%	$510,000
			Total Construction Cost	**$2,554,000**
			Engineering and Administration@ 15%	$380,000
			Permitting @ 15%	$380,000
			Subtotal	*$3,314,000*
			RESERVOIR ESTIMATED TOTAL (rounded to nearest $100,000)	***$3,300,000***
			ESTIMATED COST PER AC-FT (rounded to nearest $100)	***$27,000***

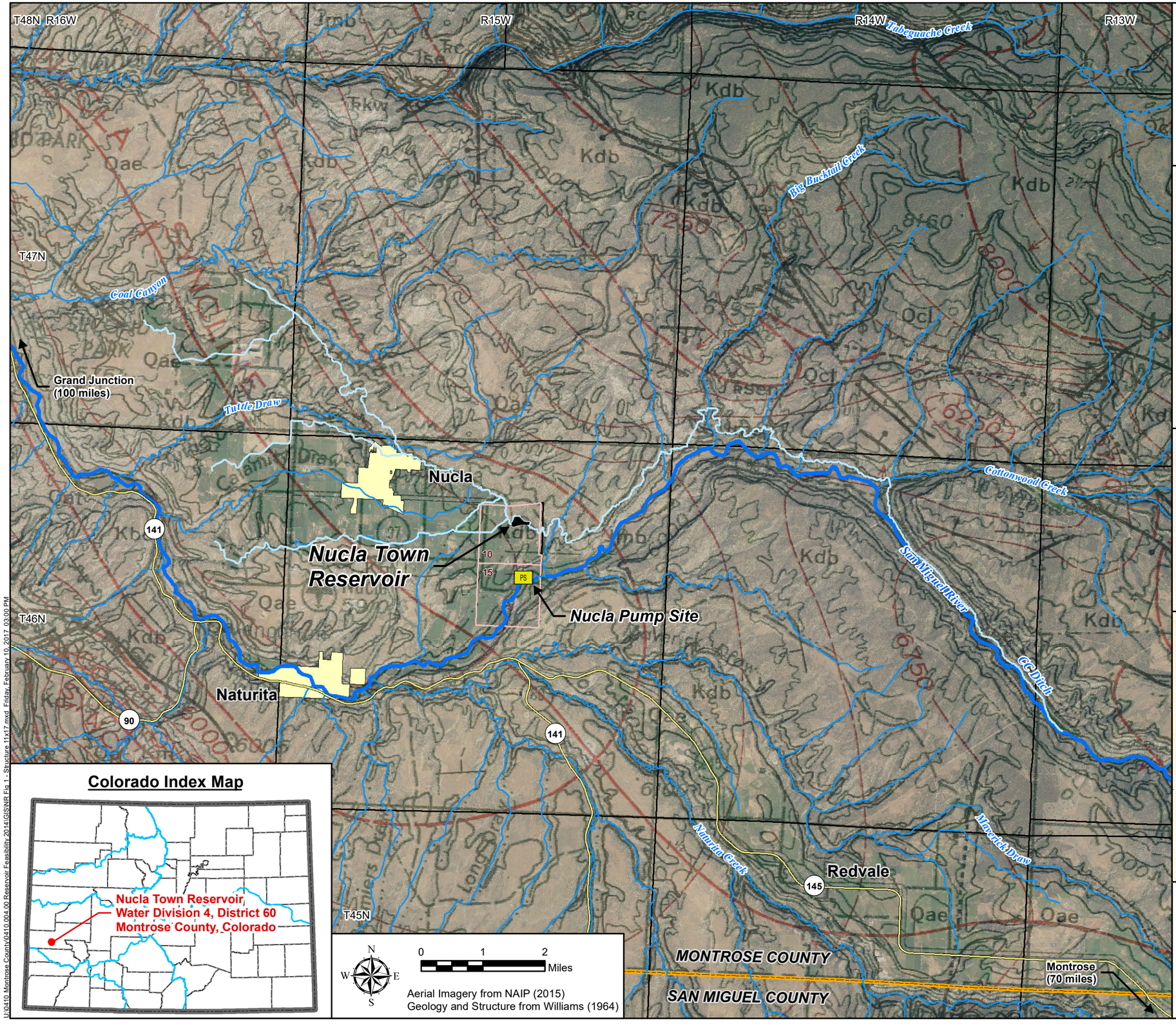
Note: Costs not included for land, easement, or Right of Way acquisition.

TABLE 4 *(continued)*

Nucla Town Reservoir Enlargement
Addition of 122 Acre-Feet
ENGINEER'S OPINION OF COSTS
February 2017

Construction Item	*Quantity*	*Unit*	*Cost*	*Extension*
Water Delivery Infrastructure				
1. Mobilization / Demobilization @ 10%	1	LS	$8,000	$8,000
			Subtotal	*$8,000*
2. Modification of Nucla Pump Site				
a. Infiltration Gallery Installation	110	LF	$300	$33,000
b. Dewatering and Water Handling	1	LS	$25,000	$25,000
c. Isolation Valves	3	EA	$4,000	$12,000
d. Erosion Control	1	LS	$5,000	$5,000
			Subtotal	*$75,000*
			Total Construction Items 1-2	***$83,000***
			Subtotal Construction Items	***$83,000***
			Contingency @ 25%	$20,000
			Total Construction Cost	**$103,000**
			Engineering and Administration@ 15%	$15,000
			Permitting @ 10%	$10,000
			Subtotal	*$128,000*
			WATER DELIVERY ESTIMATED TOTAL *(rounded to nearest $10,000)*	***$130,000***
			ESTIMATED COMBINED TOTAL *(rounded to nearest $10,000)*	***$3,430,000***

FIGURES



PS Nucla Pump Site

San Miguel River

CC Ditch

Other Streams

Highways

Nucla Town Reservoir

Project Section Lines

Towns

County Boundaries

Kd

Dakota Sandstone

Yellowish-brown and gray friable to quartzitic fluvial sandstone and conglomeratic sandstone with interbedded gray to black carbonaceous nonmarine shale. Plant impressions are common; a coarse basal conglomerate is locally present. Ranges in thickness from a few feet to about 200 feet

UNCONFORMITY

Kbc

Burro Canyon Formation

White, gray, and light-brown fluvial sandstone and conglomerate interbedded with green and purplish lacustrine siltstone, shale, and mudstone, and thin beds of impure limestone. Thickness ranges from 0 to 200 feet. Forms discontinuous lenses in the Placerville area, and is not differentiated from the Dakota Sandstone (Kd) there

Kdb

Dakota Sandstone and Burro Canyon Formation

Jm | Jmb | Jms

Morrison Formation

Variegated fluvial and lacustrine shale, mudstone, and sandstone; local thin limestone beds. Total thickness ranges from 450 to 950 feet.

Jm, *Morrison Formation, undifferentiated.*

Jmb, *Brushy Basin Shale Member. Chiefly gray, pale-green, red, and light-purple bentonitic mudstone, fluvial sandstone and conglomerate lenses, some of which contain uranium and vanadium deposits. Thickness ranges from 250 to 500 feet.*

Jms, *Salt Wash Sandstone Member. White, gray, rusty-red, and buff fluvial sandstone interbedded with red, gray, and green fluvial mudstone, with thin limestone beds near base. Uppermost continuous sandstone beds contain major uranium-vanadium deposits through much of the area. Thickness ranges from 190 feet in the north to a maximum of 490 feet in the south*

5000

Structure contours

Drawn on base of Dakota Sandstone. Solid where accuracy within 125 feet; long dashed where accuracy between 125 and 250 feet; short dashed where accuracy not within 250 feet. Arrow shows direction of dip. Contours dropped where structure unknown or too complex to show at map scale. Contour interval 250 feet. Datum is mean sea level

34

Strike and dip of beds

Horizontal beds

Anticline
Showing direction of plunge

Syncline

Monocline
Showing direction of dip

Fault
Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

Horizontal projection of inclined fault
Showing horizontal separation of datum surface

Colorado Index Map

N W E S

0 1 2 Miles

Aerial Imagery from NAIP (2015)
Geology and Structure from Williams (1964)

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR ENLARGEMENT

Site Location and Regional Geologic Map

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 1

DATE: FEB. 2017

SCALE: 1:100,000

U:\0410 Montrose County\0410.004.00 Reservoir Feasibility 2014\GIS\NR Fig 1 - Structure 11x17.mxd Friday, February 10, 2017 03:00 PM

Legend

Exploratory Locations

- Dam Boring with Coring, Packer Testing and Piezometer
- Dam Auger Boring
- Borrow Test Pit
- Sandstone Outcrop
- Montrose County Property Boundaries

Geologic Units

- af- Artificial Fill
- ef - Engineered Fill
- Qa - Quaternary Alluvium
- Qc - Quaternary Colluvium
- ss - Dakota Sandstone
- Q/sh - Quaternary Colluvium over Shale
- Water
- Wetlands

Notes:
1) All geologic contacts are inferred.
2) Topography and Aerial Image from 2016 Aerial Survey
3) Topographic Contour Interval = 2 feet

N W E S

0 80 160 Feet

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR ENLARGEMENT

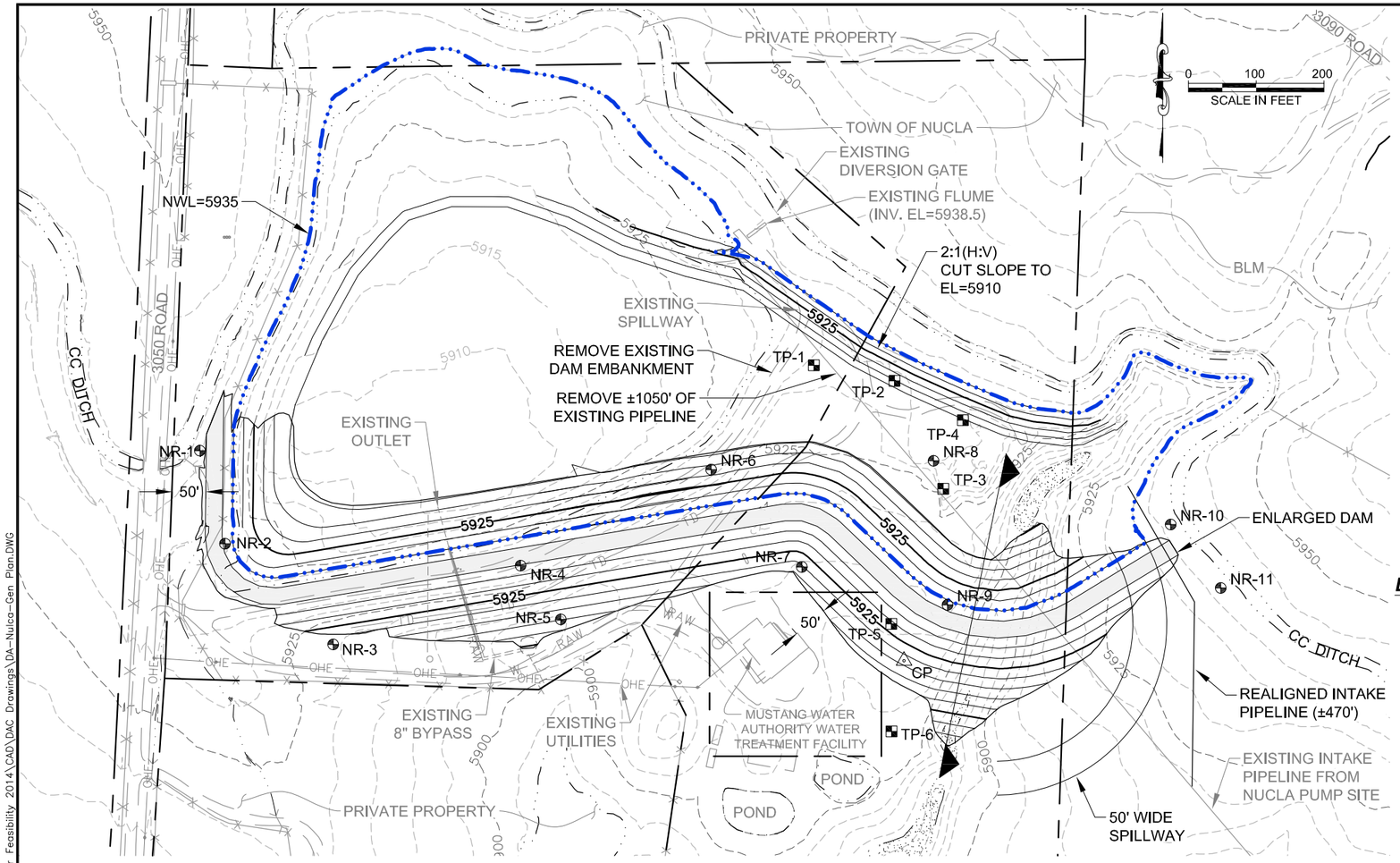
Geologic Map

DEERE & AULT CONSULTANTS, INC.

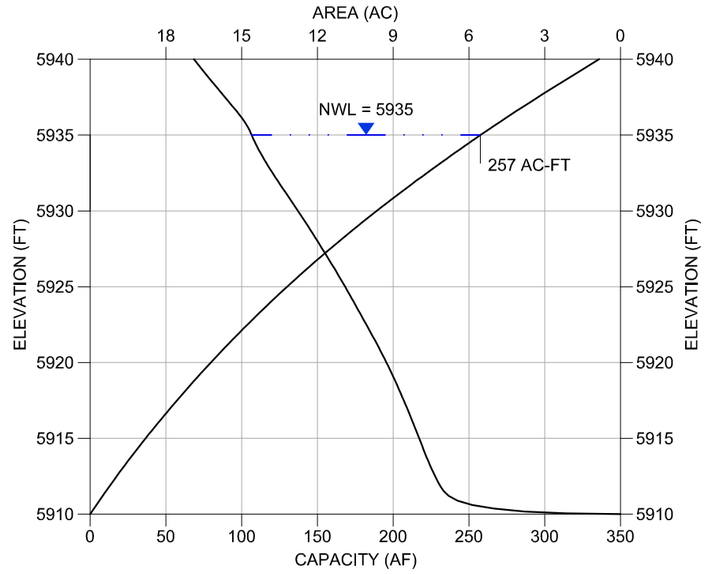
FIGURE NO. 2

DATE: FEB. 2017

SCALE: 1 inch = 80 feet

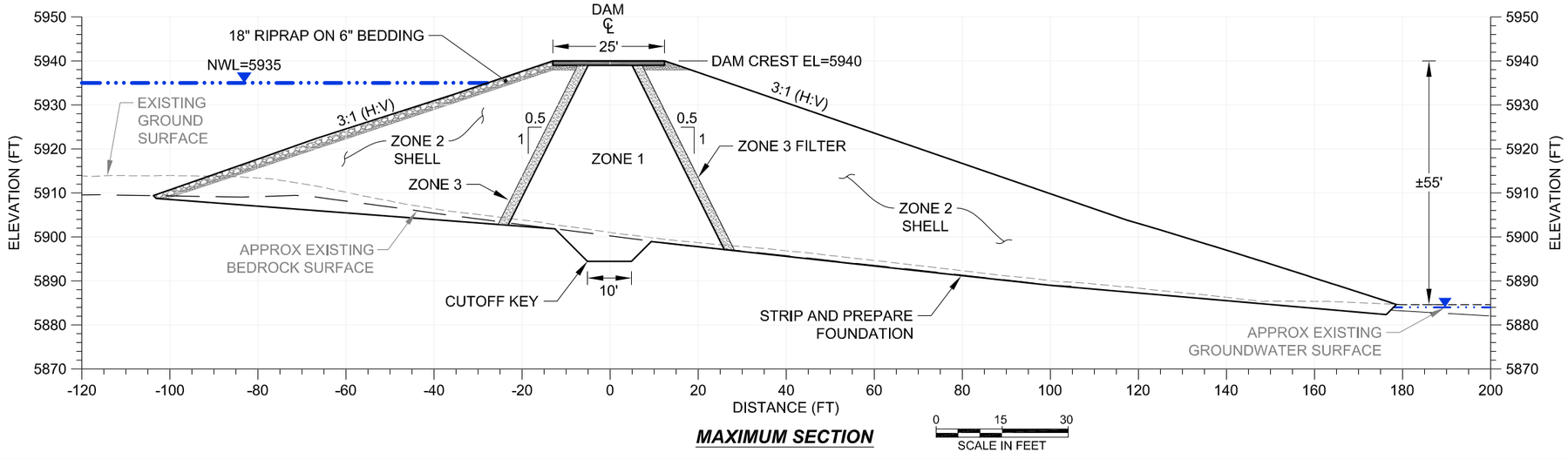


DAM & RESERVOIR PLAN



LEGEND:

NR - 6	GEOTECHNICAL BORING LOCATION
TP - 3	TEST PIT LOCATION
CP	SURVEY CONTROL POINT
TD	EXISTING TOE DRAIN
RAW	EXISTING RAW WATER MAIN
W	EXISTING TREATED WATER MAIN
X X X	EXISTING FENCE
OHE	OVERHEAD ELECTRIC
	PROPERTY LINES
	EXISTING OPEN WATER SURFACE
	EXISTING WETLANDS



MAXIMUM SECTION

NOTES:

1. TOPOGRAPHIC AERIAL SURVEY BY MAP MART (5/4/2016) AND CONTROL BY DELMONT. CONTOUR INTERVAL = 5 FEET.
2. HORIZONTAL DATA ARE RELATIVE TO THE NORTH AMERICAN DATUM OF 1983. COORDINATES ARE PROJECTED IN THE COLORADO STATE PLANE SOUTH ZONE 0503, UNITS IN FEET.
3. ALL ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988.

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR ENLARGEMENT

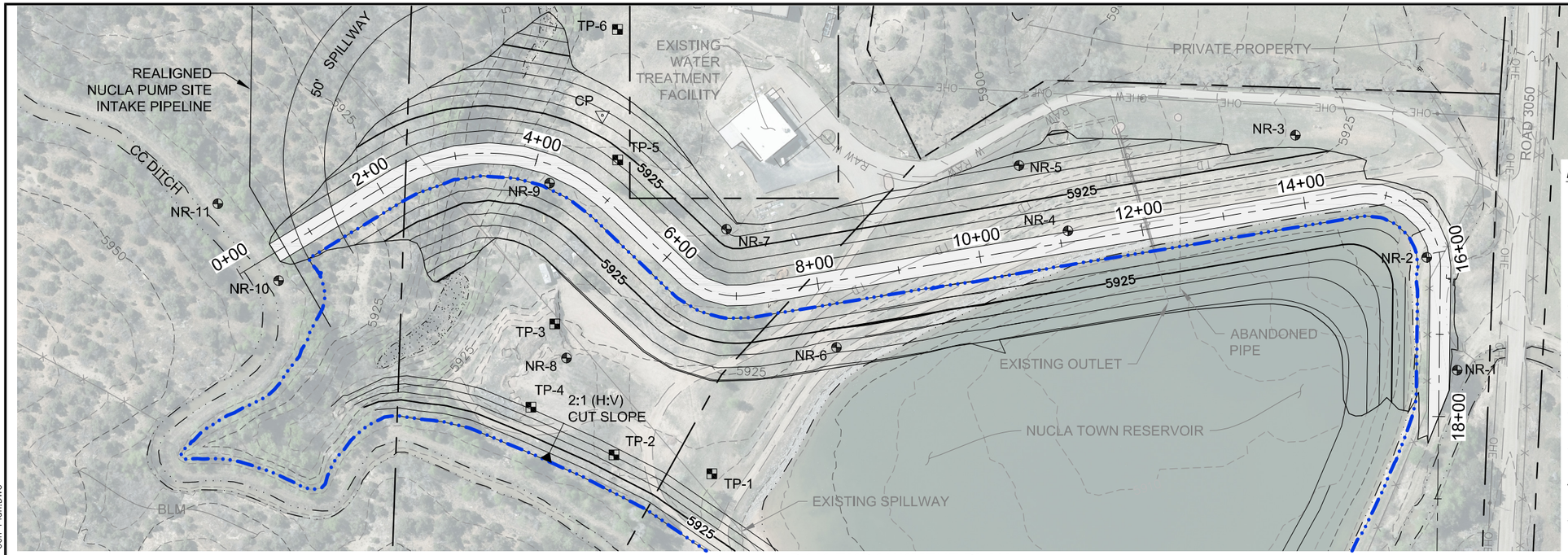
Proposed Dam and Reservoir

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 3

DATE: FEB. 2017

SCALE: AS NOTED

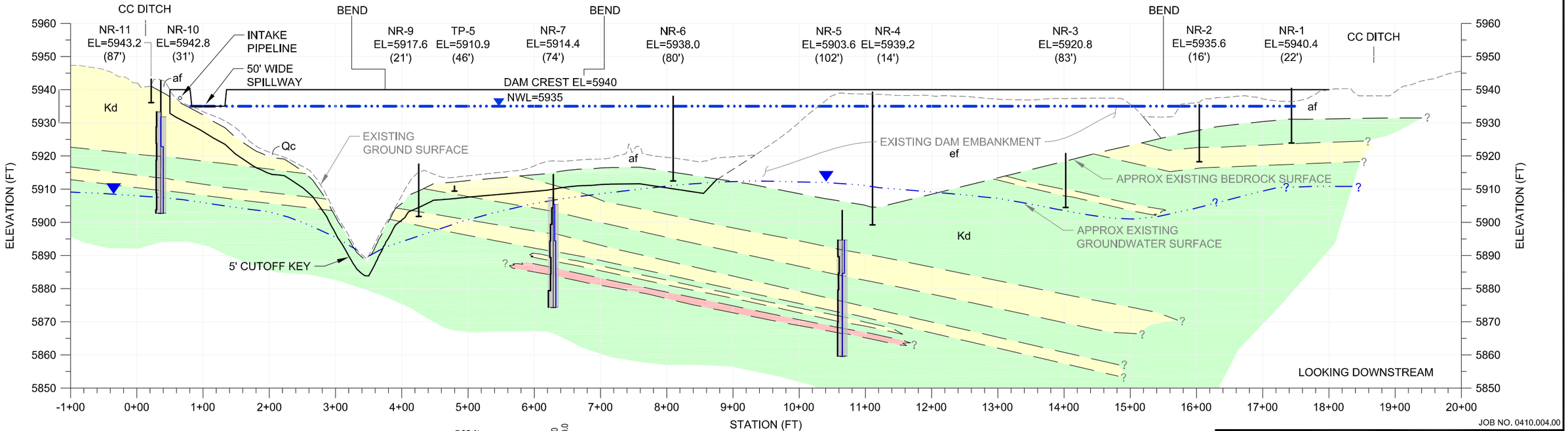


DAM EMBANKMENT PLAN

0 75 150
SCALE IN FEET
CONTOUR INTERVAL = 5FT

LEGEND:

- NR - 6 — GEOTECHNICAL BORING LOCATION
- TP - 3 — TEST PIT LOCATION
- CP — SURVEY CONTROL POINT
- TD — EXISTING TOE DRAIN
- RAW — EXISTING RAW WATER MAIN
- W — EXISTING TRENCHED WATER MAIN
- X — EXISTING FENCE
- OHE — OVERHEAD ELECTRIC
- PROPERTY LINES
- EXISTING OPEN WATER SURFACE
- EXISTING WETLANDS



JOB NO. 0410.004.00

DAM PROFILE

0 75 150
HORIZONTAL SCALE IN FEET

0 15 30
VERTICAL SCALE IN FEET (1"=30')

LEGEND:

- af — ARTIFICIAL FILL
- ef — ENGINEERED FILL
- Qc — COLLUVIUM

Kd - DAKOTA FORMATION

- SHALE
- SANDSTONE
- CLAY

ROCK QUALITY DESIGNATION (RQD) IS THE RATIO (%) OF THE CUMULATIVE LENGTH OF THE ROCK CORE >= 4 INCHES TO THE LENGTH OF THE CORE RUN.

RQD % 100 75 50 25 0

0.01 0.1 1.0 10.0 100.0 1000.0

PACKER TEST INTERVALS AND CALCULATED IN LUGEONS

NR - 9
EL= 5917.6
(21')

BORING ID
ELEVATION
(PROJECTED LENGTH)

DEPTH OF EXPLORATION

APPROXIMATE GEOLOGIC CONTACT

NUCLA TOWN RESERVOIR ENLARGEMENT

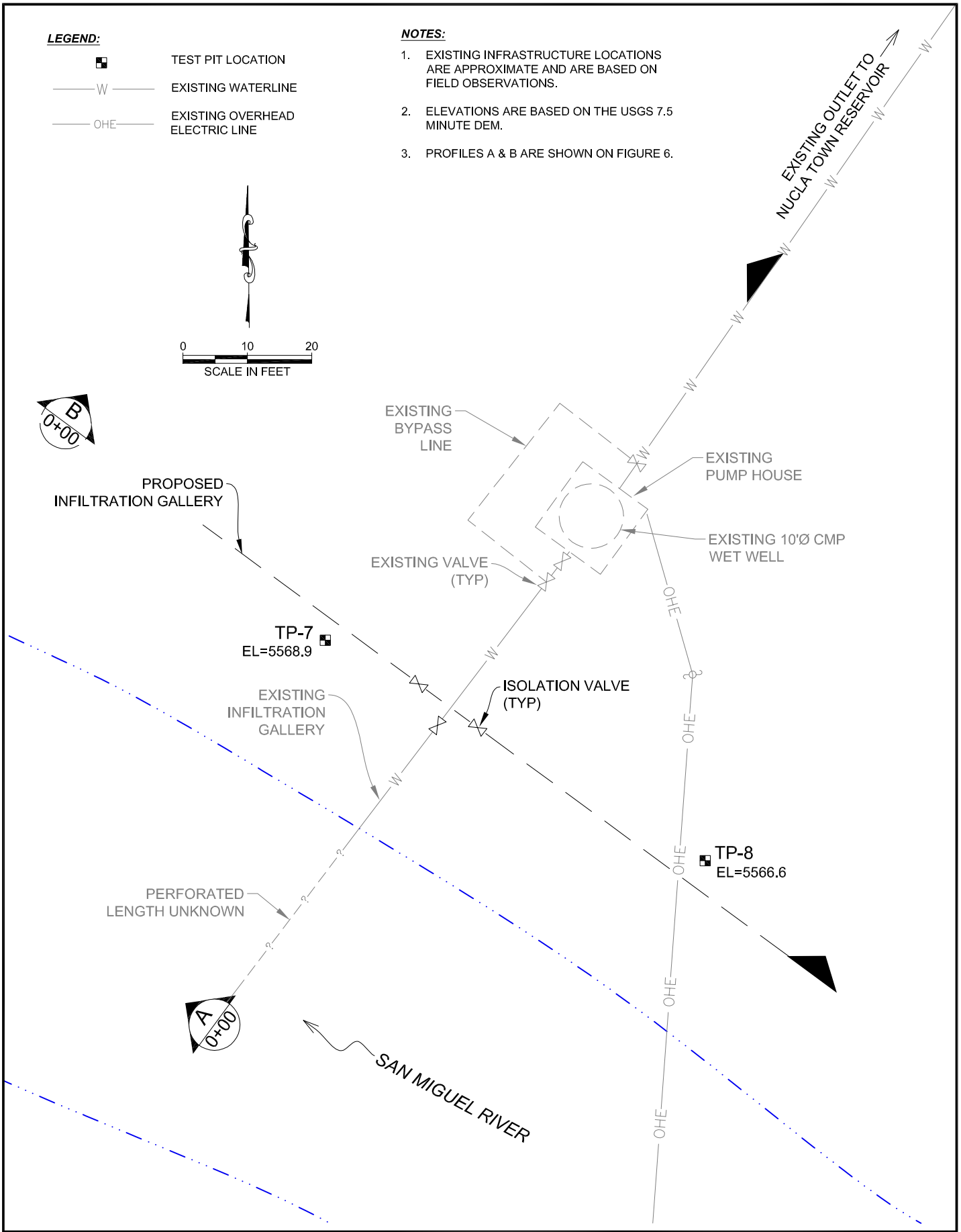
Plan & Profile Along Dam Axis

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 4

DATE: FEB. 2017

SCALE: AS NOTED



DEERE & AULT CONSULTANTS, INC.

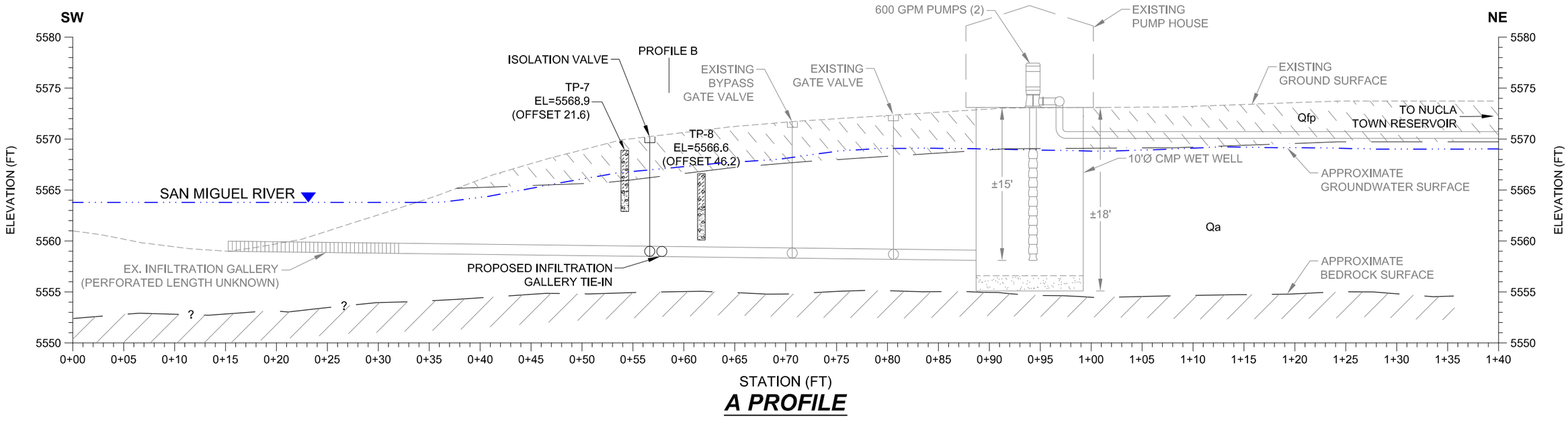
NUCLA TOWN RESERVOIR ENLARGEMENT

NUCLA PUMP SITE PLAN

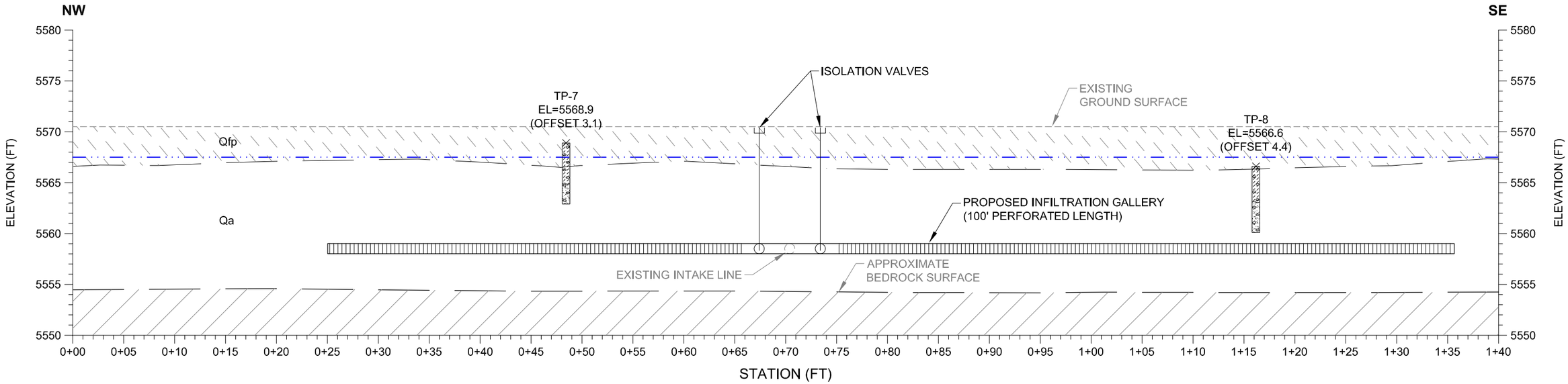
JOB NO. 0410.004.00

SCALE: AS NOTED

FIGURE NO. 5



A PROFILE



B PROFILE

0 5 10
SCALE IN FEET

NOTES:

1. ELEVATIONS BASED ON USGS DEM.
2. Qfp - FLOODPLAIN DEPOSITS
   Qa - ALLUVIUM

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR ENLARGEMENT

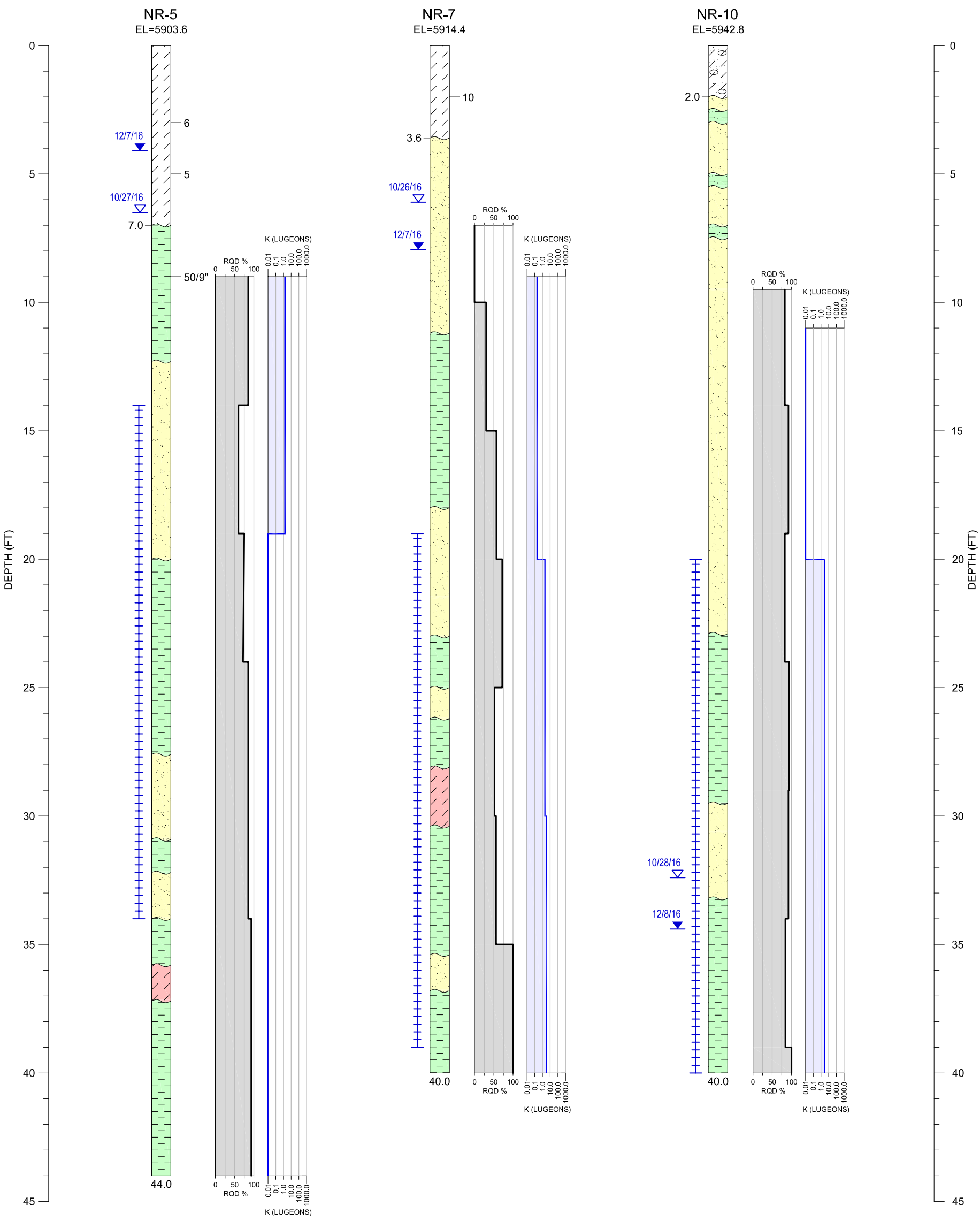
NUCLA PUMP SITE PROFILES

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 6

DATE: FEB. 2017

SCALE: 1"=10'



LEGEND:

RESIDUAL DEPOSITS: CLAY, MEDIUM STIFF TO STIFF, DRY TO WET, REDDISH BROWN TO BLACK, PLASTIC, LOCALLY SANDY, LOCACALLY GRADES TO SILT (CH, CL)

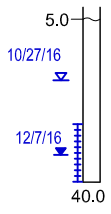
FILL: SAND AND GRAVEL, CLAYEY, MEDIUM DENSE TO DENSE, DRY TO MOIST, SILTY, LOCAL SANDSTONE COBBLES & BOULDERS, MODERATELY PLASTIC, BROWN TO RED BROWN, (SC, CL, GC)

Kd - DAKOTA FORMATION

SHALE: WEATHERED TO FRESH, DRY TO MOIST,GRAY TO BLACK, PLASTIC, LOW STRENGTH ROCK, THINLY BEDDED, LOCALLY SANDY, LOCALLY CARBONACEOUS

SANDSTONE: WELL CEMENTED, MEDIUM TO FINE GRAINED, WEATHERED TO FRESH, DRY TO WET, BUFF, YELLOW-ORANGE WHERE WEATHERED, STRONG, FRACTURED, MASSIVE, LOCAL THIN SHALE INTERBEDS

ALTERED VOLCANIC ASH: CLAY, STIFF, WET, WHITE-PALE GRAY, HIGHLY PLASTIC, BENTONITIC (CH)



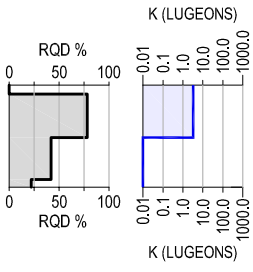
APPROXIMATE DEPTH OF GEOLOGIC CONTACT

GROUNDWATER LEVEL MEASURED WHILE DRILLING ON DATE INDICATED

PIEZOMETER INTERVAL AND MEASURED GROUNDWATER LEVELS ON DATE INDICATED.

DEPTH OF BORING (FT)

ROCK QUALITY DESIGNATION (RQD) IS THE RATIO (%) OF THE CUMULATIVE LENGTH OF THE ROCK CORE >= 4 INCHES TO THE LENGTH OF THE CORE RUN.



PACKER TEST INTERVALS AND CALCULATED PERMIABILITY IN LUGEONS

DEERE & AULT CONSULTANTS, INC.

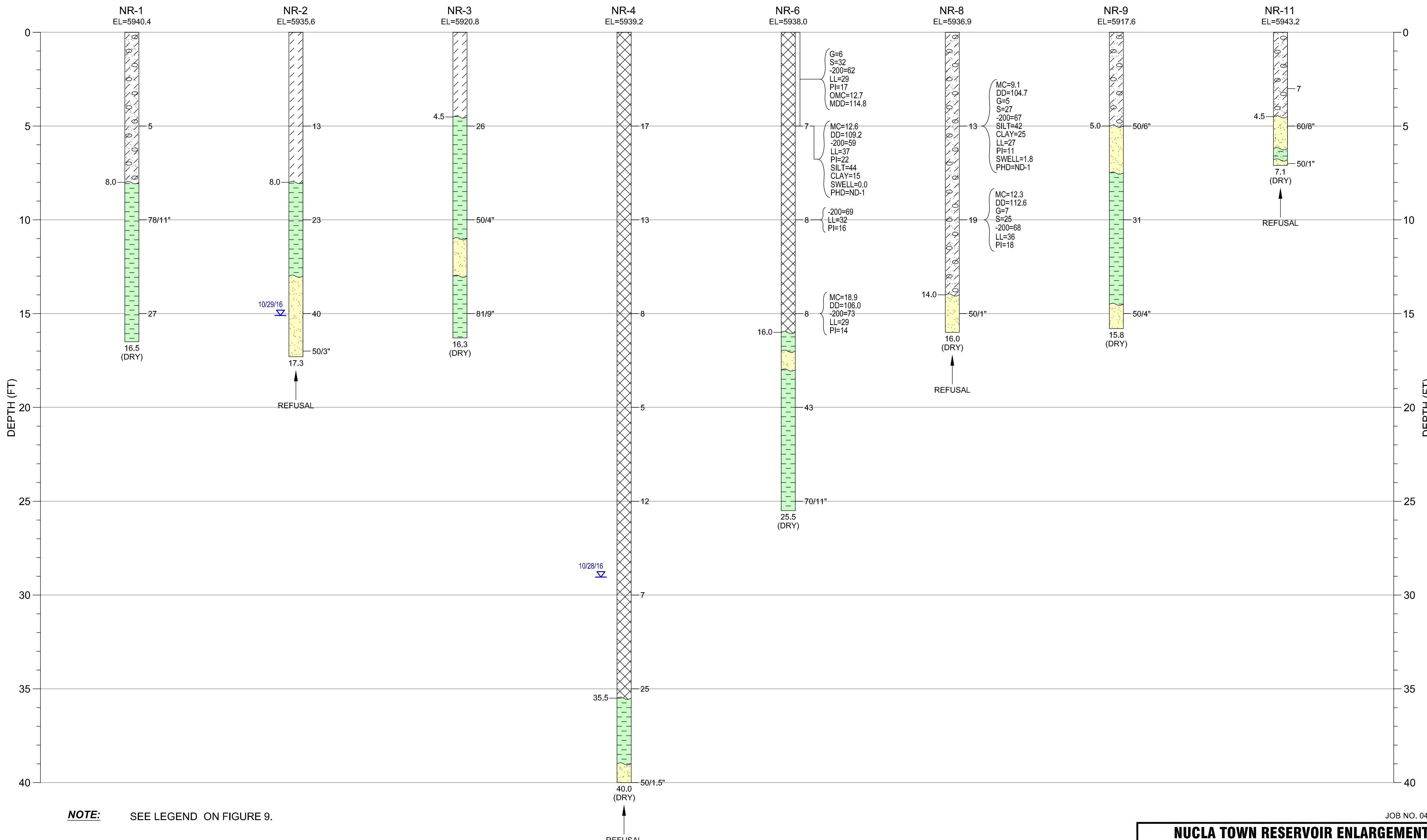
NUCLA TOWN RESERVOIR ENLARGEMENT

SUMMARY LOGS OF EXPLORATORY CORE BORINGS

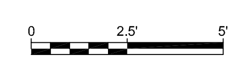
JOB NO. JOB NO. 0410.004.00

SCALE: 1 INCH=5 FEET

FIGURE NO. 7



NOTE: SEE LEGEND ON FIGURE 9.



JOB NO. 0410.004.00

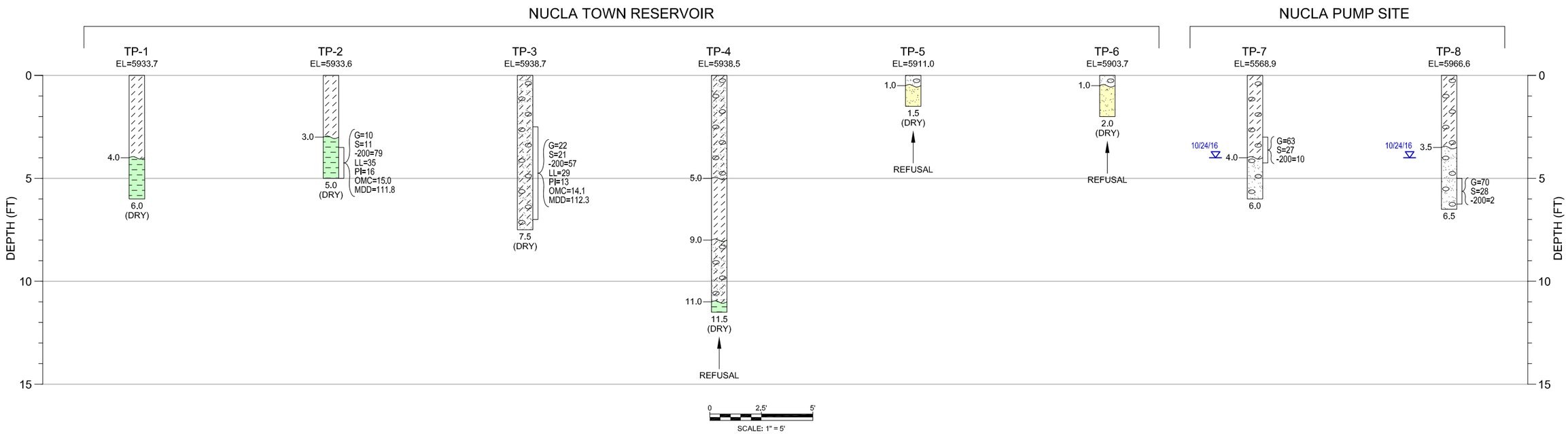
NUCLA TOWN RESERVOIR ENLARGEMENT

SUMMARY LOGS OF EXPLORATORY AUGER BORINGS

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 8

DATE: FEB. 2017 **SCALE:** AS NOTED



SOILS LEGEND:

DAM FILL: CLAY, SANDY, MEDIUM STIFF TO VERY STIFF, DRY TO MOIST, BROWN TO GRAY, LOCAL GRAVEL AND COBBLES, LOW-MODERATE PLASTICITY (CL)

ALLUVIAL DEPOSITS: SAND & GRAVEL, COBBLY, WELL GRADED, DENSE TO VERY DENSE, WET, DARK BROWN TO RED-BROWN, LOCALLY SILTY (GW, GW-GM)

FLOODPLAN DEPOSITS: CLAY, GRAVELLY, WITH SAND & LOCAL COBBLES, MEDIUM DENSE TO DENSE, MOIST TO WET, BROWN TO GRAY (CL, SC, GC)

FILL: SAND AND GRAVEL, CLAYEY, MEDIUM DENSE TO DENSE, DRY TO MOIST, SILTY, LOCAL SANDSTONE COBBLES & BOULDERS, MODERATELY PLASTIC, BROWN TO RED BROWN, (SC, CL, GC)

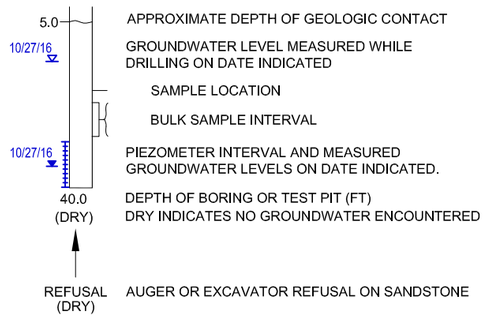
RESIDUAL DEPOSITS AND FILL: CLAY, MEDIUM STIFF TO STIFF, DRY TO WET, REDDISH BROWN TO BLACK, PLASTIC, LOCALLY SANDY, LOCACALLY GRADES TO SILT (CH, CL)

BEDROCK LEGEND:

Kd - DAKOTA FORMATION

SHALE: WEATHERED TO FRESH, DRY TO MOIST,GRAY TO BLACK, PLASTIC, LOW STRENGTH ROCK, LOCALLY CARBONACEOUS

SANDSTONE: THINLY BEDDED TO LOCALLY SANDY, WELL CEMENTED, MEDIUM TO FINE GRAINED, WEATHERED TO FRESH, DRY TO WET, BUFF, YELLOW-ORANGE WHERE WEATHERED, STRONG, FRACTURED, MASSIVE, LOCALLY SHALE INTERBEDS



NOTES:

1. EXPLORATORY BORINGS WERE DRILLED BETWEEN OCTOBER 5 AND 29, 2016 USING HOLLOW STEM AUGER, SOLID STEM AUGER, AND HQ CORING METHODS WITH A CME 850 TRACK-MOUNTED DRILL RIG.
2. EXPLORATORY TEST PITS WERE EXCAVATED ON OCTOBER 24, 2016 BY A RUBBER TIRE CAT BACKHOE WITH A TWO-FOOT WIDE BUCKET.
3. ELEVATIONS ARE BASED ON THE AERIAL LIDAR SURVEY CONDUCTED ON MAY 4, 2016 RELATIVE TO THE NAVD88 VERTICAL DATUM. THE COORDINATES WERE MEASURED BY A SUB-METER ACCURATE GPS-UNIT RELATIVE TO THE NAD83 HORIZONTAL DATUM IN THE COLORADO STATE PLANE, ZONE 3 (SOUTH) COORDINATE SYSTEM.
4. GROUNDWATER MEASURED ON THE DATE OF DRILLING, OR DATE INDICATED. GROUNDWATER LEVELS ARE EXPECTED TO FLUCTUATE SEASONALLY.
5. LAB TESTING:

MC = NATURAL MOISTURE CONTENT (%)
DD = NATURAL DRY DENSITY (PCF)
G = % GRAVEL
S = % SAND
-200 = % PASSING THE NO. 200 SIEVE (SILT & CLAY)
SILT = % SILT
CLAY = % CLAY
LL = LIQUID LIMIT %
PI = PLASTICITY INDEX %
OMC = STANDARD PROCTOR OPTIMUM MOISTURE CONTENT, (%)
MDD = STANDARD PROCTOR MAXIMUM DRY DENSITY, PCF
SWELL = SWELL / CONSOLIDATION @ 1.0 KSF (%)
PHD = PIN HOLE DISPERSIVITY
ND1 = NON DISPERSIVE SOIL

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR ENLARGEMENT

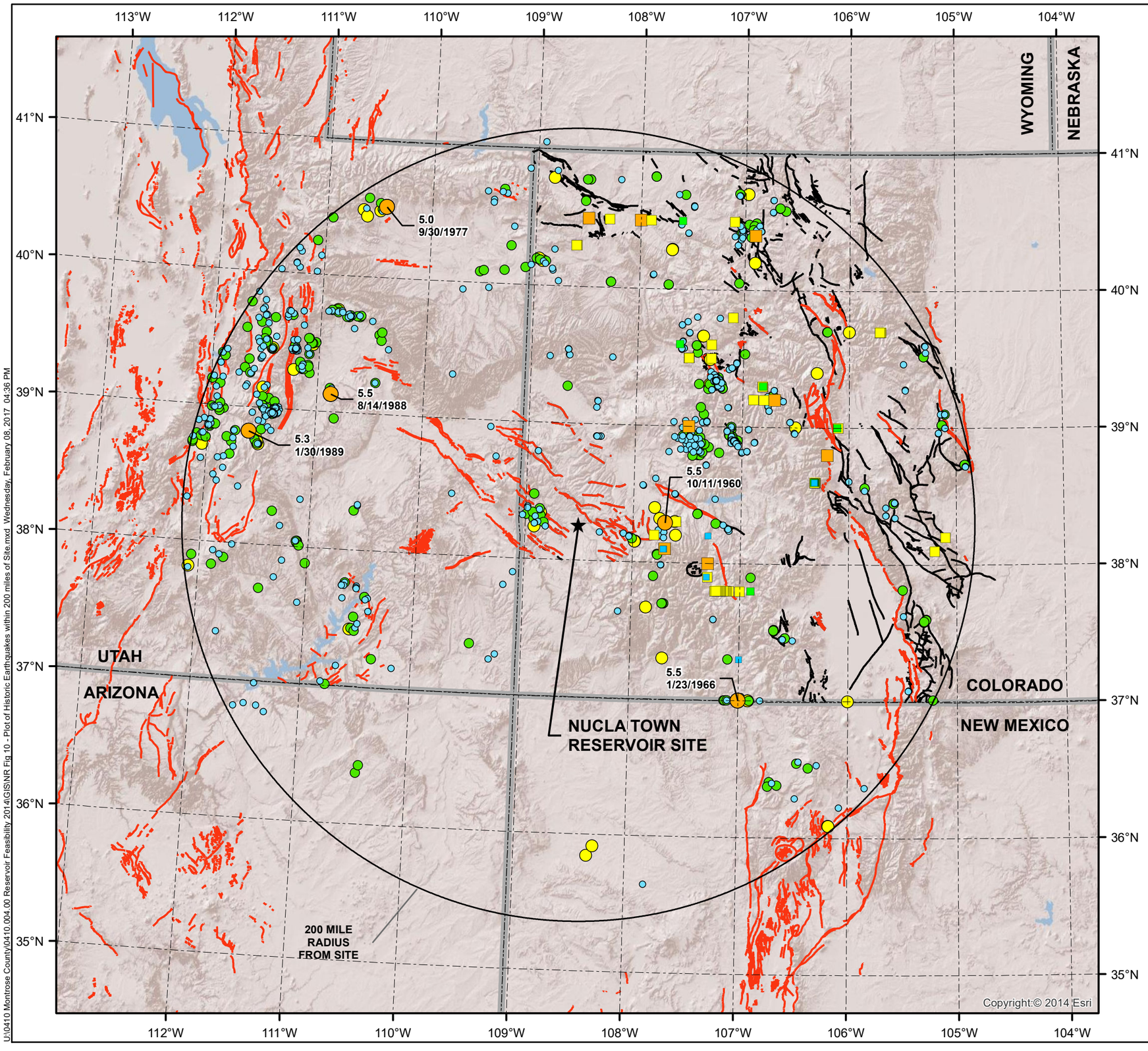
SUMMARY LOGS OF EXPLORATORY TEST PITS

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 9

DATE: FEB. 2017

SCALE: AS NOTED



LEGEND

EARTHQUAKE EPICENTERS BASED ON FELT REPORTS

- INTENSITIES F - III
- INTENSITY IV
- INTENSITY V
- INTENSITY VI

EARTHQUAKE EPICENTERS WITH PUBLISHED MAGNITUDES

- MAGNITUDE 2.0 - 2.9
- MAGNITUDE 3.0 - 3.9
- MAGNITUDE 4.0 - 4.9
- MAGNITUDE 5.0 - 5.9

Potentially Active Faults (Quaternary Period)

Other Cenezoic Era Faults

NOTES:

1. EARTHQUAKE DATA FROM U.S.G.S EARTHQUAKE DATABASE SYSTEM, (2016); AND FROM THE COLORADO GEOLOGICAL SURVEY'S EARTHQUAKE MAP SERVER (2008).
2. FIRST RECORDED EARTHQUAKE: MAY 12, 1882
   LAST RECORDED EARTHQUAKE: NOVEMBER 11, 2016
3. FAULT LOCATIONS FROM THE COLORADO GEOLOGICAL SURVEY'S LATE CENEZOIC FAULT AND FOLD DATABASE (2007), AND FROM THE USGS QUATERNARY FAULT DATABASE (2015).

N W E S

0 50 100 Miles

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR

Map of Historical Earthquakes within 200 Miles of Site and Potentially Active Faults used in Seismic Analyses

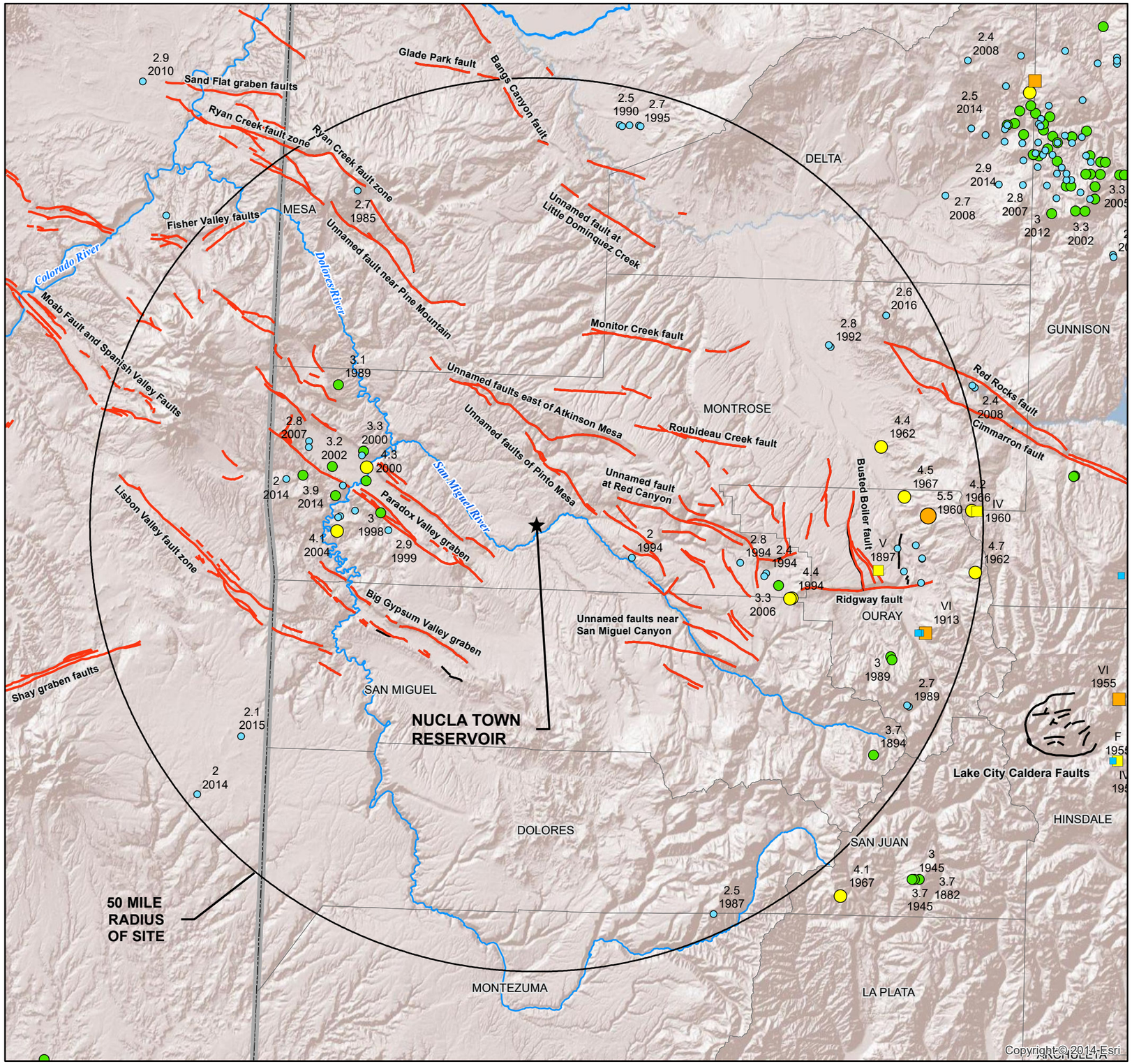
DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **10**

DATE: **FEB. 2016**

SCALE: **1 inch = 50 miles**

U:\0410 Montrose County\0410.004.00 Reservoir Feasibility 2014\GIS\NR Fig 10 - Plot of Historic Earthquakes within 200 miles of Site.mxd Wednesday, February 08, 2017 04:36 PM



U:\0410 Montrose County\0410.004.00 Reservoir Feasibility 2014\GIS\NR Fig 11 - Mapped Potentially Active Faults and Near Field Earthquake Epicenters.mxd Wednesday, February 08, 2017 04:36 PM

LEGEND

EARTHQUAKE EPICENTERS WITH PUBLISHED MAGNITUDES

- MAGNITUDE 2.0 - 2.9
- MAGNITUDE 3.0 - 3.9
- MAGNITUDE 4.0 - 4.9
- MAGNITUDE 5.0 - 5.9

EARTHQUAKE EPICENTERS BASED ON FELT REPORTS

- INTENSITIES F - III
- INTENSITY IV
- INTENSITY V
- INTENSITY VI

Potentially Active Faults (Quaternary Period)

Other Cenezoic Era Faults

NOTES:

1. FAULT LOCATIONS FROM THE COLORADO GEOLOGICAL SURVEY'S LATE CENEZOIC FAULT AND FOLD DATABASE (2007), AND FROM THE USGS QUATERNARY FAULT DATABASE (2015).
2. EARTHQUAKE DATA FROM THE COLORADO GEOLOGICAL SURVEY'S EARTHQUAKE MAP SERVER (2008) AND FROM THE U.S.G.S EARTHQUAKE DATABASE SYSTEM (2016).

N W E S

0 12 24 Miles

JOB NO. 0410.004.00

NUCLA TOWN RESERVOIR

Plot of Potentially Active Faults and Near Field Earthquakes

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 11

DATE: FEB. 2017

SCALE: 1 inch = 12 miles

APPENDIX A
DETAILED LOGS OF EXPLORATORY BORINGS

DATE START/FINISH: October 27, 2016
BORING LOCATION: Dam Foundation (West)
COORDINATES: 1,592,774' N 2,136,644' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5903.6'
GROUNDWATER EL.: 4.1' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: SS Auger
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 44.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-5

DEPTH		SOIL SAMPLES		ROCK CORE					GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
ELEVATION	FEET	TYPE	BLOWS PER 6 INCHES	RUN NO.	BOX NO.	RECOVERY, %	RQD %	FRACTURE DRAWING			
5903.6'	0									TOPSOIL	
5900.0'		S	3 2 4							CLAY, MEDIUM STIFF, MOIST, BLACK, PLASTIC,	12/7/16 ▼ (4.1')
	5	S	2 3								10/28/16 ▽ (6.5')
5895.0'										7.0' SHALE, FRESH, DARK GRAY, DRY, WEAK ROCK, (HARD SOILS)	
		S	50\9"								BEGIN HQ CORING (9.8')
5890.0'	10										
	15										
5885.0'											
	20										
5880.0'											
	25										
5875.0'											

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/26/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 27, 2016
BORING LOCATION: Dam Foundation (West)
COORDINATES: 1,592,774' N 2,136,644' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5903.6'
GROUNDWATER EL.: 4.1' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 44.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-5

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	9			1	1	100	85			SHALE, FRESH LOW STRENGTH ROCK, DARK GRAY, CLAYEY, PLASTIC, THINLY BEDDED,, SOME HORIZONTAL FRACTURES (SOME POSSIBLY MECHANICALLY INDUCED)	Run #1 12:28 - 12:40 12 MIN / 4.2' FINAL 1' WENT VERY QUICKLY
	11									MECHANICALLY INDUCED ZONE, POSSIBLY DUE TO DRILL BIT PLUGGING	
										12.3' SANDSTONE, WEATHERED, MEDIUM GRAINED, MOIST TO WET, WELL CEMENTED, MASSIVE, HORIZONTAL TIGHT FRACTURES, ORANGE BROWN TO GRAY	
	13										
5890.0'				2	1	99	60			14.6'-15.9', GRAY, FRESH, SANDSTONE	Run #2 12:58 - 1:10 12 MIN /5'
	15									1" CLAY LENS, PLASTIC	**Packer Test #1** **9.0-19.0'** 2.0×10^{-5} cm/s 20.5 ft/yr 2.1 Lugeons
										SANDSTONE, WEATHERED WITH THIN (MM SCALE) SHALE BEDS, TIGHT HORIZONTAL FRACTURES WITH ORANGE IRON STAINING	
	17										
5885.0'										18.7' THIN CLAY INTERBEDS	
	19										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER

REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)

RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)

S-SPLIT SPOON SAMPLE

▽-GROUNDWATER SURFACE DURING DRILLING

▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]

DATE: 10/27/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 27, 2016
BORING LOCATION: Dam Foundation (West)
COORDINATES: 1,592,774' N 2,136,644' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5903.6'
GROUNDWATER EL.: 4.1' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 44.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-5

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	19			3	1	99	72			SANDSTONE, WEATHERED, MEDIUM GRAINED, MOIST TO WET, WELL CEMENTED, MASSIVE, HORIZONTAL TIGHT FRACTURES, ORANGE BROWN TO GRAY	
										20.0' SHALE, FRESH, WEAK, MOIST, DARK GRAY, PLASTIC, THINLY BEDDED, LOCALLY SANDY	Run #3 2:52 - 3:10 18 MIN / 5'
	21										FRACTURES LOOK MECHANICALLY INDUCED
										22.3' SHALE BECOMES SANDIER & DARKER - MORE CARBONACEOUS	
	23										
5880.0'				4	2	100	100				Run #4 3:21 - 3:33 13 MIN / 5'
	25									SHALE IS LIGHTER AND CLAYEY	**Packer Test #2** **19-29'** 1.0×10^{-7} cm/sec 0.1ft/yr 0.01 LUGEONS
	27									27.6' SANDSTONE, FRESH, GRAY, MODERATELY STRONG, CLAY INFILLED HORIZONTAL FRACTURES AT 28.1'	
5875.0'											
	29										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/27/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 27, 2016
BORING LOCATION: Dam Foundation (West)
COORDINATES: 1,592,774' N 2,136,644' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5903.6'
GROUNDWATER EL.: 4.1' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 44.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-5

ELEVATION	FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	29			5	2	96	83			SANDSTONE, WEATHERED, MEDIUM GRAINED, MOIST TO WET, WELL CEMENTED, MASSIVE, HORIZONTAL TIGHT FRACTURES, ORANGE BROWN TO GRAY	Run #5 4:40 - 5:00 20 MIN /5'
										30.9'	
	31									SHALE, FRESH, CLAYEY, PLASTIC, THINLY BEDDED, DARK GRAY, WEAK ROCK, WITH ABUNDANT THIN SANDSTONE BEDS	
										32.2'	
										SANDSTONE, FRESH, STRONG, GRAY, FINE GRAINED, FRACTURED	
	33										
5870.0'											
				6	2	95	56			34.0'	
										SHALE, FRESH, BLACK, WET, CARBONACEOUS, THINLY BEDDED, PLASTIC, WEAK	Run #6 5:12 - 5:25 13 MIN / 5'
	35										
										35.3' SANDSTONE	Drill Rig breaks down 5:25-6:00 start back up 6:00-6:07 finish run
										35.6' SHALE	
										35.8'	
										CLAY, BENTONITIC ASH LAYER, WET, HIGHLY PLASTIC, CLAYEY, SILTY, TANISH-WHITE	
	37										
										37.2'	
										SHALE, FRESH, BLACK, WET, CARBONACEOUS	**PACKER TEST #3:** **29-44'** 1.0×10^{-7}cm/sec 0.1ft/yr 0.01LUGEONS
5865.0'											
										MECHANICAL FRACTURE	
	39										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/27/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 27, 2016
BORING LOCATION: Dam Foundation (West)
COORDINATES: 1,592,774' N 2,136,644' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5903.6'
GROUNDWATER EL.: 4.1' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 44.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-5

DEPTH		SOIL SAMPLES		ROCK CORE					GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
ELEVATION	FEET	TYPE	BLOWS PER 6 INCHES	RUN NO.	BOX NO.	RECOVERY, %	RQD %	FRACTURE DRAWING			
	39			7	3	100	93			SHALE, FRESH, BLACK, WET, CARBONACEOUS, THINLY BEDDED, PLASTIC, WEAK	Run #7 6:15 - 6:38 23 MIN / 5'
	41										
	43										
5860.0'										44.0' END OF HOLE	**WELL 10/27/16** CUTTINGS/GROUT 0-9.5' BETONITE 9.5-12.5' SAND 12.5-14.0' SCREEN 14.0-34.0' SAND 34.0-34.5' BENTONITE 34.5-44.0'
	45										
	47										
5855.0'											
	49										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/27/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 25, 2016
BORING LOCATION: Dam Foundation South
COORDINATES: 1,592,852' N 2,137,000' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5914.4'
GROUNDWATER EL.: 8.0' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: SS Auger
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-7

DEPTH		SOIL SAMPLES		ROCK CORE					GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
ELEVATION	FEET	TYPE	BLOWS PER 6 INCHES	RUN NO.	BOX NO.	RECOVERY, %	RQD %	FRACTURE DRAWING			
	0	S	4 5 5							TOPSOIL CLAY, SILTY, MEDIUM STIFF, MOIST, GRAVELLY, TANISH-BROWN 3.6' SANDSTONE, STRONG, DRY, TANNISH-BROWN, HARD, SLIGHTLY WEATHERED.	
5910.0'	5	S	50\1"								
											10/26/16 ▽ (6.6')
										7.0' AUGER REFUSAL	12/7/16 ▼ (8.0')
5905.0'	10										SET CASING BEGIN HQ CORING (7.0')
5900.0'	15										
5910.0'	20										
5895.0'	25										
5890.0'											

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/25/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 25, 2016
BORING LOCATION: Dam Foundation South
COORDINATES: 1,592,852' N 2,137,000' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5914.4'
GROUNDWATER EL.: 8.0' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-7

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	7			1	1	60	0			7-8' DRILLED SAMPLE WASHED AWAY SANDSTONE, WEATHERED, STRONG, FINE GRAINED, TAN-BROWN, LOCAL THIN SHALE BEDS, SLIGHTLY WEATHERED, HORIZONTAL FRACTURES, SOME MECHANICAL FRACTURES.	Run #1 11:32 - 12:39 7 MIN / 2' 12/7/16 ▼
	9									IRON STAINED SUB-HORIZONTAL JOINT MECHANICAL FRACTURE	
5905.0'				2	1	83	30				Run #2 11:50 - 12:11 12 MIN /5'
	11									11.2' SHALE, WEATHERED, WEAK, MOIST, THINLY BEDDED, SANDY, ORANGE-DARK GRAY-BLACK, TIGHT HORIZONTAL FRACTURES	DRILLING WATER CHANGES AROUND 11.5' TO BLACK
	13									MECHANICAL FRACTURE	**Packer Test #1** **9.0-20.0'** 3.3×10^{-6} cm/s 3.5 ft/yr 0.3 Lugeons
5900.0'	15			3	1	92	57			SHALE BECOMES DARKER AND CARBONACEOUS	Run #3 12:22 - 12:42 20 MIN /5'
											BIT PLUGGED AT 17'
	17										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/25/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 25, 2016
BORING LOCATION: Dam Foundation South
COORDINATES: 1,592,852' N 2,137,000' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5914.4'
GROUNDWATER EL.: 8.0' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-7

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	17									SHALE, WEATHERED, WEAK, MOIST, THINLY BEDDED, SANDY, ORANGE-DARK GRAY-BLACK, TIGHT HORIZONTAL FRACTURES	
										18.0' SANDSTONE, HIGHLY WEATHERED, WEAK, CLAYEY, WET, LIGHT ORANGE-GRAY	
	19									LIGHT ORANGE-BROWN, SUB-HORIZONTAL - HORIZONTAL FRACTURES, TIGHT	
5895.0'				4	1	100	72				Run #4 2:35-2:57 22 MIN / 5'
	21									21.5' IRON STAINED FRACTURE	
	23									23.0' SHALE, FRESH, WEAK, MOIST, DARK GRAY-BLACK WITH IRON STAINING ON TIGHT HORIZONTAL FRACTURES	
5890.0'					2						**Packer Test #2 20-30'** 3.0×10^{-5} cm/sec 31.4ft/yr 3.1 LUGEONS
	25			5		81	52			25.0' SANDSTONE, WEATHERED, STRONG, WET TANNISH-BROWN, IRON STAINED ROUGH FRACTURES, SUB VERTICAL FRACTURE IS IRON STAINED	Run #5 3:07-3:34 27 MIN / 5'
										26.2' SHALE, DARK GRAY, WEAK, SLIGHTLY WEATHERED, THINLY BEDDED, SANDY, CLAYEY, CARBONACEOUS	
	27										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/25/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 25, 2016
BORING LOCATION: Dam Foundation South
COORDINATES: 1,592,852' N 2,137,000' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5914.4'
GROUNDWATER EL.: 8.0' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-7

ELEVATION	FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	27									SHALE, DARK GRAY, WEAK, SLIGHTLY WEATHERED, THINLY BEDDED, SANDY, CLAYEY, CARBONACEOUS	
										28.1' CLAY, BENTONITIC ASH LAYER, WET, HIGHLY PLASTIC, CLAYEY, SILTY, TANISH-WHITE	
	29										
5885.0'				6	2	88	56				BOTTOM 1' AND TOP 6 " OF BENTONITE LENS WASHED OUT
										30.4' SHALE, DARK GRAY, WEAK, SLIGHTLY WEATHERED, SANDY, CLAYEY, CARBONACEOUS TO 31.8'	Run #6 4:51 - 5:30 39 MIN /5'
	31									MECHANICAL FRACTURE	
										SHALE EXHIBITS A CLAYSTONE TEXTURE BELOW 31.8'	DRILLER SPENT 30 MIN TRYING TO RETRIEVE CORE
	33										
5880.0'											
	35			7	2	100	60			INFILLED CLAY FRACTURES	Run #7 6:00 - 6:20 20 MIN /5'
										35.4' SANDSTONE, WEATHERED, STRONG, WET, TANNISH-BROWN, IRON STAINING ON JOINTS	**PACKER TEST #3: 30-40'** 4.9×10^{-5}cm/sec 50.7ft/yr 5.1 LUGEONS
										36.8'	
	37									SHALE, FRESH, WEAK, MOIST, DARK GRAY, WITH SANDSTONE INTERBEDS AND LIGNITE PARTINGS	

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/25/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 25, 2016
BORING LOCATION: Dam Foundation South
COORDINATES: 1,592,852' N 2,137,000' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5914.4'
GROUNDWATER EL.: 8.0' DATE: 12/7/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-7

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	37									SHALE, FRESH, WEAK, MOIST, DARK GRAY, WITH SANDSTONE INTERBEDS AND LIGNITE PARTINGS	
										INFILLED CLAY FRACTURES	
5875.0'	39										**WELL 10/26/16**
										40.0' END OF HOLE	CUTTINGS/GROUT 0-3' BETONITE 3-6' SAND 6-19' SCREEN 19-39' BENTONITE 39-40'
	41										
	43										
5870.0'											
	45										
	47										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/25/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 28, 2016
BORING LOCATION: Dam Foundation (East)
COORDINATES: 1,592,914' N 2,137,544' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5942.8'
GROUNDWATER EL.: 34.4' DATE: 12/8/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: SS Auger
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-10

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	0									TOPSOIL CLAY, MOIST, BROWN, PLASTIC, MEDIUM STIFF, WEATHERED, STRONG, DRY,	
5940.0'										2.0' SHALE 3.0' SANDSTONE, WEATHERED, STRONG, DRY	
		S	50\1"							TAN-GRAY, WELL CEMENTED, MEDIUM TO FINE GRAINED, TAN-GRAY, YELLOW- ORANGE WHERE FRACTURED, MASSIVE	NO RECOVERY GRAB AT 4.0'
	5									SHALE, CLAYEY, PLASTIC, PLATY, DARK GREY, WEAK ROCK, SOME HORIZONTAL FRACTURES	
5935.0'										5.5' SANDSTONE 7.0' SHALE 7.5' SANDSTONE	
	10									AUGER REFUSAL AT 9.5'	BEGIN HQ CORING (9.5')
5930.0'											
	15										
5925.0'											
	20										
5920.0'											
	25										
5915.0'											

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla town Reservoir [0410.004.00]
DATE: 10/28/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 28, 2016
BORING LOCATION: Dam Foundation (East)
COORDINATES: 1,592,914' N 2,137,544' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5942.8'
GROUNDWATER EL.: 34.4' DATE: 12/8/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-10

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	9			1	1	100	83			SANDSTONE, WEATHERED, STRONG, DRY TAN-GRAY, WELL CEMENTED, MEDIUM TO FINE GRAINED, TAN-GRAY, YELLOW- ORANGE WHERE FRACTURED, MASSIVE	Run #1 2:05-2:11 6 MIN / 4.5'
	11										
5930.0'	13			2	1	99	92				Run #2 2:21- 3:32 1HR 11 MIN /5' **Packer Test #1** **11.0-19.0'** 1.0×10^{-7} cm/s 0.1 ft/yr 0.01 Lugeons
	15										
	17									17.0' SANDSTONE BECOMES FRESH MECHANICAL FRACTURE	
5925.0'	19										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/28/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 28, 2016
BORING LOCATION: Dam Foundation (East)
COORDINATES: 1,592,914' N 2,137,544' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5942.8'
GROUNDWATER EL.: 34.4' DATE: 12/8/16

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-10

DEPTH		SOIL SAMPLES		ROCK CORE					GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
ELEVATION	FEET	TYPE	BLOWS PER 6 INCHES	RUN NO.	BOX NO.	RECOVERY, %	RQD %	FRACTURE DRAWING			
	19			3	1	100	83			SANDSTONE, FRESH, STRONG, FINE GRAINED, DRY, GRAY, MASSIVE	
										20' SANDSTONE BECOMES TAN TO ORANGE -BROWN	Run #3 3:37-3:51 14 MIN / 5'
	21										
5920.0'										22.9' SHALE, WEATHERED, WEAK, MOIST, THINLY BEDDED, GRAY TO ORANGE-BROWN, PLASTIC, SOME HORIZONTAL FRACTURES WITH CLAY INFILLING, AND THIN LOCAL SANDSTONE BEDS	
	23									MECHANICAL FRACTURE	
				4	2	100	94			24.4' SHALE BECOMES LESS SANDY AND SOFT	Run #4 4:01-4:18 17 MIN / 5'
	25									25.0' SHALE BECOMES BLACK AND CARBONACEOUS	
											Packer Test #2 **20-40'** 4.8×10^{-5}cm/sec 50.2ft/yr 5.0 LUGEONS
	27										
5915.0'											
	29										

BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/27/16

DEERE & AULT CONSULTANTS, INC.

DATE START/FINISH: October 28, 2016
BORING LOCATION: Dam Foundation (East)
COORDINATES: 1,592,914' N 2,137,544' E (CO State Plane South)
GROUND ELEVATION (NGVD): 5942.8'
GROUNDWATER EL.: 34.4' DATE: 12/8/2016

DRILLED BY: Elite Drilling Services - Dan
DRILLING METHOD: HQ core
DRILL BIT SIZE/TYPE: HQ TOTAL DEPTH (FT): 40.0
LOGGED BY: TWD
BOREHOLE COMPLETION: Monitoring Well

NR-10

DEPTH ELEVATION	DEPTH FEET	SOIL SAMPLES TYPE	SOIL SAMPLES BLOWS PER 6 INCHES	ROCK CORE RUN NO.	ROCK CORE BOX NO.	ROCK CORE RECOVERY, %	ROCK CORE RQD %	ROCK CORE FRACTURE DRAWING	GRAPHIC LOG	MATERIAL DESCRIPTION	FIELD NOTES & TEST RESULTS
	29			5	2	100	92			29.5' SANDSTONE, WEATHERED, CLAYEY, WITH TIGHT IRON STAINED JOINTS	Run #5 4:28-4:49 21 MIN /5'
										30.6' SANDSTONE BECOMES FRESH AND GRAY	
	31										10/28/16 ▽ (32.4')
5910.0'											
	33									33.2' SHALE,WEAK, MOIST, GRAY TO DARK GRAY, THINLY BEDDED, PLASTIC, ORANGE IRON STAINING ON HORIZONTAL FRACTURES	
				6	2	94	84				12/8/16 ▼ (34.4') Run #6 4:57-5:22 13 MIN / 5'
	35										
											WELL 10/28/16 CUTTINGS/GROUT 0-9'
	37										BETONITE 9-11' SAND 11-20' SCREEN 20-40'
5905.0'										CLAY INFILLED FRACTURE	
	39			7	2	100	100				Run #7 5:32-5:45 13 MIN / 1'
										IRON STAINING AND SLICKENSIDES ON FRACTURES	

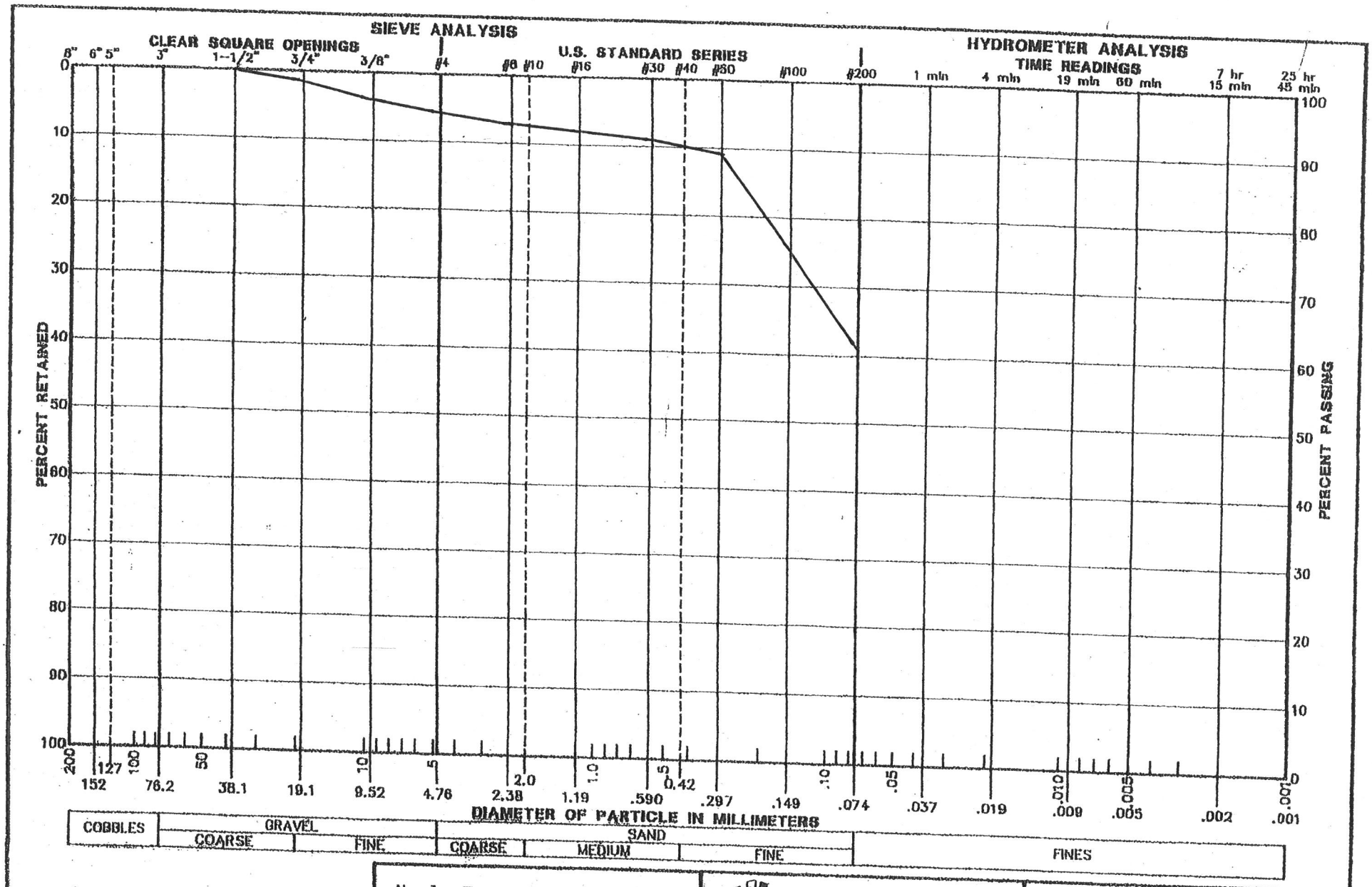
BLOWS PER 6 IN.-140 LB. HAMMER FALLING 30 IN. TO DRIVE A 2.0 IN. OD SPLIT SPOON SAMPLER
REC-RECOVERY LENGTH OF CORE/LENGTH CORED (%)
RQD-LENGTH OF SOUND CORES >4 IN./LENGTH CORED (%)
S-SPLIT SPOON SAMPLE
▽-GROUNDWATER SURFACE DURING DRILLING
▼-GROUNDWATER SURFACE AFTER DRILLING

PROJECT: Nucla Town Reservoir [0410.004.00]
DATE: 10/28/16

DEERE & AULT CONSULTANTS, INC.

APPENDIX B
LABORATORY TEST RESULTS

GRADATION AND HYDROMETER TESTS



ATTERBERG LIMITS:
LL 29
PL 17

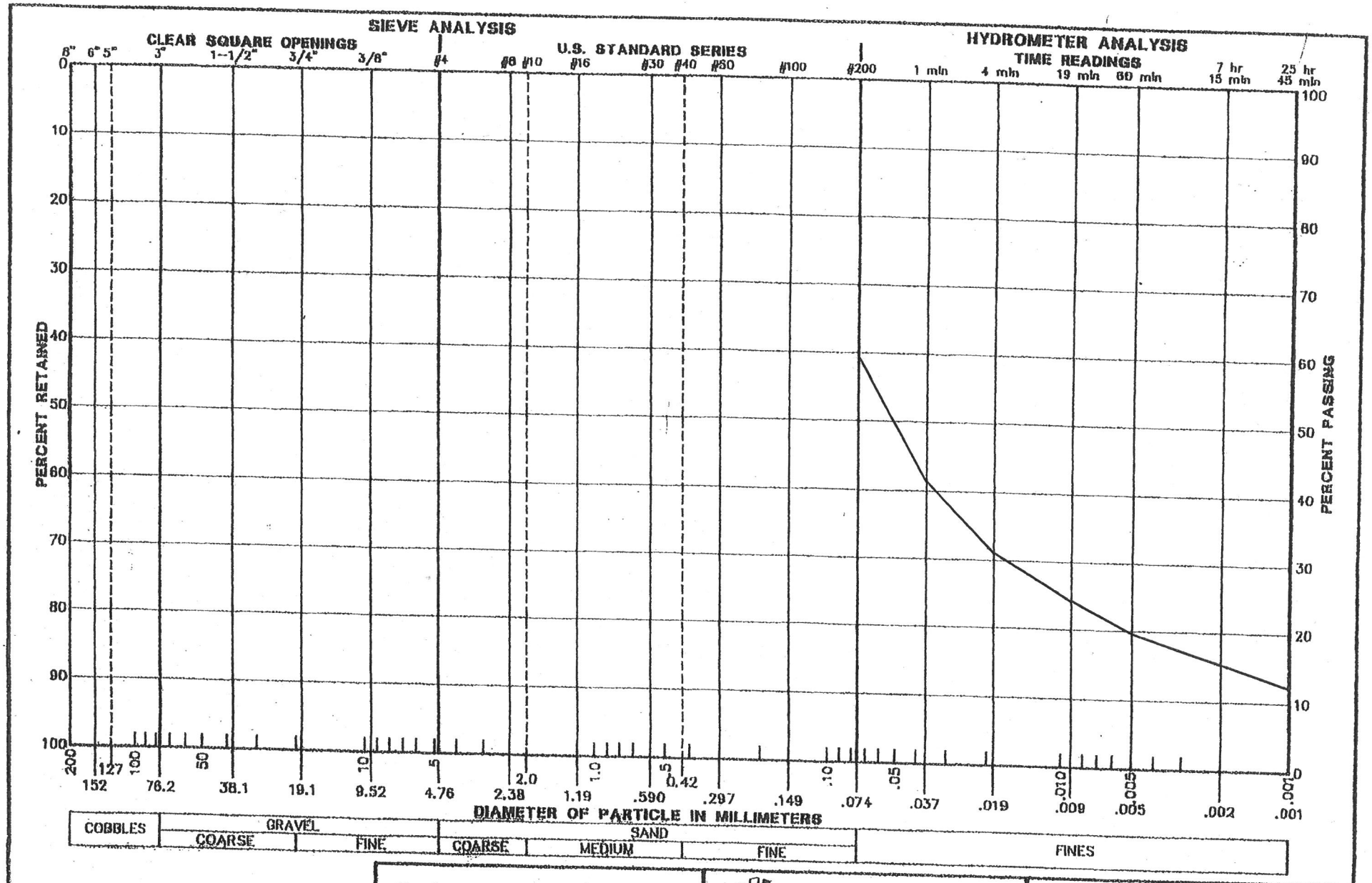
Nucla Town Reservoir

NR-6 @ 0'-5.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 1



ATTERBERG LIMITS:

LL 37

PL 22

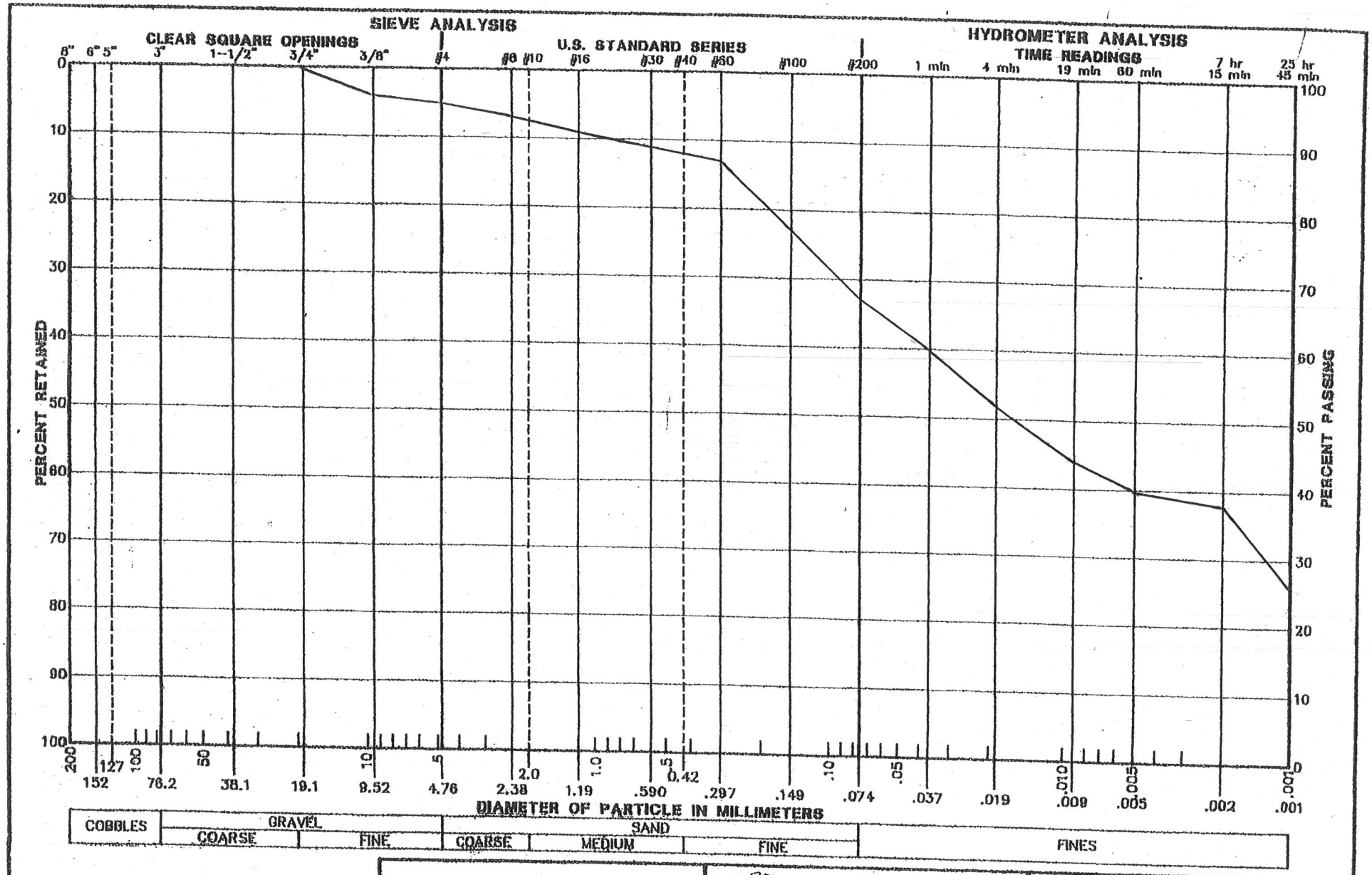
Nucla Town Reservoir

NR-6 @ 5.0'-6.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 2



ATTERBERG LIMITS:

LL 27

PL 11

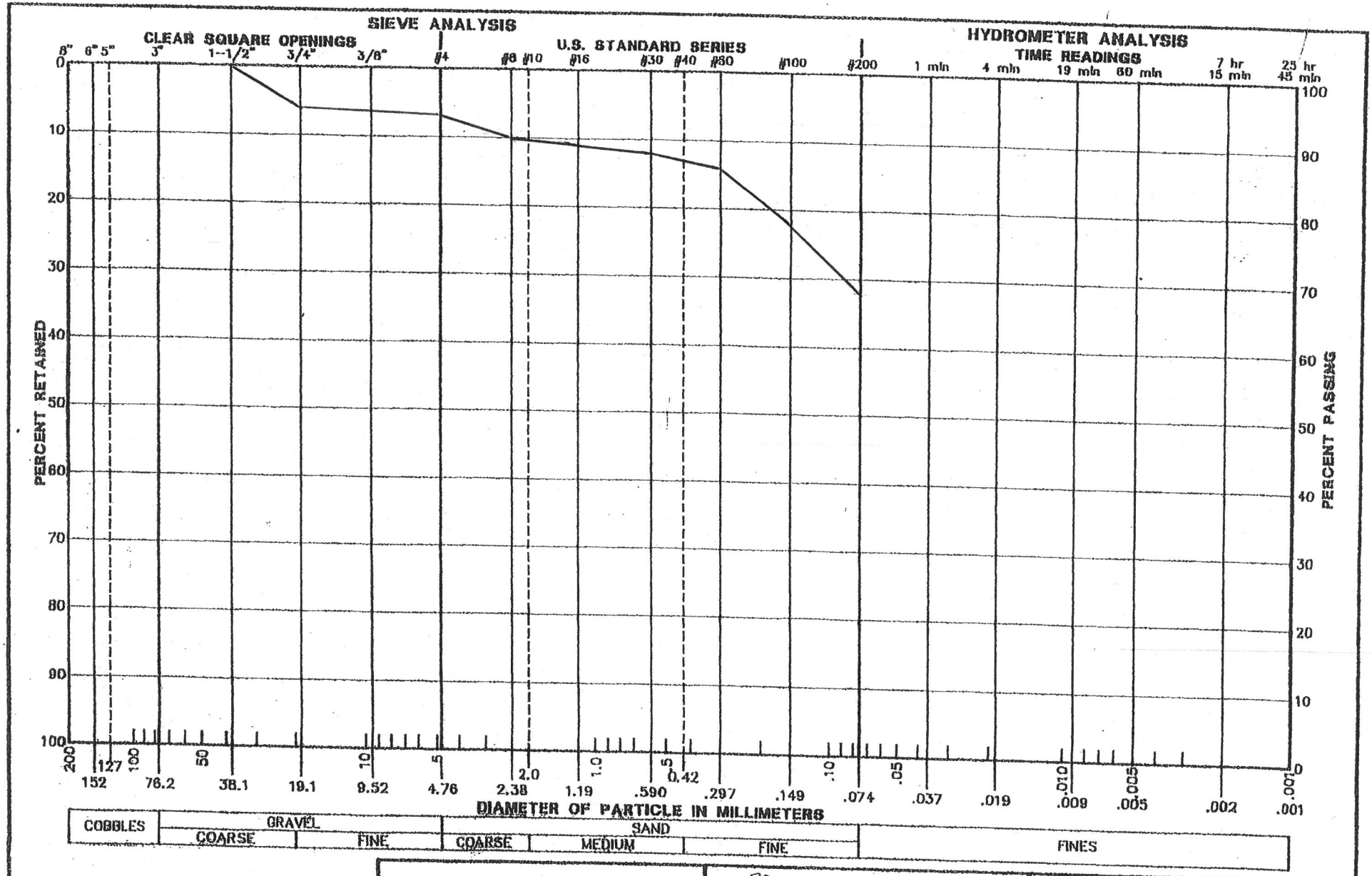
Nucla Town Reservoir

NR-8 @ 4.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 3



ATTERBERG LIMITS:
LL 36
PL 18

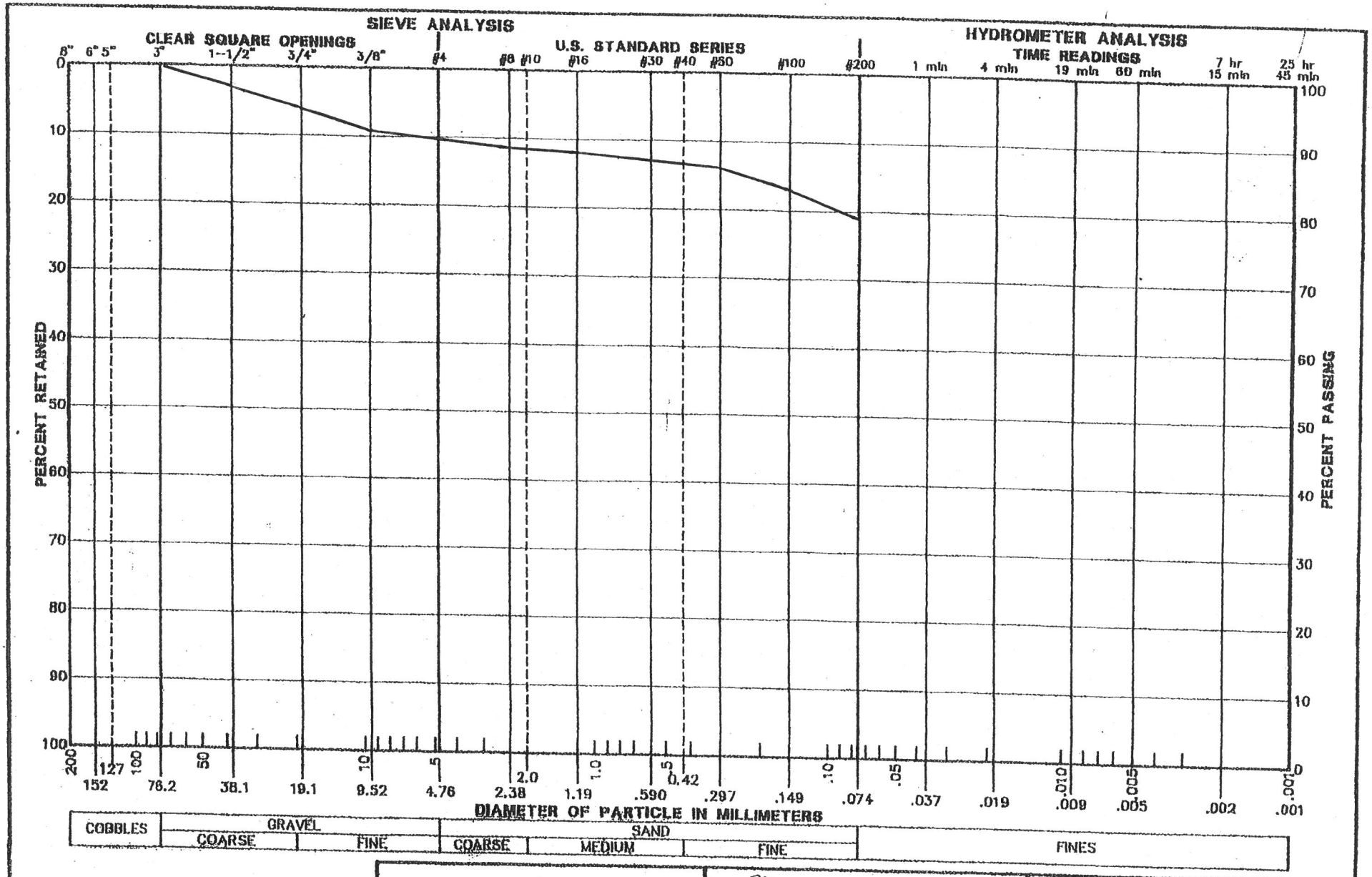
Nucla Town Reservoir

NR-8 @ 9.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 4



ATTERBERG LIMITS:

LL 35

PL 16

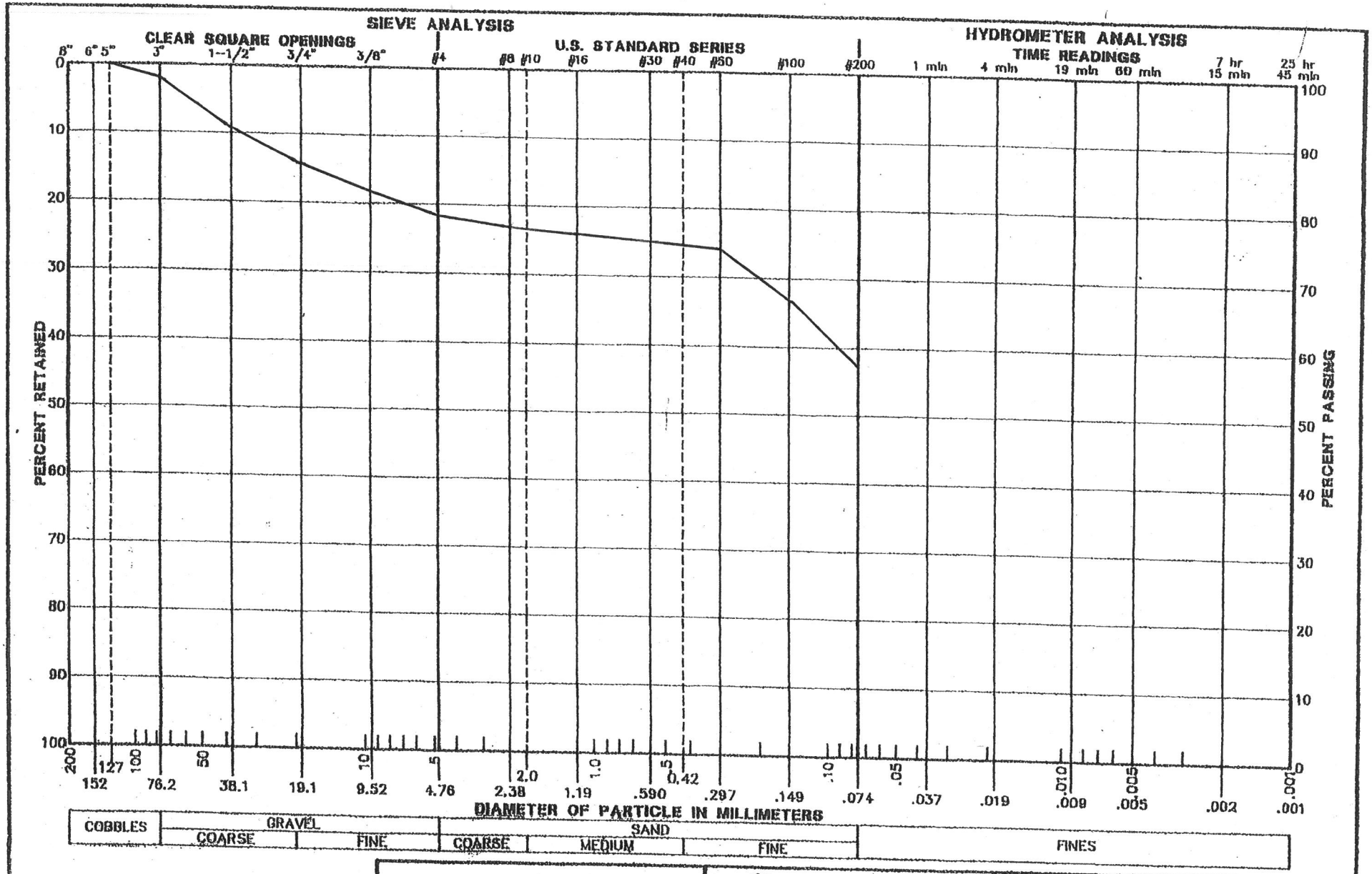
Nucla Town Reservoir

TP-2 @ 3.5'-5.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 5



ATTERBERG LIMITS:

LL 29

PL 13

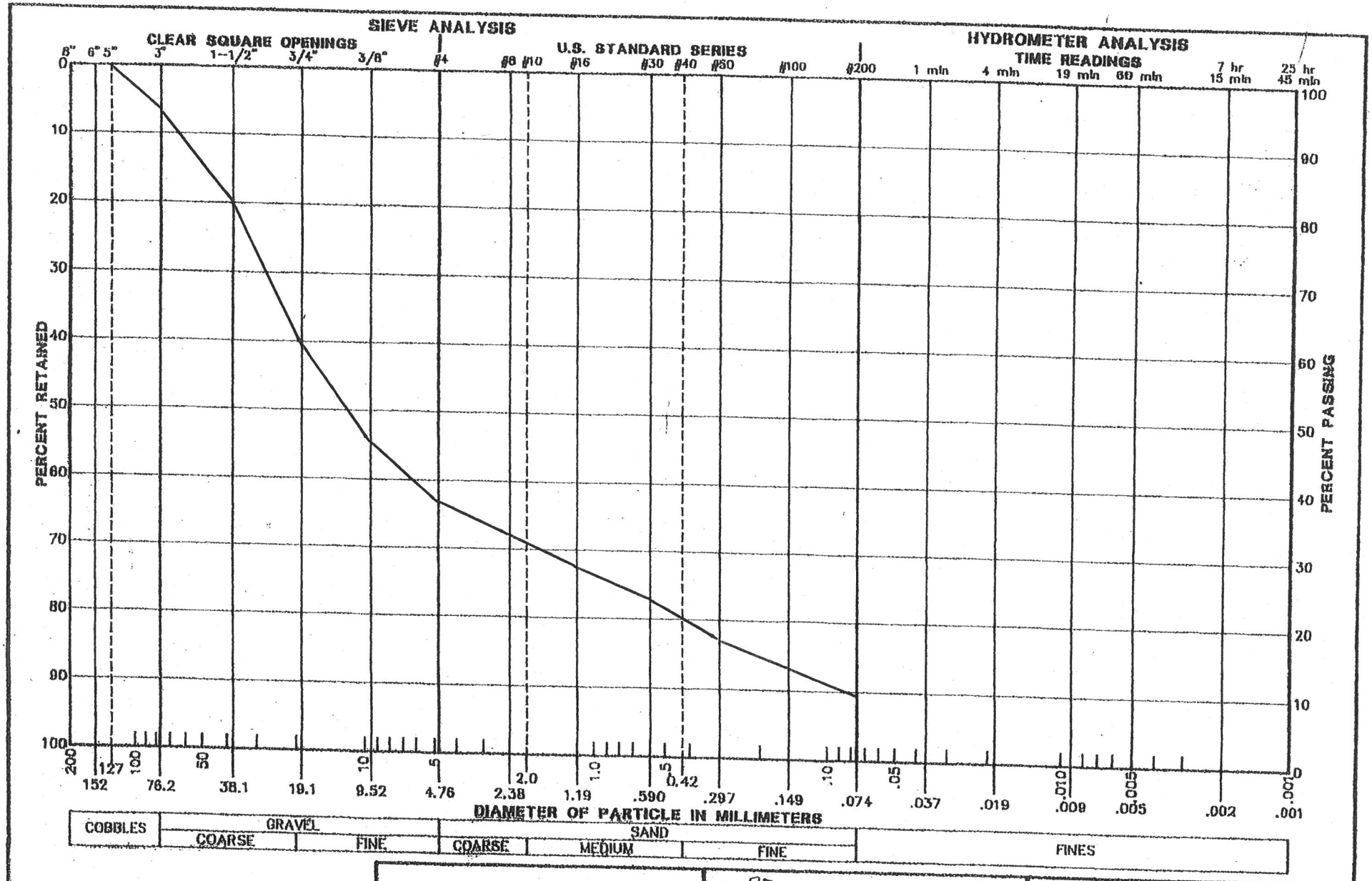
Nucla Town Reservoir

TP-3 @ 3.0'-7.0'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 6



ATTERBERG LIMITS:

LL ---

PL ---

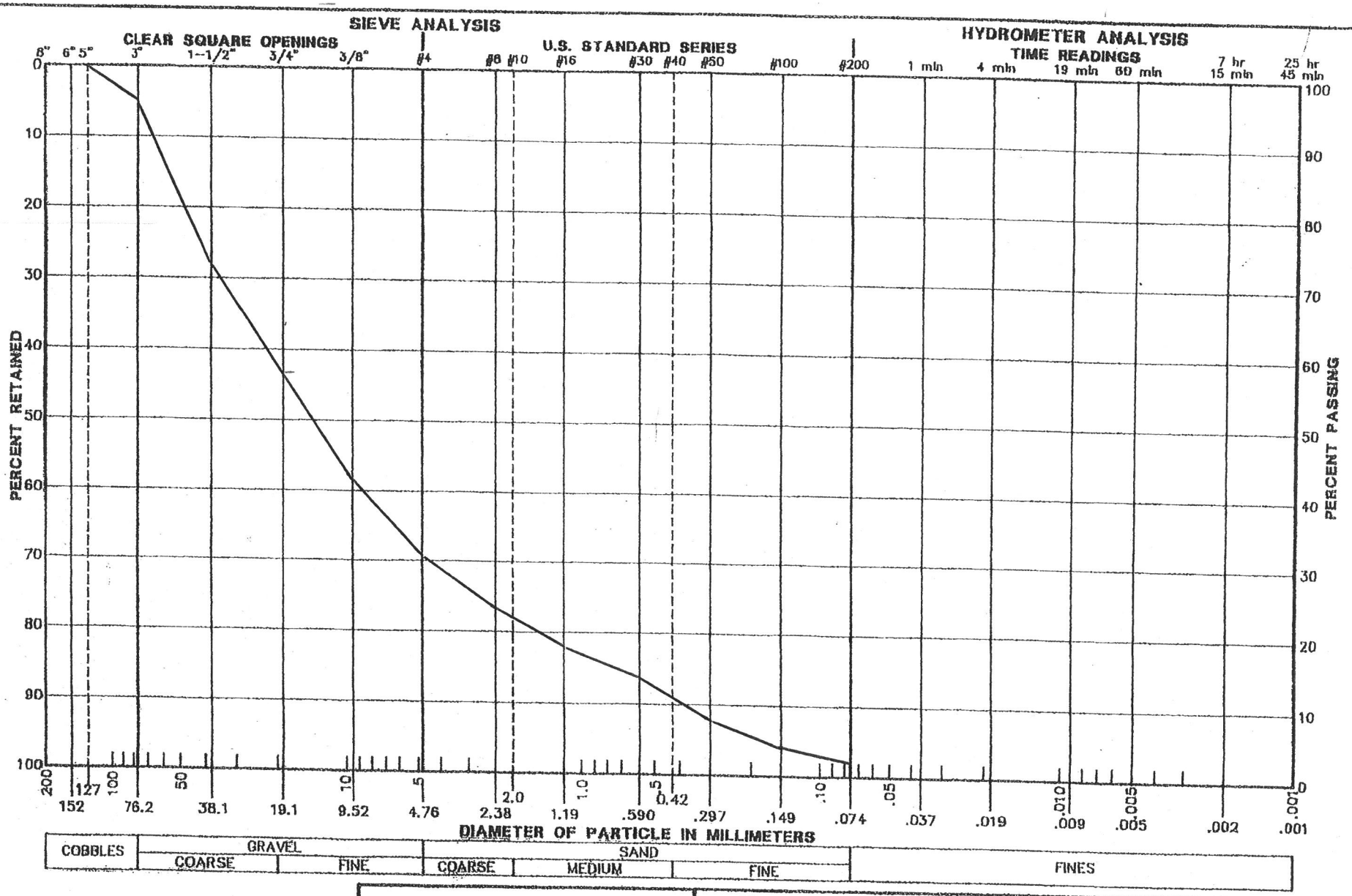
Nucla Town Reservoir

Tp-7 @ 3.0'-4.5'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 7



ATTERBERG LIMITS:

LL ---

PL ---

Nucla Town Reservoir

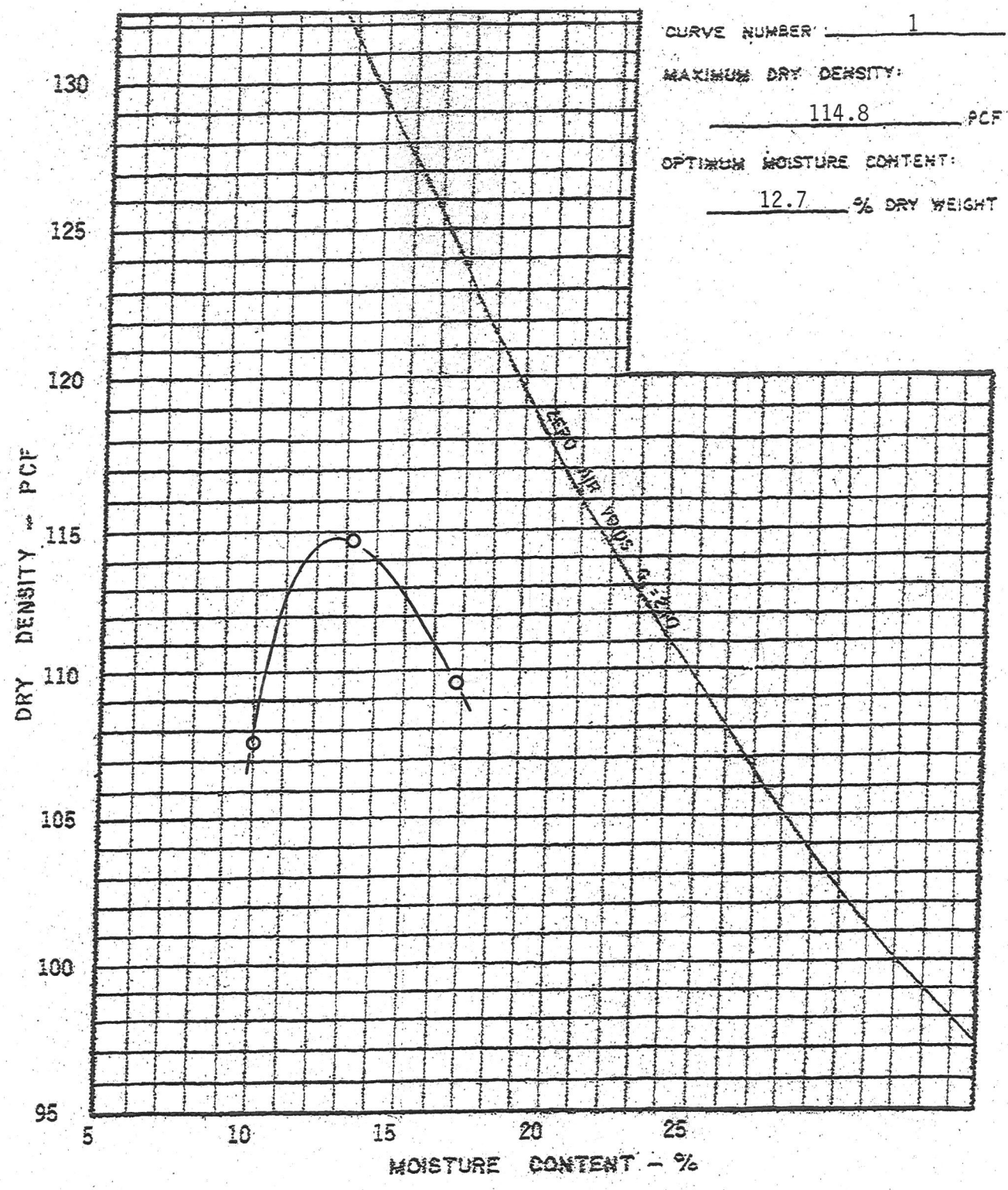
TP-8 @ 5.0'-6.5'

J.R. Valentine, Inc.

GRADATION TEST

FIGURE 8

STANDARD PROCTOR
MOISTURE/DENSITY RELATIONSHIPS

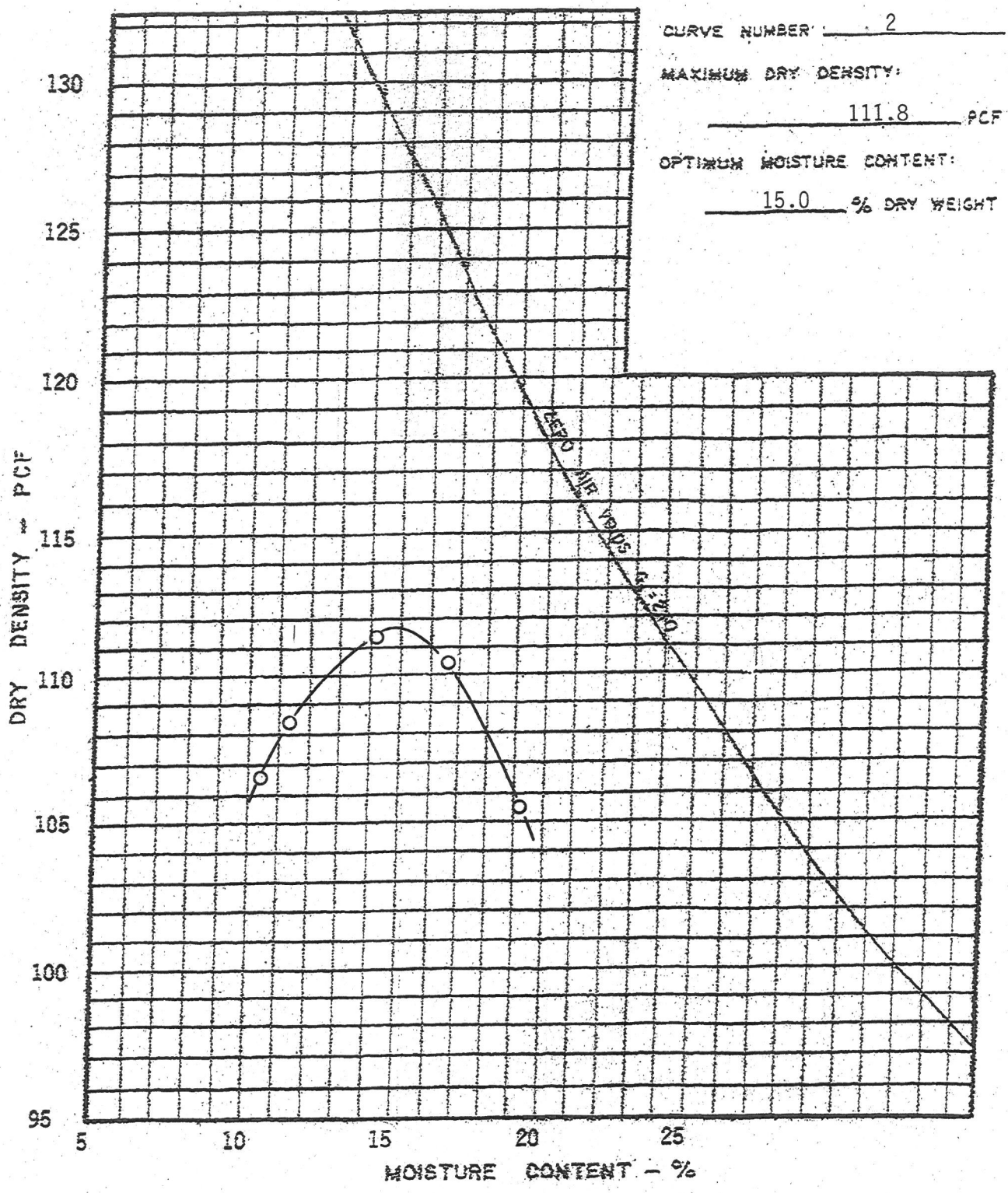


SAMPLE DESCRIPTION Sandy Clay With Some Gravel

LOCATION Nucla Town Reservoir NR-6 @0'-5.0'

COMPACTION TEST PROCEDURE ASTM D698 Method C

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION Sandy Clay with Gravel

LOCATION Nucla Town Reservoir TP-2 @ 3.5'-5.0'

COMPACTION TEST PROCEDURE ASTM D698 Method C

COMPACTION TEST RESULTS

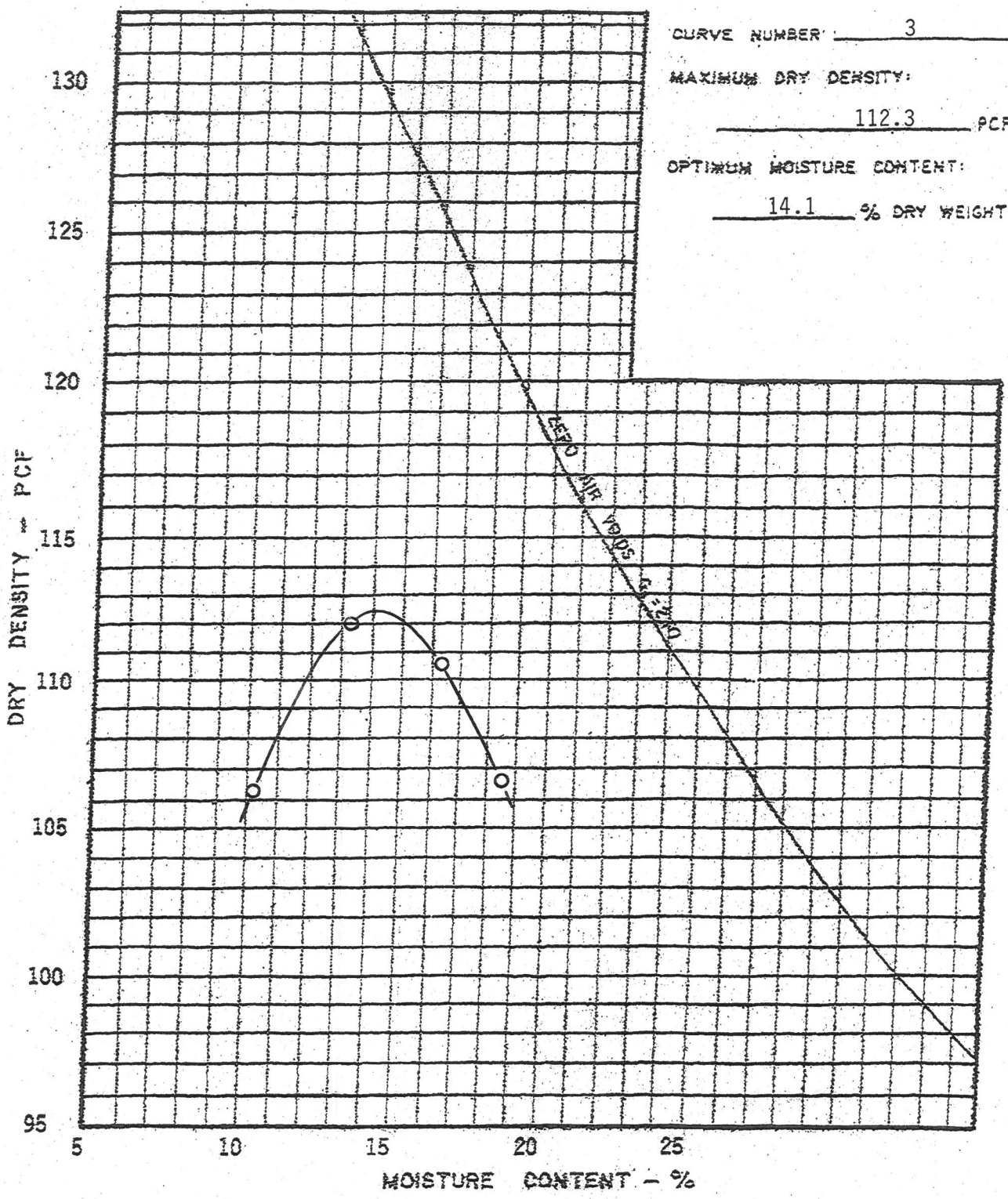
CURVE NUMBER 3

MAXIMUM DRY DENSITY:

112.3 PCF

OPTIMUM MOISTURE CONTENT:

14.1 % DRY WEIGHT



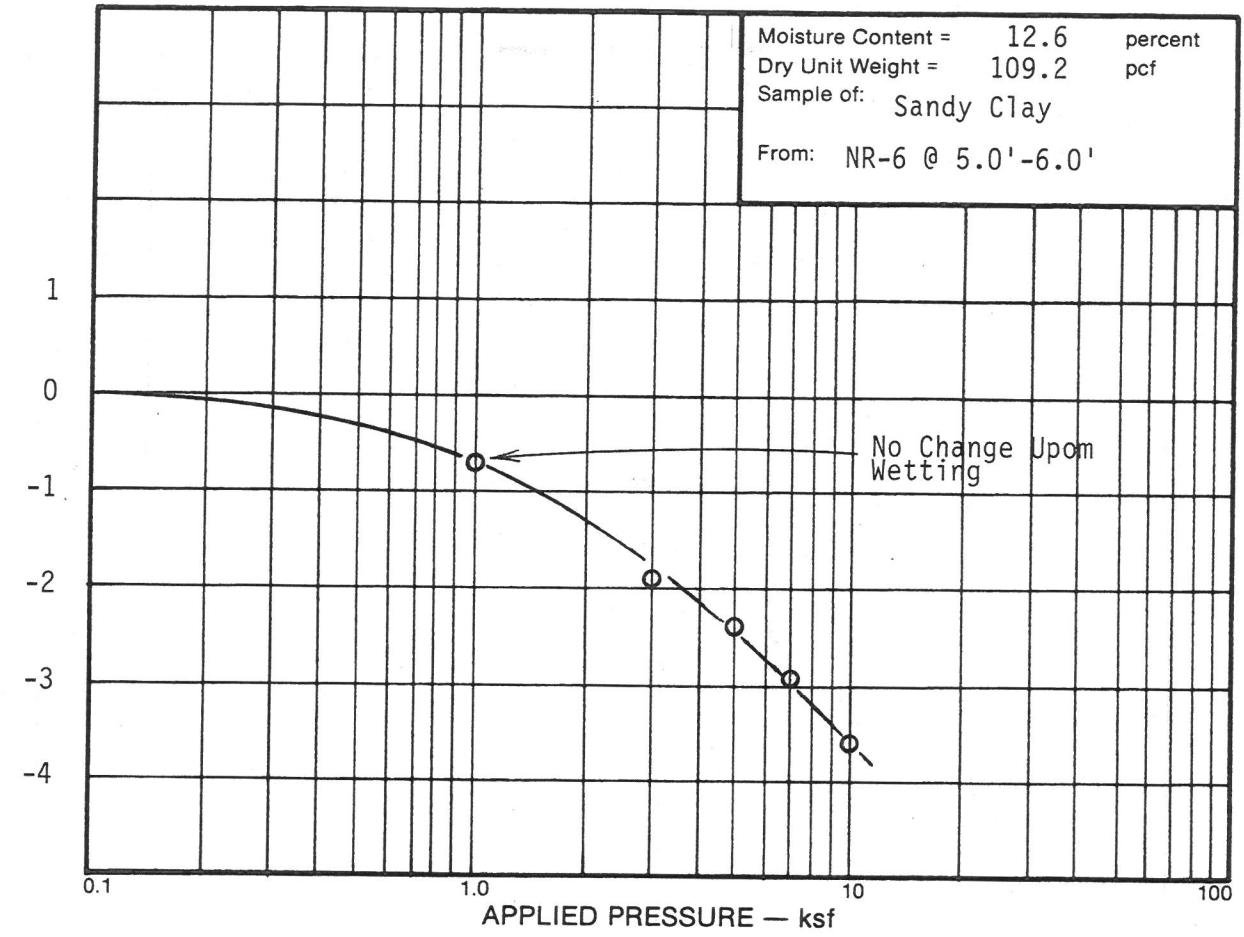
SAMPLE DESCRIPTION Sandy Clay with Gravel

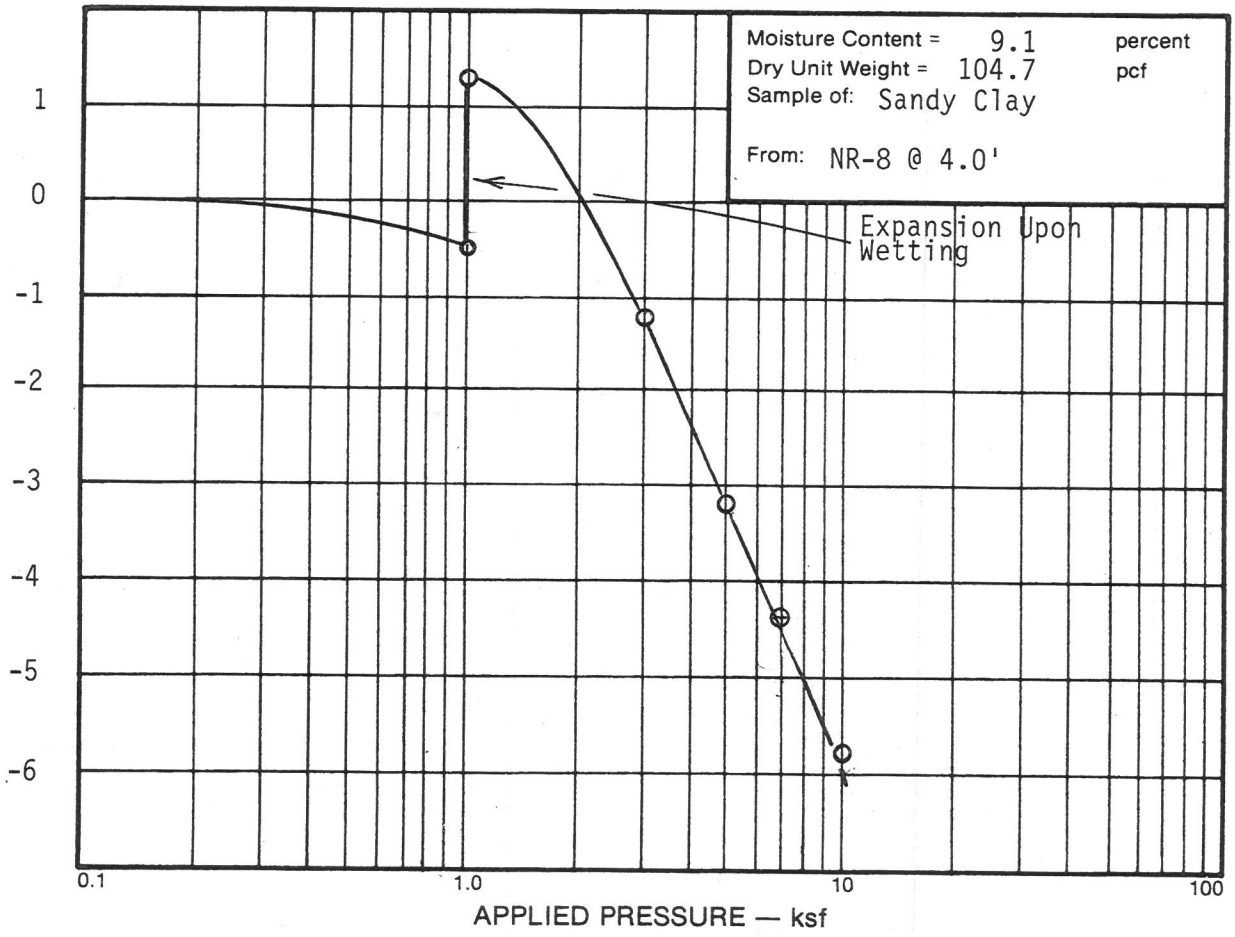
LOCATION Nucla Town Reservoir TP-3 @ 3.0'-7.0'

COMPACTION TEST PROCEDURE ASTM D698 Method C

COMPACTION TEST RESULTS

REMOLDED 1-DIMENSIONAL SWELL/CONSOLIDATION TESTS





SWELL-CONSOLIDATION TEST RESULTS

Fig. 1

APPENDIX C
CORE PHOTOGRAPHS

Boring NR-5 – Box#1

Boring NR-5 – Box#2

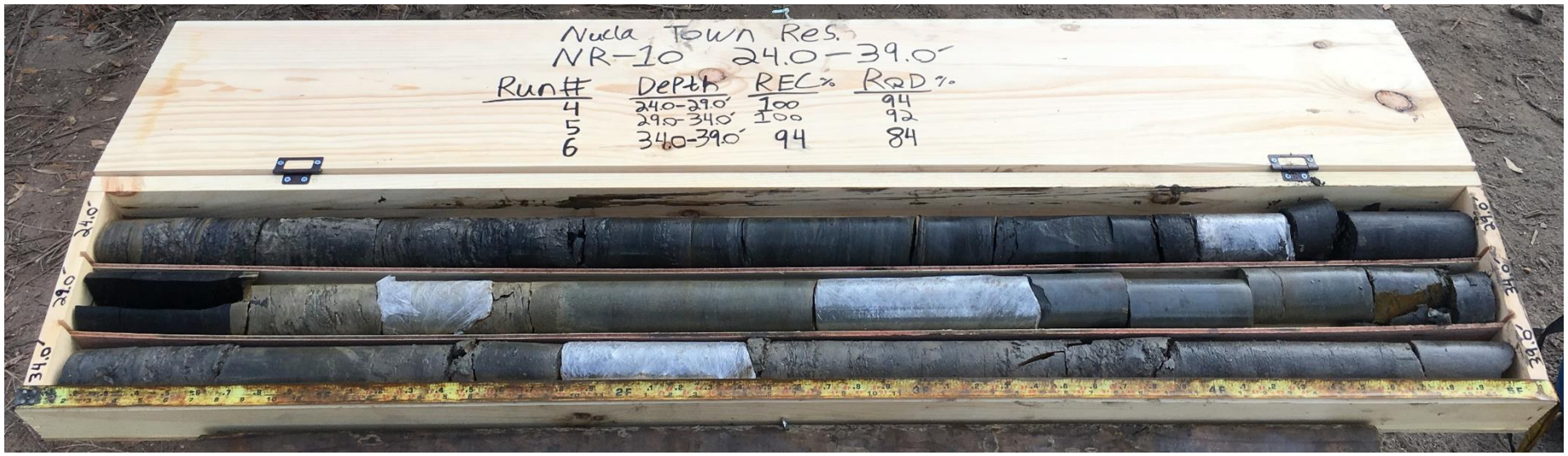
Boring NR-5 – Box#3

Boring NR-7 – Box#1

Boring NR-7 – Box#2

Boring NR-10 – Box#1

Boring NR-10 – Box#2



APPENDIX D
TEST PIT PHOTOGRAPHS

TEST PIT TP-1

TP- 1: Test pit wall with clayey fill soils overlying shale bedrock.

TP- 1: Excavated soil pile from test pit.

TEST PIT TP-2

TP- 2: Test pit wall with clayey fill soils overlying shale bedrock.

TP- 2: Fill soils and weathered shale bedrock excavated from test pit.

TEST PIT TP-3

TP- 3: Test pit with clayey sand and gravel fill.

TP- 3: Excavated pile of fill material from test pit.

TEST PIT TP-4

TP- 4: Test pit with fill soils overlying shale bedrock.

TP- 4: Excavated pile of fill soil from test pit.

TEST PIT TP-5

TP- 5: Shallow test pit showing very hard pale yellow sandstone bed.

TP- 5: Test pit excavation.

TEST PIT TP-6

TP- 6: Shallow test pit showing hard pale yellow sandstone bed on bottom.

TP- 6: Excavated pile of hard sandstone next to test pit.

TEST PIT TP-7

TP- 7: Floodplain deposits overlying saturated alluvial sand and gravel with large cobbles.

TP- 7: Excavated pile of saturated alluvial soils.

TEST PIT TP-8

TP- 8: Floodplain deposits overlying saturated alluvial sand and gravel with large cobbles.

TP- 8: Excavator bucket with saturated alluvial soils.

APPENDIX E
PACKER PERMEABILITY TEST RESULTS

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-5**	**Test No.:**	**1**
Date:	10/26/2016		
Weather:	Sunny		
Time:	13:45		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	9.0	feet	Depth to Top of Test Zone
Db	19.0	feet	Depth to Bottom of Test Zone
Dgwt	3.5	feet	Depth to Static Groundwater Table in Boring
Dg	2.0	feet	Height of Pressure Gauge above Ground
	175.0	psi	Pressure of inflated Packer

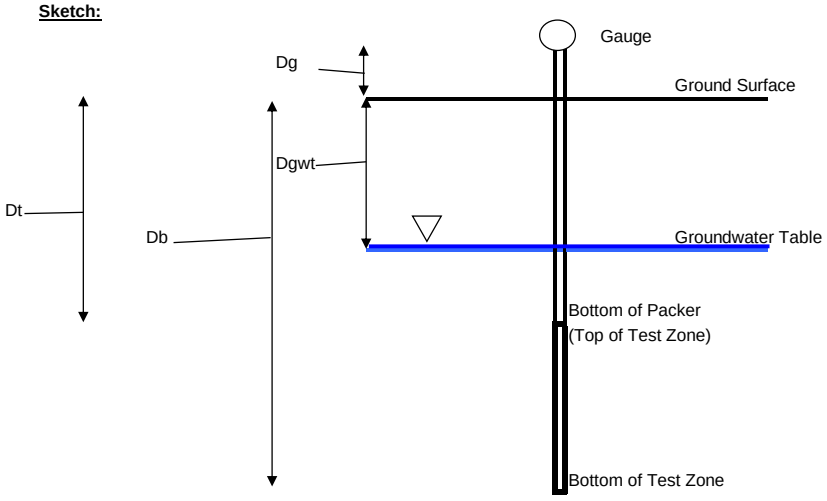
Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Sandstone with Shale (9-12.3'), weathered to fresh, moderately fractured

Field Input | **Calculations**

Water Meter Data			Gauge	Elapsed	Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Start	End	Total	Pressure	Time	Pressure	Height					k	k	k
gallons	gallons	gallons	psi	minute	feet	feet	feet	feet		gpm	ft/year	cm/sec	Lugeons
16.20	16.40	0.20	5	5	11.5	2.0	3.5	17.0	4400	0.0	10.3	1.0E-05	1.03
16.70	17.00	0.30	10	5	23.1	2.0	3.5	28.6	4400	0.1	9.2	8.9E-06	0.92
17.30	20.80	3.50	15	5	34.6	2.0	3.5	40.1	4400	0.7	76.8	7.4E-05	7.68
20.80	21.00	0.20	10	5	23.1	2.0	3.5	28.6	4400	0.0	6.2	6.0E-06	0.62
21.00	21.00	0.00	5	5	11.5	2.0	3.5	17.0	4400	0.0	0.1	1.0E-07	0.01
										Average K	20.5	2.0E-05	2.05

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-5**	**Test No.:**	**2**
Date:	10/26/2016		
Weather:	Sunny		
Time:	16:00		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	19.0	feet	Depth to Top of Test Zone
Db	29.0	feet	Depth to Bottom of Test Zone
Dgwt	4.5	feet	Depth to Static Groundwater Table in Boring
Dg	2.0	feet	Height of Pressure Gauge above Ground
	175.0	psi	Pressure of inflated Packer

Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Shale with interbedded sandstone

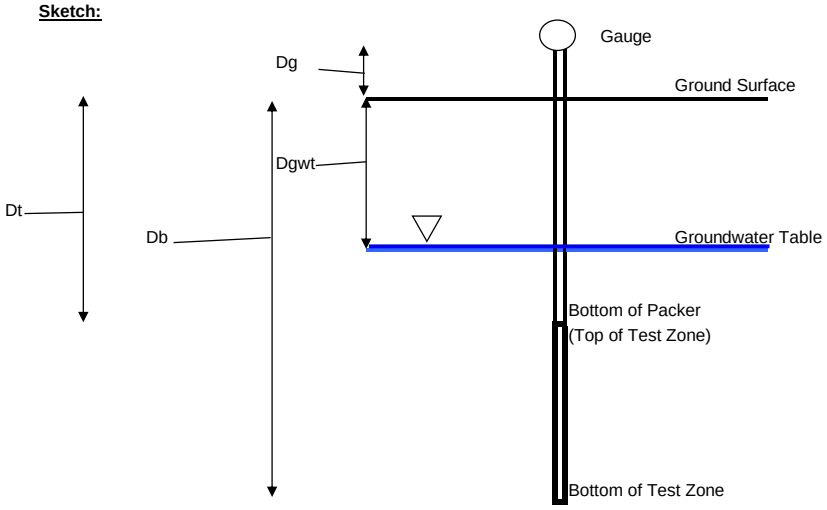
Field Input

Water Meter Data			Gauge	Elapsed
Start	End	Total	Pressure	Time
gallons	gallons	gallons	psi	minute
9.40	9.40	0.00	5	5
9.70	9.70	0.00	15	5
9.90	9.90	0.00	25	5
9.90	9.90	0.00	15	5
9.90	9.90	0.00	5	5

Calculations

Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Pressure	Height					k	k	k
feet	feet	feet	feet		gpm	ft/year	cm/sec	Lugeons
11.5	2.0	4.5	18.0	4400	0.0	0.1	1.0E-07	0.01
34.6	2.0	4.5	41.1	4400	0.0	0.1	1.0E-07	0.01
57.7	2.0	4.5	64.2	4400	0.0	0.1	1.0E-07	0.01
34.6	2.0	4.5	41.1	4400	0.0	0.1	1.0E-07	0.01
11.5	2.0	4.5	18.0	4400	0.0	0.1	1.0E-07	0.01
					Average K	0.1	1.0E-07	0.01

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-5**	**Test No.:**	**3**
Date:	10/26/2016		
Weather:	Sunny		
Time:	18:55		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	29.0	feet	Depth to Top of Test Zone
Db	44.0	feet	Depth to Bottom of Test Zone
Dgwt	6.5	feet	Depth to Static Groundwater Table in Boring
Dg	2.0	feet	Height of Pressure Gauge above Ground
	175.0	psi	Pressure of inflated Packer

Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Shale with interbedded sandstone & siltstone

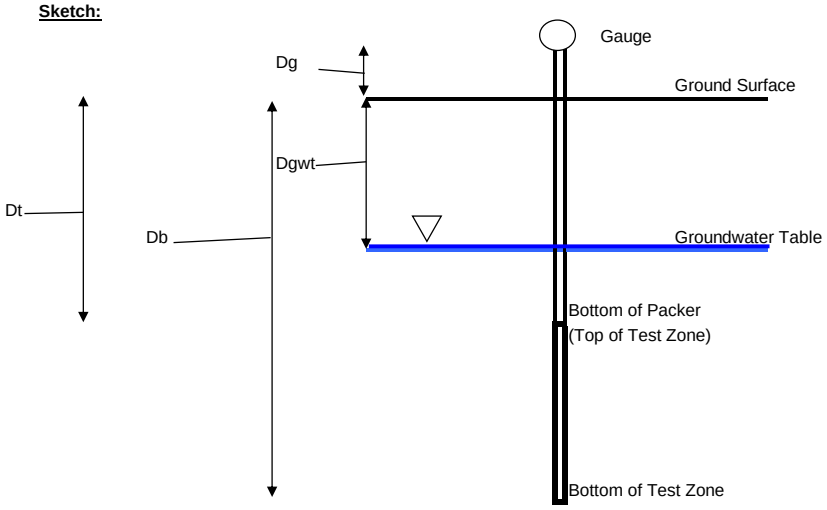
Field Input

Water Meter Data			Gauge	Elapsed
Start	End	Total	Pressure	Time
gallons	gallons	gallons	psi	minute
9.80	9.80	0.0	15	5
9.90	9.90	0.0	25	5
9.90	9.90	0.0	35	5
9.90	9.90	0.0	25	5
9.90	9.90	0.0	15	5

Calculations

Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Pressure	Height					k	k	k
feet	feet	feet	feet		gpm	ft/year	cm/sec	Lugeons
34.6	2.0	6.5	43.1	3100	0.0	0.1	1.0E-07	0.01
57.7	2.0	6.5	66.2	3100	0.0	0.1	1.0E-07	0.01
80.8	2.0	6.5	89.3	3100	0.0	0.1	1.0E-07	0.01
57.7	2.0	6.5	66.2	3100	0.0	0.1	1.0E-07	0.01
34.6	2.0	6.5	43.1	3100	0.0	0.1	1.0E-07	0.01
					Average K	0.1	1.0E-07	0.01

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-7**	**Test No.:**	**1**
Date:	10/25/2016		
Weather:	Sunny		
Time:	13:50		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	9.0	feet	Depth to Top of Test Zone
Db	20.0	feet	Depth to Bottom of Test Zone
Dgwt	8.0	feet	Depth to Static Groundwater Table in Boring
Dg	5.0	feet	Height of Pressure Gauge above Ground
	250.0	psi	Pressure of inflated Packer

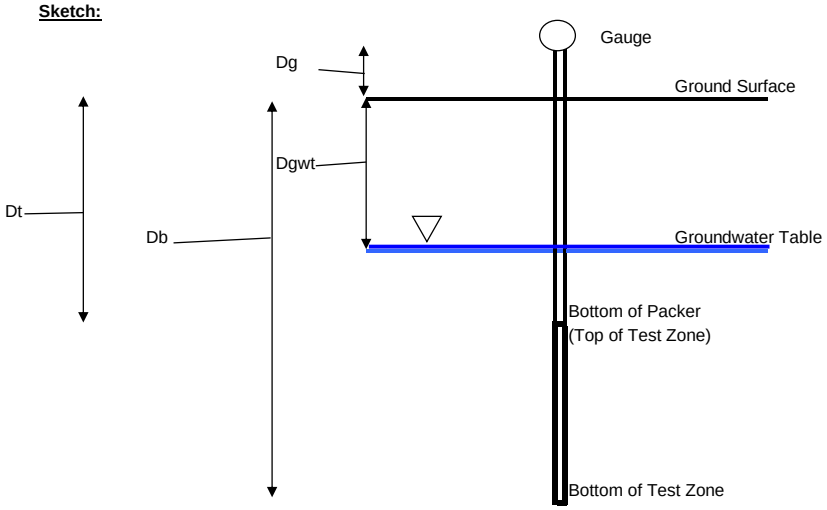
Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Interbedded sandstone & shale, weak, fractured, slightly weathered to weathered

Field Input / **Calculations**

Water Meter Data			Gauge	Elapsed	Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Start gallons	End gallons	Total gallons	Pressure psi	Time minute	Pressure feet	Height feet	feet	feet		gpm	k ft/year	k cm/sec	k Lugeons
47.2	47.2	0.0	6	5	13.8	5.0	8.0	26.8	4100	0.0	0.1	1.0E-07	0.01
47.8	53.6	5.8	12	5	27.7	5.0	8.0	40.7	4100	1.2	Packer likely not fully inflated		
54.7	55.6	0.9	18	5	41.5	5.0	8.0	54.5	4100	0.2	13.5	1.3E-05	1.35
55.3	55.3	0.0	12	5	27.7	5.0	8.0	40.7	4100	0.0	0.1	1.0E-07	0.01
55.1	55.1	0.0	6	5	13.8	5.0	8.0	26.8	4100	0.0	0.1	1.0E-07	0.01
										Average K	3.46	3.3E-06	0.35

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-7**	**Test No.:**	**2**
Date:	10/25/2016		
Weather:	Sunny		
Time:	16:10		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	20.0	feet	Depth to Top of Test Zone
Db	30.0	feet	Depth to Bottom of Test Zone
Dgwt	8.0	feet	Depth to Static Groundwater Table in Boring
Dg	4.0	feet	Height of Pressure Gauge above Ground
	250.0	psi	Pressure of inflated Packer

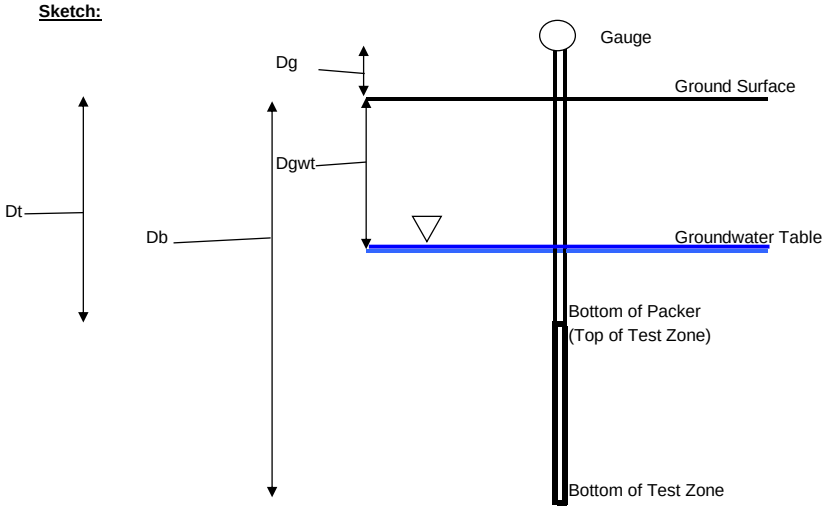
Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Interbedded sandstone & shale

Field Input / **Calculations**

Water Meter Data Start gallons	Water Meter Data End gallons	Water Meter Data Total gallons	Gauge Pressure psi	Elapsed Time minute	Gauge Pressure feet	Gauge Height feet	GWT feet	Ht feet	Cp	Q gpm	Permability k ft/year	Permability k cm/sec	Permability k Lugeons
68.8	70.1	1.3	10	5	23.1	4.0	8.0	35.1	4400	0.3	32.6	3.2E-05	3.26
71.0	73.0	2.0	17	5	39.2	4.0	8.0	51.2	4400	0.4	34.4	3.3E-05	3.44
74.0	77.3	3.3	25	5	57.7	4.0	8.0	69.7	4400	0.7	41.7	4.0E-05	4.17
77.4	79.2	1.8	17	5	39.2	4.0	8.0	51.2	4400	0.4	30.9	3.0E-05	3.09
79.2	79.9	0.7	10	5	23.1	4.0	8.0	35.1	4400	0.1	17.6	1.7E-05	1.76
										Average K	31.4	3.0E-05	3.14

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-7**	**Test No.:**	**3**
Date:	10/25/2016		
Weather:	Sunny		
Time:	19:45		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	30.0	feet	Depth to Top of Test Zone
Db	40.0	feet	Depth to Bottom of Test Zone
Dgwt	6.6	feet	Depth to Static Groundwater Table in Boring
Dg	4.0	feet	Height of Pressure Gauge above Ground
	200.0	psi	Pressure of inflated Packer

Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Sandstone with interbedded shale

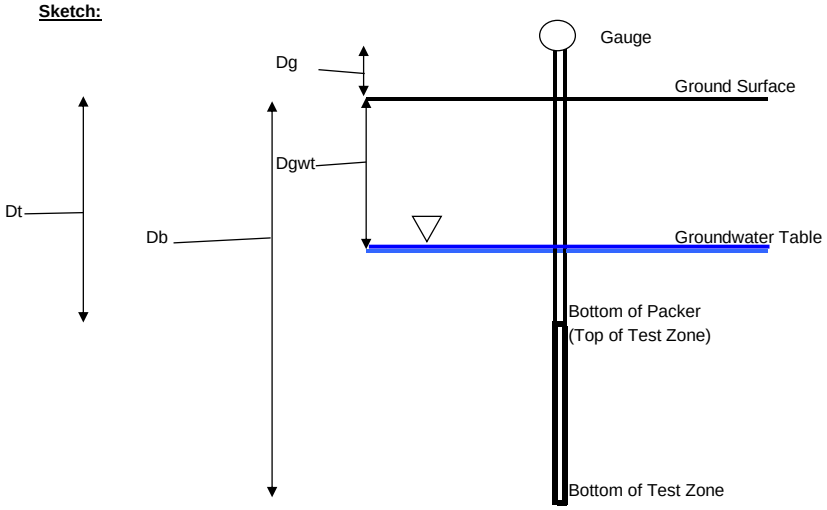
Field Input

Water Meter Data			Gauge	Elapsed
Start	End	Total	Pressure	Time
gallons	gallons	gallons	psi	minute
790.1	791.4	1.3	10	5
794.0	799.0	5.0	20	5
801.5	811.1	9.6	35	5
811.3	814.5	3.2	20	5
814.9	814.9	0.0	10	5

Calculations

Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Pressure	Height					k	k	k
feet	feet	feet	feet		gpm	ft/year	cm/sec	Lugeons
23.1	4.0	6.6	33.7	4400	0.3	34.0	3.3E-05	3.40
46.2	4.0	6.6	56.8	4400	1.0	77.5	7.5E-05	7.75
80.8	4.0	6.6	91.4	4400	1.9	92.5	8.9E-05	9.25
46.2	4.0	6.6	56.8	4400	0.6	49.6	4.8E-05	4.96
23.1	4.0	6.6	33.7	4400	0.0	0.1	1.0E-07	0.01
					Average K	50.74	4.90E-05	5.07

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-10**	**Test No.:**	**1**
Date:	10/27/2016		
Weather:	Sunny		
Time:	15:00		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	11.0	feet	Depth to Top of Test Zone
Db	19.0	feet	Depth to Bottom of Test Zone
Dgwt	NA	feet	Depth to Static Groundwater Table in Boring
Dg	2.0	feet	Height of Pressure Gauge above Ground
	160.0	psi	Pressure of inflated Packer

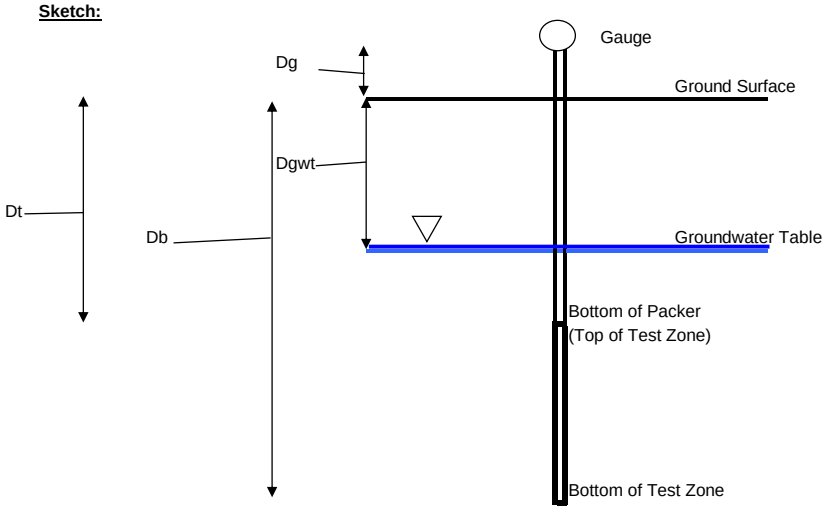
Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Sandstone, slightly weather to fresh, massive

Field Input / **Calculations**

Water Meter Data			Gauge	Elapsed	Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Start gallons	End gallons	Total gallons	Pressure psi	Time minute	Pressure feet	Height feet	feet	feet		gpm	k ft/year	k cm/sec	k Lugeons
41.1	41.1	0.0	6	5	13.8	2.0	NA	15.8	5200	0.0	0.1	1.0E-07	0.01
42.3	42.3	0.0	12	5	27.7	2.0	NA	29.7	5200	0.0	0.1	1.0E-07	0.01
42.5	42.5	0.0	18	5	41.5	2.0	NA	43.5	5200	0.0	0.1	1.0E-07	0.01
42.8	42.8	0.0	12	5	27.7	2.0	NA	29.7	5200	0.0	0.1	1.0E-07	0.01
42.8	42.8	0.0	6	5	13.8	2.0	NA	15.8	5200	0.0	0.1	1.0E-07	0.01
										Average K	0.10	1.0E-07	0.01

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

DEERE & AULT CONSULTANTS, INC.

Test Hole ID:	**NR-10**	**Test No.:**	**2**
Date:	10/27/2016		
Weather:	Sunny		
Time:	15:00		

Project Name:	Nucla Town Reservoir
Project Number:	0410.004.00
Drilling Company:	Elite Drilling Services
Superintendent:	Dan Westbrook
No. Drill Hands:	1
Other Information:	HQ3 Core
D&A Engineer:	TWD

Dt	20.0	feet	Depth to Top of Test Zone
Db	40.0	feet	Depth to Bottom of Test Zone
Dgwt	32.4	feet	Depth to Static Groundwater Table in Boring
Dg	4.0	feet	Height of Pressure Gauge above Ground
	180.0	psi	Pressure of inflated Packer

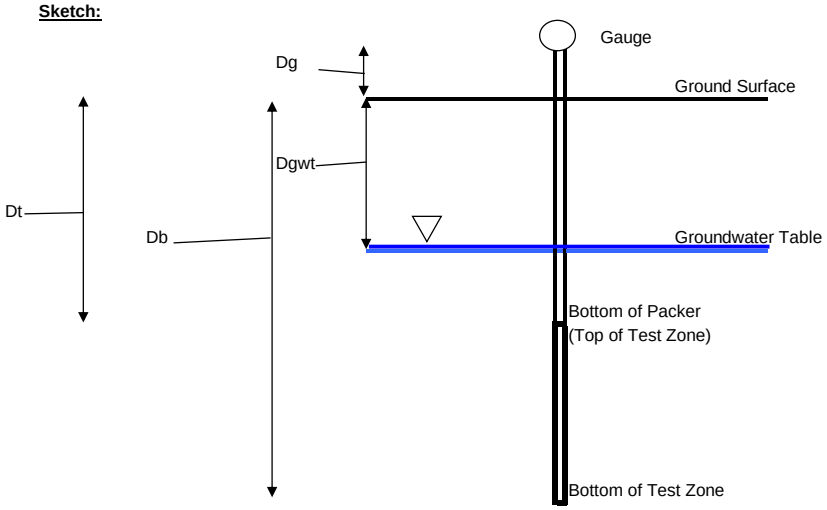
Geologic Formation: Dakota Formation

Rock Type(s) & Description:
Sandstone, slightly weather to fresh, massive

Field Input / **Calculations**

Water Meter Data			Gauge	Elapsed	Gauge	Gauge	GWT	Ht	Cp	Q	Permability		
Start gallons	End gallons	Total gallons	Pressure psi	Time minute	Pressure feet	Height feet	feet	feet		gpm	k ft/year	k cm/sec	k Lugeons
47.8	49.4	1.6	10	5	23.1	4.0	32.4	59.5	4400	0.3	23.7	2.3E-05	2.37
50.5	54.6	4.1	20	5	46.2	4.0	32.4	82.6	4400	0.8	43.7	4.2E-05	4.37
56.0	62.0	6.0	30	5	69.2	4.0	32.4	105.6	4400	1.2	50.0	4.8E-05	5.00
63.0	69.0	6.0	20	5	46.2	4.0	32.4	82.6	4400	1.2	64.0	6.2E-05	6.40
69.1	73.8	4.7	10	5	23.1	4.0	32.4	59.5	4400	0.9	69.5	6.7E-05	6.95
										Average K	50.17	4.8E-05	5.02

Sketch:



Cp Values

Length of Test Section	Diameter of Test Hole EX	AX	BX	NX	HQ
	1.44	1.84	2.3125	2.9375	3.7795
feet	inches	inches	inches	inches	inches
1	31,000	28,500	25,800	23,300	20,400
2	19,400	18,100	16,800	15,500	14,100
3	14,400	13,600	12,700	11,800	11,200
4	11,600	11,000	10,300	9,700	9,000
5	9,800	9,300	8,800	8,200	7,500
6	8,500	8,100	7,600	7,200	6,600
7	7,500	7,200	6,800	6,400	5,900
8	6,800	6,500	6,100	5,800	5,200
9	6,200	5,900	5,600	5,300	4,800
10	5,700	5,400	5,200	4,900	4,400
15	4,100	3,900	3,700	3,600	3,100
20	3,200	3,100	3,000	2,800	2,400

$k_{(ft/yr)} = Cp \times Q_{(gpm)} / Ht_{(feet)}$

1 ft/year = 9.67×10^{-7} cm/s

1 Lugeon = 10 ft/year

APPENDIX F
MONITORING WELL PERMITS AND CONSTRUCTION REPORTS

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 304217 -_____-____
DIV. 4 WD 60 DES. BASIN MD

APPLICANT

MONTROSE COUNTY COLORADO
317 SOUTH 2ND ST
MONTROSE, CO 81401-

(970) 252-4549

PERMIT TO USE AN EXISTING WELL

APPROVED WELL LOCATION
MONTROSE COUNTY
SW 1/4 NE 1/4 Section 10
Township 46 N Range 15 W New Mex P.M.

DISTANCES FROM SECTION LINES
1857 Ft. from North Section Line
2087 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 193111 Northing: 4240087

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-56056, and known as NR-5.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

APPROVED
JPM

Dick Wolfe
State Engineer

Alice A. Thyne
By

Receipt No. 3677681A DATE ISSUED 01-18-2017 EXPIRATION DATE N/A

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: 56056-MH

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Montrose County, Colorado

MAILING ADDRESS: 317 South 2nd Street

CITY: Montrose STATE: CO ZIP CODE: 81401

TELEPHONE NUMBER: (970) 252-4549

3. WELL LOCATION AS DRILLED: SW1/4, NE1/4, Sec. 10, Twp. 46 ☒ N or ☐ S, Range 15 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: _____ ft. from ☐ N or ☐ S section line and _____ ft. from ☐ E or ☐ W section line.

SUBDIVISION: _____, LOT _____, BLOCK _____, FILING (UNIT) _____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: NR-5
Easting: 193111

STREET ADDRESS AT WELL LOCATION: NA

Northing: 4240087

4. GROUND SURFACE ELEVATION 5903.6 feet DRILLING METHOD HQ Core

DATE COMPLETED 10/26/16 TOTAL DEPTH 37.0 feet DEPTH COMPLETED 44 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-7	Overburden			
7-12	Shale		dark grey	
12-20	Sandstone		brown	X
20-28	Shale		grey	
28-36	Sandstone &		brown-grey	X
	Shale Interb.			
36-37	Ash		white/tan	
37-44	Shale		grey	

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8"	0	9.8
3.78"	9.8	44

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	14.0	-3.0

PERFORATED CASING: Screen Slot Size (in): 0.01

2.375	PVC	0.154	14.0	34.0

8. FILTER PACK:
Material Sand
Size 10/20
Interval 12.5-34.5'

9. PACKER PLACEMENT:
Type _____
Depth _____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement

Remarks:
Bentonite Seal 9.5'-12.5', and 34.5-44'
Stick-up Casing w/ concrete surface completion

11. DISINFECTION: Type _____ Amt. Used _____

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD NA

Static Level 4.1 ft. Date/Time measured: 12/7/16, Production Rate _____ gpm.

Pumping Level _____ ft. Date/Time measured _____, Test Length (hrs) _____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
Deere & Ault Consultants	(303)651-1468	45331

Mailing Address: 600 South Airport Road, Suite A-205, Longmont, CO 80503

Signature:	Print Name and Title	Date
	Victor G. deWolfe, PE, PG	12/15/16

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 304218 -_____-____
DIV. 4 WD 60 DES. BASIN MD

APPLICANT

MONTROSE COUNTY COLORADO
317 SOUTH 2ND ST
MONTROSE, CO 81401-

(970) 252-4549

PERMIT TO USE AN EXISTING WELL

APPROVED WELL LOCATION
MONTROSE COUNTY
SW 1/4 NE 1/4 Section 10
Township 46 N Range 15 W New Mex P.M.

DISTANCES FROM SECTION LINES
1809 Ft. from North Section Line
1735 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 193219 Northing: 4240110

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-56056, and known as NR-7.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

APPROVED
JPM

Dick Wolfe
State Engineer

Alisa A. Thyne
By

Receipt No. 3677681B DATE ISSUED 01-18-2017 EXPIRATION DATE N/A

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: 56056-MH

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Montrose County, Colorado

MAILING ADDRESS: 317 South 2nd Street

CITY: Montrose STATE: CO ZIP CODE: 81401

TELEPHONE NUMBER: (970) 252-4549

3. WELL LOCATION AS DRILLED: SW1/4, NE1/4, Sec. 10, Twp. 46 ☒ N or ☐ S, Range 15 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: _____ ft. from ☐ N or ☐ S section line and _____ ft. from ☐ E or ☐ W section line.

SUBDIVISION: _____, LOT _____, BLOCK _____, FILING (UNIT) _____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: NR-7
Easting: 193219

STREET ADDRESS AT WELL LOCATION: NA

Northing: 4240110

4. GROUND SURFACE ELEVATION 5914.4 feet DRILLING METHOD HQ Core

DATE COMPLETED 10/25/16 TOTAL DEPTH 42.5 feet DEPTH COMPLETED 40 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-3.6	Overburden			
3.6-11	Sandstone		grey	X
11-18	Shale		dark grey	
18-28	Sandst./shale		grey-brown	X
18-30	Ash		white/tan	
30-40	Shale interb.		grey-brown	X
	w/ Sandstone			

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8"	0	7
3.78"	7	40

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	19.0	-3.0

PERFORATED CASING: Screen Slot Size (in): 0.01

2.375	PVC	0.154	19.0	39.0

8. FILTER PACK:
Material Sand
Size 10/20
Interval 6'-40'

9. PACKER PLACEMENT:
Type _____
Depth _____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement

Remarks:
Bentonite Seal 3'-6', Grout 0'-3'
Stick-up Casing w/ concrete surface completion

11. DISINFECTION: Type _____ Amt. Used _____

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD NA

Static Level 7.95 ft. Date/Time measured: 12/7/16, Production Rate _____ gpm.

Pumping Level _____ ft. Date/Time measured _____, Test Length (hrs) _____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
Deere & Ault Consultants	(303)651-1468	45331

Mailing Address: 600 South Airport Road, Suite A-205, Longmont, CO 80503

Signature:	Print Name and Title	Date
	Victor G. deWolfe, PE, PG	

Form No.
GWS-25

OFFICE OF THE STATE ENGINEER
COLORADO DIVISION OF WATER RESOURCES

818 Centennial Bldg., 1313 Sherman St., Denver, Colorado 80203
(303) 866-3581

EXST

WELL PERMIT NUMBER 304219 - - -
DIV. 4 WD 60 DES. BASIN MD

APPLICANT

MONTROSE COUNTY COLORADO
317 SOUTH 2ND ST
MONTROSE, CO 81401-

(970) 252-4549

APPROVED WELL LOCATION
MONTROSE COUNTY
SW 1/4 NE 1/4 Section 10
Township 46 N Range 15 W New Mex P.M.

DISTANCES FROM SECTION LINES
1792 Ft. from North Section Line
1189 Ft. from East Section Line

UTM COORDINATES (Meters,Zone:13,NAD83)
Easting: 193386 Northing: 4240128

PERMIT TO USE AN EXISTING WELL

ISSUANCE OF THIS PERMIT DOES NOT CONFER A WATER RIGHT

CONDITIONS OF APPROVAL

1) This well shall be used in such a way as to cause no material injury to existing water rights. The issuance of this permit does not ensure that no injury will occur to another vested water right or preclude another owner of a vested water right from seeking relief in a civil court action.
2) The construction of this well shall be in compliance with the Water Well Construction Rules 2 CCR 402-2, unless approval of a variance has been granted by the State Board of Examiners of Water Well Construction and Pump Installation Contractors in accordance with Rule 18.
3) Approved pursuant to CRS 37-92-602(3)(b)(I) for uses as described in CRS 37-92-602(1)(f). Use of this well is limited to monitoring water levels and/or water quality sampling.
4) Approved for the use of an existing well acknowledged for construction under monitoring hole notice MH-56057, and known as NR-10.
5) This well must be equipped with a locking cap or seal to prevent well contamination or possible hazards as an open well. The well must be kept capped and locked at all times except during sampling or measuring.
6) Records of water level measurements and water quality analyses shall be maintained by the well owner and submitted to the Division of Water Resources upon request.
7) Upon conclusion of the monitoring program the well owner shall plug this well in accordance with Rule 16 of the Water Well Construction Rules. A Well Abandonment Report must be completed and submitted to the Division of Water Resources within 60 days of plugging.
8) The owner shall mark the well in a conspicuous place with the well permit number and name of aquifer as appropriate, and shall take necessary means and precautions to preserve these markings.
9) This well must have been constructed by or under the supervision of a licensed well driller or other authorized individual according to the Water Well Construction Rules.
10) This well must be located not more than 200 feet from the location specified on this permit.

NOTE: Issuance of this permit does not guarantee that this well can be converted to a production well under a future permit. Additionally, pursuant to Rule 14.2 of the Water Well Construction Rules (2 CCR 402-2), monitoring holes constructed pursuant to a monitoring hole notice shall not be converted to a production well. (Upon obtaining a permit from the State Engineer, a monitoring hole may be converted to a monitoring well, recovery well for remediation of the aquifer, or a dewatering system for dewatering the aquifer.)

APPROVED
JPM

Dick Wolfe
State Engineer

Alice A. Thyne
By

Receipt No. 3677681C DATE ISSUED 01-18-2017 EXPIRATION DATE N/A

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: 56057-MH

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Montrose County, Colorado

MAILING ADDRESS: 317 South 2nd Street

CITY: Montrose STATE: CO ZIP CODE: 81401

TELEPHONE NUMBER: (970) 252-4549

3. WELL LOCATION AS DRILLED: SE1/4, NE1/4, Sec. 10, Twp. 46 ☒ N or ☐ S, Range 15 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: _____ ft. from ☐ N or ☐ S section line and _____ ft. from ☐ E or ☐ W section line.

SUBDIVISION: _____, LOT _____, BLOCK _____, FILING (UNIT) _____

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: NR-10
Easting: 193386

STREET ADDRESS AT WELL LOCATION: NA

Northing: 4240128

4. GROUND SURFACE ELEVATION 5942.8 feet DRILLING METHOD HQ Core

DATE COMPLETED 10/27/2016 TOTAL DEPTH 40 feet DEPTH COMPLETED 40 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-2	Overburden			
2-10	Mud/Sandstone			
10-23	Sandstone		brown-grey	
23-30	Sandy shale		grey-brown	
30-33	Sandstone			
33-40	Shale		grey	X

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8"	0	9.5
3.78"	9.5	40

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	20	0.5

PERFORATED CASING: Screen Slot Size (in): 0.01

2.375	PVC	0.154	20	40

8. FILTER PACK:
Material Sand
Size 10/20
Interval 11'-40'

9. PACKER PLACEMENT:
Type _____
Depth _____

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement

Remarks:
Bentonite Seal 9'-11'
Flush mounted well box in concrete pad

11. DISINFECTION: Type _____ Amt. Used _____

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD NA

Static Level 34.4 ft. Date/Time measured: 12/8/16, Production Rate _____ gpm.

Pumping Level _____ ft. Date/Time measured _____, Test Length (hrs) _____.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name:	Phone:	License Number:
Deere & Ault Consultants	(303)651-1468	45331

Mailing Address: 600 South Airport Road, Suite A-205, Longmont, CO 80503

Signature:	Print Name and Title	Date
	Victor G. deWolfe, PE, PG	

APPENDIX G
EARTHQUAKE INFORMATION

Geologic Hazards Science Center

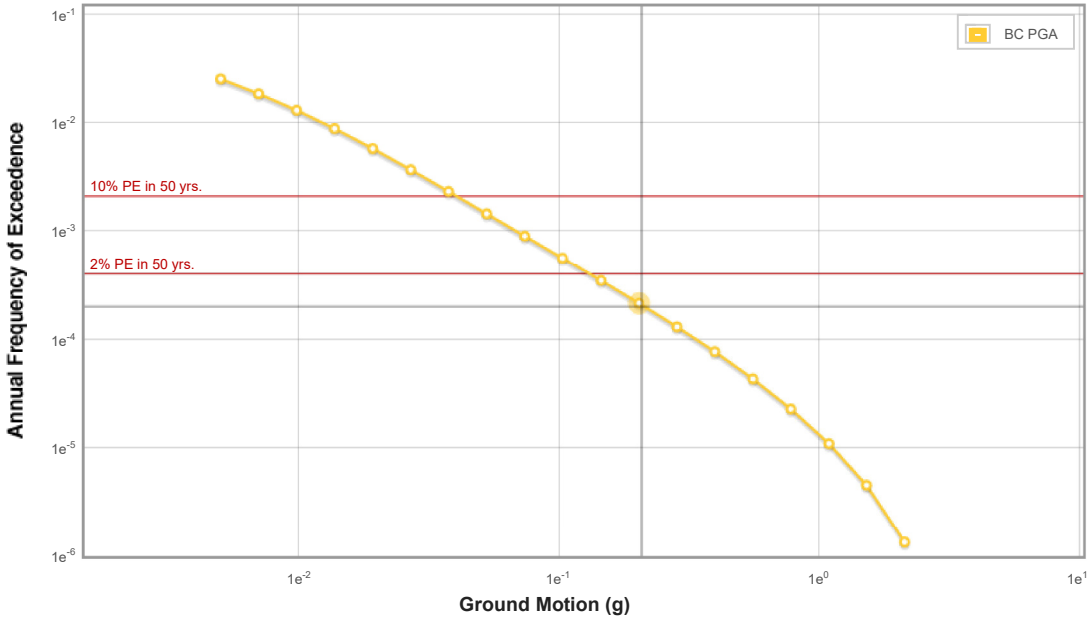
Hazard Curve Application

Notice: This web-application will no longer be available after March 1, 2017, by which point alternative means of acquiring hazard curve data will be provided. Please contact us with any questions or comments.

Please do not use this application to obtain ground motion parameter values for use with the design code reference documents covered by the U.S. Seismic Design Maps web application (e.g., the *International Building Code* and the *ASCE 7* or *41 Standard*). The values returned by the two applications are not identical; please see our documentation and the referenced codes, standards, and guidelines for more information.

Set Location | Hazard Curves | UHRS | AFE vs. Site Class | Data Access | Help & Info

Latitude: **38.25787** Longitude: **-108.50766**



Curve Selection

	PGA	0.10	0.20	0.30	0.50	1.00	2.00
BC	☑	☐	☐	☐	☐	☐	☐

Cursor Values

AFE: 1.987e-4
GM: 2.074e-1

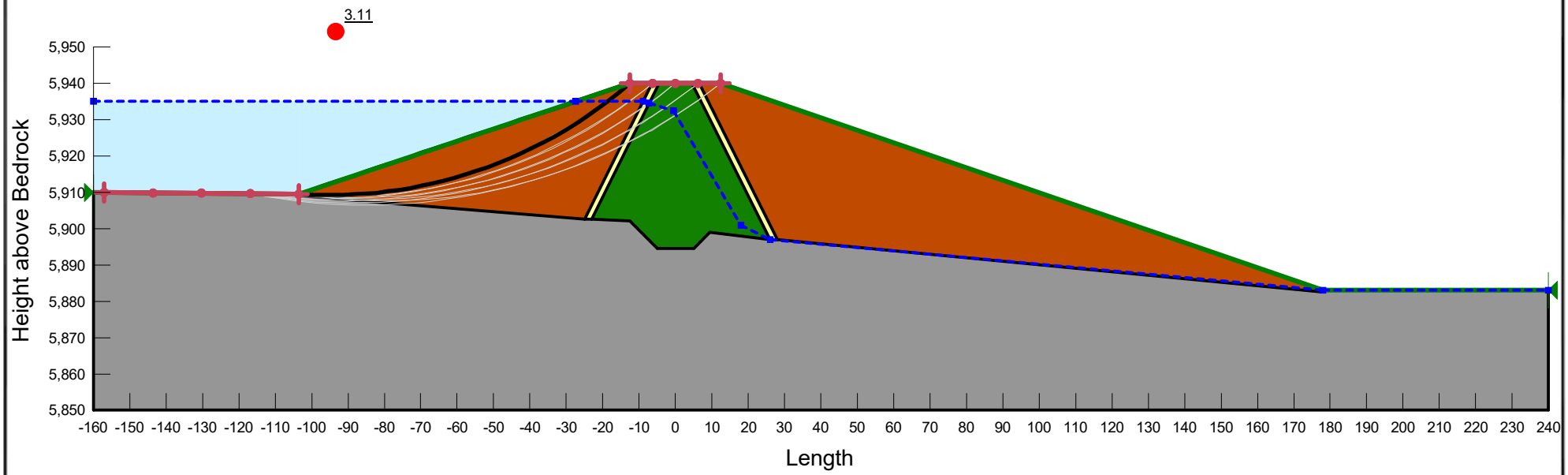
Plot Options

☑ Crosshair
☐ Value tooltip
Legend position:
◉ NE ○ SW

SHARE

APPENDIX H
STABILITY ANALYSIS

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Zone 2	143	0	45
	Zone 3	115	0	34
	Bedrock	145	2,000	36
	Zone 1	113	0	24



DEERE & AULT CONSULTANTS, INC.

Nucla Town Reservoir
Slope Stability - Upstream
Full Reservoir

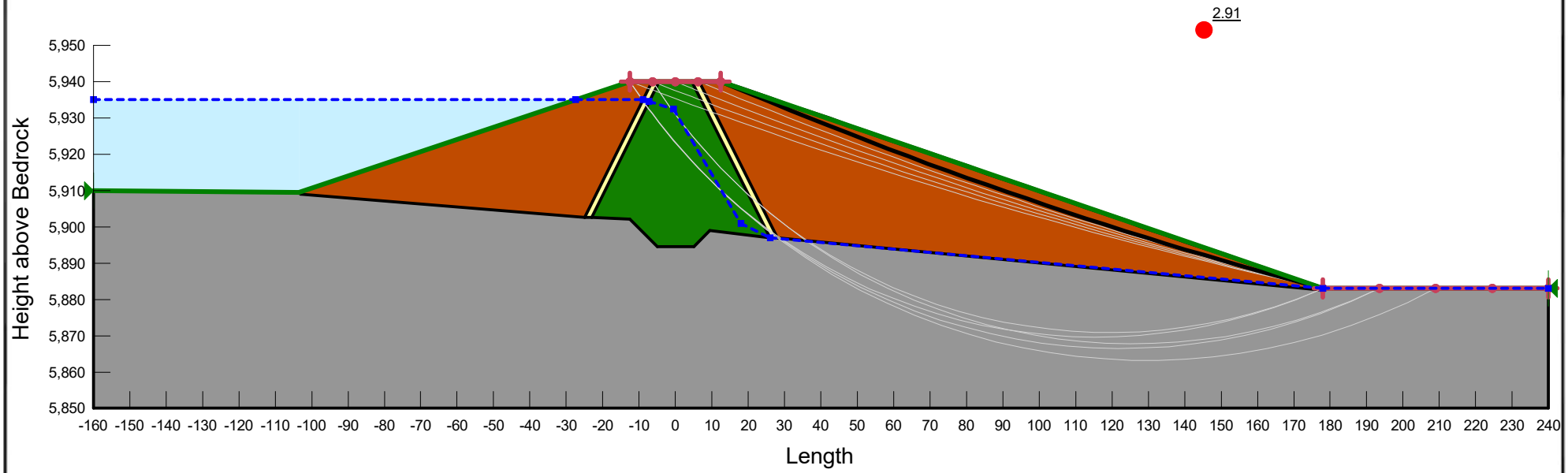
JOB NO. 0410.004.00

DATE: 1/19/2017

FIGURE NO.

1

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Zone 2	143	0	45
	Zone 3	115	0	34
	Bedrock	145	2,000	36
	Zone 1	113	0	24



DEERE & AULT CONSULTANTS, INC.

Nucla Town Reservoir
Slope Stability - Downstream
Full Reservoir

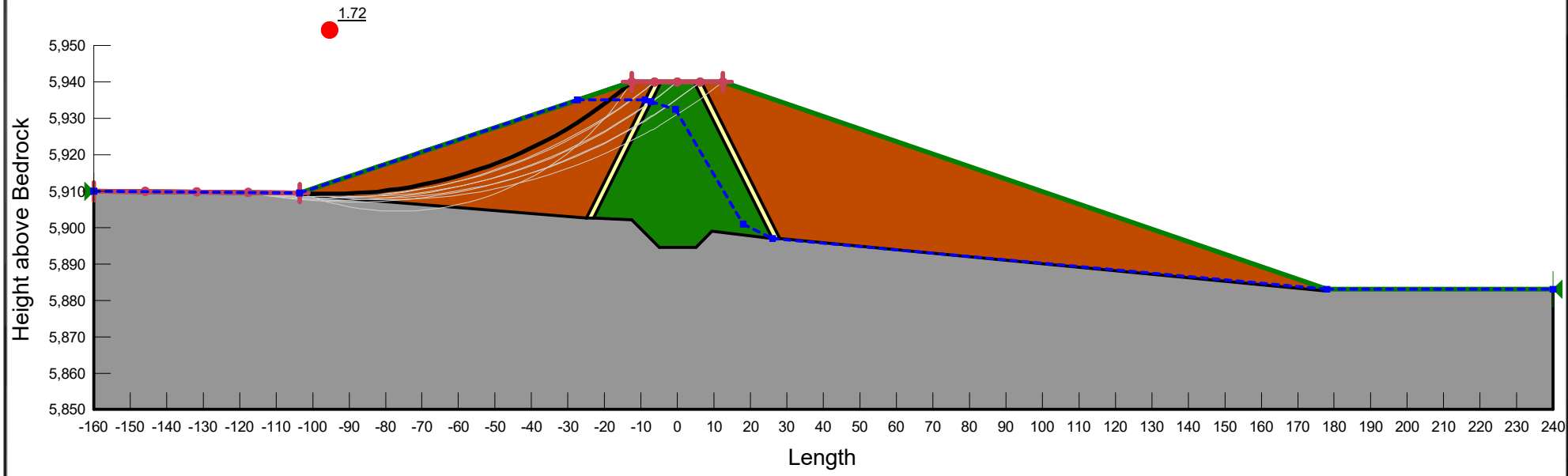
JOB NO. 0410.004.00

DATE: 1/19/2017

FIGURE NO.

2

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Zone 2	143	0	45
	Zone 3	115	0	34
	Bedrock	145	2,000	36
	Zone 1	113	0	24



DEERE & AULT CONSULTANTS, INC.

Nucla Town Reservoir
Slope Stability
Rapid Draw Down

JOB NO. 0410.004.00

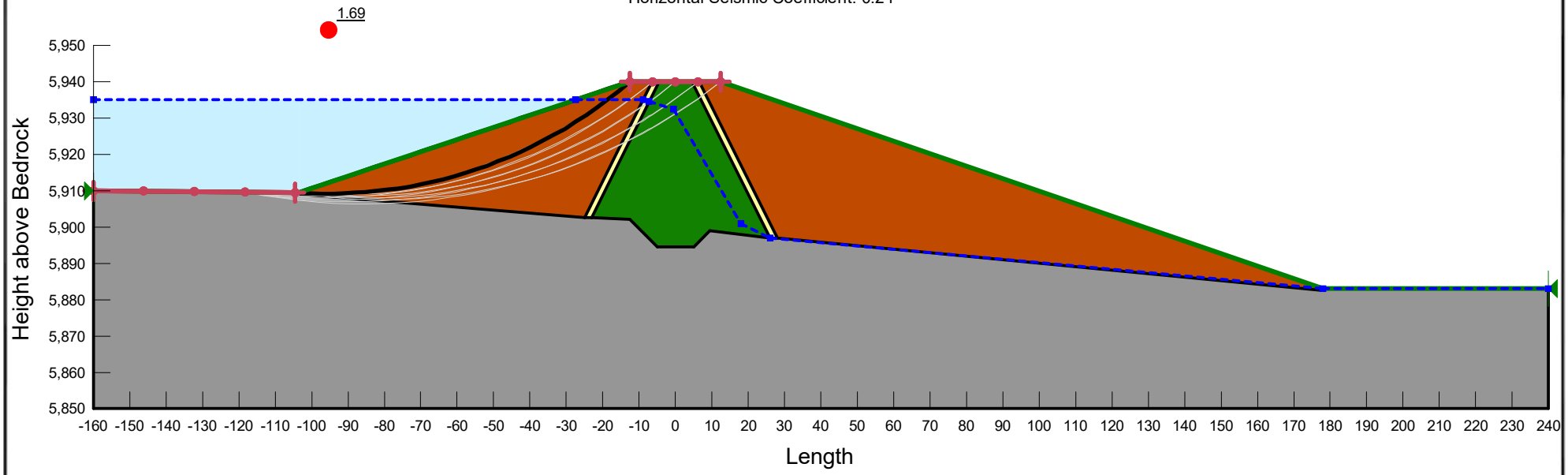
DATE: 1/19/2017

FIGURE NO.

3

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Zone 2	143	0	45
	Zone 3	115	0	34
	Bedrock	145	2,000	36
	Zone 1	113	0	24

Horizontal Seismic Coefficient: 0.21



DEERE & AULT CONSULTANTS, INC.

Nucla Town Reservoir
Slope Stability - Earthquake Upstream

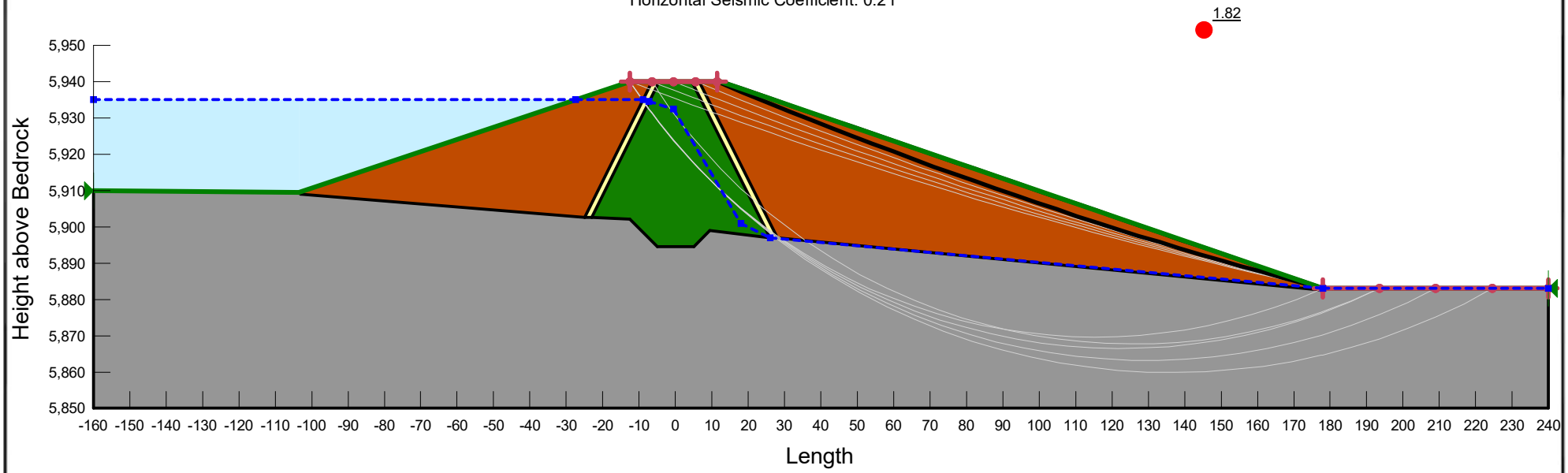
JOB NO. 0410.004.00

DATE: 1/19/2017

FIGURE NO. 4

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Zone 2	143	0	45
	Zone 3	115	0	34
	Bedrock	145	2,000	36
	Zone 1	113	0	24

Horizontal Seismic Coefficient: 0.21



DEERE & AULT CONSULTANTS, INC.

Nucla Town Reservoir
Slope Stability - Earthquake Downstream

JOB NO. 0410.004.00

DATE: 1/19/2017

FIGURE NO.

5