APPENDIX C:

Conceptual Pond Design Plan

TABLE OF CONTENTS

Tables

Figures

Attachments

Attachment 1: Evaporation/GWS Pond Volume Storage Calculations
Attachment 2: Natural Evaporation Rates (Monthly Average)
Attachment 3: Geotechnical Engineering Report

1 INTRODUCTION

Uranium One is proposing to construct and use evaporation ponds in lieu of Deep Disposal Wells ("DDWs") for the Proposed Ludeman Project (Proposed Project) located in Converse County, Wyoming. The design of the evaporation ponds are based on NRC Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities", 10 CFR Part 40, Appendix A, Criterion 5(A), and the pertinent laws and regulations indicated therein. It should be noted that these regulations apply to 11e.(2) impoundments.

1.1 Scope of Work

Uranium One's evaporation pond design scope of work includes:

- Conducting a geotechnical field and laboratory test investigation of the proposed evaporation area;
- Reviewing available data and regulatory requirements, and development of the project design criteria;
- Conducting engineering analyses and design for the evaporation ponds, including probabilistic water balance modeling, design of liner systems, design of leak collection and recovery systems; and
- Development of conceptual drawing for the construction design based on a 9,000 gpm production flow, using a two-pass reverse osmosis ("RO") filtration system to minimize waste generated from the site with restoration beginning in 2019.

2 GENERAL SITE CONDITIONS

The proposed evaporation ponds are located in the northwest quarter of Section 13 in Township 34N and Range 74W (Figure 1). The area of the evaporation ponds topography has a ridgeline across the center of the pond site in the east to west direction and slopes slightly too moderately downward to the south and north with an elevation difference of approximately 45 feet in the north direction and 50 feet in the southern direction. Vegetation on the proposed pond site consists of prairie grasses, cactus and sagebrush.

Uranium One is proposing to use four evaporation ponds with a combined surface area of approximately 54 acres. In addition to the evaporation four ground water sweep ("GWS") permeate ponds are proposed to the southeast of the satellite facility with a combined surface area of approximately 9 acres. All evaporation and GWS ponds will have a game fence to restrict access.

3 EVAPORATION AND GWS POND DESIGN AND OPERATION

The life of mine schedule for the Ludeman Satellite assumes production from six mining units for the life of the satellite plant. The evaporation ponds were sized based on the anticipated flow rates over an 8 year operational life for the plant while taking into consideration the net average, natural evaporation rates. The anticipated life of mine schedule is shown in Figure 2.

Evaporation rates in feet per year are multiplied by the surface area at a conservative estimate of 1 foot storage depth (surface area and evaporation increase with depth). To achieve the proposed evaporation quantities all storage cells must be constructed prior to plant operations and operated to fill in parallel (no pond is empty, maximizing evaporation). There is the potential to construct the evaporation ponds in phases with two cells constructed in the first year 1 cell in the third year and fourth cell in year four; however, all cells would need to be in operation prior to year five of operations. The Evaporation ponds are designed to have a total storage volume of 306.1 acre feet.

Production/Brine Evaporation Ponds

The production/brine ponds receive a mixture of brine and production permeates that is generated by the RO system after the various stages of plant processing. A two-pass RO filtration system (90 percent efficiency) is used to minimize waste generated from the plant. The plant experiences a peak flow of 8,877 gpm which occurs in December of Year 3. The peak flow results in peak production permeate and brine flow rates of 80 gpm, and 9 gpm respectively. Restoration begins in April of Year 4 and steadily escalates to a prolonged peak flow rate of 998 gpm which lasts from November of Year 5 through August Year 7. During the peak restoration cycle, brine flow rates are sustained at 106 gpm. Under preliminary design conditions, natural evaporation is assumed to be capable of evaporating 78.5 gpm per month on average based on conservative surface area exposure (1' Storage) for all four ponds. A total of approximately 40.7 million gallons of evaporation is anticipated each year. Evaporation rates are expected to vary significantly based on seasonal conditions with a low of around 20 gpm expected in winter and a high of around 180 gpm expected in summer.

Results of iterative calculations indicate an optimal design depth of six feet for the production/brine evaporation ponds (balancing storage vs. evaporation vs. cost). Two of the four cells have a top of pond cell dimension of 848 feet long by 698 feet wide. The remaining cells were designed to fit within the space available on site and are dimensioned at 998 feet long by 698 feet wide, and 848 feet long by 576 feet wide. The top surface area of the combined cells is approximately 54.3 acres. The design storage depth (not including freeboard) of each cell is less than 6 feet such that "dam" classification is avoided. The design provides 2 feet of freeboard to

protect against effects of extreme weather events (e.g. rainfall accumulation, wave run-up) and facilitates backup storage in the event of a cell failure or unforeseen circumstances. Freeboard calculations utilized for the proposed evaporation and groundwater sweep ponds were developed using the U.S. Army Corps of Engineers (ACOE) "Coastal Engineering Manual" (ACOE, 1989) was used to determine the design wave height. Supplementary ACOE references were also used (ACOE, 1984 and ACOE, 1997) to determine wave runup and wind tide effects.

Interior embankment slopes are designed at a grade of 4H:1V with a maximum cell depth of approximately 7.3' to 7.6' (includes 2 feet freeboard, 4 feet of storage, and 1.3 feet to 1.6 feet of leak detection sump depth). Exterior embankment slopes are designed at a grade of 3H:1V. A summary of cell design parameters with respect to both cell depth and cell storage are provided in Table 1. Detailed pond grading features including dimensions and locations are shown in the drawing Figure 3 and Figure 4. Calculations for volume storage requirements are included in Attachment 1.

The total volume of storage provided is 306.1 ac-ft, including freeboard, and the maximum storage volume required is 195.9 ac-ft. If a leak develops, adequate storage is available within the freeboard of the three remaining cells. The worst case scenario occurs when the four cells are at max storage and the largest pond develops a leak. The largest pond will storing 59.1 ac-ft. Wastewater would be pumped to the three remaining cells, resulting in a max storage depth of 7.2 feet (0.42 feet freeboard). The reduced freeboard is assumed to be adequate given the short duration in which this would occur (<1 month to repair). Furthermore, the probability that a leak occurs during max storage conditions is low. In the event that the lack of freeboard is a concern, the restoration flow could be slowed to minimize the incoming flow until the liner could be repaired.

Ground Water Sweep (GWS) Ponds

Prior to well field restoration, ground water is pumped out of the ground to remove any treated water that may remain in the well field zone. Unlike production/brine, water removed in the ground water sweep (GWS) phase may be disposed via surface discharge. As a result, GWS ponds are designed to optimize storage rather than evaporation, resulting in deeper ponds and a reduced footprint. Natural evaporation is still accounted for in GWS storage volume calculations but is not expected to serve as the primary means of disposal.

The GWS ponds are to be stationed southwest of the plant building. Four cells assembled in a rectangular layout make up an area with top dimensions of 260 ft x 392 ft each and depth of 10.5 ft (including freeboard). The total volume of storage provided is 71.6 ac-ft, including freeboard,

and the maximum volume required is 53.4 ac-ft (10.5 ft storage depth, 2.0 ft freeboard) as shown in Table 2. The total surface area of the GWS ponds is approximately 9.23 acres. The design storage volume of each cell is less than 15 acre-feet such that "dam" classification is avoided.

Interior embankment slopes are designed at a grade of 4H:1V with a total cell depth of 10.5' (includes 2 feet freeboard and 0.5' leak detection sump height). Exterior embankment slopes are designed at a grade of 3H:1V. GWS pond cells are equipped with the same leakage prevention system as that of the production/brine cells. The design depth provides for 2 feet of freeboard to provide rainfall storage and wave run-up protection. Leak detection sumps in each GWS cell adds an additional 0.5 feet of depth. A summary of cell design parameters with respect to both cell depth and cell storage are provided in Table 2. The GWS ponds are shown in Figure 4 with additional design information (e.g. dimensions, details, etc.) presented in Figure 3 as the evaporation ponds are consistent with the proposed design for the ground water sweep ponds as well. Calculations for volume storage requirements are included in Attachment 1.

3.1 Liner System Design

The proposed liner system for the evaporation ponds is a double liner system consisting of a 30-mill PVC bottom liner which rests on 12oz geotextile fabric, a 60-mil HDPE top liner with a 200 mill geo-net middle liner. A durable dual layered liner system has been incorporated into the pond cell design to minimize leakage potential. In addition to a double lined liner system, a leak recovery system has been integrated into the pond design. If a leak were to occur in the upper 60 mil HDPE liner the leak recovery system is designed to minimize the hydraulic head on the secondary liner. In the event that leakage occurs through the upper liner, the leakage will be collected in the leak recovery system and flow (via gravity) to a leak recovery system sump. Each evaporation pond will contain six leak detection sumps as shown in Figure 3. The use of six leak detection systems per cell will allow the operator to isolate which portion of the pond a potential leak would be located allowing for allowing for quicker and more effective repair efforts. The GWS Permeate Ponds leak detection system is consistent with the design shown in Figure 3 for the evaporations ponds with the exception that the GWS ponds will have four leak detection collection sumps per cell rather than six.

Leak detection sumps add an additional 1.3 to 1.6 feet of depth dependent upon the dimensions and slope of the pond bottom. Storage volume associated with the leak detection sumps at the bottom of pond are conservatively assumed to be "inactive" and are not included in calculated storage volumes. If a leak develops, adequate storage is available within the freeboard of the three remaining cells. The worst case scenario occurs when the four cells are at max storage and the largest pond develops a leak. The largest pond would be storing 59.1 ac-ft. Wastewater would be

pumped to the three remaining cells, resulting in a max storage depth of 7.2 feet (0.42 feet freeboard). The reduced freeboard is assumed to be adequate given the short duration in which this would occur (<1 month to repair). Furthermore, the probability that a leak occurs during max storage conditions is low. In the event that the lack of freeboard is a concern, the restoration flow could be slowed to minimize the incoming flow until the liner could be repaired.

A Chemical Resistance Chart listing the resistance of the high density polyethylene ("HDPE") and poly vinyl chloride ("PVC") liners to various chemicals at various concentrations and temperatures. The top liner of 60-mil HDPE was chosen for its long term performance and chemical resistance properties, resistance to ultraviolet radiation, high tensile strength, and high stress-crack resistance. The top liner will be exposed for the life of the project (approximately 8 to 12 years), and is designed for long-term solar radiation exposure. A standard black HDPE liner material was selected for the increased heat retention to enhance evaporation.

The secondary liner of 30-mil PVC was chosen for its long term performance and chemical resistance properties, and high tensile strength. As a secondary liner there will not be any exposure to solar radiation thus eliminating typical solar degradation issues associated with a PVC liner.

3.2 Water Balance

Flows generated are based on the use of a two-pass Reverse Osmosis (RO) System. Disposal of effluent and brine is to be completed with traditional evaporation ponds. Disposal of ground water sweep waste water is to be surface discharged.

The life of mine schedule for the Satellite Plant assumes production from six mining units for the life of the plant as shown on Figure 2. The evaporation pond cells were sized based on the anticipated flow rates through the 8 year operational life of the plant while also taking into consideration the net average, natural evaporation rates.

Natural evaporation rates for the project area were determined based on the Kohler-Nordenson-Fox equation with an applied coefficient of 0.7. The equation calculates evaporation loss from a free-water surface due to the combination of radiation heat energy and aerodynamic removal of water vapor. The aerodynamic portion of the Kohler-Nordenson-Fox equation was derived using pan evaporation data collected by the National Oceanic and Atmospheric Administration (NOAA). Class A pan evaporation rates and their accompanying pan coefficients were analyzed by NOAA from 1956 – 1970, and net averages were calculated for regions throughout Wyoming. The net mean average evaporation rate was used to assume average climate conditions and account for rainfall (e.g. Net Mean Evaporation = Mean Evaporation – Mean Rainfall). Refer to Attachment 2

for the net mean evaporation rates calculated for each month.

For natural evaporation, a pan coefficient of 0.7 has been found suitable for lakes in most portions of the United States. Pan coefficients typically increase for smaller water bodies, and decrease for arid climates. In addition, evaporation rates of solutions will decrease as solids and chemical concentrations increase indicating the need for water analysis. Wyoming pan coefficients typically lie in the range of 0.7 – 0.95 based on pond size. For conservative measure a pan coefficient of 0.70 was assumed. Evaporation rates in feet per year are multiplied by the surface area at a conservative estimate of 1 foot storage depth (surface area and evaporation increase with depth). To achieve the proposed evaporation quantities all storage cells must be constructed prior to plant operations and operated to fill in parallel (no pond is empty, maximizing evaporation). Evaporation calculations indicate that the cells will fully empty in August of year 10. This is eighteen months after the restoration of the well fields is complete.

3.3 Geotechnical Analysis

A comprehensive geotechnical report was completed by Tetra Tech in November 2013. The geotechnical analysis includes soil boring information slope stability analysis and recommended practices for pond construction. Based on soil borings, excavated material consists primarily of sand and sandstone which is suitable for embankment backfill.

Tetra Tech used slope stability software to analyze the post-construction condition of the slope embankments. The results of this analysis indicate pond slopes will be stable when built at 3H:1V slope using sandstone material found on site. Below is summary of the geotechnical analyses while the detailed Geotechnical Report can be found in Attachment 2.

<u>Settlement</u>

Based on the proposed construction and the subsurface profiles encountered within the exploratory borings settlement of the pond embankment foundation soils will be less than 1 inch. Based on the soil types encountered the majority of settlement will occur during construction. In addition, based on the liner system consisting of a double geomembrane and a 3 ft thick clay liner, the infiltration of water into the soils beneath the pond is highly unlikely, further reducing any potential for settlement.

<u>Hydrostatic Uplift Analysis</u>

Nine geotechnical exploratory borings were drilled within the proposed backup pond footprint to depths of approximately 15 feet to observe subsurface and groundwater conditions. Groundwater

was not encountered within any of the borings at the time of drilling and other factors that could contribute to fluctuations of groundwater levels were not identified.

Slope Stability

The maximum fill slope located near the southwest corner of the pond site was modeled for the slope stability analyses. The fill slope in this areas is on the order of 50 ft in height and is shown as cross section A of Figure 1 of the Geotechnical Report. The soil strength values used in eh analyses were estimated based on the soil type and experience with strengths of similar soil types. The shear strength parameters used in the analyses are presented on the slope stability figure attached in Appendix A of the Geotechnical Report. The post-construction model was the only one performed. Analyses for the partial pool and maximum pool with steady seepage models were not performed due to the triple linear construction and the low potential for any seepage or phreatic surface to develop. These analyses are typically conducted on external slopes which are low in height in comparison to the interior slopes for this project.

Liquefaction

There has been little, if any, reported damage from liquefaction in Wyoming. The earthquake or pseudo-static model for external slopes will not be performed due to the low seismic potential for the project area.

The Geotechnical Engineering study for the Proposed Ludeman Satellite Plant and Evaporation Pond has been included as Attachment 3.

4 POND CONSTRUCTION QUALITY CONTROL

Uranium One will employ an Engineering Procurement Construction Management (EPCM) firm for initial construction of the project. The EPCM will integrate a Quality Control (QC) program for pond construction in accordance with guidance provided in Reg Guide 3.11 into its site wide QC program. The site wide QC requirements are embedded into the construction specifications that are developed as part of the final project engineering design package, but before pond construction begins. Prior to pond construction, Uranium One will notify NRC staff when the site wide QC program is available at the site for inspection.

As part of the construction plans a licensed professional engineer will develop detailed specifications for excavation, embankment construction, subgrade preparation and liner placement. The plan will include testing techniques and frequencies to evaluate engineering properties of materials used in construction, compaction of earthen materials and seam integrity of

the installed liner. The Uranium One pond Quality Control (QC) plan will be integrated into the site wide QC construction plan and contain the following construction parameters:

- A geotechnical or construction inspector will be on site during embankment construction.
- Appropriate fill material will be taken from an approved, designated borrow area free of objectionable materials.
- Areas on which fill is to be placed will be scarified before its placement.
- The compaction requirements for the fill material will include the percent of maximum dry density for the specified density standard, allowable range of moisture content, and maximum loose lift thickness.
- Fill material will be compacted with appropriate compaction equipment such as a sheepsfoot, rubber-tired, or vibratory roller. The number of required passes by the compaction equipment over the fill material may vary with soil conditions.
- Fill material will contain sufficient moisture to allow the required degree of compaction to be obtained with the equipment used.
- Field density tests will be performed regularly throughout the embankment construction. Many factors influence the frequency and location of control tests. Typically, a routine control test should be performed for every 764.5 to 2293.6 cubic meters (1,000 to 3,000 cubic yards) of compacted material or as directed by the geotechnical engineer.
- Proper subgrade preparation during construction will be performed for the installation of the liner system. The site of the retention system will be cleared of all debris, vegetation, and potential root systems. The surface will be graded so that it is smooth and free of protruding rock particles. The soil will be moisture conditioned as required to prevent it from drying out before the liner is put into use.
- To the extent possible, synthetic liner seams will run up and down and not across a slope. They should not be located near the crest of a slope. Seams will be tested for integrity along their entire length using methods recommended by the manufacturer. Seaming will be performed only under the supervision of experienced personnel.
- Accepted construction standards and specifications for embankments, such as those developed by the USDA Soil Conservation Service or the U.S. Army Corps of Engineers, will be followed.
- Additional QC items will be added as determined through consultation between the pond liner vendor and Uranium One's EPCM to conform to site conditions."

5 OPERATIONAL INSPECTION PLANS

Uranium One will conduct routine pond inspections. Inspection sheets and leak detection well monitoring results will be maintained on-site and submitted in annual reports to NRC and WDEQ/LQD. In the event of a confirmed loss of liner integrity, a phone or email notification to NRC will occur within 48 hours to be followed by a written report to the NRC within 30 days. This report will detail the suspected cause of the leak, estimated amount of leaked liquid, the chemical nature of the liquid, and mitigation efforts undertaken to recover any suspected byproduct water leaked. In addition, the report will provide methods to prevent a similar event in the future. The following four sections outline the routine pond inspection.

5.1 Daily Inspections

The inspections will include visual inspections of the piping, berms, diversion ditches, freeboard, and leak detection systems. The minimum freeboard will be determined during pond design. Following construction of the storage ponds, Uranium One will determine the baseline water quality in the standpipes connected to the leak detection system and also the height of fluid within the pipes. If during the daily inspections a fluid height in any of the standpipes for the pond leak detection system is found to be in excess of six vertical inches greater than the baseline level, then will collect a sample of the fluid for analysis of specific conductance. If the specific conductance of the fluid in the leak detection system exceeds the baseline standpipe water quality by greater than 50 percent, then Uranium One will conclude that a leak has occurred in the pond’s primary liner and will perform mitigative and corrective actions.

5.2 Weekly Inspections

Weekly inspections will consist of checking the pond depth and visually inspecting the pond embankments for slumping, movement, or seepage. The pond depth measurements will be checked against the freeboard requirements. The liner system will be visually inspected to identify any damage. The perimeter game-proof fence, restricted area signs, and pond inlet piping will be checked.

The Director of Safety, Health, and Environment (SHE), and the Mine Manager, will review the inspection report. Routine weekly inspections reports will be maintained on-site by the Radiation Safety Officer (RSO) for NRC staff to review during routine site inspections.

5.3 Quarterly Inspections

Results of the quarterly inspections will be included in the quarterly report submitted to the NRC. Water levels at the wells in the leak detection network will be monitored quarterly. Should water levels rise in the wells or water appears in a previously dry well, Uranium One will begin an investigation. The investigation will evaluate whether or not the increased water levels are attributed to natural infiltration of surface water or infiltration of fluids from the pond. If the source of the water is attributed to pond leakage, then Uranium One will perform immediate corrective action to eliminate the leak and any appropriate remedial actions including characterization of impacts to shallow soils.

5.4 Annual Technical Inspection

Annual inspections will include a review of the previous year's daily, weekly, and quarterly inspections, assessment of the hydraulic and hydrologic capacities, and a survey of the embankment by qualified personnel. Uranium One will submit a copy of the report to the NRC for review.

5.5 Corrective Action Procedures

The corrective actions include notifying the NRC Project Manager by telephone or email within 48 hours and lowering the water level in the storage ponds sufficiently to eliminate the leak. Uranium One commits to completing corrective actions within 60 days, during which time Uranium One will not use the pond to store byproduct material until qualified personnel inspect the repaired liner. Uranium One will submit a report to the NRC and the WDEQ upon completion of the corrective actions, including documentation of all pond repairs. Uranium One will maintain routine daily inspections reports on-site for NRC or WDEQ staff to review during routine site inspections.

5.6 References

Engineer Manual 1110-2-1414, "Water Levels and Wave Heights for Coastal Engineering", U.S. Army Corps of Engineers Service, Washington, DC, July 1989.

Shore Protection Manual, Vol.II U.S. Army Corps of Engineers Service, Vicksburg, Mississippi – 1984

Engineer Manual 1110-2-1420, "Hydrologic Engineering Requirements for Reservoirs", U.S. Army Corps of Engineers Service, Washington, DC, October 1997.

Tables

Table 1: Production / Brine Storage Height and Volume Summary.

Cell	Cell Dimensions (L x W x H)	Freeboard Depth/Vol. (cy)	Storage Depth / Vol. (cy)	Inactive Depth / Vol. (cy)
Cell PR-1	998’ x 698’ x 6’	2.00’ / 50,576 (31.3 acre-feet)	4.00’ / 95,314 (59.1 acre-feet)	1.63’ / 1902 (1.2 acre-feet)
Cell PR-2	848’ x 576’ x 6’	2.00’ / 35,318 (21.9 acre-feet)	4.00’ / 65,765 (40.8 acre-feet)	1.32’ / 1147 (0.7 acre-feet)
Cell PR-3	848’ x 698’ x 6’	2.00’ / 42,909 (26.6 acre-feet)	4.00’ / 80,514 (49.9 acre-feet)	1.63’ / 1739 (1.1 acre-feet)
Cell PR-4	848’ x 698’ x 6’	2.00’ / 42,909 (26.6 acre-feet)	4.00’ / 80,514 (49.9 acre-feet)	1.63’ / 1739 (1.1 acre-feet)
Total Storage		**171,712 (106.4 acre-feet)**	**322,107 (199.7 acre-feet)**	**6,527 (4.1 acre-feet)**

Table 2: GWS Storage Height and Volume Summary.

Cell	Cell Dimensions (L x W x H)	Freeboard Depth/Vol. (cy)	Storage Depth / Vol. (cy)	Freeboard Depth/Vol. (cy)
Cell GW-1	392’ x 260’ x 10’	2.00’ / 7,087 (4.4 acre-feet)	8.00’ / 21,623 (13.4 acre-feet)	0.45’ / 312 (0.2 acre-feet)
Cell GW-2	392’ x 260’ x 10’	2.00’ / 7,087 (4.4 acre-feet)	8.00’ / 21,623 (13.4 acre-feet)	0.45’ / 312 (0.2 acre-feet)
Cell GW-3	392’ x 260’ x 10’	2.00’ / 7,087 (4.4 acre-feet)	8.00’ / 21,623 (13.4 acre-feet)	0.45’ / 312 (0.2 acre-feet)
Cell GW-4	392’ x 260’ x 10’	2.00’ / 7,087 (4.4 acre-feet)	8.00’ / 21,623 (13.4 acre-feet)	0.45’ / 312 (0.2 acre-feet)
	Total Storage	**28,348 (17.6 acre-feet)**	**86,492 (53.6 acre-feet)**	**1,248 (0.8 acre-feet)**

Figures

GROUND WATER SWEEP PONDS & BRINE MIXED WITH PRODUCTION PERMEATE PONDS

POND	DISTURBANCE		CUT	FILL	NET		BALANCE
	(SF)	(ACRE)	(CY)	(CY)	(CY)		(%)
GWS NORTH STORAGE POND	282,641	6.5	38,717	18,649	20,069	CUT	70.0%
GWS SOUTH STORAGE POND	302,387	6.9	25,596	37,882	12,286	FILL	38.7%
BRINE + PROD. PERMEATE STORAGE POND	2,994,923	68.8	812,284	688,824	123,459	CUT	16.4%

DRAWING ISSUE TYPES: PRB = PRE-BID POB = POST-BID IFC = ISSUED FOR CONSTRUCTION POI = POST ISSUED FOR CONSTRUCTION

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IF THIS BAR DOES NOT EQUAL ONE INCH ADJUST SCALES ACCORDINGLY

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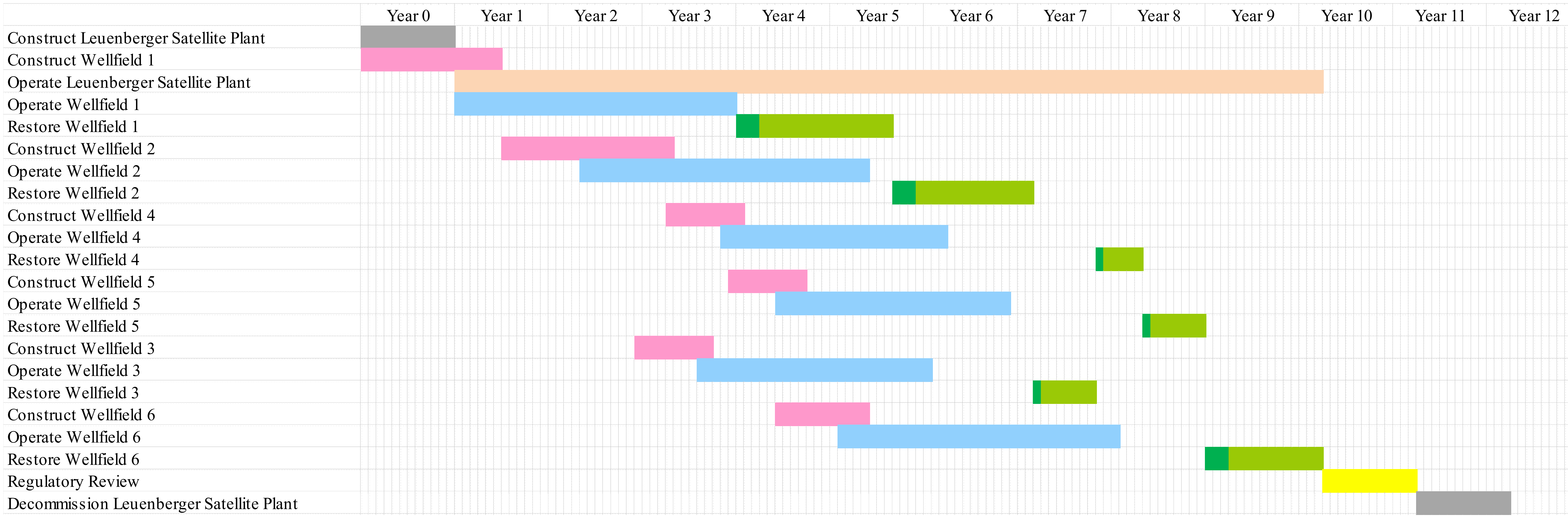
8201.2013.103	AJE	----	----	11/27/2013

LUENBERGER SATELLITE PLANT LAYOUT
LUDEMAN ISR PROJECT
URANIUM ONE
CONVERSE COUNTY, WY

FIGURE
FIG.1

DRAWING: Z:\CURRENT_PROJECTS\8201_URANIUM_ONE\8201-2013-103 LUDEMAN POND DESIGN\020-CAD\BASE\8201-2013-103-CGS01-POND-LAYOUT.DWG



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APPROVED BY: RMD

Proposed Project Schedule

REV #	DESCRIPTION	BY	DATE	FIGURE
0	Draft for Review	EGS	6/20/13	2
1	For Submittal	RMD	6/20/13	

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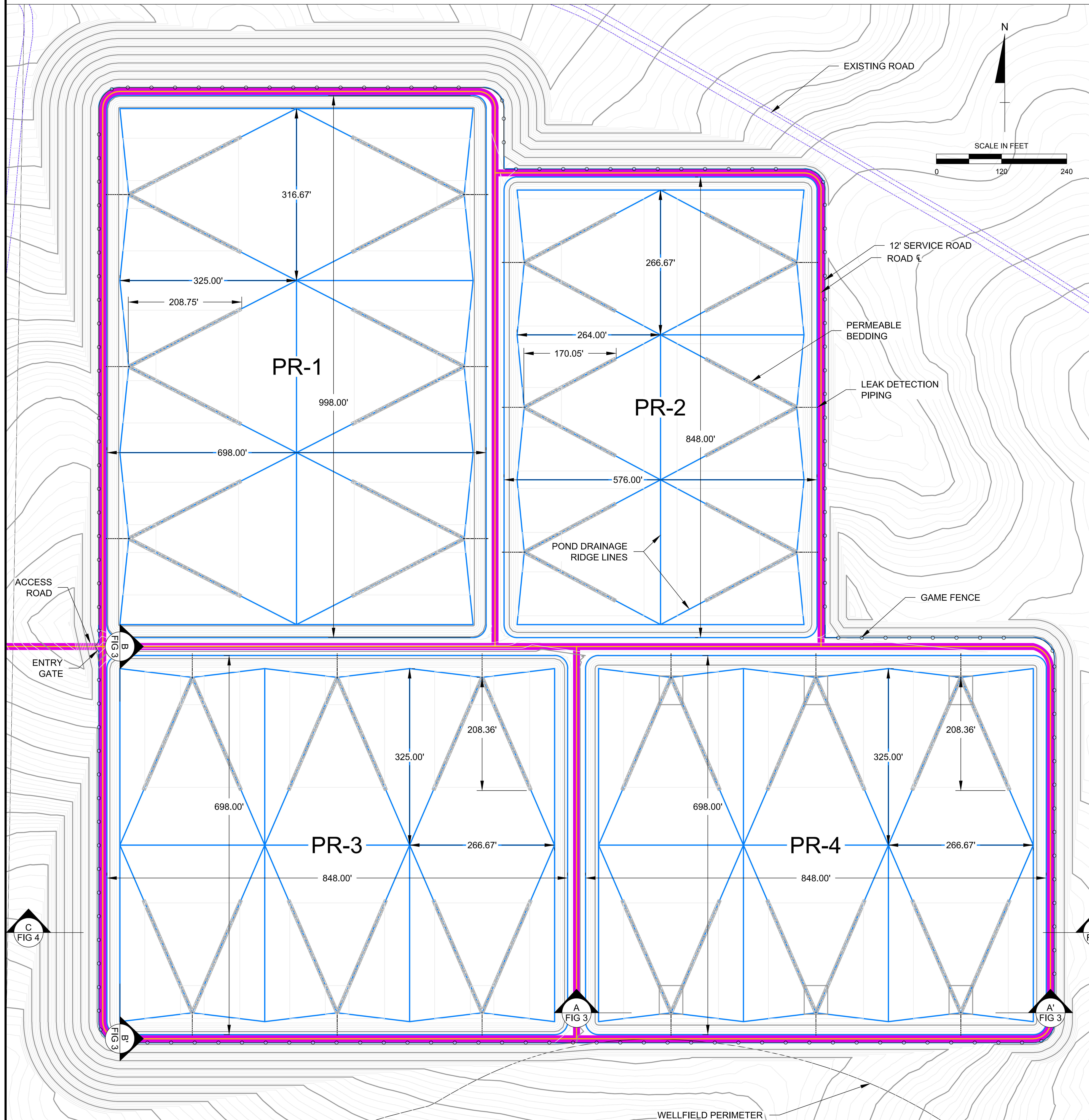
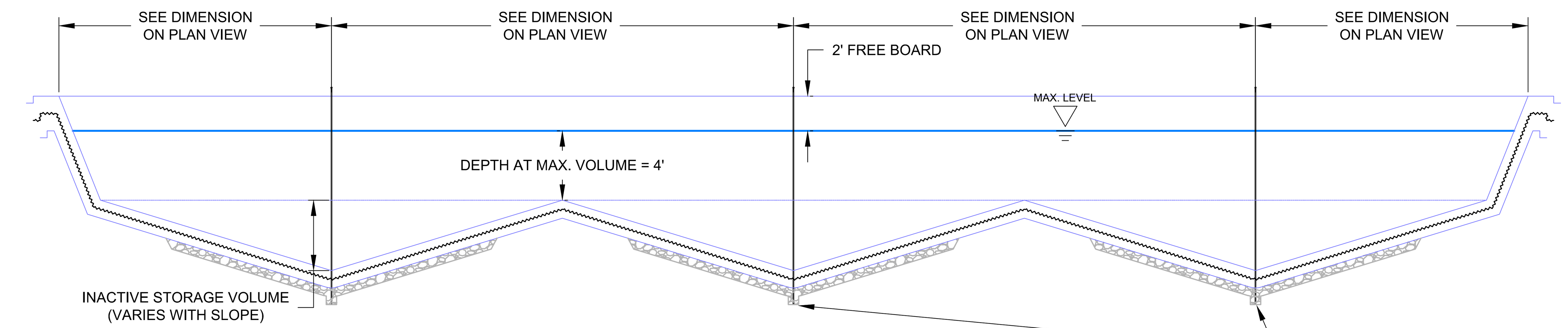
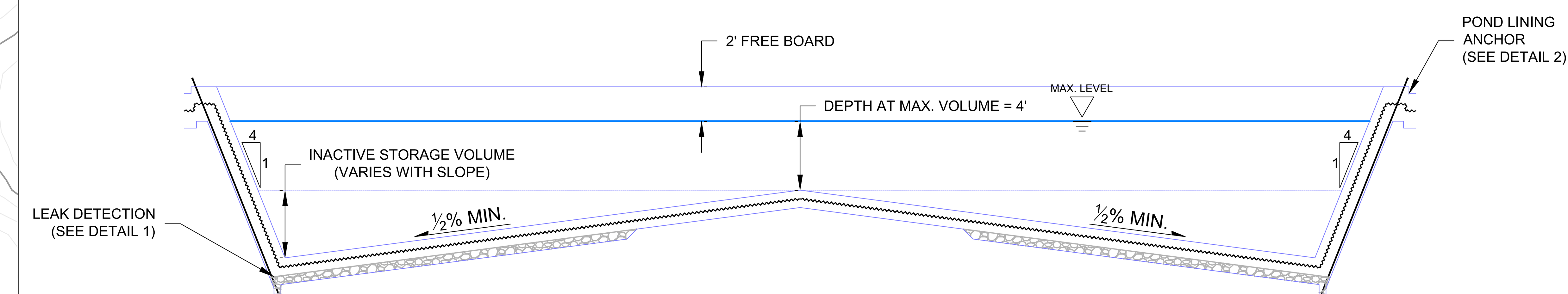




A-A' CROSS SECTION VIEW (TYP.)
EVAPORATION POND DETAIL
NTS



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EVAPORATION POND DETAIL
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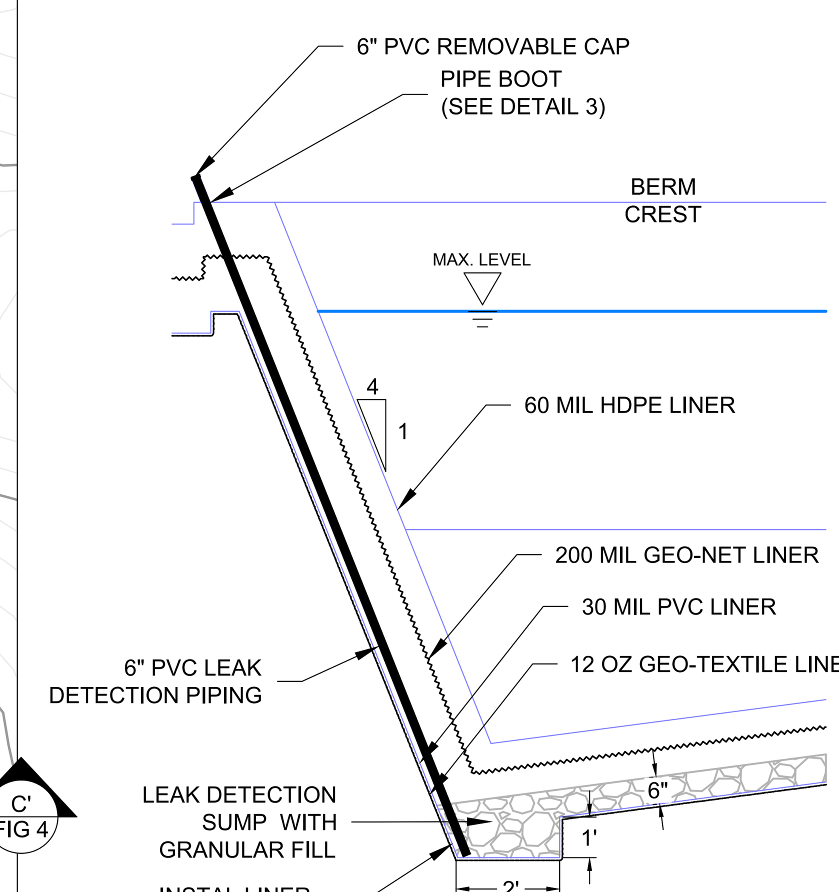
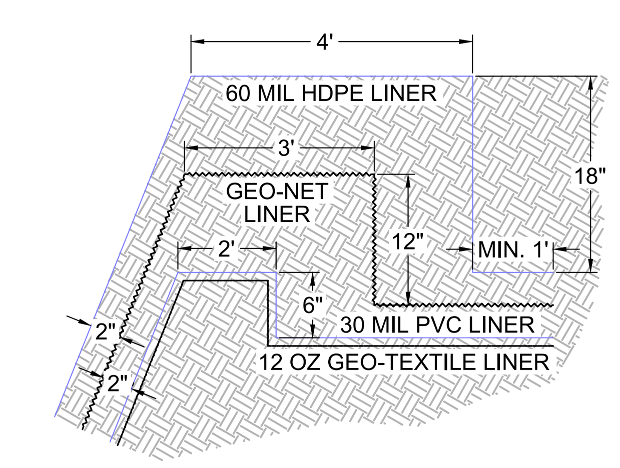


1 LEAK DETECTION DETAIL
NTS



2 POND LINER ANCHOR DETAIL
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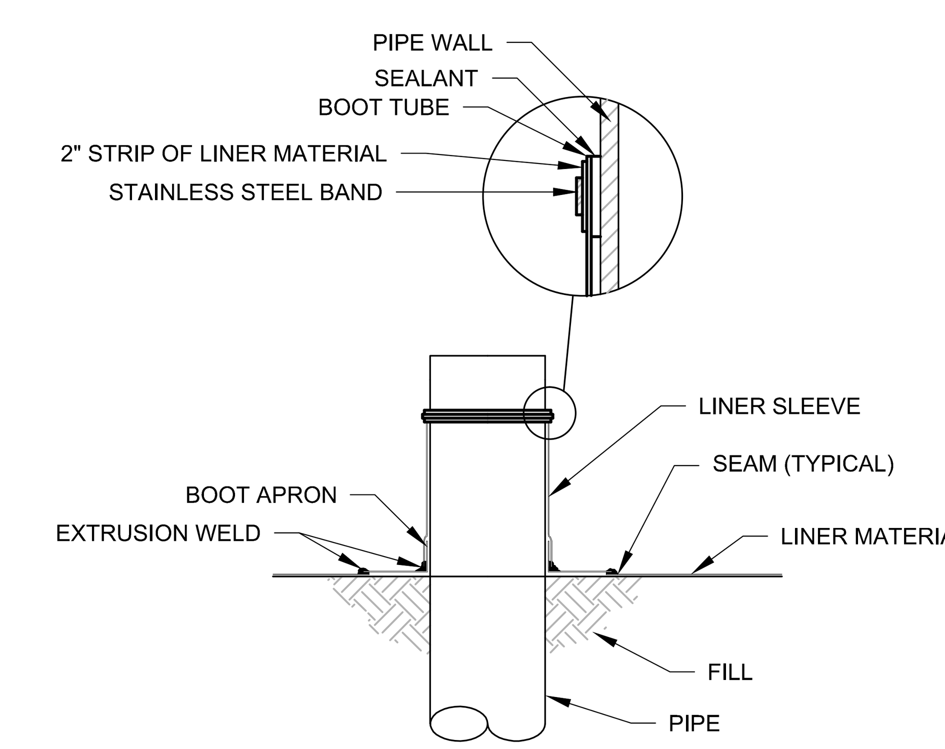

3 PIPE BOOT DETAIL
NTS

NOTE:

1. ANCHOR TRENCH IS TO BE CONSTRUCTED PER MANUFACTURES RECOMMENDATIONS

DRAWING REVISIONS TYPES: 1 PRE-BID 1 POST-BID 1 POST IFC

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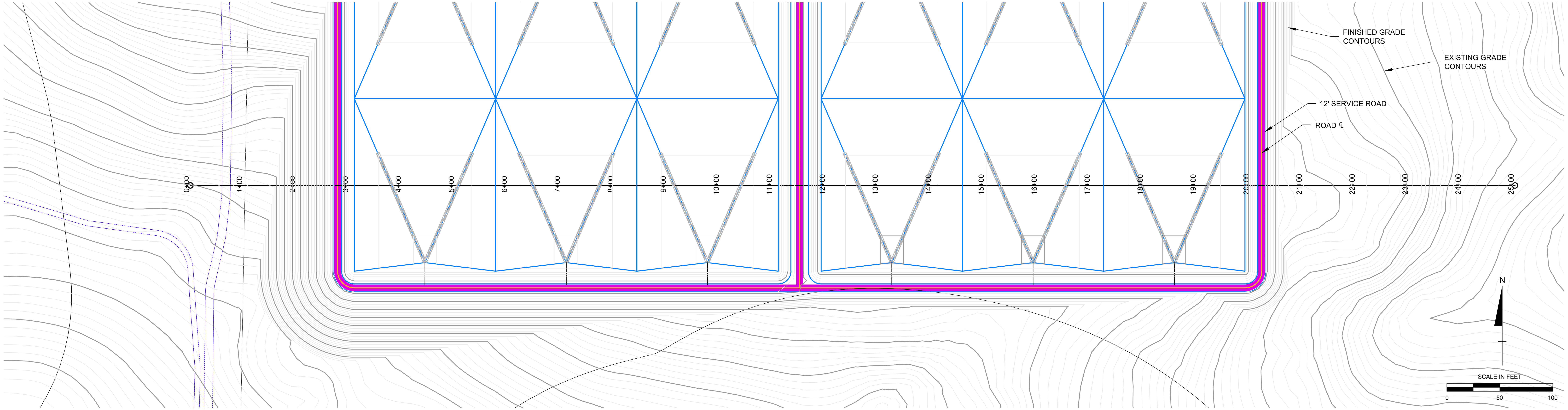
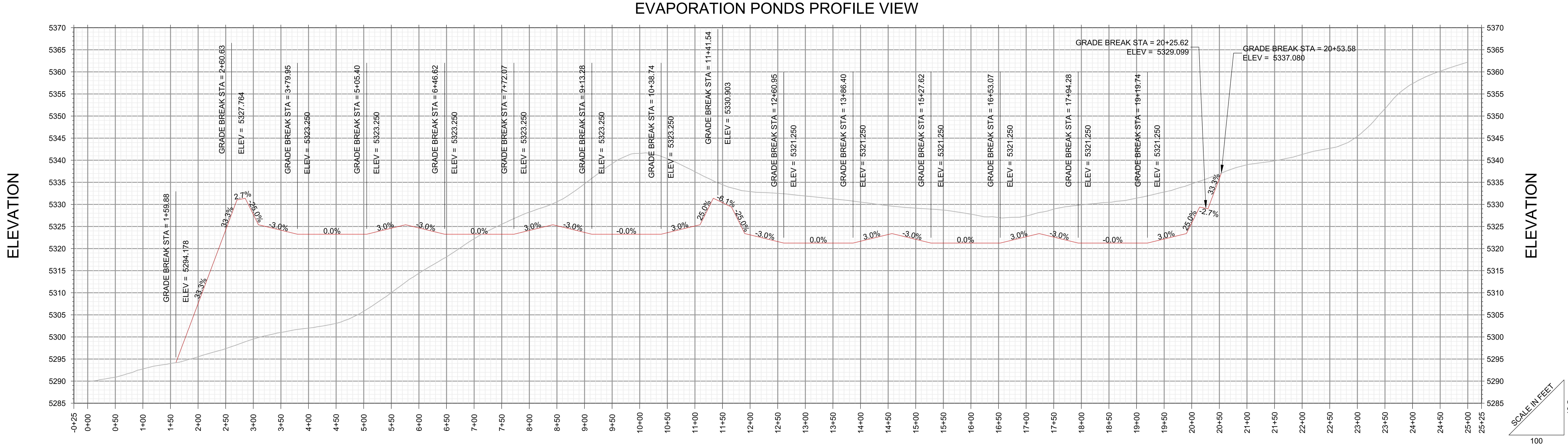
EVAPORATION POND LAYOUT AND DETAILS
LUDEMAN ISR PROJECT
URANIUM ONE
CONVERSE COUNTY, WY

FIGURE
3



EVAPORATION PONDS PROFILE VIEW



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EVAPORATION PONDS X-SECTION PROFILE
LUDEMAN ISR PROJECT
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CONVERSE COUNTY, WY

SHEET
FIG.4

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GROUND WATER SWEEP POND LAYOUT
LUDEMAN ISR PROJECT
URANIUM ONE
CONVERSE COUNTY, WY

FIGURE 3

DRAWING: Z:\CURRENT_PROJECTS\8201_URANIUM_ONE\8201-2013-103 LUDEMAN POND DESIGN\020-CAD\BASE\8201-2013-103-CGX01-PONDS-GWS.DWG

Attachment 1:
Evaporation/GWS Pond Volume Storage Calculations

Production/Brine
Pond Volume Calculations Ludeman
ISR Project - Uranium One

Description: Spreadsheet calculates inflow, evaporation and storage on a monthly basis in order to deterrmine the required number and size of evaporation pond cells. It is assumed that ponds fill in parallel (i.e. brine is at the same depth in all ponds.) Evaporation rates are calculated on the assumption that all ponds are constructed before plant begins operations and fill in parallel (i.e. at the same time). Storage at the bottom of pond (leak detection quadrants) is assumed to be inactive.

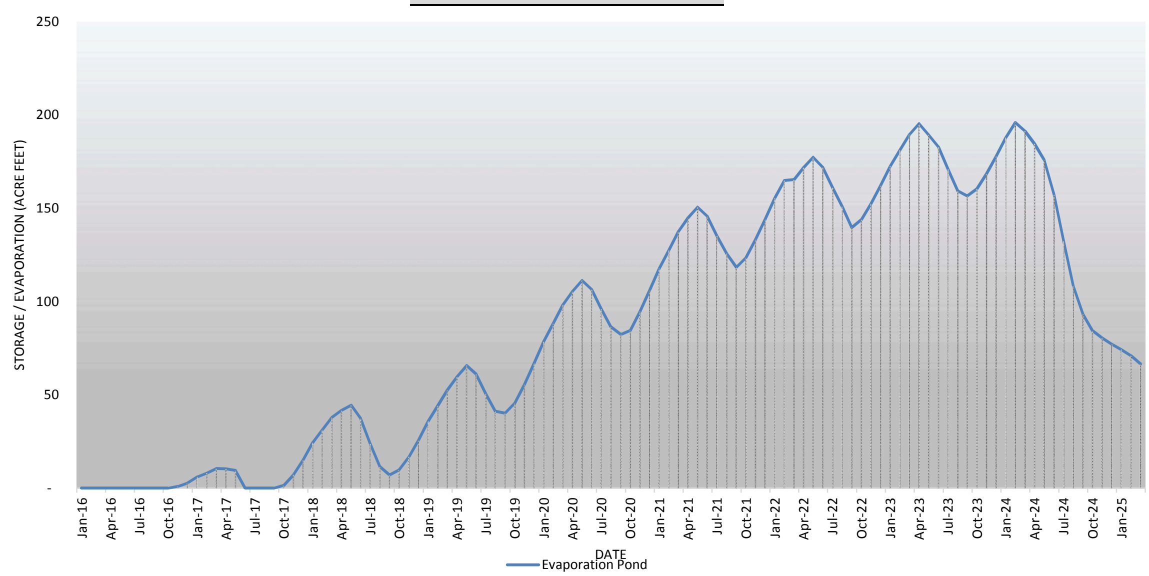
Cell Dimensions		Cell Results		Pond Results	
Depth, ft	6	Volume (total), ac-ft	76.52	Number of Cells	4
Slope, __H:1V	4	Volume (minus freeboard), ac-ft	49.91	Volume (total), ac-ft	306.10
Bottom Width, ft	800	Pond Bottom Area, ac	11.94	Volume (minus freeboard), ac-ft	199.65
Bottom Length, ft	650	Pond Surface Area, ac	13.03	Pond Bottom Area, ac	47.75
Storage Depth, ft	4.00	Pond Top Area, ac	13.59	*Evap Surface Area, ac	48.82
Freeboard Factor	18			Pond Top Area, ac	54.35
Cells are Input.					

	Cell Storage				Pond Storage (all cells)			
	Depth	Surface Area	Incr. Storage	Total Cell Storage	Depth	Surface Area	Incr. Storage	Total Pond Storage
	(ft)	ft2	ft3	NA	(ft)	ft2	ft3	ft3
Inactive Storage	VARIES BASED ON POND SLOPE AND POND DIMENSIONS	520,000	NA	140,401 (0.25% SLOPE)	DEPTH VARIES BASED ON POND SLOPE AND POND DIMENSIONS	2,080,000	NA	561,602 (0.25% SLOPE)
Active Storage	0.00	520,000	0	0	0.0	2,080,000	0	0
	0.33	523,835	172,233	172,233	0.3	2,095,340	688,931	688,931
	0.67	527,801	178,778	351,011	0.7	2,111,203	715,112	1,404,043
	1.00	531,664	174,812	525,823	1.0	2,126,656	699,247	2,103,290
	1.33	535,541	176,089	701,911	1.3	2,142,165	704,355	2,807,646
	1.67	539,550	182,766	884,677	1.7	2,158,202	731,062	3,538,708
	2.00	543,456	178,696	1,063,373	2.0	2,173,824	714,784	4,253,492
	2.33	547,375	179,987	1,243,360	2.3	2,189,502	719,949	4,973,441
	2.67	551,428	186,797	1,430,157	2.7	2,205,713	747,187	5,720,627
	3.00	555,376	182,623	1,612,780	3.0	2,221,504	730,491	6,451,118
	3.33	559,338	183,928	1,796,707	3.3	2,237,351	735,711	7,186,829
	3.67	563,434	190,871	1,987,579	3.7	2,253,736	763,485	7,950,314
	4.00	567,424	186,592	2,174,170	4.0	2,269,696	746,366	8,696,680
Freeboard	4.33	571,428	187,911	2,362,081	4.3	2,285,712	751,642	9,448,323
	4.67	575,568	194,989	2,557,070	4.7	2,302,271	779,957	10,228,280
	5.00	579,600	190,603	2,747,673	5.0	2,318,400	762,411	10,990,690
	5.33	583,646	191,936	2,939,608	5.3	2,334,585	767,742	11,758,433
	5.67	587,830	199,151	3,138,759	5.7	2,351,318	796,603	12,555,036
	6.00	591,904	194,656	3,333,415	6.0	2,367,616	778,624	13,333,660
	4.0	567,424	186,592	2,174,170	4.0	2,269,696	746,366	8,696,680

*Evaporation surface area is assumed at 1' storage depth.

STORAGE SUMMARY

Storage (AC-FT)	Month
196	Feb-24



GWS Pond Volume Calculations
Ludeman ISR Project - Uranium One

Description: Spreadsheet calculates inflow, evaporation and storage on a monthly basis in order to deterrmine the required number and size of evaporation pond cells. It is assumed that ponds fill in parallel (i.e. brine is at the same depth in all ponds.) Evaporation rates are calculated on the assumption that all ponds are constructed before plant begins operations and fill in parallel (i.e. at the same time). Storage at the bottom of pond (leak detection quadrants) is assumed to be inactive.

Cell Dimensions		Cell Results		Pond Results	
Depth, ft	10	Volume (total), ac-ft	17.90	Number of Cells	4
Slope, __H:1V	4	Volume (minus freeboard), ac-ft	13.46	Volume (total), ac-ft	71.60
Bottom Width, ft	180	Pond Bottom Area, ac	1.29	Volume (minus freeboard), ac-ft	53.83
Bottom Length, ft	312	Pond Surface Area, ac	2.11	Pond Bottom Area, ac	5.16
Storage Depth, ft	8.00	Pond Top Area, ac	2.34	*Evaporation Surface Area, ac	8.42
Freeboard Factor	20			Pond Top Area, ac	9.36

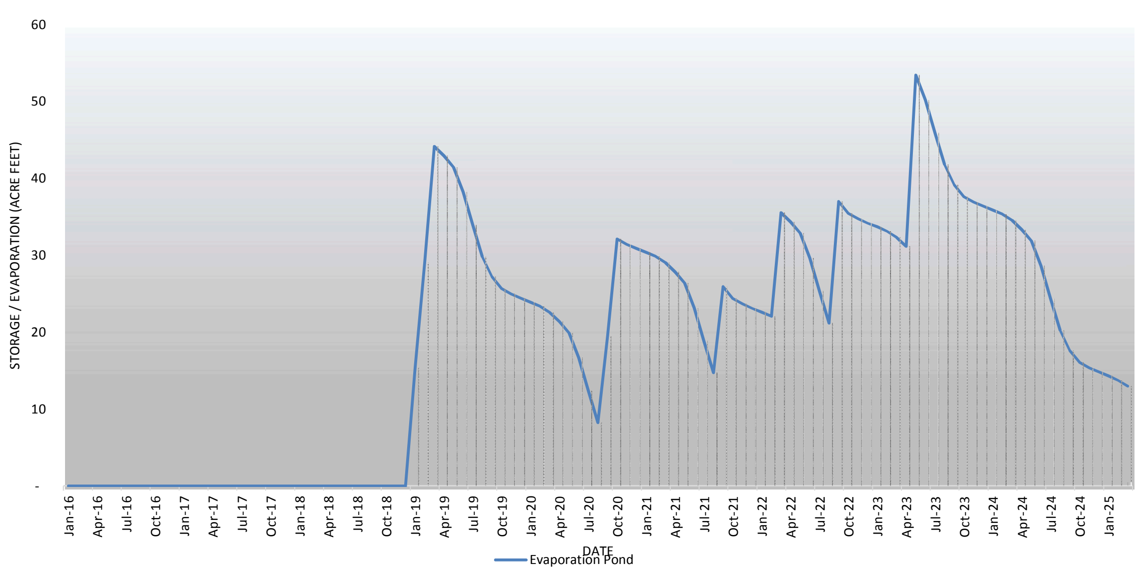
Cells are Input.

	Cell Storage				Pond Storage (all cells)			
	Depth	Surface Area	Incr. Storage	Total Cell Storage	Depth	Surface Area	Incr. Storage	Total Pond Storage
	(ft)	ft2	ft3	ft3	(ft)	ft2	ft3	ft3
Inactive Storage	VARIES BASED ON POND SLOPE AND POND DIMENSIONS	56,160	NA	4,212 (0.25% SLOPE)	DEPTH VARIES BASED ON POND SLOPE AND POND DIMENSIONS	224,640	NA	16,848 (0.25% SLOPE)
Active Storage	0.00	56,160	0	0	0.0	224,640	0	0
	0.50	58,144	28,576	28,576	0.5	232,576	114,304	114,304
	1.00	60,160	29,576	58,152	1.0	240,640	118,304	232,608
	1.50	62,208	30,592	88,744	1.5	248,832	122,368	354,976
	2.00	64,288	31,624	120,368	2.0	257,152	126,496	481,472
	2.50	66,400	32,672	153,040	2.5	265,600	130,688	612,160
	3.00	68,544	33,736	186,776	3.0	274,176	134,944	747,104
	3.50	70,720	34,816	221,592	3.5	282,880	139,264	886,368
	4.00	72,928	35,912	257,504	4.0	291,712	143,648	1,030,016
	4.50	75,168	37,024	294,528	4.5	300,672	148,096	1,178,112
	5.00	77,440	38,152	332,680	5.0	309,760	152,608	1,330,720
	5.50	79,744	39,296	371,976	5.5	318,976	157,184	1,487,904
	6.00	82,080	40,456	412,432	6.0	328,320	161,824	1,649,728
	6.50	84,448	41,632	454,064	6.5	337,792	166,528	1,816,256
	7.00	86,848	42,824	496,888	7.0	347,392	171,296	1,987,552
	7.50	89,280	44,032	540,920	7.5	357,120	176,128	2,163,680
	8.00	91,744	45,256	586,176	8.0	366,976	181,024	2,344,704
Freeboard	8.50	94,240	46,496	632,672	8.5	376,960	185,984	2,530,688
	9.00	96,768	47,752	680,424	9.0	387,072	191,008	2,721,696
	9.50	99,328	49,024	729,448	9.5	397,312	196,096	2,917,792
	10.00	101,920	50,312	779,760	10.0	407,680	201,248	3,119,040
	8.0	91,744	45,256	586,176	8.0	366,976	181,024	2,344,704

*Evaporation surface area is assumed at 8' storage depth.

STORAGE SUMMARY

Storage (AC-FT)	Month
53	May-23



Attachment 2:
Natural Evaporation Rates (Monthly Averages)

Natural Evaporation Rates (Monthly Averages)

Location		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Casper	**Mean**	**0.7**	**0.8**	**1.1**	**1.7**	**2.1**	**4.6**	**6.1**	**5.9**	**3.7**	**2.2**	**1.0**	**0.8**	**30.9**
	SD	0.6	0.5	0.9	1.2	1.8	1.6	1.1	1.1	1.4	1.0	0.6	0.4	4.5
	High	1.7	1.9	2.5	3.7	5.8	8.1	8.3	8.0	5.2	3.7	2.2	1.8	38.3
	Low	-0.8	-0.1	-1.2	-1.3	-2.6	1.1	3.8	2.2	-0.2	-0.2	-0.7	-0.4	20.6
Cheyenne	Mean	1.2	1.5	1.7	2.3	2.6	4.0	5.0	4.8	3.6	2.6	1.5	1.4	32.0
	SD	0.9	0.7	1.1	1.5	1.8	1.9	1.6	1.2	1.4	1.2	0.8	0.5	6.3
	High	2.5	305	3.8	4.2	6.4	6.9	7.9	7.8	5.6	4.0	3.6	2.4	43.3
	Low	-1.7	-0.1	-0.6	-1.2	-2.4	-0.6	1.1	2.9	-1.1	-0.8	-1.2	0.2	18.7
Lander	Mean	0.2	0.5	1.0	1.1	2.3	4.8	6.9	6.1	3.2	1.2	0.3	0.3	28.1
	SD	0.6	0.7	1.1	1.8	2.1	2.2	1.0	1.1	1.6	1.4	0.8	0.5	5.7
	High	1.1	1.8	3.0	4.3	5.8	8.3	8.5	7.7	5.3	2.9	1.9	1.1	41.3
	Low	-1.5	-1.4	-1.6	-3.0	-2.8	-1.9	5.0	2.6	-1.5	-1.8	-1.5	-0.9	12.2
Sheridan	Mean	0.1	0.4	0.9	1.5	2.1	2.6	6.2	5.3	2.6	1.5	0.4	0.3	23.7
	SD	0.5	0.4	0.7	1.4	1.9	2.6	1.4	1.3	1.4	1.2	0.6	0.5	4.4
	High	1.3	1.4	2.1	4.2	6.5	6.9	8.0	7.5	4.7	3.3	2.1	1.9	34.7
	Low	-1.0	-0.5	-1.2	-1.9	-3.1	-4.1	2.3	1.1	-0.5	-1.2	-1.4	-0.9	14.4
Rock Springs	Mean	0.8	1.1	1.9	2.7	3.8	5.5	7.1	6.1	4.3	2.6	1.2	0.7	37.7
	SD	0.5	0.6	0.7	1.1	1.4	1.9	1.0	1.2	1.3	1.2	0.8	0.5	6.6
	High	1.7	2.6	3.4	5.1	5.7	9.4	9.1	8.1	6.1	4.8	6.0	1.7	51.1
	Low	0.7	0.0	0.6	0.7	0.6	0.6	3.9	3.3	0.3	0.2	0.0	-0.3	21.0
Pathfinder Reservoir	Mean	0.6	0.7	1.5	2.2	3.5	5.1	6.8	6.0	3.7	1.7	0.9	0.6	33.3
	SD	0.4	0.5	0.7	1.1	1.6	1.7	0.9	1.1	1.2	1.1	0.4	0.3	4.0
	High	1.0	1.7	2.6	4.5	5.9	8.3	8.4	7.8	5.3	3.1	1.9	1.1	39.9
	Low	-0.9	-0.2	-0.2	0.5	0.1	1.1	5.0	2.4	1.0	-0.8	-0.2	-0.4	19.8
Whalen Dam	Mean	1.3	1.5	1.9	2.0	2.5	3.9	5.9	5.9	3.7	2.9	1.7	1.3	34.8
	SD	0.4	0.6	1.0	1.2	2.1	2.2	1.5	1.1	1.6	1.1	0.5	0.5	5.5
	High	2.0	2.8	3.5	4.0	6.3	7.7	8.5	8.0	5.6	4.4	2.6	2.2	45.3
	Low	0.4	0.6	-0.4	-0.2	-3.7	-0.9	2.6	3.5	-1.1	0.1	0.8	0.2	21.6

Note: Means, standard deviations, and high and low net evaporation (in inches) from estimates using the Kohler-Nordenson-Fox equation with a coefficient of 0.7 for evaporation

Attachment 3:
Geotechnical Report

TETRA TECH

Report for

Geotechnical Engineering Study

Proposed Ludeman Satellite Plant and Evaporation Pond
State Highway 95
Converse County Wyoming

November 7, 2013

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TETRA TECH

Geotechnical Engineering Study

Ludeman Satellite Plant
and Evaporation Pond
State Highway 95
Converse County, Wyoming

Prepared for:

Uranium One, Americas

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Tetra Tech Project No. 114-510751

November 7, 2013

Professional Engineer (Civil)
BRIAN L. CHANDLER
8095
Date 11/7/13
Wyoming

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TABLE OF CONTENTS

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for the proposed uranium processing facility to be located approximately 8 miles east of the Town of Rolling Hills, Wyoming on State Highway 95. This study was conducted for the purpose of developing foundation and site grading recommendations for the proposed new process building and site grading and slope stability analysis for the new production permeate and brine ponds. This study was conducted in accordance with Tetra Tech's professional services agreement with Uranium One Americas dated July 31, 2013 and our proposal of the same date.

The field exploration program consisted of drilling five exploratory borings for the proposed building, nine borings for the proposed new ponds, and three percolation test holes for the proposed leach field area to obtain information on the subsurface conditions. The exploratory borings were located generally as shown on the Location of Exploratory Borings, Figure 1. Samples of the soil obtained during the field exploration were tested in our laboratory to determine physical and engineering characteristics and analyzed to develop earthwork and construction design recommendations. The results of the field exploration and laboratory testing are presented herein.

This report has been prepared to summarize the data obtained during this study, and to present conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. A discussion of geotechnical engineering considerations related to construction is included in this report.

PROPOSED CONSTRUCTION

Uranium One plans to develop a satellite uranium processing facility and associated evaporation ponds as part of the Ludeman project located in Converse County, Wyoming. The project site is approximately 10 miles northeast of Glenrock on the south side of State Highway 95. The evaporation pond is expected to consist of multiple cells approximately five to ten feet deep and have a total surface area of approximately 50 acres (1,300 ft by 1,700 ft). Cuts of up

to 20 ft will be required and fills of up to 50 ft will be required. The cut and fill slopes will be constructed to 3 horizontal to 1 vertical for both interior and exterior slopes. The satellite facility will include a building, ancillary features, and a septic system with leach field. The building will have plan dimensions of approximately 80 ft by 180 ft. We assume the building will be single-story, metal-framed, slab on grade structure with moderate loads and potentially heavy floor loads.

SITE CONDITIONS

At the time of our field exploration the site was vacant and undeveloped land. The topography of the building site is relatively flat with an estimated elevation difference of less than 4 ft across the proposed building footprint. The topography of the pond site has a ridgeline across the center of the site in the east to west direction and slopes slightly to moderately downward to the south and north with an elevation difference of approximately 45 ft in the north direction and 50 ft in the south direction. Vegetation on the building site consisted of grasses and the vegetation on the pond site consisted of prairie grasses, cactus, and sagebrush.

FIELD EXPLORATION

Tetra Tech conducted the field exploration on September 19, 2013. Five exploratory borings were drilled within the proposed building footprint to depths of 25 ft and nine borings were drilled in the proposed pond area to depths of approximately 15 ft to observe subsurface and groundwater conditions and to obtain samples for laboratory testing. In addition, three shallow percolation test holes were drilled within the proposed leachfield to depths of 4 ft. The boring locations are shown on Figure 1. Uranium One personnel located the building corners and the four outside pond corners in the field with pin flags. Tetra Tech determined the boring locations referencing the pin flags. Tetra Tech established the elevations of the borings by interpolation from the topographic site plan provided.

The drill crew advanced the borings through the on-site soils with a CME 55 truck mounted drill rig using 4 inch diameter solid-stem auger. A Tetra Tech field representative logged the borings. Auger refusal was not encountered within any of the borings.

Samples of the subsurface soils were obtained using 1⅜ inch inside diameter split barrel samplers and 2 inch inside diameter California samplers. The samplers were driven into the various strata using a 140 lb hammer falling 30 inches. The total number of blows required to advance the samplers each of three successive 6 inch increments is recorded and the sum of the second and third 6 inch increments is recorded as the penetration resistance value or N value. This testing is performed in accordance with ASTM D1586, Split Barrel Sampling. When sampling with the California sampler, this test is similar to the test described by ASTM D1586. Penetration resistance values provide an indication of the relative density of granular soils or consistency of fine-grained soils. Depths at which the samples were obtained and the penetration resistance values are shown on the exploratory boring logs.

Groundwater levels were measured within the borings at the time of drilling. The borings were backfilled with auger cuttings upon completion of drilling.

Tetra Tech presoaked the percolation test holes and returned the site to perform the percolation testing. The percolation test results are presented below under the **Engineering Analysis and Recommendation** section.

LABORATORY TESTING

Samples of soil obtained during the field exploration were observed and visually classified in accordance with ASTM D2487, which is based on the Unified Soil Classification System. Samples were selected for testing to determine the engineering and physical properties in general accordance with ASTM or other generally recognized procedures. The following table summarizes the tests performed for this project:

Test	ASTM Designation
Natural Water Content	D2216
Natural Dry Density	D2937
Particle Size Analysis	D422
Atterberg Limits	D4318
Swell\Settlement Potential	D4546
Water Soluble Sulfate	

Results of all laboratory tests are summarized on Table I, presented on the figures following the exploratory boring logs, and shown on the boring logs. The laboratory data, along with the visual field logging information, were used to prepare the final exploratory boring logs.

SUBSURFACE CONDITIONS

The subsurface conditions encountered at the proposed satellite plant site generally consisted of up to 25 ft of silty clayey sand, poorly graded sand with silt, and lean clay. Claystone bedrock was encountered at a depth of 19.5 ft in boring B-2. The subsurface conditions encountered at the site of the proposed ponds generally consisted of 1 to 16.5 ft of poorly graded sand with silt to clayey sand overlying sandstone bedrock. With the exception of boring B-12, sandstone was encountered at depths ranging from 1 to 6 ft. The boring logs should be referenced for complete soil descriptions and classifications, stratum thicknesses, N values, and laboratory test results. A brief description of each soil type follows:

Process Building Site

Silty Clayey Sand (SC-SM) to Clayey Sand (SC)

Silty clayey sand to clayey sand was encountered below the topsoil borings B-1 and B-2, below the poorly graded sand in boring B-3, and below the clay in borings B-1, B-4, and B-5. The silty clayey sand to clayey sand stratum extended to depths of 10 ft in boring B-1, 19.5 ft in boring B-2, 12 ft in boring B-3 and to the maximum depths explored in borings B-1, B-4, and B-5, 25 ft. The relative density of the silty clayey sand was medium dense as indicated by the N values ranging from 12 to 26. The silty clayey sand was brown in color and generally slightly moist to moist. Laboratory test results are presented on Figures 3, 5, and 6. Laboratory testing

indicates that the silty clayey sand will settle slightly to moderately (3 to 5% at 4 ksf) upon loading and becoming wetted.

Poorly Graded Sand with Silt (SP-SM)

Poorly graded sand with silt was encountered below the topsoil in borings B-3 and B-4 and below the clay again in boring B-3. The sand with silt stratum extended to depths of 4.5 ft in boring B-3 and 9 ft in boring B-4, and again to the maximum depth explored in boring B-3, 25 ft. The relative density of the poorly graded sand with silt was medium dense as indicated by the N values ranging from 12 to 26. The sand was light brown to brown in color and generally slightly moist.

Lean Clay with Sand to Sandy Lean Clay (CL)

Lean clay with sand to sandy lean clay was encountered below the topsoil in boring B-5, below the silty clayey sand in borings B-1 and B-3, and below the poorly graded sand with silt in boring B-4. The lean clay stratum extended to depths of 17 ft in boring B-1, 18 ft in boring B-2, and 22 ft in borings B-4 and B-5. The consistency of the lean clay was stiff to hard as indicated by the N values ranging from 10 to 50. The clay was brown in color and generally slightly moist to moist.

The subsurface conditions encountered within the three percolation test holes generally consisted of sandy lean clay.

Claystone Bedrock

Claystone bedrock was encountered below the silty clayey sand in boring B-2 and extended to the depth explored, 25 ft. The claystone was firm to hard as indicated by the N values of 21 and greater than 50. The claystone was gray in color and generally slightly moist.

Pond Site

Poorly Graded Sand with Silt (SP-SM) to Silty Sand (SM)

Poorly graded sand with silt to silty sand was encountered below the topsoil in borings B-6 through B-9, B-11, B-13, and B-14 and below the clayey sand in boring B-12. The sand with silt to silty sand stratum extended to depths of 6.5 ft in boring B-6, 2 ft in boring B-7, 3 ft in borings B-8 and B-14, 1.5 ft in boring B-9, 4 ft in boring B-11, 1 ft in boring B-13, and to the maximum depth explored in boring B-12, 16.5 ft. The relative density of the sand was medium dense to dense as indicated by the N values of 19 and 37. The sand was light brown to brown in color and generally slightly moist. Laboratory test results are presented on Figure 11.

Clayey Sand (SC)

Clayey sand was encountered below the topsoil in borings B-10 and B-12. The clayey sand stratum extended to depths of 6 ft in boring B-10 and 13 ft in boring B-12. The relative density of the clayey sand was loose to medium dense as indicated by the N values ranging from 7 to 13. The clayey sand was brown in color and moist.

Sandstone Bedrock

Poorly cemented sandstone bedrock was encountered below the poorly graded sand with silt and silty clayey sand in borings B-6 through B-14 and extended to the depths in all of these borings, 15.25 to 16.5 ft. The sandstone was hard to very hard as indicated by the N values of greater than 50. The sandstone was light brown in color and generally slightly moist. Laboratory test results are presented on Figures 13, 16, 17, 22, and 24.

Groundwater

Groundwater was not encountered within any of the borings at the time of drilling. Numerous factors, such as irrigation of surrounding fields, contribute to fluctuations of groundwater levels, and evaluation of such factors is beyond the scope of this study.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

The recommended design and construction criteria presented below should be observed for the geotechnical engineering aspects of the project. The following construction details should be considered when preparing project documents.

Process Building Site

Site Grading

The existing topography of the site sloped slightly downward to the east with an elevation difference of approximately 4 ft across the proposed building footprint. The finished floor elevation was not provided to us at the time of this report. However, based on the elevation difference across the proposed building footprint, we expect that site grading will entail 1 to 4 ft of new fill placement within the building footprint to establish the finished floor elevation and to provide positive drainage away from all foundations.

Site Preparation:

The site should be properly prepared by following the general recommendations provided below.

1. All topsoil, vegetation, and organic matter should be removed from the proposed building footprint and all cut and fill areas. The topsoil and root zone was observed to be approximately 6 inches in thickness.

2. Upon completion of topsoil stripping and prior to placing site grading fill, the subgrade should be scarified to a minimum depth of 8 inches, moisture conditioned, and proof-rolled with heavy-duty vibratory compaction equipment to check for loose or soft areas. If loose or soft areas are encountered, they should be over-excavated to a competent bearing stratum and properly backfilled.

3. All site grading fill and backfill material should be approved by the geotechnical engineer. In general, the on-site existing soils encountered within the borings will be suitable for use as exterior foundation wall backfill, fill below floor slabs, and overlot fill. If additional fill is required, the sand soil and sandstone bedrock material encountered at the pond site are suitable for use at the building site. The upper 1 to 2 ft of exterior wall backfill must consist of the on-site lean clay soil encountered at the ground surface in boring B-5.

4. Fill required to obtain design grades should be placed in thin (8 inch maximum), uniform lifts and compacted to the following minimum percentages of the maximum dry density as determined by ASTM D698 (Standard Proctor).

Application	Compaction (%)
Below Foundations	100
Building Pad (below floors)	98
Exterior Foundation Wall Backfill	95
Utility Trenches	95
Overlot Fill	90

All fill material should be placed within ±2% of the optimum moisture content as determined by ASTM D698.

Excavations:

Based on the subsurface conditions encountered within the exploratory borings, the lean clay, silty clayey sand, and the poorly graded sand with silt will be encountered within foundation excavations. Conventional heavy-duty earth excavation equipment should be sufficient for anticipated excavations.

Surface Drainage:

The following drainage precautions should be observed during construction and maintained at all times after the building has been completed.

1. The ground surface adjacent to the exterior foundations should be sloped to drain away from the foundations in all directions. We recommend a minimum slope of 6 inches in the first 10 ft.

2. Roof downspouts and drains should discharge well beyond the limits of all foundation wall backfill and should be well maintained over the life of the facility.

3. Landscaping that requires irrigation should remain at least 5 ft from exterior walls.

Spread Footings

Based on the subsurface conditions encountered within the exploratory borings, we recommend the proposed building be founded on spread footings placed on the natural, undisturbed site soils. The footings should be designed using a maximum allowable bearing pressure of 2,500 psf.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1. We determined a footing depth and bearing pressure for the design of footings that should provide against bearing failure and excessive settlement. Based upon our experience and analyses using one-dimensional settlement theory, we recommend that footings be designed using a maximum allowable bearing pressure of 2,500 psf for the natural, undisturbed site soils. For footings designed using this bearing pressure, we estimate the total settlement for the footings will be 1 inch or less. We estimate differential settlement will be less than half the total settlement.

2. If loose areas are encountered during footing excavations, the footings should extend to adequate bearing soil. As an alternative, the loose or soft areas can be over-excavated and replaced with the on-site sand soils or an imported granular fill. Fill placed in over-excavations should be compacted to the specifications outlined above in the **Site Grading** section.

3. Exterior footings or footings below unheated areas should be placed at least 42 inches below final exterior grade for frost protection.

4. We recommend minimum footing widths of 18 inches for continuous footings and 24 inches for isolated pads.

5. Continuous footings and foundation walls should be reinforced to span an unsupported length of 12 ft. This will allow the foundation to span any potential soft or loose areas that are not detected during excavation.

6. Type II cement should be used in concrete in contact with the on-site soils.

7. A representative of the geotechnical engineer should observe the foundation excavations prior to concrete placement.

Floor Slabs

Based on the subsurface conditions encountered and the results of the laboratory testing, the native soils are suitable for support of moderate to heavy floor loads. Based on the expect site grading consisting of 1 to 4 ft of fill to establish the finished floor elevation, the fill should consist of the on-site sand soils or the sand soils from the pond area. Fill placed below floor slabs should be placed to at least 98% of the maximum dry density and at a moisture content within ±2% of optimum moisture as determined by ASTM D698, Standard Proctor. The following recommendations should be followed for concrete slab-on-grade construction.

1. To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints, which allow unrestrained vertical movement.

2. Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joints should be provided approximately 15 ft apart.

3. The requirements for slab reinforcement and thickness should be established by the designer based on experience and the intended use of the slab.

4. A 4-inch thick layer of free draining gravel should be placed beneath all concrete slab-on-grade floor slabs. This material should consist of minus 1½-in. aggregate with less than 60% passing the No. 4 sieve, and less than 5% passing the No. 200 sieve.

5. Floor slabs should not be placed on frozen subgrades.

Pond Site

Site Grading

All topsoil, vegetation, and organic matter should be stripped in all cut and fill areas within the pond footprint. The topsoil thickness was approximately 6 inches.

Site grading will consist of cuts of up to 20 ft on the higher elevation areas located on the southern portion of the pond site and fills of up to 50 ft at the southwest corner of the pond area to achieve the planned crest elevation of 5334.5 and the pond bottom elevation of 5328.5.

Excavation

The proposed pond will be constructed with a balanced cut and fill. In general, cuts in the higher elevation areas will entail excavations of approximately 20 ft. The excavations required in cut areas will be made mostly within the sandstone bedrock stratum and can be accomplished with conventional heavy-duty excavation equipment. In general, the sandstone was poorly cemented. Well cemented lenses may be encountered that may be difficult to excavate. Specialized equipment may be required if strongly cemented zones are encountered.

Embankment Construction

Embankments will be constructed along all sides of both cells. The embankment heights will range from 0 ft to 50 ft, will have crest widths of 12 ft, and will be constructed at 3 horizontal to 1 vertical slopes, interior and exterior. The on-site sand and sandstone is suitable for use as

embankment fill. Laboratory testing indicates that the sand and sandstone materials have between 12 and 36% passing the No. 200 sieve and is predominately non-plastic. Prior to placing embankment fill, the subgrade of all areas to receive new fill should be scarified to a minimum depth of 6 inches, moisture conditioned, and proof-rolled with heavy-duty compaction equipment. New embankment fill must be benched into existing slopes. We recommend that a bench be excavated at the toes of all slopes over 10 ft in height with minimum dimensions of 3 ft in depth and 10 ft in width.

All soils used for the construction of the earthen embankment should be processed by scarifying, mixing, or discing and applying moisture to achieve a uniform moisture content within ±2% of the optimum moisture content as determined by ASTM D698, Standard Proctor. All fill should be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698.

The on-site sand and sandstone encountered within the borings have natural moisture contents ranging from 4 to 9%. It is expected that the sand materials will have an optimum moisture contents on the order of 13%. The natural moisture contents of the sand soil ranges from 4 to 9% below optimum moisture content. Therefore, moisture will need to be added to the soil and bedrock to be used for embankment fill. If needed, we recommend a shrink factor of 25% for the overburden sands and 15% for the sandstone bedrock.

Compacted Clay Liner

As required by the NRC regulations, a 3 ft thick compacted clay liner is required to be constructed below the double geomembrane liner system. Based on the results of the field exploration, no clay soils were encountered within the cut areas of the pond site. Clay soil with a permeability of 1×10^{-5} cm/sec will need to be imported from an off-site borrow area or a geosynthetic clay liner (GCL) will need to be used. Investigation of off-site borrow areas was not part of our scope of work.

Slope Stability

As required by the NRC regulations, slope stability analyses were performed. We modeled the maximum fill slope which is located near the southwest corner of the pond site for our slope stability analyses. The fill slope in this area is on the order of 50 ft in height and is shown on Figure 1 as cross section A. The soil strength values used in our analyses were estimated based on the soil type and our experience with soil strengths of similar soil types. The shear strength parameters used in the analyses are presented on the slope stability figure attached in Appendix A. The post-construction model was the only one performed. Analyses for the partial pool and maximum pool with steady seepage models were not performed due to the triple liner construction and the low potential for any seepage or phreatic surface to develop. These analyses are typically conducted on external slopes which are low in height in comparison to the interior slopes for this project. The earthquake or pseudo-static model for external slopes also was not performed due to the low seismic potential for the project area.

Our slope stability analysis indicates that the pond slopes will be stable in the post-construction condition. The slope stability analyses summary is shown graphically for the post-construction condition in Appendix A. We used the slope stability software STABL6 for our analyses. Our analysis indicates a factor of safety on the order of 1.6 for the post-construction case. The minimum factor of safety required by the NRC for this condition is 1.3.

Settlement

Based on the proposed construction and the subsurface profile encountered within the exploratory borings, settlement of the pond embankment foundation soils will be less than 1 inch. Based on the soil types encountered the majority of settlement will occur during construction. In addition, based on the liner system consisting of a double geomembrane and a 3 ft thick compacted clay liner, the infiltration of water into the soils beneath the pond is highly unlikely, further reducing any potential for settlement.

Percolation Test Results

Percolation testing was performed at three locations within the proposed leachfield area. Three percolation test holes were drilled to depths of approximately 4 ft and percolation testing performed according to WDEQ procedures. Test Hole No. 3 had the slowest percolation rate, and therefore, should be used for the design value. Test results indicate that the on-site soils have percolation rates ranging from 13 to 26.5 minutes/inch. The table below presents the results of the percolation testing.

	Hole No. 1	Hole No. 2	Hole No. 3
Depth of Hole	38 in.	37 in.	38.5 in.
Elapsed Time (min.)	Water Level Drop (in.)	Water Level Drop (in.)	Water Level Drop (in.)
10	3/4	7/8	3/8
10	9/16	11/16	3/8
10	3/8	5/8	5/8
10	7/16	5/8	3/8
10	13/16	9/16	5/16
10	13/16	9/16	5/16
10	13/16	9/16	5/16
10	13/16	9/16	5/16
	Perc Rate 13 min/in.	Perc Rate 18 min/in.	Perc Rate 26.5 min/in.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the design data submitted to Tetra Tech, data obtained from the exploratory borings drilled at the locations indicated in Figure 1, and the proposed construction discussed in this report. The nature and extent of subsurface variations across the site may not become evident until construction. During construction, if fill,

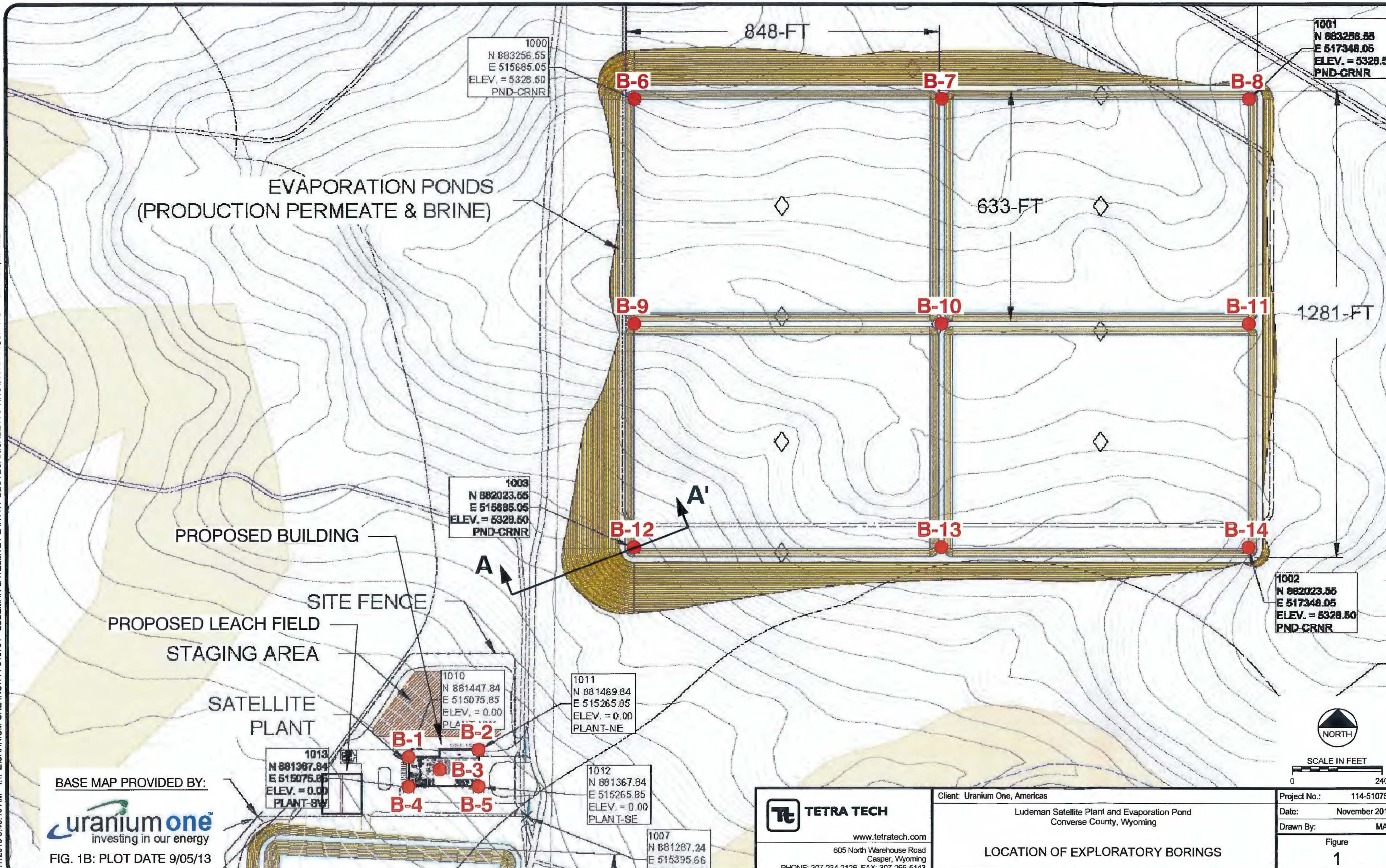
soil, bedrock or water conditions appear to be different from those described herein, this office should be advised at once so that we may re-evaluate the recommendations made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our exploratory information which has not been described or documented in this report. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analysis or modifications of the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of all fill by a representative of the geotechnical engineer.

TETRA TECH

Brian L. Chandler, P.E.
Sr. Geotechnical Engineer

Jared J. Jung, P.E.
Sr. Geotechnical Engineer



TETRA TECH

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Client: Uranium One, Americas

Ludeman Satellite Plant and Evaporation Pond
Converse County, Wyoming

LOCATION OF EXPLORATORY BORINGS

Project No.:	114-510751
Date:	November 2013
Drawn By:	MAT
Figure	1

11/7/2013 8:49:19 AM - I:\T-Z\URANIUM ONE INC\114-510751 - LUDEMAN SATELLITE PLANT\41-GEOTECHNICAL\DRAFTING\510751 FIGS.DWG - TAYLOR, MARIE

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Satellite Plant, Refer to Site Map
Borehole Number:	B-1
Driller:	High Plains
Logger:	Mark Medley
Drilling Equipment:	CME-55
Borehole Diameter (in.):	4
Date Started:	9-19-13
Date Finished:	9-19-13
Elevation and Datum:	Ground: Existing Grade
Notes:	

DEPTH (ft)	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	MATERIAL DESCRIPTION	DEPTH (ft)
0								Silty, Clayey SAND (SC-SM), medium dense, brown, slightly moist.	
	California	21							
5	California	18	5	107	24	4	33		
10	California	9							10
10								Sandy lean CLAY (CL), stiff, brown, slightly moist.	
15	California	10							
17								Clayey SAND (SC), medium dense, brown, slightly moist.	17
20	California	14							
25	California	20							25

Bottom of Boring at 25.0 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

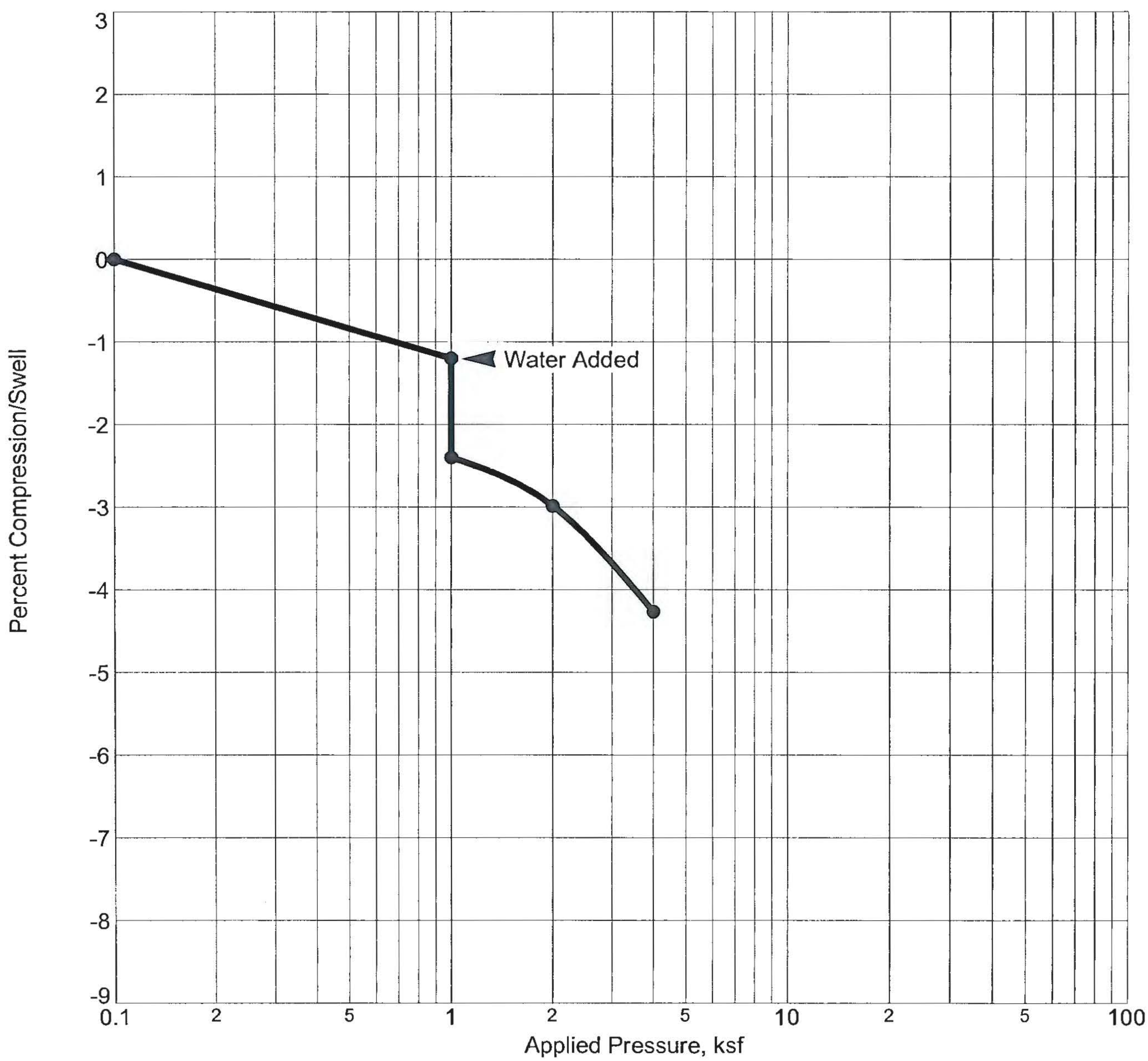
WATER LEVEL OBSERVATIONS

While Drilling Dry ft Upon Completion of Drilling ___ ft
Time After Drilling
Depth To Water (ft)
Remarks:

510751 LOGS.GPJ ' 11-6-13 ' MAT ' CASPER BORE ' TT library 4-13 (MAT)

114-510751	TETRA TECH	LOG OF EXPLORATORY BORING B-1	Fig. 2

Revised 4-04-13 (MAT)



Natural Moisture (%)	Dry Density (pcf)	LL	PI	Tested Load Increments (ksf)
5	107	24	4	1, Wetting, 2, 4

Sample ID: B-1 Depth: 5.0 ft

Classification: SILTY, CLAYEY SAND (SC-SM)

TETRA TECH

SWELL/CONSOLIDATION TEST

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Satellite Plant, Refer to Site Map

Number: 114-510751 Figure No. 3

510751 LOGS.GPJ ' 11-6-13 ' MAT ' TT_CONSOL ENGLISH

Revised 1-23-08 (MAT)

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Satellite Plant, Refer to Site Map
Borehole Number:	B-2
Driller:	High Plains
Logger:	Mark Medley
Drilling Equipment:	CME-55
Borehole Diameter (in.):	4
Date Started:	9-19-13
Date Finished:	9-19-13
Elevation and Datum:	Ground: Existing Grade
Notes:	

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Silty, Clayey SAND (SC-SM), medium dense, brown, slightly moist.	
		California	22	3	107	21	5				
5		California	22								
10		California	12	5	107						
15		California	22								
20		California	21								19.5
										CLAYSTONE BEDROCK, firm to very hard, gray, slightly moist.	
		California	50/0.7								24.7

Bottom of Boring at 24.7 ft

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

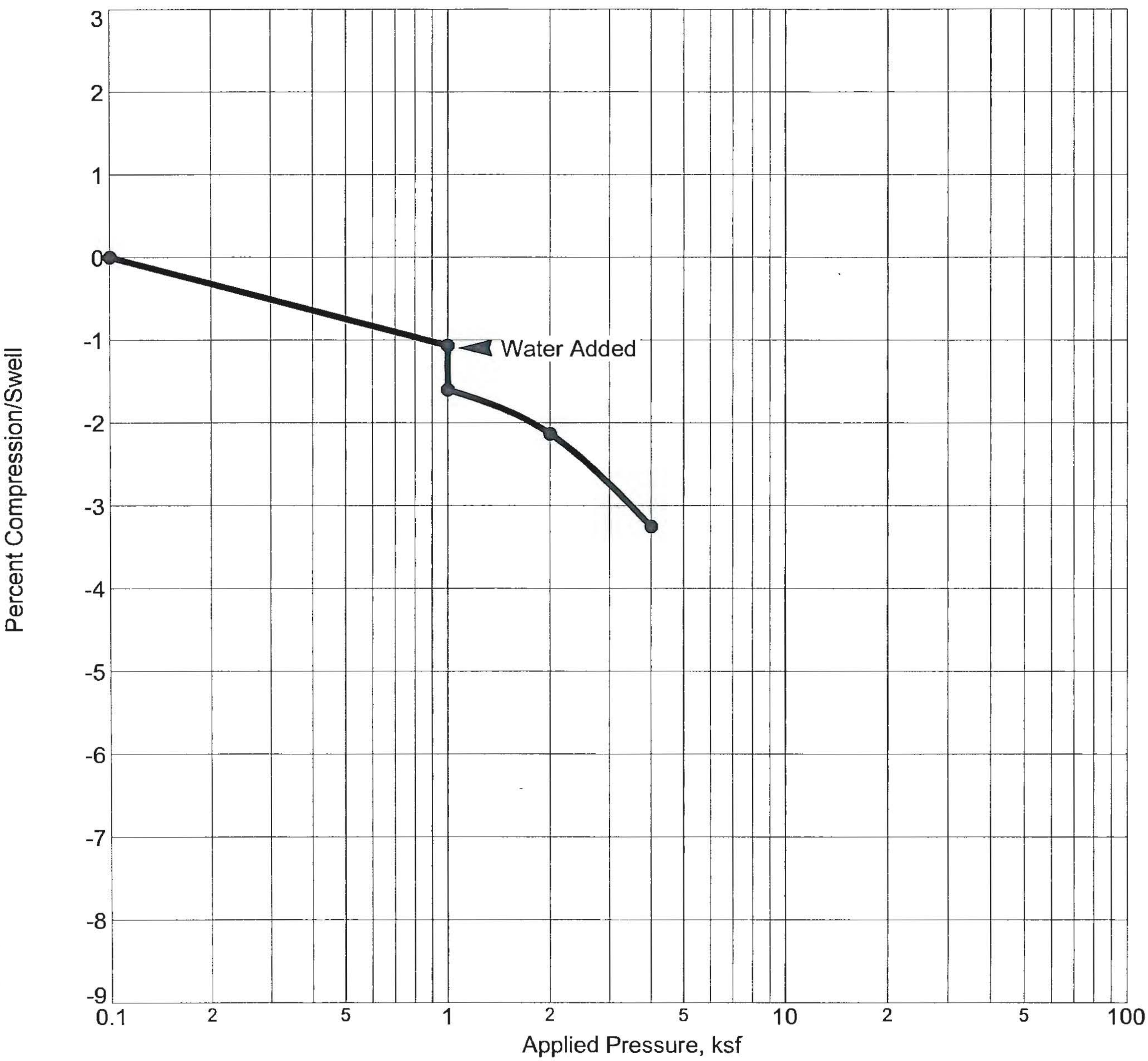
WATER LEVEL OBSERVATIONS

While Drilling ⊻ Dry ft   Upon Completion of Drilling ⊻ ft

Time After Drilling

Depth To Water (ft)

Remarks:



Natural Moisture (%)	Dry Density (pcf)	LL	PI	Tested Load Increments (ksf)
3	107	21	5	1, Wetting, 2, 4

Sample ID: B-2 Depth: 2.5 ft

Classification: SILTY, CLAYEY SAND (SC-SM)

TETRA TECH

SWELL/CONSOLIDATION TEST

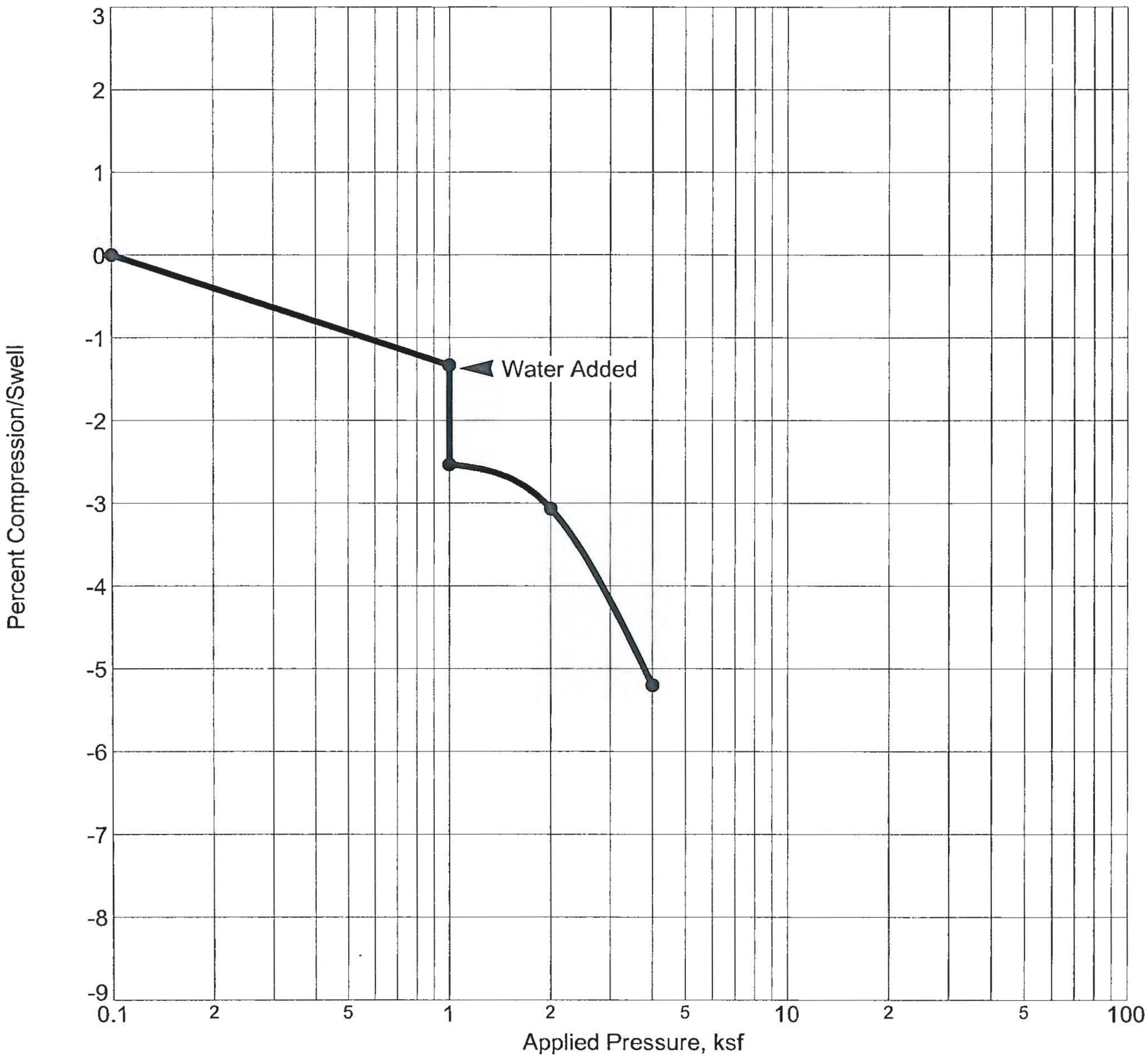
Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming

Location: Satellite Plant, Refer to Site Map

Number: 114-510751 Figure No. 5

510751 LOGS.GPJ ' 11-6-13 ' MAT ' TT_CONSOL ENGLISH

Revised 1-23-08 (MAT)



Natural Moisture (%)	Dry Density (pcf)	LL	PI	Tested Load Increments (ksf)
5	107			1, Wetting, 2, 4

Sample ID: B-2 Depth: 10.0 ft

Classification: SILTY, CLAYEY SAND (SC-SM)

TETRA TECH

SWELL/CONSOLIDATION TEST

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Satellite Plant, Refer to Site Map

Number: 114-510751 Figure No. 6

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming			
Borehole Location: Satellite Plant, Refer to Site Map			
Borehole Number: B-3		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:		

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
	Auger	California	15							Poorly graded SAND with silt (SP-SM), medium dense, brown, slightly moist.	
5	Auger	California	16	5		28	9	37		Clayey SAND (SC), medium dense, brown, slightly moist.	4.5
10	Auger	California	12								
15	Auger	California	28							Sandy lean CLAY (CL), very stiff, brown, slightly moist.	12
20	Auger	California	22							Poorly graded SAND with silt (SP-SM), medium dense, brown, slightly moist.	18
25	Auger	California	26								25

Bottom of Boring at 25.0 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ∇ Dry ft Upon Completion of Drilling ___ ft
Time After Drilling
Depth To Water (ft)
Remarks:

114-510751 | TETRA TECH | **LOG OF EXPLORATORY BORING B-3** | Fig. 7

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Satellite Plant, Refer to Site Map
Borehole Number: B-4	Driller: High Plains; Logger: Mark Medley
Drilling Equipment: CME-55; Borehole Diameter (in.): 4	Date Started: 9-19-13; Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0–9	Auger	California	13							Poorly graded SAND with silt (SP-SM), medium dense, brown, slightly moist.	9
5	Auger	California	12								
9–22	Auger	California	18							Sandy lean CLAY (CL), very stiff to hard, brown, slightly moist.	22
10											
15	Auger	California	50								
20	Auger	California	33								
22–25	Auger	California	26							Silty, Clayey SAND (SC-SM), medium dense, brown, slightly moist.	25

Bottom of Boring at 25.0 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ∇ Dry ft   Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

510751 LOGS.GPJ 11-6-13 MAT CASPER BORE TT library 4-13 (MAT)

114-510751	TETRA TECH	**LOG OF EXPLORATORY BORING B-4**	Fig. 8

Revised 4-04-13 (MAT)

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming

Borehole Location: Satellite Plant, Refer to Site Map

Borehole Number: B-5		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13

Elevation and Datum: Ground: Existing Grade

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
	Auger									Lean CLAY with sand to Sandy lean CLAY (CL), stiff to very stiff, light brown, slightly moist to moist.	
		California	20	11	98	40	24	81			
5		California	20	11	110	36	22	68			
10		California	13								
15		California	20								
20		California	19								22
										Clayey SAND (SC), medium dense, brown, moist.	
25		California	13								25

Bottom of Boring at 25.0 ft

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming			
Borehole Location: Evaporation Pond, Refer to Site Map			
Borehole Number: B-6		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:		

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Silty SAND (SM), medium dense, brown, slightly moist.	
5	Auger	Split Spoon	19	4		NV	NP	14			
	Auger									SANDSTONE BEDROCK, hard to very hard, light brown, slightly moist.	6.5
10	Auger	Split Spoon	50/0.5								
15	Auger	Split Spoon	50/0.5							Encountered small claystone lense at 15.5 ft.	15.5

Bottom of Boring at 15.5 ft

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

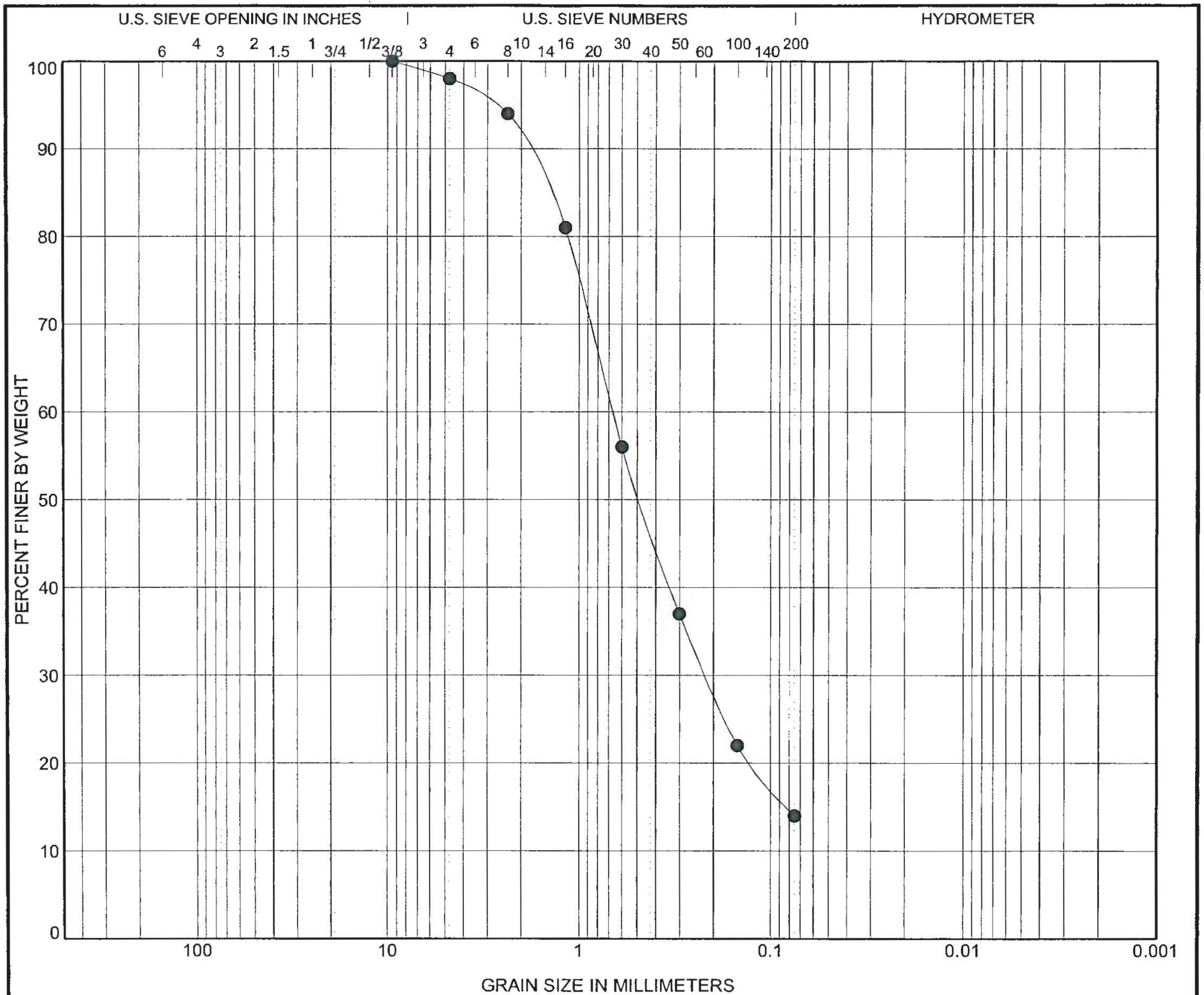
Depth To Water (ft)

Remarks:

510751 LOGS.GPJ ' 11-6-13 ' MAT ' CASPER BORE ' TT library 4-13 (MAT)

114-510751	TETRA TECH	**LOG OF EXPLORATORY BORING B-6**	Fig. 10

Revised 4-04-13 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-6 - (5 - ft)	**SILTY SAND(SM)**	**NV**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-6 - (5 - ft)	**9.5**	**0.669**	**0.217**		**2**	**84**	**14**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map

Number: 114-510751

Figure No. 11

510751 LOGS.GPJ 11-6-13 MAT TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming			
Borehole Location: Evaporation Pond, Refer to Site Map			
Borehole Number: B-7		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:		

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0–2	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	2
2–15.5	Auger									SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	15.5
5	Auger	Split Spoon	79								
10	Auger	Split Spoon	50/0.5	8		NV	NP	14			
15	Auger	Split Spoon	50/0.5								

Bottom of Boring at 15.5 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

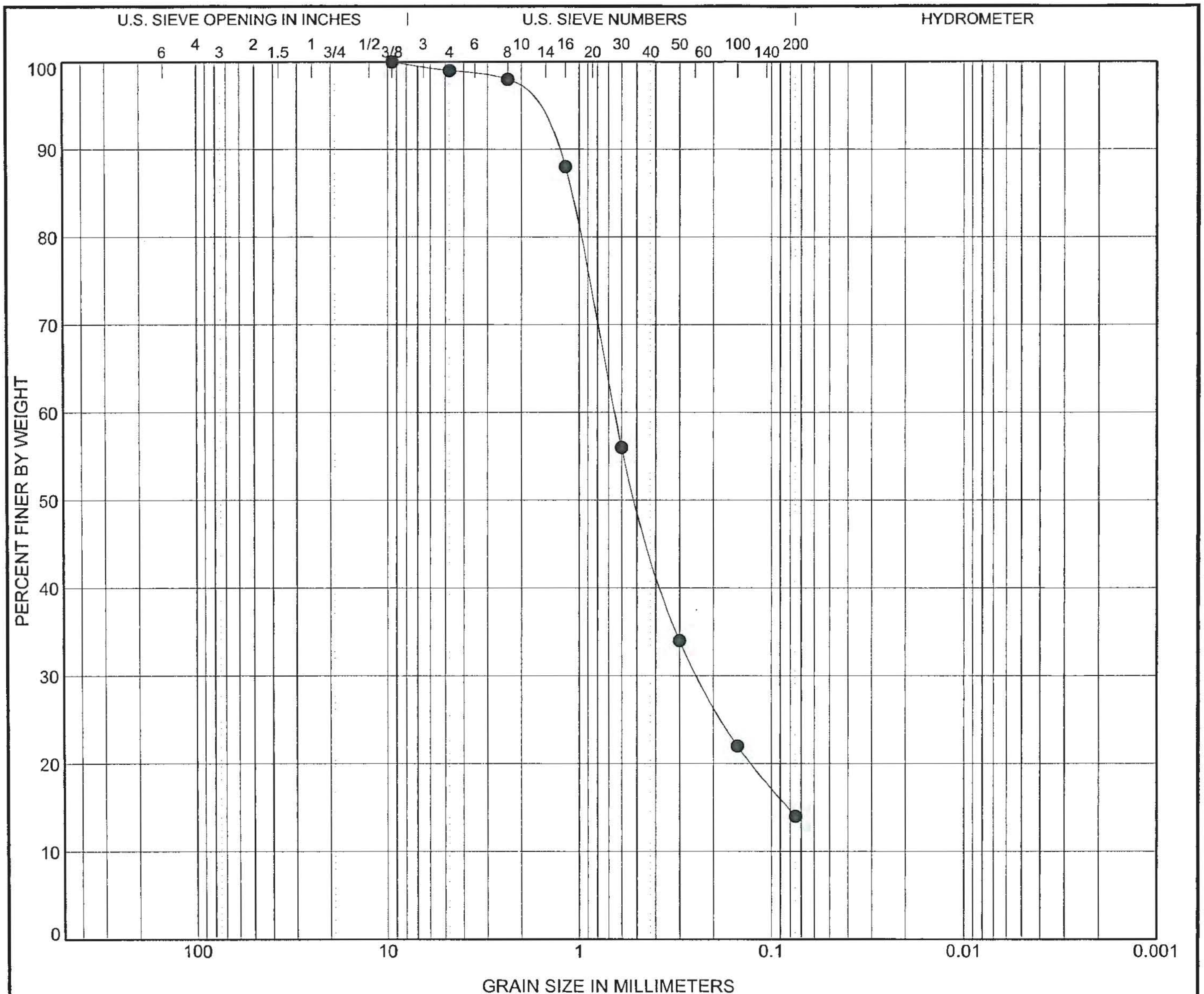
WATER LEVEL OBSERVATIONS

While Drilling ∇ Dry ft Upon Completion of Drilling ___ ft

Time After Drilling

Depth To Water (ft)

Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-7 - (10 - ft)	**SANDSTONE BEDROCK**	**NV**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-7 - (10 - ft)	**9.5**	**0.653**	**0.238**		**1**	**85**	**14**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map
Number: 114-510751

Figure No. 13

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming

Borehole Location: Evaporation Pond, Refer to Site Map

Borehole Number: B-8		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13

Elevation and Datum: Ground: Existing Grade

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0–3	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	3
3–15.25	Auger									SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	15.25
5		Split Spoon	80	5		28	4	17			
10		Split Spoon	50/0.5								
15		Split Spoon	50/0.25								

Bottom of Boring at 15.25 ft

Sampler Types:		Operation Types:
Split Spoon	Penetrometer	Auger
Shelby	Vane Shear	Air Rotary
Bulk Sample	California	Core Barrel
Grab Sample	Test Pit	Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming		
Borehole Location: Evaporation Pond, Refer to Site Map		
Borehole Number: B-9	Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55 / Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:	

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	1.5
	Auger									SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	
5	Auger	Split Spoon	60								
10	Auger	Split Spoon	76	6		NV	NP	12			
15	Auger	Split Spoon	50/0.5	6		NV	NP	15			15.5

Bottom of Boring at 15.5 ft

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

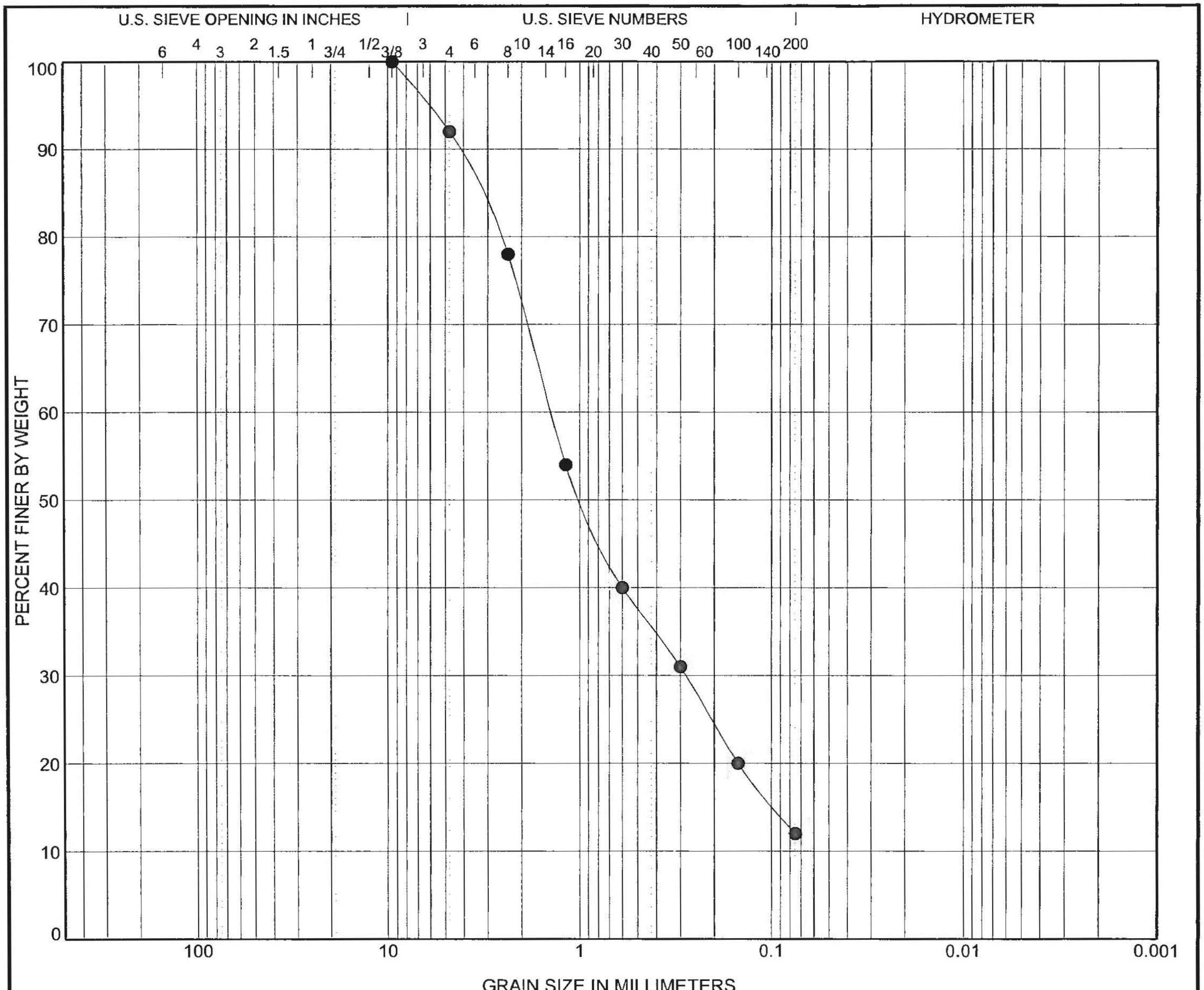
WATER LEVEL OBSERVATIONS

While Drilling Dry ft   Upon Completion of Drilling ____ ft
Time After Drilling
Depth To Water (ft)
Remarks:

114-510751	TETRA TECH	LOG OF EXPLORATORY BORING B-9	Fig. 15

510751 LOGS.GPJ ' 11-6-13 ' MAT ' CASPER BORE ' TT library 4-13 (MAT)

Revised 4-04-13 (MAT)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-9 - (10 - ft)	**SANDSTONE BEDROCK**	**NV**	**NV**	**NP**	**0.90**	**22.25**

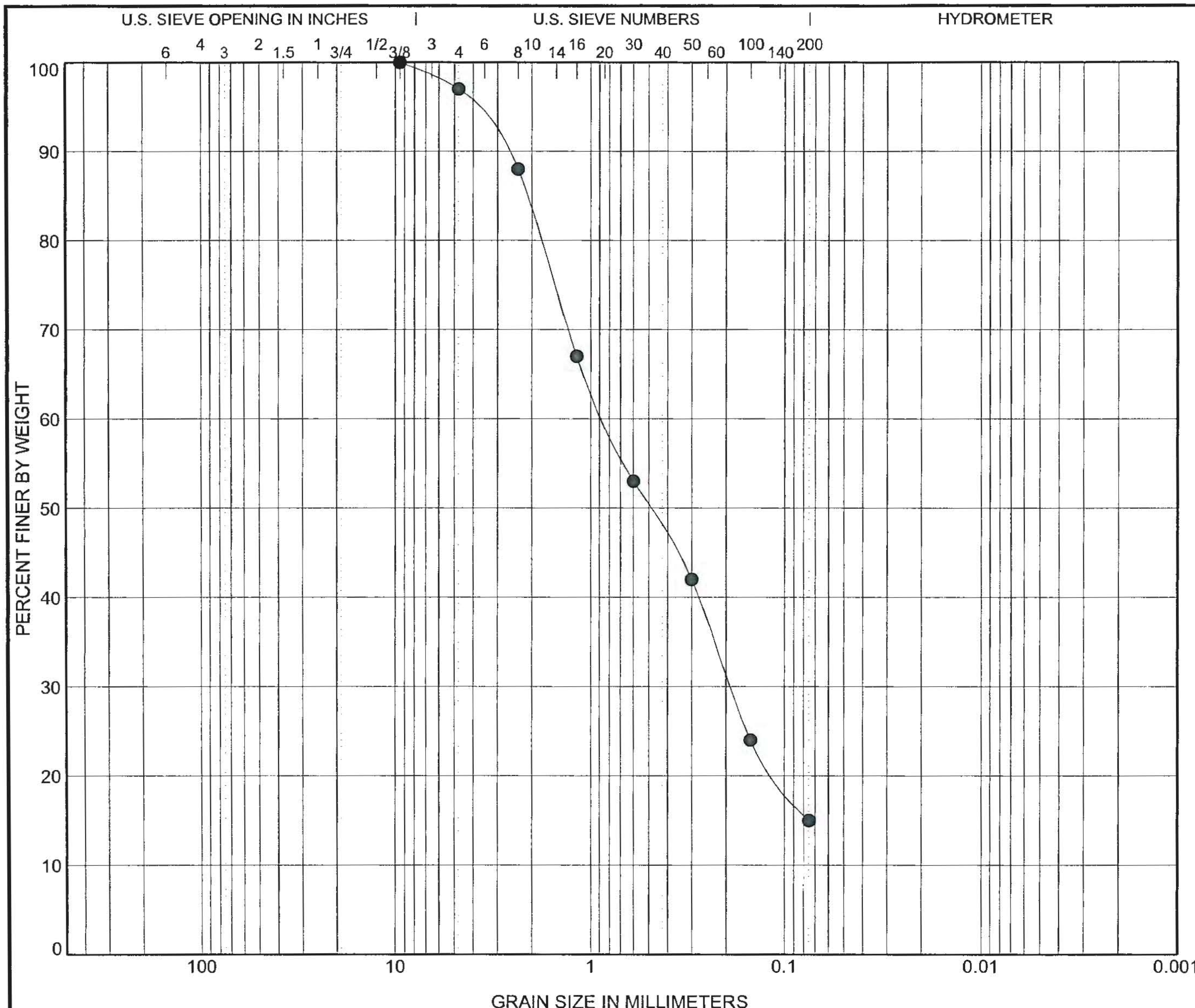
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-9 - (10 - ft)	**9.5**	**1.403**	**0.282**		**8**	**80**	**12**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map

Number: 114-510751 Figure No. 16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-9 - (15 - ft)	**SANDSTONE BEDROCK**	**NV**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-9 - (15 - ft)	**9.5**	**0.841**	**0.189**		**3**	**82**	**15**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map

Number: 114-510751

Figure No. 17

510751 LOGS.GPJ 11-6-13 MAT TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Evaporation Pond, Refer to Site Map

Borehole Number: B-10		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade		Notes:	

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Clayey SAND (SC), loose, brown, slightly moist.	
5	Auger	Split Spoon	7								6
	Auger									SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	
10	Auger	Split Spoon	50/0.25								
15	Auger		50/0.0								15

Bottom of Boring at 15.0 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft — Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Evaporation Pond, Refer to Site Map

Borehole Number: B-11	Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55; Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13

Elevation and Datum: Ground: Existing Grade

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	4
5	Auger	Split Spoon	86							SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	
10	Auger	Split Spoon	50/0.5								
15	Auger	Split Spoon	50/0.5								15.5

Bottom of Boring at 15.5 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

510751 LOGS.GPJ ' 11-6-13 ' MAT ' CASPER BORE ' TT library 4-13 (MAT)

114-510751	TETRA TECH	**LOG OF EXPLORATORY BORING B-11**	Fig. 19

Revised 4-04-13 (MAT)

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming

Borehole Location: Evaporation Pond, Refer to Site Map

Borehole Number: B-12		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13

Elevation and Datum: Ground: Existing Grade

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Clayey SAND (SC), medium dense, brown, slightly moist.	
5	Auger	Split Spoon	13	6		28	10	36			
10	Auger	Split Spoon	12								13
13	Auger									Poorly graded SAND with silt (SP-SM), dense, light brown, slightly moist.	
15	Auger	Split Spoon	37								16.5

Bottom of Boring at 16.5 ft

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:

Project Name:	Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Borehole Location:	Evaporation Pond, Refer to Site Map
Borehole Number:	B-13
Driller:	High Plains
Logger:	Mark Medley
Drilling Equipment:	CME-55
Borehole Diameter (in.):	4
Date Started:	9-19-13
Date Finished:	9-19-13
Elevation and Datum:	Ground: Existing Grade
Notes:	

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0–1	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	1
1–15.5	Auger									SANDSTONE BEDROCK, poorly cemented, very hard, light brown, slightly moist.	15.5
5		Split Spoon	78	4		NV	NP	12			
10		Split Spoon	50/0.5								
15		Split Spoon	50/0.5								

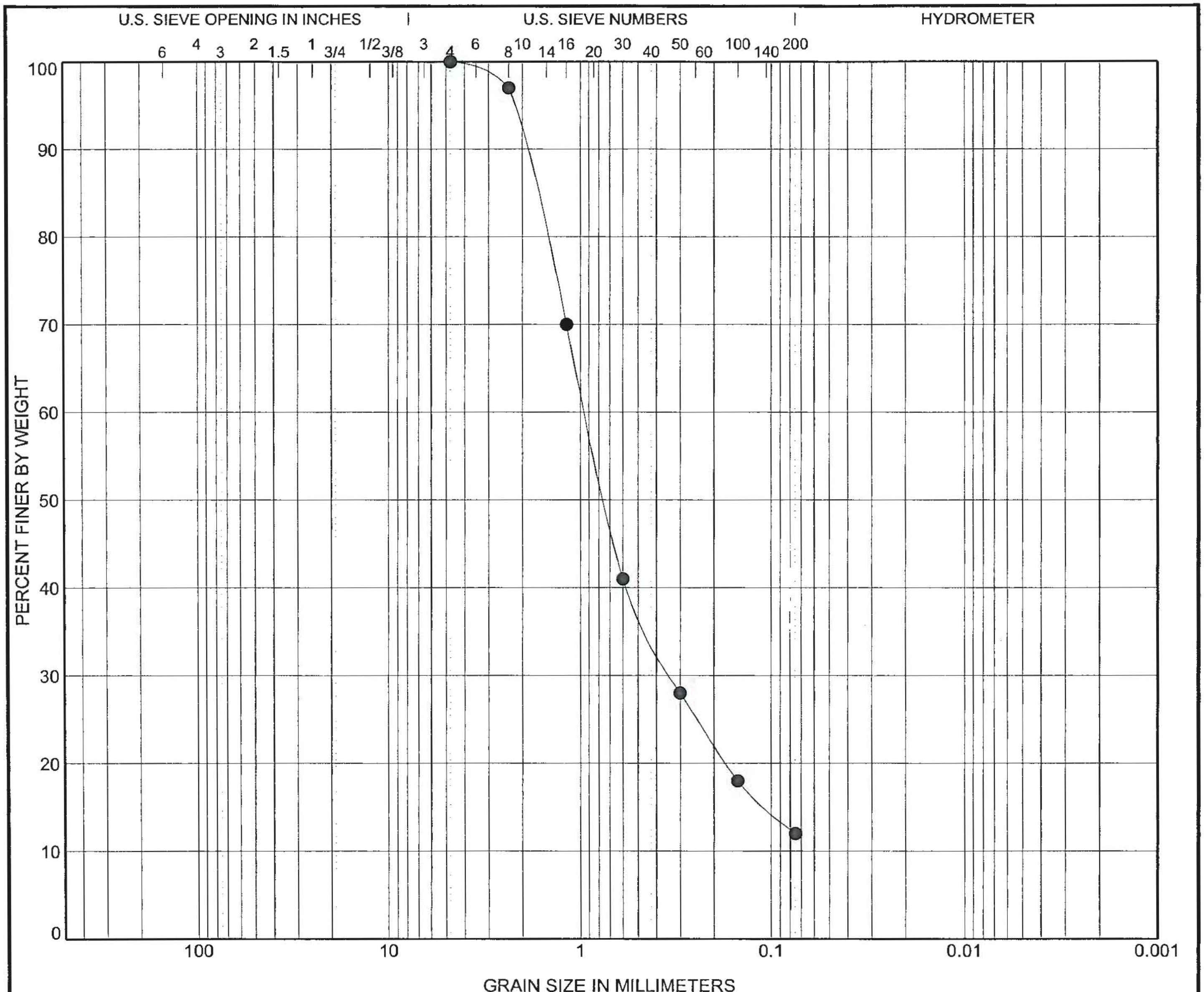
Bottom of Boring at 15.5 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling: Dry ft
Upon Completion of Drilling: ft
Time After Drilling
Depth To Water (ft)
Remarks:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-13 - (5 - ft)	**SANDSTONE BEDROCK**	**NV**	**NV**	**NP**	**2.00**	**15.70**

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-13 - (5 - ft)	**4.75**	**0.935**	**0.334**		**0**	**88**	**12**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map

Number: 114-510751

Figure No. 22

510751 LOGS.GPJ ' 11-6-13 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

Project Name: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming

Borehole Location: Evaporation Pond, Refer to Site Map

Borehole Number: B-14		Driller: High Plains	Logger: Mark Medley
Drilling Equipment: CME-55	Borehole Diameter (in.): 4	Date Started: 9-19-13	Date Finished: 9-19-13
Elevation and Datum: Ground: Existing Grade	Notes:		

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)
0	Auger									Poorly graded SAND with silt (SP-SM), loose, brown, slightly moist.	
3	Auger									SANDSTONE BEDROCK, very hard, light brown, slightly moist.	3
5	Auger	Split Spoon	87/0.9								
10	Auger	Split Spoon	50/0.5	9		NV	NP	18			
15	Auger	Split Spoon	50/0.3								15.3

Bottom of Boring at 15.3 ft

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Excavated Pit

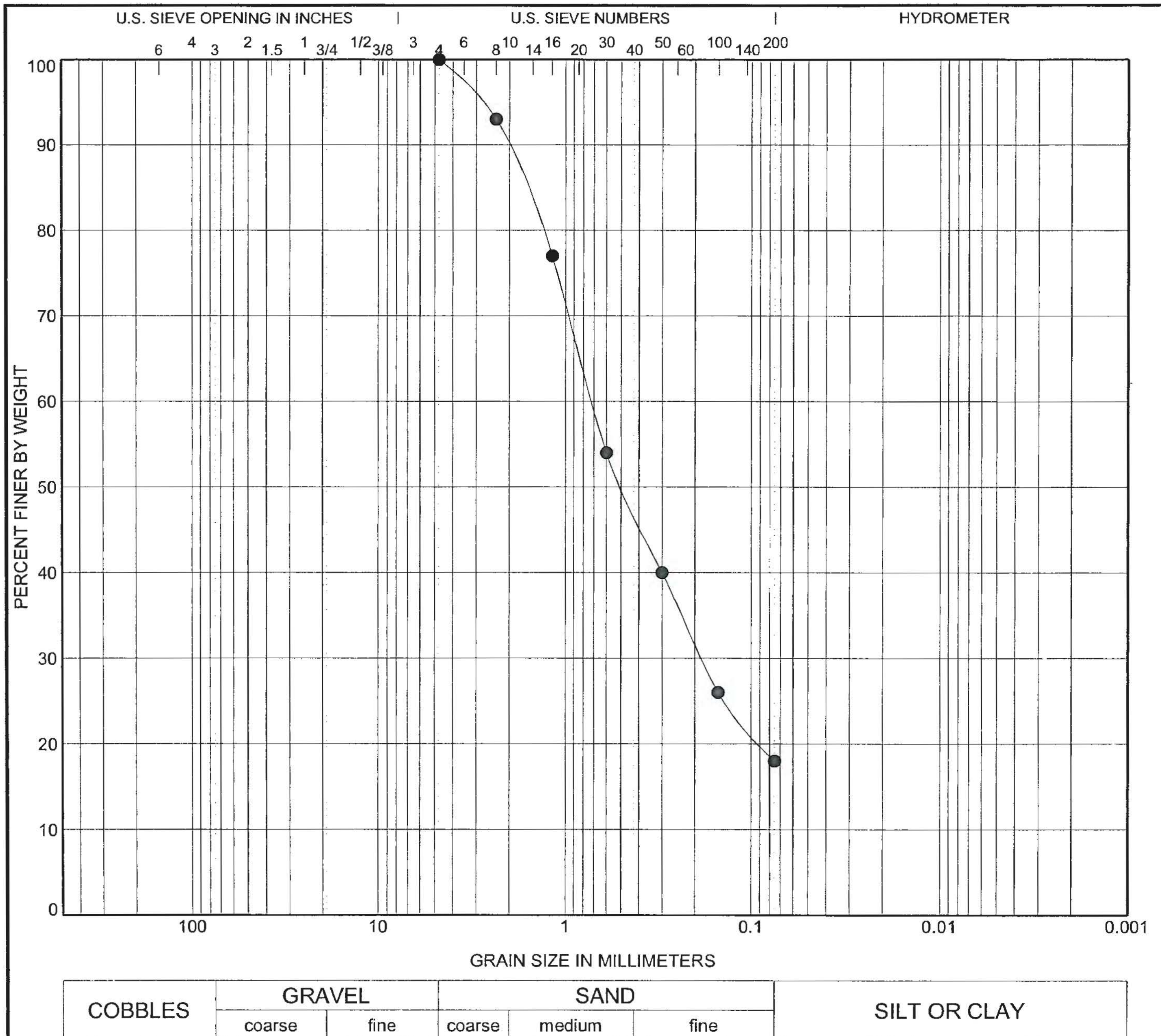
WATER LEVEL OBSERVATIONS

While Drilling ∇ Dry ft Upon Completion of Drilling ▼ ft

Time After Drilling

Depth To Water (ft)

Remarks:



Specimen Identification	Classification	LL	PL	PI	Cc	Cu
B-14 - (10 - ft)	**SANDSTONE BEDROCK**	**NV**	**NV**	**NP**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-14 - (10 - ft)	**4.75**	**0.716**	**0.183**		**0**	**82**	**18**	

TETRA TECH

GRAIN SIZE DISTRIBUTION

Project: Ludeman Satellite Plant and Evaporation Pond - Converse County, Wyoming
Location: Evaporation Pond, Refer to Site Map

Number: 114-510751

Figure No. 24

510751 LOGS.GPJ ' 11-6-13 ' MAT ' TT_US GRAIN SIZE

Revised 1-23-08 (MAT)

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Satellite Plant and Evaporation Pond
County, Wyoming

Job No

E LOCATION	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING NO. 200 SIEVE	WATER SOLUBLE SULFATES (%)	SAMPLE DESCRIPTION/CLASSIFI
DEPTH (ft)			LIQUID LIMIT	PLASTICITY INDEX	GRAVEL (%)	SAND (%)			
5	5	107	24	4			33	<0.01	Silty, Clayey Sand (SC-SM)
2.5	3	107	21	5			27		Silty, Clayey Sand (SC-SM)
10	5	107							Silty, Clayey Sand (SC-SM)
5	5		28	9			37		Clayey Sand (SC)
2.5	11	98	40	24			81	0.01	Lean Clay with Sand (CL)
5	11	110	36	22			68		Sandy Lean Clay (CL)
5	4		NV	NP	2	84	14		Silty Sand (SM)
10	8		NV	NP	1	85	14		Sandstone Bedrock
5	5		28	4			17		Sandstone Bedrock
10	6		NV	NP	8	80	12		Sandstone Bedrock
15	6		NV	NP	3	82	15		Sandstone Bedrock

NV = No Value
NP = Non-plastic

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

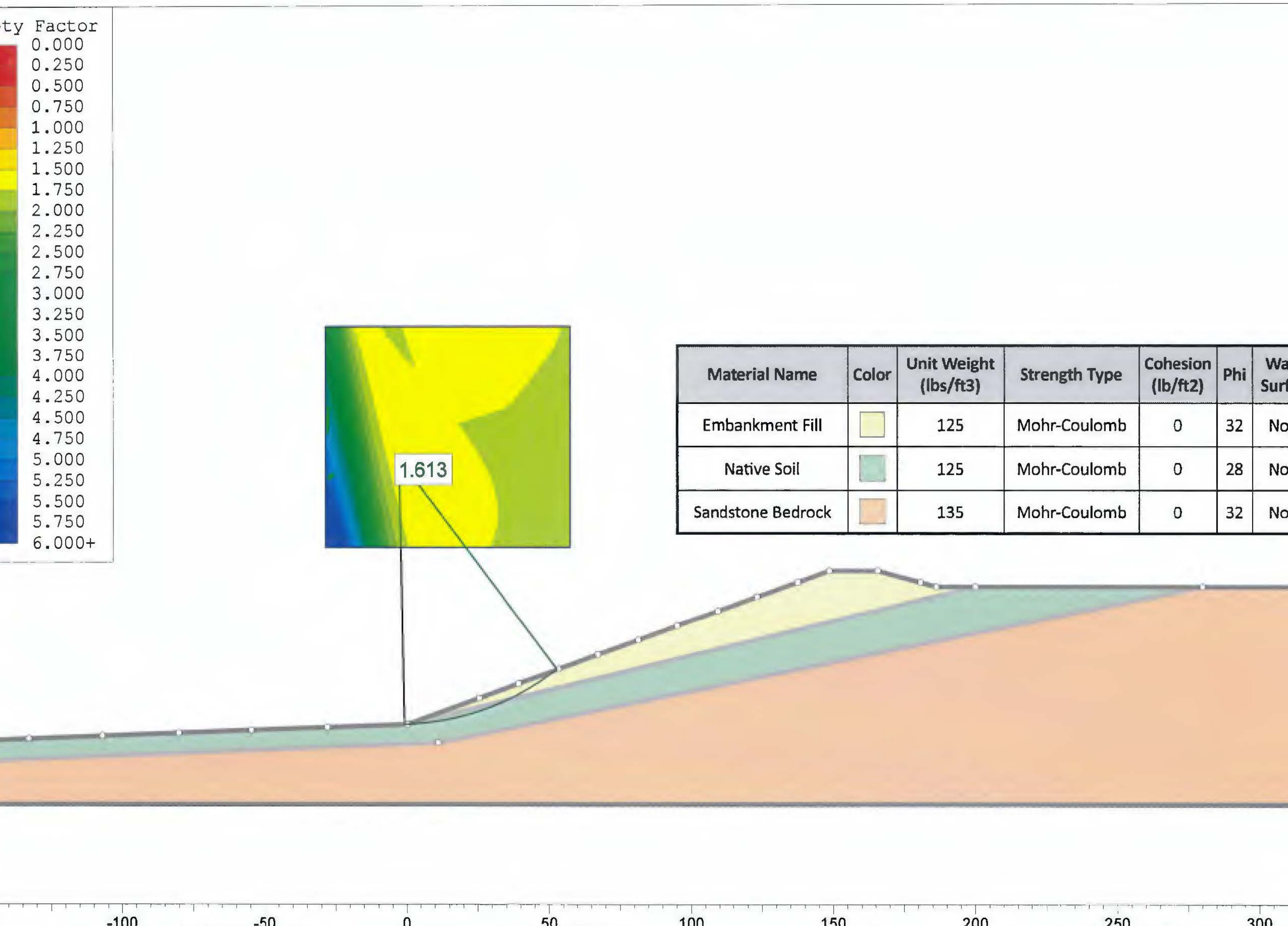
Satellite Plant and Evaporation Pond **Job No**
County, Wyoming

E LOCATION	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING NO. 200 SIEVE	WATER SOLUBLE SULFATES (%)	SAMPLE DESCRIPTION/CLASSIFI
DEPTH (ft)			LIQUID LIMIT	PLASTICITY INDEX	GRAVEL (%)	SAND (%)			
5	6		28	10			36		Sandstone Bedrock
5	4		NV	NP	0	88	12		Sandstone Bedrock
10	9		NV	NP	0	82	18		Sandstone Bedrock

NV = No Value
NP = Non-plastic

Appendix A

Slope Stability Results



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi	Wa Surf
Embankment Fill		125	Mohr-Coulomb	0	32	No
Native Soil		125	Mohr-Coulomb	0	28	No
Sandstone Bedrock		135	Mohr-Coulomb	0	32	No

Project	Ludeman Satellite Facility Evaporation Ponds		
Analysis Description	Post Construction - Section A-A'		
Drawn By	J. Jung	Scale	1:600
Company	Tetra Tech, Inc.		
Date	11/6/2013, 10:41:14 AM	File Name	Post Construction.slim

Science
6.013

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