Pre-Design Studies
Northeast Church Rock Mine Site Removal Action

Church Rock Mill Site

October 31, 2014

Prepared for:

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials (ASTM International)
CPT	cone penetration test
cm/sec	centimeters per second
cy	cubic yard
GE	General Electric
m	meter
mm	millimeter
NECR	Northeast Church Rock
NRC	United States Nuclear Regulatory Commission
NUREG	NRC Regulatory Guidelines
ohm-m	ohm-meter
PDS	Pre-Design Studies
RA	Removal Action
ROD	Record of Decision
SBT	soil behavior type
SOP	Standard Operating Procedure
tsf	tons per square foot
UNC	United Nuclear Corporation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Pre-Design Studies Report summarizes pre-design studies (PDS) conducted at the Church Rock Mill Site (Mill Site) in preparation for the Northeast Church Rock (NECR) Mine Removal Action (RA), which consists of removal of mine soil and waste materials and placement in a repository constructed at the Mill Site. The Mill Site is located approximately 16 miles northeast of Gallup, NM, as shown on Figure 1-1, *Site Location Map.* Figure 1-2, *Regional Map*, shows the location of the Mill Site and the NECR Mine Site, which is located approximately one-half mile northwest of the Mill Site. The Mill Site features are shown in Figure 1-3, *Church Rock Mill Site Layout*.

The PDS described in this report were conducted in accordance with the *Northeast Church Rock Mine Site Removal Action, Volume I: Pre-Design Studies Work Plan, Church Rock Mill Site* (MWH, 2013), hereafter referred to as the Work Plan. The scope and objectives of the PDS were described in the Work Plan. The goal of the PDS was to collect pre-design data necessary to design the RA in accordance with the proposed performance standards and United States Environmental Protection Agency's Region 9 (USEPA) *Action Memorandum: Request for Non-Time Critical Removal Action at the Northeast Church Rock Mine Site* (Action Memo) (USEPA, 2011a) and the USEPA Region 6's *Proposed Plan* (USEPA, 2012) and the *Record of Decision* (ROD) for the United Nuclear Corporation (Church Rock Mill Site) Surface Soil Operable Unit National Priorities List Site (USEPA, 2013).

1.1 REPORT BACKGROUND

As part of the pre-design data needs evaluation, MWH identified the major RA design elements and reviewed available site data. The existing data were evaluated for completeness with respect to the level of detailed information necessary to design each element of the RA. MWH (2013) identified data needs and presented field sampling plans to obtain the data necessary for design of the RA. This PDS report is one of two separate reports for the NECR RA, and describes results of the PDS conducted at the Mill Site. Results of the PDS conducted at the NECR Mine Site will be submitted separately.

1.2 REPORT OBJECTIVES AND SCOPE

The overall PDS objective was to collect data necessary to design the RA. This report summarizes the sampling activities and results of the PDS investigation at the Mill Site, as well as results of previous investigations at the Mill Site. Specifically, this report presents the following information:

- A summary of previous investigations conducted at the Mill Site
- A summary of the PDS performed at the Mill Site and results of the investigations
- A narrative interpretation of PDS data and results for the Mill Site

The report contents include the following:

- Section 1 – Background and objectives
- Section 2 – Summaries of previous investigations and pre-design data needs
- Section 3 – Summary of the results of the PDS
- Section 4 – Conclusions and remaining data needs
- Section 5 – References

Laboratory data reports, drilling logs, and field photographs documenting the PDS activities at the Mill Site are included in the appendices.

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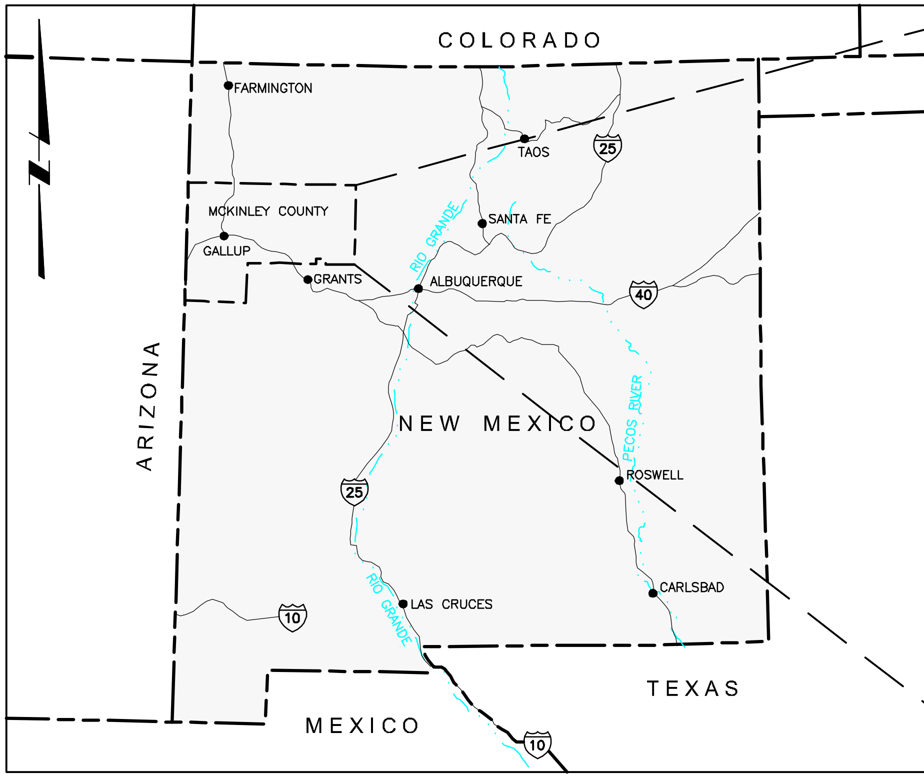

LOCATION MAP
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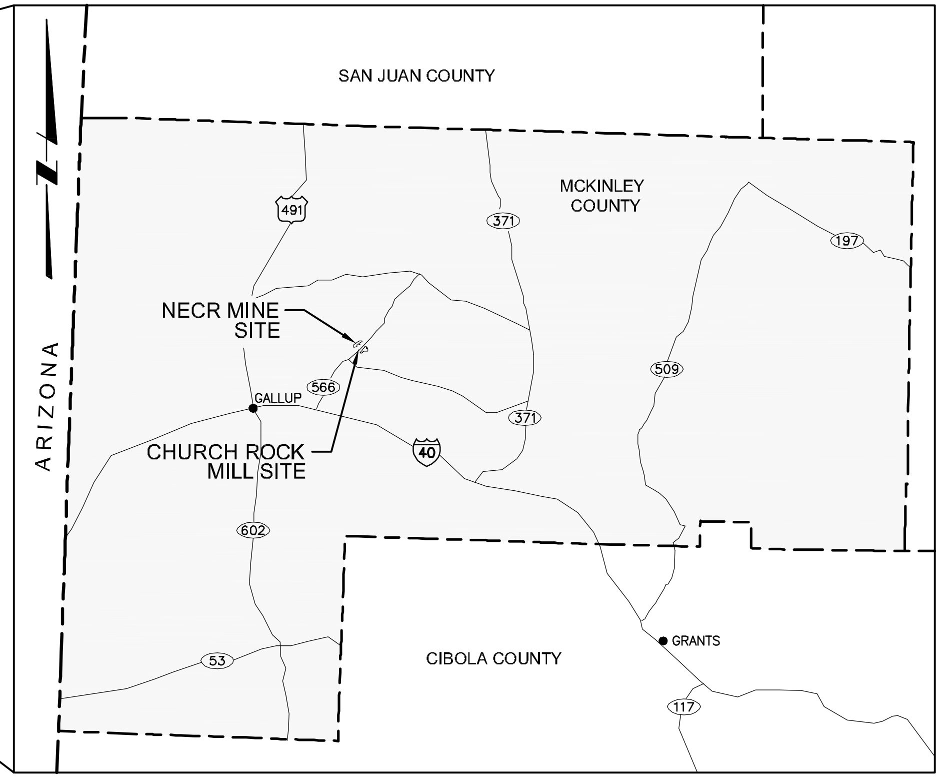

VICINITY MAP
NOT TO SCALE

					DESIGNED BY	J CUMBERS	07–14
					DRAWN BY	K TULLAR	07–14
					CHECKED BY	C STRACHAN	07–14
					APPROVED BY	E DORNFEST	07–14
					PROJECT MANAGER	T LEESON	07–14
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ISSUE REV	DESCRIPTION	TECH	ENG	DATE	CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: SITE LOCATION MAP

MWH

FIGURE: 1-1

REVISION: 0

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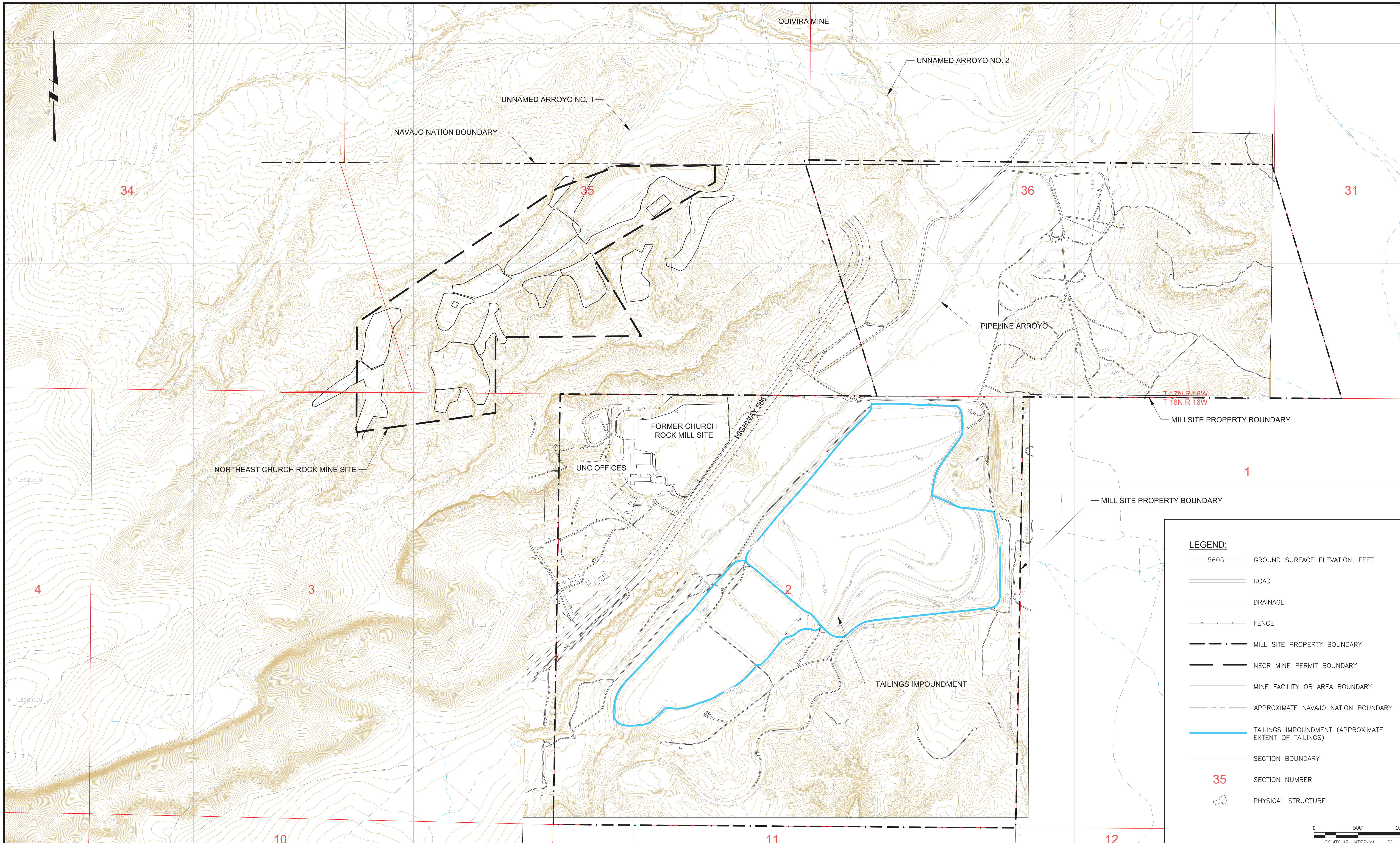

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ISSUE	DESCRIPTION	TECH	ENG	DATE
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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07–14
DRAWN BY	C FOWLER	07–14
CHECKED BY	E DORNFEST	07–14
APPROVED BY	T LEESON	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: REGIONAL MAP

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FIGURE 1-2 REVISION 0
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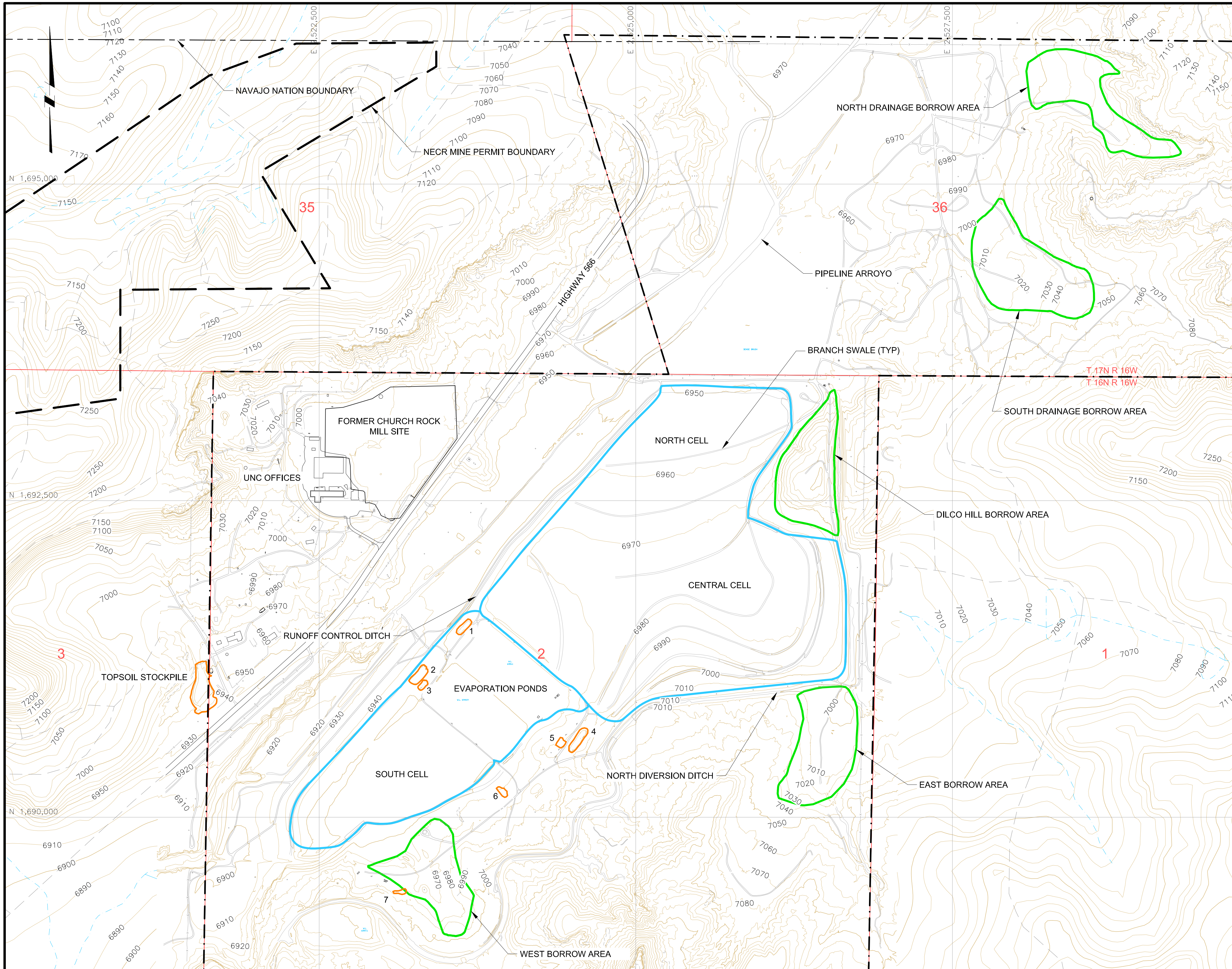

LEGEND:

- 5605 GROUND SURFACE ELEVATION, FEET
- ROAD
- DRAINAGE
- FENCE
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
- POTENTIAL BORROW AREAS
- MILL SITE PROPERTY BOUNDARY
- APPROXIMATE NAVAJO NATION BOUNDARY
- NECR MINE PERMIT BOUNDARY
- SECTION BOUNDARY
- 35 SECTION NUMBER
- 4 MATERIAL STOCKPILE AND DESIGNATION
- PHYSICAL STRUCTURE

NOTE:

1. STOCKPILE 1 IS CRUSHER FINES, STOCKPILE 3 IS ROAD BASE, AND THE REMAINING STOCKPILES (2, 4–7) ARE CRUSHED BASALT RANGING IN SIZE FROM 1 TO 15 INCHES.

0 400' 800'
CONTOUR INTERVAL = 10'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: CHURCH ROCK MILL SITE LAYOUT

MWH

FIGURE 1-3
REVISION 0
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2.0 INVESTIGATIONS CONDUCTED AT THE MILL SITE

As part of the pre-design data needs evaluation, MWH identified major RA design elements and reviewed available data for the Mill Site, specifically data related to the tailings impoundment. MWH evaluated geotechnical, geological, and hydraulic data for the tailings and underlying materials in the vicinity of the repository for mine spoils proposed as part of the RA. Specifically, the tailings data were evaluated with respect to the placement of mine spoils on top of the reclaimed tailings impoundment, in order to develop a focused PDS geotechnical investigation program. Section 2.1 summarizes previous investigations conducted at the Mill Site.

2.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Several geotechnical investigations have been conducted at the Mill Site since operation of the tailings impoundment began in 1977. A memorandum summarizing existing information about available borrow materials, tailings and underlying alluvium, and the Zone 3 Sandstone in the area of the impoundment is included in Appendix A1. The following paragraphs summarize the sources of material specific information for the Mill Site.

2.1.1 Borrow Materials

MWH identified 19 boreholes previously drilled in or near the East and West Borrow Areas. These include ten boreholes in the East Borrow Area (Sergent, Hauskins & Beckwith (SHB), 1978b and Civil Systems Inc. (CSI), 1980) and eight boreholes in or near the West Borrow Area (SHB, 1978a and CSI, 1980). Borrow material was later excavated from these areas and used for construction of the existing tailings impoundment cover. These areas were subsequently sampled and characterized (post-excavation) in 2008. These borrow areas are under consideration for repository cover material, and a MWH borrow characterization memorandum for these areas is provided in Appendix A2.

A topsoil stockpile containing approximately 20,000 cubic yards (cy) of material exists on UNC property west of Highway 566 and south of the UNC offices. Dwyer Engineering, LLC summarized the available geotechnical information for the site in 2012, which included limited geotechnical test data for the topsoil stockpile from 2008. These results are provided in the memorandum in Appendix A3.

2.1.2 Tailings

The preliminary geotechnical investigation for the tailings impoundment was conducted in 1974 (SHB, 1974). A subsequent geotechnical investigation in 1978 (SHB, 1978a) included drilling boreholes through the embankment and through the tailings within the impoundment. In 1979, UNC conducted a stability and integrity assessment of the tailings dam, which included information about the interior dikes and the south cell (SHB, 1979). Additional boreholes were drilled through the tailings impoundment in the Central Cell, in Borrow Pit No. 1, and in the

South Cell in 1985. These borehole logs are included as attachments to a UNC memorandum (UNC, 1986) and the geotechnical data is partially summarized in the impoundment Reclamation Plan (Canonie, 1991). Interim stabilization of the Central Cell was completed in 1991, and a series of shallow boreholes were drilled in the Central Cell in 1992 (UNC, 1993). These boreholes appear to have been drilled through the interim cover surface. The 1992 tailings data is included in Appendix B of the Central Cell Final Reclamation As-Built Report (Canonie, 1995). A more detailed summary of historical tailings investigations and results is included in Appendix A1.

2.1.3 Alluvium

The SHB investigations (SHB, 1974, 1976, 1978a, 1978b, 1979) include laboratory testing of more than 200 samples of alluvium taken from the vicinity of the North and Central Cells. A summary of historical investigations and properties of the alluvium beneath the tailings is included in Appendix A1.

2.2 PRE-DESIGN STUDIES

Following USEPA approval of the PDS work plan in 2013, the field portion of the PDS was conducted at the Mill Site from October through December 2013. PDS field activities at the Mill Site consisted of surveying; cone penetration tests (CPTs); drilling, excavation and soil sampling; characterization of existing site features and surrounding flora and fauna; and a cultural resources survey. Specifically, the PDS included the following, which are described in Section 3.0:

- Topographic survey of the impoundment cells and surrounding areas
- Geotechnical evaluation of tailings impoundment and underlying geologic units
- Borrow material investigation
- Volume and characteristics of on-site erosion protection materials
- Revegetation study
- Biointrusion evaluation
- Cultural resources survey
- Visual inspection and survey of branch swales and North Upstream Diversion Channel
- Debris inventory
- Soil analog studies (ongoing, results to be provided in a future addendum)

All activities were conducted in accordance with the Work Plan and the applicable SOPs included in the Work Plan. Some minor changes were implemented due to field conditions, as described in Section 3.0. Because excavation, drilling and CPT were conducted through the existing tailings impoundment cover into and through the tailings, procedures were implemented to minimize disturbance and radiological exposure, as well as to restore the cover system after sampling was complete. These procedures are outlined in the Work Plan.

3.0 SUMMARY OF MILL SITE PRE-DESIGN STUDIES

A description of each PDS task and associated results are provided below.

3.1 TOPOGRAPHY

Cooper Aerial Surveys Co. (Tucson, AZ) completed an aerial survey to update topographic information at the impoundment to an accuracy of 1 foot horizontally and 0.5 foot vertically. Ground control survey data was also collected on 100-foot intervals along Pipeline Arroyo, along the drainage swales on the existing cover, and in select locations along the north upstream diversion channel. The drilling and CPT locations were surveyed after completion. The figures provided in this report include the updated topographic information.

3.2 GEOTECHNICAL EVALUATION OF TAILINGS IMPOUNDMENT AND UNDERLYING UNITS

3.2.1 Cover Material

The existing tailings cover was sampled to evaluate the existing gravel admixture layer and underlying radon barrier, as described in the sections below. Specifically, these evaluations included geotechnical characteristics and volume of the existing gravel admixture layer and remolded saturated hydraulic conductivity of the underlying radon barrier.

3.2.1.1 Summary of Field Investigation and Sampling

On November 12 and 13, 2013, Mill Site personnel excavated twelve test pits (CS-1 through CS-12) on the existing tailings impoundment using a backhoe. The test pit locations are shown on Figure 3-1, *PDS Tailings Impoundment Sampling Locations*. The test pits were 2.5 feet wide (the width of the backhoe bucket) and ranged in length from approximately 4 to 6 feet. Excavation depths ranged from 14 inches to 2 feet. The materials excavated from the test pits were temporarily stockpiled on plastic sheeting. The table below summarizes the materials and cover layer thicknesses encountered in each test pit.

Materials encountered during the excavation were logged, and photographs of the test pit walls were taken. Photographs were also taken before and after each excavation. The test pit logs are provided in Appendix B2, along with photographs of the open excavations and representative photographs showing typical “before” and “after” conditions. Photographs showing typical backhoe excavation and backfill compaction are also included in Appendix B2.

Ten of the test pit locations (CS-1 through 6 and CS-8 through 11), exhibited three distinct material types. An upper, soft layer of sandy clay material was observed, ranging in thickness from 3 to 8 inches. A bag sample of this material was collected at each test pit location. Below the upper sandy clay layer, a layer of rock mulch was observed, ranging in thickness from 3 to 4 inches. The rock consisted of crushed basalt ranging in size from ½ inch to 3 inches. Composite bucket samples of the upper sandy clay and the rock mulch material were collected. The combined sandy clay and rock mulch layer is considered the admixture layer of the existing cover. Below the rock mulch layer, a clay material was encountered. This layer is considered the radon barrier layer of the existing cover. The test pits extended between 13 and 20 inches into the radon barrier, but did not extend through it. Bag samples and bucket samples of this material were collected.

At CS-7, a rock mulch layer was not present. Only sandy clay was observed, extending from the ground surface to the total excavation depth. Bag and bucket samples of the material were collected. This test pit is outside of the tailings impoundment on undisturbed natural ground. At CS-12, only the soft sandy clay material was observed. This material extended to a depth of 14 inches where sandstone bedrock was encountered. Both a bag sample and bucket samples were collected at this location. This test pit is likely outside of the extent of tailings deposition.

After excavation, the stockpiled cover materials were placed back in the test pit and compacted with the backhoe bucket and by wheel tracking with the backhoe. The final excavated area was graded to match the surrounding area. A stake was placed at each test pit location for subsequent gamma and location/elevation surveying. The radiological survey data is included in Appendix C. The collected cover material samples were transported to the Mill Site office area for storage and laboratory testing.

3.2.1.2 Laboratory Testing

Selected samples were submitted for geotechnical, analytical, and agronomic testing, in accordance with the Work Plan. The laboratory testing results are summarized in Table 3-1, *Summary of Geotechnical Laboratory Data – Cover Samples* and Table 3-2, *Summary of Agronomic and Analytical Laboratory Data – Impoundment Cover, Stockpiles, and Borrow Areas*. The data are provided in Appendix B1.

3.2.1.3 Volume and Composition of Admixture Material

The conceptual repository design includes the removal of the admixture material (combined rock mulch and overlying sandy clay) from within the footprint of the repository for use in RA construction. Based on the three conceptual repository alternatives, the repository footprint area could range from approximately 55 to 70 acres.

Summary of Cover Test Pit Depths and Layer Thicknesses

Test Pit	Total Excavation Depth[1] (in)	Upper Layer Thickness (in)	Thickness of Rock Mulch (in)	Total Admixture Thickness[2] (in)
CS-1	24	8	3	11
CS-2	24	7	3	10
CS-3	24	3	3	6
CS-4	24	6	4	10
CS-5	24	6	3	9
CS-6	24	4	3	7
CS-7	20	N/A	N/A	N/A
CS-8	28	4	4	8
CS-9	26	5	4	9
CS-10	25	3	4	7
CS-11	24	6	3	9
CS-12	14	14	N/A	N/A

Notes:

1. Radon barrier was encountered in test pits below the depth of the rock mulch.
2. Combined thickness of the upper sandy clay layer and rock mulch layer
3. N/A = material not encountered at the test pit location

The admixture material observed during the field excavations (including the upper sandy clay and the rock mulch layer) ranged in thickness from 6 to 11 inches, with an average thickness of approximately 8.5 inches. These values exclude the observations made at CS-7 and CS-12 where the rock mulch layer was not present. Using the range of repository footprint areas of 55 to 70 acres, and assuming an average admixture thickness of 8.5 inches, the corresponding volume of admixture material excavated from the existing cover would range from approximately 63,000 to 80,000 cubic yards.

The excavated admixture material would be comprised of mixed sandy clay soil and crushed basalt rock. Based on laboratory gradation testing, the average soil/rock mixture would be comprised of approximately 60 percent soil and 40 percent rock (by dry weight) and the rock fraction would consist of 1/4-inch to 3-inch crushed basalt material. The fines content of the soil fraction of the mixture would be approximately 57 to 73 percent and would be low-plasticity clay.

3.2.1.4 Rock Quality Scoring of Gravel in Impoundment Cover Admixture Layer

Gradations were conducted on samples of the soil-rock admixture layer of the existing impoundment cover. The median diameter (D_{50} value) of the samples tested (CS-2, CS-6, and CS-9) ranges from 0.1 to 13 mm (less than or equal to 0.5 inches). The gravel fraction of these samples was then evaluated for potential reuse as erosion protection at the site. The gravel was tested for durability in general accordance with guidelines for long-term performance outlined by the US Nuclear Regulatory Commission (NRC). These guidelines are for rock to be used for erosion protection material on exposed surfaces and utilize a rock scoring value (Johnson, 2002). In order to develop the scoring criteria, specific gravity, absorption, sodium sulfate soundness, and L.A. Abrasion tests were performed in accordance with ASTM guidelines. Durability testing results are provided in Appendix B1. The table below summarizes the durability score of the gravel fraction of the cover material.

Based on information provided in NUREG-1623 (NRC, 2002), rock for use in areas defined as critical areas must meet a score of 65 percent or greater and require oversizing if the score is less than 80 percent. The basalt samples tested from the existing cover scored 94 percent and therefore would not require oversizing for reuse as erosion protection rock.

Summary of Durability Scoring Criteria for Impoundment Cover Gravel

Laboratory Test[1]	Result[1]	Score[3]	Weighting Factor[4]	Weighted Score	Maximum Possible Score
Bulk Specific Gravity (ASTM C127)	2.78	10	9	90	90
Absorption, % (ASTM C127)	1.55	4	2	8	20
Sodium Sulfate, % (ASTM C88)	0.37	10	11	110	110
LA Abrasion (100 revs.[2]), % (ASTM C535)	5.1	8	1	8	10
TOTALS				208	220
		Score:		**94 %**	
		Oversizing required:		**none**	

Notes:

1. Test results provided by Advanced Terra Testing and CTC Geotek (2014), results presented are the median of three values.
2. Test conducted for 100 revolutions per NUREG-1623
3. Based on a range of 0 to 10, rock strength scores based on DePuy (1965 (Table 1))
4. Weighting factors for igneous rock, NUREG-1623 and DePuy (1965)

3.2.1.5 Clay (Radon Barrier) Layer

The clay layer beneath the admixture layer on the existing impoundment cover was sampled and tested for geotechnical properties. Clay layer samples are classified as low-plasticity clay (CL) with fines contents ranging from 51 to 69 percent. Water contents of the samples tested are between 6 and 11 percent (by mass) and up to 4 to 6 percent below the optimum water contents measured from the standard Proctor tests. Saturated, hydraulic conductivity tests were conducted on samples remolded to 90 percent, 95 percent, and 100 percent of the standard Proctor density for the material. Resulting conductivities range from 7.6E-08 cm/sec to 3.0E-04 cm/sec, with the lowest values of saturated hydraulic conductivity generally corresponding to the samples remolded to the greatest percent compaction. The specimens were tested at two initial confining stresses (8 and 24 psi) to replicate the range of conditions under future fill placement.

3.2.2 Tailings and Underlying Units

3.2.2.1 Cone Penetration Tests

ConeTec conducted the CPTs at the Mill Site impoundment on November 5-10, 2013 to aid in characterization of the subsurface materials. CPT is a method used to obtain in-situ soil data (e.g., soil type, moisture conditions and stratigraphy) without collecting soil samples. The raw data generated during CPT includes tip resistance, sleeve friction, friction ratio, pore pressures, and bulk resistivity. The tailings materials are not a natural deposit and therefore it is difficult to correlate CPT data obtained in tailings to published CPT-soil correlations. Therefore, the CPT investigation was intended to provide a general understanding of subsurface conditions and tailings stratigraphy in the impoundment. These conditions were then verified and further evaluated by logging boreholes and performing laboratory testing on samples obtained in the boreholes. The CPT investigation is described below. The borehole investigation and laboratory testing program are described in Sections 3.2.2.2 and 3.2.2.7.

Completed CPT locations are shown on Figure 3-1. The Work Plan specified that CPTs be conducted at 12 locations within the impoundment. However, based on conditions encountered during the field investigation, CPTs were conducted at an additional 20 locations to further characterize specific areas of the impoundment. CPTs were conducted at a total of 32 CPT locations within the impoundment. CPTs were conducted at 12 additional locations in the Central Cell, six locations in the North Cell, and two locations in the South Cell. The CPTs extended to depths ranging from 2.5 to 119 feet below the ground surface, depending on the materials encountered. A summary of the materials and the thicknesses of the layers encountered is included in Table 3-3 *Summary of Borehole and CPT Profiles*. The CPT program included tip and shear resistance measurements, dynamic pore pressure measurements, pore pressure dissipation tests, resistivity measurements, and shear wave velocity measurements.

After drilling and sampling, CPT holes were backfilled with bentonite grout, and a stake was placed at each location for subsequent gamma and location/elevation surveying. The radiological survey data are included in Appendix C. The CPT logs, pore pressure dissipation plots, and shear wave velocity calculations are included in Appendix B2.4.

3.2.2.2 Drilling and Sampling

Drilling in the tailings impoundment was performed on November 19-21, November 26-27 and December 2-4, 2013 by National Exploration, Wells & Pumps. The Work Plan included six boreholes; five in the impoundment, and one through the embankment. Two additional boreholes were drilled during field work; one in the North Cell (B-23) and one in the Central Cell (B-15). A total of eight boreholes were drilled, including one drilled through the embankment, four in the Central Cell and three in the North Cell. Figure 3-1 shows completed borehole locations. The boreholes were all paired with a CPT location.

Hollow-stem auger drilling methods were used to drill each borehole and samples were collected by various methods through the borehole lengths. A CME-85 auger rig was used to perform the drilling. Drilling depths ranged from 39 to 109 feet depending upon the conditions encountered and the presence or absence of bedrock.

Continuous (dry-core) samples were collected as the primary sampling method. Dry-core samples were logged, placed in labeled core boxes, photographed, and stored in the Mill Site office area away from the work areas. Acrylic liners were used to collect dry-core samples of the tailings. A 2.5-inch (outside diameter) California split-spoon sampler was used to obtain 2-inch diameter samples at select locations. Three-inch diameter Shelby tube samples were also collected during drilling.

After drilling and sampling, boreholes were backfilled with bentonite grout, and a stake was placed at each location for subsequent gamma and location/elevation surveying. The radiological survey data are included in Appendix C. Borehole logs, photographs of the core, and other representative photographs of drilling operations are provided in Appendix B2.

3.2.2.3 Material Contacts

The CPT data combined with the profiles from the borehole logs were used to determine the thickness and texture of the tailings layers, as well as the location of the contact between the tailings and underlying alluvium. Seven of the CPTs were paired with boreholes to correlate CPT results with direct observation of the materials encountered. The relationships used to determine the tailings-alluvium contact are described below.

Data collected from the CPTs, such as cone resistances (tip and sleeve), dynamic pore pressures, and electrical resistivity measurements, were used to identify contact locations between the tailings and underlying alluvium. Nineteen of the 32 CPTs encountered fine-grained tailings in contact with the alluvium. Four of the 19 CPTs were paired with boreholes to determine the CPT expression of the contact between fine tailings and alluvium. Typically the cone tip resistance increased by a factor of 4 to 6 from the fine tailings to the alluvium, with values increasing from approximately 10-20 tons/square foot (tsf) to a range of 40-150 tsf. Sleeve friction increased to 1.8-2.2 tsf from approximately 0 tsf within the tailings. Resistivity readings increased from approximately 0 ohm-meter (ohm-m) in the tailings to 500-650 ohm-m in the alluvium. Dynamic pore pressure measurements did not exhibit a consistent pattern during the transition from tailings to alluvium.

A different pattern delineated the contact between coarse-grained tailings and underlying alluvium. In three of the 32 CPTs, coarse-grained tailings were in contact with the alluvium. Two of these three CPTs were paired with boreholes to determine the CPT pattern of the contact between fine tailings and alluvium. The cone resistance (tip and sleeve) and the normalized soil behavior exhibited a distinct pattern at the transition from coarse-grained tailings to alluvium. Sleeve resistance increased by a factor of 3 to 5, from a range of approximately 0.3-1.0 to 2.2-6.1 tsf. Tip resistance increased from a range of approximately 30-50 to 75-250 tsf. A normalized soil behavior type (SBT) of zones 5 to 7 (clayey silt, silt, and sandy silt) were typically observed in the tailings and SBTs of 3 to 4 (clay and silty clay) were observed in the underlying alluvium.

3.2.2.4 Dynamic Pore Pressures and Pore Pressure Dissipation Tests

Dynamic pore pressures were measured during the CPTs. Eight pore pressure dissipation (PPD) tests were performed (CPT-10 (2 depths), CPT-7, CPT-8, CPT-9, CPT-11, CPT-18, and CPT-19) within the tailings impoundment. Results of the dissipation tests and dynamic pore pressure measurements indicate elevated, quasi-steady-state pore pressures in the fine-grained tailings. The pore pressure dissipation plots are included in Appendix B2.4

The resulting quasi-steady-state pore pressures from the two tests conducted within the tailings at CPT-10 showed pressure heads of about 21 and 31 feet at test depths 15 feet apart vertically. These results indicate increasing quasi-steady-state pore pressure results with depth in the tailings at that location. Other pore pressure dissipation tests conducted in Borrow Pit No. 1 at CPT-8, CPT-9, CPT-18, and CPT-19 show a range of quasi-steady-state pore pressures, without a trend of increasing quasi-steady-state pore pressures as test depths increased. The results indicate the presence of a series of depositional layers with different textures, degrees of saturation, and varying quasi-steady-state pore pressures, rather than a static water level.

The dissipation test conducted in the tailings at CPT-11 (located in Borrow Pit 2) showed a quasi-steady-state pressure head condition at about 49.5 feet below ground surface (bgs) or 4.5 feet above the bottom of the tailings. Due to the short test duration (1 hour) in this fine-grained material, this result likely overestimates the actual pressure head at this location. However, CPT-11 did exhibit the highest dynamic pore pressures throughout the impoundment, exceeding 350 feet at approximately 48 feet in depth. The dynamic pore pressures (u) measured during the CPTs within the tailings throughout the rest of the impoundment typically ranged from zero to approximately 200 feet. While these results at CPT-11 could indicate near-saturated conditions at this location, free water was not observed during drilling at this location. Additionally, the Shelby tube collected from 51.5 to 52.5 feet was not wet upon recovery, and the laboratory test results (Table 3-4, borehole TI-B11) from that sample do not indicate saturation.

The ConeTec report includes a table summarizing the data collected during the CPT investigation. The table contains a column listing depths for “Apparent Water Table”. These depths were calculated based on quasi-steady-state pore pressure measurements obtained during PPD testing. The quasi-steady-state pore pressure is typically taken to be the pore pressure measurement recorded at the end of the PPD test. In cases where a hydrostatic groundwater condition exists (i.e. no vertical flow component) and where the pore pressures at the end of PPD testing have truly dissipated to static levels, the depth of the water table at the CPT location can be calculated by subtracting the static pressure from the depth at which the PPD test was performed. ConeTec used these assumptions and procedures to estimate the Apparent Water Table depths presented in the ConeTec report.

In cases of multiple saturated or nearly-saturated fine-grained zones (as is often the case in tailings after cessation of operations), or where there is a component of flow in the vertical direction, the procedure ConeTec used to define the depth for the “Apparent Water Table” is not appropriate. In addition, when positive dynamic pore pressures are generated during CPT soundings in finer-grained materials, quasi-steady-state pore pressures measured at the time of PPD test termination are often higher than true “static” pore pressures. This overestimation of static pore pressures results in underestimation of the depth to the water table and overestimation of saturated thicknesses.

At Church Rock, and specifically in the borrow pits, the CPT results and the borings indicate the presence of coarse-grained materials above, and in some cases interlayered with, fine-grained materials. The laboratory data indicate the upper coarse-grained materials have low water contents and are partially saturated, even though many of the test specimens were obtained from zones that are below the “Apparent Water Table” depths identified by ConeTec. Likewise, laboratory testing of finer grained samples indicated that, although they were at a higher moisture content and degree of saturation, many of these materials were also partially saturated even though they are below the “Apparent Water Table” defined by ConeTec. Therefore, the elevated dynamic and quasi-steady-state pore pressures are interpreted to indicate compressible fine-grained materials that are near saturation, rather than a static water level. This is consistent with the properties of tailings placed hydraulically during milling.

3.2.2.5 Standpipe Piezometers and Free Water Assessment

A description of free water encountered during the subsurface investigation within the impoundment is presented below. In summary, free water was encountered in three boreholes: TI-B3 (in the dam), TI-B10 (Borrow Pit No. 1), and TI-B11 (Borrow Pit No. 2). The water was present in the alluvium underlying the dam at TI-B3 and in the alluvium underlying the tailings at TI-B10 and TI-B11. No free water was identified in the tailings during the drilling program.

Temporary Standpipe Piezometers

On November 9, 2013, temporary standpipe piezometers were installed by hand in the open CPT holes at CPT-10 and CPT-18. The piezometers were constructed with 1-inch diameter, flush-threaded PVC screen and casing. Each piezometer consisted of a 5-foot section of slotted screen at the bottom (including a bottom cap), and PVC casing extending to the ground surface. The piezometers were installed to depths of 62.8 and 49.6 feet bgs at CPT-10 and CPT-18, respectively.

A water level probe was used to check for the presence of water in the piezometers. Measurements were made periodically at CPT-10 from November 9 through 25, 2013. Measurements were made at CPT-18 from November 9 through December 9, 2013. Both piezometers were dry during the entire monitoring period.

The piezometer casing at CPT-10 was removed on November 25, 2013 and the casing at CPT-18 was removed on December 9, 2013. Both piezometers were removed by hand with minimal effort, indicating the CPT holes did not cave in during the monitoring period. Upon removal, the casing from both piezometers was observed to be dry, with no visible water present on the surface of the casing or slotted screen. Following casing removal, the holes were backfilled with bentonite grout.

Free Water Encountered During Drilling

Free water was encountered during drilling at TI-B3, TI-B10 and TI-B11. Water was encountered during drilling at TI-B3 below approximately 55 feet bgs (approximate elevation of 6,914) in the alluvium. The borehole was left open overnight, and the water level measured through the hollow-stem augers the next morning was approximately 66 feet bgs, or near elevation 6,903 feet within the alluvium.

Free water was encountered during drilling at TI-B10. Field observations indicated that the sampler was wet upon retrieval from within the alluvium at a depth near 90 feet bgs (approximate elevation of 6,883 feet). The augers were left in-place overnight and the water level was measured again at about 90 feet bgs the following morning.

Free water was encountered during drilling at TI-B11. Field observations indicated that the cuttings became wet at a depth of approximately 90 feet bgs (approximate elevation of 6,887) and the sampler was wet upon retrieval from within the alluvium at a depth near 92 feet bgs (approximate elevation of 6,885). Very moist to wet alluvium was encountered at TI-B1 below 34 feet bgs (approximate elevation of 6,935); however static water was not present in the borehole after drilling. TI-B1 was grouted and abandoned immediately following drilling.

3.2.2.6 Impoundment Stratigraphy

Information collected from the PDS investigation within the tailings impoundment significantly augments the existing information. The comprehensive dataset was used to update the impoundment thickness map and cross sections shown in the Work Plan. Using this dataset, Figure 3-2, *Tailings Impoundment Thickness Isopach Map*, and Figure 3-3, *Distribution and Thickness of Fine-grained Tailings,* were developed to show variation of thickness across the impoundment, as well as the thickest zones of fine-grained tailings. Table 3-3, presents information on material properties and thicknesses encountered in the impoundment during the CPT and borehole investigation.

The revised cross sections are shown in Figures 3-4 and 3-5, *Impoundment Cross Sections 1 and 2*, and *Impoundment Cross Sections 3 and 4*, respectively. A new cross section was added to the set included in the Work Plan, and the orientations of the sections were changed slightly to intercept locations of thick tailings and better illustrate subsurface conditions within the area of the proposed repository.

The previously-developed bedrock surface used to generate the maps and sections shown in the Work Plan was updated in areas where new information was obtained. Bedrock surface information was used to create the maps shown in both the Work Plan and in this report, but the bedrock surface itself is not shown in any figures other than the cross sections (Figures 3-4 and 3-5). Depressions in the bedrock surface previously interpreted in the Work Plan to be isolated depressions are now interpreted to be paleochannels. One paleochannel is in general alignment with the present day Pipeline Arroyo, and another is a tributary to that paleochannel that trends east-west through Borrow Pits 1 and 2 in the impoundment. The paleochannels are represented by a deeply eroded bedrock surface and thick alluvial deposits underlying Pipeline Arroyo and the Central Cell. The general location of the paleochannels is shown on Cross Section 2 (Figure 3-4) and Cross Section 4 (Figure 3-5).

The borehole and CPT logs included in Appendix B2 provide details to support the identification of these channels. In particular, CPT-10 encountered refusal at elevation 6,910 feet within the alluvium. However, the paired borehole TI-B10 was able to penetrate through that sandstone obstruction at elevation 6,910, and again through a second sandstone obstruction 20 feet lower before encountering competent rock near elevation 6,868 feet. A similar obstruction was encountered in TI-B15 and CPT-15. Based on the depth to rock in boreholes near CPT-9 and CPT-27, it appears those locations may also have encountered refusal on boulders or a hard clay layer within the alluvium, above the actual bedrock surface. The sandstone encountered at TI-B10 appeared to be alluvial boulders in the paleochannel.

The cross sections shown in Figures 3-4 and 3-5 are for illustrative purposes and are not presented at a large enough scale to show details such as lateral variations in impoundment cover thickness or interlayering of fine and coarse tailings. Detailed information about interlayering of fine and coarse tailings is provided in Table 3-3. The contacts shown in the cross sections were generated from topographic surfaces developed for each material type in the impoundment. Boreholes and CPT locations shown in Figures 3-4 and 3-5 are projected onto the sections; therefore the elevations of contacts shown at projected borehole or CPT locations are only the true elevation at that location when the section passes through the borehole or CPT location.

3.2.2.7 Laboratory Testing

Selected samples from the impoundment boreholes were submitted for geotechnical testing, in accordance with the Work Plan. The laboratory testing is summarized in Table 3-4, *Summary of*

Geotechnical Laboratory Data – Mill Site Impoundment, and the data are provided in Appendix B1.

3.2.2.8 Geochemical Properties of the Tailings

The acid leach milling process used at the Mill Site introduced a significant amount of sulfate into the tailings (from the sulfuric acid used for acidification). Gypsum was the primary by-product of the milling process in the 1981 Mill License Renewal Application (D'Appolonia, 1981). The concentration of gypsum in the tailings varies with grain size, with the greatest amount of gypsum likely present in the fine-grained tailings. The paragraphs below describe the processes that lead to gypsum formation and the influence of the gypsum on the tailings.

Calcium-bearing minerals naturally occur in the sedimentary rock and ore body in the region of the Mill Site. The ore milling process dissolved many of the calcium-bearing minerals, resulting in free calcium ions available in the mill circuit. Sulfate was added during the milling process in the form of sulfuric acid (H_2SO_4) to aid in the dissolution of uranium. Gypsum ($CaSO_4 \bullet 2H_2O$) may precipitate in systems when excess Ca^{2+} and SO_4^{2-} are present in aqueous solutions. As a result of the milling processes, free calcium and sulfate ions in the tailings solution precipitated in the form of gypsum after the tailings and solution were deposited in the impoundment.

The presence of gypsum is known to affect certain geotechnical laboratory test results, specifically particle-size distribution and water content. Per ASTM 2216-10, soil water content is determined by heating a soil sample to 110°C and measuring the mass of water removed by evaporation. When a sample containing gypsum is heated to 110°C, the gypsum loses its molecular water and becomes bassenite ($CaSO_4 \bullet 0.5H_20$) and anhydrite ($CaSO_4$). Since molecular water accounts for about 20 percent of the mass in gypsum, this loss of molecular water manifests itself as elevated soil water content when samples containing gypsum are dried at 110°C. For this reason, ASTM 2216-10 (ASTM, 2010) suggests drying soil samples containing gypsum at a lower oven temperature (60°C) to determine the water content. Using a lower oven temperature allows the soil (pore) moisture to evaporate without removing the molecular water from the system.

3.2.2.9 Effect of Gypsum on Geotechnical Properties of the Tailings

MWH assessed the potential for gypsum in the tailings samples upon initial review of test results, after a significant portion of the laboratory testing had already been completed. However, to properly account for the presence of gypsum in the tailings samples, the laboratory testing program was revised to obtain the water content for remaining specimens using both drying temperatures. The remaining specimens, which included 15 tailings samples, were initially dried at 60°C and weighed to calculate water content. The oven temperature was then increased to 110°C, and the same specimens were weighed a second time to calculate the water content corresponding to the 110°C oven temperature. This information provided a comparison set of data for the water contents measured at the two oven temperatures. The relationship between the water contents measured at 60°C and those measured at 110°C was then used to develop a correlation between the two values and to adjust the initial test results in samples that were heated to 110°C only. Water contents measured at 60°C, were generally about 0.5 percent to 3.0 percent lower than water contents measured at 110°C. The reduction in percent water content represents the fraction of the water in the tailings that is chemically bound in the form of gypsum, and not within pore spaces. This information, along with the SWCC data, helped to further define the volume of pore water within the tailings that would be affected by additional loading. The results of geotechnical laboratory testing on tailings impoundment samples are included in Table 3-4. Table 3-4 also includes a series of water contents measured for both oven temperatures as well as water content, specific gravity, and dry density results adjusted to reflect a 60°C water content.

The hydrometer test results for specimens containing fine-grained tailings were also likely affected by gypsum. Gypsum influences the results of particle-size analysis in two ways: 1) gypsum is a flocculant for clay minerals; and 2) gypsum has a lower density than soil, both of which can skew the fine-grained particle distributions during measurement using the hydrometer method (Arnett, 2009). Particle-size distribution tests were conducted using the standard amount of sodium hexametaphosphate as a deflocculant. Because additional deflocculant was not added to account for the presence of gypsum, the hydrometer results presented in Table 3-4 may not be representative of the actual particle sizes. The presence of gypsum in the test solution would reduce the effectiveness of the deflocculant resulting in a higher measured percentage of larger (silt-size) particles.

Results of the laboratory testing indicated that as the percentage of silt-size material in the tailings increases, the difference between the water contents measured at 60°C and 110°C also increases. The geochemical properties described above do not alter the conceptual repository design, nor do they require any additional investigation. The calculation of water content and the volume of water molecularly bound in gypsum, combined with the results of the SWCC data and the rest of the geotechnical laboratory test results, provide a comprehensive dataset for the repository design.

3.3 BORROW MATERIAL INVESTIGATION

Five potential borrow areas were investigated to determine the volume of suitable material available for use in repository cover construction and general RA regrading activities. The borrow material investigation involved borehole drilling and sampling in all five potential borrow areas. The borrow area locations are shown on Figure 3-6, *Drilling Locations and Preliminary Grading, East and West Borrow Areas*, and Figure 3-7, *Drilling Locations and Preliminary Grading, North, South, and Dilco Hill Borrow Areas*, and include the following:

- West Borrow Area
- East Borrow Area

- Dilco Hill Borrow Area
- South Drainage Borrow Area
- North Drainage Borrow Area

3.3.1 Summary of Field Investigation and Sampling

Drilling was performed November 14-18 and December 10-12, 2013 by National Exploration, Wells & Pumps. Up to five boreholes were drilled within each borrow area, in accordance with the Work Plan. Hollow-stem auger drilling methods were used at each location. A CME-85 auger rig was used to perform the drilling. Drilling depths ranged from 10 to 60 feet and varied depending upon the borrow area being investigated, the location of the borehole within the borrow area, and the presence or absence of bedrock.

Continuous (dry-core) samples were collected as the primary sampling method. Dry-core samples were logged, placed in labeled core boxes, photographed, and stored in the Mill Site office area. A 2.5-inch (outside diameter) California split-spoon sampler was used to obtain 2-inch diameter samples at typical sampling depths of 2.5, 5 and 10 feet bgs, and at additional depths depending on the materials encountered. Bulk composite samples of the cuttings were collected from a variety of depth intervals, depending on the volume of cuttings produced and the materials encountered.

After drilling and sampling, the boreholes were backfilled with drill cuttings and/or clean fill material from the borehole area, and a stake was placed at each location for subsequent location/elevation surveying. Borehole logs, core photographs, and other representative photographs of drilling operations are provided in Appendix B2.

3.3.2 Laboratory Testing

Selected samples were submitted for geotechnical, analytical, and agronomic testing. Laboratory testing is summarized in Section 3.3.3 and the results are provided in Table 3-2 and Table 3-5, *Summary of Geotechnical Laboratory Data – Borrow Areas,* and Appendix B1.

3.3.3 Summary of Results

Field investigation and geotechnical laboratory test results for each borrow area are summarized below. The table below lists the depth drilled at each borehole location, and the depth of soil encountered above bedrock.

Summary of Borrow Area Borehole Depths and Soil Thicknesses

Borehole	Total Depth (ft)	Thickness of Soil Above Bedrock (ft)
West Borrow Area		
WB-B1	36.5	>36.5
WB-B2	35.0	>35.0
WB-B3	30.0	None
WB-B4	38.7	1.0
WB-B5	24.7	22.5
East Borrow Area		
EB-B1	10.0	None
EB-B2	15.0	3.0
EB-B3	25.0	15.0
EB-B4	20.0	>20.0
EB-B5	10.8	8.5
EB-B6	17.6	11.5
Dilco Hill Borrow Area		
DH-B1	60.0	15.0
DH-B2	40.0	2.0
DH-B3	40.0	2.5
South Drainage Borrow Area		
SB-B1	25.0	>25.0
SB-B2	15.0	14.1
SB-B3	15.0	7.8
SB-B4	30.0	>30.0
North Drainage Borrow Area		
NB-B1	20.0	>20.0
NB-B2	20.0	>20.0

Based on field investigation results, preliminary grading plans were developed for each borrow area to estimate the volume of material available for repository cover construction. Grading plans were developed to avoid nearby cultural resource sites while adhering to the approximate borrow area boundaries delineated in the Work Plan. The borrow areas will be graded to drain similarly to the conceptual designs shown on Figures 3-6 and 3-7. However, final grading configurations of the borrow areas will depend on the material volumes required, the locations of the cultural resource sites, efforts to limit unnecessary disturbance to vegetation, and depths of suitable and available materials. The table below summarizes the approximate volume and predominant material types available from each borrow area.

Summary of Borrow Material Volumes and Material Types

Borrow Area	Predominant Material Types		Approximate In-Place Volume (cy)
	Soil Description	USDA Classification	
West Borrow	Clayey Sand and Silty, Clayey Sand	Sandy Loam	100,000
East Borrow	Sandy Clay and Clayey Sand	Sandy Loam	50,000
Dilco Hill	Sandy, Silty Clay	Sandy Loam	5,000
	Mixed Sandstone, Shale and Coal (Rock)	–	370,000
South Drainage Borrow	Sandy Clay and Clay with Sand	Sandy Clay Loam	170,000
North Drainage Borrow	Sandy, Silty Clay and Silty, Clayey Sand	Sandy Loam	80,000
		available soil from borrow areas	405,000
		available rock from borrow areas[1]	370,000

Notes:

1. Estimated volume of rock available from Dilco Hill

3.3.4 West Borrow Area

Five boreholes were drilled in the West Borrow Area to depths ranging from 24 to 39 feet. Drilling was generally performed at the locations shown in the Work Plan, except for WB-B4, which was moved due to access constraints. Boreholes WB-B1 and WB-B2 were drilled in the central, lower portion of the borrow area where most of the available borrow material is located. At these locations, clayey sand was encountered to the greatest depths drilled. Boreholes WB-B3, WB-B4 and WB-B5 were drilled around the perimeter of the borrow area. At WB-B3 and WB-B4, bedrock comprised of claystone, sandstone, and/or coal was encountered near the ground surface. At WB-B5, silty, clayey sand was encountered to a depth of 22.5 feet, where sandstone bedrock was encountered.

Based on the borehole logs and results of geotechnical laboratory testing, the predominant material available from the West Borrow Area is relatively homogeneous and consists of clayey sand and silty, clayey sand. The laboratory-measured sand content ranged from 46.3 to 61.6 percent for all samples tested. The fines content ranged from 37.9 to 48.6 percent and was comprised of low plasticity clay or silty clay. A small amount of gravel (less than 10 percent) was encountered in some samples. The corresponding USDA classification of the material is "sandy loam."

Based on the field investigation and the preliminary grading contours shown in Figure 3-6, approximately 100,000 cubic yards of material consisting of clayey sand and silty, clayey sand is available in the West Borrow Area.

3.3.4.1 East Borrow Area

Six boreholes were drilled in the East Borrow Area to depths ranging from 10 to 25 feet. Borehole EB-B6 was added to the drilling program presented in the Work Plan to better characterize the depth and extent of potential borrow material in the East Borrow Area. Boreholes EB-B1 and EB-B2 were drilled in the western portion of the borrow area and sandstone bedrock was encountered at or near the ground surface at both locations. Boreholes EB-B3 and EB-B4 were in the southern portion of the borrow area. At EB-B3, sandy clay was encountered to a depth of 15 feet, where sandstone bedrock was encountered. At EB-B4, sandy clay and silty, clayey sand was encountered to the maximum depth drilled (20 feet). Boreholes EB-B5 and EB-B6 were in the central portion of the borrow area. At EB-B5, sandy clay and clayey sand was encountered to a depth of 8.5 feet, where shale bedrock was encountered. At EB-B6, sandy clay was encountered to a depth of 11.5 feet, where shale bedrock was encountered.

Based on borehole logs and results of geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of sandy clay and clayey sand, with nearly equal portions of sand and fines in most samples tested. The sand content ranged from 26.6 to 50.5 percent for all samples, and the fines content ranged from 45.5 to 73.4 percent and was comprised of low plasticity clay or silty clay. A small amount of gravel (less than 10 percent) was encountered in one sample. The corresponding USDA classification of the predominant material type is “sandy loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-6, approximately 50,000 cubic yards of material consisting of clayey sand and sandy clay is available in the East Borrow Area.

3.3.4.2 Dilco Hill Borrow Area

Three boreholes were drilled in the Dilco Hill Borrow Area to depths ranging from 40 to 60 feet. At each borehole location, a relatively thin veneer of unconsolidated soil overlying bedrock was observed. The bedrock consisted of sandstone, shale, coal, and interbedded sandstone and shale. Borehole DH-B1 was drilled in the northern portion of the top of the hill. At this location, silty clay with sand, silty sand, and silty clay was encountered to a depth of 15.0 feet, where bedrock was encountered. DH-B2 was drilled in the central portion of the top of the hill. Silty clay with sand was encountered to a depth of 2.0 feet, where bedrock was encountered. DH-B3 was drilled in the southern portion of the top of the hill. Silty clay with sand was encountered to a depth of 2.5 feet, where bedrock was encountered.

Based on borehole logs and results of the geotechnical laboratory testing, a small amount of unconsolidated soil is available from the top of the hill. Material ranges in depth from approximately 2 to 15 feet, and consists of sand and sandy, silty clay. The corresponding USDA classification of this material is “sandy loam.”

Most of the available material from the Dilco Hill Borrow Area is comprised of sedimentary bedrock. Above a depth of approximately 25 to 30 feet, the predominant material type is sandstone, shale, and interbedded sandstone and shale. Below a depth of 25 to 30 feet, the predominant material is comprised of shale and coal.

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 5,000 cubic yards of sandy, silty clay is available from the top 2 to 15 feet of the Dilco Hill Borrow Area. In addition, approximately 370,000 cubic yards of mixed sandstone, shale and coal is also available. Since auger refusal was not encountered in any of the boreholes drilled, it is expected that this bedrock material can be ripped using conventional excavation equipment, such as a Caterpillar D-8 or heavier dozer, with a single tooth ripper.

3.3.4.3 South Drainage Borrow Area

Four boreholes were drilled in the South Drainage Borrow Area to depths ranging from 15 to 30 feet. Borehole SB-B4 was added to the drilling program presented in the Work Plan to better characterize the depth and extent of potential borrow material in the South Drainage Borrow Area. Borehole SB-B1 was drilled in the eastern portion of the borrow area, where sandy clay was encountered to the total borehole depth of 25.0 feet. SB-B2 was drilled in the northern portion of the borrow area. At this location, clay with sand was encountered to a depth of 14.1 feet, where sandstone bedrock was observed. SB-B3 was drilled in the southwestern portion of the borrow area. Clay with sand was encountered to a depth of 7.8 feet, where sandstone bedrock was observed. SB-B4 was drilled in the central portion of the borrow area. Sandy clay was observed to a depth of 28.5 feet, where gravelly clay was encountered.

Based on borehole logs and results of the geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of sandy clay and clay with sand. The sand content ranged from 21.6 to 46.7 percent for all samples tested, and the fines content ranged from 53.3 to 78.4 percent and was comprised of low plasticity clay. The corresponding USDA classification of the predominant material type is “sandy clay loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 170,000 cubic yards of material consisting of sandy clay and clay with sand is available in the South Drainage Borrow Area.

3.3.4.4 North Drainage Borrow Area

Two boreholes were drilled in the North Drainage Borrow Area. NB-B1 was drilled to a depth of 20.0 feet in the northwestern portion of the borrow area. At this location, silty clay with sand and silty sand was encountered to a depth of 18.0 feet, where gravelly sand was observed. NB-B2 was drilled to a depth of 20.0 feet in the southeastern portion of the borrow area. At this location, silty sand, silty clay, and sandy clay/clayey sand was encountered to the total depth drilled.

Based on borehole logs and results of the geotechnical laboratory testing, the predominant material available from this borrow area is relatively homogeneous and consists of nearly equal portions of sand and clay or silty clay. The laboratory-measured sand content ranged from 49.0 to 55.6 percent for all samples tested. The fines content ranged from 44.4 to 51.0 percent and was comprised of low plasticity silt or silty clay. The corresponding USDA classification of the predominant material type is “sandy loam.”

Based on the field investigation and the preliminary grading contours shown in Figure 3-7, approximately 80,000 cubic yards of material consisting of sandy, silty clay and silty, clayey sand is available in the North Drainage Borrow Area.

3.4 STOCKPILE MATERIAL INVESTIGATION

On-site stockpiles of topsoil, bedding material, and erosion protection material were characterized to determine the volume, composition, and geotechnical and agronomic properties of the materials. The stockpile locations are shown on Figure 1-3. Photographs of the stockpiles are provided in Appendix B2.

3.4.1 Topsoil Stockpile

The topsoil stockpile is located southwest of the Mill Site office area, west of Highway 566. On November 21, 2013, two bulk samples of the material were collected with a shovel from the stockpile. The samples were collected by scraping away material from the surface of the pile and collecting material from the interior of the pile. During the sampling, the material was visually classified as sandy clay.

The topsoil stockpile was surveyed with a hand-held GPS unit during the investigation, and the survey information was used to estimate the volume of the material. The stockpile volume is shown in the table below.

3.4.2 Stockpiles of Bedding and Erosion Protection Material

Seven separate stockpiles consisting of bedding and erosion protection material were observed near the tailings impoundment. The crushed basalt rock stockpiles are surplus materials from previous reclamation construction activities at the site.

At each stockpile location, the material was visually classified. Stockpile 1 was identified as crusher fines material. Stockpile 3 was identified as road base material. Stockpiles 2, 4, 5, 6 and 7 were identified as crushed basalt erosion protection material. The nominal D_{50} of each of the stockpiled materials was taken from the previous project specifications, as shown in the table below.

On November 13, 2013, composite bulk samples were collected from Stockpiles 1 through 5 for laboratory testing. Samples were collected by scraping away material from the surface of the pile and collecting material from the interior of the pile. At Stockpiles 2 and 3, samples were collecting using a backhoe. At Stockpiles 1, 4, and 5, samples were collected with a shovel. Samples from Stockpiles 6 and 7 were not collected because of the large size of the material.

The stockpiles were surveyed during the investigation, and the survey information was used to estimate the volume of material in each pile. The below above lists the material types and the approximate stockpile volumes.

Volume and Type of Stockpiled Materials

Stockpile Designation	Material Type[1]	Approximate Volume (cubic yards)	Measured Median Particle Size (D_{50}) inches (mm)[2]
Topsoil Stockpile	Sandy Clay	20,000	<0.075 mm (Note 3)
Stockpile 1	Crusher Fines	1,300	0.03 (0.7)
Stockpile 2	1.5-inch Erosion Protection Rock	2,850	0.94 (24.0) 0.89 (22.5)
Stockpile 3	Road Base	680	0.50 (12.8)
Stockpile 4	1.5-inch Erosion Protection Rock	2,920	1.2 (29.8)
Stockpile 5	6-inch Erosion Protection Rock	470	Note 4
Stockpile 6	9-inch Erosion Protection Rock	260	Note 4
Stockpile 7	15-inch Erosion Protection Rock	280	Note 4

Notes:
1. Descriptions based on gradation specifications from previous construction activities
2. Measured as a portion of this investigation
3. Hydrometer tests not performed
4. Large riprap samples were not tested for gradations.

3.4.3 Laboratory Testing

Selected samples from Stockpiles 1, 2, 3, and 4 were submitted for geotechnical and agronomic testing. Laboratory test results for the stockpile samples are provided in Table 3-2 and Table 3-6, *Summary of Geotechnical Laboratory Data – Site Stockpiles*, and Appendix B1.

3.4.4 Rock Quality Scoring

Samples from stockpiles 2, 4 and 6 were evaluated as potential sources for reuse as riprap and erosion protection at the site. The gradations from stockpiles 2 and 4 indicate D_{50} values ranging from 0.9 to 1.2 inches for the three samples tested. Samples were tested for durability based on guidance for long-term performance outlined by the NRC. The guidance is for rock to be used for erosion protection on exposed surfaces and utilize a rock scoring value (Johnson, 2002). In order to develop the scoring criteria, specific gravity, absorption, sodium sulfate soundness, L.A. Abrasion, unconfined compressive strength, and splitting tensile strength tests were performed in accordance with ASTM guidelines. Strength tests were performed on core samples from larger specimens of the rock. Results of the durability testing are provided in Appendix B1 and summarized in the table below.

Based on information provided in NUREG-1623 (NRC, 2002), rock for use in areas defined as critical areas must meet a score of 65 percent or greater and require oversizing if the score is less than 80 percent. Based on the test results (rock score of 69 percent), the basalt from the stockpiles tested would require 11 percent oversizing if it were to be used as erosion protection rock in critical areas.

Summary of Durability Scoring Criteria for Stockpiled Nominal 1-inch Basalt

Laboratory Test[1]	Result	Score[3]	Weighting Factor[4]	Weighted Score	Maximum Possible Score
Bulk Specific Gravity (ASTM C127)	2.77	10	9	90	90
Absorption, % (ASTM C127)	1.98	3	2	6	20
Sodium Sulfate, % (ASTM C88)	9.37	5.6	11	62	110
LA Abrasion (100 revs.[2]), % (ASTM C535)	5.9	8	1	8	10
Unconfined Compressive[e] Strength, psi (ASTM D7012, method C)	14,440	3	7	21	70
Splitting Tensile Strength[5], psi (ASTM D3967)	1,320	9	10	90	100
TOTALS				277	400
		Score:		**69%**	
		Oversizing required:		**11%**	

Notes:

1. Test results provided by Advanced Terra Testing and CTC Geotek (2014), table includes the average of 2 results.
2. Test conducted for 100 revolutions per NUREG-1623
3. Based on a range of 0 to 10, rock strength scores based on (DePuy, 1965 (Table 1))
4. Weighting factors for igneous rock, NUREG-1623 and DePuy (1965)
5. Tests conducted on core samples from the D_{50} = 9-inch stockpile.

3.5 VEGETATION EVALUATION

Cedar Creek Associates, Inc. conducted vegetation analog and baseline surveys on October 19-23, 2013 to evaluate the following information: 1) successive vegetative communities on undisturbed ground near the impoundment (vegetation analogs), to provide information necessary to design a long-term and low-maintenance vegetated repository cover, and 2) baseline surveys of the borrow areas to quantify the plant and animal communities at the proposed borrow areas that will be disturbed during construction.

3.5.1 Revegetation of Repository Cover

Identified vegetation communities that are projected to colonize and occupy the repository cover during the design life are as follows: 1) early to mid-successional (also termed "reclaimed"); 2) grassland (mid-successional); and 3) shrubland (late-successional or climax community). The ecological succession among the projected repository cover communities is expected to follow this same sequence of reclaimed, grassland and shrubland. Although highly dependent on land management practices and climatic factors, vegetation succession is expected to progress through the communities listed above, over the following approximate durations:

- Reclaimed Community: 0 - 50 years
- Grassland Community: 25 - 100 Years
- Shrubland Community: 50 - 1,000 Years

Vegetation surveys were conducted at the three vegetation communities. Cedar Creek used methods that quantified the vegetative parameters of the local vegetation analogs. Information collected as part of this analysis will be used during design of the RA. The vegetation communities identified and results of the revegetation evaluation are included in Appendix D.

3.5.2 Baseline Evaluation of Borrow Areas

Results of the vegetation and wildlife surveys at the borrow areas indicate that no rare, threatened or endangered species occur within any of the potential borrow sites. Additionally, noxious weeds, musk thistle, and tamarix were all observed in the East Borrow area during the vegetation surveys. If soils from the East Borrow Area are used to construct the repository cover, the noxious weeds in the East Borrow Area should be managed via chemical control prior to construction. This will minimize or prevent the spread of noxious weeds as a result of construction.

Further results of the baseline and analog surveys indicate that the baseline and analog sites are comparable. Therefore, the analog sites can be used as a reference for post-construction revegetation success criteria. Survey results indicate which species will likely prove successful during revegetation. These results, coupled with other project experience in the arid west, will be used to develop an effective and efficient revegetation plan for the repository cover and the borrow areas disturbed during construction. Additional details about the baseline surveys are included in Appendix D2.

3.6 BIOINTRUSION EVALUATION

Cedar Creek Associates, Inc. conducted biointrusion (animal and plant) surveys on October 19-23, 2013 for each vegetation community identified in the Work Plan. An animal biointrusion evaluation was performed to determine the presence of burrowing animals in the Mill Site vicinity. Animal biointrusion sampling occurred as small mammal trapping and incidental wildlife observation transects. Pocket gophers, prairie dogs, and badgers were not identified on the existing impoundment cover, but they were identified in the vicinity of the Mill Site. Discussions with UNC personnel indicate that evidence of prairie dogs and badgers has not been observed on the existing cover, and evidence of pocket gophers on the cover has not been observed in 10-15 years (L. Bush, pers. comm., July 9, 2014). Results of Cedar Creek's biointrusion evaluation are included in Appendix D1.

Plant biointrusion survey results indicate the presence of a zone of calcium carbonate accumulation at depths ranging from 50 to 70 cm (1.6 to 2.3 feet) at the three vegetation communities projected to colonize the repository cover. The calcium carbonate zone can restrict water infiltration and plant root depth and cause roots to spread laterally. As part of the design process, further characterization of the borrow area soils may be necessary to investigate the concentration of calcium carbonate throughout the depth of the excavations proposed in the borrow areas. Additional information about plant biointrusion and the presence of calcium carbonate in the soils is included in Appendix D1.

3.7 KNOWN CULTURAL RESOURCES AT THE MILL SITE

Dinetahdoo Cultural Resources Management (Dinetahdoo) conducted a cultural resources inventory at each of the borrow areas between October 22-24, 2014. The inventory was performed prior to drilling, to identify archeological sites located within the borrow investigation areas. The survey was conducted under New Mexico State Historic Preservation Office permit number NM-13-236-SM. Prior to the field survey, Dinetahdoo personnel also interviewed nearby residents about the location of any sacred places, burials, or traditional cultural places that might be affected by the PDS investigation.

The survey covered a total area of approximately 72 acres, including a buffer zone extending about 50 feet beyond the proposed limits of each of the borrow areas shown in the Work Plan. Dinetahdoo demarcated cultural resources sites in the field at the time of the survey, and recommended a 50-ft buffer be maintained around each site to ensure that the sites were not disturbed during the PDS.

No previously-recorded archeological sites were identified near the borrow areas. Four new documented sites and seventeen isolated occurrences were identified and evaluated by Dinetahdoo during the inventory. One of the four archeological sites is the location of an Anasazi artifact scatter. The other three archeological sites were Anasazi habitations. The exact locations of the cultural resources sites have been redacted in order to preserve confidentiality. No traditional cultural places were identified in the area of interest.

Dinetahdoo recommended archeological clearance for the PDS field work activities and subsequent construction activities in the areas surveyed, provided the following stipulations are met:

- Construction activities in the borrow areas shall be confined to the five inventoried areas. The limits of the inventoried areas extend up to 270 feet beyond the proposed limits of grading in some locations, due to borrow area modifications as a result of the PDS.

- Any new discoveries shall be immediately reported to the New Mexico State Historic Preservation Office

Further recommendations include the following:

- Re-flag and avoid sites LA177467/NM-Q-21-123 (inside the South Drainage Borrow Area) and LA177468/NM-Q-21-124 (inside the East Borrow Area).

- Re-flag and monitor ground disturbing activities within 50-ft of sites LA177466/NM-Q-21-122 (outside the North Drainage Borrow Area) and LA177469/NM-Q-20-61 (inside the West Borrow Area).

The recommendations from Dinetahdoo will be implemented during RA construction. As part of the design process, a cultural resources inventory will be performed for the remaining areas planned to be impacted during construction of the RA. Results of the cultural resources inventory of the borrow areas are included in Appendix E.

3.8 INVENTORY OF THE LOCATION, NATURE AND VOLUME OF MILL SITE SURFACE DEBRIS

An inventory of observable surface debris and solid waste was conducted at the Mill Site to quantify the volume and type of debris present. The Mill Site survey included surficial debris located in the southwest area of the Mill Site, materials and wastes located near the tailings impoundment, the tailings impoundment evaporation sprinkler system, and other materials observed while traversing the site. The debris located near the Mill Site office buildings and shaft construction yard were also inventoried and are included in the volume estimates below. Based on site information, some but not all, of these materials were used during mill operations and should be assumed to have elevated concentrations of radionuclides. The management approach for these materials will be developed during design of the RA.

A written description, photographic record, estimate of the size and quantity, and survey coordinates of the debris locations were recorded for each object or area containing debris that was identified during the PDS. This information is included in Appendix B4. The locations, material types, whether or not the material was fixed to the surface, and, in some cases, length or area of the debris are shown on Figure 3-13, *Mill Site Debris Overview*. Each distinct pile or piece of debris is identified by a unique identification number in Figures 3-14 through 3-16. The numbers correspond to the descriptions listed in the table in Appendix B4.1. The debris observed was composed of metal, concrete, plastic, fiberglass/rubber, and/or wood.

An estimate of the volume of material present for each item of debris observed was made based on field observation and, in some cases, the length or area of the item was measured using the GPS. The estimated total volume for large items such as buildings and large tanks excludes the void space within the structure. Some items contained more than one type of material (i.e., the buildings located on the southeast side of the tailings ponds are metal and wood, and also contain insulation and miscellaneous parts/debris). For material type volume calculations, the volume of the mixed material debris was classified by the predominant material. A burial pit located northeast of the office building is estimated to contain about 3,700 cy of trash and debris. The table below summarizes the estimated total volume of debris based on the material type. Total estimated volume of debris at the Mill Site is approximately 6,870 cy. The most prominent debris material is metal. The second largest volume of material on the site is concrete which includes foundations, vaults, and loading docks located in the shaft construction yard and near the office buildings. The volume totals are based on the final volumes for debris that is anticipated to be compressible.

Summary of Debris Volume by Material Type

Material	Volume (cu. yds.)
Metal	1,870
Concrete	615
Plastic	450
Wood	175
Fiberglass/Rubber	60
Misc. Buried Debris	3,700
Total	**6,870**

Note: The volume of miscellaneous buried debris is an estimate of the buried trash and debris located northeast of the Mill Site office building.

A similar debris assessment was conducted at the mine site and identified approximately 25,600 cy of debris. The results are presented in the NECR Mine Site PDS Report.

3.9 VISUAL INSPECTION AND SURVEY OF BRANCH SWALES AND NORTH DIVERSION CHANNEL

Several impoundment branch swales (Branch Swales A through H) and the North Upstream Diversion Channel were visually inspected to document existing conditions, in order to provide data necessary for design of the RA. The swale and channel locations are shown on Figure 3-8, *Branch Swales and North Upstream Diversion Channel Section Locations*. The evaluations were performed on November 27, December 7, and December 14, 2013, and included a qualitative evaluation of the physical condition of the materials used for construction, the physical condition of the drainage rock or channel bottom, and the amount of sediment and vegetation accumulation. For the North Diversion Channel, the evaluation also included qualitative evaluation of the condition of the berm located west and north of the channel (the roadway berm).

Based on the field observations, sections of swales or the channel with similar characteristics were identified and grouped together. These groupings are shown on Figure 3-8. The existing conditions were summarized for each of these sections. Table 3-7, *Summary of Branch Swale Conditions* presents a summary of the condition of the branch swales, and Table 3-8, *Summary of North Upstream Diversion Channel Conditions* presents a summary of the conditions of the North Diversion Channel. Representative photos for each swale or channel section are provided in Appendix B3.

In addition to the qualitative evaluations, cross sections were surveyed across each branch swale and channel in several locations. Cross sections were surveyed along the entire length of Branch Swales A, E, F, G and H and portions of Branch Swales B, C, and D and the North Upstream Diversion Channel. Representative cross sections through the branch swales are shown on Figures 3-9 through 3-11, *Branch Swale Cross Sections*. Representative cross sections through the diversion channel are shown on Figure 3-12, *North Upstream Diversion Channel Cross Sections*. The corresponding locations of the representative cross sections are shown on Figure 3-8. The existing drainage swales and the north diversion can be incorporated into the RA design. Some localized areas may require maintenance or improvements during construction to remove vegetation or siltation. The sizes of the existing swales and diversion channel may require adjustments to accommodate design flows. This evaluation will be completed during RA design.

Table 3-1 Summary of Geotechnical Laboratory Data - Cover Samples

Cover Layer	Sample	Sample Type (1)	Sample Depth Interval (in)		Material Description (2)	USCS (2)	USDA Classification (3)	Water Content (by mass) (%)	Specific Gravity	Standard Proctor (max. dd@opt. w.c.) (pcf @ %)	Atterberg Limits (%) (5)			USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	% Silt	USDA % Clay (<0.002 mm)	L.A. Abrasion (6) (% loss)	Sodium Soundness (7) (% loss)	Absorption (8) (%)	Pinhole Dispersion (9)	Remolded Saturated Hydraulic Conductivity (10) (cm/sec)			Confining Stress (psi)	SWCC: -5 bar Water Content (by mass) (%) (10)	SWCC: Saturated Water Content (by mass) (%) (11)
											LL	PL	PI										90%	95%	100%			
Admix. (Gravel/ Soil Mixture)	TI - CS01 - 02A	Bulk	0	11	Clayey Gravel with Sand		Loam							33.3	23.4	43.3	28.0	15.3										
	TI - CS02 - 02A	Bulk	0	10	Clayey Gravel with Sand		Clay Loam		2.81 (4)					36.9	17.0	46.1	28.8	17.3	3.8	0.37	1.06							
	TI - CS03 - 02A	Bulk	0	6	Clayey Gravel with Sand		Loam							53.6	18.7	27.7	18.1	9.6										
	TI - CS04 - 02A	Bulk	0	10	Clayey Gravel with Sand		Loam							53.6	18.2	28.2	18.0	10.2										
	TI - CS05 - 02A	Bulk	0	9	Sandy Lean Clay		Loam							13.9	34.4	51.7	31.2	20.5										
	TI - CS06 - 02A	Bulk	0	7	Clayey Gravel with Sand		Loam		2.77 (4)					48.4	18.5	33.1	23.4	9.7	5.7	0.14	1.91							
	TI - CS07 - 02A	Bulk	0	20	Sandy Lean Clay	CL	Loam	7.8			28	13	15	1.1	41.0	60.9	42.4	18.5										
	TI - CS08 - 02A	Bulk	0	8	Clayey Gravel with Sand		Loam							56.7	18.5	24.8	17.2	7.6										
	TI - CS09 - 02A	Bulk	0	9	Clayey Gravel		Loam		2.78 (4)					53.6	14.2	32.2	21.2	11.0	5.1	1.17	1.55							
	TI - CS10 - 02A	Bulk	0	7	Clayey Gravel with Sand		Loam							41.4	19.7	38.9	26.1	12.8										
	TI - CS11 - 02A	Bulk	0	9	Clayey Gravel with Sand		Sandy Loam							30.7	30.1	39.2	26.1	13.1										
	TI - CS12 - 02A	Bulk	0	14	Sandy Lean Clay	CL	Loam	9.1			33	13	20	1.3	28.8	69.9	43.5	26.4										
Radon barrier (clay layer)	TI - CS03 - 04A	Bulk	6	24	Sandy Lean Clay	CL	Loam	6.0			28	14	14	6.3	38.7	55.0	36.1	18.9										
	TI - CS06 - 04A	Bulk	7	24	Sandy Lean Clay	CL	Loam	11.0			30	13	17	6.7	34.2	59.1	40.2	18.9										
	TI - CS10 - 04A	Bulk	7	25	Sandy Lean Clay	CL	Loam	7.7			29	14	15	2.3	39.5	58.2	36.9	21.3										
	TI - CS08 - 04A	Bulk	8	28	Sandy Lean Clay	CL	Loam	8.1	2.67	119.4 @ 11.9	27	12	15	11.3	35.0	53.7	36.7	17.0					9.1E-06	1.1E-05	1.5E-06	24		
	TI - CS05 - 04A	Bulk	9	24	Sandy Lean Clay	CL	Loam	9.6			29	12	17	1.3	37.3	61.4	42.0	19.4										
	TI - CS09 - 04A	Bulk	9	26	Sandy Lean Clay	CL	Loam	7.7			28	13	15	4.0	38.1	57.9	40.0	17.9										
	TI - CS11 - 04A	Bulk	9	24	Sandy Lean Clay	CL	Clay Loam	8.6	2.68	115.0 @ 14.9	32	13	19	5.1	28.4	66.5	40.7	25.8					7.6E-08	1.4E-07	1.0E-07	24		
	TI - CS02 - 04A	Bulk	10	24	Sandy Lean Clay	CL	Sandy Clay Loam	11.4			28	12	16	3.6	44.7	51.7	30.4	21.3										
	TI - CS04 - 04A	Bulk	10	24	Sandy Lean Clay	CL	Clay Loam	15.0	2.68	113.5 @ 15.0	35	15	20	0.9	35.0	68.2	37.2	26.9					4.6E-06	6.2E-06	2.3E-07	8		
	TI - CS01 - 04A	Bulk	11	24	Sandy Lean Clay	CL	Loam	9.2	2.68	117.3 @ 13.0	29	15	14	2.0	39.8	58.2	39.0	19.2				ND3	3.0E-04	4.6E-05	7.8E-07	8	8.6 / 9.6	21.7 / 19.0

Notes: 1. Sample Types: Bulk = bucket/grab sample

2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay

3. USDA = United States Department of Agriculture, USDA classifications are based on the sand/silt/clay fraction of the sample and on USDA grain-size designations.

4. Bulk saturated surface dry (SSD) specific gravity of the gravel fraction, average of three results (ASTM C127).

5. LL = liquid limit, PL = plastic limit, PI = plasticity index

6. L.A. abrasion results are percent loss, by mass, for 100 revolutions.

7. Weighted percent loss for the 3/4-inch to 3/8-inch size range

8. Average of three results for the gravel fraction of the cover gravel/soil mixture samples

9. Pinhole dispersion test (ASTM method A) conducted on a specimen remolded to approximately 95% of the maximum standard Proctor density at optimum water content. ND3 = slightly to moderately dispersive clays that erode slowly under 2-inch or 7-inch head.

10. Flexible wall permeameter tests conducted on specimens remolded to approximately 90, 95 and 100% of the maximum standard Proctor density and tested at the confining stresses shown in the table.

11. SWCC test conducted on material passing the No. 10 sieve, remolded to approximately 95% of the maximum standard Proctor density and optimum water content. SWCC tests performed with pairs of specimens for each test.

Table 3-2 Summary of Agronomic and Analytical Laboratory Data - Impoundment Cover, Stockpiles, and Borrow Areas

Area	Sample	Sample Type [1]	Sample Depth Interval (in)		Calcium, sat. paste (meq/L)	Cation Exchange Capacity (meq/100g)	Conductivity, sat. paste (mmhos/cm)	Exchangeable Sodium (%)	Lime as $CaCO_3$ (%)	Magnesium, sat. paste (meq/L)	Organic Matter (% by mass)	pH, sat. paste	Phosphorus, Olsen (mg/kg)	Potassium (mg/kg)	Potassium, sat. paste (meq/L)	Sodium (mg/kg)	Sodium Adsorption Ratio (SAR)	Sodium, sat. paste (meq/L)	Sodium, soluble (mg/kg)	Total (Kjeldahl) Nitrogen (mg/kg)	Radium 226 (pCi/g)
Borrow Areas	WB-B2-04	Bulk	0	120	27.30	25.2	2.63	0.3	2.8	9.50	1.5	7.4	6.0	94	0.26	23	0.2	0.87	7.3	280	1.0 ± 0.5
	EB-B4-03	Bulk	0	120	27.90	25.5	3.30	0.8	2.3	13.10	0.9	7.7	6.0	178	0.46	83	0.7	3.35	33.1	280	1.1 ± 0.5
	NB-B1-04	Bulk	0	180	5.34	20.4	1.01	1.0	6.6	3.18	0.4	8.0	7.0	136	0.16	69	1.1	2.37	20.9	280	0.8 ± 0.5
	SB-B4-01	Bulk	0	180	26.10	24.5	2.66	0.6	6.1	10.30	0.8	7.8	7.0	292	0.72	49	0.3	1.20	13.2	336	1.0 ± 0.5
	DH-B3-02	Bulk	0	120	7.07	10.3	1.84	3.3	0.4	4.26	0.2	7.8	6.0	42	0.05	155	4	9.61	75.6	168	1.3 ± 0.6
Cover Samples	TI-CS02-01	Bulk	0	7	30.40	30.5	2.95	0.4	2.5	8.36	1.5	7.7	7.0	309	0.87	40	0.2	1.04	10.5	448	1.5 ± 0.6
	TI-CS07-01	Bulk	0	6	6.27	24.8	0.81	0.1	2.1	1.94	1.5	7.8	8.0	251	0.40	10	0.1	0.29	2.6	392	1.7 ± 0.5
	TI-CS11-01	Bulk	0	6	23.90	22.0	2.81	0.9	3.4	8.23	1.3	7.7	7.0	268	0.95	80	1	4.19	36.2	336	1.0 ± 0.6
Stockpiles	Topsoil Stockpile	Bulk	-	-	11.10	33.5	2.30	1.9	1.9	7.99	0.4	7.9	4.0	196	0.20	228	2.3	7.16	84.1	224	1.0 ± 0.6

Note: 1. Sample Type: Bulk = bucket/grab sample

Table 3-3 Summary of Borehole and CPT Profiles

Site Location:	North Cell									
	Dam									
Hole Number:	3	28	1	29	2	4	24	13	23	25
Surface Elevation (ft):	6969	6962	6970	6957	6960	6965	6962	6969	6962	6969
CPT or Paired CPT/Borehole[1] :	paired	cpt only	paired	cpt only	paired	cpt only	cpt only	cpt only	paired	cpt only
Embankment (thickness in feet):	47	-	-	-	-	-	-	-	-	-
Cover/Fill (thickness in feet):	-	10	18	9	12.5	13	7	4	13	2.5
Coarse Tailings (thickness in feet):	-	16	17	-	0	2	-	-	2	-
Interlayered Coarse/Fine Tailings (thickness in feet):	-	-	-	-	0	4.5	-	-	-	-
Fine Tailings (thickness in feet):	-	1	-	1	2	-	-	-	1	-
Bottom of Tailings Elevation (ft):	-	6935	6935	6947	6945	6945	6955	6965	6946	6967
Alluvium (thickness in feet):	23	57	53	93	19	6	15	-	27	-
Sandstone (Zone 3) (thickness in feet):	*	-	*	-	5	2	-	-	22.5	-
Sandstone/Shale (Zone 2) (thickness in feet):	-	-	-	-	-	-	-	-	5	-
CPT Footage:	9	84	88	103	34	27.5	22	4	43	2.5
Borehole Footage:	70	-	70	-	38.5	-	-	-	70.5	-

Site Location:	Borrow Pits													
	Perimeter of Borrow Pit 1				Borrow Pit 1							Borrow Pit 2		
Hole Number:	5	14	20	17	6	9	10	8	16	18	19	11	27	12
Surface Elevation (ft):	6973	6980	6979	6975	6974	6976	6973	6976	6973	6972	6975	6978	6977	6979
CPT or Paired CPT/Borehole[1] :	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only	paired	paired	cpt only	cpt only	cpt only	paired	cpt only	cpt only
Cover/Fill (thickness in feet):	5	6	7	7	7	7	8	9	8	6	5	43	15	43
Coarse Tailings (thickness in feet):	-	11.5	14	8	8	15	14	16	7	6	23	-	-	-
Interlayered Coarse/Fine Tailings (thickness in feet):	-	-	7	-	-	23	-	-	18	0	-	-	-	-
Fine Tailings (thickness in feet):	-	3.5	5	6	19	0	22	19	10	30	17	11.5	-	2
Bottom of Tailings Elevation (ft):	6968	6959	6946	6954	6940	6931	6929	6932	6930	6930	6930	6924	6962	6934
Alluvium (thickness in feet)[2] :	33	14.5	13	27	2	24	61	17	12	8	13	42.5	65	7
Sandstone (thickness in feet) (Zone 3):	-	-	-	-	-	++	++	-	-	-	-	-	++	-
Sandstone/Shale (thickness in feet) (Zone 2):	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Sandstone (thickness in feet) (Zone 1):	-	-	-	-	-	-	3	-	-	-	-	6	-	-
CPT Footage:	38	35.5	46	48	36	69	63	61	55	50	58	97	80	52
Borehole Footage:	-	-	-	-	-	-	108	66	-	-	-	103	-	-

Site Location:	West Side of Central Cell and South Cell [3]							
	Central Cell				South Cell			
Hole Number:	15	26	7	21	22	30	31	32
Surface Elevation (ft):	6977	6973	6972	6966	6968	6962	6951	6950
CPT or Paired CPT/Borehole[1] :	paired	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only	cpt only
Cover/Fill (thickness in feet):	3	6	7	5	6	6	6	5
Coarse Tailings (thickness in feet):	27	8	8	-	25	21	20	35
Interlayered Coarse/Fine Tailings:	-	-	26	-	-	-	-	-
Fine Tailings (thickness in feet):	-	1	0	-	2	1	4	-
Bottom of Tailings Elevation (ft):	6947	6958	6931	6961	6935	6934	6921	6910
Alluvium (thickness in feet):	41.5	13	29	16	61	47	50	79
Sandstone (thickness in feet):	*, ++	-	+	-	-	-	-	+
CPT Footage:	55	28	70	21	94	75	80	119
Borehole Footage:	71.5	-	-	-	-	-	-	-

Notes:

1. Profiles for "CPT only" holes interpreted based on cpt/borehole pairs and CPT signatures are described in Section 3.2.2.
2. Wet alluvial soils encountered at about 90 feet below the ground surface at borings B10 and B11.
3. CPT soundings only (no boreholes) along the west side of the central cell and the south cell.

(*) Boring terminated in alluvium, prior to refusal
(+) CPT terminated in alluvium, prior to refusal
(++) CPT refusal likely on a boulder, or hard clay layer within the alluvium
(-) Material type not encountered, or CPT footage only

Table 3-4 Summary of Geotechnical Laboratory Data - Mill Site Impoundment

Area	Boring	Sample Type [9]	Sample Depth Interval (ft.)		Material Description [1]	USCS [1]	Water content (by mass, %) 110C	Water content (by mass, %) 60C	SWCC - Saturated water content (by mass, %) [2]	SWCC - Specimen dry density (pcf) [2]	Dry density (pcf), 110C	Dry density (pcf), 60C	Specific gravity, 110C	Specific gravity, 60C	Atterberg limits (%) LL	PL	PI	USCS % gravel (size)	USCS % sand (size)	% Passing No. 200 sieve	% Silt (size)	USDA % clay (size <0.002 mm)	Saturated Hydraulic conductivity (cm/sec) [3]	Hydraulic conductivity confining stress (psi)	Consolidation (Cc) [7]	Collapse potential (%) (inundation load (psf))	Triaxial [12] (peak friction angle (ϕ) (degrees), cohesion (psf), where applicable)
CENTRAL CELL	TI-B1	CA	16	16.5	Lean Clay with Sand (Fill)	CL	16.2				104.7				33	13	20	0.3	27.2	72.5	42.9	29.6					
	TI-B1	CA	20.5	21	Coarse Tailings		6.1	5.7																			
	TI-B1	CA	21	21.5	Coarse Tailings		7.5		21.9 / 19.8	96.5 / 99.6	105.5							0.0	90.7	9.3	5.5	3.8	3.7E-04	18	0.024		
	TI-B1	ST	27	27.5	Coarse Tailings	SP	4.0				97.6		2.67			NP		0.0	92.7	7.3	5.2	2.1	2.9E-03	14			34.9
	TI-B1	CA	30	30.5	Coarse Tailings		13.9	13.5																			
	TI-B1	CA	30.5	31	Coarse Tailings		14.6		29.6 / 33.8	84.2 / 83.6	91.6												3.0E-07	25	0.092		
	TI-B1	CA (top)	31	31.5	Coarse Tailings		0.8	0.4																			
	TI-B1	CA (bottom)	31	31.5	Fine Tailings	CL		41.6				76.5	2.68	*2.69*	44	17	27	0.0	30.9	69.1	54.6	14.5					33.3
	TI-B1	CC-AC	32	33	Coarse/Fine Tailings	CL	29.3	*27.8*							33	16	17	0.0	46.7	53.3	37.4	15.9					
	TI-B1	CA	36	36.5	Clayey Sand		21.0	19.9	36.3 / 33.2	85.2 / 88.0	97.3		2.73					0.0	62.5	37.5	32.8	4.7	1.7E-06	32	0.059		
	TI-B1	CA	41	41.5	Lean Clay with Sand	CL	26.7				98.6				31	15	16	0.0	18.2	81.8	54.7	27.1	1.2E-07	35			
	TI-B1	ST	45	46	Clayey Sand		22	21.2			106.0														0.058		34.4
CENTRAL CELL - BORROW PIT 1	TI-B10	ST (top)	10	11	Coarse Tailings		9.7	9.1			110	110.5	2.63	2.65													
	TI-B10	ST (bottom)	10	11	Coarse Tailings		9.0		20.7 / 21.5	102.6 / 101.2	96.8							0.2	71.9	27.9	16.6	11.3	4.3E-04	34	0.094		
	TI-B10	CC-AC [4] (top)	12.5	14	Coarse Tailings		6.7	6.3					2.61	2.64													
	TI-B10	CC-AC [4] (bot)	12.5	14	Coarse Tailings		7.5		31.3 / 31.4	85.0 / 85.0	99.1							0.7	71.5	27.8	18.9	8.9	6.7E-05	36			
	TI-B10	CA	15	15.5	Coarse Tailings		9.3				103.0																
	TI-B10	CA	16	16.5	Coarse Tailings	SM	6.5				100.0		2.65			NP		2.4	82.3	15.3	10.2	5.1					
	TI-B10	ST	21.5	22.5	Coarse/Fine Tailings	CL	28.1	*26.7*			91.9	*92.9*			43	19	24	0.0	43.0	57.0	51.4	5.6			0.111		
	TI-B10	CA	25.75	26	Fine Tailings		43.7	41.0																			
	TI-B10	CA	26	26.5	Fine Tailings	CH	60.4	*57.4*			63.1	*64.3*	2.71	*2.80*	74	27	47	0.0	10.0	90.0	82.6	7.4					
	TI-B10	ST	30.3	30.7	Fine Tailings	CH	47.7	*45.3*			72.2	*73.4*	2.71	*2.78*	57	22	35	0.0	24.3	75.7	68.4	7.3					
	TI-B10	ST	32	32.5	Coarse Tailings	SM	15.4				100.1		2.67			NP		0.0	83.1	16.9	12.6	4.3					
	TI-B10	CA	35	35.5	Fine Tailings		50.2	*47.7*			71.3	*72.5*															
	TI-B10	CA	35.5	36	Fine Tailings		54.2	51.4																			
	TI-B10	CA	36	36.5	Coarse/Fine Tailings	SC/CL	33.9	*32.2*			86.7	*87.8*	2.68	*2.72*	36	16	20	0.0	50.6	49.4	31.1	18.3					
	TI-B10	ST (top)	40	41	Fine Tailings		47.3	45.7			70.5	73.7	2.54	2.56													
	TI-B10	ST (bottom)	40	41	Fine Tailings	CH	49.7	*47.2*	47.7 / 55.7	75.3 / 67.9	73.3	*74.5*			61	21	40	0.0	20.7	79.3	46.5	32.9	2.9E-08	58	0.315		
	TI-B10	CA	46	46.5	Silty Sand		9.9				95.4		2.74					0.0	65.8	34.2	23.4	10.8					
	TI-B10	ST	55	56	Silty Sand		14.1		25.7 / 24.8	98.0 / 99.9	100.8												2.4E-05	72	0.139		
	TI-B10	CA	66	66.5	Silty Sand / Sandy Silt	SM/ML	13.8				94.5					NP		0.0	50.1	49.9	33.4	16.5					
	TI-B10	CA	71	71.5	Silty Sand		18.1				100.8																
	TI-B10	CA	91	91.5	Clayey Sand		18.6				105.6		2.66														
	TI-B10	CC	106.9	107.3	Sandstone		14.2				109.1												1.4E-07	115			
CENTRAL CELL - BORROW PIT 2	TI-B11	CA	6	6.5	Sandy Clay (Fill)		8.6				93.5																
	TI-B11	ST	15	16	Clayey Sand (Fill)		8.2		16.0 / 16.3	117.7 / 116.6	110.4		2.67					3.9	57.6	38.5	24.6	13.9	2.5E-05	38	0.085		
	TI-B11	CA	21	21.5	Sandy Clay (Fill)		12.3				107.6																
	TI-B11	ST	30.5	31.5	Sandy Clay (Fill)	CL	13.7				112.4				30	13	17	7.1	41.3	51.6	33.9	17.7	9.0E-07	51	0.059		
	TI-B11	CA	45.5	46	Fine Tailings		117.2	88.7																			
	TI-B11	ST	51.5	52.5	Fine Tailings	CH	63.0	*59.9*			62.5	*63.7*	2.75	*2.84*	91	30	61	0.0	2.7	97.3	90	7.3	3.1E-08	67	0.482		
	TI-B11	ST	56	57	Silty Sand	SM	16.2		31.0 / 30.8	90.6 / 92.8	77.9		2.64			NP		0.0	60.4	39.6	31.9	7.7	5.6E-04	72	0.129		
	TI-B11	CA	61	61.5	Sandy Clay		16.0				95.4							0.0	38.7	61.3	44.1	17.2					
	TI-B11	CA	66	66.5	Silty Sand		14.2				96.2																
	TI-B11	CA	81	81.5	Clayey Sand with Gravel		11.0				107.6		2.76					12.9	65.6	21.5	9.9	11.6					
	TI-B11	CA	100	100.2	Sandstone		21.1				103.9												1.3E-05	112			
CENTRAL CELL - BORROW PIT 1	TI-B8	CA	25	25.5	Coarse Tailings		9.0	8.4			103.7	104.2	2.72	2.72													
	TI-B8	CA [5]	25.5	26	Coarse Tailings		6.2		25.7	94.6	99.6							0.0	87.9	12.7	7.9	4.8	3.6E-04	46			
	TI-B8	CA [5]	26	26.5	Coarse Tailings	SM	16.8		27.0	94.8	91.7					NP		0.0	76.0	24.0	19.0	5.0					
	TI-B8	ST	30	31	Fine Tailings	CH	65.1	*61.8*			61.5	*62.7*			74	25	49	0.0	9.2	90.8	81.2	9.6			0.426		
	TI-B8	ST	31	31.5	Fine Tailings		44.3	41.4																			
	TI-B8	ST (top)	35	36	Coarse Tailings		14.3	13.6			90.9	91.4	2.66	2.67													
	TI-B8	ST (bottom)	35	36	Coarse Tailings		16.5		31.2 / 39.3	89.3 / 82.3	89.6		2.67										1.6E-05	43			
	TI-B8	ST (top)	41	42	Fine Tailings		41.8	*39.7*			79.2	*80.4*	2.60	2.63													
	TI-B8	ST (bottom)	41	42	Coarse/Fine Tailings	SC/CL	35.6	34.3	33.1 / 31.6	88.7 / 90.7	82.8	83.6			35	16	19	0.0	51.2	48.8	40.7	8.1	1.3E-07	53	0.262		
	TI-B8	CC-AC (top)	43.5	44.5	Coarse/Fine Tailings		31.2	29.3			91.0	92.3															
	TI-B8	CC-AC [6] (bot)	43.5	44.5	Fine Tailings		45.6	*43.3*	47.9 / 49.0	74.4 / 73.6	73.6	*74.8*						0.0	14.5	85.5	74.7	10.8	3.0E-08	61			

Table 3-4 Summary of Geotechnical Laboratory Data - Mill Site Impoundment (continued)

Area	Boring	Sample Type [9]	Sample Depth Interval (ft.)		Material Description [1]	USCS [1]	Water content (by mass, %) 110C	Water content (by mass, %) 60C	SWCC - Saturated water content (by mass, %)[2]	SWCC - Specimen dry density (pcf) [2]	Dry density (pcf), 110C	Dry density (pcf), 60C	Specific gravity, 110C	Specific gravity, 60C	Atterberg limits (%) LL	PL	PI	USCS % gravel (size)	USCS % sand (size)	% Passing No. 200 sieve	% Silt (size)	USDA % clay (size <0.002 mm)	Saturated Hydraulic conductivity (cm/sec)[3]	Hydraulic conductivity confining stress (psi)	Consolidation (Cc)[7]	Collapse potential (%) (inundation load (psf))	Triaxial [12] (peak friction angle (ϕ) (degrees), cohesion (psf), where applicable)
BORROW PIT 1 (cont.)	TI-B8	CC-AC	44.5	45	Fine Tailings								2.59	2.60													
	TI-B8	CA	46	46.5	Lean Clay with Sand	CL	21.9				95.2		2.72		30	16	14	0.0	27.9	72.1	55.6	16.5					
	TI-B8	CA	56	56.5	Silty Sand	SM	12.6				97.6		2.70			NP		0.0	57.0	43.0	30.9	12.1					
	TI-B8	BULK	63.5	64	Shale		X				X												X	X			
CENTRAL CELL	TI-B15	CA	6	6.5	Coarse Tailings		5.4				101.1							0.0	87.5	12.5	9.8	2.7					
	TI-B15	CA	11	11.5	Coarse Tailings		6.8				93.8																
	TI-B15	CC-AC	13.5	14	Coarse Tailings	SM	19.0	18.4					2.68			NP		0.0	69.6	30.4	22.6	7.8					
	TI-B15	ST	15.5	16	Coarse Tailings	SM	14.2				90.4		2.66			NP		0.0	54.9	15.1	10.1	5.0	8.3E-04	38	0.126		
	TI-B15	CA	21	21.5	Coarse Tailings	SM	12.7				99.8		2.68			NP		0.0	80.6	19.4	13.3	6.1					
	TI-B15	CC-AC	28.5	29.5	Coarse Tailings	SM	19.3						2.66			NP		0.0	65.4	34.6	24.4	10.2					
	TI-B15	CA (top)	31	31.5	Silty Sand		22.3	21.3																			
	TI-B15	CA (bottom)	31	31.5	Silty Sand	SM	17.1				101.8		2.71			NP		6.2	51.9	41.9	25.9	16.0					
	TI-B15	CA	41	41.5	Clayey Sand		11.4	10.1			87.1	88.1															
	TI-B15	CA (top)	46	46.5	Sandy Silt		25.8	24.0																			
	TI-B15	CA (bottom)	46	46.5	Sandy Silt	ML	17.3				99.3		2.81			NP		0.0	37.0	63.0	55.7	7.3					
	TI-B15	CA	56	56.5	Silty Clay		11.7	10.5			104.2	105.3															
	TI-B15	CA	66	66.5	Clayey Sand		12.7	11.8			100.7	101.5															
NORTH CELL	TI-B23	ST	15.5	15.75	Coarse Tailings		20.7	19.6			87.7		2.77					0.0	62.8	37.2	34.1	3.1					
	TI-B23	ST	17.25	17.5	Sandy Clay		22.5				101.9		2.73					0.0	31.1	68.9	46.5	22.5					
	TI-B23	ST	26	27	Lean Clay	CL	21.6				101.7		2.73		49	18	31	0.0	8.8	91.2	43.8	47.5			0.046		
	TI-B23	CA	45.2	45.7	Sandstone		13.8				108.7												2.4E-07	43			
	TI-B23	CA [8]	65.5	66	Shale		10.2				103.0												9.7E-08	62			
	TI-B2	CA	6	6.5	Silty Sand with Gravel (Fill)		7.7				100.4		2.68					26.9	29.9	43.2	30.7	12.5					
	TI-B2	CA	11	11.5	Clayey Sand (fill)		24.5				75.9		2.73					0.0	65.4	34.6	30.3	4.3					
	TI-B2	CC-AC	13.5	14.5	Fine Tailings		41.7	*39.6*										0.0	23.1	76.9	49.2	27.7					
	TI-B2	CA	15	15.5	Silty Sand		6.9				90.4		2.68														
	TI-B2	CA	21	21.5	Silty Sand		7.0				91.4		2.74					0.0	82.9	17.1	11.5	5.6					
	TI-B2	CA	26	26.5	Lean Clay with Sand	CL	23.5				93.2				34	16	18	0.0	20.9	79.1	51.5	27.6					
	TI-B2	BULK	38.4	38.7	Sandstone		13.5				X																
DAM	TI-B3	CA	11	11.5	Silty Sand (dam)		5.1				108.4		2.64					5.4	74.7	19.9	13.5	6.4					
	TI-B3	CA	16	16.5	Silty Sand (dam)		4.7				105.3															-2.8 (2,236)	
	TI-B3	ST	21	22	Sandy Clay (dam)	CL	16.0				111.1				30	12	18	0.0	32.8	67.2	41.7	25.5				-0.03 (2,709)	32.2, 195
	TI-B3	CA	26	26.5	Sandy Clay (dam)		12.0				106.8				25	13	12										
	TI-B3	CA	31	31.5	Sandy Clay (dam)		16.1				108.4																
	TI-B3	ST (top)	35	36	Clayey Sand (dam)		10.5	10.2																			
	TI-B3	ST (bottom)	35	36	Clayey Sand (dam)	SC	14.7				102.2		2.67		23	14	9	2.1	50.2	47.7	30.9	16.8			nc	-0.7 (4,608)	33.7, 135
	TI-B3	CA	41	41.5	Sandy Clay (dam)		21.5				90.6							0.0	33.8	66.2	41.7	24.5					
	TI-B3	CA	45.5	46	Sandy Clay (dam)		17.0	17.7			110.1	109.4															29.3, 293
	TI-B3	CA	46	46.5	Sandy Clay (dam)		18.0				104.8				28	13	15										
	TI-B3	ST	56	57	Lean Clay	CL	22.1	21.1			105.3	106.2	2.72		43	14	29	0.0	11.7	88.3	48.4	39.9				-1.5 (7,204)	22.2, 494
	TI-B3	CA	61	61.5	Silty Clay		25.8				99.0							0.0	22.0	78.0	54.9	23.1					

Notes: 1. Material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available.
2. SWCC tests conducted with pairs of specimens for each test.
3. Flexible wall permeameter tests conducted at confining pressures representing confining stresses for the proposed design fill. Confining stresses were estimated as the existing overburden stress on the specimens (depth times total unit weight of material above) plus the maximum anticipated fill height for the location times the estimated unit weight of fill.
4. Specimen remolded to the in-situ water content and density of the Shelby tube sample from 10-12.5 for the SWCC.
5. Remolded SWCC and permeability tests conducted on a 50-50 mixture of the materials from these two specimens, remolded to the average measured density of the two CA samples.
6. SWCC specimen remolded to the in-situ water content and density of the Shelby tube sample from 41-42 feet.
7. Compression indices estimated using the maximum anticipated loading during fill placement and the range of loading during testing. Initial void ratios are calculated using the average specific gravity for all samples of 2.70.
8. Shale sample had multiple horizontal fractures and was likely disturbed during sampling.

9. Sample Types: CC = continuous core, CC-AC = continuous core in acrylic liner, top/bottom indicates the specimen was taken from the top or bottom of the sample interval
10. Values in italics were calculated based on the relationship (WC60=0.951(WC110)-.0611) between the water content results measured for 15 tailings samples at the two oven temperatures.*
11. Shaded cells are alluvium.
12. Consolidated undrained (CU) triaxial shear, staged loading of one specimen with pore pressure measurements

ST = 3" diam. Shelby tube, CA = California sample
R = remolded, nc = Cc not calculated, because fill will not be placed in this location
X = testing not possible due to sample disturbance
LL = liquid limit, PL = plastic limit, PI = plasticity index

Table 3-5 Summary of Geotechnical Laboratory Data - Borrow Areas

Area	Sample	Sample Type [1]	Sample Depth Interval (ft)		Material Description [2]	USCS [2]	USDA Classification [3]	Water Content (by mass, %)	Dry Density (pcf)	Porosity	Specific Gravity	Standard Proctor (max. dd@opt. w.c.), (pcf @ %)	Atterberg Limits (%) [4]			USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	% Silt	USDA % Clay (<0.002 mm)	Pinhole Dispersion [5,6]	Remolded Saturated Hydraulic Conductivity [7] (cm/sec)			SWCC: -5 bar Water Content (by mass, %) [8]	SWCC: Saturated Water Content (by mass, %) [8]
													LL	PL	PI							80%	85%	90%		
West Borrow	WB-B1-01A	CA	3.0	3.5	Clayey Sand			3.8	88.8	46.7	2.67															
	WB-B1-03A	CA	11.0	11.5	Clayey Sand	SC	Sandy Loam	6.4	111.0	33.3	2.67		28	18	10	2.8	48.6	48.6	32.8	15.8						
	WB-B1-06	Bulk	5.0	10.0	Silty, Clayey Sand	SC-SM	Sandy Loam				2.64	112.5 @ 13.7	26	20	6	0.8	52.3	46.9	31.0	15.9	ND3	7.2E-04	5.8E-04	2.1E-04	6.6 / 6.2	31.7 / 32.4
	WB-B2-02A	CA	5.5	6.0	Clayey Sand	SC	Sandy Loam	5.6	87.1	47.8	2.67					8.6	53.5	37.9	23.8	14.1						
	WB-B2-05	Bulk	10.0	20.0	Clayey Sand	SC	Sandy Loam						26	17	9	9.9	46.3	43.8	27.7	16.1	ND3	8.5E-05	1.2E-04	6.4E-05	6.4 / 6.7	30.9 / 33.7
	WB-B5-001B	CA	3.0	3.5	Clayey Sand			3.7	92.5	44.3	2.66															
	WB-B5-002A	CA	6.0	6.5	Silty, Clayey Sand	SC-SM	Sandy Loam	5.1	86.9	47.7	2.66		24	17	7	0.0	56.3	43.7	27.8	15.9						
	WB-B5-005	Bulk	0.0	10.0	Silty, Clayey Sand	SC-SM	Sandy Loam					117.3 @ 12.7				0.0	61.6	38.4	22.8	15.6						
East Borrow	EB-B2-001A	CA	3.0	3.5	Weath. Sandstone			5.8	107.1	35.8	2.67															
	EB-B3-003B	CA	10.5	11.0	Sandy Lean Clay	CL	Sandy Loam	6.0	83.1	50.7	2.70		26	15	11	0.0	46.3	53.7	34.9	18.8						
	EB-B4-02A	CA	6.0	6.5	Sandy Lean Clay	CL	Sandy Loam	5.4	80.7	51.2	2.65					0.0	48.5	51.5	33.9	17.6						
	EB-B4-06	Bulk	10.0	20.0	Silty, Clayey Sand	SC-SM	Sandy Loam				2.67	117.1 @ 12.9	23	17	6	0.0	50.5	49.5	32.0	17.5	ND3	8.7E-04	9.0E-04	4.4E-04	4.6 / 4.2	30.8 / 29.8
	EB-B5-02B	CA	5.5	6.0	Clayey Sand	SC	Sandy Loam	6.7	93.8	44.4	2.71		27	15	12	8.8	45.7	45.5	28.8	16.7						
	EB-B6-01B	CA	3.0	3.5	Sandy Clay			7.6	91.2	46.1	2.71															
	EB-B6-03	Bulk	0.0	10.0	Lean Clay with Sand	CL	Clay Loam					114.8 @ 14.1				0.0	26.6	73.4	44.3	29.1	ND3	2.3E-04	3.6E-05	2.9E-05	9.4 / 9.3	32.8 / 32.2
	EB-B6-04A	CA	11.0	11.5	Sandy Lean Clay	CL	Sandy Clay Loam	8.6	95.2	43.3	2.69		31	13	18	0.0	31.1	68.9	43.8	25.1						
South Borrow	SB-B1-01A	CA	3.5	4.0	Sandy Lean Clay	CL	Sandy Loam	7.1	91.4	49.3	2.89					0.0	43.1	56.9	39.2	17.7						
	SB-B1-03A	CA	11.0	11.5	Sandy Lean Clay	CL	Sandy Clay Loam	6.6	82.6	50.7	2.69		31	15	16	0.0	46.7	53.3	32.9	20.4						
	SB-B1-04	Bulk	0.0	25.0	Sandy Lean Clay	CL	Sandy Clay Loam				2.70	115.5 @ 14.2	33	14	19	0.0	42.6	57.4	30.7	26.7	ND1	2.3E-04	5.7E-05	1.4E-04	6.4 / 5.9	31.9 / 30.3
	SB-B2-02B	CA	5.5	6.0	Sandy Lean Clay	CL	Loam	7.7	80.1	52.6	2.70		36	15	21	0.0	29.8	70.2	45.4	24.8						
	SB-B3-02A	CA	6.0	6.5	Lean Clay with Sand	CL	Clay Loam	10.2	84.3	49.7	2.69		40	17	23	0.0	21.6	78.4	46.2	32.2						
	SB-B4-01	Bulk	0.0	15.0	Sandy Lean Clay	CL	Sandy Clay Loam	7.1			2.67	114.1 @ 14.4	33	15	18	0.8	39.6	59.6	35.7	23.9	ND3	3.4E-04	2.0E-04	7.4E-05	9.1 / 8.6	29.6 / 33.5
North Borrow	NB-B1-03B	CA	10.5	11.0	Silty Sand	SM	Sandy Loam	5.4	84.4	49.5	2.68		25	22	3	0.0	55.6	44.4	30.3	14.1						
	NB-B2-01B	CA	3.0	3.5	Silty Sand	SM	Sandy Loam	4.9	81.9	50.3	2.64		27	23	4	0.0	51.2	48.8	33.9	15.0						
	NB-B2-04	Bulk	0.0	10.0	Sandy, Silty Clay	CL-ML	Sandy Loam					113.9 @ 14.5	26	19	7	0.0	49.0	51.0	32.5	18.5	ND3	4.0E-04	2.7E-04	7.5E-05	4.9 / 4.7	29.5 / 29.9
Dilco Hill	DH-B1-01B	CA	3.0	3.5	Silty Sand			3.5	88.8	46.6	2.66															
	DH-B1-03	Bulk	0.0	10.0	Sandy, Silty Clay	CL-ML	Sandy Loam	5.4			2.67	117.5 @ 13.8	25	19	6	2.0	47.4	50.6	35.0	15.6	ND4	6.3E-04	7.1E-04	2.5E-04	4.2 / 4.1	39.6 / 35.0
	DH-B1-10	Bulk	35.0	45.0	Lean Clay with Sand	CL	Loam	10.3			2.38					1.5	20.9	77.6	60.9	16.7	ND3	1.6E-04	2.5E-05	3.2E-06	5.8 / 6.0	25.7 / 24.5
	DH-B2-03	CA	15.0	15.5	Silty Clay with Sand	CL-ML	Sandy Loam	10.5	96.7	39.2	2.55		29	24	5	0.0	27.7	72.3	66.9	5.4						
	DH-B3-05	Bulk	20.0	30.0	Sandy Lean Clay	CL	Loam	7.3			2.66	116.3 @ 13.0	29	18	11	2.5	34.6	62.9	45.5	17.4						

Notes: 1. Sample Types: CA = California sample, Bulk = bucket/grab sample

2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available. USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay

3. USDA = United States Department of Agriculture, USDA classifications are based on the sand/silt/clay fraction of the sample and on USDA grain-size designations.

4. LL = liquid limit, PL = plastic limit, PI = plasticity index

5. With the exception of DH-B1-03, which was tested at a density based on the natural in-situ density measured from the CA samples, specimens were remolded to approximately 85% of standard Proctor density and between the estimated natural and optimum water contents for the soil.

6. ND1 = nondispersive clay with very slight to no colloidal erosion under 15-inch or 40-inch head; ND4, ND3 = slightly to moderately dispersive clays that erode slowly under 2-inch or 7-inch head (ASTM test method A)

7. Specimens remolded to approximately 80%, 85%, and 90% of maximum standard Proctor dry density and between the estimated natural and optimum water contents for the soil.

8. Specimens remolded to approximately 85% of maximum standard Proctor dry density and between the estimated natural and optimum water contents for the soil. SWCC tests performed with pairs of speciments for each test.

Table 3-6 Summary of Geotechnical Laboratory Data - Site Stockpiles

Area	Sample	Sample Type [(1)]	Material Description	USCS [(2)]	Specific Gravity	Atterberg Limits (%) [(4)] LL	PL	PI	USCS % Gravel	USCS % Sand	% Passing No. 200 Sieve (fines)	L.A. Abrasion (% loss) [(5)]	Sodium Sulfate Soundness (% loss) [(6)]	Absorption (%) [(7)]	Unconfined Compressive Strength (psi) [(8)]	Splitting Tensile Strength (psi) [(8)]
Stockpiles	Topsoil-01	Bulk	Sandy Clay	CL	2.68	33	10	23	2.6	32.4	65.0					
	Topsoil-02	Bulk	Sandy Clay	CL	2.71	39	12	27	0.5	26.8	72.7					
	TI-SP1-01	Bulk	Crusher Fines						1.9	80.8	17.3					
	TI-SP2-01A	Bulk	Erosion Protection Gravel		2.78 [(3)]				93.0	6.3	0.7	5.7	8.26	1.868		
	TI-SP2-01C	Bulk	Erosion Protection Gravel						83.3	4.9	11.8					
	TI-SP3-01A	Bulk	Road Base (gravel with sand)						67.4	24.6	8.0					
	TI-SP4-01A	Bulk	Erosion Protection Gravel		2.75 [(3)]				98.0	1.2	0.8	6.1	10.47	2.091		
	TI-SP6 (56A)	Bulk	9-inch riprap												20,780 and 23,630	1,320 and 1,400
	TI-SP6 (56B)	Bulk	9-inch riprap												19,100 and 14,440	1,530 and 1,720

Notes: 1. Bulk = bucket/grab sample
2. USCS = Unified Soil Classification Sysytem, material descriptions are based on field observations, and refined with laboratory data, if available.
USCS classifications are provided only where sufficient laboratory data are available. CL = low plasticity clay
3. Average of three bulk saturated surface dry (SSD) specific gravity results for the rock samples (ASTM C127)
4. LL = liquid limit, PL = plastic limit, PI = plasticity index
5. L.A. Abrasion results are percent loss, by mass, for 100 revolutions.
6. Weighted percentage loss for 0.75 to 1.5-inch size range
7. Average of three absorption results
8. Specimens were collected from the 9-inch stockpile and cored for strength testing.

Table 3-7 Summary of Branch Swale Conditions

Swale Section[1]	Observation Date	Sedimentation[2]	Approx. Depth of Sediment Accumulation Above Rock	Vegetation Accumulation[3]	Other Observations
Branch Swale A					
A-1	11/27/2013	Moderate	Up to 3"	Moderate to Heavy	
A-2	11/27/2013	Heavy	Up to 12"	Moderate to Heavy	Sediment accumulation appears to be from erosion of the south slope of the swale.
A-3	11/27/2013	Light	< 1/2"	Light to Moderate	
A-4	11/27/2013	Moderate	Up to 2"	Moderate	Low area, with standing water present.
A-5	12/7/2013	Moderate	Up to 3"	Moderate to Heavy	
Branch Swale B					
B-1	11/27/2013	Moderate	Up to 2"	Moderate	Sediment accumulation appears to be from erosion of east slope of the swale.
B-2	11/27/2013	Light	< 1/2"	Moderate	
Branch Swale C					
C-1	12/7/2013	Heavy	Up to 8"	Moderate	Sediment accumulation appears to be from erosion of the east slope of the swale.
C-2	12/7/2013	Light	< 1/2"	Moderate	
C-3	12/7/2013	Moderate	Up to 1"	Moderate	
C-4	12/7/2013	Heavy	Up to 12"	Moderate	Sediment accumulation appears to be from erosion of the south slope of the swale.
C-5	12/7/2013	Light	< 1/2"	Light to Moderate	
C-6	12/7/2013	Moderate	Up to 2"	Light to Moderate	
Branch Swale D					
D-1	12/7/2013	Heavy	Up to 8"	Moderate	Sediment accumulation appears to be from erosion of the east slope of the swale.
D-2	12/7/2013	Moderate	Up to 2"	Moderate	
D-3	12/7/2013	Light	< 1/2"	Moderate to Heavy	
D-4	12/7/2013	Moderate	Up to 1"	Light	Low area, with standing water present.
D-5	12/7/2013	Moderate	Up to 2"	Light	
D-6	12/7/2013	Moderate	Up to 2"	Heavy	
Branch Swale E					
E-1	12/7/2013	Heavy	Up to 6"	Moderate to Heavy	Partial erosion of side rock to bottom in places.
E-2	12/7/2013	Light	< 1/2"	Moderate to Heavy	Partial erosion of side rock to bottom in places.
Branch Swale F					
F-1	12/14/2013	Minimal	None	Moderate	
F-2	12/14/2013	Minimal	None	Light	Partial erosion of side rock to bottom in places.
Branch Swale G					
G-1	12/14/2013	Minimal	None	Moderate	Partial erosion of side rock to bottom in places.
G-2	12/14/2013	Minimal	None	Light	
Branch Swale H					
H-1	12/7/2013	Light to Moderate	Up to 2"	Moderate	
H-2	12/7/2013	Light	< 1/2"	Moderate	

Notes: 1. Swale sections are shown on Figure 3-8.

2. Sedimentation:

Minimal = Erosion protection rock is entirely visible, with little to no accumulation of sediment

Light = Erosion protection rock is mostly visible, with less than 1/2 inch sediment accumulation above the rock in places

Moderate = Erosion protection rock is not visible, or only partially visible, with accumulation of sediment up to approximately 3 inches above the rock

Heavy = Erosion protection rock is not visible, with accumulation of sediment up to approximately 6 inches or greater

3. Vegetation:

Minimal = None, or only occasional vegetation present

Light = Some light vegetation present (grasses/small shrubs), covering up to approximately 1/3 of the surface

Moderate = Up to approximately 2/3 of the surface covered with vegetation and/or tumbleweeds

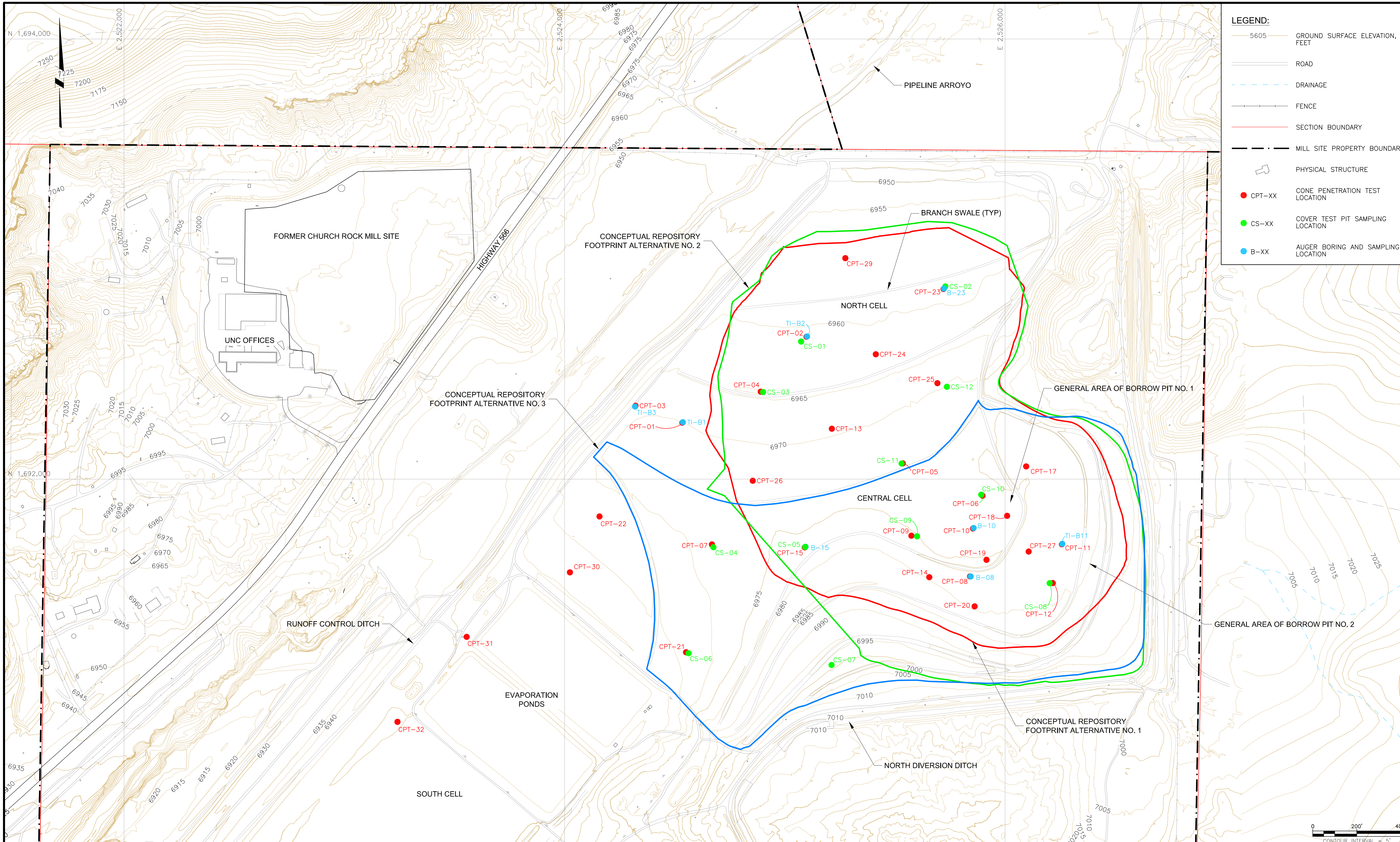
Heavy = Nearly entire surface covered with heavy vegetation and/or tumbleweeds

Table 3-8 Summary of North Upstream Diversion Channel Conditions

Channel Section[1]	Observation Date	Sedimentation[2]	Approx. Depth of Sediment Accumulation	Vegetation Accumulation[3]	Condition of Roadway Berm	Other Observations
NDC-1	12/14/2013	Light	Up to 6"	Moderate	Steep, comprised of sandstone and fill, some minor erosional rills present in fill material, lightly vegetated.	No erosion protection rock is present on bottom or sides.
NDC-2	12/14/2013	Minimal	None	Light to Moderate	Less steep, covered with erosion protection rock, little or no vegetation.	Erosion protection rock is present on bottom and sides.
NDC-3	12/14/2013	Minimal	None	Moderate	Steep, comprised of sandstone and fill, heavily vegetated.	No erosion protection rock is present on bottom, some small rock on sides.
NDC-4	12/14/2013	Minimal to Light	Up to 2"	Light to Moderate	Less steep than previous section, erosion protection rock extends about 2/3 up the slope, lightly vegetated.	Erosion protection rock is present on bottom and east slope, and 2/3 up west slope.
NDC-5	12/14/2013	Light to Moderate	Up to 12"	Moderate to Heavy	Steep, comprised of sandstone and fill, some minor erosional rills present in fill material.	No erosion protection rock is present on bottom or sides.
NDC-6	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Less steep than previous section, comprised of sandstone and fill, some minor erosion rills present in fill material with sediment accumulation at the toe, heavily vegetated.	No erosion protection rock present. Sediment accumulation appears to be from East Borrow Area. Channel is less well-defined in this area.
NDC-7	12/14/2013	Light	Up to 6"	Moderate to Heavy	Comprised of fill, some minor erosion rills present, heavily vegetated.	No erosion protection rock is present on bottom or sides, east slope of channel becomes increasingly shallow (moving south to north).
NDC-8	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Comprised of fill, some erosion rills present, with some sediment accumulation at the toe, heavily vegetated.	No erosion protection rock is present on bottom or sides. Sediment accumulation appears to be from area east of channel. East embankment becomes increasingly shallow toward the north.
NDC-9	12/14/2013	Moderate to Heavy	Up to 18"	Heavy	Comprised of fill, some minor erosion rills present, lightly vegetated.	No erosion protection rock is present on bottom or sides. An incised erosional cut is present at the bottom of the channel, in what appears to be shale.

Notes:

1. Channel sections are shown on Figure 3-8.
2. Sedimentation:
   - Minimal = Little to no accumulation of sediment on channel bottom
   - Light = Accumulation of sediment up to approximately 6 inches in portions of channel bottom
   - Moderate = Accumulation of sediment up to approximately 12 inches in portions of channel bottom
   - Heavy = Accumulation of sediment up to approximately 18 inches or greater in portions of channel bottom
3. Vegetation:
   - Minimal = None, or only occasional vegetation present
   - Light = Some light vegetation present (grasses/small shrubs), covering up to approximately 1/3 of the surface
   - Moderate = Up to approximately 2/3 of the surface covered with vegetation and/or tumbleweeds
   - Heavy = Nearly entire surface covered with heavy vegetation and/or tumbleweeds



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ISSUE	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	D MIRANDA	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

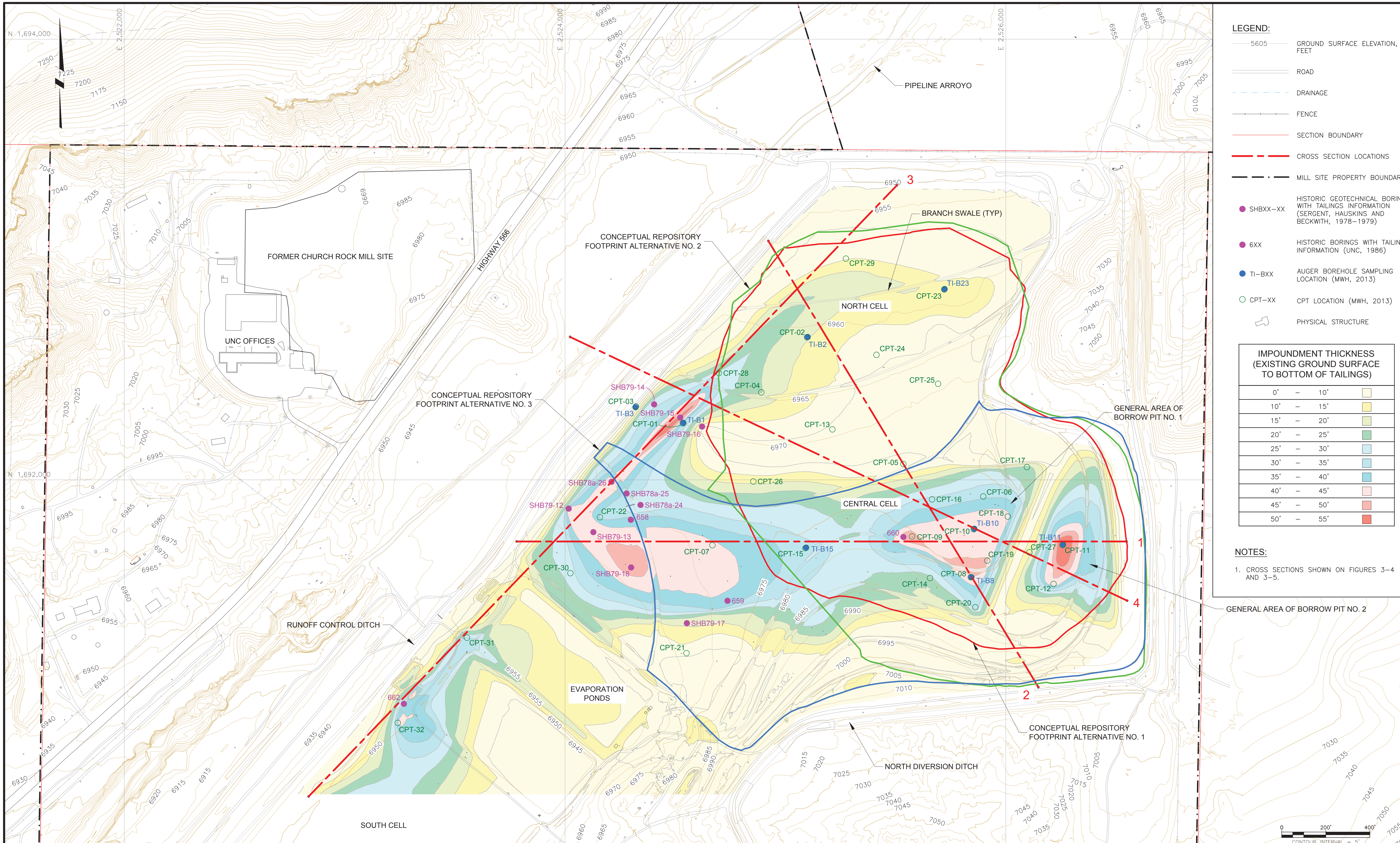
PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: PDS TAILINGS IMPOUNDMENT SAMPLING LOCATIONS

FIGURE 3-1 REVISION 0

FILE NAME 10504918 PDS4



0	FINAL	CF	ED	10–14
ISSUE REV	DESCRIPTION	TECH	ENG	DATE

DRAWING REFERENCE(S):

- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.
- THE GROUND SURFACE ELEVATIONS SHOWN ON THE BORING LOGS IN THE SERGENT, HAUSKINS AND BECKWITH (SHB) (1978 AND 1979) REPORTS WERE ADJUSTED BY MINUS 5 FEET VERTICAL, BASED ON A COMPARISON BETWEEN THE 2013 TOPOGRAPHY AND THE TOPOGRAPHY SHOWN IN THE OCTOBER 1978 REPORT PREPARED BY SHB.
- BORROW PIT CONFIGURATIONS BASED ON TOPOGRAPHY INCLUDED WITH UNC (1993) AND OPERATIONAL AERIAL PHOTOGRAPHS.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: TAILINGS IMPOUNDMENT THICKNESS (COVER AND TAILINGS) ISOPACH MAP

MWH

FIGURE 3-2 REVISION 0
FILE NAME 10504918 PDS5

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LEGEND:

⊗ TAILINGS NOT ENCOUNTERED

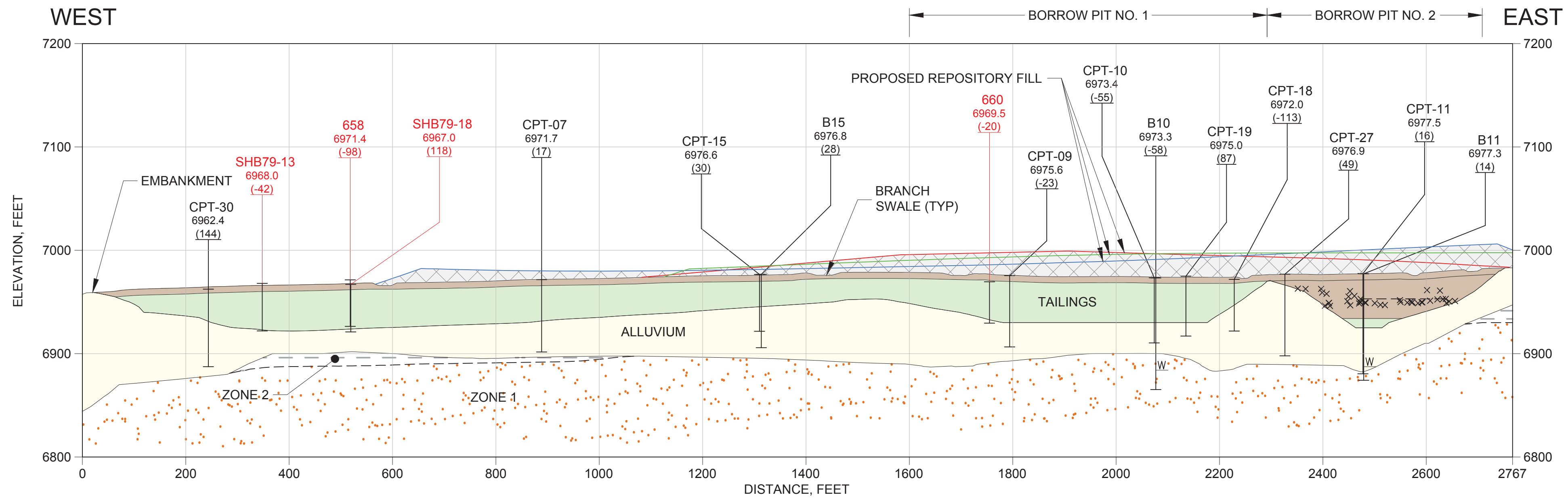
○ FINE-GRAINED TAILINGS 5 FT THICK OR LESS

● FINE-GRAINED TAILINGS GREATER THAN 5 FT THICK

NOTE: 2013 CPT LOCATIONS SHOWN ON AERIAL PHOTO DATED NOVEMBER 4, 1980, TAKEN FROM CHESTER ENGINEERS (2012).

PROJECT LOCATION	CHURCH ROCK MILL SITE
PROJECT	PRE-DESIGN STUDIES REPORT
TITLE	DISTRIBUTION AND THICKNESS OF FINE-GRAINED TAILINGS
FIGURE	3-3
REVISION	0
FILE NAME	10504918 PDS6

MWH



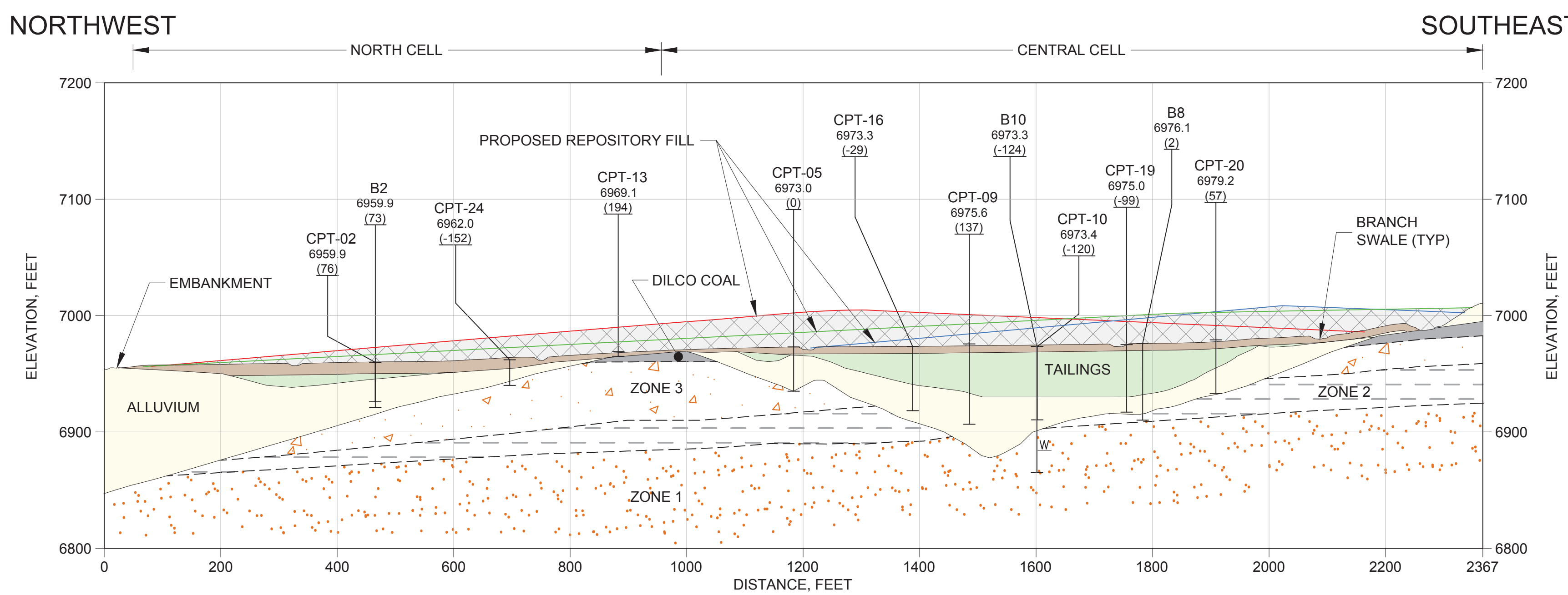
CROSS SECTION 1

VERTICAL SCALE 0 75' 150' — HORIZONTAL SCALE 0 150' 300'

VERTICAL EXAGGERATION = 2X

LEGEND:

- PROPOSED REPOSITORY FILL
- EXISTING COVER/FILL
- TAILINGS (UNDIFFERENTIATED FINE AND COARSE)
- ALLUVIUM
- DILCO COAL
- ZONE 3 SANDSTONE
- ZONE 2 SHALE AND COAL
- ZONE 1 SANDSTONE
- REPOSITORY ALT 1 NORTH AND CENTRAL CELL
- REPOSITORY ALT 2 NORTH AND CENTRAL CELL
- REPOSITORY ALT 3 CENTRAL CELL
- × BURIED MILL DEMOLITION DEBRIS
- DEBRIS AREAS (CONCRETE, STEEL, EXCAVATED MILL MATERIAL)
- CONTACT, SOLID WHERE APPROXIMATE, DASHED WHERE UNCERTAIN
- W WATER ENCOUNTERED DURING DRILLING (MWH, 2013)
- SHB79-14 / 6968 / (467): BORHOLE DESIGNATION; ELEVATION; OFFSET; EXISTING GROUND SURFACE; BORING EXTENT
  - PDS 2013 BORING AND/OR CPT LOCATIONS (SHOWN IN BLACK)
  - HISTORIC BORINGS (SHOWN IN RED)
  - DIMENSIONS AND ELEVATIONS IN FEET



CROSS SECTION 2

VERTICAL SCALE 0 75' 150' — HORIZONTAL SCALE 0 150' 300'

VERTICAL EXAGGERATION = 2X

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 3–1.
2. CROSS SECTIONS WERE GENERATED FROM TOP–OF–UNIT SURFACES DEVELOPED FROM MWH BOREHOLE AND CPT INFORMATION AND SELECT HISTORIC BOREHOLES THAT PROVIDE INFORMATION ABOUT TAILINGS, THE EMBANKMENT, AND/OR ALLUVIUM. ADDITIONAL INFORMATION ON ZONE 1, ZONE 2, ZONE 3 AND DILCO COAL IS FROM TOP–OF–UNIT SURFACES DEVELOPED BY CHESTER ENGINEERS. LOCATIONS OF BOREHOLES PROJECTED ONTO CROSS–SECTIONS ARE FOR LOCATION REFERENCE ONLY.
3. LOCATIONS OF DEBRIS IN BORROW PIT 2 WERE SURVEYED DURING MILL DECOMMISSIONING.
4. HISTORIC BOREHOLE AND DEBRIS ELEVATIONS ARE BASED ON THE BEST AVAILABLE INFORMATION. DUE TO SURVEY ERROR AND DATUM CORRECTIONS, THE ELEVATIONS OF THE BOREHOLES, DEBRIS AND CONTACTS SHOWN ARE APPROXIMATE.
5. EXISTING COVER/FILL THICKNESS IS SHOWN AS AN ESTIMATED AVERAGE THICKNESS OF 10 FEET FOR THE NORTH CELL AND 6 FEET FOR THE CENTRAL CELL.
6. WATER ENCOUNTERED DURING DRILLING AND SHOWN HERE IS WITHIN ALLUVIUM.
7. TABLE 3–5 AND FIGURE 3–3 PROVIDE MORE DETAILED INFORMATION ON LOCATION OF FINE AND COARSE TAILINGS.

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ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
• EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

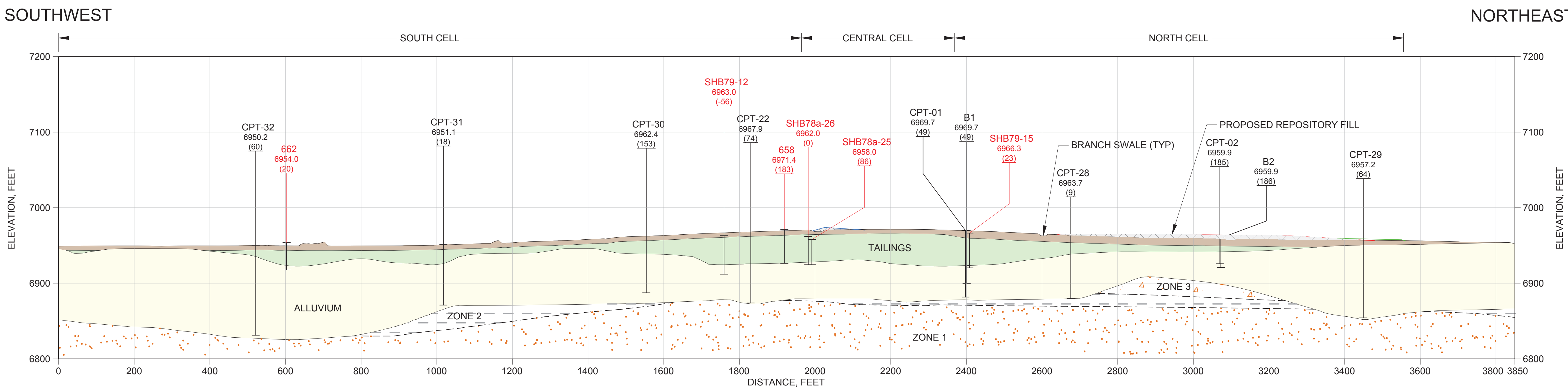
PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: IMPOUNDMENT CROSS SECTIONS 1 AND 2

MWH

FIGURE: 3-4 REVISION: 0

FILE NAME: 10504918 PDS7



CROSS SECTION 3

VERTICAL SCALE 0 75' 150' HORIZONTAL SCALE 0 150' 300'

VERTICAL EXAGGERATION = 2X

LEGEND:

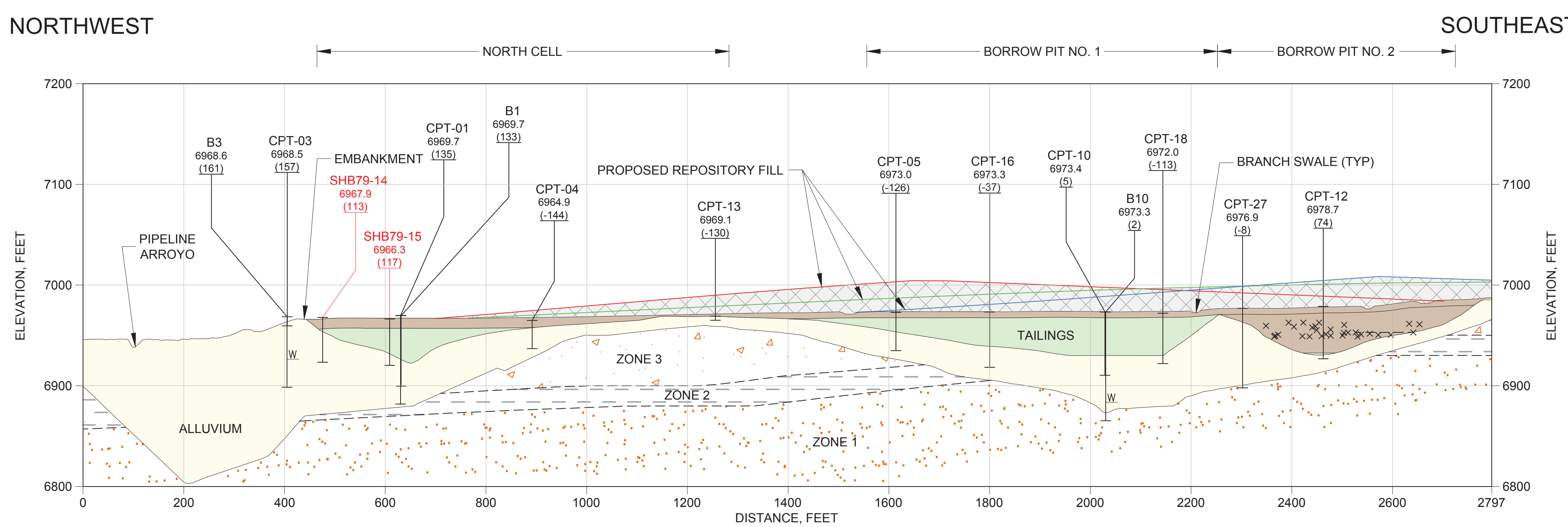
- PROPOSED REPOSITORY FILL
- EXISTING COVER/FILL
- TAILINGS (UNDIFFERENTIATED FINE AND COARSE)
- ALLUVIUM
- DILCO COAL
- ZONE 3 SANDSTONE
- ZONE 2 SHALE AND COAL
- ZONE 1 SANDSTONE
- REPOSITORY ALT 1 NORTH AND CENTRAL CELL
- REPOSITORY ALT 2 NORTH AND CENTRAL CELL
- REPOSITORY ALT 3 CENTRAL CELL
- × BURIED MILL DEMOLITION DEBRIS
- ×– –× DEBRIS AREAS (CONCRETE, STEEL, EXCAVATED MILL MATERIAL)
- CONTACT, SOLID WHERE APPROXIMATE, DASHED WHERE UNCERTAIN
- W WATER ENCOUNTERED DURING DRILLING (MWH, 2013)

SHB79-14 — BORHOLE DESIGNATION
6968 — ELEVATION
(467) — OFFSET
EXISTING GROUND SURFACE
BORING EXTENT

PDS 2013 BORING AND/OR CPT LOCATIONS (SHOWN IN BLACK)

HISTORIC BORINGS (SHOWN IN RED)

DIMENSIONS AND ELEVATIONS IN FEET



CROSS SECTION 4

VERTICAL SCALE 0 75' 150' HORIZONTAL SCALE 0 150' 300'

VERTICAL EXAGGERATION = 2X

NOTES:

1. CROSS SECTION LOCATIONS SHOWN ON FIGURE 3–1.
2. CROSS SECTIONS WERE GENERATED FROM TOP–OF–UNIT SURFACES DEVELOPED FROM MWH BOREHOLE AND CPT INFORMATION AND SELECT HISTORIC BOREHOLES THAT PROVIDE INFORMATION ABOUT TAILINGS, THE EMBANKMENT, AND/OR ALLUVIUM. ADDITIONAL INFORMATION ON ZONE 1, ZONE 2, ZONE 3 AND DILCO COAL IS FROM TOP–OF–UNIT SURFACES DEVELOPED BY CHESTER ENGINEERS. LOCATIONS OF BOREHOLES PROJECTED ONTO CROSS–SECTIONS ARE FOR LOCATION REFERENCE ONLY.
3. LOCATIONS OF DEBRIS IN BORROW PIT 2 WERE SURVEYED DURING MILL DECOMMISSIONING.
4. HISTORIC BOREHOLE AND DEBRIS ELEVATIONS ARE BASED ON THE BEST AVAILABLE INFORMATION. DUE TO SURVEY ERROR AND DATUM CORRECTIONS, THE ELEVATIONS OF THE BOREHOLES, DEBRIS AND CONTACTS SHOWN ARE APPROXIMATE.
5. EXISTING COVER/FILL THICKNESS IS SHOWN AS AN ESTIMATED AVERAGE THICKNESS OF 10 FEET FOR THE NORTH CELL AND 6 FEET FOR THE CENTRAL CELL.
6. WATER ENCOUNTERED DURING DRILLING AND SHOWN HERE IS WITHIN ALLUVIUM.
7. TABLE 3–5 AND FIGURE 3–3 PROVIDE MORE DETAILED INFORMATION ON LOCATION OF FINE AND COARSE TAILINGS.

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ISSUE / REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10–14

DRAWING REFERENCE(S):
• EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LESSON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

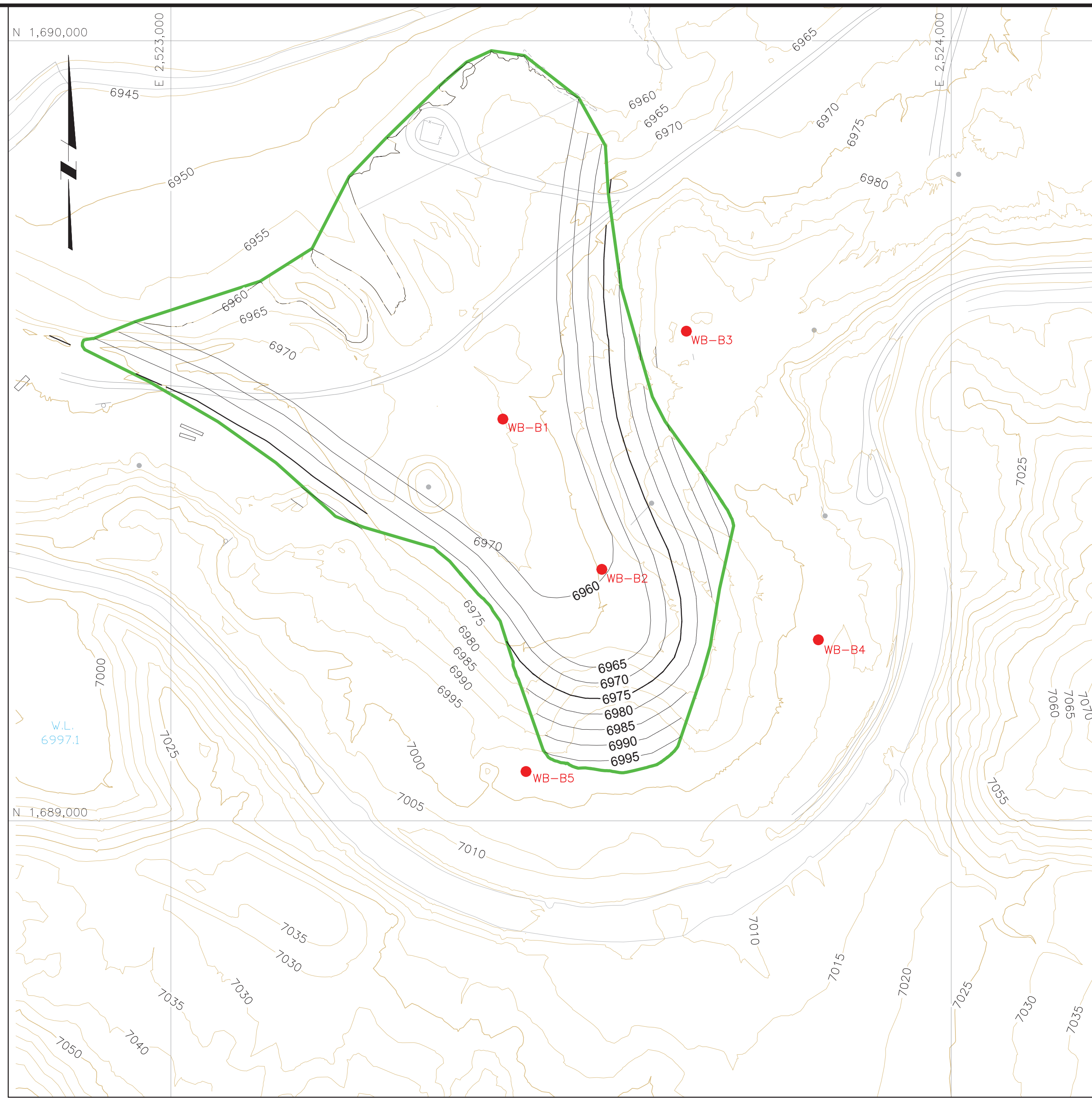
PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: IMPOUNDMENT CROSS SECTION 3 AND 4

MWH

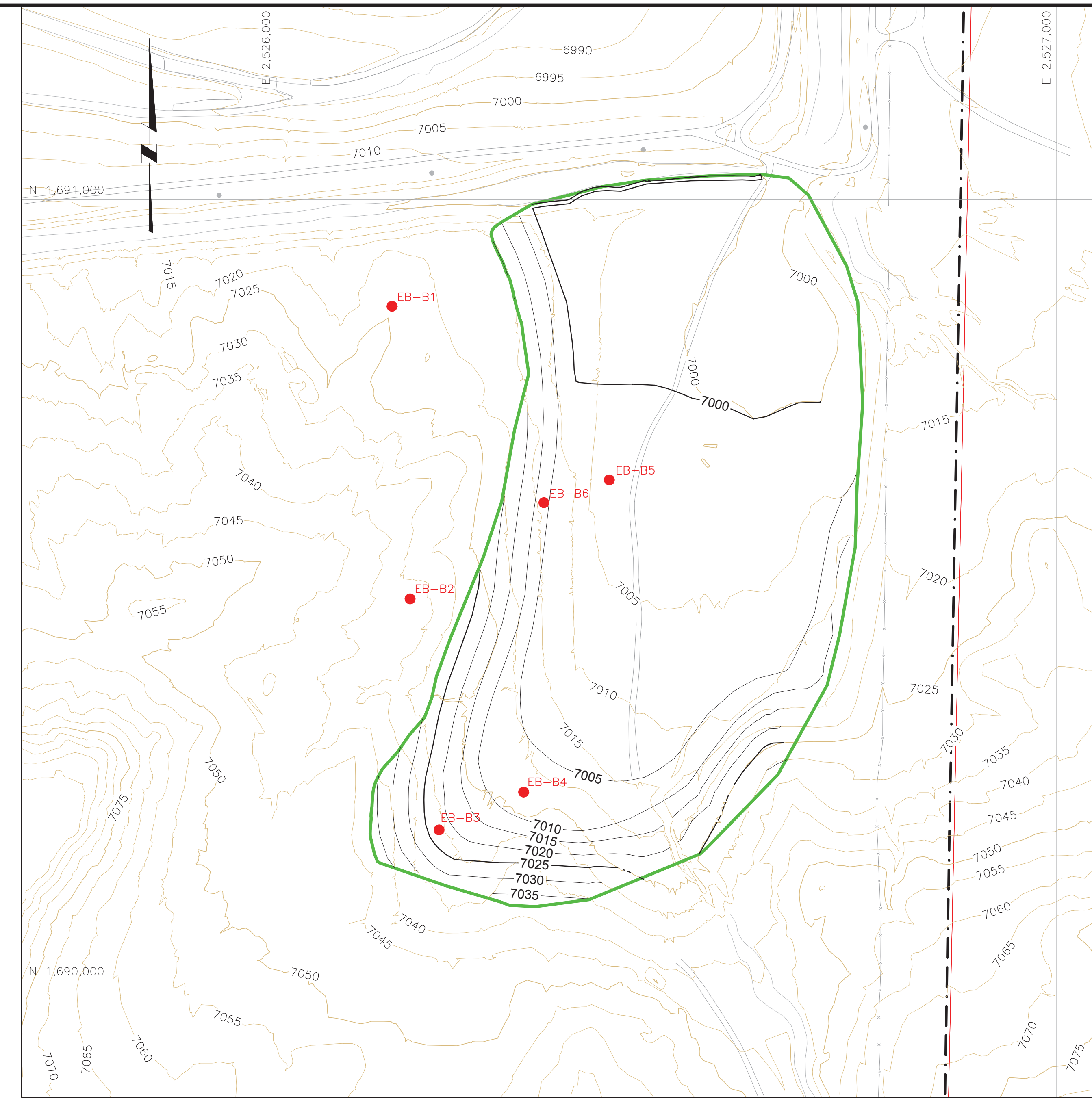
FIGURE: 3-5 REVISION: 0

FILE NAME: 10504918 PDS7



WEST BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'



EAST BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- PRELIMINARY GRADING CONTOUR
- ROAD
- DRAINAGE
- APPROXIMATE LIMIT OF BORROW EXCAVATION
- SECTION BOUNDARY
- MILL SITE PROPERTY BOUNDARY
- WB-B5 — BORROW AREA DRILLING LOCATION

NOTE:

1. CULTURAL RESOURCE SITES (IF IDENTIFIED) HAVE BEEN ACCOUNTED FOR IN THE PRELIMINARY GRADING PLANS WITH A 100 FT BUFFER ZONE.
2. PROPOSED BORROW AREA BOUNDARIES REPRESENT EXTENTS OF GRADING TO EXTRACT USABLE MATERIAL AND MAINTAIN POSITIVE FINAL DRAINAGE. BOUNDARIES HAVE BEEN MODIFIED FROM WORK PLAN BASED ON GRADING TIE-INS.

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	D MIRANDA	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: DRILLING LOCATIONS AND PRELIMINARY GRADING EAST AND WEST BORROW AREAS

FIGURE 3-6
REVISION 0
FILE NAME 10504918 PDS9

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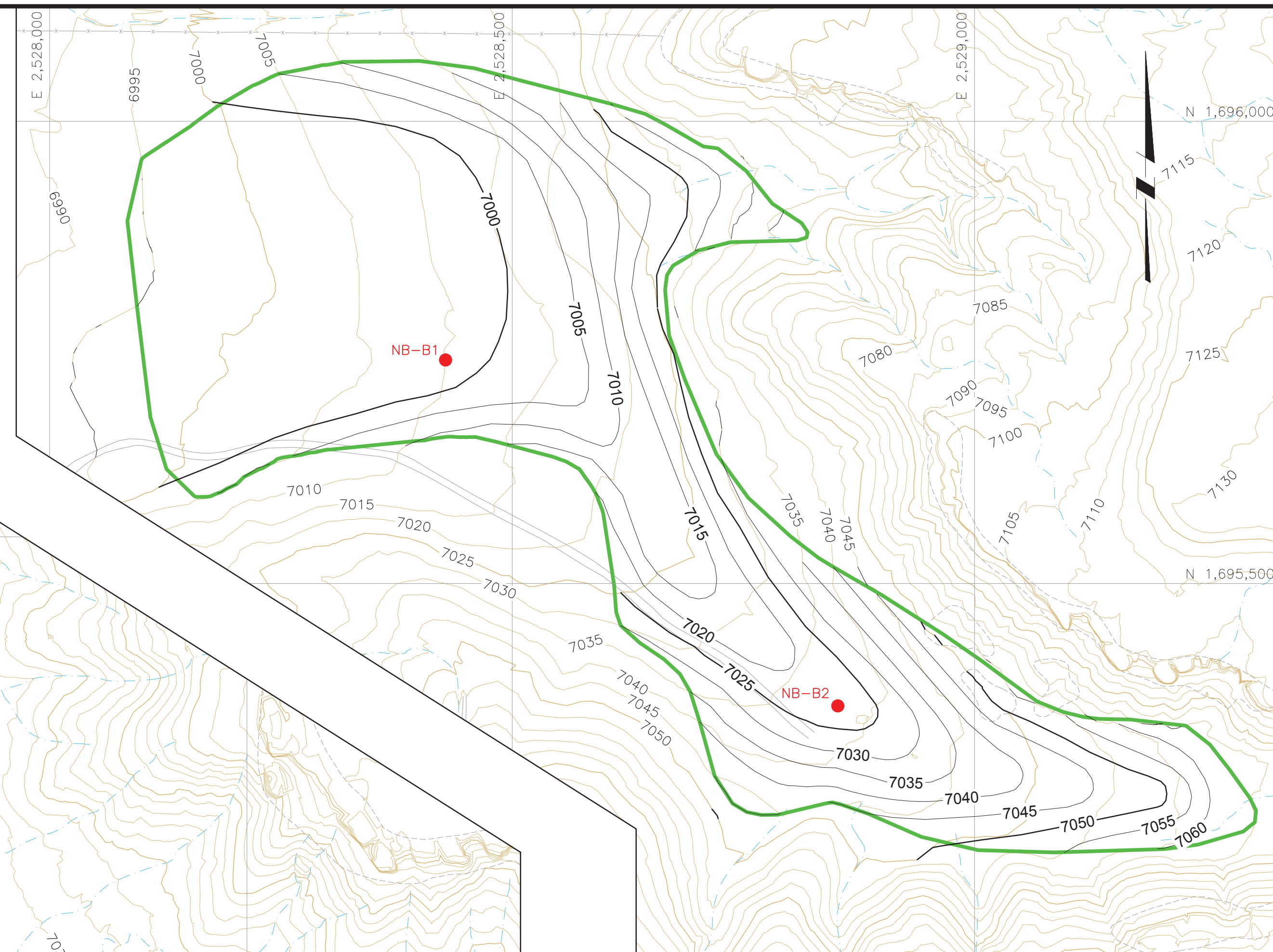
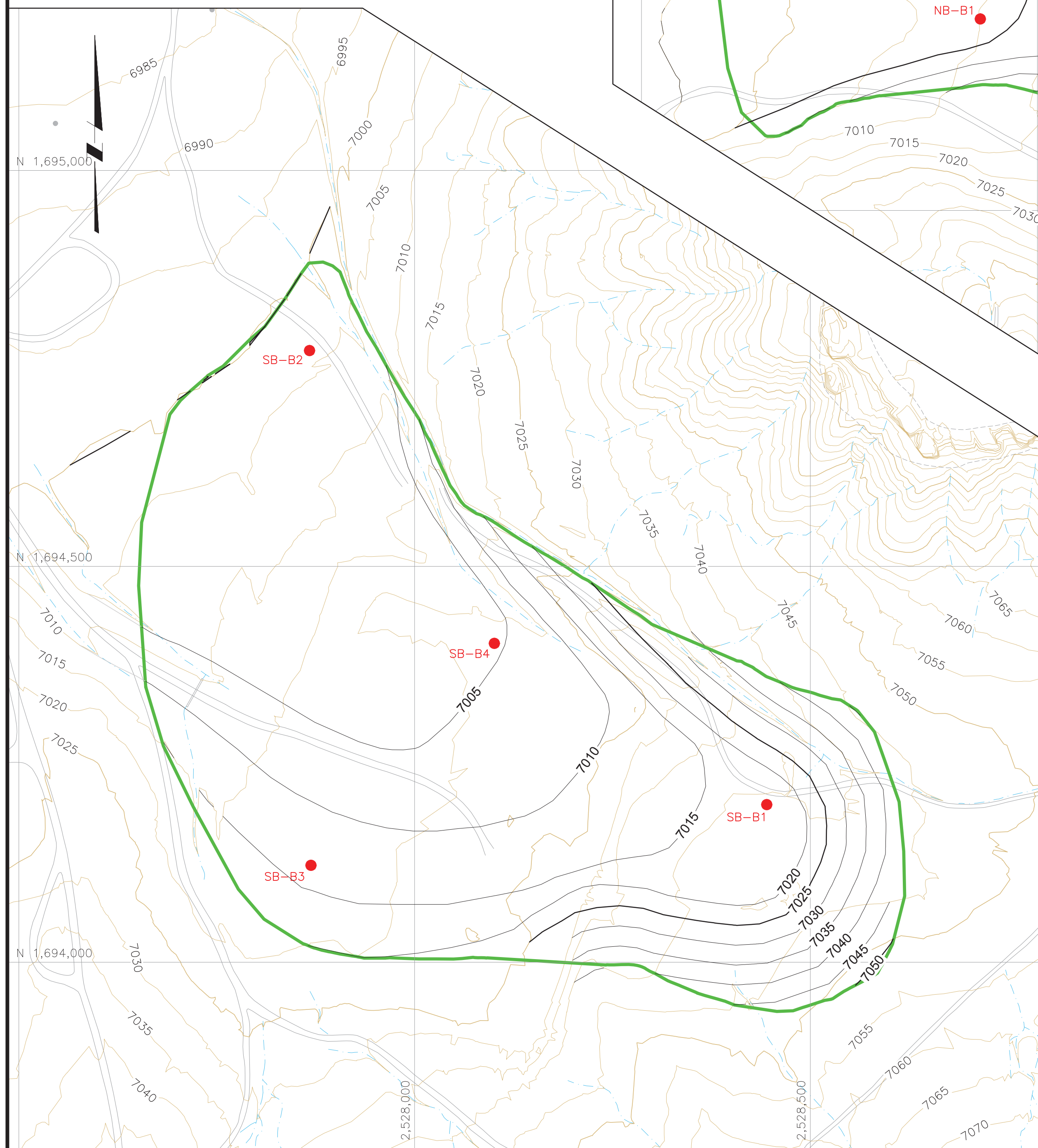


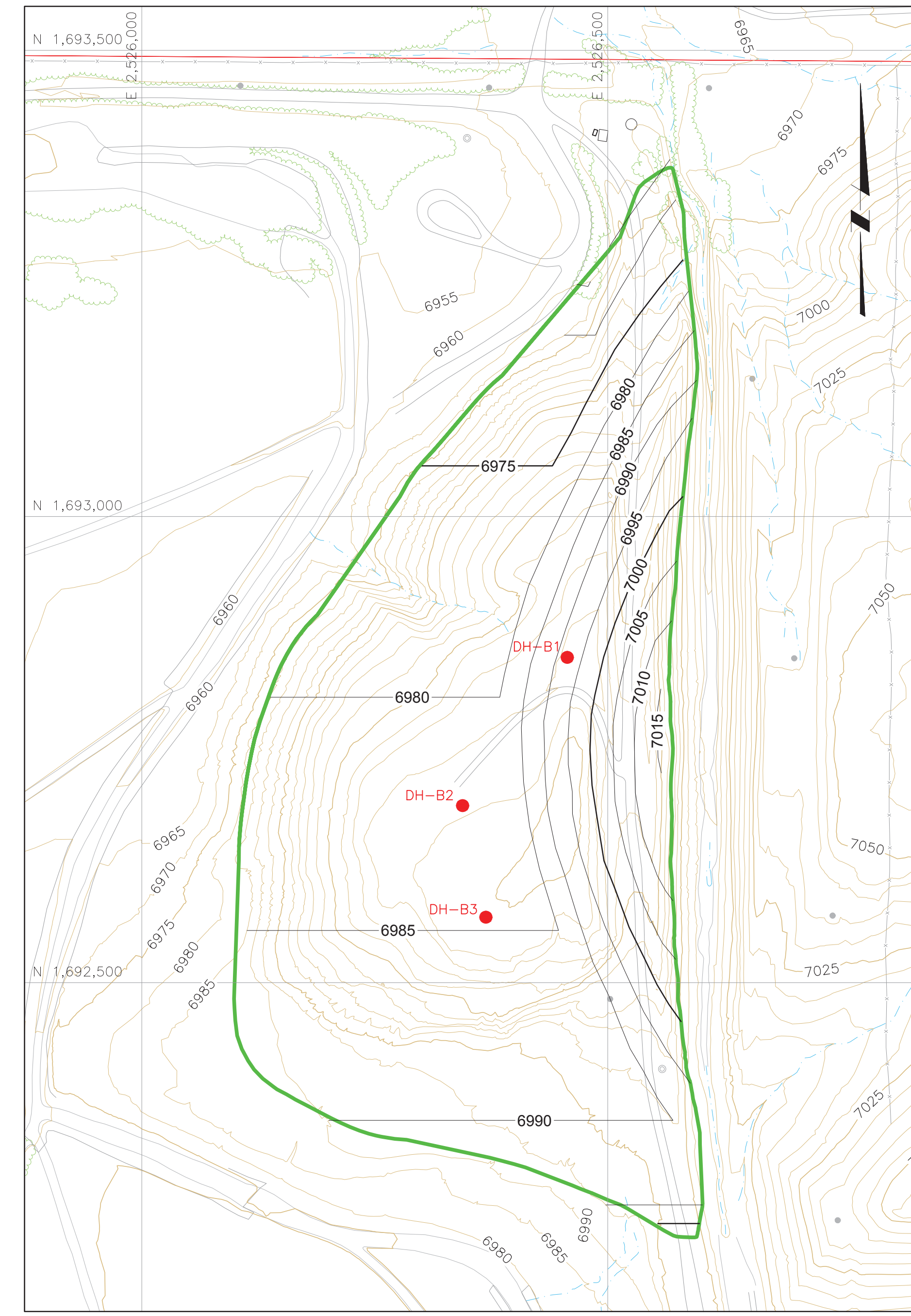
NORTH DRAINAGE BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'



SOUTH DRAINAGE BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'



DILCO HILL BORROW AREA

0 100' 200'
CONTOUR INTERVAL = 5'

LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- PRELIMINARY GRADING CONTOUR
- ROAD
- DRAINAGE
- APPROXIMATE LIMIT OF BORROW EXCAVATION
- SECTION BOUNDARY
- WB-B5 — BORROW AREA DRILLING LOCATION

NOTE:

1. CULTURAL RESOURCE SITES (IF IDENTIFIED) HAVE BEEN ACCOUNTED FOR IN THE PRELIMINARY GRADING PLANS WITH A 100 FT BUFFER ZONE.
2. PROPOSED BORROW AREA BOUNDARIES REPRESENT EXTENTS OF GRADING TO EXTRACT USABLE MATERIAL AND MAINTAIN POSITIVE FINAL DRAINAGE. BOUNDARIES HAVE BEEN MODIFIED FROM WORK PLAN BASED ON GRADING TIE-INS.

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07–14
DRAWN BY	D MIRANDA	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

unc

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: DRILLING LOCATIONS AND PRELIMINARY GRADING NORTH, SOUTH, AND DILCO HILL BORROW AREAS

MWH

FIGURE: 3-7
REVISION: 0
FILE NAME: 10504918 PDS10

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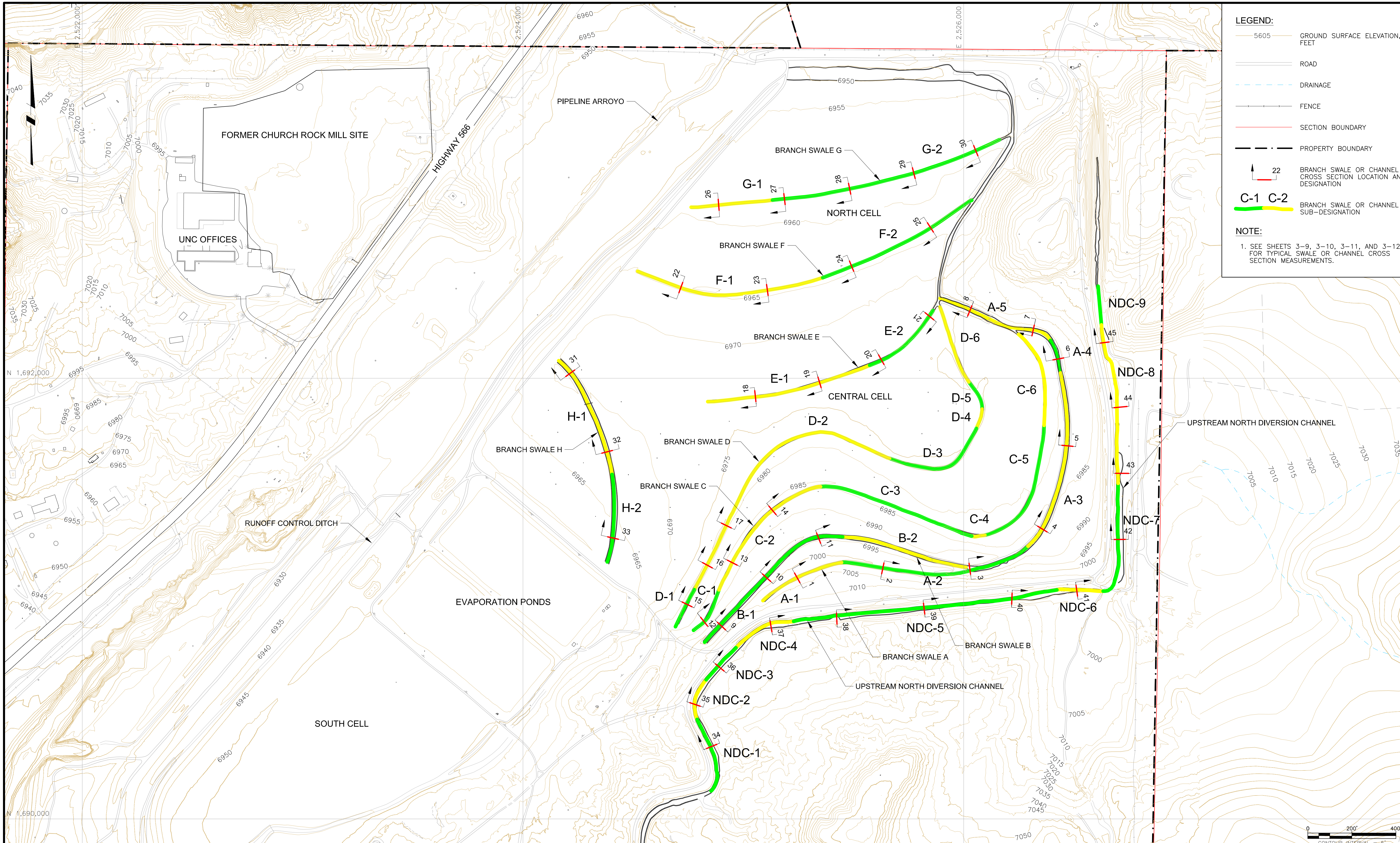

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DRAWING REFERENCE(S):
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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

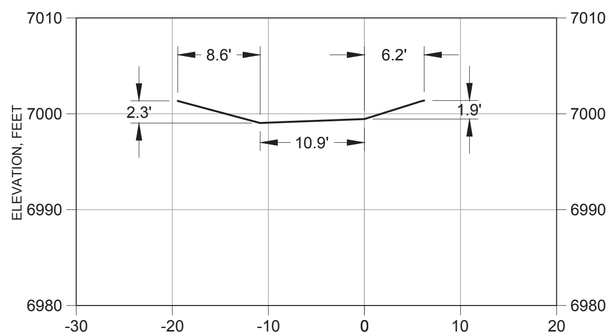
DESIGNED BY	J CUMBERS	07-14
DRAWN BY	D MIRANDA	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALES AND NORTH UPSTREAM DIVERSION CHANNEL SECTION LOCATIONS

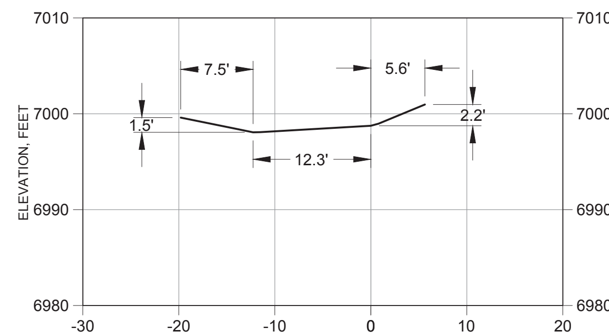
MWH

FIGURE 3-8
REVISION 0
FILE NAME 10504918 PDS11

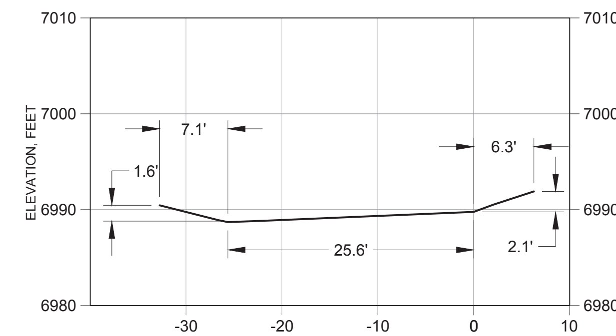
BRANCH SWALE A



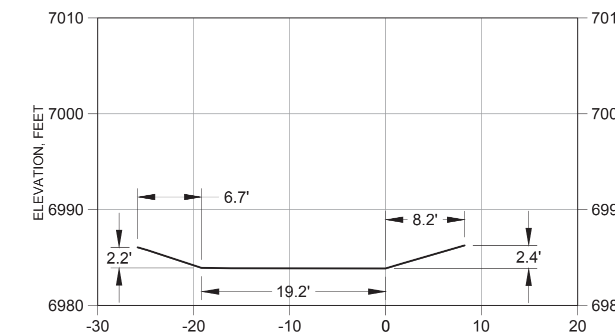
1 3-8 BRANCH SWALE A-1



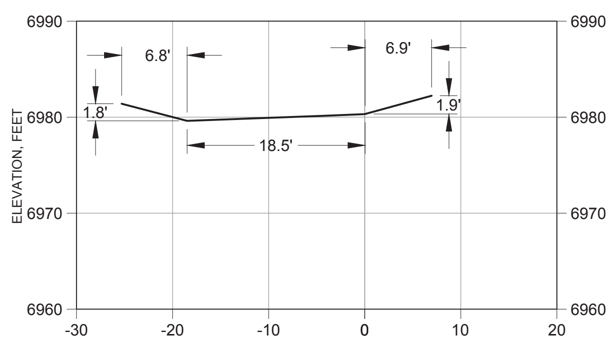
2 3-8 BRANCH SWALE A-2



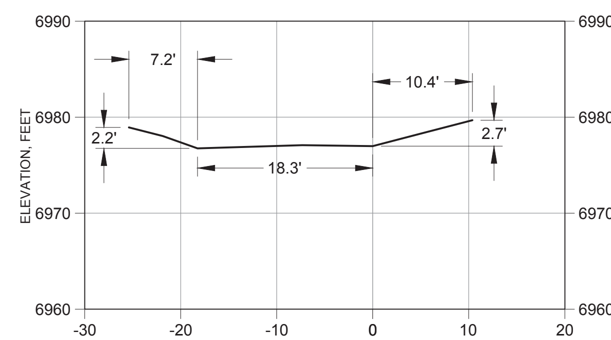
3 3-8 BRANCH SWALE A-2



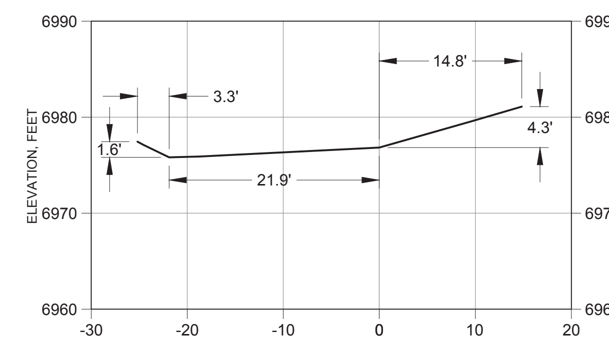
4 3-8 BRANCH SWALE A-3



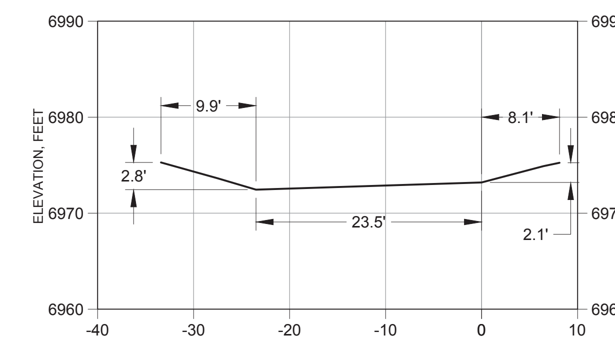
5 3-8 BRANCH SWALE A-3



6 3-8 BRANCH SWALE A-4

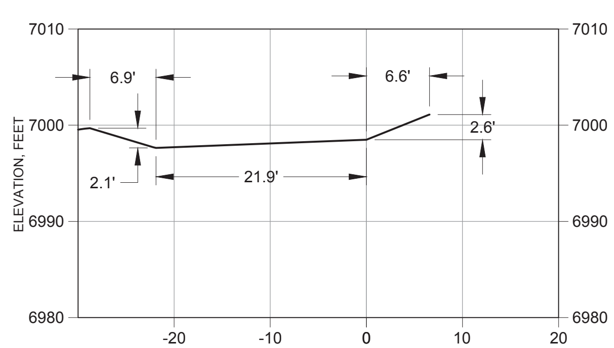


7 3-8 BRANCH SWALE A-5

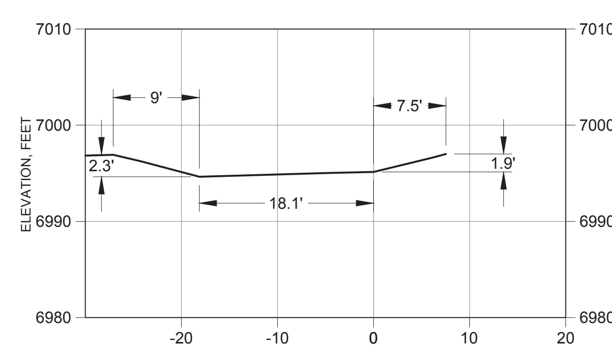


8 3-8 BRANCH SWALE A-5

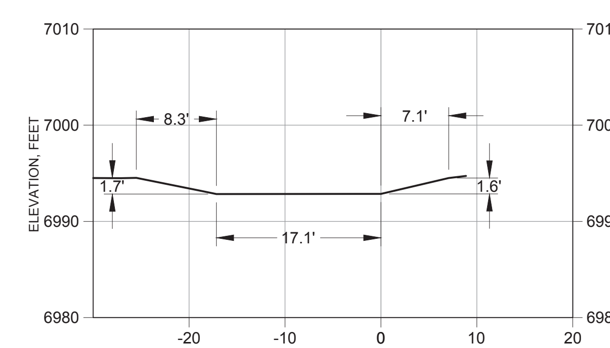
BRANCH SWALE B



9 3-8 BRANCH SWALE B-1



10 3-8 BRANCH SWALE B-1



11 3-8 BRANCH SWALE B-1

0 10' 20'

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DRAWING REFERENCE(S):
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PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: BRANCH SWALE CROSS SECTIONS (1 OF 3)

MWH

FIGURE: 3-9 REVISION: 0

FILE NAME: 10504918 PDS12

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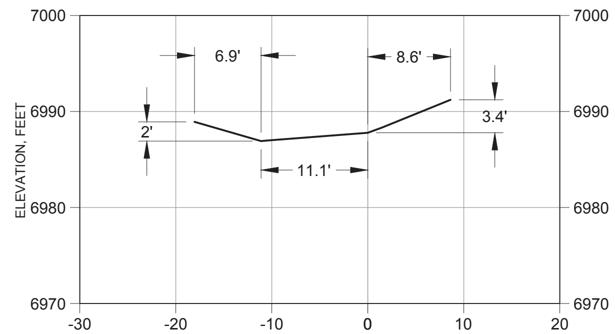
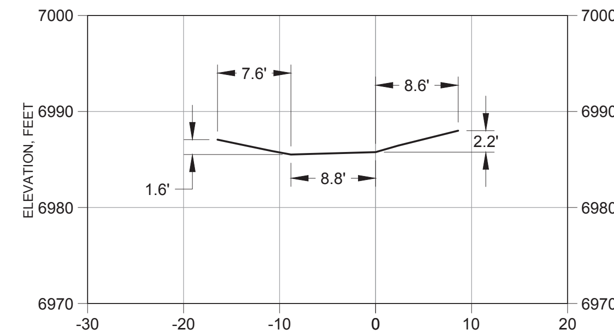
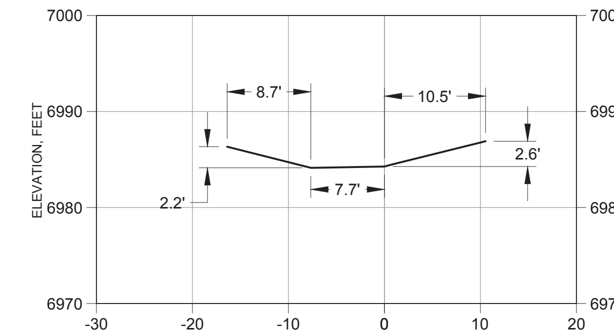
BRANCH SWALE C



12 / 3-8 BRANCH SWALE C-1

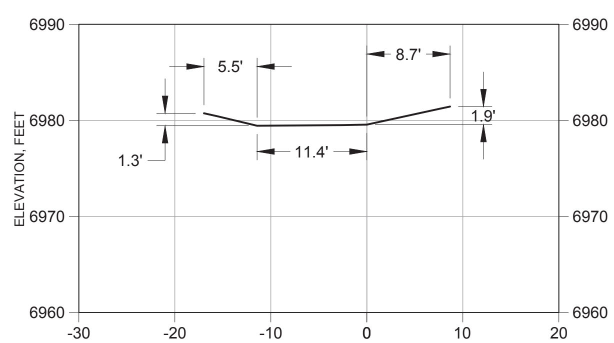


13 / 3-8 BRANCH SWALE C-2

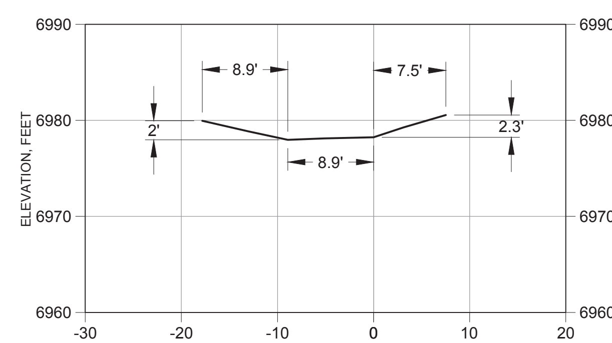


14 / 3-8 BRANCH SWALE C-2

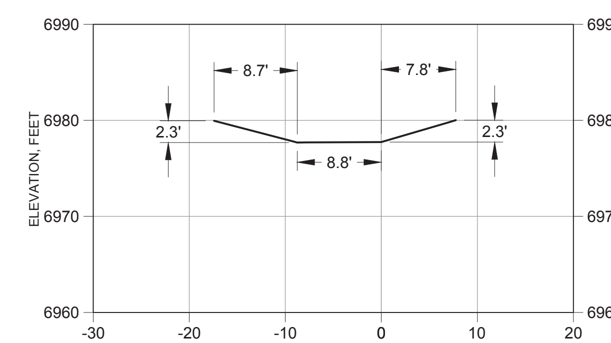
BRANCH SWALE D



15 / 3-8 BRANCH SWALE D-1

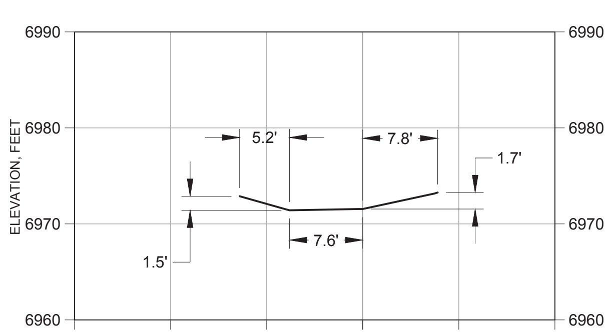


16 / 3-8 BRANCH SWALE D-2

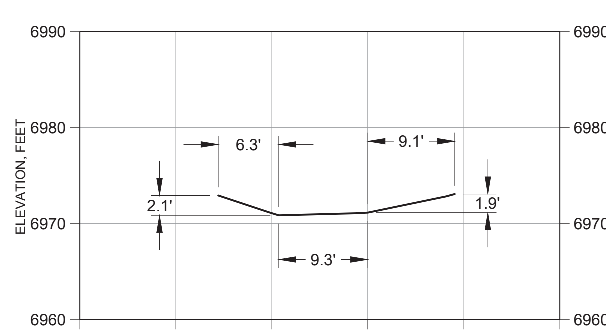


17 / 3-8 BRANCH SWALE D-2

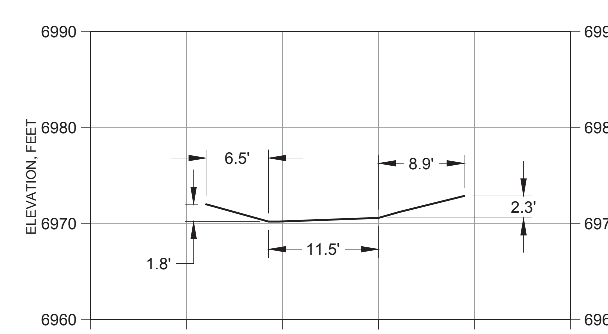
BRANCH SWALE E



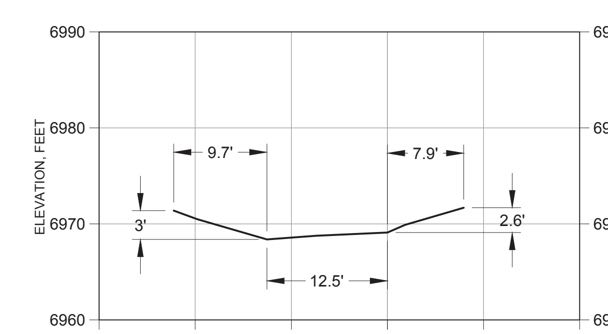
18 / 3-8 BRANCH SWALE E-1



19 / 3-8 BRANCH SWALE E-1



20 / 3-8 BRANCH SWALE E-2



21 / 3-8 BRANCH SWALE E-2

0 10' 20'

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALE CROSS SECTIONS (2 OF 3)

MWH

FIGURE 3-10 REVISION 0
FILE NAME 10504918 PDS12

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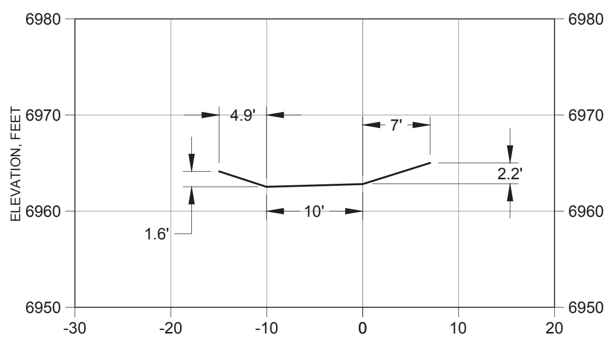
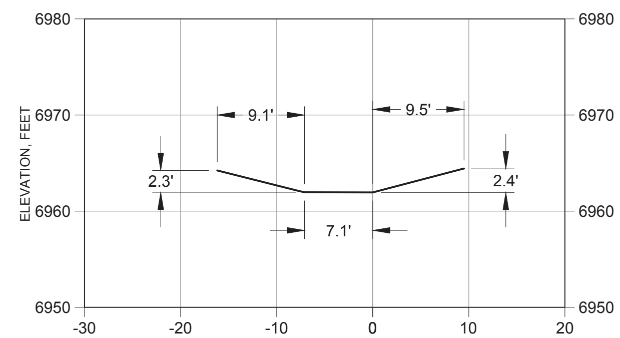
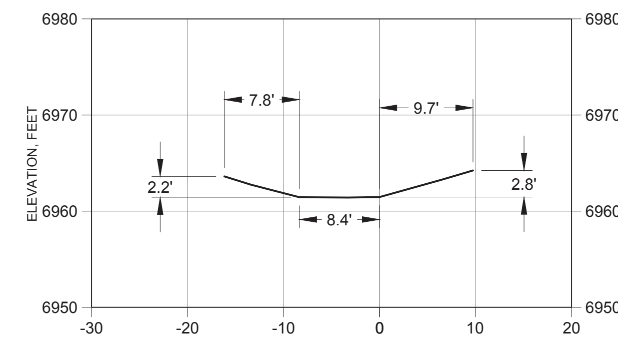
BRANCH SWALE F



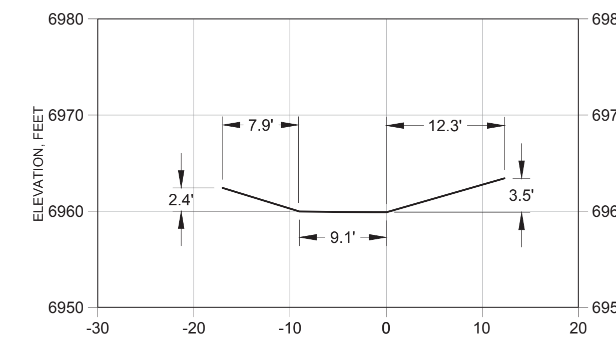
22 3-8 BRANCH SWALE F-1



23 3-8 BRANCH SWALE F-1

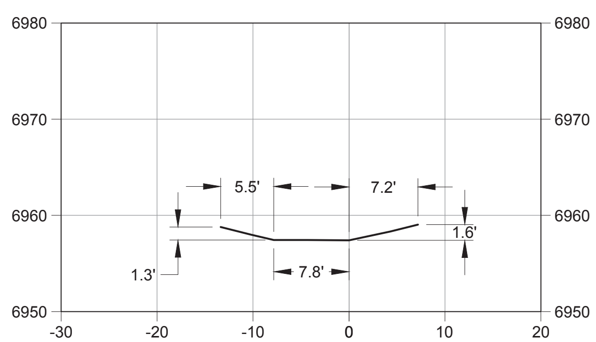


24 3-8 BRANCH SWALE F-2

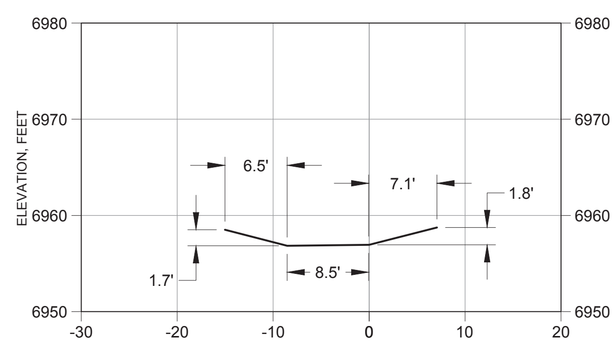


25 3-8 BRANCH SWALE F-2

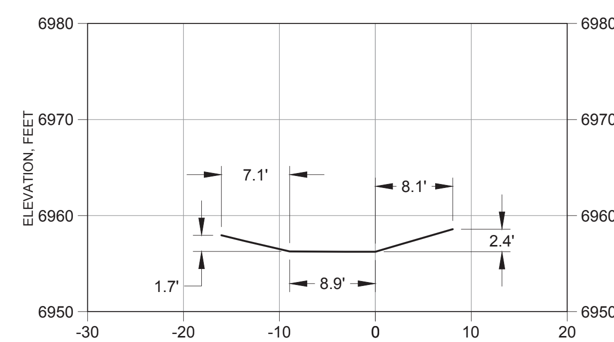
BRANCH SWALE G



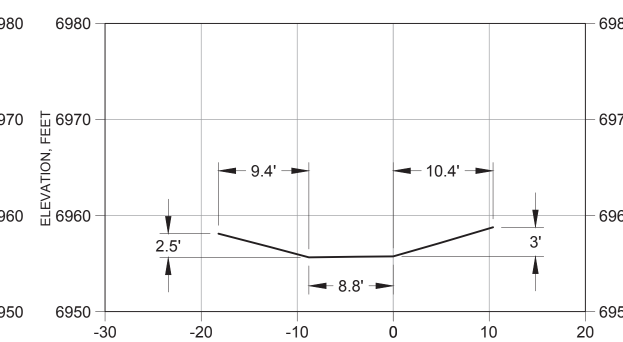
26 3-8 BRANCH SWALE G-1



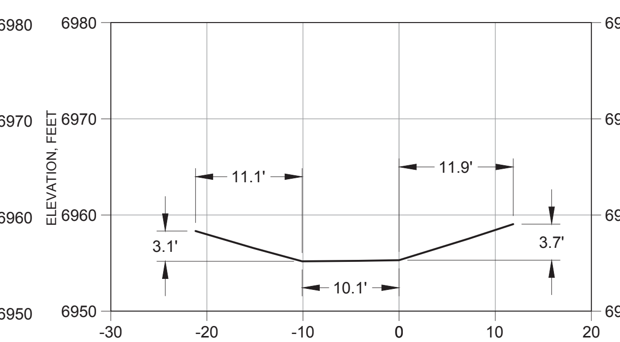
27 3-8 BRANCH SWALE G-2



28 3-8 BRANCH SWALE G-2

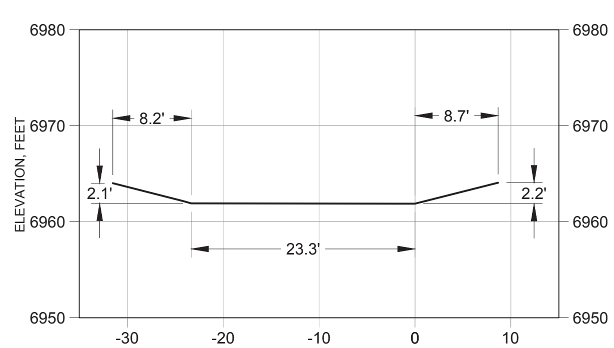


29 3-8 BRANCH SWALE G-2

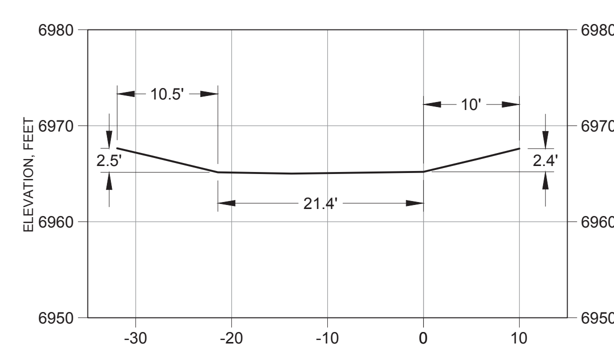


30 3-8 BRANCH SWALE G-2

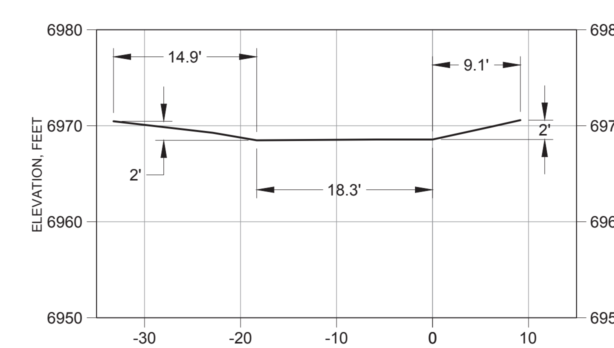
BRANCH SWALE H



31 3-8 BRANCH SWALE H-1



32 3-8 BRANCH SWALE H-1



33 3-8 BRANCH SWALE H-2

0 10' 20'

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

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DRAWN BY	K TULLAR	07–14
CHECKED BY	C STRACHAN	07–14
APPROVED BY	E DORNFEST	07–14
PROJECT MANAGER	T LEESON	07–14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: BRANCH SWALE CROSS SECTIONS (3 OF 3)
FIGURE: 3-11
REVISION: 0
FILE NAME: 10504918 PDS12

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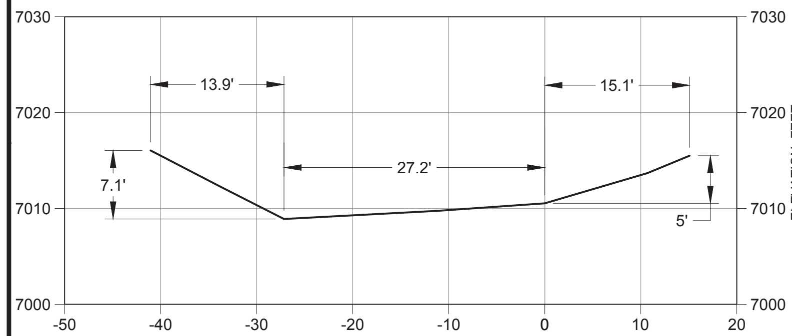
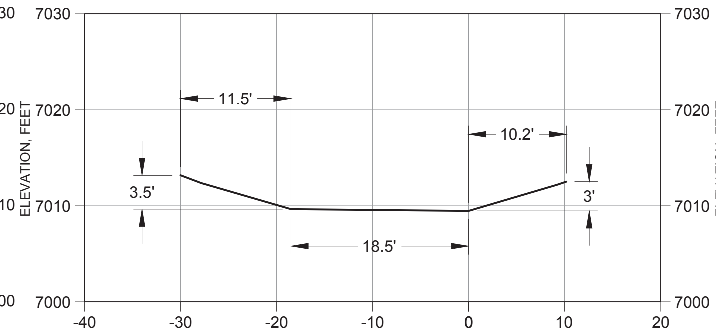
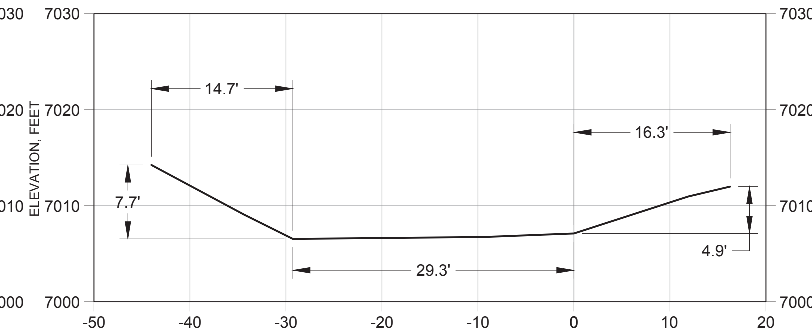
NORTH UPSTREAM DIVERSION CHANNEL



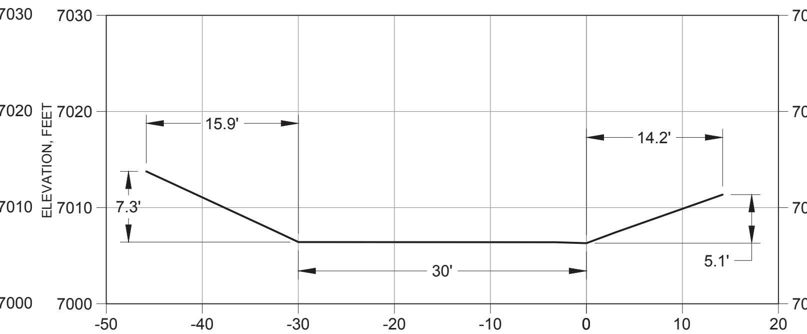
34 / 3-8 DIVERSION CHANNEL NDC-1



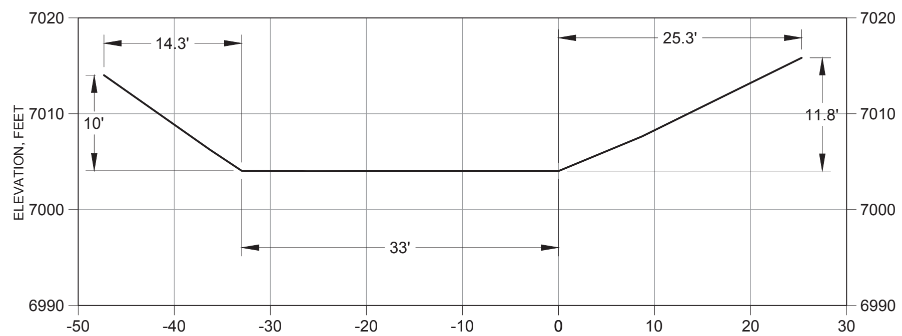
35 / 3-8 DIVERSION CHANNEL NDC-2



36 / 3-8 DIVERSION CHANNEL NDC-3



37 / 3-8 DIVERSION CHANNEL NDC-4



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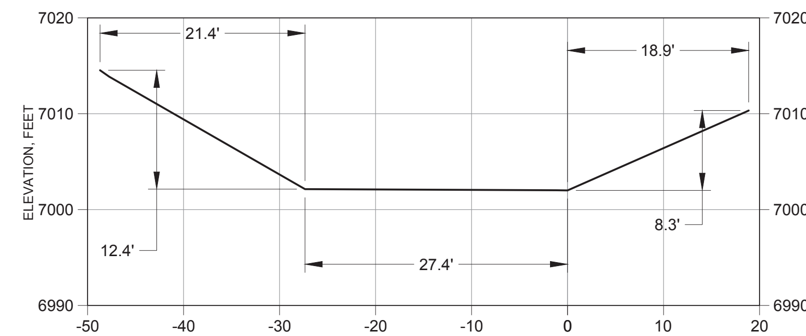

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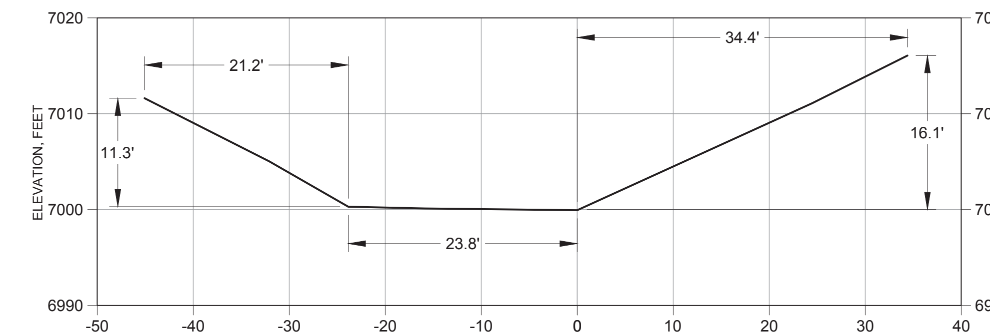
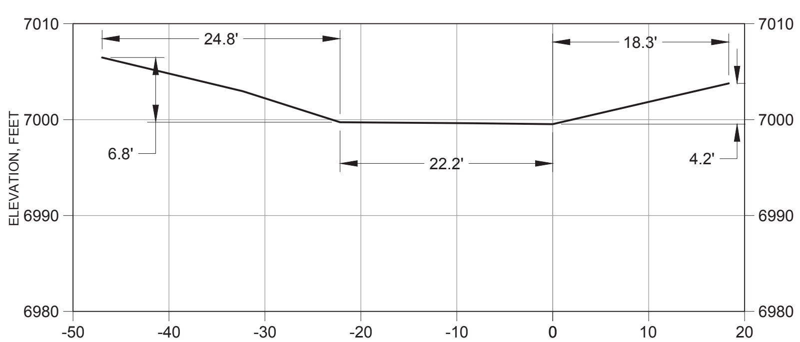
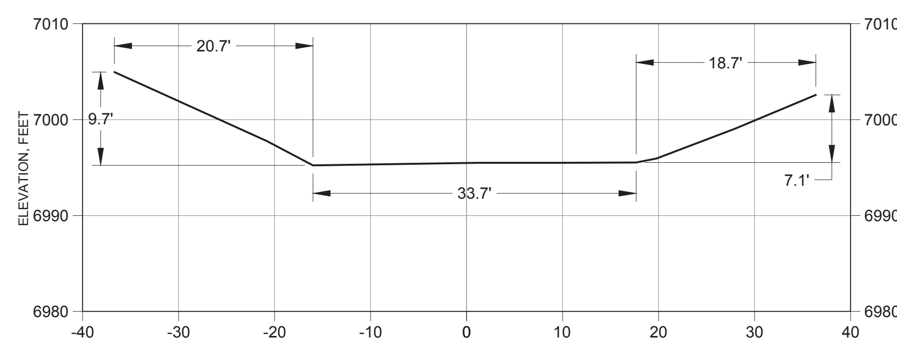


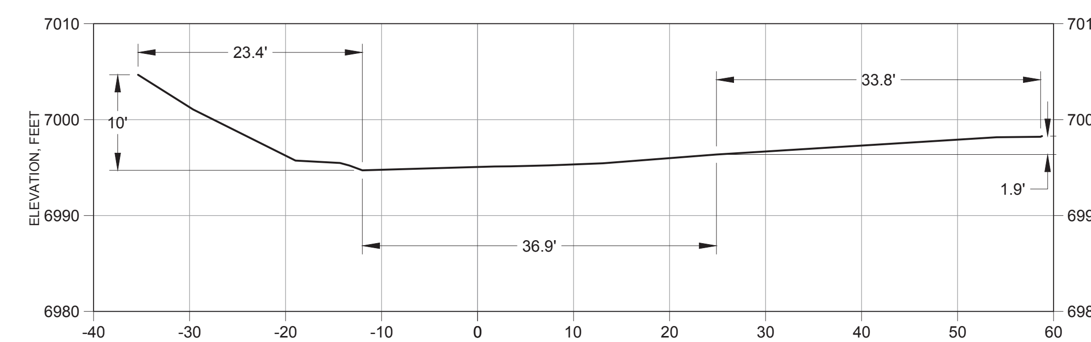
40 / 3-8 DIVERSION CHANNEL NDC-5



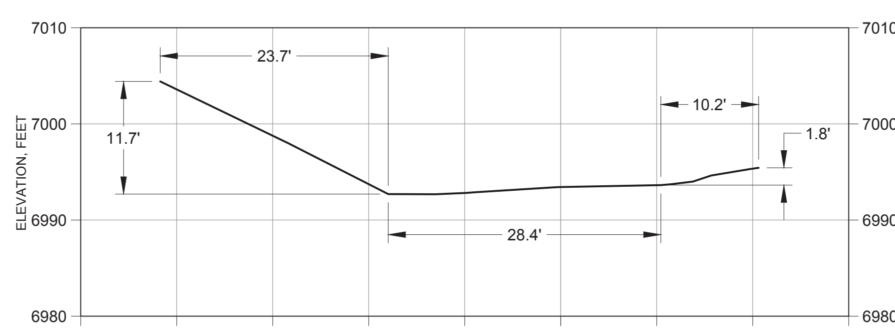
41 / 3-8 DIVERSION CHANNEL NDC-6



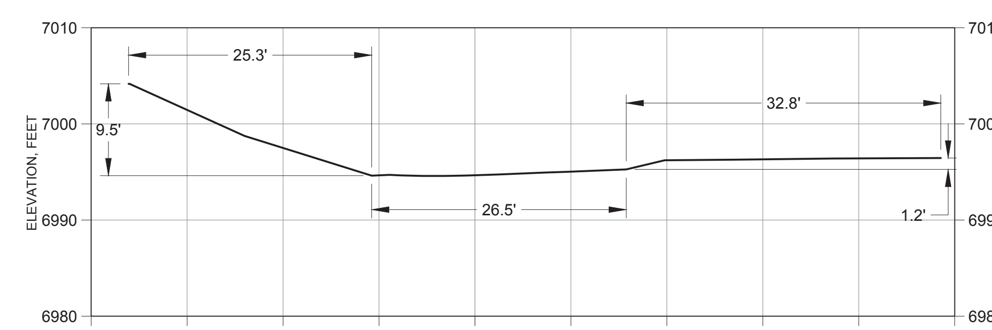
42 / 3-8 DIVERSION CHANNEL NDC-7



43 / 3-8 DIVERSION CHANNEL NDC-8



44 / 3-8 DIVERSION CHANNEL NDC-8



45 / 3-8 DIVERSION CHANNEL NDC-8

0 10' 20'

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	J CUMBERS	07-14
DRAWN BY	K TULLAR	07-14
CHECKED BY	C STRACHAN	07-14
APPROVED BY	E DORNFEST	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: NORTH UPSTREAM DIVERSION CHANNEL CROSS SECTIONS

MWH

FIGURE: 3-12
REVISION: 0
FILE NAME: 10504918 PDS12

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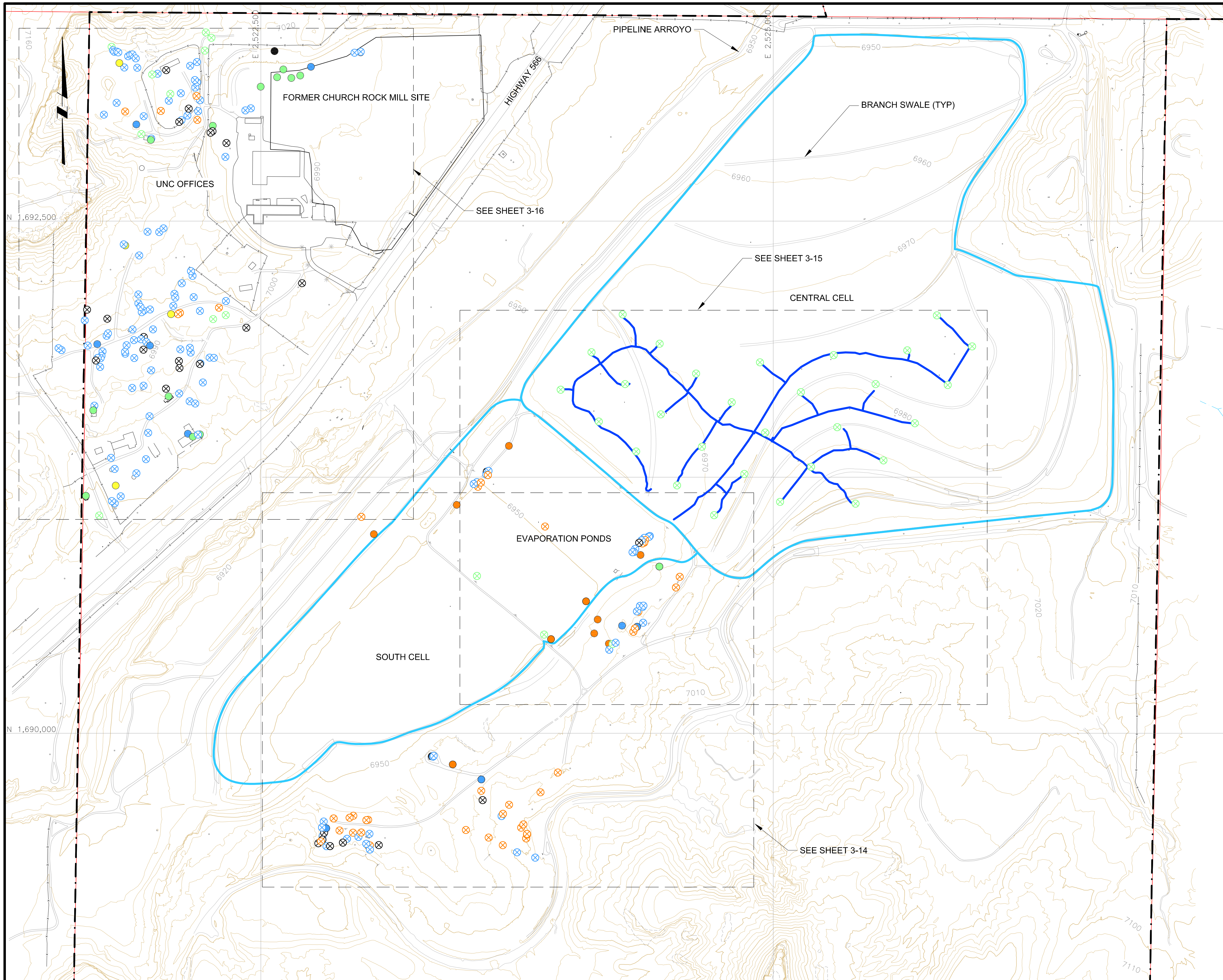

LEGEND:

5605	GROUND SURFACE ELEVATION, FEET
	ROAD
	DRAINAGE
	FENCE
	TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
	SECTION BOUNDARY
	MILL SITE PROPERTY BOUNDARY
	PHYSICAL STRUCTURE

EXISTING DEBRIS TYPE:

NON-FIXED	FIXED	
		METAL
		CONCRETE
		PLASTIC
		WOOD
		OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 250' 500'
CONTOUR INTERVAL = 10'

ISSUE	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE
PROJECT: PRE-DESIGN STUDIES REPORT
TITLE: MILL SITE DEBRIS OVERVIEW

MWH

FIGURE 3-13 REVISION 0
FILE NAME 10504918 PDS16

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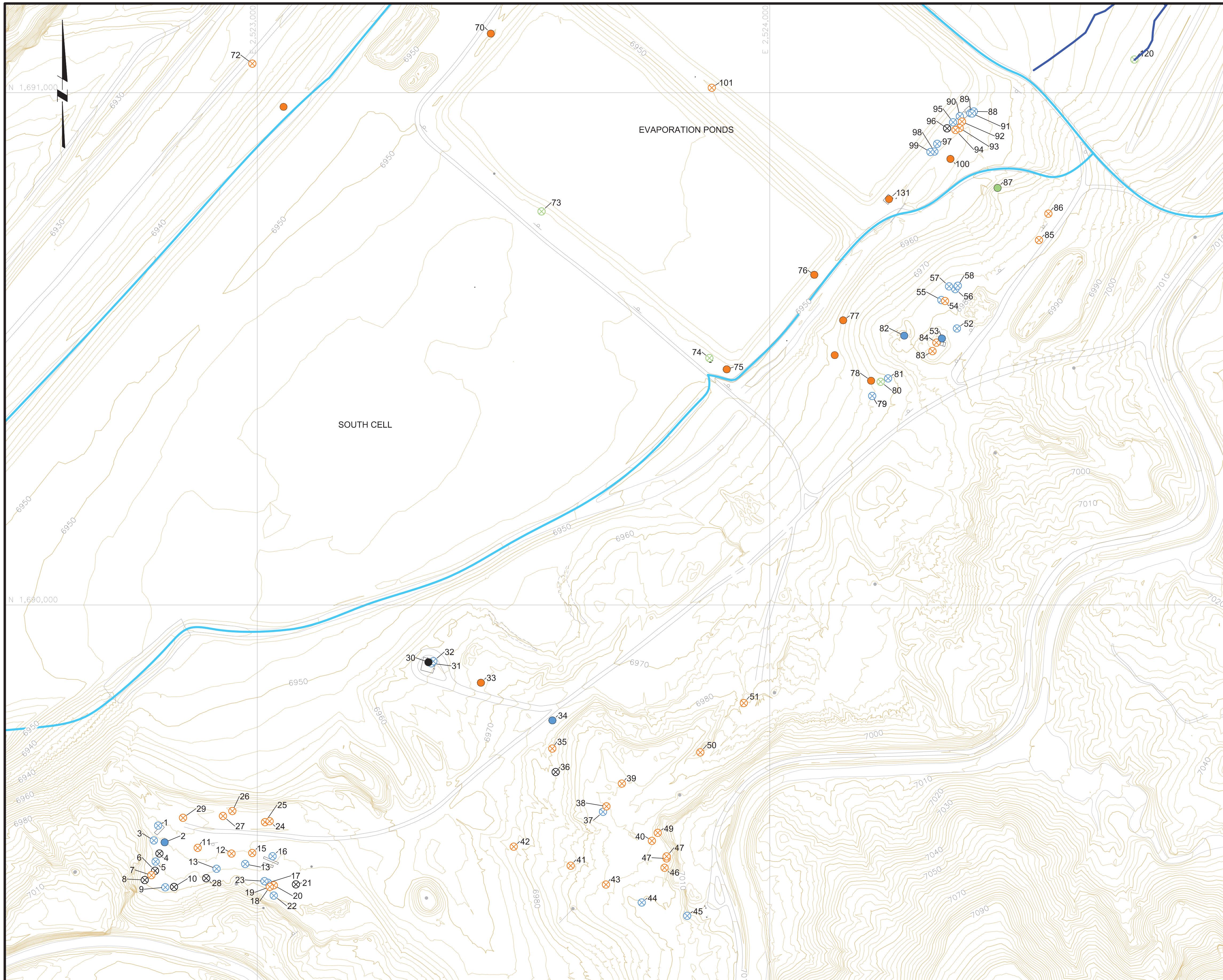


LEGEND:

- 5605 — GROUND SURFACE ELEVATION, FEET
- ROAD
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)

EXISTING DEBRIS TYPE:

NON-FIXED FIXED

- METAL
- CONCRETE
- PLASTIC
- WOOD
- OTHER
- DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'
CONTOUR INTERVAL = 2'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

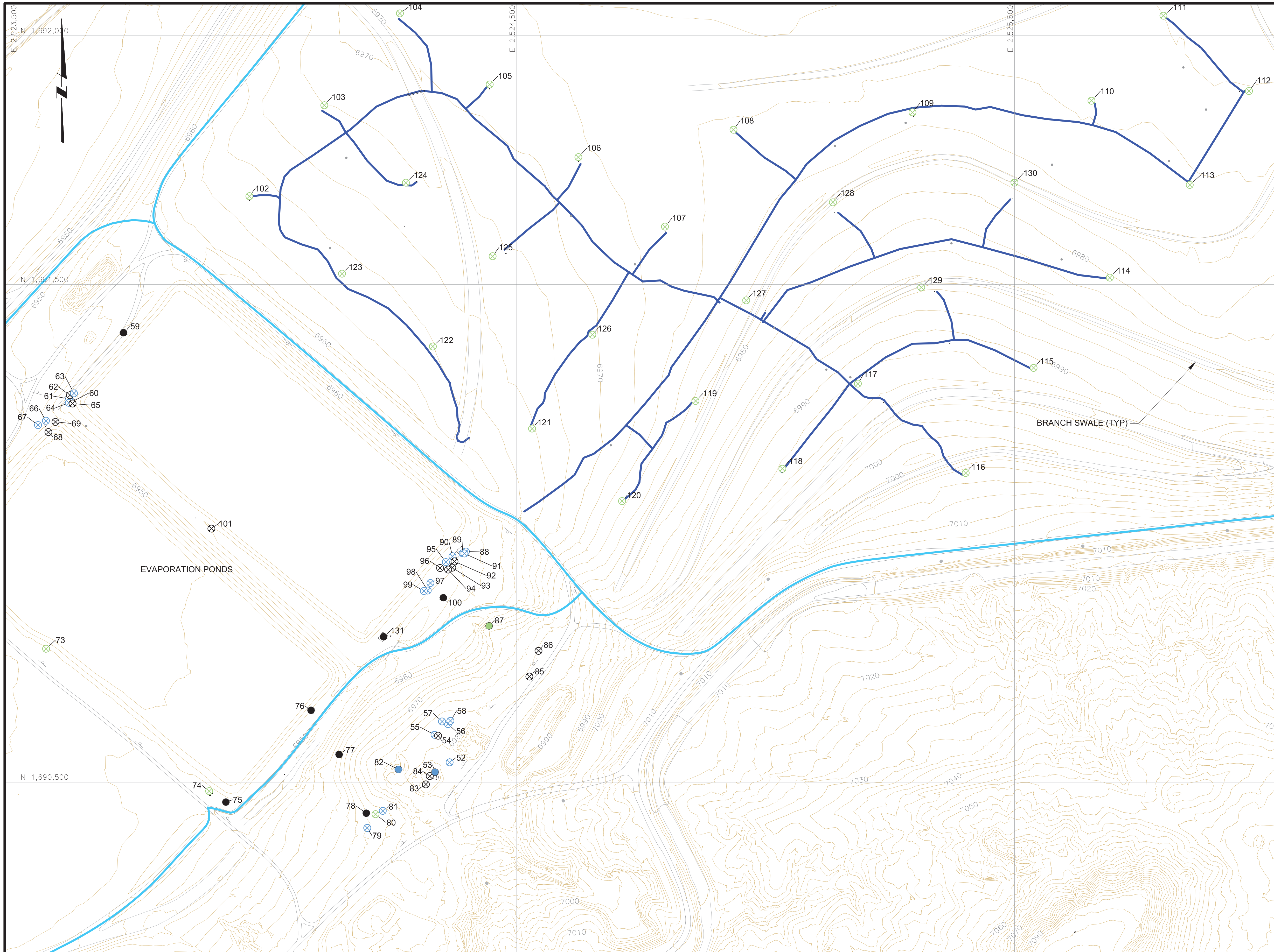
TITLE: MILL SITE DEBRIS INVENTORY (1 OF 3)

MWH

FIGURE: 3-14 REVISION: 0

FILE NAME: 10504918 PDS17

N:\Design-Drafting\Clients_Q-Z\United Nuclear Corporation\PRE-DESIGN STUDIES CHURCH ROCK\2014-02-28 pds report\10504918 PDS17



LEGEND:

5605	GROUND SURFACE ELEVATION, FEET
	ROAD
	TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)

EXISTING DEBRIS TYPE:

NON-FIXED	FIXED	
⊗	●	METAL
⊗	●	CONCRETE
⊗	●	PLASTIC
●	●	WOOD
⊗	●	OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'

CONTOUR INTERVAL = 2'

N:\Design-Drafting\Clients_0-Z\United Nuclear Corporation\PRE-DESIGN STUDIES CHURCH ROCK\2014-02-28 pds report\10504918 PDS18

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

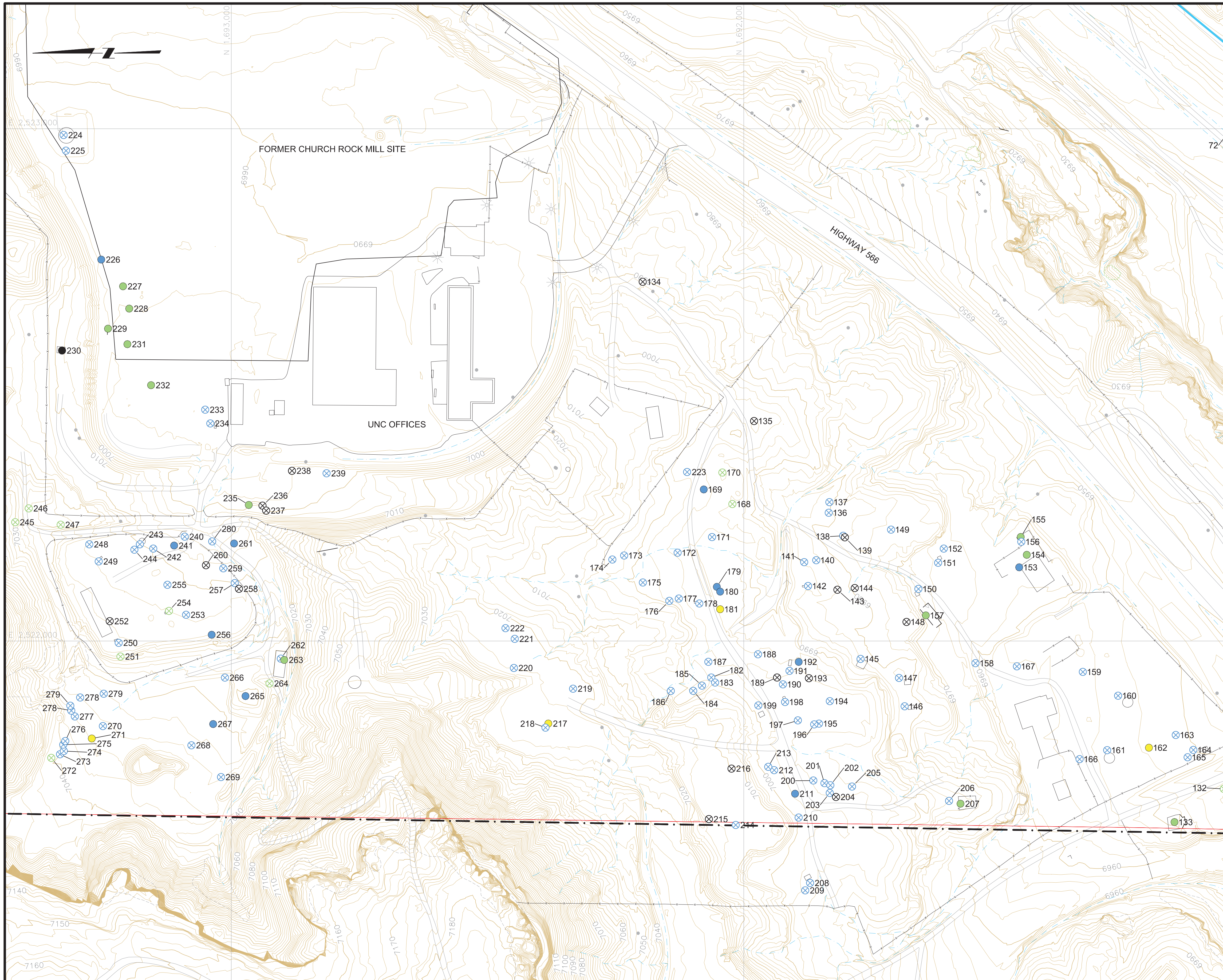
TITLE: MILL SITE DEBRIS INVENTORY (2 OF 3)

MWH

FIGURE: 3-15

REVISION: 0

FILE NAME: 10504918 PDS18



LEGEND:

- 5605 GROUND SURFACE ELEVATION, FEET
- ROADS
- DRAINAGE
- FENCE
- TAILINGS IMPOUNDMENT (APPROXIMATE EXTENT OF TAILINGS)
- SECTION BOUNDARY
- MILL SITE PROPERTY BOUNDARY
- PHYSICAL STRUCTURE

EXISTING DEBRIS TYPE:

NON-FIXED	FIXED	
		METAL
		CONCRETE
		PLASTIC
		WOOD
		OTHER
		DRISCO PIPE

NOTES:

1. FIXED DEBRIS IS PARTIALLY BURIED.
2. DESCRIPTION OF DEBRIS BY IDENTIFICATION NUMBER IS PROVIDED IN APPENDIX B.

0 100' 200'
CONTOUR INTERVAL = 2'

N:\Design-Drafting\Clients_Q-Z\United Nuclear Corporation\PRE-DESIGN STUDIES CHURCH ROCK\2014-02-28 pds report\10504918 PDS19

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	ED	10-14

DRAWING REFERENCE(S):
- EXISTING SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED DEC 2013 BY COOPER AERIAL SURVEYS CO.

PROJECTION: STATE PLANE COORDINATES
ZONE: NEW MEXICO WEST
DATUM: NAD 83
UNITS: US FEET

DESIGNED BY	K JOHNSON	07-14
DRAWN BY	C FOWLER	07-14
CHECKED BY	E DORNFEST	07-14
APPROVED BY	T LEESON	07-14
PROJECT MANAGER	T LEESON	07-14
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: CHURCH ROCK MILL SITE

PROJECT: PRE-DESIGN STUDIES REPORT

TITLE: MILL SITE DEBRIS INVENTORY (3 OF 3)

FIGURE: 3-16 REVISION: 0

FILE NAME: 10504918 PDS19

4.0 SUMMARY AND CONCLUSIONS

The PDS were conducted at the Mill Site in preparation for design of the repository, as a part of the NECR Mine Site RA. The goal of the PDS was to collect pre-design data and information necessary to design the RA in accordance with the proposed performance standards and United States Environmental Protection Agency's Region 9 (USEPA) *Action Memorandum: Request for Non-Time Critical Removal Action at the Northeast Church Rock Mine Site* (Action Memo) (USEPA, 2011a) and the USEPA Region 6's *Proposed Plan* (USEPA, 2012) and the *Record of Decision* (ROD) for the United Nuclear Corporation (Church Rock Mill Site) Surface Soil Operable Unit NPL Site (USEPA, 2013). The tasks that were conducted during the PDS consisted of the following:

- Topographic survey of the impoundment cells and surrounding areas
- Geotechnical evaluation of tailings impoundment and underlying units
- Borrow material investigation
- Volume and characteristics of on-site erosion protection materials
- Revegetation study
- Biointrusion evaluation
- Cultural resources survey
- Visual inspection and survey of branch swales and North Upstream Diversion Channel
- Debris inventory

Results of the individual investigations are described in Section 3.0 and the data are provided in Appendices. The significant results from the PDS at the Mill Site are summarized below, along with findings that potentially impact RA design.

The tailings encountered in the tailings impoundment are laterally and vertically heterogeneous, and contain varying amounts of fine-grained tailings. This variability is consistent with the operation of the mill and location of slurried tailings discharge and ponded water within the impoundment. As a result of this heterogeneity, the tailings water content varies throughout the impoundment and within individual tailings profiles. Based on the CPT work, observation of collected samples, and laboratory testing, the tailings profiles encountered in the PDS investigation are unsaturated.

While there is variability in the tailings particle-size distribution and water content, the tailings impoundment is a suitable repository site, with appropriate design considerations for tailings settlement. Potential performance issues related to tailings settlement will be accommodated during design with the total amount and rate of loading from mine spoils placement.

Results of the borrow investigations and preliminary grading layouts indicate that up to 400,000 cy of soil are available in the borrow areas, excluding the Dilco Hill Borrow Area which is mostly sedimentary rock. The preliminary grading and excavation plans exclude areas within 100 feet (buffer zone) of the identified cultural sites. Approximately 20,000 cy is available in the topsoil stockpile. The soil in the borrow areas has an average fines content of 53 percent, indicating it is suitable for construction of an evapotranspirative (ET) cover. Based on preliminary designs and assuming a repository capacity of 900,000 cy with a three foot thick ET cover, up to 323,000 cy of cover and clean fill soil could be required for repository construction. This soil volume does not include fill required for regrading at the NECR Mine Site. If more than 420,000 cy of borrow is required for RA construction at both the Mine and Mill Sites, rock material could be excavated from the Dilco Hill and crushed in limited quantities.

The existing soil-gravel admixture in the cover on the impoundment can be stripped and reused during RA construction. Volume estimates indicate there is up to 80,000 cy of this material available, depending on the final repository design. Grading plans will dictate whether additional larger rock are needed to supplement the rock sizes presently in the admixture layer.

The existing erosion protection rock present at the Mill Site (in stockpiles) could be used as supplemental material for RA construction. The durability scoring of the existing stockpiled materials indicates some oversizing may be required for this material, depending on its intended future use. Riprap for channels would likely need to be imported, due to the limited volumes of material stockpiled on site.

The existing clay layer (radon barrier) beneath the cover admixture layer was tested for geotechnical properties, including remolded saturated hydraulic conductivity. The clay layer is suitable for a physical barrier between the mine spoils and underlying tailings. Testing of remolded samples of the clay layer material indicate that saturated conductivities on the order of 10^{-7} cm/sec would be achieved if the material was reworked and compacted at near optimum water content to between 95 and 100% of standard Proctor density.

The existing drainage swales and the north diversion can be incorporated into the RA design. Some localized areas may require maintenance or improvements during construction to remove vegetation or siltation. The sizes of the existing swales and diversion channel may require adjustments to accommodate design flows. This evaluation will be completed during RA design.

Animal biointrusion studies results indicate the presence of pocket gophers, prairie dogs, and badgers in the vicinity of the Mill Site. The vegetation and biointrusion studies also identified a calcium carbonate accumulation zone in the vegetation analog areas that could potentially restrict plant root and water infiltration depth. Further characterization of the borrow area soils is necessary to investigate the concentration of calcium carbonate throughout the depth of the excavations proposed in the borrow areas, in order to design the evapotranspirative cover and specify organic amendments necessary for vegetation establishment.

Results of the vegetation and wildlife surveys at the borrow areas indicate the following:

1. No rare, threatened or endangered species occur within any of the potential borrow sites.

2. If soils from the East Borrow Area are used to construct the repository cover, the noxious weeds in the area should be managed via chemical control prior to construction, in order to minimize the spread of noxious weeds as a result of construction.

3. The baseline and analog sites are comparable; therefore the analogs can be used as a reference for post-construction revegetation success criteria.

The data collected and summarized in this report as a portion of the PDS meet the objectives of the Work Plan and are sufficient for use in the RA design. The only identified data gap is potential further agronomic characterization of borrow area soils, which would be implemented during the design phase.

5.0 REFERENCES

Arnet, M.P., 2009. *Particle Size Distribution of Gypseous Samples*. Texas A&M University. May.

ASTM, International. 2010. *Standard D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.* West Conshohocken, PA. www.astm.org.

Canonie Environmental, 1991. *Tailings Reclamation Plan As Approved by NRC March 1, 1991, License No. SUA-1475, Church Rock Site, Gallup, New Mexico*. 3 Volumes. August.

Canonie Environmental, 1995. *As-Built Report, Central Cell Final Reclamation, Church Rock Site, Gallup, New Mexico*. June.

Civil Systems Inc. (CSI), 1980. *Final Design Report Southeast Evaporation Ponds, for United Nuclear Corporation Church Rock Facility, Gallup, New Mexico.* August.

D'Appolonia. 1981. *State of New Mexico Environmental Improvement Division, Uranium Mill License renewal Application-Environmental Report License No. NM-UNC-ML, UNC Mining and Milling Church Rock Operations Division of United Nuclear Corporation. Vol.1, Text and Tables.* December.

Dwyer, S., 2012. *Memo: Summary of NECR Geotechnical Data Available to Date.* January 3.

De Puy, O.W., 1965. *Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures.* Engineering Geology, Vol.2, pp 31-46. July.

MWH Americas, Inc. (MWH), 2013. *Northeast Church Rock Mine Site Removal Action, Volume I: Pre-Design Studies Work Plan, Church Rock Mill Site* October.

Sergent, Hauskins & Beckwith (SHB), 1974. *Preliminary Geotechnical Investigation Report, Tailings Dam. Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. October.

Sergent, Hauskins & Beckwith (SHB), 1976. *Geotechnical Investigation Report, Tailings Dam and Ponds, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. May.

Sergent, Hauskins & Beckwith (SHB), 1978a. *Geotechnical and Design Development Investigation Report, Tailings Dam and Ponds, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. July.

Sergent, Hauskins & Beckwith (SHB), 1978b. *Engineering Analysis Report – Embankment Volumes-Borrow Quantities, Tailings Disposal Systems Analysis, UNC Church Rock Mill Site*. Church Rock, New Mexico. October.

Sergent, Hauskins & Beckwith (SHB), 1979. *Geotechnical Investigation Report, Stability and Integrity Assessment, Church Rock Uranium Mill, United Nuclear Corporation.* Church Rock, New Mexico. Volume 1. July.

UNC Mining and Milling, 1986. *Letter to Canonie Environmental Services Corporation, Re: Previous Geotechnical Data – Tailings & NECR.* October 14.

United Nuclear Corporation (UNC), 1993. *Letter to Canonie Environmental Services Corporation.* September 28.

United Nuclear Corporation (UNC), 2014. *Discussion with Larry Bush*. July 9.

U.S. Environmental Protection Agency (USEPA), 2011. *Action Memorandum: Request for a Non-Time-Critical Removal Action at the Northeast Church Rock Site*, McKinley County, New Mexico, Pinedale Chapter of the Navajo Nation. September 29.

U.S. Environmental Protection Agency (USEPA), Region 9, 2012. *United Nuclear Corporation Superfund Site Surface Soil Operable Unit Proposed Plan*, Gallup, New Mexico. July 20.

U.S. Environmental Protection Agency (USEPA), Region 6, 2013. *Record of Decision*, United Nuclear Corporation Site, McKinley County, New Mexico. March 29.

U.S. Nuclear Regulatory Commission (NRC) (Johnson, T.L.). 2002. *NUREG-1623 - Design of Erosion Protection for Long-Term Stabilization*. Office of Nuclear Material Safety and Safeguards, Washington, DC. September.