Northeast Church Rock Mine Site Removal Action

Pre-Design Studies Work Plan
Northeast Church Rock Mine Site

August 16, 2013

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LIST OF ACRONYMS

ACM	Asbestos containing materials
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
COC	chain-of-custody
COPC	Constituent of Potential Concern
cpm	counts per minute
USEPA	United Stated Environmental Protection Agency
EE/CA	Engineering Evaluation/Cost Assessment
EDRA	Eastern Drainage Removal Action
ET	Evapotranspirative
FSL	Field Screening Level
FSP	Field Sampling Plan
GE	General Electric
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
IRA	Interim Removal Action
KeV	Kiloelectronvolt
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mg/kg	milligrams per kilogram
NaI	sodium iodide
NECR	Northeast Church Rock
NELAC	National Environmental Laboratory Accreditation Conference
NEMSA	non-economic materials storage area
NRC	Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
pCi/g	PicoCurie per gram
PDSP	Pre-Design Studies Work Plan
PPE	Personal Protective Equipment
PTW	Principal Threat Waste
QAPP	Quality Assurance Project Plan
RA	Removal Action
RAL	Removal Action Level
RAO	Removal Action Objective
RCRA	Resource Conservation and Recovery Act of 1976
RSE	Removal Site Evaluation
SAP	Sampling and Analysis Plan
SRSE	Supplemental Removal Site Evaluation
SOP	Standard Operating Procedure
TCLP	Toxicity characteristic leaching procedure
TPH	Total Petroleum Hydrocarbons
UNC	United Nuclear Corporation

1.0 WORK PLAN

1.1 INTRODUCTION

This work plan describes data collection activities that will be conducted at the Northeast Church Rock (NECR) Mine Site (Mine Site) that are necessary for design of the Northeast Church Rock Mine Site Removal Action (RA). It includes a description of pre-design data gaps that have been identified and a Field Sampling Plan (FSP) for collection of the necessary pre-design data at the Mine Site to support the design of the RA. This work plan has been prepared by MWH on behalf of General Electric Company and its indirect subsidiary United Nuclear Corporation (GE/UNC) for submittal to the U.S. Environmental Protection Agency, Region 9 in response to the *Action Memorandum: Request for Non-Time Critical Removal Action at the Northeast Church Rock Mine Site* (Action Memo., USEPA, 2011). The Action Memo selected the RA alternative of removing mine spoils and debris from the Mine Site and consolidating the material in an above-ground repository at the Church Rock Mill Site (Mill Site), as described in the Engineering Evaluation and Cost Evaluation (EE/CA)(USEPA, 2009), prepared by USEPA Region 9. MWH proposes to conduct these pre-design activities in accordance with the NECR Mine Site *Removal Site Evaluation Work Plan* (RSE Work Plan; MWH, 2006), with plans specific to the current activities or methods that have been updated included in this work plan.

This work plan describes data gaps and pre-design data needs and provides a SAP specific to the NECR Mine Site. Pre-design data needs and a field sampling plan related to the Mill Site repository are addressed in the *Pre-Design Studies Work Plan (PDSP), Church Rock Mill Site* (MWH, 2013b). An updated version of the *Quality Assurance Project Plan* (QAPP) from the RSE Work Plan, and a site-specific Health and Safety Plan (HASP) that covers all field activities associated with pre-design data collection at the Mine Site and the Mill Site will be issued with the final versions of this and Mill Site PDSPs. The two PDSPs, the QAPP, and the HASP constitute the Sampling and Analysis Plan (SAP) in accordance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988).

1.2 BACKGROUND AND OBJECTIVES

The RA alternative selected by the USEPA in the Action Memo includes design of: (1) the removal of approximately 870,000 cubic yards of mine spoils (and debris) from the Mine Site; (2) a site status survey and restoration of the Mine Site; and (3) consolidation of the mine spoils into a repository at the Mill Site. The Action Memo was issued following completion of a removal site evaluation (RSE) (MWH, 2007a) and USEPA's publication and public review and comment of the EE/CA. A summary of the site history and information on prior investigations and removal actions is included in Section 1.3.

The key components and performance criteria for the RA of the Mine Site are:

- Excavation of all mine waste materials that exceed the RA limit of 2.24 picocuries per gram (pCi/g) Ra-226 within 10 feet of the final proposed ground surface.
- Transport of mine waste materials on State Highway 566 to the Church Rock Mill Site and placement into the above-ground repository.
- Off-site disposal or reprocessing of principal threat waste (PTW), defined as Mine Site soils containing either greater than 200 pCi/g of Ra-226 and/or greater than 500 milligrams per kilogram (mg/kg) of total uranium.

- Confirmation scanning, and sampling and analysis consistent with the Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM; USEPA, 2000) to ensure that the RA Objectives (RAOs) have been met.
- Restoration of the mine site including backfilling and regrading of excavated areas, construction of erosion and sedimentation control measures, and re-vegetation of the disturbed areas with native species.

Mine waste materials consist of mine spoils (soil) containing Ra-226 in excess of the Removal Action Level (RAL) of 2.24 pCi/g Ra-226, as well as mine debris, such as scrap metal, concrete, wood, and rubber from various locations at the Mine Site.

The Mine Site cleanup levels are 2.24 pCi/g for Ra-226 and 230 mg/kg for uranium. As described by USEPA (2011), the uranium has been determined to be co-located with the Ra-226, and removing the Ra-226 that exceeds 2.24 pCi/g will also remove the uranium levels above the site cleanup level of 230 mg/kg. Therefore, excavation of soils at the Mine site will be based on the Ra-226 RAL of 2.24 pCi/g and continue until confirmation results are below the RAL in accordance with MARSSIM procedures.

This PDSP has been prepared to facilitate the design of the RA in accordance with the requirements and proposed performance standards listed above, as well as the final site ARARs as presented in the Action Memo. A summary of the preliminary basis of design specifications for the RA is presented in Table 1-1 via a detailed summary of the individual components of the removal design. Table 1-1 includes individual design elements, the performance criterion that guides each design element, the site data currently available for design, and any additional data deemed necessary. Project documents related to the Mine site and that are maintained in a project database are listed in Table 1-2. Regulatory references related to the RA design performance criteria are listed in Table 1-3.

1.3 SUMMARY OF REMOVAL SITE EVALUATIONS

The Mine Site consists of approximately 125 acres, located primarily on lands held by the United States in trust for the Navajo Nation adjacent to the Navajo Reservation. The Mine Site is located in a narrow canyon with an arroyo that drains to the northeast downstream of NECR-1 (unnamed arroyo no. 1) into another arroyo (unnamed arroyo no. 2) that drains into Pipeline Arroyo (see Figure 1-1). Several specific features or areas of the site were identified in the RSE Work Plan and are labeled on Figure 1-1.

The NECR-1 pad was constructed of non-economic mine materials consisting of sandstone and clay shale fragments, and some native soils, while the NECR-2 pad was constructed primarily of native soils. The NEMSA and the Boneyard were revegetated in 1994, after being covered with one foot of native topsoil. The water treatment ponds (Pond 1, Pond 2, and Pond 3/3a) were originally filled with water and sediments from storm water runoff that drained the tailings sand backfill areas, as well as water from mine operations. The sediments were periodically removed and placed on the Sediment Pad for temporary storage prior to being transported off-site for processing at the mill. Residual tailings were removed from the ponds and the Sediment Pad as part of the 1986 cleanup pursuant to Condition 33 of NRC Permit License No. SUA-1475 (UNC, 1989a). The sand backfill areas (sandfills 1, 2 and 3) originally were used to store tailings from the Church Rock Mill. The tailings were removed and used to backfill the mine workings. The sand backfill areas were then included in the 1986 cleanup pursuant to Condition 33 of NRC Permit License No. SUA-1475 (UNC, 1989b), and now consist of native soils.

In 2007 UNC conducted the initial Removal Site Evaluation (RSE) at the Mine Site (which included step-out area no. 1) with USEPA oversight (MWH, 2007a). Numerous additional supplemental RSEs were conducted subsequent to the RSE through 2011, consisting of radiological characterization of surface soils investigations, surveying geophysical anomalies, and testing for geotechnical properties, as described in the reports listed below. The supplemental RSEs also included investigation of subsurface soils, the results of which were transmitted electronically to USEPA in 2008. Also in 2008, a set of figures were transmitted to USEPA that summarized the results of the RSE and supplemental RSEs that were conducted through 2008 including both surface and subsurface soils; a copy of these figures is included in Appendix B. These figures were reissued to USEPA in 2011, at which time boundaries showing the extent of the areas included in the Interim Removal Action (IRA) were added (MWH, 2010b). The results of subsequent SRSEs conducted in 2009 through 2012 are not shown in Appendix B, but are presented in the documents listed below (no additional radiological characterization has been conducted on the Mine site proper since 2008). The following reports present the results of the RSEs and supplemental RSEs, including the Red Water Pond Rd. and Eastern Drainage SRSEs (MWH, 2010a; MWH, 2011a):

- Removal Site Evaluation Report (MWH, 2007a)
- Results of Geophysical Survey, Memorandum (MWH, 2007b)
- Supplemental Removal Site Evaluation Report (MWH, 2008)
- Red Water Pond Road Supplemental Removal Site Evaluation Report (MWH, 2010a)
- Supplemental Removal Site Evaluation Report, Eastern Drainage Area (MWH, 2011a)
- Geophysical Anomaly Trenching Report (MWH, 2011b)
- Summary of NECR Geotechnical Data Available to Date, Memorandum (Dwyer, 2012)

The results of the two subsurface soils SRSEs conducted at the mine site and unnamed arroyo no. 1 were submitted electronically to USEPA in 2008.

Results of the Interim Removal Action and the Eastern Drainage Removal Action are presented in these reports:

- Interim Removal Action Completion Report (MWH, 2010b)
- Interim Removal Action Status Report (MWH, 2010c)
- Interim Removal Action Completion Report Addendum (MWH, 2011c)
- Construction Completion Report, Eastern Drainage Removal Action (MWH, 2013a)

A summary of the significant findings of these investigations is included below.

The RSE and SRSEs conducted through 2011 included static gamma surveying of surface soil, and sampling and analysis of surface and subsurface soils on the Mine Site and in adjacent areas (step-out area 1, unnamed arroyo no. 2, Red Water Pond Rd., and the Eastern Drainage area). Field investigation methods included scan and static gamma radiation surveys, surface soil sampling, and subsurface soil sampling, and included the following approximate numbers of samples:

- 2,350 static gamma points
- 750 surface and subsurface soil samples

The RSE Field Screening Level (FSL) for Ra-226 was 2.24 pCi/g. The scan and static gamma radiation surveys targeted Ra-226 concentrations based on a site-specific correlation between

Ra-226 concentrations in pCi/g and gamma levels in counts per minute (CPM) for each gamma meter used. The results of the gamma surveys indicated that surface soils within the initial boundaries of each of the on-site areas contained surface soils with Ra-226 concentrations above the FSL. Surface soil samples (≤0.5 feet bgs) and subsurface soils (>0.5 ft bgs) were collected from each of the survey areas, and analyzed for the preliminary constituents of potential concern (COPCs) (Ra-226, arsenic, molybdenum, selenium, uranium, and vanadium). The results showed that Ra-226 and uranium exceeded the field screening levels at some locations, while all results for molybdenum, selenium and vanadium were below their respective FSLs. The arsenic concentrations did not correlate with Ra-226 concentrations and there did not appear to be any spatial pattern in concentrations within the survey areas, which indicated that arsenic is not associated with the past mine activities

Based on the results of investigations in the area north of NECR-1 around the home sites (Step-out Area No. 1), USEPA conducted a removal action in 2007 of soils around three of the home sites that showed exceedance of the FSL. The USEPA removal action was initially limited to a 0.5-acre area surrounding each home site; however the extent of excavation was expanded in the field. After the soils were excavated, USEPA conducted a final gamma survey and soil sampling of the excavated areas, and then backfilled the areas with clean soil, where required, and revegetated the areas (Ecology & Environment, 2007). Approximately 5,000 cubic yards of soil were excavated by USEPA and disposed of off-site by GE/UNC.

Subsequent to the USEPA removal action, the USEPA issued a *Request for a Time-Critical Removal Action* memorandum (USEPA, 2007) to UNC for cleanup of soils exceeding 2.24 pCi/g in the larger area around the home sites (Step-out Area No. 1) and in the unnamed arroyo no. 1. The Interim Removal Action (IRA) was conducted in 2009 and 2010, and surface and subsurface soils containing Ra-226 above the action level of 2.24 were removed from Step-out Area No. 1 and from unnamed arroyo no. 1, consistent with MARSSIM. The results of the IRA were confirmed by a Post-IRA Status Survey of the step-out area and a Final Status Survey of the arroyo consisting of gamma surveying, soil sampling and analysis (MWH, 2010c; MWH, 2011c). Approximately 100,000 cubic yards of soil were removed from the IRA areas, and stockpiled on the NECR-1 pile. In addition NECR-1 was regraded to direct runoff from the top surface to Pond 3 and was covered with clean soils and revegetated (MWH, 2010b).

In 2011 a SRSE was conducted in the area east of Red Water Pond Rd., referred to as the Eastern Drainage area. The SRSE consisted of direct gamma radiation surveying, soil sampling and analysis, and development of a revised correlation, similar to the previous SREs. The results of that investigation indicated the presence of surface and subsurface soils containing Ra-226 above 2.24 pCi/g (MWH, 2011a). Consequently, USEPA issued a *Request for a Time-Critical Removal Action at the Northeast Church Rock Site Drainage East of Red Water Pond Road (Step Out Area #2)* (USEPA, 2011). In response to that request, GE/UNC conducted a Removal Action of the Eastern Drainage area in 2012, as described in the *Construction Completion Report, Eastern Drainage Removal Action* (MWH, 2013a). Approximately, 30,000 cubic yards of soil were removed from the Eastern Drainage area, and a small area within the previous IRA area, and stockpiled on the NECR-1 pad (soils with Ra-226 only) and the TPH Stockpile (soils with commingled TPH and Ra-226).

During soil excavation activities conducted in 2009 during the IRA, hydrocarbon impacts were observed in soils and bedrock along the southern edge of the IRA excavation area and beneath the northern portion of the NECR-1 pad. Analytical testing of soil samples demonstrated that material was predominantly diesel-range petroleum hydrocarbons. Soil and bedrock beneath the NECR-1 pad and in step-out area no. 1 were then investigated in order to estimate the vertical and lateral extent of TPH impacts, as described in the document *Petroleum Investigation Results and Bioventing Pilot Study Plan* (MWH, 2010d). A bioventing pilot study was conducted (MWH, 2011d), which recommended bioventing and monitored natural attenuation to remediate TPH-impacted soils. At the direction of USEPA, surface soils that had been left in place in step-out area no. 1 during the IRA that contained commingled TPH and Ra-226 were excavated during the Eastern Drainage Removal Action (MWH, 2013a). Approximately 4,000 cubic yards of TPH-impacted soil were excavated in 2009 during the IRA and another approximately 3,700 cubic yards were excavated in 2012 during the EDRA. The excavated TPH-impacted soils were placed in the TPH Stockpile Area located south of Pond 3, as shown on Figure 1-2.

Soils were collected from test pits advanced at the Mine Site in 2011 for testing of geotechnical engineering parameters and summarized in the memorandum *Summary of NECR Geotechnical Data Available to Date* (Dwyer, 2012). The samples were submitted to an engineering laboratory and tested for Standard Proctor, moisture content, bulk density, volume change parameters and hydraulic properties. The data were collected to support design of the Removal Action to evaluate remolding parameters and volume changes due to excavation, transport and placement of the soils in the Mill Site repository.

A geophysical survey was conducted at the NECR mine site in 2006 using two surface geophysical techniques: magnetic and electromagnetic induction. The results of that investigation were described in the memorandum *Results of Geophysical Survey, Northeast Church Rock Mine Site* (MWH, 2007b). The results showed 57 point locations with magnetic anomalies. Excavation of test trenches was then conducted at the locations of selected anomalies as a Supplemental Removal Site Evaluation (SRSE). The objective was to conduct a visual survey and to characterize the types of materials causing the anomalies from these areas. Approximately two locations per general area in which the anomalies were detected were selected as representative of the anomalies observed, based on their strength, size and location, for a total of 16 test trenches. Two additional test trenches were added based on anecdotal information regarding additional buried debris. During the test trenching, some type of metallic material was observed in at least one trench in each area, with the exception of Vent Holes 3 and 8, where no metallic objects were observed. The Boneyard contained a large quantity of metallic material, mostly consisting of hoist cables, empty fire extinguishers, rusted empty barrels, wire mesh, rusted empty one-gallon refrigerant cans, and steel-reinforced cloth. In other areas, metallic objects were primarily single isolated objects or a few small objects together, consisting of hoist cable, electrical cable, iron pipe, wire mesh, rusted barrels, a culvert and other scrap metal. The quantity and size of these materials within each area was generally small.

1.4 IDENTIFICATION OF SUPPLEMENTAL DATA NEEDS

A preliminary basis of design and identification of the major design elements was developed based on the performance criteria described above. The basis of design and existing data were reviewed to identify data gaps and supplemental data needs. The existing data were evaluated for completeness with respect to the level of data necessary to design each element of the RA at the mine site. A summary of the basis of design, available data, and potential data gaps is included in Table 1-1. The results of this evaluation identified additional pre-design data needs for the mine spoils, soil and debris removal at the Mine Site, which are described below.

The supplemental data needs identified to design the RA at the Mine Site are divided into four types: (1) radiological characterization of mine spoils to confirm the removal action area footprint, volume of potentially clean soil at the mine site, average Ra-226 concentrations in soils removed from the step-out areas and volume of PTW; (2) inventory of solid waste, mine debris and fixed structures (mine debris) and potential buried insulation material; (3) evaluation of soil geotechnical properties; (4) RCRA hazardous waste characteristics of stockpiled soils containing total petroleum hydrocarbons commingled with Ra-226.

As part of the predesign studies, a surface gamma radiation survey will be conducted along the FSL boundary to confirm the lateral extents of the RA soil excavation areas. This will be conducted in selected areas where uncertainty in the exact location of the RA boundary exists based on the RSE results.

Some of the soils at the Mine Site that were used to construct mine facilities and from drilling of the shaft and vents consist of clean, native soils. These soils are primarily present within portions of the NECR-1 and NECR-2 pads, particularly around the mine shafts. A significant volume of clean material may also be present within the road that leads north out of the NECR-2 pad towards the Sediment Pad, and the berms downstream of Ponds 1, 2 and 3 (see Figure 1-2). The RSE results (MWH, 2007a) indicated the presence of these clean materials, but were not sufficient to estimate the extent or volume for the design of the RA.

The majority of the soils removed during the interim actions contained Ra-226 concentrations at or near the 2.24 pCi/g RAL. Composite soil samples will be collected of these soils from select areas on the NECR-1 pad to evaluate the average Ra-226 concentrations to assist with the removal design.

As discussed previously, the *Request for Time-Critical-Removal Action* (USEPA, 2011) requires that PTW be disposed of offsite and not placed within the repository to be built at the Church Rock Mill Site. Surface and subsurface analytical results from the RSE (MWH, 2007a) indicated the presence of PTW at some locations, as shown on Figure 1-3. Those locations where PTW was identified primarily consisted of single sample locations with the next closest sample location indicating Ra-226 and total uranium concentrations below PTW values. Additional samples will be collected for screening and analysis near the existing PTW locations to more accurately calculate the volume of PTW for design of the RA.

As discussed previously, the Mine Site included a number of buildings, such as the magazine building, and other structures made of concrete and/or metal (e.g., vent and shaft openings and auxiliary equipment, tank stands, etc.). Additionally, there are other items located at the ground surface, such as power and telephone poles, telephone junction boxes, fencing/gate material and miscellaneous loose debris (scrap metal and concrete at the ground surface). Previous site surveys have noted these materials, but a comprehensive survey of the location, nature and size or volume of these materials has not been conducted. Current pre-design plans include placing all of the mine debris into the waste repository at the Mill Site. As such, it is necessary to develop a complete inventory of the location, nature and quantity or volume of these materials.

In February 2008, UNC conducted a video survey of several mine vents and the two mine shafts (NECR-1 and NECR-2). However, the condition and extent of the vent and shaft covers and related structures was not fully documented. In order to determine what the final disposition of the vents, shafts and related structures, it is necessary to inventory and document the condition of these structures. Shaft 1 at the NECR-1 pad is covered with soil and is currently inaccessible; therefore inspection of this shaft will be conducted during the RA construction once the overlying soil is removed.

Within the northeastern corner of Pond 1, anecdotal evidence (UNC, personal communication) indicated that building insulation material made of vermiculite was buried a few feet below ground surface near Pond 1. Vermiculite is a hydrous, silicate mineral similar to biotite and is often geologically associated with asbestos. If asbestos is present in this insulation material, it will be necessary to remove the material as per OSHA Construction Asbestos Standard 29 CFR 1926.1101 to ensure worker safety and proper handling and disposal. Therefore, an attempt will be made to locate and collect samples of this material for analysis of asbestos fibers.

The volume of impacted soils at the Mine Site has been determined based on the in-situ density of the soils. This density may be different from the density at which the materials will be placed in the repository, resulting in a change in total volume of the soil materials as placed. Depending on the material type (clay, sand, or gravel) and the in-situ density, the materials could either increase or decrease in volume as they are excavated, transported to the repository, and compacted in the waste repository. Additional soil geotechnical testing is necessary to estimate the expected volume change between excavation and transport and placement of the soils in the repository.

1.5 REPORTING

Technical calls – GE/UNC and their consultants will hold at least two technical calls with the Agencies prior to and during implementation of the field activities. Additional calls will be held as necessary. The Agencies will be contacted at least 14 days prior to commencing any field activities at the Mine Site associated with this work plan.

Laboratory reports and electronic files – Copies of the validated laboratory reports will be provided to the Agencies with the Final Report described below or sooner, if requested. The USEPA will also be provided with electronic copies of relevant tabular and spatial data as Excel® files and ArcGIS® shape files. Maps will also be provided in PDF format.

Pre-Design Studies Report – the results of the Pre-Design Studies will be included in the Design Work Plan, which will be submitted to the agencies no later than 90 days after approval of the Pre-Design Studies Report for the Church Rock Mill Site. The following information will be included:

- a summary of the investigations performed and results of the investigations
- a narrative interpretation of data and results
- resultant design parameters and design criteria
- conclusions and recommendations for the repository design
- a summary of validated laboratory test data
- data validation reports and laboratory data reports
- results of statistical and modeling analyses
- copies of field notes and log books
- photographs documenting the work conducted

2.0 FIELD SAMPLING PLAN

2.1 SAMPLING RATIONALE AND OBJECTIVES

The pre-design studies include radiological characterization activities and solid waste or mine debris characterization activities. This section describes the sampling rationale and objectives of each of the planned pre-design field activities. The equipment, procedures and methods that will be used to collect the field data are described in Sections 2.2 through 2.4.

2.1.1 Volume of Potentially Clean Material

In order to estimate the extent and volume of clean materials, drilling and sampling will be conducted in the following areas:

- NECR-1 pad
- NECR-2 pad
- Access road that leads north from the NECR-2 pad
- Berm downstream of Ponds 1 and 2
- Berm downstream of Pond 3

Additionally, sample locations have been included in the eastern end of the NECR-1 pile where soils excavated from the IRA were placed. These locations are included in order to evaluate average Ra-226 concentrations in those soils.

Proposed sample locations are presented on Figure 2-1. Sample locations were selected judgmentally based on the area of concern, existing sample locations, and topographic constraints. Locations were selected at a spacing of approximately 150 to 200 feet from each other or other existing sample locations, similar to the spacing used for subsurface sample locations advanced during the supplemental RSEs (see Appendix B). The actual location of each sample point may change in the field based on access limitations, observed field conditions, and discussions with UNC personnel.

2.1.2 Volume of Principal Threat Waste

The volume of principal threat waste will be evaluated in the field by drilling, screening and soil sampling at locations adjacent to the RSE sampling locations that indicated the presence of PTW, as shown on Figure 2-1. Up to three sample locations will be placed around each location where PTW is expected based on the RSE and SRSE results (see Figure 1-3 and Appendix B). Drilling will continue to the base of mine spoils as determined by visual observation and/or until gamma screening indicates that the interval of PTW material has been identified. Soil samples will be collected for field screening and laboratory analysis to estimate the vertical and lateral extent of PTW.

2.1.3 Removal Action Boundary Survey

In order to confirm the location of the RA boundary, a gamma survey will be conducted along selected portions of the FSL boundary that was developed based on the RSE (MWH, 2007a). The survey will consist of a walk-over survey to screen for the location of the RA boundary. Then static gamma measurements will be collected to confirm the walkover survey results. This gamma surveying will be conducted before excavation along the RA boundaries begins.

2.1.4 RCRA Hazardous Waste Characteristics

Soil samples will be collected from the TPH Stockpile for analysis of RCRA hazardous waste characteristics (toxicity, ignitability, corrosivity and reactivity). Two samples will be collected as 4-point composites and homogenized in the field prior to shipment to the laboratory. Both sets of samples will be collected to be representative of the soils present in the stockpile based on visual observation of the soils.

2.1.5 Engineering Properties of Mine Spoils

In order to determine the potential increase or decrease in volume resulting from excavation of the soils and placement in the repository, soil sampling and testing for geotechnical properties of the soils will be conducted. Borings will be drilled at select locations at the Mine Site, in order to collect samples of materials that are subject to changes in volume after excavation, transportation, and placement in the repository. The proposed boring locations are shown on Figure 2-1.

2.1.6 Nature and Volume of Mine Site Debris

An inventory of known surface and subsurface debris and solid waste present over the full extent of the RA area will be prepared based on existing data collected during the RSE and SRSEs at the Mine Site and additional site reconnaissance conducted under this work plan. These data will be integrated with data collected from excavation of test trenches that were conducted at the Mine Site in April 2011 as part of a Supplemental Removal Site Evaluation (SRSE). The April 2011 SRSE included a trench to characterize the types and density of materials present that caused geophysical anomaly signals during a geophysical survey of the site in 2006 (MWH, 2007b).

During the site reconnaissance, an attempt will be made to locate any unknown vent locations and inspect all vent locations and Shaft #2. The condition of Shaft #1 will be evaluated during construction of the RA. UNC maintains historical mine maps that show the location of the vents and shafts, and those maps will be used to supplement the site reconnaissance. The condition of each vent and Shaft #2 will be documented, with particular emphasis on the condition of the caps or plug at the vent and shaft openings. This information will be used in the design to evaluate if grade changes require adjustment of the shaft and vent caps, as well as the need for any additional or rehabilitation of shaft or vent caps or plugs.

The integrated data from the two activities described above will be used to estimate the nature and volume of non-earthen solid waste and fixed mine structures that are present within the RA area. The report will provide details necessary to evaluate the feasibility and requirements for removal of these materials and placement within the repository at the Mill Site. It will also provide details necessary to understand how to remove the fixed structures, if required (e.g., vents and buildings).

2.1.7 Presence of Potential Asbestos Containing Material

The volume and nature of the reportedly buried insulation material will be estimated by advancing test pits in the area where the material is expected to be present. If vermiculite material is encountered, trenching will be continued to determine the vertical and lateral extent of the material. If vermiculite material is not encountered in the initial test pit, four additional test pits will be excavated approximately 5 to 15 feet outside the limits of the initial test pit. If vermiculite insulation is encountered, samples of the material will be collected for analysis of asbestos fiber counts.

2.2 FIELD SAMPLING EQUIPMENT AND PROCEDURES

The field sampling equipment and procedures that will be used for the pre-design activities will be consistent with the *Final Removal Site Evaluation Work Plan* (MWH, 2006). SOPs discussing the equipment, methods and procedures that are specific to this scope of work, including updates to existing SOPs are described in detail in Appendix A.

2.2.1 Subsurface Soil Sampling

Boreholes for screening and collecting subsurface soil samples will be advanced using a hollow-stem auger rig in accordance with and MWH SOP-01, *Hollow Stem Auger Drilling, Sampling, and Cone Penetration Testing*. Drilling and sampling will be conducted as follows:

1. The borings will be drilled to native, undisturbed soils or bedrock, or to practical auger refusal based on visual observation and gamma screening to confirm that clean materials are encountered
2. The materials encountered during drilling will be logged (from both auger cuttings and discrete samples) in accordance with MWH SOP-17. General field conditions and photographs will also be logged in accordance with MWH SOP-14.
3. Discrete soils samples will be collected during drilling at each boring location at a maximum frequency of every five feet, using a continuous (dry-core) sampler and/or a 2.5-inch outside diameter California-type sampler (split-spoon), in accordance with MWH SOP-07.
4. Soil samples will be collected for gamma screening, chemical analysis, or geotechnical testing according to the analytical program described in Section 2.4, and summarized Table 2-1. Gamma screening.

Boreholes advanced for evaluation of clean soils, IRA soils and/or PTW, will be screened in the field following the ex-situ gamma screening procedure described below in Section 2.2.2. Samples will be collected for ex-situ gamma screening a minimum of every 5 feet bgs screened using. A minimum of one sample per borehole will be collected for laboratory analysis of Ra-226. The sample will be collected across an interval that is representative of the soil encountered at that location.

Within boreholes where gamma screening suggests the presence of Ra-226 near or above 200 pCi/g (PTW), two samples will be collected for analysis of Ra-226 and total uranium. One sample will be collected where the highest concentration of radionuclides is indicated by the gamma screening, and one sample will be collected beneath the PTW interval in order to confirm the vertical extent of PTW.

If levels of Ra-226 above 200 pCi/g are encountered based on the gamma screening, a composite sample of soils across the identified PTW interval will be prepared in the field, and submitted to the laboratory for analysis of Ra-226 by USEPA Method 901.1 and for total uranium by USEPA Method 6020.

Subsurface soil samples collected from the TPH Stockpile for compositing will be collected using the methods described in SOP-07. The 4-point samples will be mechanically blended in the field as a composite before being put into the appropriate sample container.

2.2.2 Subsurface Soil Screening

Selected subsurface soils collected during drilling for radiological characterization will be field-screened using an ex-situ gamma screening method to estimate the Ra-226 activity, as detailed in AVM-SOP-4. This field soil screening procedure consists of measuring 609 KeV peak gamma radiations, which indicates the Ra-226 activity based on the radiological decay chain. A single channel analyzer (SCA), such as Ludlum L221 integrated with a Ludlum 44-20 3x3 NaI scintillation detector is used to measure radiation of a particular energy (e.g., 609 KeV). A reference sample and subsequent investigation samples are placed in a heavily shielded counting chamber (plastic bag lined 1.5 inch thick x 7.5 Inch ID x 12 inch tall lead ring collimator with a 1.5 inch thick lead bottom shield). The heavily shielded counting chamber lowers the background counts thus selectively measures the activity in the sample. The 3x3 NaI detector lined with a plastic sheet is then placed on the sample inside the chamber and 609 KeV gamma radiation counts are obtained. The reference sample is soil sample collected from the Site that has a known Ra-226 activity from laboratory analysis. A sample with a Ra-226 activity of approximately 2.0 pCi/g will be used (conservatively below the RAL of 2.24 pCi/g). The count rate of the screening samples (cpm) is then compared to the reference soil count rate, which provides an estimate of the screening sample Ra-226 activity.

2.2.3 Subsurface Sampling of Potential Asbestos Containing Materials

Sampling of potential ACM will be conducted using the procedures described here and in general accordance with the procedures described in MWH SOP-07, *Soil Sampling*. Sampling and handling will also be conducted using the safety procedures described in the HASP for investigation of potential ACM.

A test pit will be excavated using a backhoe or an excavator in the area that reportedly contains buried insulation material, in accordance with SOP-08, *Trenching and Test Pits*. The test pit will extend no deeper than 10 feet and no longer than 25 feet in attempt to locate the insulation material over a general area (i.e., only an approximate location of the material is known). If insulation material or other ACM material is not encountered in the initial test pit, up to four additional test pits will be excavated approximately 5 to 15 feet outside the limits of the initial test pit. If insulation material is encountered, a minimum of three distinct samples of the material will be collected. If the material is heterogeneous or more than one volume of suspect material is encountered more samples will be collected that are representative of the material(s). Collection of all samples will be conducted using wet methods in order to minimize the amount of potential ACM asbestos fiber release (e.g., spraying the material and excavation during the work). All sampling tools will be decontaminated between uses in order to prevent cross-contamination, in accordance with SOP-31, *Equipment Decontamination*. The following steps shall be taken to collect samples of potential ACM:

1. Prior to sampling, document the nature and location of the material, including the following:
   - Describe and illustrate the material on the test pit log, including color, texture, shape and size of material particles. Or other information that indicates what kind of product it is.

- Classify the material as thermal insulation or a miscellaneous material
- Record its location with a GPS
- Take several photographs of the material

2. Determine the number of samples to be collected from each homogenous material. The general rule of thumb for thermal insulation material is to collect a minimum of three samples per homogenous material volume.

3. Determine the sample locations judgmentally based on the volume and location of the material (i.e., representative of the material based on visual observations and spread out over the extent of the material).

4. Collect the sample using a sample tool and place it in a sample container (a small resealable bag).

The samples will be packaged and shipped in the same manner as the soil samples, which is described in Section 2.3.4.

2.2.4 Field Quality Control Samples

Equipment rinsate samples and field replicates will be collected for all soil sampling events. Field replicate soil samples will be collected as splits of the original grab sample at a rate of five percent for the primary laboratory.

Equipment rinsate blanks will be prepared daily when non-dedicated, reusable sampling equipment are used for collection of samples for chemical laboratory analysis (e.g., split-spoon samplers). At the end of each day, the sampling team will take one equipment rinsate sample from each set of non-dedicated sampling equipment just before its final use. Each equipment rinsate sample will be identified in the field log with the team members, date, sampling equipment and associated samples specific to that team's field decontamination procedure on each day. The rinsate sample sets will be submitted to the laboratory with the associated field samples. Equipment rinsate samples will be collected at a frequency of one each day per chemical analysis type. Rinsate samples will be prepared and collected as follows:

- Prepare a sample container to be used for the rinsate blanks.
- Pour contaminant-free reagent-grade water directly over the decontaminated equipment and into the sample containers.
- Label and transport the samples to the analytical laboratory using the same procedures used for primary samples.
- Analyze the rinsate sample for the same analytes as the associated field samples.

The laboratory will conduct the analyses of rinsate blanks in an identical fashion to the associated field samples. In other words, aqueous rinsate blank samples for soil samples will be prepared and analyzed as soil samples using the same analytical method and reported accordingly.

2.2.5 Decontamination Procedures

All soil sampling equipment will be cleaned and decontaminated prior to use at each location. Additional details on decontamination procedures are located in SOP-31. Large equipment such as drill rig augers and excavator buckets will be decontaminated using a pressure washer. Smaller equipment such split-spoon and continuous samplers will be decontaminated as follows:

- Wash the equipment in low- or non-phosphate detergent (e.g., Alconox® or Liqui-Nox® solutions made as directed by the manufacturer)
- Rinse with dilute nitric acid
- Rinse with potable water
- Rinse twice with deionized or distilled water

Rinse water will be handled as Investigation Derived Waste (IDW).

The drilling rig and any support vehicles will be decontaminated, screened and inspected prior to leaving the Mine Site.

2.2.6 Disposal of Investigation Derived Waste

Generation of IDW such as equipment decontamination wastewater, rinsate, soil cuttings, sample containers, and personal protective equipment (PPE) will be minimal. Soil cuttings generated from excavation of test pits and from drilling at NECR-1 will be put back into the test pits and boreholes once excavation or drilling is complete at each location. Any residual cuttings will be evenly spread on the ground surface on top of the test pit or drill hole from which they came. If additional backfill material is necessary, clean soils will be imported from the UNC property and used to backfill the remainder of the borehole or excavation.

Solid IDW, such as PPE will be characterized, as necessary, and disposed of in accordance with State and Federal Regulations. Liquid IDW will be discharged into the lined decontamination sump located at the Mine Site and allowed to evaporate.

2.3 SAMPLE DOCUMENTATION AND DESIGNATION

2.3.1 Field Notes

On-site staff will use a weather-resistant, bound, survey-type field logbook with numbered, non-removable pages to record in black or blue indelible ink all pre-design field activities including soil sampling, trenching, drilling, etc. Daily information will be recorded as described in MWH SOP-14, *Field Documentation*, and include at a minimum the information listed below.

- Dates and times
- Name and location of the work activities
- Weather conditions
- Personnel, subcontractors and visitors on site
- Sample/locations and methods (including sampling equipment)
- Time of sample collection, and sample depths
- Samples submitted to the laboratory for analyses

- Sample type (e.g., gamma measurement, soil, rinsate water, co-located, or trip blanks)
- Name of carrier transporting the sample (e.g., name of laboratory and shipping carrier)
- Photograph numbers and descriptions (if applicable)
- Description of decontamination activities
- Schematic drawings of sample locations (if not done on field forms)
- Any deviations from the field sampling plan
- Health & Safety meetings, including topics discussed and attendees
- Accidents, including near misses
- Problems and corrective actions
- Field equipment calibration details
- Investigation Derived Waste inventory
- Other relevant observations as the field work progresses

The locations of boreholes and observations during recon will be surveyed with a hand-held GPS accurate to within three feet, in accordance with MWH SOP-10.

Observations made during site reconnaissance of site debris and fixed structures will be documented with a written description, photographs and recording the coordinates of the object(s) using a GPS. Location coordinates will consist of multiple points for objects that are large. Documentation will include an estimate of the volume of material present and information about whether and how the object is fixed to the ground. This information will be used to determine the nature and volume of material that will be placed in the waste repository and or left on-site and allow determination of how it will be removed and transported, if required.

2.3.2 Sample Labeling and Designation

All samples will be labeled in a clear, precise way for proper identification in the field and for tracking in the laboratory. The samples will have identifiable and unique numbers. Detailed sampling handling procedures are provided in SOP-06, *Sample Management and Shipping*. At a minimum, the sample labels will contain the following information:

- Facility name
- Sample identification
- Sample depth
- Date of collection
- Time of collection
- Initials or name of person(s) collecting sampling

A coding system will be used to uniquely label and identify each sample collected. The system will allow for quick data retrieval and tracking of all samples. The sample designation will be recorded on the sample label and logbook, and will comprise three parts or fields. Samples will be numbered sequentially for each type of sample collected (i.e., surface sampling, soil boring, field gamma measurement).

Samples IDs will consist of two parts.

Part 1 will be designated as the survey area:

- NECR1
- NECR2

- POND12
- POND3
- SAND1
- SAND2
- SAND3
- SEDPAD
- NEMSA
- YARD
- MAG

Part 2 will be a field that begins with alphabetic characters that identify the type of sample. Sample-type codes include the following:

- ER = equipment rinsate blank
- SS = surface soil
- SB = soil boring
- TP = test pit
- GM = gamma measurement
- WP = wipe sample
- TB = trip blank
- RB = rinsate blank sample

Three digits will follow the alphabetic character(s) of Part 2 and will be sequential (e.g., "001" for the first sample location collected, "002" for the second sample location collected, "003" for the third sample collected). In the case of a soil boring or test pit sample, Part 2 will end with the depth interval, referenced to below ground surface (bgs) in parentheses.

As an example, sample designation NECR1-SS004(0-0.5') is the 4th surface soil sample collected from 0 to 0.5 feet bgs from NECR-1. Replicate samples will be hidden from the laboratory by using a "200" identifier in the sample designation. The replicate sample designation for the example described above would be NECR1-SS204(0-0.5').

2.3.3 Chain-of-Custody

Each sample and/or measurement will be properly documented to facilitate timely, accurate, and complete analysis of data. The documentation system is used to identify, track, and monitor each sample or measurement from the point of collection through final data reporting. Where practicable, this documentation system may be electronic. Chain-of-custody (COC) protocol will be implemented and followed for all samples. A sample is considered to be in a person's custody if it is: 1) in a person's physical possession; 2) in view of the person after taking possession; or 3) secured by that person so that no one can tamper with it.

COC forms will be used to ensure that the integrity of samples is maintained. All of the information requested on the form must be filled out, including:

- Sample number
- Date and time of collection
- Sample depth
- Analytical parameters
- Method of sample preservation
- Number of sample containers
- Shipping arrangements and airbill number, as applicable
- Recipient laboratories
- Signatures of parties relinquishing and receiving the sample at each transfer point

Whenever a change of custody takes place, both parties will sign and date the chain-of-custody form, with the relinquishing person retaining a copy of the form. The party that accepts custody will inspect the custody form and all accompanying documentation to ensure that the information is complete and accurate. Any discrepancies will be noted on the chain-of-custody form.

2.3.4 Sample Handling and Shipment

After collection, samples will be properly stored to prevent degradation of the integrity of the sample prior to its analysis. Where practicable, MWH may electronically document sample handling, preservation, and storage. Sample preservation and holding times are to be maintained from the time of sampling until the time of analysis.

All samples designated for off-site laboratory analysis will be packaged and shipped in accordance with applicable U.S. Department of Transportation regulations. Samples will be sealed in the appropriate sampling container. Sample containers will be placed in clean protective foam or bubble pack sleeves. Custody seals will be placed on each sample container after collection such that it must be broken to open the container. Sufficient packing material will be placed in each ice chest to protect the sample containers (e.g., bubble wrap or foam material).

Samples collected for geotechnical testing that will be placed in 5-gallon buckets and will contain radioactive materials. Consequently, the samples will be handled and shipped in accordance with procedures described in MWH SOP-6. The samples will be shipped to a laboratory with a license to test radioactive materials.

Sampling personnel will inventory the sample containers from the Site prior to shipment to ensure that all samples listed on the COC form are present. All containers collected from a specific sampling interval will be packed and shipped together in the same shipping container. The originals of the analysis request COC forms will be sealed in a waterproof plastic bag and placed inside the shipping container prior to sealing of the container. The cooler will be taped shut using strapping tape over the hinges and custody seals placed across the top and sides of the cooler lid. Custody seals will be used to preserve the integrity of each sample container and cooler from the time the sample is collected until it is opened by the laboratory. Two or more custody seals will be signed, dated, and placed on the front and back of the sample cooler prior to transport. Clear tape will be placed over the custody seals to prevent inadvertent damage during shipping. The tape should not allow the seals to be lifted off with the tape and then reaffixed without breaking the seal.

2.4 ANALYTICAL PROGRAM

2.4.1 Sampling Summary

This section describes the analytical program that will be used for the analysis of surface and subsurface soil samples submitted to a chemical laboratory.

Samples will be processed for three groups of analytes as listed below:

- Radionuclides
- Hazardous waste characteristics (toxicity, ignitability, corrosivity and reactivity)
- Soil engineering properties
- Asbestos

A summary of the location and anticipated quantities of samples and analyses is included in Table 2-1.

2.4.2 Radionuclides and Hazardous Waste Characteristics

Soil samples collected for analysis of radionuclides and hazardous waste characteristics will be analyzed using the following analytical methods:

- Ra-226 will be analyzed by USEPA Method 901.1
- Total uranium by SW-846 6020/200.8
- Toxicity (TCLP Metals) by USEPA Methods 6010, 7470 and 3010
- Ignitability by USEPA Method 1010
- Corrosivity by USEPA Method 9045/9040
- Reactivity (cyanide and sulfide) by USEPA Method SE Sec. 7.3.3.2/7.3.4.2

2.4.3 Engineering Property Tests

Soil samples collected for geotechnical analysis will be tested for the following parameters:

- Moisture content by ASTM D2216
- Dry density by ASTM D2937
- Standard proctor compaction by ASTM D698

2.4.4 Asbestos Analysis

Potential ACM material will be analyzed for asbestos fibers using NIOSH Method 9002 for bulk asbestos fiber analysis.

2.4.5 Analytical Laboratories

2.4.5.1 Chemical Laboratory

GE/UNC intends to continue to use Energy Laboratory, Inc. for all radionuclide and hazardous waste characteristic analyses. All analyses will be performed at the Casper, Wyoming facility. Energy Labs is a NELAC certified analytical laboratory and was previously approved by USEPA for the project. The shipping and contact information for this laboratory are as follows:

2393 Salt Creek Highway
Casper, WY 82601
Tele: (888) 235-0515

The laboratory project manager is Tessa Parke and can be reached by phone at (888) 235-0515 x3249 or by e-mail at tparke@energylab.com.

2.4.5.2 Engineering Laboratory

Samples collected for testing of engineering properties will be submitted to and analyzed by Applied Soil Technologies, LLC, located in Sparks, Nevada. The shipping and contact information for this laboratory are as follows:

56 Coney Island Drive
Sparks, NV 89431
Tele: (775) 284-5500

The laboratory project manager is Rob Valceschini and can be reached by phone at (775) 284-5500 or by email at Rob@AppliedSoilWater.com.

2.4.5.3 Asbestos Laboratory

The samples with potential ACM will be submitted to and analyzed by Assaigai Analytical Laboratories in Albuquerque, New Mexico, a National Voluntary Laboratory Accreditation Program (NVLAP) accredited lab. The shipping and contact information for this laboratory are as follows:

4301 Masthead N.E.
Albuquerque, NM 87109
Tele: (505) 345-8964

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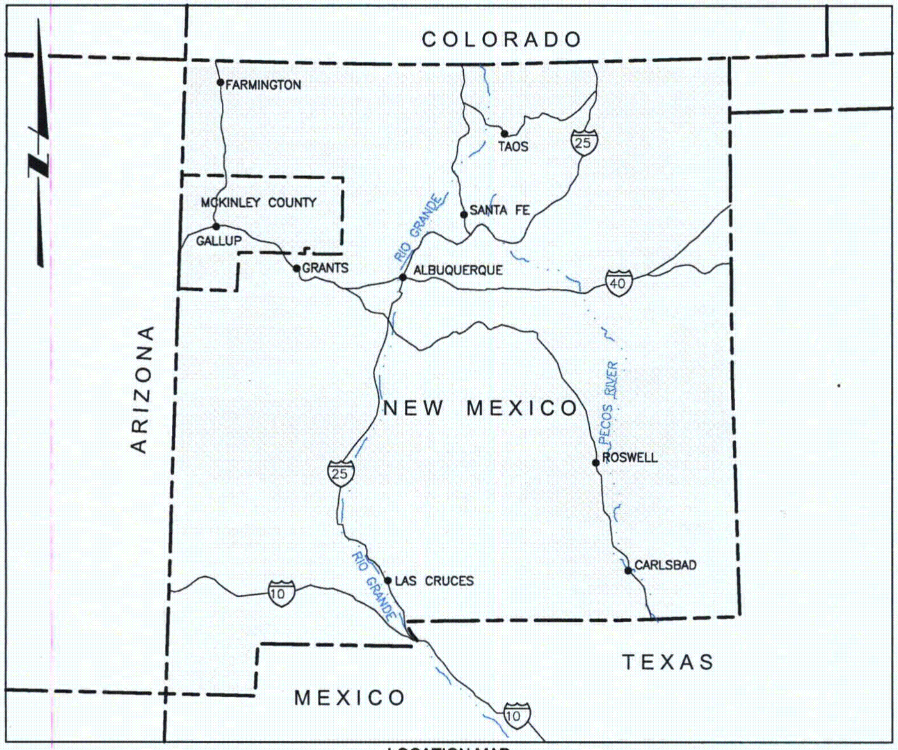
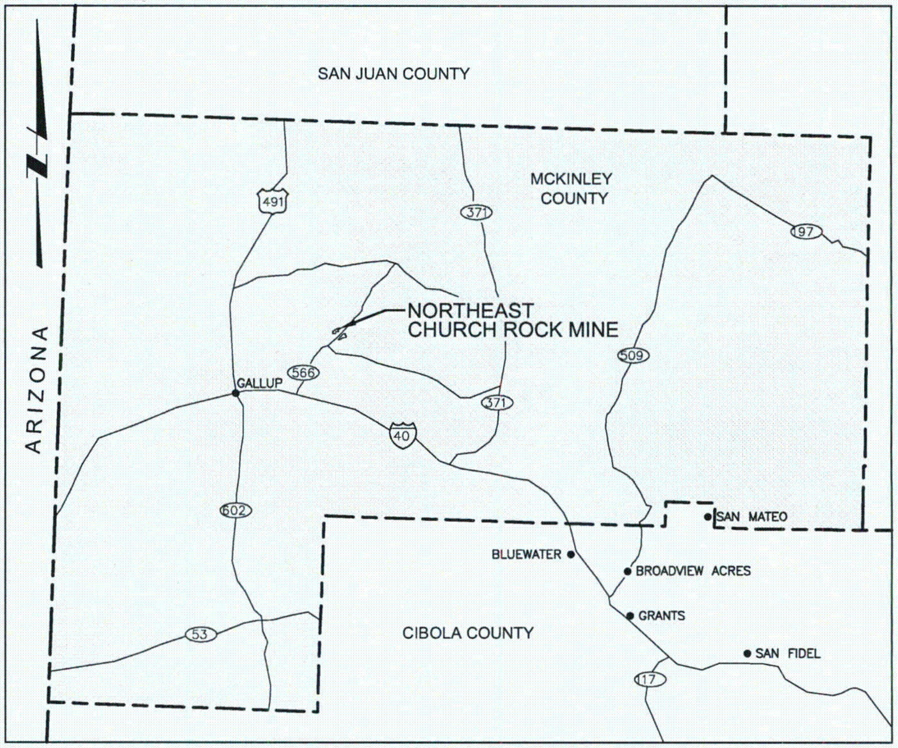
FIGURES

N:\Design-Drafting\Clients_Q-Z\United Nuclear Corporation\10502852 NECR Pre-Design Studies Work Plan\013-Sheet Set\10502852D004



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

DESIGNED BY	K JOHNSON	8/6/2013
DRAWN BY	C FOWLER	8/6/2013
CHECKED BY	K JOHNSON	8/6/2013
APPROVED BY	K JOHNSON	8/6/2013
PROJECT MANAGER	T LEESON	8/6/2013
CLIENT APPROVAL		
CLIENT REFERENCE NO		

PROJECT LOCATION: NORTHEAST CHURCH ROCK MINE

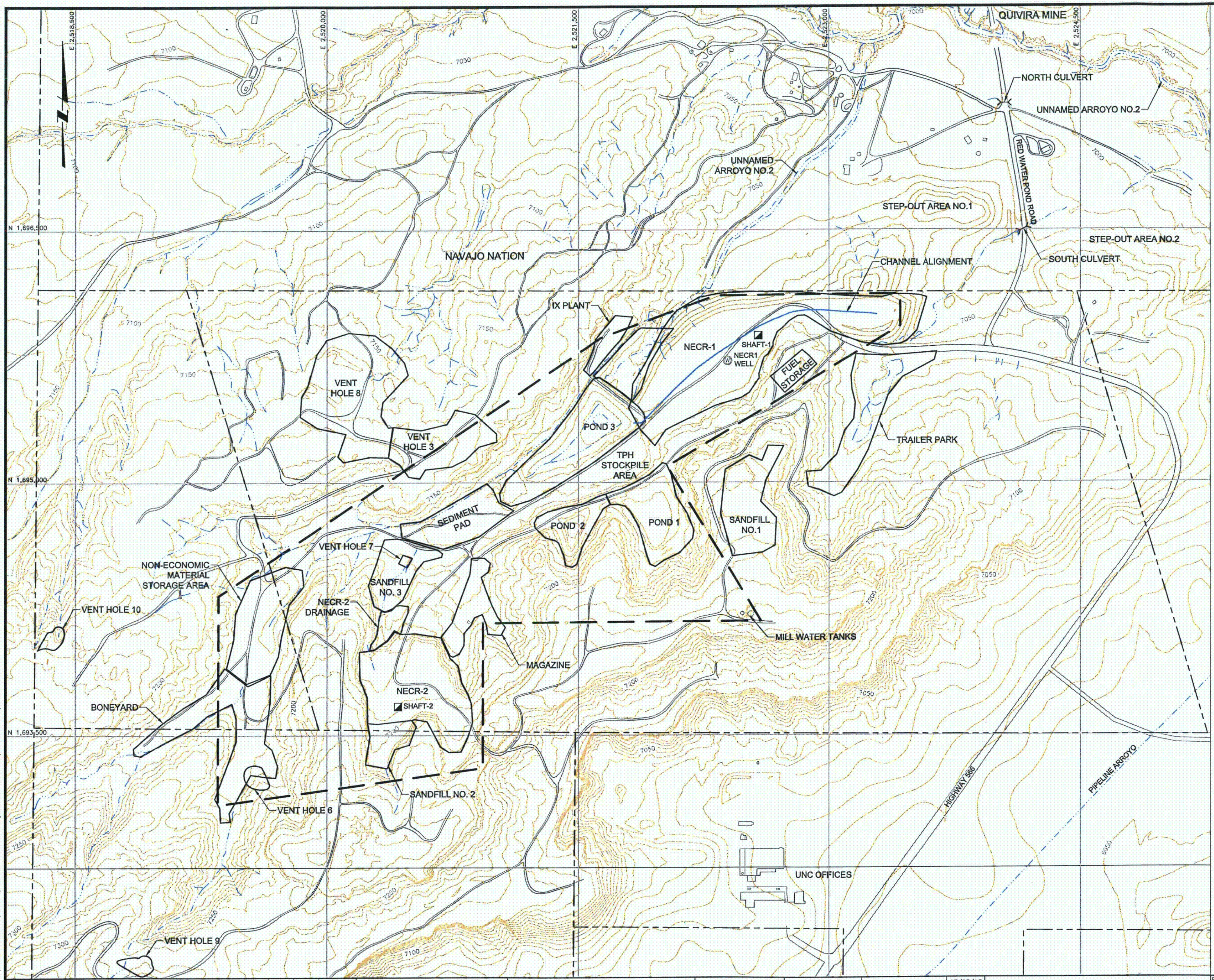
PROJECT: NECR BIOVENT DATA REPORT

TITLE: SITE LOCATION MAP

MWH

FIGURE: 1 | REVISION: 0

FILE NAME: 10502852D004



LEGEND:

- 7040 EXISTING GROUND SURFACE CONTOUR & ELEVATION, FEET
- NECR MINE PERMIT BOUNDARY
- FACILITY BOUNDARY
- APPROXIMATE NAVAJO NATION BOUNDARY
- ROADS
- NATURAL DRAINAGE
- PHYSICAL STRUCTURE
- SHAFT
- WELL

PLAN

SCALE

300 0 300 600 FEET

CONTOUR INTERVAL = 10 FEET

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	TL	08/15/13

DISCLAIMER:
THIS DRAWING WAS DEVELOPED THROUGH THE APPLICATION OF PROFESSIONAL ENGINEERING SKILL AND PROPRIETARY METHODOLOGIES, PROCESSES, AND KNOW HOW OF MWH AS AUTHOR, ALL PURSUANT TO THE TERMS OF A CONTRACTUAL SCOPE OF WORK GOVERNING ITS PREPARATION. THIS DRAWING MAY NOT BE USED OR MODIFIED OTHER THAN IN STRICT ACCORDANCE WITH THE TERMS OF THE GOVERNING CONTRACT AND SCOPE OF WORK OR OTHERWISE ABSENT THE INVOLVEMENT AND CONSENT OF THE AUTHOR. ANY ALTERATION OR ADAPTATION OF THIS DRAWING SHALL BE CONSISTENT WITH THE AUTHOR'S CONTRACTUAL AND PROPRIETARY RIGHTS AND BE AT USER'S SOLE RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY OF MWH.

DRAWING REFERENCE(S):
ORIGINAL SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED MAY 2007 BY COOPER AERIAL SURVEYS CO. AND USGS 10m DIGITAL ELEVATION MODELS (DEM).

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

DESIGNED BY	T LEESON	07/23/13
DRAWN BY	C FOWLER	07/23/13
CHECKED BY	T LEESON	07/23/13
APPROVED BY	T LEESON	07/23/13
PROJECT MANAGER	T LEESON	07/23/13
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: NORTHEAST CHURCH ROCK MINE

PROJECT: PRE-DESIGN STUDIES WORK PLAN

TITLE: NECR MINE SITE LAYOUT

MWH

FIGURE: 1-2

REVISION: 0

FILE NAME: 10502852D001

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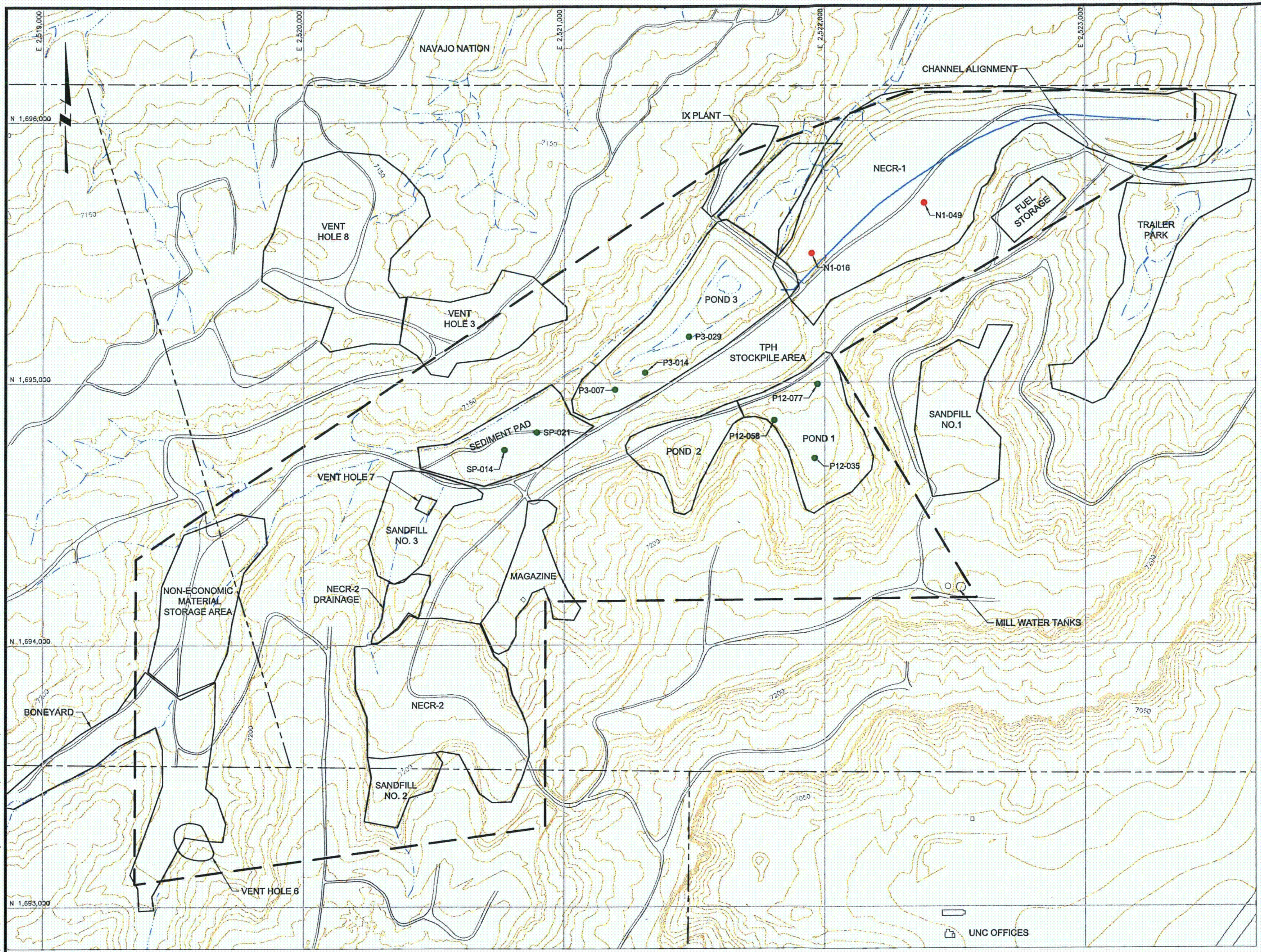

LEGEND:

7040	EXISTING GROUND SURFACE CONTOUR & ELEVATION, FEET
	NECR MINE PERMIT BOUNDARY
	FACILITY BOUNDARY
	APPROXIMATE NAVAJO NATION BOUNDARY
	ROADS
	NATURAL DRAINAGE
	PHYSICAL STRUCTURE
P12-035	RSE SURFACE SOIL SAMPLE LOCATIONS (TEST PIT)
N1-16	RSE SUBSURFACE SOIL SAMPLE LOCATIONS (SOIL BORING)

NOTES:

1. SURFACE AND SUBSURFACE LOCATIONS WITH Ra–226 >200 pCi/g AND/OR TOTAL URANIUM >500 mg/Kg SHOWN IN REMOVAL SITE EVALUATION (2007).
2. RSE = REMOVAL SITE EVALUATION (MWH, 2007).
3. FURTHER INFORMATION ON SOIL SAMPLING AND TEST RESULTS ARE PROVIDED IN MWH, 2007; MWH, 2008; MWH 2010a; MWH, 2010b; MWH, 2011. PORTIONS OF THESE REPORTS ARE INCLUDED IN APPENDIX B.

PLAN

SCALE
200 0 200 400 FEET
CONTOUR INTERVAL = 10 FEET

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	TL	08/15/13

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

DESIGNED BY	T LEESON	07/23/13
DRAWN BY	C FOWLER	07/23/13
CHECKED BY	T LEESON	07/23/13
APPROVED BY	T LEESON	07/23/13
PROJECT MANAGER	T LEESON	07/23/13
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

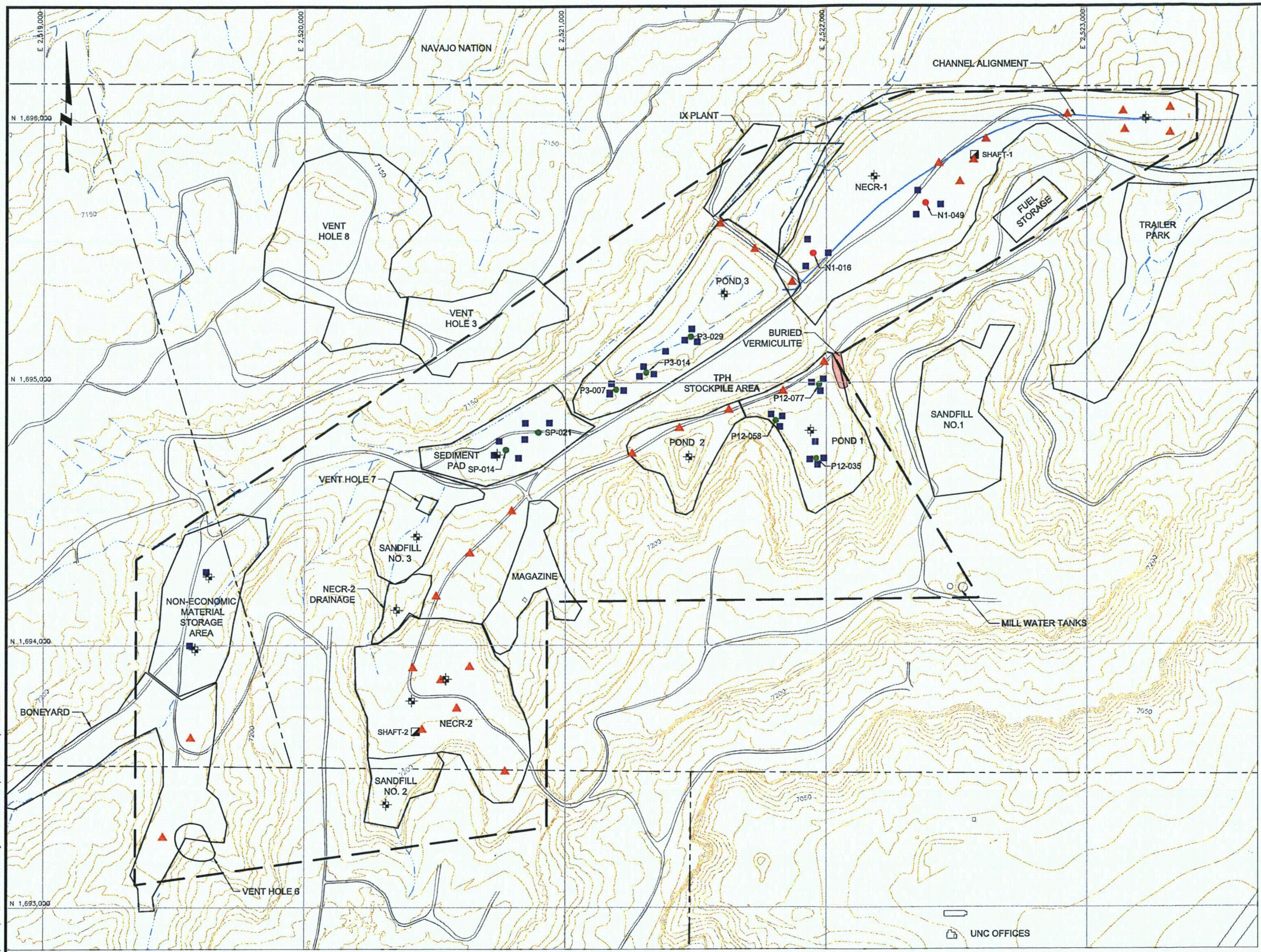
PROJECT LOCATION
NORTHEAST CHURCH ROCK MINE

PROJECT
PRE-DESIGN STUDIES WORK PLAN

TITLE
SAMPLING LOCATIONS CONTAINING PRINCIPAL THREAT WASTE

FIGURE 1-3
REVISION 0
FILE NAME 10502852D002

N:\Design–Drafting\Clients_G–Z\United Nuclear Corporation\10502852 NECR Pre-Design Studies Work Plan\013–Sheet Set\10502852D002



PLAN

SCALE

200 0 200 400 FEET

CONTOUR INTERVAL = 10 FEET

LEGEND:

- 7040 — EXISTING GROUND SURFACE CONTOUR & ELEVATION, FEET
- NECR MINE PERMIT BOUNDARY
- FACILITY BOUNDARY
- APPROXIMATE NAVAJO NATION BOUNDARY
- ROADS
- NATURAL DRAINAGE
- POTENTIALLY BURIED VERMICULITE (TEST PIT AREA)
- PHYSICAL STRUCTURE
- P12-035 — RSE SURFACE SOIL SAMPLE LOCATIONS (TEST PIT)
- N1-016 — RSE SUBSURFACE SOIL SAMPLE LOCATIONS (SOIL BORING)
- SHAFT

PROPOSED SCREENING/SAMPLING LOCATIONS[1]

- PROPOSED SCREENING/SAMPLING LOCATION FOR PTW OR DEPTH OF FSL
- PROPOSED SCREENING/SAMPLING LOCATION FOR CLEAN SOILS
- PROPOSED SAMPLING LOCATION FOR GEOTECHNICAL TESTING

NOTES:

1. PROPOSED LOCATIONS THAT ARE ADJACENT WILL BE COMBINED IN THE FIELD INTO ONE LOCATION.
2. LOCATIONS SELECTED FOR LABORATORY SAMPLES WILL BE BASED ON SCREENING RESULTS.

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
0	FINAL	CF	TL	08/15/13

DISCLAIMER: THIS DRAWING WAS DEVELOPED THROUGH THE APPLICATION OF PROFESSIONAL ENGINEERING SKILL AND PROPRIETARY METHODOLOGIES, PROCESSES, AND KNOW HOW OF MWH AS AUTHOR, ALL PURSUANT TO THE TERMS OF A CONTRACTUAL SCOPE OF WORK GOVERNING ITS PREPARATION. THIS DRAWING MAY NOT BE USED OR MODIFIED OTHER THAN IN STRICT ACCORDANCE WITH THE TERMS OF THE GOVERNING CONTRACT AND SCOPE OF WORK OR OTHERWISE ABSENT THE INVOLVEMENT AND CONSENT OF THE AUTHOR. ANY ALTERATION OR ADAPTATION OF THIS DRAWING SHALL BE CONSISTENT WITH THE AUTHOR'S CONTRACTUAL AND PROPRIETARY RIGHTS AND BE AT USER'S SOLE RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY OF MWH.

DRAWING REFERENCE(S): ORIGINAL SURFACE TOPOGRAPHY GENERATED FROM AERIAL PHOTOGRAPHS DATED MAY 2007 BY COOPER AERIAL SURVEYS CO. AND USGS 10m DIGITAL ELEVATION MODELS (DEM).

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

DESIGNED BY	T LEESON	07/23/13
DRAWN BY	C FOWLER	07/23/13
CHECKED BY	T LEESON	07/23/13
APPROVED BY	T LEESON	07/23/13
PROJECT MANAGER	T LEESON	07/23/13
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

PROJECT LOCATION: NORTHEAST CHURCH ROCK MINE

PROJECT: PRE-DESIGN STUDIES WORK PLAN

TITLE: PROPOSED MINE SITE SAMPLE LOCATIONS

FIGURE: 2-1

REVISION: 0

FILE NAME: 10502852D003

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TABLES

Table 1-1. Basis of Design Summary

Design Element	Performance Criterion	Performance Criterion Reference or Guidance[1]	Data Reference[1]	Available Data	Potential Data Gaps
Mine Site Cleanup					
Excavation of mine spoils	Remove soils and mine spoils above cleanup standard (1.14 pCi/g Ra-226 above background)	RG002	Limits established in 571, as shown on 614 390	390 provides verification of removal of tailings sand from sandfill areas.	Volume of potential clean material in specific areas at the mine site (e.g., around the shafts, roads, and pond berms. See Figure 2-1 for sampling locations. Average Ra-226 concentrations of stockpiled soils removed during the removal actions (IRA and EDRA).
Removal of mine debris	Removal of mine debris	RG002; NMED, Air Quality Bureau (RG031)	570, 612	Geophysical investigation, test trenching logs and photos. Debris at mine site approximately 15,000 to 20,000 cy. Some of this material can be compressed prior to disposal. Debris at mill site consists of tanks, timber, piping, scrap metal, concrete, etc., with approximate volume of 7,800 cy. Some of this material can be compressed during disposal.	Updated inventory of known surface and subsurface debris and solid waste present over the full extent of the RA area
Asbestos	Removal of asbestos-containing materials, if present	RG032	No reported data.	Personal communication regarding the location of vermiculite insulation material that may contain asbestos.	Volume and nature of buried vermiculite insulation material near Pond 1, and whether it contains asbestos. See Figure 5-1 for sampling locations.
Vents, shafts, and drill holes	Locate and plug all vents and shafts Plug drill holes encountered during construction	NM SMCRA	604	Memorandum and video documenting location and condition of shafts and vents.	Inventory of vents and shafts, and their current condition. Investigation of current condition of shafts and vents.
Transport of mine spoils and debris	Relocation of mine spoils and debris to repository	RG021, NMDOT	None	USEPA baseline gamma survey of Highway 566	
Disposal of Principal Threat Waste	Off-site disposal of soil or mine spoils with Ra-226 above 200 pCi/g and/or total uranium above 500 mg/kg	RG002	571, as shown on a 614	Ra-226 and/or Uranium concentration above PTW limits detected in surface and subsurface soil samples collected during the RSE.	Volume, spatial location and average concentration of Principal Threat Waste (PTW). See Figure 5-1 for sampling locations.
Final Status survey	MARSSIM release criterion, based on a 95% UCL	RG010, RG026	Background results and correlations, as reported in 571 and 605	Background, correlation and construction excavation control survey results	No field data required for design. May require updated correlation during construction.
Repository and Cover Design					
Site restoration	Attainment of erosional stability and preclusion of off-site transport of generated sediments from the mine permit area. Establish self-sustaining ecosystem consistent with pre-mining conditions.	RG023, RG001	RSE and SRSE reports 605	RSE and SRSE reports Revegetation information in 605 is sufficient as baseline information.	No field data required for design.

Notes:

(1) Performance criteria references and guidance documents are listed in Table 1-3. Project document references are provided in Table 1-2.

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Table 1-2. Index of Project Documents for the Northeast Church Rock Mine Site

Record No.	Document/Dataset	Author	Date Issued	Description
290	Discharge Plan for Northeast Church Rock Mine Backfill	United Nuclear Corp.	Feb 1979	A discharge plan for using coarse Church Rock Mill tailings for backfilling the Church Rock mine site.
390	Tailings Sand Backfill Cleanup Verification Report	United Nuclear Corp.	Apr 1989	Provides data that verify that the byproduct material from the tailings sand backfill areas and associated mine ponds were removed.
391	Cleanup of Tailings at the Northeast Church Rock Mine	United Nuclear Cop.	Oct 1989	Letter documenting the submittal and objectives of Docs. 390 and AB018.
540	Closeout Plan	MWH	30 Jan 2004	Closeout plan submitted to MMD at the State of New Mexico
560	Removal Site Evaluation Work Plan	MWH	30 Aug 2006	Initial Sampling and Analysis Plan and Quality Assurance Project Plan for Removal Site Evaluations (RSEs) at the mine site.
561	Background Technical Memorandum	MWH	11 Nov 2006	Results of surface soil sampling and analysis within background reference area to establish mean background value, and within the mine site to develop the RSE statistical correlation between gamma (CPM) and Ra-226 (pCi/g)
570	Geophysical Survey Report	MWH	11 Jun 2007	Results of magnetics (mag) and electromagnetic induction (EM) surveys that were conducted to identify subsurface geophysical anomalies within the mine site.
571	Removal Site Evaluation Report	MWH	1 Oct 2007	Results of the Removal Site Evaluation (RSE) conducted between August and December 2006, including a baseline human health risk assessment.
580	Supplemental Removal Site Evaluation Report	MWH	29 Feb 2008	Results of sampling and analysis of surface soils conducted in November 2007 as a supplement to the RSE. Document submitted only as a "draft" document.
581	Supplemental RSE subsurface soil sample results	MWH	Feb 2008	Results of sampling and analysis of subsurface soils conducted in January 2008 as a supplement to the RSE (no formal report was issued).
582	Supplemental RSE Subsurface soil sample results dataset	MWH	Apr 2008	Results of sampling and analysis of subsurface soils in additional areas conducted in April 2008 as a supplement to the RSE (no formal report was issued).
600	Amendment to the Work Plan for Evaluating Petroleum Impacted Soils	MWH	21 Jan 2010	Describes amendments to the petroleum investigation plan and the results of the initial site screening and soil sampling and analysis for TPH from the 2009 IRA petroleum excavation.
601	Red Water Pond Rd. Supplemental RSE Report	MWH	26 Jan 2010	Results of sampling and analysis of surface and subsurface soils within the area adjacent to and east of Red Water Pond Rd.
602	Bioventing Pilot Study Results	MWH	24 Feb 2010	Presents the results of a bioventing pilot study to evaluate the feasibility of utilizing bioventing to degrade petroleum hydrocarbon impacts at the site.
603	Vegetation & Wildlife Evaluations / Revegetation Recommendations, 2009 Evaluations and Planning	Cedar Creek	Feb 2010	Evaluation of vegetative conditions and revegetation potential for the 2009 IRA area, as well as a revegetation plan for the 2009 IRA.
604	Video Surveys of Mine Shafts and Vents	UNC	Apr 2010	Video and memorandum documenting location and condition of mine shafts and vents
605	Interim Removal Action Completion Report	MWH	29 Jun 2010	Summary of Interim Removal Action documenting completion of the IRA construction activities.
606	Interim Removal Action Status Report	MWH	29 Jun 2010	Results of the post-IRA status surveys verifying post-IRA cleanup in accordance with MARSSIM.
607	Petroleum Investigation Results and Bioventing Pilot Study Plan	MWH	22 Jul 2010	Presents the results of drilling, soil sampling and chemical analysis for TPH from a subsurface investigation conducted of the petroleum impacts. It also presents an analysis of remedial alternatives and a plan for conducting a bioventing pilot study to evaluate that remedial option.
610	East Drainage Supplemental Removal Site Evaluation Work Plan	MWH	7 Jan 2011	Work plan for the supplemental RSE that was conducted in 2011 within the East Drainage area.
611	East Drainage Supplemental Removal Site Evaluation Report	MWH	2 Feb 2011	Results of the supplemental RSE that was conducted in 2011 within the East Drainage area.
612	Geophysical Anomaly Trenching Report	MWH	8 Feb 2011	Results of trenching with an excavator at the location of selected geophysical anomalies identified in the 2007 geophysical survey.
613	Interim Removal Action Completion Report Addendum	MWH	4 Mar 2011	Summary of results of additional IRA activities conducted in late 2010, including soil sampling and analysis, gamma surveying, and excavation or covering of impacted soils.
614	Summary of RSE and SRSE data through Apr 2008 - maps	MWH	Apr 2008, reissued Nov 2011	Summary maps showing the results of the 2006 RSE, the 2007 supplemental RSE (surface soil), and the two 2008 supplemental RSEs (subsurface (#005 through #007 above).
620	Eastern Drainage Construction Work Plan	MWH	23 Aug 2012	Work plan for Removal Action as per USEPA AOC.
621	Eastern Drainage Removal Action Construction Work Plan	MWH	30 Aug 2012	Presents the design, methods, and construction approach for implementing the actions necessary to complete the Eastern Drainage Time Critical Removal Action (TCRA) for the Northeast Church Rock Mine Site.

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Table 1-3. Index of Regulatory and Guidance Documents for the Removal Action

Record No.	Document	Author	Date Issued
RG001	National Pollutant Discharge Elimination System Final General Construction Permit	US Environmental Protection Agency	Feb 2012
RG002	Action Memorandum: Request for a Non Time Critical Removal Action at the Northeast Church Rock Mine Site	US Environmental Protection Agency, Region 9	Sep 29, 2011
RG003	Manual on Uniform Traffic Control Devices	US Department of Transportation. Federal Highway Administration	2007
RG004	NUREG/CR-4620 Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments	US Nuclear Regulatory Commission	1986
RG005	NUREG/CR-3397 Design Considerations for Long-Term Stabilization of Uranium Mill Tailings Impoundments	US Nuclear Regulatory Commission	1983
RG006	NUREG-1620 Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978	US Nuclear Regulatory Commission	Jun 2003
RG007	NUREG-1623 Design of Erosion Protection for Long-Term Stabilization	US Nuclear Regulatory Commission	Sep, 2002
RG008	NRC Regulatory Guide 3.64 Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers	US Nuclear Regulatory Commission	Jun 1989
RG009	NUREG/CR-3533 Radon Attenuation Handbook for Uranium Mill Tailings Cover Design	US Nuclear Regulatory Commission	1984
RG010	NUREG/CR-5849 Manual for Conducting Radiological Surveys in Support of License Termination	US Nuclear Regulatory Commission	1992
RG011	Comprehensive Transportation Safety Plan	New Mexico Department of Transportation	Apr 2009
RG012	Probable Maximum Precipitation Estimates, Colorado River and great Basin Drainages Hydrometeorological Report No. 49	National Oceanic and Atmospheric Administration	1977
RG013	Final Staff Technical Position, Design of Erosion Protective Covers for Stabilization of Uranium Mill Tailings Sites	U.S. Nuclear Regulatory Commission	Aug 1990
RG014	10 CFR 20.1101 (Subpart B) Radiation Protection Programs	US Nuclear Regulatory Commission	
RG015	10 CFR 20.1301 (Subpart D) Dose Limits for Individual Members of the Public	US Nuclear Regulatory Commission	
RG016	10 CFR 20.1302 (Subpart D) Compliance with Dose Limits for Individual Members of the Public	US Nuclear Regulatory Commission	
RG017	10 CFR 40 Domestic Licensing of Source Material	US Nuclear Regulatory Commission	
RG018	10 CFR 61.51 Disposal Site Design for Land Disposal	US Nuclear Regulatory Commission	
RG019	40 CFR 192 Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings	US Environmental Protection Agency	
RG020	40 CFR 264.310 Closure and Post-Closure Care	US Environmental Protection Agency	
RG021	49 CFR 105-177	Occupational Safety and Health Administration	
RG022	Federal Register (FR) 71 National Ambient Air Quality Standards for Particulate Matter		
RG023	NMAC 19.10.5 Natural Resources and Wildlife, Non-Coal Mining Existing Mining Operations	New Mexico Administrative Code	
RG024	NMAC 20.3.4 Environmental Protection Radiation Protection Standards for Protection Against Radiation	New Mexico Administrative Code	
RG025	ASTM Section C and D Test Standards		
RG026	MARSSIM		
RG027	NMAC 20.3.13.1313 Post-Closure Observation and Maintenance	New Mexico Administrative Code	
RG028	United Nuclear Corporation Superfund Site Surface Soil Operable Unit Proposed Plan Gallup, New Mexico	US Environmental Protection Agency Region 9	Jul 2012
RG029	Technical Approach Document, Revision II. UMTRA-DOE/AL 050425.0002.	Department of Energy	1989
RG030	WSSRAP Disposal Facility Technical Specifications, Section 2300: Waste removal, Handling, and Placement. WP-437, Disposal Cell Construction.	Department of Energy	May 2000
RG031	40 CFR 61 Subpart M. National Emission Standard for Asbestos. National Emissions Standards for Hazardous Air Pollutants	US Environmental Protection Agency	
RG032	OSHA Construction Asbestos Standard 29 CFR 1926.1101	Occupational Safety and Health Administration	
RG033	Surface Mining Control and Reclamation Act		Dec 2006
RG034	NUREG-1757 Volume 2, Revision 1, Appendix P		
RG035	NUREG-3.11 Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills (rev.2)	US Nuclear Regulatory Commission	December 1977

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Table 2-1. Summary of Subsurface Soil Sampling Program

Sample Set	Sampling Method	Estimated Borehole Quantity	Estimated Sample Quantity	Sample Vol.	Container	Analytical Suite
Subsurface Soil Samples for Screening and Chemical Analysis						
NECR-1	Judgmental	15	5	1-qt	ZipLoc™	See note [1,2]
NECR-2	Judgmental	6	3	1-qt	ZipLoc™	See note [1]
Ponds 1 and 2	Judgmental	16	5	1-qt	ZipLoc™	See note [1]
Pond 3/3a	Judgmental	10	4	1-qt	ZipLoc™	See note [1]
Sediment Pad	Judgmental	6	3	1-qt	ZipLoc™	See note [1]
NEMSA	Judgmental	2	2	1-qt	ZipLoc™	See note [1]
Boneyard	Judgmental	2	2	1-qt	ZipLoc™	See note [1]
	Totals	**57**	**24**			
Subsurface Soil Samples for Engineering Tests						
NECR-1	Judgmental	3	3	5-gals	Bucket	See note [3]
NECR-2	Judgmental	2	2	5-gals	Bucket	See note [3]
Ponds 1 and 2	Judgmental	2	2	5-gals	Bucket	See note [3]
Pond 3/3a	Judgmental	1	1	5-gals	Bucket	See note [3]
Sediment Pad	Judgmental	1	1	5-gals	Bucket	See note [3]
Sandfills 1 & 2	Judgmental	2	2	5-gals	Bucket	See note [3]
NEMSA	Judgmental	2	2	1-qt	ZipLoc™	See note [3]
	Totals	**13**	**13**			
Quality Control Samples						
Field replicates	Rate of 5%	As above	5%[3]	As above	As above	See note [1]
Equipment rinsates	One per day	n/a	1/dy	1 liter	Glass Bottle	Ra-226 only

Notes:

[1] Ra-226 (USEPA 901.1) and total uranium (USEPA 6020) for PTW locations and Ra-226 only for clean soil/FSL locations.

[2] Samples will also be collected from the TPH stockpile for analysis of hazardous waste characteristics, and samples of buried insulation material will be collected for analysis of asbestos.

[3] Moisture content (ASTM D2216); dry density (ASTM D2937); and standard proctor compaction (ASTM D698).

[4] The quantity of replicates is based on the percentage indicated times the total number of samples.

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APPENDIX A

STANDARD OPERATING PROCEDURES

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APPENDIX A.1

AVM STANDARD OPERATING PROCEDURES

SOP -1
AVM Environnemental Services, Inc.
Direct Gamma Radiation Level to Ra-226 Soil Concentration Correlation
For Gamma Radiation Surveys at Uranium Mill and Mine Sites

1.0 Purpose

The purpose of this procedure is to update the Ra-226 concentrations in surface soil to direct gamma radiation level correlation for NECR Eastern Drainage IRA (Step-out Area 2). A correlation was developed and used for the Step-out Area 2 SRSE in April 2011, which was reported in the September 2011 Supplemental Removal Site Evaluation Report, Eastern Drainage Area. This correlation, for site-specific calibration of field instrumentation (2'x2' NaI scintillation detector), for determining Ra-226 concentration in surface soil by performing direct gamma radiation level survey, will be updated for Step-out Area 2 post status IRA survey to determine Ra-226 concentrations in surface soils by direct gamma radiation survey.

2.0 Scope

Ra-226 is primarily an alpha emitting radionuclide with a gamma radiation emission of 186 KeV at about 4% intensity. This low energy and intensity of the Ra-226 gamma radiation emission makes impractical to determine Ra-226 in the field by direct gamma radiation measurement. However Bi-214, a Ra-226 decay product, emits high energy gamma radiations (46.3 % intensity @ 609.3 keV, 15.1% intensity @ 1120.3 keV and 15.8% intensity @ 1764.3 keV) at a total of approximately 80% intensity. The gamma radiations of Bi-214 can be easily and accurately measured in the field utilizing a NaI scintillation detector, such as 2x2 NaI Scintillation detector having high gamma radiation sensitivity The Ra-226 levels in soil could be measured as a surrogate for gamma measurement of Bi-214 gamma radiation levels, as to the measurement described in Section 4.3.2 of the MARSSTM. Bi-214 is a decay product of Ra-226 through radon-222, a gaseous form, some of which emanates from soil. This phenomenon results in activity disequilibrium between Ra-226 and Bi-214 in the soil. The Rn-222 gas emanation fraction from the soil varies with different geometric characteristics of a particular soil. Therefore, a site-specific calibration is necessary. Previous studies have shown that about 30 to 40% of the Rn-222 gas decayed from Ra-226 in soil emanates out of the surface soil, indicating that significant (about 65%) of this would decay into Bi-214 in the soil matrix.

If the soil geometry and other parameters such as moisture, radon emanation fraction, contamination distribution profile, gamma ray shine from nearby sources, and land topography are consistent, the ratio of Bi-214 to Ra-226 would be consistent. This means there would be a direct correlation between Bi-214 gamma radiation levels and Ra-226 concentrations in the soil. The gamma radiation from other naturally occurring isotopes in soil, such as Th-232 decay products and K^{40}, may contribute to gross gamma radiation intensity. In addition, background gamma radiation from cosmic rays also contributes to gross gamma radiation intensity. However, the gamma radiation level from such naturally occurring isotopes and sources are generally at a constant level. A linear regression would identify such a constant to correct for and minimize interference with the gamma radiation level and Ra-226 soil concentration correlation.

The correlation procedure is designed to calibrate a 2"x 2" NaI scintillation detector by determining a site-specific correlation between gamma radiation level and Ra-226 concentration in soil. The gross gamma radiation intensity (count rate) will be measured at ten locations. Soil samples will be collected from these locations for Ra-226 analysis by an off-site laboratory. The locations of the soil samples and gamma radiation level measurement for correlation may be based on the predominant concentration expected in field or concentration of interest. Direct gamma radiation level or gamma radiation exposure rate measurements may be made to select sampling locations. A linear regression will be performed between gamma radiation count rate and corresponding Ra-226 concentrations in soil to determine the Correlation. The goal is to attain a correlation coefficient (r^2) of 0.8 or better.

Ra-226 contamination in soil at the NECR Eastern Drainage area varies from background level to near 100 pCi/gm distributed in surface (0-6") to subsurface soils. The removal action of the contaminated soil at the NECR is expected to change the contamination distribution and concentration to a fairly homogeneous distribution at or near the cleanup level in surface soils. Therefore, the contamination distribution assumption for correlation for remedial action support survey and final status survey will be for homogeneous distribution in surface soils near the cleanup level concentration.

3.0 Instrumentation

A 2"x2" NaI Scintillation detector (an Eberline SPA-3 or Ludlum 44-10 detector) and a Scaler/Ratemeter, (Eberline ESP-1/2 or Ludlum Model 2221) will be used for field gamma radiation level measurements and to select sampling locations. The Scaler/Ratemeter will be calibrated, using SOP-1 to assure that it properly counts the electronic pulse generated and sent by the detector. An optimum operating high voltage for the detector will be established by performing a high voltage plateau on the detector using SOP -1. The input sensitivity (threshold) of the Scaler/Ratemeter will be set @ 100 mV to avoid interference from low level background radiation. The pulses generated by the detector for gamma radiation (609 KeV) from Bi-214 are significantly higher than 100 mV, as verified by using 1% uranium ore standard.

During the excavation control survey (remedial action support survey), it is likely that the Ra-226 concentration in soil near the excavated areas is elevated. Gamma radiation shine from such areas may interfere with gamma radiation level measurement at excavated areas, as the high energy gamma radiation can travel long distance in air, up to 50 feet, before ionizing. If needed, shine interference will be reduced by placing the detector in a 0.5-inch thick collimated lead shield. In addition to obtaining a correlation for a bare (uncollimated) detector, a correlation will also be developed for a lead collimated detector by obtaining gamma radiation level measurements for both collimated and uncollimated detector at each location.

4.0 Gamma Radiation Level Measurements and Soil Sample Collection for Updating Correlation

Gamma radiation level measurements and corresponding surface soil Ra-226 concentrations data base for the updated SRSE correlation were provided in the September 2011 *Supplemental Removal Site Evaluation Report, Eastern Drainage Area*. Selective surface soil samples collected during excavation control and all of the IRA status survey, and corresponding one-minute static gamma radiation level measurements with 0.5 inch lead collimated detector will be used for updating the SRSE correlation. Soil samples will be collected using SOP-15, *Surface Soil Sampling*. Soils samples will be shipped to an off-site vendor laboratory for Ra-226 analysis using EPA gamma spectroscopy method 901.0.

5.0 Linear Regression Analysis

To determine the correlation between gamma radiation level counts and corresponding Ra-226 concentration in soil content, i.e. to determine a calibration equation, a liner regression analysis will be performed on the sample Ra-226 concentration in pCi/gm, Y, and the associated gamma radiation level count rate, cpm at X, from all the sample locations using a least-square liner regression and plotting the results.

Linear regression data will be summarized by the generalized equation:

$$Y = mX + b$$

where,

Y = soil concentration in pCi/gm,
m = slope, pCi/gm/cpm
X = count rate (the mean) in cpm
b = constant, y intercept

This correlation will provide a site specific calibration factor (m) in pCi/gm/cpm for the 2"x2" NaI detector, with a constant (b) to correct for any interference, specifically at lower range.