

TAILINGS RECLAMATION PLAN
AS APPROVED BY NUCLEAR REGULATORY COMMISSION
MARCH 1, 1991
LICENSE NO. SUA - 1475

1.0 SITE DESCRIPTION AND OPERATIONS

1.1 Introduction

This document presents the Reclamation Plan as approved by the Nuclear Regulatory Commission (NRC) for United Nuclear's Church Rock uranium mill and tailings disposal facility near Gallup, New Mexico. This Reclamation Plan represents the single, comprehensive document that incorporates the changes made to the plan since the original submittal. This plan supersedes the proposed Reclamation Plan originally submitted to the NRC in June 1987. This Reclamation Plan is submitted as required under license condition No. 34 of License No. SUA-1475, which requires that a single, comprehensive document be submitted. This document contains a description of the approved Reclamation Plan in Volume I, and the specifications and updated cost estimate, based on the composite plan, in Volume III in Appendices B and F, respectively. The original plan has been amended in various documents, which were submitted to the NRC on the following dates:

1. January 20, 1988
2. May 23, 1988
3. June 29, 1988
4. July 26, 1988
5. August 31, 1988
6. February 23, 1989
7. September 12, 1990
8. December 4, 1990
9. February 13, 1991
10. March 4, 1991

The plan was approved in March 1991 with several significant technical changes from the original plan submitted. Since United Nuclear submitted the proposed Reclamation Plan on June 1, 1987, the Reclamation Plan has undergone review with subsequent revisions. In the intervening period, United Nuclear has implemented several components of the plan, in accordance with the proposed plan as directed by the NRC via various amendments contained in the NRC License. These components are integral to the successful completion of the tailings reclamation plan. The details of these activities are discussed later in this document and in other documents incorporated into this plan by reference. These components are integral to the successful completion of the tailings reclamation plan. The details of these activities are discussed later in this document and in other documents incorporated into this plan by reference. Specifically, United Nuclear has implemented the following actions:

1. Interim stabilization of tailings, control of blowing tailings, and cleanup of wind-blown tailings in accordance with License Conditions 16 and 33;
2. Decommissioning of the mill in accordance with License Conditions 26 and 33;
3. Collection of tailings seepage in accordance with License Condition 30; and
4. Construction of an enhanced evaporation system in accordance with License Condition 32.

1.2 Site Characteristics

UNC Mining and Milling, a division of United Nuclear Corporation (United Nuclear) operated the Church Rock uranium mill and adjacent tailings disposal area (the Church Rock facility or site) near the western border of New Mexico. Uranium ore from two

proximate mine sites, identified here as the Old Church Rock (OCR) and Northeast Church Rock (NECR) mines, was processed at the mill site and discharged to the tailings disposal area from 1977 to 1982.

The United Nuclear mill and tailings disposal site is located about 20 miles northeast of Gallup, New Mexico, in McKinley County, shown on Figure 1-1. The mill is accessed via State Highway 566 from its intersection with Interstate 40 about 10.5 miles to the south of the mill. Figure 1-1 also shows the mill site location in relation to county boundaries, nearby communities, and highway systems.

The mill and tailings disposal areas are located in Section 2 of Township 16 North, Range 16 West, as illustrated on Figure 1-2. The NECR mine site is located at the northern termination of Highway 566 in Section 35, Township 17 North, Range 16 West, south of the Navajo Indian Reservation. The OCR mine site is located adjacent to Highway 566 about three miles south of the mill in Section 17, Township 16 North, Range 16 West.

United Nuclear owns the surface of Section 2, Township 16 North, Range 16 West, and Section 36, Township 17 North, Range 16 West, which adjoins Section 2 to the north. Figure 1-2 illustrates the land surface ownership status. As shown on this figure, Quivira Mining Company (Quivira) has surface facilities (vacant offices and storage) occupying an area of approximately three acres to the north of United Nuclear's land in the east half of Section 36. Quivira also has inactive mining facilities on the Navajo Indian Reservation north of the United Nuclear site.

United Nuclear's tailings disposal area occupies approximately 100 acres, and the mill facilities area occupies approximately 25 acres, as shown on Figure 1-3. The conditions depicted on Figure 1-3 are the conditions present in 1987 before implementing any reclamation activities. Since 1987, significant work has been completed, as described

in this plan. The site conditions present in the Spring of 1991 are presented on Figure 1-4. In this plan, many of the drawings are presented with the 1987 site base map, or with the conditions present before reclamation to give the reader an understanding of the scope of changes involved in the total reclamation of the site, and the progress that has been achieved in the seepage collection program. Drawings that show the conditions present in late 1990 and early 1991 are provided where appropriate to show the significant progress at the site. Attempts have been made to clearly identify the point in time depicted on the drawings. However, the reader is advised to review the drawings with caution and note what date of conditions is being depicted.

The tailings disposal area was subdivided during operations by cross-dikes into cells identified as the South Cell, Central Cell, and North Cell areas. In addition, two soil borrow pits (Pits No. 1 and No. 2) were located in the Central Cell area. Borrow Pit No. 1 was filled with tailings and has been regraded and covered. Borrow Pit No. 2 was used for storage of recovered, neutralized water extracted by the three pumping well systems (Northeast, East, and North Cross-Dike Seepage Control Systems) that operated at the locations shown on Figure 1-3.

As shown on Figure 1-4, by the Spring of 1991, the North and Central Cells of the tailings disposal area were regraded and covered, Borrow Pit No. 2 was drained, additional extraction well systems were installed, and evaporation ponds and spray evaporation systems were constructed to evaporate tailings seepage water produced by the extraction well systems. Also shown is the area where wind-blown tailings have been removed.

The United Nuclear mill and tailings disposal facilities are situated on an alluvial plain in the Pipeline Canyon at an average elevation of 7,000 feet. An ephemeral drainage channel, referred to as the Pipeline Arroyo, is situated between Highway 566 and the tailings disposal area. El Paso Natural Gas Company has a pipeline right-of-way

adjacent to the channel between the highway and Pipeline Arroyo. The Pipeline Arroyo traverses the site to a point 2.5 miles southwest of the mill site where it joins the Rio Puerco, a larger ephemeral drainage. The surrounding terrain is varied, consisting of narrow canyons, arroyos, steep cliffs, and mesas. Vegetation in the lowland area is sagebrush/grassland with transition to pinyon/juniper in the upland areas.

1.3 Climate

The United Nuclear site is situated in an arid to semi-arid continental climate with sunshine more than 50 percent of the time throughout the year. Climatological data from the site indicate that winds are generally moderate, originating from the west and southwest, parallel to the trend of Pipeline Canyon, shown on Figure 1-3. Wind frequency and velocity are usually highest during the spring. Temperatures during the year average approximately 50 degrees Fahrenheit with a maximum daily average of 68 degrees (in July) and minimum daily average of 31 degrees (in January). The annual average precipitation for the area is approximately 14 inches. The majority of the precipitation occurs during the summer. Net pan evaporation averages approximately 54 inches per year and exceeds net precipitation. A summary of the precipitation-evaporation data for the Church Rock site is presented in Table 1.1.

1.4 Mining and Milling Operations

United Nuclear began uranium milling operations in May 1977. Ore for processing was primarily obtained from two proximate underground mines, the NECR and OCR mines, owned and operated by United Nuclear. Ore from other sources, including Quivira's mine, was also processed at the mill (United Nuclear, 1987). Primary ore feed was obtained from the NECR mine from the Westwater Canyon member of the Jurassic Morrison Formation. Average ore grade of the mill feed was about 0.12 percent U_3O_8 .

The United Nuclear mill employed a conventional acid leach, solvent extraction process to produce yellowcake. The mill was designed to operate with a throughput of 4,000 tons per day (tpd). During its operation (1977 to 1982), the mill processed approximately 3.8 million tons of ore (United Nuclear, 1987). Figure 1-3 shows the general mill facilities configuration used during operations.

Approximately 3.8 million tons of uranium tailings were generated from milling operations. United Nuclear constructed a tailings disposal area as shown on Figure 1-3 to accommodate the coarse and fine fractions of the tailings. Borrow Pits No. 1 and No. 2 were excavated to provide additional tailings storage and construction materials for the tailings retention embankment. Material removed from the borrow pits not ultimately used for embankment construction was stored, and remains on the eastern side of the tailings disposal area (Figure 1-3). This material is available for use as cover material during reclamation, as described in detail later.

Ore was milled from 1977 until July 1979, when a breach in the tailings disposal area occurred in the southern retention embankment. United Nuclear cleaned the spill to the satisfaction of all regulatory agencies and recommenced milling operations in the fall of 1979. The milling operations continued until May 1982, when the mill was placed on standby due to a depressed uranium market.

After recommencing operations in 1979, tailings seepage was suspected at the north side of the tailings disposal area. United Nuclear has installed numerous wells since then, to address this issue. Many of these wells are currently in use as monitor wells and for pumping to intercept seepage from the tailings disposal area, as discussed in Section 6.0 of this plan.

1.5 Population

The city of Gallup, approximately 20 miles southwest of the site, is the largest population center within McKinley County. The county is sparsely populated with a 1990 census population density of 11.2 people per square mile as compared to 12.5 people per square mile in the state and 68.6 people per square mile in the United States.

The county is culturally diverse. In 1990, 72 percent of the population was American Indian including Navajo, Zuni, and Hopi, and 16 percent was Anglo-American, including 13 percent of Spanish origin.

A steady increase in population occurred in Gallup, New Mexico, and McKinley County from 1950 to 1990. Substantial growth occurred between 1970 and 1980 due to mining activities such as United Nuclear's Church Rock operation. A decline in mining activities and the closure of several uranium mining and milling operations has increased unemployment and resulted in a slowing of the population growth trend since 1980.

The Church Rock facility is located in a sparsely populated area of McKinley County. The nearest residence is situated approximately one mile northwest from the center of the tailings disposal area. The nearest point of ground water use is located 1.7 miles northeast of the perimeter of the tailings disposal area.

The demography has changed modestly since the proposed plan was submitted in 1987, as indicated in the annual descriptions of demographic changes provided to the NRC by United Nuclear in accordance with License Condition 31. The changes in local population do not have an impact on the radiological analyses completed in 1986 as part of this plan.

1.6 Geology

The United Nuclear mine and mill facilities are located in the Colorado Plateau physiographic province. The Cretaceous and Mesozoic sediments, which crop out in the area, dip two degrees to four degrees to the north-northwest into the San Juan Basin and emerge south of the San Juan Mountains in the Farmington, New Mexico area.

Erosion during the Pleistocene epoch carved valleys into the Cretaceous sediments. These valleys have since been filled with alluvium. Bedrock subcrops are in contact with this alluvium in the Pipeline Arroyo and across the tailings disposal area. The thickness of the alluvium on-site varies up to 150 feet thick.

The bedrock units of interest at the United Nuclear site are, in descending order, the Dilco Coal Member (Dilco), the Upper Gallup Sandstone, and the Upper D-Cross Tongue of Mancos Shale (Mancos). The Dilco is a sequence of alternating sandy siltstones, sandstones, coals, and carbonaceous shales. The mill facilities are located on the Dilco Coal Member. The thickness of this unit varies from 0 to 300 feet in the site area.

Underlying the Dilco, is the Upper Gallup Sandstone. The Upper Gallup Sandstone has been subdivided into three units in the site area: Zone 3, an upper sandstone; Zone 2, a shale and coal parting member; and Zone 1, a lower sandstone unit. The sandstone units generally subcrop beneath alluvium throughout the tailings disposal area, but crop out in a limited area.

The Mancos underlies the Upper Gallup Sandstone throughout the tailings disposal area and subcrops under the alluvium at the south end of the tailings disposal area.

1.7 Hydrogeology

The hydrogeology of the United Nuclear site is best described in two phases. The first phase represents natural or background site conditions prior to the onset of mining and milling activities. This pre-mining phase is characterized by the lack of a continuous ground water system in all near-surface geologic formations in the site vicinity. The second phase represents site conditions as they existed after the changes that occurred as a result of the mining and milling activities. The following provides a summary of the pre- and post-mining and milling phases of the hydrogeologic site conditions. A detailed discussion of the hydrogeology of the site and the Corrective Action Program (CAP) is presented in Section 6.0 of this plan. Detailed discussions have also been included in numerous documents submitted since 1987, including the Geohydrologic Report (GHR) (Canonie, 1987a), in the Amendments I and II to the proposed reclamation plan submitted in 1987 (Canonie, 1988b and 1989a) approved by the NRC, and in the Remedial Design Report (RD) (Canonie, 1989d) approved by the NRC and EPA. As described in Section 6.0, United Nuclear has been implementing control of tailings seepage, indicated in the CAP and RD in accordance with License Condition 30 and the EPA's Record of Decision.

Pre-Mining and Milling - Prior to mining and milling activities, the near-surface bedrock units and the alluvium in the vicinity of the tailings disposal area were unsaturated. The alluvium and exposures of the Upper Gallup Sandstone received minor amounts of water from direct precipitation. The exposures of the Upper Gallup Sandstone in the site area serve as a part of the recharge area for the Upper Gallup Sandstone aquifer to the north in the San Juan Basin. However, the recharge from precipitation did not result in saturated conditions at the site. Evidence of unsaturated conditions in these geologic formations comes from the construction log for United Nuclear's NECR mine shaft constructed at the beginning of 1968, and from the absence of water in geotechnical borings in the tailings disposal area drilled before tailings disposal. Both

the construction log and the boring logs show saturated conditions did not exist in the tailings disposal area above the Mancos. Therefore, both the alluvium and the Upper Gallup Sandstone in the vicinity of the United Nuclear facility were essentially unsaturated prior to mining activities at the site.

Post-Mining and Milling - Conditions at the site began to change in 1968, as a result of discharge of mine water into the arroyo. Artificial recharge from the arroyo to the alluvium occurred via discharge of mine water from both the United Nuclear and Quivira mines. This discharge saturated portions of the alluvium and Zone 3 and Zone 1 of the Upper Gallup Sandstone, creating a transient, temporary, artificial ground water system.

Tailings Seepage - Milling operations began in May 1977, and continued through May 1982. Disposal of tailings into the tailings disposal area continued through October 1982 while the mill circuits were being cleaned. The seepage from the tailings created a localized mound on top of the artificial system.

Both the artificial system and the seepage mound represent transient hydrogeologic conditions at the site. Since the original sources of water (i.e., mine water discharge and later seepage from tailings disposal) have been removed, eventually the system will return to the unsaturated condition that existed prior to mining and milling activities at the site.

1.8 Surface Water Hydrology

The United Nuclear Church Rock site is located west of the Continental Divide in the Rio Puerco Basin on the Colorado Plateau. This region is characterized by numerous mesas, buttes and plateaus, interspersed with steep gullies and arroyos. The smaller drainages flow only as a result of intense rainfall events. Only the larger drainage basins have either intermittent or perennial flow.

The United Nuclear site is located in the Pipeline Arroyo drainage basin, which drains into the North Fork of the Rio Puerco drainage. The Pipeline Arroyo Basin above the United Nuclear site has a drainage area of 18.2 square miles. The North Fork of the Rio Puerco drainage basin drains 280 square miles above the confluence of Pipeline Arroyo. The Pipeline Arroyo Basin above the United Nuclear boundary has a maximum relief of about 800 feet. Upland areas consist of relatively flat mesas with extremely steep sideslopes. Channel slopes vary considerably (0.0054 to 0.0347 feet per feet) and are dependent on local bedrock controls.

There are no surface water bodies, diversions, or control structures below the mill site within Pipeline Arroyo. Above the mill site is one impoundment capable of storing approximately ten acre-feet of runoff for livestock watering.

Diversion ditches, constructed while the facility was operating, intercept runoff from the small drainage basins to the east of the tailings disposal area and route the runoff around the tailings disposal area to Pipeline Arroyo.

A bedrock outcrop within Pipeline Arroyo, designated the "nickpoint," provides a local base control for the arroyo channel (Figure 1-3). Channel gradients above the nickpoint are quite shallow, and the channel is wide and shallow. Below the nickpoint channel, gradients are steep, and the channel is narrow and deep.

1.9 Site Activities 1987 to 1990

United Nuclear has pursued an aggressive plan of remedial action since the proposed plan was submitted in June 1987. All of these actions were taken pursuant to various NRC license amendments and EPA seepage remedial action approvals. Figure 1-4 shows the site as it existed in the Spring 1991. Comparison of Figures 1-4 and 1-3

(which depicts 1987 conditions) provides a measure of the significant work completed to date, even absent an approved remediation plan.

1.9.1 Seepage Collection Activities

Beginning in 1988, United Nuclear initiated construction of the seepage CAP approved by NRC and EPA. Two 5-acre hypalon-lined evaporation ponds were constructed to dispose of collected seepage as shown on Figure 1-4. United Nuclear also constructed 15 new seepage collection wells, 12 in Zone 3 and three in the southwest alluvium. The location of these wells is shown on Figure 1-4. These wells began operation in 1989 in conjunction with pre-existing seepage collection wells, described to the NRC in the June 1987 plan and shown on Figure 1-3. An additional eight new extraction wells have recently been constructed, seven in Zone 3 (Phase II) and 1 in the southwest alluvium, and are expected to be operating by the end of the Third Quarter 1991. Between August 7, 1989 and July 26, 1991, approximately 59 million gallons of water have been collected by the systems.

To enhance evaporation, United Nuclear installed a series of spray mister nozzles on the evaporation pond embankments. It has also installed 26 impact spray guns over the reclaimed Central Cell, as shown on Figure 1-4. United Nuclear has submitted annual reports to the NRC and EPA evaluating progress made by operation of the seepage collection system pursuant to NRC License Condition 30 and the EPA Administrative Order.

1.9.2 Tailings Reclamation

Beginning in 1989, United Nuclear initiated an interim tailings reclamation program in conformance with NRC license requirements. United Nuclear cleaned up and revegetated over 60 acres of land containing wind-blown contaminated tailings. The

cleaned area is outlined in Figure 1-4. This area was identified in the Wind-blown Tailings Cleanup Verification Reports for Sections 1, 2, and 36 (United Nuclear, 1989 and 1990), submitted to the NRC in accordance with License Condition 33. United Nuclear has recontoured and covered the North and Central Cells of the tailings disposal area with a minimum of one foot of radon attenuating soil cover, as shown on Figure 1-4. All of this work was performed in accordance with license requirements and was completed using the technical specifications, described in the June 1987 proposed reclamation plan and modified as a result of comments by the NRC.

1.9.3 Mill Decommissioning

The proposed reclamation plan submitted in June 1987 included a Mill Decommissioning Plan. After initial review and comment, NRC decided it needed to amend United Nuclear's license, to require submittal of a more detailed Mill Decommissioning Plan by the end of 1990. United Nuclear submitted a detailed Mill Decommissioning Plan for the Church Rock mill to the NRC on December 22, 1990. Supplemental information was submitted to NRC on April 10, 1990 in response to NRC review comments. The Mill Decommissioning Plan was approved by the NRC in January 1991, and United Nuclear began decommissioning in 1991.

The Mill Decommissioning Plan is presented in Section 7.0 and includes a description of:

1. Dismantling procedures for the portions of the mill that will not be salvaged,
2. Cleaning and decontaminating procedures for foundations that are to remain in the mill area,
3. Procedures for excavating foundations which cannot be decontaminated,

4. Disposal procedures for of mill debris and contaminated foundation material in Borrow Pit No. 2,
5. The radiation safety program to be followed during mill decommissioning,
6. The monitoring to be conducted,
7. The records and reports to be generated and maintained, and
8. Security.

The plan also incorporates an equipment salvage and sales program designed to help defray the cost of reclamation. Certain pieces of equipment have been removed and decontaminated for sale. Others have been sold and removed from the facility.