GROUND WATER / SCHEDULE

Project 86-060-04
July, 1988

Canonie Environmental

Amendment I

Reclamation Plan
License No. SUA-1475

Church Rock Site
Gallup, New Mexico

Prepared for:

UNC Mining & Milling
A Division of United Nuclear Corporation
Gallup, New Mexico

UNITED NUCLEAR CORPORATION

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July 26, 1988
UNC-ALO-88-119M

Mr. Dale Smith, Director
Uranium Recovery Field Office
US Nuclear Regulatory Commission
730 Simms Street
Suite 100
Golden, CO 80401

Dear Mr. Smith:

Enclosed for your consideration is Amendment I to United Nuclear Corporation's (UNC) Tailings Reclamation Plan submitted to NRC on June 1, 1987. The enclosed document amends UNC's proposed reclamation plan to include an active seepage remediation program. It provides a general overview of reclamation activities and a specific implementation schedule for the various work tasks leading to final site remediation. The work as described takes into account the many discussions we have had with NRC and other involved agencies. The amendment contains a description of the active seepage cleanup program UNC proposed on April 27, 1988. It includes details such as location and number of pumpback wells, anticipated operating conditions, retention/evaporation pond construction details and the attendant construction schedule.

UNC continues to believe that its original approach to seepage remediation as contained in its reclamation plan of June 1, 1987 is technically correct and in conformance with regulatory requirements. The active seepage cleanup program described in this amendment is proposed in order to provide additional assurances that any groundwater resources in the area will not be impacted by the tailings facility and to expedite agency approvals.

The proposed implementation schedule contained in this submittal is of singular importance as it is integral to the entire program. UNC is committed to implementing the tailings reclamation program described in the document; however, the schedule provided is based on anticipated approvals forthcoming from all involved agencies by October 1, 1988. Obviously, modification of the reclamation plan as presented and/or delays in receiving approvals will necessarily affect implementation.

Further, while UNC is committed to performance of the reclamation plan, UNC cannot commit expenditures on this project until all involved agencies have concurred that UNC's proposal satisfies their concerns. You are aware that EPA's Record of Decision may result in a site remediation proposal which differs from UNC's proposed reclamation program. Should EPA elect to pursue remediation measures which differ from those proposed in the reclamation plan, UNC's ability to commence performance of the reclamation plan may be impaired. This could preclude prompt implementation of reclamation in accordance with the schedule.

Finally, UNC is aware that NRC technical staff are continuing their review of the reclamation plan. We have been informed that this review will not be completed until September or October. Technical discussions continue between your staff and ours. It is important that NRC expedite its review of the plan in coordination with the other involved agencies if UNC is to proceed on the schedule presented in the amendment.

UNC strongly believes that the program described in this amendment is the most suitable program to resolve involved agency concerns. It provides additional technical groundwater protection measures and is economically feasible. If you have any questions or require additional information please do not hesitate to contact me.

Sincerely yours,

Juan R. Velasquez
Manager, Environmental Affairs

JRV:nlk

cc: William Rowe - EPA
Michael Burkhart - NMEID
Harry Pettengill - NRC
Edward Hawkins - NRC

bcc: Paul McLain
Chuck Johnson
Michael Brennan - Holland & Hart

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License No. SUA-1475

Canonie Environmental

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

RECLAMATION PLAN AMENDMENT I
UNITED NUCLEAR CORPORATION SOURCE MATERIAL LICENSE SUA-1475
CHURCH ROCK SITE
GALLUP, NEW MEXICO

1.0 INTRODUCTION

United Nuclear Corporation (UNC) submitted a Reclamation Plan for the Church Rock uranium mill and tailings disposal facility near Gallup, New Mexico, [Canonie Environmental Services Corp. (Canonie), 1987a] on June 1, 1987. UNC is now submitting this document as Amendment I to the Reclamation Plan which provides an overview of the revised reclamation activities based on comments provided by the Nuclear Regulatory Commission (NRC) and an associated implementation schedule. An active seepage remediation program is an integral part of the amended Reclamation Plan. Details of the active seepage remediation system, including extraction wells, retention/evaporation ponds, and enhanced evaporative mist systems are provided herein.

1.1 Current Site Conditions

Figure 1 illustrates current site conditions at the Church Rock facility. Sand-like tailings were hydraulically disposed within a 100-acre impoundment. Since mid-1982 when mill operations were terminated, the tailings have partially dried, become exposed, and have been blown to the north in the prevailing wind direction. Wind-blown tailings contaminated soils are found in minor amounts over an area of approximately 50 acres (Canonie, 1987a).

A pit, approximately 45-foot deep, known as Borrow Pit No. 2, conservatively estimated to contain about 44 million gallons of water, is located adjacent to and east of the main body of disposed tailings as shown on Figure 1. The water originates from three groups of pumping wells which extract tailings seepage from the underlying bedrock formations. This collected water is neutralized and stored in Borrow Pit No. 2. The water is disposed of by both natural and an enhanced solar evaporation mist system on the surface of the tailings. The system also serves the function of controlling the blowing of tailings.

The west side of the tailings impoundment is bounded by an ephemeral drainage channel (Pipeline Arroyo) which will be reconfigured as part of the reclamation activities (Canonie, 1987a). The mill facilities and the mine site tailings storage areas located to the west of the tailings disposal area will be subject to reclamation efforts.

1.2 Current Hydrogeologic Conditions

Prior to mining and milling activities, no contiguous ground water system was known to exist in the near surface geologic units, including alluvium and Zone 3 and Zone 1 of the Gallup Sandstone, in the general area of the tailings disposal (Canonie, 1987b). It is believed that water was first introduced to formations underlying the site by the discharge of mine water into Pipeline Arroyo and later by seepage of tailings liquids from the tailings impoundment and Borrow Pit No. 2.

Mine water was discharged to Pipeline Arroyo for a period of approximately 17 years during operations. The chemistry of the mine water discharge was altered as it flowed into the alluvium resulting in the water quality observed today in the alluvium, Zone 1, and Zone 3 in the areas outside the influence of tailings seepage (Canonie, 1987b; Canonie, 1988).

The seepage from the tailings also migrated into the alluvium, as well as underlying Zone 1 and Zone 3 sandstones, as shown schematically on Figure 2 and described in more detail in the Geohydrologic Report (GHR) (Canonie, 1987b). Favorable geochemical properties of the alluvium neutralize the acidic seepage from the tailings impoundment (Canonie, 1988).

In the northern end of the disposal area, the alluvium was removed for use in constructing the impoundment's earthen perimeter retention embankments. Tailings liquids seeped directly into the underlying Zone 3 sandstone bedrock formation in this area. Tailings liquids and neutralized seepage also entered Zone 1 through the bottom of Borrow Pit No. 2. The geochemistry of Zone 1 and Zone 3 is not as conducive to neutralizing the acidic seepage as the alluvium. There are two discrete acidic seepage plumes in Zone 1 and Zone 3. Figure 3 illustrates the approximate extent of the seepage plumes in Zone 1 and Zone 3 which are described in more detail in the previous GHR (Canonie, 1987b). Seepage migration has generally occurred to the northeast in Zone 3 and east in Zone 1 in the direction of the bedrock dip. The plume is more extensive in Zone 3 than in Zone 1 because Zone 3 has a higher permeability than Zone 1. Seepage that migrated into these formations is currently being collected on a limited basis by three sets of pumping wells shown on Figure 3. The collected seepage is neutralized, stored, and evaporated within Borrow Pit No. 2.

A mist evaporation system with a capacity of 350 gallons per minute (gpm) has been installed on the surface of the central tailings cell to dispose of water stored in Borrow Pit No. 2. The system operates from mid-April to mid-October in accordance with NRC approvals. Figure 3 shows the location of the mist evaporation system along with the general operations of the current seepage extraction system.

1.3 Reclamation Plan Objectives

The objective of the Reclamation Plan, as amended, is to attain long-term stabilization of uranium milling by-product materials solely within the existing tailings disposal area. The plan will thus control future releases of contaminants to effectively eliminate threats to public health, welfare, and the environment. These objectives will be met by consolidating all by-product materials within the tailings disposal impoundment, reconfiguring surface water drainage channels adjacent to the site to prevent erosion by flood waters, collecting and evaporating seepage currently within the underlying bedrock formations, and capping the site to prevent surface water infiltration and radon emissions.

2.0 ACTIVE SEEPAGE REMEDIATION AMENDMENT

The Reclamation Plan originally submitted (Canonie, 1987a) employed a passive approach of natural contaminant attenuation and dissipation of the tailings seepage mound to provide the long-term protection of human health and the environment. This amendment to that plan accelerates the attenuation process by incorporating an active seepage extraction and disposal system with the reclamation activities described in the original submittal. While the original approach to seepage remediation remains technically appropriate, the active approach proposal provides additional assurances that ground water resources will not be impacted by the tailings facility.

Active seepage remediation will consist of the following primary activities:

- Collection of seepage within Zone 3 of the Gallup Sandstone utilizing extraction wells.

- Elimination of the source of seepage to Zone 1 by dewatering Borrow Pit No. 2.

- Construction of an evaporation disposal system to include two synthetically-lined evaporation ponds and associated pond mist system.

- Disposal of the collected seepage from Zone 3 and water from Borrow Pit No. 2 by evaporation within the tailings disposal area.

The design of this program for active seepage remediation is based on the site specific hydrogeological and geochemical data (Canonie 1987b; Canonie, 1988). Conclusions upon which this active seepage remediation program are based include the following:

- Active remediation of Zone 3 will be performed in areas of acidic tailings seepage delineated by pH measurements of less than seven. Since Zone 3 has no acid buffering capacity, pH measurements below seven are interpreted as the extent of the tailings seepage plume in that formation.

- Seepage in Zone 3 emanates from the tailings disposal area to the northeast. This area, shown on Figure 3, will be the location of the ground water extraction wells.

- Seepage in Zone 1 originates from its outcrop in Borrow Pit No. 2. Since Borrow Pit No. 2 will be dewatered as part of the reclamation activities, the source of seepage will be removed. No additional active remediation will be required for Zone 1. The permability of Zone 1 is so low that the formation will not support pumping once the pit is dry. Wells currently pumping from Zone 1 adjacent to Borrow Pit No. 2 have already demonstrated this low productivity which precludes pumping and extraction of seepage as a viable remediation option in Zone 1 (Canonie, 1987b).

- The remaining North Cross Dike and all the East pump-back wells will be decommissioned in 1989, when Borrow Pit No. 2 is dewatered.

- Acidic seepage is not present in the alluvium due to the large buffering capacity of the soil (Canonie, 1987b; Canonie, 1988). Analytes detected in the saturated alluvium are primarily derived from percolation of mine water through the alluvial soils and therefore are considered "background" concentration levels. Tailings seepage cannot be identified in the alluvial soils; therefore, no active remediation is necessary for the alluvium.

The seepage collection system in Zone 3 will utilize both existing wells and new wells to be installed during the interim stabilization phase of reclamation. The evaporation disposal system will consist of 1) a two-pond, ten-acre lined evaporation/surge system equipped with an enhanced evaporation mist system, and 2) a separate mist or spray evaporation system installed on the surface of the tailings. The evaporation disposal system will be installed and operated entirely within the tailings disposal area.

The following sections provide the basis for the selection of the seepage collection and evaporation disposal systems for active seepage remediation at the site. Figures 4 through 6 schematically illustrate the major components of the two systems. Details of the components of the lined evaporation ponds are provided on the drawings contained in Appendix A. Table 1 summarizes the water balance upon which operation of the system is based.

2.1 Seepage Collection System

The seepage collection system for Zone 3 was designed based on the following hydrologic conditions:

- o The extractable volume of the acidic plume in Zone 3 (Figure 3), is estimated to be 200 million gallons or less, based on an area of the plume of 100 acres, an observed average saturated thickness of 60 feet, and an extractable porosity of 10 percent. The system was designed to remove this approximate volume. However, monitoring of hydrogeologic conditions during operation of the system will determine the extent of pumping actually required.

- o The saturated thickness and the extent of the acidic plume, as delineated by the pH seven contour, was used to determine the general locations of the wells. The actual locations will be finalized in the field.

- o The limited extent of the saturated thickness of Zone 3 and projected reductions in well efficiencies during remediation control the number of wells that can be installed and operate efficiently for periods of several years or more.

2.2 Well Locations

Figure 4 shows the approximate locations of 14 new wells that will initially be utilized for the Zone 3 seepage collection system. Figure 5 illustrates the general construction details for each extraction well. Four wells in the existing Northeast pump-back system will also continue to operate. In 1990, six additional new wells will be installed within and at the northern boundary of the acidic plume as shown on Figure 6.

Extraction well locations were selected to pump from the maximum saturated thickness observed in the formation, as presented on Figures 4 and 6, thereby effectively intercepting the seepage plume to the east-northeast. Figure 4 provides an isopach map of saturated thickness based on water levels measured in Zone 3 wells in October, 1987. The figure shows that maximum saturated thicknesses of 40 feet to 60 feet in Zone 3 are encountered north and northeast of the tailings area, where the majority of the wells are proposed to be installed. Wells were not located further to the east because of the small (less than ten feet) saturated thickness of Zone 3 in that area.

The ground water system at the site is transient (Canonie, 1987b). Since additional recharge from mine water discharge and tailings disposal sources has ceased, water levels in Zone 3 will continue to decline in response to current and future dewatering activities. Therefore, the final location of each well will be determined immediately prior to its installation based on the most current water level measurements available.

The proposed spacing of the wells, as shown on Figures 4 and 6, was determined by employing an analytical model (Theis equation) to ensure that:

- o The wells will create a hydraulic barrier to further migration of the acidic plume.

- o The wells will dewater the eastern extremities of the acidic plume where the small saturated thickness precludes direct placement of wells.

- o The intersection of cones of depression from adjacent pumping wells will not cause excessive interference between wells which would impact the efficiency of the system.

The final spacing of the wells will be adjusted during their installation based on aquifer tests conducted in the first two or three wells that are installed.

2.2.1 Well Design and Operation

Figure 5 presents typical well completion details for the new wells to be installed for the seepage collection system. The wells will be completed with the screen entirely within and at the base of Zone 3. Each well will be constructed with six-inch diameter polyvinyl chloride (PVC) casing and screen.

The wells will be drilled using rotary air/foam methods, if possible. Alternatively, use of mud-rotary methods may be required. A geophysical log of each borehole will be obtained prior to well installation to provide the data for final adjustments to the design details of the wells.

The wells are predicted to operate at an average initial rate of five gpm based on pumping records for existing on-site wells and the hydrologic properties of Zone 3 (Canonie, 1987b). Initial extraction rates may be higher or lower in each well than the five gpm chosen as the best estimate for design of the system. However, the proposed evaporation disposal system has the flexibility to accommodate variability in well pumping rates.

Pumping rates are predicted to decline by approximately 20 percent per year based on the long-term pumping records for existing on-site wells and hydrologic properties of Zone 3. The decline in pumping rates will be caused by the reduction of saturated thickness and the anticipated reduced efficiencies of the well screens due to precipitates. Some of the new wells may have to be replaced each year in order to maintain the production rate of the system.

The number and timing to replace wells will be determined based on system performance. Once a well begins to lose its ability to pump efficiently it will be evaluated for stimulation to improve productivity or, if its productivity declines to or below one gpm for a period of one month, possible replacement. The well will be stimulated and cleaned, then turned off and allowed to recover to determine whether the formation can produce sufficient water to merit replacement of the well. If the water level recovers sufficiently to produce one gpm, but the efficiency of the well does not allow production of one gpm or more, then the well will be replaced. If the water level in the well does not recover sufficiently to allow production of water in amounts greater than one gpm, the well will be decommissioned.

The goal of active seepage remediation is, to the extent technically practical, to remove the acidic seepage from Zone 3. The system will be decommissioned upon a determination by UNC in conjunction with the NRC that the hydrogeologic or water quality conditions in Zone 3 are adequate. Based on the schedule presented in Section 3.0 of this amendment, these conditions are expected to be met by the end of 1995.

2.3 Evaporation Disposal System

Extracted seepage from the pumping wells will be directed to the evaporation pond and/or mist or spray evaporation systems for disposal. The evaporation disposal system was designed based on both climatic and operational considerations. Table 1 summarizes the operational considerations, and Table 2 summarizes the average monthly net evaporation and precipitation rates for the site used for design purposes. This data, in addition to the anticipated pumping rates for the seepage collection system, were used to size the ponds and mist and spray systems.

Evaporation will be from the surface of the ponds, through atomizing mist nozzles installed in each pond, and through the mist or spray evaporation systems installed in the Central Cell of the tailings area.

2.3.1 Evaporation Pond

Figure 4 schematically shows the location and configuration of the evaporation disposal system. The two-pond, ten-acre (bottom area) evaporation system, shown in detail on the drawings in Appendix A, will be installed in the north end of the South Cell of the tailings disposal area. The size of the ponds was determined based on the volume of storage required to contain seepage pumped from the collection system and precipitation during non-evaporative periods. The location of the ponds is constrained by the presence of soft, fine-grained tailings and the slope of the tailings surface within the disposal area.

Based on the net evaporation rates presented in Table 2, evaporation from the surface of the ponds is estimated to be 9.2 million gallons per year conservatively assuming that the surface area is ten acres. The actual surface area will be greater than the ten-acre base area because the side slopes result in increased surface area, and therefore increased evaporative capacity as the ponds fill.

The evaporation pond system will be equipped with two lines of atomizing mist nozzles, one line for each of the ponds to increase the evaporative capacity of the system. The pond mist system is designed to operate at a maximum rate of approximately 350 gpm (5 gpm per atomizing mist nozzle), at least 10 hours per day, 7 days per week during the evaporative season. For design purposes, the evaporative efficiency of the pond mist system was estimated to be 35 percent, or 123 gpm, based on the observed efficiencies of similar systems operating at other sites. As shown in Table 1, evaporation from the pond mist system is predicted to be 15 million gallons per year based on the design efficiency. Therefore, the total evaporation rate from the ponds, including the mist system, is estimated to be approximately 24.2 million gallons per year.

2.3.2 Tailings Mist and Spray Evaporation Systems

Additional evaporative capacity will be provided by the existing mist or future spray evaporation systems located on the tailings surface in the Central Cell of the tailings disposal area.

Existing Tailings Mist System - Currently, a mist evaporation system located in the Central Cell with a capacity of 350 gpm (4.2 gpm per nozzle) is being used to evaporate water stored in Borrow Pit No. 2. Figures 3 and 4 and the drawings in Appendix A show the general location and configuration of this system. This system was approved for operation by the NRC and has been operating since mid-April of 1988. The mist system is scheduled to continue operating until 1990, when the system will be removed so that tailings grading and soil cover placement for interim stabilization can commence in that area.

The mist system is currently operating 12 hours per day, 5 days per week, except during precipitation events. All water discharged through the system currently originates from Borrow Pit No. 2. The total volume of water to be discharged through the mist evaporation system in 1988 is estimated to be 20 million gallons. The system will be shutdown at the end of the evaporation season in mid-October in accordance with NRC license conditions. At that time, all seepage pumped from the existing pump-back wells will be discharged to Borrow Pit No. 2 until the evaporation pond is constructed and operational.

Future Tailings Spray Evaporation System - A spray evaporation system will replace the existing mist evaporation system on the tailings after interim stabilization grading and cover placement are completed in the Central Cell of the tailings disposal area. The spray system has been designed so that there will be no infiltration into the cover soils. The system will consist of a series of spray guns which can each wet an area of approximately one acre. The guns will be operated sequentially to balance application rates and evaporation rates. Table 2 presents the evaporation rates for the site used in the design. The maximum application rates will vary depending on the month and may range up to 5,800 gallons per day, per acre.

The spray system was selected to replace the mist system, for this site, because of greater flexibility of operation. The capacity of the spray system is greater than the anticipated volume of seepage predicted to be discharged to the system. Therefore, if the volume from the seepage collection system is temporarily greater than anticipated, the spray system will be able to accommodate the additional volume. Spray guns can also be added or subtracted from the system to adjust to changes in climatic conditions, such as dry or wet years, or to changes in volumes pumped from the seepage collection system.

2.4 Operational Water Balance

The design of the seepage collection and evaporation disposal systems was based on a water balance which provides that all seepage collected from Zone 3, as well as stored seepage in Borrow Pit No. 2, will be evaporated between the years 1988 and 1996. Table 1 summarizes the water balance of inflow and outflow for active seepage remediation. The following sections provide a more detailed discussion of each of the components of inflow and outflow.

2.4.1 Inflow

Inflow to the system will consist of 1) seepage pumped from the collection system, 2) water pumped from Borrow Pit No. 2, and 3) precipitation. The contribution from each of these components is described below.

Seepage Collection System - Pumping volumes from the existing wells and the new wells vary from year to year depending upon the number of wells operating and the anticipated decline in pumping rates due to well productivity. Table 1 presents the total volumes estimated to be pumped each year from the wells, and Tables 3 and 4 present details of pumping from Zone 3 and Borrow Pit No. 2.

Pumping volumes from the new wells are based on an expected initial pumping rate of five gpm per well. The volumes are also based on an expected 20 percent decline in the pumping rate of each well per year. Since 14 wells will be installed initially and 6 more wells will be added the following year, the volumes pumped are also based on the number of wells that are proposed to operate during a given year.

The volume of seepage to be pumped from Zone 3 is estimated to be 200 million gallons. This volume was estimated from the area of the acidic plume in Zone 3 as delineated by the pH 7 contour (Canonie, 1987b) (100 acres), an average saturated thickness of Zone 3 of 60 feet determined from May, 1986 water level data reported in the GHR (Canonie, 1987b), and an extractable porosity of 10 percent. The porosity of ten percent was selected based on data for pumping tests conducted in on-site Zone 3 wells. The pumping test data, (summarized in the GHR), indicate that the average storativity of Zone 3 is 0.05. Therefore, approximately five percent of the water contained in the formation can be removed by pumping. For design purposes, this percentage of pumpable volume was increased two times to ten percent.

The potential for additional recharge to the Zone 3 plume from infiltration of precipitation was evaluated to determine whether the volume of this potential recharge source would change the anticipated volume to be pumped from Zone 3. The potential recharge was evaluated using the water balance method [Environmental Protection Agency (EPA), 1975]. This method utilized mean monthly temperature data from Gallup, New Mexico, for the years 1951 through 1980, and precipitation data from the Church Rock site for the years 1980 through 1986. The results of this analysis showed that percolation through the compacted soil cover as designed will not occur. Therefore, no resaturation of Zone 3 or remobilization of residual seepage will take place after capping the tailings area. This conclusion is considered to be conservative because the analysis assumed that no runoff occurred and that all the water from precipitation was available for infiltration. (Backup data are available upon request).

The water balance recharge calculations were confirmed by using the EPA computer model "The Hydrologic Evaluation of Landfill Performance" (HELP), (EPA, 1984). As with the water balance method, the HELP model predicted no percolation of precipitation through the cap. The fact that no percolation is predicted to occur indicates that the cap material behaves like an evaporative sponge in this climate, retaining enough water to prevent deep percolation during rainfall events and also allowing evapotranspiration of the retained water during dry periods.

The validity of the above conclusions is verified by site conditions which existed prior to mining and milling activities. Prior to mining operations, the infiltration area to Zone 3 was covered by uncompacted alluvium with a probable hydraulic conductivity of 10^{-3} centimeters per second (cm/sec) to 10^{-4} cm/sec. Even with this transmissive cover soil, site climatological conditions were such that saturated conditions did not exist in Zone 3 (Canonie, 1987b). This is empirical evidence that deep infiltration and recharge will not occur in any significant amounts, as a function of climate and soil properties, at the Church Rock site.

Borrow Pit No. 2 - The water stored in Borrow Pit No. 2 is discharged to the existing mist evaporation system and will be discharged to the evaporation pond when the system is constructed. As shown in Table 4, approximately 28 million gallons will be removed from the pit by the end of 1988. This volume includes pumping from the pit, evaporation from the pit's water surface, seepage from the pit, and inflow to the pit from the existing pump-back wells.

In 1989, the only inflow to the pit is expected to be precipitation and possible seepage from the surrounding saturated alluvium and Zone 1. The dewatered pit will act as a collection well for these formations. This small quantity of seepage and precipitation will be pumped to the evaporation disposal system.

Precipitation - Inflow to the evaporation pond from precipitation was estimated from the on-site average monthly net evaporation data presented in Table 2. Total inflow from precipitation is estimated to be 300,000 gallons per year for a 10-acre pond surface area.

2.4.2 Outflow

Outflow from the system will include evaporation from the surface of the evaporation ponds, evaporation from the pond mist system, and evaporation from the mist and spray evaporation systems located on tailings (depending on which system is in operation). The following provides a description of each of these components.

Pond Surface - Evaporation from the surface of the ponds was calculated from the average monthly net evaporation rates presented in Table 2 and a surface area of ten acres. Table 1 shows that the volume of water estimated to evaporate from the pond surface each year is 9.2 million gallons.

Pond Mist System - The mist system in the evaporation ponds is designed to achieve an average evaporation rate of 123 gpm assuming 35 percent efficiency. The estimated maximum volume disposed through the mist system is 15 million gallons per year.

Mist and Spray Evaporation Systems - The volume of water discharged through the mist and spray evaporation systems may vary up to 18 million gallons per year depending on the evaporation requirements during the time period in consideration. As shown in Table 1, the volumes discharged through the mist and spray evaporation systems decline corresponding to the declining discharge rates from the seepage collection system.

3.0 AMENDED RECLAMATION PLAN OVERVIEW

The proposed overall Reclamation Plan for the site can be divided into three general phases identified as 1) interim stabilization, 2) seepage collection, and 3) final reclamation cover. The interim stabilization phase (1988-1992) is designed to mitigate existing environmental surface impacts of past operations, to minimize immediate contaminant exposure pathways, to minimize future subsurface impacts, and to prepare the site for installation of the final reclamation cover (1993-1997). Seepage collection, occurring during interim stabilization and extending into the final reclamation cover periods, is designed to contain and remove to the extent practical, the seepage plumes in Zone 1 and Zone 3.

The following paragraphs provide a generalized synopsis of reclamation activities which will be performed as part of each of the three phases. Figures 4, 6, and 7 illustrate major components of each phase on an annual basis for the entire anticipated period of reclamation. The proposed schedule of each reclamation phase is provided on Figure 8 and is based upon acceptance and approval of the plan from all regulatory agencies on or before September 30, 1988. The schedule for implementing this plan will correspondingly change if receipt of approvals is delayed.

3.1 1988 to 1989

Figure 4 illustrates reclamation activities which will occur during the remainder of the 1988 construction season and through 1989. Activities initiating in 1988 include plugging 41 existing monitoring wells in the area of active reclamation to eliminate hydrologic pathways between geologic formations and to allow future reclamation activities to progress unimpeded. The western portion of the North Cross Dike pump-back system will be decommissioned at the time these wells are plugged. During 1988, the radiological survey submitted with the tailings reclamation plan in 1987 (Canonie, 1987a) will be supplemented to include areas northeast of the tailings impoundment and off of the UNC property, in Section 1, T16N, R16W, to ascertain if wind-blown tailings-affected soils extend beyond UNC's property.

In preparation for disposal of stored seepage in Borrow Pit No. 2 and increased volumes of collected seepage, the synthetically-lined evaporation pond system will be constructed in 1988. An isolated area of tailings in the north end of the South Cell will first be regraded in preparation for construction of the pond system within the tailings impoundment, as shown schematically on Figure 4. Details of the system are illustrated on the drawings contained in Appendix A. The constructed ponds will have adequate capacity to store collected seepage during non-evaporative periods of the year and will also be used to evaporate seepage during the evaporation season. The ponds will each be equipped with an enhanced evaporation atomizing mist system to increase their evaporative capacity prior to the 1989 evaporation season. As part of 1988 activities, the existing mist evaporation system on the tailings surface has been expanded and is being used to eliminate stored water in Borrow Pit No. 2.

The following year (1989), tailings in the North Cell will be regraded in preparation for the disposal of wind-blown tailings. Soils affected by wind-blown tailings to the north and east of the impoundment will be stripped and placed over the regraded tailings in the north end of the tailings disposal area. At that time, the tailings in the North Cell will be soil-covered, preventing further dispersion of tailings outside of the impoundment by wind.

Borrow Pit No. 2 is expected to be initially dewatered near the end of 1989. This will remove the primary source of seepage into Zone 1. The existing Zone 1 pumping wells located adjacent to Borrow Pit No. 2 (East and remaining North Cross Dike pump-back wells, shown on Figure 3) will be decommissioned when dewatering of Borrow Pit No. 2 has been completed. Borrow Pit No. 2 may have to be temporarily used to store water in 1990 when the Central Cell area of tailings is being regraded and the mist evaporation system is not in operation.

New Zone 3 pumping wells will be installed in 1989, as described in Section 2.0, to increase the ground water extraction rate from Zone 3. The new wells are estimated to operate at an initial average maximum rate of approximately 5 gpm, declining by approximately 20 percent per year. As shown on Figure 4, these wells will be located approximately within the boundaries of the acidic plume in Zone 3. Locations of the wells have been selected to prevent further migration of the contaminant plume and make use of the maximum available saturated thickness of the formation. Because of the transient nature of the ground water system, the saturated thickness and shape of the plume are expected to change with time. Therefore, final well locations will be determined immediately prior to well installation based on evaluation of the most current hydrogeologic data.

3.2 1990 to 1992

Figure 6 illustrates those reclamation activities which are proposed to occur in 1990-1992. Earthwork activities consist of regrading the tailings in the Central and South Cells of the tailings disposal area. Following regrading, a one-foot thick soil cover will be placed over the regraded tailings to prevent further wind dispersion of the tailings from these areas toward the north.

In 1990, the mist evaporation system will be removed from the central portion of the tailings disposal area to allow tailings regrading and soil cover placement in that general area, as shown on Figure 6. During soil covering of the Central Cell and placement of the spray evaporation system, the water from the seepage collection system will, if necessary, be directed to Borrow Pit No. 2, as requested by the NRC. Figure 6 also shows six new Zone 3 pumping wells that are proposed to be installed along the northern boundary of the acidic plume. These wells will bring the total number of new wells to 20. The spray evaporation system will be placed over the soil-covered tailings in the Central Cell area to continue providing sufficient capacity for evaporation of water from the Zone 3 wells. Water temporarily stored in Borrow Pit No. 2 will be pumped to the evaporation disposal system when the Central Cell spray system is operational. Regrading and soil cover placement in the South Cell will occur in 1991.

The dewatered Borrow Pit No. 2 will provide suitable capacity and flexibility for the disposal of demolished mill structures in 1992. Although the objective of the plan is to dewater the pit prior to 1992, the uncertainties associated with seepage pumping rates and evaporation rates require that mill decommissioning be scheduled in 1992 to assure that the pit will be ready to receive the demolished milling materials.

3.3 1993 to 1997

Reclamation activities in 1993 will consist of pumping and evaporation of seepage. Final reclamation cover placement activities will be initiated in 1994 and will be completed in 1997. As shown on Figure 7, the Zone 3 pumping wells, evaporation pond, and spray system in the Central Cell are anticipated to operate through 1995 assuming that, as estimated, the seepage plume in Zone 3 has been mitigated to the extent practical by the end of 1995. The seepage remediation system will be decommissioned when the Zone 3 formation has been effectively dewatered, as determined by the inability of the pumping wells to further withdraw practical quantities of water.

Final reclamation activities during the period from 1994 through 1997 primarily involve reconfiguring the Pipeline Arroyo channel so that the channel can contain the Probable Maximum Flood and have minimal impact on the reclaimed tailings. Riprap will be placed in channel sections susceptible to erosion to maintain channel stability. Excess soil, generated by widening and deepening the channel, will be utilized to increase the thickness of the soil cover over the tailings. The ultimate thickness of the soil cap will be four feet, which is the thickness necessary to reduce radon emissions to the maximum acceptable regulatory compliance requirement.

It is anticipated that the evaporation ponds will be regraded and capped with the four-foot final soil cover in 1996. The south drainage channel will then be constructed (after there no longer exists impounded seepage within the evaporation ponds) to direct precipitation runoff away from the capped site. The north drainage channel will be constructed in 1997 to direct runoff from the north away from the reclaimed site. As part of the remaining reclamation activities, Borrow Pit No. 2 will be graded and capped with the final four-foot-thick soil cover. Following all capping and channel excavation operations, the entire site and all disturbed areas will be surveyed, as necessary, to verify clean up and will be revegetated to minimize erosion.

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REFERENCES

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TABLES

TABLES

TABLE 1

ANNUAL SUMMARY OF WATER BALANCE FOR NEW EVAPORATION PONDS
(MILLIONS OF GALLONS)(1)

	1988(2)	1989	1990	1991	1992	1993	1994	1995	1996
Starting Inventory(3)	0	8.8	8.7	8.9	9.3	7.5	6.4	11.0	7.4
Inflow(4)									
Input from Seepage Collection Wells	1.2	27.9	33.4(5)	33	27.7	25.4	18.1	14.5	0
Input from Borrow Pit No. 2	7.5	16.8	9.7	9.7	3.6	0	0	0	0
Outflow									
Net Evaporation from Surface	+0.15	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-7.4
Evaporation from Pond Misters	0	-15	-15	-15	-15	-15	-4.3	-8.9	0
Evaporation to Misters or Spray	0	-20.6	-18.7	-18.1	-8.9	-2.1	0	0	0
Ending Inventory	8.8	8.7	8.9	9.3	7.5	6.4	11.0	7.4	0

Notes:

1. Based on detailed monthly water balance.
2. New evaporation ponds currently scheduled to start operation 12/1/88.
3. Must have sufficient end-of-year storage capacity to store first quarter imputs for following year.
4. See Tables 3 and 4 for details of inflow from seepage collection wells and Borrow Pit No. 2.
5. 8.1 million gallons directed to Borrow Pit No. 2 while Central Cell regraded and spray evaporation system installed. Volume later pumped from Borrow Pit No. 2 to evaporation ponds.

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TABLE 2

MONTHLY NET EVAPORATION RATES, CHURCH ROCK SITE

Month	Estimated Monthly Net Evaporation (In)(1)	g/ac-d
January	-0.51	- 462
February	-0.12	- 109
March	0.25	769
April	2.62	2,371
May	4.42	4,000
June	6.12	5,539
July	6.46	5,847
August	6.12	5,539
September	5.10	4,616
October	2.75	2,489
November	0.71	643
December	-0.51	- 462
Average Annual	34 in/yr	

Note:

1. Monthly net evaporation rates estimated by distributing the average annual rate for the Church Rock site based on the distribution of monthly evaporation rates reported for 30 years of data for the Gallup station.

TABLE 3

SUMMARY OF DESIGN PUMPING RATES AND VOLUMES - SEEPAGE COLLECTION WELLS

	1988	1989	1990	1991	1992	1993	1994	1995
Number of Existing Wells in Operation:								
NE	6	4	4	4	4	4	0	0
E	12	6	0	0	0	0	0	0
NXD	9	3	0	0	0	0	0	0
Total	27	13	4	4	4	4	0	0
Total Average Flow Rate Existing Wells, gpm	24	15	8	6	5	5	0	0
Number of New Wells in Operation	0	14	20	20	20	20	20	20
Total Average Flow Rate New Wells, gpm	0	70	72	58	43	44	35	28
Total Average Flow Rate, gpm	24	85	80	64	48	49	35	28
Total Gallons, Millions	12	43.6	41.5	33	27.7	25.4	18.1	14.5
Cumulative Total Gallons, Millions	12	55.6	81.8	115	142.7	168.1	186.2	200
Gallons from Zone 3, Millions	7.9	27.9	41.5	33	27.7	25.4	18.1	14.5
Cumulative Gallons, Zone 3, Millions	7.9	35.8	77.3	110.3	138	163.4	181.5	196

Assumptions:

1. First 14 new wells average 5 gpm each at start.
2. First 14 new wells operate 7 months in 1989.
3. Production from Zone 3 declines at 20 percent/year regardless of the number of replacement wells constructed.
4. Wells will operate 24 hours/day, 365 day/year.
5. Six new wells operate for eight months in 1990 and average five gpm each at start.
6. Pumping rate in 1991 and 1992 reduced during January and February so that the storage capacity of the ponds is not exceeded.

TABLE 4

SUMMARY OF WATER BALANCE FOR BORROW PIT NO. 2
(MILLIONS OF GALLONS)

	1988	1989	1990	1991	1992
Starting Inventory	44	22	16	14	4
Inflow					
Input from Pumping	10.8	0	8.1	0	0
Seepage into Pit	0	15	0.1	0.1	0
Outflow					
Net Evaporation from Surface	-4.2	-2.0	-0.92	-0.92	-0.4
Net Seepage from Pit	-1.6	-1.6	0	0	0
Existing Mist Evaporation	-20	0	0	0	0
Transfer to New Ponds	-7.5	-16.8	-9.7	-9.7	-3.6
Ending Inventory	22	16	14	4	0

Assumptions:

1. Beginning water inventory in Borrow Pit No. 2 is 44×10^6 gallons.
2. Borrow Pit No. 2 must be dewatered by 1992 to accept mill debris according to the current schedule.
3. Evaporation rate estimated from rates presented in Table 2.