Project 86-060-39
August 1996

SMITH
ENVIRONMENTAL TECHNOLOGIES CORPORATION

As-Built Report

Final Reclamation
Borrow Pit No. 2

Church Rock Site
Gallup, New Mexico

Prepared For:

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

SMITH
ENVIRONMENTAL TECHNOLOGIES CORPORATION

August 28, 1996

86-060-39

Mr. Edward M. Morales
UNC Mining and Milling
State Road 566
21 miles northeast of Gallup
Gallup, NM 87301

Transmittal
Borrow Pit No. 2 As-Built Final Report
Church Rock Site

Dear Ed:

Enclosed are two copies of the above-referenced report for your files. The following modifications to the draft report were made in response to your comments:

1. The volume of the radon attenuation cover placed over Borrow Pit No. 2, described in Section 3.1, was changed from 24,000 cubic yards to 27,500 cubic yards to account for material placed over non-tailings areas. As in the draft report, the testing of the radon attenuation cover placed over the swales is described separately in Section 5.1.2.4.

2. The location of the North Cell Drainage Channel is identified on Sheet 4. In addition, the section of the branch swale below the confluence of Swales B and C is explicitly identified as part of Swale B. The reference to this section as Swale B is done to maintain consistency with Western Technologies' terminology. Western Technologies' reports refer to 3-inch riprap being placed only in Swales A and B.

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Please call Todd or me at (303) 790-1747 with any questions or comments.

Very truly yours,

Suzie du Pont
Project Supervisor

SdP/ajw

Enclosure

cc: Juan Velasquez, United Nuclear Corporation

August 1996

Final Reclamation
Borrow Pit No. 2

SMITH

April 1996 86-060-39

AS-BUILT REPORT
BORROW PIT NO. 2 FINAL RECLAMATION

Prepared for:

United Nuclear Corporation
Church Rock Facility

Smith Environmental Technologies Corporation
304 Inverness Way South, Suite 200
Englewood, CO 80112

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AS-BUILT REPORT

BORROW PIT NO. 2 FINAL RECLAMATION
UNITED NUCLEAR CORPORATION
CHURCH ROCK FACILITY
GALLUP, NEW MEXICO

1.0 INTRODUCTION

This report describes the backfilling and construction of the final reclamation cover for Borrow Pit No. 2 at United Nuclear Corporation's (United Nuclear's) Church Rock facility. The site is located northeast of Gallup, New Mexico, along State Highway 566, as shown on Sheet 1. United Nuclear is continuing reclamation of the site as scheduled, in accordance with the "Tailings Reclamation Plan as Approved by NRC March 1, 1991, License Number SUA-1475" (Reclamation Plan) [Canonie Environmental Services Corp. (Canonie), 1991].

Reclamation of Borrow Pit No. 2 consisted of backfilling the pit with decommissioned mill materials and soil, completing the radon attenuation soil cover, placing the erosion protection cover and constructing drainage swales over the reclaimed surface. The reclamation was performed from 1991 to 1995 and encompassed approximately 10 acres in an area located immediately east of the Central Cell of the tailings disposal area.

Construction of the final cover for Borrow Pit No. 2 represents the fourth stage of final reclamation for the tailings disposal area. Final reclamation of the North Cell was completed in 1993 as documented in the "As-Built Report, North Cell Final Reclamation" (Canonie, 1994), final reclamation of the Central Cell was completed in 1994 as documented in the "As-Built Report, Central Cell Final Reclamation" (Canonie, 1995), and final reclamation of the South Cell was completed in 1995, as documented in the "As-Built Report, South Cell Final Reclamation" [Smith Environmental Technologies Corporation (Smith Environmental), 1996]. Interim stabilization of the entire tailings disposal area was completed from 1989 to 1991 and consisted of regrading the tailings and placing the interim soil cover. As-built reports for interim stabilization include the

North Cell (Canonie, 1990), Central Cell [Western Technologies, Inc. (WTI), 1991], South Cell (Canonie, 1992a) and Central Cell Addendum (Canonie, 1992b). Mill decommissioning activities are described in the "Mill Decommissioning Report" (United Nuclear, 1993).

Sheet 2 shows the design plan view and Sheet 3 shows the design details and cross sections for the installation of the final cover over Borrow Pit No. 2. Construction activities included:

1. Backfilling the borrow pit with soil and materials such as structural steel, piping and concrete generated during mill decommissioning activities

2. Placing and compacting 18 inches of soil to complete the radon attenuation barrier

3. Covering the radon attenuation barrier with a minimum of 3 inches of rock

4. Placing and compacting soil over the rock cover

5. Constructing drainage swales and channels to control surface water runoff

These construction activities were performed in accordance with the design drawings (Sheets 2 and 3) and the specifications provided in Appendix B of the Reclamation Plan (Canonie, 1991). Sheet 4 shows the as-built plan view of the final cover and surface water controls constructed in 1995 for Borrow Pit No. 2. Final reclamation of the South Cell, including construction of Branch Swales H, I, and J, was also completed during the 1995 construction season. Details of the South Cell final reclamation are provided in a separate as-built report (Smith Environmental, 1996).

Construction services for the reclamation activities were provided to United Nuclear by Nielson's General Contractors (Nielson's). Table 1 lists the equipment used by Nielson's during construction. The crushed rock for the erosion protection cover and the riprap and bedding material for the drainage swales and channels were provided by Hamilton

Brothers, Inc. (Hamilton). WTI provided geotechnical sampling and testing services. WTI's 1995 field reports of daily construction activities are included in Appendix A.

The following sections of this document describe the construction activities and quality control procedures implemented during backfilling of Borrow Pit No. 2 and construction of the radon attenuation layer, erosion protection cover and surface water controls. Copies of the geotechnical test results are provided in the appendices.

2.0 BACKFILLING AND INTERIM COVER PLACEMENT

Beginning in 1991, Borrow Pit No. 2 was backfilled with soil and materials generated during decommissioning of the mill site. Mill materials were placed in discrete layers, each of which was covered with a minimum of 1.5 feet of compacted soil. After backfilling was completed in 1994, an interim cover was placed over the borrow pit and compacted to a minimum of 90 percent of standard Proctor [American Society for Testing and Materials (ASTM) D 698] in preparation for installation of the radon attenuation cover.

2.1 Construction Methods and Materials

In July 1991 Nielson's began backfilling operations by placing and compacting a 3-foot thick layer of soil at the base of Borrow Pit No. 2 to provide future support for equipment working in the pit. After the base layer was placed, a layer of decommissioned mill material about 2.5 feet thick was placed in the pit. The materials were covered with 2 feet of soil, which was compacted and worked down into the mill materials. Additional soil was then added to bring the total thickness of compacted cover to 1.5 feet above the mill materials. Decommissioned mill material placed in Borrow Pit No. 2 in 1991 included structural steel and siding from demolished buildings, process equipment, piping, tanks, wooden staves, and barrels containing lab ore samples. Approximately 30,000 cubic yards (cy) of fill soil and 15,000 cy of mill materials were placed in Borrow Pit No. 2 during 1991.

In 1992, an average of 3.5 feet of decommissioned mill materials were placed in Borrow Pit No. 2. These materials consisted primarily of concrete from the process area foundations, sumps, and floors. Some structural steel, piping, and other materials were also placed in the borrow pit. After the mill materials were placed, they were covered with 2 feet of soil, which was compacted and worked into the mill debris. Additional soil was then added to the cover and compacted until the total thickness of the new cover was about 4 feet. The cover soil placed in 1992 was primarily excavated from the

mill site, ore pad, and catch basins. A total of approximately 32,000 cy of soil and 28,000 cy of mill materials were placed in Borrow Pit No. 2 during 1992.

A small volume of decommissioned materials was placed in the southeast corner of Borrow Pit No. 2 in 1993. These materials consisted of piping, solution pumps and other miscellaneous items from the Northeast Church Rock Mine IX Plant. The materials were covered with compacted soil from the Borrow Pit No. 2 stockpile area. A total of approximately 25,000 cy of fill soil and 5,000 cy of decommissioned materials were placed in Borrow Pit No. 2 during 1993.

In 1994 a small amount of remaining miscellaneous mill equipment was placed in a mound in the center of Borrow Pit No. 2. This mound was covered with soil, and the entire borrow pit was backfilled to near the surface with fill soil from the Borrow Pit No. 2 stockpile area. This fill, referred to as the interim cover, was compacted to form a base for the radon attenuation cover. A total of approximately 170,000 cy of fill soil and 2,000 cy of mill materials were placed in Borrow Pit No. 2 during 1994.

In 1995, a number of tanks were cut up and placed in Borrow Pit No. 2. A total of 5,000 cy of contaminated soil was also removed during swale construction and placed in the borrow pit. These materials were buried beneath the clean soils comprising the surface of the fill soil (i.e., the interim cover). Afterwards, the borrow pit area was compacted in preparation for construction of the radon attenuation cover.

2.2 Specifications and Testing

Construction specifications for backfilling Borrow Pit No. 2, as stipulated in the Reclamation Plan (Canonie, 1991), are listed below. These specifications are designed to minimize post-reclamation settling which could damage the radon attenuation cover. Adherence to the specifications was maintained through size reduction and efficient stacking of materials, survey control, and field density testing of the backfilled soils.

1. The mill material shall be placed in lifts not exceeding 5 feet and compacted using soil to work into existing void spaces. Each lift shall be covered with a

uniform lift of 1-foot minimum thickness of soil, measured loose, that has been compacted to a minimum of 90 percent of the maximum dry density as determined by the standard Proctor method of compaction (ASTM D 698).

2. Tailings and ore materials being graded or placed in fill sections in Borrow Pit No. 2 shall be placed in 18-inch maximum thickness lifts, measured loose, and shall be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D698 or tracked into place. Materials which are excessively wet shall be air-dried or mixed with dry fill prior to placement in Borrow Pit No. 2 so that no free liquids flow from the backfill materials.

2.2.1 Lift Placement

The majority of the mill debris was placed in Borrow Pit No. 2 during 1991 and 1992. The average lift thickness reported for these years was 2.5 and 3.5 feet, respectively, which was well within the specified maximum of 5 feet. The volume of debris placed during 1993 and 1994 was relatively small and these materials were also small in size. The mill materials were typically reduced in size prior to placement to allow for efficient stacking and to minimize the formation of void spaces. After placement, heavy equipment was used to further crush and compact the material. The maximum lift thickness reported in any one area of the pit was 5 feet. This occurred in 1992 and was limited to reinforced concrete where further size reduction was not practical.

Each lift of material was covered by a minimum of 1.5 feet of soil which was compacted to promote filling of the void spaces. Additional soil was then added to fill any depressions that were created. These measures exceeded the specification which required the placement of a minimum of 1 foot of compacted soil over mill debris. The phased filling of the borrow pit between 1991 and 1995 was also beneficial because it provided for a longer settlement period prior to placement of the final cover.

2.2.2 *Field Density*

In-place density testing of the Borrow Pit No. 2 fill material was conducted in 1991, 1994 and 1995 using the sandcone method (ASTM D1556). The test results are presented in Appendix B. There is no frequency requirement in the specifications for testing fill density because the 90 percent compaction requirement can normally be achieved with the compaction provided by haulage equipment during placement operations.

A total of 8 density tests were conducted in 1991 during the initial phase of backfilling. These tests, which indicated a relative compaction between 88 and 97 percent (average of 93 percent) of standard Proctor, verified the effectiveness of the compaction methods employed. These materials located at the base of the pit will have been subjected to additional compaction between 1991 and 1995 with the phased placement of the remaining fill layers.

Six density tests were conducted in 1994 when the majority of the fill material was placed. All 6 of these tests indicated a relative compaction of 100 percent of standard Proctor. Prior to placement of the radon attenuation cover in 1995, the entire Borrow Pit No. 2 area was grubbed of the volunteer vegetation growing on the fill surface (i.e., interim cover) and compacted. A survey grid system was then established and a total of 25 density tests were performed uniformly over the fill material. The test results ranged between 91 and 100 percent relative compaction compared to standard Proctor. The average compaction percentage of 98 percent indicates that compaction exceeded the specifications for fill material.

3.0 RADON ATTENUATION LAYER

The radon attenuation layer over Borrow Pit No. 2 consists of 18 inches of compacted soil and is designed to reduce the long-term radon flux from the underlying tailings to 20 picoCuries per square meter per second ($pCi/m^2/sec$). The soil radon attenuation layer was placed, compacted and tested as described below.

3.1 Construction Methods and Materials

Prior to placement of the radon attenuation cover, Borrow Pit No. 2 was grubbed of vegetation using scrapers and a motor grader. The top of the interim soil cover was then scarified and moisture conditioned prior to placing the final soil cover to provide for adequate bonding between the interim and final soil covers.

The soil used to construct the radon attenuation cover was obtained from the Borrow Pit No. 2 stockpile area (Sheet 4), which is located south of the borrow pit. The soil within the stockpile ranges from a silty clay to a sandy lean clay and meets the soil classification requirements specified on Figure B-1 of the Reclamation Plan's technical specifications. The soil was excavated and transported to Borrow Pit No. 2 using scrapers. Fine grading of the soil cover was performed using a motor grader.

The soil cover was conditioned to meet construction specifications by adding water and compacting. This process consisted of scarifying the soil with a roame plow and/or motor grader and spraying water on top of the soil using a water wagon. A sheepsfoot compactor was used to obtain primary compaction. Afterwards the top of the soil layer was sealed using a pneumatic roller.

The total volume of radon attenuation cover placed over Borrow Pit No. 2, excluding swale areas, was approximately 27,500 cy. The radon attenuation cover placed in the swale areas (about 1 acre) was inspected and tested separately as described in Section 5.0 of this report. The 27,500 cy of soil cover was placed, moisture

conditioned and compacted in 11 work days between June 15 and July 28, 1995, at an average rate of about 2,500 cy per work day.

3.2 Specifications and Testing

Construction specifications for placement of the radon attenuation cover as stipulated in the Reclamation Plan (Canonie, 1991) are listed below. Adherence to these specifications was maintained through strict survey control and geotechnical testing of soil properties and field density.

1. A total of 18 inches of soil cover shall be placed over the interim cover.

2. Soil used for the radon attenuation cover shall be clays, silts and fine-grained sands which fall within the gradation envelope shown on Figure B-1 of Appendix B.

3. The radon attenuation cover is to be compacted to a minimum of 95 percent of the maximum dry density at a moisture content of within 2 percent above the optimum moisture content as determined by the Standard Proctor Compaction Method (ASTM D 698).

4. The areas surrounding the borrow area that are incorporated into the reclamation work, such as drainage swales in native soils, will be excavated and regraded in accordance with the construction drawings, and compacted to a minimum of 90 percent of the maximum dry density as determined by the Standard Proctor Compaction Method (ASTM D 698).

The following sections discuss the survey control and geotechnical testing performed to verify that the radon attenuation cover was constructed in accordance with specifications.

3.2.1 *Survey Control*

To insure that the radon attenuation cover was applied uniformly and that the required total cover thickness of 18 inches was achieved, Borrow Pit No. 2 was surveyed on a 100-foot by 100-foot grid system. Elevations for the final lift were established in the field by placing wooden stakes at each grid location with the top-of-grade marked by a blue ribbon. These top-of-grade stakes were checked frequently and reestablished as necessary during placement of the final soil cover.

3.2.2 *Soil Properties*

The suitability of the borrow soil for use in the radon attenuation cover was verified by performing gradation and Atterberg tests at 76 locations distributed uniformly over the radon attenuation cover as the soil was placed. The tests indicated that the soil was within the specified gradation limits and met soil classification requirements. The testing frequency of 1 gradation test for every 361 cy of soil (i.e., 27,500 cy/76 gradation tests) exceeded the specified test rate of 1 test for every 1,000 cy placed. The laboratory reports documenting the results of the gradation and Atterberg tests for the radon attenuation layer are presented in Appendix C.

3.2.3 *Field Density*

In-place field moisture-density testing of the soil cover was conducted using the sand-cone method (ASTM D 1556). A total of 67 locations distributed uniformly over the tailings soil cover were tested, of which 58 met the required density and moisture specifications on the initial test. The remaining locations were recompacted until additional testing confirmed that required minimum moisture-density standards were met. The test frequency of 1 moisture-density test for every 410 cy of soil (i.e., 27,500 cy/ 67 moisture-density tests) exceeds the specified test rate of 1 test for every 500 cy placed. The laboratory reports documenting the results of the sand cone testing are presented in Appendix D.

The average dry density and moisture content of the 67 passing tests were 109.2 pounds per cubic foot (pcf) and 15.6 percent, respectively. This average dry density and in-situ moisture content are higher than the values used in the Reclamation Plan (Canonie, 1991) design of 108.0 pcf and 12.9 percent, respectively. The average values from the testing correspond to an in-situ porosity of 0.33 and a saturation of 83 percent, as compared to the design values of 0.33 and 68 percent for porosity and saturation, respectively. The higher density and degree of saturation of the radon attenuation layer will provide improved radon attenuating properties as compared to the cover modeled in the Reclamation Plan.

3.2.4 Proctor Tests

A total of 11 standard Proctor tests and 5 One-Point Proctor tests were conducted during completion of the radon attenuation cover over Borrow Pit No. 2. The results of these tests are presented in Appendix E. The standard Proctor tests were performed in accordance with ASTM D 698 to determine the relationship between moisture and density in the soil over a range of moisture and density values.

The Reclamation Plan specifies that standard Proctor tests be conducted for every 15 field density tests, and One-Point Proctor tests be performed for every 5 field density tests. The total of 9 standard Proctor tests performed on the cover material resulted in a testing frequency of 1 standard Proctor test performed for every 6.1 field density tests, and the combined total of 16 standard Proctor and One-Point Proctor tests resulted in a testing frequency of 1 test for every 4.2 field density tests.

4.0 EROSION-PROTECTION COVER

The erosion-protection cover consists of 6 inches or more of a soil/rock matrix placed on top of the radon attenuation soil cover. The soil/rock matrix is designed to promote surface water runoff and protect the underlying radon attenuation soil layer from wind and water erosion. The erosion-protection cover was constructed over the entire area of Borrow Pit No. 2 except for the drainage swales, which were riprapped in accordance with the Reclamation Plan (refer to Section 5.0 for drainage swale construction). Construction methods, materials and testing for the erosion-protection cover are described below.

4.1 Construction Methods and Materials

The soil/rock matrix was constructed by placing a minimum of 3 inches of rock mulch over the completed radon attenuation soil cover, then placing a 4- to 6-inch layer of random soil material over the rock mulch. The soil was then forced into the rock mulch voids to form the soil/rock matrix.

The rock mulch consisted of a basaltic aggregate with a D_{50} of 1.5 inches. This same rock was also used as riprap in the drainage swales described in Section 5.0. Construction of the rock mulch layer consisted of dumping the rock directly from haul trucks and scrapers onto the top of the completed radon attenuation cover in a series of wind rows. A motor grader then spread the rock to the required thickness of 3 inches or greater.

The soil placed on top of the rock mulch was obtained from the Borrow Pit No. 2 stockpile area and was excavated, transported and placed using scrapers. A pneumatic compactor was then used to force the soil into the underlying rock mulch, thereby creating the required soil/rock matrix. Finish grading of the top of the completed cover was performed using a motor grader.

4.2 Specifications and Testing

Construction specifications for construction of the erosion protection cover as stipulated in the Reclamation Plan include:

1. The rock mulch is to be dense limestone or other suitable rock and is to meet the following criteria: specific gravity = 2.6 or greater; absorption = 1.8 percent or less; and sodium sulfate loss = 10 percent or less. Alternatively, the rock source shall have a minimum score of 50 using the scoring criteria shown in Table D1 of the August 1990 Staff Technical Position (STP), "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites" [Nuclear Regulatory Commission (NRC), 1990] or equivalent, and shall be oversized, if needed, in accordance with the procedures provided in Appendix D of the August 1990 STP.

2. The rock mulch is to be placed a minimum of 3 inches thick and have a nominal D_{50} of 1.5 inches with the following size gradations: 100 percent passing a 3-inch screen; 8 to 37 percent passing a 1-inch screen; and, 0 to 8 percent passing a No. 4 screen.

3. The soil for the soil/rock matrix is to be a clayey sand to sandy clay with no more than 25 percent of the soil greater than 1/2-inch in diameter. The soil is to be placed in a 4- to 6-inch lift over the rock mulch and compacted a minimum of 2 inches into the rock mulch. After compaction, the top of the soil layer is to be a minimum of 3 inches and a maximum of 4.5 inches above the rock mulch.

Adherence to the specifications was maintained through geotechnical testing of the rock mulch and by measuring the rock mulch thickness and final soil layer thickness as described below.