0400134176OE

40-1341

EDGEMONT MILL

DECOMMISSIONING PROJECT

NRC SOURCE MATERIAL LICENSE
SUA-816

DECONTAMINATION AND DECOMMISSIONING

FINAL REPORT

TENNESSEE VALLEY AUTHORITY

MARCH 1990

0-0461

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The purpose of this report is to document in summary form that the Edgemont Uranium millsite and the tailings disposal site have been designed, decommissioned, constructed, and reclaimed in accordance with the Final Environmental Statement (FES) and Nuclear Regulatory Commission (NRC) Source Material License SUA-816. The FES was prepared and issued by NRC's Office of Nuclear Material Safety and Safeguards (NMSS).

The principal objectives of the Edgemont decommissioning project were to isolate and stabilize the tailings to prevent misuse by man and dispersal by natural forces, such as wind, rain, and flood waters, reduce radon emissions from the tailings, and to release the millsite for unrestricted use. The controls were designed to be effective for a minimum of 200 years, but with a design objective of 1,000 years where practical.

Completion of the project entailed the excavation, transportation, and encapsulation of approximately 3.03 million cubic yards (CY) of mixed contaminated material: 1,637,350 CY of sand tailings, 977,750 CY of slime tailings, 16,000 CY of mill site structures, 259,700 CY of contaminated native soil, and 140,600 CY of organic contaminated material.

The FES, which provided the conceptual design, was the basis used by the MacLaren Engineers et al. to develop the final, approved design. During construction operations, conditions were encountered which were not addressed in the conceptual design. This resulted in twelve modifications to the remedial action plan. The differing conditions were:

1. TVA accepted for disposal, radioactive material associated with the Department of Energy (DOE) cleanup of the Edgemont, South Dakota, vicinity properties.

2. The steep portions of the Pine Hills windblown tailings area east of the mill site were not cleaned because of safety, environmental, aesthetic, radiological, and economic reasons.

3. A recalculation of the Probable Maximum Precipitation (PMP) event using new hydrometeorological data resulted in increases to the estimated runoff and minor modifications to the geometry of the south perimeter drainage ditch outlets.

4. Drilling and in-situ testing required to confirm the presence of impermeable shale around the perimeter base of the proposed disposal basin encountered an area in the southwest corner of the basin that did not meet design specifications for permeability. The 5-foot deep perimeter liner key trench was realigned in the basin to exclude this non-specification area in the southwest corner.

5. The perimeter liner placed along the sides of the disposal basin above the level of the competent shale (constructed to ensure physical separation of the wastes from the previous strata and groundwater) was designed for 10 feet but was constructed at a 13-foot average.

6. The disposal basin excavation exceeded the design volume to provide additional capacity for more tailings/contaminated material than originally planned.

7. All tailings were transported dry by trucks limited to units in the 30-35 ton range (rather than using a slurry option). The tailings were layered with alternating layers of slime and sand in the disposal basin to form a multilayered system.

8. The tailings were encapsulated within the disposal basin in three cells rather than four.

9. The depth of the cap and cover over the encapsulated layered tailings was reduced from 10 feet to 9 feet.

10. The construction of the containment embankment was staged over four years rather than one.

11. The standard for the compacted clay material used to construct the perimeter liner, the cap, and the upstream (core) portion of the containment dam was changed from 100 percent standard Proctor maximum dry density at 2-4 percent wet to 95 percent and -4 to +4 percent wet.

12. To provide for placing more layered tailings each year in each cell, the 3-foot impervious cap constructed over each filled cell was delayed one year. To confirm that the majority of tailings consolidation had occurred before the cap construction began, settlement monitoring plates were installed.

All of the site work was completed in conformance with the specifications and drawings, and the as-built drawings reflect an accurate depiction of the existing site conditions.

I. INTRODUCTION

The NRC Source Material License SUA-816, Amendment No. 33, License Condition No. 22, requires TVA as the licensee to submit a final decontamination and decommissioning report.

This report provides a summary of the required design standards and the history of the design development. This report summarizes the remedial action taken on the Edgemont mill site to decommission the mill and the associated contaminated materials. Finally, this report summarizes the remedial action taken to permanently dispose of the contaminated materials in an engineered facility.

II. PROJECT OVERVIEW

A. Project Description

On August 16, 1974, TVA purchased the existing mill facility and the mineral rights to approximately 99,000 acres of exploration properties at Edgemont, South Dakota. Approximately 2.3 million tons of tailings were produced at the Edgemont mill from 1956 to 1972. The mill was never operated by TVA. Based on extensive engineering, economic, and environmental studies, TVA decided not to use the mill for processing uranium ore. Based on this decision and because the mill site did not meet NRC criteria for siting of uranium mills, NRC amended TVA's Source Material License to require TVA to decommission the mill and the associated contaminated materials. During decommissioning activities, which began in 1986 and were completed in 1989, TVA removed approximately 4.5 million tons of tailings, contaminated native soil, building equipment, and debris from the Edgemont processing site. This material was deposited approximately two miles away in a repository designed and engineered for long-term disposal of a minimum of 200 years but with a design objective of 1,000 years where practicable.

The contaminated material was transported by truck to the repository. Alternating layers of slime and sand tailings were placed in the disposal basin to form a multilayered system. The debris and building equipment were placed in the bottom of the basin and encased with sand tailings. Either sand tailings, contaminated native soil, or shale backfill was placed between the slime tailings and the bottom of the clay cap.

A perimeter liner was placed along the sides of the disposal basin and keyed into competent shale to provide a physical separation of the contaminated wastes from the native strata and groundwater. The perimeter liner was extended beneath the upstream toe of the containment dam and also keyed into competent shale.

The basin face of the containment dam was also lined with clay. A clay cap cover, compacted fill material, and topsoil was then placed over the contaminated material with the clay cap tied to the perimeter liner. The disposal basin, with sides lined with clay, competent shale on the bottom, a clay lined containment dam, and a clay cap with cover, completely encapsulates the contaminated material. The permability of the clay and shale encapsulating the contaminated material is $1x10^{-7}$cm/se^ or less. Because of the bulk dry transportation of the material and the 300 to 700 foot thick competent shale underlying the basin, a bottom liner was not necessary.

The clay cap and cover will minimize surface precipitation infiltrating the disposal basin. The cover was constructed with 2 percent slopes from the basin crown to a maximum of 5 percent leading to perimeter ditches. Surface runoff will move across the basin at non-erosion velocities to the perimeter diversion channel. This perimeter ditch isolates the disposal basin from the surrounding area and has been designed to carry the surface run off from a PMP event at non-erosion velocities.

B. Decommissioning Contractor

In 1978, TVA entered into a management services contract with Silver King Mines, Inc. (SKM), for the Edgemont uranium/vanadium mill site and properties. In 1979, the services contract was modified to include the decommissioning work on the existing uranium/vanadium mill and stabilization of the existing uranium mill tailings and associated contaminated materials within a repository designated by TVA.

C. TVA Management Overview of Project

As the NRC licensee, TVA had overall responsibility for assu.'ng that the decommissioning activities were conducted in accordance with the license conditions. TVA monitored the work activities of SKM, provided assistance, as necessary, and conducted evaluations of the procedural, operational, and radiological aspects of the work conducted by S!M.

TVA maintained a direct enforcement link with SKM, by virtue of the contract between TVA and SKM. TVA designated a project manager who served as TVA's direct technical contact with SKM and had overall operational responsibility for the project. The onsite control of the decommissioning project was vested in the SKM Resident Manager.

III. DECOMMISSIONING DESIGN

A. Design Development History

The decommissioning design for the Edgemont Uranium Mill and Mill Site was an evolutionary process that began before TVA's decision to decommission the uranium mill. As outlined in section III, TVA purchased the mill and mining properties with the intention of producing U_3O_8 as a part of its nuclear fuel supply.

On January 28, 1976, TVA applied for a renewal of Source Material License SUA-816. Subsequent to the application, TVA conducted extensive engineering, economic, and environmental studies at the existing mill that led to the decision not to use the Edgemont facility for milling uranium ore. As a result of TVA's decision, the NRC amended the source material license to require TVA to prepare a decommissioning plan and a supporting environmental report for the mill. The engineering and environmental data developed in previously completed studies were used in the decommissioning plan and environmental report. These include studies by Francis-Meador-Gelhaus (Ref. No. 1), Solution Engineering (Ref. No. 2), and Hazen Research (Ref. No. 3).

Additional studies, specific to the decommissioning plan, were prepared to supplement the earlier data base. The TVA Decommissioning Plan Environmental Report was submitted to the NRC on February 26, 1979 (Ref. No. 4).

NRC evaluated the TVA Decommissioning Plan Environmental Report, and other alternatives and reported their results in the "Final Environmental Statement", June 1982 (Ref. No. 5). In the FES, the NRC found TVA's proposal to be "generally satisfactory . . . ." NRC's FES, and subsequent license conditions, required that TVA "perform and submit for NRC review and approval detailed engineering studies . . . ." To meet that obligation, SKM, on behalf of TVA, contracted MacLaren Engineers et al. to perform the required engineering studies.

MacLaren submitted the first of what was to be 12 reports in the fall of 1982. With one significant exception, the plan proposed by TVA and accepted by the NRC was followed. (That exception dealt with slurry/mechanical transport of the tailings.) The MacLaren reports are:

No.	Subject	Date
1	Prelim. Geotech./Disp. Site	Oct. 1982
2	Materials Handling	Oct. 1982
3	Maintenance Shop	Dec. 1982
4	Structure Decommissioning	Jan. 1983
5	Haul Road & Ancillary Struct.	Jan. 1983
6	Open Land Rad Assessment	Feb. 1983
7	Geotechnical - Disposal Site	Feb. 1983
8	Geotechnical - Mill Site	Feb. 1983
9	Decommissioning Design	Aug. 1983
10	Disposal Site Design	Aug. 1983
11	Geotechnical Recommendations	Feb. 1983
12	Rad Safety Requirements	May 1983

B. Design Standards

The design prepared by MacLaren Engineers was fundamentally based on the NRC FES. The FES, in turn, was prepared in accordance with 10 CFR, Part 51.

Design objectives used by MacLaren were taken from the FES (Ref. No. 5), the Source & By-Product Materials License (Ref. No. 6), the Safety Evaluation Report (Ref. No. 7), Engineering Assessment of Inactive Uranium Mill Tailings (Ref. No. 8), NRC Position Paper Uranium Mill Tailings management (Ref. No. 9), and NRC Position Paper Guidelines for Decontamination of Facility and Equipment Prior to Release for Unrestricted Use (Ref. 10).

IV. MILL SITE/VICINITY REMEDIAL ACTION

A. Description of Areas/Facilities Requiring Decommissioning

1. Tails Areas and Open Areas

The Edgemont Uranium processing site is a 254-acre plot of land situated on the east side of the City of Edgemont, South Dakota (attachment 1). The property is bisected by Cottonwood Creek, bordered on the north by the Cheyenne River, the west by the Burlington Northern Railroad, the east by a local topographic feature known as "the Pine Hills," and the south by a Fall River County all-weather road.

The processing site contained several sand tailings piles and slime tailings ponds. The extent of contamination was investigated and reported by Solution Engineering (September 1980, Ref. No. 2). Francis-Meador-Gelhaus (January 1982 Ref. No. 1), and MacLaren Engineers et al. (January-February 1983, Ref. No. 11). The MacLaren reports were the most detailed and provided the basis for the decommissioning design.

As reported by MacLaren, the contamination generally covered the entire mill site and ranged in depth from 6 inches to 77 feet. Additional investigations showed that some areas peripheral to the processing site were contaminated by windblown tailings. Documentation of the construction lines and grades is shown on the millsite As-Built Cross Sections (attachment 2), millsite topographic maps (attachment 3) , and the millsite aerial photographs (attachment 4).

2. Buildings

The processing complex consisted of a three-story main steel structure of approximately 44,000 square feet and seven ancillary buildings. Three additional support buildings were constructed at the southern-most portion of the control area to facilitate decommissioning operations.

Structure contamination was studied and reported by MacLaren Engineers. Subsequent to the investigation, the buildings were classified as candidates for in-situ decontamination or designated to be dismantled and buried in the disposal basin with the tailings.

3. Pine Hills

Pine Hills, which is adjacent to the mill site to the east and southeast, consists of steep, tree-covered slopes; valleys; and draws.

A large area of Pine Hills (approximately 41 acres) was contaminated by a thin veneer of windblown material. The contamination was primarily located in the valleys and draws nearest the mill site. The extent of contamination was outlined in TVA's February 5, 1988, submittal to the NRC (Ref. No. 12).

4. DOE Properties

The U.S. Department of Energy (DOE) was responsible for vicinity property cleanup. This included properties adjacent to the millsite, in the town of Edgemont, and in the Cottonwood Community. The cleanup on these properties was conducted by DOE's contractors, Bendix Field Engineering Corporation and the United Nuclear Corporation. TVA/DOE responsibilities are outlined in the TVA/DOE cooperative agreement dated April 24, 1987 (Ref. No. 13).

B. <u>Radiological Cleanup</u>

1. Land Cleanup

The cleanup criteria established for areas where cover was to be added to a minimum depth of 6 inches was 17 pCi/g averaged over 100 square meters. This figure was obtained by adding the established 2 pCi/g background soil radium content for the project area to the NRC criteria of 15 pCi/g (10 CFR Part 40 Appendix A). For areas where less than 6 inches of cover would be added, a cleanup criteria of 7 pCi/g (NRC criteria of 5 pCi/g + 2 pCi/g background) was established.

Detailed cleanup methodologies were described in onsite procedures, (HPP/22, 4/8/88, HPP/25, 9/15/88 Ref. No. 14 and Ref. No. 15, respectively). Following removal of bulk tailings, the processing site was gridded into 20-foot by 50-foot blocks and surveyed with a shielded micro-R meter. Based on onsite testing (Ref. No. 16), it was established that a correlation existed between the content of radium in the soil and the difference in readings obtained with and without a lead shield placed directly under the detector. Where conditions prohibited direct gamma readings due to wet or frozen conditions and as a check on the correlation procedure, soil samples were taken for an accurate assessment of the block.

For soil analysis of a block, a composite sample of 1000 grams was required. The sample was desiccated and counted in a low background chamber. A correlation formula determined the pCi/g radium content of the block. One out of every 40 soil samples was analyzed by an independent outside laboratory for control purposes.

Over 14,000 blocks were surveyed, encompassing more than 321 acres. As required by the FES, a post-decommissioning soil sample program was conducted across the former processing site and the samples sent to an independent outside laboratory for radium analysis. The results were presented in the report, Post Decommissioning Radiological Surveys, November 1989 (Ref. No. 17). None of the samples exceeded 3.0 pCi/g for areas cleaned by TVA.

2. Structure Cleanup

The decommissioning of onsite structures was accomplished using a procedure developed for building clearance (HPP/24, 8/18/88, Ref. No. 18). EPA release criteria (Ref. No. 19) states that for gamma radiation, no building shall exceed 20 uR/hr above background. The established background gamma rate was 12 uR/hr for t e project area. Radon levels were also monitored within each remaining structure and the following criteria applied:

> The radon decay product concentration should not exceed 0.02 working levels for an average, and in any case, the radon decay product concentration could not exceed 0.03 working levels. To assure no alpha contamination remained on external or internal surfaces, the following limits were used: surface alpha concentrations could not exceed an average greater than 5000 dpm/100 cm^2 over an area greater than 1 m^2, nor could the surface alpha concentration exceed 15,000 dpm/100 cm^2 over an area not more than 100 cm^2.

The mill structure, along with all but three of the adjacent ancillary buildings, was removed and buried in the disposal basin. The three ancillary buildings, along with the three support structures, were thoroughly cleaned and radiologically cleared.

No areas within the six cleared structures exhibited reading in excess of 32 uR/hr (20 uR/hr criteria + 12 uR/hr background). Radon levels were determined to be below 0.02 working levels at all times and no structure exceeded the surface alpha concentration limits.

3. Pine Hills

Cleanup standards and criteria for the accessible areas of the Pine Hills were the same as that used for the processing site. In areas where cleanup was not practicable, an alternative proposal was approved that provided a practical equivalent to the requirements of 10 CFR, Part 40, Appendix A.

NRC cleanup criteria were applied to Pine Hills in areas that comprise level areas, valleys, and draws. Steep tree-covered slopes with a thin veneer of windblown tailings were not cleared because of safety and environmental considerations as outlined in a February 5, 1988, submitted from TVA to the NRC (Ref. No. 12).

Methodologies used in cleaning the processing site were also applied to Pine Hills cleanup. Approximately 29 acres were cleared in Pine Hills, while approximately 12 acres that contained slight amounts of contamination were left undisturbed. The average calculated level of 8.6 pCi/g residual Ra-226 in the area not cleaned is only 1.6 pCi/g above the cleanup standard of 7 pCi applied to the processing site.

4. DOE Properties

In accordance with the TVA/DOE cooperative agreement (Ref. No. 13), contaminated material, removed by DOE from vicinity properties, was trucked to the TVA mill site. This material was later removed to the disposal basin by TVA for burial. The last DOE material was received in October 1988.

C. Groundwater Monitoring Program

TVA conducted groundwater quality monitoring at the Edgemont mill site, beginning in August 1986, and continuing until January 1990. The original monitoring consisted of nine (9) wells which were measured for water levels, and sampled monthly. The samples collected were analyzed for eight (8) parameters. On March 28, 1988, TVA submitted a new groundwater monitoring plan in accordance with 10 CFR, Part 40, Appendix A. NRC issued a license amendment on April 12, 1988, that incorporated the plan submitted by TVA. Under this plan, six (6) potential compliance wells and three (3) proposed background wells were to be sampled and analyzed for 41 parameters. Sampling was initiated on June 15, 1988. During this program, 26 sample events were collected until January 1990. The results of this groundwater monitoring and the geohydrologic data collected by TVA showed that there was no significant continuous aquifer across the mill site. Only 2 compliance wells initially produced sufficient water for sample analysis. Within 6 months of initiation of the new program and after the tailings piles and slime ponds were removed from the mill site, only 1 of the potential compliance wells would produce a sufficient quantity of water for lab analysis. Data collected by TVA were reported in semiannual reports and other submittals to NRC.

The groundwater monitoring license requirement (SUA-816 condition 28) was deleted by NRC license amendment No. 33 dated January 2, 1990.

D. Reclamation Plan Overview and Deviations from Original Plan

The objectives of the mill site reclamation were to: 1) stabilize soil, 2) make the site available for productive use, and 3) restore the riparian community of the rechanneled portion of Cottonwood Creek (FES section 2.2.2.7).

The entire site was recontoured before reseeding. Potential offsite borrow areas were not disturbed because sufficient material was available on the mill site and disposal site for fill. Areas were graded to promote positive drainage, with minimal slopes to decrease erosion potential. Water spreading bars were constructed below drainages originating on the hills east of the site to minimize gully formation and to retain moisture for vegetation establishment. The channel of Cottonwood Creek was reconstructed to approximate the predevelopment configuration, with banks graded to slopes of 5H:1V or less.

Topsoil was applied over the entire site to a depth of 15 to 20 cm (6-8 in.). The area was then ripped to a depth of 26-31 cm (10-12 in.) to break the interface between the topsoil and subsoil. The recontouring and topsoiling were completed in early March 1989.

Fertilizer was applied at a rate of approximately 40 pounds per acre nitrogen and 34 pounds per acre phosphorus in a 34-40-0 fertilizer mix at approximately 115 pounds per acre. This reduction in fertilization rate from that suggested in the FES (100-120 pounds per acre nitrogen and 200 pounds per acre phosphorus) was based on topsoil samples taken following placement. Use of this reduced fertilization rate will result in less competition from weed species and reduce runoff of excess nutrients into Cottonwood Creek and the Cheyenne River. Seeding of the mill site was completed by May 10, 1989.

The originally proposed seed mix for the mill site included the shrub, Louisiana Sagewort (Artemisia ludoviciana). Initially, seed of this species was available for approximately 19 acres; however, in 1989 seed of this species was not available and Winterfat (Eurotia lanata) was substituted. This change was coordinated with the South Dakota Department of Game, Fish, and Parks (Ref. No. 20) and the NRC was notified.

Shrub and tree species were obtained from the local Soil Conservation Service (SCS) office and were planted in the spring of 1989. This reduced competition for available moisture that would have resulted if shrubs and trees were planted after grass establishment. Because the trees and shrubs were obtained from sources with plants edaphically adopted to the Edgemont area, it was not necessary to overwinter them in an onsite lathe house. The trees and shrubs were planted in clusters or short rows rather than in two band as proposed. This planting created a more natural appearance and eliminated the need for plowing strips along the banks to plant the seedlings. The trees and shrubs were watered, and wood fiber mulch (sawdust) was placed around their base.

Some areas of the mill site and a temporary haul road were redisturbed during the summer of 1989 to facilitate cleanup of organic material located under the office building and water tower. These areas were recontoured, topsoiled, ripped, fertilized, and seeded during October 1989.

The entire area was mulched with native hay at a rate of 2 tons per acre and was anchored by use of a crimper to prevent blowing. During the summer, weed growth (primarily fireweed <u>Kochia americana</u>) was controlled by mowing.

Following the first growing season, visual inspection showed good-to-excellent grass establishment and growth that should be sufficient to allow quantitative evaluation in 1990.

Tree and shrub survival is fair to good with some growth being shown by some individuals. Survival will again be evaluated during 1990.

V. <u>DISPOSAL SITE</u>

A. <u>Design Features</u>

1. Seismic Stability - Containment Dam

Regulatory Guide 3.11 (Ref. No. 21) states that, "in areas where embankments are subjected to seismic disturbances, analyses should be made of the seismic effects on dams." As indicated in the Environmental report (Ref. No. 4), the disposal site is located in a low-risk seismic zone. This fact, coupled with the unsaturated character of the wastes and the maximum final reclaimed slope of 5:1 across the containment dam face, combine to produce a design which has essentially no risk of failure due to seismic activity. The calculated "critical" maximum ground acceleration for the containment dam was about 0.2g, which is some four times greater than the design acceleration for the Edgemont area (0.05g).

2. Containment Dam Design

The location of the disposal site at the head of an ephemeral drainage required construction of a containment dam to enclose the disposal basin. This dam was designed to meet NRC Regulatory Guide 3.11 (Ref. No. 21).

The key elements of the dam included the following:

* An upstream "core" zone of highly compacted, low-permeability silty clay to minimize seepage.

* A downstream shell of compacted weathered shale for stability.

* An inclined, continuous chimney drain to intercept any seepage which might occur through the core zone.

* A series of horizontal finger drains extending from the chimney drain to the downstream toe of the dam.

* A toe collector drain.

* Riprap facing on the downstream slope for erosion protection.

* A cutoff trench to allow extending the clay core zone down into the impervious shale.

* A series of gravity relief wells designed to relieve any potential artesian pressures that may develop under the downstream portion of the dam.

3. Geotechnical Engineering/Clay Liner

The decommissioning plan presented in the FES (Ref. No. 5) provided for disposal of c[illegible]aminated wastes in a "partially below-grade" facility and for "encapsulation" of the wastes with natural or engineered materials having a permea[illegible] of $1x10^{-7}$ cm/sec or less. The results of the detailed geotechnical investigation conducted on the site determined that low permeability, competent shale (permeability $1x10^{-7}$ cm/sec or less) was present across the base of the site, and that this material was overlain by relatively more pervious weathered shale and soils.

Based on these findings and on calculations of seepage and contaminant migration rates, the site was developed with the following major features:

* A compacted clay perimeter liner was keyed into the competent shale and extended up the sides of the disposal basin to provide physical separation of the wastes from the previous strata and the shallow groundwater and to retard the release of contaminants.

* A clay-lined containment dam was constructed across the downstream end of the basin to enclose the disposal area.

* An encapsulation system consisting of a clay cap and cover tied to the perimeter liner was placed over the wastes to reduce surface infiltration into the tailings.

Since the clay perimeter liner (including the lining on the upstream face of the containment dam) was "keyed" into impervious shale and formed a continuous seal around the perimeter of the basin, excavation of the central portion of the basin to the impervious shale was not considered necessary.

4. Bottom Liner Exemption

Geotechnical data was collected to determine the physical characteristics of the material under and around the disposal basin. This data showed that the material underlying the disposal area was unweathered shale that ranged in depth from 300 to 700 feet. The permeability of this material was found to be 1×10^{-7} cm/sec or less. TVA provided this information, along with a detailed engineering justification and a request for an exemption to the EPA liner requirement for impoundments, to the NRC on April 13, 1984 (Ref. No. 22). NRC concurred with the above justification and request with an approval for a liner exemption for the Edgemont disposal basin on November 16, 1984 (Ref. No. 23).

5. Perimeter Drainage Design

The perimeter drainage system consists of ditches along the perimeter of the disposal site to intercept overland flow and convey storm water around and away from the area. The ditches were designed with a maximum gradient of 0.5 percent and sufficient hydraulic capacity to convey the flow from the PMP event. The channels are designed for non-erosive flow velocities during the design storm.

The perimeter drainage systems discharge into the natural drainage systems to the northwest, southeast, and southwest of the disposal site. These three ditch outlets required special erosion protection treatment. The design of riprap protection of the channel outlets was based on the PMP event with a return period in the 1:10,000 to 1:30,000 year range (Ref. No. 24).

B. Disposal Site Construction

1. Changes from Original Design

Eight operational and construction changes were made from the original MacLaren design:

a. MacLaren revised the alignment of the southwest portion of the perimeter liner because of unexpected geotechnical conditions.

b. The perimeter liner was designed for a thickness of 10 feet, but because of operational efficiencies was built 12-14 feet thick.

c. The ultimate capacity of the basin exceeded the MacLaren design because of additional excavation to allow for more tailings and contaminated material.

d. MacLaren planned the basin construction to be in four seasons using four "cells." The basin was built in three seasons using three "cells."

e. To allow more time for placing layered tailings in each of the three cells, the construction of the 3 foot impervious cap over each filled cell was delayed 1 year. To confirm that the majority of tailings consolidation had occurred before the cap construction began, settlement monitoring plates were installed.

f. The depth of the cap and cover over the encapsulated layered tailing was reduced from 10 feet to 9 feet (Ref. No. 25).

g. The construction of the containment embankment was staged over 4 years rather than 1 year because of logistical considerations.

h. The standard for the compacted clay material used to construct the perimeter liner, the cap, and the upstream (core) portion of the containment dam was changed from 100 percent standard Proctor maximum dry density at 2-4 percent wet to 95 percent and -4 to +4 percent wet.

2. As-Built Construction

Actual construction of the disposal site was conducted in accordance with the plans and specifications in MacLaren Report 10 (Ref. No. 11), with the above noted exceptions.

Documentation of the construction lines and grades is shown on the Disposal Basin As-Built Cross Sections (attachment 5), Disposal Basin Topographic map (attachment 6), and the Disposal Basin Aerial Photograph (attachment 7). Permanent QA/QC records for the project document the results of 1,736 density tests, 286 laboratory tests, and 153 flexible wall parameter tests.

3. Settlement Monitoring

Settlement monitoring of the final tailings surface was conducted in disposal basin Cells 1 and 2 prior to clay cap and final cover construction. The results of this monitoring program showed that primary consolidation was complete prior to clay cap construction and that the rate of consolidation could be reasonably well predicted using standard geotechnical engineering techniques.

4. Post Construction Radiological Assessment

As required by the FES 4.2.2.7, Site Surveys, radiological surveys were conducted prior to and after decommissioning at the disposal basin area for radon flux, gamma dose rates, and radium-226 soil content. Two 3000 meter transects crossing at the approximate center of the disposal basin were established, and testing was conducted at prescribed intervals along each transect. Testing results indicate background levels of gamma dose rates and radium-226 while radon flux rates were near those obtained during the 1983 baseline testing. A complete summary of the radiological assessment can be found in the report Post Decommissioning Radiological Surveys, November 1989. (Ref. No. 17)

5. Reclamation of Disposal Basin and Other Areas

The objectives of the reclamation plan for the disposal site, haul road, and stockpile areas were to: 1) stabilize the tailings and provide livestock forage on all other disturbed areas (FES 2.2.2.9).

Following placement of the clay cap and cover material, stockpiled topsoil was applied and ripped and mixed to a depth of 26 to 31 cm (10 to 12 in.) to provide a topsoil growth medium of 1 foot. The haul road and stockpile area were topsoiled with 15-20 cm (6 to 8 in.) of material and ripped and mixed to a depth of 26-31 cm (10-12 in.) after recontouring to blend with surrounding terrain.

Final contouring and placement of topsoil were completed in September 1989. Fertilizing (115 pounds per acre of a 34-30-0 mix) and final seeding were accomplished during October 1989. All seeding was done with a rangeland drill with depth control bands and double disc furrow openers.

Because of a misinterpretation, the seed mix originally proposed (ER Table 4.6-7 and FES Table 2.5) was actually planted rather than the mix recommended in Table 2.7 of the FES. Although some of the species in the recommended mix have advantages, it is believed that the species planted will provide for the establishment of a self-perpetuating maintenance-free stand of vegetation. The reclaimed area will be monitored and additional species may be interseeded, if necessary, to supplement the stand establishment.

No trees or deep rooted shrubs were planted on the disposal basin, stockpile, or haul road areas. All disturbed areas have been fenced to prevent/minimize grazing, while vegetation is becoming established. Fencing will remain around the disposal basin to prevent livestock grazing. Following vegetation establishment, quantitative data will be collected and statistically analysed to ensure that cover and density of perennial species equal the cover and density of perennial species at control areas for two consecutive growing seasons.

VI. CONCLUSIONS

The completed condition of the mill site is shown in the Millsite As-Built Cross Sections (attachment 2). As documented in Section V. A., B., C., and D., the Edgemont mill site was cleaned to meet criteria discussed in Section IV. B.

A total of approximately 3.03 million CY of mixed contaminated material: 1,637,350 CY of sand tailings, 977,250 CY of slime tailings, 16,000 CY of mill site structures and debris, 259,700 CY of contaminated native soil and 140,600 CY of organic contaminated material were encapsulated within the engineered disposal basin.

The completed condition of the disposal basin and containment dam is shown in the Disposal Basin As Built Cross Sections (attachment 5). As documented in Section VI. A., B., and C., the mixed contaminated material is completely encapsulated within the disposal basin.

REFERENCES

1. Francis-Meadoer-Gelhaus Inc., 1982. "Edgemont Uranium Millsite Boring Program and Gamma Survey" for Silver King Mines, Inc.

2. Solution Engineering, Inc. "Phase I, Study of Residual Uranium and Vanadium in Edgemont Tailings Edgemont, South Dakota" for Silver King Mines, Inc., September 1980.

3. Hazen Research, Inc. "Process Design and Cost Analysis for the Edgemont Uranium - Vanadium Mill," Volume I and Volume II Appendix, February 9, 1977.

4. Tennessee Valley Authority, 1979. "Edgemont Uranium Mill Decommissioning Plan Environmental Report," Docket No. 40-1341.

5. U.S. Nuclear Regulatory Commission, 1982 (NUREG-0846). "Final Environmental Statement Related to the Decommissioning of the Edgemont Uranium Mill," Tennessee Valley Authority, Docket No. 40-1341.

6. U.S. Nuclear Regulatory Commission "Source & Byproducts Material License SUA-81," Docket No. 40-1341.

7. U.S. Nuclear Regulatory Commission, 1983. "Safety Evaluation Report by the Division of Waste Management in consideration of the Decommissioning of Tennessee Valley Authority's Edgemont Uranium Mill Source Material License SUA-816," Docket No. 40-1341.

8. Ford, Bacon & Davis Utah, Inc., 1978. "Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota," for the U.S. Nuclear Regulatory Commission.

9. U.S. Nuclear Regulatory Commission, Position Paper, "Uranium Mill Tailings Management," May 1977.

10. U.S. Nuclear Regulatory Commission, position paper, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, November 1976.

11. MacLaren Engineers, Inc., 1983. "Reports 1-12, TVA Project, Edgemont Mill Decommissioning," for Silver King Mines, Inc.

12. Letter to R. Dale Smith, NRC, from R. Gridley, TVA, dated February 5, 1988 "Edgemont Mill Decommissioning Remedial Action for Windblown Tailings Pine Hills Area" Docket No. 40-1341.

13. DOE Interagency Agreement (IA) No.: DE-AI04-84AL27241, Modification No.: M002. Uranium Mill Tailings Remedial Action Project - Edgemont, South Dakota," January 28, 1987.

14. Letter to R. Dale Smith, NRC, from R. Gridley, TVA, dated April 1, 1988 "Site Land Clearing Procedure HPP/22 R-1" Docket No. 40-1341.

15. Letter to R. Dale Smith, NRC, from R. Gridley, TVA, dated December 15, 1988, "Edgemont Uranium Mill Decommissioning Project - Source Material License SUA-816 - Procedure HPP/25, Site Clearing Peripheral Areas" Docket No. 40-1341.

16. Letter to R. Dale Smith, NRC, from J. W. Hufham, TVA, dated December 31, 1985 "Survey Techniques Used in Securing Gamma-Radium Correlations" Docket No. 1341.

17. Letter to Ramon Hall, NRC, from M. J. Ray, TVA, dated January 5, 1990, "Edgemont Decommissioning Project - Post Decommissioning Radiological Survey" Docket No. 40-1341.

18. "Building Clearing Procedure HPP/24 R-1" prepared by Silver King Mines, Inc., Edgemont Project dated August 18, 1988.

19. EPA 40 CFR Part 192 Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings.

20. Letter to Doug Yoder, TVA from Ronald Glover, South Dakota Department of Game, Fish and Parks, dated March 7, 1989,"Revegetation Plan."

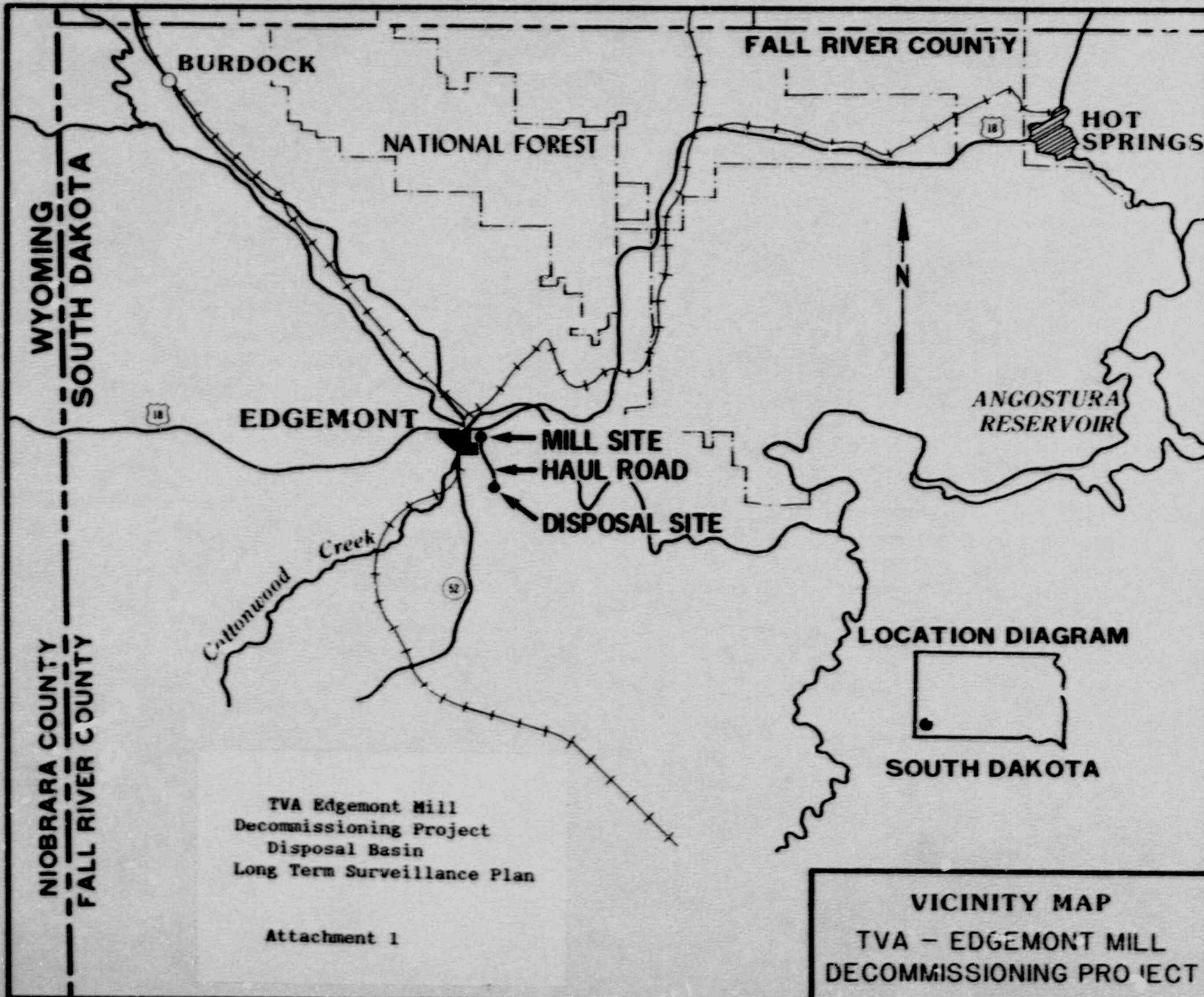
21. U.S. Nuclear Regulatory Commission, Regulatory Guide 3.11, 1977. "Design, Construction and Inspection of Embankment Retention Systems for Uramium Mills." Published by Office of Standards Development.

22. Letter to R. Dale Smith, NRC, from L. M. Mills, TVA, dated April 13, 1984, "Edgemont Uranium Mill Decommissioning - Summary of Environmental Review Concerning Conformance with 40 CFR Part 192 - Primary Standard Requiring a Liner for Impoundments" Docket No. 40-1341.

23. Memorandum to R. Dale Smith, NRC, from Robert E. Browning, NRC-NMSS, dated November 16, 1984, "Request for NMSS Concurrence in Exemption of TVA's Edgemont Disposal Site From 40 CFR Part 192 Liner and Ground-water Monitoring Requirements."

24. Letter to R. Dale Smith, NRC, from J. W. Hufham, TVA, dated December 20, 1984, "TVA Project Edgemont Mill Decommissioning - Addendum, Disposal Site Drainage Design."

25. Letter to Manager of Nuclear Licensing - TVA, from R. Dale Smith, NRC, dated May 16, 1986, "AMENDMENT OF SUA-816."

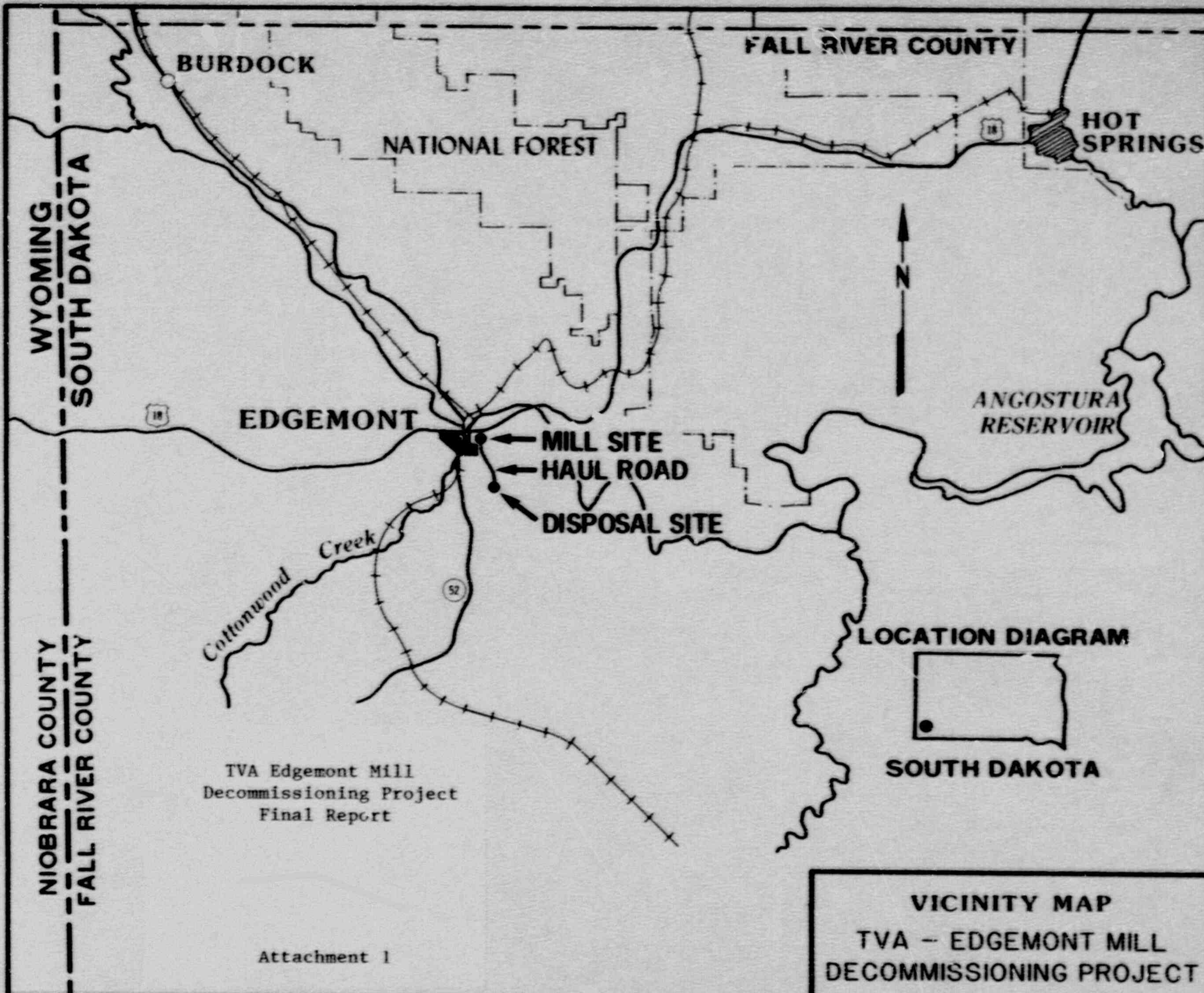


TVA Edgemont Mill
Decommissioning Project
Disposal Basin
Long Term Surveillance Plan

Attachment 1

VICINITY MAP

TVA – EDGEMONT MILL
DECOMMISSIONING PROJECT



TVA Edgemont Mill
Decommissioning Project
Final Report

Attachment 1

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 75

APERTURE CARD/HARD COPY AVAILABLE FROM

RECORDS AND REPORTS MANAGEMENT BRANCH