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OCT 19 1989

Mr. Paul H. Lohaus
Branch Chief, Operations Branch
Division of Low-Level Waste
Management & Decommissioning
Office of Nuclear Materials Safety
and Safeguards
Mail Stop 5-E-4
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Lohaus:

Enclosed are the revised pages for the Spook Final Remedial Action Plan (RAP) which reflect the cell design changes described in PID No. 15-S-02. The revisions are typed in bold print and text deletions are indicated by brackets. The sections on the groundwater compliance strategy have not required revisions. We recommend that these pages be incorporated into the Final Spook RAP.

Should you have any questions, please contact Chris Watson of my staff at FTS 844-3941.

Sincerely,

Mark L. Matthews
Acting Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/enclosure:
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4.0 SITE DESIGN

4.1 INTRODUCTION

This section of the RAP describes the design of the remedial action at the Spook tailings site. The design presented in this report meets the requirements of PL95-604. This section of the report is divided into the following six subsections: (1) this introduction; (2) a brief summary of the proposed remedial action; (3) a more detailed description of the various aspects of the remedial work undertaken to stabilize the tailings; (4) a description of the construction requirements of the remedial action; (5) an analysis of the potential for reprocessing; and (6) a discussion of site acquisition. The third section is divided into subsections that describe the design, the rationale for the design, alternatives considered, and design criteria.

4.2 SUMMARY OF REMEDIAL ACTION

The principal feature of the design is the stabilization of the tailings and contaminated material in the Spook pit, herein defined as "stabilization in place." The disposal cell will have [] topslopes of three to eight percent. On the north and south ends of the pile, the sideslopes will be 50 percent (two horizontal to one vertical); the east and west sides of the pile will be vertical. This will be achieved with concurrent placement of AML materials. The base of the cell will be nearly hexagonal and cover 5 acres inside the pit [] with an average depth of about 40 feet (maximum depth of 54 feet). The proposed cell configuration and a typical cross section are illustrated in Figures 4.1 and 4.2, respectively. The tailings and contaminated materials will be covered with a 1.5-foot-thick low-permeability layer; the upper surface of the layer will be crowned to promote positive drainage, thereby reducing infiltration. Along the perimeter of the vertical sides of the pile, the low-permeability layer will extend 20 feet past the limit of placement of contaminated materials. The bottom of the pit will be covered with a three-foot-thick foundation layer by the state of Wyoming under the state AML Program.

Concurrent with construction of the disposal cell, the state of Wyoming will proceed with reclamation of the Spook pit under the AML Program. The restoration will involve placing and compacting stockpiled overburden material in the pit, bringing the surface of the backfill up to the approximate pre-mining ground surface. The backfill will average about 56 feet thick above the tailings and will serve as a radon barrier for the tailings as well as eliminate the need for erosion protection rock.

The former mill yard and windblown areas will be graded and revegetated under the AML Program. The final restricted area will cover 13 acres. This restricted area corresponds to the surface area of the pit plus a 200-foot-wide perimeter buffer zone. This buffer will ensure stability of the pit wall in the event future mining activities are initiated in the Spook area. The remainder of the designated site will

be released for use consistent with existing land use controls following completion of remedial action.

4.3 PERMANENT FEATURES - DESIGN DETAILS

4.3.1 Introduction

This section provides details of the major components of the design. All design approaches, unless otherwise discussed in the following section, are outlined in the Technical Approach Document (TAD) (DOE, 1988). Where applicable, alternatives considered are discussed as justification for the selected design.

4.3.2 General requirements

The detailed design complies with the EPA standards and all requirements applicable to the UMTRA Project. In addition, the detailed design complies with all the criteria, methods, and approaches set out in the TAD (DOE, 1988) and the Standard Review Plan (NRC, 1985).

4.3.3 Pile location

Design details - As briefly described in Section 4.2, the remedial action calls for the stabilization of all tailings and contaminated materials in the Spook pit.

Design rationale - The selection of stabilization in place (SIP) in the Spook pit as the preferred disposal alternative was the result of a series of reviews (by technical specialists) and cost considerations. Briefly, the tailings will be stabilized in the Spook pit for the following reasons:

- SIP followed by AML reclamation eliminates the need for rock to protect the pile from erosion.
- Below-grade disposal is more geomorphologically stable than above-grade disposal.
- SIP presents the fewest potential negative impacts to the surrounding environment and is preferred by the local population.
- SIP is the least costly action alternative.

Alternatives considered - A regional search for alternate disposal sites for the Spook tailings pile was conducted by Ford, Bacon & Davis Utah Inc. (FBDU, 1981). Three nonspecified alternate sites in addition to SIP were identified at five, 10, and 15 miles from the tailings site. The alternate disposal sites were not considered any further because of long haul distances.

Another option involves stabilization on site (SOS) of the tailings adjacent to the Spook pit. The SOS option was evaluated and not considered any further for the following reasons:

- SOS involves two separate construction projects and areas (i.e., stabilization of the pile adjacent to the pit and reclamation of the pit under the AML Program) versus the combined construction project for the SIP option.
- A nearby source for durable erosion protection rock was not identified. Haul distances of 50 to 100 miles would be encountered in importing erosion protection rock.
- The stabilized pile would have to be set back a significant distance from the Spook pit to accommodate AML Program work.
- The pile might be less stable during seismic activity.
- SOS costs are more than SIP.

4.3.4 Pile layout

Design detail - The tailings presently rest on the top edge, highwalls, and bottom of the Spook pit; in addition, windblown contamination and contaminated soil under the tailings and in the mill yard are present. All contaminated materials will be placed in the south-central portion of the Spook pit to create a **disposal cell with topslopes from three to eight percent. The cell will have 50 percent sideslopes (two horizontal to one vertical) on the north and south ends and be covered with the low-permeability layer. The east and west sides of the cell will be vertical and the low-permeability layer will extend 20 feet past the limit of placement of contaminated materials.** The tailings in the pit will be relocated prior to placement of the foundation layer. The proposed pile configuration and a typical cross section are shown in Figures 4.1 and 4.2, respectively.

The **disposal cell** will be nearly hexagonal and cover 5.0 acres. The **cell** will rise an average of **40** feet (maximum height of 54 feet) above the pit floor and be at an average depth of about **50** feet below the original and surrounding ground surface. The base of the **disposal cell** will be 15 feet above the current groundwater level.

Design rationale - The **cell** layout is designed to effectively use the limited, relatively level area available at the base of the pit by using either **vertical sides or** 50 percent sideslopes. Slope failure will not be a concern even with these steep sideslopes since the pile will be completely covered with overburden material concurrent with stabilization of the tailings and contaminated materials. This layout also minimizes the surface area, thus minimizing the amount of material required for the

low-permeability layer. Crowning the upper surface of the pile on the topslopes will promote positive drainage and thus reduce infiltration into the tailings.

Alternatives considered - Other pile layouts were evaluated in determining the design. A relatively shallow layer of contaminated materials could be placed over the entire pit floor; this design, however, would increase the surface area of tailings exposed to infiltration and have a potential negative impact on groundwater quality. A very deep pile with nearly vertical sideslopes would minimize the surface area exposed to infiltration, but would be difficult to place and would be more subject to near surface geomorphic instability. Also, contaminated materials placed against the pit high walls would be subject to lateral percolation from seeps known to occur from the walls.

4.3.5 Abandoned Mine Lands (AML) Program reclamation design

Design criteria - The state of Wyoming has designed the reclamation of the Spook pit according to the applicable standards associated with the AML Program. Several elements of the AML design are also incorporated into the plan to stabilize the Spook tailings. Accordingly, the DOE established the following design criteria for the pit reclamation:

- The Spook pit will be backfilled with available overburden materials to a sufficient depth, density, and moisture content to achieve the EPA standards for radon emission from the tailings.

- The low-permeability layer, as placed by the DOE, will be covered with a 10-feet thick layer of granular backfill material by the AML Program to enhance lateral drainage around the stabilized pile.

- The final ground surface achieved by the AML Program will be geomorphically stable such that surface erosion (due to wind, overland flow, or gully migration) will not reach the stabilized tailings during the 200- to 1000-year design life of the remedial action.

- The Spook pit will be backfilled using reasonable lift thicknesses and compactive effort such that the final ground surface will not settle to a degree that ponding would occur or that positive drainage is not promoted. The DOE expects that ponding of surface water, as might result from differential ground settlement, will not occur above the stabilized tailings during the design life of the remedial action.

4.3.6 Foundation preparation

Design detail - The foundation area for the proposed tailings pile will be prepared as follows:

- o Vegetation will be removed.
- o Loose surface materials will be excavated near the south access ramp in the pit, and will be replaced in lower areas to the north.
- o Surface boulders will be removed.
- o A three-foot-thick foundation layer will be placed and compacted at the bottom of the pit by the state of Wyoming under the AML Program.
- o Excess cut materials and all boulders will be placed and compacted in the adjacent pit areas.

Design rationale - In order to prepare a surface suitable for placement of the tailings and contaminated materials and provide a stable foundation, the pit floor must be leveled and stabilized.

4.3.7 Placement of tailings

Design detail - The tailings that presently extend from the top of the high wall to the bottom of the Spook pit will be placed in the disposal area in layers and compacted. Tailings resting against the high wall inside the pit will be cut away down to the foot of the high wall per the design (Figures 4.1 and 4.2). Windblown contamination, contaminated soils underlying the tailings, mill yard soils, and the small ore piles will be placed and compacted in the disposal embankment. Materials with a Ra-226/U-238 ratio greater than 4.8 will be assumed to be tailings. Organic material and demolition debris may be incorporated in parts of the pile. The maximum percentage of organics contained within the embankment will be limited to five percent by volume and the material will be distributed in a manner that will avoid pockets or layers of organic matter. The sequence of placement of the contaminated materials in the tailings embankment is not critical for meeting the EPA criteria and will be at the subcontractor's option.

Design rationale - Tailings will be compacted to 90 percent standard Proctor in order to reduce both primary and long-term settlement. Excessive settlement could lead to deformation of the surface of the pit pile, potentially disrupting and concentrating surface-water flow. The percent compaction is based on laboratory test results which indicate anticipated settlement for calculated loadings.

- Backfilling the pit with compacted overburden material and grading the surface to prevent ponding of surface water above the tailings and promote sheet flow.

- Keying or benching the upper contact of the pit wall interface to eliminate vertical boundaries between the backfill and the pit wall which may open as a result of settlement (potentially allowing a direct entry by sheet flow runoff).

- Stabilizing the pile about 15 feet above the current groundwater level.

- Placing a foundation layer over the bottom of the pit before placing tailings or backfill that will retard leachate migration.

The pile will be contoured to shed percolating groundwater. The low-permeability layer will be **placed** on the top and **50 percent sideslopes** of the pile to reduce percolation of groundwater through the tailings. This layer will minimize infiltration into the stabilized tailings during placement of the backfill materials. []

Design rationale - Groundwater protection at the Spook site will be enhanced by reducing the amount of water infiltrating the stabilized pile which will, in turn, reduce the leaching and migration of tailings contaminants into the underlying Wasatch Formation. Contouring the stabilized pile surface will promote positive drainage and prevent standing water from accumulating during and after construction. The low-permeability layer will reduce infiltration of direct precipitation during AML construction activities. Tailings will be removed from direct contact with the pit highwalls where groundwater seeps (observed elsewhere in the pit) could percolate through the tailings.

Design criteria - The pile cover shall be sloped to promote positive drainage. The low-permeability layer shall be uniformly sloped with no depressions which will hold water and promote infiltration. The low permeability layer materials will be soils obtained from AML overburden pile No. 700. The material will consist predominantly of soils with classification ML, CL, SC, and SM when classified in accordance with ASTM D2487, and will have a maximum particle size of two inches and a minimum of 40 percent passing the No. 200 sieve. Tailings shall be removed from direct contact with the pit highwalls.

During construction, precautions shall be taken to ensure that no more water than necessary is introduced onto or into the tailings. The proposed location for the tailings is between two existing low points in the pit; therefore, any water collecting in the pit will pond at these points, away from the pile.

Tailings pile placement and geometry

The tailings will be placed in the south-central portion of the Spook pit at an elevation of 5023 feet, on a prepared foundation approximately 18 feet above the groundwater table of the upper sandstone unit. The foundation will consist of three feet of fine-grained alluvial materials from either the #200 or #400 overburden piles (AML, 1987) on top of compacted pit-fill sands. Under the AML Program, adsorption tests were performed on the foundation materials. The results of these tests showed that movement of contaminants (e.g., radium-226 and selenium) in groundwater would be retarded by this foundation (Hydro, 1987).

The topslopes of the cell will vary from three to over seven percent and the sideslopes on the north and south ends of the cell will be 2:1 (50 percent). On the east and west, the cell will have vertical sides.

Low-permeability layer

The purpose of the low-permeability layer is to [] provide protection for the tailings cell from the AML Program construction activities and to limit potential infiltration during placement of the backfill, especially in the event of a break in the construction schedule. The low-permeability layer will be a minimum of 1.5 feet thick over the topslopes of the disposal cell and on the sideslopes (north and south ends of the cell). On the east and west sides of the cell, the low-permeability layer will extend 20 feet past the horizontal limit of tailings placement. This layer will have a saturated hydraulic conductivity of 1×10^{-6} to 1×10^{-7} cm/s. It will be composed of fine-grained alluvial materials from the #700 overburden pile (DOE, 1988b). Percolation of leachate through the tailings is limited by the net rate of recharge and not by the low-permeability layer. Because the recharge rate is less than the saturated hydraulic conductivity of the low-permeability layer, all infiltration should percolate through the tailings.

Drainage layer

This layer will consist of ten feet of the coarsest overburden materials available, and will have a saturated hydraulic conductivity of approximately 1×10^{-4} cm/s. By ensuring that few fine-grained materials are placed immediately over the low-permeability layer, there will be two to three orders of magnitude difference in saturated hydraulic conductivity between these layers. Therefore, saturated conditions during construction could not build up to any significant extent before drainage around the tailings materials occurs.

Pit backfill

The AML Program backfill materials will be placed in one-foot lifts and compacted to 90 percent standard Proctor density. Seventy percent of these materials are sands derived from the sandstone bedrock, 25 percent are fine-grained materials from the alluvium that covered the bedrock before mining, and five percent are silts and clays derived from shale layers in the bedrock. The placement of these various materials in lifts will result in a backfill with heterogeneous properties. The uppermost layer of the backfill will consist of relatively fine-grained topsoil and alluvial materials for use as a growing medium. These soils will limit near-surface infiltration of precipitation by increasing runoff while providing moisture retention so that more water is available for evapotranspiration.

Surface features

The AML Program will be responsible for regrading and revegetating the surface of the reclaimed pit. Existing drainages will be reestablished both to the north and south of the disposal areas. The surface will be recontoured so that the relocated tailings will be approximately under a drainage divide with slopes of five to seven percent. Reseeding the area with endemic plant species, fencing the area, and monitoring plant growth will ensure that a healthy plant community will become established. These activities will promote surface runoff of precipitation and transpiration of soil moisture to the atmosphere.

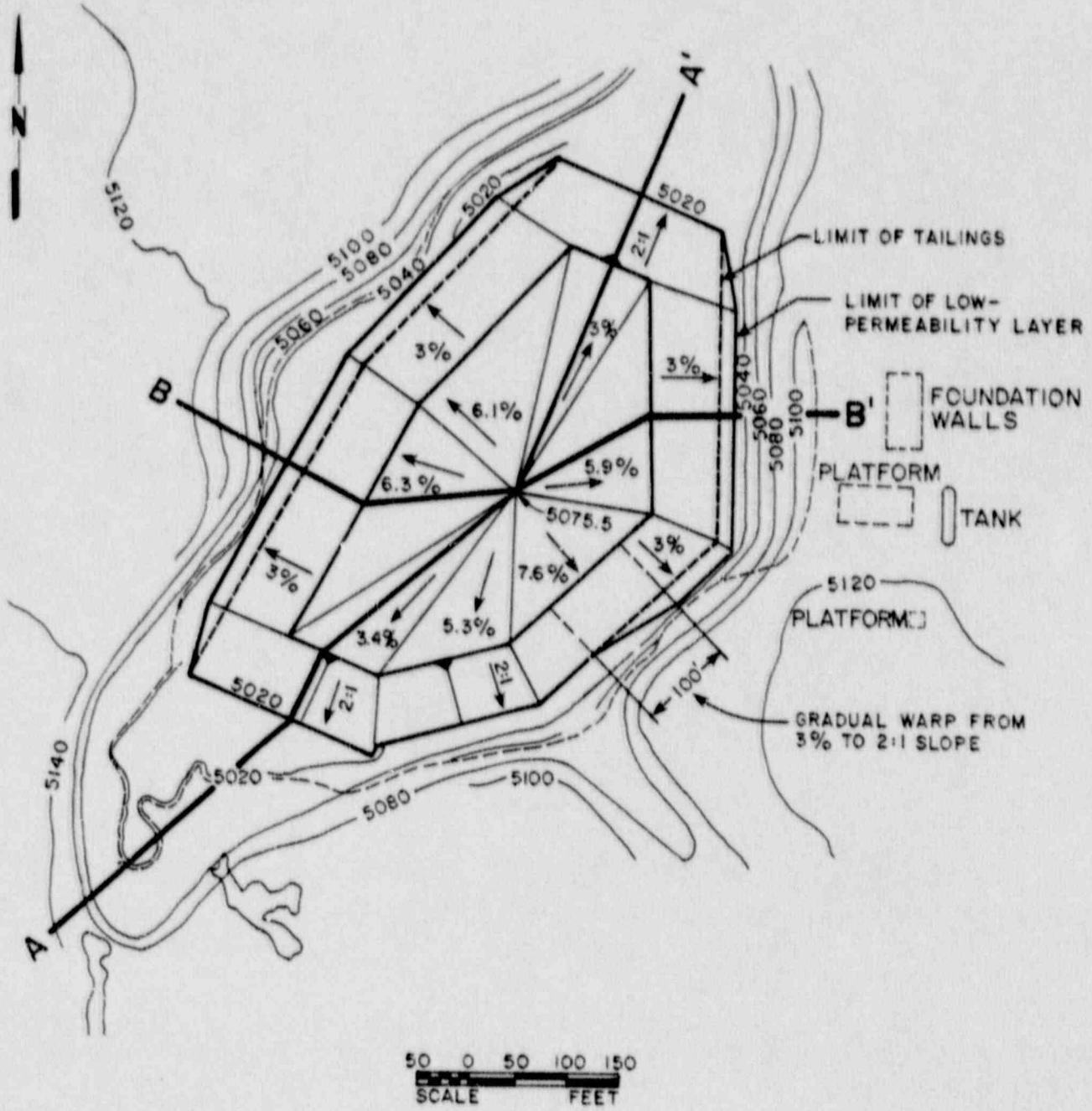

FIGURE 4.1
PROPOSED TAILINGS CONFIGURATION, STABILIZATION IN PLACE
SPOOK SITE
CONVERSE COUNTY, WYOMING

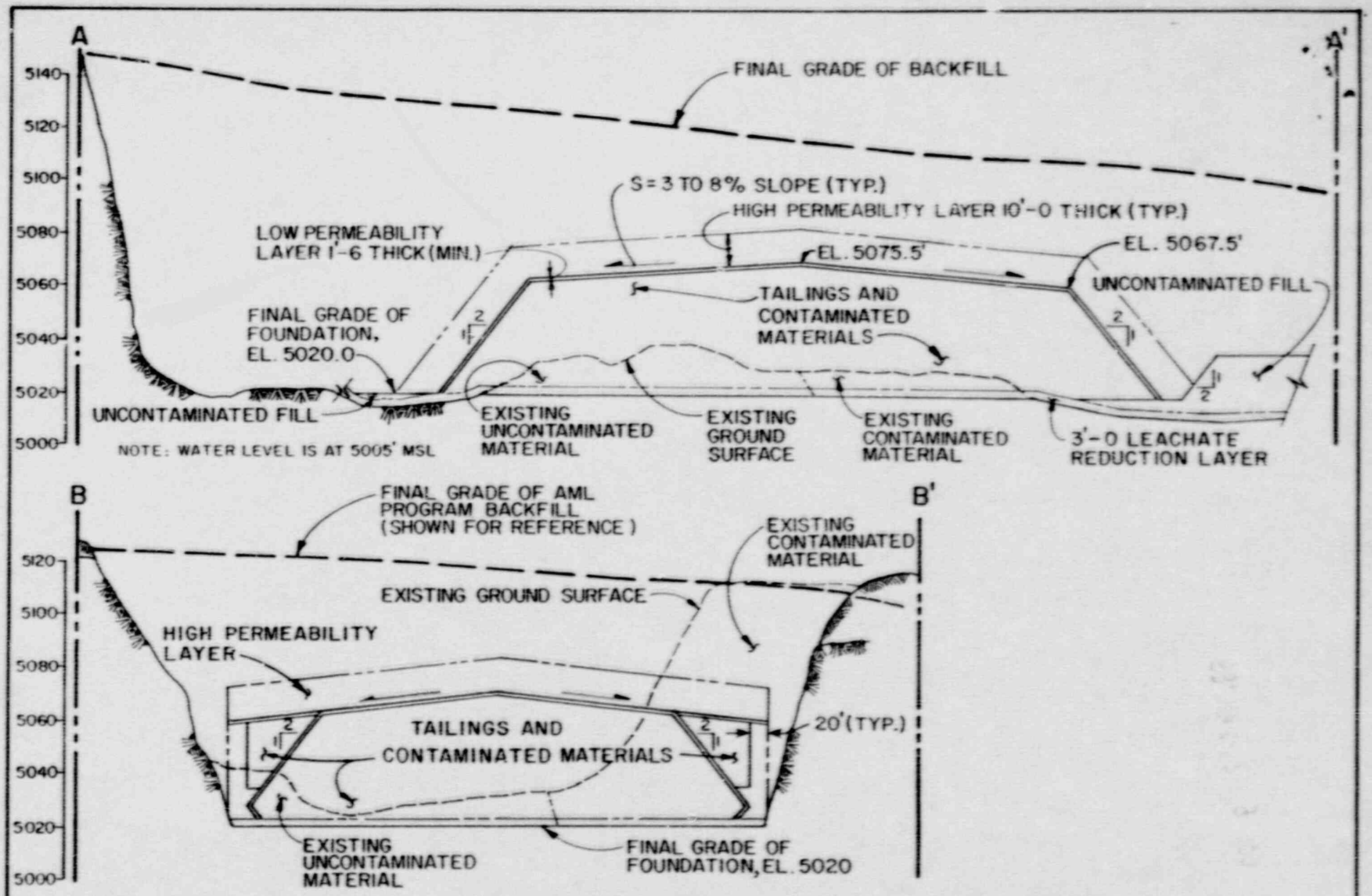

FIGURE 4.2

TYPICAL CROSS SECTIONS, STABILIZATION IN PLACE, SPOOK SITE-CONVERSE COUNTY, WYOMING