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UMTRA-SNL/74 4244
August 1982

ENVIRONMENTAL ASSESSMENT OF REMEDIAL ACTIONS ON THE URANIUM MILL TAILINGS AT THE SPOOK SITE, CONVERSE COUNTY, WYOMING

U.S. Department of Energy

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ABSTRACT

This document assesses the environmental consequences of a proposed remedial cleanup action at the inactive uranium mill at the Spook site in Converse County, Wyoming.

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1 THE PROPOSED ACTION AND THE ALTERNATIVES TO IT

1.1 NEED FOR THE ACTION

The site of the Spook mill, which processed uranium ore from 1962 to 1965, is in Converse County, Wyoming. The mill is no longer in use. Remaining at the site, called the Spook site in this document, are concrete foundations, timber, machine parts, and electrical equipment. Also remaining are the mill tailings, which are the residues of the processing operations. These residues are mostly in the form of finely crushed rock, much like sand; they cover an area of about 5 acres to varying depths. The Spook site includes a large open pit, the Hardy Fee mine, into which some of the tailings have been dumped (Sharp and Gibbons, 1964).

The tailings contain some radioactive materials left from the processing of the ore. In principle, natural processes like wind could move these materials to places where people might be exposed to them. If the pile is not properly stabilized, the migrating radioactive materials could be a health hazard to people who live or work close to them.

The health hazard that the Spook tailings present can be expressed in terms of the number of deaths that they might cause. No one now works at the site, and there are two households within a 2.5-mile radius. The chances that the pile could cause a death are therefore remote. The cumulative pile-induced health effect in 25 years is predicted to be 0.00013 death; in other words, over a period of 192,000 years, the probability is that only one death would occur that could be attributed to radiation exposure from the pile. This number suggests that the tailings by themselves are not very dangerous. A health hazard could occur, however, if people unknowingly used the sandy tailings in building materials or as fill on land where people live and work. Some tailings in the United States have, in fact, been used in these ways and have exposed people to levels of radiation that are greater than the natural levels to which they are normally exposed. The tailings will remain radioactive for thousands of years; if the pile is left as it is, people in the future may use the tailings or live near them without taking care to avoid the radiation they produce.

In 1978 the U.S. Congress heard testimony about the health hazards of the tailings left at inactive uranium mills. Finding that these tailings may pose a hazard to the public, Congress then passed the Uranium Mill Tailings Radiation Control Act, Public Law 95-604. Among other provisions, this law required that the U.S. Department of Energy (DOE) take action to stabilize the inactive tailings piles in a "safe and environmentally sound" manner. It directed the DOE to do this work in cooperation with other Federal agencies, with state governments, and with any affected Indian tribal governments. Among the places at which this action is required is the Spook site, the location of which is shown in Figure 1-1.

The need for remedial action at the Spook site rests, then, on the need to eliminate a potential health hazard produced by the radioactive materials in the tailings pile. The U.S. Congress has mandated such action, and this environmental assessment is a step toward carrying out that work.

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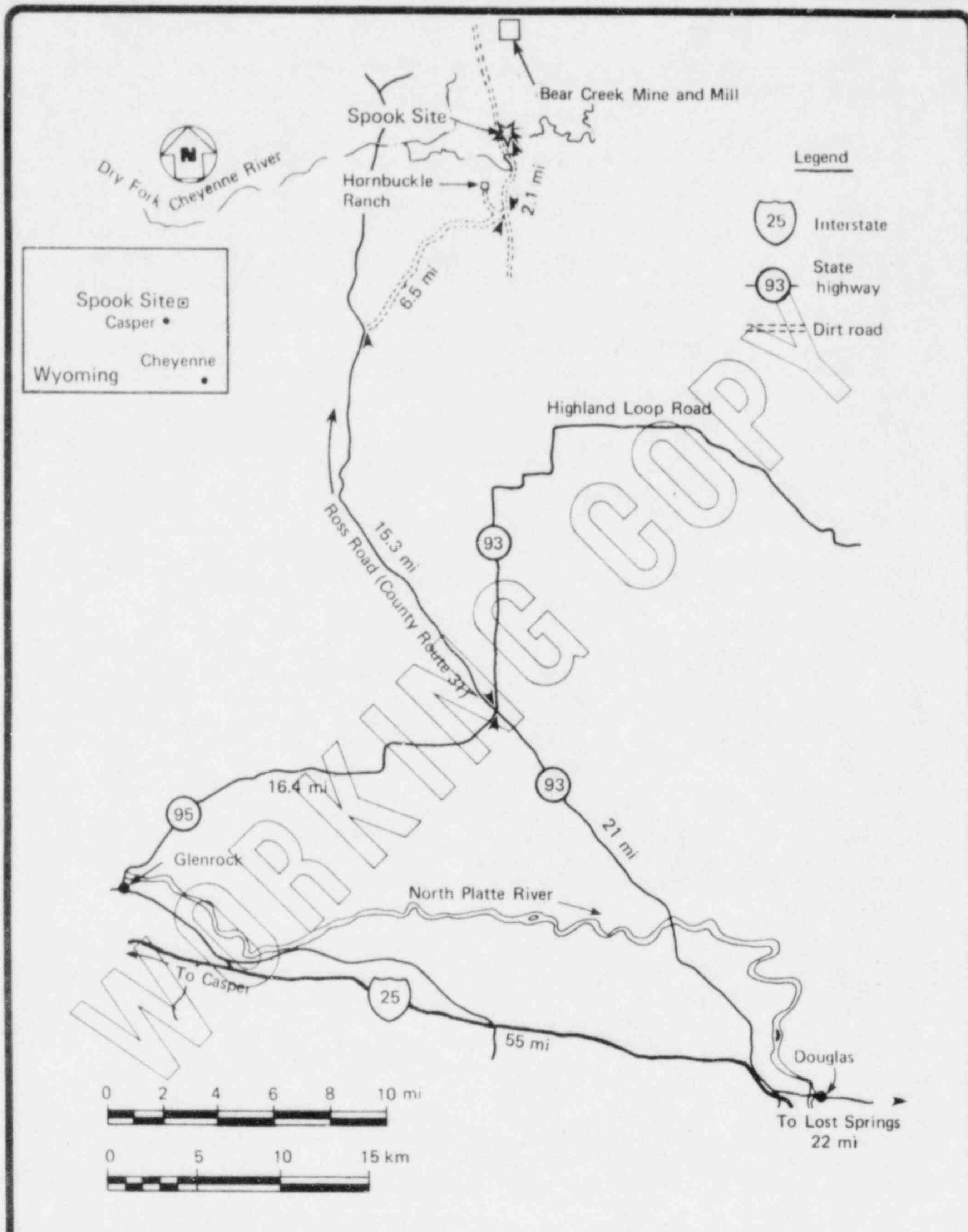

Figure 1-1. Site location.

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This environmental assessment is required by the National Environmental Policy Act which, among other requirements, calls for careful attention to the effects that major Federal actions will have on the human environment. Before any such action can begin, the agency that will perform it must study its environmental impacts. This environmental assessment examines the short-term and long-term effects of the action proposed for the tailings at the Spook site. The U.S. Department of Energy (DOE) will use the information and analyses presented here to determine whether the action will have a significant impact on the environment. If the impacts are judged significant, a more detailed document called an environmental impact statement may be required. If the impacts are not judged significant, the DOE may issue an official "finding of no significant impact." These steps and documents are defined and prescribed in Federal law as regulations issued by the Council on Environmental Quality (CEQ) in Title 40, Code of Federal Regulations, Parts 1500 through 1508.

As defined by the CEQ regulations, an environmental assessment is a "concise public document" that "briefly" provides certain kinds of information and analyses. The remainder of Chapter 1 summarizes the proposed action and describes alternatives to it. Chapter 2 summarizes the present condition of the environment. Chapter 3 predicts the impacts of the project on that environment. Chapter 4 is a brief summary of Chapters 1 through 3. Many of the details of the studies on which this document is based are in the appendixes at the end of this document. Other details are in supporting documents referenced in this assessment.

1.2 THE PROPOSED ACTION

This section summarizes a preliminary plan for the remedial action at the Spook site. The plan has been developed with the technical requirements necessary to meet U.S. Environmental Protection Agency interim standards (Appendix A). The types of permits and licenses that may be required during the proposed remedial action have been identified in Appendix B. Specifics of the remedial action will be determined during the engineering-design study that will be required for the project. The details outlined in this report may not be the actual design developed as a result of the engineering study but should provide sufficient information to determine the environmental impacts of the proposed action.

The tailings, located partially along the rim of the pit and partially in the pit, form a steeply sloped fan-shaped pile. The pile shows evidence of erosion from runoff water. The tailings cover about 5 acres, and wind-blown contamination has been spread over approximately 16 additional acres. These areas are shown in Figure 1-2.

The proposed remedial action at the Spook site is consolidation of the approximately 138,500 cubic yards of tailings and 40,800 cubic yards of associated contaminated material into one pile to be located in the west end of the existing mine pit, as shown in Figure 1-2 (see Appendix C) (FBDU, 1981). Because this portion of the pit is slightly higher than the eastern portion, surface water does not collect there. The contaminated material

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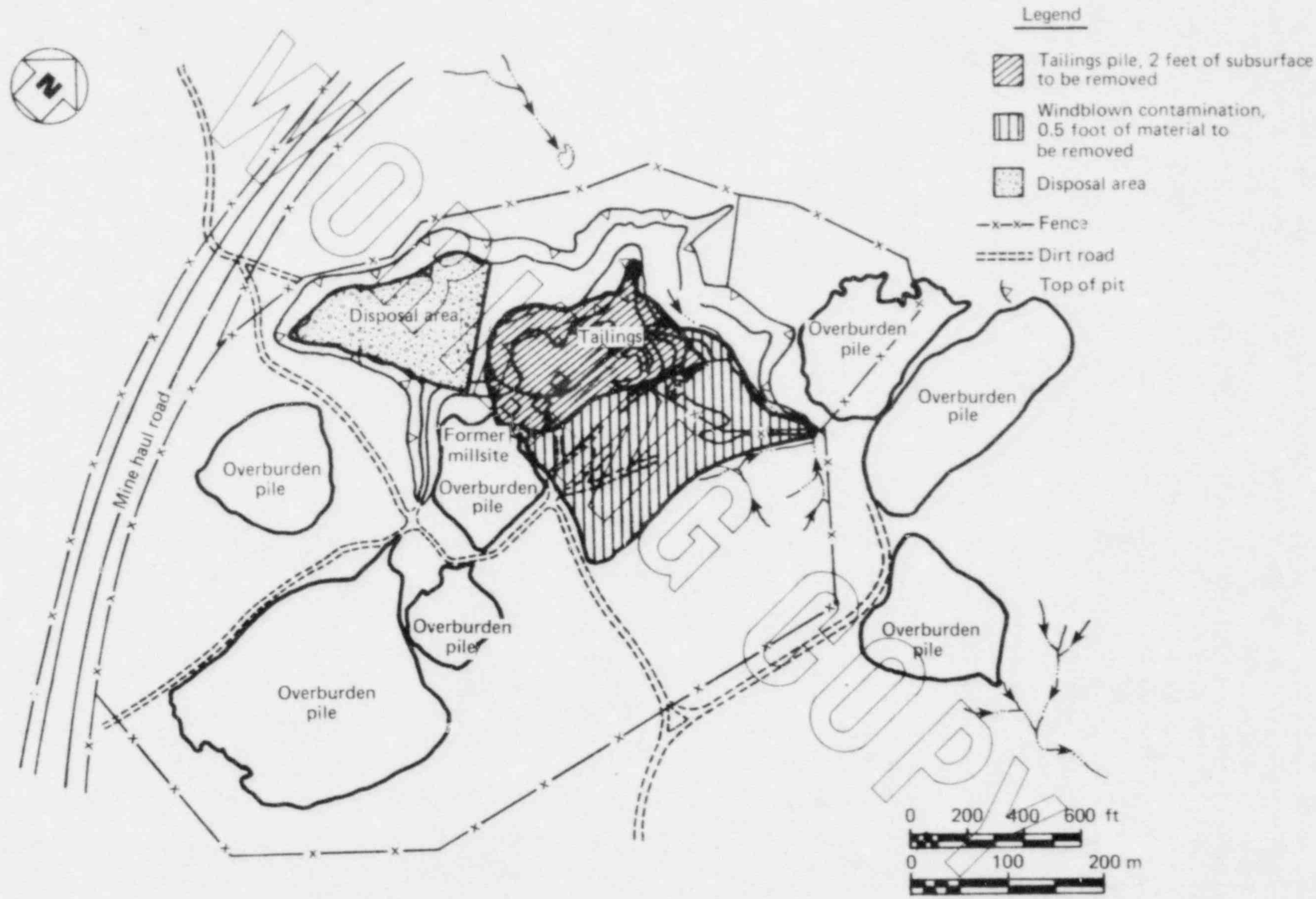

Figure 1-2. Detailed site map and decontamination plan.

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would be placed in a generally triangle-shaped area, with the high walls of the pit forming the boundaries on two of the three sides. The west end of the pit is approximately 80 feet deep. Using the pit walls to enclose the tailings would reduce the volume of cover material required and would also provide protection from wind and water erosion.

The floor of the pit to be used for the disposal area would be flattened and leveled. The tailings along the rim of the pit would be loaded into a dump truck by a front-end loader and deposited in the disposal area in the pit. Tailings that have spilled over the edge of the pit would be picked up by front-end loaders working from the pit floor at the base of the pile. The tailings are expected to slough off the high wall as material is removed from below. The tailings could then be easily loaded into trucks and transported to the disposal area. Contaminated material would be removed to a depth of approximately 2 feet from the former millsite area, as shown in Figure 1-2. About 6 inches of material would be removed from the area contaminated by windblown tailings. The extent of windblown contamination is difficult to determine because of the presence of near-surface ore and low-grade ore in the overburden piles. This contaminated material would be removed in the same manner as for the tailings. During the removal of contaminated material, a water truck would be used for dust control. Foundations and remaining equipment would be broken up and placed in the disposal area.

It has been estimated by the Office of Environment of the Department of Energy that 15 properties in the vicinity of the Spook site have been contaminated by material from the site and will require cleanup. The exact locations of these vicinity properties have not been determined; therefore, based on experiences at Grand Junction and Salt Lake City, some general assumptions have been made for costs and time (see Appendix C). The vicinity-property cleanup would take 7.5 days, cost $190,000, including engineering and contingency, and add an additional 1500 cubic yards of contaminated material to the pile. The vicinity-property cleanup crew will be the same as the remedial-action crew. It is assumed the vicinity-property cleanup would be completed early in the remedial-action program at the Spook site.

Measurements of the levels of gamma radioactivity and analyses of soil samples could be used to determine when the areas on and near the Spook pile have been cleaned to radiation levels allowed by the Environmental Protection Agency standards. Because the site includes an inactive uranium open-pit mine, there is a possibility that low-grade ore may be found at near-surface locations and in the overburden piles surrounding the pit. This would make it difficult to determine whether any elevated radiation levels are due to the remaining tailings contamination or to the nearby low-grade ore. Additional laboratory analyses may be required to determine the uranium-238 and radium-226 concentrations in the soil. The ratio of these isotopes can indicate whether the contaminating material is uranium ore or tailings. Low concentrations of uranium-238 relative to the concentrations of radium-226 in samples would indicate that the ore has been processed and that the elevated levels of gamma radiation could be attributed to tailings.

After the contaminated material is emplaced, compacted, and contoured, the overburden piles would be used as cover material. The overburden piles contain coarse and fine material. It may be necessary to segregate the overburden according to texture. The finer-grade material in the overburden

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piles would be placed on the tailings first, and the coarser material last. Several factors to be determined include the levels of radioactivity in the overburden and the capability of the material to reduce the amount of radon coming from the tailings. Calculations (see Appendix C) indicate that 10 feet of a silty-sandy cover would reduce the radon emanation from the tailings to about 11 picocuries per square meter per second. [Note to reviewers: The amount of cover will be reviewed when final Environmental Protection Agency standards are available.]

The effects of the uranium in the surrounding open pit will be considered in the final assessment of the amount of cover required to reduce radon, because a natural radon source will surround the stabilized tailings pile. For this environmental assessment, it has been assumed that all conditions for proper radon reduction would be met by disposing of the tailings below grade in the base of the pit and covering them to a depth of about 10 feet with overburden from nearby piles and about 1.5 feet with rock in the form of riprap; the calculations in Appendix C show that this 11.5-foot-thick cover would require about 74,000 cubic yards of material. With diversions of surface water along the rim of the pit bordering the stabilized pile, with the pile contoured to a 5:1 slope on the open side, and with the riprap covering, wind and water erosion of the tailings should be eliminated. Figure 1-3 shows cross-sections of the proposed stabilized pile.

At the completion of the remedial action, the site will be fenced. The site will be owned by the U.S. Department of Energy. An inspection will be conducted to determine the need, if any, for continued maintenance and monitoring. The requirements for inspection will be specified by the Nuclear Regulatory Commission (NRC) in their licensing of the maintenance of the disposal site. The NRC will also evaluate the results of the inspection and make further recommendations.

The estimated cost for the proposed remedial action of stabilizing in the pit is about $1.7 million in 1982 dollars, including engineering and contingency costs. An estimated peak employment of 16 workers would be required, and the remedial action would probably be completed in about 16 60-hour work weeks. (See Appendix C.)

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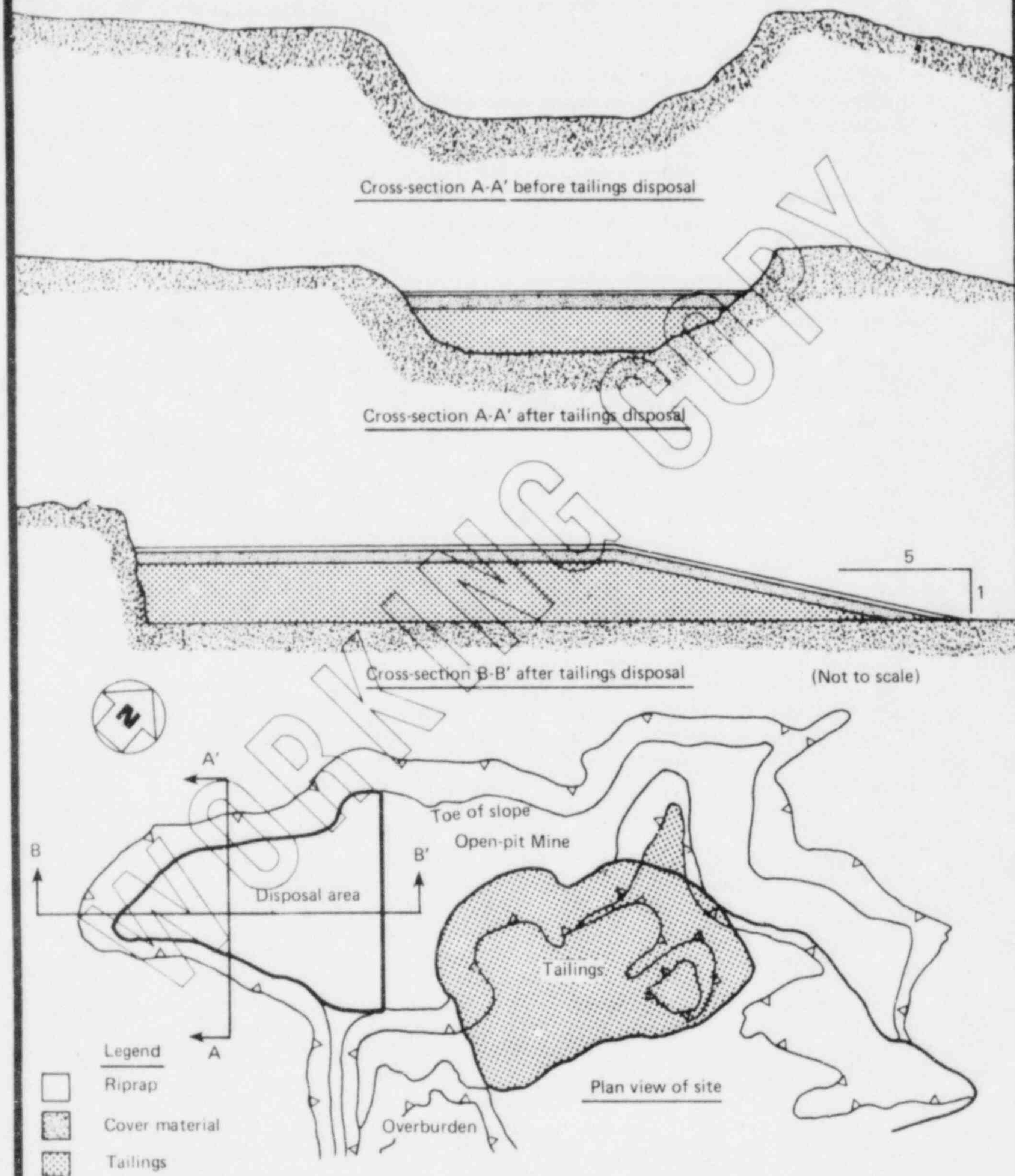

Figure 1-3. Cross-sections of proposed stabilized pile.

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1.3 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives discussed in this section include a no-action alternative and several plans that include moving the tailings to other disposal locations.

Under the no-action alternative, the Spook site would be left as it is. The U.S. Department of Energy cannot choose this alternative because the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604) requires that the Spook site be brought into compliance with the Environmental Protection Agency (EPA) standards; the radon-exhalation rate and the level of gamma radiation there now exceed the proposed EPA standards. The no-action alternative is discussed here (Section 1.3.1) to provide a standard for comparison with the proposed action and other alternatives.

The other alternatives would provide for secure long-term stabilization of the contaminated materials. Economic considerations include the costs of transporting the tailings from the Spook site and the preparation required for below-grade disposal at the alternative site(s). It is assumed for the alternatives involving moving the tailings that the vicinity properties would be cleaned up and the contaminated material first moved to the Spook site.

Any alternative involving the removal of the tailings from the site would involve additional risks of personal injury through vehicular accidents. These risks would be greater than the risk of potential injury from radiation released during the proposed action of stabilization in the pit. The transportation of the tailings would temporarily increase the chance for exposure of the general public to the radiation. There also would be increased accident and exposure risks to employees engaged in moving the materials.

Because all of the alternatives for moving the tailings off the site would be more expensive than the proposed action and would provide no calculable additional health benefits, they do not appear to be cost-effective. If the tailings were removed, the Spook site would be available for future mining operations. However, moving the tailings to one of the unspecified alternative disposal sites would remove a previously undisturbed area from future unrestricted use. For these reasons, these alternatives are only presented in enough detail to explain why they have not been addressed further in this document.

1.3.1 Alternative 1: no action

The no-action alternative means the tailings pile, foundations, and other contaminated areas would be left as they are.

Under the no-action alternative, wind and water would continue to erode the tailings and spread contamination. Water moving through the tailings might continue to carry contamination into the pit. The remaining concrete foundations, timber, machine parts, and electrical equipment would remain on the surface. Contaminated material at the 15 vicinity properties would not be removed.

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1.3.2 Alternative 2: move tailings to the Bear Creek Uranium Mine and Mill

The Bear Creek Uranium Mine and Mill, operated by Rocky Mountain Energy Company, is located 2.5 miles north of the Spook site. A well-maintained road located immediately west of the site could be used to haul the tailings to the Bear Creek mill for disposal in the tailings pond there. Transportation costs for hauling the contaminated material and tailings to the Bear Creek site would constitute the major portion of the cost, $450,000 in 1982 dollars, including engineering and contingency costs. The tailings could be reprocessed at Bear Creek, but reprocessing the tailings for uranium is not economically feasible (FBDU, 1981).

Public Law 95-604, however, does not specifically authorize remedial actions like alternative 2; Section 104(f) of the law requires that the Federal government receive title to the radioactive materials and the land for their disposal. This environmental assessment therefore cannot assume that the U.S. Department of Energy is allowed to select alternative 2. If future laws or arrangements permit moving the Spook tailings to the Bear Creek mill, the Department of Energy may examine the feasibility of alternative 2 in detail. To select alternative 2 for the remedial action would require a separate environmental assessment.

1.3.3 Alternative 3: disposal in another open pit

Another open pit that could be used for the disposal of the tailings is located about 1 mile south of the Spook site. The use of this distant pit offers no advantages over the use of the Spook pit, and transportation costs would be added. These additional transportation costs are estimated at about $180,000, including engineering and contingency costs.

1.3.4 Alternative 4: move the tailings to an unspecified disposal site within a 5-mile, 10-mile, or 15-mile radius

This alternative would be possible if a site suitable for below-grade disposal is within a radius of 5, 10, or 15 miles from the Spook site. The disposal site would have to meet the criteria (DOE, 1982) for hydrologic conditions, distance from population centers, and meteorological conditions. Adequate volumes and types of cover material would have to be available from the pit excavation. To estimate the cost of this alternative, this assessment assumes that 10 feet of cover, without a coarse final cover, would meet the criteria.

Costs for alternative 4 have been estimated at $3.6 million for a site 5 miles away, $4.1 million for a site 10 miles away, and $4.6 million for a site 15 miles away. These estimates are in 1982 dollars, including contingency and engineering costs. (See Appendix C.)

Moving the tailings to a new disposal site would involve additional cost, additional chance of vehicular accidents, and additional exposure risk to the general public.

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REFERENCES FOR CHAPTER 1

DOE (U.S. Department of Energy), 1982. Criteria for Evaluating Disposal Sites for Wastes Transferred in Connection with the Uranium Mill Tailings Remedial Action Program (UMTRAP), UMTRA-DOE/ALO-7, Uranium Mill Tailing Remedial Actions Project Office, Albuquerque, New Mexico.

FBDU (Ford, Bacon & Davis Utah Inc.), 1981. Engineering Assessment of Inactive Uranium Mill Tailings, Spook Site, Converse County, Wyoming, DOE/UMT-0119 (FBDU-360-15), prepared for the U.S. Department of Energy, Albuquerque, New Mexico.

Sharp, W.N., and A.B. Gibbons, 1964. Geology and Uranium Deposits of the Southern Part of the Powder River Basin, Wyoming, U.S. Geological Survey Bulletin 1147-D.

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2 AFFECTED ENVIRONMENT

This chapter describes the existing environment that would be affected by the proposed action. Data used in the preparation of this chapter were obtained, in part, from engineering assessments of the Spook site (FBDU, 1977 and 1981), from field visits, and from other published and unpublished sources.

2.1 BRIEF DESCRIPTION OF THE AFFECTED AREA

The Spook millsite and tailings are located in east-central Wyoming, in Converse County. The site is not near population centers. The closest towns are Douglas, 36 miles southeast, and Glenrock, 32 miles southwest. Casper, Wyoming, is 48 miles southwest. (See Figure 1-1.)

The site is at the southern edge of the Thunder Basin National Grassland (see Figure E-1 in Appendix E). The area is characterized by rolling hills. The average difference in elevation between the lowest land in the area and the crests of the hills is about 200 feet. The Dry Fork of the Cheyenne River is about 1 mile south of the site. Cottonwood trees occur along streambeds, and the land is primarily covered with sagebrush and grasses.

The area has a semiarid climate, with most precipitation occurring as rain in the spring and during summer thunderstorms. Persistent strong winds blow from the southwest.

Almost all of the land in the area of the site is private ranchland used for cattle grazing. A number of mining concerns have been established within 15 miles of the site in the last 10 years, and the county population more than doubled during the decade. However, the sparse population in the site area remains unchanged.

2.2 DESCRIPTION OF THE EXISTING TAILINGS PILE

Western Nuclear, Inc. (a subsidiary of Phelps Dodge Corporation) built the Spook upgrader in late 1961 and early 1962, and the Wyoming Mining and Milling Company operated it until June 1965. During its operation, the upgrader processed 187,000 tons of ore with an average grade of 0.12 percent U_3O_8. After crushing and acid leaching of the ore, the residues, or tailings, were dumped into the adjacent open pit of the Hardy Fee mine and along its southern edge (Sharp and Gibbons, 1964). There are approximately 138,500 cubic yards of tailings on the site.

The fan-shaped tailings pile occupies approximately 5 acres. Since some of the tailings have been dumped into the open pit, which is almost 80 feet deep in places, the depth of the tailings in the pit is highly variable. The tailings primarily consist of medium-grained to fine-grained sands that have not been stabilized, and gully and rill erosion of the tailings into the pit has occurred. Vegetation is established on about 50 percent of the pile.

Substantial wind erosion of the tailings has extended the contamination over an additional 16 acres.

More information about the Spook site is contained in the engineering assessments (FBDU, 1977 and 1981).

2.3 WEATHER

The climate at the Spook site is representative of the climate of the east-central region of Wyoming (USDA, 1941; NRC, 1979). Climate data from Casper, Wyoming, which are the most complete for the area, are suitable for describing the weather of the Spook site. Data from the towns of Douglas, Bill, and Dull Center and from the Bear Creek mine and mill area (NRC, 1977) also serve to describe the weather at the Spook site.

2.3.1 Wind

Wind speeds average about 13 miles per hour (all directions, annually) according to a 30-year record (NRC, 1979). The maximum wind speed on record is 81 miles per hour, and the windiest months are December, January, and February. Winds blow most frequently from the southwest (17 percent) and west-southwest (15 percent) (NRC, 1979).

Summer storms have occasionally produced tornadoes, but these are described as overgrown whirlwinds compared to the destructive varieties found farther east (USDA, 1941). Their appearance is reported in the eastern part of the state about once a year. Only five tornadoes were reported within 50 miles of the Morton Ranch, 17 miles from the Spook site, between 1950 and 1979 (NRC, 1979).

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2.3.2 Precipitation

The area is semiarid, with average annual precipitation of 12 to 14 inches. Most of the moisture is carried to the area by easterly winds, especially during the spring months, when half the annual precipitation arrives in the form of rain and infrequent heavy, wet snowfall. Summer precipitation is mainly from scattered thunderstorms, and is therefore extremely variable and localized.

2.3.3 Temperature

Summer temperatures average 67°F (19°C) overall, with average maximum temperatures of 82°F (28°C). Extreme high temperatures in summer reach 104°F (40°C). In winter, the overall average temperature is 26°F (-3°C), the average low temperature is 15°F (-9°C), and the extreme lows reach -40°F (-40°C). The average length of the frost-free growing season is 129 days, with the average last date of killing frost occurring on May 22 and the average first date of killing frost occurring on September 28.

2.4 AIR QUALITY

The Spook site is located in the Casper Intrastate Air Quality Control Region, one of four such areas in the State of Wyoming. Air quality in this region is considered to be good but subject to potential decline in the future because of projected increases in mining and industry (CCPC, 1978).

The air-quality-sampling station in the Wyoming network nearest to the Spook site is located at Burks Ranch near the Platte River between Douglas and Glenrock, about 32 miles to the south. Monitoring at private industrial sites has also been done nearer to the Spook site in connection with the preparation of environmental statements for mine and mill construction (NRC, 1977 and 1979).

The current levels of total suspended particulates in the Casper Intrastate Air Quality Control Region range from 13 to 21 micrograms per cubic meter of air (annual geometric means). The comparable national primary and secondary standards are 75 and 60 micrograms per cubic meter. The State of Wyoming standard is 60 micrograms per cubic meter.

Data on the levels of the other pollutants for which Environmental Protection Agency standards exist--sulfur dioxide, hydrocarbons, oxides of nitrogen, and ozone--are lacking, although Converse County was reported in 1977 to have the second-highest 24-hour value in the state for sulfur dioxide at 45 micrograms per cubic meter (0.15 parts per million, volumetric basis) (NRC, 1979). This is well below the 260 microgram-per-cubic-meter 24-hour State of Wyoming standard (DEQW, 1982).

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2.5 SURFACE AND SUBSURFACE FEATURES

The local Monument Hill unit of the Wasatch Formation underlies the tailings (Davis, 1970). Regional correlation suggests that the formation dips very gently (less than 1 degree) to the north. The local Monument Hill unit consists predominantly of thick lenses of medium-grained to coarse-grained sandstones with some interbedded claystones and carbonaceous shales that can be found in the adjacent Hardy Fee open-pit mine. The mineralization in this mine occurred near the bottom of the pit in a cream-colored, very coarse, clayey sandstone (Sharp and Gibbons, 1964). The thick sandstone beds of the Monument Hill unit thin out about 2 miles to the north, and finer-grained facies become more prominent. In the Wasatch Formation, the siltstone and shale are semi-consolidated, and the sandstones are often friable. However, the claystones probably act as a barrier to vertical water movement, inducing greater horizontal permeability. The low vertical permeability and the interfingering of the formation create many separate and often artesian aquifers in the Wasatch Formation.

Beneath the Monument Hill unit are about 200 to 300 feet of finer-grained Wasatch sediments. Below the Wasatch Formation lies the Fort Union Formation. This formation is about 3000 feet thick and consists of two portions: an upper fine-grained unit, characterized by clayey siltstone (known as the Lebo Member), and a coarser lower unit, containing mostly fine-grained sandstone (known as the Tullock Member).

Because the soils in the immediate area are weathered remnants of surface outcrops, most of the soils are sandy. Soils weathered from shale are fine grained. The soils have been disturbed by the past mining and milling activities on and near the site. The surface erosion at the site is a result of wind and water runoff.

Three faults have been mapped in the area, each about 1 mile long; two are 0.3 and 1 mile east of the site, and one is 0.3 mile west of the site. They strike north-northwest to south-southeast (Sharp and Gibbons, 1964). The Spook site is located in seismic Zone 1, an area where only minor earthquake damage would be expected (NOAA, 1973).

Major mineral resources in the area include coal, uranium, oil, and gas. Uranium is being mined about 1 mile north of the site. Coal occurs mainly in the lower Wasatch and upper Fort Union Formations and is mined throughout the basin. Three coal discoveries have been made within 3 miles of the site (NRC et al., 1977). Oil and gas also have been important resources in the Powder River Basin, which occupies much of northeastern Wyoming. The Dry Fork oil and gas field contains oil and gas within the Cretaceous Formation thousands of feet below the surface. This field is 2.5 miles north-northeast of the site (Denson and Horn, 1975).

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2.6 WATER

2.6.1 Surface water

The Spook site is immediately adjacent to an ephemeral tributary of the Dry Fork of the Cheyenne River. The drainage area of this tributary is about 200 acres at the site. It flows only in response to extremely sporadic high-intensity rainstorms and rapid snowmelt, as shown by data collected from 1965 through 1973 from two small ephemeral watersheds located approximately 15 miles south of the Spook site (Rankl and Barker, 1977). The site is well above the flood level of the Dry Fork.

The U.S. Geological Survey has maintained a stream-gauging station on the Dry Fork since November 1976 about 3 miles southwest of the Spook site. From November 1976 through September 1980, runoff at this station averaged approximately 810 acre-feet per year, ranging from less than 200 to more than 2500 acre-feet per year. The Dry Fork has extended periods of no flow, particularly during the months of January, July, and August.

Local runoff from the millsite and tailings at the Spook site drains into the adjacent abandoned mine pit. The large capacity of the pit prohibits surface runoff from flowing from the pit to surrounding areas because the pit acts as a large retention and sedimentation reservoir.

Surface waters in the region are typically of sufficient quality to be suitable for livestock (Dames & Moore, 1975; NRC et al., 1977). Total dissolved solids concentrations of 800 to 1200 milligrams per liter are common for water in the Dry Fork, with the higher concentrations normally occurring during periods of lower flow. Ephemeral surface waters in the area normally have lower contents of total dissolved solids but higher concentrations of suspended solids than those found in the Dry Fork. Surface waters tend to be hard to very hard with occasional high concentrations of arsenic, iron, and manganese (Dames & Moore, 1975).

Several surface-water samples were collected in the area of the Spook site and analyzed for radium-226 during the engineering assessment of remedial action options (FBDU, 1981). These samples showed that no contamination of surface waters can be attributed to the tailings pile. Concentrations were generally well below the Environmental Protection Agency Interim Primary Drinking Water Regulations and were similar to background concentrations measured adjacent to the nearby Bear Creek mill (NRC et al., 1977) and the Morton Ranch uranium mill (NRC, 1979).

2.6.2 Ground water

Several aquifers occur below the Spook site at different depths within the Wasatch and Fort Union Formations. The water quality and yield vary considerably. The unconfined aquifers in the area include water in valley alluvium tapped by very shallow wells. No shallow wells exist in the immediate vicinity of the Spook tailings.

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Hydraulic conductivities in the region surrounding the Spook site are representative of clayey sandstone, ranging from 0.6 to 14.3 feet per day (Dames & Moore, 1975). The potentiometric gradient in the area is generally toward the north and northeast (Dames & Moore, 1975; NRC et al., 1977).

Because of the claystone layers in the Wasatch and Fort Union Formations, the vertical permeability of the rock section is less than the horizontal permeability. Data collected at the nearby Bear Creek project substantiate this expectation. At the Bear Creek site, vertical hydraulic conductivities were found to be approximately one-half as great as horizontal hydraulic conductivities (Dames & Moore, 1975).

Most of the wells in the area are completed in sandstone units of the Wasatch Formation and are less than 300 feet in depth. In Converse County fewer than 50 water wells are completed at depths greater than 500 feet (FBDU, 1981). Three of these deeper wells are within 5 miles of the site and are completed in sandstone members of the Fort Union Formation. Two stock-water wells are on the site itself; they have been completed at depths of 300 and 700 feet.

Regional ground-water recharge areas include land at higher elevations such as the Black Hills located about 125 miles to the northeast, the Bighorn Mountains located approximately 100 miles to the northwest, and (to a limited extent) local high ground along the Cheyenne River Divide. Local recharge areas primarily intercept storm runoff and stream waters along permeable formations. No data exist to show whether the abandoned open-pit mine at the Spook site is a recharge point for ground water. Even if it were, its local recharge potential would be small because of the limited precipitation that is trapped on the site.

Ground water in the area is generally acceptable for stock watering (Dames & Moore, 1975). Some wells also yield water suitable for domestic purposes (NRC, 1979). Typical concentrations of total dissolved solids vary from about 300 to 1500 milligrams per liter. The waters are generally rich in calcium and sulfate.

Concentrations of dissolved radium-226 at the Spook site have generally been found to be well below Environmental Protection Agency drinking-water standards. Concentrations compare well with background data collected in the region (Dames & Moore, 1975; NRC et al., 1977; NRC, 1979), suggesting that little, if any, contamination of ground water has occurred from the tailings pile.

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2.7 ECOSYSTEMS

A biological reconnaissance was made of the Spook site in July 1981. All flora and fauna observed on and adjacent to the site were recorded. These records and additional biological data used in this assessment are available in a separate report (Westech, Inc., 1982). The additional data were taken from biological baseline data for the Bear Creek mine, 2.5 miles north of the site (NRC, 1977), and for Kerr-McGee properties to the south of the site (Kerr-McGee, 1979).

The rolling hills surrounding the area are dominated by native bunchgrass and big sagebrush. The Dry Fork of the Cheyenne River lies approximately 1 mile south of the Spook site. The river plain supports mesic vegetation such as cottonwood, snowberry, and rose.

The site has been divided into seven intergrading habitats (Westech, Inc., 1982). These are described in detail in Appendix D. The most disturbed areas are barren, but sagebrush, Indian ricegrass, needle-and-thread, western wheatgrass, and cheatgrass are all common. Many weedy species have invaded the disturbed areas.

Much of the wildlife observed on the site is attracted by the site's physical diversity. Available habitat adjacent to the tailings in the open pit includes cliff faces, rubble, and adits (caves). Kestrels nest on the cliffs, great-horned owls in the adits, and rock wrens in the rubble. Mule deer find refuge in all the jumble. If the pit and associated features were not on the site, many of the observed species would be scarce or absent.

The major game species in the area is the pronghorn antelope. It is estimated to have a density of five to seven animals per square mile (NRC, 1977). Except for domestic animals, no other large mammals are common. Antelope at the site were probably abundant before the development of the area, but they now use the site much less. Deer probably were never abundant.

Sage grouse and mourning doves are two other game species inhabiting the area, although neither is abundant. No sign of sage grouse was observed on the site. The closest lek is reported to be 8 miles away (Kerr-McGee, 1979).

No threatened or endangered species were observed on the site or in the area surrounding it. Information available from the U.S. Fish and Wildlife Service (Ayensu and DeFilipps, 1978) and the Wyoming Game and Fish Department (1977) suggests that the area probably does not support any threatened or endangered species.

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2.8 RADIATION

Atoms that spontaneously transform into new atoms are said to be "radioactive." The original atom is called the "parent," and the atom produced by the transformation is called the "daughter product," or simply the "daughter." This transformation process is called "radioactive decay," or simply "decay." The rate at which atoms decay is the "activity," measured by the unit "curie." A more convenient unit for measuring the activity of the atoms in tailings piles is the picocurie, which is one-millionth of one-millionth of a curie.

When atoms undergo radioactive decay, they emit "radiation." Three types of radiation are discussed in this assessment; they are "alpha" and "beta" radiation, which are tiny particles, and "gamma" radiation, which is pure energy. Alpha and beta radiation do not penetrate far into matter; gamma radiation can penetrate deeper into matter in the same way as X-rays.

When radioactive parent atoms decay to radioactive daughter atoms, a "radioactive decay series," or simply a "decay series," is formed. Uranium-238 is such a radioactive parent atom. The uranium-238 decay series includes thorium-230, radium-226, radon-222, short-lived radon daughters, and other radioactive atoms; it ends with lead-206, an atom that is not radioactive. The only member of this series that is not a solid is radon-222; it is an inert gas. Radon does not react chemically with other elements; it can diffuse out of matter and into the atmosphere.

Trace amounts of uranium-238 and its daughters are found everywhere on the earth; therefore, radon-222, or simply radon, and its short-lived daughters contribute significantly to the background radiation exposure of the general population. In the uranium milling process, radium, the parent of radon, is concentrated in the tailings, which then become a source from which radon emanates into the atmosphere.

When the daughter products in a radioactive decay chain have shorter half-lives than the parent, the daughter activities will increase until they equal the activity of the parent. When the activities of the parent and its daughters are equal, the daughters are said to be in "100-percent equilibrium" or simply in "equilibrium." If the daughters are diluted or carried away as they are formed, they will never reach 100-percent equilibrium.

Since radon is an inert gas, it contributes very little to a person's radiation exposure; it is inhaled and exhaled leaving no residual effect. The radon daughters, however, are solids; they can deposit in the bronchi and lungs as they are inhaled. Once deposited, radon daughters decay and expose the person to radiation.

The unit "working level" (WL) is used to measure radon-daughter concentration; it is defined as any concentration of radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 million electron volts of alpha energy. A concentration of 100 picocuries per liter (pCi/l) of radon with the radon daughters at 100-percent equilibrium will result in a radon-daughter concentration of 1 WL. At equilibrium levels less than 100 percent, the number of working levels corresponding to a given radon

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concentration is reduced. The working-level month (WLM) is a unit of radon-daughter exposure; it is defined as the exposure resulting from the inhalation of air with a concentration of 1 WL of radon daughters for 170 working hours.

Near tailings piles the highest concentrations of radon and its daughters in air typically occur on top of the piles, reaching a maximum on a still, dry day when the tailings are dry. No measurements of radon-daughter concentrations or equilibrium values have been made at the Spook site; however, extensive studies have been carried out by the Environmental Protection Agency at the Vitro tailings site in Salt Lake City, Utah. These studies show that the radon daughters were at 3 to 13 percent of equilibrium with the radon in the air over the pile (Duncan and Eadie, 1974).

Equilibrium ratios similar to those at the Vitro site in Salt Lake City are assumed to exist at the Spook site. The analyses in this assessment assume that the radon daughters at the Spook pile are at 10-percent equilibrium with the radon. In motionless air, the radon-daughter concentration reaches 10-percent equilibrium with the radon present in about 5 minutes (Evans, 1980). On the Spook tailings pile, which is about 300 feet wide and 700 feet long, the average wind speed would have to be less than 1 mile per hour to achieve this condition. As noted in Section 2.3.1, wind speeds in the vicinity of the Spook site average about 13 miles per hour. The assumption of 10-percent equilibrium is conservative (to overestimate the hazard); it therefore provides a calculated upper bound to radon-daughter exposures and health effects.

Radon concentrations have been measured in the vicinity of the Spook tailings pile using calibrated Wrenn chambers (FBDU, 1977). The concentrations have been reported as 17.1 pCi/l on the tailings, 2.8 pCi/l at 0.4 mile downwind of the tailings, and 1.1 pCi/l at 1.75 miles upwind of the tailings. The average radon background in the Spook area is about 1.1 pCi/l. At 10-percent equilibrium and a radon concentration of 17.1 pCi/l, the radon-daughter concentration on the pile would be about 0.017 WL.

The intensity of gamma radiation in air is frequently expressed in roentgens. A microroentgen is one-millionth of a roentgen.

Natural gamma background exposure rates in the Spook area vary between 9 and 13 microroentgens per hour (μR/hr), averaging 12 μR/hr, as measured 3 feet above the surface with an energy-compensated Geiger-Mueller detector (FBDU, 1977). Above the surface of the tailings pile, gamma exposure rates ranged from 67 to 650 μR/hr and averaged 330 μR/hr. At the former millsite, gamma exposure rates reached a maximum of 200 μR/hr (FBDU, 1977).

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2.9 LAND USE

Ninety-eight percent of the land in Converse County is agricultural, and 91 percent of the agricultural land is used for dry grazing. Industrial use constitutes 1 percent of the land use, while all remaining uses (e.g., urban, roads) constitute less than 1 percent each (CCPC, 1978).

The Spook site is surrounded by private land used for cattle and some sheep ranching. Within a 15-mile radius of the site are many mining concerns. Some are the Bear Creek Uranium Mine and Mill, Kerr-McGee Uranium Mine, Exxon Uranium Mine and Mill, TVA Morton Ranch Uranium Mine and Mill, and Peabody Coal-Gasification Site. Land use by acreage is shown in Appendix E.

2.10 NOISE

The Spook site is in a region primarily used for livestock grazing, wildlife habitat, and mineral exploration. The nearest permanent houses are at the Hornbuckle Ranch, about 2 miles to the southwest. No major noise sources exist at the site except for a north-south haul road that runs immediately west of the property, over which intermittent truck traffic passes.

Remote areas such as at the Spook site typically have low sound levels that range from about 15 to 45 decibels on the A-rated scale (dBA). For example, measured noise levels at the Grand Canyon (North Rim) range from 15 to 31 dBA (EPA, 1972). Measured noise levels for a farm in a valley location, taken from the same study, range from 33 to 44 dBA. Noise levels in these ranges would be typical of the Spook site except when a truck passes. The passage of a large, earthmoving truck measured at a distance of 50 feet can produce a sound level of short duration in the range of 82 to 93 dBA.

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2.11 SCENIC, HISTORIC, AND CULTURAL RESOURCES

The Spook site is located in the southwestern corner of the Thunder Basin National Grassland. The topography consists of rolling plains, low hills, buttes, and broad, level river courses.

Although it is not on the National Register of Historic Places, the Boseman trail is of historic interest. The Boseman trail was used for travel to Montana by early military personnel located at Fort Fetterman. Today, Ross Road (County Route 31) follows the route of the Boseman trail.

Intensive cultural-resource surveys have been conducted of approximately 33 sections of land within an 8-mile radius of the tailings site (Eckles et al., 1980), including the quarter-section in which the tailings are located. No cultural-resource sites were found in that quarter-section or within three adjacent quarter-sections.

2.12 SOCIOECONOMIC CHARACTERISTICS OF THE AFFECTED REGION

Converse County has experienced a fluctuating population in the last 20 years. In 1960 the county had 6366 residents; by 1970 the population had decreased slightly, to 5938; and by 1980 the population had more than doubled, to 14,069. If current planned energy developments materialize, a population of 23,877 is projected by 1987 (CCPC, 1978). The fluctuating county population is indicative of fluctuations in energy development in the area.

Socioeconomic studies of the area uniformly conclude that Converse County and the towns of Douglas and Glenrock are well prepared for additional growth:

> Previous experiences with rapid growth situations show that the towns have the understanding and capability to manage growth in an efficient manner. Both Douglas and Glenrock have been preparing their communities to meet the additional demands that the expanded development of energy resources would place on them. Since that development has not occurred to date, both towns are capable of absorbing additional growth with a minimum of problems (Mountain West Research, Inc., 1981).

Housing in Converse County in 1981 experienced about a 4-percent vacancy rate. There were 171 vacancies in the 365 motel rooms and 5350 permanent residential dwellings in the county. As indicated in Appendix F, Converse County is currently experiencing some out-migration because energy developments are lagging behind their projected schedules. The vacancy rate may increase as a result (CCPC, 1978).

Unemployment in Converse County in 1980 was a low 3.1 percent. The number of people seeking employment was 245. Mining, the major employment

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sector, accounts for 29 percent of the employed labor force. The services sector accounts for almost 14 percent of the employed labor force (Wyoming Employment Security Commission, 1981).

Community services in Converse County and Douglas and Glenrock can accommodate growth. There is space for an additional 1680 students in the schools. The Converse County Memorial Hospital in Douglas experienced a 53-percent occupancy in 1980, and a new hospital is planned. The planned sewage treatment facilities can serve an additional 14,000 people, although the Douglas sewer system is currently strained; new facilities are under construction. The water systems can accommodate an additional 8000 people.

Outdoor recreational opportunities are abundant in the area; hunting and fishing are particularly popular.

Converse County has 2.6 public safety officers per 1000 population. Fire protection is provided by 67 volunteers. Douglas and Glenrock have fire insurance ratings of 7 and 8, respectively, which are typical of rural towns.

The existing network of Federal, state, and county roads is adequate for current and projected traffic. Douglas has an airport for light planes, and the regional commercial airport is located in Casper.

The county is financially healthy (see Appendix F). Revenues in 1980 were $6.5 million, and expenditures were $5.7 million. Highway and public-safety funds receive 31 and 21 percent, respectively, of the 1980 general-fund appropriations. The county could legally incur an additional $6.5 million of debt.

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3 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

This chapter assesses the impacts that the proposed remedial action would have on the environment described in Chapter 2.

3.1 IMPACTS OF RELEASES OF RADIATION

The radiation from the Spook site may increase the potential for health effects among people who live and work nearby. This section describes the expected impacts of radiation releases during the proposed action.

3.1.1 Pathways and mechanisms for the transport of radioactive material to people

There are five principal potential environmental pathways of exposure to man from the tailings radiation:

1. Inhalation of short-lived radon daughters resulting from the continuous radioactive decay of the radium in the tailings. Radon is a gas that can diffuse through the tailings into the atmosphere. This gas decays into a series of daughter products; when these daughters are inhaled, they may be deposited in the bronchi and lungs where they then decay, emitting radiation.

2. External whole-body gamma exposure from the decay of radionuclides in the tailings.

3. Inhalation and ingestion of windblown tailings. The primary exposure is from the alpha emitters thorium-230 and radium-226, each of which deposits in the bones if ingested and in the bronchi and lungs if inhaled.

4. Ingestion of ground and surface water contaminated with radioactive elements (primarily radium).

5. Contamination of food through uptake and concentration of radioactive elements by plants and animals.

The largest portion of radiation exposure to the population near the Spook site is from inhalation of radon daughters; a minor part of the potential exposure is from gamma radiation. The other potential routes of exposure are much less significant at Spook.

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3.1.2 Radiation doses during remedial action

The model used to generate the estimates presented in this section does not account for natural variability among people, nor does it distinguish whether a person is a smoker. It assumes that health effects are linearly proportional to exposures, which means that any small exposure to radon daughters is assumed to be capable of producing health effects. These and other assumptions can give rise to a rather large variance in the number of health effects predicted by the model. In this analysis these uncertainties are overcome by using conservative assumptions in the model so as not to underestimate the health effects caused by exposure to radon daughters. Also, the estimated radon-daughter exposure of persons near the Spook tailings is small and well within the range of variability of exposure from natural background sources.

Health effects attributable to such a limited exposure are well below the limits of meaningful calculation. This analysis uses the model, along with conservative assumptions, to estimate an upper limit for possible health effects from radon-daughter exposure to the remedial-action work force and local population.

Approximately 16 weeks will be required to complete the proposed remedial action using a 16-person crew. Approximately 50 percent of this time would be needed to transfer the tailings into the west side of the open-pit mine and to contour the tailings. The remainder of the time would be used to place cover material over the tailings.

Since workers would be directly exposed to uncovered tailings during transfer and contouring operations, gamma-radiation exposures to workers on the site would be greatest then. Once the tailings begin to be covered, gamma-radiation exposure levels would diminish rapidly.

3.1.2.1 Radiation doses to the general public

The population around the site receives radiation exposure mainly from pathway 1 listed in Section 3.1.1. These exposures and the resultant health effects are given in this section. The methods of calculation are included in Appendix G of this assessment.

The only residence within 2 miles of the Spook tailings is the Hornbuckle Ranch, at a distance of 1.75 miles. Twelve persons reside at this ranch; seven persons are continuous residents and five persons are seasonal residents. Appendix G describes the model used to estimate an upper limit to the exposure of these people to radon daughters from the Spook tailings. The model accounts for the location of persons, wind direction, and atmospheric dilution of the radon daughters.

In one year each person associated with the Hornbuckle Ranch would receive an exposure of less than 0.007 working-level month (WLM) from the Spook tailings. This exposure is estimated to cause no more than 8.4×10^{-6}, or 0.000008 lung-cancer death per year of exposure among the 12 persons. Another way of expressing this is that one fatal lung cancer due to the

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Spook tailings would be expected to occur among the 12 persons in about 120,000 years of exposure to the radon daughters from the Spook tailings.

During the 4 months that the remedial action is in progress, the radon-daughter concentration is assumed to double because of the disturbance of the tailings. Exposure to radon daughters from the Spook tailings during the remedial action period is estimated to cause an upper limit of 5.6×10^{-6}, or 0.000006, lung-cancer death among the 12 persons. Another way of expressing this is that one fatal lung cancer due to the remedial action would be expected to occur among the 12 persons in about 180,000 years.

The Bear Creek Uranium Mine and Mill is located about 2 miles north of the Spook tailings; 235 persons are employed at Bear Creek. In theory, radon from the Spook tailings can contribute to a radon-daughter exposure to the employees at the Bear Creek site. This exposure is negligibly small when compared to the exposure from radon daughters from the Bear Creek Mine and Mill and from background; therefore, these employees were not included in calculation of health effects caused by radon from the Spook tailings.

Because no permanent residents live within 0.2 mile of the pile and because gamma radiation from the site beyond this distance is negligibly small when compared with natural background, no health effects to the general public were attributed to gamma radiation from the piles. Similarly, for the other radiation pathways listed in Section 3.1.1, no exposures to the general public can be attributed to the tailings.

3.1.2.2 Radiation doses to workers

A worker at the site would receive radiation exposure mainly from pathways 1, 2, and 3 listed in Section 3.1.1. These exposures and resultant health effects are given in this section. The methods of calculation are included in Appendix G of this assessment.

At 10-percent equilibrium, with a radon concentration of 17.1 picocuries per liter (FBDU, 1981), the radon-daughter concentration is about 0.02 working level. During a 240-hour work month, rather than the standard 170-hour work month, a worker would receive 0.1 WLM in 16 weeks. Under the assumption that the disturbance of the tailings surface will double the radon-release rate, this analysis predicts that a worker would receive an exposure of 0.2 WLM over the approximate 4-month period of the remedial action project.

The estimator described in Appendix G predicts that the exposure of an individual crew member to 0.2 WLM would result in a risk of dying from lung cancer of 2.0×10^{-5}, or 0.00002. This risk is not an appreciable fraction of the average normal risk, approximately 0.04 (Wyoming State Health Department, 1980) of dying of lung cancer in Wyoming. In a work force of 16 persons, each exposed to 0.2 WLM from radon daughters during the remedial action, an upper bound to the number of lung-cancer deaths attributable to the exposure would be 3.2×10^{-4}, or 0.0003. This number may be compared to the approximately 0.6 death that would normally be expected among 16 Wyoming residents at the current 4-percent rate of lung-cancer deaths.

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The level of gamma radiation on the tailings pile averages 330 microroentgens per hour, including a background of about 12 ± 3 microroentgens per hour (FBDU, 1981). It is assumed that a remedial action worker will be exposed at this level of gamma radiation for 8 weeks before the millsite is cleaned up and sufficient cover is placed on the pile to reduce gamma radiation to background. The worker's exposure to gamma radiation above background from the tailings will be 480 hours x (330-12) microroentgens per hour, or 153,000 microroentgens (153 milliroentgens) total. According to the risk estimators in the BEIR-III report (National Academy of Sciences, 1980) shown in Appendix G, this one-time exposure of a male aged 20 to 49 will theoretically result in an individual risk of dying from cancer of 1.2×10^{-5} (Appendix G). The average normal risk of dying of cancer in the state of Wyoming is much larger, about 0.17 (Wyoming State Health Department, 1980). The estimated upper limit for excess cancer deaths in a 16-person work force because of remedial action exposure is 1.9×10^{-4}, or 0.0002. This number may be compared with the approximately 2 deaths from cancers other than lung cancer that would be expected among 16 persons at the 13-percent rate prevailing in Wyoming.

Workers who are not at the Spook site continually during the remedial action will receive even smaller doses of radiation. For example, the driver of a truck hauling typical contaminated material from a vicinity property 10 miles away would receive a dose of less than 0.12 milliroentgen per load (DOE, 1982).

Remedial-action workers on the Spook site will probably inhale some contaminated dust raised by earthmoving equipment. The degree of exposure will depend on the precautions taken. In the absence of operating procedures, detailed plans for equipment use, and radiation measurements taken under remedial-action conditions, predictions of exposure rates are not feasible. The use of water-sprinkling equipment and other dust-suppression techniques are not expected to control dust completely; therefore, dust-protection masks may be worn during some operations.

3.1.3 Radiation doses from hypothetical accidents

High winds occurring while the tailings are being excavated could blow some of the loose material from the working area into open rangeland. In principle, the radioactive material could then contaminate vegetation, which ultimately could be ingested by beef cattle. Only a small fraction of the loose material could be picked up, and it would be spread over a large area. No grazing animal would be expected to consume enough contaminated vegetation to deposit hazardous amounts of radioactive material in its flesh. No significant impact in terms of increase in public exposure to radiation is projected.

If a truck carrying contaminated material from one of the 15 vicinity properties were to overturn on a public road, persons who stood near the material would be exposed to a low level of radiation. This exposure would be brief--roughly, no more than a few hours--because the crew from the Spook site would go to the accident scene and reload the material; members of the general public would be kept at a distance. Someone standing 10 feet away

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from the truckload of typical vicinity-property material for 3 hours would receive a radiation dose of less than 0.1 milliroentgen (DOE, 1982). Such a dose would be much smaller than the doses derived for workers in Section 3.1.2.2, and the possibility that it would produce health effects would be meaninglessly small.

3.1.4 Radiation doses after remedial action

The remedial-action efforts that have been proposed for the Spook site are designed to reduce radiation doses to meet the proposed standards established by the U.S. Environmental Protection Agency: the emanation of radon from the tailings will be reduced to 2 picocuries per square meter per second or less above the normal emission from the earth covering. At this level the doses received from exposure to radon daughters from the Spook site will be comparable to those from natural background. They will, in fact, lie within the normal range of variation of exposure from natural background levels of radon daughters (EPA, 1980).

3.2 IMPACTS ON AIR QUALITY

The proposed action would not produce large amounts of air pollutants, nor would the emission of any pollutants continue for a long time. No permanent reduction in air quality would occur, and short-term effects would be minimal.

Preliminary estimates suggest that the equipment in use during the remedial action would consume about 60,000 gallons of fuel (see Appendix C). This fuel would be consumed over a period of about 16 weeks.

Emission factors for trucks, scrapers, backhoes, and similar equipment used for construction and hauling (EPA, 1975) predict that the following amounts of pollutants would be released to the atmosphere per week for 16 weeks: carbon monoxide, 350 pounds; hydrocarbons, 110 pounds; oxides of nitrogen, 2000 pounds; sulfur dioxide, 120 pounds; and particulates, 70 pounds. (See Appendix C for details of these calculations.) These values are all less than those for which air-quality monitoring is required in Wyoming.

Earthmoving activities can be expected to raise fugitive dust, especially in high winds, but the amounts would not be excessive. Fugitive-dust emission is recognized by the Wyoming Air Quality Standards (DEQW, 1982) as a controllable source of particulate air pollution, but no numerical limits are given. Instead, the standards require that the emission of fugitive dust be limited to prevent "unnecessary amounts" from becoming airborne. A list of appropriate control measures is given, which includes applications of water, chemicals, oil, or asphalt to dirt roads and material stockpiles; covering open-bodied trucks; paving of roads; and prompt removal of spilled earth from paved roads.

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3.3 IMPACTS ON SOILS

Soils at the site have been previously disturbed during mining and milling operations. The overburden from the operations would be used for cover material on the pile; therefore, no new land would be affected by the proposed remedial action. No new areas would be disturbed by road construction because there are sufficient haul roads around the site. Approximately 1500 cubic yards of fill material would be used during the vicinity-property cleanup.

3.4 IMPACTS ON MINERAL RESOURCES

There may be minable uranium and coal resources adjacent to and beneath the pile. For this reason, it would probably be necessary for the agency that owns the site upon completion of remedial action to also own the mineral rights. However, the total area affected by this purchase would be small. No other mineral resources should be impacted by the proposed action.

3.5 IMPACTS ON WATER

As noted in Appendix C, the demand for water during remedial action operations will amount to approximately 988,400 gallons (54,000 gallons for worker use, 800,000 gallons for dust suppression, and 134,400 gallons for domestic purposes). This water will be consumed and lost from existing wells.

Because runoff from the millsite and tailings drains into the abandoned mine pit, there is no potential for contamination of local surface waters by radioactive materials. Because the strata of the pit contain the host rock of uranium ore in the area, water in those strata would be contaminated far more by natural sources than by the tailings. Only windblown material could be carried into local stream channels under present conditions. Thus, the implementation of the proposed action would further reduce potential contamination of local surface waters by stabilizing contaminated materials in the pit.

Several conditions suggest that ground-water contamination resulting from the stabilized tailings pile will be negligible. First, precipitation in the area is low compared with evapotranspiration. As a result, only a small amount of the total precipitation falling on the stabilized pile will percolate deep enough through the cover material to encounter and leach the tailings.

Second, the pile will be stabilized in the same zone that contains the in-situ ore. Water in that zone would be contaminated by natural sources of radioactive materials far more than by the tailings.

Third, water development in Converse County is expected to undergo little change in the future. As a result, artesian conditions in deeper aquifers containing potable water should continue to exist, thus presenting a hydraulic barrier to the movement of contaminants into those aquifers.

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Other conditions minimizing the potential for contamination of ground-water supplies by the stabilized pile include (1) the absence of shallow ground-water systems below the site, (2) the relatively low hydraulic conductivity of the host rock, and (3) the ability of the clayey host rock to adsorb solutes. These conditions result in long transit times of solutes to potential ground-water supplies. Solutes that do reach a local supply can be expected to have been highly diluted or to have decayed to innocuous levels.

3.6 IMPACTS ON PLANTS AND ANIMALS

The diverse physical surroundings that resulted from the excavation of the Hardy Fee mine pit probably are responsible for the present variety of wildlife on the Spook site. Much of the physical diversity could be eliminated if the tailings were buried in the pit. Portions of the cliff faces that support kestrel and swallow nesting could be destroyed. The adits that support nesting great-horned owls could be filled and the rubble supporting nesting rock wrens buried. Therefore, there might be less variety of wildlife after remedial action.

During the remedial action, nearby wildlife would be adversely affected by noise, dust, and human encroachment, but these impacts would have no lasting effects. After the remedial action is completed, the area would return to natural conditions and would support plants and animals typical of the surrounding area.

No threatened or endangered wildlife or plant species would be affected by the remedial action.

Little endemic vegetation would be lost during remedial action. The overburden for cover would come from disturbed areas that have not returned to natural conditions.

Over time, big sagebrush could become established on the buried tailings pile after the remedial action. The long roots of this species could penetrate to the tailings, giving radon an avenue of escape. Over the long term, this possibility cannot be prevented by methods of disposal now available.

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3.7 IMPACTS ON LAND USE

The proposed action would not affect land use of the surrounding area for the long term. Over the short term, construction activity may be a nuisance to nearby grazing livestock. The pit will be unavailable for uranium mining at the completion of remedial action.

3.8 IMPACTS ON NOISE LEVELS

Noise levels would increase in the vicinity of the tailings site, borrow sites, and haul roads during the proposed action. These increases, involving ordinary trucks, loaders, scrapers, and similar equipment, would not be unusual. No harmful impacts would occur provided regulations designed to prevent noise-related injury to workers are followed. These regulations require reduced exposure time to any noise levels above 90 decibels, and no exposure at all to any noise levels above 115 decibels.

3.9 IMPACTS ON SCENIC, HISTORIC, AND CULTURAL RESOURCES

The remedial action may affect scenic qualities in the immediate area of the site. The site is in a vast range area, however, and has not been identified as having special scenic qualities. The site is not visible from any major thoroughfare or to people other than nearby residents and workers and an occasional hunter.

No historic or cultural resources would be affected by the remedial action.

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3.10 IMPACTS ON POPULATION AND WORK FORCE

The proposed action would generate 16 employment positions for 16 weeks, given a 60-hour work week. With a 15-percent turnover rate for semi-skilled positions, the total work force would consist of 18 people. The local job market can supply 14 of the 18 workers (Wyoming Employment Security Commission, 1981). Four managerial and radiation-safety professionals would in-migrate. These four in-migrants would generate two indirect job slots, given a 1.6 multiplier (see Appendix F). The six job slots represent a population increase of 12 people, three of whom would be school-aged children. As indicated in Chapter 2, Converse County could easily accommodate 12 new residents.

3.11 IMPACTS ON HOUSING, SOCIAL STRUCTURE, AND COMMUNITY SERVICES

The 12 new residents will require six of 171 vacant housing units. The communities have experienced both in-migration and out-migration attributable to mining activities; therefore, the new residents would have little effect on the social structure. The existing community services can easily handle the small influx of people (see Appendix F).

3.12 IMPACTS ON ECONOMIC STRUCTURE

The project would create expenditures totaling $1.7 million. Given the 4-percent state sales tax, of which half is returned to the counties and municipalities, the local area would accrue $34,000 in sales tax revenue. These figures are based on the assumption that local contractors will do the remedial-action work.

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3.13 IMPACTS ON TRANSPORTATION NETWORKS

The proposed remedial action would have no impact on public roads because the Spook site is not near any major thoroughfares. Assuming individual trips and no car pools, the transportation impact would consist of about 32 daily trips of the 16 workers commuting from Douglas and Glenrock. State Routes 93 and 95 and Ross Road (County Route 31) (see Figure 1-1) could easily accommodate the additional daily trips. The heavy equipment used at the site would travel over the highways only twice, at the beginning and end of the remedial action. Trucks carrying material from vicinity properties would also use the roads, but would constitute such little traffic as to have a negligible impact on transportation networks.

3.14 USE OF ENERGY AND OTHER RESOURCES

The proposed action would use about 60,000 gallons of fuel; this total includes both diesel fuel and gasoline. This number has been generated from average-use factors for the equipment types expected to be used (Caterpillar Tractor Company, 1981). (See Appendix C for details.)

The consumption of potable water by workers is expected to be about 54,000 gallons, an estimate derived from the average number of workers (16) and an assumed use of 35 gallons each per day for 96 working days. This water could be purchased from local ranchers.

Water for dust control also could be supplied by local ranchers. A 4000-gallon water truck making about two trips per day for 96 days would carry the necessary water, about 800,000 gallons. The minor amounts of water for equipment washdown and other construction-site uses are included in this estimate.

3.15 ACCIDENT IMPACTS NOT ARISING FROM RELEASES OF RADIATION

The remedial action at the Spook site would require the hauling of offsite contaminated material, cover material, and riprap. An estimated 7330 vehicle miles would be required to accomplish this (see Appendix C). Transportation by truck produces 7.94 vehicle accidents, 3.45 total fatalities, and 1.48 driver fatalities per 1 million vehicle miles (NSC, 1980). Truck transportation during the proposed remedial action is therefore expected to produce 0.06 vehicle accident, 0.02 total fatality, and 0.01 driver fatality.

During the operation of all types of machinery, such as trucks, tractors, forklifts, and cranes, about 0.15 accident occurs per man-year (DOT, 1977). The remedial action at the Spook site has been estimated to require about 16 workers for 16 60-hour weeks, or about 8 man-years of labor to completion (see Appendix C). Therefore, fewer than two accidents, both nonfatal, resulting in loss of work time might be expected during the entire project.

3.16 MITIGATION MEASURES

The remedial action would be conducted in accordance with all State and Federal safety rules and regulations. Monitoring also would be conducted to detect windblown dust and to help prevent recontamination of cleaned areas by equipment tires.

Dust-abatement procedures will keep windblown dust to a minimum. Dust masks and ear-protection devices will be available to workers at the site during stabilization operations. Standard construction practices will be used to isolate work areas and limit the total area of active disturbance.

Total shielding of the workers from gamma radiation while moving and recontouring the tailings pile is not practicable. However, once the application of soil cover is under way, the workers will spend most of their time on top of the soil cover, which will shield them from nearly all of the gamma radiation from the pile.

To prevent access to the site after remedial action, the area will be fenced, and ownership will be transferred to the Department of Energy. A permanent ground-water monitoring well will be located downgradient from the pile to determine whether any contamination is migrating from the tailings pile, in compliance with the Environmental Protection Agency standards. An inspection will be conducted to determine the need, if any, for continued maintenance and monitoring. The requirements for inspection will be specified by the Nuclear Regulatory Commission (NRC) in their licensing of the maintenance of the disposal site. The NRC will also evaluate the results of the inspection and make further recommendations.

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REFERENCES FOR CHAPTER 3

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4 SUMMARY

4.1 THE PROPOSED ACTION

The Spook millsite and tailings are located in east-central Wyoming, in Converse County, 48 miles northeast of the city of Casper, Wyoming. The site is 72 miles west of the border between Wyoming and South Dakota. The Dry Fork of the Cheyenne River is about 1 mile south of the site.

The proposed remedial action is consolidation of the tailings and contaminated material in the west end of an inactive open-pit mine on the Spook site. Overburden left from the mining operation would be used as cover material. The existing pit walls would enclose the stabilized pile on two of its three sides, providing protection from wind and water. Proper contouring of the open side of the pile and diversion of surface water along the rim of the pit would also help to minimize wind and water erosion.

The proposed remedial-action program has been developed to meet the proposed and interim standards issued by the Environmental Protection Agency for the disposal of tailings and the cleanup of contaminated land.

4.2 SUMMARY OF THE ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

Table 4-1 summarizes the short-term and long-term impacts (discussed in Chapter 3) of the proposed remedial action.

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Table 4-1. Summary of the environmental impacts of the proposed action

Affected part of environment	Short-term impacts	Long-term impacts
Radiation	Increase in radon-daughter concentration at the site (from existing 0.017 working level to about 0.034 working level)[a]	Reduction of radon-daughter concentration at the site to approximately background levels (about 0.001 working level)
	Increase in windblown tailings depending on wind velocities during remedial action	Elimination of windblown tailings
	Gamma exposure to workers (150 milliroentgen over 8 weeks compared to background of about 5.8 milliroentgen over 8 weeks)	Reduction of gamma-radiation levels to background (about 12 microroentgen per hour or approximately 100 milliroentgen per year)
Air quality	Increase in air pollutants during operation (quantities vary according to pollutants, but all are lower than emission standards)	
	Increase in fugitive-dust emissions (quantities vary with wind velocity)	
Soils		Approximately 1500 cubic yards of fill would be used at the vicinity properties
		Overburden from previous mining (74,000 cubic yards) would be used as cover, resulting in a slightly beneficial impact because no new areas would be disturbed for cover
Minerals		Access to some uranium resources would be limited by filling the pit

Table 4-1. Summary of the environmental impacts of the proposed action (continued)

Affected part of environment	Short-term impacts	Long-term impacts
Water	Increased demand for potable water (54,000 gallons onsite worker use plus 134,400 gallons domestic use over 16 weeks) Increased use of water for dust control (800,000 gallons over 16 weeks)	Minor decrease in radioactivity of surface runoff
Plants and animals	Minor disruption of wildlife from machinery noises and encroachment	Loss of a portion of the habitat for cliff-nesting and cave-nesting birds
Land use	May affect nearby grazing during remedial action	Loss of existing pit for uranium mining
Noise	Increase in machinery noise heard by workers on the site (short intermittent periods of 90 to 115 decibels on the A-rated scale may occur)	
Scenic, historic, and cultural resources	none	
Population and work force	Increased employment positions (16 for 16 weeks)	
Housing, social structure, and community services	Adequate housing and services available	

Table 4-1. Summary of the environmental impacts of the proposed action (continued)

Affected part of environment	Short-term impacts	Long-term impacts
Economic structure	Increased revenue ($34,000) to local area	
Transportation network	Additional commuting traffic (16 round trips)	
Energy use	Irretrievable use of fuel (60,000 gallons) during remedial action	
Nonradiation accidents	Worker accidents on the site during remedial action (two injuries)	

[a]Quantitative estimates of impacts are in parentheses.

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GLOSSARY

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GLOSSARY

alpha particle — A positively charged particle emitted from certain radioactive materials. It consists of two protons and two neutrons, and is identical with the nucleus of the helium atom. It is the least penetrating of the common radiations and hence is not dangerous unless alpha-emitting substances have entered the body.

aquifer — A unit of unconsolidated or consolidated material that is sufficiently permeable to conduct ground water; the source of wells. A confined aquifer is overlain by relatively impermeable material. An unconfined aquifer is one associated with the water table.

background radiation — Naturally occurring low-level radiation to which all life is exposed. Background radiation levels vary from place to place on the earth.

BEIR — Biological Effects of Ionizing Radiation. An acronym for a committee of the National Academy of Sciences and the report, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980, generated by the committee.

beta particle — A particle emitted from some atoms undergoing radioactive decay, identical to an electron. Beta radiation can cause skin burns, and beta emitters are harmful if they enter the body.

curie (Ci) — The unit of radioactivity of any nuclide, defined as precisely equal to 3.7×10^{10} disintegrations per second.

daughter product — The nuclide remaining after a radioactive decay. A daughter atom may itself be radioactive, producing further daughter products.

dose — A general term denoting the quantity of radiation or energy absorbed.

emanation — Emission of radon from radioactive materials within the earth.

endemic — Belonging to or native to a locality or region.

exposure — In a strict technical sense, a measure of the ionization produced in air by X or gamma radiation. The special unit of exposure is the roentgen, defined below. When the term "exposure" is used in connection with the inhalation of radon daughters, the special unit is the working-level month, defined below.

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external gamma radiation	Gamma radiation emitted from a source(s) external to the body, as opposed to internal gamma radiation emitted from ingested or inhaled sources.
eyrie	A cliffside nest of a bird of prey.
facies	Part of a rock body; differentiated from other parts by appearance or composition.
FBDU	Ford, Bacon & Davis Utah Inc.
gamma background	Natural gamma ray activity everywhere present, originating from two sources: (1) cosmic radiation, bombarding the earth's atmosphere continually, and (2) terrestrial radiation. The amount of natural gamma radiation absorbed by a person in the United States ranges from about 60 to about 125 millirems per year.
gamma ray	Electromagnetic radiation emitted from the nucleus of a radioactive atom, with specific energies for the atoms of different elements and having penetrating power similar to that of X-rays.
ground water	Subsurface water in the zone of full saturation.
health effect	Adverse physiological response from radiation exposure (in this report, one health effect is defined as one cancer death from exposure to radioactivity).
inert gas	One of the chemically unreactive gases: helium, neon, argon, krypton, xenon, and radon.
job slot	A labor position generated by the project.
lek	Mating grounds for sagehens, where the males perform their peculiar dance to attract females.
lens	A geologic deposit thick in the middle and thin at the edges.
man-rem (person-rem)	A unit used in health physics to express amounts of radiation received by groups of people. It is obtained by summing individual amounts of radiation received by all people in the population.
mesic	Characterized by a moderate amount of moisture.
μR/hr	Microroentgen per hour (10^{-6} R/hr).
mR/hr	Milliroentgen per hour (10^{-3} R/hr).

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nuclide — A general term applicable to all atomic forms of the elements; nuclides comprise all the isotopic forms of all the elements. Nuclides are distinguished by their atomic number, atomic mass, and energy state.

pCi/g — Picocurie per gram (10^{-12} Ci/g).

pCi/l — Picocurie per liter (10^{-12} Ci/l).

pCi/m^2-s — Picocurie per square meter per second (10^{-12} Ci/m^2-s).

potentiometric surface — An imaginary surface representing the total head of ground water and defined by the level to which water will rise in a well.

rad — The basic unit of absorbed dose of ionizing radiation. A dose of 1 rad means the absorption of 100 ergs of radiation energy per gram of absorbing material.

radioactive decay chain — A succession of nuclides, each of which transforms by radioactive disintegration into the next until a stable nuclide results. The first member is called the parent, the intermediate members are called daughters, and the final stable member is called the end product.

radioactivity — The spontaneous decay or disintegration of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation.

radium — A radioactive element, chemically similar to barium, formed as a daughter product of uranium (uranium-238). The most common isotope of radium, radium-226, has a half-life of 1620 years. Radium is present in all uranium-bearing material. Trace quantities of both uranium and radium are found in all areas, contributing to the background radiation.

radon — A radioactive, chemically inert gas. The nuclide radon-222 has a half-life of 3.8 days and is formed as a daughter product of radium (radium-226).

radon background — Low levels of radon gas found in air resulting from the decay of naturally occurring radium in the soil.

radon concentration — The amount of radon per unit volume of air. In this assessment, the average value for a 24-hour period, determined by collecting data for each 30-minute period of a 24-hour day and averaging these values.

radon daughter — One of several short-lived radioactive daughter products of radon (several of the daughters emit alpha particles).

radon-daughter concentration — The concentration in air of short-lived radon daughters, expressed in terms of working level (WL).

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radon flux	The quantity of radon emitted from a surface in a unit time per unit area (typical units are pCi/m^2-s).
recharge	The processes by which water is absorbed and added to the zone of saturation of an aquifer, either directly into the formation or indirectly by way of another formation.
rem (roentgen equivalent man)	The unit of dose equivalent of any ionizing radiation which produces the same biological effect as a unit of absorbed dose of ordinary X-rays, numerically equal to the absorbed dose in rads multiplied by the appropriate quality factor for the type of radiation. The rem is the basic recorded unit of accumulated dose equivalent to personnel.
riprap	An irregular protective layer of broken rock.
roentgen (R)	A unit of exposure to ionizing radiation. It is that amount of gamma or X-rays required to produce ions carrying 1 electrostatic unit of electrical charge, either positive or negative, in 1 cubic centimeter of dry air under standard conditions, numerically equal to 2.58×10^{-4} coulombs per kilogram of air.
tailings	The remaining portion of a metal-bearing ore after most of the desired metal, such as uranium, has been extracted. Tailings also may contain other minerals or metals not extracted in the process (e.g., radium).
UMTRA	Uranium Mill Tailings Remedial Action
vicinity properties	Properties to which contaminated material has been transported from the tailings site.
working level (WL)	A unit of radon daughter exposure, equal to any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 million electron volts of potential alpha energy. This level is equivalent to the energy produced in the decay of the daughter products that are present under equilibrium conditions in a liter of air containing 100 pCi of radon-222. It does not include decay of lead-210 (22-year half-life) and subsequent daughter products.
working-level month (WLM)	The exposure resulting from the inhalation of air with a concentration of 1 WL of radon daughters for 170 working hours.

AGENCIES AND PERSONS CONSULTED

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AGENCIES AND PERSONS CONSULTED

Assistant to Pete Greiner, Wyoming State Highway Commission, to determine "Maximum Roadway Use Approval" requirements to maintain compliance with Highway Safety Act of 1966 and subsequent amendments.

Grey Bogden, Director of Environmental and Occupational Safety, Western Nuclear Company, Lakewood, Colorado, to determine status and future plans concerning excess overburden materials adjacent to the Spook site.

Lillian Chambers, Converse County Assessor, Converse County Courthouse, Douglas, Wyoming, to obtain information regarding ownership of site and borrow areas.

Department of Environmental Quality, Division of Air Quality, Cheyenne, Wyoming, to obtain copy of Wyoming Air Quality Standards and Regulations, 1982 edition.

F. Dickson, State Conservationist, Wyoming Soil Conservation Service, Cheyenne, Wyoming, to obtain information on soil-leasing requisites for surface and subsurface resources and mineral royalties grants.

Dave Eckles, Associate State Archaeologist, University of Wyoming, Laramie, Wyoming, to obtain information on latent or registered archaeological resources in proposed borrow site locales.

Ed Grant, Industrial Siting Councilman, Cheyenne, Wyoming, to determine State permit needs for construction operations in north Converse County.

Richard T. Hornbuckle, Hornbuckle Ranch, north of Douglas, Wyoming, to determine availability and costs of water for dust abatement during remedial action.

James May, Wyoming Conservation Commissioner, Laramie, Wyoming, to determine State water resource conservation requirements relative to remedial action program in Converse County.

Daniel B. Mitchell, Director, National Climate Center, National Oceanic and Atmospheric Administration, Federal Building, Asheville, North Carolina, to request summarized wind data for weather stations nearest Spook millsite.

Charles Porter, Wyoming Department of Environmental Quality, Solid Waste Management Program Assistant, Cheyenne, Wyoming, to determine remedial action program level of compliance.

Ron Reckner, Associate Geologist, Bureau of Land Management, Platte River Resource Area, Douglas, Wyoming, to receive soil map legend data and information on "Free Use Permit" requirements.

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Appendix A

ENVIRONMENTAL PROTECTION AGENCY PROPOSED AND INTERIM STANDARDS
AND NUCLEAR REGULATORY COMMISSION LICENSING CRITERIA
FOR INACTIVE URANIUM PROCESSING SITES

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Appendix A

ENVIRONMENTAL PROTECTION AGENCY PROPOSED AND INTERIM STANDARDS AND NUCLEAR REGULATORY COMMISSION LICENSING CRITERIA FOR INACTIVE URANIUM PROCESSING SITES

A.1 ENVIRONMENTAL PROTECTION AGENCY STANDARDS

Under Public Law 95-604, no remedial action may begin until final cleanup standards have been promulgated. The final standards have not yet been issued. However, in order to permit remedial action to begin at contaminated vicinity properties, the Environmental Protection Agency (EPA) has issued interim standards (45 FR 27366-27368, April 22, 1980) for open lands and structures in which elevated radiation levels occur because of the presence of residual radioactive materials from a designated inactive processing site. The numerical criteria are outlined in Table A-1.

Table A-1. EPA interim standards for remedial action cleanup of open lands and structures

Type of radiation	Standard
External gamma radiation (EGR) in dwellings	Remedial action required if EGR greater than 0.02 milliroentgen per hour above background
Radon daughter concentration (RDC) in dwellings	Remedial action required if RDC greater than 0.015 working level including background (annual average)
Radium-226 concentration on open lands	Remedial action required if radium-226 greater than 5 picocuries per gram

The EPA has also proposed standards governing the disposal of residual radioactive materials from inactive uranium processing sites (46 FR 2556-2563, January 9, 1981). These standards place limits on the amounts of certain elements and substances that may be released from the final disposal site. In addition, the disposal of the radioactive material must be done in such a manner that there is a reasonable expectation that the limits in the proposed standards will be maintained for at least 1000 years. The standards impose the following limits:

1. The average annual release of radon-222 at the surface of the site is limited to values less than or equal to 2 picocuries per square meter per second (annual average) plus the radon emission expected from the material covering the tailings.

2. Concentrations of the elements listed in Table A-2 in sources of underground drinking water are limited. Material released from a disposal site is neither to cause the concentrations of the specified elements in underground drinking water to exceed the levels in Table A-2 nor to result in any increase in their concentrations in water that exceeded those levels before the remedial actions for causes other than residual radioactive material. These limitations apply to underground drinking water beyond 1.0 kilometer from a disposal site that was a processing site and beyond 0.1 kilometer from a new disposal site.

Table A-2. EPA proposed standards for element concentration in sources of underground drinking water

Element	Maximum permissible concentration in ground water	
Arsenic	0.05	milligram/liter
Barium	1.0	milligram/liter
Cadmium	0.01	milligram/liter
Chromium	0.05	milligram/liter
Lead	0.05	milligram/liter
Mercury	0.002	milligram/liter
Molybdenum	0.05	milligram/liter
Nitrate nitrogen	10.0	milligrams/liter
Selenium	0.01	milligram/liter
Silver	0.05	milligram/liter
Combined radium-226 and radium-228	5.0	picocuries/liter
Gross alpha particle activity including radium-226 (but excluding radon and uranium)	15.0	picocuries/liter
Uranium	10.0	picocuries/liter

3. Materials released from disposal sites should not cause an increase in the concentration of any toxic substance in any surface waters. In general, surface waters means any bodies of water on the earth's surface that the public may traverse or enter, or from which food may be taken.

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A.2 NUCLEAR REGULATORY COMMISSION LICENSING CRITERIA

The Nuclear Regulatory Commission (NRC) has not issued and does not intend to issue regulations that apply to the cleanup and disposal of residual radioactive materials at the Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I inactive uranium processing sites. In conformance with UMTRCA, NRC concurrence in proposed remedial actions and determinations as to the licensability of disposal sites for such materials will be to assure compliance with the final EPA standards discussed in Section A.1. On October 3, 1980, however, the NRC did issue regulations governing disposal of tailings from active uranium-milling operations. These regulations (45 FR 65533-65536) are not applicable to Uranium Mill Tailings Remedial Action Program remedial actions, but do contain technical criteria, primarily in the form of performance objectives, for disposal of uranium mill tailings. Although they will not be applied by the NRC to the inactive sites, the NRC technical criteria embody considerations that are relevant to the evaluation of remedial-action alternatives for an UMTRCA Title I inactive site.

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Appendix B

APPLICABLE PERMITS, LICENSES, OR APPROVALS
FOR REMEDIAL ACTION
AT THE SPOOK SITE

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Appendix B

APPLICABLE PERMITS, LICENSES, OR APPROVALS FOR REMEDIAL ACTION AT THE SPOOK SITE

Applicable permit, license, or approval	Granting or approving authority	Remarks
Free use permit	Bureau of Land Management, Platte River Resource Area, Casper District Office, Wyoming	Title 43, Code of Federal Regulations, Mineral Material Regulations, Part 3620; classification requirements; 90-day review period; inter-governmental agency cooperative agreement; possible royalty fee of $0.10 per ton.
Maximum roadway use approval	Wyoming Department of Transportation, Wyoming Department of Public Safety, Highway Patrol	Tandem vehicles not to exceed state and county road weight limits of 36,000 pounds; 20,000 pounds single-axled vehicles; gross weight exceeding these limitations is determined by the bridge, the distance from the front to the rear axle of a tandem vehicle.
Water rights lease	Private-land owner	Culinary water use during approximate 16-week period; diversion rights from private water user.
Solid waste disposal approval	Wyoming State Solid Waste Division	Under Resource Conservation and Recovery Act requirements, notification and plat identification of site under post-closure requirements.
NRC license	U.S. Department of Energy, U.S. Nuclear Regulatory Commission, Wyoming State Division of Radiological Health Services	Closure requirements approval; ownership reverts to the Secretary of Energy (Section 104(f) of Public Law 95-604); process still in proposal stage.

Appendix C

SUPPORT CALCULATIONS, SCHEDULES, AND STANDARDS

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Appendix C

SUPPORT CALCULATIONS, SCHEDULES, AND STANDARDS

C.1 VOLUMES OF CONTAMINATED MATERIALS

The information in this section has been derived from data taken from the Engineering Assessment of Inactive Uranium Mill Tailings, Spook Site, Converse County, Wyoming, prepared by FBDU (1981) for the U.S. Department of Energy, Albuquerque, New Mexico. The assessment states that there are 187,000 tons of contaminated tailings. At 100 pounds per cubic foot, 187,000 tons is approximately 138,500 cubic yards. The volumes of contaminated subsurface and windblown areas listed in Table C-1 were computed from planimeter readings taken from the area decontamination plan, Figure 9-1 of the engineering assessment, as shown in Figure C-1A.

Table C-1. Contaminated volumes

Area	Volume (cubic yards)
Tailings	≈ 138,500
2 feet contaminated subsurface	≈ 27,900
0.5 foot contaminated windblown	≈ 12,900
Total	≈ 179,000

The contaminated materials are to be stacked in the west end of the existing mine pit as shown in Figure C-1A. The sides of the triangle are considered to be vertical for contingency and for ease of calculating.

The dimensions in Figure C-1 give the following volumes for the four portions of the pile labeled in Figure C-1B:

1. Portion a, 90,500 cubic yards.

2. Portion b, 57,200 cubic yards.

3. Combined portions c and d, 45,200 cubic yards.

The total volume contained is therefore 192,900 cubic yards, which allows contingency volume at about 8 percent.

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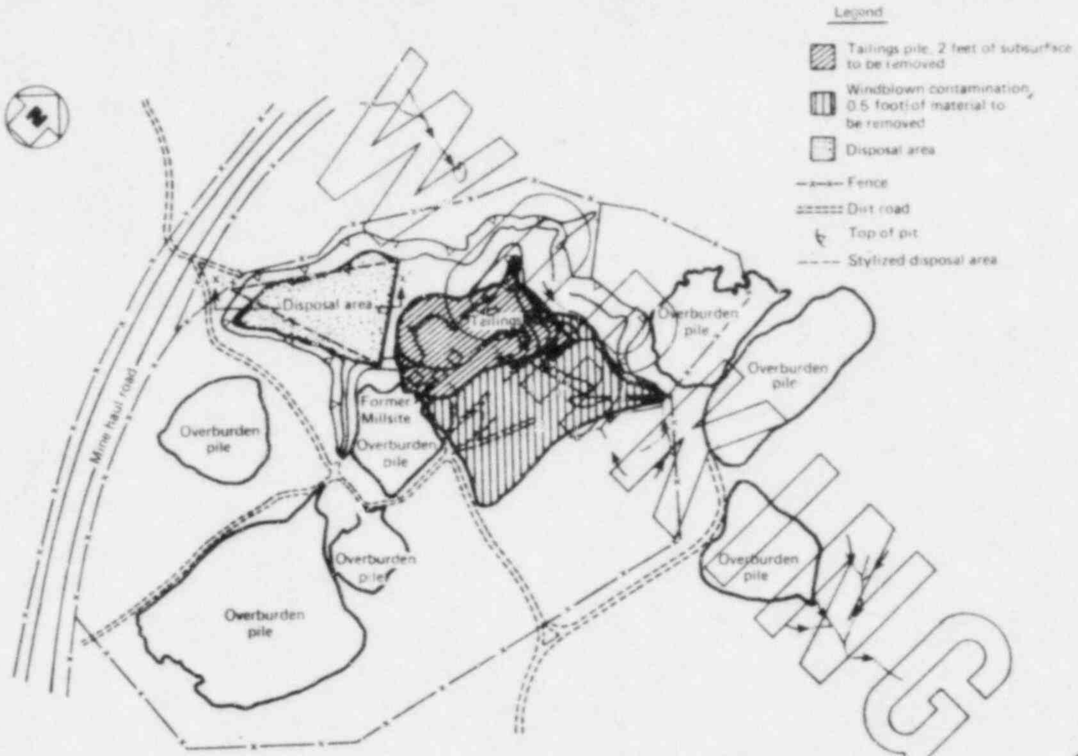
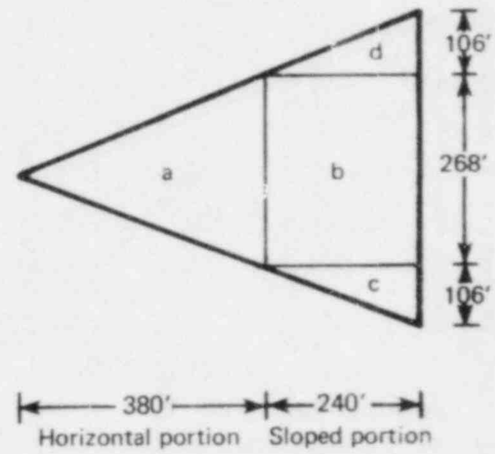
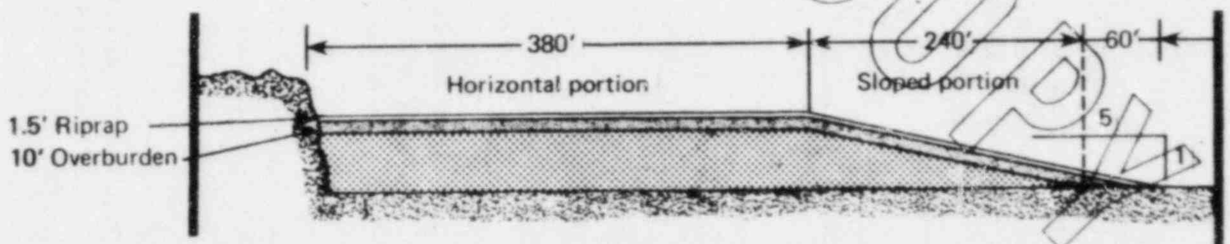


C-1A. Detailed site map and area decontamination plan.



C-1B. Dimensions of stylized disposal area.



C-1C. Section of x - x′ of disposal area.

Figure C-1. Spook proposed–action calculation diagrams.

(Not to scale)

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The entire stack will be covered with 11.5 feet of cover material, consisting of 10 feet of overburden and 1.5 feet of rock. Table C-2 shows the volume of material required for the cover in terms of the portions labeled in Figure C-1B.

Table C-2. Cover-material volumes

Area		Volume (cubic feet)
Cover volume of a	=	585,000
Cover volume of b	=	822,000
Cover volume of c and d	=	325,000
Subtotal		1,732,000
Plus 15% contingency		260,000
Total		1,992,000

The total cover volume needed is approximately 2,000,000 cubic feet, or 74,000 cubic yards.

Disposal at unspecified locations at distances of 5, 10, and 15 miles is also costed. These options all include excavation, fine cover and rock cover, and work force and equipment estimates.

The disposal pit would be 30 feet deep with 1:1 sloped sides, and would have two access trenches. The pit is assumed square in plan view. Fine cover material, 6.5 feet thick (from the pit), and rock cover 1.5 feet thick at the top, would seal the pit after filling. The total thickness allowed for disposal of tailings is then 22 feet.

The disposal pit and the successive layers of cover are all inverted truncated pyramids. Likewise, the cover-layer volumes consist of a fine-cover volume of 59,600 cubic yards and a rock-cover volume of 14,200 cubic yards. Final surface dimensions are 507 x 507 feet.

The access trenches would require excavation. The trenches are assumed to be 20 feet wide at road level and to have a 1:1 side slope and a roadway grade of 10 percent. The total volume to be excavated for both access ramps is 13,500 cubic yards.

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C.2 DURATION AND EQUIPMENT

The heavy equipment that will be required for this work is as follows:

1. Four 12-cubic-yard dump trucks.
2. One grader.
3. One water truck.
4. Two front-end loaders.
5. One bulldozer/compactor.

Assuming that the haul is an eighth of a mile and a truck can make eight trips per hour, we can compute the number of hours and vehicle-miles needed to move the contaminated material shown in Table C-1. Under these assumptions, the 179,000 cubic yards of contaminated material can be moved in the four dump trucks in about 8 weeks. The trucks will travel a total of 3800 vehicle-miles.

The haul for the cover material is approximately 0.25 mile. The trucks will be able to make about four trips per hour. To move the 74,000 cubic yards of contaminated material will require about 7 weeks and 3100 vehicle-miles.

The total time and number of vehicle-miles required, plus 1 week contingency that includes leveling, is 16 weeks and 7000 vehicle-miles.

C.3 PERSONNEL, EQUIPMENT, AND FUEL USE

Table C-3 provides the information used in the calculation of the personnel required and the projected fuel consumption for the proposed action, including cleanup of the vicinity properties.

The emissions for earthmoving equipment (cat, shovel, scraper, truck, loader, etc., with diesel or gasoline engines), used in off-highway* situations, are obtained from the Compilation of Air Pollutant Emission Factors (EPA, 1975). The particulate emissions produced by the proposed action are shown in Table C-4.

Man-years are calculated for 16 men for 16 weeks, assuming that 2000 hours is the standard for a man-year, even though it is expected that the work will be completed on a 60-hour-per-week basis. The project will require, under these assumptions, 7.7 man-years.

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*Off-highway means hauling, moving, scraping, digging, or bulldozing (even though some of the route may use roads or highways).

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Table C-3. Equipment, fuel, and personnel estimates

	Number	Gallons per hour	Hours	Total gallons
Equipment				
Dump truck, 12 cubic yards	4	5.0	960	19,200
Grader, Caterpillar 12G	1	4.6	960	4,400
Water truck	1	6.2	960	6,000
Loaders, 5 cubic yards, Caterpillar 980C	2	8.5	960	16,300
Compactor/dozer	1	10.0	960	9,600
Total				55,500
		Including contingency		60,000
Personnel (the operators above plus the following)				
Oiler	1			
Supervisor	1			
Surveyor	1			
Helper	1			
Radiologists, health-physics managers	3			
Total	16			

Table C-4. Particulate emissions for the proposed action

Pollutant	Emission factors: Pounds per 1000 gallons of fuel burned	Total gallons of fuel	Pounds of pollutant	Pounds per month
Carbon monoxide	92.2	60,000	5,550	1,400
Hydrocarbons	30	60,000	1,800	450
Oxides of nitrogen	524	60,000	31,450	7,850
Sulfur dioxide	31.2	60,000	1,850	450
Particulates	17.7	60,000	1,050	250

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C.4 COST ESTIMATES

Four different cost estimates are outlined in this section. The items in all of the sections are rounded to the nearest $1000. The time, personnel, and equipment figures are taken from Sections C.2 and C.3.

C.4.1 Stabilization in the pit (the proposed action)

Table C-5. Cost itemization for stabilization in the pit

Item		Cost
Leveling the stack area in pit, full crew for 4 each 10-hour days = 16 men x 40 hours x $25 per hour.		$ 16,000
Stacking 179,000 cubic yards of contaminated tailings and soils (Table C-1). 0.25-mile round trip at $3.60 per cubic yard. This includes excavation, loading, hauling, placement, and compaction.		644,000[a]
Covering of the contaminated stack with 74,000 cubic yards (Section C.1) of overburden that is at the site. 0.5-mile[b] round crip at $3.60 per cubic yard. This includes excavation, loading, hauling, placement, and compaction.		266,000[a]
Health-physics management and radiological monitoring. An average of 3 workers at $300 per day per worker, for 6 days a week for 16 weeks.		86,000
Vicinity properties, 7 at $9675 and 8 at $7920.		131,000
	Subtotal	$1,143,000
	Engineering, 15%	171,000
	Contingency, 30%	343,000
	Rounded total	$1,650,000

[a]Cost developed using Means (1981), supplemented by interviews with Salt Lake City, Utah, contractors in the summer of 1981.

[b]Although the haul is farther than the previously listed item, the material is not contaminated, and the cost is therefore lower. The high cost of handling contaminated material is a result of the additional time required for such actions as radiological monitoring, truck washdown, lining the truck bed with a plastic sheet, tarp-cover placement, and tarp-cover removal.

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C.4.2 Move tailings to the Bear Creek Uranium Mine and Mill (Alternative 2)

The transportation cost of hauling the tailings and contaminated material to the Bear Creek site is

2.5 miles x 179,000 cubic yards of contamination x $1.00* per cubic yard per mile ≈ $450,000.

C.4.3 Disposal in another open pit (Alternative 3)

Using the same cost per cubic yard per mile as in Section C.4.2, the transportation cost of hauling the tailings to an open pit 1 mile south of the Spook site is

1 mile x 179,000 cubic yards of contamination x $1.00 ≈ $180,000.

C.4.4 Stabilization at distances of 5, 10, and 15 miles (Alternative 4)

The following assumptions have been applied in calculating the costs of disposal at unspecified locations at distances of 5, 10, and 15 miles.

1. Cover material would consist of 6.5 feet (2 meters) of soil plus either 1.5 feet of minus 6-inch coarse material and riprap (for a total of 8 feet) or 0.5 foot of topsoil (for a total of 7 feet).
2. A suitable disposal site would be within a specified radius of 5, 10, or 15 miles.
3. The disposal site would require minimal preparation prior to excavation. This would include stripping of vegetation and stockpiling of removed soil.
4. The disposal site would be suitable for evaluation according to the ranking system established by the DOE (1982).
5. Haul roads would require upgrading for 2 miles on any option.
6. Total below-grade disposal would be possible to a depth of 30 feet.
7. The fine-grained cover would be available from excavation of the disposal site.

*Cost developed using Means (1982).

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8. Coarse cover and riprap or revegetation would be used depending on the area and the proposed action (i.e., if the proposed action calls for revegetation, disposal sites would be revegetated and the assumption made that water for irrigation would be available at the site.

9. Coarse material and riprap material would be available within a 5-mile radius. Drilling and blasting would be required.

10. The costs of excavating, loading, hauling, placing, and compacting coarse and riprap material would be $4.40 per yard for a 5-mile haul.

11. The cost of handling contaminated material, including excavating, loading, hauling, placing, and compacting (in trucks lined with plastic sheeting and covered with tarps) would be as follows:

    $5.55 per yard for a 5-mile haul
    $7.35 per yard for a 10-mile haul
    $9.15 per yard for a 15-mile haul

12. Dust-control water would be available within 5 miles of the disposal site.

13. The disposal site would be security fenced.

The cost estimates for disposal at unspecified locations at distances of 5, 10, and 15 miles are included in Tables C-6, C-7, and C-8, respectively.

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Table C-6. Cost itemization for stabilization at 5 miles

Item		Cost[a]
Site preparation, setup, level, preliminary survey, 40 hours for 16 men, $25 per hour plus equipment at $100 per hour		$ 20,000
Excavating pit, replacing fine-cover soil after filling, 0.5-mile haul distance. 326,100 cubic yards at $2.90 per cubic yard		946,000
Placing contaminated material in pit, 5-mile haul. 179,000 cubic yards at $5.55 per cubic yard		993,000
Drilling and blasting cover rock, piling at blasting area. 14,200 cubic yards at $6.00 per cubic yard		85,000
Hauling and emplacing cover rock, 5-mile haul. 14,200 cubic yards at $4.40 per cubic yard		62,000
Constructing 2-mile length of 30-foot-wide gravel road. Gravel at $2.90 per cubic yard		103,000
Security fencing, 2200 lineal feet at $12.60 per foot		28,000
Management, health physics personnel, 360 man-days at $350 per man-day		126,000
Vicinity properties, 7 at $9675 and 8 at $7920		131,000
	Subtotal	$2,494,000
	Engineering, 15%	374,000
	Contingency, 30%	748,000
	Total	$3,616,000

[a]Costs are rounded to the nearest $1000.

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Table C-7. Cost itemization for stabilization at 10 miles

Item		Cost[a]
Site preparation, setup, level, preliminary survey, 40 hours for 16 men, $25 per hour plus equipment at $100 per hour		$ 20,000
Excavating pit, replacing fine-cover soil after filling, 0.5-mile haul distance. 326,100 cubic yards at $2.90 per cubic yard		946,000
Placing contaminated material in pit, 10-mile haul. 179,000 cubic yards at $7.35 per cubic yard		1,316,000
Drilling and blasting cover rock, piling at blasting area. 14,200 cubic yards at $6.00 per cubic yard		85,000
Hauling and emplacing cover rock, 5-mile haul. 14,200 cubic yards at $4.40 per cubic yard		62,000
Constructing 2-mile length of 30-foot-wide gravel road. Gravel at $2.90 per cubic yard		103,000
Security fencing, 2200 lineal feet at $12.60 per foot		28,000
Management, health physics personnel, 432 man-days at $350 per man-day		151,000
Vicinity properties, 7 at $9675 and 8 at $7920		131,000
	Subtotal	$2,842,000
	Engineering, 15%	426,000
	Contingency, 30%	853,000
	Total	$4,121,000

[a]Costs are rounded to the nearest $1000.

Table C-8. Cost itemization for stabilization at 15 miles

Item	Cost[a]
Site eparation, setup, level, preliminary survey, 40 hours for 16 men, $25 per hour plus equipment at $100 per hour	$ 20,000
Excavating pit, replacing fine-cover soil after filling, 0.5-mile haul distance. 326,100 cubic yards at $2.90 per cubic yard	946,000
Placing contaminated material in pit, 15-mile haul. 179,000 cubic yards at $9.15 per cubic yard	1,638,000
Drilling and blasting cover rock, piling at blasting area. 14,200 cubic yards at $6.00 per cubic yard	85,000
Hauling and emplacing cover rock, 5-mile haul. 14,200 cubic yards at $4.40 per cubic yard	62,000
Constructing 2-mile length of 30-foot-wide gravel road. Gravel at $2.90 per cubic yard	103,000
Security fencing, 2200 lineal feet at $12.60 per foot	28,000
Management, health physics personnel, 504 man-days at $350 per man-day	176,000
Vicinity properties, 7 at $9675 and 8 at $7920	131,000
Subtotal	$3,189,000
Engineering, 15%	478,000
Contingency, 30%	957,000
Total	$4,624,000

[a]Costs are rounded to the nearest $1000.

C.5 WATER USE

It is estimated that 35 gallons of potable water are required per person per work day. For 16 workers, 54,000 gallons of potable water will be needed.

Water is also needed for dust control. A typical water truck holds 4000 gallons. At an estimated average of two trips a day about 800,000 gallons will be required.

An increased population of 12 people, each using 100 gallons per day for 16 weeks, will require a total of approximately 34,000 gallons from the Converse County supplies of domestic water.

The total increase in demand for water is as follows:

54,000 gallons	worker use
800,000 gallons	dust control
134,000 gallons	domestic use
988,400 gallons	total

C.6 ACCIDENT RISK

The following truck accident and fatality rates were obtained from the National Safety Council Accident Facts, 1980 Edition. The total of estimated vehicle-miles is taken from Sections C.2 and C.8.

Table C-9. Accident rates

Item	Rate	Vehicle-miles	Accidents
Accident rate (all trucks)	7.94 accidents / 1 million vehicle-miles	7330	0.058
Fatality-involvement rate	3.45 deaths / 1 million vehicle-miles	7330	0.025
Driver-fatality rate	1.48 deaths / 1 million vehicle-miles	7330	0.011

C.7 AIR-QUALITY STANDARDS AND CONSTRUCTION SOUND LEVELS

Table C-10 is a list of Federal primary and secondary air-quality standards.

Table C-11 includes measurements of sound levels at various distances from different types of construction equipment.

C.8 VICINITY PROPERTIES

The following are generic assumptions for the 15 vicinity properties at Spook:

1. There are 100 cubic yards of contaminated material and required fill at each property.
2. Half the properties require a 5-mile haul and half require a 10-mile haul. An odd number would be considered as a 5-mile haul.
3. Fill is available at 5 miles from the properties.
4. Equipment is available within 5 miles of the property, and it is 5 miles from one property to another.

The assumed equipment for remedial action at the vicinity properties is shown below. This equipment is the same for both the 5-mile and 10-mile hauls.

1. Two "lowboy" trailers with trucks.
2. Ten dump trucks, 12 cubic yards each.
3. Three pick-up trucks.
4. Three front-end loaders.
5. Three bulldozers.

Note: Some operators will work with more than one equipment item.

The relevant data per site, as calculated for the 5-mile haul situation, are as follows:

1. There would be about 400 gallons of fuel used. This number is from the number of running hours for the equipment times the hourly fuel use of the equipment.
2. The crew is estimated to be about the same crew used for material handling, working on the vicinity properties before material-handling work can commence at the site. This is basically during the set up and survey at the site.

Table C-10. Federal ambient air standards

Pollutant	Averaging period	Standards[a]		Remarks
		Primary	Secondary	
Sulfur dioxide	annual	0.03 parts-per-million (ppm) (80 micrograms per cubic meter or 80 $\mu g/m^3$)	none	Arithmetic mean
	24 hours	0.14 ppm (365 $\mu g/m^3$)	none	Not to be exceeded more than once per year
	3 hours	none	0.5 ppm (1300 $\mu g/m^3$)	Not to be exceeded more than once per year
Particulates	annual	75 $\mu g/m^3$	60 $\mu g/m^3$	Geometric mean
	24 hours	250 $\mu g/m^3$	150 $\mu g/m^3$	Not to be exceeded more than once per year
Carbon monoxide	8 hours	9 ppm (10,000 $\mu g/m^3$)	Same as Primary	Not to be exceeded more than once per year
	1 hour	35 ppm (40,000 $\mu g/m^3$)	Same as Primary	Not to be exceeded more than once per year
Ozone	1 hour	0.12 ppm (235 $\mu g/m^3$)	Same as Primary	Not to be exceeded more than once per year
Hydrocarbons	3 hours	0.24 ppm (160 $\mu g/m^3$)	Same as Primary	Corrected for methane. Not to be exceeded more than once per year
Nitrogen dioxide	annual	0.05 ppm (100 $\mu g/m^3$)	Same as Primary	Arithmetic mean
Lead	3 months	1.5 $\mu g/m^3$	Same as Primary	Arithmetic mean

[a]At standard temperature (25°C) and pressure (sea level: 760 millimeters of mercury) conditions.

Source: Title 40, Code of Federal Regulations, Part 50.

Table C-11. Sound levels from construction equipment

Equipment	feet / meters	25 / 7.6	50 / 15.2	100 / 30.5	200 / 60.9	500 / 152.9	1000 / 304.5
		Sound levels in decibels on the A-rated scale (dBA) at indicated distances from source					
IMPACT EQUIPMENT							
Jackhammers, rock drills, and pneumatic chippers		87-104	81-98	75-92	69-86	61-78	55-72
INTERNAL COMBUSTION ENGINE-POWERED EQUIPMENT							
Earthmoving							
Tractors, bulldozers		82-102	76-96	70-90	64-84	56-76	50-70
Scrapers, graders		86-99	80-93	74-87	68-81	60-73	54-67
Trucks		88-99	82-93	76-87	70-81	62-73	56-67
Backhoes		78-99	72-93	66-87	60-81	52-73	46-67
Front-end loaders		79-92	73-86	67-80	61-74	53-66	47-60
Materials Handling							
Cranes (moveable)		82-93	76-87	70-81	64-75	56-67	50-61
Derrick cranes		92-94	86-88	80-82	74-76	66-68	60-62
Stationary Equipment							
Compressors		80-93	74-87	68-81	62-75	54-67	48-61
Generators		77-88	71-82	65-76	59-70	51-62	45-56
Pumps		75-77	69-71	63-65	57-59	49-51	43-45

Source: EPA, 1972.

3. It will take 1 day of 9 hours to complete the remedial action at two vicinity properties. Therefore, the eight properties at 5 miles will take 4 days.

4. Adding the travel miles of the equipment items calculates to about 330 vehicle-miles and 1000 yard-miles.

5. Based on $25 per hour for labor, and using the estimated hourly equipment involved, the cost per property is about $7920. Adding engineering fees and contingency gives a rounded total of $11,500 per property.

The relevant data per site, as calculated for the 10-mile haul situation, are as follows:

1. There would be about 500 gallons of fuel used. This number is from the number of running hours for the equipment times the hourly fuel use of the equipment.

2. The crew is estimated to be about the same crew used for material handling working on the vicinity properties before material-handling work can commence at the site. This is basically during the set up and survey time at the site.

3. It will take 1 day of 11 hours to complete the remedial action at two vicinity properties. Therefore, the seven properties at 10 miles will take 3.5 days.

4. Adding the travel miles of the equipment items calculates to about 480 vehicle-miles and 1500 yard-miles.

5. Based on $25 per hour for labor, and using the estimated hourly equipment charge for the equipment involved, the cost per property is about $9675. Adding engineering fees and a contingency gives a rounded total of $14,000 per property.

The hours per day for each situation of 9 and 11 hours averages to the 10-hour day used throughout this document.

The total time for remedial action at the vicinity properties is the total for the 5-mile haul properties and the 10-mile haul properties as shown above, or about 7.5 days.

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C.9 EFFECT OF COVER ON RADON EMISSIONS

The following values were used to estimate the effect of 3 meters of a silty-sandy cover on radon emissions from tailings:

1. Emission from standard bare tailings (radium-226 content of 285 picocuries per gram) assumed to be 285 picocuries per square meter per second (NRC, 1980).

2. Diffusion coefficient from tailings assumed to be 0.047 square centimeters per second and porosity of air in the tailings assumed to be 0.35 (NRC, 1980).

3. Diffusion coefficient for silty sand assumed to be 0.022 square centimeters per second and porosity of air in the cover assumed to be 0.294 (NRC, 1978).

4. Radon attenuation for 3 meters of silty sand estimated to be equal to 0.039, using an equation from FBDU (1980).

Using these assumptions, the radon flux from a 3-meter cover of silty sand is estimated to be about 11 picocuries per square meter per second.

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REFERENCES FOR APPENDIX C

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Appendix D

SUMMARY OF BIOLOGICAL FIELD STUDIES

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SUMMARY OF BIOLOGICAL FIELD STUDIES

The terrain surrounding the Spook site consists of rolling plains. The Dry Fork of the Cheyenne River winds through these plains. The predominant kinds of vegetation are sagebrush and grasses; trees occur in mesic areas. The Spook site lies within the grama-needlegrass-wheatgrass association of potential natural vegetation types defined by Kuchler (1964).

D.1 HABITAT

During the 1981 reconnaissance, two sagebrush communities, four grassland communities, and a highly disturbed "barren" area were mapped. All communities had suffered at least some disturbance from past mining activities. All plants recorded during the reconnaissance are listed in Table D-1. Because the plant communities are quite similar to each other, major habitats were defined according to the degree of past disturbance they had experienced. The following seven types of habitats have been distinguished by Westech, Inc., (1982) on or near the site:

1. "Barren" area. This area included the tailings and overburden piles, parts of the mine pit, haul roads, and other disturbed parts of the site that have essentially failed to revegetate. Only 11 plant species were recorded in this area: western wheatgrass, Japanese brome, cheatgrass, foxtail barley, Indian ricegrass, lamb's quarters, pale bastard toadflax, curl-cup gumweed, prairie sunflower, scarlet globemallow, and fourwing saltbush. Several of these are considered undesirable or noxious species.

2. Indian ricegrass/weedy forb (Orhy/forb). Much of the disturbed area has been invaded by weedy forbs. Unlike the "barren" area, however, Indian ricegrass has also become established in this community. The difference between the two appears to be a function of the degree of disturbance (the most heavily disturbed sites were "barren") and perhaps of soil type and nutrient composition.

3. Cheatgrass/forb (Brte/forb). Like the community above, this type was found on naturally revegetated disturbed areas. Microsites appeared to be slightly more mesic than the Orhy/forb type, and consequently were dominated by the cool-season cheatgrass.

4. Big sagebrush/silver sagebrush (Artr/Arca). Some areas of the Spook site, particularly swales and slight drainages, were only partially disturbed during mining or have been naturally revegetated by a mixture of sagebrush and grasses. Although big sagebrush usually dominates in these areas, the more mesic silver sagebrush is co-dominant at microsites.

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Table D-1. Vegetation recorded at the Spook site

Species	Common name
GRAMINOIDS	
Agropyron caninum	bearded wheatgrass
Agropyron cristatum	crested wheatgrass
Agropyron smithii	western wheatgrass
Bouteloua gracilis	blue grama
Bromus inermis	smooth brome
Bromus japonicus	Japanese brome
Bromus tectorum	cheatgrass
Buchloe dactyloides	buffalograss
Carex filifolia	thread-leaf sedge
Hordeum jubatum	foxtail barley
Koeleria cristata	prairie junegrass
Oryzopsis hymenoides	Indian ricegrass
Sitanion hystrix	squirreltail
Stipa comata	needle-and-thread
Stipa viridula	green needlegrass
FORBS	
Arenaria hookeri	Hooker sandwort
Artemisia frigida	fringed-leaf sagewort
Astragalus bisulcatus	two-grooved milkvetch
Astragalus gracilis	slender milkvetch
Astragalus spatulatus	draba milkvetch
Chenopodium album	lamb's quarters
Chrysopsis villosa	hairy golden aster
Cirsium arvense	Canada thistle
Cirsium canescens	platte thistle
Comandra umbellata	pale bastard toadflax
Delphinium geyeri	Geyer larkspur
Erigeron pumilus	low fleabane
Gaura coccinea	scarlet gaura
Gilia spicata	spicate gilia
Grindelia squarrosa	curl-cup gumweed
Helianthus annuus	common sunflower
Helianthus petiolaris	prairie sunflower
Hymenopappus filifolius	narrow-leaved hymenopappus
Lappula redowskii	low stickseed
Lepidium densiflorum	common pepperweed
Machaeranthera canescens	hoary aster
Machaeranthera grindelioides	goldenrod
Melilotus officinalis	yellow sweet clover
Mirabilis linearis	narrow-leaved four o'clock
Musineon divaricatum	leafy musineon
Paronychia sessiliflora	stemless nailwort
Oxytropis lambertii	purple pointloco

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Table D-1. Vegetation recorded at the Spook site (continued)

Species	Common name
FORBS (continued)	
Penstemon albidus	white-flowered penstemon
Phacelia hastata	whiteleaf phacelia
Phacelia linearis	threadleaf phacelia
Phlox hoodii	Hood's phlox
Psoralea agrophylla	silverleaf scurfpea
Psoralea esculenta	Indian bread-root
Psoralea tenuiflora	slender-flowered scurfpea
Salsola kali	Russian thistle
Sphaeralcea coccinea	scarlet globemallow
Vicia american	American vetch
WOODY PLANTS	
Artemisia cana	silver sagebrush
Artemisia tridentata	big sagebrush
Atriplex canescens	fourwing saltbush
Chrysothamnus viscidiflorus	green rabbitbrush
Gutierrezia sarothrae	broom snakeweed
Populus deltoides	Great Plains cottonwood

5. Big sagebrush/needle-and-thread/Indian ricegrass (Artr/Stco/Orhy). This community was dominant in the buffer surrounding the Spook site. Where disturbed, it has been invaded by cheatgrass, Japanese brome, and blue grama. It supported the largest species diversity of all communities present in the area, and corresponded to the sagebrush communities described by the U.S. Nuclear Regulatory Commission (1977) and Kerr-McGee (1979).

6. Needle-and-thread/Indian ricegrass (Stco/Orhy). This community occurred on undisturbed, well-drained hillsides. Although needle-and-thread and Indian ricegrass were most visible, a considerable amount of the canopy coverage was composed of blue grama and thread-leaf sedge.

7. Needle-and-thread/western wheatgrass/Indian ricegrass (Stco/Agsm/Orhy). This type was very similar to the needle-and-thread/ricegrass community, except that it occurred in more mesic sites where western wheatgrass was present.

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Riparian habitat. Although not mapped at the Spook site, riparian habitat was available to wildlife about 0.5 mile south of the site along the Dry Fork of the Cheyenne River. This habitat consisted of open stands of cottonwood, with an understory of snowberry, rose, and mesic grasses. It is heavily grazed by livestock but provides important habitat diversity for wildlife in the area.

D.2 BIRDS

Seventeen species of birds were recorded at the Spook site during the brief reconnaissance (Table D-2). All were considered to be breeding on or near the site except the common flicker, mountain bluebird, and brown-headed cowbird, which were recorded in riparian habitat 0.5 mile away.

The disturbed area of the site contributed the greatest number of species (11), compared to seven species in sagebrush and six species in grassland habitats. The species diversity is a result of the diversity of microsite habitats in the disturbed area. For example, the mine contains cliff habitat (the highwall), cave habitat (adits), trees, boulder piles, sagebrush and grassland inclusions, and abandoned buildings. Nest sites are available within the disturbed area that are not available in the other two major habitats. American kestrels and bank swallows nested in holes along the cliff-like highwall of the pit, while great horned owls, Say's phoebes, and cliff swallows had built nests in the adits. Rock wrens nested in boulder piles, while loggerhead shrikes were observed in cottonwoods at the edge of the site.

Four other species (mourning dove, western meadowlark, vesper sparrow, and lark sparrow) were recorded in all three habitats. These species usually nest on the ground in open habitat and can use a wide variety of open-vegetation communities. Horned larks and lark buntings could also be expected to use all three major habitats, although none were recorded in the disturbed area. Similarly, the killdeer was observed only in sagebrush habitat, although it could potentially nest in all three types.

In comparison to the Spook site, 33 bird species were reported in the Bear Creek mine area (NRC, 1977). In all likelihood, all of these species might also be found, at least seasonally, at or near the Spook site. Two upland game birds (mourning dove and sage grouse) are present in the area in relatively low numbers (NRC, 1977; Kerr-McGee, 1979). The only sage grouse lek reported near the Spook site was about 8 miles southwest (Kerr-McGee, 1979). No sage grouse or their evidence (feathers, droppings) were observed at the Spook site during the brief reconnaissance, although habitat was available adjacent to the site.

No waterfowl were recorded during the reconnaissance. The Spook site does not contain sufficient habitat to support waterfowl; the best adjacent habitat is along the Cheyenne River, 0.5 mile south of the site.

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Table D-2. Birds observed at the Spook site, July 1981

Species[a]	Habitat: Sagebrush	Habitat: Grassland	Habitat: Disturbed
American kestrel (Falco sparverius)	X		X
Killdeer (Charadrius vociferus)[b]	X		
Great horned owl (Bubo virgianus)			X
Mourning dove (Zenaida macroura)	X	X	X
Common flicker (Colaptes aurates)[b]		other habitats	
Say's phoebe (Sayornis saya)			X
Horned lark (Eremophila alpestris)	X	X	
Cliff swallow			X
Bank swallow			X
Rock wren			X
Loggerhead shrike			X
Mountain bluebird[b]		other habitats	
Western meadowlark (Sturnella neglecta)	X	X	X
Brown-headed cowbird (Molothrus ater)[b]		other habitats	
Lark bunting (Calamospiza melancorys)	X	X	
Vesper sparrow (Pooecetes gramineus)	X	X	X
Lark sparrow	X	X	X

[a]Nomenclature from Dorn (1978).
[b]Recorded within 2 miles of the site.

The only raptors recorded at the site were American kestrels and great horned owls. The highwall of the pit could potentially support nesting prairie falcons, but no falcons or their evidence were observed. The surrounding sagebrush habitat should support ferruginous hawks, and red-tailed hawks might nest along the Cheyenne River. Although neither of these species was observed during the reconnaissance, Kerr-McGee (1979) reported nesting ferruginous hawks south of the Spook site in 1978.

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In summary, all birds observed at the Spook site during the reconnaissance are common in the region. Several nested at the site because of the variety of available nest sites created by past mining activities. No birds were observed directly on the tailings pile, which is part of the "barren" habitat.

D.3 MAMMALS

Mammals recorded at the Spook site are listed in Table D-3. Only seven undomesticated (wildlife) species were observed. In comparison, the U.S. Nuclear Regulatory Commission (1977) reported 12 species at the Bear Creek project.

Antelope are the most common big-game mammal in the vicinity. They were observed in sagebrush habitat south of the Spook site during the reconnaissance. The surrounding area is classified as year-round pronghorn habitat, with density estimates of five to seven animals per square mile (NRC, 1977; Kerr-McGee, 1979). Populations in winter are higher than summer populations at the Bear Creek mine (NRC, 1977).

Antelope in the region are dependent on open, rolling sagebrush habitat (Sundstrom et al., 1973). While the Spook site itself might occasionally be used by antelope, it is small and the habitat within the site is relatively poor compared to that of adjacent areas. It is therefore unlikely that the Spook site receives significant antelope use.

Mule deer were observed on the site and in adjacent habitats. Regional populations are considered low. The Nuclear Regulatory Commission (1977) estimated a population of 24 mule deer at the Bear Creek project north of the Spook site, while Kerr-McGee (1979) reported an estimate of only 50 deer in its 73,000-acre area south of the Spook site. However, both reports considered the Cheyenne River to be important habitat (particularly in winter) for mule deer, and there is probably considerable deer movement between the river and the Spook site.

Mule deer are apparently attracted to the Spook site by the escape cover created by the mine pit and overburden piles. During the reconnaissance, several mule deer were observed bedded in the shade cast by the highwall, and deer tracks were followed about 30 feet into an adit. In addition, natural revegetation of the mine area has resulted in a diverse mixture of desirable browse (e.g., shrubs such as big sagebrush, silver sagebrush, green rabbitbrush, and four-wing saltbush) and forbs (Table D-1).

Coyote tracks were recorded in all three major habitats at the Spook site (Table D-3). Desert cottontails were observed in sagebrush and disturbed habitats; in the latter, they were particularly common around boulder piles and abandoned buildings and equipment.

Pocket gopher mounds were found in loose soils in all three habitats. Skull fragments of cottontail, pocket gopher, deer mouse, and prairie vole were identified in great horned owl casts found below perches on the highwall

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Table D-3. Mammals recorded at the Spook site, July 1981

Species[a]	Habitat: Sagebrush	Grassland	Disturbed
Carnivora			
Coyote (<u>Canis</u> <u>latrans</u>)	X	X	X
Lagomorpha			
Desert cottontail (<u>Sylvilagus</u> <u>audubonii</u>)	X		X
Rodentia			
Northern pocket gopher (<u>Thomomys</u> <u>talpoides</u>)	X	X	X
Deer mouse (<u>Peromyscus</u> <u>maniculatus</u>)			X
Prairie vole (<u>Microtus</u> <u>ochrogaster</u>)			X
Artiodactyla			
Domestic cattle (<u>Bovus</u> spp.)	X		X
Domestic sheep[b]	X		
Mule deer (<u>Odocoileus</u> <u>hemionus</u>)	X	X	X
Pronghorn (<u>Antilocapra</u> <u>americana</u>)[b]	X		

[a]Nomenclature from Rothwell et al. (1978).
[b]Recorded within 2 miles of the site.

and in adits. Kerr-McGee (1979) trapped small rodents in the study area south of the Spook site and found deer mice to be most abundant, followed by thirteen-lined ground squirrels, olive-backed pocket mice, northern grasshopper mice, Ord's kangaroo rats, and sagebrush voles. No ground squirrels were seen on or near the Spook site. The remaining species are nocturnal or secretive, and their presence could not be documented during the reconnaissance. Adits in the mine area were examined for bats but none were found.

In summary, the Spook site supported a diversity of mammals comparable to that of surrounding undisturbed areas. Some species, including mule deer and cottontails, are attracted to the habitat provided by the mine. Others, such as antelope, occasionally use the site.

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D.4 REPTILES AND AMPHIBIANS

No reptiles or amphibians were recorded at the Spook site during the reconnaissance. The prairie rattlesnake, bull snake, garter snake, short-horned lizard, leopard frog, and tiger salamander have been reported in adjacent study areas (NRC, 1977; Kerr-McGee, 1979). Suitable habitat for the first four species was present at the Spook site.

D.5 THREATENED AND ENDANGERED SPECIES

No threatened or endangered species of plants or animals were observed at the Spook site. Dorn (1977) listed two plants, Comatium plattensis and Comatium megarrhizum, as rare and endangered in Converse County. Both species could potentially occur near the Spook site. The first, a parasitic dodder, is reported from the Rocky Mountain region (Rickett, 1973). The second is found in grasslands (Dorn, 1977).

Ayensu and DeFilipps (1978) prepared a list of endangered and threatened plants of the United States. According to Kerr-McGee (1979), none of the listed species that occur in the short-grass prairie of eastern Wyoming have ever been collected in Converse County.

Three endangered wildlife species potentially occur in the region. Black-footed ferrets are usually associated with prairie dog colonies (Wyoming Game and Fish Department, 1977). No colonies are located on or immediately adjacent to the Spook site; however, Clark (1978) reported fairly recent sightings of ferrets in Converse County, and it is possible that ferrets are present in the region.

Bald eagles have been reported in the winter along the Cheyenne River (NRC, 1977). However, no nests are known in the region, and these sightings are likely of wintering birds.

Peregrine falcons have apparently never been common in Wyoming (Wyoming Game and Fish Department, 1977). They nest primarily on cliffs near water, and suitable nesting habitat is not available near the Spook site.

The Wyoming Game and Fish Department (1977) has identified several species of wildlife that are considered rare in the state. Those that might occur in the Spook-site region are the spotted bat, meadow jumping mouse, and burrowing owl. None were seen during the reconnaissance.

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D.6 POTENTIAL BIOLOGICAL CONSTRAINTS

As discussed above, no plant or animal species that have federal threatened or endangered status or that are considered rare in the State of Wyoming were observed at the Spook site. The site and adjacent areas do not provide habitat for threatened or endangered species.

No concentrations of big game in the area were observed during the reconnaissance. An area 2 to 4 miles north of the Spook site is reported to be antelope winter range, but the site itself does not provide habitat attractive to antelope.

Several species of wildlife are found at the Spook site because of the habitat diversity created by mining disturbance and subsequent revegetation. However, none of these species are rare in the region, and the mine is not considered critical habitat.

Little wildlife use of the tailings pile was observed, and very little vegetation grows on or near it. Consequently, there are no biological constraints to reclamation or future management of the Spook site.

D.7 RECLAMATION CONSTRAINTS

The most likely form of remedial action at the Spook site is tailings burial. Depending on the depth of burial, burrowing rodents such as the northern pocket gopher might contact contaminated soils. Similarly, should deep-rooting plants such as big sagebrush become established on the reclaimed area, they might contact contaminated soils. One form of mitigation that might be considered at the Spook site is placement of tailings in the adits of the mine pit. In this manner, tailings would be buried deep enough to ensure no contamination of plants or wildlife.

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Appendix E

LAND USE

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LAND USE

Almost 75 percent of Converse County, Wyoming, is privately owned, and the major land use is ranching. Table E-1 lists the uses of the land by acreage. A land-use map is included as Figure E-1.

Table E-1. Converse County land use

Use	Acres	
Urban areas		
Douglas	3,840	
Glenrock	800	
Total urban		4,640
Rural housing		
(536 units at 1 acre/unit)	536	
Rural recreational		
(83 units at 5 acres/unit)	415	
Total housing		951
Agricultural		
Irrigated cropland	68,316	
Dry cropland	20,702	
Irrigated pasture (seasonal)	16,735	
Nonirrigated grazing	2,420,199	
Tree covered	142,437	
Total agricultural		2,668,389
Industrial		31,010
Water areas		4,082
Rural business (highway convenience, guest areas, and mobile home parks)		815
Local government (parks and schools)		2,535
Transportation		
Interstate highway	1,543	
State and Federal highways	3,528	
County roads	4,737	
Railroads	2,330	
Total transportation		12,138
Total county		2,724,560

Source: Converse County Planning Commission, 1978.

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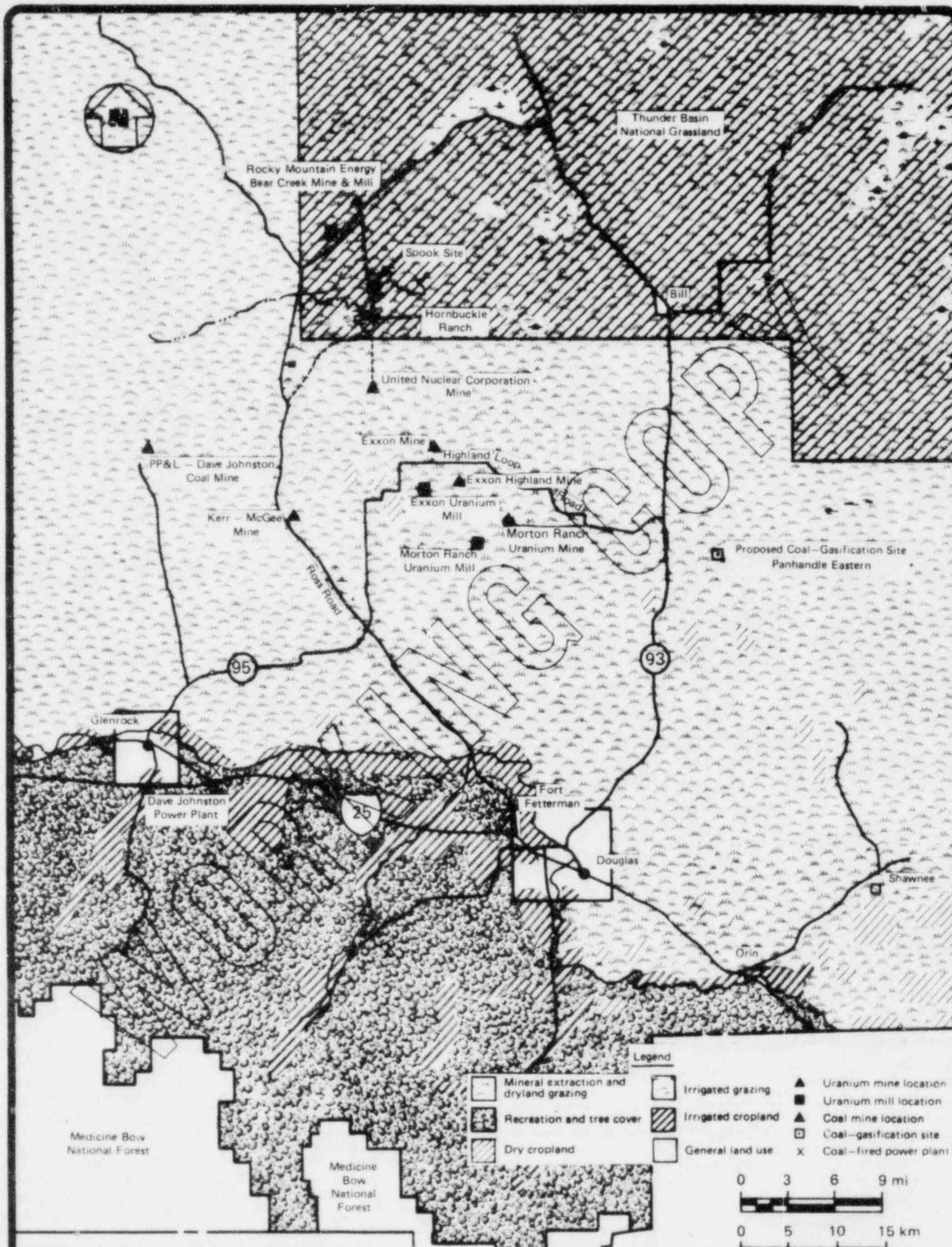

Figure E-1. Land use.

REFERENCES FOR APPENDIX E

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Converse County Planning Commission, 1978. Converse County Land Use Plan, pp. 1.4 and 1.5.

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Appendix F

SOCIOECONOMIC CHARACTERISTICS AND IMPACTS ON THE AFFECTED REGION

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Appendix F

SOCIOECONOMIC CHARACTERISTICS AND IMPACTS ON THE AFFECTED REGION

This appendix addresses the socioeconomic characteristics of the area in terms of population, physical plant, and fiscal capacity. This supply-side characterization is then juxtaposed with the demands that the remedial-action program will place on area resources.

The socioeconomic aspects affected by the remedial-action program have been examined to determine whether a temporary influx of workers would strain the abilities of the county and nearby towns to provide services. Questions that have been researched include these:

1. Is the population large enough to provide workers for the remedial action in the next 2 to 4 years?
2. Is the current work force fully employed or would the remedial action create local employment?
3. Is housing available for in-migrant temporary workers?
4. Are the water and sewer systems capable of accommodating more people?
5. How well can area schools, health-care facilities, public-safety systems, and public works absorb growth?
6. Do the county and towns have a sufficient tax base to afford new growth (which may mean expanded services)?

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F.1 POPULATION

Converse County has experienced rapid energy development and accompanying growth and is expected to continue to grow as new energy projects come on line. The county grew more than any other Wyoming county between 1970 and 1980; it experienced a 136.9 percent increase in population during the decade. In 1980, 14,069 people lived in the county, compared to 5938 in 1970. The towns of Douglas and Glenrock are the urban areas, as defined by the U.S. Census, of the county. The urban population data are displayed in Table F-1.

Table F-1. Population of incorporated areas

Town	1980	1970	Percent change
Douglas	6030	2677	125.3
Glenrock	2736	1515	80.6
Lost Springs	9	7	28.6
Total	8775	4199	109.0

Source: U.S. Department of Commerce, 1981.

The urban population more than doubled during the decade, and the rural population also increased. In 1980, 38 percent of the residents lived in rural areas, whereas in 1970, 29 percent of the residents lived in rural areas. The rural population data are shown in Table F-2.

Table F-2. Rural population

Census division	1980	1970	Percent change
Douglas	3,325	1,311	153.6
Glenrock	1,969	428	360.1
Total rural	5,294	1,739	204.4
Total Converse County	14,069	5,938	136.9

Source: U.S. Department of Commerce, 1981.

Population projections based on the realization of ten proposed energy projects would result in an aggregate Converse County population of almost 24,000 by 1987, including 5000 new permanent residents. Therefore, should the projections materialize, Converse County would experience a large migrant influx in the next 5 years. However, the population projections do not show a steady rate of growth. The data in Table F-3 show an expected out-migration in 1983, then an influx for the next 4 years.

Table F-3. Population projections

Year	A. Annual permanent employee additions	B. Induced service sector employee additions	C. Additional permanent population	D. Construction employees	E. Induced service sector employees	F. Annual additional construction-related population	G. Permanent population level	H. Aggregate population level
Douglas								
1982	51	77	320	136	34	340	6,992	7,332
1983	(187)	(281)	(1,170)	872	218	2,180	5,822	8,002
1984	78	117	488	1,345	336	3,362	6,310	9,672
1985	132	198	825	1,736	434	4,340	7,135	11,475
1986	373	560	2,333	1,515	379	3,788	9,468	13,256
1987	196	294	1,225	1,576	394	3,940	10,693	14,633
Glenrock								
1982	53	80	333	37	9	92	3,028	3,120
1983	13	20	83	238	60	596	3,111	3,707
1984	27	41	170	367	92	918	3,281	4,199
1985	42	63	263	473	118	1,182	3,544	4,726
1986	80	120	500	413	103	1,032	4,044	5,076
1987	37	56	233	430	108	1,076	4,277	5,353
Converse County[a]								
1982	104	156	650	174	44	436	13,917	14,353
1983	(174)	(261)	(1,088)	1,110	276	7,772	12,829	20,601
1984	105	156	653	1,712	428	4,280	13,482	17,762
1985	174	261	1,088	2,209	552	5,522	14,570	20,092
1986	453	680	2,833	1,929	482	4,822	17,403	22,225
1987	233	350	1,458	2,006	502	5,016	18,861	23,877

Figures in parentheses are negative.

Table F-3. Population projections (continued)

A. Given by the Converse Area Industrial Association.

B. Induced Service Sector Employees: For every permanent base job, there are additional jobs created in the service sector; i.e., teachers, clerks, retail store owners, doctors, etc. The multiplier for this is 1.5; therefore, Induced Service Sector Employees = permanent employees x permanent service multiplier.

C. Additional Permanent Population: = (permanent employees + induced service employees) x permanent population multiplier (2.5).

D. Given by the Converse Area Industrial Association. It is assumed that most of the construction employees will seek housing in the local community. The Converse Area Industrial Association has not committed itself to a plan for construction housing at the plant site. Seventy percent are assumed to reside in the county.

E. Induced Service Sector Employment: The multiplier for construction induced service employees is considerably less than for the permanent sector. Therefore, induced service sector employment = construction employees x construction service multiplier (0.25).

F. Additional Construction-Related Population: This population should be more transitory than the permanent sector. Additionally, many people working on construction will not bring their families to the area. Construction employees + construction-induced service employees x construction-related population (2.0) = annual additional construction-related population.

G. Permanent Population Level: = current population + cumulative total of additional permanent population.

H. Aggregate Population Level: = annual figure in column F added to annual figure in column G.

Source: Converse County Board of Commissioners, 1981a.

[a]County totals exceed the sum of Douglas and Glenrock because some new residents may live in unincorporated areas.

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The population projections are based on an expectation that 80 percent of the influx will reside in the town of Douglas. Should these projections materialize, Converse County would have a greater population concentration in towns and fewer people residing in rural areas than at present. However, the forecasted growth rate is heavily influenced by one project: the proposed WyCoal Gas Conversion Project of the Panhandle Eastern Pipe Line Company. Should the company fail to obtain the necessary capital for the project, population growth would be more stable, as shown in Figure F-1.

F.2 HOUSING

During the past decade the number of housing units increased roughly in proportion to population growth. Table F-4 documents the housing supply as noted in the 1980 census.

Table F-4. Housing supply

Town	1980	1970	Percent change
Douglas	2338	1066	119.3
Glenrock	1044	514	103.1
Total Converse County	5350	2291	133.5

Source: U.S. Department of Commerce, 1981.

A significant reliance on mobile homes to meet the current housing demand is shown in Table F-5, where the housing types are listed.

Table F-5. Housing types, 1980 (by percentage)

Town	Single-family dwellings	Duplexes and apartments	Mobile homes
Douglas[a]	62.2	18.4	19.4
Glenrock[b]	57.0	25.0	18.0
Total Converse County[a]	60.7	14.3	25.0

Sources:
[a]Sierz, 1981, p. 1.
[b]Mountain West Research, Inc., 1981, p. 39.

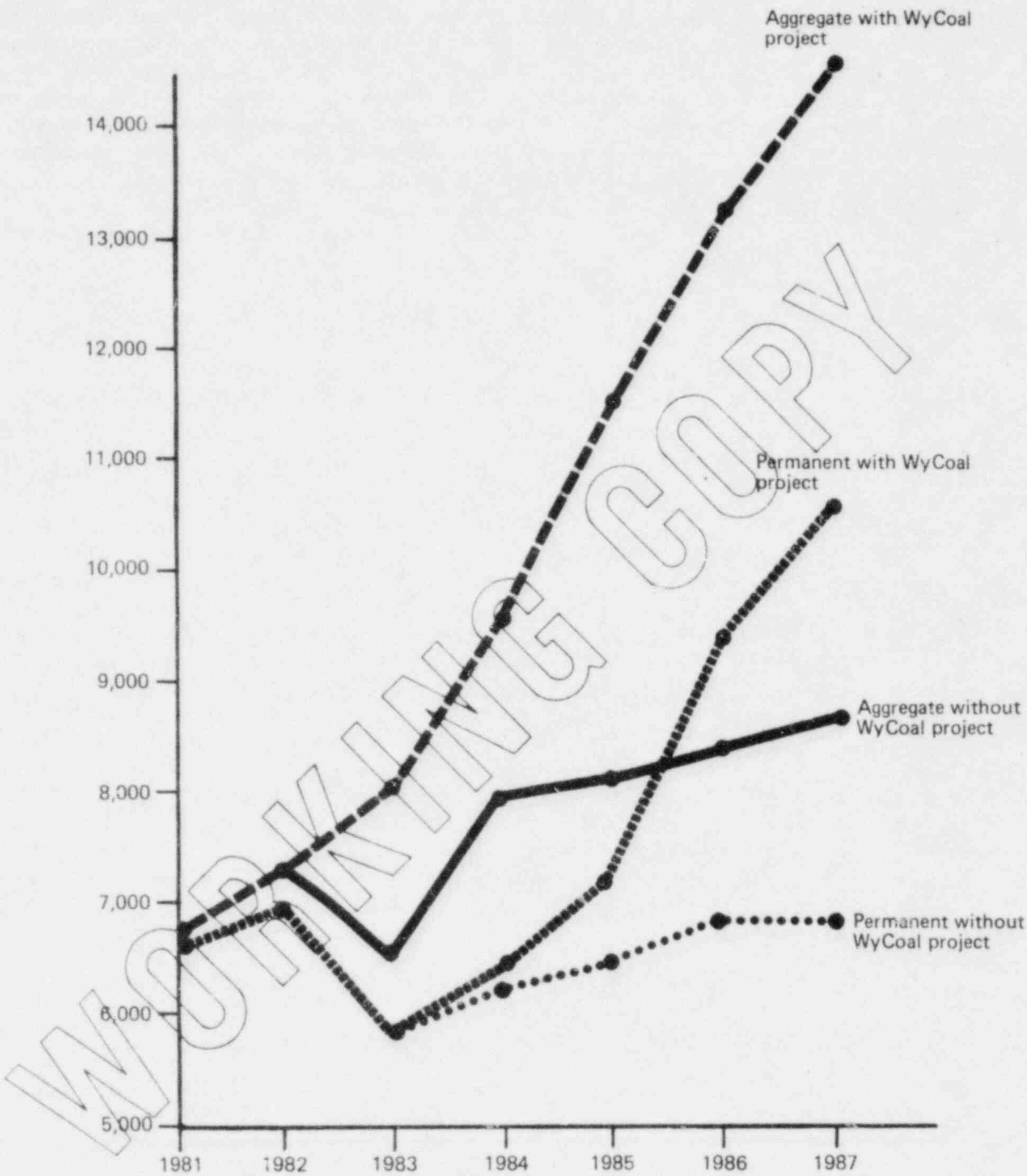

Figure F-1. Population projection estimates, Douglas and 3-mile peripheral area.

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Approximately 25 percent of the housing units in Converse County are rentals (Sierz, 1981). Since over half of the housing supply in the county is reasonably new, deterioration is not expected to be a problem in the near future (Mountain West Research, Inc., 1981, p. 40).

Vacancy rates in Converse County are low, between 3 and 5 percent, although the 1980 preliminary census figures listed an 8-percent vacancy rate for the county. Local officials state that the vacancy rate is approximately 3 percent, but note that recent layoffs in the uranium industry have freed some housing (Mountain West Research, Inc., 1981, p. 40). For the purpose of this report, a median 4-percent vacancy rate is assumed.

F.3 EMPLOYMENT

Converse County experienced a 3.1-percent (3.0 for males, 3.3 for females) unemployment rate in 1981 (Wyoming Employment Security Commission, 1981, p. 16). The low unemployment rate has been nearly constant for a decade, even though the labor force tripled in size between 1970 and 1980. Employment figures for each year are shown in Table F-6.

Table F-6. Labor force, employment, and unemployment

	Converse County				Wyoming
Year	Labor force	Total employment	Total unemployment	Unemployment rate	Unemployment rate
1970[a]	2600	2490	110	4.2	4.4
1971[a]	3070	2970	100	3.3	4.4
1972	2966	2864	102	3.4	3.8
1973	2835	2750	85	3.0	3.3
1974	3183	3096	87	2.7	3.4
1975	3942	3826	116	2.9	4.2
1976	4517	4412	105	2.3	4.1
1977	5333	5186	147	2.8	3.6
1978	6175	6010	165	2.7	3.3
1979	6714	6573	141	2.1	2.7
1980	7952	7707	245	3.1	3.9

Source: Wyoming Employment Security Commission, 1980b, p. 9.
[a]1970 and 1971 data based on number of jobs at place of work. 1972 and subsequent data based on number of workers at place of residence.

The most important industrial sector is mining, which accounts for 30 percent of employment, with the services sector second at almost 14 percent. Employment for all sectors from 1970 to 1980 is shown in Table F-7.

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Table F-7. Converse County employment:[a] 1970, 1975, 1980

Industrial sector	Employment by industrial sector			Percent of total employment			Percent average annual growth		
	1970	1975	1980	1970	1975	1980	1970-1975	1975-1981	1970-1980
Total employment	2341	3981	7809	100.0	100.0	100.0	11.2	14.4	12.8
Farm proprietors	311	280	244	13.3	7.0	3.1	-2.1	-2.7	-2.4
Farm labor	150	217	192	6.4	5.5	2.5	7.7	-2.4	2.5
Mining	162	686	2266	6.9	17.2	29.0	33.5	27.0	30.2
Construction	174	307	645	7.4	7.7	8.3	12.0	16.0	14.0
Manufacturing	15	44	71	0.6	1.1	0.9	24.0	10.0	16.8
TCPU[b]	203	388	389	8.7	9.7	5.0	13.8	0.1	6.7
Wholesale trade	28	61	128	1.2	1.5	1.6	16.9	16.	16.4
Retail trade	304	478	905	13.0	12.0	11.6	9.5	13.6	11.5
FIRE[b]	50	103	171	2.1	2.6	2.2	15.6	10.7	13.1
Services	229	304	1071	9.8	7.6	13.7	5.8	28.6	16.7
Government	360	710	905	15.4	17.8	11.6	14.5	5.0	9.7
Other	355	403	822	15.2	10.1	10.5	2.6	15.3	8.8

Source: Wyoming Employment Security Commission, 1980b, p. 7.

[a]1970 data based on number of jobs at place of work. 1975 and 1980 data based on place of residence.

[b]TCPU = transportation, communication, public utilities.
FIRE = finance, insurance, real estate.

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Per capita personal income increased significantly in response to higher-paying jobs generated by energy development. Per capita income rose from $3879 in 1970 to $8048 in 1978, and to $11,343 in 1980 (Mountain West Research, Inc., 1981, p. 80).

The county experiences low unemployment, but skilled and semiskilled manpower required for remedial action is currently available in the area.

F.4 DEMOGRAPHICS

The population of Converse County is predominantly Caucasian, as shown in Table F-8.

Table F-8. Racial configuration

Town	White	Black	American Indian, Eskimo, Aleutian	Asian, Pacific Island	Other
Douglas	5,855	2	56	4	113
Glenrock	2,655	5	33	8	35
Total Converse County	13,679	11	109	20	250

Source: U.S. Department of Commerce, 1981, p. 4.

Converse County has young residents; 50 percent are under the age of 25, and over 80 percent are under 45. The population is grouped by age and sex in Table F-9.

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Table F-9. Population by age and sex, Converse County, 1970, 1980

Sex and age group	1970[a]	Percent of total[a]	1980[b]	Percent of total[b]	Average annual growth 1970-1980
Male population	2,969	50.0	7,220	51.3	9.3
0-5	283	4.7	961	6.8	13.0
6-15	687	11.6	1,329	9.4	6.8
16-24	357	6.0	1,297	9.2	13.8
25-44	674	11.4	2,358	16.8	13.3
45-64	616	10.4	940	6.7	4.3
65+	352	5.9	335	2.4	-0.5
Female population	2,969	50.0	6,849	48.7	8.7
0-5	229	3.9	923	6.6	15.0
6-15	658	11.1	1,284	9.1	6.9
16-24	341	5.8	1,210	8.6	13.5
25-44	697	11.7	2,101	14.9	11.7
45-64	638	10.7	886	6.3	3.3
65+	406	6.8	445	3.2	0.9
Total population	5,938	100.0	14,069	100.0	9.0
0-5	512	8.7	1,884	13.4	13.9
6-15	1,345	22.7	2,613	18.6	6.9
16-24	698	11.7	2,507	17.8	13.6
25-44	1,371	23.1	4,459	31.6	12.5
45-64	1,254	21.1	1,826	13.0	3.8
65+	758	12.7	780	5.5	0.3

Sources:
[a]U.S. Department of Commerce, 1970.
[b]U.S. Department of Commerce, 1981.

33000072010E F.5 EDUCATION

Converse County has 17 schools, 8 in urban areas and 9 in rural areas. Table F-10 documents the enrollment activity over the past 2 years.

Table F-10. Student enrollment, Douglas and Glenrock districts

	Fall 1980	Fall 1981
School District No. 1 (Douglas)		
126.5 teachers, 1981-1982		
Dry Creek Elementary	14	17
Moss Agate Elementary	6	6
Nachtman Elementary	1	1
Reynolds Ranch Elementary	7	7
Shawnee Elementary	17	17
Wagonhound Elementary	4	4
Walker Creek Elementary	9	15
White Elementary	8	8
East Elementary	391	387
West Elementary	360	350
South Elementary	285	301
Douglas Middle	473	474
Douglas High	568	556
Total	2143	2143
School District No. 2 (Glenrock)		
70.7 teachers, 1981-1982		
Chaparral Elementary	4	5
Deer Creek Elementary	1	--
Ogallala Elementary	3	--
Glenrock Elementary	640	530
Glenrock Middle	279	431
Glenrock High	330	348
Total	1257	1314

Source: State of Wyoming, 1981 and 1982.

School enrollment in the Douglas district has remained constant in the last 2 years; it was 2143 in 1980 and 1981. The physical capacity of the district schools is 3000. Therefore, an additional 850 students could be accommodated. The student-teacher ratio has improved to 16.9 students per teacher in 1981, down from 17.4 students per teacher in 1980. Currently, 126 teachers are employed by the Douglas district.

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Enrollment in the Glenrock district has increased from 1257 in 1980 to 1314 in 1981. The physical capacity of the school district is 2150; an additional 830 students could therefore be accommodated. The student-teacher ratio has improved from 20.7 students per teacher in 1980 to 18.6 students per teacher in 1981. The Glenrock district employs 70 classroom teachers, not including specialists.

F.6 WATER AND SEWER

F.6.1 Water

The Douglas water system has a capacity of 4.3 million gallons per day (mgd). If the water treatment system were expanded, the capacity would be 5.8 mgd. The water storage capacity is 7 million gallons. The current water capacity can serve in excess of 12,000 people and could be expanded to serve 16,000 (Sierz, 1981). The Douglas water comes from the North Platte River and Box Elder Spring.

Glenrock obtains water from underground resources. The current well-water supply is 1.2 mgd; however, the town intends to expand its capacity in 1982 to approximately 2.2 mgd. The storage capacity is 1.7 million gallons. The water capacity can currently serve a population of 5000 (Stuart/Nichols Associates, 1978).

F.6.2 Sewer

The sewer collection in Douglas is presently adequate to meet the town's needs. However, the sewage-treatment facility is inadequate. The nonaerated lagoon system now in use was designed to serve a population of 1900. Plans are under way to upgrade the treatment facility to enable it to handle a population of 15,000.

Glenrock has two sewage-treatment lagoons. The smaller lagoon serves the downtown area and can support about 2000 people. This lagoon currently does not meet Environmental Protection Agency standards for effluent emissions. The larger lagoon serves the new developments east of town and can serve 6000 people. The town plans to combine flows from these lagoons to overcome the problems with the smaller lagoon.

The town of Douglas provides once-a-week residential garbage collection. Commercial garbage is collected on a demand basis. The town uses a 140-acre landfill owned by the county. The landfill is expected to be adequate for 100 years.

In Glenrock, garbage is handled by a private contractor. The town staffs and operates the city-county landfill. The town's collection system is adequate, but the landfill site will need to be replaced within the next 5 years.

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Utilities in Douglas and Glenrock include electricity supplied by the Pacific Power and Light Company and Mountain Bell telephone service. Natural gas service is supplied to each community by the Kansas-Nebraska Natural Gas Company (Mountain West Research, Inc., 1981).

F.7 TRANSPORTATION

An airport in Douglas is capable of servicing light planes. The major regional airport is located in Casper, Wyoming, approximately 30 miles west of Glenrock and 55 miles west of Douglas. A new Douglas airport is in the planning stages (Sierz, 1981).

Two railroads offer freight service in Converse County. They are the Chicago and Northwestern and the Chicago, Burlington and Quincy.

Continental Trailways buses arrive and depart daily from both Douglas and Glenrock.

U.S. Interstate 25 traverses Converse County from east to west. Six state highways and 63 county roads also run through the county.

The remedial-action workers would use State Highways 93 and 95, and County Route 31 (Ross Road). The proposed remedial action would increase the average daily traffic by 32 trips every day except Sunday for 16 weeks. The average daily traffic counts before remedial action are as follows:

State Highway 93 (Douglas side)	2754
State Highway 95 (Glenrock side)	3433
County Route 31 (Ross Road)	2312
Junction of Routes 93, 95, and 31	3792

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F.8 HEALTH CARE

The public health needs of the residents in the Douglas and Glenrock area are primarily served at the Converse County Memorial Hospital in Douglas. Fifteen physicians have privileges at the hospital. The use rates for the 32-bed hospital are shown in Table F-11. A new hospital containing 44 beds is under construction.

Table F-11. Converse County Memorial Hospital use

	1979	1980
Admissions	1666	1591
Patient days	7128	6225
Average length of stay	4.3	3.8
Percent occupancy	61.0	53.6

Source: Wyoming Department of Health, 1982.

Glenrock has a diagnostic and treatment center, and tertiary care facilities are available in Casper. Emergency medical care is provided by four full-time emergency medical technicians and three part-time technicians. Two ambulances serve the area. Long-term care is provided by the Michael Manor Health Care Center in Douglas, which has 60 beds.

F.9 RECREATION

Recreational opportunities are abundant in and near Converse County. During all four seasons, people enjoy recreational activities in the Laramie Mountains in the southern part of the county and along the North Platte River. Big-game hunting takes place throughout the county. Fishing is also popular, especially along the North Platte River and at Glendo Reservoir, which is only a few miles southeast of Douglas.

Recreational opportunities are available through the towns of Douglas and Glenrock and the school districts. The town of Douglas currently owns approximately 27 acres of developed park land, and operates an 18-hole golf course. A new paved bike path along the river will be extended in the near future.

School District No. 1 maintains approximately 47 acres in Douglas for outdoor recreation use by the general public. Most of the district's outdoor and indoor facilities are located at the recreation center at the senior high school. The indoor center includes facilities for basketball, racquetball, handball, swimming, rifle shooting, and weightlifting. The indoor center is open to the public on a regular basis.

Additional recreation is offered by the private sector. At present, Douglas has a bowling alley, an outdoor pool, and a movie theater.

The town of Glenrock currently has six developed park areas. A wide range of facilities can be found on the 106 acres composing these parks, including ballfields, picnic grounds, and a swimming pool. An additional 80 acres of park land will be developed to include a softball complex, a motorcross track, and picnic facilities.

School District No. 2 also has public recreational areas. The district currently has 25 acres of developed park land and 15 acres of undeveloped park land. Plans for additional facilities at the new school site include a football stadium, baseball diamond, playground equipment, and tennis, volleyball, and basketball courts.

Some recreational opportunities provided by the private sector in Glenrock include a bowling alley and a movie theater (Mountain West Research, Inc., 1981).

F.10 PUBLIC SAFETY

This section discusses law enforcement and fire protection for Converse County and the towns of Douglas and Glenrock.

F.10.1 Law enforcement

The County Sheriff's department employs 15 officers, 5 dispatchers, 6 jailers, and 1 records clerk. The department has 12 vehicles and is responsible for patrolling 4200 miles of highways and roads (Sierz, 1981).

The Douglas police department has 13 positions for sworn officers. Additionally, six nonsworn officers are employed. The department has six vehicles, four of which are equipped as patrol cars (Sierz, 1981).

The Glenrock police department consists of eight full-time sworn officers. The department has three vehicles equipped as patrol cars.

Altogether, Converse County maintains 2.6 officers per 1000 population.

F.10.2 Fire protection

The Converse County and Douglas fire department is composed of 27 volunteers. Fire department vehicles consist of one mini-pumper, three fast-attack vehicles, one tanker, one rescue unit, and one extrication truck. Douglas has a fire insurance rating of 7 (Sierz, 1981).

Glenrock is also served by a volunteer fire department with 40 volunteers (combined city and county). The department has four pumpers. Glenrock has a fire insurance rating of 8.

F.11 FISCAL CONDITIONS

F.11.1 Converse County

Between 1975 and 1980, total county revenues increased from $1.7 million to $6.5 million, reflecting an annual average increase of approximately 31 percent. The property tax is the county's largest revenue source, accounting for 45.7 percent of total revenue in 1980. The sales tax, the second largest source of county revenue, accounted for 9.2 percent of the 1980 revenue. (Dollar values have been rounded to the nearest hundred-thousand in this section.)

During the period of 1976 to 1980, total assessed valuation increased at an average annual rate of 8.9 percent, from $18.8 million to $26.4 million. Property classes experiencing the most rapid growth in assessed valuation included construction and mining equipment (54.8 percent), natural gas production (40.9 percent), railroad (29.4 percent), nonagricultural land (25.8 percent), and industrial facilities (28.6 percent). Oil production, although increasing at a rate of only 1.5 percent in assessed valuation, was the largest source of assessed value in Converse County, accounting for 42.9 percent of the total in 1980. The value of all minerals composed almost 64 percent of total county assessed valuation in 1980.

Another major source of revenue for Converse County is the sales tax. Currently, a 4-percent sales tax is levied in the county. This consists of a 3-percent state tax, of which the county and municipalities receive one-third, and a 1-percent local option tax, all of which goes to the county and municipalities. The largest source of sales tax collections is the retail sector, which accounted for 61.2 percent of total sales tax collections in 1979.

From 1975 to 1980, total expenditures for Converse County increased from $1.3 million to $5.7 million, an average annual growth rate of 33.9 percent. Total general-fund expenditures accounted for 80.8 percent of total expenditures in 1980, having grown from the 1975 level of $0.8 million to $4.6 million. Major general fund expenditures were for roads and bridges, law enforcement and judicial services, and general administrative services.

F.11.2 Town of Douglas

Between 1979 and 1980, total general-fund revenues in Douglas increased at a rate of 13 percent, rising from $1.5 million to $1.7 million. The state 3-percent sales tax (which includes use tax receipts) accounted for 27.2 percent of 1980 general revenues. The local option 1-percent sales tax added $0.4 million to 1980 revenues. Grants were a significant portion of total revenues (51.5 percent in 1980) and primarily were earmarked to finance specific capital-improvement projects.

Although the growth of Douglas revenues has slowed somewhat in recent years, large cash balances carried forward in fiscal year 1980-81 have left the town fiscally sound. Currently, Douglas is debt free. The 1981 State legislature enacted an oil and gas severance tax and a sales tax to alleviate impacts, which should substantially enhance the town's ability to finance future growth.

During the period from fiscal year 1977-78 to fiscal year 1980-81, total expenditures from the general, public works, and utilities funds increased from $1.7 million to $2.5 million. The capital facilities budget increased from $3.0 million in 1979 to $3.4 million in 1981. Utilities expenditures were $0.7 million in 1981, up from the 1978 level of $0.2 million.

F.11.3 Town of Glenrock

Between 1977 and 1980, total receipts for Glenrock increased at an annual average rate of 26.8 percent, rising from $0.8 million to $1.6 million. General revenues increased at a rate of 18.4 percent, from $0.6 million to $1.2 million. The largest source of revenue is the sales tax, which provided 40.6 percent of general-fund revenues and 30.3 percent of total revenues in 1980.

The economic recession of early 1982 and its effect on the various sectors of the economy have resulted in lower than expected revenues for the town of Glenrock. Because of this, some new service programs could not be undertaken as planned. However, the town revenue outlook should be significantly improved by the additional oil and gas severance tax passed by the 1981 State legislature, as well as a sales tax for the purpose of alleviating impacts.

During the period from 1977 to 1980, total expenditures increased from $0.8 million to $1.5 million, an average annual increase of 24.3 percent. General-fund expenditures increased at a rate of 32.8 percent per year, from $0.4 million to $0.9 million.

F.11.4 Taxes in Converse County

Mill levies assessed in Converse County during fiscal year 1980-81 are presented in Table F-12. The total valuation for the county in 1981 was determined to be $369,731,358. The legal debt limit in Wyoming is 2 percent of the assessed valuation, or $7.4 million. The county currently has a net debt of $838,975, leaving $6.6 million that could be used (Converse County Board of Commissioners, 1981b).

Table F-12. Tax levies for 1981, Converse County
(Total county valuation 369,731,358)

	District valuation							
	248,808,394	44,717	43,886	11,506,799	12,035	27,628,230	77,315,255	4,372,042
School district	1	1NRFP	1S	Douglas	L.S.	2	2S	Glenrock
State	none	none	none	none	none	none	none	none
Foundation	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
County wide school	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
County general	8.371	8.371	8.371	8.371	8.371	8.371	8.371	8.371
County airport	0.422	0.422	0.422	0.422	0.422	0.422	0.422	0.422
County library	0.781	0.781	0.781	0.781	0.781	0.781	0.781	0.781
Parks and recreation	0.404	0.404	0.404	0.404	0.404	0.404	0.404	0.404
County hospital	1.614	1.614	1.614	1.614	1.614	1.614	1.614	1.614
County health service	0.408	0.408	0.408	0.408	0.408	0.408	0.408	0.408
Courthouse bond red.	0.431	0.431	0.431	0.431	0.431	0.431	0.431	0.431
Courthouse bond int.	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144
Hospital bond red.	2.380	2.380	2.380	2.380	2.380	2.380	2.380	2.380
Hospital bond int.	1.597	1.597	1.597	1.597	1.597	1.597	1.597	1.597
Special school	22.000	22.000	22.000	22.000	22.000	25.000	25.000	25.000
School district bond	0.929	0.929	0.929	0.929	0.929	1.463	1.463	1.463
School bond int.	0.118	0.118	0.118	0.118	0.118	0.361	0.361	0.361
1975 school dist. bond	3.653	3.653	3.653	3.653	3.653	0.559	0.559	0.559
1975 school bond int.	0.737	0.737	0.737	0.737	0.737	0.405	0.405	0.405
1978 school dist. bond						1.760	1.760	1.760
1978 school bond int.						2.008	2.008	2.008
1980 school dist. bond						2.012	2.012	2.012
1980 school bond int.						4.760	4.760	4.760
1980 school dist. bond						--	--	--
1980 school bond int.						4.323	4.323	4.323
Rural fire protection	0.500		0.500			0.500	0.500	
Weed-pest control	0.413	0.413	0.413	0.413	0.413	0.413	0.413	0.413

Table F-12. Tax levies for 1981, Converse County (continued)
(Total county valuation 369,731,358)

	District valuation							
	248,808,394	44,717	43,886	11,506,799	12,035	27,628,230	77,315,255	4,372,042
City general				8.000				8.000
1972 water bond								3.017
1972 water bond int.								3.181
1973 sewer bond								0.251
1973 sewer bond int.								0.540
1973 fire equip. bond								0.502
1973 fire equip. int.								0.260
Special hospital dist.			3.000				3.000	3.000
Special cemetery dist.							0.953	0.953
Total	62.902	62.402	65.902	70.402	62.402	78.116	82.069	97.320

Municipal valuations: Douglas, 11,579,334; Glenrock, 4,374,032; Lost Springs, 12,806.

Special tax on cattle, horses, and mules, 10.000; special tax on sheep, 10.000; predatory tax on cattle, 2.000; predatory tax on sheep, 20.000.

L.S. - Lost Springs

NRFP - No rural fire protection

1S - School District No. 1 South

2S - School District No. 2 South

Source: Converse County Assessor's Office, 1981.

F.12 SOCIOECONOMIC IMPACTS OF THE PROPOSED ACTION

The occupational categories and staffing levels necessary to complete the proposed action are as follows:

Occupation	Quantity
Equipment operator	9
Supervisor/engineer	1
Oiler	1
Surveyor	1
Surveyor assistant	1
Health physicist	1
Health technician	2
Total	16

The project would be completed in 16 weeks, assuming a 60-hour work week. The schedule by weeks and tasks is graphically displayed in Figure F-2.

The equipment needed is as follows:

Equipment	Quantity
Dump truck	1
Grader	1
Water truck	1
Loader	2
Dozer/compactor	1
Pickup truck	2

Figure F-2. Schedule for onsite stabilization.

F.13 LABOR-FORCE AVAILABILITY

According to the Wyoming Employment Security Commission, 245 people are unemployed in Converse County. Males account for 165 of the unemployed, while 80 females are seeking employment (Wyoming Employment Security Commission, 1980a). In the first quarter of 1981, the drop in mining and construction employment accounted for approximately 70 of the unemployed (Wyoming Employment Security Commission, 1981, p. 29).

Given the small work force (16) needed for the remedial action, and given that the proposed action requires equipment operators with skills similar to those used in mining and construction, the local labor force can be expected to fill 12 of the job slots. Not only can the local area supply the needed work force, but workers would still be available for competing projects. Professional and managerial positions (4) will be filled by in-migrants.

F.14 MIGRATION AND INDIGENOUS LABOR-FORCE REQUIREMENTS

If unemployed people in the mining and construction sectors can fill the heavy-equipment operator, oiler, surveyor, and surveyor assistant positions, then the local labor force can supply 14 workers, including turnover [(12 x 15-percent separation rate = 2) + (12 skilled) = 14 skilled workers].

Under a conservative assumption that the supervisor/engineer and the radiation-safety professionals cannot be supplied from the local labor force, four workers would be temporary in-migrants. Because of the specialized nature of these positions, no turnover was assumed. The indigenous and in-migrant work force is listed in Table F-13.

Table F-13. Origin of work force

Position	Indigenous	In-migrant
Equipment operator	9	
Oiler	1	
Surveyor	1	
Surveyor assistant	1	
Turnover	2	
Supervisor/engineer		1
Health physicist		1
Health technician		2
Total	14	4

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F.15 INDIRECT EMPLOYMENT OPPORTUNITIES

Calculation of the indirect job slots for a deconstruction project such as the Spook remedial actions is difficult because most nonbasic employment data are generated assuming that both a construction and an operation work force are required. In Converse County, the project will be completed in 16 weeks, and no operation work force will be needed.

Because of the brief duration of the project, the inducements for nonbasic employment will be few. Thus, for the purpose of this assessment, a 1.6 multiplier is used. While this multiplier is consistent with the Housing and Urban Development Rapid Growth from Energy Projects (1976) and the Environmental Protection Agency Action Handbook (1978), its use probably predicts a worst-case induced impact.

Thus, to compute induced labor, the 1.6 multiplier is applied only to the in-migrant labor force because the indigenous population currently receives goods and services. Multiplying 0.6 times the four nonlocal job slots predicts two additional in-migrant induced job slots.

While an argument can be made that additional people will migrate to Converse County to avail themselves of potential economic good fortune (based on expenditures of $1.7 million), the short duration of the project will hold significant migration to a minimum. What is more likely to occur economically is that the labor-force participation rate will increase; that is, residents will take a temporary part-time job to assist in the provision of services.

F.16 POPULATION IMPACTS

To calculate the population impacts generated by the four direct job slots and the two indirect slots, the demographic data available from the 1980 U.S. Census were used. To compute the percentage of married versus single population, the data base generated by the Construction Worker Profile (Mountain West Research, Inc., 1975) and the Bureau of Reclamation Construction Worker Survey (Chalmers, 1977) was used. The population impacts are shown in Table F-14.

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Table F-14. Population impacts

	In-migrant direct employment	In-migrant indirect employment	Total
Total job slots	4	2	6
Single (24.6%)[a]	1	0	1
Married (75.4%)	3	2	5
Married but would not relocate family (26.5%)[a]	1	0	1
Family present	2	2	4
Family size of 2.6[b]	5	5	10
Total population impact	7	5	12
Adults	5	4	9
Children	2	1	3

[a]Mountain West Research, Inc., 1975.
[b]Average family size, 1980 U.S. Census, Converse County, Wyoming.

F.17 DEMOGRAPHICS OF INCREASED POPULATION

The principal purpose in computing the probable demographic profile of the in-migrant population is to determine the potential impact on the school system. To compute the age of the children who will in-migrate, the age-distribution data for Converse County (Table F-9) were used. The age data indicate that 13.4 percent of the children will be less than 5 years of age and 86.6 percent will be of school age. Table F-15 summarizes the impact on schools.

Table F-15. Impact of school-aged children

	Direct	Indirect	Total
Total children	2	1	3
Under school age, < 5 years (13.4%)	0	0	0
School age, 5 to 17 years (86.6%)	2	1	3

A summary of the demands that the project will place on Converse County resources due to the proposed remedial action follows in Table F-16.

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Table F-16. Project demands on Converse County

Impact category	Demand
School population	3 children
Housing and motel rental	6 units
Water (100 gallons per person per day)	1200 gallons per day
Sewer (103 gallons per person per day)	1236 gallons per day

Table F-17 portrays the ability of the community to accommodate the temporary influx of people caused by the proposed remedial action.

Table F-17. Demand versus community infrastructure supply

	Project demand (people)	Current supply
Rental housing units (4% vacancy)	6	171
Water (people)	12	8,264
Sewer (people)	12	14,234
Education (people)	3	1,680
Skilled and semi-skilled workers	14	245

It is obvious that the project would not strain the community infrastructure.

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F.18 FISCAL IMPACT

The remedial action would inject $1.7 million into the Converse County economy over 16 weeks. The budget for the proposed action, the details of which are included in Appendix C, is shown in Table F-18.

Table F-18. Cost estimates of the proposed remedial action

Item		Cost[a]
Level stack area in pit		$ 16,000
Stack contaminated tailings and soils		644,000
Cover for contaminated stack		266,000
Health physics and radiological monitoring		86,000
Vicinity properties cleanup		131,000
	Subtotal	$ 1,143,000
Engineering, 15 percent		171,000
Contingency, 30 percent		343,000
	Total	$ 1,650,000
	Rounded total	$ 1,700,000

[a]Costs are rounded to the nearest $1000.

Assuming that local contractors would do the work and that the in-migrants would purchase goods and services in Glenrock or Douglas, the 4-percent sales tax applied to the $1.7 million would generate tax revenues of $68,000. In Wyoming, one-half of this amount is returned to the county and municipalities; thus, Converse County would receive $34,000 in sales-tax revenue for the 16-week project.

Some evidence exists that the aforementioned fiscal impact is very conservative; in other words, it reflects the minimum fiscal benefit to Converse County. To fully appreciate the fiscal benefit, a multiplier effect should occur; that is, a dollar received by an employer or local business associated with the remedial action is spent on other goods and services in the area and is in turn spent on additional goods and services. This multiplier effect increases the fiscal impact of each dollar spent on the Spook site remedi . action.

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The income multiplier to be used in this analysis is $2.02. In other words, for every dollar spent on the remedial action an additional $1.02 is spent through the multiplier effect. The use of this multiplier is substantiated in A Guide to Methods for Impact Assessment of Western Coal/Energy Development, prepared by Mountain West Research, Inc. (1979), for the Missouri River Basin Commission.

Using this multiplier, the impact of the $1.7 million becomes $3.4 million added to the local economy. Thus, employers, local businesses, and governments (through taxes) would benefit from the expenditures.

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Appendix G

ESTIMATES OF HEALTH EFFECTS OF RADIATION

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ESTIMATES OF HEALTH EFFECTS OF RADIATION

The contaminated material at the Spook site exposes people who live and work nearby to low levels of radiation. In theory, the radiation doses received by these people could produce health effects, principally an undetectably small number of excess cancer deaths. This appendix derives upper limits to the numbers of health effects that might be expected in people who live and work near the Spook site and in the workers who carry out the remedial actions there.

G.1 METHODS OF ANALYSIS

The estimations made in this appendix are based on data presented in BEIR-III, the major report issued by the National Research Council of the National Academy of Sciences (1980). Because the BEIR-III report itself does not always make firm recommendations about the best way to use the data, these estimates also make use of recommendations published in scientific journals.

G.1.1 Health effects of exposure to radon daughters

When radon gas escapes from tailings and from other materials, the radioactive daughters produced from its decay may become concentrated in the air. Persons who live or work nearby breathe this air and are therefore exposed to the radiation emitted by the radon daughters. The BEIR-III report gives a model for estimating the health effects of such exposures. The unit of concentration used in the BEIR-III report is the working level (WL); it is defined as any concentration of radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 million electron volts of alpha energy. The unit of exposure used in the BEIR-III report is the working-level month (WLM); it is defined as the exposure resulting from the inhalation of air with a concentration of 1 WL of radon daughters for 170 working hours. The total exposure of one or more persons is the product of the number of persons and the average exposure they receive; the unit for the measurement of such a population exposure is the person-WLM.

Several studies of lung cancer in miners exposed to radon-daughter concentrations in air are used to formulate the model given in the BEIR-III report for predicting the risk of lung cancer. Because this model is age dependent and arose from studies of workers, it must be interpreted before it can be used for estimating risks of lung cancer from low-level exposures to the general population. Cohen (1982b) has used the BEIR-III model to estimate the population risk to lung cancer as 520×10^{-6} deaths per person-WLM. He has also presented data (Cohen, 1982a) suggesting that this model overestimates

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radon-induced lung cancer among nonsmokers by a factor of 40. Evans et al. (1981) have reviewed the miner studies, lung-cancer risk estimates published by several authors, and epidemiological evidence. They conclude that the most defensible upper bound to the lifetime lung-cancer risk for the general population is 100 x 10^{-6} deaths per person-WLM.

Cohen (1982a) equates the effectiveness of WLM for occupational exposure to WLM for population exposure. He discusses several factors that affect the effectiveness of WLM exposures and cites two references that bracket his assumption of equality. Cohen's assumption of equal effectiveness is accepted here, and the risk factor of 100 x 10^{-6} deaths per person-WLM is used to calculate an upper bound for lung-cancer deaths in the remedial-action workers and the population living near the Spook tailings.

G.1.2 Health effects of exposure to gamma radiation

The tailings emit gamma rays that deliver radiation doses to nearby people; unlike the radiation from radon daughters, which principally affects the lungs, the gamma radiation produces an "external" exposure to the whole body. The rad is a unit for the measurement of dose received by a person; for gamma radiation the rad is essentially equal to the roentgen, the unit for measuring the intensity of gamma radiation in air.

The BEIR-III report contains several models for determining cancer risk resulting from exposure to gamma radiation. It is necessary to define the person at risk in order to know which risk model is applicable. This analysis assumes the work force is predominantly males who range in age from 20 to 49 years. The average age is assumed to be 35 years and the average age at death is assumed to be 70 years.

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G.2 CALCULATIONS OF HEALTH EFFECTS

Calculated health effects at the Spook site are presented in the body of this report. The methods of calculation are shown here.

G.2.1 General public

Only 12 members of the general public live close enough to the Spook site to be affected by detectable concentrations of radon daughters from the tailings. They live at the Hornbuckle Ranch (Figure 1-1), about 1.75 direct miles south of the site. Although only seven of these residents live there throughout the year, this conservative analysis assumes that all of them do. Measurements have shown that the radon-daughter concentration is at background levels at the ranch when the wind is from the south (FBDU, 1981).

This analysis assumes that the 12 persons spend 70 percent of their time at the ranch; 50 percent is spent indoors and 20 percent is spent outside. Of the remaining 30 percent, 10 percent is spent at a distance of 0.75 mile from the tailings, and 20 percent is spent at a distance great enough for the radon-daughter concentration from the tailings to be negligible. The wind rose for Casper, Wyoming, (FBDU, 1981) shows that the wind blows from northerly directions less than 25 percent of the time; this same wind pattern is assumed at the Spook site. For conservativism this analysis assumes that the wind blows toward the ranch 25 percent of the time.

As noted in Section 2.8, the average radon concentration 0.4 mile downwind from the edge of the pile is 2.8 picocuries per liter (pCi/l), while the average background concentration in the Spook area is 1.1 pCi/l. The difference, attributable to the tailings, is 1.7 pCi/l.

To estimate the concentration of radon daughters at distances other than 0.4 mile from the pile, it is necessary to know how their concentrations are diluted as they move through the air. Appendix A-3 of Meteorology and Atomic Energy (Slade, 1968) contains a log-log plot of normalized average axial concentrations versus travel distance for several conditions of atmospheric stability. Over the distances of interest in this report, the slopes of the curves for the stability conditions are approximately equal; therefore, the dilution of a contaminant between two points is affected very little by the stability of the atmosphere. The curve for Pasquill's condition F (minimum dilution) can be normalized to the measured radon concentration of 1.7 pCi/l at 0.4 mile downwind. The radon concentration at 0.75 mile read from this normalized curve is 0.58 pCi/l and at 1.75 miles is 0.17 pCi/l.

To derive the number of working levels corresponding to these concentrations, the equilibrium value discussed in Section 2.8 must be estimated. Measurements at the Vitro tailings pile in Salt Lake City suggest that 10 percent is a conservative estimate of the average equilibrium value at the smaller Spook pile. The average wind speed at the Spook site is 13 miles per hour. This speed will carry radon daughters 0.75 mile in about 3.5 minutes and 1.75 miles in about 8 minutes. The radon-daughter equilibrium will be less than 10 percent at 0.75 mile and 15 percent at 1.75 miles (Evans, 1980).

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The radon-daughter concentration is assumed to be at 50-percent equilibrium indoors. Although some data show that this factor is appropriate for radon emanating from sources close to a structure (UNSCEAR, 1977), it is an overestimate for radon carried from distant sources by wind.

For these equilibrium values the radon-daughter concentration in working levels is calculated as follows:

$$\frac{0.58 \text{ pCi/l}}{100 \text{ pCi/l-WL}} \times 0.1 = 5.8 \times 10^{-4} \text{ WL for 0.58 pCi/l at 0.75 mile, and}$$

$$\frac{0.17 \text{ pCi/l}}{100 \text{ pCi/l-WL}} \times 0.15 = 2.6 \times 10^{-4} \text{ WL for 0.17 pCi/l at 1.75 miles.}$$

Under the assumptions discussed above, a 1-year exposure is

$$(0.1 \times 5.8 + 0.2 \times 2.6 + 0.5 \times \frac{0.5}{0.15} \times 2.6) \times 10^{-4} \text{ WL} \times \frac{730 \text{ hr}}{170 \text{ hr}}$$

$$\times 12 \text{ months} \times 0.25$$

$$= 0.007 \text{ WLM.}$$

The number of lung-cancer deaths from the Spook tailings among the 12 persons who live within 2 miles of the site would be less than

$$0.007 \text{ WLM/yr} \times 100 \times 10^{-6}\text{/WLM-person} \times 12 \text{ persons}$$

$$= 8.4 \times 10^{-6}$$

$$= 0.000008 \text{ lung-cancer death per year of exposure.}$$

During the 4 months of remedial action, the radon concentration is assumed to be 100 percent higher because of disturbance of the tailings. The number of lung-cancer deaths due to the remedial action would then be

$$8.4 \times 10^{-6}\text{/year} \times \frac{4 \text{ months}}{12 \text{ months/year}} \times 2.0$$

$$= 5.6 \times 10^{-6}$$

$$= 0.000006 \text{ lung-cancer death.}$$

As shown in the main text of this assessment, the exposure from gamma radiation from the Spook site in all populated areas is at or very near natural background. This condition is expected to continue throughout the remedial action. Therefore, no meaningful calculation of health effects among the general public from exposure to gamma radiation from the tailings can be made.

G.2.2 Remedial-action workers

As shown in Section 3.1.2.2, remedial-action workers working directly on the tailings will receive an exposure of 0.2 WLM. Using the risk estimator of 100×10^{-6} death per WLM-person to determine the upper limit for lung-cancer

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mortality, one calculates

$$0.2 \text{ WLM} \times 100 \times 10^{-6}/\text{WLM-person} = 2.0 \times 10^{-5} \text{ per person.}$$

The upper bound for lung cancer among the 16 workers would be

$$2.0 \times 10^{-5}/\text{person} \times 16 \text{ persons} = 3.2 \times 10^{-4} = 0.0003 \text{ lung-cancer death.}$$

For worker exposure to gamma radiation, the calculation is based on the risk factors described in Section G.1.2. The total gamma exposure due to the tailings is

$$D = 480 \text{ hours} \times (330-12) \text{ microroentgens/hour}$$

$$= 153{,}000 \text{ microroentgens}$$

$$= 0.153 \text{ roentgen}$$

where the 12 microroentgens/hour due to background is explicitly subtracted.

To estimate the leukemia and bone-cancer mortality, one uses the coefficients given in Table V-16 of the BEIR-III report. The BEIR committee recognized that for doses of 1 rad per year or less the quadratic component--the term containing the square of the dose--in the calculation is so small that it can be safely ignored. Because the doses in this assessment are much less than 1 rad per year, the dose-squared term was not included in the calculations. For these two cancers, the text in the report recommends a short latent period (assumed here to be 0) and a risk period of 25 years. The age-dependent regression coefficients for males aged 20 to 34 and 35 to 49 are averaged to calculate the annual risk from leukemia as

$$\left(\frac{1.138 + 0.8511}{2}\right) \times 10^{-6}/\text{person-rad-year} \times 0.153 \text{ roentgens} \times 1 \frac{\text{rad}}{\text{roentgen}}$$

$$= 1.5 \times 10^{-7} \text{ death per person per year of risk.}$$

The lifetime leukemia risk is

$$1.5 \times 10^{-7}/\text{person-year} \times 25 \text{ years} = 3.8 \times 10^{-6} \text{ per person.}$$

The bone-cancer risk is 2.2 percent of the leukemia risk or

$$3.8 \times 10^{-6}/\text{person} \times 0.022 = 8.4 \times 10^{-8} \text{ per person.}$$

To estimate the risk from fatal cancers other than leukemia and bone cancer, this analysis uses the model given in Table V-19 of the BEIR-III report. For these cancers the text of the report recommends a 10-year latent period followed by a lifetime risk. For the remedial-action workers, then, a 25-year risk period follows the 10-year latent period. The annual risk from cancers other than leukemia and bone cancer would be

$$\left(\frac{1.774 + 2.278}{2}\right) \times 10^{-6}/\text{person-rad-year} \times 0.153 \text{ roentgens} \times 1 \frac{\text{rad}}{\text{roentgen}}$$

$$= 3.1 \times 10^{-7} \text{ death per person per year of risk.}$$

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The lifetime risk is

$$3.1 \times 10^{-7}\text{/person-year} \times 25 \text{ years} = 7.8 \times 10^{-6} \text{ per person.}$$

The lifetime risk from all forms of cancer is obtained by summing the risk of leukemia, bone cancer, and other cancers. This gives

$$3.8 \times 10^{-6}\text{/person} + 8.4 \times 10^{-8}\text{/person} + 7.8 \times 10^{-6}\text{/person}$$

$$= 1.2 \times 10^{-5} \text{ per person.}$$

The lifetime risk for a crew of 16 persons would be

$$1.2 \times 10^{-5}\text{/person} \times 16 \text{ persons} = 1.9 \times 10^{-4}$$

$$= 0.0002 \text{ cancer death.}$$

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