RECLAMATION PLAN

REVISION

Highland Uranium Operations
Exxon Minerals Company
P.O. Box 3020
Casper, Wyoming 82602

Wyoming State Environmental Quality Act Permit No. 218-C
(Issued November 26, 1974)

August 1, 1981

Revised
March 1, 1982
June 28, 1982
February 8, 1983
June 18, 1984

Supplemented
December 6, 1984

Revised
April 16, 1985

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1. INTRODUCTION

The Wyoming State Open Cut Land Reclamation Act Permit No. 67 was issued to Exxon Minerals Company's Highland Uranium Operations on August 3, 1970 and the Wyoming State Commissioner of Public Lands accepted Exxon's proposed reclamation plan for the project on January 6, 1972. On March 1, 1973, Permit No. 67 was amended to include additional lands.

The Open Cut Land Reclamation Act Permit was converted to Environmental Quality Act Permit No. 218-C on November 26, 1974, which incorporated Exxon's revised (March 1974) Reclamation Plan, as well as the U.S. Nuclear Regulatory Commission's Final Environmental Statement for the Highland Uranium Operations (referenced in and attached to the Reclamation Plan).

Exxon has completed its uranium mining activities at Highland and herein provides a revised and final reclamation plan. Figure 1 depicts the reclamation schedule for Exxon's Highland Uranium Operations site activites, including the surface mine, underground mine, pilot solution mine, and mill. Figure 2 (sheets 1 & 2 included) shows the final features and contours for the entire permitted area.

The reclamation plan includes sloping about one half of the walls around Pits 3 and 4. A lake will form in the pit area for livestock and wildlife use. The lake will receive runoff only from its immediate vicinity. The remaining mine site will be reclaimed using practices that have been successfully used during the life of the mine.

The Exxon commercial scale solution mine as amended to Wyoming DEQ Permit No. 218-C in 1980 and included in the existing U.S. NRC License No. SUA-1139 has been cancelled.

The remaining uranium reserves, associated lands, and parts of the Highland facilities have been leased and/or sold to Everest Minerals Corporation. Section 3 of this report describes these properties. Although this Mining and Reclamation Plan includes all affected lands within the currently permitted area, reclamation of the lands and facilities conveyed to Everest Minerals Corporation will become the responsibility of Everest upon issuance of appropriate Wyoming EQA permits to Everest. Exxon will continue restoration of the pilot solution mine aquifers to the current permit requirements until completion or until Everest is bonded to do this work themselves under DEQ approval.

Upon issuance of the appropriate Wyoming EQA permits to Everest, the DEQ will release Exxon from the reclamation responsibility for those properties conveyed to Everest. Until such time, Exxon will retain full responsibility and appropriate bonding for reclamation of its disturbances in the entire permit area. Everest has permits from the DEQ for drilling. Disturbances under these permits are Everest's responsibility.

2. STATEMENT OF LAND USE

2.1 Land Use

Land in the immediate vicinity of the Highland Uranium Operations is used almost entirely for sheep and cattle grazing. One landowner about five miles west of the area does engage in some dryland wheat farming, but there is no evidence that farming has ever been attempted in the mining area. Several abandoned homestead sites are located along the Box Creek drainage and local landowners have indicated that the homesteads were established in the mid-1920's and were worked for a year or two, then abandoned. None of the abandoned homesteads are within Exxon's mining permit area or within the area covered by Exxon's February 2, 1984 mining permit amendment application.

Because livestock grazing and wildlife habitat was the previous land use, Exxon will restore land affected by its mining and processing operations to conditions suitable for livestock and wildlife use.

2.2 Land Disposition

The current land status includes Exxon owned fee land and land held by surface agreements with local ranchers. Restored land held in surface agreements will revert to the ranchers, while the disposition of Exxon fee land has yet to be determined. Much of the fee land with mineral reserves and mineral rights held with federal claims or leases, has been leased or sold to Everest Minerals Corporation. In 1973, the U.S. Forest Service expressed an interest in acquiring the land, however, they have recently retracted that interest. Other fee lands without uranium reserves will probably be sold to neighboring ranchers for livestock grazing with the exception of land associated with Highland Reservoir (see Section 9) and the tailings basin. Title to the tailings

basin will be deeded to a state or federal government agency as required by federal law.

2.3 General Water Use

A number of small water impoundments suitable for stock and wildlife use have been constructed around the property in conjunction with mining progress. All of the water contained in these ponds is appropriated under permits granted by the State Engineer's Office. Those ponds permitted in the landowner's name will remain in place upon final reclamation and provide supplemental water sources for livestock and wildlife.

Highland Reservoir and the North Pond Reservoir will remain as part of the final reclamation. Highland Reservoir is a prominent feature of the reclamation plan and has been in the Highland Uranium Operations' reclamation plans from the earliest thinking. The hydrologic modeling and water use plans are summarized in Section 9. The North Pond Reservoir is formed by Spoil Pile 6 intercepting small drainages from the north and west and will be used for stock and wildlife watering.

Fawn, Buck, and Doe Reservoirs located north of the Tailings Impoundment were originally permitted as State Engineer Permit Nos. 7376 Res., 7377 Res., and 7378 Res., respectively. These reservoirs were abandoned in 1980 in conjunction with the Second Enlargement of the Tailings Basin Evaporation Reservoir, Permit No. 8125, since the ponds were within the drainage area of the enlarged reservoir. The water which accumulates in those ponds is now appropriated under Permit No. 8125 Res. For final reclamation, these three reservoirs

will be backfilled during construction of a permanent diversion channel shown on Figure 2. In the interim, all three impoundments will be available to provide fresh water supplies for wildlife in the area.

3. LANDOWNER'S CONSENT

Exxon Corporation, of which Exxon Minerals Company is a Division, owns nearly all of the surface on which surface mine excavations are located as well as most of the surface on which overburden disposal areas are found. In addition, Exxon owns the tailings basin, mill and underground surface plant sites. Such ownership is evidenced by warranty deeds and U.S. Patents on file in the Converse County Courthouse.

Fowler Ranch Partnership, a partnership consisting of Lee and Rachel Fowler and their three daughters, is the owner of most of the remainder of the disturbed lands covered by Permit No. 218-C. A surface agreement between Humble Oil and Refining Company (precedessor in interest of Exxon) and Lee and Rachel Fowler (predecessors in interest to the above named owner) was executed October 28, 1969. The agreement was recorded by the Clerk of Converse County on December 15, 1969, and may be found in Book 481 - Minerals, page 532.

Sections 1-2 and 1-3 of the above-mentioned agreement are reproduced verbatim below and serve to establish surface landowner consent to Exxon's mining and reclamation plans.

"1-2 For and in consideration of the payments to be made to Surface Owners as specified in this agreement, Surface Owners hereby release and discharge Humble from any and all rights, claims, damages, liability and causes of action for injury or damage to, or destruction of, the surface interests, or for the loss of use or occupancy of the surface interests, resulting from or in connection with any

work, operations or activities conducted by or for Humble, or any facilities constructed, placed or used by or for Humble, in, upon or under the Premises or any other lands at any time or times prior to or during the term hereof. This paragraph is subject only to the express provisions of this contract concerning use of the surface interests by Surface Owners, as stated below.

The work, operations and activities conducted by or for Humble as referred to above are called "operations" in this agreement, and include (without limitation) any and all locations, exploration, development, excavation, mining, extracting, processing and treatment, constructing, making, using or removing any facilities, and transportation, reclamation and other work or activities on, in or under the Premises or any other lands.

"Facilities", as the term is used herein, includes (without limitation) any and all buildings, structures, plants, pits, shafts, underground workings, excavations, stockpiles, waste piles, tailings deposits, tools, machinery, equipment, powerlines, pipelines, and other surface or underground facilities constructed, placed or used for or in connection with any of Humble's operations.

1-3 For the same consideration as stated above, Surface Owners hereby grant to Humble, insofar as they have the right to grant the same, for the entire term hereof, all rights, easements, leasehold estates and other rights, interests and estates in, upon or under the Premises, to the extent deemed necessary or desirable to Humble in its sole

discretion at any time or times during the term hereof for any or all of the operations and facilities, and in addition to any and all other rights and interests in the Premises granted to Humble by any of the Surface Owners under any other instruments or agreements.

This agreement is for a primary term of 35 years (until October 28, 2004)."

The remaining disturbed land is owned by Mortons, Incorporated, and, in an undivided interest, by Dorothy M. Swearingen, Ruth N. Whiting, Emma B. Nummerick, Ella Marie Saxon, and Margaret G. Blaze, Executrix of the Margaret G. Miles Estate, Allen Lee Sims and Aurthur M. Sims.

The Mortons, Inc. property is covered by surface agreements and a mining lease. The surface agreement was executed January 1, 1969 and was recorded by the Clerk of Converse County on August 13, 1969, and may be found in Book 404, Agriculture and Lands, page 475.

The primary term of the agreement was one year but is extended annually by rental payments.

Sections 1-2 and 1-3 of the surface agreement are reproduced verbatim below and serve to establish surface landowner consent to conduct various operations on the property.

"1-2 For and in consideration of the payments to be made to Mortons as specified in this agreement, Mortons hereby releases and discharges Humble from any and all rights, claims, damages, liability and causes of action for injury or damage to the surface interests, or for the loss of use or occupancy of the surface interests, resulting from or in connection with any prospecting, exploration or assessment work, operations or activities conducted by or for Humble.

The prospecting, exploration or assessment work, operations and activities referred to above are called "operations" in this agreement, and include (without limitation) any and all location, exploration, and annual assessment work. If Humble should elect to conduct other development, construction, excavation, mining, extracting, processing, treatment, depositing waste, tailings and other materials and stockpiling, then any compensation due Mortons by reason thereof shall be covered by future agreement or by the bond prescribed by law.

1-3 For the same consideration as stated above, Mortons hereby grants to Humble, insofar as it has the right to grant the same, for the entire term hereof, all rights, easements, leasehold estates and other rights, interests and estates in, upon or under the Premises, to the extent deemed necessary or desirable by Humble in its sole discretion at any time or times during the term hereof for any or all of the operations."

The Mortons, Inc. mining lease was executed on October 29, 1975. The primary term of the agreement was one year but it is renewed annually by rental payments. A summary memorandum of this lease was recorded by the Clerk of Converse County on December 8, 1975 and may be found in Book 607, Minerals, page 402.

Section 1 of the above-mentioned agreement is reproduced verbatim below and serves to establish landowner consent to mining and reclamation plans.

"1. The Lessor, for and in consideration of the sum of $10.00 cash in hand paid, the receipt and adequacy of which is hereby acknowledged and of the covenants and agreements hereinafter contained to be faithfully kept, observed and performed by the Lessee, has granted, demised, leased and let and by these presents does grant, demise, lease and let exclusively unto said Lessee the following described lands and premises situated, lying and being in the County of Converse, State of Wyoming, hereby releasing and waiving all rights under and by virtue of the Homestead laws of the State of Wyoming, to-wit:

Township 36 North, Range 72 West, 6th P.M.

Section 20: NW¼NW¼

Section 30: N½NW¼

Section 33: S½NE¼NE¼

Section 34: NW¼NW¼, W½NE¼NW¼

Containing 205.99 acres, more or less.

TO HAVE AND TO HOLD the same for a period of time hereinafter set forth, with the exclusive right and privilege during the term hereof, of entering upon and into said lands and to explore for, mine, remove, develop and ship all minerals, metals, ores and materials of whatsoever nature or sort (hereinafter called "leased substances") with the exception of coal, oil and gas, oil shale, bentonite, sand and gravel or rock crushed for aggregate in or under the above described properties."

The Dorothy M. Swearingen, Ruth N. Whiting, Emma B. Numerick, Ella Marie Saxon, and Margaret G. Blaze, Executrix of the Margret G. Miles Estate, Allen Lee Sims and Authur M. Sims, property is covered by five surface agreements, each covering the entire area and containing the exact same language in each.

The five agreements were recorded by the Clerk of Converse County. The agreements may be found in the county land records. The effective date, recording dates, and record locations are summarized below. The term of the agreements is indefinite as they are held by continuing activities and annual rental payments.

Owner	Dates		Book of	Page Number
	Effective	Recorded	Minerals	
Dorothy M. Swearingen	10/01/71	4/03/72	527	522
Ruth N. Whiting	10/01/71	4/03/72	527	566
Emma B. Numerick	10/01/71	4/03/72	527	573
Ella Marie Saxon	10/01/71	4/24/72	529	226
Margaret G. Blaze, Executrix of the Margaret G. Miles Estate, Allen Lee Sims and Aurthur M. Sims	10/01/71	4/03/72	527	580

The body of the first page of the surface agreements is reproduced verbatim below and serves to establish surface ownership consent to mining and reclamation plans.

"For the considerations hereinafter stated, the undersigned hereby give and grant unto Humble Oil & Refining Company, a corporation qualified to do business in the State of Wyoming with its principal office in Houston, Texas, ("Humble") the sole and exclusive right and easement, with all other interests and estates necessary or desirable in connection therewith, to or under the following described lands in the County of Converse, State of Wyoming, to-wit:

In Township Thirty-six (36) North, Range Seventy-two (72) West, of the 6th Principal Meridian:

The Southeast Quarter (SE¼), and the Northeast Quarter of the Southwest Quarter (NE¼SW¼), and the East Half of the Northwest Quarter (E½NW¼), and the West Half of the Northeast Quarter (W½NE¼), and the Southeast Quarter of the Northeast Quarter (SE¼NE¼)in Section Seven (7); and

The West Half (W½), and the West Half of the Southeast Quarter (W½SE¼), and the Southwest Quarter of the Northeast Quarter (SW¼NE¼) in Section Nineteen (19).

In Township Thirty-six (36) North, Range Seventy-three (73) West, of the 6th Principal Meridian:

The west half of the Southwest Quarter (W½SW¼) in Section Fourteen (14); and

The Northwest Quarter (NW¼) and the South Half (S½) in Section Fifteen (15); and

The North Half of the North Half (N½N½) in Section Twenty-two (22); and

The East Half of the Northwest Quarter (E½NW¼) and the South Half of the Northeast Quarter (S½NE¼) and the Northeast Quarter of the Northeast Quarter (NE¼NE¼) in Section Twenty-four (24);

containing 1,760 acreas, more or less.

"Operations" for purposes of this instrument shall mean and include each and every activity desired by Humble in the exploration, maintenance, development and mining of its mining claims upon the above described lands or other lands or its other mining properties including by way of illustration and not by way of limitation any and all location, exploration, development, excavation, mining, extracting, processing and treatment, constructing, making, using or removing any facilities, and transportation, reclamation and other work or activities."

Exxon and Everest Minerals Corporation reached agreement January 14, 1983 transferring certain property, facilities and reserves including surface fee, mineral fee, mining claims and surface and mineral agreements and mining lease rights to Everest.

A summary memorandum of the January 14, 1983 agreement was recorded by the Clerk of Converse County on August 29, 1983, and may be found in Book 812, Miscellaneous, page 353.

On August 17, 1983, a memorandum was signed which outlines the specific reclamation responsibilities of Exxon and Everest to each other. A copy of this memorandum is found in Appendix 1.

Exxon will remain responsible to the DEQ and will remain bonded for all its reclamation within the entire permit area until the DEQ approves Everest's mining permit and accepts their bond. Everest holds DEQ drilling permits within Exxon's permit boundary. Everest is solely responsible for its disturbances under its permits.

4. PROCEDURES TO PROTECT LIVESTOCK, PUBLIC SAFETY, PROPERTY, WILDLIFE & PLANT LIFE

The Highland Uranium Operations are by their remote location not subject to many of the activities which could endanger public safety or be considered a public nuisance.

The Highland area is reached by a private access road 1-3/4 miles from a county highway. The entrance to the road is clearly marked as being private. In addition, the entrance gate is posted directing visitors to the main office. The entrance gate is locked outside of normal business hours.

The surface mining and overburden areas, the mill site and the tailings basin are all fenced with sheep-tight, barbed wire and woven screen fencing as shown on Figure 4. This serves the dual purpose of protecting livestock from the mining operations and protecting subsequent reclamation from livestock damage until established. The areas are further posted as being restricted areas as required by the U.S. Nuclear Regulatory Commission. Other fences are maintained in the area by the surface owner for his grazing operations. All fence relocations are coordinated with the surface owner to assure that such relocations do not unduly restrict his operations. Following the establishment of successful reclamation and subsequent bond release for the property, fence relocations may be made as required by the landowner for post-mining land use.

Reasonable efforts are made to restrict access of the general public to the mining area. Unauthorized or unsupervised visits are against Company policy and any persons detected in such visits are immediately removed from the premises.

Company safety rules require the use of personal protection equipment such as hard hats and safety glasses by employees and visitors. These rules are strictly enforced.

Dust emissions are controlled within the guidelines and standards of the Wyoming Department of Environmental Quality, Air Quality Division, and of the Federal Clean Air Act. Emission sources in the mill are connected to approved dust collectors. Emission sources in other surface operations, primarily dust generated by haul road traffic, are controlled by water sprinkling.

Noise exposure to vehicle operators is controlled to 85 dBA or less for an 8-hour period by enclosed cabs on all heavy equipment. Noise protection in other areas is provided where necessary, generally by providing ear plugs or ear muffs.

Adequate fire control systems provide fire protection for all Highland facilities.

Wildlife is protected by Exxon's refusal to allow hunting on any lands under its control. The result is that both deer and antelope herds have increased at Highland and seem to thrive on the grazing provided in reclaimed areas.

5. VEGETATION AND ANIMAL LIFE BEFORE AND AFTER MINING AND RECLAMATION

5.1 Vegetation

A baseline biota survey was conducted by personnel from the Wyoming Game and Fish Commission in June, 1972. Their report is contained in the Final Environmental Statement (FES) on the Highland Mill, issued by the U.S. AEC (predecessor of the U.S. NRC) in March, 1973. A listing of trees, shrubs, grasses and forbs found at the Highland area is included in that environmental statement.

The Highland area is typical of the Great Plains. The temperature and lack of rainfall support relatively little vegetation, which in turn restricts species diversity and animal population sizes. There are no perennial flowing streams and, therefore, little aquatic life.

Vegetation consists mainly of native grasses and sagebrush. There are no native trees except for small patches of cottonwood trees in isolated locations along drainage bottoms.

The ground cover is about 40% according to the Applicant's Environmental Report dated July, 1971, which was a prerequisite to the AEC's issuance of the FES noted above.

More recent studies concerning cover density in the area include the FES related to Highland's Solution Mining Project dated November, 1978 and some unpublished in-house baseline work done in 1979 on undisturbed land within the permit area. The Solution Mine FES cited Environmental Reports from two nearby companies which listed

plant cover between 25 and 35%. The 1979 in-house vegetation baseline work followed the format outlined in DEQ/LQD Guideline #2 as revised March, 1978 and concluded that vegetative cover averaged 35% and total ground cover (vegetation, litter, and rock) was about 47%.

The topsoil is classified as "Northern Brown". It varies in thickness from a few inches to several. Greater depths may be found in some drainage bottoms.

5.2 Animal Life

Domestic animals formerly inhabited the Highland area. By choice of the landowner, the domestic animals have been limited to sheep. Cattle can be grazed on the land, but they require supplemental winter feeding.

Deer and antelope are the only big game animals known to frequent the area. Small herds of both animals reside within the Highland area and are regularly seen grazing on reclaimed areas, undisturbed by the industrial activity around them. Other small animals are present, including rabbits, field mice, ground squirrels, small birds, and the animals which prey on them.

No endangered species have been identified in the Highland area, although the ferruginous hawk (Buteo regalis), the American peregrin falcon (Falco peregrinos), and the trumpeter swan (Olor buccinator) could possibly be found locally according to comments by the State Conservationist, Soil Conservation Service, U.S.D.A.

5.3 Revegetation Plans

During the fall of 1970, Exxon became a member of the Upper Cheyenne Conservation District and began a cooperative planning effort with the local Soil Conservation Service Office. The resulting conservation plan was approved by the District Commissioners in November, 1970.

The thrust of the conservation planning was twofold. Recommended reclamation practices and seeding requirements were developed by the SCS to assist Exxon in reclaiming disturbed areas to the satisfaction of the SCS and the Conservation District. The plan also provided for recommendations on surface water drainage channels and reservoirs.

The present revegetation program has developed from evaluations of past revegetation efforts and experimental seeding trials at Highland. Exxon will continue to assess revegetation efforts and may propose improvements to the program as considered appropriate.

Following reclamation contour work, the overburden is sampled to a depth of four feet to determine its suitability as root zone material. Composite samples are collected from auger holes located over the area to be reclaimed, with approximately one hole per six (6) acres as described in Section 13.2 on reclamation monitoring. The samples are analyzed for pH, conductivity, saturation, particle size, texture, SAR, Se, B, NO_3/N_2, Mo, Cu, As, and acid-base potential. If any problem areas are identified by these analyses, they will be handled as described in Section 13.2. Analytical results are reported in the Annual Report to DEQ.

After overburden suitability is confirmed, the overburden has been covered with six inches of topsoil. However, in future the depth will be managed to deplete all topsoil stockpiles with coverage expected to average about seven inches (minimum of six inches).

The seed bed is prepared with a disc, chisel plow, and/or harrow as necessary. Seed bed preparation and seeding are performed along the contour of the land surface.

Revegetation includes planting a cover crop ahead of the permanent seed mixture. Cover crops will be planted either in the late spring or the fall, depending upon when recontouring is completed. When a cover crop is planted in the fall, the associated permanent seed mixture will be planted the next fall; when the cover crop is planted in the spring, the permanent seed mixture will be planted that fall. Fall planted cover crops will be mowed before they produce viable seed to prevent second year volunteer growth. The permanent seed will be planted after October 31 to prevent fall germination.

A rangeland drill or a grain drill is used to plant the cover crop. A rangeland drill is used to plant the permanent seed mixture.

The fall planted cover crop will be Winter Wheat planted at a rate of 50 pounds per acre. Steptoe Barley or Millet will be planted in the spring at a rate of 50 pounds per acre.

The permanent reclamation seed mixture consists of a mixture of grass and shrub species, with some consideration given to site specificity. In all areas the basic seeding application rate is 13 pounds (lbs) of pure live seed (PLS) per acre. Six species comprise the base mixture, with other species added for special site considerations as follows:

The seed mixture to be planted on level terrain and on north and east slopes (Base seed mixture).

	% of Mix
Rosana Western Wheatgrass	30
Critana Thickspike Wheatgrass	25
Slender Wheatgrass	20
Regar Meadow Brome	10
Four-wing Saltbush	5
Winterfat	10

The seed mixture to be planted on south and west slopes:

	% of Mix
Prairie Sandreed	20
Rosana Western Wheatgrass	24
Critana Thickspike Wheatgrass	20
Slender Wheatgrass	16
Regar Meadow Brome	8
Four-wing Saltbush	4
Winterfat	8

The seed mixture to be planted on moist sites such as ditches and drainage swales:

	% of Mix
Lutana Cicer Milkvetch	10
Rosana Western Wheatgrass	27
Critana Thickspike Wheatgrass	22.5
Slender Wheatgrass	18
Regar Meadow Brome	9
Four-wing Saltbush	4.5
Winterfat	9

The seed mixture to be planted on problem erosion areas:

	% of Mix
Tall Fescue	10
Rosana Western Wheatgrass	27
Critana Thickspike Wheatgrass	22.5
Slender Wheatgrass	18
Regar Meadow Brome	9
Four-wing Saltbush	4.5
Winterfat	9

The above reclamation seed mixtures were agreed to by Exxon after extensive discussions with WDEQ/LQD and the Wyoming Game and Fish Commission. Individual species planted in the current seed mixtures are discussed below:

a) Western Wheatgrass is one of the four dominant native grasses in the Highland premining range, the others being Thickspike Wheatgrass, Blue Grama and Prairie Sandreed. Western Wheatgrass is among the most valuable range grasses of North America, widely regarded as the foundation of the western range livestock industry. It is an important constituent of most spring, summer and fall ranges and cures well into palatable, nutritious forage for winter grazing. It has exceptional value as a soil binder due to extensive creeping rootstock. It starts slowly from seed but seedlings are good competitors and form sod by spreading rhizomes.

b) Thickspike Wheatgrass is more abundant than Western Wheatgrass on the native slopes and uplands, but less abundant in the drainages. It requires somewhat less moisture than Western Wheatgrass. It shares Western's many good qualities including good year-round palatability and strong sod forming ability. Seedling vigor of Thickspike exceeds that of Western.

c) Slender Wheatgrass is a Wyoming native bunch grass which prefers somewhat more moisture than either Western or Thickspike, and it is shorter lived. It is quite alkali-tolerant, which gives it an advantage over other grasses in swales and playas. It has not been identified as native to the Highland site,

d) Meadow Brome is an introduced species from southwestern Asia which does well on locations where precipitation exceeds 15 inches per year. Since Highland's precipitation averages 12 inches per year this species does best in swales and other areas which gather moisture. It forms sod and tolerates cold well. It spreads vegetatively.

e) Four-wing Saltbush is a Highland native shrub which is easily established into hardy stands from seed. It tolerates grazing well, is high in protein, and is palatable for livestock and wildlife. It is mostly deciduous, but some leaves persist through the winter. It provides valuable protein to grazing and browsing animals throughout the winter.

f) Winterfat is a native sub-shrub which is found in the Highland area, although not in abundance. It is difficult to establish from seed due to slow germination. It grows well under dry conditions and is hardy, palatable and nutritious.

g) On south and west slopes Prairie Sandreed is added to the seed mixture. This is a rhizomatous, long-lived, warm-season grass native to Highland where it is the predominant grass on sandy ridge tops. This grass provides high quality, palatable summer grazing, as well as winter forage on wind-swept areas.

h) On moist sites, such as ditches and drainage swales, Cicer Milkvetch is added to the seed mixture because of its high water tolerance. It is a rhizomatous perennial legume native to Europe. It offers good soil erosion protection since it is long-lived with a vigorously creeping root system. It is readily grazed by livestock and big game animals.

i) Tall Fescue is added to the seed mixture for problem erosion areas. This is an introduced tall bunch grass which develops a deep, broad root system.

In addition to the above species, the following may be added at one pound of pure live seed per acre to further enhance reclamation. These species experienced good success in the Highland's experimental test plot area.

j) Intermediate Wheatgrass is an introduced sod-forming grass. It provides very good early spring grazing and is recognized as a suitable cool-season grass for 10-inch to 14-inch precipitation areas. It has formed excellent stands in the plot. It will be a good addition to the base seed mixture.

k) Switchgrass is an important native warm-season grass which has produced dense spreading sod in the test plot. It is very common in the central and southern Great Plains where it is an important forage, pasture and erosion control grass. Seedling viability at Highland was only fair, but once established it spread well, surviving very dry years and flourishing in wet years. It will be a good addition for moist sites and problem erosion areas.

l) Great Basin Wildrye is a native bunch grass which requires very little moisture. It is highly palatable. Its great height, seed production and dense low growth provide excellent wildlife habitat. It has shown excellent productivity in the test plot. It will be planted on relatively flat areas.

As previously noted, sagebrush was a dominant shrub on the pre-mining range. However, it has been omitted from the reclamation seed mixture since local ranches who own the land or to whom the land will likely be sold, and Exxon staff, consider sagebrush an undesirable species for domestic livestock grazing. Winter shrub forage for resident wildlife populations will be provided by Four-wing Saltbush and Winterfat, thereby eliminating the need for sagebrush to serve this purpose.

Seeding variations are not based on soil types since the type and quality of topsoil used for reclamation at Highland are generally homogenous. Since the reclamation species used are well adapted to the limited precipitation typical of the Highland area, no irrigation is necessary.

The seeding mixtures described above, in combination with previous reclamation at Highland, should result in good species diversification over the entire reclaimed site, and allow for sound grazing management. The reclaimed property in conjunction with the surrounding native range will provide good habitat diversity and year-round forage for the indigenous wildlife.

Exxon will protect revegetation from livestock grazing during the first two years after planting the permanent seed mixture.

Temporary revegetation is performed on topsoil piles and certain disturbed areas for soil stabilization and protection. For this purpose it is necessary that the vegetation cover be established

easily and readily. Therefore, fast germinating seed with wide environmental tolerance are used. Commercially available dryland pasture mixtures generally including some combination of Crested Wheatgrass, Intermediate Wheatgrass, Smooth Brome, Russian Wildrye, Slender Wheatgrass, Western Wheatgrass, and Yellow Blossom Sweetclover are seeded into the topsoil or disturbed area. If necessary, such seed mixtures may be preceded by the establishment of a grain cover crop.

6. TOPSOIL REMOVAL, STORAGE AND REPLACEMENT

6.1 Topsoil Removal

Topsoil is removed from all disturbed areas, whether initial excavation or overburden storage pile, using rubber-tired tractor scrapers. In areas where topsoil is thin, self-elevating scrapers are generally used to assure segregation of the top layer of soil from the less useful subsoil. In areas where the topsoil is thicker, conventional push-loaded scrapers may be used.

Visual control is used to distinguish the topsoil from underlying subsoil. The topsoil is classified as "Northern Brown" and is readily identified by its chocolate brown appearance. The underlying subsoil is typically sandy in character and is light brown to yellow in appearance.

6.2 Topsoil Storage

Topsoil thus removed has been placed in stockpiles at predetermined locations in close proximity to replacement areas. Past reclamation efforts at Highland have shown that all stockpiled topsoil used to date has been suitable for revegetation. Based on these results, all remaining topsoil presently in stockpiles is expected to be equally suitable. However, in order to verify this, samples of topsoil will be collected after it is spread for reclamation and analyzed for N, P, Organic Matter, K, pH, texture, and particle size prior to reseeding. If this analysis finds the topsoil atypically low in N, P or K compared to native range, fertilizer will be applied. Vegetative cover on topsoil piles is achieved with a commercially available dryland pasture mixture as was discussed in Section 5.3.

6.3 Topsoil Replacement

Following contouring of the disturbed area with a grader, topsoil is replaced with scrapers. It will be spread in approximately uniform lifts across the disturbed area and will be bladed smooth to establish uniform cover. When considered appropriate, a farm tractor with a disc cultivator and/or a chisel plow is used to break up soil lumps prior to seeding.

Experimental plots have been reclaimed at Highland using both four and six-inch layers of topsoil. Indications are that four inches are sufficient for satisfactory revegetation. However, in future the depth will be managed to deplete all topsoil stockpiles with coverage expected to average about seven inches (minimum of six inches).

For temporary reclamation on areas other than topsoil piles, the subsoil/overburden is disked and drill seeded directly with the dryland pasture mixture unless the surface is too rough or steep. In these cases the dryland pasture mixture is broadcast seeded. Broadcast seeding of the dryland seed mix is done at a rate of approximately 30 pounds/acre.

7. PLANS FOR REESTABLISHING CONTOURS

7.1 Original Contours

Prior to disturbance of any surface area in 1970, Exxon contracted for an aerial survey of the Highland area which produced a contour map showing the original land surface topography. Figure 3 shows the original topography with the final disturbed area outlined.

7.2 Recontouring Summary

Surface contours of disturbed areas will blend in with the pre-mining topography. While slopes may be modified, relative elevation differences are maintained and little change has occurred in the regional drainage pattern. In order to minimize the amount of surface runoff over the reclaimed tailings basin, the drainage pattern in the immediate area of the tailings basin will be modified. The final property wide drainage pattern is shown in Figure 2.

7.3 Solution Mine and Underground Mine

Solution mining and underground mining activities have had very little effect on surface contours. At completion, the surface facilities associated with these operations will be removed and the sites restored to be compatible with original contours.

Surveys to detect any subsidence of surface area above the underground mine have been conducted for several years and the results submitted to the LQD in the Annual Reports starting in 1980. The indicated subsidence is neither visible to the unaided eye, nor significant. The maximum subsidence to date is fourteen inches and the average subsidence is much less. The underground mine closed in January 1982, eliminating any additional extraction. During operation Exxon backfilled in high stopes and this will mitigate any significant effect in those areas which have the most subsidence potential. No surface cracks have been observed and none are expected. Field measurements of subsidence are consistent with predictions made by an outside consultant.

Long-term subsidence was evaluated by Jack Parker and Associates, rock mechanics consultants, in 1981. An excerpt from the consultant's report follows:

> "Most of the subsidence is due to dewatering. Providing that we mine out no areas wider than the "critical width" of the bridge or arch, there should be no gross subsidence effects. I understand that plans for the future call for no such mining. I expect subsidence to continue for a few months, to a total of 1½ ft. - but it should be widespread and imperceptible to the unaided eye, with no fractures to surface."

7.4 Surface Mine Overburden Stockpiles

Exxon's basic surface mining plan has been to excavate overburden and uranium ore from a series of consecutive pits. Most overburden from the first two pits was placed in surface stockpiles adjacent to the mining area, whereas most of that from subsequent pits was used to backfill the previously mined pits. Overburden stripping was completed in the first quarter of 1983.

Overburden has been placed on stockpiles by two operations. That from Pit No. 1 was placed using scrapers, whereas the overburden from Pit Nos. 2, 3, and 4 was removed by trucks and shovels and placed by truck dumping. In the latter operation, bulldozers were used to level dumped overburden. Both operations have resulted in good compaction of surface dumped overburden.

All overburden stockpiles have been reclaimed with the exception of access roads and facilities which are necessary to operations and areas which will provide tailings pond reclamation cover. The 1974 reclamation plan committed to overburden stockpile slopes of less than 20-30 degrees (less than 2.75h:1v for 20 degrees, 1.734h:1v for 30 degrees). The reclaimed overburden stockpiles are flatter than this, being 3h:1v or flatter. These slopes have required little erosion repair while the grasses were becoming established. Erosion on slopes with well established vegetation is less evident than on the native range.

7.5 Surface Mine Pits

The mined out areas of Pits 3 and 4 will be reclaimed as a lake. Half of the lake shore high walls will be reduced to slopes averaging approximately 3 horizontal to 1 vertical (3h:1v) down to at least elevation 5079 feet ASL. The slope above 5079 feet ASL will be topsoiled and planted with the appropriate permanent seed mixture.

Approximately 15% of the lake shore will be sloped, topsoiled and planted to the then current water's edge in order to provide ready access to the water in the early years before the lake fills to elevation 5079 feet ASL. This area is included in the 50% overall high wall which will be sloped. The final lake water elevation is expected to be approximately 5119 feet ASL. In practice, due to the earth moving methods being employed in the slope reduction, slopes of only slightly steeper than 3h:1v are being developed below the 5079 elevation down to the backfill benches (approximately the 5050 elevation) around approximately 25 percent of the pit walls; this is in addition to the 15 percent developed to the bottom of the pit. As such, the available access will increase with time as the Reservoir fills as shown in the following table:

Year	Percent Available Access
1984	15
1994	40
2000	50

On the north and west sides of Pit 3 slopes will exceed 500 feet in length. These slopes will be modified to include the terraces shown on Figure 10. The terraces will each be about 20 feet wide will be gently sloped (about 10:1) to slow but not collect runoff.

No more than half of the pit highwall will be left standing. Appendix 2 contains a wall stability study demonstrating the high walls will be stable due to a combination of inherent rock strength, cut angle and some wall buttressing. These walls will have a minimum safety factor of 1.3 and a maximum probability of failure of less than five percent. Note that the cross section C-C' in Case I on Plate 3 of Appendix 2 should be labeled A-A'.

Depressions existing at or near the crest of the highwalls will be filled in so as to prevent water accumulation. Further, areas along the crest of the highwalls will be sloped where possible to prevent surface runoff from areas above the crest from reaching the face of the highwalls. Surface runoff will be directed either to stock ponds away from the highwall crests or into the Highland Reservoir via existing ramps as shown on Figures 2 and 10.

Sheep tight fences will be placed along the crest of the highwalls.

Sloped in areas will be idle for at least six months after sloping before topsoiling to allow natural compaction of the fill portion of the slope. Settling cracks in the fill will be repaired prior to applying topsoil.

8. SURFACE WATER DRAINAGE AND DIVERSIONS, GROUNDWATER LEVELS

8.1 Surface Water

There are no perennial flowing streams in the vicinity of Highland Uranium Operations. The nearest flowing stream in the same drainage basin is the Upper Cheyenne River located about 70 miles to the southeast. Water flows in the normally dry stream beds only during the spring runoff period and occasionally during a severe thunderstorm.

Highland mining activity has affected the surface water drainage patterns of approximately 4970 acres as shown on Figure 5. Five basins were affected including Highland Reservoir area, North Pond area, Antelope Draw area, Tailings Basin area and South Slope area.

Drainage into the Highland Reservoir (to be permitted by State Engineer) has been limited to 840 acres, which will maintain water levels and quality as discussed in Section 9. There will be no surface water discharge from Highland Reservoir.

Drainage from the North Pond area will also be contained with no surface discharge. Approximately 560 acres will drain into Fowler Draw Stock Reservoir (State Engineer Permit 7727 Stk. Res.) and Sheep Draw Stock Reservoir (State Engineer Permit 8219 Stk. Res.). Exxon Drainage Ditch (Permit 25463) connects the Fowler reservoir to the Sheep Reservoir. Overflow from the two stock reservoirs and runoff from an additional 300 acres will supply the North Pond Reservoir (to be permitted by State Engineer).

Antelope Draw supplies Antelope Reservoir (Permit 7430 Res.). Since the original course of the draw below the reservoir has been affected by mining activity a spillway was constructed to carry overflow from the reservoir. The spillway design includes rip rap protection where it drops down the dam face and approximates the size and gradient of Antelope Draw. The spillway outlets into natural drainages leading to Box Creek.

The Antelope Reservoir spillway is designed to safely convey the 100-year one-hour storm of 2.3 inches of precipitation deposited on the 1950 acre runoff area.

The runoff rate calculation was based on Soil Conservation Service (SCS) and Design of Small Dams (DSD) methods. The average soil type in the drainage area was determined by DSD methods to be SCS Hydrologic Soil Group B. SCS complex group number 70 was selected based on the soil group, slopes and fair range condition with an antecedent moisture condition of II. The unit hydrograph method was used to determine peak runoff assuming the DSD thunderstorm rainfall distribution. Calculated peak runoff was 640 cfs.

The Antelope Reservoir spillway is 12 ft wide with a slope of a quarter percent and has 2:1 side slopes. Manning's Equation was used to determine the following flow conditions assuming a Manning's n of 0.02: Q = 640 cfs; w = 12 ft; s = 0.0025, ss = 2:1; d = 4.5 ft.

Since the channel depth is 6 ft, the minimum freeboard following a 100-year thunderstorm would be 1.5 ft. The spillway is 800 ft long,

ending at the headwaters of the original diversion ditch constructed prior to July 1, 1973.

The original diversion channel has an average grade of 0.4 percent, with 2:1 side slopes and a 15 ft wide bottom. Using the same assumptions as for the reservoir spillway yields the following flow conditions:

Q = 640 cfs; w = 15 ft; s = 0.004; ss = 2:1; d = 3.6 ft.

Since the ditch is over 4 ft deep along its entire length, it will safely convey the 100-year storm runoff. This ditch blends into a natural drainage several hundred feet wide which will safely convey many times the flow from a 100-year storm.

Runoff from the Tailings Basin and the surrounding area will be drained by the tailings basin diversion channel. This channel will be designed to contain flows as required by the NRC (currently, the one hour probable maximum thunderstorm of 14 inches). dc pg. 31

Runoff south of the mining area directly enters the Box Creek drainage. The 2-A Reservoir (Permit 7517 Res.) in this area was constructed by depositing overburden stockpile 2-A into the drainage. The spillway was constructed to carry overflow from the reservoir around spoil pile 2-A back into Box Creek.

Design details of Antelope Reservoir, Spillway and Channel are shown in Figures 6a and 6b.

Diversion channels and dams are topsoiled and seeded construction and are stable. Routine inspections and erosion repairs are made as necessary until successful vegetative growth is established.

8.2 Ground Water Levels

8.2.1 Introduction

Ground water flow is commonly divided into three types of flow systems: local, intermediate and regional flow (Toth, 1963). The flow systems are differentiated by the lengths of the ground water flow paths. Local systems have flow paths ranging in length from a few hundred feet to several thousand feet, intermediate systems range from several thousand feet to several miles, and regional systems range from several miles to several tens of miles. Figure 13 illustrates the superposition of these three types of flow systems.

Regional flow through the Upper Cretaceous Parkman Sandstone is shown on Figure 14. Although the Parkman Sandstone underlies the Fort Union Formation, it is likely that regional flow directions would be very similar in the Tailings Dam and Ore Body Sandstones. Regional flow is to the northeast in the Highland area.

Intermediate flow in the Highland vicinity is from the recharge area at Blizzard Heights to the North Fork Box Creek area as shown on Figure 15. Blizzard Heights is a topographically high area about 5,600 feet above mean sea level and located about nine miles west of EMC's mining operations. North Fork Box Creek is about two miles east of the surface mine and is at an elevation of 5,100 feet. Figure 15 shows a generalized intermediate flow net which represents premining

ground water flow between Blizzard Heights and North Fork Box Creek. Data used to develop the flow net are referenced on Figure 15.

It is assumed that the potentiometric levels in the Tailings Dam Sandstone and Ore Body Sandstones were equal in the predevelopment flow system. The flow net is in reasonable agreement with premining potentiometric water levels reported by Hagmaier (1971) and Dames & Moore (1972). It is also consistent with the observation that, in a semiarid region like Highland, the potentiometric surface is typically a significant depth below the elevation of the recharge area and a lesser depth below the elevation of the discharge area. The flow net shows the potentiometric surface to be about 170 feet below the surface elevation of Blizzard Heights, and the water table at the discharge area to be at nearly the same elevation as the ground surface (average elevation of about 5,100 feet).

Local flows within an area may vary from regional and intermediate flow patterns due to local anomalies in the geological strata, and due to mining operations which cause temporary alterations to the flow patterns. Mining operations which have created temporary local flow patterns in the Highland area include:

- EMC's underground mine dewatering
- EMC's surface mine dewatering
- EMC's pilot in-situ mining operations
- EMC's water supply wells
- TVA's North Morton Ranch underground mine dewatering
- Kerr McGee's Sequoyah (Bill Smith) mine operations dewatering

8.2.2 PreMining Regional Ground Water Gradients

A relatively detailed study of the regional ground water regime and its significance to deposition of economically recoverable quantities of uranium is presented in an unpublished Ph.D. thesis (Hagmaier, 1971).

Figure 16 (taken from EMC's September 3, 1980 response to NRC's June 18, 1980 request for additional hydrologic information--also submitted to WDEQ/LQD on September 9, 1980) shows the estimated pre-mining ground water potentiometric surface in the Highland area. These contours were derived from information supplied by EMC and from information obtained during previous studies of the area by engineering contractors. Insufficient information was available to allow the development of a potentiometric map for the individual aquifers in the Highland mine area. Figure 16 represents the Highland Ore Sands aquifer; water level measurements used to construct this Figure were obtained during the 1970-1971 time period.

A more detailed plot of the estimated pre-mining ground water levels is shown on Figure 17. The contours shown in this Figure indicate the top of the saturated zone. Data from which this map was constructed were obtained from the Hagmaier thesis well inventory, a Dames & Moore dewatering study performed for EMC in 1971, a Dames & Moore dewatering study performed for United Nuclear Corporation in 1975, the existing topographic surface, and elevations of natural springs recorded on USGS 15-minute quadrangle maps.

The estimated premining ground water contours shown on Figures 16 and 17 are in good agreement.

8.2.3 1978 Regional Groundwater Gradients

Figure 18 (taken from the supporting information to EMC's "Application for Amendment of Mining Permit 218C for Solution Mining of Uranium and Expansion of Permit Area Highland Uranium Operations" Sec. 2, Figure 2.1B, updated 2-29-80) depicts the estimated mid-1978 ground water surface in the Highland area.

8.2.4 Current (mid-1984) Situation

Dewatering operations ceased at EMC's underground mine in early-1982, and at EMC's surface mine in mid-1984. EMC ceased pumping water out of the mined aquifer at EMC's in-situ mining operation in May 1984.

The TVA North Morton Ranch underground mine and Kerr McGee's Sequoyah mines continue to be dewatered, but at reduced rates; these dewatering operations impact the ground water levels and gradients in the ore sands as shown on Figure 20. Everest Minerals' future operations will have only minor impacts on local water levels at Highland. No other current or proposed mining operation in the region is expected to have significant impact on ground water levels or flow directions at the Highland site.

During mid-1984, water levels were measured at various wells in the Highland area. These data have been used to estimate the current ground water elevations in the TDSS and ore sands aquifers (the two water-bearing strata intercepted by the reclamation lake). The estimated ground water elevation plots are shown on Figures 19 and 20.

8.2.5 Post-Reclamation Situation

When mining operations have terminated in the Highland area, and reclamation has been achieved, the local ground water levels and gradients are expected to return to the pre-mining status. The extimated post-reclamation (approx. year 2025) ground water gradients are shown on Figure 21.

Because of existing site features (i.e., ground water cones of depression at EMC's underground and surface mines, and recharge from the tailings basin), seepage from the tailings basin is essentially radial. Based on EMC's operational status, site geological and hydrological parameters, and the amount of liquid in the tailings basin, Exxon Production Research Company (EPR) has predicted that the regional ground water flow direction will be re-established by 1993, and that any remaining effects of tailings basin seepage will be directed towards the North Fork of Box Creek (EPR, Feb. 1982). However, the TVA and Kerr McGee dewatering activities that have been in operation (and continue at reduced rates) between EMC's Highland operations and the ground water recharge area at Blizzard Heights will have the effect of extending the recovery date beyond 1993. It is more likely that the regional ground water flow direction will be fully re-established around the turn of the century.

8.2.6 References

Dames & Moore, Consultants, "Hydrologic Evaluation - Pit 5 Lake Reclamation, Highland Uranium Mine, Converse County, WY", 1980.

Exxon Production Research Company, "Highland Uranium Tailings Impoundment Seepage Study", Feb. 1982.

Exxon Production Research Company (Springer, N.K. and Mitro, R.J.), "Surface Mine Reclamation Lake Study for Highland Uranium Operations", Jan. 1983.

Hagmaier, J.L., Ground Water Flow, "Hydrochemistry and Uranium Deposition in the Powder River Basin, Wyoming," Ph.D. Thesis, University of North Dakota, 1971.

Toth, J., "A Theoretical Analysis of Ground Water Flow in Small Drainage Basins", Jour. Geophy. Res., 68, 1963.

9. HIGHLAND RESERVOIR

From the earliest planning stages of the Highland Uranium Operations, a reclamation reservoir was included in the final open pit area. Lake water studies were completed in 1983 and 1984 to fully address lake water quality, shape, size and filling rate.

The 1984 study concluded good quality water could be achieved in the lake without increasing the drainage area of the lake beyond the Pit 3 and Pit 4 immediate drainage area. However, this quality can only be achieved if pit wall sloping is minimized in the ground water inflow and outflow areas of the pits. Because DEQ regulations require that 50% of the lake shore be sloped, this case was studied and yielded good quality water if the sloped areas are minimized on the west side of the pits and the southwest corner of Pit 4.

This plan is included in the reclamation map in Figure 2.

Sloping on the west sides of the pits is restricted to the areas identified as the least stable, that is, with a probability of deep seated failure exceeding 5%.

The wall stability study identified the southwest corner of Pit 4 as a less stable area. Therefore, this will be sloped but without pushing down the wall into the pit since this would cover the water outflow aquifers. This wall section will be cut back to a nominal 3:1 slope down to the 5079 elevation. The cut material will be placed in the present mine shop area to promote drainage to the pit lake.

The wall stability study is found in Appendix 2.

A summary of the lake water studies as well as the studies themselves are found in Appendix 3. Figure 10 contains cross-sections of the lake.

The Highland Reservoir is used for wildlife watering now and will be used for stock watering after revegetation has been established and protected from grazing during the first two years following permanent seed mixture planting.

Design of the reservoir has taken into account an ultimate use as a water recreation area and fishery under the jurisdiction of the state of Wyoming, in addition to its use for livestock and wildlife watering. Such use, is of course, subject to acceptance by the State of this reservoir area. In anticipation of such use, Exxon Minerals has taken or is taking the following steps:

1) Exxon personnel have contacted the Wyoming State Game & Fish Commission. Exxon will work with the Commission to establish fish in the Highland Reservoir.

Game & Fish Commission personnel contacted on this matter were:

- Cheyenne Office: Mr. Kevin Johnson
- Casper Office: Mr. Larry Peterson & Mr. Ron McKnight.

Our on-going fishery development relationship will be mainly with the Commission's Casper office.

2) Exxon Minerals, with advice from the Game & Fish Commission, will develop the Highland Reservoir and will stock the Reservoir with appropriate fish species. Presently, Exxon Minerals is sloping Reservoir pitwalls in

accordance with the proposed plan, and water is flowing into the Reservoir from the immediate surface drainage area and from the Ore Sands aquifer. Inflow from the Tailings Dam Sandstone (TDSS) aquifer has not yet reached its full potential (determined by visual observation); therefore, the Ra-226 concentration of the water presently contained within the Reservoir is higher than predicted by the EMC model. However, within several years, after TDSS aquifer inflow is fully established, we expect the Ra-226 concentration of the water to actually be below that predicted by the model due to phenomena (e.g., sedimentation, co-precipitation, biological actions, etc.) not accounted for in the model; such Ra-226 concentration decreases have been observed in similar situations in the Shirley Basin Mining District.

Colorado State University, Department of Radiology and Radiation Biology conducted a study on fish uptake of radium for the Pathfinder Shirley Basin Mine proposed recreational lake. The Study Report, "Radium Bio-accumulation In Trout", Susan K. Rope and F. W. Whicker, November 30, 1980, has been reviewed by the Exxon Minerals technical staff and found to be germane to the Highland Reservoir. An important aspect of the study is that it was designed on the basis of a thorough review of pertinent literature. The proposed Pathfinder recreational lake and the Getty Deep Pond (sampling station No. 12 in the Study Report) are both similar in physical characteristics and water quality to the Highland Reservoir. The study concluded the radiation dose would be acceptable for humans eating fish reared in waters similar to those expected in the Highland Reservoir. Dose calculations, based on reasonable environmental conditions and a fish consumption pattern of one per week, flesh only, indicated a person's body (bone) burden at the end of 50 years of continuous ingestion would be approximately 0.4 percent (approximately 0.04 nCi) of the maximum permissible; this

would induce a cumulative bone dose equivalent of 500 mrem received over 50 years, for an average of 10 mrem/year, as compared to the maximum permissible bone dose equivalent for non-radiation workers of 2800 mrem/year.

3) Exxon Minerals' on-going monitoring program for the Highland Reservoir found in Section 13 will allow EMC to routinely assess the Reservoir water quality in comparison to the water quality characteristics used in the CSU study for the Pathfinder recreational lake.

4) When Exxon's reclamation obligations to the state under the Environmental Quality Act have been met and the reclamation bond released, public access to the reservoir is to be provided by donated easement or other appropriate donative transfer to the state agency or governmental representative undertaking such public purpose activity. Subject to State acceptance, the transfer will include lands now owned by Exxon outlined on Figure 2 and such access corridor connecting with lands or roadways of the state as Exxon may be able to negotiate for and reasonably acquire. Pending reclamation bond release, Exxon will monitor and maintain the reservoir, work with appropriate agencies to develop the reservoir, and, at the appropriate time, stock it with fish.

The other lands bordering the reservoir, owned by others (presently the Fowler Ranch Partnership and Everest Minerals Corporation), are expected to remain in private ownership.

10. TREATMENT OF WASTES

Radioactive materials are contained in the mine water and in the waste process solutions from the mill. Treatment of these wastes is described below.

10.1 Mine Water

Ground water was removed from the surface mine by pumping the water through a pipeline to the clay-lined mill pond. This water was stored in the pond and then pumped to the mill for use in the chemical processing of the uranium ore. This practice ended when the mill operation ceased in mid 1984. The mill pond will hold about 48 acre feet.

The millpond was emptied at the end of mill operations. The only water that will be in the millpond in the future will be surface runoff.

Water in the mill pond will be monitored quarterly for concentrations of uranium, radium -226, and sodium. Thorium -230 analyses will be performed annually. In order to ensure that no contaminants in the mill pond water reached the ground water undetected, a monitor well was installed immediately northeast of the pond. The well is completed in the sand immediately under the clay and shale underlying the pond. Sampling of this well will be conducted quarterly and analyses performed on the above mentioned parameters (Th-230 analyzed annually). Analytical results for these two locations will be included in the Annual Reports. Monitoring of the pond and well will continue until they are reclaimed.

Reclamation of the mill pond area will occur in 1985. A composite sample will be collected from the sediments at the bottom of the pond and analyzed for U, Ra-226, pH, conductivity, SAR, B, Se, NO_3/N_2, Mo, Cu, As, and acid-base potential. For reclamation, all water will be removed from the pond and the slimes will be allowed to dry. The dam material will be pushed back over the top of the excavated pond to bury the sediments at least five feet deep and re-establish approximately the original contours as indicated on Figure 2. However, if the area covered by sediments in excess of WDEQ Guideline #1 Table I-4 for the surface suitability of overburden exceeds that which can be covered five feet deep by dam material, the excess sediments will be hauled to the tailings basin for disposal. The mill pond access road over Antelope Diversion Ditch, with a culvert now in place, will be removed to restore an open channel.

10.2 Mill Wastes

Mill wastes (referred to as tailings) are liquid and solid, acidic and radioactive. These mill tailings are stored in a basin created by the construction of a clay-core earth dam across a natural dry valley having a small watershed. Details of the design and construction of the dam (including the two subsequent dam lifts) have been submitted to the Wyoming DEQ, the State Engineer, and the U.S. NRC, and were approved by these agencies.

The uranium tailings are produced from a loosely cemented silica sandstone ore and contain small amounts of gypsum. The gypsum results from the reaction of calcite with sulfuric acid in the milling process. Most of the materials are minus 28 mesh, and it will range downward into submicron clays.

The method of tailings disposal employed causes the coarser fraction to settle near the discharge point and the finer fraction to flow and be deposited away from the discharge point. The sandy material forms a beach which drains freely and rapidly becomes structurally stable; the upstream face of the tailings basin dam is protected from wave erosion by such a beach. The finer fraction resists drying and has very little bearing strength even when the surface is dry. Dry tailings sands are protected from wind erosion by a variety of techniques including sprinkling, overburden cover, a chemical stabilizing agent, and wind breaks.

A seepage collection system is built into the dam design to retrieve the water which seeps into the embankment. The system built into the dam consists of a sand chimney drain, blanket drain, and toe drains which channel the seepage flow into a drainage basin at the toe of the dam as described in the construction permit applications. The water is collected in two ponds and pumped back into the tailings basin. A map and a cross section of this water collection system are found in Figures 7 and 8. Authorization may be sought in the future to allow discharging the seepage water off the property or into Highland Reservoir since the water meets DEQ livestock standards.

The tailings basin seepage collection/pumpback system will be maintained in operation until final reclamation of the tailings basin is undertaken in accordance with NRC requirements.

The ground water gradient in the vicinity of the tailings basin, and the entire Highland area, is expected to return to its pre-mining direction following reclamation of the property as per the seepage study which the DEQ has reviewed. The normal northwest to southeast ground water flow was altered by mining operations creating a hydrologic cone of depression. After the backfilled pits and lake have recharged, the regional ground water gradient should be re-established. The NRC requires a plan for monitoring ground water east of the basin in the direction of this normal regional flow, in addition to the monitoring program already established. Exxon's proposal is currently under study by the NRC in consultation with the DEQ.

Highland's tailings basin reclamation plan is designed to meet the objectives set forth in recently promulgated EPA reclamation standards. As such, the plan is designed to reduce radon emanations from the reclaimed basin to less than 20 $pCi/m^2/sec$ above background and to reduce gamma radiation in the area to background levels. In order to accomplish this, the tailings basin is expected to be reclaimed as shown in Figure 2 and as described below, subject to NRC approval:

a. Contour tailings to receive cover.
b. Dewater pond via enhanced evaporation using spray systems.
c. Excavate a diversion channel north of the basin to divert runoff from northside drainages away from the tailings.
d. Cover the tailings with overburden from the north side diversion channel, the north side of Overburden Stockpile #1 and the east side of the Pit 2 backfill.

e. Slope the tailings dam face and the north side of Overburden Stockpile #1 to 5h:1v.

f. Cover the disturbed area with at least seven inches of topsoil.

g. Revegetate the disturbed area.

The details of this plan are not yet finalized due to continuing uncertainties in tailings reclamation requirements. The NRC is currently writing regulations based on the EPA standards and the EPA standards are under legal challenge. Exxon will submit the final reclamation plan to the DEQ as soon as it is approved by the NRC.

This plan is submitted now to show that the tailings basin reclamation and the reclamation of the remainder of the site are essentially independent.

11. DISPOSAL OF BUILDINGS, OTHER STRUCTURES AND MISCELLANEOUS RECLAMATION

11.1 Underground Facilities

Underground mining operations at Highland were completed in the first quarter of 1982. All shafts were completely backfilled to within approximately 15 feet of the surface and plugged with concrete to within a few feet of the surface, and most were then filled with overburden. The main shaft and ventilation shaft depressions will be filled with overburden during final reclamation. All surface facilities will be removed. The foundations will be broken up and either removed for burial or will be buried in place at least two feet deep. The only exception to date will be one small powder magazine building which the landowner would like left for his use as a storage building. A copy of his request is found on the following page. Any future requests from the landowner to leave facilities for ranching use will be submitted to LQD for approval and will include the landowner's written request.

The underground mine containment berm will be reclaimed by scarifying the liner, filling the basin with broken concrete, paving, wood, steel and other miscellaneous construction materials from decommissioning of the underground mine facilities as well as earth fill. The waste materials will be buried under at least two feet of clean fill.

11.2 Surface Mine Facilities

The surface mine and mining contractor shops will be removed. The foundations will be broken up and either removed for burial or will be buried in place with at least two feet of cover.

October 12, 1984

Exxon Minerals Company
Highland Uranium Operations
P.O. Box 3020
Casper, Wyoming 82602

Attention: Mr. James B. Shannon

We the undersigned, representing the Fowler Ranch Partnership, do hereby request that the Exxon underground mine powder magazine building in Sections 17, R36N, T72W not be reclaimed but instead be left intact for our use in ranching operations. We assume responsibility for this building.

We also request that wells #12 (U.W. 47769), #30 (U.W. 47768) and #47 (U.W. 48338) not be reclaimed and instead be left for our use in livestock watering. We will apply for Wyoming State Engineer permits on these wells simultaneously with Exxon's request to the State Engineer that your permits be terminated. We will assume all responsibility for these wells when our State Engineer permits are granted.

Signed This Date Oct 31-84

By L.L. Fowler
Rachel Fowler

/ksj

L.N [illegible] DIVISION
RECEIVED APR 22, 1985
TFN 1 6/242 PERMIT

218C-R1

11.3 Mill, Tailings Booster Pumphouse, Tailings IX Facilities

The buildings, process vessels and machinery will be checked for residual radioactivity levels. Material, equipment or vessels that are clean or can be conveniently decontaminated and salvaged, will be sold if buyers can be found. If decontamination and/or salvage is not feasible, such buildings, material, equipment and vessels will be disposed of in the mill tailings basin or other NRC approved location.

The mill foundations and concrete slabs will be broken up. Mill concrete that does not meet NRC release criteria for unrestricted use will be disposed of in the tailings basin in accordance with conditions specified in EMC's NRC license. Other concrete will be used as fill material around the site or buried in place at least two feet deep.

A conservative estimate for the total volume of mill buildings, foundations, equipment, and pavement is 14 thousand cubic yards. The capacity available for fill material in the tailings basin, prior to placement of the reclamation cap, will be over 1.3 million cubic yards. Total disposal in the tailings basin, if necessary, would only require approximately 1% of the space available.

The mill decommissioning and reclamation will proceed in two phases. The first phase will be completed in 1985 as shown on Schedule I. The second phase will be done by Everest when Everest is through using the facilities.

Phase one includes reclaiming the ore pad, crusher, fine ore bins, CCD, tailings booster pumphouse and tailings IX sites, plus decommissioning the grinding, leaching, and SX circuits, but not dismantling the main mill and SX buildings.

Phase two will include reclaiming the main mill, SX, changehouse and office building sites along with the surrounding support facility sites. Everest Minerals Corporation has purchased these facilities for use in solution mining. Exxon will continue to bond for this reclamation until the DEQ approves the Everest permit and bond.

The mill water pond and the road to the pond across Antelope Draw is discussed in Section 10.

11.4 Solution Mine Facilities

All buildings, roads and other facilities, including the wells, will be left for Everest Minerals except for the original pilot wells. These wells will be abandoned according to DEQ regulations as soon as the NRC, which has been cooperating with the DEQ, grants permission to do so.

11.5 Sand and Clay Stockpiles

The small sand piles on the mill ore pad will be spread out to yield side slopes not exceeding 3h:1v. They will be topsoiled and reclaimed.

A clay stockpile on the south end of the Pit 2 backfill may be used in tailings pond reclamation. Therefore, it has been temporarily stabilized by seeding it with the dryland seed mixture.

The basic method for reclaiming the clay stockpile area will not depend on whether the stockpile is used for tailings pond reclamation. The site will be contoured to less than 3h:1v slopes and it will be topsoiled and planted as normal.

Although this material has been specifically segregated for possible use on the tailings pond, the material is typical of much of the overburden already successfully reclaimed and will not require special treatment. The screen analysis of a composite sample from the surface of the pile was 20.3% +200 Tyler mesh, 8.2% -200, +325 Tyler mesh and 71.5% -325 Tyler mesh.

11.6 Wells and Pipelines (Excluding Solution Mine Area)

Figure 9 contains a map of all wells and pipelines. Table 1 contains a listing of all wells and indicates which have been sold to Everest Minerals. Exxon will remain bonded for these facilities until Everest Minerals has a DEQ permit and is bonded.

Two EPA discharge points have been in use, identified as locations 002 and 007. Their locations are shown on the map in Figure 4. The 002 location supplies water to sheep at the landowners request. The 007 location discharged water from pit crest dewatering wells. The 002 location may remain in use until mine reclamation is completed. The 007 location is no longer is use. Its surface pipeline will be removed and its discharge location reclaimed.

Wells not sold to Everest and not approved for the landowners use in ranching will be abandoned according to DEQ regulations. The mill tailings lines will be salvaged. Buried pipelines will be left in place. The only buried line that conveys radioactive material is the tailings water recycle line which will be flushed with fresh water before abandoning its use. The buried lines are below the frost line (at least three feet deep) so will not interfer with ranching activity. No surface lines will be left in place except those sold to Everest Minerals in the Solution Mine area and at the mill site.

The surface facilities of abandoned buried lines, such as vertical culverts down to valves and meters, will be reclaimed by removing the culverts, filling the holes and reclaiming the sites.

11.7 Roads

All surface mine haul roads will be ripped and reclaimed. The tailings line road will be contoured to 3h:1v maximum side slopes, ripped and reclaimed. The underground mine road and the paved access road will be left for Everest Minerals.

Exxon Minerals will reclaim approximately two and one half miles of private paved access road to the Highland Uranium Operations in the event that either Everest Minerals does not gain the necessary permits and bonding to assume responsibility for the road, or the landowners do not provide written requests that the road not be reclaimed. The described road is within Exxon's current mining permit area and the amendment area covered by Exxon's February 2, 1984 application.

Reclamation will be accomplished by removing the pavement for burial at least 4 ft deep either in the tailings basin, or in a hole excavated within the mining permit area for this purpose. The roadbed will then be covered with 6 in of topsoil and plated with the base permanent seed mixture described in the mining permit revision reclamation plan.

Exxon Minerals will continue to include the cost of this reclamation in its bond calculations until either the reclamation work has been completed, Everest Minerals is appropriately bonded for the cost, or the landowners have provided written requests that the road not be reclaimed.

12. ALTERNATIVES

The major feature of Highland mine reclamation is the Highland Reservoir. Two basic alternatives in the lake design were considered: 100% versus 50% wall sloping and a 3,180 acre lake watershed versus 840 acres.

12.1 Percent Sloping

The 1984 lake water study concluded that sloping the entire lake shore will ultimately produce a lake which may not be useable for livestock and most wildlife. It would be acceptable during at least the first 200 years.

Slightly more rangeland would be available for grazing.

We concluded the long term value of a good quality lake far outweighed the value of the small additional grassland produced by 100% sloping.

12.2 Watershed

The reclamation plan includes only the 840 acre drainage area in the immediate vicinity of the lake. The drainage area could be increased to 3,180 by diverting the Antelope Draw drainage.

The 1984 lake study concluded the lake would be suitable for livestock and wildlife without this additional watershed.

12.3 Contingency

If Radium 226 concentrations in the reservoir water are increasing during the first ten years after the date of the permit revision and reach 25 picocuries per liter (pCi/l), Exxon and LQD representatives will meet to determine the cause and recommend corrective action. If analysis of the situation indicates that the radium 226 concentration of the water will exceed 30 pCi/l at such time as the lake is intended to serve as a public fishery, Exxon will carry out appropriate corrective activities such as treating one volume of the reservoir with Barium Chloride.

Exxon will maintain surety arrangements based on treating one volume of water in the reservoir with a Barium Chloride treatment process.

13. RECLAMATION & POST-RECLAMATION MONITORING

13.1 Water

There will be three water monitoring programs. One will monitor the tailings basin, one the Highland Reservoir and one the mill water pond as discussed below.

13.1.1 Tailings Basin

Ground water levels in wells completed in the Tailings Dam Sandstone (TDSS) and Ore Sands aquifers as shown on Figure 11 will be monitored semiannually. Four wells completed in the Ore Sands and six completed in the TDSS are proposed for this purpose.

Wells that will be routinely monitored for water quality in accordance with NRC requirements for tailings basin seepage monitoring are shown on Figure 12 and listed in Table 2. Exxon Minerals will continue to monitor those wells in accordance with NRC requirements until the tailings basin is reclaimed and deeded to a State or Federal agency for long term monitoring and maintenance as required by Federal law.

The NRC currently requires these wells to be sampled quarterly and the samples analyzed for dissolved U-nat., Ra-226, Th-230, Pb-210, and Po-210. as well as pH, sulfate, total dissolved solids, arsenic and selenium. Chloride, calcium and magnesium are also measured.

13.1.2 Highland Reservoir

Groundwater levels in the wells identified on Figure 12A in the Tailings Dam Sandstone (TDSS), the Ore Sandstone and the Pit 2 Backfill (2BFR) will be measured semiannually.

The water quality monitoring wells are identified on Figure 12A and listed in Table 2A. These wells will be monitored quarterly in 1985 - 1986 and semiannually thereafter.

The well samples and Highland Reservoir will be analyzed annually for total ammonia, nitrate and nitrite (as N), aluminum, barium, cadmium, chromium, copper, lead, manganese, mercury, vanadium, iron, molybdenum, zinc, nickel, fluoride, boron, magnesium, potassium and sodium. Semiannually they will be analyzed for pH, conductivity, arsenic, selenium, natural uranium, radium-226, bicarbonate, carbonate, calcium, chloride, sulfate and total dissolved solids. The additional 1985 and 1986 samples will be analyzed for pH, total dissolved solids, arsenic, selenium, natural uranium and radium-226.

Annually, two additional samples will be obtained from the Highland Reservoir (one from a depth of D/3 and one from 2D/3, where D=depth of the reservoirs deepest point); these samples will be analyzed for pH, dissolved oxygen, calcium, total dissolved solids and radium-226.

This program will continue until, the earlier of, bond release or LQD's permission to discontinue it.

13.1.3 Mill Pond

The mill pond and its monitor well will be sampled quarterly until the pond is reclaimed. These samples will be analyzed for U-Nat., Ra-226 and Na; Th-230 will be analyzed annually.

13.1.4 Reporting Results

The results obtained from the above described monitoring programs will be included and discussed in the Annual Reports to the LQD. Results will be compared to Highland Reservoir and tailings seepage modeling predictions. The water levels in Highland Reservoir and the wells shown on Figure 12A will be presented graphically. The concentrations of total dissolved solids, dissolved uranium and dissolved radium-226 in water from Highland Reservoir and wells RM-3, W-35, W-47 and XXXVIII will be presented graphically.

13.2 Overburden and Ore Stockpile Areas

Overburden and ore stockpile areas being reclaimed will be sampled prior to topsoiling to a composite depth of four feet with one sample collected per six (6) acres using a 500 foot grid pattern. Samples will be analyzed for pH, conductivity, percent saturation, SAR, NO_3/N_2, As, Se, B, Mo, Cu, acid-base potential, texture classification and percent sand, fine sand, clay and silt. Overburden unsuitable for reclamation according to DEQ-LQD Guideline No. 1 due to excessive As, Se, B, Mo or Cu will not be allowed within the top four feet. It will either be removed for burial or buried in place. Overburden unsuitable for reclamation according to DEQ-LQD Guideline No. 1 for pH, conductivity, SAR, acid-base potential or texture, will be covered with either a foot of topsoil or six inches of suitable overburden and six inches of topsoil. To date, no overburden has been identified as being unsuitable due to these secondary considerations.

The overburden sampling intensity will be increased using a 50 foot grid pattern before mitigation of unsuitable overburden is begun due to excessive As, Se, B, Mo or Cu.

data resulting from the overburden/ore stockpile areas monitoring program will be submitted to the LQD in future Annual Reports.

13.3 Topsoil

Topsoil will be sampled after it is spread. Samples will be analyzed for pH, K, N, P, organic matter, texture, percent sand, fine sand, clay and silt. The results will be submitted to the LQD in future Annual Reports.

13.4 Vegetation

Exxon Minerals will establish a Reclamation Comparison Area (RCA) jointly with LQD in 1985 on undisturbed land within the permit area in line with LQD's October 1, 1984 letter (Appendix 5). The RCA will be used for the evaluation of reclamation success on Highland areas disturbed by Exxon Minerals after June 31, 1973, and reclaimed by Exxon Minerals. The RCA will be large enough to adequately represent premining vegetation and to facilitate adequate random sampling of vegetation parameters, and will be managed in the same manner as the surrounding area, e.g., the RCA will not be fenced to exclude grazing.

In order to assess reclamation success, the following vegetation parameters will be sampled on the RCA and reclamation areas for the last two consecutive years prior to requesting respective bond reductions/release.

- Vegetative cover
- Species composition and diversity

Sampling methodology will generally follow that provided in LQD Guideline No. 2, January 1981.

The Motyka Index of similarity will be used for evaluating the community comparability. The minimum acceptable index (percent of similarity) will be mutually agreed to between the LQD and Exxon Minerals prior to evaluation for bond reduction/release.

Vegetation data collected on the RCA will be directly compared to the data collected on reclaimed areas without mathematical adjustment for climatic changes. Environmental protection performance standards (concerning vegetation and land use) listed in Chapter IV, Section 2 of the WDEQ/LQD Rules and Regulations will be achieved on reclaimed areas disturbed prior to July 1, 1973; specifically:

a. Disturbed areas will be restored for livestock and wildlife grazing;

b. Wildlife habitat will be restored on reclaimed areas in a manner commensurate with habitat conditions existing in the area prior to land disturbance;

c. Total vegetative cover and percent total cover (absolute values) on reclaimed areas will be at least equal to that of the RCA;

d. Species diversity and composition on reclaimed areas will be suitable for livestock and wildlife grazing;

e. Reclaimed areas will be capable of withstanding grazing pressure at least to that which the areas sustained prior to mining disturbance.

The vegetation data will be submitted to LQD in future Annual Reports and bond release requests.

14. EXTENT OF SURFACE DISTURBANCE & RECLAMATION COSTS

The extent to which surface areas are disturbed, along with the calculated reclamation costs, are updated in each Annual Report.

It should be noted that essentially all of the Exxon surface disturbances have already occurred. The reclamation schedule for the disturbed area is shown in Figure 1.

Exxon's current estimate of final reclamation costs for the Highland Uranium Operations in 1985 dollars is $13.6 million. This reclamation cost is recalculated each year and included in the Annual Report for bonding requirements. Details of the current estimate including the cost of the contingency plan, monitoring and DEQ contingency fee follow:

	1985 Dollars
• Cost to reclaim tailings basin area	$ 6,900,000

Includes:

		$ k
Contour tailings	0.7 MBCY @ $1.30	910
Strip topsoil	77 kBCY @ $1.30	100
Slope Dam 5 to 1	434 kBCY @ $0.77	334
Build PMF Channel	1.6 MBCY @ $1.30	2,080
Slope Dump 1-5 to 1	11 kBCY @ $1.30	14
Cover tailings-3 meters	1.4 MBCY @ $1.30	1,820
Topsoil & Revegetate	374 acres @ $1200	449
Monitor, Evaporate Water, Stabilize Sand		140
NRC Long Term Maintenance Fee		400
Overhead		600
		6,847

• Cost to reclaim Pits 2, 3 and 4	$ 2,500,000

Includes:

		$ k
Wall Sloping-15% to Pit Bottom and 35% to 5079' ASL	1,400 kBCY @ $0.75	1,050
Topsoil & Revegetate	400 acres @ $1,200	480
Terraces	400 kBCY @ $0.75	300
Overhead		700
		2,530

- Cost to decommission mill and reclaim mill site (including mill pond) — $ 1,100,000

  Includes:

		$ k
Mill Decommissioning		784
Pond Decommissioning		58
Decontaminate Mill & Site	100 kBCY @ $1.37	137
Topsoil & Revegetate	70 acres @ $1,200	84
Overhead		40
		1,103

- Cost to reclaim underground mine site — $ 100,000

  Includes:

		$ k
Decommission Head Frames and Buildings		46
Bury Foundations	6 kBCY @ $1.30	8
Topsoil & Revegetate	7 acres @ $1,200	8
		62

- Cost to restore expanded well field and decommission and reclaim solution mine area. — $ 1,000,000

- Cost to complete reclamation of roads and miscellaneous disturbed areas — $ 500,000

- Barium Chloride Treatment Contingency Plan — $ 500,000

  Includes:

	$ k
Capital	
Pumps	41
Pipe	38
Fittings	27
Tanks	3
Flowmeters	4
Power System	17
Pipe Anchors	2
Utility Boat	3
Buildings	37
Engineering and Contractor Service	34
Contingency	17
	223
Operations	
Labor	125
$BaCl_2$	40
Materials	40
Power	47
Contingency	25
	277
	500

- DEQ Contingency — $ 1,000,000

- TOTAL — $13,600,000

EXXON MINERALS COMPANY
HIGHLAND URANIUM OPERATIONS

SUMMARY OF ESTIMATED COSTS
TO TREAT ONE VOLUME OF RESERVOIR WATER
(POSSIBLY IN MID-1990s) WITH $BaCl_2$ TO REDUCE RADIUM -226

• Capital Costs per Attachment I	$189,000
• Operating Costs Per Attachment II	$277,000
• Total Costs	$466,000

DMR/ksj
3/25/85

218C-R1

m. 4.26.1985 TRN 161242

ATTACHMENT I

CAPITAL COST ESTIMATE
FOR POSSIBLE $BaCl_2$ TREATMENT OF
HIGHLAND RESERVOIR WATER

	$k
• Pumps	
+ 2-20 Horse Gould 8"x10"-12", 10¼" Impeller	10.0
+ 1-30 Horse Gould 8"x10"-12", 12" Impeller (Model #3405 Direct Drive 1050 rpm pumps)	5.4
+ 3- ½ gpm Durco metering pumps	4.5
+ 1-100 gpm 2 Horse Durco fiberglass $BaCl_2$ Mix Pump	1.1
+ Starters	
- Gould Pumps	6.0
- Durco Pumps	2.0
+ Installation (Including Wiring)	12.0
Subtotal	41.0
• Pipe	
+ 5000 feet 10" SDR-17 Polyethylene Pipe by Polypipe Industries @ 6.25/ft	31.3
+ 600 feet 1½" SDR-17 Polyethylene Pipe	0.3
+ Installation	6.4
Subtotal	38.0
• Fittings	
+ 3-10" Butterfly Valves	2.0
+ 3-10" Check Valves	6.0
+ 3-10" Strainers	3.0
+ 3-8"x10" Reducers - Polyethylene	0.5
+ 20-10" Flanges - Polyethylene	3.0
+ 20-10" Flanges - Steel	1.5
+ Miscellaneous Fittings	3.0
+ Installation	8.0
Subtotal	27.0
• Tanks	
+ 1-2250 gallon 8'x6' Fiberglass	2.0
+ 1-400 gallon 4'x4' Fiberglass	0.5
+ Installation	0.5
Subtotal	3.0

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		k$
• Flow Meters		
+ 3-Turbine Meters		3.0
+ Installation		1.0
	Subtotal	4.0
• Power System		
+ 4,000 feet 3-phase Power Line		8.0
+ 600 feet 3-phase Cable		2.5
+ 200 KVA Transformer 3-phase bank 34kv to 440v		2.0
+ Installation		4.5
	Subtotal	17.0
• Pipe Anchors		
+ 4,000 feet - 3/4" Nylon Rope		2.0
• Utility Boat & Motor		3.0
• Buildings		
+ 15'x30'x8' $BaCl_2$ Make Up Building		11.0
+ 14'x20'x8' Pump House		7.0
+ Pump House Skid		15.0
+ Heat & Lights		4.0
	Subtotal	37.0
10% Contingency		17.0
TOTAL		189.0

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ATTACHMENT II

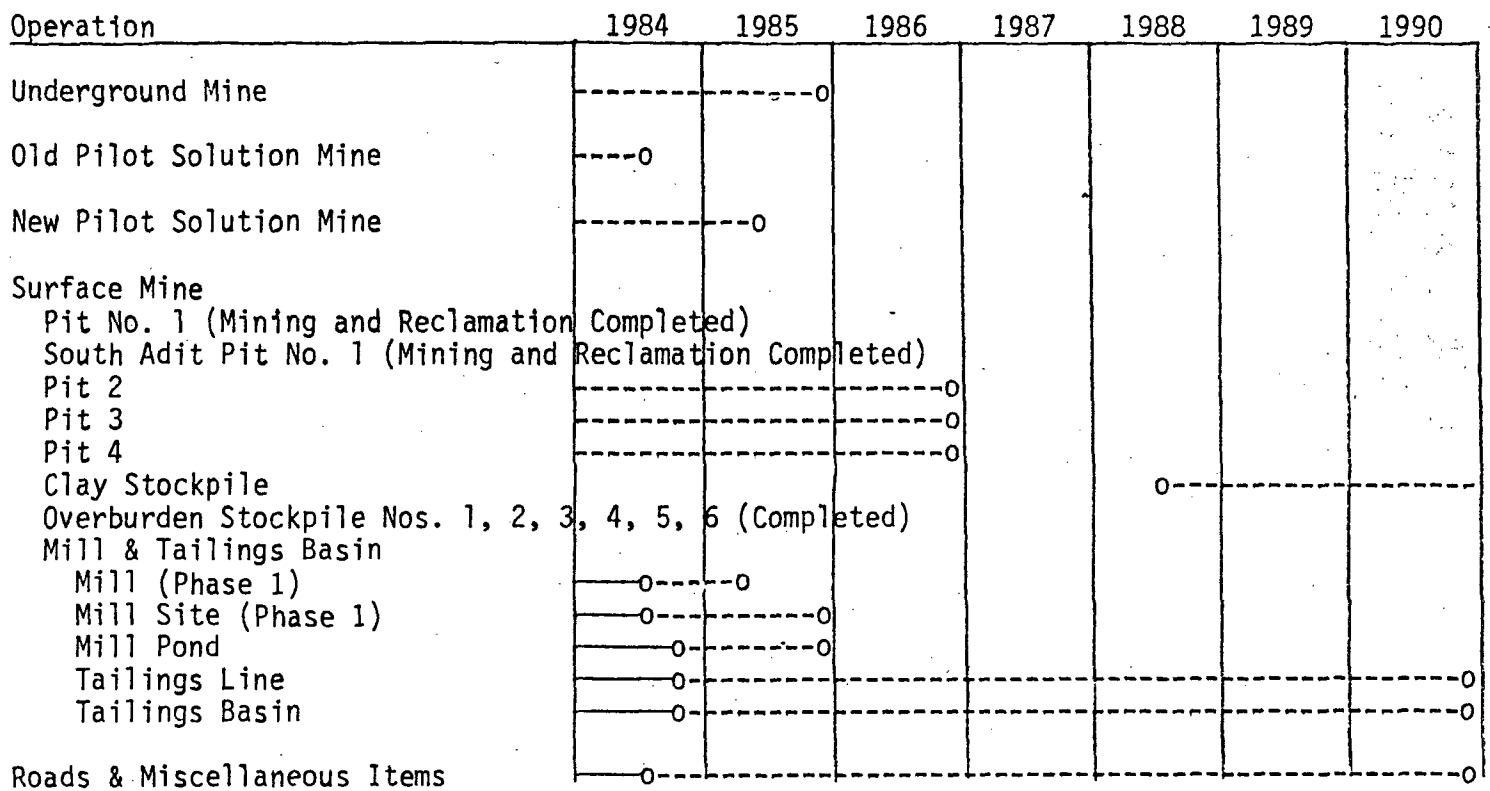
OPERATING COST ESTIMATE
FOR POSSIBLE $BaCl_2$ TREATMENT OF
HIGHLAND RESERVOIR WATER

		$k
• Contract Labor		
+ $20/hr x 2080 hrs/y x 1½ persons x 2 yrs		125
• $BaCl_2$		
+ 10 k AF x 5 ppm $BaCl_2$ x $0.30/lb		40
• Other Materials & Supplies		
+ $20 k/yr x 2		40
• Power		
+ Warm Weather @ 1800/mo x 12		22
- 40 k KWH/Month x 2.175 ¢/KWH	$870/mo	
- 70 KW Demand x $2.86/KW	200/mo	
- 14 KW Reactive Net Demand x $0.60/KW	8/mo	
- Minimum	700/mo	
	$1778/mo	
+ Cold Weather @ 2100/mo x 12		25
- 51 k KWH/Month x 2.175 ¢/KWH	$1109/mo	
- 70 KW Demand x $3.36/KW	235/mo	
- 14 KW Reactive Net Demand x $0.60/KW	8/mo	
- Minimum	700/mo	
	$2052/mo	
• Contingency		25
TOTAL		277

March 26, 1985 TR-11 Litwin

FIGURE 1

HIGHLAND RECLAMATION SCHEDULE



o——o Stripping, Mining, Operating, and/or Processing
o----o Reclamation, Restoration, and/or Decommissioning

May 1984

TABLE 1

LIST OF NON-MONITORING WELLS

Well	State Engineer Number	Disposition
1	UW 2491	Sold to Everest Minerals
3	UW 2493	Sold to Everest Minerals
4	UW 2494	Exxon Reclaim
5	UW 2495	Exxon Reclaim
6	UW 2600	Exxon Reclaim
11	UW 14378	Exxon Reclaim
12	UW 20001, 41461	Convey to Landowner
13	UW 20002, 41462, 47770	Exxon Reclaim
14	UW 20003	Sold to Everest Minerals
15	UW 20004	Sold to Everest Minerals
16	UW 20005	Sold to Everest Minerals
17	UW 20006	Sold to Everest Minerals
19	UW 20008	Removed by Pit 3 Mining
20	UW 20009	Sold to Everest Minerals
21	UW 20010	Sold to Everest Minerals
22	UW 20011	Sold to Everest Minerals
23	UW 20012	Sold to Everest Minerals
24	UW 20013	Sold to Everest Minerals
25	UW 20014	Exxon Reclaim
26	UW 20015	Exxon Reclaim
30	UW 47768	Convey to Landowner
33	UW 43340	Exxon Reclaim
34	UW 43341	Exxon Reclaim
36	UW 43343	Exxon Reclaim
37	UW 43344	Exxon Reclaim
38	UW 43345	Sold to Everest Minerals
39	UW 49797	Exxon Reclaim
40	UW 48331	Exxon Reclaim
42	UW 48333	Exxon Reclaim
43	UW 48334	Exxon Reclaim
44	UW 48335	Exxon Reclaim
45	UW 48336	Exxon Reclaim
IX No. 1	UW 40466	Exxon Reclaim
IX No. 2	UW 51588	Exxon Reclaim
IX No. 3	UW 51589	Exxon Reclaim
Solution Mine No. 1	UW 52448	Sold to Everest Minerals

TABLE 2
TAILINGS BASIN
LIST OF EXXON MINERALS MONITORING WELLS

Well ID	Completion Zone
Water Level Monitoring	
W18	Ore Sands Aquifer
W35	Ore Sands Aquifer
W41	Ore Sands Aquifer
TDM XI	Ore Sands Aquifer
EM5	Tailings Dam Sandstone (TDSS) Aquifer
RM3	Tailings Dam Sandstone (TDSS) Aquifer
RM4	Tailings Dam Sandstone (TDSS) Aquifer
TDM IX	Tailings Dam Sandstone (TDSS) Aquifer
TDM XII	Tailings Dam Sandstone (TDSS) Aquifer
TDM XXI	Tailings Dam Sandstone (TDSS) Aquifer
Water Quality Monitoring	
RM1	TDSS
RM2	TDSS
RM3	TDSS
RM4	TDSS
TDM D_R	TDSS
TDM VI	Ore Sands
TDM VI_R	Ore Sands
TDM VII	TDSS
TDM IX	TDSS
TDM X	Fowler Formation
TDM XI	Ore Sands
TDM XII	TDSS
TDM XIX	Fowler Formation
TDM XX	Ore Sands
TDM XXI	TDSS
TDM XXIII	TDSS
TDM XXIV	Ore Sands
TDM XXV	TDSS
TDM XXVI	TDSS
TDM XXVII	Fowler Formation
TDM XXVIII	TDSS
TDM XXIX	Ore Sands
TDM XXX	Ore Sands
TDM XXXI	TDSS
TDM XXXII	Ore Sands
TDM XXXIII	TDSS
TDM XXXIV	TDSS
TDM XXXV	TDSS
TDM XXXVI	TDSS

TABLE 2A
HIGHLAND RESERVOIR
LIST OF EXXON MINERALS MONITORING WELLS

RM1	TDSS
RM2	TDSS
RM3	TDSS
RM4	TDSS
TDM XXXIV	TDSS
TDM XXXV	TDSS
XXXVII	2BFR
XXXVIII	2BFR
W-18	Ore Sands
W-35	Ore Sands
W-41	Ore Sands
W-46	Ore Sands
W-47	Ore Sands
EM5	TDSS

Note: TDSS= Tailings Dam Sandstone Aquifer
2BFR= Pit 2 Backfill

APPENDIX 3

HIGHLAND RESERVOIR

Background

From the earliest planning stages of the Highland Uranium Operations, a reclamation lake was included in the final open pit areas.

- In the Proposed Reclamation Plan attached to Permit No. 67 issued on August 3, 1970 by the Wyoming Office of State Land Commissioner, under The Open Cut Land Reclamation Act, on page 1, it was stated,

  "Stripping and mining will begin in the Phase I. pit which is at the shallow end of the ore body. The overburden from this pit will be deposited in a designated storage area or placed in the tailings dam fill area. Stripping will continue in the Phase II. pit, which adjoins the Phase I. pit. As soon as the ore has been removed from a sufficient area of the Phase I. pit, backfilling will begin using overburden from the Phase II. pit. Stripping, mining, and backfilling will continue in this manner through the ore body. The final cut will remain open and when the pumps are removed it will probably fill with water to the water table."

- In the "Applicant's Environmental Report, Highland Uranium Mill, Converse County, Wyoming" July 1971, submitted by Humble Oil and Refining Company, Minerals Department (now Exxon Minerals Company) to the United States Atomic Energy Commission, page 78, it was stated,

  "The one or two mine areas that will not be backfilled with overburden and revegetated will fill with water to the water table and become lakes. Their recreational value is being considered; but because of the time period until they will be available, no definite plans have been developed."

  In Section V, Environmental Effects Which Cannot Be Avoided, page 112, it was stated,

  "Permanent Effects

  The principal permanent environmental effect will be a change in topography. The early overburden will be placed in areas which become flatter than the original areas and higher. There will be two depressions which will form lakes when the water table returns to its original level. These lakes will be available for watering sheep or possibly for recreation."

- In the "Applicant's Response, Agency Comments on Draft Statement, Highland Uranium Mill, Docket No. 40-8102" August 1972, submitted by Humble Oil and Refining Company, Minerals Department (now Exxon Minerals Company) to the United States Atomic Energy Commission, a discussion of the residual lakes and lake quality is on pages 3 through 6. The concluding statement of this section, on page 6, states,

The principal parameters used in the study are briefly described below:

- Lake Pit Stratigraphy - The stratigraphy of Pits 3 and 4 is depicted in Figure 12 of the ERP study report. There are four sandstone and three shale layers, the shale layers separating the sandstone layers. Uranium ore deposits occur only in the three lower sandstones, namely, the 50 (Upper), the 40 (Middle), and the 30 (Lower) sandstones.

- Lake Pit Size and Shape - The size and shape of the pit in which the lake will form is shown in Figure 2 of this permit revision.

- Precipitation and Evaporation - Precipitation data from three stations in the Highland region were averaged to estimate the annual precipitation rate of 12.3 inches.

  Evaporation data from three stations in the Highland region were compared to the regional value given in the Water Atlas of the United States. The two sets of data agreed, and an annual evaporation rate of 43.8 inches was used in the study.

- Surface Water Volumes - A total surface drainage area of 3180 acres (Antelope Draw plus 840 acres) was selected as the prime option in the EPR report. An estimated annual surface water runoff rate of 6% of annual rainfall was determined in the study. Therefore, 184 acre-feet of surface runoff would flow into the lake annually, of which 144 acre-feet would be from Antelope Draw. The lake area which increases during lake filling was subtracted from the drainage area for this calculation. In the 1984 study the 840 acre drainage area will supply 40 acre-feet/year to the lake.

- Ground Water Volumes - Based on available pre-mining ground water level data, EPR constructed a ground water flow net between the regional recharge and discharge areas. The aquifers in the lake area are sandstones; permeabilities were determined from several pump tests and core analyses.

  The permeability tests support a tailings dam sand permeability of 4643 millidarcies (md) or 4.4×10^{-3} cm/sec. This value was used in the 1984 study for the tailings dam sand aquifer. A permeability of 2000 md or 1.9×10^{-3} cm/sec was used for the ore sand aquifers. The 1983 study very conservatively assumed 2000 md for all the sandstone aquifers.

  Measured permeabilities of the shale layers were extremely low, and were assigned a value of zero. Laboratory measurements indicated the sandstones have an average porosity of 30%.

  Ground water flows in and out of the lake area are schematically depicted in Figure 8 of the 1983 report.

- Backfill Characteristics - Overburden, a mixture of sands and shales, is used to cover the exposed ore zones in most locations within the lake pit. The backfill has a measured porosity of 35% and a permeability of approximately 42 md, or 4.1×10^{-5} cm/sec.

- Radium and TDS Content of Inflows - The dissolved radium and total dissolved solids content of the various waters entering the lake are listed in Tables C.1 through C.8 of the EPR study report. These values are based on local field measurements from specific aquifers at Highlnad and information from the Wyoming Water Resources Research Institute.

Summary Results Of The Lake Study

- The 1984 study concluded that good water quality could be achieved without the Antelope Draw diversion into the lake. It will be necessary to restrict pit wall sloping to 50% of the lake shore as depicted in Figure 2.

- Surface Elevation - Table 3 of the 1984 study shows the water elevation of the lake at 2000 years. The steady state water elevation is 5119 feet, which is predicted to be reached in 60 years. The lake fills more rapidly in the early years, reaching 5079 feet, the base of the 3-to-1 slopes, in less than 25 years.

- Radium Content Of Lake Water - The ore sandstones in the pit walls will be covered with overburden on most of the western walls where ground water flows in. Portions of the pit bottom lower ore sand will not be covered with overburden. Although this contributes to the dissolved radium in the lake water, the inflow of the low-TDS ground water from the lower sandstone is needed to maintain acceptable TDS levels in the lake water. The basis for this decision is discussed in Appendix F to the study report. As sediments are deposited in the lake, the radium contribution to the lake water from the ore body sandstone at the bottom of the pit decreases.

  Initially, the dissolved radium concentration of lake water will be approximately 20 pCi/l; analyses of samples collected from the pond currently forming in the pit support this value. The dissolved radium concentration will decrease to less than 5 pCi/l within a few years. The dissolved radium content of lake water will remain at this approximate concentration for about 70 years and slowly increase to 14 pCi/l in 700 years.

  Graph 20 of the 1984 study report shows the predicted relationship between time and dissolved radium content of the lake water (with and without the Antelope Draw diversion).

- Total Dissolved Solids Content of Lake Water - The initial TDS concentration of the lake water is predicted to be approximately 370 mg/l. The TDS concentration will increase to a maximum of approximately 4763 mg/l in about 2000 years.

  Graph 21 of the 1984 study report shows the predicted relationship between time and TDS content of the lake water (with and without the Antelope Draw diversion).

"Thus, no uranium minerals will be exposed to atmospheric oxidation and the water which fills the reclaimed pit should not contain radioactive materials in excess of the MPC for discharge in unrestricted areas."

This MPC for Ra-226 is defined by the USNRC in 10 CFR Part 20.106, Table II, Appendix B, Radioactivity in Effluents to Unrestricted Areas, as 30 pCi/l.

- In the "Final Environmental Statement Related to Operation of the Highland Uranium Mill," March 1973, prepared and issued by the United States Atomic Energy Commission, two lakes are referenced on page 50:

"Since water pumping will have ceased, the water table will return to its normal level producing two lakes with ground water and rainfall. The northern most of the two lakes is located on a topographic high and will therefore collect no runoff or sediment. The lake created to the south is in a drainage path and would collect sediment. The drainage area from which water will flow into the southern most lake was measured to be 2,500 acres."

The US AEC Final Environmental Statement was an attachment to the Reclamation Plan, Permit Application to Wyoming Department of Environmental Quality, March 12, 1974.

- In Permit 218C, issued November 26, 1974 by the Wyoming Department of Environmental Quality to Exxon Company, U.S.A. the final lake is addressed in the Reclamation Plan. On page 2 of the Application, it is stated,

* "A paved highway system will provide easy access and the two lakes created by the final pits could be used for fishing, boating, and water sports."

On page 9 of the Application, it is stated,

"The lake left at the end of the mining project will fill the remaining pit up to the natural water table."

Additionally, the reclamation lake is shown on the 1" = 500' attached map, Final Plan Map Showing Proposed Approximate Contours.

Therefore, the final reclamation lake has been included in the conceptual reclamation plans from the earliest thinking, and is approved in Mining Permit 218C. However, the specific characteristics of this lake, including its shape, size, filling rate, and specific water qualities were not completely addressed in these original documents. The attached studies, "Surface Mine Reclamation Lake Study for Highland Uranium Operations" (April, 1983) and "Reclamation Lake Water Quality for Highland Uranium Operations" (May, 1984) do address these subjects.

Objectives Of Lake Study

In early 1981, project economics dictated that Pits 3 and 4 would be the final open pits. With the approximate final configuration known, Exxon initiated a hydrologic study with these objectives:

- determine position and configuration of in-pit overburden stockpiles (barrier dumps) that would result in the best achievable water quality

- predict with hydrologic modelling the lake filling rate, final water elevation, changes in water quality, and ultimate lake water quality

- determine the minimum surface water addition that is required to achieve ultimate water quality below 5000 ppm TDS and Ra-226 below 30 pCi/l.

- evaluate sensitivity of the lake to changes in input parameters.

The lake study was started in early 1981 and completed in April 1983. Exxon Production Research Company conducted the investigation. EPR is an affiliate of Exxon Corporation with responsibility for research, development, and engineering studies relating to discovery and production of petroleum, oil shale, coal and other minerals. EPR performs research application work for the operating affiliates of Exxon Corporation worldwide, covering exploration (geology, geophysics and geochemistry), drilling, mining, production, pipelines, offshore operations, reservoir analysis, and arctic development.

In 1983 additional mineable reserves were identified in the west end of Pit 4 below another mining area. This additional mining caused minor adjustments in the lake size and shape.

This change in plans triggered the 1984 study to identify the effect on lake water quality of this mining. At this time we took the opportunity to reevaluate the permeability of the principal aquifer feeding the lake as it was felt the original study had been overly conservative. That is, in all cases where a range of numbers was available for the lake modeling parameters, the numbers used in the model were always selected to the side of the average which would yield higher TDS and radium 226 concentrations. This consistent conservatism in all factors resulted in a lake model which overpredicted TDS and radium 226 concentrations.

This conservatism was far in excess of customary and was reduced in the 1984 study by removing it from one factor, the permeability of the tailings dam sand acquifer. The benefit of this change was to reduce the lake drainage area needed to maintain TDS and Ra-226 concentration below 5,000 ppm and 30 pCi/l, respectively.

The 1984 study also discovered an effect of pit wall sloping not identified in the 1983 study. The earlier study assumed incorrectly that none of the tailings dam sand acquifer would be covered by wall sloping. This was discovered and corrected in the 1984 study.

Summary of Lake Study

EPR developed a lake simulation computer program (LSP) to model the final reclamation impoundment. Input data were collected by the Highland Uranium Operations staff from field studies or obtained from reputable references. EPR also conducted various laboratory analyses of soil characteristics to establish applicable study parameters.

Radiological Assessment Of The Lake Water

The ultimate dissolved radium content of the lake water is 13 pCi/l, approximately one-half the NRC's maximum permissible concentration (MPC) for discharge to unrestricted areas which Exxon originally committed to achieving. Exxon assessed the associated radiological impact on humans of this radium concentration. This assessment shows that the maximum radiation dose to humans resulting from the 13 pCi/l lake water amounts to only a small fraction of either the regulatory limit or that due to natural radiation sources. This assessment is found in Appendix 4.