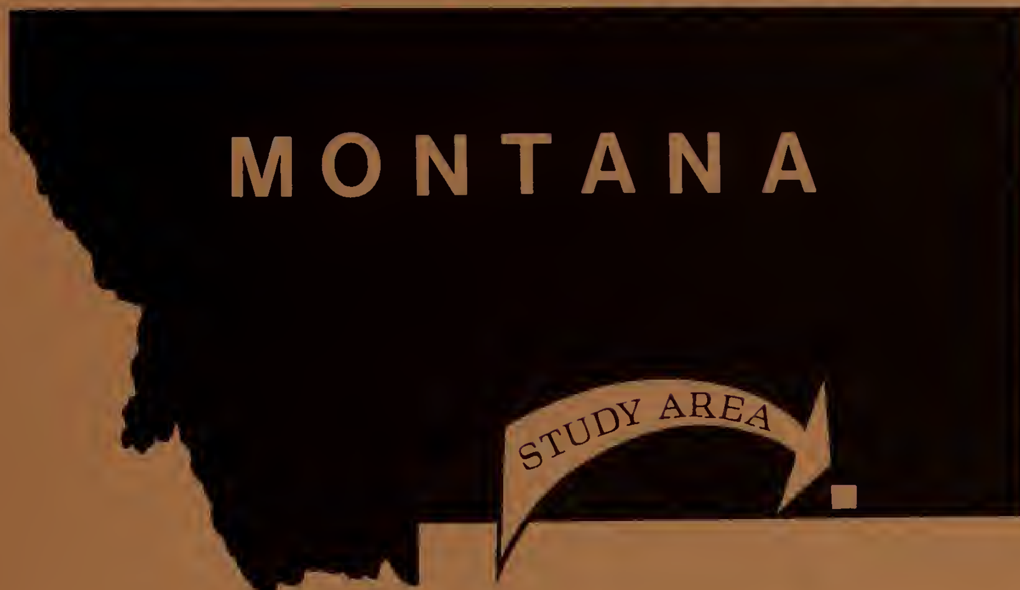
SUMMARY



RESOURCE and POTENTIAL RECLAMATION EVALUATION

BEAR CREEK STUDY AREA –WEST MOORHEAD COALFIELD

EMRIA REPORT #8 1977

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT
BUREAU OF RECLAMATION
GEOLOGICAL SURVEY

EMRIA
(Energy Mineral Rehabilitation Inventory and Analysis)

EMRIA is a coordinated approach to the collection, analysis, and interpretation of overburden (soil and bedrock), water, vegetation, and energy resource data. The main objective of the effort is to assure adequate baseline data for choosing reclamation goals and establishment of lease stipulations through site-specific preplanning for surface mining and reclamation.

These reports are prepared through the efforts of the Department of the Interior principally by the Bureau of Land Management, Bureau of Reclamation and Geological Survey. Assistance is also provided by other Federal and State agencies.

Reports under this effort are:

EMRIA Report	Location
1	Otter Creek Montana
2	Hanna Basin, Wyoming
3	Taylor Creek, Colorado
4	Alton, Utah
5	Bisti West, New Mexico
6	Foidel Creek, Colorado
7	Red Rim, Wyoming
8	Bear Creek, Montana

SUMMARY
BEAR CREEK STUDY AREA
WEST MOORHEAD COALFIELD, MONTANA

INTRODUCTION

This summary presents a brief nontechnical discussion of the detailed studies on the Bear Creek Study Area. Backup data may be found in the main report. The study area is located in Powder River County, Montana, and is comprised of about 3,200 acres including all or parts of Sections 33 and 34, T. 8 S., R. 45 E., and Sections 2, 3, 4, and 11, T. 9 S., R. 45 E., Montana, Principal Meridian. The general location is shown on plate 1. Area topography and specific locations are shown on plate 2. Photograph 1 presents an aerial view of the study area.

CLIMATE

The Bear Creek Study Area has a continental climate with cold winters, warm summers, and large variations in seasonal temperatures and precipitation. The area is semiarid.

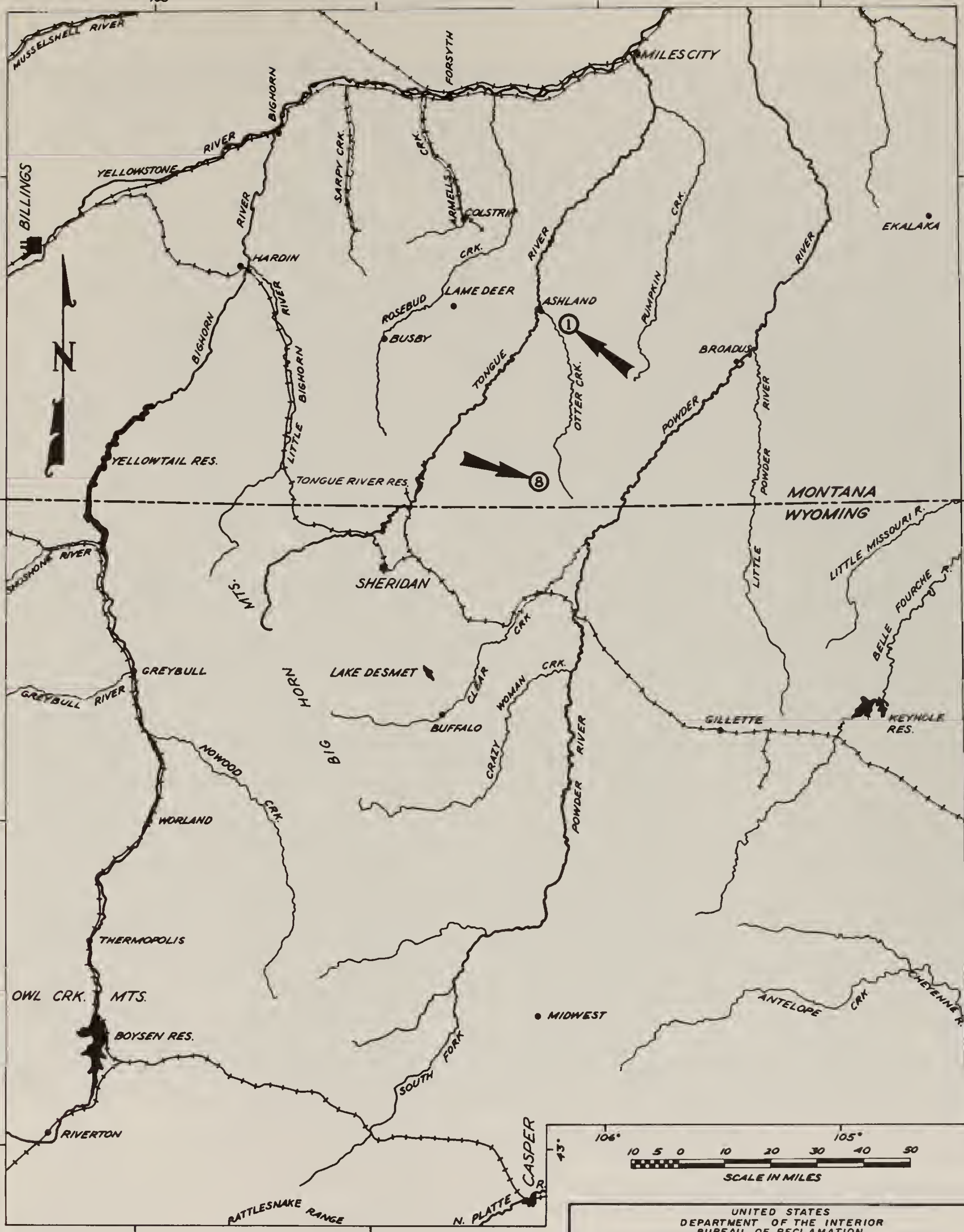
Mean temperatures vary between 19.4^{o} F in January to 71.2^{o} F in July with extremes of 109^{o} F and -44^{o} F having been recorded. The frost-free period at Otter, the nearest weather station, averages 127 days. The growing season for hardy crops (28^{o}) is about 147 days between early May and early October. The growing season for native grasses in the area normally begins late in April and ends about July 15 when the available moisture is consumed.

Annual precipitation averages 15 inches in the vicinity of the study area. Much of the moisture comes in the spring and early summer. Even though mean annual precipitation appears to be adequate for reclamation, the occurrence of a year receiving less than 10 inches is about 10 percent.

The climate in the Bear Creek area is generally conducive to revegetation of disturbed land with adapted plant species. Soil moisture is high during the early growing season and plant growth is rapid. In normal years most adapted plants can be established before the soil moisture is depleted. However, reclamation plans must consider the long period of moisture stress in the summer, frost hazards in the fall and spring, cyclic dry years, severe thunderstorms, and moisture depletion by winds. Good planning and management can do much to prevent or reduce these hazards.

PHYSIOGRAPHY

The study area is located on the upper reaches of the Bear Creek drainage tributary of Otter Creek which joins the Tongue River near Ashland, Montana. The area is part of the unglaciated portion of the Great Plains Physiography Province. It is characterized by moderately dissected continental deposits of shale, siltstone, sandstone, and coal. Resistant sandstone caps isolated buttes and benches along drainage divides.



① OTTER CREEK STUDY SITE - EMRIA NO. 1

⑧ BEAR CREEK STUDY AREA - EMRIA NO. 8

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RESOURCE & POTENTIAL RECLAMATION EVALUATION
EMRIA STUDY AREAS
MONTANA–WYOMING

GENERAL LOCATION MAP

DESIGNED ____ SUBMITTED ____
DRAWN G. TAUCHER RECOMMENDED ____
CHECKED ____ APPROVED ____
BILLINGS, MONTANA MARCH 1976 | 1305–600–35

Plate 2

GN
MN
0°50'
15 MILS
15°
267 MILS

UTM GRID AND 1972 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 20 FEET

MONTANA

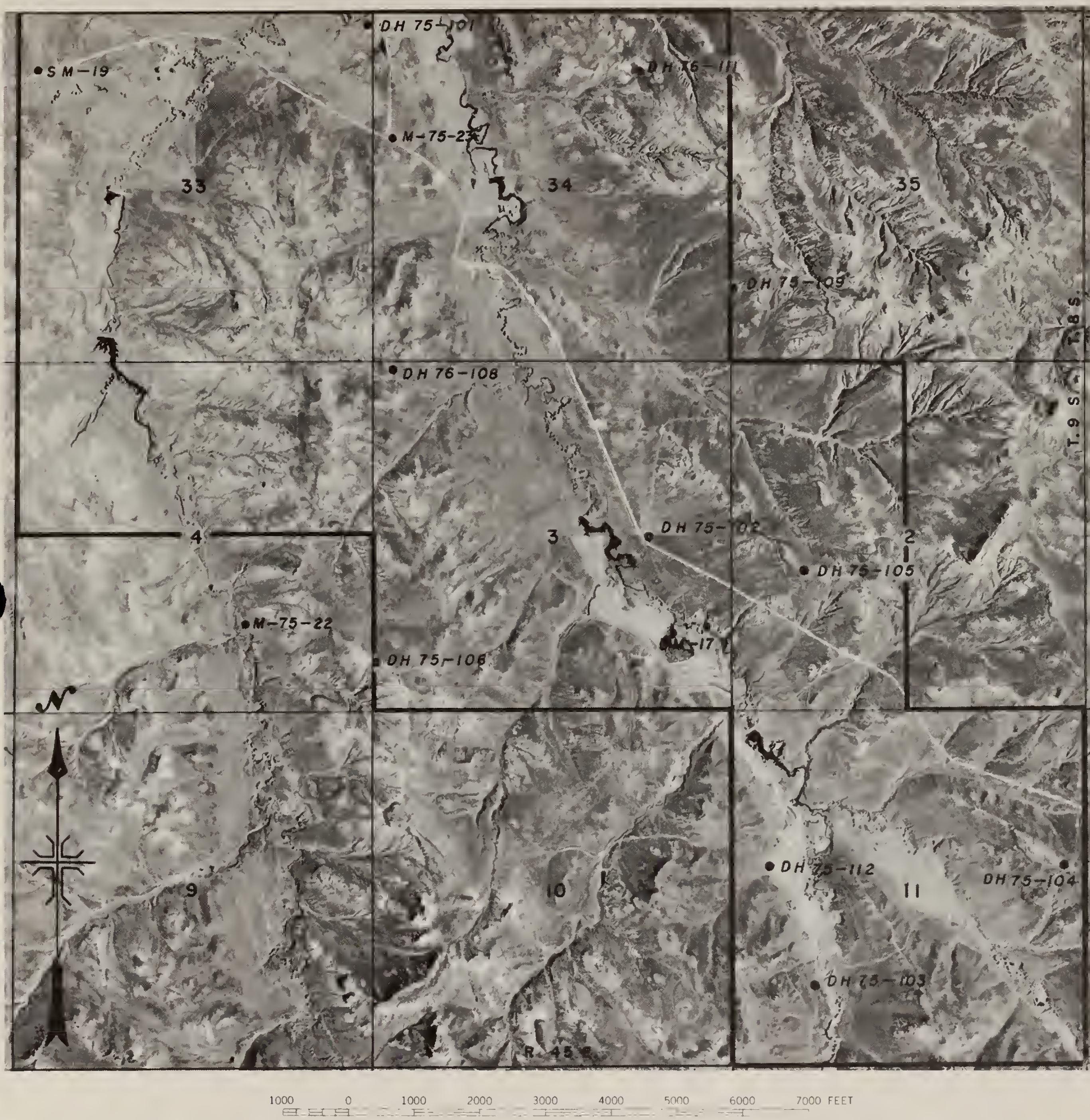
QUADRANGLE LOCATION

PORTION OF U.S.G.S. BEAR CREEK SCHOOL QUAD.

RESOURCE & POTENTIAL RECLAMATION EVALUATION

BEAR CREEK STUDY AREA
WEST MOORHEAD COAL FIELD, MONT.

TOPOGRAPHY



Photograph 1 - Aerial view of the Bear Creek Study Area (outlined by heavy line). This photograph is a portion of the Bureau of Land Management Photograph 089 (6/1/72).

Slopes become progressively steeper away from valley floors. Surface gradients range from 1 percent along valley flood plains to 35 percent on the flanks of buttes. Elevations vary from 3740 feet on Bear Creek at the north edge of the area to over 4100 feet on a topographic high immediately east of the area.

GEOLOGY

The Bear Creek Study Area is underlain by the Tongue River member of the Fort Union Formation which consists of a series of soft siltstones, shales, and weak to moderately cemented sandstones. Beds of carbonaceous shale and coal of varying thicknesses occur throughout the member. Clinker, produced by burning of coalbeds, crops out along the walls of stream valleys throughout the area. On the Bear Creek drainage, burning of the Anderson coalbed has produced thick deposits of clinker.

Three major coalbeds, Anderson, Dietz, and Canyon, underlie parts of the study area within 200 feet at the surface. The Anderson bed, which is the youngest stratigraphically, averages over 25 feet thick. The Dietz and underlying Canyon coalbeds average about 10 and 22 feet in thickness, respectively.

COAL RESOURCES

The coal resources measured, indicated, and inferred for the Anderson, Dietz, and Canyon coalbeds under less than 200 feet of overburden is 165,800,000 tons. Stripping ratios of coal seams within 200 feet of the surface are 2.7, 12.3, and 7.3 cubic yards of overburden per ton of coal for the Anderson, Dietz, and Canyon coalbeds, respectively.

Analyses of coal are not available from the Bear Creek Study Area itself, but the three potential surface mineable beds in the area have been analyzed at many places in the surrounding area. The Anderson, Dietz, and Canyon coalbeds, on an as-received basis, commonly range in heating valve from 7,700 to 9,000 Btu, in sulfur content from 0.15 to 0.5 percent and in ash content from 3.0 to 5.0 percent. The coal is all subbituminous C in rank.

Trace element data have been compiled on the Anderson, Dietz, and Canyon coalbeds or their equivalents in the northern part of the Powder River Basin. Concentrations of trace elements are not unusual when compared to those in coals in other regions.

HYDROLOGY

Streams in the Bear Creek Study Area flow intermittently, mostly in response to spring runoff. Shallow water also occurs in alluvium, clinker, and permeable units of the Tongue River Member of the Fort Union Formation. Movement of water through the Tongue River Member is controlled by topography, structure, and thin confining layers.

Water quality is variable and depends on the conditions of surface runoff and ground water recharge and movement. Water quality in the shallow aquifers in the Bear Creek area changes as the water moves from areas of recharge.

Mining of strippable coalbeds in the Bear Creek area will partially drain water from the coalbeds, saturated overburden, and alluvium. Eight shallow stock wells and one domestic well could be dewatered. Aquifers beneath the mined coal are not expected to be adversely affected. In addition, mining will cause Bear Creek and its tributaries to become losing streams near mine cuts. Mine inflow and mine drainage volumes are expected to be low, however.

Post-mining monitoring in mine spoils will be necessary to determine the effects of spoils on the quality of water recharged to subjacent aquifers.

VEGETATION, SOIL-WATER-VEGETATION RELATIONSHIPS

The vegetation is mainly grassland with scattered types dominated by shrubs. Ponderosa pine savannah occupies highlands near the fringes of the study area. The most abundant grasses are western wheatgrass, green needlegrass, bluebunch wheatgrass, and blue grama. Many northerly-facing slopes have stands of big sagebrush with an understory of bluebunch wheatgrass. An extensive vegetation type on relatively steep, lower slopes has mixed stands of little bluestem, bluebunch wheatgrass, blue grama, and needle-and-thread. Present flood plains have a cover of silver sagebrush with an understory of green needlegrass. Western wheatgrass and blue grama are dominant on gentle, lower slopes. Much of the valley floor area is used as flood irrigated hay meadows. A mixture of introduced and native grass species occur in the meadows, and western wheatgrass and green needlegrass occur on valley floor areas that are used as rangeland.

Kinds and productivity of vegetation in the area are influenced by quantities of soil moisture, which are controlled, in general, by the distribution and depths of snow and by amounts of run-in water from upslope areas. Maximum soil-moisture storage apparently is achieved during the peak of the spring rainy season. Quantities of soil moisture are least on the steeper areas where little bluestem, winterfat-blue grama and breaks type vegetation occur. The breaks stype vegetation is dominated by bluebunch wheatgrass, stonyhills muhly and snakeweed. Quantities of soil moisture are greater on gently sloping areas of lower hillslopes and on valley floors which receive run-in water from upslope. The associated vegetation types are big sagebrush-bluebunch wheatgrass, green needlegrass-western wheatgrass, and western wheatgrass-blue grama. Areas with the most soil moisture are in drainageways and on flood plains where the vegetative cover is silver sagebrush and green needlegrass.

Voids facilitate infiltration of water into a soil profile. The amount of voids required to permit rapid infiltration can be computed when the moisture-retention capability of the soil is known. Soil moisture-retention characteristics can be approximated either in the field or in the laboratory.

Infiltration rates are moderate and are estimated to be about 5 centimeters per hour for most of the soils. Rates on sandy channel beds and on areas of baked sandstone and siltstone probably exceed 20 centimeters per hour. Rates for shale-derived soils on steep slopes are probably less than 1 centimeter per hour.

SEDIMENT YIELDS

Annual source-area sediment yield estimates on the study area vary from none to about 2 acre-ft/mi^2 (acre-feet per square mile). Yields from most of the area are low to moderate and less than 0.5 acre-ft/mi^2. Differences in the slope of the land and associated amounts of vegetation and rock cover appear to be the main factors causing the variations in sediment yields. There is very little channel erosion in the study area.

Estimated sediment discharges from drainage basins are low to moderate. Yields range from 0.1 to 0.35 acre-ft/mi^2 for basins that are about 3 to 8 square miles in area. Yields range from 0.04 to 0.5 acre-ft/mi^2 for smaller drainage basins, 0.2 to 1.4 square miles in area.

SOILS

Soil and Bedrock Material

Description of Principal Soil Bodies

Soils in the Bear Creek Study Area can be placed in three major categories based primarily on their parent material, mode of development, and land form. These are: (1) terrace soils, (2) colluvial soils, and (3) residual soils.

The terrace soils, which comprise about 43 percent of the study area, are generally a medium textured, brownish-gray material with moderate to moderately well developed structure. These moderately permeable soils form on deep alluvium. The infiltration and moisture retention capacity are adequate for most of the precipitation to enter and be retained by the soil.

The stronger developed profiles, which constitute the majority, are usually noncalcareous and nonsaline to a depth of 18 to 24 inches, but the lower horizons and parent material may contain much soluble salt and are moderately calcareous. This soil group is generally nonsodic.

Soil in this group will provide a plentiful source of moderately good to good planting media for revegetation.

The colluvial soils, covering only 10 percent of the area, are derived from slope wash materials along the side slopes of valleys. These soils are usually light brownish-gray and have a medium to fine texture. Erosion has been an important factor in the development of these soils, Immature profiles are common.

Permeability is moderately slow but the infiltration rate is adequate to retain much of the precipitation, except on the steeper slopes where considerable runoff and erosion occurs. The available waterholding capacity of disturbed material is adequate for any projected use.

The colluvial soils are slightly to moderately saline with large amounts of soluble salts in the subhorizons and parent material. Sodium is not a major problem. Because of salinity and depth, these lands are only moderately well to poorly suited as a source of plant media for revegetation.

The ridge crest and steeply sloping land with residual soils comprise about one-half of this area. These soils are generally 20 inches or less in depth over shale. Surface erosion is moderate to severe and is an important factor in soil development and depth of the soil mantle. Because of the erosive forces, there is a close chemical and physical relationship between these immature soils and the weathering parent material.

The soil texture of these calcareous soils is medium to moderately fine. Soil colors are quite variable and range from a light gray to a light yellowish-brown.

Although the surface infiltration is adequate, the internal drainage retards water movement and there is much runoff and erosion. This shallow soil group is usually nonsodic but may contain large amounts of soluble salt in the subhorizons and parent material.

Shallow depth, salinity, and bedrock outcrops make these lands a poor source of resurfacing material.

Land Suitability

A detailed land classification survey was used to evaluate and characterize the overburden quantity and quality for revegetating the area if it is surface mined.

The land classification specifications established four land classes, 1, 2, 3, and 6, to group land of equal suitability for the specific use of revegetation. Class 1 lands provide the most desirable and plentiful source of easily stripped revegetation material. Land in this class may have surplus suitable material that can be used in deficient areas. Class 2 lands have adequate resurfacing material but of lower quality or more difficult to strip and handle. Class 3 lands are marginally suitable but can meet the planting media needs for their revegetation. Class 6 lands do not have adequate suitable material, and it will be necessary to borrow or modify material to revegetate the area.

The results of the land classification survey expressed as the percent of the area follows: Class 1 - 32; Class 2 - 32; Class 3 - 24; Class 6 - 10; and RsOW and homestead 2.

Bedrock Suitability

The consolidated bedrock in the Bear Creek area is generally unsuited for use as plant media at or near the surface of reconstructed land in surface mined tracts. However, most bedrock profiles do contain some

layers of suitable material, also some material that may be susceptible to modification if usable material is critically short in localized tracts. Modification methods that may be effective are leaching, mixing, weathering, and soil amendments. The principal limiting factors are structure instability, high clay content, slow permeability, low cation exchange capacity, and erosiveness.

Soil Inventory

A detailed toxonomic soil inventory was made in the Bear Creek Study Area to obtain soil, land use, and environmental data. Data from the inventory will be used to develop multiple resource management plans for use prior to surface mining. The mapping units are evenly divided between Aridisols and Entisols, but the areal distribution of the Entisols is much greater.

GREENHOUSE

Most bedrock samples from the Bear Creek area, 87 percent, produced high or medium yields under controlled conditions. However, the majority of the samples would be unsuited for use as plant growth media. Most of the material is fine-textured and has salinity and sodium problems.

Samples from the soil mantle in the Bear Creek area are suitable for use as plant growth media. With one exception, the surface samples yielded in the high range. Subsurface material from deeper than 36 inches is variable and ranges from nonsaline-nonsodic to saline-sodic. The latter is unsuited for use as plant growth media unless it is susceptible to modification.

ALTERNATE OBJECTIVES OF RECLAMATION

Three reclamation objectives and non-mining were considered as possible alternatives for the Bear Creek Study Area. The non-mining option was considered unacceptable because of the need for energy and indication that the area could be reclaimed if surface mined.

Objective No. 1 would return the area to its present condition. Because of the difficulty and impracticality of restoring an area to its exact premining condition, this objective was not acceptable for the Bear Creek area.

Objective No. 2 would provide a relatively uniform layer of suitable material spread on spoils reshaped to the desired topographic relief. This would provide adequate potential for revegetation with native grasses and satisfy most environmental requirements. Agricultural potential of some lands would be degraded but some would be improved. Following placement of the surface material applicable seedbed preparation and planting methods would be used to establish native grass and designated plant species.

Objective No. 3 is similar to No. 2 but where possible most areas deficient in surfacing material would be improved by borrowing material from deep soil areas. The idealized objective would reconstruct profiles in most areas that would be capable of maximum agricultural productivity attainable in this climatic area. Legal limitations on transporting material across ownership lines, distance from deficient tracts to available material, and overall economic limitations will prevent attainment of the idealized conditions.

Reclamation and revegetation plans for the Bear Creek area should consider combination of Objectives No. 2 and 3. Present productive capacity of the better soils would be retained and tracts of many low quality range would be improved.

RECOMMENDATIONS FOR RECLAMATION

Reclamation plans must conform to the Montana State law which requires a return of surface-mined lands to approximately their natural state, revegetating with principally native plants on slopes with similar gradients to premining conditions but not exceeding 20 percent. Profile improvement to increase agricultural productivity is permitted and should be considered and incorporated where applicable in each reclamation plan. Safeguards to prevent deterioration of water resources must be implemented.

Toxic material must be placed 8 feet below the surface. Highly saline material is not considered toxic if placed in the subsurface position below the primary plant root zone.

Surface Shaping and Revegetation

Successful revegetation of surface-mined land requires: (1) selection and placement of suitable overburden material; (2) proper shaping of the area surface; (3) selection of adapted species; (4) use of proper seed-bed preparation and planting procedures; (5) application of fertilizer and/or soil amendments, and (6) management of the revegetated area until the vegetation is permanently reestablished.

The land classification survey indicates there is an adequate amount of suitable soil material for revegetation in the Bear Creek area. However, material used in the subsoil position will usually be moderately to highly saline. Bedrock material will normally not be needed for use on the surface, but it may be needed for the subsoil and substratum in reconstructed profiles. Although there is adequate soil material, some borrowing or modification of material will be required to revegetate the very shallow soil areas. Material for surface use, usually from the upper 12 inches of the soil profile, and material for subsurface use should be stripped and stockpiled separately.

Premining planning should determine the surface relief required to enhance infiltration and retention of precipitation, promote leaching and reduce runoff and erosion. Grading of spoils into slopes compatible

with the adjacent unmined area would help re-establish the present snow distribution and run-in patterns. Changing the configuration of the land surface would change quantities of water available for storage in a given soil material.

Both spring and fall planting are successful in this area but fall planting on fallow land reduces plant competition and the hazard from wind and water erosion. Preplanting surface preparation and planting procedures presently being used successfully in reclamation work should be selected for compatibility with the material in the reconstructed profile and surface relief. This may include disking, ripping, contour planting, pitting, gouging basins or a combination of these and other practices. Species for planting and planting rates should be determined locally by the agency that will administer the land during the reclamation period.

Separate stockpiling of soils with distinctly different vegetation covers has been recommended. This material would then be replaced on similar slopes and position returning the area to an as is condition, Under current State law and mining practices, this is not an acceptable option.

Sediment Control

Source-area sediment yield will be increased slightly to moderately during the mining and rehabilitation periods. The intensity of sediment-control measures will determine how much, if any, additional sediment would be discharged to the main channel of Bear Creek, Temporary reservoirs and/or water spreaders may be necessary to trap sediment from flows occurring before areas have been graded, surface treated and seeded, or from flows caused by unusually heavy storms that may overtop furrows or pits during the rehabilitation period. Grassed drainageways if used in the reclamation plan should be constructed sufficiently wide to prevent channel erosion and to promote uniform deposition of sediment that will maintain the designed gradients of the drainageways.

Assuming that the area will be returned to rangeland and hay meadow uses, the measures recommended for revegetation should be used as needed.

Infiltration and Soil Detachability

Reestablishment of voids in compacted areas should be accomplished early in the rehabilitation period to increase infiltration. The required voids could be created either by holding precipitation in small gouged pits or contour furrows or by repeated sprinkler irrigations at controlled rates until voids are established.

Measurements in flowing water indicate that the detachability of alluvial colluvial soils increases with depth in the soil profile. Consideration

of stockpiling these soils by horizons and replacing them as they existed before mining was covered in the report. However, the upper soil horizon are only a few inches thick and under present State law and mining practices this is not considered to be a viable option.

Hydrology

To reduce impacts of surface mining on the area hydrology the following suggestions should be considered and used where applicable: (1) divert natural floodwaters around mined areas to maintain natural sediment load, (2) isolate toxic materials to prevent their saturation by surface and subsurface waters, (3) monitor streamflow, quality of surface and subsurface waters, and water levels in shallow aquifers before, during, and after mining to ensure that problems beyond those predicted will be observed, and (4) determine the availability of aquifers for replacement of wells affected by mining activities.