INTRODUCTION

The material hereby submitted constitutes an initial response to the Office of Surface Mining's "Apparent Completeness Letter," dated March 20, 1980. This submittal is to provide sufficient information and detail in order that the completeness of the filed plan can be reevaluated, as well as provide a schedule of the work to be completed during the summer of 1980. It is the intent of the Applicant to submit, by April 15, 1980, a formal Addendum which will contain: 1) the initial response information, as well as other information which may be available at that time; 2) replacement pages for all affected portions of the previously filed plan.

The material comprising this initial response is arranged in the order in which the section and items were presented in the "Apparent Completeness Review." Blue pages denote major section headings, e.g., Cultural Resources, Hydrology and Geology, etc., and the yellow pages separate responses to the items under each section.

The material presented in this initial response is intended to replace or supplement the previously filed and amended plan. Any inconsistencies between the material hereby submitted and the filed plan will be corrected in the formal Addendum. All maps or drawings submitted in this initial response will be correctly renumbered to maintain the numbering sequence in the previously filed plan.

INITIAL RESPONSE
TO
THE OFFICE OF SURFACE MINING'S
APPARENT COMPLETENESS REVIEW

- SKYLINE MINES PROJECT -

MARCH 27, 1980

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OFFICE OF SURFACE MINING - APPARENT COMPLETENESS REVIEW LETTER

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United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

OFFICE OF THE REGIONAL DIRECTOR

20 MAR 1980

Mr. Vernal Mortenson
Coastal States Energy Co.
7 Greenway Plaza
Houston, Texas 77046

Dear Mr. Mortenson:

We have reviewed the mining and reclamation plan for the proposed Skyline Coal Mining Project which was received by the Office of Surface Mining on November 17, 1979. Our review has been conducted pursuant to the Permanent Regulatory Program (with appropriate cross references to 30 CFR 211 which incorporate the Interim Regulatory Program), to determine if the submitted mining and reclamation plan is sufficiently complete so that OSM may proceed with a detailed technical review.

Based on this review, we have found the plan to be incomplete. When the deficiencies identified in our review are corrected, we will be able to schedule the more detailed technical analysis. (The technical analysis would be prepared to determine if the plan meets the requirements of SMCRA and appropriate regulations.) Other items in the plan have been found to be "complete"; however, this does not imply that the information submitted has been determined to be in compliance with SMCRA and the applicable environmental performance standards. OSM may request additional information on these complete portions as well as resubmitted information once the technical and environmental analyses are underway. We will be reviewing your mining and reclamation plan and our subsequent action on the plan in accordance with the National Environmental Policy Act (NEPA).

The attached list identifies those areas that are incomplete. The most significant of the deficiencies are denoted by an asterisk. We have referenced the particular sections of the regulations to provide further guidance in developing a complete plan.

We believe it would be to your advantage to continue to use the Permanent Program regulations as your guide in preparing your plan, as eventually these regulations or a State equivalent of them will be applicable to the proposed

Skyline Mine. However, if for any reason Coastal States Energy and Getty Mineral Resources does not agree with this approach, please advise us accordingly.

If you have any questions concerning our initial review or subsequent steps to take, please contact me or my staff.

Sincerely,

Don Crane

DONALD A. CRANE

Enclosure

cc: Ron Daniels
Reed Christensen, FS
Jackson Moffitt, USGS

Attachment
Apparent Completeness Review
Skyline Mine Project

Cultural Resources

Sections 783.12, 784.17 (211.4(d), 211.10(c))

* 1. The applicant must provide documentation that the Utah State Historic Preservation Officer (SHPO) has concurred with the assessment that sites AERC 270/U1 and AERC 270/U2 are not eligible for listing in the National Register of Historic Places. Such concurrence must show that the Utah SHPO has approved and accepted the reports in order for OSM to begin the Section 106 consultation process.

* 2. The applicant must provide one map which illustrates the following for the entire mine plan area:

a) All sites and isolated finds located;

b) The perimeters of all areas intensively inventoried; and

c) All areas of proposed surface disturbance over the life of the mine (e.g., roads, powerlines, conveyor routes, mine facilities, loadouts, portals, etc.).

3. The applicant must provide a quantitative estimate of subsidence over the life of the mine.

Hydrology and Geology

Sections 783.14(a), 784.14, 783.15(a)(1) and (b), 783.16, 784.16 (211.10(c), 211.40(a))

1. The description of geologic conditions in the application should include an evaluation of potential geologic hazards (i.e., area of rock fall and slumps in the mine plan area) in relationship to proposed structures and facilities and the area (Section 22 and 27) around Electric Lake in Huntington Canyon.

* 2. The applicant must identify any areas where ground water will be intercepted by face-up activities. Vague statements about some-but-little water being intercepted by the mine are insufficient.

* 3. The applicant's cross-sections and structure contour maps drawn on coal seams give an unnecessarily vague picture of the groundwater hydrology. Isopach maps of affected aquifers (Aberdeen SS and Star Point SS) should be included with the plan to be used with the existing structure contour maps of the coal seams. A map of the potentiometric surface of the confined water system and water table contour map of unconfined systems should be included.

* 4. No baseline data on groundwater quality is given from the wells, citing the difficulty of obtaining proper well completions; however, 4 of these wells are listed as sources for the monitoring program. The wells should qualify

for both or neither, and the aquifer being tested should be identified. The applicant should describe the test well design and sampling procedure. Potential acid-forming, toxic-forming, or alkalinity-producing material above and below the coal seams (e.g., ~25 feet above and 25~ feet below) should be identified and included in the mining plan.

5. The applicant should submit a single map at a scale of 1:100,000 or more detail showing the regional drainage and stream classification. The narrative to this map should identify water quality and physical characteristics of the streams.

* 6. The applicant must supply alternative water supply information for the holders of water rights that would be affected if reclamation of the Skyline mine was unsuccessful (i.e., if the sediment ponds were to fail to control TSS from the mine or load out facility or if revegetation was to fail and erosion ruined the water supplies) or if mining adversely affected flow from springs and seeps. Specifically, the application must discuss the potential effects of underground mining on the two springs located adjacent to the northeast corner of the lease area (Plate 9, Vol. A-1). Mitigation for these springs should be addressed.

* 7. The applicant must submit detailed plans for the design of sediment ponds prior to the consideration of the mine plan. If such plans are not submitted, a schedule for their submission must be supplied with the realization that no approval of this mining and reclamation plan will occur until such plans are submitted and evaluated.

8. The applicant should supply the source of its hydrograph and/or runoff data and supply references for using specific SCS runoff curves.

9. The applicant should supply a quantitative basis for its lack of water treatment facilities for mine discharge water.

Alluvial Valley Floors

Section 785.19(c)

* 1. The applicant should submit all available site-specific precipitation data to confirm (or deny) the generalized precipitation data given in Jeppson et al. (1968).

* 2. The applicant should also supply information which describes any flood irrigation practices taking place on drainages similar to these in the mine plan area in the general region of the Skyline Mine.

* 3. The applicant should submit information which compares the productivity of lowland (valley floor vegetation) with upland vegetation to demonstrate that the lowland vegetation does not take advantage of additional water (either through subirrgation and/or flood irrigation) so as to result in increased productivity.

Vegetation and Revegetation

Sections 782.17(a), 783.19, and 783.20(779.20) (211.10(c))

* 1. The applicant should supply data on the occurrence of the threatened and endangered (and rare) plant species occurring in the region in the zones represented by the mine area. If such plants do not occur in the mine area some indication of the techniques of search or measurement should be included in the plan.

* 2. The applicant must supply data showing detail on the potential for competitive replacement of native species by introduced species from the proposed seed mixture.

* 3. The applicant should supply data showing potential productivity of the proposed introduced species and give information demonstrating the stated acclimitization of the seed types to be used.

4. The number of surface acres which are anticipated to be disturbed is not clear. The application indicates different acreages on pages: 1-21, vol. 1; 1-22, vol. 1 (2 places); and 3-57, vol. 2.

* 5. The applicant should supply information on soil/plant associations on the mine plan and permit areas (soil series should be identified).

6. Maps should delineate topographic features or cadastral location in order to properly locate soil/vegetation associations on proposed surface disturbance areas.

Fish and Wildlife

Sections 783.20, 784.21 (211.10(c), 211.4(d))

* 1. The applicant should supply data on the occurrence of the threatened or endangered species within the mine plan area and adjacent areas and should indicate the measurement or search methods used to determine their presence or absence. The U.S. Fish and Wildlife Service list of threatened and endangered species as well as other lists of such species and ranges in the State should be used to determine the potential presence of endangered and threatened species.

* 2. The application should include a map showing habitat and migration routes for the major terrestrial wildlife types in the mine plan area and adjacent areas.

* 3. The applicant must indicate what mitigation methods are being applied to lessen the impact of the proposed operation on terrestrial wildlife. In particular, the impact of the conveyor system on the migration of deer, elk, and moose should be considered and mitigated.

Soil Resources

Section 783.21 (211.10(c))

* 1. The chemical and physical analyses of topsoil and overburden for areas proposed for surface disturbance and major structures is not clear. It appears that data has been incorrectly collated to sites. In addition, not all of the parameters have been examined such as acidity or alkalinity. Based on the limited information submitted, the applicant will have to test for sodic concentrations of topsoil and overburden.

2. The soil resource information should include an analysis as to the suitability of the topsoil in different vegetation areas and the amount available for use in these different areas.

3. Maps should delineate topographic features or cadastral location in order to properly locate soil/vegetation associations on proposed surface disturbance areas.

* 4. A soil survey at the reconnaissance level for the lease area and a high-intensity detailed soil survey for the portal area, facilities area, and surface disturbance area should be included in the application. The standards used in the soil survey should be identified or the Soil Conservation Service (SCS) National Cooperative Soil Survey Standards should be used. Scales of the maps should be no less than 1:12,000. Complete mapping unit descriptions should be included in the application.

* 5. Potential productivity of existing soils should be included in the application.

Topography and Maps

Sections 783.25 (211.10(b))

1. The application is inconsistent in showing that maps are prepared by or under the direction of and certified by a qualified registered professional engineer or professional geologist; this inconsistency should be corrected.

Air Quality

Sections 784.13 (21.40(a))

1. The applicant should list methods of suppressing dust from truck transport of coal.

2. The applicant implies that dust mitigation measures have been modeled but doesn't state how the mitigation has been evaluated; this deficiency should be corrected.

*Economic Coal Recovery (USGS comments)

Sections 211.4(b), 211.10(c)(6)(xv), 211.30, 211.32, and 211.35

1. The plan does not include recoverable reserves for each Federal lease; however, it will not be necessary to submit this information now as each mining company is required to comply with the General Mining Order No. 1, which requires reporting recoverable coal reserves from each Federal lease.

2. The applicant plans to store underground wastes and excess surface spoil in underground workings. They also plan to return coal processing wastes to abandoned underground workings. The plan should state that whenever wastes of this nature are to be stored underground, the applicant will notify the USGS Mining Supervisor by submitting a map showing the proposed disposal area and an explanation of how it will be accomplished so that the maximum amount of coal can be recovered from the disposal area prior to disposal. Wastes should only be stored in abandoned areas where pillars must be left and only after the maximum amount of coal has been recovered.

3. It states in the plan that the applicant does not plan to construct or utilize coal processing facilities as a part of the Skyline project. Information generated by the company relative to making this decision should be submitted in detail as a part of the plan. Cleaning or not cleaning coal must be considered in determining maximum economic recovery.

4. Several times throughout the plan, it states that maximum economic recovery (MER) will be considered. More explanation as to how MER will be achieved is necessary, including some detail on technology not utilized which would maximize coal recovery in the mine, i.e., coal cleaning, full seam mining in thick seams, etc.

5. It must be noted that no entry level or panel workings in which the pillars have not been completely extracted within safe limits shall be permanently abandoned or rendered inaccessible, except with the prior written approval of the USGS Mining Supervisor.

6. The proposed projections on the mining plan maps have some areas without proper explanation as to whether or not they are to be mined. Explain your reasons for not mining areas containing coal of mineable thicknesses that are not shown to be mined.

7. The "A" Seam, in the northwest part of the property has a potential for the longwall multilift method. We believe the company should consider this system.

Miscellaneous

1. The following points will also need clarification or explanation before the technical analysis is started:

A. Section 2.3.2, page 2-26, states that springs are of local origin, yet section 2.3.5, page 2-29, states that the water quality of the springs can be used as indices of the quality of the deep underground system;

B. Section 4.19.2, page 4-66, states that mine site diversion channels will be designed to carry a 100 yr-24 hr. precipitation event, yet a 10 yr-24 hr. rainstorm was used in the design;

C. Appendix A-1, hydrology, page 37, states daily flows range from 0.6 to 200 cfs for Huntington Creek and 1 to 50 cfs for Pleasent Valley Creek, yet table 4, page 41, lists the 25- and 50- year floods as 78 and 84 cfs for Huntington Creek and 26 and 28 cfs for Pleasent Valley;

D. The correlation of flow duration curves, as shown in Appendix A-1, hydrology, page 22, is no longer an acceptable technique. Concurrent flow events are now correlated. A check should be made to see if this changes the results.

2. All plan type maps that show the property and drill hole locations or other exploration data should identify the boundaries of each Federal lease (211.20).

3. The application indicated the owner has been cited for violations at another mine. However, the specific actions utilized to abate the violations listed has not been included in the application (782.14(c)). This information should be submitted.

CULTURAL RESOURCES

SECTIONS 783.12, 784.17 (211.4(d), 211.10(c))

CULTURAL RESOURCES

SECTIONS 783.12, 784.17 (211.4(d), 211.10(c))

Cultural Resources

*1. The applicant must provide documentation that the Utah State Historic Preservation Officer (SHPO) has concurred with he assessment that sites AERC 270/U1 and AERC 270/U2 are not eligible for listing in the National Register of Historic Places. Such concurrence must show that the Utah SHPO has approved and accepted the reports in order for OSM to begin the Section 106 consultation process.

Cultural Resources

Section 783.12, 784.17 (211.4(d), 211.10(c))

*1. The applicant must provide documentation that the Utah State Historic Preservation Officer (SHPO) has concurred with the assessment that sites AERC 270/U1 and AERC 270/U2 are not eligible for listing in the National Register of Historic Places. Such concurrence must show that the Utah SHPO has approved and accepted the reports in order for OSM to begin the Section 106 consultation process.

Response: The cultural resource data as submitted in the Skyline Application (Volume A-4--Archaeology) were also submitted to the Utah State Archeologist and to the State Historic Preservation Officer for their review. Copies of the clearances from both of these offices are attached. (See Attachments A and B.)

Attachment A

SCOTT M. MATHESON
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
300 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801/533-5755

January 8, 1980

Mr. Keith Welch
Coastal States Energy Company
411 W. 7200 S.
Suite 200
Midvale, UT 84047

Dear Mr. Welch:

I have reviewed the archeological clearance data provided by you in connection with the Coal Mine development near Scofield, Utah. The clearance procedures and its results are acceptable. We are about to provide an archeological clearance. It has, no doubt, been pointed out to you that the clearance does not necessarily mean that archeological sites do not exist beneath the existing surface. I urge you to notify us if any subsurface cultural materials be unearthed in the course of development.

If you have any questions, please let me know.

Sincerely,

La Mar W. Lindsay
Assistant State Archeologist

LWL:ro

Attachment B

SCOTT M. MATHESON
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
307 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801/533-5755

March 20, 1980

Chairperson
Environmental Coordinating Committee
State Planning Office
118 State Capitol
Salt Lake City, Utah 84114

RE: Skyline Mine , Carbon Co.

Dear Chairperson:

In response to your request for review and in accordance with your responsibility as outlined in 36 CFR 800.4 we are happy to consult with you concerning your project.

The staff has determined, after review, that if the stated procedures, projects or regulations are followed as outlined, there will be no known effect upon any potential or listed National Register historic, archeological or cultural sites.

If you have any questions or concerns, please contact James L. Dykman, Compliance Administrator, or Wilson G. Martin, Preservation Development Coordinator, Utah State Historical Society, 307 West 200 South, Salt Lake City, Utah 84101, 533-6017.

Sincerely,

Melvin T. Smith

Melvin T. Smith
Director and
State Historic Preservation Officer

JLD:re: C942 Carbon

(3) Concur with findings/recommendations

cc: Keith W. Welch, Environmental Coordinator, 411 West 7200 South Suite 200, Midvale, Utah 84047

Cultural Resources

*2. The applicant must provide one map which illustrates the following for the entire mine plan area:

(a) All sites and isolated finds located;
(b) The perimeters of all areas intensively inventoried; and
(c) All areas of proposed surface disturbance over the life of the mine (e.g., roads, powerlines, conveyor routes, mine facilities, loadouts, portals, etc.).

*2. The applicant must provide one map which illustrates the following for the entire mine plan area:

a) All sites and isolated finds located;
b) The perimeters of all areas intensively inventoried; and
c) All areas of proposed surface disturbance over the life of the mine (e.g., road, powerlines, conveyor routes, mine facilities, loadouts, portals, etc.).

Response: The attached map (see Archeology Map) illustrates the requested information with the exception of the sites on through Spring Ridge surveyed by J. Terry Walker. These sites are sufficiently remote to preclude inclusion on a map of reasonable scale. They are, however, included in the application because of a reference in the site specific analysis of the Central Utah Coal--Final Environmental Statement (Department of Interior-1979).

Cultural Resources

3. The applicant must provide a quantitative estimate of subsidence over the life of the mine.

*3. The Applicant must provide a quantitative estimate of subsidence over the life of the mine.

Response: Replace page 4-57, vol. 3 of permit application with the following page.

4.17 SUBSIDENCE CONTROL PLAN

This section describes in further detail the Applicant's design of mine plan ensuring minimal environmental impacts, specifically subsidence effects of the proposed Skyline project. Section 3.1 - SKYLINE MINING OPERATION PLAN describes in detail the proposed methods of coal resource extraction and mine development selected partly on nonsubsidence criteria. Section 2.2 present the detailed geological information, site specific and general, which provided an analytical base for mine plan and subsidence control design. The following subsections describe the principal factors involved in controlling subsidence impacts resultant of the proposed mining operations.

4.17.1 Subsidence Damage Probability Survey

Careful review of the permit area shows that the following areas could face potential subsidence damage caused by mining: Mountain Fuel Supply gas pipeline, upper reaches of Electric Lake Reservoir, perennial streams of the permit area, and public roads which cross the permit area. These potential damage areas are identified on Map 3-35.

Springs, aquifers and aquifer recharge areas which may also be affected by subsidence are identified in the Hydrologic Inventory Report prepared by Vaughn Hansen Associates and presented in Volume A-1, Appendices.

4.17.2 Mining Methods

The mining methods to be used by the Applicant include longwall mining, room and pillar mining with pillar removal, and room and pillar mining with pillars left in place in areas where it is necessary to prevent subsidence. Subsections 3.1.4 and 3.1.5 contain descriptions of the mining methods to be implemented by the Applicant.

Full extraction areas (room and pillar panels with pillar removal, and longwall panels) are, by definition, planned and controlled subsidence areas. The extent of these full extraction areas is shown on Map 3-35. Subsidence prediction work has shown the expected maximum planned and controlled subsidence will vary from 0 to 16 feet assuming that the total cumulative extraction from the three mineable seams will not exceed 30 feet.

HYDROLOGY AND GEOLOGY

SECTIONS 783.14(a), 784.14, 783.15(a)(1) and (b),
783.16, 784.16 (211.10(c), 211.40(a))

HYDROLOGY AND GEOLOGY

SECTIONS 783.14(a), 784.14, 783.15(a)(1) and (b),
783.16, 784.16 (211.10(c), 211.40(a))

Hydrology and Geology

1. The description of geologic conditions in the application should include an evaluation of potential geologic hazards (i.e., area of rock fall and slumps in the mine plan area) in relationship to proposed structures and facilities and the area (Section 22 and 27) around Electric Lake in Huntington Canyon.

Report - Communicated w/ 11/
1156 S (Jackson Moffat)
Statistics USGS

ROY P. FULL
MINING GEOLOGIST
246 EAST 3900 SOUTH
SALT LAKE CITY, UTAH 84107
TELEPHONE (801) 266-6433

COASTAL STATES ENERGY COMPANY
SKYLINE PROJECT
CARBON AND EMERY COUNTIES, UTAH

February 11, 1980

The Influence of Geologic Conditions Upon Future Mining

The location of the Skyline property on the west limb of the Clear Creek anticline is readily apparent from a review of the broad structural features of the north end of the Wasatch Plateau coal field. Major displacements along the Joes Valley fault zone in the southern part of the field have decreased to the north, and only limited offsetting is evident within the Skyline property.

The Connelville fault, trending approximately N 20° E, marks the east boundary of the property, but other faulting within the tract trends more northerly with variations of a few degrees either to the east or west. The absence of underground working in the property makes the interpretation of structural conditions dependent upon surface observations and comparison to similar conditions in adjacent properties. Only the Valentine fault and the North Joes Valley fault have recognizable offsets at the surface, and both appear to be weakening rapidly to the north. Neither are evident in the north part of the property.

More important to mining conditions will be the influence of secondary structures. A number of these features have been identified on the surface by physical evidence, but the amount of displacement cannot be determined from these observations. Most are thought to reflect adjustments where vertical displacements will be less than ten feet, but the final determination is dependent upon mine development. With flexibility in mine planning, these secondary structures should not create serious operating problems.

Of further concern in mine development will be the influence of these secondary structures upon immediate roof and floor conditions. Nothing has been observed to suggest that major problems will occur. The zones do not in general appear to be strong, and only limited disturbance of the roof and floor is anticipated. No major movement of water within these structures is expected.

One of the stronger of the secondary zones on the property has been observed in Eccles Canyon at a distance of several hundred feet west of drill holes EC-8 and EC-9 (Plate 1). This being near the initial proposed slope entry on the Upper O'Connor seam (No. 1 Mine), it can be anticipated that some disturbance will be encountered between 500 and 1,000 feet west of the portal. Surface indications suggest that the adjustments are not along a single fault, but that several strands may exist over a width of two to three hundred feet. This condition can cause support problems locally along the main entry system,

but only a limited amount of mining will be done that close to the outcrop area, and no major problems are anticipated in extending the main entry system to the west.

By far the best underground experience record in the vicinity of the Skyline property is the work done in the Winter Quarters mines (Figure 3, September 1979 report) to the northeast of the subject tract. This operation, opened prior to 1880, operated until 1930. Quite complete engineering maps are available for the property, which show nearly continuous workings for three and one-half miles in a north-south direction. The south end of the mine extends into Eccles Canyon, and mining was done along the common boundary with the Skyline property at the center of Section 13.

The mine occupies a similar structural position to that of the Skyline property. Both are on the west flank of the Clear Creek anticline, and both are bounded by the Connelville fault zone on the east side. Only the Winter Quarters No. 4 mine was extended east of the west limit of the Connelville fault zone.

A record of first-hand knowledge of the mining conditions within the Winter Quarters mines was prepared by Stanley C. Harvey in July 1979. Mr. Harvey was associated with the operation much of the time from 1913 until 1924, being mine foreman during the later years. His account of operating conditions is fully supported by existing engineering maps. Roof conditions were reported to be good over most of the mine with only a limited amount of shaley top. Other than the east-

west faulting to the north and south of Winter Quarters Canyon, no major offsets were encountered, particularly to the south toward Eccles Canyon. Movement along the east-west dike zones within the No. 1 mine were reported to be small with only minor roof problems immediately adjacent to the structures. The continuity of mining operations with a high percentage of pillar extraction further supports favorable mining conditions.

Up to the present time nothing has been observed to suggest that the structural conditions within the Skyline property will differ greatly from those previously discussed for the Winter Quarters mines. More north-south fracturing and faulting is recorded in the Skyline tract than is evident in the Winter Quarters mines, but the magnitude of most of the zones is believed to be relatively small. With sufficient interval between structural zones, mining operations should not be greatly restricted if flexibility is maintained in mine planning.

Careful monitoring of surface conditions over future mining operations will be essential on the Skyline property. Geologic mapping of the surface has shown some areas of limited slumping or landsliding, largely reflecting the movement on the west dipping beds toward the lower canyons. Other than the area located in Section 22 just west of Huntington Canyon, all of slump areas are limited in extent (Plate 1).

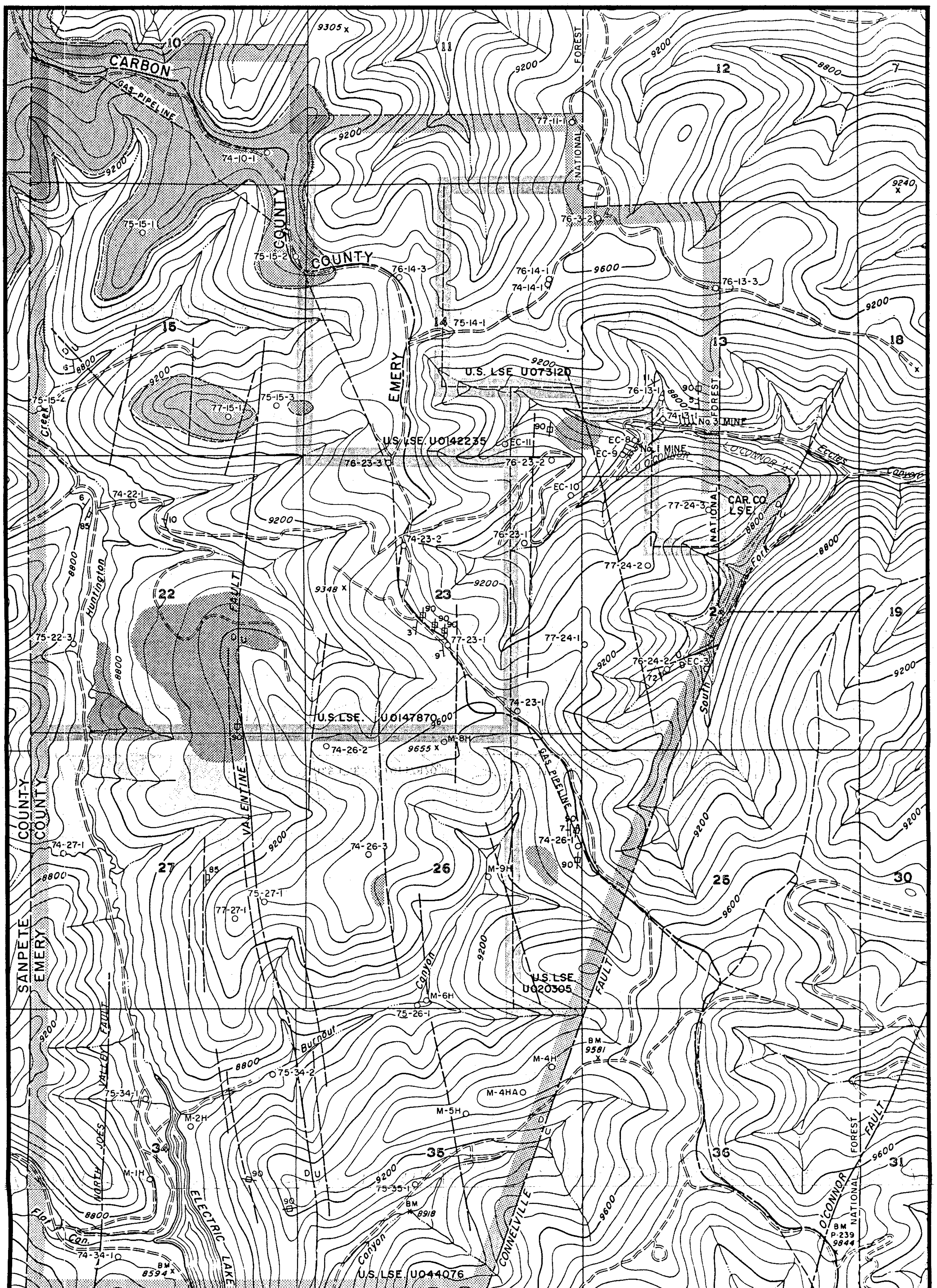
The area in Section 22 occupies relatively flat terrain below a scarp on the Valentine fault. Displacement on the fault appears to be small, but vertical jointing and fracturing has

permitted blocky sandstones to slump toward the lower slopes along Huntington Canyon. Near the upper limits of the slump area the rocks do not appear to be far out of place, but the lower slopes are strewn with disoriented sandstone blocks. Two holes drilled in the slump area during the 1979 season indicate a thickness of approximately 100 feet of unconsolidated material. The slump area is stable and mining should not influence further adjustment.

Multiple seam mining within the Skyline property will necessitate surface monitoring for possible subsidence, particularly along the course of the existing gas transmission line. With cover over the major part of the mine area ranging from 1,000 feet to more than 1,500 feet, disturbance from subsidence should be minimal. Interruption of the numerous springs within the area does not appear likely as most are supplied by laterally moving waters within favorable sandstone units in the upper part of the west dipping Blackhawk sediments. Sufficient subsidence to disrupt the continuity of these aquifers appears unlikely, and any general adjustment at the surface is not regarded as a potential to redirect surface waters to underlying mine openings. Fine grained silty and shaley sediments, particularly in the lower Blackhawk Formation, should adequately restrict the downward movement of water from higher stratigraphic units. Only limited surface disturbance is anticipated from subsidence resulting from mining on the Skyline property.

Limited areas of outcrop of the three principal coal seams occurs on the Skyline property. The Upper O'Connor seam and the Lower O'Connor 'A' seam have been exposed in Eccles Canyon near the east edge of the property, and to a lesser extent in the South Fork of Eccles Canyon. The Lower O'Connor 'B' seam does not outcrop at a minable thickness. Openings will be driven for mine development from Eccles Canyon on the upper and lower seams (No. 1 and No. 3 Mines) with an internal connection to the Lower O'Connor 'B' seam (No. 2 Mine). Mining to the limited area of outcrop is unlikely, and no surface disturbance along the outcrop is anticipated.

Roy P. Full



R6E

R7E

EXPLANATION

CASTLEGATE SANDSTONE

BLACKHAWK FORMATION (WITHIN SKYLINE PROPERTY)

FAULT (SHOWING APPARENT DISPLACEMENT) D/U

FAULT OR FRACTURE ZONE (DISPLACEMENT NOT EVIDENT)

LANDSLIDE OR SLUMP AREA

COAL SEAM OUTCROP

STRIKE AND DIP OF BEDDING (6)

STRIKE AND DIP OF JOINTING (85)

VERTICAL JOINTING (90)

76-15-1 DRILL HOLE LOCATION AND NUMBER

SCALE: 1000 0 1000 2000 3000 FEET

CONTOUR INTERVAL: 80 FEET

BASE MAP FROM U.S. GEOL. SUR. TOPOGRAPHIC MAPS

GEOLOGY BY ROY P. FULL AND DONALD REITZ

COASTAL STATES ENERGY COMPANY
SKYLINE PROJECT

TOPOGRAPHIC MAP WITH SURFACE GEOLOGY

CARBON AND EMERY COUNTIES, UTAH

PREPARED BY ROY P. FULL, MINING GEOLOGIST
246 EAST 3900 SOUTH, SALT LAKE CITY, UTAH

JOB NO.	SCALE AS NOTED DATE AUG., 1979
DWG. NO.	MAP OR FIGURE NO. PLATE I
REVISION	

Hydrology and Geology

*2. The applicant must identify any areas where ground water will be intercepted by face-up activities. Vague statements about some-but-little water being intercepted by the mine are insufficient.

Question Raised By OSM

2. The applicant must identify any areas where ground water will be intercepted by face-up activities. Vague statements about some-but-little water being intercepted by the mine are insufficient.

Response:

As stated in the hydrology report, ground water in the region exists under water table, artesian, and perched conditions. Plate 7 of the hydrologic inventory shows the estimated water contours of the ground water table. Since this plate was made, additional water table information has been obtained in the Eccles Canyon areas as part of an ongoing Coastal States effort to better define the hydrologic characteristics of the area. This information has been used to update the information on Plate 7 of the original report, particularly in the Eccles Canyon area, and a copy is attached as Attachment 1. When this new map of water table contours is compared to the contours of the Upper O'Connor Coal Seam (Plate 1 of the hydrologic inventory), the portion of the coal seam that is expected to be beneath the water table may be predicted. Such a comparison indicates that the portion of the Upper O'Connor Coal Seam within the Skyline Property and east of the 8700 feet water table contour in Eccles Canyon Attachment 1 is probably above the regional ground water table. The major portion of the Skyline Property is located west of this contour where the coal seam is probably beneath the water table. As noted in the hydrologic inventory, permeability of the aquifer is very low. Consequently, even when under the regional water table, mining operations are expected to produce relatively small quantities of water. As noted in the hydrologic inventory, the Blackhawk

Formation has a high clay content which gives it the ability to seal rapidly. Consequently even when mines encounter faults in the Blackhawk, water yields are expected to rapidly decrease to quite small flows. This appraisal of the ground water yeild within the mine is substantiated by the experience of Valley Camp of Utah, Inc. as reported on page 77 and 78 of the hydrologic inventory.

Water may also be encountered by mining operations above the regional water table. As stated in the hydrology report, sandstone lenses or drains convey water within the geologic formations above the water table. Consequently, even though mining operations near the portal area will be substantially above the ground water table, some ground water will likely be encountered, particularly in the southwest quarter of Section 13. Springs near the recently drilled test well in the protal area are evidence that water does exist to some extent considerably above the regional water table. Locations of these areas where localized ground water flow will be encountered by mining activities cannot be predicted precisely in advance but are not expected to produce large flows of water because of generally low permeabilities and the localized nature of this ground water source.

Hydrology and Geology

*3. The applicant's cross-sections and structure contour maps drawn on coal seams give an unnecessarily vague picture of the groundwater hydrology. Isopach maps of affected aquifers (Aberdeen SS and Star Point SS) should be included with the plan to be used with the existing structure contour maps of the coal seams. A map of the potentiometric surface of the confined water system and water table contour map of unconfined systems should be included.

Questions Raised By OSM:

3. The applicant's cross-sections and structure contour maps drawn on coal seams give an unnecessarily vague picture of the ground water hydrology. Isopach maps of affected aquifers (Aberdeen SS and Star Point SS) should be included with the plan to be used with the existing structure contour maps of the coal seams. A map of the potentiometric surface of the confined water system and water table contour map of unconfined water system and water table contour map of unconfined systems should be included.

Response:

An isopach map of the Aberdeen Sandstone has been prepared from information obtained primarily from the exploratory holes drilled during 1979 (Attachment 2). These exploratory holes do not extend through the Star Point Sandstone as it is located beneath the Aberdeen Sandstone and is about 1000 feet thick. Consequently, an isopach of the Star Point under the lease area is unavailable. Neither of these sandstones qualifies as an aquifer as defined in section 701.5 of OSM regulations (i.e. a zone, stratum, or group of strata that can store and transmit water in sufficient quantities for a specific use). These two well cemented sandstones, as stated in the hydrologic inventory, have very low permeabilities and do not feed the springs on the Skyline Property. These springs in the overlying Blackhawk Formation are fed from perched water in shallow sandstone lenses underlain with shale well above the regional groundwater level. There are no wells presently operating on or near the Skyline Property. Useable quantities of water from wells in either the Aberdeen Sandstone or the Star Point Sandstone are unlikely unless a fracture zone is encountered. At the portal area a well was drilled into the Aberdeen sandstone and tested and then drilled into the Star Point Sandstone and again tested, but did not produce a sustained yield of five gallons per minute.

The potentiometric surface using data from the shallower holes, primarily from the Blackhawk Formation, is shown in Attachment 3. Potentionmetric data from the deeper holes penetrating the Star Point Sandstone within the lease and from the exposed Star Point Sandstone east of the lease have been used to prepare Attachment 4. Under the lease area both potentiometric surfaces are below the ground surface, even in the bottoms of the Canyons, and the deeper holes under the Blackhawk show a generally higher potentiometric surface than the shallower holes. East of the lease area, where the Star Point Sandstone is exposed, the potentiometric surface intersects the ground surface in the canyons producing springs along the bottoms of the canyons. Water table conditions exist primarily in shallow alluvial deposits along larger perennial streams.

Hydrology and Geology

*4. No baseline data on groundwater quality is given from the wells, citing the difficulty of obtaining proper well completions; however, 4 of these wells are listed as sources for the monitoring program. The wells should qualify for both or neither, and the aquifer being tested should be identified. The applicant should describe the test well design and sampling procedure. Potential acid-forming, toxic-forming, or alkalinity-producing material above and below the coal seams (e.g., ~25 feet above and 25~ feet below) should be identified and included in the mining plan.

Question Raised By OSM:

4. No baseline data on groundwater quality is given from the wells, citing the difficulty of obtaining proper well completions; however, four of these wells are listed as sources for the monitoring program. The wells should qualify for both or neither, and the aquifer being tested should be identified. The applicant should describe the test well design and sampling procedure. Potential acid-forming, toxic-forming, or alkalinity-producing material above and below the coal seams (e.g., 25 feet above and 25 feet below) should be identified and included in the mining plan.

Response:

As stated in the hydrologic inventory, core holes were used to obtain ground water information. As these wells were being drilled, static water levels were measured above the coal zone, in the coal zone, and below the coal zone in the Star Point Sandstone. The wells were finally cased down to the Star Point and the bottom 20 feet of the casings were perforated. Measuring the static water levels at different stages of drilling showed that deeper ground water had a higher piezometric head than the shallow ground water. Because of this, four shallow wells were drilled adjacent to four of these deep wells, and casings with perforations in the bottom 20 feet were installed. Piezometric heads were measured in shallow and deep holes showing the vertical piezometric gradient associated with the ground water.

The instability of the Blackhawk Formation made it difficult to keep uncased holes open for several hours. Reliable water quality samples could not be obtained from the core holes. Several holes were more than 1000 feet deep and one was more than 2000 feet deep.

Two wells have been drilled in Eccles Canyon to determine aquifer characteristics of the Star Point Sandstone. The locations of these wells, W13-1 and W17-1, are shown on Attachment 1. Well W13-1 extends through the Blackhawk Formation into the Star Point Sandstone and is now cased. During the drawdown and recovery tests, reported in detail in the hydrologic inventory, the casing had not been installed.

The water quality analyses reported in Attachment 5 were measured from samples collected after periods of pumping from the well. Well W17-1 is located adjacent to Eccles Creek in the canyon bottom and extends through alluvial materials before penetrating the Star Point Sandstone. The well had been pumped for a few hours when the water quality sample was collected. Results of the laboratory analysis of this sample are also contained in Attachment 5.

Throughout the coal-bearing Blackhawk Formation numerous varieties of sandstone and shale layers exist. The springs issue from the base of these sandstones underlain with shale. The water quality of the springs and the quality of seeps with old mines nearby is good. As discussed in the hydrologic inventory, the longer ground water is in transit through the formation, the poorer the quality. However, TDS is generally less than 350 mg/l.

ATTACHMENT 5

RESULTS OF WATER QUALITY ANALYSES OF SAMPLES FROM ECCLES CANYON WELLS

Well or Spring		W13-1	W13-1	W13-1	W17-1
Date of Sample		10-26-79	11-06-79	12-04-79	11-21-79
Parameter	Units				
FIELD MEASUREMENTS					
Discharge	gpm				90
pH	units		7.35	7.4	7.4
Specific Conductance	umhos/cm @ 25° C		740	510	540
LABORATORY MEASUREMENTS					
Alkalinity, as $CaCO_3$	mg/l			230.00	270.00
Ammonia, NH asN	mg/l	.01	.01	.01	.01
Arsenic, Total	mg/l				
Arsenic, Dissolved	mg/l				.001
Barium, Total	mg/l				
Barium, Dissolved	mg/l				.060
Bicarbonate	mg/l		278.60	280.60	329.40
Cadmium, Total	mg/l				
Cadmium, Dissolved	mg/l	.001	.001	.001	.001
Calcium	mg/l		43.20	61.60	112.80
Chloride	mg/l		1.0	4.0	3.0
Chromium, Total	mg/l			.001	
Chromium, Dissolved	mg/l	.001	.005		.001
Copper, Total	mg/l				
Copper, Dissolved	mg/l	.001	1.306	.005	.004
Cyanide	mg/l	.001	.001	.001	.001
Fluoride	mg/l				.13
Iron, Total	mg/l	.010	.225	6.96	2.450
Iron, Dissolved	mg/l	.010	.015	1.92	1.850
Lead, Total	mg/l				
Lead, Dissolved	mg/l		.011	.001	.001
Magnesium	mg/l		30.72	21.12	11.52
Manganese, Total	mg/l		.091	.030	.114
Mercury, Total	mg/l	.0002	.00005	.0002	.00005
Nitrate, NO_3 as N	mg/l	.01	.01	.01	.01
Oil and Grease	mg/l	2.6			
Phenol	mg/l	.001	.001	.001	.001
Phosphate, PO_4 as P Ortho	mg/l			.340	
Potassium	mg/l		12.500	5.700	2.117
Selenium, Total	mg/l				
Selenium, Dissolved	mg/l	.001	.001	.001	.001
Silver, Total	mg/l				
Silver, Dissolved	mg/l	.001	.001	.001	.001
Sodium	mg/l		76.50	6.72	3.89
Sulfate	mg/l		185	33.0	63.0
Suspended Solids	mg/l	.215	166	15.0	
Total Dissolved Solids	mg/l		480	284	384
Turbidity	mg/l		18.00	50.00	25.00
Zinc, Total	mg/l				
Zinc, Dissolved	mg/l	.005	.007	.022	.006
BOD, 5 day	mg/l			1.0	1.0
COD	mg/l	9.2	8.5	8.0	4.2
MPN Fecal Coliform	MPN/100 ml		2.0	3.0	2.2
MPN Total Coliform	MPN/100 ml		490	26.0	2.2
Phosphate, PO_4 as P Total	mg/l	.440	.420		.400

Hydrology and Geology

* 4. Potential acid-forming, toxic-forming, or alkalinity-producing material above and below the coal seams (e.g., ~ 25 feet above and ~25 feet below) should be identified and included in the mining plan.

Response: The attached sample analysis reports submitted by Commercial Testing and Engineering Co., Denver, Colorado, are tendered to document that no potential acid-forming or toxic-forming material is to be found either above or below the coal seams. The equipotential figures do show some alkalinity producing tendencies occur.

The analysis reports are arranged by seam, i.e., McKinnon, Upper O'Connor, and Lower O'Connor A (no roof- or floor-rock analyses for the Lower O'Connor B) and then by sample location, e.g., roof, floor.

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

SINCE 1908

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

October 16, 1979

COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

Sample identification by

Coastal States Energy Co.

Kind of sample reported to us	Floor Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Core Hole No. 79-35-2
Sample No. RL-12
756.40' - 756.90'
Salina No. 2569
McKinnon Seam

Analysis report no. 72-86889

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	2.75	xxxx
% Ash	87.59	90.07
Btu	733	754
% Sulfur	0.09	0.09

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.05	0.05
% Sulfate Sulfur	0.00	0.00
% Organic Sulfur {Diff}	0.04	0.04
% Total Sulfur	0.09	0.09

WATER SOLUBLE ALKALIES

	Dry Basis
% Na_2O	0.016
% K_2O	0.015

APPARENT SPECIFIC GRAVITY at 2.75% Moisture = 2.39

ACIDITY (pH)

Equipotential	1:5	1:20
7.93	8.11	8.45

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

GDP/md/pm

COMMERCIAL TESTING & ENGINEERING CO.

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October 16, 1979

COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

Sample identification by

Coastal States Energy Co.

Kind of sample reported to us	Roof Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Core Hole No. 79-35-2
Sample No. RL-9
1146.15' - 1146.90'
Salina No. 2566
Upper O'Connor Seam

Analysis report no. 72-86886

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	2.54	xxxx
% Ash	85.93	88.17
Btu	608	624
% Sulfur	0.28	0.29

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.23	0.24
% Sulfate Sulfur	0.01	0.01
% Organic Sulfur (Diff)	0.04	0.04
% Total Sulfur	0.28	0.29

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.007
% K_2O	0.028

APPARENT SPECIFIC GRAVITY at 2.54% Moisture = 2.42

ACIDITY (pH)

Equipotential	1:5	1:20
7.94	8.45	8.80

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Kind of sample reported to us	Floor Rock	Coastal States Energy Co.
Sample taken at	xxxxx	Core Hole No. 79-14-2 Sample No. RL-2 520.79' - 521.54'
Sample taken by	Coastal States Energy Co.	Salina No. 2549 Upper O'Connor Seam
Date sampled	xxxxx	
Date received	10-3-79	

Analysis report no. 72-86869

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	3.26	xxxx
% Ash	90.47	93.52
Btu	197	204
% Sulfur	0.03	0.03

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.02	0.02
% Sulfate Sulfur	0.00	0.00
% Organic Sulfur {Diff}	0.01	0.01
% Total Sulfur	0.03	0.03

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.010
% K_2O	0.028

APPARENT SPECIFIC GRAVITY at 3.26% Moisture = 2.54

ACIDITY (pH)

Equipotential	1:5	1:20
8.49	8.47	8.68

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D Palmer

G. D. PALMER, Manager, Denver Laboratory

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WESTERN DIVISION MANAGER
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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Kind of sample reported to us	Floor Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Coastal States Energy Co.

Core Hole No. 79-35-2
Sample No. RL-8
1152.55' - 1153.30'
Salina No. 2565
Upper O'Connor Seam

Analysis report no. 72-86885

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	1.91	xxxx
% Ash	93.46	95.28
Btu	440	449
% Sulfur	0.03	0.03

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.02	0.02
% Sulfate Sulfur	0.00	0.00
% Organic Sulfur {Diff}	0.01	0.01
% Total Sulfur	0.03	0.03

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.007
% K_2O	0.016

APPARENT SPECIFIC GRAVITY at 1.91% Moisture = 2.56

ACIDITY (pH)

Equipotential	1:5	1:20
8.04	8.18	8.20

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

Charter Member

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STERN DIVISION MANAGER
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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Kind of sample reported to us	Roof Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Coastal States Energy Co.

Core Hole No. 79-14-2
Sample No. RL-7
690.18' - 690.68'
Salina No. 2554 A
Lower O'Connor ~~X~~ Seam

Analysis report no. 72-86874

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	4.15	xxxx
% Ash	58.33	60.86
Btu	4765	4971
% Sulfur	1.21	1.26

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.80	0.83
% Sulfate Sulfur	0.01	0.01
% Organic Sulfur {Diff}	0.40	0.42
% Total Sulfur	1.21	1.26

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.010
% K_2O	0.021

APPARENT SPECIFIC GRAVITY at 4.15% Moisture = 2.11

ACIDITY (pH)

Equipotential	1:5	1:20
7.96	8.34	8.66

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D Palmer

G. D. PALMER, Manager, Denver Laboratory

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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Kind of sample reported to us	Floor Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Coastal States Energy Co.

Core Hole No. 79-10-1
Sample No. RL-1
2000.00' - 2000.75'
Salina No. 2545
Lower O'Connor A Seam

Analysis report no. 72-86865

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	4.58	xxxx
% Ash	87.69	91.90
Btu	927	972
% Sulfur	0.04	0.04

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.01	0.01
% Sulfate Sulfur	0.01	0.01
% Organic Sulfur {Diff}	0.02	0.02
% Total Sulfur	0.04	0.04

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.013
% K_2O	0.008

APPARENT SPECIFIC GRAVITY at 4.58% MOISTURE = 2.31

ACIDITY (pH)

Equipotential	1:5	1:20
8.55	8.92	8.99

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D Palmer

G. D. PALMER, Manager, Denver Laboratory

GDP/md /pm

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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Kind of sample reported to us	Floor Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Coastal States Energy Co.

Core Hole No. 79-14-2
Sample No. RL-8
697.81' - 698.60'
Salina No. 2555
Lower O'Connor ~~B~~ Seam "A"

Analysis report no. 72-86875

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	5.28	xxxx
% Ash	88.94	93.90
Btu	689	727
% Sulfur	0.15	0.16

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.09	0.09
% Sulfate Sulfur	0.01	0.01
% Organic Sulfur {Diff}	0.05	0.06
% Total Sulfur	0.15	0.16

WATER SOLUBLE ALKALIES

	Dry Basis
% Na_2O	0.007
% K_2O	0.008

APPARENT SPECIFIC GRAVITY at 5.28% Moisture = 2.25

ACIDITY (pH)

Equipotential	1:5	1:20
7.10	7.27	7.10

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D Palmer

G. D. PALMER, Manager, Denver Laboratory

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COASTAL STATES ENERGY COMPANY
5 Greenway Plaza East
Houston, Texas 77046

October 16, 1979

Sample identification by

Coastal States Energy Co.

Core Hole No. 79-35-2
Sample No. RL-1
1229.6' - 1229.9'
Salina No. 2558
Lower O'Connor A Seam

Kind of sample reported to us	Floor Rock
Sample taken at	xxxxx
Sample taken by	Coastal States Energy Co.
Date sampled	xxxxx
Date received	10-3-79

Analysis report no. 72-86378

SHORT PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	2.33	xxxx
% Ash	87.55	89.64
Btu	682	698
% Sulfur	0.21	0.21

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.13	0.13
% Sulfate Sulfur	0.00	0.00
% Organic Sulfur {Diff}	0.08	0.08
% Total Sulfur	0.21	0.21

WATER SOLUBLE ALKALIES

Dry Basis

% Na_2O	0.010
% K_2O	0.030

APPARENT SPECIFIC GRAVITY at 2.33% Moisture = 2.43

ACIDITY (pH)

Equipotential	1:5	1:20
7.75	8.20	8.38

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D. Palmer

G. D. PALMER, Manager, Denver Laboratory

GDP/mdpm

Final Copy Watermarked For Your Protection

Charter Member

Hydrology and Geology

5. The applicant should submit a single map at a scale of 1:100,000 or more detail showing the regional drainage and stream classification. The narrative to this map should identify water quality and physical characteristics of the streams.

Question Raised By OSM:

5. The applicant should submit a single map at a scale of 1:100,000 or more detail showing the regional drainage and stream classification. The narrative to this map should identify water quality and physical characteristics of the streams.

Response:

The Skyline Property is drained by Huntington Creek on the west and on the east by Eccles Creek which is a tributary of Pleasant Valley Creek. Attachment 6 has been prepared to show the perennial and the intermittant and ephemeral streams in the region surrounding the Skyline Property. All surface streams shown on Attachment 6 have been classified by the Utah Division of Health as

1C protected for domestic use with prior treatment process,

3A protected for cold water aquatic life, and

4 protected ofr agricultural uses including stockwatering.

Electric Lake has been classified as 3A and 4 while Scofield Reservoir has been classified as 1C, 3A, 4, as well as

2B protected for recreational uses, excluding swimming.

The numerical standards which apply to these classifications are given in Table 6 of the original hydrologic inventory. A significant water quality sampling program has been conducted on Eccles Creek, Pleasant Valley Creek, and Huntington Creek as well as some of the major tributaries of Huntington Creek and Eccles Creek on the Skyline Property. Locations of these sampling stations as well as results of the laboratory analyses of the samples collected from each station are contained on Plate 3 and in Attachment 3 of the original hydrologic inventory. Surface waters are of high quality throughtout the region shown on Attachment 6.

The original hydrologic inventory (pages 18 thru 41) contains information regarding the flow characteristics of Huntington Creek, Eccles Creek, and Pleasant Valley Creek. These are the three major streams in the Skyline Property region. The large majority of the remaining streams shown on Attachment 6 flow only seasonally or after major precipitation events.

Fish and Wildlife

*3. The applicant must indicate what mitigation methods are being applied to lessen the impact of the proposed operation on terrestrial wildlife. In particular, the impact of the conveyor system on the migration of deer, elk, and moose should be considered and mitigated.

Hydrology and Geology

*6. The applicant must supply alternative water supply information for the holders of water rights that would be affected if reclamation of the Skyline mine was unsuccessful (i.e., if the sediment ponds were to fail to control TSS from the mine or loadout facility or if revegetation was to fail and erosion ruined the water supplies) or if mining adversely affected flow from springs and seeps. Specifically, the application must discuss the potential effects of underground mining on the two springs located adjacent to the northeast corner of the lease area (Plate 9, Vol. A-1). Mitigation for these springs should be addressed.

Question Raised By OSM:

6. The applicant must supply alternative water supply information for the holders of water rights that would be affected if reclamation of the Skyline Mine was unsuccessful (i.e. if the sediment ponds were to fail to control TSS from the mine or loadout facility, or if revegetation was to fail and erosion ruined the water supplies) or if mining adversely affected flow from springs and seeps. Specifically, the application must discuss the potential effects of underground mining on the two springs located adjacent to the northeast corner of the lease area (Plate 9, Vol. A-1). Mitigation for these springs should be addressed.

Response:

As an aid in determining the characteristics of the two springs located adjacent to the northeast corner of the lease area, these springs will be added to the list of springs selected for continued monitoring. These springs will be referred to as S12-1 and S13-7. Spring 12-1 is claimed under water use claim numbers 91-432 and 91-472, while S13-7 is claimed under water use claim numbers 91-433 and 91-473. These springs are used for stockwatering and have claims totalling 0.011 cubic feet per second (5 gallons per minute) each. If underground mining by Coastal States is determined to have materially damaged rights associated with these springs, Coastal States will make appropriate reconciliatory action. If necessary, Coastal States will construct a pipeline and pump a comparable flow of water from the portal area to the springs.

Long mining history in the area shows that adverse effects to water supplies by coal mining activities do not destroy the use of the water for stockwatering or irrigation. In fact, mining in the area sometimes tends to increase the quality of the water by intercepting some groundwater and reducing its contact time with underground formations. Summer thunderstorms commonly occur on these watersheds which carry large

quantities of suspended solids into the stream. Abandoned mines adjacent to the lease and existing mines nearby, where no reclamation has been practiced, do not show that a threat to existing water rights has resulted from suspended solids in the stream or from adverse water quality associated with mining.

Water used by Coastal States is covered by an exchange and transfer of rights from Scofield Reservoir to wells and springs in Eccles Canyon. Consequently, damage to existing rights by the use of water by Coastal States is not an issue. If reclamation of the proposed Skyline Mine was unsuccessful and consequently damaged existing water rights or if mining adversely affected flow from springs and seeps and damaged water rights, Coastal States would provide alternative water supplies either from drilling new wells in Pleasant Valley Canyon or by pumping water up the canyon from Scofield Reservoir.

Hydrology and Geology

*7. The applicant must submit detailed plans for the design of sediment ponds prior to the consideration of the mine plan. If such plans are not submitted, a schedule for their submission must be supplied with the realization that no approval of this mining and reclamation plan will occur until such plans are submitted and evaluated.

*7. The applicant must submit detailed plans for the design of sediment ponds prior to the consideration of the mine plan. If such plans are not submitted, a schedule for their submission must be supplied with the realization that no approval of this mining and reclamation plan will occur until such plans are submitted and evaluated.

Response: The following pages (3-36, 3-27, and 4-52) should replace the appropriate pages in the previously filed plan. The attached material entitled, "Skyline Project Sedimentation Pond Design Description," documents the design of the sedimentation ponds. The maps (3-42, 3-43, 3-44, and 3-45) are the design drawings for the mine-site and loadout facility sedimentation ponds.

The combined emergency and principal spillway pipe will have an inlet within the pond at the 8596-foot level, 24 feet above the pond bottom. Utilizing an anti-seep collar, this pipe will safely pass any runoff from a 24-hour, 100-year storm. The pipe will be sized to pass a one-foot head of pressure (70cfs), which is more than the maximum runoff inflow rate expected from the 30-acre portal site during a 24-hour, 100-year storm.

As a principal spillway, the pipe will release runoff at a rate allowing 24-hour detention of the runoff resultant of a theoretical 24-hour, 10-year rainstorm. Since the pond is sized to detain the entire 24-hour runoff from a 10-year rainstorm, adequate pond size is ensured independently of the principal spillway pipe size finally selected. To prevent overtopping in the event that the principal/emergency spillway becomes blocked, a riprapped overflow section along the embankment crest will be provided with the capability of passing the 100-year, 24-hour precipitation event. The preliminary design of this pond is shown in plan view on Map 3-8 (Drawing 102-C) and in cross-section on Map 3-12A (Drawing 111-C).

The detailed design of the mine site sedimentation pond is shown in Map 3-42 (Drawing 1-204-C) and the pond cross-section with detailed construction notes are shown in Map 3-43 (Drawing 1-207-C).

Coal Loadout Sediment Pond

A detention pond will be located adjacent to the storage silos at the coal loadout site. It will detain surface runoff and associated sediment from the 7-acre administration site. Precipitation from a 24-hour, 10-year rainstorm has been calculated to be 2.45 inches. It is assumed that, during a rainstorm, the ground would become quickly saturated and infiltration would be negligible due to the steep canyon slopes adjacent to the flatland site area.

The required volume for providing a theoretical 24-hour detention of the above runoff has been estimated as: 2.45 inches per acre x 7 acres = 62,000 cubic feet. The required volume for sediment storage has been estimated as: 0.10 acre-feet x 7 acres = 31,000 cubic feet. The combined volumes equal 93,000 cubic feet.

The coal loadout sediment pond embankments will contain a volume of 93,000 cubic feet at a 6-foot depth. One foot has been added for

freeboard and an additional 5% added for settlement of the embankments. Combined depth of the contained pond volume will be 8 feet. Berm width at the top of the embankments (7928-foot level) will be 8 feet. Embankment slopes will be constructed at 2h:1v.

A single pipe will be used for both the emergency and principal spillway with its inlet at the 7926-foot level, 6 feet above the pond bottom. Using an anti-seep collar, this pipe will safely pass, through the dam, any runoff from a 24-hour, 25-year storm. The pipe will be sized to pass at 30 ft./sec a one-foot head of pressure. This is more than the maximum runoff inflow rate expected from the 7-acre mine site during a 24-hour, 25-year storm.

Functioning as principal spillway, the pipe will release runoff at a rate that will allow a 24-hour detention of the runoff resultant of a 24-hour, 10-year rainstorm. A riprapped section along the pond embankment crest, similar to that described previously, will be provided to prevent overtopping should the principal emergency spillway pipe become blocked during an extreme precipitation event.

The preliminary design of the coal loadout sedimentation pond is shown in plan view on Map 3-9A (Drawing 103-C) and in cross-section on Map 3-12A (Drawing 111-C).

The detailed design of the loadout sediment pond is shown in Map 3-44 (Drawing 3-201-C) and the pond cross-section with detailed construction notes are shown in Map 3-45 (Drawing 3-203-C).

3.2.2 Overburden and Topsoil Handling

A comprehensive discussion pertaining to this operational component of the mine plan is presented in Section 4.6 - TOPSOIL AND SUBSOIL HANDLING PLAN.

3.2.3 Blasting

The Applicant will conduct surface blasting in conjunction with the construction of operational facilities. Blasting operations will be conducted only by experienced, trained and competent individuals fully knowledgeable of the hazards involved. To meet this prerequisite, the Applicant will conduct a continuous recruiting, training and testing program designed to ensure that all persons working with explosives:

4.13 PONDS, IMPOUNDMENTS, BANKS, DAMS AND EMBANKMENTS - MINE PLAN AREA

4.13.1 Sedimentation Ponds

Two sediment ponds for surface water runoff will be required, one at the mine site and the second at the coal loadout site. Each pond is designed to provide adequate volume for sediment containment plus an adequate volume for a theoretical 24-hour detention of runoff from a 24-hour, 10-year precipitation event. The location and preliminary design characteristics of each of these two ponds is described in Section 3.2 - COMPONENTS OF OPERATION, subsection 3.2.1 - Ponds, Impoundments and Dams. The maintenance for each pond is described in Section 3.2 - COMPONENTS OF OPERATION, subsection 3.2.8 - Procedures for Construction through Removal of Major Structures and Facilities. The reclamation timetable for removing the pond structures is presented in Section 4.2 - RECLAMATION TIMETABLE.

The detailed design for sedimentation pond construction has been completed. The design drawings for the mine site and loadout sedimentation ponds are shown in Maps 3-42 and 3-43 (Drawings 1-204-C and 1-207-C) and Maps 3-44 and 3-45 (Drawings 3-201-C and 3-203-C) respectively.

4.13.2 Permanent and Temporary Impoundments

The only impoundments will be sedimentation ponds at the mine site and coal loadout site. There are no other impoundments planned by the Applicant.

4.13.3 Coal Processing Waste Banks, Dams and Embankments

There will be no coal processing waste banks, dams or embankments constructed within or adjacent to the permit area, as no coal processing waste is anticipated.

SKYLINE PROJECT

SEDIMENTATION POND DESIGN DESCRIPTION

1.0 GENERAL

All surface storm water runoff from distrubed areas will be routed to sedimentation ponds through a system of surface ditches and buried culverts. Clean water runoff from the surrounding hillsides will be diverted around disturbed areas using diversion channels. The sedimentation pond for the portal area facilities is sized to provide retention of the runoff water from the 24-hr, 10-yr precipitation event. This pond is shown in plan view on Drawing 1-204-C, sections and details are shown on Drawing 1-207-C. A combined principal and emergency spillway pipe is sized to safely pass the runoff from the 24-hr, 100-yr storm. The sedimentation pond at the coal storage and loadout area, shown in plan view on Drawing 3-201-C and in cross-section on Drawing 3-203-C, is sized to contain the precipitation runoff from the 10-yr, 24-hr precipitation event. A single discharge pipe will be used for both emergency and principal spillway. This pipe will safely accept the runoff from a 24-hr, 100-yr storm.

2.0 PORTAL AREA POND CRITERIA

The sedimentation pond located at the mine portal area has been designed using the following criteria:

A. Contributing area - 36 acre

B. Sediment storage volume
C 0.1 AF per acre of disturbed area - 156,800 cu.ft. (36 AF)

C. Pond design storm - 10 year return frequency, 24-hr duration event

- o Total precipitation depth = 2.4 inches
- o Total runoff depth = 1.44 inches
- o Total runoff volume = 188,200 cu.ft.
- o Peak inflow rate = 38 cfs

D. Spillway capacity design storm - 100 year return frequency, 24-hr duration event

- o Total precipitation depth = 3.6 inches
- o Total runoff depth = 2.5 inches

- o Total runoff volume = 326,700 cu.ft.
- o Peak inflow rate = 65 cfs

The above precipitation data was developed from the clear creek summit station records presented in the National Oceanographic and Admospheric Administration literature and summarized in the following table:

Table 2-1 Estimated Return Periods for Short Duration Precipitation (Inches)

Station: Clear Creek Summit — Elevation: 9630 ft.
Latitude: 39° 39' — Longitude: 111° 12'

	DURATION									
	5 min	10 min	15 min	30 min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
Return Period (years)										
1	.10	.16	.20	.28	.35	.46	.57	.84	1.08	1.33
2	.12	.19	.25	.34	.43	.57	.70	1.04	1.34	1.65
5	.16	.24	.31	.43	.54	.72	.90	1.34	1.73	2.14
10	.19	.29	.37	.51	.65	.86	1.06	1.55	1.99	2.45
25	.24	.38	.48	.66	.84	1.08	1.31	1.88	2.39	2.92
50	.25	.38	.48	.67	.85	1.13	1.40	2.07	2.67	3.29
100	.27	.42	.53	.73	.93	1.24	1.54	2.29	2.96	3.65

Sources: National Oceanographic and Atmospheric Administration, and Utah State University

3.0 LOADOUT AREA POND CRITERIA

The following criteria was used for the design of the sedimentation pond:

A. Construction area - 5.3 acre

B. Sediment storage volume @ 0.1 AF per acre of disturbed area - 23,100 cu.ft. (.53 AF)

C. Pond design storm - 10 year return frequency, 24-hr duration event

- o Total precipitation depth - 2.4 inches
- o Total runoff depth - 1.44 inches
- o Total runoff volume - 27,700 cu.ft.
- o Peak inflow rate - 8.5 cfs

D. Spillway capacity design storm - 100 year return frequency, 24-hr duration event

- o Total precipitation depth - 3.6 inches
- o Total runoff depth - 2.5 inches
- o Total runoff volume - 48,100 cu.ft.
- o Peak inflow rate - 15 cfs

4.0 POND OPERATING CHARACTERISTICS

The spillway riser at both ponds is set at an elevation such that the entire volume of runoff from the design storm event would be contained within the pond with no discharge if the water surface levels prior to the storm were at the sediment storage level or lower. This will allow retention of runoff water for essentially any period of time necessary to provide sediment removal. Each pond is provided with a dewatering valve located just above the sediment storage level to provide for discharge of the storm water when clarified. The sedimentation pond depth/capacity curves are shown on the attached figures 1 and 2.

Alternatively the ponds can be maintained in an essentially full condition. Under this condition the runoff from the design event would serve to replace previously clarified water with the new storm water, and although some mixing would occur it is expected that it would have little consequence to the discharged water quality. Provisions to discharge extreme precipitation events up to the 100 year frequency, 24-hour duration precipitation event though the spillway riser has been made. The spillway discharge characteristics are shown on figures 3 and 4 attached. The portal area pond discharges into a 72 inch diameter conugated steel pipe which carries the Eccles Creek drainage beneath the portal facilities. This pipe has been sized to accommodate the flows from the 100 year, 24-hr storm without hindering discharge from the sedimentation pond.

The discharge risers at each pond will be equipped with a circular trash and oil barrier which will force the flow down under the barrier into the spillway and eliminate direct surface flow into the riser.

The portal area pond has a length to width ratio of approximately 4:1. The loadout area pond has length to width ratio of about 2:1.

In addition to runoff water collection from disturbed areas at the portal site the pond will also receive water discharged from the mine. This water will normally be routed to a storage tank for eventual return to the mines for dust suppression use however in the event the tank is full provisions to discharge into the pond are necessary. The mine water volumes are expected to be small and intermittant and will therefore not have a significant influence in the pond hydrological characteristics.

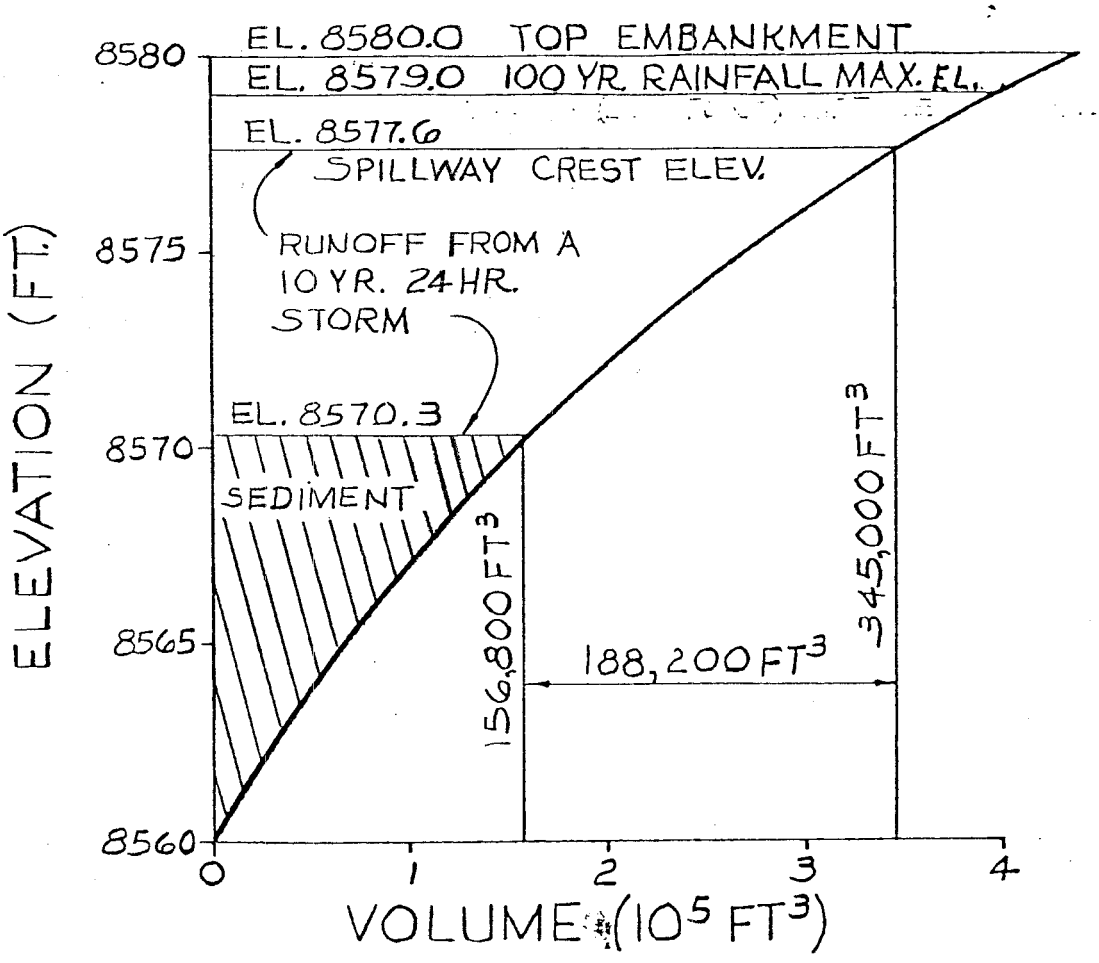
5.0 CONSTRUCTION CONSIDERATIONS

The sedimentation pond at the portal area will be located partly on cut and partly on fill. The interior side slopes will be 1:1 (H:V) where rock is exposed. Where fill or existing soil materials are encountered the side slopes will be 2:1 (H:V). To eliminate seepage in fill or soil materials a 3 foot thick blanket of selected materials having a seepage rate of not more than 10^{-4} cm/sec will be provided at the loadout area the pond will be constructed in the existing soils with excavated materials used for the pond embankments. The side slopes will be 2:1 (H:V) for both interior and exterior slopes. Here also a 3 foot thick blanket of selected material will be provided to eliminate excessive seepage should the existing soils prove excessively permeable. Anti-seepage collars will be provided around the discharge pipes of both ponds. All fill materials will be compated to not less than 90% maximum proctor density.

Prepared by

Michael D. Phillips
Registered Professional Engineer
(Civil) State of Utah No. 5167

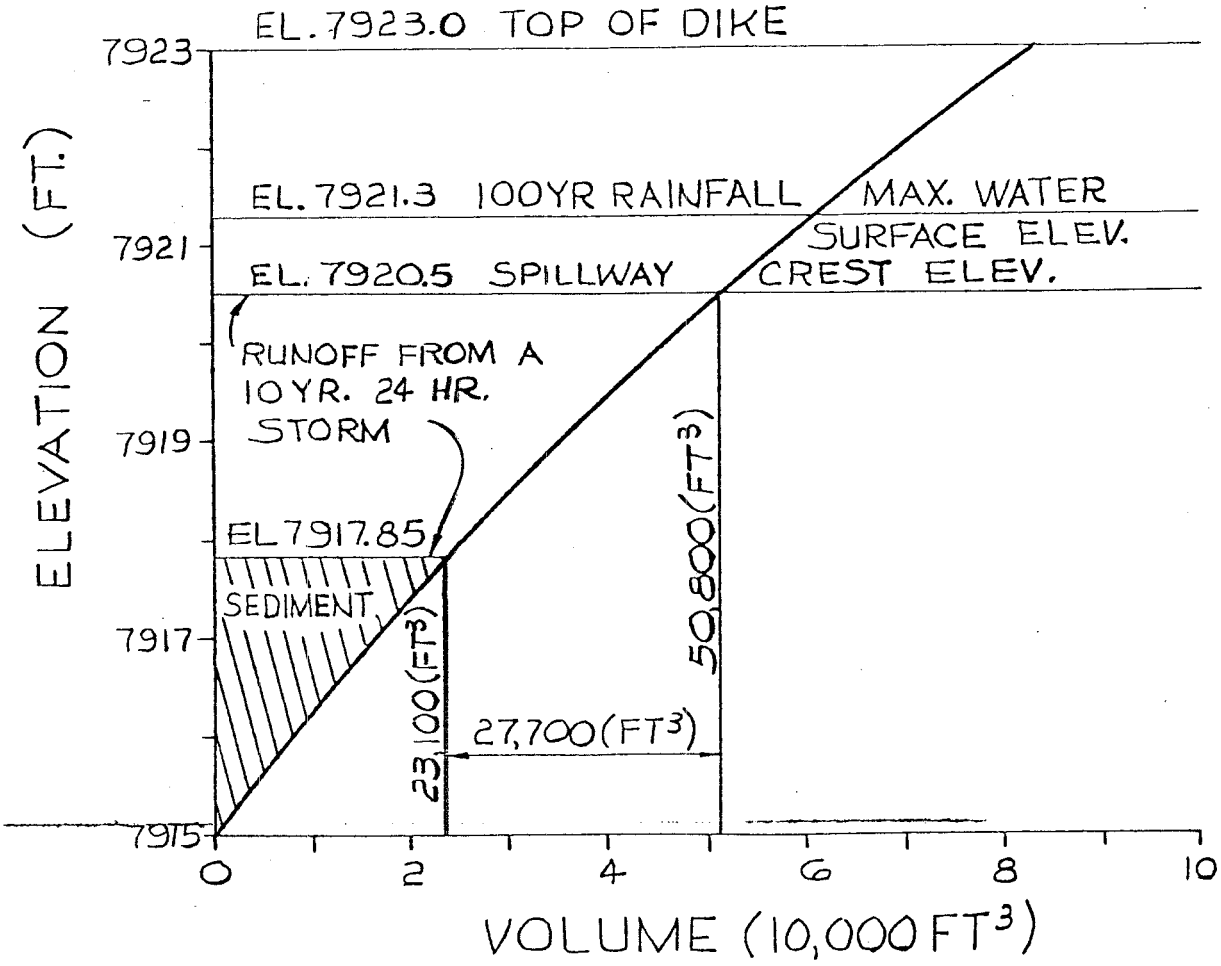
FIGURE 1



PORTAL AREA SEDIMENTATION POND
DEPTH-CAPACITY CURVE

KAISER ENGINEERS
OAKLAND, CALIFORNIA

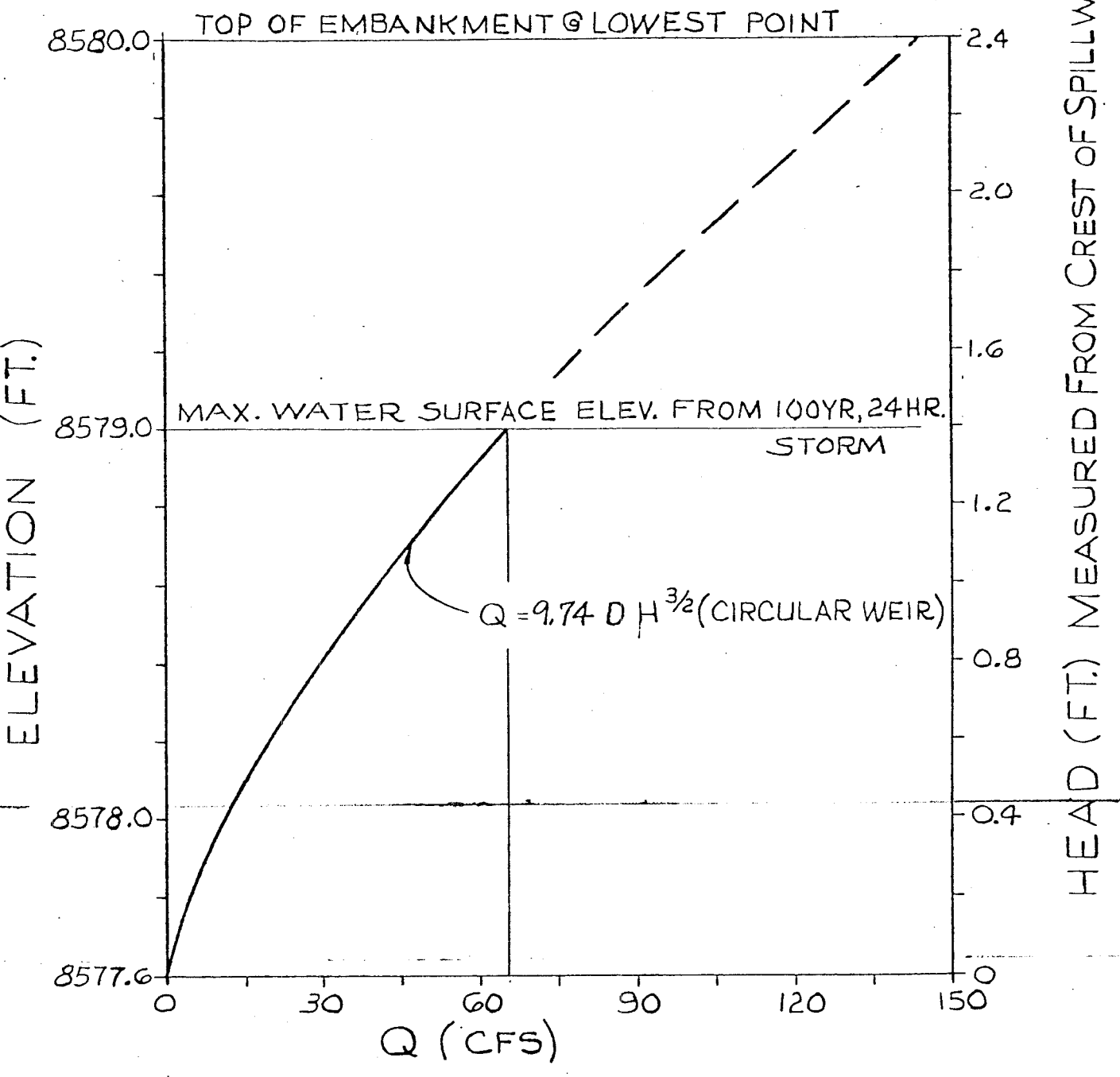
FIGURE 2



LOADOUT AREA SEDIMENTATION POND
DEPTH - CAPACITY CURVE

KAISER ENGINEERS
OAKLAND, CALIFORNIA

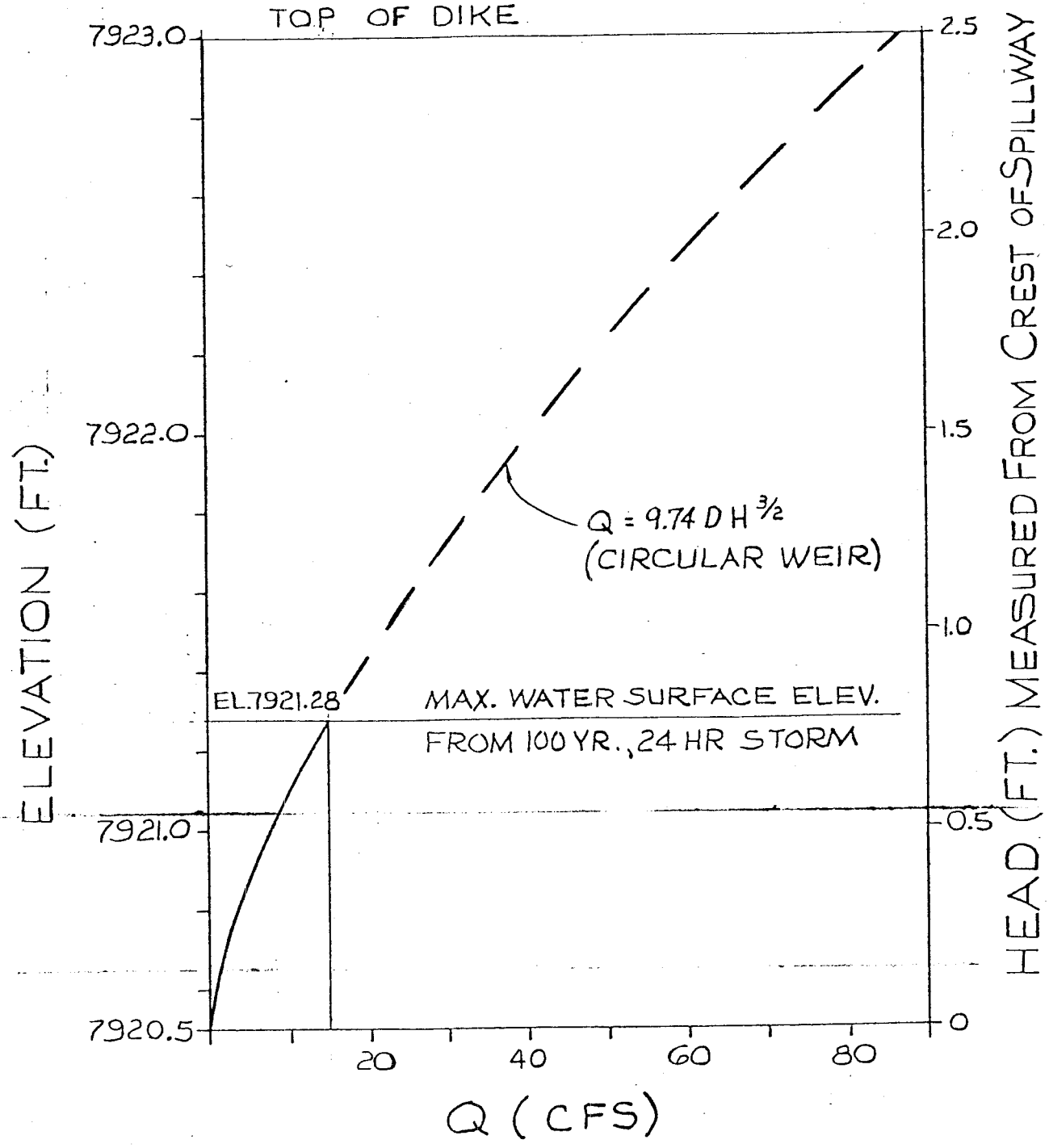
FIGURE 3



PORTAL AREA SEDIMENTATION POND
SPILLWAY CAPACITY CURVE

KAISER ENGINEERS
OAKLAND, CALIFORNIA

FIGURE 4



LOADOUT AREA SEDIMENTATION POND
SPILLWAY CAPACITY CURVE

KAISER ENGINEERS
OAKLAND, CALIFORNIA

Hydrology and Geology

8. The applicant should supply the source of its hydrograph and/or runoff data and supply references for using specific SCS runoff curves.

8. The applicant should supply the source of its hydrograph and/or runoff data and supply references for using specific SCS runoff curves.

Response: First reference for the hydrological calculations is the National Oceanic and Atmospheric Administration Precipitation and Frequency Atlas of the Western United States, V. 6, Utah. Project location is in Region I.

1. It was used to determine the precipitation rates and storm durations. It was also used for correction factors for site location and altitude and to derive the intensity duration curves.

Reference to the Soil Conservation Service field manual published by the Department of Agriculture. Used for determination of runoff volumes and peak flows. Also used to determine the hydrologic soil groups. This area has several varying soil groups and ground covers. The curve numbers used range from 60 through 74. Ground covers range from 15% thru 50%. Soil groups used were B or D.

Hydrology and Geology

9. The Applicant should supply a quantitative basis for its lack of water treatment facilities for mine discharge water.

Question Raised By OSM:

9. The applicant should supply a quantitative basis for its lack of water treatment facilities for mine discharge water.

Response:

Valley Camp of Utah, Inc. operates a mine adjacent to the proposed Skyline Mine. Valley Camp has been issued an NPDES discharge permit which has standards for seven parameters of the effluent from their mine. Table 1 lists these seven constituents along with the minimum, maximum, and average measurements of these parameters as well as the standard as given in the NPDES permit. As can be seen in this table, levels of pH, acidity, alkalinity, and iron have been well within the limits of the NPDES standard in all of the 31 samples collected prior to January 1, 1980. The level of oil and grease, although averaging much less than the standard, did have one sample of the 17 collected that exceeded the standard. In order to prevent such an occurrence, Coastal States will install oil skimmers which will remove most of the oil and grease from the effluent at the Skyline Mine. Total suspended solids will be controlled at the Skyline Mine by the use of a sedimentation pond. Total dissolved solids of the Valley Camp discharge averaged much less than the NPDES permit standard. However, one of the 31 samples collected did exceed the standard. Such an occurrence is obviously very rare and does not have serious environmental consequences.

Because of the high quality water which experience in the area indicates will be discharged from the Skyline Mine, no treatment facilities besides the oil skimmer and sedimentation pond mentioned earlier should be required.

Table 1. Results of Water Quality Measurements of the Valley Camp Mine Discharge.

Parameter	Number of Measurements	Minimum	Average	Maximum	NPDES Standard
pH	31	7.0	7.48	8.4	6.5 - 9.0
Acidity	31	6	17.6	32	Alkalinity levels should be above Acidity levels
Alkalinity	31	104	210	336	
Iron	31	0.012	0.25	1.934	Average 3.5 Maximum 7.0
Oil and Grease	17	1	1.3	15.6	10
Total Suspended Solids	31	1	34.6	178	30
Total Dissolved Solids	31	200	306	951	750

ALLUVIAL VALLEY FLOORS

SECTION 785.19(c)

ALLUVIAL VALLEY FLOORS

SECTION 785.19(c)

Alluvial Valley Floors

*1. The applicant should submit all available site-specific precipitation data to confirm (or deny) the generalized precipitation data given in Jeppson et al. (1968).

Question Raised by OSM:

1. The applicant should submit all available site-specific precipitation data to confirm (or deny) the generalized precipitation data given in Jeppson et al. (1968).

Response:

Precipitation records are available at Clear Creek (latitude 39° 39', longitude 111° 09', elevation 8300 feet) and Scofield (latitude 39° 44', longitude 111° 09', elevation 7700 feet and previously known as Winter Quarters). As shown in the annual summary of Climatological Data for Utah, the long-term annual mean precipitation at Clear Creek in 1956 was 21.65 inches. As shown in the Climatic Summary, the mean annual precipitation at Scofield (Winter Quarters) between 1893 and 1924 was 19.46 inches. These amounts correspond quite closely to the values shown on maps by Jeppson et. al. (1968) although they are slightly lower than Jeppson's values. This fact seems to confirm that the generalized precipitation data given in Jeppson et al. (1968) are quite accurate in the vicinity of the Skyline Property.

Precipitation in eastern Utah: Monthly, annual, and average amounts (in inches and hundredths)—Continued

VERNAL, UINTAH COUNTY.—Elevation, 5,205 feet

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1894											6.00	1.16	
1895	1.03	0.54	1.39	0.08	1.51	0.53	0.76	0.49	0.38	1.03	1.33	.27	9.13
1896	.45	.29	.38	.89	.94	.04	1.86	.58	2.48	.69	.42	.04	9.09
1897	.16	1.11	.86	.58	.62	.23	1.08	.26	2.83	2.34	.42	1.21	12.49
1898	.63	.47	.64	.50	2.03	*.50	.34	*.75	1.01	.53	.39	.17	7.72
1899	.47	.55	1.98	.39	.09	.78	.64	1.63	T	1.64	.46	.50	8.41
1900	.47	.12	.15	2.00	.23	.14	.03	.22	1.46	.57	1.21	.04	6.67
1901	.71	1.38	.61	.33	.86	.21	.21	.73	.04	.42	.27	.45	5.93
1902	.21	.53	.85	.72	.52	.51	.12	.49	.99	.05	1.12	.91	7.04
1903	.31	.91	1.02	.47	1.30	.89	1.83	.13	1.30	.55	.18	*.05	9.75
1904	*.03	1.29	1.85	1.22	1.38	.21	.52	.41	1.81	.15	.97	.21	10.59
1905	.96	.29	1.11	1.52	2.55	.25	1.18	1.02	1.00	.32	2.77	1.72	14.76
1907	.51	.41	.76	.41	1.37	.50	.29	.92					
1908							.84	1.59	2.45	.55	.80		
1909	1.64	.52	.16	.62	.08	.17	.87	1.97	1.48	.15	1.10	.56	9.62
1910	*.85	.01	.67	.00	.01	.15	1.12	.72	.82	1.25	.17	.65	5.84
1911	1.06	.91	.57	.11	T	.30	.28	.01	1.69	1.06	.62	.19	6.14
1912	.09	.22	2.24	.69	.84	.03	.48	.63	.40	2.45	.18	.09	8.28
1913	.30	1.05	.45		.01	1.09				T			
1914											.00		
1915			.21			.00	T	T	2.20	.33	1.04	.72	
1916	2.83	1.09	1.16	.05	.09	.00	.22	.39	.25	2.64	.19	*.07	8.71
1917	.70	.58	.64	.54	2.53	.02	.37	.00	1.46	.05	.05	.24	7.35
1918	*.70	*.25	.16	1.46	.05	.07	1.61	.19	1.32	.95	.35	*.55	7.67
1919						.00	.06			1.01	2.19	.70	
1920	.25	.61	1.65	1.18	1.15	.10	T	1.96	.14	1.13	1.45	.20	9.82
1921	.87	.15	.50	1.48	2.05	.46	.77	.65	.31	*.45	.52	1.95	19.11
1922	.62	.88	1.08	1.94	1.54	.03	1.58	*1.70	.20	*1.00	*1.30	.70	13.12
1923	.65	.76	.50	2.09	*.50	*T	.07	.70	1.16	.52	.59	*.49	7.48
1924	.50	.00	.10	.65	.98	.00	.50	.43	1.13	.61	.15	.45	5.50
1925	.00	.20	T	.10	.10	1.57	1.30	2.43	1.05	2.16	.34	.15	9.40
1926	.34	.02	.44	.80	.13	.00	.49	.74	1.61	.00	.33	.30	5.20
1927	*.50	1.47	1.54	.01	.21	1.47	.88	*1.06	*3.70	1.44	1.28	.95	14.76
1928	.23	T	.67	*.10	2.38	*.00	*T	.00	.20	3.32	1.18	T	8.65
1929	.82	*.60	1.40	1.67	1.22	.20	.84	.85	1.39	.95	.00	.05	9.99
1930	.95	.20	.54	.79	.68	.12	.21	1.35	1.63	.62	1.60	.60	5.70
Average	.66	.55	.78	.80	.90	.32	.64	.75	1.21	1.03	.99	.51	9.11

VICTOR, EMERY COUNTY.—Elevation, 5,250 feet

1911						0.47		0.46					
1912							1.07	.11	1.03	1.32		0.29	
1913	0.09	0.59	0.09	0.00	0.00	.45	.77	.23	1.35	.10	1.31	1.05	5.85
1914	1.32	.44	.47	.57	.49	1.79	3.09	.09	.05	.52	.09	.20	9.24
1915	1.05	1.21	.19	.95	.56	.51	.09	.09	1.05	.00	1.16	.94	7.53
1916	1.47	.68	.37	.09	.00	.00	.33	1.36	.60	1.56	T	.08	6.74
1917	.30	.50	.00	.53	1.15	.00	1.25	.19	1.56	.00	T	.09	5.48
1918	.10	.00	.67	.63	.00	.61	1.50	.17	1.51	1.00	T	.52	6.71
1919	T	.10	.02	.07	.42	.09	1.31	1.12	1.57	.17	*.50	.16	5.36
1920	.18	.93	.73	.41	1.15	.25	T	1.42	.80	1.82	.30	.50	8.54
1921	.90	.09	.11	.25	.25	.11	1.85	3.69	.33	.15	.00	1.15	8.80
1922	.39	.53	.50	.14	.60	.14	.40	2.61					
Average	.59	.50	.39	.36	.46	.39	1.05	.95	.98	.72	.35	.52	7.15

WARNER RANGER STATION, GRAND COUNTY.—Elevation, 9,450 feet

1916						0.01	5.50	3.17	0.87				
1917							1.82	.97	1.32				
1918						1.86	3.48	1.33					
1919							3.08	3.03	2.06				
1920							1.74						
1921						.34	3.06	5.13					
Average						.74	3.11	2.62	1.42				

8 miles southeast of Castleton.

WATSON, UINTAH COUNTY.—Elevation, 6,210 feet

1898			0.92	0.37						1.50			
1907		1.25	.90	.05		T		0.72		0.30			
1919													
1921					0.27	0.60	1.10	1.24	2.01	2.35	.55	0.50	
1922	0.10	1.18	1.29	1.06	1.58	1.55	2.10	1.11	.14	1.63	.41	.46	12.67
1923	.33	.98	.60	.44	.29	1.64	1.73	.51	1.12	.46	1.36	1.97	11.45
1924	1.20	.93	1.77	1.13	.95	2.63	1.62	1.31	.87	.71	.60	.04	13.25
1925	.74	.42	.31	1.74	.93	1.30	.14	.00	2.61	.22	1.05	1.15	10.71
1926	1.02	.22	.22	.01	.31	T	2.85	2.52	.00	3.35	.40	.47	12.27
1927	.98	.35	1.21	1.30	2.13	.02	.80	.36	1.42	.60	.19	.01	9.05
1928	1.53	.48	.73	1.05	.61	.47	.78	.66	.24	1.35	1.02	.99	9.26
1929	.61	.42	.25	1.19	.81	.06	.67	.47	2.81	.83	1.39	.65	9.55
1930	.62	.24	1.30	1.18	.36	T	1.67	2.18	.62	1.25	.46	.76	10.29
1931	.31	.12	.74	1.45	.12	2.51	2.16	2.11	T	.81	.87	.79	11.58
1932	.03	.35	.57	2.45	.77	.03	.82	3.95	.09	.36	1.17	1.18	13.37
1933	.51	.61	3.43	1.08	.31	.09	1.99	1.67	2.10	.83	1.19	.50	14.25
1934	.07	T	.65	.67	.96	.16	.32	1.39	.71	1.58	.35	1.15	7.82
1935	T	.18	.39	.18	.88	2.19	3.39	2.15	1.45	.73	.18	.65	12.23
1936	.36	.35	.49	.75	1.97	.66	1.11	1.96	.65	.71	.78	1.72	11.51
1937	.69	.74	.74	.70	.45	2.44	1.39	1.45	3.58	.42	1.20	.46	14.17

Precipitation in eastern Utah: Monthly, annual, and average amounts (in inches and hundredths)—Continued

WATSON, UINTAH COUNTY.—Elevation, 6,210 feet—Continued

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1928	0.28	T	2.47	0.40	1.87	0.30	0.56	1.54	0.78	3.84	2.74	0.52	15.30
1929	.51	0.63	1.14	1.58	.94	.38	1.92	1.93	4.60	.84	.54	.06	15.10
1930	.79	.40	.89	1.27	.97	.23	2.21	1.88	2.20	.01	2.93	.05	13.83
Average	.55	.49	1.00	.97	.88	.82	1.46	1.45	1.43	1.13	.97	.69	11.87

Station located at Rainbow Mine, of the Gilson Asphaltum Co., about 2¾ miles southwest of Watson.

WELLINGTON, CARBON COUNTY.—Elevation, 5,540 feet

1900	*0.24	0.00	0.30	1.76	0.09	0.27	0.00	1.11	1.48	0.00	*0.45	0.00	5.70
1901	.25	1.19	.10	.20	.37	.02	.33	.99	T	*.57	.00	.05	3.98
1902	.24	.29	1.05	*.30	.02	.00	.02	.24	.31	.05	1.60	.25	4.37
1903	.52	.09	.76	*.10	.82	.53	1.05	.33	1.28	*.35	.00	.05	6.09
1904	.35	.02	.55		1.66		.15	1.12	T	.80			
1905	.60	.10	.52			.00	.00	1.90	2.20				
1906	1.15		.90	.70	.42	.00	.35	.67	1.02				
1907			.05	.10	.36						.40	.20	
1908	.90	1.40			.40						.40	1.30	
1909		1.80	.00								1.10	2.30	
Average	.53	.59	.47	.53	.52	.19	.27	.91	.90	.35	.55	.58	6.39

WINTER QUARTERS, CARBON COUNTY.—Elevation, 7,750 feet

1891								0.50	0.10	1.85	0.00		
1892			0.85	0.20	0.00	1.89	0.33	.67	.55	.11	1.51		
1893	1.80	1.60	2.80	.20	.00	.00	4.50	2.12	1.11	*.25	0.22	1.67	16.27
1894			1.96	.39	1.70	4.00	.71	2.04	.97				
1908								1.65	3.37	2.95	1.02	1.88	
1909	[1]8.38	5.40	2.47	7.49	3.34	.58	4.12	19.15	3.21	.26	5.55	3.31	64.26
1910	3.76			.00									
1911	2.60	1.00	.55	.40	.66	1.67	1.31	.32	2.01	.20	.93	.34	11.99
1912	1.03	.47	2.27	.77	1.15	.95	1.79	1.22	1.66	3.89	.35	1.56	17.11
1913	.83	1.49	.48	.43	.77	2.47	3.35	2.49	2.89	1.30	.62	1.03	18.15
1914	1.15	.23	1.05	3.64	.84	3.30	2.78	1.66	.33	2.65	.04	1.00	18.72
1915	*2.00	*2.50	.53	2.79	2.88	1.44	.81	*.45	1.59	.00	3.21	1.61	19.81
1916	3.38	1.49	1.25	.63	.11	.01	2.13	*2.00	.23	4.31	.52	.86	16.95
1917	.04	1.42	1.06	2.09	2.58						1.51		
1918												.83	
1919	.09	4.49	.81	1.85	1.36	.05	1.41	1.55	2.45	1.70	1.55	1.08	18.42
1920	.43	1.27	2.93	2.95	1.03	.69	.56	2.32	1.58	2.71	.61	1.52	18.61
1921	2.96	1.25	.38	1.52	1.86	.59	1.90	3.43	.96	1.01	.45	3.01	19.62
1922	.83	2.42	1.50	1.10	1.70	2.02	.68	3.69	.73	.65	1.52	3.61	20.45
1923	1.12	1.02	1.26	1.94	1.41	.42	2.93	.94	.62	1.32	.38	.76	14.12
1924	.53	.25	1.87	.25	.88	.03	.67	.46	1.08	1.40	.89	2.53	10.84
1925	.89	1.49	1.20										
Average	2.46	1.68	1.37	1.60	1.42	1.16	1.81	2.06	1.49	1.54	1.21	1.66	19.46

[1] Amount verified.

Record prior to 1918 for Scofield, altitude 7,625 feet, 2 miles northeast of Winter Quarters.

WOODSIDE, EMERY COUNTY.—Elevation, 4,645 feet

1911	*0.60	*0.75	*0.50	0.13	0.00	0.66	0.70	0.65	3.07	0.38	0.14	0.31	7.89
1912	.12	.42	1.68	.39	.31	.38	.36	.61	.73	2.28	.25	.04	7.57
1913	.00	.78	.23	.00	.39	.68	.53	*.15	.35	T	.95	1.14	5.20
1914					.60	.53	1.15	.00	.00		.00	.10	
1915	1.31	.55	*.25	*.35	*.55	.21	.09	.20	1.55	.00	1.04	1.05	7.15
1916	3.20	.25	.44	.12	.03								
Average	1.05	.55	.62	.20	.31	.49	.57	.32	1.14	.66	.48	.53	6.92

YELLOWSTONE RANGER STATION, DUCHESNE COUNTY.—Elevation, 7,600 feet

1916						T	1.86	1.86	0.84	3.90	0.47		
1917		1.90	0.40	2.50		0.24	1.35	.41	2.16		.48	0.14	
1918		.73	2.26	1.30	0.98	1.49	3.18	.39	2.21	1.91	.77		
1919	0.00	1.41	.78	1.66	.75	.00	1.40	.75	2.92	1.64	1.04		
1920	.38		.90	.81	.10	2.99	3.52	1.25	3.30	2.40			
1921	2.32			3.19	.87		4.01	.47	.50				
1922				3.00	.72	.84	3.42	.91	.84	2.30	1.40		
1923	1.20				.12	.73		1.38					
1924				1.17	.00		.02						
1925			.13	.59	1.07	2.77	1.33	3.23	3.42	2.24	1.40		
1926					.45	.40	1.61	2.27	1.15	.63	2.31		
1927				.49	1.74	1.77	3.51	5.08	.70				
1928				2.45	.71	1.05	2.77	.73	5.66				
1929				1.01	.57	1.78	2.71	3.58	1.11				
1930					.32	2.82	4.55	2.46					
Average	.95	1.35	.89	1.27	1.39	.67	1.75	2.39	2.04	2.05	1.40	.77	16.95

16 miles northwest of Altonah.

Station	January Precipitation	January Departure	February Precipitation	February Departure	March Precipitation	March Departure	April Precipitation	April Departure	May Precipitation	May Departure	June Precipitation	June Departure	July Precipitation	July Departure	August Precipitation	August Departure	September Precipitation	September Departure	October Precipitation	October Departure	November Precipitation	November Departure	December Precipitation	December Departure	Annual Precipitation	Annual Departure
	2.32	.62	.88-	.93	.14-	1.55	1.36-	.23	1.19-	.53	.00-	.76	.30-	.39	.31-	.65	.21-	.75	1.02-	.46	.17-	1.06	1.88	.33	9.58-	6.36
	13.70		-		2.41		-		-		-		-		-		-		-		-		7.47		-	
	1.05	.61	.34-	.14	.05-	.40	.90	.21	.20-	.69	.28-	.21	.68-	.17	.26-	1.00	.07-	.82	.79	.05	.00-	.48	.71	.17	5.11-	2.87
	2.52	.97	.20-	1.50	T -	1.59	.38-	.79	.25-	.51	.50-	.09	.71-	.81	.15-	1.58	T -	1.36	.33-	1.03	.33-	.80	.41-	1.33	5.46-	10.82
...LAND	2.55		.85		.00		1.57		2.97		.25		.56		.05		.00		2.56		.35		1.51		13.24	
...RESEARCH LAB	1.55		.65		.02		1.06		2.65		.27		.10		.03		.21		1.09		.41		.99		8.93	
...LOWEM PH	-		-		-		-		-		-		-		-		-		-		-		3.70		-	
	2.04	1.16	.65-	.19	-		-		-		-		-		.05-	.57	.04-	.40	1.16-	.45	.27-	1.24	E 1.48	.25	-	
...RIVER REFUGE	1.93	.87	.30-	.55	.10-	1.14	1.36-	.09	2.00	.58	.47-	.92	.72-	.03	.01-	.42	.03-	1.08	.89-	.54	.19-	.93	1.20	.23	8.78-	4.11
	1.06	.22	.47-	.53	.08-	1.19	.59-	.22	.50-	.04	.50-	.04	.66-	.57	.31-	1.31	.11-	.67	.36-	.71	.00-	.73	.29-	.66	5.82-	8.64
...CANYON PH	3.66	1.80	1.31-	.97	.17-	2.69	2.23	.35	1.58	.23	.86-	.66	1.37-	.54	1.19-	.97	.15-	.81	.98-	1.09	.17-	1.02	.39-	1.14	13.93-	7.51
...CANYON	4.21	2.61	2.93	.34	.58-	1.73	1.11-	1.13	2.25-	.04	.47-	1.67	1.22	.41	.11-	1.22	.47-	.26	1.90-	.09	1.23-	.97	2.61	.42	17.95-	3.05
	2.19	1.53	.43-	1.01	.10-	1.14	.94-	.23	1.10	.35	.74-	.72	.69-	.22	.54-	.72	.02-	.71	.75-	.46	.05-	.81	.87-	.42	8.12-	4.25
...ROCK	.56-	.02	.57-	.21	.06-	.93	1.42	.40	.70-	.35	2.93	1.50	.38-	.34	.05-	.66	.24-	.69	.42-	.60	.05-	.59	.15-	.37	6.36-	2.88
...ING	1.64	.59	.27-	1.03	.08-	1.00	.27-	.77	.18-	.55	.18-	.42	.69-	.35	.63-	.63	T -	1.47	.91-	.35	.07-	.75	.25-	1.10	4.93-	7.84
	1.24	.64	.23-	.50	.29-	.42	.05-	.48	.32-	.09	.50-	.32	.72	.06	1.28	.54	.20-	.87	.70-	.10	.00-	.41	.20-	.51	5.03-	2.46
...CK	E 1.30	.66	.59	.20	.25-	.51	.25-	.59	.13-	.48	.12-	.66	.50	.09	.12-	.82	.12-	1.00	1.60	.33	.10-	.28	.36-	.17	E 5.24-	3.23
	1.82		.31		.07		1.38		2.19		.34		.58		.00		.15		.39		.52		1.30		8.65	
...ER	.55		.03		.00		.42		.30		2.82		.42		.65		.13		.91		.20		.13		5.54	
...CITY	3.85	2.13	1.08-	.55	.09-	1.88	1.64-	.37	3.32	1.47	.89-	.54	.26-	.31	T -	.72	T -	1.15	1.77-	.01	.78-	.80	1.80	.11	15.30-	2.61
...CANYON CAA AP	.77		.33		.04		.51		.52		.29		1.53		1.08		T		.75		.05		.05		6.32	
...CANYON NF	1.13-	.25	.34-	1.43	.02-	1.84	1.14-	.05	.63-	.24	.43-	.28	1.04-	.32	1.57-	.36	.32-	1.33	.86-	.87	.10-	.93	.19-	1.39	8.09-	9.25
	.05	.27	.64	.56	.12-	.35	.61	.03	1.45	.82	.00-	.52	.04-	.12	.00-	.42	.01-	.26	.22-	.26	.03-	.42	.19-	.06	4.06-	.72
...DALE	1.11	.43	.09-	.56	.00-	.56	.62	.26	.81	.25	T -	.53	.23-	.73	.03-	1.25	.43-	.50	.41-	.40	.00-	.49	.15-	.48	3.87-	4.69
...ROCK	E 1.78		1.25		.05		.58		1.44		.32		.64		.32		T		1.03		T		1.56		E 2.97	
...PEAKS NM	-		-		-		-		-		.45		1.91		1.30		.07		-		-		-		-	
...CITY CAA AP	.88		.42		.09		.66		1.00		.53		1.97		.22		.11		.27		.08		.27		5.53	
...CITY PH	.97	.05	.51-	.54	.09-	1.27	.35-	.50	.70-	.13	.35-	.08	1.96	.67	.02-	1.26	.26-	.82	.23-	1.15	.13-	.87	.26-	.67	5.71-	6.84
...ILLE	.71		.34		T		-		-		-		-		-		-		-		-		-		-	
	1.05		.34		.12		.02		.27		.82		.24		.19		.01		.76		T		.06		3.08	
...CREEK WATER PL	4.55	1.93	E 1.91-	.87	.33-	3.15	E 1.84-	1.19	E 3.58	1.00	.80-	.43	.60-	.15	T -	1.18	.22-	1.02	3.43	1.24	1.10-	1.37	1.85-	.83	E20.21-	5.92
...EEK //	3.59	1.28	2.02-	.16	.25-	1.47	1.27-	.22	1.23-	.26	.77-	1.09	2.57	[illegible]	[illegible]	[illegible]	.35-	1.12	1.16-	.60	.13-	1.37	2.70	.72	16.49-	5.16
...ILLE	2.20	1.03	.88-	.50	.15-	1.32	1.02-	.14	1.95	.73	.49-	.60	1.76	.92	.26-	.90	.16-	.60	1.42	.14	.50-	.69	2.98	1.91	13.77-	.07
...INE	3.30	1.99	.30-	.95	.15-	1.26	1.50	.17	2.25	.74	.76-	.02	.57	.06	.00-	.57	.00-	.80	1.27	.03	.11-	1.03	1.53	.02	11.72-	1.82
...WOOD WEIR	3.31	1.56	1.82-	.12	.45-	2.07	1.94-	.59	2.31	.17	.30-	.82	1.26	.43	.05-	1.03	.31-	.63	2.89	.88	1.21-	.71	2.66	.91	18.61-	2.22
...FORT	1.03	.03	1.20	.09	.26-	1.27	1.69	.23	.69-	.31	.32-	.74	.32-	[illegible]	T -	.88	T -	.54	1.17-	.21	.02-	1.24	.46-	.55	7.15-	5.93
...CREEK DAM	5.00	2.39	1.60-	.98	.19-	1.85	1.33-	.37	1.48	.38	.29-	1.71	.37-	[illegible]	.24-	.95	.56-	.32	1.08-	1.26	.52-	1.94	3.11-	.23	13.84-	6.46
...CAA AP	1.40	.64	.55-	.26	.06-	.53	.47-	.44	.37-	.46	.27-	[illegible]	.19-	[illegible]	T -	.41	.05-	.33	.65-	.38	.02-	.49	.03-	.60	3.95-	3.62
	1.22	.70	.55-	.11	T -	.82	.42-	.43	.47-	.52	.31-	.23	.45	.03	T -	.54	.02-	.57	.85	.14	T -	.53	.09-	.46	4.18-	3.42
...EXP RANGE	.06		.30		T		1.23		.53		.52		.20		T		.00		.09		T		E .13		E 3.08	
...R N M	.96		.17		.00		.47		2.16		.84		.10		.11		.05		1.23		.14		.54		6.07	
...ISLE	.87	.25	.59-	.03	T -	.77	1.34	.58	.82	.08	.27-	.67	.21-	.81	.13-	1.08	.51-	.55	.81-	.16	.00-	.51	E .61	.03	E 5.95-	3.53
	1.07		.75		T		.33		.97		.04		.21		T		.11		.68		.03		.39		4.58	
...CANYON	4.66		1.68		E .22		1.23		2.20		.47		.60		.32		.30		2.49		.90		3.21		E18.27	
...DAM	2.48	1.45	.78-	.30	.14-	1.47	1.41	.04	1.71	.43	.45-	1.19	.85	.25	.37-	.50	.27-	.48	1.54-	.04	.05-	1.41	1.92	.63	11.98-	2.56
...ETS	2.11	1.29	.49-	.46	.06-	1.04	1.14	.12	.59-	.57	.33-	.50	.45-	.35	.40-	.36	.12-	.55	.75-	.31	.17-	.59	.73-	.04	7.00-	3.47
...ASHLEY RS	1.50	.62	.46-	.54	.19-	.93	.95-	.20	-		-		-		-		-		-		-		-		-	
	1.11	.62	.21-	.34	.00-	.45	.53	.13	.21-	.34	.65-	.45	.20-	.67	.12-	1.17	.39-	.52	.10-	.64	.00-	.30	.62	.12	5.52-	4.01
...RISE	1.47	.88	.47-	.18	.34-	.74	.51-	.37	.65	.29	.63	.13	.89	.12	T -	1.23	.02-	.37	.19-	1.11	.12-	.78	.41-	.48	5.70-	3.72
...RISE BERYL JCT	.50		.21		.23		.33		.56		.45		.32		E T		E .04		.23		.00		.00		E 3.27	
...SORENSENS R	1.92		.61		.07		1.92		.76		.35		.93		.28		.15		.53		.04		.72		7.95	
...ATE	.28-	.69	.12-	.86	.00-	.95	.40-	.22	.00-	.59	.22-	.41	.86-	.74	.51-	1.39	.00-	1.24	1.40	.35	E .02-	.63	E .34-	.67	E 4.05-	8.24
	2.74	1.33	.66-	.81	.05-	1.37	1.26-	.03	.95-	.37	.22-	.88	1.17	.17	.89-	.43	.10-	.52	.72-	.81	.12-	.86	.59-	.96	9.29-	5.54
	2.22		.42		.01		.71		1.70		T		.66		.37		.11		.99		.13		1.31		8.63	
...ON	3.25	1.23	1.04-	.99	.20-	2.14	1.69-	.51	3.36	1.26	E .30-	1.01	.49-	.13	.07-	.81	.23-	.87	2.12	.34	E .73-	.99	1.57-	.49	E14.85-	5.11
	1.23		.14		.00		.70		.60		.01		1.44		.45		.05		.20		.00		.21		5.03	
	2.34	1.14	2.42	1.00	E .05-	1.81	2.18	.58	.65-	.78	.35-	.49	T -	.82	.03-	.82	.17-	.71	1.30	.02	.31-	.82	.67-	.57	E10.31-	4.08
	1.16	.70	.10-	.29	.12-	.44	.23-	.39	.49-	.21	.26-	.22	.13-	.38	.09-	.58	.11-	.87	.75-	.04	.00-	.39	.57	.08	3.99-	3.03
	T -	.50	T -	.33	.00-	.62	.22-	.39	.55	.15	.20-	.33	1.35	.55	.62-	.46	.28-	.61	.79-	.40	.18-	.27	T -	.53	4.06-	3.63
...ATE	2.51		1.03		.03		1.89		2.69		.43		.61		.11		.15		2.00		.94		1.39		13.78	
...ND	2.41	1.39	.46-	.80	.09-	1.57	.82-	.83	1.90-	.11	.41-	.85	.13-	.65	T -	.65	.09-	1.33	.69-	.81	.54-	.71	1.13-	.36	8.73-	7.29
	.35-	.41	-		-		-		-		-		-		-		T -	.70	.17-	.57	T -	.60	.17-	.13	-	
...STEEL	1.44		E .44		.08		.36		.36		T		.00		.03		.04		.63		E .26		1.04		E 4.68	
...ILLE	-		-		-		-		-		.28		.25		.10		.03		1.05		E .20		1.10		-	
...VILLE PH	2.60	1.73	1.47	.64	.17-	1.03	1.10-	.19	-		-		-		-		-		-		-		-		-	
...RIVER ANY	.43	.06	.05-	.36	.00-	.42	.22-	.26	.03-	.42	.82-	.42	.67	.17	.24-	.54	.10-	.81	.46-	.22	T -	.42	.11-	.31	2.33-	3.75
...IN PH	.81-	.48	.12-	1.32	.00-	1.36	.20-	.63	.18-	.46	.89	.52	.96-	.06	E .34-	.67	.02-	.76	.16-	.82	.00-	.64	.05-	1.46	E 3.64-	8.14
...N SUGAR FACT	-		-		.16		.91		.78		.60		.47		.06		.09		.36		.04		.28		-	
...ILLE CAA AP	.17-	.20	.17-	.20	T -	.32	.13-	.16	.02-	.32	T -	.39	.12-	.59	.10-	.67	.07-	.47	.38-	.30	.05-	.22	.19-	.17	1.34-	4.01
	1.65		.16		T		.73		1.29		.36		2.09		.18		.48		1.23		.05		.93		8.95	
...APE RANCH	3.30		1.60		.40		.20		2.71		.33		T		T		.00		E 1.91		.05		.27		E10.77	
	.82	.10	.25-	.50	T -	.85	.51-	.31	.61	.01	.44-	.02	1.16-	.12	.40-	1.27	T -	1.30	.43-	.55	T -	.48	.14-	.68	4.76-	5.98
	2.73	.75	.77-	1.13	.14-	1.65	.70-	.58	1.20-	.27	.32-	.61	.57-	.21	.08-	.95	.26-	.74	1.55	.15	.40-	.98	2.35	.66	10.67-	5.66
	1.54-	.72	.14-	.93	.00-	1.02	.66-	.20	.55-	.53	.22-	.81	.50-	.34	.47-	1.47	.33-	.93	.51-	.75	.00-	.87	.61-	.21	5.57-	7.14
...INE CITY CREEK	RECORD IS PUBLISHED UNDER NEW STATION NAME, CITY CREEK WATER PLANT.														-		-		-		-		-		-	
	.26-	.32	.02-	.77	T -	.66	.46	.05	.10-	.35	.05-	.44	.17-	.39	.26-	.33	.00-	.61	.28-	.50	.00-	.63	.11-	.60	1.73-	5.55
	.71	.07	.77-	.19	.05-	.99	1.07-	.32	2.62	.96	.02-	.88	.53-	.35	.00-	1.24	.00-	.69	.30-	.72	.00-	.66	.00-	.73	6.05-	5.74
...SOUTH RANCH	2.03		.38		.03		.46		1.78		.35		.23		.10		.00		1.19		.85		1.09		8.26	
	1.07	.53	.17-	.28	T -	.56	.71-	.22	.33-	.43	.23-	.66	.13-	.44	.08-	.64	.10-	.73	1.18	.19	.08-	.32	.51-	.14	4.39-	3.70
	2.73		.97		.24		1.16		1.23		.33		.49		.40		.04		1.82		.57		3.07		13.05	
	2.10	.72	.07-	1.41	.00-	1.44	.68-	.25	.25-	.33	1.43	1.11	.05-	1.08	.16-	1.03	.01-	1.05	.62-	.36	.00-	.84	.09-	1.18	5.43-	7.17
	2.31	.11	1.71	.23	.07-	1.76	2.08	.59	.92-	.46	.00-	.66	.68-	.23	.30-	.76	.04-	.72	1.59	.25	.26-	1.04	.66-	.64	9.66-	5.10
	1.25	.61	.10-	.67	E .10-	.82	1.06	.29	.85	.00	1.09	.50	.55-	.57	.35-	.52	.11-	.55	.55-	.21	T -	.47	.37-	.44	E 6.29-	2.85
	1.64		.16		.03		.66		.65		.22		.65		.10		T		1.18		.01		.72		6.14	
	1.46	.63	.44-	.34	.20-	.74	.48-	.70	1.91	.75	.49-	.41	.35-	.28	.43-	.33	.03-	1.05	.57-	.79	.07-	.75	1.30	.65	7.73-	3.35
	1.06		.39		.04		1.40		.71		.16		.16		.28		.04		.73		.00		.41		5.38	
	2.02	1.18	.28-	.67	.00-	.89	.41-	.61	.61-	.30	.44-	.23	1.03-	.40	.48-	1.06	.00-	1.25	.66-	.65	.12-	.69	.45-	.54	6.50-	6.13
	1.10		E .10		T		.31		.47		.25		1.95		T		T		E .15		.00		.20		E 4.54	
	1.65	.35	1.23-	.15	.12-	1.69	2.36	.83	1.20-	.39	.02-	.63	.34-	.44	.05-	.87	.15-	.86	.94-	.39	.22-	.80	.25-	1.14	8.59-	8.16
	2.94	1.25	.64-	.55	.09-	1.81	.74-	1.45	2.57	.39	.53-	.66	.48-	.18	T -	.91	T -	1.14	1.19-	.59	.54-	1.12	1.92	.22	11.64-	6.86
...KVND	.45	.03	.19-	.29	.13-	.44	.61	.25	.50	.07	.26-	.05	1.30	.25	1.03-	.32	.29-	.48	.36-	.22	.03-	.32	.51	.03	5.80-	1.59
	-		-		-		-		-		-		-		-		-		-		-		1.34		-	
	2.74	1.19	.69-	.55	.10-	1.82	.96-	.58	1.63-	.09	.85-	.18	.39-	.18	.06-	.62	.07-	1.13	1.12-	.54	1.17-	.16	1.39	.08	11.68-	4.99
...EXP STA	2.65		.69		.05		.97		1.99		.74		.36		[illegible]		.06		1.52		.53		1.26		10.82	
...RICAN FORK	2.50	.81	1.01-	.56	.14-	1.49	2.02	.24	1.71	.01	T -	.95	.16-	.66	.11-	.64	.31-	.65	1.06-	.52	.32-	1.01	2.08	.45	11.46-	5.27
...FORD FARM	.45-	.43	.27-	.60	.13-	.84	.96	.41	.70-	.03	.35	.01	.25-	.49	.00-	1.23	.03-	.53	.00-	.60	T -	.47	.30-	.29	3.24-	5.09
	1.51		1.16		.09		1.21		2.79		.32		.15		T		T		1.67		1.18		.87		10.71	
	E .69	.54	E .42-	.14	E .07-	.74	E .63-	.80	.54-	.63	T -	.65	.76-	.20	.40-	.61	.15-	.88	1.66	.46	.27-	.28	.73	.35	E 6.47-	3.58
	2.29	1.07	.57-	.22	.24-	1.20	2.01	.85	1.21-	.18	.67-	.58	.64	.11	.77-	.16	.30-	.63	.65-	.49	.02-	.87	.61-	.25	5.66-	2.48
	1.03		.47		.25		.88		.52		.65		.76		1.28		.14		.57		.05		.25		6.79	
	.69		.02		.58		.07		.14		.24		.87		.61		.00		.57		.34		.05		3.98	
	2.74	1.04	1.27-	.13	.13-	1.58	1.33-	.44	2.33	.91	.33-	.77	.14-	.55	T -	.84	.11-	.71	2.25	.78	.70-	.69	1.53	.30	12.1-	2.68
...AC AP //8	.51-	.16	1.10-	.30	.30-	.76	1.35	.55	.51-	.23	.73	.28	.29-	.45	.03-	.78	T -	.40	.11-	.77	.06-	.46	.13-	.62	5.06-	3.41
...ILLE	.55-	.37	.53-	.42	.18-	1.32	.56-	.33	1.10	.35	.00-	.43	.31-	.62	.02-	[illegible]	T -	.79	.42-	.51	.05-	.74	.30-	.55	4.00-	6.50
	.52-	.21	E .38-	.31	E T -	.88	.70-	.53	.12-	.60	T -	.43	.52-	.29	.55-	.24	T -	.95	.30-	.69	.06-	.59	.37-	.49	E 3.02-	6.24

SEE REFERENCE NOTES FOLLOWING STATION INDEX

RADIAN
CORPORATION

26 March 1980

Mr. Kevin Yocum
Coastal States Energy Company
1354 E. 3300 S., Suite 303
Salt Lake City, Utah 84106

Subject: Precipitation Data for the Clear Creek Area

Dear Kevin:

I contacted Arlo Richardson, the State Climatologist for Utah, regarding historical precipitation data and 1979 data for the Clear Creek area.

According to Mr. Richardson, precipitation was measured in the village of Clear Creek during the period 1921-1967. The average annual precipitation during that period was 23.10 inches. Considering the similarity in the elevation and terrain of Clear Creek and the mouth of Eccles Canyon, I feel that the long-term average for Clear Creek is closely representative of the mouth of Eccles Canyon.

The publication Climates of the States (Gale Research Company, 1978) contains isopleths of long-term average precipitation for the State of Utah. The isopleths indicate that precipitation averages as much as 30 inches annually in the higher elevations of the Clear Creek - Eccles Canyon area. According to Arlo Richardson, precipitation was measured at Clear Creek Summit (near Boardinghouse Peak and at a similar elevation) during the period 1964-1970, and that the average annual precipitation was 27.70 inches. Both references indicate what is expected - that precipitation tends to increase with increasing elevation in mountainous terrain. In summary, I feel that the average annual precipitation at the mouth of Eccles Canyon is close to 23 inches and ranges up to about 30 inches in the higher elevations in the vicinity.

Regarding 1979 precipitation in the area, it has been established that the 8.34 inches measured on top of Boardinghouse Peak is likely to be lower than the actual precipitation amount because frequent high winds caused snow to blow over the gauge without being captured. Arlo Richardson, however, suggested a method for estimating 1979 precipitation at the

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mouth of Eccles Canyon and at Boardinghouse Peak, based on the assumption that average precipitation data for Clear Creek and Clear Creek Summit are representative of the mouth of Eccles Canyon and Boardinghouse Peak, respectively.

Precipitation was not recorded during 1979 at Clear Creek and Clear Creek Summit. However, according to Mr. Richardson, available data indicate that precipitation averaged about 69% of normal in the region of the Wahsatch Range in which the area of interest is located. Therefore, the estimated 1979 precipitation for the mouth of Eccles Canyon is about 16 inches, and about 19 inches for Boardinghouse Peak. The year 1979, then, was exceptionally dry. Precipitation amounts measured or estimated in the region during 1979 should not be considered at all representative of normal amounts.

I hope this information will be useful, and please feel free to call if I can be of further assistance.

Sincerely,

David L. Harper

David L. Harper
Staff Meteorologist

DLH:na

Alluvial Valley Floors

*2. The applicant should also supply information which describes any flood irrigation practices taking place on drainages similar to these in the mine plan area in the general region of the Skyline Mine.

Alluvial Valley Floors

*2. The applicant should also supply information which describes any flood irrigation practices taking place on drainages similar to these in the mine plan area in the general region of the Skyline Mine.

Response. The major drainages in the Skyline property pertaining to this question are Eccles Canyon and Huntington Creek Canyon. There are no known flood irrigation systems in drainages similar to the above-named drainages in the general area of the Skyline Mine. The lack of flood irrigation practices is due to several factors, including a very short growing season, steep gradients of canyon floors, shallow soil, and the abundance of precipitation. Flood irrigation practices in the drainages associated with the Skyline property are restricted to the lower elevations where conditions are more favorable.

Alluvial Valley Floors

*3. The applicant should submit information which compares the productivity of lowland (valley floor vegetation) with upland vegetation to demonstrate that the lowland vegetation does not take advantage of additional water (either through subirrigation and/or flood irrigation) so as to result in increased productivity.

RESPONSE AND WORK PLAN

Alluvial Valley Floors - Section 785.19 (c)

Deficiency 3. The applicant should submit information which compares the productivity of lowland (valley floor vegetation) with upland vegetation to demonstrate that the lowland vegetation does not take advantage of additional water (either through subirrigation and/or flood irrigation) so as to result in increased productivity.

Response.— The deficiency statement presumes that comparsion of productivity of upland vegetation with lowland (valley floor) vegetation would yield meaningful results. Valley floor areas represent only a small porportion of the total land surface in the lease area, and would not be comparable because of differences in total amounts of biomass. They differ further in porportion of herbaceous and grass components as compared to shrub and tree types. Diversity is also present within the valley floor vegetative type. Streamsides support those kinds with large and continuous water requirements. More desicated substrates away from streamsides proper support other kinds of, vegetation, usually those types with lesser water requirements. Because of these factors, it seems improbable that comparison of lowland plant productivity with upland productivity would be of value.

Work plan.— The valley floor areas will be studied to determine the effects of flood water and/or subirrigation on vegetation. During the growing season of 1980 productivity measurements will be obtained from the valley bottom area of Eccles Canyon. The region to be studied is mainly in the vicinity of the coal handling and loading facilities proposed near the mouth of Eccles Canyon. Productivity measurements will be based

on techniques already outlined in previous reports and used in the analyses of the types in the lease area. Attempts will be made to determine if subirrigation or flooding is responsible for, or is directly related to high water table or to spring and summer flooding. Such measurements will include depth to standing water in the soil, depth of root penetration, and soil moisture amounts.

VEGETATION AND REVEGETATION

SECTIONS 782.17(a), 783.19, and 783.20(779.20) (211.10(c))

VEGETATION AND REVEGETATION

SECTIONS 782.17(a), 783.19, and 783.20(779.20) (211.10(c))

Vegetation and Revegetation

*1. The applicant should supply data on the occurrence of the threatened and endangered (and rare) plant species occurring in the region in the zones represented by the mine area. If such plants do not occur in the mine area some indication of the techniques of search or measurement should be included in the plan.

Vegetation and Revegetation -
Sections 782.17(a), 783.19, 783.20 (779.20) (211.10(c))

Deficiency 1.— The applicant should supply data on the occurrence of the threatened and endangered (and rare) plant species occurring in the region of the zones represented by the mine area. If such plants do not occur in the mine area some indication of the techniques of search or measurement should be included in the plan.

Response.— In the report submitted by Endangered Plant Studies, Inc. to Coastal States Energy Company on vegetation, plant communities, threatened and endangered plants, soils, and reclamation, dated September 1979 (as ammended February 1980, and hereinafter referred to as Report) a negative declaration was presented on endangered and threatened plants. On page 13 of Report such a declaration is presented.

> "A search of the literature has failed to indicate the presence of any of the proposed endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas during this investigation."

On that same page (13 of Report) it is stated that the search for endangered and threatened plants was conducted. "The region was searched on a quarter section by quarter section basis, with each community type within each quarter section being traversed.

Investigations of threatened and endangered plant species, and for other rare or unique species, were undertaken by on site investigation on a plant community basis. Plant communities of the kind which occupy the lease area and vicinity are notoriously complacent as regards habitat types for rare plant species (see Welsh, S. L. 1979. Endangered and threatened plants of Utah: A case study. Great Basin Naturalist Memoirs 3: 69-80). Despite this, all community types were systematically searched by study teams walking parallel transects through the larger commumities, and by individual search in the smaller vegetative types. A list of species for each community (Report, pp. 50-55) was developed during the process. Endangered and threatened species were not found.

Vegetation and Revegetation

*2. The applicant must supply data showing detail on the potential for competitive replacement of native species by introduced species from the proposed seed mixture.

Deficiency 2.— The applicant must supply data showing detail on the potential for competitive replacement of native species by introduced species from the proposed seed mixture.

Response.— Report (as ammended February 1980) does not directly respond to the "deficiency" noted above. It is our understanding that competitive replacement of native vegetation is not the goal or the intent of reclamation procedures. Rather, introduced species are planted to establish suitable cover and forage until such time as native species can become reestablished in the disturbed areas. In pages 20 and 21 of Report such conclusions are indicated. "They (the species proposed for use in reclamation) meet Forest Service Requirements (as published in "User guide to vegetation," November 1979) and most will ultimately be replaced as native plants from surrounding areas move into the region. This observation is supported by natural colonization of native species on areas previously disturbed in this region."

Observations of reseeding attempts along the Mountain States Fuel pipeline indicate successful establishment of smooth brome, meadow foxtail, and of other grasses, especially on the better soils. Soils that previously supported grasses, forbs, elderberry, and aspen were successfully reclaimed within two or three years following disturbance. On the shallower soils of steep slopes, the establishment was slower, but even there, some success was attained.

Replacement of reseeded species by components of adjacent undisturbed communities was also rapid on the better soils and achieved some limited success in the time interval on poorer soils.

Photographs on pages 44 and 45 of the amended report show that reseeded grasses achieved almost 100% coverage, and with native forbs grasses and sedges encroaching on the pipeline area. It is also evident that the native sedges achieved as great a coverage as was present in adjacent undisturbed areas. Evidence of successful replacement on soils previously occupied by forest types is found in Photograph No. 1 of this reply. Seedlings of spruce are noted along the burn margin in rocky soil Photographs 2 and 3 show successful establishment of elderberry and sagebrush across the pipeline corridor. Recolonization of the pipeline is evident in Photographs 4 and 5, especially by elderberry. In Photograph No. 6, low rabbitbrush is reestablished on shallow soils of an exposed ridge.

It appears that lack of success in establishment of either native or introduced species may be compounded on the pipeline corridors by disturbance resulting from vehicular travel (Photograph No. 7), thus increasing the potential for erosion.

Work plan.— Transects will be established along the pipeline corridor during the 1980 growing season to determine cover, frequency, and composition of species within this previously disturbed area. Production will be determined as was reported previously.

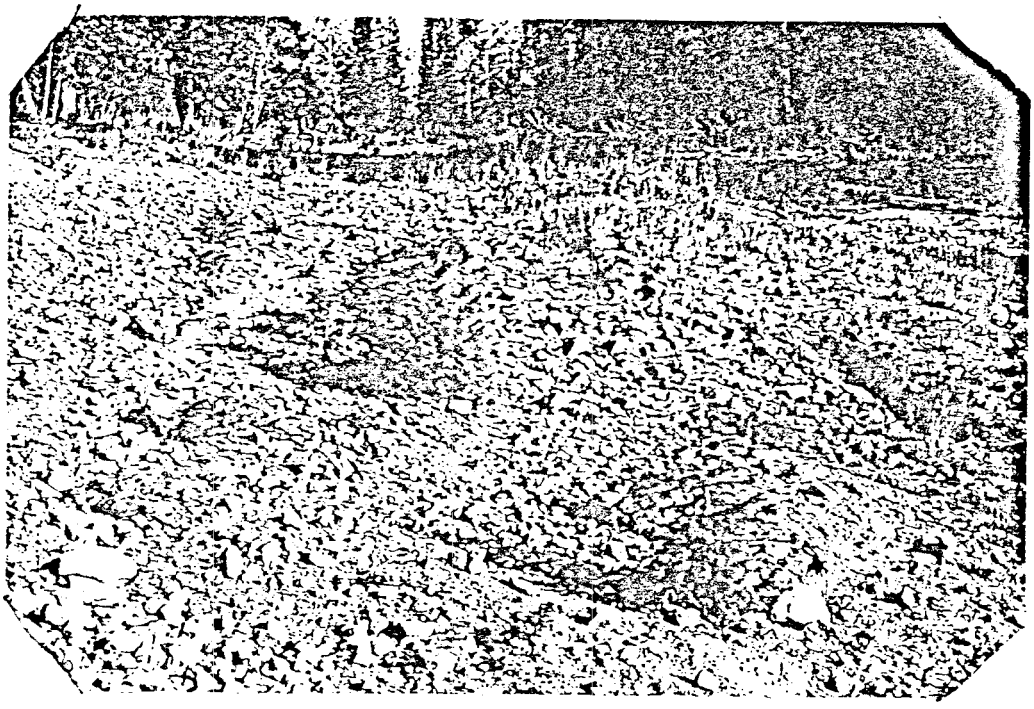
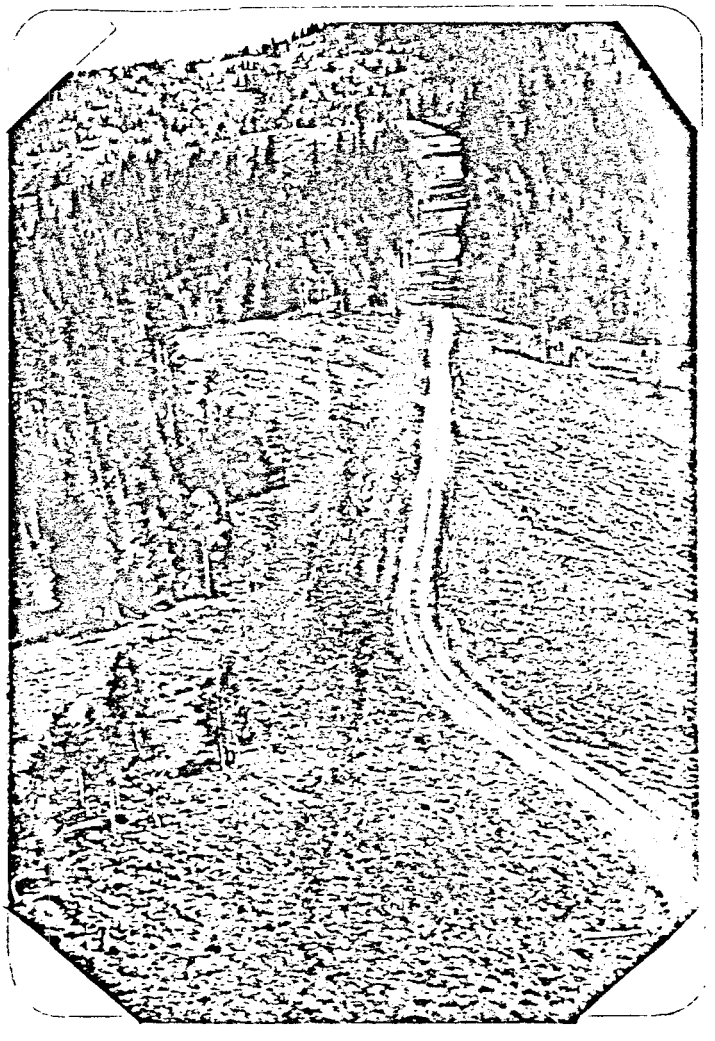
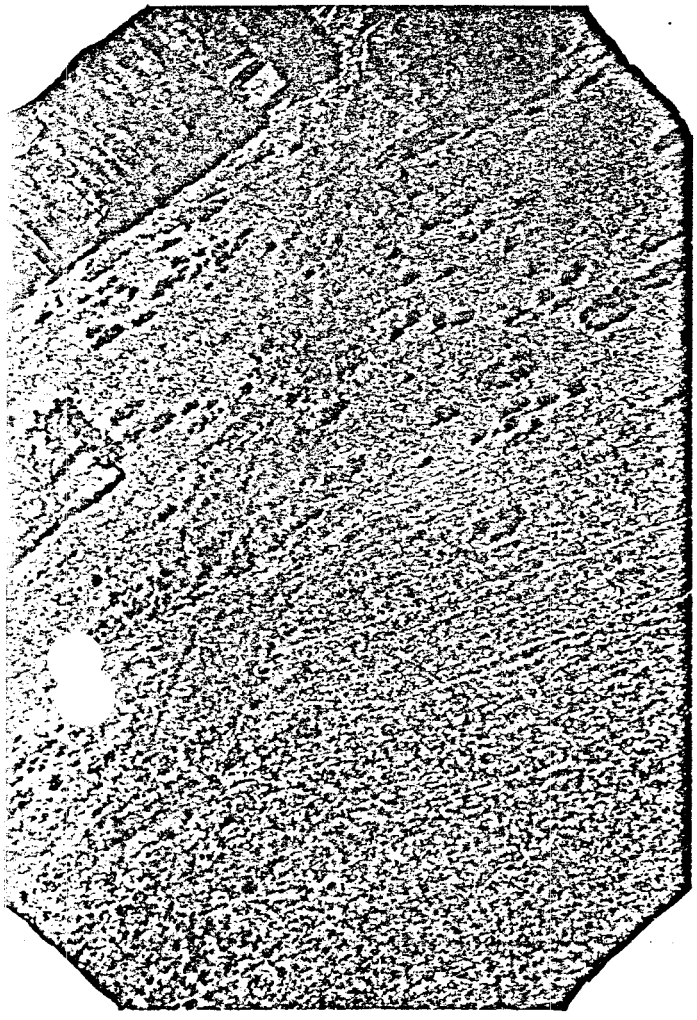


Photo No. 1

Photo No. 2

Photo No. 3





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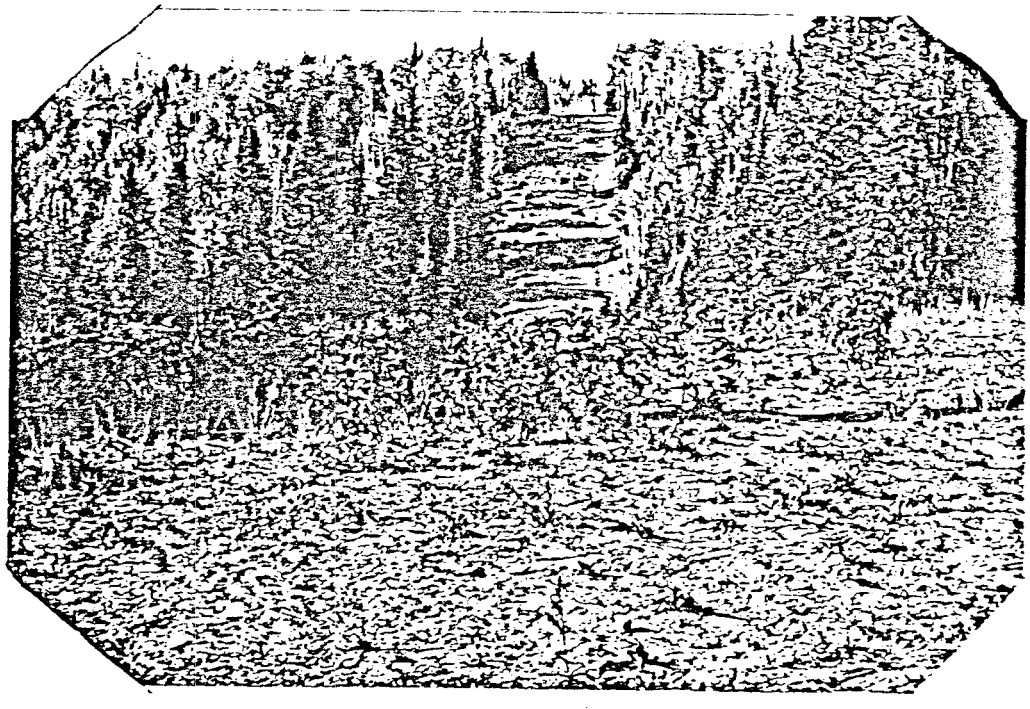

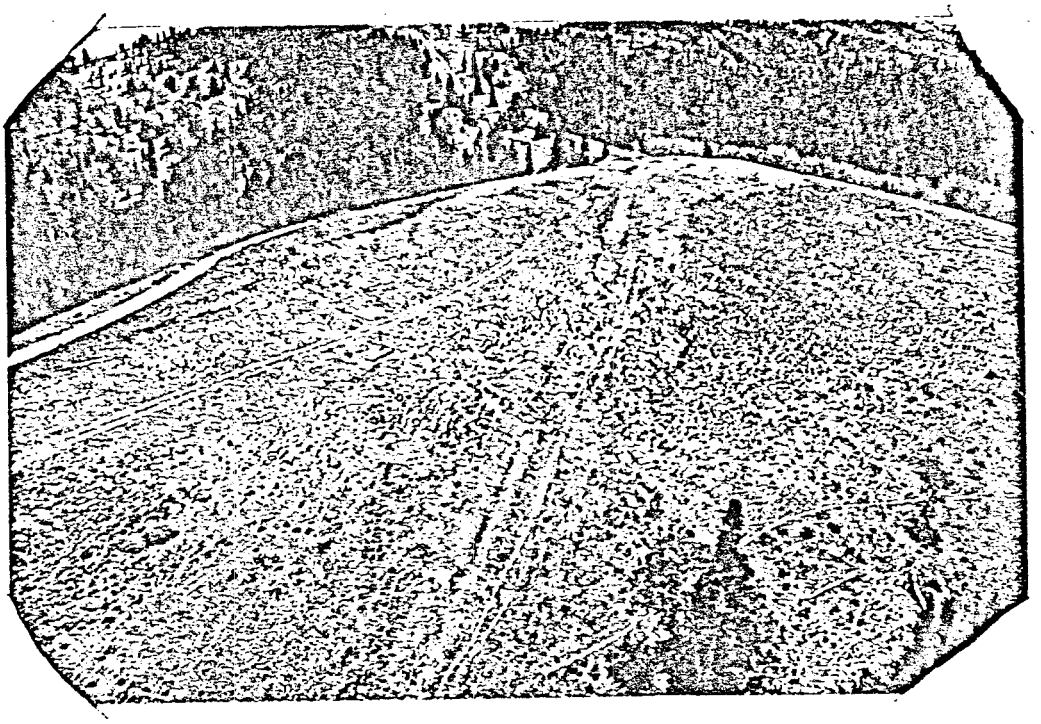

Photo No. 6

Photo No. 7

Vegetation and Revegetation

*3. The applicant should supply data showing potential productivity of the proposed introduced species and give information demonstrating the stated acclimitization of the seed types to be used.

Deficiency 3.— The applicant should supply data showing potential productivity of the proposed introduced species and give information demonstrating the stated acclimatization of seed types to be used.

Response:— The species recommended for planting in the disturbed areas are essentially those included in the publication of Plummer, Christensen, and Monsen (1968, Restoring Big-Game Range in Utah. Publ. 68-3. Utah Division of Fish and Game). Others were recommended by Robert Thompson (Per onal communication 1979) of the U. S. Forest Service, Price, Utah. While no productivity measurements of existing reclaimed sites on the lease area were undertaken, the recommendations in literature and in correspondence support the observations from the field. Productivity is inferred from the use of the introduced species to improve depleted rangeland in the region, and acclimatization from the success in areas already reclaimed. Native species are included in the plan for reclaimation at various places in Report. Especially, spruce and elderberry are suggested. Others include spreading sweet root, heart-leaf arnica, and fringed brome (see p. 21 of Report).

Vegetation and Revegetation

4. The number of surface acres which are anticipated to be disturbed is not clear. The application indicates different acreages on pages: 1-21, vol. 1; 1-22, vol. 1 (2 places); and 3-57, vol. 2.

4. The number of surface acres which are anticipated to be disturbed is not clear. The application indicates different acreages on pages: 1-21, vol. 1; 1-22, vol. 1 (2 places); and 3-57, vol. 2.

Response: Page 1-22, vol. 1, and page 3-57, vol. 3 should be changed as per the following two pages.

	Mine No. 1	Mine No. 2	Mine No. 3
Extent of Horizontal Workings	1,128.47 acres	0	755.13 acres
Extent of Vertical Workings	Surface to 1,200'		Surface to 1,000'

The anticipated amount of total surface land acreage during the first five years of operation to be affected by underground mining activities is 1,295.59 acres.

Area of Surface Disturbance

The construction/installation of surface facilities at the mine site, loading area, as well as the mine access road and conveyor belt route during the first five years of operation will disturb 74.8 acres.

During the second five years of operation, 1.0 acre will be disturbed for the construction/installation of a ventilation shaft.

The total surface disturbance for the life of the project will be 75.8 acres.

Legal description of disturbed acreage (First Five Years):

Beginning at the Southeast Corner of Section 11, R. 6 E., T. 13 S., Salt Lake Meridian, thence south 500', thence east 2620', thence south 4210' thence west 750', thence north 200', thence west 640', thence south 7440', thence 2745' west, thence north 62° west 1285', thence north 86°30' west 5860', thence north 1235', thence east 6600', thence north 27°30' east 5210', thence west 10230', thence north 2510', thence north 48°30' east 5230', thence south 60° east 7145', thence north 2120', thence east 150' to the Point of Beginning.

3.4 AREA AFFECTED BY EACH PHASE OF OPERATIONS

The area to be affected by the proposed Skyline Mines project can be divided into two major categories:

(a) Surface acreage disturbed by construction/ installation of coal handling and associated facilities, and

(b) Surface acreage overlying underground mine workings.

Disturbed Surface Acreage

The construction/installation of offices, bathhouse, workshop, portal, fans, and other necessary facilities will require a site of 35.7 acres of which 1.1 acres will be used for water bench. The temporary coal loading and handling facility at the mouth of Eccles Canyon will require 9.0 acres of which a sedimentation pond will require 0.6 acres. The enclosed conveyor belt transporting material from the mining portals to loading points is expected to disturb 31.1 acres, including a mine access roadway along the conveyor belt from the mine site to the by-pass roadway. In total, the surface acres disturbed for installation and construction purposes will be 75.8 acres.

The premining phase of earth work and dirt removal is scheduled to commence in the spring of 1980 and continue until completed. The actual construction and installation of facilities necessary for coal mining and handling is to begin in early 1981.

Area Overlying Underground Mining

Interpretation of the available geological data and bore holes information indicates that certain portions of all three seams within the leasehold are nonmineable. Total acreage values for mineable acreage do not include such areas.

The total acreage mineable for the Upper O'Connor seam is 3,956 acres. Hence, during mining of the Upper O'Connor seam, the total acreage under which mining activity is to occur will be 3,956 acres. During mining of the Lower O'Connor "B" seam, the horizontal area of mine workings will

Vegetation and Revegetation

*5. The applicant should supply information on soil/plant associations on the mine plan and permit areas (soil series should be identified).

Deficiency 5.— The applicant should supply information on soil/plant associations on the mine plan and permit areas (soil series should be identified).

Response.— Maps of soils and plants are appended, but soil series information is not available for the region (Personal communication by Gary Moreau, SCS, Price Utah, 1980). Such information will be supplied as soon as it is available for the region.

Vegetation and Revegetation

6. Maps should delineate topographic features or cadastral location in order to properly locate soil/vegetation associations on proposed surface disturbance areas.

Deficiency 6. - Maps should delineate topographic features or cadastral location in order to properly locate soil/vegetation associations on proposed surface disturbance areas.

Response. - Maps of soil/plant associations are appended to the revised report which follows. They are marked with cadastral locations.

REPORT OF VEGETATION, PLANT COMMUNITY ANALYSIS, THREATENED AND ENDANGERED PLANT SPECIES, SOILS, AND RECLAMATION PLANS FOR COASTAL STATES ENERGY COMPANY McKINNON PROPERTIES, SKYLINE PROJECT, CARBON-EMERY COUNTIES, UTAH

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Date:

September 1979,
amended February 1980

ABSTRACT

Reported herein are the findings of investigations of vegetation, plant community analysis, threatened and endangered plant species, soils, and reclamation potential. These investigations were designed to provide answers to questions on environmental parameters as included in OSM regulations (783.19, 783.21, 784.13, 784.21), U.S. Forest Service requirements, and those of the Division of Oil, Gas, and Mining.

Included is a description of the plant communities, a list of plant species by community type, estimates of cover, composition, and frequency for each community, maps of areas to be disturbed, a map of vegetation of the entire area, soils data, and estimates of reclamation potential.

Intensive surveys were conducted of the proposed portal-yard area, roads, and of other sites which will be modified by removal of vegetative cover and soil. Reference areas selected from within the plant communities in the McKinnon Property were surveyed intensively also.

Soils are described, and methods of sampling and analysis are discussed. The information presented provides data to satisfy

criteria for mining permit applications (OSM 783.21) and for reclamation plans (OSM 784.13).

Recommendations are given for reclamation potential.

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INTRODUCTION

The McKinnon Properties of the Coastal States Energy Company, Skyline Project, consists of about 10 square miles of land situated in the Wasatch Plateau of Utah astride the Carbon-Emery county line. The northeast corner of the property is about three miles southwest of the community of Scofield. The property straddles the divide between the headwaters of Huntington Creek, on the west, and Clear Creek, on the east.

Elevations vary from a low of about 8500 feet in the Huntington Creek drainage to a high of about 9500 feet on the divide crests. Canyons are entrenched into the underlying coal-bearing strata. Canyon slopes are steep, rounded, and vegetated. Only exceptionally are sandstone strata exposed as cliffs of much relief.

The purpose of this report is to provide information on vegetation, soils, endangered and threatened plant species, and reclamation potential during and following development of portions of this region as an underground mine of large magnitude.

Requirements for reclamation of disturbed surface sites dictate a two-level approach to investigation of vegetation and soils. The sites to be disturbed will have vegetation and soils removed. Such

areas require intensive study to provide information on vegetation, its kinds, communities, and productivity prior to the action, and similarly intensive studies of soils to gain data as to the nature and productive potential of those substrates. Extensive studies of the entire region have been designed wherein selection of reference sites have been selected which provide for comparison with disturbed sites and with regional changes.

Lower Eccles Canyon, mainly on private property, is described in summary form, and a vegetation map is appended.

VEGETATION

General description. -- The Skyline Project properties and adjacent areas occur within an aspen-spruce-fir phase of the boreal forest biome, with representatives of cool desert shrub, riparian, and, to a lesser extent, the mountain brush community types present as significant, though minor, components.

The spruce-fir community, a type mainly of north-facing slopes (see Figures 3, 5, 8, 11, 14, 17, 23, and 24), is dominated by Engelmann spruce and subalpine fir, with variants supporting admixtures of aspen and wet meadow subtypes characterized by species of sedges and grasses. This forest type constitutes some six percent of the lease area (see Table II), but when added to the spruce, fir, aspen community some 40 percent of the lease area is accounted for. The forest floor is frequently subjected to dense shade. Grasses and sedges are represented by Carex hoodii, Bromus carinatus, Poa fendleriana, and Poa reflexa. Principle forbs in the spruce-fir community include Arnica cordifolia, Lathyrus lanzwertii, Osmorhiza chilensis, Penstemon whippleanus, and Stellaria jamesii (see Table I for a complete species list).

The aspen community is a forest type with Populus tremuloides as the principle tree species (see Figures 2, 4, 7, 10, 12, 16, and 22). Only nine percent of the lease area is dominated by aspen alone (Table II). South-facing slopes and ridges are main localities of this community. It is transitional, however, to the aspen, grass, forb, elderberry community which occupies some 33 percent of the lease area. The aspen and aspen, grass, forb, elderberry communities together occupy 42 percent of the lease area.

Species diversity in the aspen community is great. The main ground layer species are the same as those in the aspen, grass, forb, elderberry community with which the aspen community is transitional. More than 80 species of plants are present in the aspen community.

The aspen, grass, forb, elderberry community is very large, as noted above. The species in this community are, with minor exceptions, the same as cited for the aspen community.

The sagebrush-snowberry, sagebrush, and fringed sagebrush occupy only 13 percent of the lease area. They occur mainly on shallow soils. Collectively they are remarkably diverse, with some 90 species of vascular plants among them.

Fringed sagebrush occurs on only one percent of the area where it is confined to ridge crests at high elevations. Only 16 species were noted for the type.

The riparian community type consists of continuous strips of wetland vegetation along the major drainages, as in the valley bottoms of Huntington Creek, Eccles Canyon, and along other minor tributaries. The community also occupies spring lines, seeps, and perennially wet channels down slope from minor springs, as in the valley of Huntington Creek. Dominant species on the wet lands are red top, silver sagebrush, sedge species, grasses, and numerous forbs.

Disturbed areas are present in the proposed lease area, some of which have been treated to reclamation procedures. Both introduced and native species were observed growing along the pipeline corridor which traverses the ridge dividing Huntington Creek and Clear Creek drainages. The proposed portal-yard area is also disturbed, though evidence of reclamation is neglegible.

Crested wheatgrass, intermediate wheatgrass, smooth brome, orchard grass, tall oatgrass, bulbous wheatgrass, and bluegrass are introduced species which are now naturalized in disturbed areas. Numerous examples of natural re-establishment were observed both along the pipeline corridor and in the portal-yard area. Native species noted in the disturbed sites include yarrow, Artemisia species, sagebrush, aster, sedge, rabbitbrush, thistle, penstemon, bluegrass, cinquefoil, western coneflower, red elderberry and horsebrush. The disturbed areas are mapped with the main plant communities in which they occur.

Sparingly-vegetated sandstone ledges occupy about one percent of the lease area. Species present on the ledges include serviceberry, aster, sedge, ferns, and others which are uncommon in the other more densely vegetated communities.

Eccles Canyon, east of the lease area, is vegetated by similar plant communities as described for the lease area. However, Gambel oak, curl-leaf mountain mahogany, and blue spruce are components of the vegetation. The former two occur as minor stands on the dry south-facing slope of the canyon, the latter in the alluvial terraces at the mouth of Eccles Creek.

Maps. -- Maps of vegetative types were made for three main regions, the lease area, portal-yard area, and Eccles Canyon east of the lease area.

The lease area and Eccles Canyon were mapped by use of a mosaic of aerial photographs. Community types were outlined on the photographic mosaic in the field, where accuracy was assured by correlation of actual communities to those discernible on the photographs.

The portal-yard area was mapped by use of a plane-table. Plant communities were plotted on the map from the plane-table triangulations.

Species lists by vegetative type. -- As each plant community was being sampled for its vegetation, a list of all species of vascular

plants was compiled. The list was enlarged by checking subtypes within each of the plant communities. Species not included on initial lists were added as the studies proceded from July through September.

The lease and portal-yard area species lists are included together in Table I. Eccles Canyon species are included also, except for the Gambel oak and curl-leaf mountain mahogany which are present as minor components in the canyon.

Community analysis (methods). -- Sites representative of the major vegetation types and slope-exposure differences in the lease area were selected. Typically three exposure differences where chosen for each reference area in the lease area, a ridge summit or south-facing slope in a grass-forb-elderberry community, a south-facing slope in aspen, and a north-facing slope in spruce-fir-aspen or spruce-fir. Permanent transects, each 100 meters in length were established in each vegetative type at each reference area. The transects are permanently marked with steel rebar stakes painted red. The rebar stakes are permanent photographic points for contemporary and future reference.

Validation studies were conducted in the communities which are proposed for disturbance by removal of vegetation and soil mantle. In the portal-yard area three communities are represented; aspen, sagebrush, and spruce fir. A transect was placed within each of those communities. A proposed waste rock disposal area is occupied by

aspen, riparian, and spruce fir communities. As that area is not now proposed for use in storage of rock wastes, it is now designated as Reference Site WD. A transect was placed in each of those types. Finally, the proposed bypass road passes through an unusually well-developed aspen community, and one transect was placed so as to validate the community data prior to construction of the road.

At each reference and validation site in grass-forb-elderberry, aspen, and riparian types sampling procedures followed those outlined by Daubenmire (1957) for the canopy coverage method. For each species of forb, grass, or shrub the canopy is projected as cover of the ground, and such cover is estimated in six cover classes. Thirty 2 x 5 dm rectangular plots were placed at three-meter intervals along the 100-meter transects. Total cover, frequency percent, and composition percent were computed for the species along each transect. Spruce-fir and aspen sites were studied by application of the quarter method of Curtis (1956), which gives emphasis to relative cover and relative density measurements. Tree species were further studied by using 5 x 15 meter plots to ascertain size-class distribution in each of the forest types.

Ages of trees were determined by coring of selected trees by using a Swedish increment borer. Average increments of growth in diameter per year were measured.

Productivity measurements of grass and forb species were made by using the weight estimate method as outlined in the Range Analysis Handbook (USDA 1970). The weight of each species was estimated in 10 plots in each forb community. This technique yielded information on production in pounds of forage per acre, figures which give values for determination of grazing capacity for domestic livestock.

Community analysis (results and discussion). -- Results of community analysis at validation and reference sites are presented in Tables III-XVII and XVIII-XLVII, respectively. A plant community characteristics summary is included in Table XLVIII. A productivity summary for forbs, shrubs, and grasses growing in the validation areas is presented in Table XLIX, and a summary of tree growth rates in the validation areas is included in Table L.

Greatest diversity of species was observed in transects in the reference areas occupied by aspen, and by the grass-forb-elderberry with which it intergrades. Those two types included 23-32 plant species in transects and in the productivity plots. Spruce fir transects yielded 17-26 and the riparian communities 15-26 species. The community type with least diversity in the reference areas is the sagebrush community, with 10-14 species.

Sites in the reference areas differed in production of herbage which can be eaten by livestock. Aspen and grass-forb-elderberry communities varied from 451.8 to 835.5 pounds per acre. Sagebrush

in Site 3 exceeded even that, with some 917.1 pounds per acre. Spruce fir is assumed to be nonproductive because of shading and poor representation of species in the forest floor. The riparian habitats measured in the reference areas yielded only 180.5 and 286 pounds in Sites 3 and 4 respectively.

The importance of the aspen and grass-forb-elderberry communities, which occupy some 42 percent of the lease area, is seen in the comparison of area occupied by that community and that occupied by other types (see Table II).

Despite the importance of spruce-fir, and spruce-fir-aspen community in the total vegetative cover of the lease area, these types are of little value in forage production. They are of value in protection of both wildlife and livestock. The dense shade provides cool bedgrounds, while main grazing areas are in adjacent aspen and grass-forb-elderberry communities.

Productivity of aspen is equalled by spruce and fir species. All produced an annual growth increment averaging 4.2 mm per year. Aspen occurs in a density of only one-third of the number of trees per acre when compared to spruce and fir. Spruce and fir production is most significant as a timber source, and historically has contributed substantially to lumber production in the lease area and in Eccles Canyon, where scars of drag roads provide mute evidence of lumbering operation.

Sagebrush and snowberry-sagebrush communities are productive (917.1 pounds per acre) and extensive, representing some 13 percent of the lease area. Despite the relatively small area occupied, the type is of much importance to grazing and browsing animals.

Relative vitality of tree stands indicates that aspen sites are composed of different size classes; young, moderate, and old. This seems to assure the continuity of the aspen community. Where aspen grows in admixture with spruce and fir, as at Validation Site 1, it appears that the woodland is successional with trends towards dominance by the coniferous species. In more xeric sites, such as at Reference Site 3 - Aspen, the stand of aspen is composed of trees of all age and size classes. In that site, there is a substantial understory of chokecherry which is subordinate to the aspen overstory.

The composition of the spruce-fir community at the portal-yard area indicates a climax forest dominated by spruce, with young, intermediate, and old trees being represented. Fir trees are represented by a large number of seedlings, but the lack of trees of intermediate and older ages suggests that fir is not successful in dominating the forest type.

The xeric conditions prevailing at Reference Sites 1 and 2 give an opposite picture, with fir as the dominant and spruce as the subordinate species. Codominance of spruce and fir is demonstrated at Reference Site 3, where each species is represented by young, intermediate, and old trees.

That the communities in the portal yard and proposed bypass road validation sites are similar to the reference areas is indicated in the congruence of species numbers in each of the types. Aspen diversity of 19-25 is only somewhat lower than in the reference areas, which are from 22-29. Riparian communities are higher than that of the sedge type in Burnout Canyon Reference Site 3 (15-17 vs. 27-34) but are not significantly different from those in the riparian zone of Reference Site 4 (17-26 vs. 27-34). These latter two sites are both in the drainage bottom to the southwest of the portal-yard area.

Total productivity of the validation sites and other areas to be disturbed is 839 animal units (see Table XLIV). This area will be lost to production during the active period of mine operation. Assuming a grazing period of three months (July, August, and September), then the reduction is equivalent to the loss of nine cow-calf units for the entire three-month period.

Sample adequacy. -- In preliminary studies prior to actual sampling in the early spring field season, it was determined that approximately 20 2 x 5 dm plots would be adequate. With this number of plots a 10-percent increase in the number failed to yield a 10-percent increase in the number of species. To insure confidence in sampling suitability, a total of 30 plots was measured in each vegetative type.

THREATENED AND ENDANGERED PLANT SPECIES

Passage of the Endangered Species Act of 1973 (Public Law 23-205) provided the legal basis for establishment of lists of endangered and threatened plant species. Such lists were prepared under direction of the Smithsonian Institution, and were published subsequently in the Federal Register (40: 27824-27924. 1975; and 41: 24524-24572. 1976). Work on endangered and threatened plants of Utah has been reviewed by Welsh, Atwood, and Reveal (1975), and re-evaluated by Welsh (1978). More recently an illustrated manual of endangered and threatened plants of Utah was written by Welsh and Thorne (1979).

The region under investigation was included in a report on threatened and endangered species of the Central Coal Lands of Utah (Welsh 1976).

A survey of the literature has failed to indicate the presence of any of the proposed endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas during this investigation. The region was searched on a quarter section by quarter section basis, with each community type within each quarter section being traversed. None of

the proposed threatened or endangered species were encountered in either the lease area or in the surrounding areas.

STABILIZATION AND REVEGETATION OF DISTURBED AREAS

OSM 784.13

All of the OSM regulations § 784.13 (a), (b), (1), (2), (3), and (4) are covered in the proposal submitted by Kaiser Engineers. The biological aspects of OSM § 784.13 (b) (5) are considered herein.

Schedule of revegetation. -- Areas to be disturbed should be engineered in such a manner as to allow initial revegetation attempts in the first growing season following disturbance. Revegetation, to be successful, should be attempted in spring or fall when soil moisture conditions are optimum, or in the summer when irrigation is used to bring soil moisture to adequate levels.

Species and amounts per acre. -- The species to be applied and the numbers or amounts per acre will depend on the exposure and on the steepness of slope. It is recommended that south-facing slopes of 33: 1 or lower and flat areas be treated to seedings at the rate of 12 pounds per acre in the following mixtures:

smooth brome (Lincoln)	3-4 lbs./acre
timothy or meadow foxtail	1-2 lbs./acre
yellow sweet clover	1-2 lbs./acre
alfalfa (Ladac or Nomad)	1-2 lbs./acre
Lewis flax (native)	1-2 lbs./acre
orchard grass	1-2 lbs./acre

Most of the species recommended for seeding are acclimated to the region, but not native. They meet Forest Service requirements (as

published in "User Guide to Vegetation, Nov. 1979) and most will ultimately be replaced as native plants from surrounding areas move into the region. This observation is supported by natural colonization of native species on areas previously disturbed in this region. South-facing slopes at angles of 2: 1 or 1: 2 should be treated to hand-set plants of sagebrush, rabbitbrush, snowberry, or red elderberry at not less than 1-meter intervals, with the openings being seeded by broadcast of the same species noted above and at the same rate per acre.

North-facing slopes, which are shaded, should be treated to hand-set seedlings of Engelmann spruce and/or subalpine fir at intervals not to exceed 2.5 meters in all directions. Successful plantings will crowd others in time and provide a forest cover. Spreading sweet root (Osmorhiza chilensis) and heart-leaf arnica (Arnica cordifolia) can be seeded in the intervals along with grasses in the following amounts:

spreading sweet root	1-2 lbs./acre
heart-leaf arnica	1-2 lbs./acre
smooth brome	3-4 lbs./acre
fringed brome	1-2 lbs./acre
orchard grass	1-2 lbs./acre

Methods to be used in planting and seeding. -- Combinations of hydro-mulch, cyclone seeding, or broadcasting by hand and hand-set planting of native shrubs and trees will insure a plant cover of a permanent nature. Grass species should be planted immediately after disturbance. The use of native and naturalized species recommended above is based on observations of reclamations in the lease area and at other sites in the Wasatch Plateau.

Mulching techniques. -- On all but the steeper slopes (2: 1 and 1:2), a straw mulch will allow retention of moisture for seed germination. The steeper slopes might require a hydro-mulch of a more permanent nature, and/or the addition of burlap matting.

Irrigation. -- Should lower-than-average precipitation, or irregularities of distribution of that precipitation, occur following the initiation of reclamation attempts, then irrigation might be necessary on a short-term basis. Otherwise, irrigation might be necessary should vegetation fail and have to be replaced. The species recommended above are known to survive in this region without artificial application of additional water.

Measures proposed to be used to determine the success of revegetation. -- Measurements of vegetation should be conducted yearly to ascertain the success of seeding attempts, for at least the first five years. Where success is apparent, as represented by achievement of 80% of the original cover during the five-year period, the intervals of future study should be placed at five years. Any area not achieving 80% of the original cover in the first five years should be re-evaluated and an attempt made to successfully vegetate those areas.

Standard ecological methods as outlined in the section on vegetation can be applied to determine the degree of success of revegetation attempts.

Soil testing plan for evaluation of results of topsoil handling and reclamation procedures related to revegetation. -- Soils for

coverage of slopes and fills can be harvested from 0-20 in. under aspen, 0-18 in. under spruce fir, and under sagebrush 0-8 in. Soils should be of textural classes similar to those determined in this study. They should have a minimum of small-to-large stones, even if this should require screening (less than 10%), and with soluble salts of less than 10 ppm. These parameters can be tested by application of standard procedures as noted in the soils discussion (see above).

If the soils are gathered from each of the portal-yard area vegetation types and stored in a common stockpile, the index of fertility, as measured by the Kjeldahl method, for total nigrogen would be approximately 0.175% (Tables LXVIII and LXVIX). Soils could be gathered and stored from any newly disturbed locations such as access roads or Grass/Forb Elderberry sites if it is of suitable quality. This figure would be lower if soils were added from disturbance areas. Disturbance areas, including mine spoils, drill pads, and road cuts, are assumed to be lower in total nitrogen than in undisturbed sites where soils and vegetation are intact. Comparison of soils of the A and B horizons from all reference sites with vegetation types similar to the portal yard area indicates an average total nitrogen of 0.143%, a figure approximating the assumed percentage of the yard-area soils.

Total nigrogen in soils is a function of organic matter content which decreases with depth of soils. Hence, by testing for total nigrogen, one can determine whether stockpiled soils are derived from A and B horizons. Levels that average 0.175 percent should indicate

current levels standards. Certainly the use of levels up to the maximum 0.288% in aspen soils should be encouraged.

Should it be necessary to store topsoil during the operational period, those soils can be vegetated by use of the species listed above for stabilization of south-facing gentle slopes and flat areas (i.e., grasses, forbs, and native shrubs).

Reclamation recommendations. -- Seeds and seedlings of selected native species might require hand gathering and digging in the mine lease area. All others are available in the commercial market. A nursery of tree and shrub species might be maintained on the property for transplantation in critical areas.

Estimate of soil volume available for storage and reclamation from portal-yard area. -- The yard area consists of approximately 39 acres in spruce-fir, aspen, sagebrush, and disturbed roadway, drill pad, mine dumps and miscellaneous. Total area of each type was determined. Average soil depths for each type was used to compute soil volume. A total estimated yield of 85,748 cubic yards is indicated (Chart I.). This should allow for burial of the entire site to an average depth of approximately 1.4 feet. Should additional soils be required, it is suggested that top soils (A & B zones) be harvested from the bypass road right-of-way.

Chart I. Estimate of Soil Volume in Each Vegetation Type in the Portal Yard Area

Soil	Vegetation	Acreage	Av. Depth	Cu. Yds.
Argic Cryoboroll	Aspen	8.6	1.7	23,587
Typic Cryoboroll	Spruce/Fir	17.5	1.5	42,350
Lithic Cryocrept	Sagebrush	3.1	.8	4,001
Disturbed	Disturbed	9.8	1.0*	15,801
	TOTAL:	39.0		85,748

* It is assumed that approximately one foot of soil can be reclaimed from disturbed road fill, cuts, and other parts of the disturbed area.

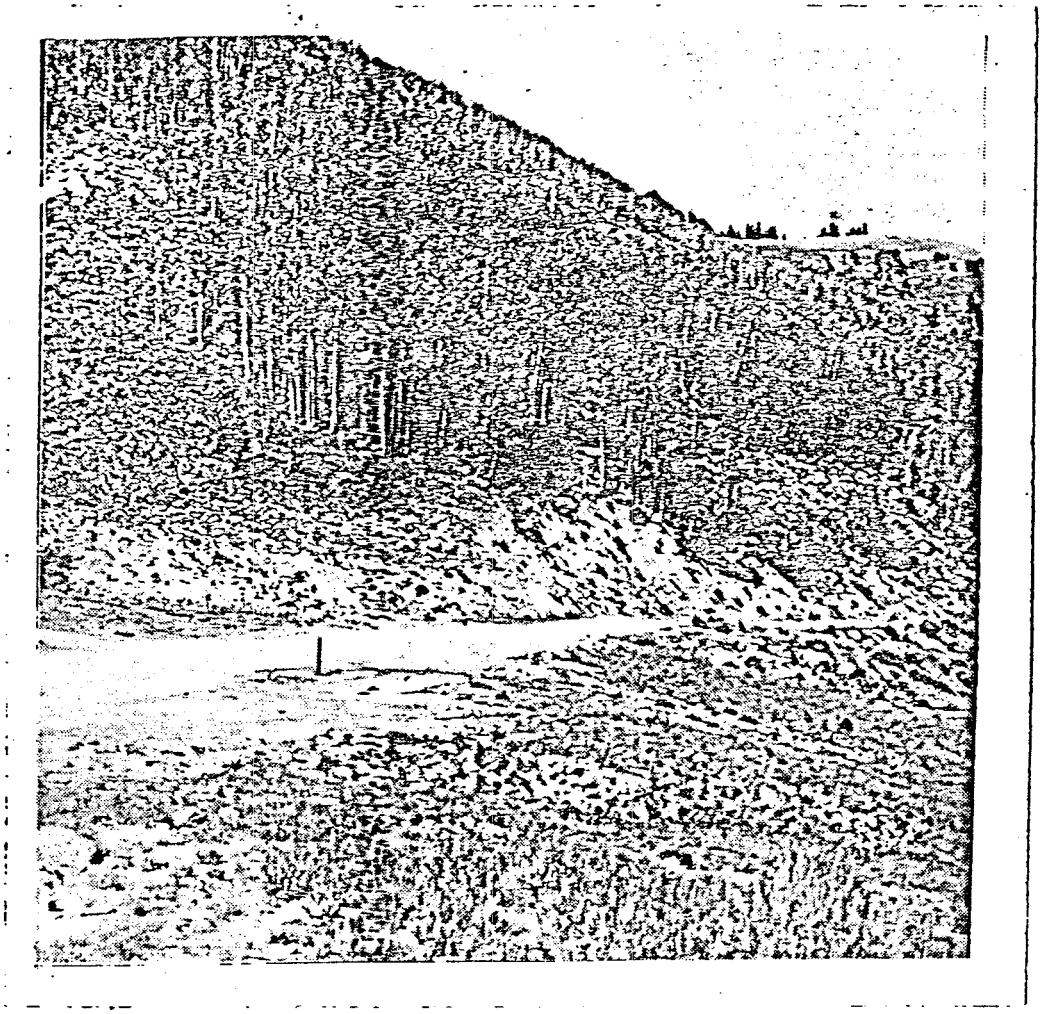

Fig. 1. Portal Yard Area

View northeast from disturbed drill site.
Validation site No. 4 Sagebrush in left background
and site No. 5 Aspen in right background.

Fig. 2. Portal Yard Area

Validation site No. 1 Aspen permanent study transect line.

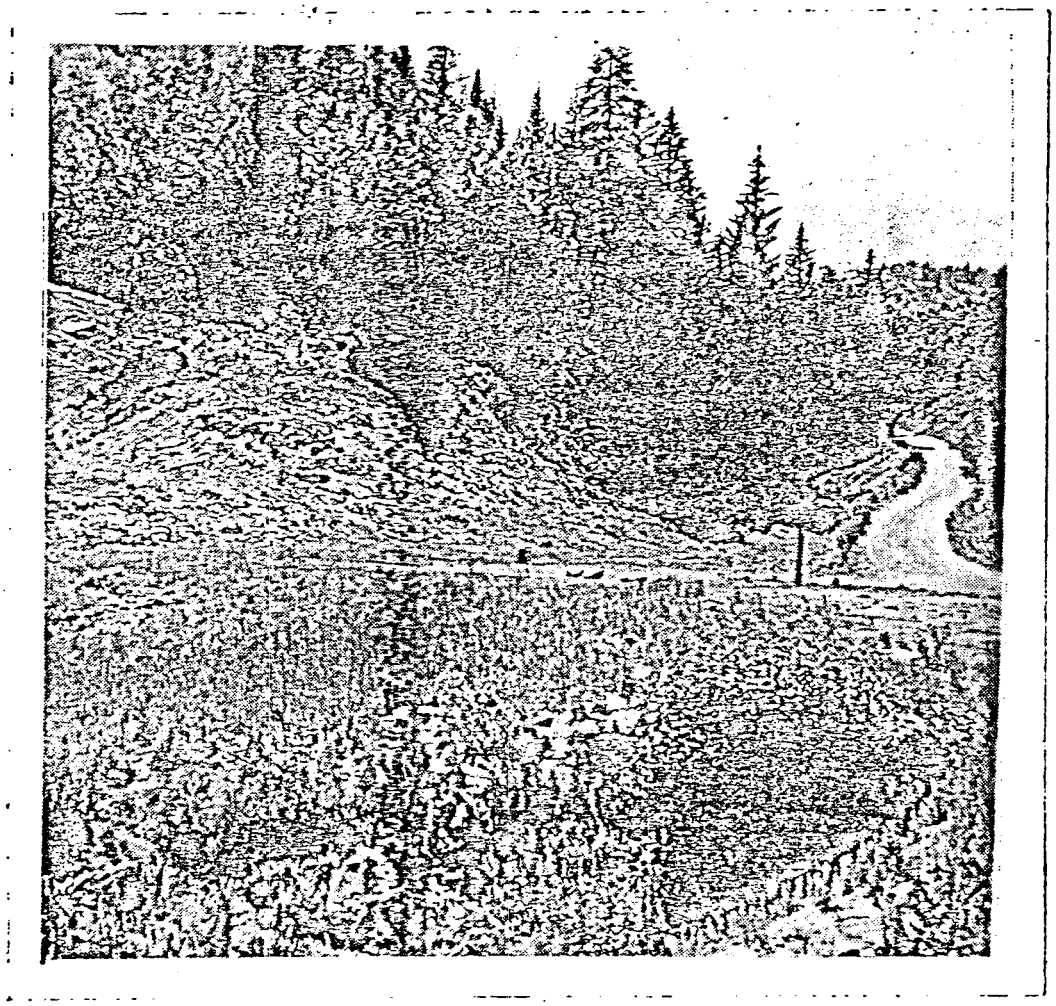

Fig. 3. Portal Yard Area

View southwest from disturbed drill site with validation site No. 8 Spruce/Fir in background.

Fig. 4. Portal Yard Area

View northwest from disturbed drill site with validation site No. 1 Aspen in the background.

Fig. 5. Portal Yard Area

Validation Site No. 8 Spruce/Fir permanent transect line.

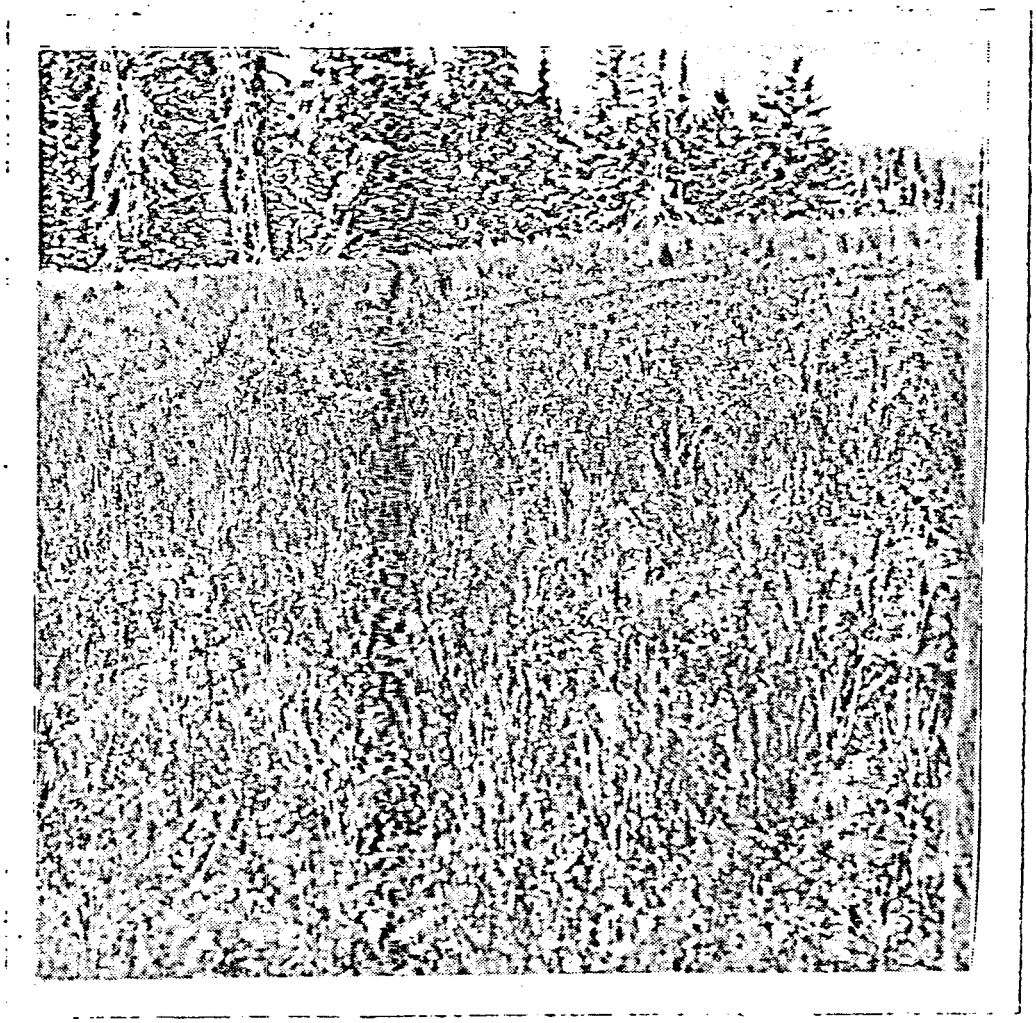

Fig. 6. Reference Site No. 1

Grass/Forb/Elderberry permanent transect line.

Fig. 7. Reference Site No. 1

Aspen permanent transect line on south facing slope looking east.

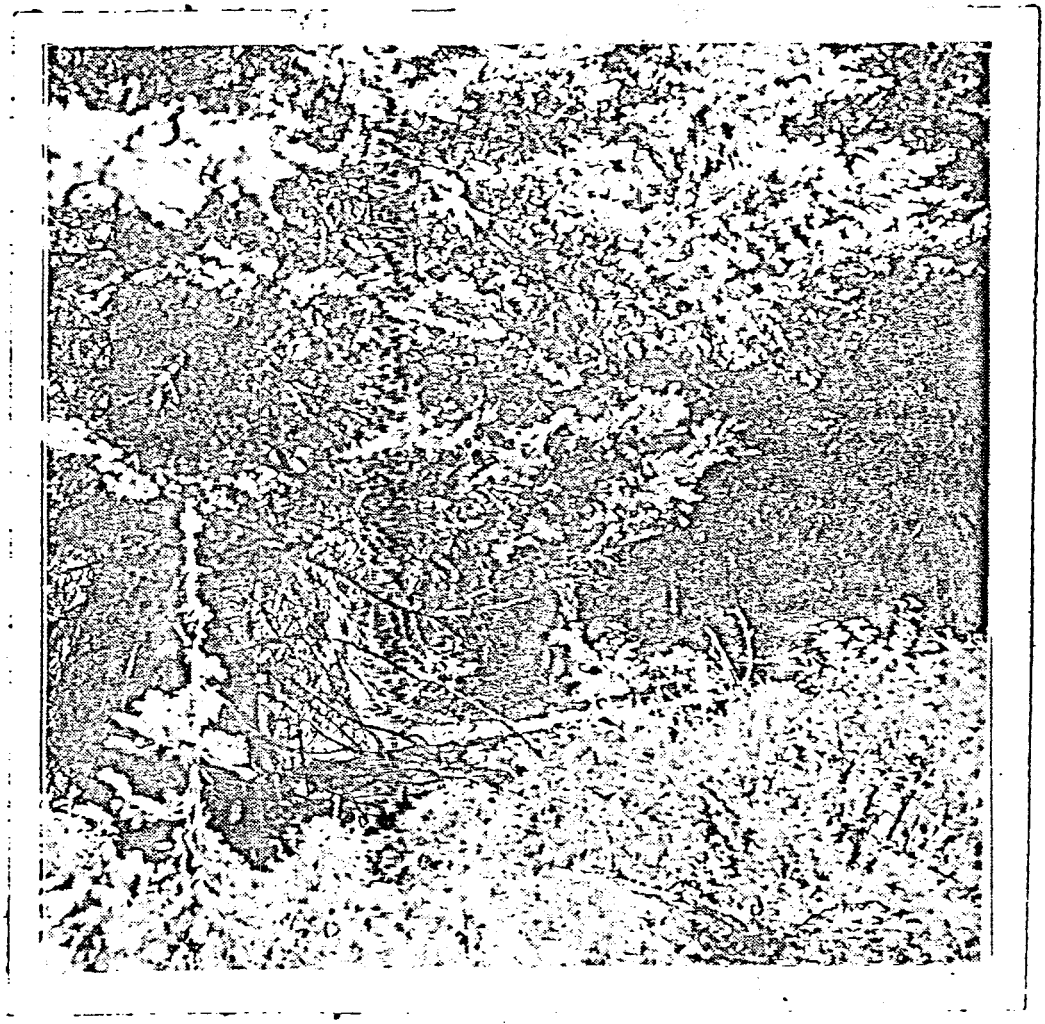

Fig. 8. Reference Site No. 1

Spruce/Fir permanent transect line on north facing slope looking east.

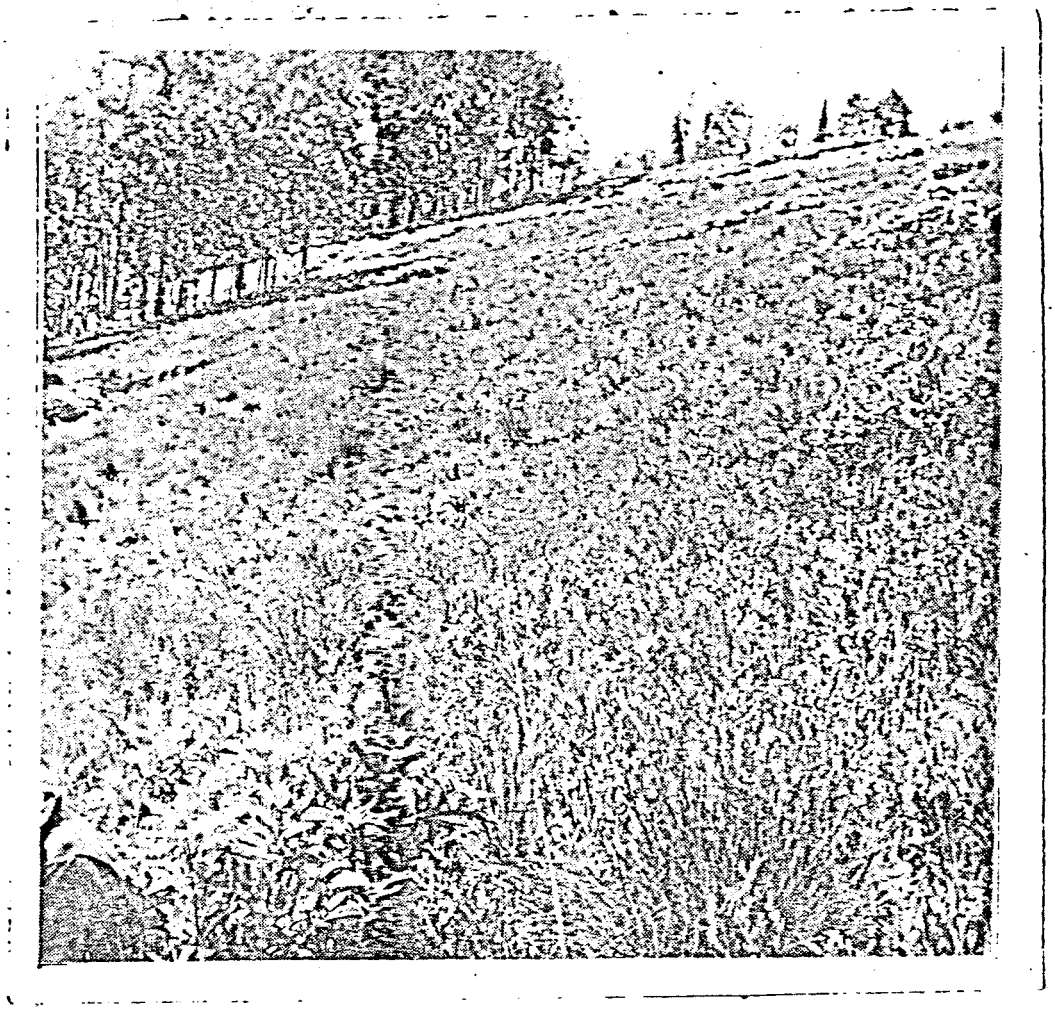

Fig. 9. Reference Site No. 2

Grass/Forb/Elderberry permanent transect line looking west northwest.

Fig. 10. Reference Site No. 2

Aspen permanent transect line on south facing slope looking west.

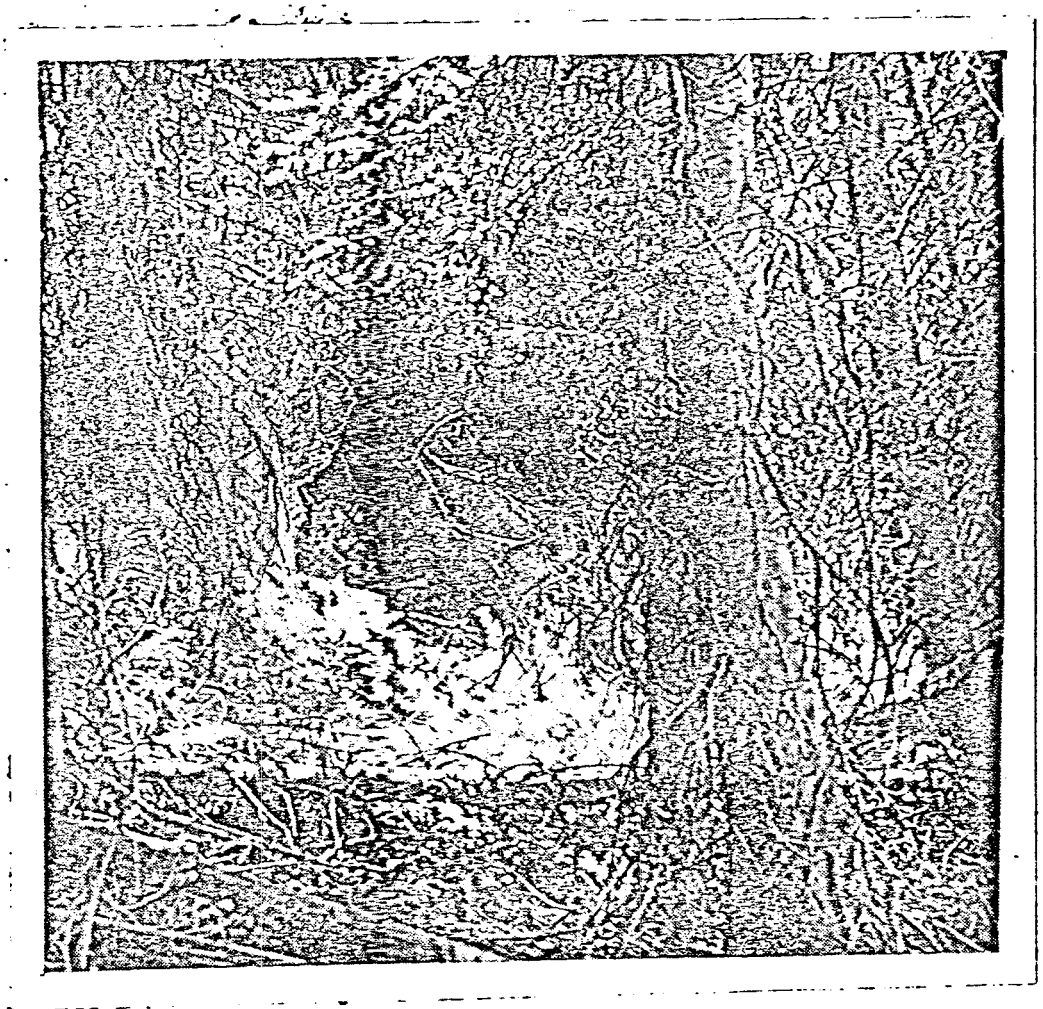

Fig. 11. Reference Site No. 2

Spruce/Fir permanent transect line on north facing slope looking southwest.

Fig. 12. Reference Site No. 3

Aspen permanent transect line on south facing slope looking east.

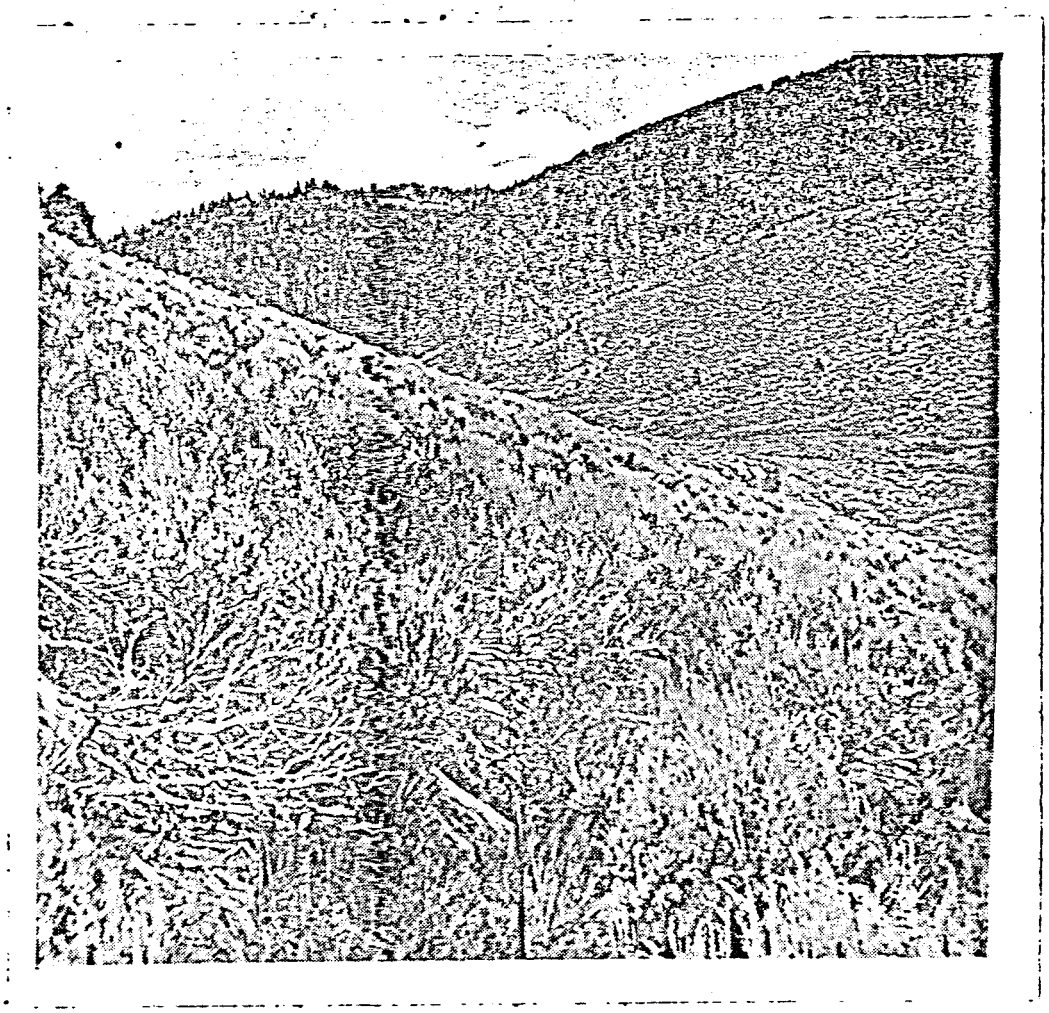

Fig. 13. Reference Site No. 3

Sagebrush permanent transect line on south facing slope looking east.

Fig. 14. Reference Site No. 3

Spruce/Fir permanent transect line on north facing slope looking east.

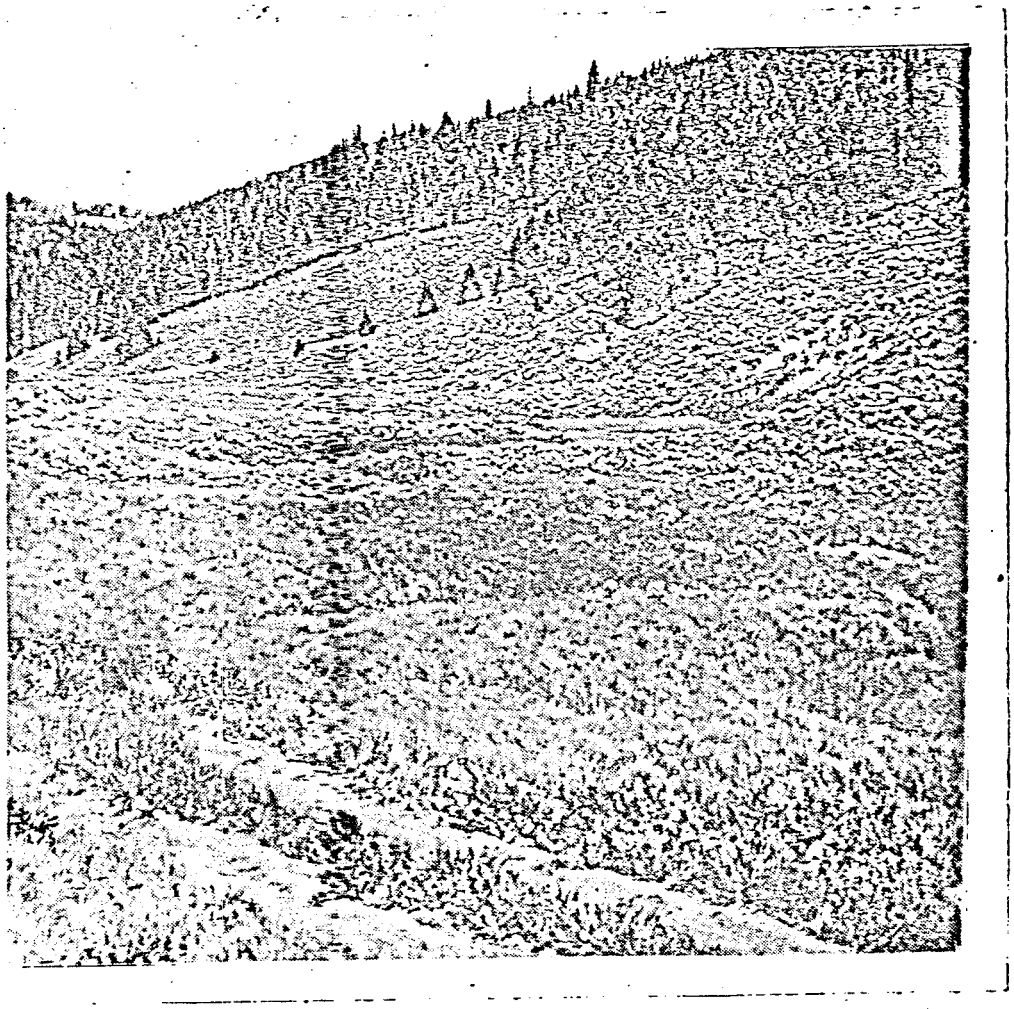

Fig. 15. Reference Site No. 3

Riparian vegetation on permanent transect line following stream meander. Looking east in mouth of Burnout Canyon.

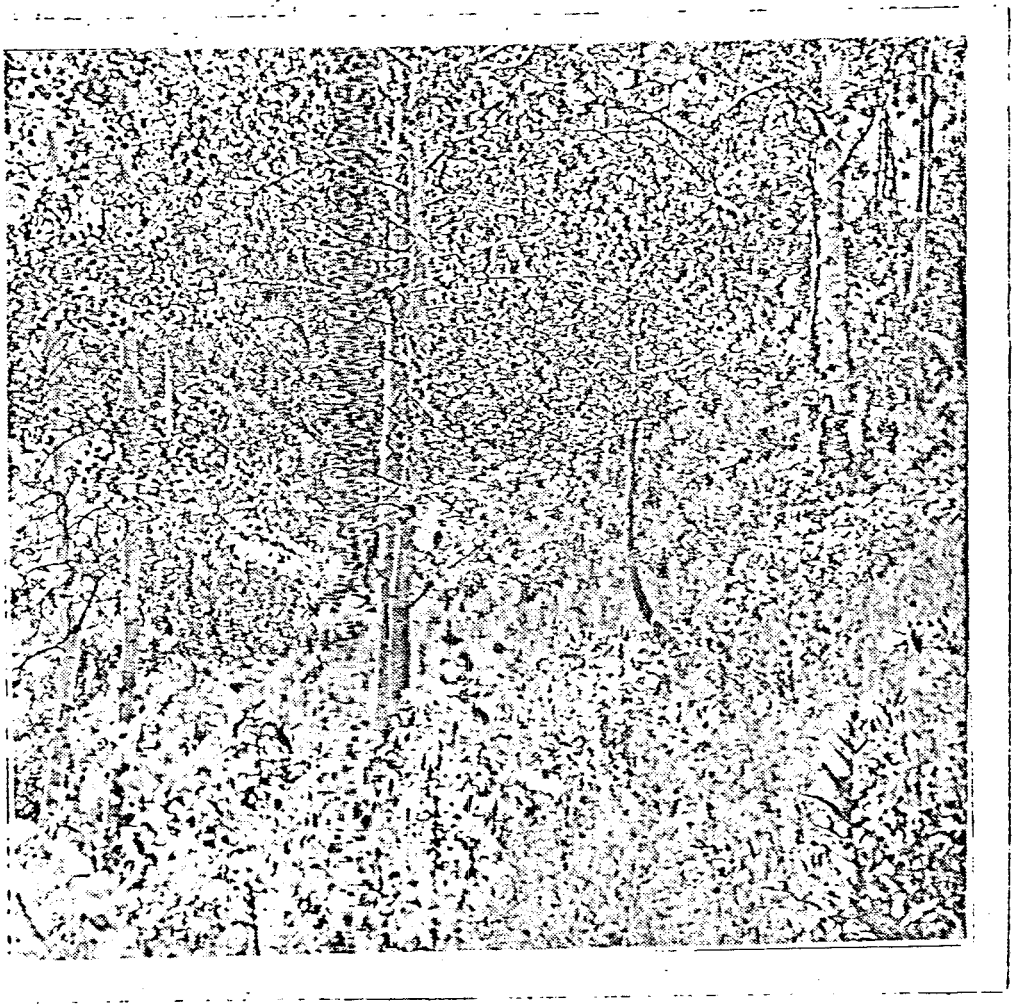

Fig. 16. Reference Site No. 4

Aspen permanent transect line on contour of south facing slope and to the left in background.

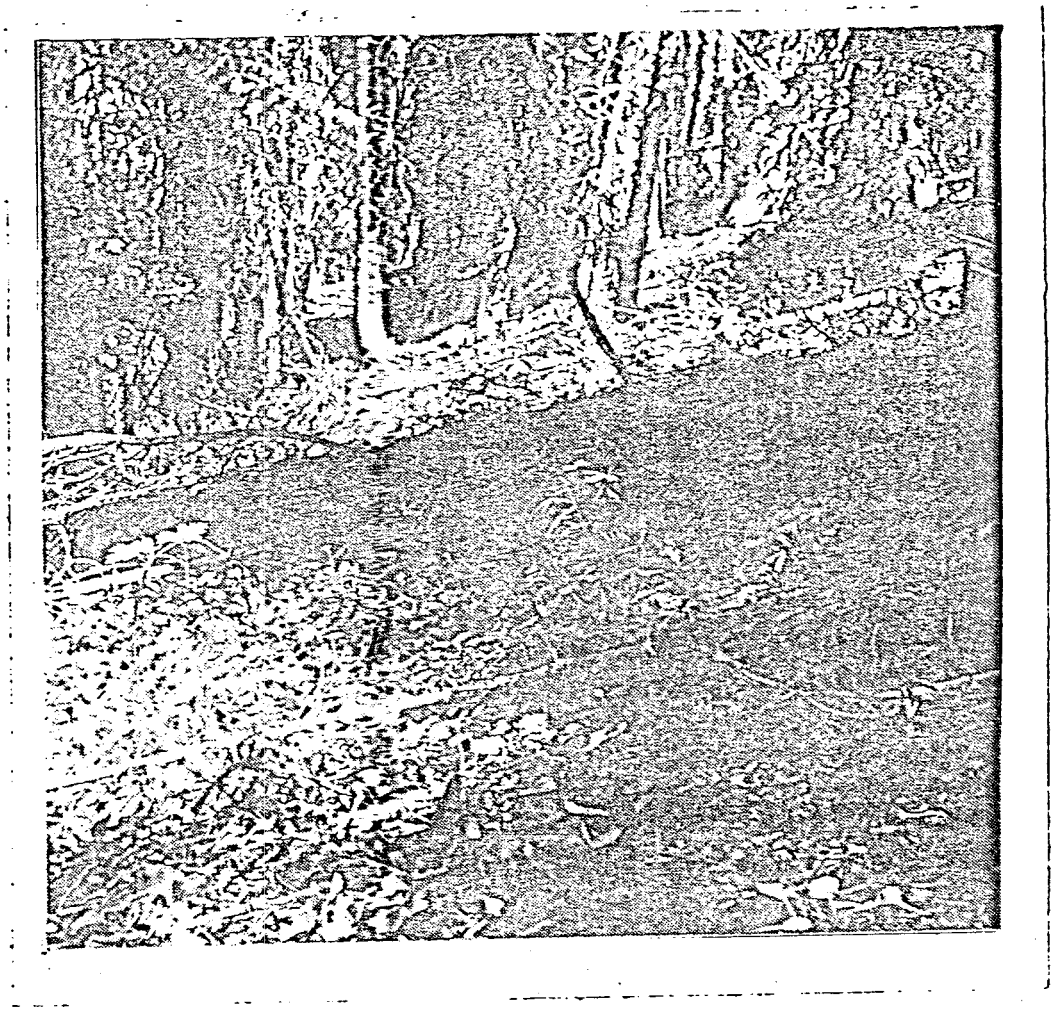

Fig. 17. Reference Site No. 4

Spruce/Fir permanent transect line following contour of north facing slope looking east.

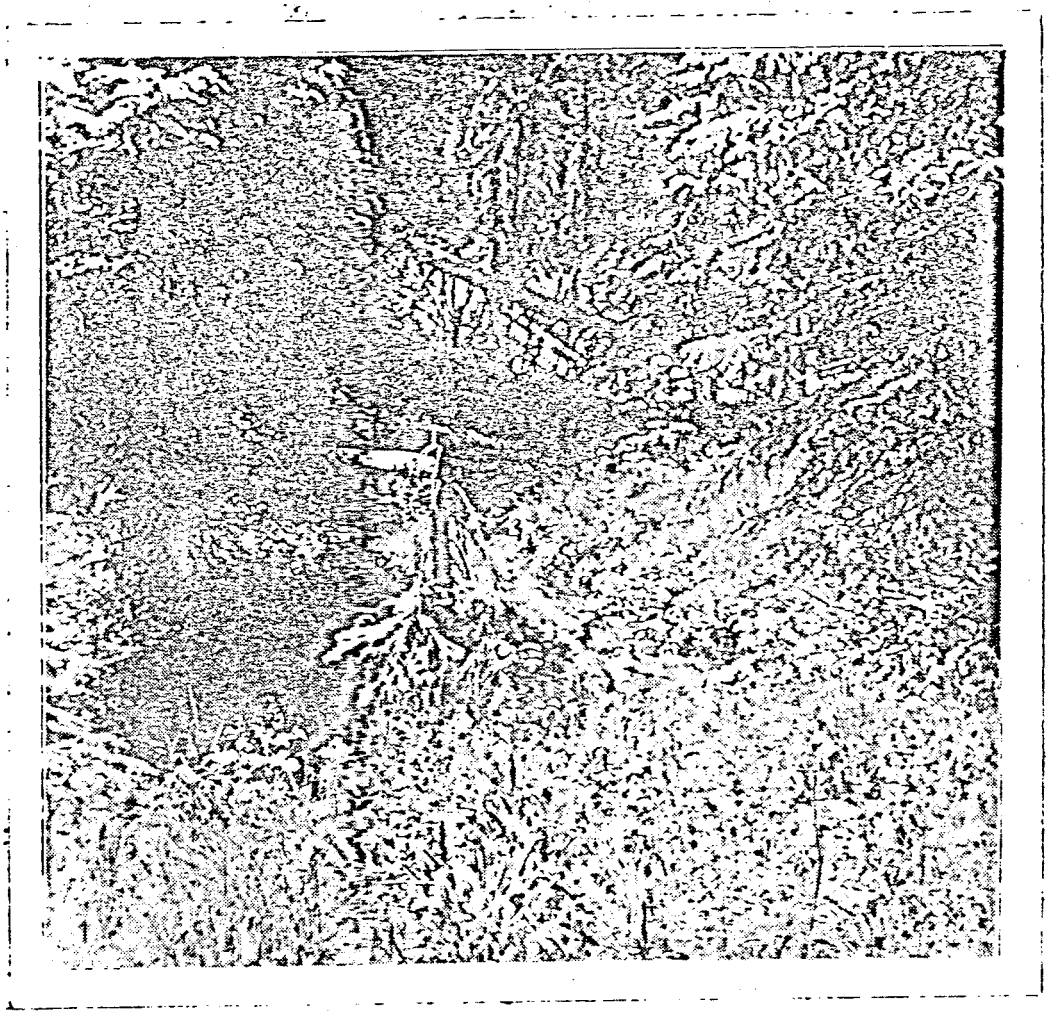

Fig. 18. Reference Site No. 4

Riparian vegetation permanent transect line parallel to stream looking west.

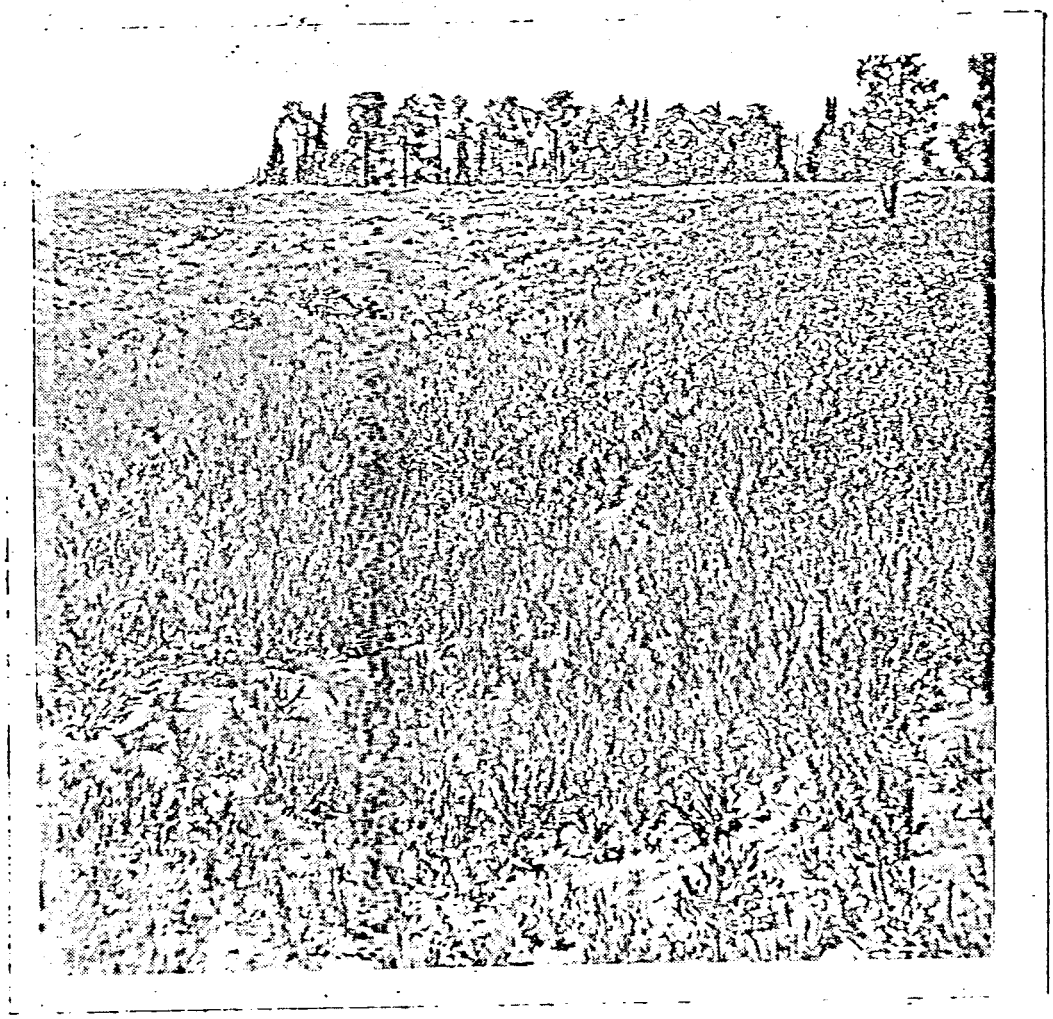

Fig. 19. Reference area gas pipeline route revegetation

General view of pipeline with ecotones between native species on the right and reseeded species in the lighter pathway through the center.

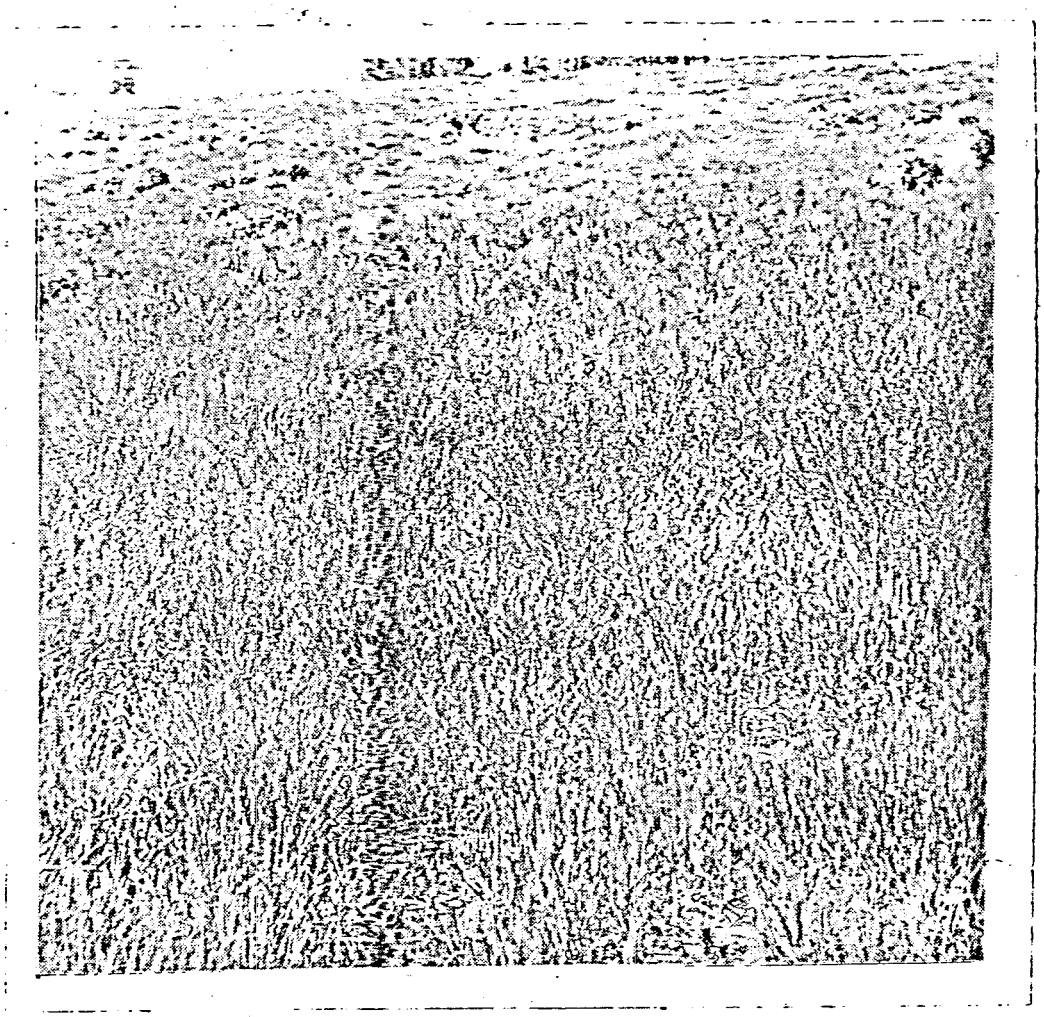

Fig. 20. Reference area gas pipeline route vegetation

Closeup view of colonization of native species from the Grass/Forb/Elderberry (Sedges) type adjacent to the pipeline.

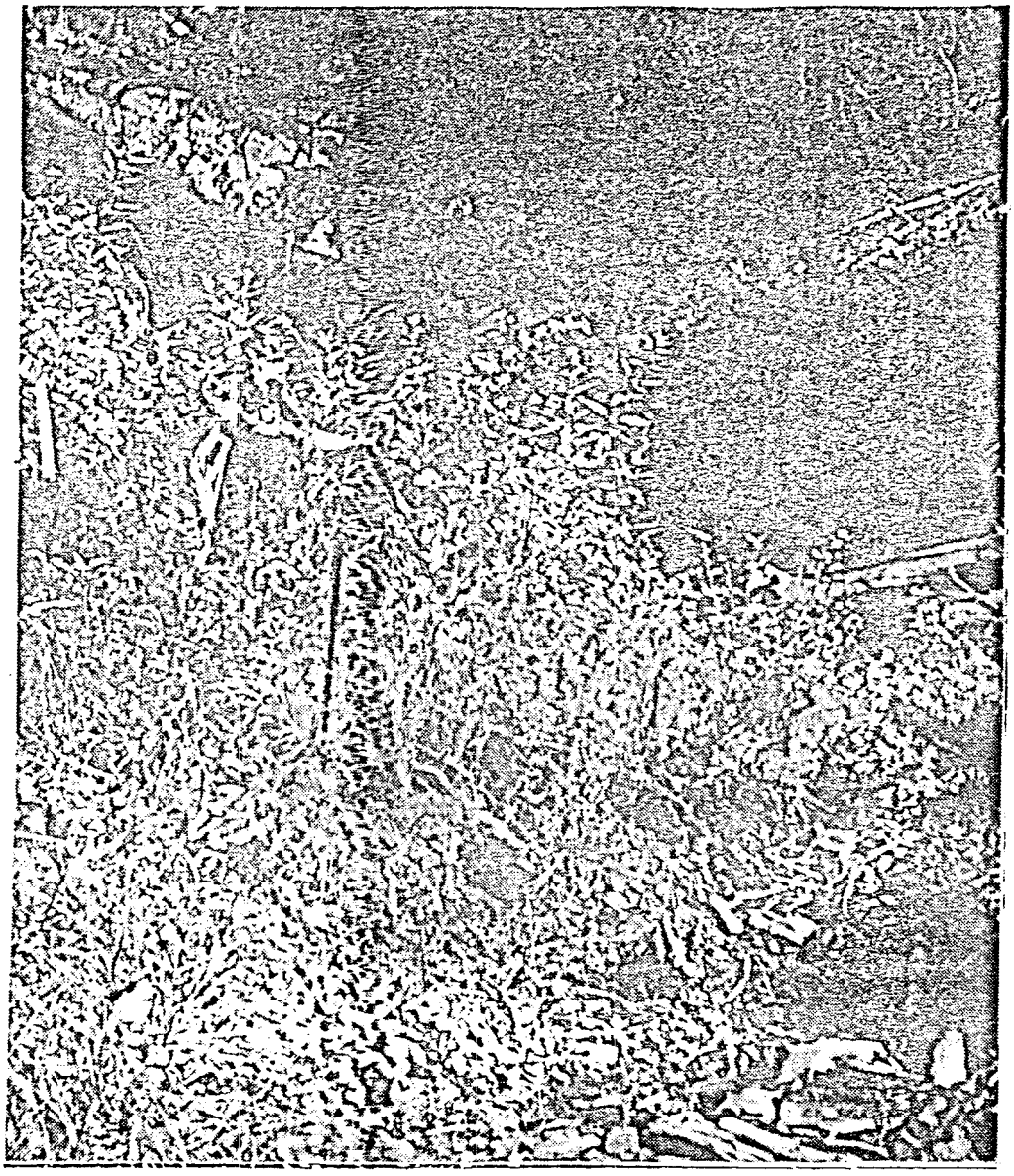

Fig. 21. Reference Site WD - Riparian

Along permanent transect line facing west from permanent stake.

Fig. 22. Reference Site WD - Aspen

View facing west along permanent transect line on contour of south-facing slope.

Fig. 23. Reference Site WD - Spruce/Fir

View facing east along permanent transect line on contour of north-facing slope.

Fig. 24. Proposed Bypass Access Road Validation Site - Aspen Slump

View east along permanent transect line on contour line.

Table I. Species list by plant community types for:

Coastal States Energy Project, McKinnon Properties, Skyline Project; Riparian (R), Spruce-fir (SF), Aspen (A), Grass-Forb-Elderberry (GFE), Snowberry-Sagebrush (SS), Sagebrush (SB), Fringed sagebrush (FS), Disturbed (D), Seeded on pipeline (1), and Seeded on pipeline and roads (2).

	R	SF	A	GFE	SS	SB	FS	D	SL
Abies lasiocarpa		X							
Achillea millefolium	X		X	X	X	X		X	X
Actea rubra		X							
Agastache urticifolia			X	X					
Agoseris aurantiaca			X	X					
Agropyron caninum	X		X	X	X	X			
cristatum							1		
intermedium			2	2				2	
spicatum			X			X	X		
smithii						X			
Agrostis scabra			X						
stolonifera	X								
variabilis	X								
Alopecurus pratensis			1			1		1	
Amaranthus sp.								X	
Amelanchier alnifolia									X
Androsace septentrionalis					X				
Antennaria microphylla			X			X	X		X
Aquilegia coerulea	X								
Arabis drummondii			X	X		X			
Arctostaphylos patula		X	X						
Arenaria sp.		X							
Arnica chamissonis	X								
cordifolia		X							
Arrhenatherum elatius			1					1	
Artemisia cana	X								
cana var. bolanderi	X			X					
dracunculus				X				X	
frigida							X		
tridentata						X		X	
Aster chilensis				X		X		X	
engelmannii		X							X
occidentalis	X								
Astragalus argophyllus				X					
convallarius						X			
Barbarea orthoceras	X								

Table I. (continued)

	R	SF	A	GFE	SS	SB	FS	D	SL
Bromus anamolus						X			
carinatus		X	X	X	X	X			X
inermis			2	2		2		2	
tectorum					X		X		
Calamagrostis neglecta	X								
Caltha leptosepala	X								
Capsella bursa-pastoris			X	X					
Cardamine cordifolia	X	X							
Cardaria draba								X	
Carex aquatilis	X								
egglestonii				X					
geyeri									X
hoodii			X	X	X	X		X	X
kellogii	X								
lanuginosa	X								
praegracilis	X								
microptera	X								
nebraskensis	X								
rossii			X			X			
rostrata	X								
vallicola					X				
Castilleja leonardii						X			
linariifolia			X			X			
Catabrosa aquatica	X								
Cerastium sp.	X								
Chenopodium fremontii			X	X	X		X	X	
Chorispora tenella				X					
Chrysothamnus nauseosus					X	X			
vicidiflorus				X	X	X	X	X	
Cirsium scariosum (foliosum)	X			X	X			X	
vulgare								X	
Clematis hirsutissima						X			
Cleome serrulata				X					
Claytonia lanceolata		X		X					
Collinsia parviflora		X	X	X					
Collomia linearis			X	X	X				
Comandra umbellata						X			
Corallorhiza sp.			X						
Crepis accuminata					X				
Cryptantha crassisepala			X	X					
Cystopteris fragilis									X
Dactylis glomerata	X		2			2		2	
Danthonia unispicata									X

Table I. (continued)

	R	SF	A	GFE	SS	SB	FS	D	SL
Delphinium menziesii occidentale			X	X					
Deschampsia caespitosa	X			X					
Descurainia californica pinnata	X								
Draba sp.	X		X	X		X			
Eleocharis sp.			X	X					
Elymus glaucus			X						
Epilobium alpinum	X								X
paniculatum	X	X							
angustifolium			X			X			
Equisetum arvense								X	X
Erigeron lonchophyllus	X								
speciosus	X								
subtrinervis				X					
Eriogonum umbellatum				X					
Erysimum asperum						X			X
Fragaria virginana			X	X	X	X			
Frasera speciosa	X	X	X						
Fritillaria atropurpurea						X			
Galium trifidum				X					
Gayophytum nuttallii			X	X					
Gentiana sp.			X	X	X	X			
Geranium fremontii	X								
richardsonii			X			X			
Geum macrophyllum	X								
Gilia aggregata	X								
sp. (annual)						X			
Glaux maritima						X			
Glyceria striata	X								
Habenaria sparsiflora	X								
Hackelia floribunda	X								
patens		X	X	X	X	X			
Helenium hoopesii						X			
Heracleum lanatum	X	X	X	X	X	X	X		
Hieracium scouleri	X	X							
Hordeum brachyantherum			X						
jubatum	X			X					
Hydrophyllum capitatum		X	X	X				X	
Iva axillaris		X		X					
Juncus articus	X								
ensifolius	X								
longistylis	X								
	X								

Table I. (continued)

	R	SF	A	GFE	SS	SB	FS	D	SL
Koeleria nitida				X					
Lactuca serriola			X						
Lappula occidentalis				X	X				
Lathyrus lanzwertii		X	X	X	X	X	X		X
pauciflorus			X						
Lepidium densiflorum				X					
Ligusticum porteri						X		X	
Linanthus harknessii				X					
Lithophragma bulbosa			X						
Loncera involucrata	X	X							X
utahensis	X								
Lupinus argenteus	X								
sericeus						X			
Luzula parviflora	X								
Machaeranthera bigelovii						X			
canescens				X					
Madia glomerata				X					
Mahonia repens			X			X			
Medicago sativa			X	X		X		X	
Melica bulbosa			X	X		X			
Mertensia ciliata	X	X	X	X					
Mimulus guttatus	X								
Mitella stenopetala	X								
Moneses uniflora		X							
Monolepis nuttallianus						X		X	
Muhlenbergia filiformis	X								
racemosus									X
Nemophila breviflora			X						
Orthocarpus tolmei							X		
Osmorhiza chilensis		X							
occidentalis		X	X	X					
Pachystima myrsinites	X								
Penstemon humilus						X			
procerus	X					X			
subglaber			X			X			
watsonii				X	X	X	X	X	
whippleanus		X	X						
Phacelia hastata			X	X	X	X		X	
heterophylla			X		X	X			
sericea						X		X	
Phleum alpinum	X								
pratense	X							2	
Phlox caespitosus						X			

Table I. (continued)

	R	SF	A	GFE	SS	SB	FS	D	SL
Physocarpus malvaceous		X							
Picea engelmannii		X							
pungens	X								
Pinus flexilis							X		
Plagiobothrys scouleri	X								
Poa bulbosa								X	
canbyi			X						
fendleriana			X			X	X	X	X
interior			X						
nervosa				X					
pratensis	X		X	X		X		X	
reflexa	X		X	X					
sandbergii						X			X
Polemonium foliosissimum	X		X			X			
pulcherrimum	X				X				
Polygonum aviculare						X		X	
bistortoides			X	X					
douglasii	X				X			X	
sawatchense			X	X		X			
Populus tremuloides			X						
Potentilla anserina	X								
fruticosa	X					X			
glandulosa				X					
gracilis	X			X		X		X	
Prunus virginiana									X
Pseudotsuga menziesii					X				
Pyrola secunda		X							
Ranunculus alismaefolius	X								
ina moenus		X							
testiculatus			X						
Ribes cereum					X	X			
hudsoneanum			X						
inerme						X			
montigenum	X	X		X					
viscosissum	X								
Rorippa curvipes	X								
Rosa woodsii						X			
Rubus idaeus	X								X
parviflorus									X
Rudbeckia occidentalis			X		X	X		X	
Rumex acetosella								X	
crispus								X	
salicifolius	X			X					

Table I. (continued)

	R	SF	A	GFE	SS	SB	FS	D	SL
Salix geyeri	X								
glauca									X
rigida	X								
Sambucus coerulea		X	X						
racemosa	X	X	X	X	X	X		X	
Saxifraga odontoloma	X								
Scrophularia lanceolata						X			
Sedum debile									X
Senecio integerrimus	X			X		X			
multilobatus						X			
serra			X	X		X			
Shepherdia canadensis	X								
Sitanion hystrix							X		
Silene anterrhina					X				
menziesii						X			X
Smilacina stellata			X			X			
Solidago parryi									X
Sorbus scopulina									X
Stellaria jamesiana		X	X	X		X			
Stipa columbiana	X		X	X	X	X			
lettermannii			X	X	X	X	X		
Symphoricarpos oreophilus		X	X	X	X	X	X		X
Taraxacum officinale	X		X	X				X	
Tetradymia canescens							X		
Thalictrum fendleri		X	X	X	X	X			
Thermopsis montana			X						
Thlaspi montanum		X							
Tragopogon dubius	X		X			X			
Trifolium kingii			X						
repens	X								
Trisetum spicatum		X		X					
wolfii	X								
Urtica dioica	X			X				X	
Valeriana occidentalis				X					
Veratrum californicum	X	X	X	X					
Verbascum thapsus						X		X	
Veronica serphyllifolio	X								
Vicia americana			X	X		X			
Viguiera multiflora			X			X			
Viola adunca		X							
canadensis		X							
praemorsa			X	X					

Table II. Plant communities of the McKinnon Properties lease area by percent of area covered.

Taxa	%
Sagebrush	11
Spruce/Fir/Aspen	28
Spruce/Fir	12
Aspen	9
Riparian	3
Aspen Grass/Forb/Elderberry/Conifer	33
Fringed Sagebrush	1
Snowberry/Sagebrush	2
Miscellaneous (stony outcroppings)	1
TOTAL:	100%

Table III. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Validation Site No. 1 Portal Yard Area	SW1/4 Sec 13 T13S R6E Elev. 8750 ft., South facing slope	Aspen

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Poa pratensis	30.0	87	19
	Bromus carinatus	24.0	77	15
	Total Grasses	54.0		34
Forbs	Lathyrus lanzwertii	53.0	80	34
	Stellaria jamesianna	18.0	93	12
	Achillea millefolium	15.0	64	10
	Galium trifidum	5.0	50	4
	Fragaria virginiana	2.0	7	2
	Hackelia floribunda	2.0	10	2
	Agastache urticifolia	1.0	7	T
	Chenopodium fremontii	1.0	14	T
	Geranium fremontii	1.0	4	T
	Smilacina stellata	1.0	7	T
	Taraxacum officinale	1.0	4	T
	Viola (white flower) canadensis	1.0	10	T
	Hydrophylum capitatum	.5	4	T
	Thermopsis montana	.5	4	T
	Descurainia californica	.4	17	T
	Total Forbs	102.4		64
Browse	Symphoricarpos oreophilus	2.0	7	2
	Populus tremuloides	1.0	4	T
	Total Browse	3.0		2
	Totals	159.4		100%

Table IV. Grazing Productivity

SITE	LOCATION	VEGETATION
Validation Site No. 1 Portal Yard Area	SW1/4 Sec 13 T13S R6E Elev. 8750 ft., South facing slope	Aspen

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Bromus carinatus	70.20	15
	Elymus glaucus	69.90	15
	Agropyron caninum	25.20	6
	Poa pratensis	24.00	6
	Agropyron inermes	12.15	3
	Stipa columbiana	T	T
	Total Grasses	201.45	45
Forbs	Lathyrus lanzwertii	124.00	28
	Hackelia floribunda	41.00	10
	Achillea millifolium	36.00	8
	Stellaria jamesiana	21.16	5
	Chenopodium fremontii	8.40	2
	Fragaria virginiana	5.10	1
	Galium trifidum	4.20	1
	Circium scariosum	2.40	T
	Viola canadensis	.90	T
	Taraxacum officinale	.60	T
	Aster sp.	.27	T
	Arabis drummondii	.25	T
	Descurainia californica	T	T
	Total Forbs	244.28	55
Browse	Populus tremuloides	.70	T
	Symphoricarpos oreophilus	T	T
	Total Browse	.70	T
	Totals	446.4	100%
	Est. Potential Prod. for Site	446.4 lb/acre	

Table V. Tree Productivity

SITE

Validation Site No. 1
Portal Yard Area

LOCATION

SW1/4 Sec 13 T13S R6E
Elev. 8750 ft., South
facing slope

VEGETATION

Aspen

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	22.42	100	86.7

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Populus tremuloides	1		1	10	10	2	
Abies lasiocarpa	8	2		10	10	5	

Table VI. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Validation Site No. 5 Portal Yard Area	SE1/4 Sec 13 T13S R6E Elev. 8680 ft., South facing slope	Sagebrush

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Poa pratensis	20.9	74	19
	Poa fendleriana	7.3	37	6
	Stipa lettermanii	4.4	17	4
	Stipa columbiana	2.2	10	2
	Bromus carinatus	2.1	17	2
	Total Grasses	36.9		33
Forbs	Geranium fremontii	11.2	37	10
	Penstemon subglaber	11.2	50	10
	Gayophytum nuttallii	4.3	30	4
	Achillea millefolium	3.5	27	3
	Lathyrus lanzwertii	1.8	20	2
	Stellaria jamesiana	1.0	24	T
	Comandra umbellatum	.5	4	T
	Phlox caespitosus	.5	4	T
	Descurainia californicum	.2	7	T
	Smilacina stellata	.2	7	T
	Lappula occidentalis	.1	4	T
	Lupinus argenteus	.1	4	T
	Phacelia hastata	.1	4	T
	Total Forbs	34.9		29
Browse	Artemisia tridentata	26.5	60	24
	Symphoricarpos oreophilus	13.2	40	12
	Rosa woodsii	1.7	17	1
	Prunus virginiana	1.1	10	1
	Total Browse	42.5		38
	Totals	114.3		100%

Table VII. Grazing Productivity

SITE	LOCATION	VEGETATION
Validation Site No. 5 Portal Yard Area	SE1/4 Sec 13 T13S R6E Elev. 8680 ft., South facing slope	Sagebrush

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Agropyron caninum	91.7	9
	Poa pratensis	28.3	3
	Stipa columbiana	28.0	3
	Agropyron smithii	6.3	T
	Stipa lettermanii	4.2	T
	Carex hoodii	3.5	T
	Total Grasses	162.0	15
Forbs	Geranium fremontii	237.4	22
	Agastache urticifolia	63.3	6
	Circium scariosum	54.0	5
	Smilacina stellata	15.3	2
	Achillea millefolium	14.4	2
	Aster sp.	7.0	T
	Hackelia floribunda	3.0	T
	Silene antirrhina	1.0	T
	Stellaria jamesiana	.9	T
	Lathyrus lanzwertii	.8	T
	Hydrophyllum capitatum	.6	T
	Descurainia californica	.5	T
	Arabis drummondii	T	T
	Chenopodium fremontii	T	T
	Collomia linearis	T	T
	Viola sp.	T	T
	Total Forbs	398.2	37
Browse	Artemisia tridentata vasseyana	215.3	20
	Symphoricarpos oreophilus	163.1	15
	Chrysothamnus nauseosus	128.3	12
	Rosa woodsii	11.6	1
	Populus tremuloides	6.3	T
	Total Browse	524.2	48
	Totals	1084.6	100%
	Est. Potential Prod. for Site	1084.6 lb/acre	

Table VIII. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Validation Site No. 8 Portal Yard Area	SW1/4 Sec 13 T13S R6E Elev. 8750 ft., North facing slope	Spruce/Fir

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Bromus carinatus	1.1	10	2
	Poa reflexa	.3	14	T
	Total Grasses	1.4		2
Forbs	Arnica cordifolia	17.7	54	19
	Osmorhiza chilensis	9.9	60	16
	Geranium fremontii	3.3	24	5
	Lupinus sericeus	3.0	24	5
	Aquilegia coerulea	2.7	10	4
	Lathyrus lanzwertii	2.3	14	4
	Fragaria virginiana	2.2	24	3
	Pyrola secunda	2.1	34	3
	Thalictrum fendleri	1.6	14	3
	Aster sp.	1.2	14	2
	Smilacina stellata	1.2	4	2
	Epilobium alpinum	1.0	7	2
	Viola sp.	.7	10	1
	Castilleja linariifolia	.5	4	1
	Lonicera involucrata	.5	4	1
	Polemonium sp.	.5	4	1
	Mitella stenopetala	.3	14	T
	Achillea millefolium	.1	4	T
	Viola adunca	.1	4	T
	Total Forbs	50.9		81
Browse	Pachystima myrsinites	3.3	7	5
	Symphoricarpos oreophilus	2.6	24	4
	Ribes cereum	2.2	10	3
	Abies lasiocarpa	1.7	17	3
	Rubus idaeus	.5	4	1
	Picea engelmannii	.2	7	1
	Total Browse	10.5		17
	Totals	62.8		100%

Table IX. Tree Productivity

SITE

Validation Site No. 8
Portal Yard Area

LOCATION

SW1/4 Sec 13 T13S R6E
Elev. 8750 ft., North
facing slope

VEGETATION

Spruce/Fir

Taxa	Mean Distance	Relative Frequency	Density per Acre
Abies lasiocarpa		35	
Picea engelmannii	9.2	55	511.3

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Abies lasiocarpa	47			1	1		
Picea engelmannii	8		1	8	4		3
Populus tremuloides	9	4			1		
Sorbus scopulina			1				

Table X. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site WD	NW1/4 Sec 23 T13S R6E Elevation 9020 ft. So. facing slope	Aspen

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Bromus carinatus	29.4	74	20
	Poa pratensis	24.0	74	16
	Agropyron caninum	13.8	67	9
	Elymus glaucus	13.6	40	9
	Carex hoodii	.5	4	T
	Poa reflexa	.5	4	T
	Total Grasses	81.8		54
Forbs	Nemophila breviflora	19.1	70	13
	Lathyrus lanzwertii	16.0	30	11
	Collomia linearis	6.0	34	4
	Polygonum sawatchense	4.6	37	3
	Stellaria jamesiana	2.8	17	2
	Galium trifidum	2.0	14	1
	Chenopodium fremontii	1.9	27	1
	Descurainia californica	1.5	10	1
	Achillea millefolium	1.4	10	1
	Thallictrum fendleri	1.0	7	1
	Helenium hoopesii	.6	10	T
	Agastache urticifolia	.5	4	T
	Osmorhiza chilensis	.2	7	T
	Viola sp.	.2	10	T
	Hackelia floribunda	.1	4	T
	Total Forbs	57.9		38
Browse	Sambucus racemosa	6.8	30	5
	Abies lasiocarpa	2.8	4	2
	Symphoricarpos oreophilus	1.2	4	1
	Total Browse	10.8		8
	Totals	150.5		100%

Table XI. Tree Productivity

SITE

Reference Site WD

VEGETATION

Aspen

LOCATION

NW1/4 Sec 23 T13S R6E
Elevation 9020 ft.
So. facing slope

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	11.001	100	426.14

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	> 15"d.
Populus tremuloides	36		4	11	2	4	2

Table XIII.

Tree Productivity

SITE

Reference Site WD

LOCATION

NW1/4 Sec 23 T13S R6E
Elevation 9020 ft.
No. facing slope

VEGETATION

Spruce/Fir

Taxa	Mean Distance	Relative Frequency	Density per Acre
Picea engelmannii	14.40	77	210.07
Abies lasiocarpa		23	

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Picea engelmannii	1		4	3	4	2	2
Abies lasiocarpa	28		2		1	1	

Table XIV. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site WD	NW1/4 Sec 23 T13S R6E Elevation 9050 ft. Canyon Floor	Riparian

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Carex hoodii	24.6	54	15
	Poa reflexa	9.7	40	6
	Poa fendleriana	7.6	20	4
	Agrostis stolonifera	6.2	24	4
	Elymus glaucus	2.8	14	2
	Glyceria stricta	1.2	4	1
	Eleocharis sp.	1.1	10	T
	Bromus carinatus	.5	4	T
	Hordeum brachyantherum	.5	4	T
	Stipa columbiana	.5	4	T
	Total Grasses	54.7		32
Forbs	Saxifraga odontiloma	27.3	54	16
	Epilobium alpinum	11.7	37	7
	Veratrum californicum	11.1	17	6
	Mimulus guttatus	8.7	40	5
	Achillea millefolium	8.4	34	5
	Osmorhiza chilensis	6.1	27	4
	Rorippa curvipes	6.1	20	4
	Helenium hoopesii	5.7	20	3
	Lathyrus lanzwertii	5.0	10	3
	Equisetum arvense	3.8	20	2
	Monesis uniflora	2.8	4	2
	Viola canadensis	2.5	7	1
	Thaictrum fendleri	2.1	4	1
	Galium trifidum	1.2	4	1
	Rudbeckia occidentalis	1.2	4	1
	Senecio integerrimus	1.2	4	1
	Vicia americana	1.2	4	1
	Plagiobothyrus scouleri	.5	4	T
	Stellaria jamesiana	.5	4	T
	Taraxacum officinale	.2	7	T
	Gentiana sp.	.1	4	T
	Total Forbs	107.4		63
Browse	Ribes viscosissimum	6.4	20	4
	Sambucus racemosa	1.2	4	1
	Abies lasiocarpa (seedlings)	.1	4	T
	Total Browse	7.7		5
	Totals	169.8		100%

Table XV. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site WD	NW1/4 Sec 23 T13S R6E Elevation 9050 ft. Canyon floor	Riparian

PLOT SIZE: .96 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Carex hoodii	10.2	12
	Poa reflexa	1.5	2
	Elymus glaucus	1.2	2
	Bromus carinatus	.9	2
	Poa fendleriana	.8	1
	Agrostis stolonifera	.2	T
	Agropyron caninum	T	T
	Total Grasses	14.8	19
Forbs	Helenium hoopesii	19.2	24
	Rorippa curvipes	18.0	22
	Saxifraga odontiloma	9.0	11
	Aster engelmanii	5.1	6
	Delphinium occidentale	4.8	6
	Rudbeckia occidentalis	2.8	4
	Geranium richardsonii	2.4	3
	Epilobium paniculatum	.8	1
	Veratrum californicum	.7	1
	Mimulus guttatus	.6	1
	Achillea millefolium	.2	T
	Lathyrus lanzwertii	.2	T
	Osmorhiza chilensis	.2	T
	Taraxacum officinale	.2	T
	Capsella bursa-pastoris	T	T
	Galium trifidum	T	T
	Gentiana sp.	T	T
	Viola canadensis	T	T
	Total Forbs	64.2	79
Browse	Ribes viscosissimum	1.4	2
	Sambucus racemosa	.4	T
	Total Browse	1.8	2
	Totals	80.8	100
	Est. Potential Prod. for Site	80.8 lb/acre	

Table XVI. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Proposed Bypass Road Validation Area	NW1/4 Sec 24 T13S R6E Elevation 9140 ft. - On contour from Waste Rock Disposal Area to south fork existing trail	Aspen slump

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Poa reflexa	6.8	55	7
	Poa pratensis	4.0	20	4
	Carex hoodii	.9	10	1
	Bromus carinatus	.8	5	1
	Total Grasses	12.5		13
Forbs	Lathyrus lanzwertii	20.0	65	20
	Stellaria jamesiana	14.2	70	14
	Collomia linearis	9.1	35	9
	Helenium hoopesii	6.6	25	6
	Achillea millefolium	5.6	30	5
	Rudbeckia occidentalis	5.1	35	5
	Polygonum sawatchense	4.9	50	5
	Chenopodium fremontii	4.8	45	5
	Epilobium paniculatum	3.8	30	4
	Viola sp.	2.8	15	2
	Osmorhiza chilensis	1.9	25	2
	Galium trifidum	1.8	20	2
	Aster sp.	.8	5	1
	Veratrum californicum	.8	5	1
	Descurainia sp.	.6	25	1
	Hackelia floribunda	.4	15	T
	Draba sp.	.1	5	T
	Mitella stenopetala	.1	5	T
	Total Forbs	84.4		81
Browse	Ribes cereum	3.1	5	3
	Sambucus racemosa	2.8	15	2
	Populus tremuloides	.8	5	1
	Total Browse	6.7		6
	Totals	102.6		100%

Table XVII. Tree Productivity

SITE

Proposed Bypass Road
Validation Area

LOCATION

NW1/4 Sec 24 T13S R6E
Elevation 9140 ft.
On contour from Waste Rock Disposal Area to south fork existing trail.

VEGETATION

Aspen slump

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	19.14	52	118.91
Abies lasiocarpa		40	
Picea engelmannii		8	

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
(Data not taken)							

Table XVIII. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 1	NE1/4 Sec 14 T13S R6E Elevation 9540 ft. No. facing slope	Spruce/Fir

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Agropyron caninum	.7	10	2
	Bromus carinatus	.6	7	1
	Poa reflexa	.5	4	1
	Total Grasses	1.8		4
Forbs	Lupinus sèriceus	16.3	47	39
	Lathyrus lanzwertii	9.3	37	22
	Achillea millefolium	2.7	14	7
	Claytonia lanceolata	2.1	17	5
	Arnica cordifolia	1.6	17	4
	Osmorhiza chilensis	1.6	30	4
	Collinsia parviflora	1.2	14	3
	Chenopodium fremontii	.6	7	1
	Descurainia pinnata	.5	4	1
	Hackelia floribunda	.5	4	1
	Helenium hoopesii	.5	4	1
	Pyrola secunda	.5	4	1
	Agoseris aurantiaca	.2	7	1
	Viola adunca	.2	7	1
	Galium trifidum	.1	4	T
	Gayophytum nuttallii	.1	4	T
	Phacelia hastata	.1	4	T
	Total Forbs	38.1		91
Browse	Ribes montigenum	1.3	4	3
	Abies lasiocarpa	.8	14	2
	Picea engelmannii	.1	4	T
	Total Browse	2.2		5
	Totals	42.1		100%

Table XIX. Tree Productivity

SITE

Reference Site 1

VEGETATION

Spruce/Fir

LOCATION

NE1/4 Sec 14 T13S R6E
Elevation 9540 ft.
No. facing slope

Taxa	Mean Distance	Relative Frequency	Density per Acre
Picea engelmannii	11.15'	25	350.3
Abies lasiocarpa		75	

Taxa	< 1" Diameter		> 1" Diameter				
	< 3' tall	> 3' tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	> 15"d.
Picea engelmannii	12		2		1		8
Abies lasiocarpa	46						3

Table XX. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 1	NE1/4 Sec 14 T13S R6E Elevation 9540 ft. No. facing slope	Grass/Forb/ Elderberry

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Agropyron caninum	20.9	55	13
	Stipa columbiana	17.9	30	11
	Stipa lettermannii	11.9	45	7
	Melica bulbosa	11.2	40	7
	Poa pratensis	10.1	27	7
	Bromus carinatus	9.9	55	6
	Poa fendleriana	7.6	40	5
	Poa reflexa	.1	5	T
	Total Grasses	89.6		56
Forbs	Achillea millefolium	24.9	60	15
	Madia glomerata	13.5	45	9
	Stellaria jamesiana	10.9	50	7
	Helianthella uniflora	5.0	10	3
	Lathyrus lanzwertii	4.9	25	3
	Polygonum sawatchense	4.5	35	3
	Chenopodium fremontii	2.5	25	1
	Circium scariosum	1.9	5	1
	Taraxacum officinale	1.9	25	1
	Hackelia floribunda	1.6	15	1
	Collomia linearis	1.5	10	T
	Phacelia hastata	.8	5	T
	Capsella bursa-pastoris	.1	5	T
	Descurainia californica	.1	5	T
	Total Forbs	74.1		44
	Totals	163.7		100%

Table XXI. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 1	NE1/4 Sec 14 T13S R6E Elevation 9540 ft. No. facing slope	Grass/Forb/ Elderberry

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Agropyron caninum	122.50	19
	Melica bulbosa	78.00	12
	Bromus carinatus	18.00	3
	Poa pratensis	15.50	3
	Stipa columbiana	14.00	3
	Stipa lettermannii	5.20	T
	Agropyron smithii	3.00	T
	Hordeum jubatum	.70	T
	Poa reflexa	.30	T
	Total Grasses	257.20	40
Forbs	Achillea millefolium	159.12	25
	Phacelia hastata	57.60	9
	Hackelia floribunda	39.25	6
	Taraxacum officinale	29.00	4
	Stellaria jamesiana	24.84	3
	Agoseris aurantiaca	17.40	5
	Arabis drummondii	4.75	T
	Lappula occidentalis	4.20	T
	Lathyrus lanzwertii	4.00	T
	Viola sp.	2.70	T
	Madia glomerata	2.00	T
	Nemophila breviflora	1.50	T
	Chenopodium fremontii	.30	T
	Galium trifidum	.30	T
	Cleome serrulata	.25	T
	Aster sp.	T	T
	Collinsia pariflora	T	T
	Descurainia pinnata	T	T
	Descurainia californica	T	T
	Delphinium occidentale	T	T
	Gayophytum nuttallii	T	T
	Rumex salicifolius	T	T
	Total Forbs	347.21	52
Browse	Chrysothamnus vicidiflorus	52.00	8
	Sambucus racemosa	T	T
	Total Browse	52.00	8
	Totals	656.4	100
	Est. Potential Prod. for Site	656.4 lb/acre	

Table XXII. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 1	NE1/4 Sec 14 T13S R6E Elevation 9540 ft. So. facing slope	Aspen

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Agropyron caninum	13.3	70	10
	Poa reflexa	6.3	54	5
	Melica bulbosa	1.3	4	1
	Poa pratensis	1.1	10	1
	Bromus carinatus	.6	7	T
	Carex hoodii	.1	4	T
	Total Grasses	22.7		17
Forbs	Galium trifidum	29.0	97	21
	Nemophila breviflora	19.9	80	14
	Collomia linearis	16.1	84	12
	Stellaria jamesiana	15.5	74	11
	Lathyrus lanzwertii	13.7	67	10
	Collinsia parviflora	4.7	60	3
	Rudbeckia occidentalis	3.0	10	2
	Achillea millefolium	2.5	20	2
	Delphinium menziesii	2.3	24	1
	Gayophytum nuttallii	1.8	10	1
	Viola sp.	.8	14	T
	Osmorhiza occidentalis	.6	7	T
	Senecio serra	.5	4	T
	Polygonum sawatchense	.4	17	T
	Chenopodium fremontii	.3	14	T
	Descurainia pinnata	.1	4	T
	Lithophragma bulbosa	.1	4	T
	Penstemon sp.	.1	4	T
	Taraxacum officinale	.1	4	T
	Total Forbs	111.5		83
	Totals	134.2		100%

Table XXIII. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 1	NE1/4 Sec 14 T13S R6E Elevation 9540 ft. So. facing slope	Aspen

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Bromus carinatus	14.70	2
	Carex hoodii	6.30	1
	Melica bulbosa	2.00	T
	Stipa columbiana	2.00	T
	Poa reflexa	1.80	T
	Agropyron caninum	1.40	T
	Agropyron inermis	1.35	T
	Total Grasses	29.55	3
Forbs	Nemophila breviflora	152.40	21
	Galium trifidum	70.20	10
	Helenium hoopesii	59.70	8
	Lathyrus lanzwertii	16.50	3
	Stellara jamesiana	15.64	3
	Collomia linearis	15.25	3
	Phacelia hastata	14.70	2
	Delphinium occidentale	10.64	2
	Agastache urticifolia	5.70	1
	Hydrophyllum capitatum	3.00	T
	Madia glomerata	2.75	T
	Gayophytum nuttallii	2.20	T
	Osmorhiza chelensis	1.89	T
	Descurainia californica	1.75	T
	Achillea millefolium	.96	T
	Collinisia parviflora	.75	T
	Viola	.60	T
	Polygonum sawatchense	.25	T
	Chenopodium fremontii	T	T
	Cryptantha sp.	T	T
	Total Forbs	374.88	52
Browse	Sambucus coerulea	314.00	44
	Populus tremuloides	5.60	1
	Total Browse	319.60	45
	Totals	724.0	100
	Est. Potential Prod. for Site	724.0 lb/acre	

Table XXIV. Tree Productivity

SITE

Reference Site 1

LOCATION

NE1/4 Sec 14 T13S R6E
Elevation 9540 ft.
So. facing slope

VEGETATION

Aspen

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	10.89	100	367.29

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Populus tremuloides	1		3	12	9	1	1

Table XXV. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 2	NW1/4 Sec 23 T13S R6E Elevation 9400 ft.	Grass/Forb/ Elderberry

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Stipa lettermannii	10.6	40	8
	Carex hoodii	9.8	30	8
	Bromus carinatus	5.1	27	4
	Melica bulbosa	4.8	30	4
	Agropyron caninum	3.8	27	3
	Poa pratensis	1.0	7	T
	Poa reflexa	1.0	7	T
	Stipa columbiana	.5	4	T
	Total Grasses	36.6		27
Forbs	Lathyrus lanzwertii	30.1	97	23
	Collomia linearis	26.3	97	20
	Viola adunca	18.3	84	14
	Helenium hoopesii	10.3	34	8
	Galium trifidum	4.0	77	3
	Gayophytum nuttallii	3.4	37	3
	Collinsia parviflora	1.5	27	1
	Madia glomerata	1.3	20	1
	Polygonum sawatchense	.8	17	T
	Lappula occidentalis	.7	10	T
	Stellaria jamesiana	.5	7	T
	Chenopodium fremontii	.3	14	T
	Nemophila breviflora	.3	14	T
	Arabis drummondii	.2	10	T
	Descurainia pinnata	.1	4	T
	Total Forbs	98.1		73
	Totals	134.7		100%

Table XXVI. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 2	NW1/4 Sec 23 T13S R6E Elevation 9400 ft.	Grass/Forb/ Elderberry

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Carex hoodii	98.0	12
	Bromus carinatus	21.0	3
	Agropyron caninum	13.0	2
	Melica bulbosa	12.0	1
	Stipa lettermannii	9.8	1
	Poa reflexa	1.2	T
	Poa pratensis	.5	T
	Total Grasses	155.5	19
Forbs	Helenium hoopesii	306.0	37
	Lathyrus lanzwertii	232.2	28
	Collomia linearis	65.8	8
	Viola adunca	39.0	5
	Galium trifidum	2.7	T
	Phacelia hastata	2.7	T
	Gayophytum nuttallii	2.2	T
	Hydrophylum capitatum	1.5	T
	Nemophila breviflora	1.5	T
	Stellaria jamesiana	.9	T
	Arabis drummondii	.8	T
	Polygonum sawatchense	.8	T
	Aster sp.	.5	T
	Chenopodium fremontii	T	T
	Collinsia parviflora	T	T
	Taraxacum officinale	T	T
	Total Forbs	656.6	78
Browse	Artemisia tridentata	23.4	3
	Total Browse	23.4	3
	Totals	835.5	100
	Est. Potential Prod. for Site	835.5 lb/acre	

Table XXVII. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 2	NW1/4 Sec 23 T13S R6E Elevation 9300 ft. No. facing slope	Spruce/Fir

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Carex hoodii	6.2	24	9
	Bromus carinatus	3.2	30	5
	Total Grasses	9.4		14
Forbs	Stellaria jamesii	14.8	67	21
	Lathyrus lanzwertii	12.1	27	17
	Osmorhiza chilensis	7.0	60	10
	Mitella stenopetala	4.3	14	6
	Hackelia floribunda	3.2	20	6
	Fragaria virginiana	3.1	27	4
	Viola canadensis	2.8	20	4
	Achillea millefolium	2.3	14	3
	Moss sp.	2.1	4	3
	Hydrophyllum capitatum	2.0	17	3
	Thlaspi montanum	1.4	10	2
	Galium trifidum	1.0	7	1
	Taraxacum officinale	.6	7	T
	Viola praemorsa	.6	7	T
	Epilobium alpinum	.2	7	T
	Pyrola secunda	.2	7	T
	Claytonia lanceolata	.2	7	T
	Arenaria sp.	.1	4	T
	Chenopodium fremontii	.1	4	T
	Thalictrum fendleri	.1	4	T
	Silene menziesii	.1	4	T
	Total Forbs	58.3		80
Browse	Abies lasiocarpa	2.5	10	4
	Sambucus racemosa	.1	4	T
	Ribes viscosissimum	1.5	10	2
	Total Browse	4.1		6
	Totals	71.80		100%

Table XXVIII. Tree Productivity

SITE

Reference Site 2

VEGETATION

Spruce/Fir

LOCATION

NW1/4 Sec 23 T13 R6E
Elevation 9300 ft.
No. facing slope

Taxa	Mean Distance	Relative Frequency	Density per Acre
Abies lasiocarpa	12.94	82	260.14
Picea engelmannii		18	

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	> 15"d.
Abies lasiocarpa	19	4		2	1	9	
Picea engelmannii				1		3	

Table XXIX. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 2	NW1/4 Sec 23 T13S R6E Elevation 9300 ft. So. facing slope	Aspen

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Poa pratensis	29.8	84	12
	Bromus carinatus	15.8	64	7
	Carex hoodii	9.6	20	4
	Agropyron caninum	5.8	24	2
	Melica bulbosa	1.7	7	1
	Stipa lettermannii	.5	4	T
	Total Grasses	63.2		26
Forbs	Collomia linearis	37.2	94	15
	Nemophila breviflora	31.3	64	13
	Galium trifidum	27.2	84	10
	Lathyrus lanzwertii	18.3	64	8
	Stellaria jamesii	18.1	90	8
	Achillea millefolium	10.3	47	4
	Collinisa parviflora	8.3	74	3
	Hackelia floribunda	8.3	27	3
	Viola adunca	4.7	27	2
	Agastache urticifolia	2.1	4	1
	Descurainia pinnata	1.8	10	1
	Thalictrum fendleri	1.2	4	T
	Vicia americana	1.2	4	T
	Delphinium occidentalis	.6	7	T
	Hydrophylum capitatum	.6	7	T
	Draba sp.	.5	4	T
	Polygonum sawatchense	.5	4	T
	Phacelia hastata	.5	4	T
	Total Forbs	172.7		68
Browse	Sambucus coerulea	10.6	14	4
	Abies lasiocarpa	2.1	4	1
	Populus tremuloides	1.8	10	1
	Symphoricarpos oreophilus	.5	4	T
	Total Browse	15.0		6
	Totals	250.9		100%

Table XXX. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 2	NW1/4 Sec 23 T13S R6E Elevation 9300 ft. So. facing slope	Aspen

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Bromus carinatus	45.90	11
	Agropyron caninum	35.70	8
	Poa pratensis	28.75	6
	Carex hoodii	8.75	2
	Melica bulbosa	5.20	1
	Stipa columbiana	4.80	1
	Stipa lettermannii	3.50	T
	Total Grasses	132.60	29
Forbs	Helenium hoopesii	120.30	27
	Lathyrus lanzwertii	88.00	20
	Hackelia floribunda	48.25	11
	Rudbeckia occidentalis	27.50	6
	Stellaria jamesiana	11.04	3
	Nemophila breviflora	7.50	2
	Galium trifidum	5.10	1
	Hydrophylum capitatum	4.20	1
	Ranunculus inamoenus	2.50	T
	Descurainia pinnata	1.00	T
	Thalictrum fendleri	.90	T
	Viola adunca	.90	T
	Fragaria virginiana	.30	T
	Delphinium occidentale	.28	T
	Lithophragma bulbifera	.25	T
	Collinisa parviflora	T	T
	Taraxacum officinale	T	T
	Total Forbs	318.02	71
Browse	Populus tremuloides	1.00	T
	Sambucus racemosa	.20	T
	Total Browse	1.20	T
	Totals	451.8	100
	Est. Potential Prod. for Site	451.8 lb/acre	

Table XXXI. Tree Productivity

SITE

Reference Site 2

VEGETATION

Aspen

LOCATION

NW1/4 Sec 23 T13S R6E
Elevation 9300 ft.
So. facing slope

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	10.53	100	392.86

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Populus tremuloides	23	1	1	7	9	6	
Abies lasiocarpa	1		1	1			
Picea engelmannii		1					

Table XXXII. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8700 ft. So. facing slope	Aspen

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Bromus carinatus	51.8	94	41
	Poa reflexa	14.5	50	12
	Carex hoodii	7.5	17	6
	Agropyron caninum	7.2	20	6
	Melica bulbosa	7.1	30	6
	Poa pratensis	3.8	10	3
	Poa fendleriana	.5	4	T
	Stipa columbiana	.2	7	T
	Stipe lettermannii	.1	4	T
	Total Grasses	92.7		74
Forbs	Lathyrus lanzwertii	15.8	77	13
	Helenium hoopesii	5.8	27	4
	Nemophila breviflora	2.9	34	2
	Mertensia ciliata	2.7	10	3
	Smilacina stellata	1.8	10	1
	Chenopodium fremontii	1.2	34	1
	Descurainia californica	.9	24	T
	Ranunculus inamoenus	.5	4	T
	Rudbeckia occidentalis	.5	4	T
	Galium trifidum	.3	14	T
	Viola canadensis	.3	14	T
	Collinsia parviflora	.2	10	T
	Hackelia floribunda	.1	4	T
	Hydrophyllum capitatum	.1	4	T
	Lappula occidentalis	.1	4	T
	Penstemon watsonii	.1	4	T
	Polygonum sawatchense	.1	4	T
	Total Forbs	33.4		24
Browse	Populus tremuloides	2.0		2
	Total Browse	2.0		2
	Totals	128.1		100%

Table XXXIII. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8700 ft. So. facing slope	Aspen

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Bromus carinatus	207.3	43
	Agropyron caninum	40.6	9
	Carex hoodii	8.8	2
	Stipa columbiana	5.2	T
	Stipa lettermannii	2.1	T
	Melica bulbosa	2.0	T
	Total Grasses	266.0	54
Forbs	Mertensia ciliata	51.6	11
	Hackelia floribunda	37.5	8
	Lathyrus lanzwertii	32.0	7
	Urtica dioica	21.9	4
	Penstemon watsonii	18.8	4
	Chenopodium fremontii	10.5	2
	Helenium hoopesii	1.5	T
	Nemophila breviflora	1.2	T
	Thalictrum fendleri	.6	T
	Achillea millefolium	.5	T
	Ranunculus inamoenus	.2	T
	Rudbeckia occidentalis	.2	T
	Collinsia parviflora	T	T
	Descurainia californica	T	T
	Total Forbs	176.5	36
Browse	Populus tremuloides	38.5	8
	Artemisia tridentata	7.0	2
	Total Browse	45.5	10
	Totals	488.0	100
	Est. Potential Prod. for Site	488.0 lb/acre	

Table XXXIV. Tree Productivity

SITE

Reference Site 3

VEGETATION

Aspen

LOCATION

NE1/4 Sec 34 T13S R6E
Elevation 8700 ft.
So. facing slope

Taxa	Mean Distance	Relative Frequency	Density per Acre
Populus tremuloides	23.84	85	76.65
Abies lasiocarpa		15	

Taxa	< 1" Diameter		> 1" Diameter				
	< 3'tall	> 3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	> 15"d.
Populus tremuloides	59			4	8		4

Table XXXV. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8660 ft. No. facing slope	Spruce/Fir

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Carex hoodii	1.2	14	4
	Poa fendleriana	.2	7	T
	Total Grasses	1.4		4
Forbs	Penstemon whippleanus	4.0	17	11
	Lathyrus lanzwertii	3.6	14	10
	Vaccinium scoparium	2.7	24	8
	Lupinus sericeus	1.2	4	4
	Potentilla fruticosa	1.2	14	4
	Fragaria virginiana	.6	7	2
	Viola canadensis	.5	4	2
	Antennaria microphylla	.2	4	T
	Collinsia parviflora	.1	4	T
	Galium trifidum	.1	4	T
	Lepidium densiflorum	.1	4	T
	Pyrola secunda	.1	4	T
	Total Forbs	14.4		41
Browse	Abies lasiocarpa	18.4	54	51
	Ribes montigenum	1.2	4	4
	Artemisia tridentata	.1	4	T
	Total Browse	19.7		55
	Totals	35.5		100%

Table XXXVI. Tree Productivity

SITE

Reference Site 3

LOCATION

NE1/4 Sec 34 T13S R6E
Elevation 8660 ft.
No. facing slope

VEGETATION

Spruce/Fir

Taxa	Mean Distance	Relative Frequency	Density per Acre
Abies lasiocarpa	9.64	35	468.74
Picea engelmannii		65	

Taxa	<1" Diameter		>1" Diameter				
	<3'tall	>3'tall	1"-3"d.	3"-6"d.	6"-12"d.	12"-15"d.	>15"d.
Abies lasiocarpa	127	2	11	2	1		3
Picea engelmannii	7		5	2	6	1	3

Table XXXVIII. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8640 ft. So. facing slope	Artemisia

PLOT SIZE: 9.6 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Bromus carinatus	47.4	5
	Stipa lettermannii	27.3	3
	Agropyron caninum	17.5	2
	Stipa collumbiana	2.0	T
	Carex hoodii	.4	T
	Total Grasses	94.6	10
Forbs	Penstemon watsonii	62.5	7
	Lathyrus lanzwertii	44.2	5
	Helenium hoopesii	21.0	2
	Cirsium sp.	.6	T
	Total Forbs	128.3	14
Browse	Artemisia cana	694.2	76
	Total Browse	694.2	76
	Totals	917.1	100
	Est. Potential Prod. for Site	917.1 lb/acre	

Table XXXIX. Plant Community Characteristics

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8620 ft. Canyon floor	Riparian

	Taxa	% Cover	% Freq.	% Comp.
Grasses	Deschampsia caespitosa	15.8	30	26
	Carex aquatilis	12.1	24	20
	Carex microptera	8.8	17	15
	Carex rostrata	6.2	10	10
	Poa pratensis	4.3	14	7
	Juncus ensifolius	5.3	10	9
	Total Grasses	52.5		87
Forbs	Epilobium sp.	2.2	24	4
	Trifolium repens	1.2	14	2
	Potentilla fruticosa	1.2	4	2
	Equisetum arvense	.7	10	1
	Galium trifidum	.7	10	1
	Achillea millefolium	.6	7	1
	Fragaria virginiana	.5	4	1
	Rorippa curvipes	.5	10	1
	Circium scariosum	.1	4	T
	Collinsia parviflora	.1	4	T
	Total Forbs	7.8		13
Browse	Artemisia cana	.1	4	T
	Total Browse	.1	4	T
	Totals	60.4		100%

Table XL. Grazing Productivity

SITE	LOCATION	VEGETATION
Reference Site 3	NE1/4 Sec 34 T13S R6E Elevation 8620 ft.	Riparian

PLOT SIZE: .96 sq. ft.

	Taxa	Dry Wt. Prod.	% Comp.
Grasses	Carex aquatilis	63.0	35
	Carex rostrata	30.8	17
	Carex microptera	26.2	15
	Deschampsia caespitosa	22.5	13
	Juncus ensifolius	16.5	9
	Poa pratensis	7.8	4
	Bromus carinatus	4.2	7
	Total Grasses	171.0	95
Forbs	Circium scariosum	9.0	5
	Epilobium alpinum	.4	T
	Achillea millefolium	T	T
	Aster sp.	T	T
	Trifolium repens	T	T
	Galium trifidum	T	T
	Potentilla fruticosa	T	T
	Total Forbs	9.4	5
Browse	Artemisia cana	T	T
	Total Browse	T	T
	Totals	180.4	100
	Est. Potential Prod. for Site	180.4 lb/acre	

Table XL-A. Validation Site Tree Maturity and Productivity

Site		Range of Tree Ages yrs.	Range of Tree Diam. cm.	Estimate of Successional Status
Portal Yard Area Site 1	Aspen	13-87	4.2-28.2	Apparently stable climax
8	Spruce	54-210	21-72	Mature spruce
	Fir	35-76	1.2-34	Seral Fir secondary succession - logging
Rock Waste Disposal	Spruce	45-77	7.8-43.1	Apparently stable climax for both species
	Fir	52-80	7.9-42.9	
	Aspen	33-108	8.5-39.1	Mature and subclimax
Bypass Access Road	Aspen	23-76	6.0-34.1	Apparently seral to spruce fir climax