THIRD COMPLETENESS REVIEW
BLUE BLAZE COAL COMPANY
Carbon County, Utah
PRO/007/020
January 1991

R614-301-100 General Contents (SMW)

114.100 The application will contain a description of the documents upon which the permittee bases their legal right to enter. The description will identify the documents by type, date of execution, lands to which pertain, and the legal rights claimed by the applicant. (See Page 4-2)

114.200 Pages 4-6, 4-8 and 4-13 identify where the private mineral estate has been severed from the private surface estate. For these areas, please submit a copy of the written consent of the surface owner, a copy of the conveyance that grants the right to extract coal by certain methods or demonstrate by applicable Utah law, the permittee has the legal authority to extract coal by those operations. (See Page 4-2 & Table 4-1)

142. Please label all maps so as to distinguish those operations which occurred prior to August 3, 1977. (See Plates 3-1 & 8-1)
(See Plates 3-3 & 3-4)

R614-301-231 General Requirements (HS)

The permittee has failed to consistently represent the proposed disturbed area. As depicted on plate 3-1, the proposed location of the topsoil stockpiles have been omitted from the disturbance. Additionally, the unhatched area northeast of the old concrete garage has also been omitted from the proposed disturbance. (See Plate 3-1)

As depicted on various maps (i.e., Plates 3-1, 8-1, 8-2, etc.), minor areas around the perimeter of the proposed disturbance are included or excluded from the disturbance depending upon the plate reviewed. The permittee must make necessary changes so that all maps or plates are accurate and consistent. (See Revised Plates)

R614-301-300 Biology (SMW)

322.220 Only one copy of Plate 10-1D identifies the golden eagle nest 189.01. All copies of Plate 10-1D available to all agencies must have this nest identified. Additionally, the Division of Wildlife Resources (DWR) has requested that all raptor nest locations be identified on a map which is suitable for overlay on the mining sequence map.
(See Plate 10-d, 3-3 & 3-4)

R614-301-400 Land Use and Air Quality (SMW)

412.200 The permit must contain a copy of a letter with comments from the land owner concerning the proposed postmining land use. (See page 3-57 & 3-59a)

R614-301-500 Engineering (JK & DD)

511. All references to the previous UMC regulations must be eliminated from the PAP. Such references are found on pages 2-3, 2-4, and 3-42. (Removed UMC references)

521. The applicant needs to make sure that the text and the maps correspond with each other and that they are internally consistent. This cannot be emphasized too strongly. A couple of specific problems found in the PAP should illustrate the need for the applicant to devote some attention to this.

First, the supply trailers, substation, bath houses, and the 5000-gallon fuel tank are all mentioned in section 3.2.3 of the text but are not shown on the Surface Facilities Map, Plate 3-1. All Surface facilities must be shown on the Surface Facilities Map. (See Plate 3-1)

Second, the shop is not even mentioned in the text but is shown on Plate 3-1 and Plate 3-2A (Cross Section C-C'). And then, Plate 3-1 locates the shop near the mine office on the west side of the canyon while Plate 3-2A has it near the Castlegate 'A' portals on the east side of the canyon (!). Again, consistency between the maps and the text is very important. (See page 3-4 & Plates 3-1, 3-2A)

521.131 A map must be included in the PAP which shows all boundaries of lands and names of present owners of those lands, both surface and subsurface, included in or contiguous to the permit area. (See Plate 4-1)

525.140 The subsidence monitoring monument layout described on Page 3-41 is not shown on Plate 3-5 (Subsidence Monitoring Plan). Also, the proposed underground workings in the Hiawatha seam must be shown on Plate 3-5. (Overlay Plate 3-5 on Plates 3-3 & 3-4)

The applicant will be required to establish subsidence monitoring stations adjacent to Beaver Creek and in the vicinity of NW1/4 of SE1/4 of SW1/4 of Section 8, T13S, R8E. (See Plate 3-5)

525.210 The applicant will be required to submit isopach maps depicting the overburden above each coal seam on and adjacent to the mine plan area. Isopleths should be established on 100 ft. intervals. (See Plates 6-6 & 6-7)

R614-301-728 Probable Hydrologic Consequences (PHC) Determination (TM)

Undermining of Beaver Creek has been addressed from the standpoint of monitoring upstream of the permit area using Beaver Creek Coal monitoring stations. To provide an adequate assessment for the PHC statement, the operator is required to address all the requirements of R614-301-728. The operator has not provided appropriate baseline data for Beaver Creek, upstream and downstream of the property, to adequately define the hydrologic resources affected by mining. (See page 7-58)

R614-301-731.800 Water Rights and Replacement (TM)

The operator has not provided the necessary documentation to the Division of Water Rights as referenced in the Division of Water Right's letter to Pamela Grubaugh-Littig on January 25, 1991. (See pages 3-24, 3-25, 3-26 & 3-26a

R614-301-731.300 Acid- and Toxic-Forming Materials (HS)

The permittee has not provided adequate physicochemical analyses (as specified in the Division's Second Completeness Review R614-301-521.140 & R614-301-731.300) of coal waste or excess spoil. The acid based potential (Diversion Guidelines for Management of Topsoil and Overburden, Table 6) of the coal waste (i.e., located in the vicinity of test pit #8) and the roof and floor material must be determined immediately. (See page 8-20a & Appendix 5)

Additionally, the permittee refers to the material located around test pit #8 as noncoal waste. The material in this area is excess spoil and/or coal mine waste. Please make necessary revisions. (See page 3-12)

On page 3-12, the permittee describes the disposal of the material in the vicinity of test pit #8. The permittee describes blending this material with run-of-mine coal. As inferred on Plate 3-1 "Note:" the permittee indicates the use of subsoil to dispose of "coal waste from old operations." The permittee must be consistent as to the disposal procedures for coal mine waste, underground development waste, etc. If the material in question is disposed of on site, then specific plans which fulfill the requirements of R614-301-553.200 Spoil and Waste & R614-301-233 Topsoil Substitutes and Supplements, must be submitted and approved. (Removed Statement Plate 3-1)

jbe
A:\007020.1

STATE OF UTAH
NATURAL RESOURCES
Water Rights

File PRO/007/030
Copy PAM, TOM

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Robert L. Morgan, State Engineer

Southeastern Area • 453 S. Carbon Avenue • P.O. Box 718 • Price, UT 84501-0718 • 801-637-1303

January 25, 1991

Division of Oil, Gas & Mining
Attn: Pam Grubaugh-Littig
355 West North Temple
3 Triad Center, Suite 320
Salt Lake City, Utah 84180

Re: Blue Blaze Mine Permit Review

Dear Pam:

On June 8, 1991, I corresponded with you concerning the above referenced mine permit. At that time, I indicated that several matters needed to be taken care of through this Division. Since that time, I have in my office a permit request for the sedimentation pond, and also an application for the stream channel alteration permit, which has been numbered 91-91-02SA. These matters are presently being reviewed for approval. As I previously mentioned, the water rights will still need to be addressed and approved through this Division. (See pages 3-24, 3-25, 3-26 & 3-26a)

If you have any questions about the sedimentation pond or stream alteration permit that are presently being reviewed, please feel free to contact me.

Sincerely,

Mark P. Page
Area Engineer

cc: Roger Skaggs
P.O. Box 784
Price, Utah 84501

MPP/mjk

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE RESOURCES

Norman H. Bangerter
Governor
Dee C. Hansen
Executive Director
Timothy H. Provan
Division Director

1596 West North Temple
Salt Lake City, Utah 84116-3195
801-533-9333

1-28-91 cc/P. Grubaugh-Littig

January 10, 1990

Dr. Dianne R. Nielson, Director
Utah Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, UT 84180-1203

Attn: Pamela Grubaugh-Littig

Dear Dianne:

I am responding to the second completeness review for the Blue Blaze Mine. After reviewing the updated materials we determined not all of our concerns (August 16, 1990) were addressed. Specifically, we requested the company to adjust plate 10-6, which was included in the new materials as 10-b, by showing the high-priority elk summer range as critical elk summer range. This was not accomplished. The map designations should be C-E-SU instead of H-E-SU. The text (10-20) should also be changed to reflect this adjustment in classification. (See Plate 10-b & page 10-20)

Thank you for the opportunity to review and provide comment. If we can be of any further assistance in this matter, please contact Ken Phippen of our Southeastern office (637-3310).

Sincerely,

Timothy H. Provan
Director

Copy PAM, TOM, Susan

State of Utah
DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

Norman H. Bangerter
Governor
Suzanne Dandoy, M.D., M.P.H.
Executive Director
Kenneth L. Alkema
Director

6 East Main
P.O. Box 800
Price, Utah 84501

RECEIVED
JAN 16 1991
DIVISION OF
OIL, GAS & MINING

January 14, 1991

Ms. Pamela Grubaugh-Littig
Division of Oil, Gas & Mining
365 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Dear Ms. Grubaugh-Littig:

Re: Permit Application Package, Blue Blaze Co
Blaze Mine, PRO/007/020, Folder #2, Carbon C

I have reviewed responses to the completeness revie Blue Blaze Mine which were received on December 17, 1990. January 2, 1991 I met with Mr. and Mrs. Skaggs to discuss ap rovals and permits required by the Division of Environmental Health. The applicant has requested to work directly with the local health department and myself in approval of drinking water and sewerage facilities. Failure to obtain necessary approvals will be considered a violation of the PAP and reported to DOGM. Based upon my review and discussion of the project, I offer the following comments:

1. Reference to the drinking water system for the mine should clearly indicate all water will be hauled. Review and approval of facilities for storage and distribution of drinking water is required prior to placing the facilities in service. (See page 3-3j & 3-4)

2. Reference to the sewage disposal system should indicate that it is a holding tank system. Review and approval of the sewerage system is required prior to placing the facilities in service. (See page 3-3m & 3-4)

3. The plans for the sediment pond include sufficient information to complete my review. I will proceed when DOGM has determined the hydrology for design of the sediment pond is acceptable.

If you have any questions, or I can be of further assistance, you may reach me at 637-3671.

Sincerely,

David R. Ariotti, P.E.
Southeast District Engineer
Division of Environmental Health

cc: Claron Bjork, Southeastern Utah District Health Dept.
Kiran Bhayani, Bureau of Water Pollution Control
Mike Georgeson, Bureau of Drinking Water/Sanitation

Blue PRO/007/020
Copy to PAM #2

STATE OF UTAH
DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

BAQE-690-90

Norman H. Bangerter
Governor
Suzanne Dandoy, M.D., M.P.H.
Executive Director
Kenneth L. Alkema
Director

Bureau of Air Quality
288 North 1460 West
P.O. Box 16690
Salt Lake City, Utah 84116-0690
(801) 538-6108

RECEIVED
NOV 05 1990
DIVISION OF
OIL, GAS & MINING

October 31, 1990

CERTIFIED MAIL

William R. Skaggs
Blue Blaze Coal Company
P. O. Box 784
Price, Utah 84501

Dear Mr. Skaggs:

(See Attached letter dated 2/8/91 from Bureau of Air Quality)

Re: Permit Application Package, Blue Blaze Coal Company, Blue Blaze Mine, PRO/007/020

We recently received a copy of a letter addressed to Ms. Pamela Grubaugh-Littig, Division of Oil, Gas, and Mining, from our Southeast District Engineer, Mr. David R. Ariotti. In this letter he states that the applicant should contact the Bureau of Air Quality (BAQ) concerning the approval order dated March 3, 1981, which was included in the permit application package. To date, we have not heard from you. However, we offer the following comments:

1. Through our initial investigation, we have determined you are the owner/operator of the Blue Blaze Mine and wish to commence operation.

2. The approval order dated March 3, 1981, was issued by the BAQ to a previous owner/operator. As far as we know, the mine was never operated and there has not been a program of continuous construction since that time. Section 3.1.5, Utah Air Conservation Regulations (UACR), states that if a continuous program of construction, installation, modification, relocation or establishment is not proceeding, (18 months after issuance of an approval order), the Executive Secretary may revoke the approval order. Blue Blaze Coal Company needs to furnish the BAQ the details on this situation so an approval order decision can be made.

3. If a new approval order needs to be issued, it must be done in accordance with Section 3.1, UACR. A new notice of intent (NOI) would need to be submitted to the BAQ and an approval order be issued prior to initiation of construction or modification. A source is required to apply Best Available Control Technology (BACT) to all emission points (BACT would be determined on 1990, not 1981, technology).

After we review your details and/or a new NOI, we will decide whether we can amend the 1981 approval order or need to issue a new order. In any event, current BACT will be required. Please be advised that it may take as long as six months for the BAQ to issue an approval order after the notice of intent has been received. A complete and accurate notice of intent will save you considerable time. If you have any questions, please contact Donald Robinson, Engineering Manager, at (801) 538-6108.

Sincerely,

Montis R. Keller

for F. Burnell Cordner, Executive Secretary
Utah Air Conservation Committee

FBC:DER,HGN:jiw

cc: Southeast Utah District Health Department
David R. Ariotti, Regional Engineer
DOGM, Pamela Grubaugh-Littig

DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

Norman H. Bangerter
Governor
Suzanne Dandoy, M.D., M.P.H.
Executive Director
Kenneth L. Alkema
Director

Bureau of Air Quality
1950 West North Temple
P.O. Box 16690
Salt Lake City, Utah 84116-0690
(801) 536-4000
(801) 536-4099 FAX

BAQE-074-91

February 8, 1991

William R. Skaggs
Blue Blaze Coal Company
P.O. Box 784
Price, Utah 84501

Re: Payment of Fee - Modified Approval Order - Underground Coal Mine, Gordon Creek Canyon
Carbon County CDS B

Dear Mr. Skaggs:

This letter is to inform you that the above referenced project has been reviewed. Your approval order can be issued. However, we must first receive the approval order fee of $700.00.

I have enclosed a copy of the invoice. Please return it with your payment. Please note that Section 3.1.1, Utah Air Conservation Regulations, requires an approval order be issued by the Executive Secretary, Utah Air Conservation Committee, prior to initiation of construction or modification.

Thank you for your cooperation in this matter.

Sincerely,

Joyce I. Wiswell
Office Technician
Technical Evaluation Section

Enclosure

SECTION 7
HYDROLOGY

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Plate 7-9 Reclamation Drainage

(Note: Plates 7-3, 7-7, and 7-8 eliminated)

Section 7

HYDROLOGY

7.1 Ground Water Hydrology

Scope

The purpose of this section is to present a review of hydrogeologic information relevant to the Blue Blaze No. 1 and No. 2 Mines. A plan of action is presented to ensure that underground coal mining operations are in compliance with Office of Surface Mining (OSM) and Utah Division of Oil, Gas and Mining (DOGM) hydrology regulations.

This section includes a description of hydrologic conditions of the region, the Blue Blaze No. 1 and No. 2 mine areas, use and monitoring of hydrologic resources, and a determination of the possible hydrologic consequences of mining activity.

7.1.1 Method of Study

This study was largely based on review and analysis of available data. A field reconnaissance of the area was made with the aid of the Division of Oil, Gas and Mining (Darin Worden 1988-1990). Hydrologic data collected from wells and springs in the area were evaluated. Data evaluated also include drill hole logs, mine maps of the permit area, published and open file reports from the U.S. Geological Survey, Utah Geological Survey, Bureau of Land Management, and the U.S. Forest Service. Beaver Creek Coal Company records were also used to study the hydrology of the area.

Field reconnaissance of the mine area permitted observation of the geologic setting of springs and seeps, and confirmation of the geologic observations made from in-house aerial photo reconnaissance. In addition, information on hydrologic conditions encountered, in the adjacent Beaver Creek Mines, were reviewed.

7.1.2 Existing Ground Water Resources

7.1.2.1 Regional Ground Water Hydrology

The region has been characterized generally as one of regional ground water recharge (Price and Arnow, 1974). The lithologic nature of the Upper Cretaceous strata generally render these units unsuitable as significant aquifers. Price and Arnow (1979) do not identify Gordon Creek area as a region for potential large scale ground water development. In general, all the upper Cretaceous sediments of the area have low hydraulic conductivities and low specific yields (0.2 to 0.7 percent) (Price and Arnow, 1974). Much of the precipitation that falls in the Wasatch Plateau exits the area by overland flow and evaporation. Much of the water that does

enter the ground moves only short distances before discharging as springs and seeps (field observations made by Darin Worden - DOGM and Roger Skaggs - Blue Blaze Coal Company). Detailed descriptions of the formations discussed below are presented in Section 6.

The principal water-bearing formations of the Wasatch Plateau are the sandstone units of the Mancos Shale Group. These include the Emery and Ferron Sandstones (Price and Arnow, 1974). These sandstone units occur in the southern portions of Emery County, and probably do not extend into the Gordon Creek area (Fisher, 1960).

The Star Point Formation overlies the Mancos Shale. It is composed of littoral sandstones interbedded with tongues of the Mancos Shale. The Star Point Formation contains the Panther, Storrs, and Spring Canyon sandstone members. Lines (1985) identified the Blackhawk-Star Point Sandstone Formation as a regional aquifer. The majority of the water contained in the Blackhawk-Star Point aquifer resides in the sandstone tongues of the Star Point Formation. It is likely that the Star Point Sandstone is the only formation within the permit and adjacent areas that contains groundwater on an aerially-extensive basis.

The Blackhawk Formation overlies the Star Point Sandstone and contains the principal coal beds mined in the area. The Blackhawk is comprised of several hundred feet of interbedded sandstone, shale, siltstone, and coal. The Aberdeen Sandstone is a marine sandstone unit of the Blackhawk Formation. Sandstone units of the Blackhawk are generally very-fine grained, and have a significant clay content. Ground water that occurs in this formation, generally occurs in laterally discontinuous perched aquifers. As a result, the Blackhawk is not a significant regional aquifer, and little work has been done to determine its hydraulic characteristics.

Two pump tests conducted in the basal part of the Blackhawk in the Eccles Canyon show that this formation is a very poor aquifer (Vaughn Hansen, 1979). Transmissivities determined were 21.0 and 16.3 gallons per day per foot (gpd/ft) from these pump tests. Recovery tests on these same two wells resulted in transmissivities of 16.6 and 17.9 gpd/ft.

Both the Blackhawk and Star Point Formations serve as sources of spring and seep water flow in the Wasatch Plateau region. The larger springs are often important sources for stock watering and domestic water supply. Perennial springs are also significant in providing basal flow to streams in the region.

Field observations indicate that spring discharge is related to spring occurrence. Small springs and seeps occur along the valley flanks where water infiltrates from the surface, moves a short distance and discharges at a point lower on the surface. Larger springs occur where the surface recharge encompasses a larger area, and water moves through the subsurface a longer distance before

discharging near the base of valleys. These two types of springs exhibit seasonal flow variations, dependant on the amount of precipitation available for recharge. A third type of spring occurs where discharge is from a sedimentary unit of wide aerial extent and contains relatively large quantities of water in storage. As a result, short term fluctuations in recharge have little effect on discharge rate.

Geologic conditions play an important role in the occurrence of springs. Water that percolates into the ground moves through the permeable sediments downgradient, until an impermeable unit is encountered at which time water flow is redirected along the impermeable interface until the surface is encountered and spring discharge occurs or the impermeable unit pinches-out and water again moves vertically.

The Castlegate Formation overlies the Blackhawk Formation. The Castlegate is principally composed of massive sandstones. Minor amounts of shale, siltstone, and conglomerate (local occurrence) are also present. Within the Wasatch Plateau the Castlegate Formation forms very steep cliffs, which are commonly deeply incised by canyon walls. Due to the vertical nature of the Castlegate Formation surface exposures it does not act as a significant recharge area; water that does enter the Castlegate has entered via the overlying Price River Formation. The fine-grained nature of the overlying Price River Formation result in only small amounts of water reaching the Castlegate Formation from the overlying Price River Formation. Due to the steep canyon wall exposures, water of the Castlegate is quickly drained, rendering this unit largely insignificant as an aquifer.

The upper Price River Formation consists of interbedded sandstone, shale, and siltstone. The upper Price River Formation, overlies the Castlegate Formation, and also is not considered to be a significant aquifer within the area. Groundwater contained within the Price River Formation occurs within perched aquifers. As a result, the Price River Formation does not have much significance as an aquifer. Laboratory tests on sandstone from the Price River show that it has generally high porosity (21%) but apparently a low permeability (Cordova, 1964).

7.1.2.2 Mine Plan Area Aquifers

This section contains groundwater information pertinent to the mine area. Included herein are the following: 1) a description of the potential aquifers in the mine area; 2) depth to water data measured in wells within the permit area; and 3) approximate rates of discharge or usage.

Formations which outcrop within the proposed Blue Blaze Coal Company permit and adjacent areas include quaternary alluvium, the Price River Formation, the Castlegate Formation, the Blackhawk Formation,

the Star Point Sandstone, and the Mancos Shale. A regionally extensive groundwater system has not been identified in the permit area (Engineering Science, 1984). Characteristics of these formations, and their potential to serve as aquifers in the permit and adjacent areas is presented below.

Price River Formation. The Price River Formation consists of interbedded sandstone, shale, and claystone. Due to its limited outcrop extent within the permit and adjacent areas, the presence of claystone and shale within the formation, and drainage of the formation by deeply incised canyons, the upper Price River Formation is not considered to be a significant aquifer within the permit and adjacent areas. According to the Cumulative Hydrologic Impact Assessment, recently completed by DOGM (1989) for the Upper Gordon Creek Area (including the Blue Blaze Mine), "groundwater associated with the Price River Formation may be characterized as occurring within a 'perched' aquifer and represents a relatively insignificant hydrologic resource."

Castlegate Sandstone. The Castlegate Sandstone member of the Price River Formation consists of 150 to 500 feet of white to gray, coarse-grained often conglomeratic sandstone with a few thin interbedded mudstones or shales near the base. Cliffs often form along outcrops of the Castlegate Sandstone. Based on the limited area of exposure for surface recharge (due to the steep slopes), the limited potential for recharge from the overlying perched aquifers of the Price River Formation (due to the fine-grained nature and resulting low permeability of the formation), and drainage of the sandstone in the deeply incised canyons of the area water contained within the Castlegate is insignificant. Consequently, this formation is not considered to be a significant aquifer.

Blackhawk Formation. The Blackhawk Formation underlies the Castlegate Sandstone and consists of several hundred feet of interbedded sandstone, siltstone, shale, and coal. The Castlegate A and Hiawatha coal seams (to be mined by BBCC) are located near the base of the Blackhawk Formation. The Blackhawk Formation has a mixed lithology of sandstones, shales, and coals which produce alternating perched aquifers and impermeable beds (Doelling, 1972). Four springs were identified in the area by the 1989 Cumulative Hydrologic Impact Assessment with "all springs discharging from the Blackhawk Formation". Figure 7-1 shows an example of perched aquifer flow in the Blackhawk Formation.

The above-mentioned springs are associated with fractures and/or channel sands that are of limited areal extent, which contain water perched over shale beds and have limited recharge areas. This type of spring commonly has considerable variation in flow because of the limited recharge area and the limited amount of storage in the aquifer (Engineering Science, 1984).

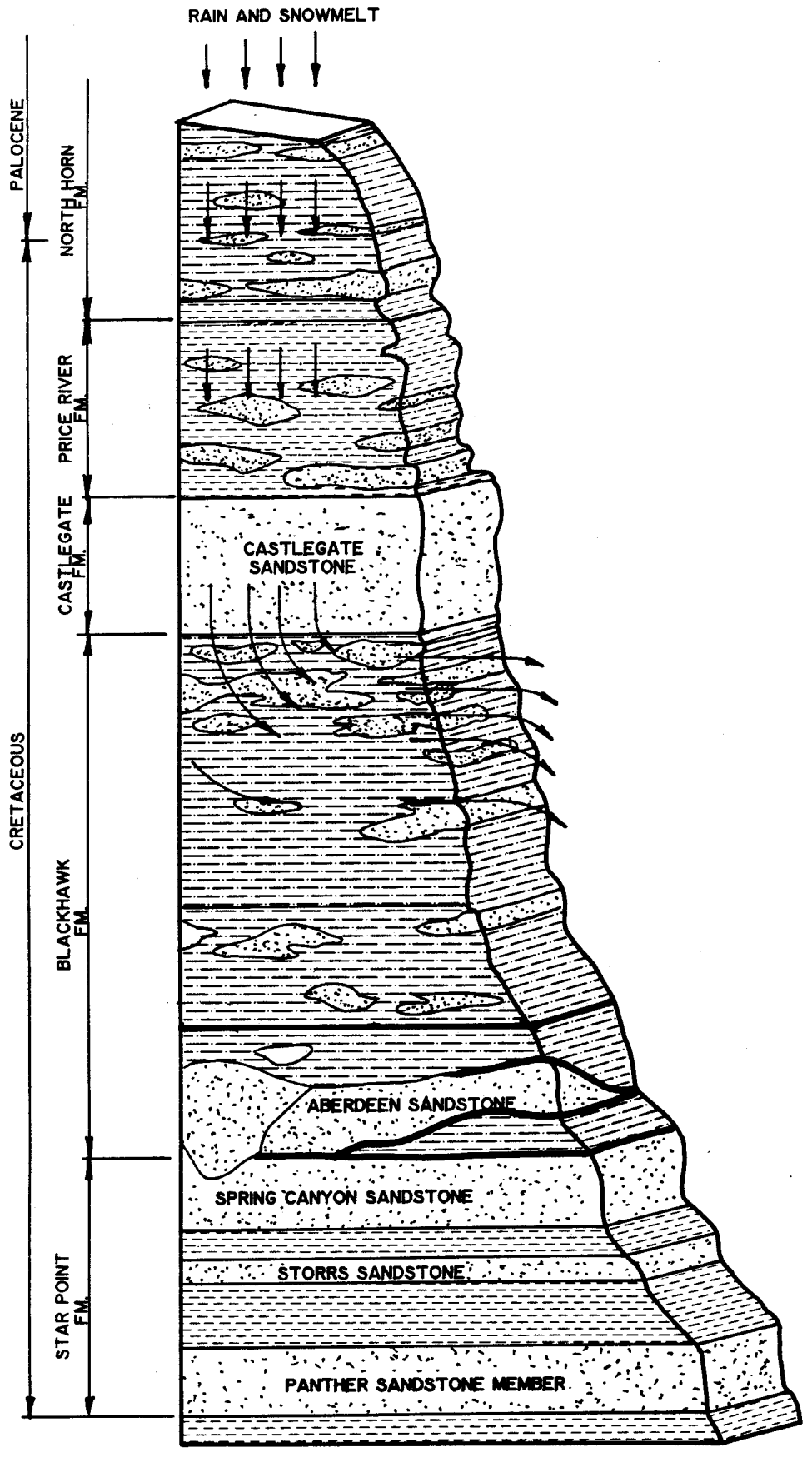


FIGURE 7-I. PERCHED AQUIFIER FLOW IN THE BLACKHAWK FORMATION

EarthFax

According to DOGM (1989), mine inflow on the proposed Blue Blaze Mine area are insignificant, with the exception of mine inflow at the Beaver Creek Mine.. All mining in the area occurs within the Blackhawk Formation, this indicates that extensive aquifers are not present within the Blackhawk Formation in the permit and adjacent areas. Thus, the Blackhawk Formation is not considered to be a significant aquifer in the proposed Blue Blaze Mine area.

The Aberdeen Sandstone has been mapped in drill holes and in surface exposures. It has been found to be thin (only several feet in thickness) and it undergoes a facies change, where sandstone beds grade into finer-grained deposits, within the mine area (Hansen, 1988). As a result, the Aberdeen is present as a very thin fine-grained sandstone, interbedded with siltstones and shales in the Blue Blaze mine area. Due to this lithologic condition the Aberdeen Sandstone is not a significant aquifer in the permit area.

Star Point Sandstone. The Star Point Sandstone consists of fine to medium grained sandstone that decreases in grain size with depth. This unit consists of several littoral sandstone tongues separated by Mancos shales (Doelling 1972). Regionally, recharge to the Star Point occurs primarily from vertical movement of water through the overlying Blackhawk Formation. Due to the low vertical permeability of the Blackhawk Formation, the magnitude of this recharge is limited.

Mancos Shale. Underlying the Star Point Sandstone is the Masuk member of the Mancos Shale. The Masuk Shale consists of blue-gray fissile claystone or silty claystone which weathers light blue-gray to light tan. Although the Masuk Member of the Mancos Shale may be locally saturated beneath the Star Point Sandstone, it is not considered to be an aquifer. Except where extensively fractured, the low-permeability shales in the Masuk will transmit only relatively small quantities of water (Lines, 1985).

Quaternary Alluvium. Unconsolidated Quaternary deposits are present along streams and generally consist of silts, sands, and occasional gravels. The alluvium deposits receive water from the adjacent bedrock in some of the deeply incised canyons. Water is probably supplied to the alluvium by seepage from the Blackhawk-Star Point aquifer. Discharge from the Quaternary alluvium is to the surface water system. Due to the limited areal extent of alluvium in the area, this unit is not considered to be a significant aquifer.

Depth to Water

Four exploratory holes were drilled (LMC-1 through LMC-4) within the permit boundary in the late 1970's and early 1980's. Drill hole locations are shown on Plates 7-1 and 7-2. Three wells (LMC-1, LMC-3, and LMC-4) were retained as open holes. Water-level data are collected from these holes. Table 6-3 contains drill hole data

pertinent to the hydrologic resources of the area. Drill hole logs are found in Appendix 3A.

On February 27, 1992, measurements were collected by EarthFax Engineering from the three wells (LMC-1, LMC-3 and LMC-4) to determine total depth and static water level. Water level and depth measurements were collected by means of a 1500-foot electric water-level indicator manufactured by Solinst. All three wells were found to be dry.

Hole LMC-1 was drilled to a depth of 900 feet in September 1976. A log of this hole is provided in Appendix 3A. LMC-1 was drilled into the Blackhawk Formation through the Castlegate A coal seam with the bottom subsequently being sealed to a depth of approximately 600 feet and remaining open above that depth. The hole depth was determined to be 599 feet below ground surface without detecting water. Personal communication with Mr. Joseph A. Harvey indicates that LMC-1 was dry to 900 feet during drilling.

Hole LMC-2 was drilled to a depth of 568 feet, through the Castlegate A in October 1976. A log of this hole is provided in Appendix 3A. The hole was subsequently sealed to a depth of 50 feet below ground surface. Due to its shallow remaining depth, no groundwater measurements have been collected from this hole. Mr. Harvey indicates that the hole was dry to a depth of 568 feet during drilling.

Hole LMC-3 was drilled to a depth of 836 feet in November 1976. This hole was subsequently sealed to a depth of about 665 feet, remaining open above that depth. A log of this hole is provided in Appendix 3A. Well LMC-3 was probed and found to be dry to a total hole depth of 664 feet below ground surface. Mr. Harvey indicates that the hole was dry to a depth of 836 feet during drilling.

Hole LMC-4 was drilled through the Blackhawk Formation to a depth of 430 feet, below both the Castlegate A and into the Hiawatha coal seam, in January 1980. This hole was subsequently sealed to a depth of approximately 220 feet, remaining open above that depth. A log of this hole is provided in Appendix 3A. Well LMC-4 was measured to a depth of 217 feet below ground surface without detecting water. Mr. Harvey indicates that this hole was also dry to total depth during drilling.

Each of the drill holes is open (i.e., uncased) from its bottom to the surface. Thus, the measured dry conditions are indicative of not only the bottoms of the holes but also each overlying layer penetrated by the holes. Thus, neither the coal nor the overlying or underlying strata were found to contain groundwater at the hole locations.

In addition to the above measurements, data were collected from wells LMC-1 and LMC-3 by Mr. Roger Skaggs of BBCC in December, 1991.

These measurements were collected by attaching two test tubes to the end of a steel cable, lowering the cable into the drill hole until the bottom of the hole was reached, and allowing the test tubes to rest on the bottom for several minutes before retrieving the cable. The length of the cable was measured at the surface while the cable was extracted. Using this method, drill hole LMC-1 was found to be dry at a depth of 600 feet. Well LMC-3 was found to be dry at a depth of 650 feet. Thus, although non-standard methods were used, the December 1991 data corroborate the February 1992 data by indicating that holes LMC-1 and LMC-3 are dry.

Discussions with Mr. Joseph A. Harvey, who was present at the time the holes were drilled, further corroborate the absence of groundwater within the coal seams as well as strata which lie both above and below the coal seams. According to Mr. Harvey, who was under contract with C & W Coal Producers Corp. at the time the holes were drilled, each hole was dry during drilling and upon completion. Completion dates were September 1976 for LMC-1, November 1976 for LMC-3, and January 1980 for LMC-4. Hole LMC-2 (completed in October 1976) was also reported to be dry during drilling. Appendix 6A contains a notarized letter from Mr. Joseph A. Harvey, outlining his responsibilities and observations regarding ground water at these drill holes.

A review of records on file with DOGM, as well as discussions with former mining personnel, indicate that the Gordon Creek #2 Mine (operated by Beaver Creek Coal Company in the Castlegate A seam) immediately southwest of the proposed permit area, was a dry mine with only sporadic occurrences of groundwater inflow that dried up within a short time. The Gordon Creek #3 Mine (operated by Beaver Creek Coal Company in the Hiawatha seam immediately east of the proposed permit area) was dry until a 12-foot graben was encountered in the northeast portion of the mine. Groundwater from the graben was produced from the floor of the mine at a peak rate of approximately 400 gallons per minute. During retreat mining, the same faulted zone was dry, either as a result of previous dewatering, or as a result of elevation differences. It is possible that groundwater was stored in the fault zone and when dewatered, there was insufficient recharge from overlying strata to maintain the groundwater discharge.

The three exploration drill holes (LMC-1, LMC-3 and LMC-4) are open from the surface to total depth. Thus, the measured dry conditions are indicative not only of the bottoms of the holes but also each overlying layer penetrated by the holes. Hence, the measurement collected in hole LMC-1 indicates that the Blackhawk Formation at that location is dry above the Castlegate A seam (the uppermost of the two seams proposed to be mined.

LMC-3 and LMC-4 each penetrated the Star Point Sandstone during drilling (extending 33 feet into the Star Point at LMC-3, and 203 feet at LMC-4). LMC-4 penetrated the entire thickness of the Spring

Canyon Member of the Star Point, and reached a total depth in a shale tongue of the Mancos Shale Formation (Appendix 3A). Drilling measurements in hole LMC-3 indicate the entire Blackhawk Formation and the upper portions of the Star Point Formation are dry. Thus the stratigraphic intervals above the Castlegate A, the Castlegate A seam itself, below the Castlegate A to the Hiawatha, the Hiawatha coal seam itself, and the upper portions of the Star Point Formation are dry at the location of LMC-3. The measurement collected in hole LMC-4 indicates that the entire Blackhawk Formation and the upper member (Spring Canyon) of the Star Point Formation at the location of LMC-4 are dry.

Based on the LMC drill-hole water level measurements and information concerning the adjacent mines, it is concluded that both the Castlegate A and Hiawatha coal seams, as well as, the immediately underlying and overlying strata are dry. The long history of mining in the area and the periodic measurements from the drill holes suggest that these seams and strata are not seasonally saturated. The occurrence of groundwater while mining in the Castlegate A and Hiawatha coal seams will depend primarily on whether a faulted zone is encountered that contains groundwater in storage or that is hydraulically connected with an overlying perched zone. Based on the dry nature of previous mine workings in the area, as well as observations and measurements obtained from the LMC drill holes, the probability of significant sustained inflows to the Blue Blaze mines is considered minimal. This conclusion is in agreement with Cumulative Hydrologic Impact Assessments prepared for the area by Engineering Science (1984) and DOGM (1989).

Recharge

Snowmelt and rain are the main sources of recharge to the groundwater system in the permit and adjacent areas. Normal annual precipitation in the area is approximately 20 inches per year (Waddell et al., 1981). Approximately 65 percent of this precipitation normally falls during the months of October through April (Waddell et al., 1981), mostly as snowfall.

Ground water recharge primarily occurs where permeable lithologies are exposed at the surface. Vertical migration of groundwater occurs through permeable rock units and/or along zones of faulting and fracturing. Lateral migration initiates when groundwater encounters impermeable rocks and continues until either the land surface is intersected (and spring discharge occurs) or other permeable lithologies or zones are encountered that allow further vertical flow" (DOGM, 1989). This condition creates the perched aquifers in the Price River and Blackhawk Formations discussed previously.

In areas that are capped by the Price River Formation and the Blackhawk Formation (such as occurs within the proposed permit and adjacent areas), Danielson et al. (1981) indicated that "steep

slopes promote rapid snowmelt runoff and reduce recharge to the groundwater system." This condition is intensified by the relatively low permeability of the Price River and Blackhawk Formations. The limited amount of recharge in the area is reflected by the small number of springs as well as the dry conditions encountered by previous mine workings in the permit and adjacent areas and the LMC drill holes. Figure 7-2 is a map of potential recharge areas in the mine vicinity.

Water was encountered during the mining operations in the adjacent mines. After removal of the Castlegate "A" coal seam, water occasionally seeped into the mine from the roof or more rarely, from the floor. Generally, minor amounts of water were encountered when mining took place beneath a fluvial sandstone channel. The channels behave as perched aquifers that are confined by associated flanking shales. Water production diminished rapidly and does not pose a significant problem for the Blue Blaze Mining operations. Most of the water that is encountered will be used within the mine for dust suppression.

Ground water occurrence and availability may be controlled by faults. However, little data is available to determine how faults may affect the distribution of ground water. In the Eccles Canyon and Winter Quarters Canyon areas, it was determined that faults are relatively insignificant as conduits for ground water movement (Vaughn Hansen, 1979). The conditions are expected to be similar in the proposed Blue Blaze Mine area.

7.1.3 Water Quality

Ground water from the Upper Cretaceous sediments in the Wasatch Plateau is characterized by total dissolved solids (TDS) contents of less than 1,000 milligrams per liter (mg/l) (Doelling, 1972). Ground water from the Price River Formation has TDS ranging from 238 to 303 mg/l. Water from the Blackhawk formation has TDS concentrations ranging from 245 to 903 mg/l (Davis and Doelling, 1977). Total dissolved solids from springs issuing from the Blackhawk, Star Point Sandstone, and the Price River Formations were found to range from 63 to 796 mg/l (Waddle and Others 1981). Wells to the west of the lease area show that the water is of the calcium bicarbonate type.

In the lease area, water quality is available from surface points above and below the proposed mine (Plate 7-1). Water quality and flow rate data of spring monitoring stations appear in Appendix 6B. Appendix 6C contains surface water quality and discharge data. Figures 7-3, 7-4, 7-5, and 7-6 compare water quality of the spring water to that of the surface water.

Areas to be mined within the permit area and areas that were previously mined (1927 to 1950's) can be seen on Plates 3-3 & 3-4. Information on water quantity and quality are not available during

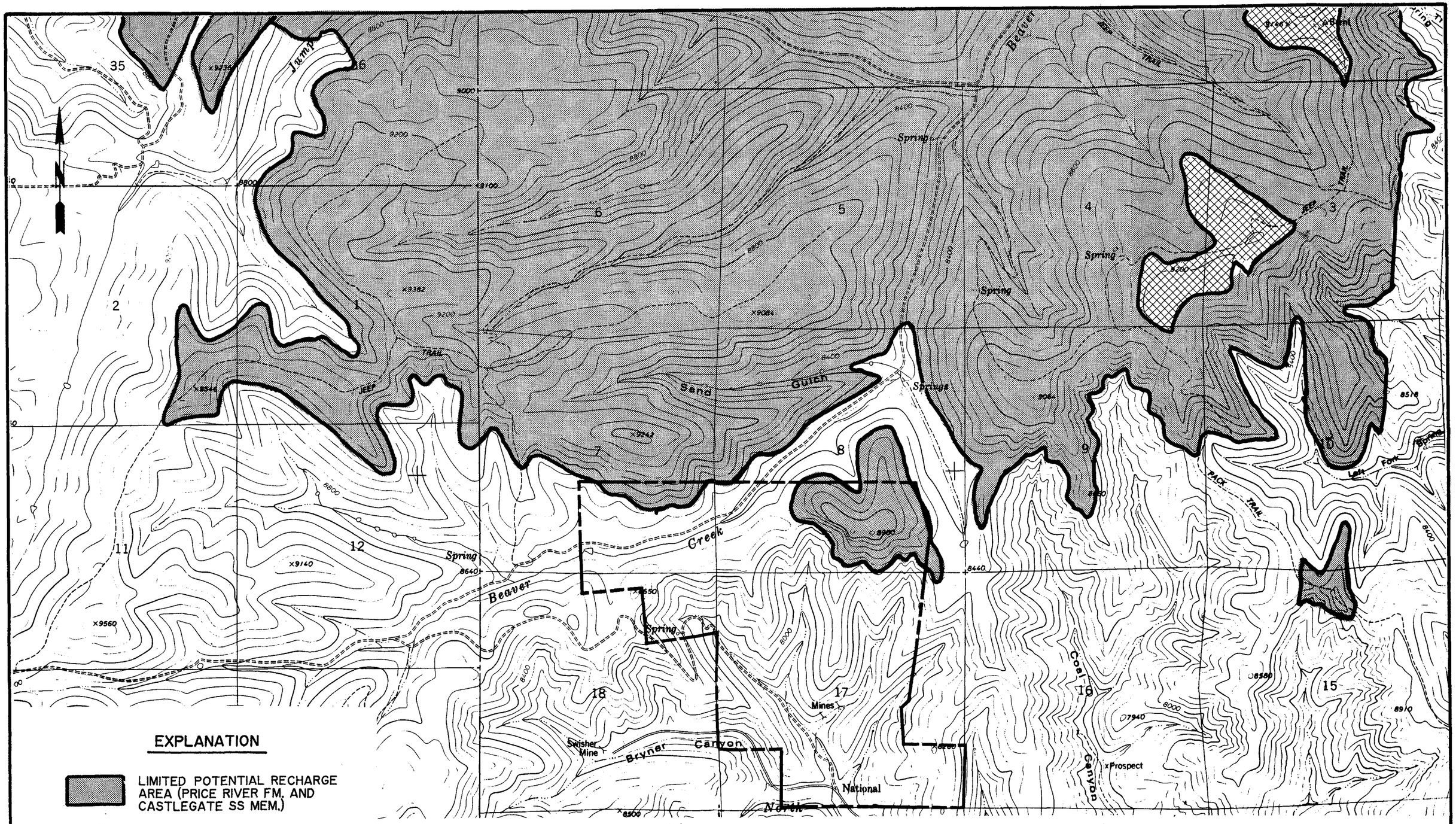
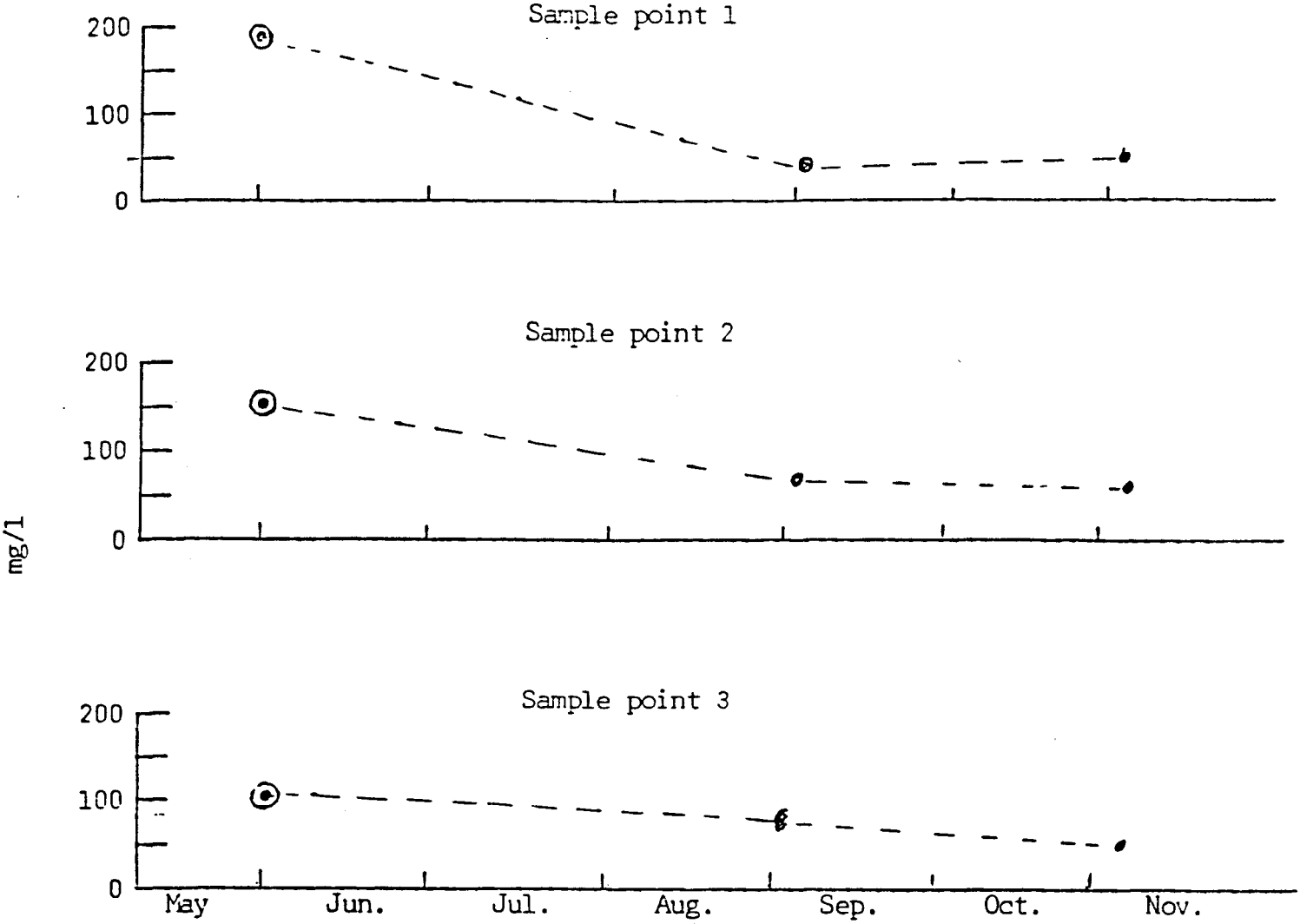


FIGURE 7-2. POTENTIAL RECHARGE AREAS

Figure 7-3

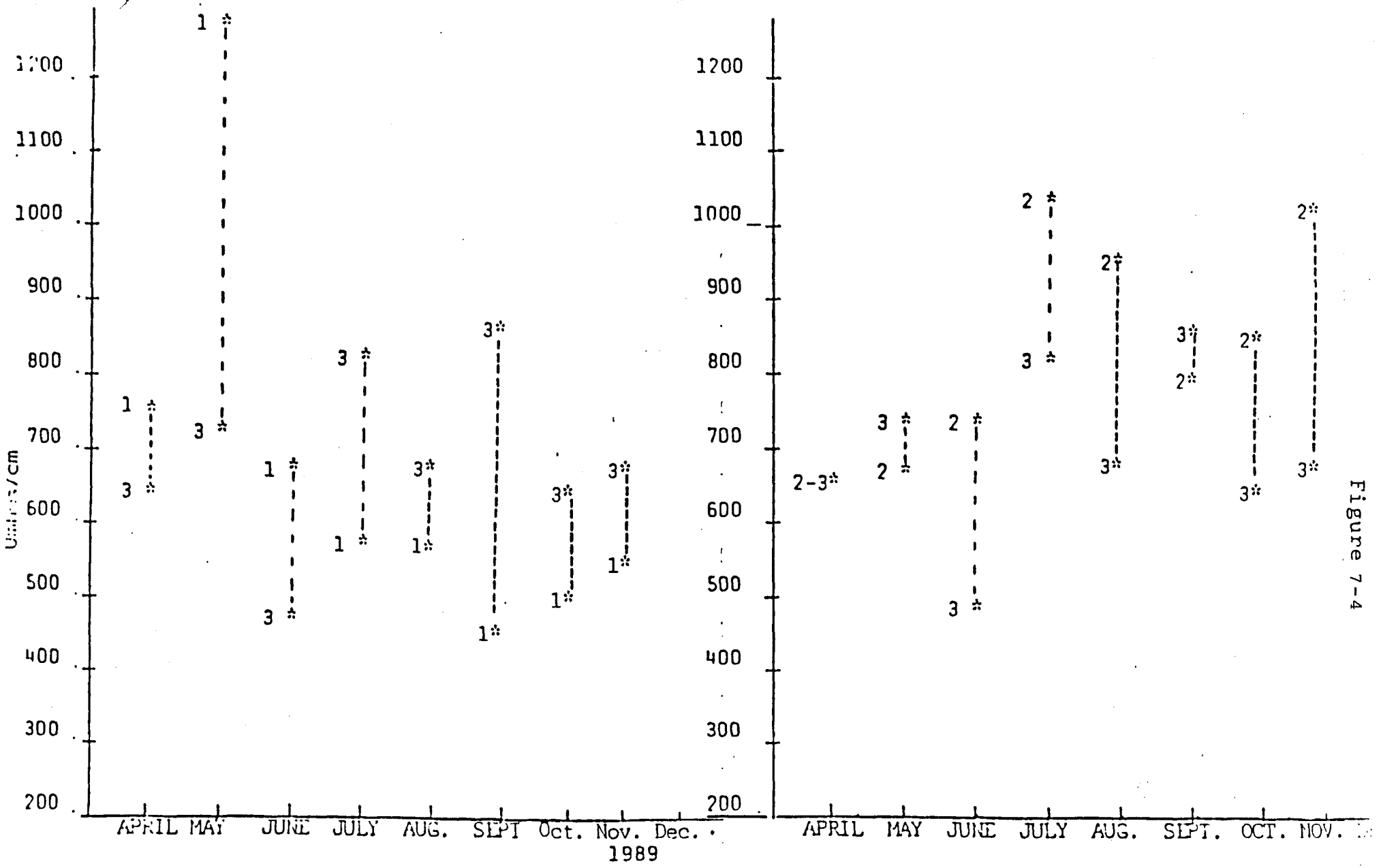


1989

Comparison of SO_4 concentrations in spring and surface water in the Blue Blaze No. 1 and No. 2 Mine area (see Plate 7-1 for location and Table 7-1 for sample type).

1	Upper Sample point	underground
2	Upper Sample point	underground
3	Lower Sample point	surface

3/1/90

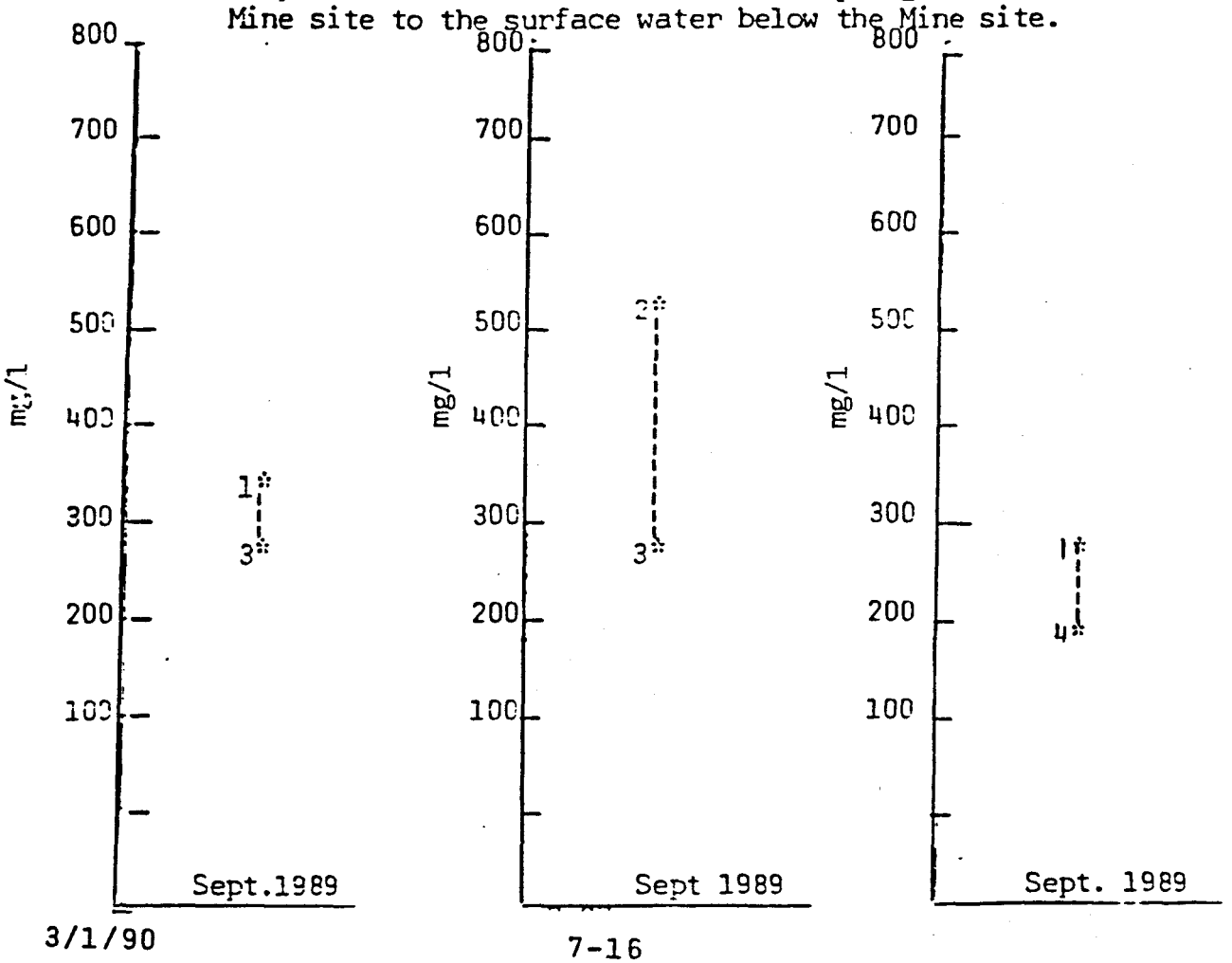


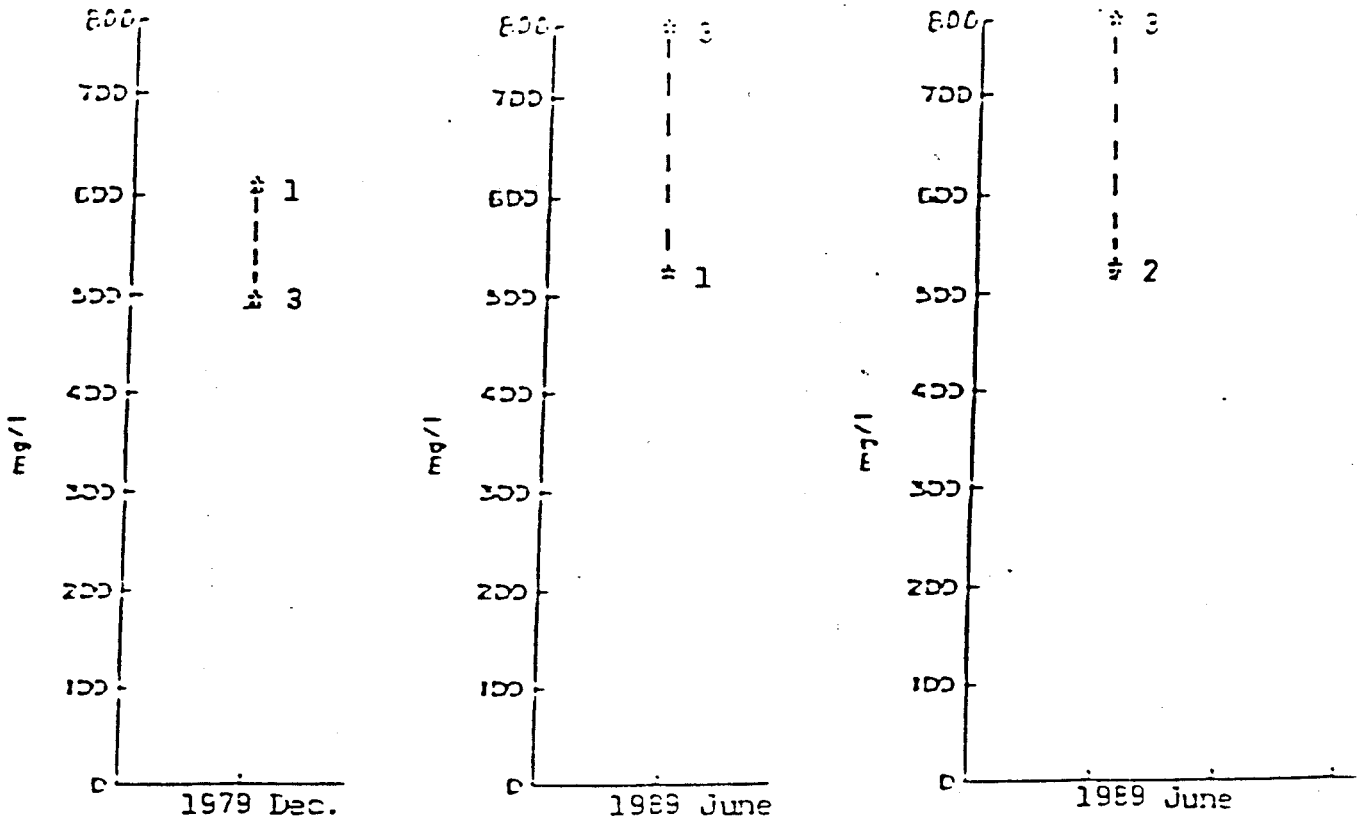
1 Upper Sample point underground North Fork Gordon Creek above mine site
2 Upper Sample point underground Right Fork Gordon Creek above mine site
3 Lower Sample point Surface North Fork Gordon Creek below mine site

Figure 7-4

Comparison of electrical conductivity between the underground water upstream and the water surface

Comparison of TDS concentrations in springs above the Mine site to the surface water below the Mine site.





1	Upper Sample point	underground	North Fork Gordon Creek above mine site
2	Upper Sample point	Underground	Right Fork Gordon Creek above mine site
3	Lower Sample point	Surface	North Fork Gordon Creek below mine site

Figure 7-6

the early mining period (1927 to 1950). The monitored springs will overlie the areas to be mined. Three springs located within the proposed permit area are monitored by BBCC. Data collected from these sources are presented in Appendix 6B. These data indicate that one of the monitored springs (Station No. 1) discharges at a typical rate of 5 to 15 gallons per minute. The remaining two monitored springs (Station Nos. 2 and 4) discharge at rates of 1 to 2 gallons per minute.

In the Gordon Creek area, there does not appear to be a significant difference between the surface water quality and ground water quality. In general the surface water has somewhat higher TDS, which is probably the result of increased mineralization due to increased travel distance. Comparisons of TDS, SO_4, and electrical conductivity between water from up stream springs (sample points 1 and 2) and down stream surface water (sample point 3) show similar water characteristics (Figures 7-3, 7-4, 7-5, and 7-6). This indicates that much of the water in the streams result from ground water discharge.

7.1.4 Water Supply

The use of water in the Gordon Creek area is almost exclusively for stock watering. No ground water rights have been filed by Blue Blaze, however, water is leased from Victor Sweets (Figures 3-5 and 3-5a).

Data contained in Appendix 6B of the permit application package indicate that water rights have been filed on a limited number of springs in the permit and adjacent areas. These include monitoring Station No. 4 and downstream from monitoring Station No. 1. Usage of these springs is for stock watering. Legal rates of usage of spring water generally vary from 0.06 to 0.37 acre-feet per year (all less than 0.25 gallon per minute).

No water rights exist within the permit and adjacent areas for water wells. One right exists for the use of water encountered in underground coal mining operations (File No. 330 with Sweet Coal Company-see Appendix 1 of the permit application package). Since this mine is not active, the right is not currently in use.

All groundwater associated with the above discharges issue from the Blackhawk Formation. As noted above, this formation is not considered an extensive aquifer within the permit and adjacent areas. Water issues from perched aquifers of limited areal extent; hence the low flow and usage rates of the springs.

7.1.5 Ground Water Monitoring Plans

Several springs and seeps have been identified in the North Fork Gordon Creek area (Plate 7-1). Most seeps are seasonal and do not serve as a source of stock water or base flow. Two springs of local

significance in the North Gordon Creek lease area are the Marakis Spring (sample point 1), and an unnamed spring (sample point 2). Discharge from these points varies with the amount of precipitation received during the winter months. The ground water source for these springs is a sandstone bed of the Blackhawk Formation. Spring flow is also observed to be emitting from the Blackhawk Formation at point #4 (Plate 7-1).

Monitoring points No. 1, 2, 3, 4, 5, & 6, as shown on Plate 7-1, have been monitored for the past two years for baseline studies and are now being monitored for operational studies. Monitoring at points No. 7 & 8 has started to develop baseline information before mining commences in these areas. For data on the flow and other required perimeters (see Appendix 6B).

Groundwater monitoring during operation of the mine will consist of the following: collection of flow and water-quality data from springs at Station Nos. 1, 2, and 4, collection of flow and water-quality data from sustained inflows to the mines, collection of water-level data from holes LMC-3 and LMC-4, replacement/relocation of holes LMC-1 and LMC-2 into the Star Point Sandstone, drilling and completion of an in-mine monitoring well from the Castlegate A seam into the Star Point Sandstone, and monitoring of these wells. The in-mine well and the replacement/relocation LMC-1 and LMC-2 wells will be completed as monitoring wells. Well drilling, completion and development will be conducted in compliance with regulatory standards. Monitoring data will be reported to the Division.

Flow and water-quality data are currently collected from three springs within the permit area. Monitoring of these springs will continue, once each calendar quarter that the springs are accessible, during mining operations. The data to be collected from these springs are listed in Table 7-1. Water samples will be collected in the months of March, June, August, and October. As of permit approval the waters will be analyzed according to the Divisions operational list of water parameters (Table 7-2) as outlines in "Guidelines for Establishment of Surface and Groundwater Monitoring Programs for Coal Mining and Reclamation Operations".

Significant sustained inflows to the mine workings are not anticipated. However, if an inflow of water is encountered, and that flow exceeds 1 gpm for a period of at least 30 days, flow and water quality data will be collected from that inflow once each quarter as long as the inflow point remains accessible during mining operations. Data will be collected as close to the point of issuance as possible to prevent contamination by mining operations.

TABLE 7-1

GROUNDWATER BASELINE MONITORING PARAMETERS

Field Parameters	
Flow (gpm) or Depth to Water (ft)	pH (standard units)
Specific Cond. (μmhos/cm @ 25 °C)	Temperature (°C)
Laboratory Parameters (mg/l)	
Aluminum, Total	Arsenic, Total
Barium, Total	Bicarbonate
Boron, Total	Cadmium, Total
Calcium	Carbonate
Chloride	Chromium, Total
Copper, Total	Fluoride
Hardness, Total	Iron, Total
Lead, Total	Magnesium
Manganese, Total	Mercury, Total
Molybdenum, Total	Nickel, Total
Nitrogen, Ammonia	Nitrogen, Nitrate
Nitrogen, Nitrite	Phosphate
Potassium	Selenium, Total
Sodium	Sulfate
Sulfide	Total Dissolved Solids
Total Suspended Solids	Zinc
Quality Assurance Checks	
Total Anions (meq/l)	Total Anions (meq/l)
Cation/Anion Difference	Calculated TDS

Note: Data to be collected once each calendar quarter.

The data listed in Table 7-1 will be collected from mine inflows. Following this initial baseline period of 2 years, future monitoring will continue on a quarterly basis as long as the location is accessible in accordance with Table 7-2 unless the data indicate that an alternative monitoring program is necessary. Any alternative to Tables 7-1 and 7-2 for the mine inflows will be approved by the Division prior to implementation.

Should discharge from the mine become necessary, water will be treated in the sedimentation pond if needed to meet effluent limitations. Discharged water would also be monitored for flow and water quality on a monthly basis.

Water-level data will be collected from holes LMC-3 and LMC-4 once each calendar quarter that the holes are accessible during mining operations. Water level measurements will be taken in March, June, August and October. These data will be collected using an electronic water-level indicator. To protect the surface at each hole, a 5-foot long section of 2-inch diameter steel casing, fitted with a cement basket at its lower end, will be inserted 3 feet into each hole. The annulus between the outside of the casing and the hole wall will then be filled with concrete. The concrete will extend approximately 3 inches above the ground surface, forming a pad measuring approximately 2 feet by 2 feet. The pad will be sloped away from the exterior of the casing to preclude ponding of water on the pad. The top of the casing will be fitted with a cap and a lock to prevent unauthorized entry. All water-level measurements will be corrected to depth from ground surface to permit correlation with previous measurements.

To better predict the potential for groundwater inflows to occur to the Hiawatha seam during mining, two existing drill holes (LMC-1 and LMC-2) will be replaced/relocated and extend approximately 30 feet into the uppermost saturated zone beneath the Hiawatha seam (assumed to be a lens of the Star Point Sandstone). These wells were initially drilled as exploratory holes and then plugged to depths of approximately 600 feet (LMC-1) and 50 feet (LMC-2) below ground surface. These holes will be either replaced/relocated from the surface using air rotary drilling rigs. It is currently anticipated that the existing hole diameter (4.75 inches) will be maintained.

Based on the typical fine-grained nature of the Star Point Sandstone, the aperture of the screen slots will be 0.010 inch. The screen will extend approximately 20 feet below the depth at which water was first encountered. The remainder of the hole below the bottom of the screen will serve as a point of accumulation for cuttings and sediment that sloughs from the edges of the hole during the short time prior to completion.

TABLE 7-2

GROUNDWATER OPERATIONAL-POST MINING MONITORING PARAMETERS

Field Parameters	
Flow (gpm) or Depth to Water (ft)	pH (standard units)
Specific Cond. (μmhos/cm @ 25 °C)	Temperature (°C)
Laboratory Parameters (mg/l)	
Bicarbonate	Chloride
Calcium	Carbonate
Dissolved Solids, Total	Hardness, Total
Iron, Total	Magnesium
Manganese, Total	Potassium
Sodium	Sulfate

Following placement of the screen and casing, a sand filter pack will be emplaced in the hole using a one-inch diameter tremie pipe. The filter pack will consist of 20- to 40-mesh silica sand. The sand will be poured slowly into the tremie pipe and washed into the hole with water to prevent bridging in the pipe. Sufficient filter pack material will be added to extend approximately 15 feet above the top of the screen. Pelletized or slurried bentonite will then be emplaced via tremie pipe to a thickness of about 5 feet on top of the filter pack. The remainder of the annulus between the drill-hole wall and the casing will then be sealed with neat cement, with approximately 5 percent bentonite added to reduce shrinkage. A 2-inch diameter lockable protective surface casing will be installed on the completed hole as indicated above for LMC-3 and LMC-4.

Following completion, the holes will be renumbered (to designate their conversion to monitoring wells) as BBCC-1 and BBCC-2 (see Figure 7-7). Approvals and permits to drill these wells will be obtained from the Division of Water Rights and appropriate Government agencies.

Assuming the permit is written to allow initial access to the Castlegate A seam via the Blue Blaze No. 2 Mine, a third monitoring well (BBCC-3) will be installed within the Blue Blaze No. 2 Mine (Castlegate A seam) at the location shown on Plate 3-4. This location was chosen to be within a cross cut of the main entries at a point that is as far south as possible without encountering the existing underlying mine workings of the old National Coal Company Mine (compare with Plate 3-3 of the permit application). By placing the well within a main cross cut near the mine entry, access to the well will be maintained throughout operations in the mine.

Figure 6-3 shows structural contours and surface fracture locations as obtained from Hansen (1988). Assuming a groundwater flow direction that is similar to the structural dip, the location of BBCC-3 should allow adequate triangulation with BBCC-1 and BBCC-2 to permit delineation of the potentiometric surface of the Star Point Sandstone within the mine areas. If necessary, the location of BBCC-3 will be revised northward a short distance to ensure that the well is placed on the same side as BBCC-1 and BBCC-2 of the major fault systems defining the No. 1 Mine boundaries. This will allow better correlation between the three wells.

BBCC-3 will be drilled to a minimum diameter of 4 inches and will extend to a depth of approximately 30 feet into the uppermost saturated zone beneath the Hiawatha seam (thus being consistent with BBCC-1 and BBCC-2). Due to the anticipate depth to water in this hole (probably less than 300 feet), it is considered practical to collected water-quality samples from BBCC-3. Thus, this monitoring well will be completed using 2-inch diameter PVC casing and slotted screen. Filter pack, bentonite, and neat cement will be added to the annular space using a tremie line as indicated above. BBCC-3

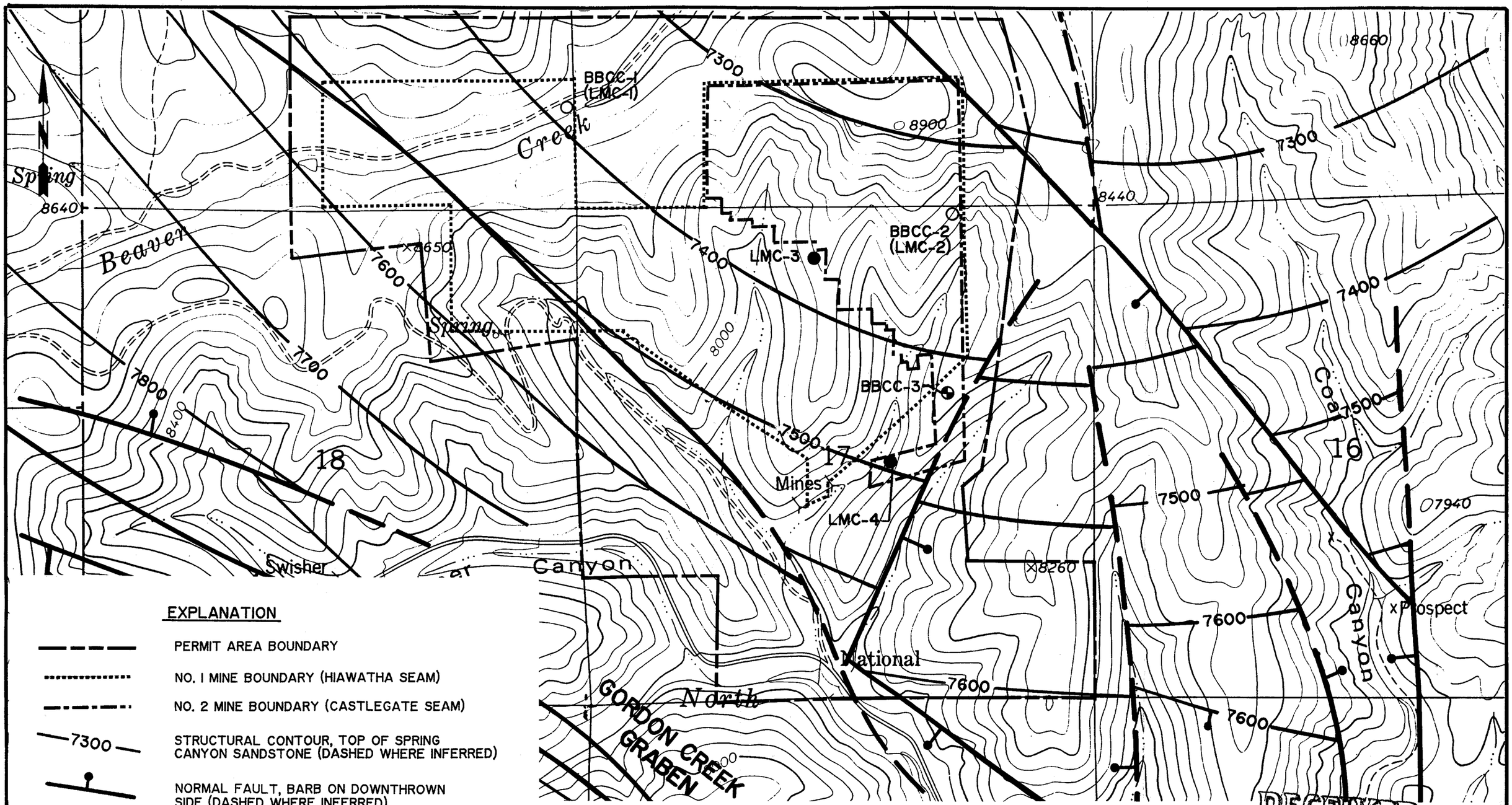


FIGURE 7-7. GEOLOGY AND PROPOSED MONITORING WELL LOCATIONS

will be completed at the surface with a waterproof, flush-mounted protective cover to prevent damage by mine traffic.

Following drilling, each hole will be surveyed to provide horizontal and vertical control. Future water-level measurements will then be corrected to elevations to facilitate development of potentiometric surface maps.

During the baseline monitoring period, water-level data will be collected from BBCC-1 and BBCC-2, while data collected from BBCC-3 will be in accordance with Table 7-2. These data will be collected once each quarter when the wells are accessible. Baseline data will be collected for a period of two years. After one year this baseline data will be incorporated into a revised PHC and submitted for review to the Division. The revised PHC will review all baseline hydrologic data and address mining impacts of mining the Hiawatha coal seam.

The primary groundwater concern associated with mining in the Hiawatha seam is the potential of mine inflow to occur to the mine such as occurred at the Gordon Creek #3 Mine. This type of inflow (sudden and sustained inflow from a fracture through the floor in a mine that was otherwise dry) can be expected only if mining encounters a fracture that is hydraulically connected to an over pressured lens beneath the coal (probably a sandstone lens of the Star Point Sandstone that is confined beneath a shale tongue). If this condition exists within the permit area and the pressure is sufficient to cause significant inflows to proposed mine workings, the water level should rise well above the base of the Hiawatha seam nearly immediately upon completion of the monitoring wells (i.e., well before even the first year of baseline data collection). impacts.

Primary reserves on the property are in the Hiawatha seam. Thus, it is desirable to access the lower seam as soon as possible. It is anticipated that approximately 6 months of time will be required from the time mining begins until the two above-ground holes are replaced/relocated and the in-mine hole is accessed and drilled. Considering potential delays (due to access, weather, etc.), start-up times for the additional mine, etc., it is probable that mining in the Hiawatha seam could not begin for a period of 1.5 to 2 years following access to the Castlegate seam with a one-year baseline period. Avoiding an additional year of delay to the Hiawatha seam during baseline monitoring would be desirable.

Following the baseline period, water-level data will be collected from BBCC-1 and BBCC-2 and water-level and quality data will be collected from BBCC-3, in accordance with Table 7-1, once each calendar quarter that the holes are accessible during mining operations. If the baseline data suggest that an alternative to Table 7-1 is appropriate for BBCC-3, this alternative will be approved by the Division prior to implementation.

By the end of each month following each calendar quarter (i.e., April 30, August 31, October 31, and January 31), a report will be submitted to the Division summarizing monitoring activities during the previous quarter. Annual reports summarizing monitoring activity will also be submitted to the DOGM. Quarterly reports will include field measurements, observations, and analytical results received during the previous quarter. Annual reports will include field measurements, observations, and analytical results received during the entire year. If any data indicate non-compliance with permit conditions, Blue Blaze Coal Company will promptly notify the Division and take appropriate actions as provided for in R645-300-145 and R645-301-731.

7.1.6 Mitigation and Control Plan

Presently, Blue Blaze Coal Company does not foresee any impacts to ground water. In the unlikely event water quantity and/or quality is reduced, Blue Blaze Coal Company will replace any water that is impacted by mining operations. The replacement water will either come from: 1) Blue Blaze's 403 acre feet (Water Right #330) (that is presently being tested and monitored at the sampling locations in the permit area); or 2) will be obtained by purchasing additional water from other sources. The water quality of this replacement water is shown in Appendix 6B. The subsidence monitoring plan will also be used to detect any impacts to the existing springs as discussed in Section 3.4.8.

If spring flow is diminished in quantity and/or quality by mining activity, water resources will be replaced on a case to case basis according to a plan designed in consultation with the DOGM.

7.2 Surface Water Hydrology

Scope

Through a combination of field efforts by Beaver Creek Coal Company and Blue Blaze Coal Company personnel and a drainage study by the Land Group and a literature review by Hydrosciences, Suite 304, 205 West 700 South, Salt Lake City; surface water hydrology information has been assembled to satisfy regulations set forth by Utah Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM) for the Blue Blaze No. 1 and No. 2 Mines. A description of the baseline information for the existing resources, as well as, a discussion of the runoff control plans for operations and reclamation are provided below.

7.2.1 Methodology

The baseline hydrologic study was based on review of literature and available data obtained from the United States Geological Survey (USGS), the U.S. Forest Service, the State of Utah, Beaver Creek Coal Company, and Blue Blaze Coal Company, and mine permit applications for the surrounding mines. A field reconnaissance was

performed to confirm the location and characteristics of surface water courses, springs, and seeps.

7.2.2 Existing Surface Water Resources

7.2.2.1 Regional Surface Water Hydrology

Most of the regional area is drained by tributaries to the Green and Colorado Rivers. The principal tributaries in the region are the Price and San Rafael Rivers and Muddy Creek. The Green River flows through the eastern edge of the Central Utah region.

The U.S. Geological Survey completed a report entitled "Hydrologic Reconnaissance of the Wasatch Plateau - Book Cliffs Coal Field Area, Utah" which considers the development of coal resources in central Utah (Waddell, et.al., 1981). The Blue Blaze No. 1 and No. 2 Mines lies within the study area near the headwaters of tributaries to the Price River. Much of the water from the Price River is diverted for irrigation use.

Approximately 50 to 70 percent of the stream flow occurs during the May-July snowmelt runoff period (Waddell, et.al., 1981). Summer precipitation usually results in minor amounts of runoff. Intense convective rainfall during the summer period may cause short duration, high intensity runoff in localized areas. The 100-year 6-hour precipitation is approximately 2.0 inches in the mountain areas.

Water quality in the Price River and its tributaries is good at the higher elevations. In most cases, the surface waters at the higher elevations have the maximum concentration of dissolved solids are less than 250 mg/l and are a calcium bicarbonate type.

At lower elevations below diversions, the water changes to a sodium sulfate type with dissolved solids ranging from 2,500 to more than 6,000 mg/l (Waddell, et.al., 1981). These changes are caused by leaching of salts by irrigation return flows and natural runoff from areas underlain by Mancos Shale.

7.2.2.2 Mine Plan Area Surface Water Hydrology

The three principal surface water courses found within and adjacent to the mine permit area are Beaver Creek to the north of the permit area, North Fork of Gordon Creek through the center of the property, and the Gordon Creek to the south of the property. (See Plate 7-1)

Beaver Creek is a perennial stream that flows through the northern edge of the permit area. Perennial flow is maintained by base flow collected in a series of beaver ponds and Jewkes and Gunnison Homestead Springs. Both springs have dried up during drought periods but normally provide contributions during low flow periods. The discharge rate from Jewkes Spring varies from 1.10 to 38 gallons

per minute (see Appendix 6B). The discharge from the Gunnison Homestead Spring varies from 3 to 136 gallons per minute (see Appendix 6B).

The Gunnison Homestead Spring is actually a seepage area along a small tributary to Beaver Creek. Discharge measurements have been taken near the confluence of the spring discharge channel and the tributary to Beaver Creek. Thus, the higher flow rates in June included surface runoff from snowmelt conditions.

The general flow direction of Beaver Creek is north east toward the Price River. The watershed areas of Beaver Creek or its tributaries above the lease boundary are less than one square mile. The drainage pattern in the upper portions of the Beaver Creek basin near the permit area is dendritic. This drainage pattern, of Beaver Creek, is detailed on Plate 7-1. The valley profile is not as steep as the North Fork of Gordon Creek. Beaver ponds are common along the stream channel.

Flow and water quality are presently being monitored at several locations. Station 2-3-W is the station monitored by Beaver Creek Coal Co., that will be added to monitoring sites of Blue Blaze Coal Co. when Beaver Creek Coal Company has completed monitoring in the area. Water quality samples have been collected monthly when weather permits. The location of Station 2-3-W is presented on Plate 7-1.

Station 2-4-W is located on Upper Beaver Creek just to the west of the permit area. A Parshall Flume was installed by Beaver Creek Coal at the site in 1982. Water quality samples have been collected monthly when weather permits.

Station USGS 2-2 refers to a water quality monitoring location, on Beaver Creek, near the center of the lease block. This site was abandoned, by Beaver Creek Coal Company, in 1978.

The USGS maintains a gauging station near the mouth of Beaver Creek (Station No. 09312700). During the period of record from 1960 to 1975, the minimum annual discharge of 338 acre-feet occurred during water year 1961. The maximum annual discharge of 1,610 acre-feet occurred in water year 1973. (see Appendix 6B)

As indicated in Appendix 6B, flow in Beaver Creek is perennial throughout most of the year. The discharge during the late summer and fall is very low (see Appendix 6B). Flows at the lower station are slightly larger than the upper station. Water quality characteristics are similar.

The North Fork Gordon Creek is a small basin of about 1 square mile in an area that is located almost entirely within the lease block. The North Fork Gordon Creek has a un-named canyon to the east, which in this report will be called the Right Fork North Fork Gordon

Creek. This canyon will contain the mine facilities and surface operations.

The North Fork Gordon Creek is an intermittent stream which flows south into the Gordon Creek just below the coal lease area. Beaver Creek Coal Co. monitoring location 2-2-W is located on the Gordon Creek below the mine area. This is located on Plate 7-1 and will become a monitoring point for Blue Blaze Coal Company when Beaver Creek Coal Company has completed its monitoring. The North Fork Gordon Creek normally flows during the snowmelt period and usually is dry throughout the remainder of the year. The stream was dry at all monitoring periods through the summer of 1978. Flow was observed at three monitoring locations in the North Fork Gordon Creek. A small flow of 1.5 gpm was also observed at the upper station on the Right Middle Fork North Fork Gordon Creek on June 2, 1978 but the flow infiltrated into the channel bottom and was not observed at the lower station.

Several intermittent springs or seeps are found in the North Fork Gordon Creek watershed. These springs or seeps appear to be discharges from perched water zones which have intersected the ground surface. The primary springs in the North Fork Gordon Creek drainage are located to the northwest of the portal area. These springs are located well above the coal seam elevation along the stream alignment. Even when this spring is flowing, stream flow is observed in the main channel at 30 gpm. Even during much of the snowmelt period, the North Fork Gordon Creek maintains characteristics of an intermittent stream since discharge rates often decrease in the down stream direction.

Gordon Creek is the other principal stream found on the lease block. This drainage is located south of the proposed mining area at an elevation below the coal seam. Therefore, it should not be affected by the mining operation.

Stream flows in the Gordon Creek are larger than flows in the North Fork Gordon Creek. Flow begins much earlier during the snowmelt season. This perennial stream is monitored by Beaver Creek Coal Company as previously mentioned (see Appendix 6B).

A comparison of the data in Appendix 6B, for the two locations on the North Fork monitored during 1978 shows that the stream is losing flow between the upper and lower station. Thus, the lower reaches of the North Fork Gordon Creek within the lease area exhibit characteristics of an ephemeral stream in the sense that the ground water table is generally below the bottom of the channel and flow is from the stream.

A detailed representation of the North Fork of Gordon Creek shows it is steeper than Beaver Creek. The channel gradient is relatively uniform across the coal lease property. The canyon sides are steep

and rocky. The characteristics of the channel and valley are indicative of a stream in a youthful stage of development.

Surface Water Quality

Beaver Creek Coal and Blue Blaze Coal sampling points are the permanent water quality sampling locations shown on Plate 7-1. Sample point 2-3-W corresponds with the stream gauging station on Beaver Creek. Sample points 2-5-W and 2-6-W correspond with monitoring of Jewkes Spring and Gunnison Homestead Spring, respectively. Sample point 2-2-W is on Gordon Creek below the facilities area. The discharge point from the sedimentation pond is designated as sample point No. 3.

Sampling point No. 1 of Blue Blaze Coal is located in the channel of North Fork Gordon Creek. This point is an ephemeral spring.

Sampling point No. 2 is a seep along the Right Middle Fork North Fork Gordon Creek. Flow from this seep does not flow far enough to enter the main stream channel of the North Fork Gordon Creek. Usually, this seep can not be seen flowing on the surface 100 feet from its origin.

Sampling point No. 3 is located prior to entering the Gordon Creek below the proposed sedimentation pond.

Sampling point No. 4 is also located in the North Fork Gordon Creek drainage. This point of ground water discharge is located on the hillside above the creek bottom.

Sampling point No. 5 is located on the confluence of the Right Middle Fork North Fork Gordon Creek and the North Fork itself.

Sample point No. 6 is located in the canyon above the mine site to the east. This is a dry canyon except when rainfall or snowmelt in the spring occurs.

The water quality data for these areas are located in Appendix 6B. The only difference in quality from the sources No. 1 to No. 3 is in mineralization and dissolved particles (see Figures 7-3, 7-4, 7-5, and 7-6).

The Price River and its tributaries from the confluence with Green River to Castle Gate, are classified 3C and 4. This reach includes the flows from Gordon Creek and its tributaries but not Beaver Creek. Class 3C means that the particular stream is protected for non-game fish and other aquatic life, and Class 4 means that the stream is protected for agricultural use. Tables 7-3 and 7-4 list numerical standards for both of these classes.

Beaver Creek is included in the classifications for the Price River and tributaries from Castle Gate to it's headwaters. These are 1C

TABLE 7-3

NUMERIC CRITERIA FOR AQUATIC WILDLIFE

Parameter	Aquatic Wildlife 3A	3B	3C	3D
PHYSICAL				
Total Dissolved Gases	(1)	(1)		
Dissolved Oxygen (MG/L) (2)				
30 Day Average	6.5	5.5	5.0	5.0
7 Day Average	9.5 5.0	6.0 4.0		
1 Day Average	8.0 4.0	5.0 3.0	3.0	3.0
Max. Temperature (C	20	27	27	
Max. Temperature Change (C	2	4	4	
pH (Range)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)	10	10	15	15
METALS (3) ACID SOLUBLE UG/L) (4				
Arsenic (Trivalent)				
4 Day Average	190	190	190	190
1 Hour Average	360	360	360	360
Cadmium (5				
4 Day Average	1.1	1.1	1.1	1.1
1 Hour Average	3.9	3.9	3.9	3.9
Chromium (Hexavalent)				
4 Day Average	11	11	11	11
1 Hour Average	16	16	16	16
Chromium (Trivalent) (5)				
4 Day Average	210	210	210	210
1 Hour Average	1700	1700	1700	1700
Copper (5)				
4 Day Average	12	12	12	
1 Hour Average	18	18	18	18
Cyanide (Free)				
4 Day Average	5.2	5.2	5.2	
1 Hour Average	22	22	22	22
Iron (Maximum)	1000	1000	1000	1000
Lead (5)				
4 Day Average	3.2	3.2	3.2	3.2
1 Hour Average	82	82	82	82
Mercury				
4 Day Average	0.012	0.012	0.012	0.012
1 Hour Average	2.4	2.4	2.4	2.4
Nickel (5)				
4 Day Average	160	160	160	160
1 Hour Average	1400	1400	1400	1400
Selenium				
4 Day Average	5.0	5.0	5.0	5.0
1 Hour Average	20	20	20	20
Silver				
4 Day Average	0.12	0.12	0.12	
1 Hour Average (5)	4.1	4.1	4.1	4.1
Zinc (5)				
4 Day Average	110	110	110	110
1 Hour Average	120	120	120	120
INORGANICS (MG/L) (3)				

TABLE 7-4

NUMERIC CRITERIA FOR DOMESTIC, RECREATION, AND AGRICULTURAL USES

Parameter	Domestic Source	Recreation and Aesthetics		Agriculture
	1C	2A	2B	4
BACTERIOLOGICAL (30-DAY GEOMETRIC MEAN) (NO./100 ML)				
Max. Total Coliforms	5000	1000	5000	
Max. Fecal Coliforms	2000	200	200	
PHYSICAL				
Min. Dissolved Oxygen (MG/L) (1)	5.5	5.5	5.5	
pH (RANGE)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)		10	10	
METALS (ACID SOLUBLE, MAXIMUM MG/L) (2)				
Arsenic	0.05			0.1
Barium	1.0			
Cadmium	0.01			0.01
Chromium	0.05			0.10
Copper				0.2
Lead	0.05			0.1
Mercury	0.002			
Selenium	0.01			0.35
Silver	0.05			
INORGANICS (MAXIMUM MG/L)				
Boron				0.75
Fluoride (3)	1.4-2.4			
Nitrates as N	10			
Total Dissolved Solids (4)				1200
RADIOLOGICAL (MAXIMUM pCi/L)				
Gross Alpha	15			15
Radium 226, 228 (Combined)	5			
Strontium 90	8			
Tritium	20000			
ORGANICS (MAXIMUM UG/L)				
Chlorophenoxy Herbicides				
2,4-D	100			
2,4,5-TP	10			
Endrin	0.2			
Hexachlorocyclohexane (Lindane)	4			
Methoxychlor	100			
Toxaphene	5			
POLLUTION INDICATORS (5)				
Gross Beta (pCi/L)	50			50
Bod (MG/L)		5	5	5
Nitrate as N (MG/L)		4	4	
Phosphate as P (MG/L)(6)		0.05	0.05	

(protected for domestic use with prior treatment), 3A (agricultural). Tables 7-3 and 7-4 list numerical standards for classes 1C and 3A.

7.2.2.3 Water Monitoring Plan

Surface water monitoring sites appear on Plate 7-1. In the Blue Blaze Mine Area, Beaver Creek and Gordon Creek are perennial streams. The Left Fork North Fork Gordon Creek is an intermittent stream. Both the Right and Right Middle Forks North Fork Gordon Creek are ephemeral.

Baseline surface water flow rate measurements, as well as, field and laboratory analytical water quality data are found in Appendix 6C. This data meets the baseline data requirements as outlined in the Division's guidance document entitled, "Guidelines For Establishment of Surface and Ground Water Monitoring Programs For Coal Mining and Reclamation Operations - January 1986". Baseline data will continue to be collected as outlined in the above referenced document, and as outlined below, until the Division grants approval to commence data collection for the operational period. All field measurements will be obtained concurrently with collection of water flow measurements and laboratory samples.

Perennial stream monitoring sites will be monitored monthly for flow rate during both baseline and operational mining activities. Water quality samples will be collected and analyzed for the parameters listed in Tables 7-5 and 7-6 during baseline and operational/postmining periods, respectively. Postmining data collection will be conducted every year, until termination of bonding. The perennial stream sites will be monitored for flow rate and water quality at a frequency of twice (high and low flow) per annum during the postmining period.

Intermittent stream reaches will be analyzed for flow rate and water quality monthly during both baseline and operational time periods. Water quantity and quality data will be collected twice per annum during postmining until termination of bonding. Field and laboratory analytical parameters to be analyzed for during baseline and operational/postmining time period are listed in Tables 7-5 and 7-6, respectively.

The ephemeral streams will be monitored for flow rate and water quality quarterly during runoff events during baseline and mine operation time periods. Parameters to be analyzed for during baseline and mine operation periods are listed in Tables 7-5 and 7-6, respectively.

A certified annual inspection report as well as quarterly reports will be submitted to the Division as required by R645-301-514.300

TABLE 7-5

SURFACE WATER BASELINE MONITORING PARAMETERS

Field Parameters	
Flow (gpm) or Depth to Water (ft)	pH (standard units)
Specific Cond. (μmhos/cm @ 25 °C)	Temperature (°C)
Dissolved Oxygen (ppm) - perennial streams only	
Laboratory Parameters (mg/l)	
Aluminum, Total	Arsenic, Total
Barium, Total	Bicarbonate
Boron, Total	Cadmium, Total
Calcium	Carbonate
Chloride	Chromium, Total
Copper, Total	Fluoride
Hardness, Total	Iron, Total
Lead, Total	Magnesium
Manganese, Total	Mercury, Total
Molybdenum, Total	Nickel, Total
Nitrogen, Ammonia	Nitrogen, Nitrate
Nitrogen, Nitrite	Oil and Grease
Phosphate	Potassium
Selenium, Total	Sulfate
Sodium	Total Dissolved Solids
Sulfide	Total Settleable Solids
Total Suspended Solids	Zinc
Quality Assurance Checks	
Total Anions (meq/l)	Total Anions (meq/l)
Cation/Anion Difference	Calculated TDS

TABLE 7-6

SURFACE WATER OPERATIONAL-POST MINING MONITORING PARAMETERS

Field Parameters	
Flow (gpm) or Depth to Water (ft)	pH (standard units)
Specific Cond. (μmhos/cm @ 25 °C)	Temperature (°C)
Dissolved Oxygen (ppm)-perennial streams only	
Laboratory Parameters (mg/l)	
Acidity	Bicarbonate
Calcium	Carbonate
Chloride	Hardness, Total
Iron, Total	Magnesium
Manganese, Total	Potassium
Oil and Grease	Sulfate
Sodium	Total Dissolved Solids
Total Settleable Solids	Total Suspended Solids
Quality Assurance Checks	
Total Anions (meq/l)	Total Anions (meq/l)
Cation/Anion Difference	Calculated TDS

7.2.3 Surface Water Development, Control and Diversions

7.2.3.1 Water Supply (Surface)

The water supply intake for use underground will be pumped from the North Fork Gordon Creek through a 2-inch line to the mine. The location of the pump house is presented on Plate 3-1. Water rights were obtained from Sweet Coal Company (See Appendix 1, Figure 3-5 and 3-5a).

7.2.3.2 Sedimentation Control Structures and Diversions

General Description

The sediment control plan for the facility area during operations is shown on Plates 7-4 and 7-5. The undisturbed runoff from above the site area on the North Fork and Right Fork drainages will be diverted around the disturbed area and drainage from the disturbed areas will be collected and routed to the sedimentation pond. The drainage network was developed with several objectives in mind:

1. To divert as much undisturbed area runoff around the facilities area.

2. To route all runoff from disturbed areas through a sediment pond.

3. To provide adequate drainage of roads and parking areas.

4. To create channels, culverts and diversions which are stable.

5. To satisfy DOGM design specifications.

During installation of the operational sediment control structures, Blue Blaze Coal Company will install a combination of containment berms, straw bale dikes, and silt fences to contain sediment. Due to the maintanence concerns of the straw bales and silt fences, where possible for long term use, containment berms with silt fence or straw bale overflows will be used. These sediment control structures will be located downstream from the areas disturbed by the site construction.

Additionally, Blue Blaze Coal Company will either limit construction within the stream channel to those periods when the stream is not flowing or bypass stream flow around the active site construction area. Installation of the bypass culverts will proceed from the lower end of the pad area, by the sediment pond, upstream toward the upstream end of the pads. If it is not possible to work during periods the stream is not flowing, the stream flow will be diverted using a diversion dike and a flexible culvert capable of passing the 2 year flood. As sections of the bypass culvert are installed, the

flexible culvert and diversion dike will be moved upstream to allow the next section of the bypass culvert to be installed.

Methodology

The following methods were used to determine runoff volumes and peak flows for design of diversions, culverts and sedimentation pond.

Determination of Precipitation Depth. Precipitation depths were determined for the 25 year-6 hour, 10 year-24 hour, and 100 year-6 hour storms. The depth values for these storms were determined from Miller, et al. (1973).

Determination of Runoff Volume. The SCS curve number method was used to determine the runoff volume. According to the U.S. Soil Conservation Service (SCS) (1972), the algebraic and hydrologic relations between storm rainfall, soil moisture storage, and runoff can be expressed by the equations:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (1)$$

and

$$S = \frac{1000}{CN} - 10 \qquad (2)$$

where:

Q=Direct runoff volume (inches)
S=Watershed storage factor (inches)
P=Rainfall depth (inches)
CN=Runoff the curve number (dimensionless)

It should be noted that (a) Equation (1) is valid only for P >= 0.2S (otherwise Q = 0), (b) Equation (2), as stated, is in inches, with the values of 1000 and 10 carrying the dimensions of inches, although metric conversions are possible, and (c) CN is only a convenient transformation of S to establish a scale of 0 to 100 and has no intrinsic meaning.

Curve numbers for the watersheds of concern were obtained by evaluating the watershed surface characteristics based on soils, vegetative type and other surface disturbances. This determination was based on maps and field reconnaissance of the site. The curve numbers for the watersheds were determined using the estimated cover density of the vegetative community and reading the value from

Figure 7-7a, assuming hydrologic soil groups B and C (as is typical of much of the region). For the disturbed areas, curve numbers were chosen from professional judgement and tabulated values presented by the U.S. Soil Conservation Service (1972).

Curve Numbers values were determined by a weighted average based on the percentage of each basin occupied by a given land surface category. Land surface categories were assigned the following curve numbers:

Undisturbed land	Used 70
Disturbed land	Used 89
Reclaimed land	Used 80

Antecedent Moisture Condition II was used for all runoff estimates.

Hydrograph Synthesis. Runoff hydrographs were developed, for the storm events, using the SCSHYDRO computer program. This program, originally developed by Hawkins and Marshall (1980), has been modified by EarthFax Engineering, Inc. to add additional rainfall distributions and allow batch file processing. The SCSHYDRO program was designed to simulate the surface runoff response of a drainage to precipitation, using the SCS triangular hydrograph method.

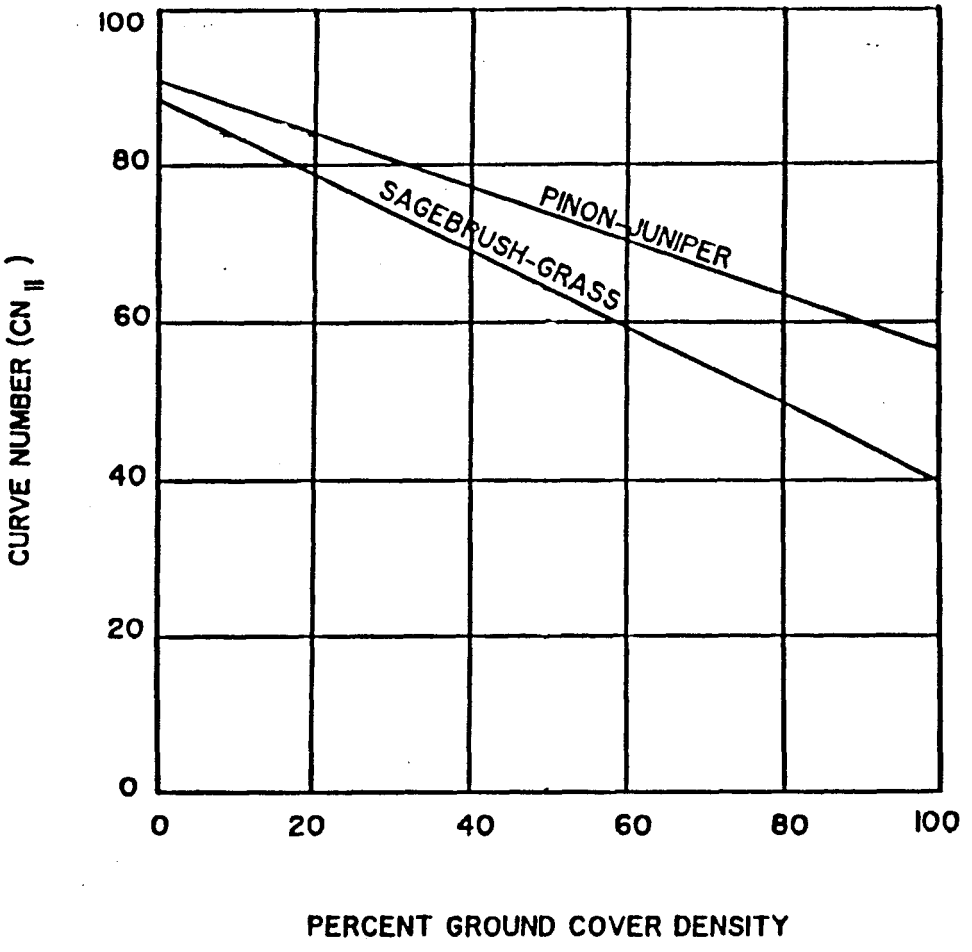
The SCS method yields a total rainfall excess, the difference between rainfall depth and precipitation loss. For a given storm, the incremental excess for a given time period of a storm can be computed as the difference between the accumulated excess at the end of the current time period and the accumulated excess at the end of the previous period (SCS, 1972). The computer program calculates the incremental volume using:

$$\Delta Q = \left[\frac{(P(t + \Delta t) - 0.2S)^2}{P(t + \Delta t) + 0.8S}\right] - \left[\frac{(P(t) - 0.2S)^2}{P(t) + 0.8S}\right] \qquad (3)$$

where S is as previously defined using the curve number and values for $P(t+\Delta t)$ and $P(t)$ are determined from the rainfall mass curve.

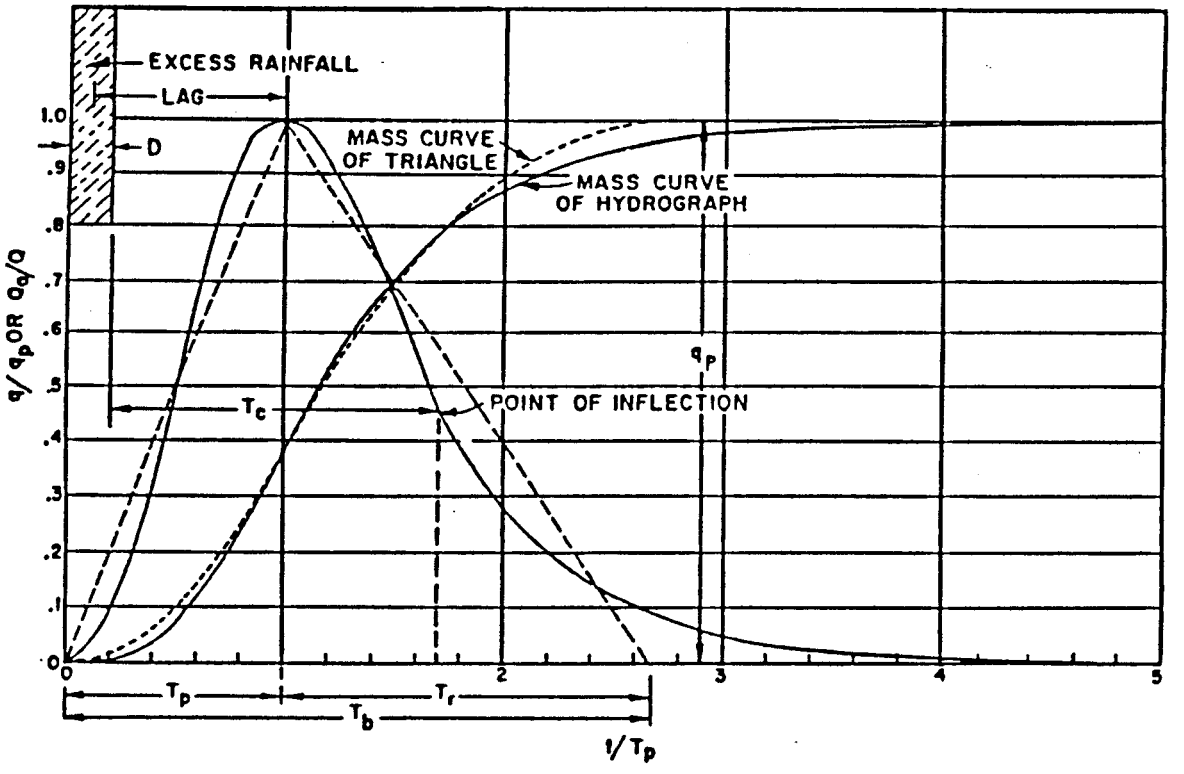
This rainfall excess is then translated to an outflow hydrograph using the SCS triangular dimensionless unit hydrograph (SCS, 1972). The unit hydrograph shown in Figure 7-8 is a typical curvilinear hydrograph. It is characterized by its time to peak (T_p), recession time (T_r), time of base (T_b), and the relations between these parameters (i.e., $T_r = 1.67T_p$; $T_b = 2.67T_p$). Thus, from the geometry of a triangle, the incremental runoff (ΔQ can be defined by the equation:

Figure 7-7a



GRAPH FOR ESTIMATING RUNOFF CURVE NUMBERS OF FOREST-RANGE COMPLEXES IN WESTERN UNITED STATES: JUNIPER-GRASS AND SAGE-GRASS COMPLEXES.

Figure 7-8



DIMENSIONLESS UNIT HYDROGRAPH AND MASS-CURVE.

EarthFax

$$q_p = \frac{0.75\ \Delta Q}{T_p} \qquad (4)$$

where:

q_p=Peak flow rate (in/hr, if Q is in inches and T_p in hours), and

other parameters previously defined.

The flow at any time $0 < t < T_r$ may be determined by simple linear proportioning of the triangular unit hydrograph. The time to peak is related to the familiar expression "time of concentration" (T_c) by the equation:

$$T_c + \Delta t = 1.7\ T_p \qquad (5)$$

in which the factor 1.7 is an empirical finding cited by the U.S. Soil Conservation Service (1972).

The time of concentration may be estimated by several formulas. For this report, T_c was determined from the following equations (U.S. Soil Conservation Service, 1972):

$$L = \frac{\lambda^{0.8}\ (S+1)^{0.7}}{1900\ Y^{0.5}} \qquad (6)$$

and

$$T_c = 1.67\ L \qquad (7)$$

where:

L=Watershed lag time (hours)
λ=Hydraulic length of the watershed, or distance along the main channel to the watershed divide (feet)
S=Watershed storage factor defined in Equation (2)
Y=Average watershed slope (percent)
T_c=Time of concentration (hours)

The U.S. Soil Conservation Service (1972) shows that Δt must equal $0.2T_p$. Hence, the computer code uses only T_c, and from this value computes Δt, T_p, T_r, and interim unit hydrograph ordinates. To

convert the unit hydrograph ordinates to cubic feet per second, the following relation is used:

$$q_{cfs} = q_{\frac{inch}{hr}} * 645.33 * Area \quad (8)$$

where:

Area=Drainage area (square miles)
q=Discharge (cubic feet per second)

Channel Hydraulics. The capacity of the undisturbed and disturbed area diversion channels, at the peak flow rate, was determined using the FlowMaster I™ program developed by Haestad Methods (1990). This program solves for prismatic channel capacity using the Manning equation:

$$V = \frac{1.486}{n} * R^{2/3} * S^{1/2} \quad (9)$$

and the continuity equation:

$$Q = A * V \quad (10)$$

where:

V=Velocity (feet per second)
R=Hydraulic radius (feet)
S=Hydraulic slope (feet per foot)
n=Manning's roughness coefficient
Q=Discharge (cubic feet per second)
A=Flow area (square feet)

Channel parameters required for the solution of Equations (9) and (10) were obtained from design cross sections and the proposed longitudinal profile of the various channels. Values of the roughness coefficient were obtained by comparing proposed conditions with tabulated values provided by Chow (1959) and the U.S. Soil Conservation Service (1956).

For the design of the undisturbed area diversions and the reclaimed channels, a maximum permissible velocity of 5 feet per second was determined to be non-erosive. This was determined from Barfield,

et. al. (1981) based on a graded loam soil with gravel for sediment laden flows.

Sediment Volume Determination. The anticipated sediment volume from the disturbed area was determined using the relationship:

Sediment Yield = 0.05 ac-ft/ac * # Acres Disturbed(11)

The 0.05 Ac-Ft/Ac value is an arbitrary initial estimate of sediment storage requirements.

Designs and Specifications

The design description and specifications for water and sediment control structures follow. Calculations supporting these designs are presented in Appendix 6E.

Undisturbed Area Runoff Control.

General. Runoff from the undisturbed area upstream of the surface facilities in the Right Fork North Fork Gordon Creek and the North Fork Gordon Creek will be diverted around the mine facilities via five diversion channels and six culverts. The culverts are designed as temporary structures for the life of the facility and will be removed following the operations. These culverts are sized to pass the 10 year-6 hour event.

Diversions. The diversions will convey a portion of the undisturbed area on the slopes immediately above the disturbed pad areas to channels or culverts. These channels are sized to pass the 10 year-6 hour precipitation event. Plate 7-4 shows the location of the diversions and culverts and the drainage area to each structure.

Undisturbed diversion channel UD-1 will be located above the topsoil stockpile and will divert runoff from 12.45 undisturbed acres to the road side ditch for the State Highway. The diversion will be trapezoidal in shape and will be constructed with a 1 foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.08 to 0.15 foot/foot (see Figure 7-9). The channel will be constructed in natural materials. The 10 year-6 hour peak flow for the drainage is 0.36 cubic feet per second (cfs). To handle this event the diversion channel will have a maximum flow depth of 0.11 foot and a maximum velocity of 3.42 feet per second (fps). The channel depth is planned to be 1 foot deep resulting in a free board of 0.89 foot. The velocity is less than 5 fps, therefore, it is deemed to be non-erosive.

The UD-2 undisturbed diversion channel will be located above the coal stockpile and handling area and will divert runoff from 7.54 undisturbed acres to the North Fork Gordon Creek channel above the entrance to culvert UC-4 (see Plate 7-4). The diversion will be trapezoidal in shape and will be constructed with a 1 foot bottom

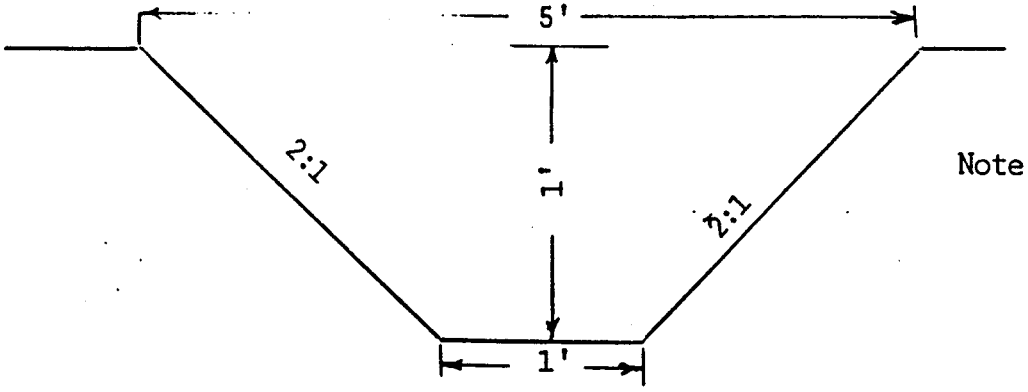
width, 2H:1V sideslopes, and a channel slope ranging from 0.05 to 0.09 foot/foot (see Figure 7-9). The channel will be constructed in natural materials. The 10 year-6 hour peak flow for the drainage is 0.22 cfs. To handle this event the diversion channel will have a maximum flow depth of 0.09 foot and a maximum velocity of 2.45 fps. The channel depth is planned to be 1 foot deep resulting in a free board of 0.91 foot. The velocity is less than 5 fps, therefore, it is deemed to be non-erosive.

Runoff from the undisturbed area above the portal area on the north side of the Right Fork North Fork Gordon Creek will be collected by diversion channel UD-3 and will divert runoff from 11.42 acres to undisturbed area by-pass culvert UC-2 (see Plate 7-4). The diversion will be trapezoidal in shape and will be constructed with a 1 foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.07 to 0.10 foot/foot (see Figure 7-9). The channel will be constructed in natural materials. The 10 year-6 hour peak flow for the drainage is 0.33 cfs. To handle this event the diversion channel will have a maximum flow depth of 0.11 foot and a maximum velocity of 2.90 fps. The channel depth is planned to be 1 foot deep resulting in a free board of 0.89 foot. The velocity is less than 5 fps, therefore, it is deemed to be non-erosive.

Undisturbed diversion channel UD-4 will be located above the portal area on the southeast side of Right Fork North Fork Gordon Creek and will divert runoff from 3.50 undisturbed acres to by-pass culvert UC-1 (see Plate 7-4). The diversion will be trapezoidal in shape and will be constructed with a 1 foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.05 to 0.10 foot/foot (see Figure 7-9). The channel will be constructed in natural materials. The 10 year-6 hour peak flow for the drainage is 0.38 cfs. To handle this event the diversion channel will have a maximum flow depth of 0.13 foot and a maximum velocity of 3.94 fps. The channel depth is planned to be 1 foot deep resulting in a free board of 0.87 foot. The velocity is less than 5 fps, therefore, it is deemed to be non-erosive.

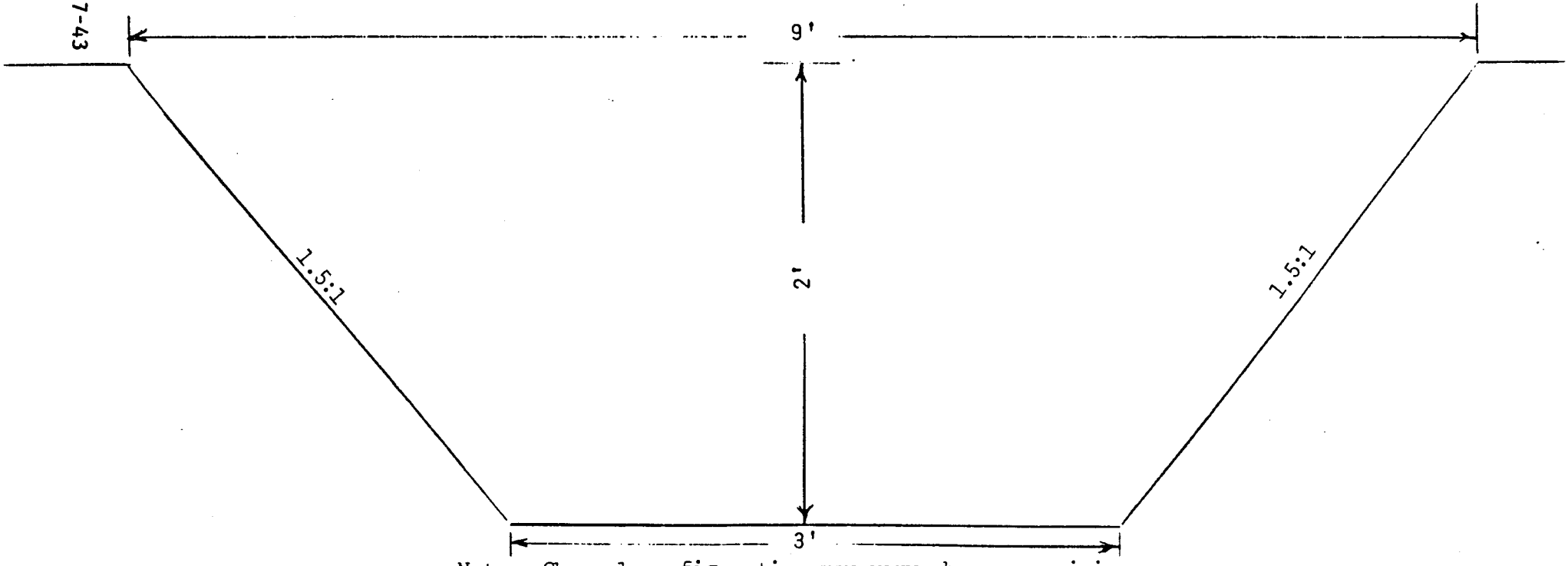
The UD-5 undisturbed area diversion channel will be located above the facilities area in the Right Fork North Fork Gordon Creek. This diversion will divert runoff from the channel of the Right Fork North Fork Gordon Creek to by-pass culvert UC-1. The drainage area to this diversion will be 142.68 acres in size. The diversion will be trapezoidal in shape and will be constructed with a 3 foot bottom width, 1.5H:1V sideslopes, and a channel slope ranging from 0.04 to 0.06 foot/foot (see Figure 7-9). The channel will be constructed in natural materials. The 10 year-6 hour peak flow for the drainage is 3.91 cfs. To handle this event the diversion channel will have a maximum flow depth of 0.29 foot and a maximum velocity of 4.46 fps. The channel depth is planned to be 2 foot deep resulting in a free board of 1.71 foot. The velocity is less than 5 fps, therefore, it is deemed to be non-erosive.

Figure 7-9



Note: Longitudinal not drawn because of consistent slope.

Note: Channel configuration may vary; however, minimum cross-sectional area will be maintained at 3 sq. ft.



Note: Channel configuration may vary; however, minimum cross-sectional area will be maintained at 12 sq. ft.

Culverts. The culverts to be utilized to by-pass the runoff from the undisturbed areas above the mine facilities will be installed as shown on Plate 7-4 and 7-5. Undisturbed area culvert UC-1 will by-pass drainage runoff from diversion UD-4 and UD-5. The combined 10 year-6 hour peak flow from these diversions is 4.29 cfs. The culvert size to be installed in this section of the drainage is 1.5-foot diameter. Based on inlet control conditions, to pass the peak flow with a headwater to depth ratio of one or less requires a culvert diameter of 1.5 feet. A trash rack will be installed on the inlet to this culvert. Figure 7-10 presents the design of the trash rack.

Culvert UC-2 will receive runoff from diversion UD-3. The 10 year-6 hour peak flow for this culvert is 0.33 cfs. A 1-foot diameter culvert is planned to be installed at this location. This size is based on inlet control conditions for the culvert with a headwater to depth ratio of one or less. A trash rack will be installed on the inlet to this culvert. Figure 7-10 presents the design of the trash rack.

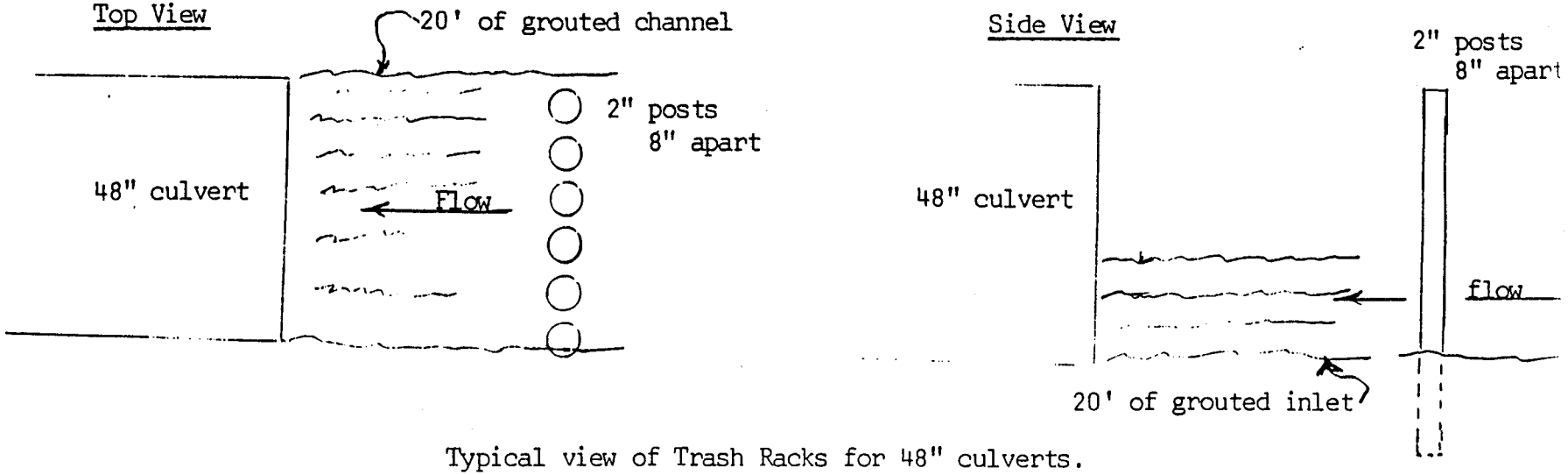
Discharge from culverts UC-1 and UC-2 will be combined in UC-3. The combined 10 year-6 hour peak flow from these culverts is 4.62 cfs. This flow can adequately be handled by a 1.5-foot diameter culvert.

The UC-4 culvert will by-pass runoff from the North Fork Gordon Creek and UD-2. The combined 10 year-6 hour peak flow for this culvert is 9.55 cfs. Based on inlet control conditions, the required culvert diameter for this flow is 2.0 feet. However, Blue Blaze Coal Company will install a 3-foot diameter culvert in this section as a conservative measure. A trash rack will be installed on the inlet to this culvert to prevent plugging by brush and debris. Figure 7-10 presents the trash rack design.

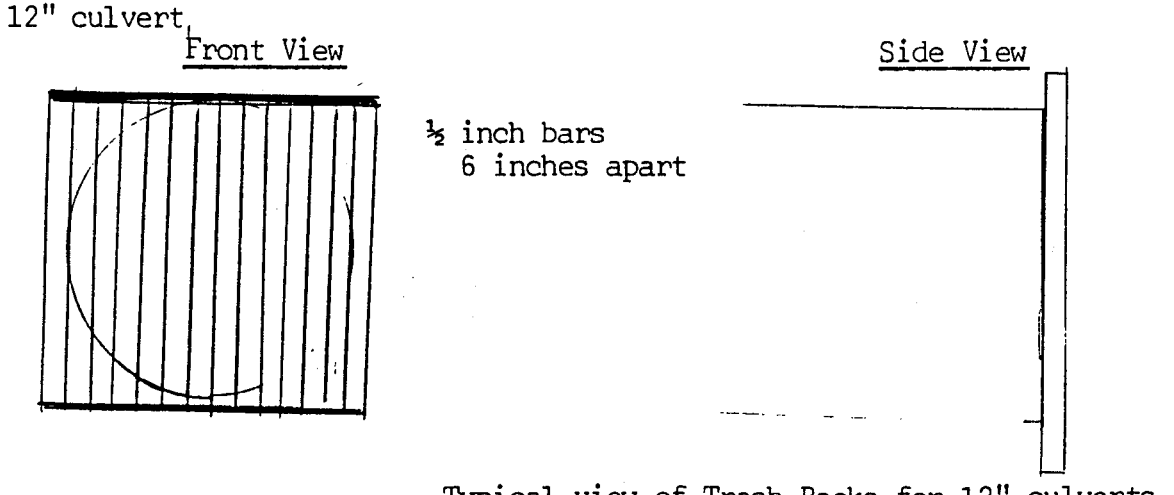
Flow from culverts UC-3 and UC-4 will be combined in UC-5 (see Plates 7-4 and 7-5). The combined peak flow from the 10 year-6 hour event for these culverts is 14.17 cfs. The required culvert diameter to pass this flow is 2.0 feet, based on open-channel flow conditions. However, Blue Blaze Coal Company will install a 3-foot diameter culvert in this section as a conservative measure.

Discharge at the outlet of culvert UC-5 will have an exit velocity of approximately 8.8 fps. This will be controlled by installing a graded riprap on the bottom and along the sides of the channel for an approximate distance of 30 feet downstream from the culvert outlet to a location where the outflow from the sediment pond spillway will enter the channel (see Plate 7-6). The riprap will have a D_{50} of 0.8 foot. The gradation of the riprap is presented in Table 7-7. A 6-inch thick layer of 1" D_{50} gravel will be installed beneath the riprap.

Figure 7-10



Typical view of Trash Racks for 48" culverts.



Typical view of Trash Racks for 12" culverts.

Table 7-7

Riprap Gradations

Diameter Gradation	Diameter Size
RD-1 Channel Section	
D_{100}	0.75 feet
D_{85}	0.63 feet
D_{50}	0.5 feet
D_{15}	0.05 feet
RD-2 Channel Section	
D_{100}	0.9 feet
D_{85}	0.75 feet
D_{50}	0.6 feet
D_{15}	0.06 feet
RD-3 Channel Section	
D_{100}	1.5 feet
D_{85}	1.25 feet
D_{50}	1.0 feet
D_{15}	0.1 feet

The road culvert U-6 is sized to handle the complete flow from the North Fork Gordon Creek drainage for the 100 year-6 hour storm. The required size of this culvert is a 3-foot diameter culvert. Blue Blaze Coal Company will install a 3.5-foot diameter culvert to be consistent with the culvert installed on the state highway. This culvert will use a trash rack installed upstream of the culverts inlet. Angular riprap will be installed at the inlet and outlet of the culvert and will be riprapped for a distance of 20 feet to insure no erosion of the ditch banks upstream or downstream will occur.

Prior to installation of the culverts, Blue Blaze Coal Company will survey the channels of the Left and Right Forks North Fork Gordon Creek above the proposed disturbed area and the North Fork of Gordon Creek below the disturbed area, to determine capacity of the channels. This evaluation will be based on the low flow portion of the channel to determine the average annual flow. This flow will be compared against the 10 year-6 hour peak flow to ensure that the culverts have adequate capacity.

Disturbed Area Runoff and Sediment Control

General. In order to minimize additional sediment loading to any streams from the disturbed area, runoff from these areas will be collected in the sedimentation pond and treated prior to discharge (See Plate 7-5 & 7-6). The runoff from the disturbed and undisturbed areas will be directed to the sedimentation pond which can adequately contain runoff from a 10 year-24 hour storm event.

The disturbed area D-1 will be sloped to a trapezoidal collection ditch D-1 then directed around the coal stock pile to the incised sedimentation pond. The undisturbed area south and east of diversion ditch D-1 will flow across culvert UC-1, UC-3, and UC-5 and enter D-1 (see Plate 7-5). The disturbed area D-2 below the stockpile will be collected and directed to a culvert, DC-1, where it will be directed to the sedimentation pond via ditch D-1. The soil storage area, a disturbed area D-3, will be collected with a berm around the storage area and direct the water through a culvert, DC-2, directly to the sedimentation pond. Calculations supporting these designs are presented in Appendix 6e.

Disturbed Area Diversions. The major portion of the 9.33 acres of disturbed area and 12.54 acres of the undisturbed area, which could not be efficiently diverted around the disturbed facilities area, will be collected by a disturbed area diversion ditch, D-1. The D-1 channel will be trapezoidal in shape and located where the slope of the mine area will direct the water into this channel. The channel will flow directly to the sedimentation pond. The diversion will be constructed with a 1 foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.05 to 0.17 foot/foot. The channel will be constructed in pad fill materials. The 10 year-6 hour peak flow for the drainage is 2.09 cfs. To handle this event the channel will

have a maximum flow depth of 0.32 foot and a maximum velocity of 6.18 fps. The channel depth is planned to be 1 foot deep resulting in a free board of 0.68 foot (see Figure 7-9). The velocity is greater than 5 fps. However, due to the extensive maintenance that will occur on this diversion during operation, no riprap protection will intially be installed. The diversion may require some erosion control protection at different locations, such as bends or drops. If deemed neccessary during operation and the channel shows any excessive erosion, Blue Blaze Coal Company will install riprap or other effective erosion control measures.

A culvert DC-1 will be installed to carry disturbed area water from the area below the loadout area under the road and directly to the sedimentation pond via D-1. The peak discharge to this culvert will be 1.16 cfs. A 1-foot diameter culvert is planned to be installed at this location. This size is based on inlet control conditions for the culvert with a headwater to depth ratio of one or less.

The soil stockpile area, with a peak runoff of 1.25 cfs, will be directed to culvert DC-2 with use of a berm surrounding the soil stockpile. The flow will drain directly to the sedimentation pond through culvert DC-2. A riprap apron will be grouted at the outlet of this culvert to eliminate any erosion to the inslope of the sediment pond. A 1-foot diameter culvert is planned to be installed at this location. This size is based on inlet control conditions for the culvert with a headwater to depth ratio of one or less.

Sedimentation Pond Design. The extent of the disturbed area of the Blue Blaze No. 1 and No. 2 Mines is approximately 10.3 acres. This area will be treated by sediment control structures. An additional 15.66 acres of undisturbed area which could not be efficiently diverted around the operation will also be treated. The areas around all surface facilities including buildings, trash containers, snow removal and stockpile will be sloped so that the water drainage from these facilities will enter the disturbed area drainage ditches that direct the water flow directly to the sedimentation ponds.

The siltation structure location is presented on Plate 7-5. All runoff from disturbed areas will be directed to the sedimentation pond with exception of the access road located below the sedimentation pond. Silt fences will be placed along the road ditches to control the off-site sedimentation. Figure 7-11 shows the silt fence design.

The required storage volume for runoff from a 10-year 24-hour precipitation event for all areas draining to the sedimentation pond is 1.03 acre-feet (see Appendix 6e). A runoff curve number of 89 was used for disturbed area drainage, while an area weighted curve number of 70 was used for undisturbed drainage areas above the Blue Blaze No. 1 and No. 2 Mine area. The undisturbed area curve number

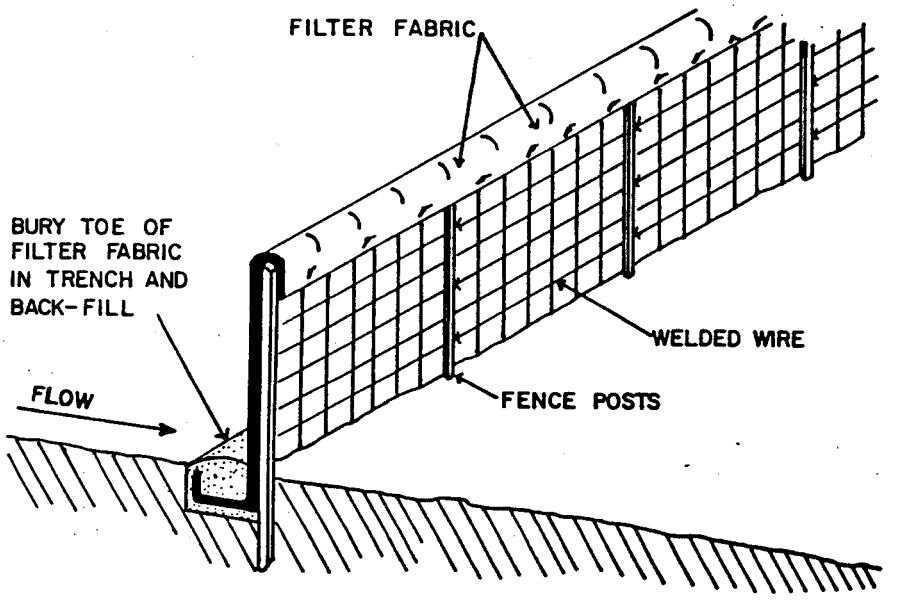


FIGURE 7-II. CULVERT INLET AND OUTLET PROTECTION.

is based on the estimate for antecedent moisture condition II for the oak, aspen and mixed conifer cover complexes at the headwaters of the undisturbed areas. Time of concentration was determined using the curve number procedure. The 10-yr, 24-hr rainfall was obtained from NOAA (1973) "Precipitation Frequency Atlas of the Western United States". The rainfall obtained for this storm is 1.8 inches.

An additional 0.52 acre-feet is required to provide a one year sediment storage volume for the sediment yield anticipated from disturbed areas. This is based on an initial sediment yield estimate for the disturbed area of 0.05 acre-feet of sediment per acre disturbed. Due to future design considerations Blue Blaze Coal Company will provide 1.25 acre-feet of sediment storage volume in the sediment pond.

The sediment pond will be a temporary, incised/embankment pond capable of containing a 10 year-24 hour runoff volume of 1.03 acre-feet and a sediment storage volume of 1.25 acre-feet. Based on a 60 percent cleanout criteria, the pond will have an operational sediment capacity of 0.75 acre-feet at an elevation of 7573.30. Plate 7-6 presents the plan view and cross-sections of the pond. The stage-capacity curve for the pond is presented in Appendix 6e. Total capacity of the pond below the invert of the spillway is 2.38 acre-feet. As indicated on the stage-capacity curve, the pond will have the required capacity, of 1.03 acre-feet for runoff and 1.25 acre-feet for sediment, with the spillway set at 7578.70.

The sediment pond is located in a area below all mine disturbed areas therefore disturbed area water will be directed towards the sedimentation pond and cannot enter the main stream. The pond is located in an area of level configuration and the stream does not have a definite channel. By mainly incising the sedimentation pond and constructing an embankment dam type pond and culverting the stream in a manner which can handle the water flow under extreme conditions, there will be limited chance of the undisturbed stream water from entering the pond or the water from the sedimentation pond from entering the stream before it is treated (see Plate 7-5).

As indicated in Appendix 6e, the peak flow to the sediment pond from the 25 year-6 hour storm is 5.0 cfs. The spillway channel will consist of an armored open channel over the southeast corner of the embankment, as presented in Plate 7-6. A cross section drawing of the spillway for the pond is provided in Plate 7-6. The spillway will have a depth of 1.3 feet and a width of 10 feet with a slope of 3% for the crest section through the embankment. The discharge capability using the Broad Crested Weir Formula for this structure is 30.87 cfs. The flow depth above the spillway at the design flow will be 0.30 foot (Elev. 7578.7). This will provide a 1.0 foot freeboard between the spillway flowing at a design elevation of 7579.00 and the crest of the pond embankment at 7581.00.

The spillway outlet will be riprapped (see Plate 7-6). The riprap will consist of a D_{50} of 6-inches with a gradation as presented in Table 7-5. The riprap will be placed in a layer with a minimum thickness of 6-inches. The riprap will consist of angular riprap grouted with cement from the exit of the pond to where it intersects the North Fork Gordon Creek drainage channel below the disturbed area. The 50% outslope of the pond will be protected with riprap cemented into place so erosion will be minimized. Design calculations for the riprap are presented in Appendix 6e. The angle of entrance of the spillway channel into the stream channel will be no greater than 45° from the channel alignment of the North Fork Gordon Creek.

Riprap will be placed on the 50% slopes of the inlet channels to the pond (see Plate 7-6). This will consist of 1.5-inch riprap cemented into place. This will minimize erosion and potential structure stability problems to the impoundment.

The runoff storage volume will be maintained by the use of a 2-inch decant line. As indicated on Plate 7-6, the inlet of the decant will be located at an elevation of 7575.30. The discharge from this decant will be controlled by a locking valve located on the outslope of the sediment pond embankment at the pipe outlet. This valve will used to drain the excess water from the sedimentation pond 24 hours after any storm to allow settling of the sediment from the impound. The decant will be 24 inches above the 60% sediment clean out level (see decant design on Plate 7-6).

A sediment marker will be placed at the edge of the pond to indicate the depth and volume of sediment in the pond. The marker will have designations which will indicate when cleaning of the pond is necessary (see Figure 7-12).

A Percolation test was performed to indicate the area to be suitable for the construction of the sedimentation pond (see Figure 7-13). Also the seismic area is a 2B under the Utah Building Code that indicates the area is safe for the construction of sedimentation ponds. The Static Safety Factor calculations are located in Appendix 3.

A report of construction and inspection on the sediment pond, by a professional engineer, will be reported at the end of construction to the Division.

Maintenance and Monitoring

The sedimentation pond shall be inspected after each major storm to determine if water needs to be treated and to check the sediment level and clean-out as necessary. The pond will be cleaned when

SEDIMENT MARKER

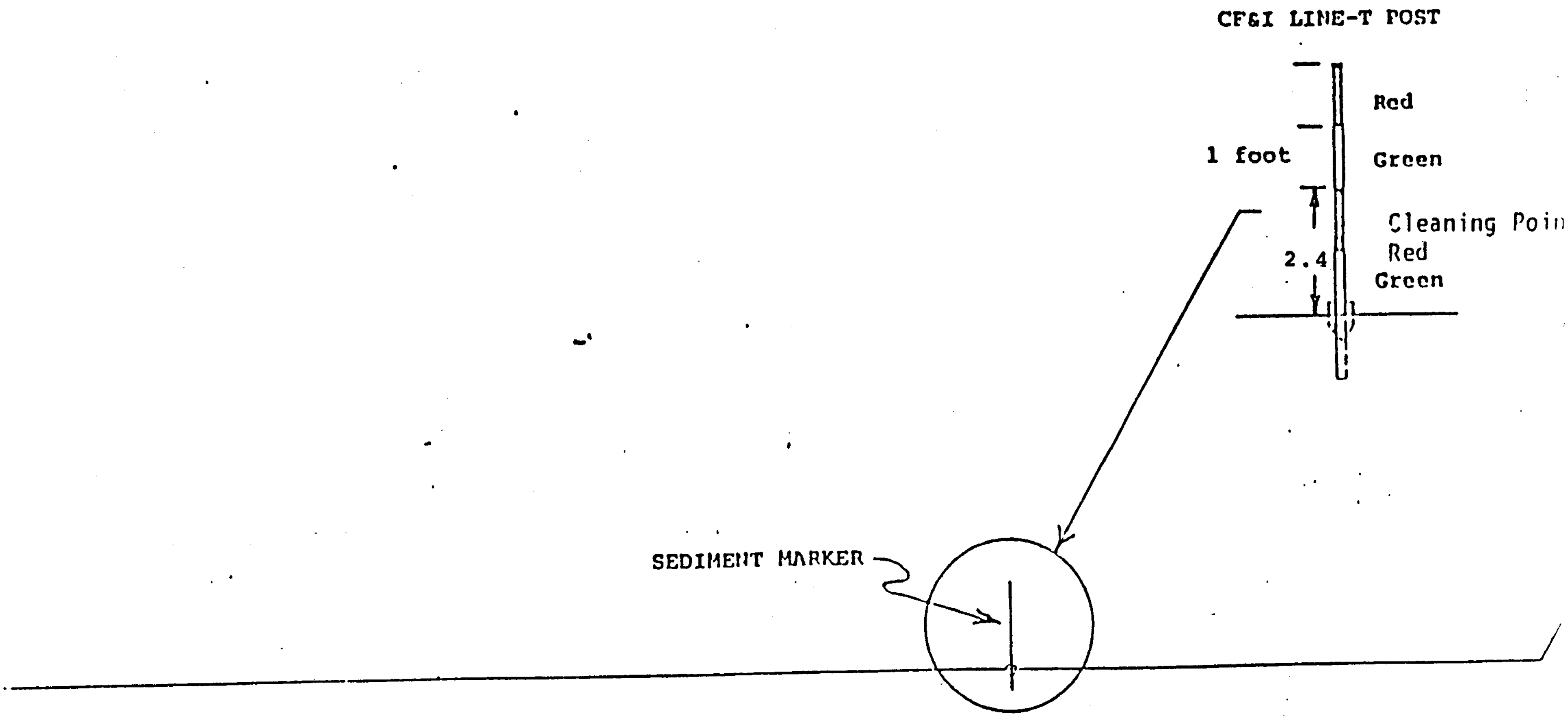


Figure 7-12

Figure 7-13

UTAH STATE DEPARTMENT OF HEALTH

PERCOLATION TEST CERTIFICATE

I certify that percolation tests have been conducted on property located at future mine site lying in the SE¼, NE¼, SW¼ of Section 17, T13S, R8E, SLB&M.

in accordance with requirements specified in the Code of Waste Disposal Regulations, Parts IV and V, adopted by the Utah State Board of Health and the Utah Water Pollution Control Board, and that percolation rates, calculated as specified by said regulations, are as follows:

Test Hole No.	Test Hole Depth	Inches Drop Final 30 Minute Period	Percolation rate Minutes per inch
1	36"	7/8"	34min/"

Statement of soil and ground water conditions to a depth of 10 feet, or at least for a minimum of 4 feet, below the bottom of the proposed absorption system:

0 - 18" Sandy Loam
18-- 20" coal mixture
20 - 36" sandy Loam (some rock)

no ground water was encountered.

Signed John L. Hughes P.E.

Date Oct '90

Address 905 N 600 East.
Price, Ut. 84501

sediment builds to 60% of the maximum level, as shown on the sediment marker on Figure 7-12. Sediment removed from the pond shall be immediately removed from the site area by blending it with the coal.

Additionally, the sediment pond will be inspected quarterly by a qualified individual. Any weakness or defect in the structure will be corrected as quickly as possible.
The pond discharge will be monitored as per the requirements of the NPDES Permit UT-0023761 until bond release or until the pond is removed.

Ditches, culverts and other drainage controls shall be inspected after each major storm, and cleaned as necessary. The pond embankments will be revegetated with the temporary seed mix described in Section 3.5.5.2. Any areas where revegetation is not successful or where rills and gullies develop will be repaired and revegetated accordingly.

Reclamation Design

Following the completion of mining operations, the mine site area will be reclaimed as discussed in Chapter 3 of this application. As part of the reclamation activities, Blue Blaze Coal Company will be reestablishing the natural drainage patterns and reconstructing the drainage channels.

The channels to be reestablished are the Right Fork North Gordon Creek and North Fork Gordon Creek. These channels will need to be reestablished within the canyon bottom. Due to the proposed site configuration of the canyon bottom, where the site will be divided into two sections, and the need to remove the operational sediment pond embankment to allow the removal of the existing by-pass culvert and construction of the reclaimed channel, it is not practical to have the sediment pond remain in-place through the reclamation period.

Additionally, incorporation of sediment ponds into the final reclamation plan would necessitate the continued use of undisturbed area diversions above the reclaimed slopes and use of culverts to convey some of this undisturbed runoff through the reclaimed area. The use of such facilities, for initial phases of reclamation until adequate vegetation were established, would require the subsequent re-disturbance of these re-vegetated areas to allow the structures to be removed. This is impractical since the limited area in the canyon bottom, especially in the Right Fork North Fork Gordon Creek, would be affected. The use of sediment ponds would simply lengthen the time necessary to establish permanent vegetation throughout the permit area. Therefore, ponds will not be used to control sediment during reclamation. Therefore, Blue Blaze Coal Company proposes regrading the site area, removing the by-pass culverts, reclaiming

the undisturbed diversion ditches, and reclaiming the sedimentation pond.

To minimize the impacts of the reclamation work, Blue Blaze Coal Company commits to construct the reclaimed stream channels commencing at the upstream end of each channel. This will allow the sediment pond to remain in-place and provide sediment protection for the greatest area for the longest period of time.

Sediment Control Measures

Blue Blaze Coal Company proposes to employ the following alternative methods in varying degrees to limit and control sediment runoff:

1. Filter fabric (silt) fences
2. Surface ripping
3. Mulch crimped into the surface
4. Straw bales
5. Seeding
6. Reseeding areas that do not exhibit successful germination

Based on Simons, et. al. (1983), these methods are some of the best currently available.

The proposed alternative sediment control measures can be classified into three categories: filtering structures, mechanical treatment, and surface protection measures. Filtering structures inhibit runoff and sediment transport capacity by reducing flow velocity. They also physically trap sediment in the filter openings while allowing water to pass through. Mechanical treatment increases surface roughness thereby reducing overland flow velocity, which minimizes the sediment transport capacity. Detaining some of the would-be runoff also improves soil moisture for plant germination. Surface protection measures include mulching, mulch binders, netting, and seeding. These measures are the most effective controls since they minimize the amount of soil detached by raindrop impact, and thus limit soil loss at the source. Surface protection measures also increase the surface roughness and increase soil infiltration.

Simons, et. al. (1983) indicates that synthetic filter fabric is more efficient than straw bales at trapping silt. Therefore, synthetic fabric fences and not straw bales will be utilized wherever possible. The approximate locations of these silt fences for reclamation are indicated in Plate 3-7. The locations shown are diagrammatic only. The fences will be installed parallel to the contours with the ends of the fences turned up perpendicular to the contours to contain the sediment. Silt fences will be installed in accordance with Figure 7-11. The filter fabric will be composed of a perforated synthetic fabric and will be installed against a separate supportive backing. To prevent sediment runoff from

passing under the fence, the fabric will be secured by burying the bottom edge of it in a small trench along the length of the fence.

Mechanical treatment of slopes of less than 10% will be performed by ripping the soil to a depth of 18 inches. Ripper shanks should be spaced about seven feet apart, and create parallel slots four to ten inches wide. Ripping will loosen the soil and allow root penetration and increase moisture storage. This will allow for quicker vegetation establishment, which will reduce erosion.

In regard to surface protection measures, for slopes less than 10 % a straw mulch will be used. For slopes greater than 10%, an erosion control matting will be installed. The mulch or matting significantly reduces the amount of sediment yield from an area (Simons, et. al., 1983) The mulch or matting also helps retain moisture to allow for seed germination.

Permanent plant growth is the best method of controlling erosion from slopes, according to Simons, et. al. (1983, p.4.44). Upon completion of the grading in accordance with the plan depicted in Plate 3-6, and ripping of the soil, the reclaimed area will be seeded with grasses and legumes. The seed mix is addressed in Section 3. Seeding will be performed at the appropriate time of the year in consideration of available moisture for germination. Areas in which the seed does not germinate will be reseeded.

Whenever possible, a minimum of one method of sediment control will be in place during reclamation construction. The existing pond will be left in place until the end of the grading operation, and then will be removed starting from the upper end of the canyon and working downstream. Prior to the removal of the ponds, filter fabric (silt) fences will be installed to collect sediment runoff. Upon completion of the grading and soil ripping, the reclaimed area will be seeded and mulched. Upon successful completion of vegetation establishment, the silt fences will be removed.

An evaluation of the effectiveness of the alternative sediment control structures was conducted. This evaluation compared the sediment production from the reclaimed surface assuming:

- Bare Surface
- Bare, Ripped Surface
- Ripped and Mulched Surface
- Ripped and Mulched Surface with Silt Fences

The sediment production from these surfaces was compared to the sediment production expected from the reclaimed surface with an established vegetative cover of 50 percent (that required for bond release). The Universal Soil Loss Equation was used to make these comparisons. Inputs, justification, and calculations are presented in Appendix 6e. Based on these calculations, the proposed

alternative sediment control measures provide better erosion control than the reclaimed, re-vegetated surface is able to provide.

The alternative sediment controls constructed during reclamation will be inspected monthly and after every major storm event. Corrections to any weaknesses in the implementation of the sediment control plan will be remedied immediately to prevent future silt runoff into the main stream channel. Corrective action will be taken:

- when sediment builds up on either side of a silt fence to half its height,
- when the sediment fence is listing more than 20 degrees from the vertical,
- when the straw bales become 50% saturated with silt,
- when the ground surface is gullied from erosion due to lack of vegetation establishment, or
- when the mulch and seed have been transported by wind or overland flow.

Corrective action will consist of repairing/replacing or adding filter fabric fences as necessary, replacing straw bales, regrading of the ground surface only as necessary to fill in gullies caused by erosion, and reseeding and mulching to reestablish vegetation. Soil material trapped by sediment control measures that is not used in repairing the site will be removed and disposed of off site in approved areas.

As each reach of reclaimed channel is constructed and riprapped, the regraded surfaces shall be mulched and the edge of the stream channel will be lined with silt fence or straw bale dikes. This will provide sediment protection until the vegetation on the regraded slopes is established well enough to minimize erosion.

During reclamation construction, the road ditches will utilize silt fences at periodic intervals to collect sediment from the drainage areas which may by-pass the sediment pond prior to leaving the site area.

Efforts will be made to minimize the construction activities during wet periods. Also, during short periods when reclamation construction activities will be suspended, the construction site will be left in a conditions which would minimize the impact on the hydrologic system if a rainfall event were to occur.

Reclaimed Channel Designs

This section provides the design of the reclaimed stream channels and a description of the sediment control measures that will be implemented during the reclamation activities. The reclaimed channels will be permanent diversions of the stream and will be sized to handle the flow from a 100 year-6 hour event. Plate 7-9

presents the drainage areas of the proposed drainages following reclamation activities. Appendix 6e presents the calculations for the peak flows for these drainages.

Drainage from the 171.50 acre Right Fork North Fork Gordon Creek, as shown on Plate 7-9 and 3-7, will flow through the reclaimed stream channel RD-1. The peak flow for the 100 year-6 hour event for this drainage is 9.43 cfs. The reclaimed channel will be trapezoidal in shape and will be constructed with a 5-foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.06 to 0.12 foot/foot (see Figure 7-14). The channel will be constructed in regraded fill materials and will be riprapped to provide a stable stream section. To handle this event, the channel will have a maximum flow depth of 0.35 feet and a maximum velocity of 5.90 fps. The channel depth is planned to be 1 foot deep resulting in a free board of 0.65 feet. The velocity is greater than 5 fps requiring the installation of riprap protection. Based on the U.S. Army Corps of Engineers (1970), riprap with a D_{50} of 0.5 feet is appropriate to provide adequate erosion protection. Material gradation for this riprap is presented in Table 7-5.

The RD-2 reclaimed stream channel will receive flow from the 348.30 acre Left Fork North Fork Gordon Creek drainage. The reclaimed channel will be trapezoidal in shape and will be constructed with a 5-foot bottom width, 2H:1V sideslopes, and a channel slope ranging from 0.04 to 0.10 foot/foot (see Figure 7-14). Peak flow for this drainage for the 100 year-6 hour event is 19.10 cfs. The channel will be constructed in regraded fill materials and will be riprapped to provide a stable stream section. To handle this event, the channel will have a maximum flow depth of 0.60 feet and a maximum velocity of 6.95 fps. The channel depth is planned to be 2 feet deep resulting in a freeboard of 1.40 feet. The velocity is greater than 5 fps requiring riprap protection. Therefore, riprap will be installed in the reclaimed channel. Based on the U.S. Army Corps of Engineers (1970), a D_{50} of 0.6 feet is appropriate to provide adequate erosion protection. Material gradation for this riprap is presented in Table 7-5.

7.3 Probable Hydrologic Consequences

The Probable Hydrologic Consequences (PHC) on mining the proposed Blue Blaze Mine area herein determined as per Utah Coal Mining Regulation R645-301-728.100 and R645-301-728.200.

Baseline geologic information is presented in Section 6 of this PAP. Baseline hydrologic information is presented in Sections 7.1 and 7.2 of this PAP.

7.3.1 PHC Determination

Water will be pumped from the North Fork Gordon Creek into the mine for use in dust abatement. It is not anticipated that large

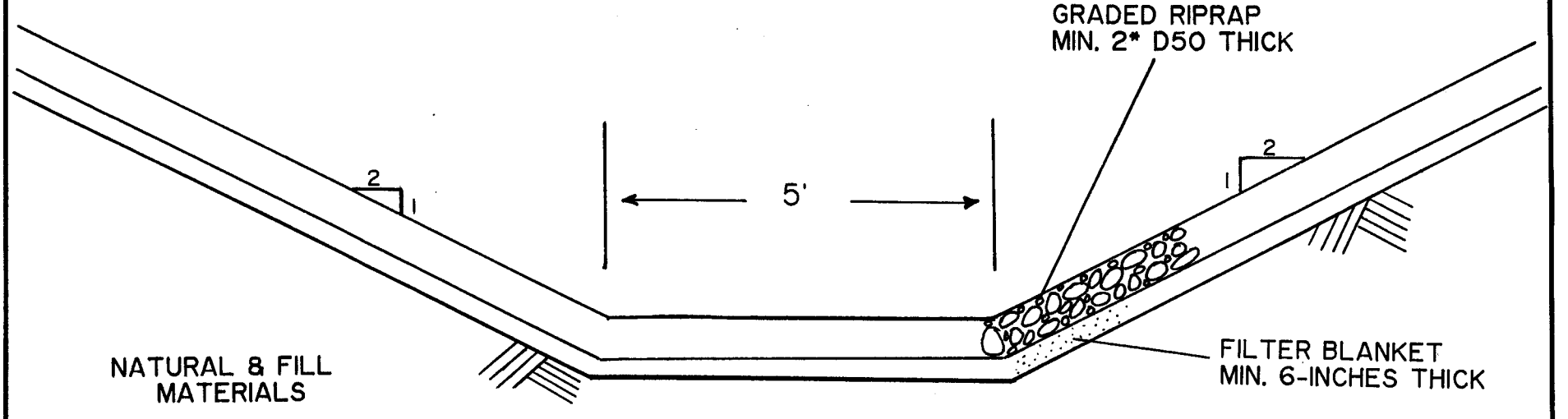


FIGURE 7-14. TYPICAL CROSS-SECTION FOR RECLAIMED CHANNELS.

EarthFax

quantities of ground water will be encountered throughout the duration of mining. As a result, discharge of water from the mine will not be necessary. Small quantities of water that may be encountered during mining operations will be used in conjunction with dust abatement.

7.3.1.1 Sediment Yield

The potential impact of construction, mining, and reclamation on sediment yield is an increase in suspended sediment in the surface waters downstream from the disturbed area. Sediment-control measures (such as sedimentation pond, diversions, etc.) have been designed (Section 7.2) to minimize impact that could result from elevated TSS and TDS concentrations. These facilities will be regularly inspected (see Section 7.2) and maintained as outlined in the permit and DOGM regulations.

7.3.1.2 Ground Water Hydrology

To date, the mining operations in the area have not had an impact on groundwater. Furthermore, as outlined below, wells drilled in the Blue Blaze permit area indicate the absence of aquifers in the area above the mine elevation that could be impacted by mining. Drill hole data is found in Table 6-2. Table 6-2 reveals depths to the Castlegate A and Hiawatha coal seams, as well as total depth drill and measured depth. The regional and mine plan area hydrology is discussed in Section 7.1. Seasonal wate quality and wuantity data for surface and groundwater is found in Appendices 6B and 6C respectively.

Surface water quality and quantity data has been collected seasonally for 3 years. Goundwater quality and quantity data has been collected seasonally for a period of 3 years.

Effects of Historic Mining on the Hydrologic System

Due to the extensive historic mining in the area, the Blue Blaze mines should not have any incremental impact on the hydrologic balance in or adjacent to the proposed mine area. Plates showing historic mine development and the proposed Blue Blaze mine area are found in Appendix 6F.

Extensive mining of the Castlegate 'A' coal seam within and adjacent to the proposed permit area has been conducted by Beaver Creek Coal Company (Gordon Creek No. 2 Mine), Blue Blaze Coal Co. (No. 3 Mine), and Swisher Coal Co. (Gordon Creek No. 6 Mine). Although numerous faults were intersected in the above mentioned mines, none of the mining operations shown on Map 3 of Appendix 6F encountered any significant amounts of water during mining of the Castlegate 'A' coal seam. Both the Blue Blaze No. 3 Mine and Gordon Creek No. 2 Mine were mined and pillared below Beaver Creek without any apparent incremental impact to the hydrologic system of the area.

Historically, large amounts of the Hiawatha Coal seam have been mined out to the southwest of the proposed permit area by Sweet Coal Company's Sweet Mine, Blue Blaze Company's No. 1 Mine, National Coal Company's No. 1 Mine, and Beaver Creek Coal Company's No. 3 Mine. Locations of these mines are shown on Map 4 of Appendix 6f. Many faults have been mined through in the Hiawatha seam with only insignificant/minor amounts of water being encountered. Only one fault has produced significant quantities of water when mined through. This fault lies in the east portion of the permit area and was intersected in mining of the Beaver Creek Coal Company No. 3 Mine. Inflows of approximately 400 gpm occurred (Map 8 of Appendix 6f). This fault is believed to be in communication with Beaver Creek, and will be avoided when mining the proposed Blue Blaze No. 1 Mine. Avoidance of this fault will be accomplished by closely monitoring mining activities in the fault area.

Prediction of Mining Impacts on Ground Water Hydrology

Potential impacts to the groundwater hydrologic system as a result of mining within and adjacent to the mine plan area can be divided into the following areas:

1. Impacts to the perched aquifer systems as a result of subsidence.

2. Impacts to the regional aquifer system.

3. Impacts to the Gordon Creek surface drainage system.

Impacts to the Perched Aquifer System

The hydrologic data presented in Section 7.1 indicate an absence of significant perched aquifers from the surface to a depth below the Hiawatha coal seam of the Blackhawk Formation. This stratigraphic interval encompasses the layers above the Castlegate A coal, the Castlegate A coal, the interval below the Castlegate A and above the Hiawatha coal, the Hiawatha coal itself, and the underlying Spring Canyon member of the Star Point Formation. The geology of the area and the occurrence of springs in the Blackhawk Formation (Section 7.1) indicate the presence of small, laterally discontinuous perched aquifers in the Blackhawk. These small perched aquifers within or adjacent to the mine plan area may be impacted as a result of mining related subsidence. These water sources are to be monitored as discussed in Section 7.1.

The perched aquifers of the Blackhawk Formation characteristically produce water from channel sandstones bounded by impervious shale beds at their bases. If subsidence fractures do intersect these perched aquifers, clay minerals contained within these shale beds may seal the fracture planes. Sealing of the fracture planes may allow spring discharge to continue uninterrupted.

According to the Cumulative Hydrologic Impact Assessment prepared for the area by DOGM (1989), "Subsidence impacts are largely related to extension and expansion of the existing fracture system and upward propagation of new fractures." Vertical and lateral migration of water is partially controlled by fracture conduits. Potential changes include increased flow rates along fractures and diverting flow along new fractures or within permeable lithologies. Subsurface flow diversion may result in diminution and/or loss of flow to springs that are undermined.

Retreat mining also results in uniform downwarping and lowering of strata above the mined interval. This uniform downward movement is generally not accompanied by a significant degree of fracturing. As a result, the original attitude and integrity of the strata are maintained. Little impact on the perched aquifers of the overburden are expected to result from downwarping.

Due to the following the effects of mining on the hydrologic resources associated with perched aquifers are considered minimal: 1) small number of springs, 2) low and/or erratic spring flow, 3) absence of municipal water use rights, 4) water loss experienced at one location may be accompanied in an increased flow at another location, and 5) possible sealing of subsidence fractures by clay minerals.

Impacts to the Regional Aquifer System

As previously discussed (Section 7.1), the regional aquifer system of the area probably lies below the mine in the Star Point Formation. Drill hole data from wells LMC-3 and LMC-4 indicate the upper portions of the Star Point that underlie the Blue Blaze Mine are dry. Dry conditions have been observed as deep as 203 feet into the Star Point Formation (below the Hiawatha coal) in LMC-4.

Water occurred in the adjacent mine (Beaver Creek #3) when a 50 foot fault was encountered emitting water in at the rate of 400 gpm. This fault indicated on Plates 7-2 and 6-1, to the east of drill hole LMC-2, will be avoided while mining advances in this area.

Due to the absence of water directly beneath the Blue Blaze Mine and planned avoidance of known water bearing fractures, effects of mining on the regional Star Point aquifer system are considered minimal and/or nonexistent.

Impacts to the Hydrologic System Resulting From Subsidence

The mine has been designed to preclude subsidence of perennial and intermittent stream reaches. Stream buffer zones beneath intermittent and perennial stream reaches are shown on Plate 3-3. Retreat mining will only occur beneath ephemeral stream reaches. Thus, no alteration of perennial or intermittent streamflow is anticipated.

As noted in the above-referenced Cumulative Hydrologic Impact Assessment, mining in the area adjacent to the proposed Blue Blaze permit area has not resulted in hydrologic impacts due to subsidence. Given the lack of extensive aquifer systems in lithologic units that overlie the coal within the permit and adjacent areas, groundwater is not considered to be a significant renewable resource in areas that may be affected by subsidence. Thus, subsidence caused as a result of mining by BBCC will not cause significant groundwater impacts within the permit or adjacent areas.

Potential Hydrocarbon Contamination

The regional ground water system in the proposed Blue Blaze permit area does not exist proximal to proposed mine intervals. Well seep and spring data indicate the absence of significant perched aquifers above the proposed mine area. The absence of significant perched aquifers, and a regional aquifer located at least a couple of hundred feet below the lowest interval to be mined, indicate the hydrology of the area is not in danger of having it's resources diminished.

Diesel fuel, oils, greases, and other hydrocarbons products will be stored at the mine site. Diesel fuel will be contained in above-ground tanks. Diesel fuel may spill during filling of the storage tank, leakage of the tank, and filling of vehicle tanks. Hydrocarbons may be spilled during use in surface and underground activities.

The extent of contamination by spillage of hydrocarbons is small for the following reasons: first, tanks will be located above-ground and thus leakage can be readily detected and abated, and spillage of hydrocarbons during filling of the tank and mine vehicles is minimized to avoid loss of an economically valuable product, and the fuel storage area will be surrounded by a berm of sufficient size to contain a fuel spill if the tanks were to rupture. In the event of a fuel or hydrocarbon leak or spill, Blue Blaze Coal Company will abate the problem in accordance with "The Spill Prevention and Contamination Control Plan (SPCC).

Road Salting

The access road to the mine is a gravel road maintained by the county. Paving of the road is not expected. Since the road is to remain gravel, the likelihood of road salting is extremely small. As a result, the likelihood of road salting impacting water quality is very remote.

Structures and Renewable Resource Information

Information regarding structures and renewable resources within the permit and adjacent areas is provided in Section 3.4.8 of the permit

application package. The subsidence control and monitoring plan is also presented in Section 3.4.8.

Interbasin Transfer of Water

Ground water intercepted by the mine which is a tributary of the Price River Basin will remain within the Price River Basin runoff area. The Gordon Creek Drainage is a tributary of the Price River Basin. Interbasin transfer of water cannot occur in this mining area.

Prediction of Mining Impacts on Surface Water

Local surface water hydrology consists of mountain streams which originate as springs, seeps, and watershed runoff. The majority of runoff occurs during the months of April, May and June as higher elevation snow packs are reduced.

The primary surface disturbances resulting from the Blue Blaze Mine surface facilities are on the southern draining watersheds. Within this subdrainage will be located the surface facilities including mine portals, conveyor systems, stockpiles, loadout facilities, parts supplies, power transformers, roadways, offices and all other systems associated with the mine operation.

In accordance with State and Federal regulations, a runoff conveyance and sedimentation control plan has been developed which mitigates the impacts of mining operations. Surface runoff originating upon or traveling across disturbed areas is diverted into a sedimentation pond which improves water quality and decreases peak runoff flows. Through the ponding process, some additional water loss is anticipated in the form of increased surface evaporation.

Although some surface waters are temporarily diverted out of their original channels, they shortly thereafter re-enter the main channel and continue their course downstream having experienced little overall modification. Disturbed waters exiting the sedimentation pond will re-enter the natural downstream drainage system. Overall hydrologic consequences to surface flows are expected to be minimal.

Surface Water Quality

Analytical surface water quality and flow rate date are found in Appendix 6C. Figure 7-3 through 7-6 summarize ground and surface water electrical conductivity, TDS and SO_4 concentrations.

Stream flow of the North Fork of Gordon Creek flows across the Mancos Shale immediately downstream from the mine area. Since the Mancos Shale is a gypsiferous formation, sulfate and TDS concentrations naturally increase (Waddell et. al., 1981). Thus, if additional input of these constituents from the mine waters occurs,

its impact is considered minimal. Increased mining activities may impact local water quality due to increased erosion potential and increased suspended sediment concentrations of runoff from disturbed areas.

Movement of particulate matter usually occurs as the direct result of either surface runoff erosion or as wind blown erosion. Sediment volumes and quantities expected would be greater during heavy construction phases than during non-construction periods. To combat the potential for decreased water quality resulting from increased sediment loads, a sediment pond will remove sediments originating from disturbed areas.

Data presented in Appendix 6B indicate that some naturally occurring seasonal variations exist with some water quality criteria, but that no long term water quality trends are evident.

Stream waters will be protected from elevated TSS concentrations by a sedimentation pond and silt fences. Only minor increases in TSS concentrations may occur, these minor increases will have no significant impact. After mine reclamation, water quality will approach those of pre-mining conditions.

Public Water Supplies

The water located in the Gordon Creek Drainage system is not a public water supply. The water in this drainage is used for agricultural, livestock, wildlife and industrial use (see Appendix 6B). As a result, impacts to public water supply are nonexistent.

Flooding Potential of Downstream Areas

Runoff from all disturbed areas flows through a sedimentation pond or other sediment-control device (Section 7.2). Three factors indicate that these sediment-control devices minimize or preclude potential flooding impacts to downstream areas as a result of mining operations.

1. The sediment-control facilities have been designed to be geotechnically stable. Thus, the potential is minimized for breaches of the sediment-control devices to occur that could cause downstream flooding.

2. By retaining sediment on-site in the sediment-control devices, the bottom elevations of stream channels downstream from the disturbed areas are not artificially raised. Thus, the hydraulic capacity of the stream channels is not altered.

3. The flow routing that occurs through the sediment control devices reduces peak flows from the disturbed areas. This precludes flooding impacts to downstream areas.

Following reclamation, stream channels will be returned to a stable state, thus minimizing detrimental effects that may result from flooding.

Hydrologic impacts to both the groundwater and surface water systems are considered to be minimal to nonexistent in the Blue Blaze Mine Permit Area, and adjacent areas. Groundwater contained in perched aquifers that overlie the intervals to be mined are small, laterally discontinuous, and do not contain appreciable quantities of water.

The regional groundwater system of the area does not exist proximal to the proposed mine intervals. Well data indicate the absence of significant perched aquifers above the proposed mine and the regional aquifer lies at least a couple hundred feet below the proposed mine. As a result hydrology in the area is not in danger of having its resources diminished by mining activity.

As outlined above, surface diversions have been designed to control and mitigate any adverse affects that could occur to surface waters of the area as a result of mining activity.

7.4 Alluvial Valley Floor Determination

A reconnaissance investigation for Alluvial Valley Floor (AVF) assessment was performed in accordance with State and OSM Regulations. Identification of locations where unconsolidated stream-laid deposits occur was performed using a surficial geology map of the area. Further, an analysis of aerial photographs of the mine permit site and adjacent areas was conducted in order to identify possible alluvial deposits that were not included in the surficial geology map. A break in valley side slopes producing an identifiable valley floor served as the primary criteria for identifying possible alluvial deposits. Aerial photo analyses revealed two small locations along Beaver Creek where possible alluvial deposits exist.

From a geomorphic standpoint, the rugged mountainous terrain of the permit site has resulted in drainages still in a youthful stage of development. The streams are confined in narrow, steep-sided, V-shaped valleys with steep channel gradients. Meanders normally associated with AVF development are absent except in a few isolated locations along Beaver Creek.

The site along Beaver Creek that was designated as possible alluvium in the aerial photograph analysis exhibits stream meandering and numerous beaver ponds. A field visit to the site confirmed the photo analysis. Soils in the valley were flooded or water logged.

The other site designated as possible alluvium is on a tributary to Beaver Creek in the southwest corner of Section 7, T13S, R8E. This small deposit occurs at the mouth of the tributary and probably consists of alluvial and debris flow materials. The site was partially flooded and the soils were water logged during a field visit to the site.

The valley floor along Beaver Creek and its tributary in Section 7 would be incapable of supporting agricultural activities without proper drainage. Even with adequate drainage, agricultural development would be restricted to grasses and pasture because of the high elevations and short growing seasons. Possible alluvial deposits were also identified at the mouth of Bryner Canyon and continuing downstream along the Gordon Creek. The alluvial deposits at this location are below the coal outcrop and thus, could not be directly impacted by mine subsidence. The soils investigation showed the upper reaches of this alluvial deposit to be disturbed and consisting of about 90 percent fill material. Disturbance results from road cuts and coal waste. Included in the area are small areas of Patmos and Podo soils as well as areas of rock outcrops. Even before disturbance, the site had limited range and wildlife capability. The valley floor is quite narrow along this reach of Gordon Creek.

Agricultural developments are not found along Gordon Creek or Beaver Creek in the vicinity of the mine. The agricultural potential of the valley floors in the area is limited by the soil capability and the short growing season. The narrow valleys are occupied by the stream and the road and both break up the narrow valley so that development of hay meadows or improved pasture is impractical.

7.5 References

Barfield, B.J., Warner, R.C. and Haan, C.T. 1981. Applied Hydrology and Sedimentology for Disturbed Areas. Oklahoma Technical Press, Stillwater, 603 pp.

Cordova, R.M., 1964, "Hydrogeologic Reconnaissance of Part of Headwaters Area of the Price River, Utah", Utah Geological and Mineral Survey, Water Resources Bulletin 4a, p. 26.

Danielson, T.W., M.D. ReMillard, and R.H. Fuller. 1981. Hydrology of the Coal-Resource Areas in the Upper Drainages of Huntington and Cottonwood Creeks, Central Utah. Water-Resource Investigations Open-File Report 81-539. U.S. Geological Survey. Salt Lake City, Utah.

Davis, F.D., and Doelling, H.H., 1977, "Coal Drilling at Trail Mountain North Horn Mountain and Johns Peak area, Wasatch Plateau, Utah", Utah Geologic and Mineral Survey, Bulletin 112, p. 90.

Doelling, H.H., 1972. Central Utah Coal Fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery; Utah Geological and Mineral Survey, Monograph Series no. 3, Wasatch Plateau. Salt Lake City, Utah.

Engineering-Science, 1984. Cumulative Hydrologic Impact Assessment with Respect to the Gordon Creek No. 2 Mine. Prepared for U.S. Office of Surface Mining, Denver, Colorado.

Environmental Protection Agency, 1976. Erosion and Sediment Control: Surface Mining in the Eastern U.S. Vol. 2; Design, EPA-526/3-76-006.

Farmer, E.F. and S.E. Fletcher, 1972. Some Intra-Storm Characteristics of High-Intensity Rainfall Bursts. Proc. Symposium on Distribution of Precipitation in Mountainous Areas WMO. Geilo, Norway.

Fisher, D.J., Erdmann, C.E., and Reeside, J.B., 1960. "Cretaceous and Testing Formation of the Book Cliffs, Carbon, Emery, and Grand Counties, Utah, and Garfield and Mesa Counties, Colorado", U.S. Geological Survey Professional Paper 332, p. 80.

Hansen, C. D., 1988, "Geology o the Jump Creek 7 1/2' Quadrangle, Carbon County, Utah," M.S. Thesis, Brigham Young University, 70 pp.

Harvey, J.A., 1992. Personal communication.

Lines, G.C., 1985. The Ground-Water System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah. U.S. Geological Survey Water-Supply Paper 2259. Washington, D.C.

McCuen, R.H., 1982. A guide to hydrologic Analysis Using SCS Methods.

OSM, 1981. Hydrology and Sediment Yield Work Manual. Prepared for Office of Surface Mining, Region V, Denver CO.

Price, D. and Arnow T. 1974. Summary Appraisals of the Nation's Groundwater Resources - Upper Colorado Region. U.S. Geological Survey Professional Paper 813-C, 40 pp.

U.S. Bureau of Reclamation. 1977. Design of Small Dams. U.S. Government Printing Office, Washington, 816 pp.

U.S. Soil Conservation Service. 1972. National Engineering Handbook - No. 4 - Hydrology. U.S. Government Printing Office, Washington, D.C.

Utah Division of Oil, Gas and Mining, 1989. Upper Gordon Creek Cumulative Hydrologic Impact Assessment. Utah Department of Natural Resources. Salt Lake City, Utah.

Vaughn Hansen and Associates, 1979, "Consultants Report on the Geology and Hydrology of the Skyline Mine of Coastal States Energy Corporation".

Waddell, K.M., P. Kay Contratto, C.T. Sumsion, and J.R. Butler. 1981. Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal-Fields Area, Utah. U.S. Geological Survey Water-Supply Paper 2068. Washington, D.C.

Wischmeyer, W.H., 1977. Procedure for Computing Sheet and Drill Erosion on Project Areas. USDA, Soil Conservation Service, Tech Release No. 41 (Rev. 2).

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Section 8

SOIL RESOURCES

8.1 Scope

A soil inventory of the Blue Blaze Mines area was conducted to provide soil resource information to meet the requirements of the Utah Division of Oil, Gas and Mining (DOGM) and the Office of Surface Mining (OSM). The soil survey was performed by Richard A. Foster, Soil Scientist, (USDA Soil Conservation Service) in February 13, 1990 (Section 8.3.1). This is in addition to the soil survey which was performed by George Cook, (Range Conservationist), Earl Jensen, (Soil Scientist) and Gary Moreau, (District Conservationist) of the SCS in May 1980 (Appendix 5).

8.2 Methodology

Soil mapping of the Blue Blaze Mines area (Plate 8-1) is a refinement of USDA Soil Conservation Service manuscript mapping. The soils mapping was done by Patrick D. Collins (Botanist/Reclamation Specialist) using the information supplied by George Cook of the SCS as to the locations, types and depths of soils.

George Cook (SCS) and Richard A. Foster used the pit method to estimate depths and quality of the soil. Detailed pedon are described to depths of 60 inches, or until bedrock, whichever was shallowest. These pits were dug below the No. 1 Mine area, up the canyon where new disturbance will occur, and at previously disturbed areas.

The soils to be saved for reclamation were tested at a approved laboratory using the DOGM guidelines. The parameters tested were pH, electrical conductivity, saturation percent, particle size, soluble Ca, Mg & Na, Total N, Nitrate-N, Organic carbon, available water capacity, rock fragments above 2mm size, and soil color. Where a high pH was indicated, tests were preformed for Selenium and Boron.

Present and potential uses of the soils of the site have been evaluated based on Soil Conservation Service Soil Survey Interpretation information. The soils have no potential as cropland or pasture land. The soils have also been evaluated for the potential production as rangeland and their capability groups are given.

The soils have been correlated by the SCS. Classifications are based on morphology as described in the field, and to a lesser degree on the analytical data. Where analytical data do not support the field description the soils are classified according to the field description.

8.3 Soil Resource Information for the Mine Plan Area

8.3.1 Soils Identification

The soils at the Blue Blaze Mines were initially identified on site. This allowed the consultant to determine slopes, land forms, and vegetation patterns (See Section 8.2). The soil descriptions were compared with recorded characteristics of the soils in adjacent areas and in the official SCS series descriptions. Map units are comprised of soil series and inclusions found within an area to make them site specific. The differences in symbols between the SCS report located in Appendix 5 and the new SCS guidelines dated June 1988 used on Plate 8-1, are as follows:

FIA	=	Shupert-Winetti Complex
GIG	=	Curecanti
HIG	=	Senchert
JIB	=	Brycan Loam
DM	=	Mine Dumps (Previous Disturbed Area)
		Rabbitex

Shupert-Winetti Complex

The Shupert - Winetti complex consists of very deep, well drained, moderately permeable soils on narrow valley and canyon floors. These soils formed in alluvium derived from sandstone and shale. Slope is 1 to 8 percent. Elevation ranges from 4,600 to 7,200 feet but commonly is 5,200 to 6,400 feet. Average annual precipitation is 12 to 16 inches, and average annual air temperature is 43 to 45 degrees F.

These soils are fine-loamy, mixed (calcareous), frigid Typic Ustifluvents.

Brycan

The Brycan Series consists of very deep, well drained, moderately slowly permeable soils on alluvium derived from shale and sandstone. Slope is 3 to 8 percent. Elevation is 7,700 to 8,600 feet. Average annual precipitation is 16 to 20 inches, and average annual air temperature is 38 to 45 degrees F.

These soils are fine-loamy, mixed Cumulic Haploborolls.

Rabbitex

The Rabbitex series consists of very deep, well drained, moderately permeable soils on mountain slopes and ridgetops. These soils formed in residuum andl colluvium derived dominantly from sandstone, shale, limestone, and siltstone. Slope is 15 to 70 percent. Elevation is 7,000 to 9,200 feet. Average annual precipitation

range from 16 to 20 inches, and average annual air temperature ranges from 38 to 45 degrees F.

These soils are fine-loamy, mixed Typic Calciborolls.

Senchert

The Senchert family consists of moderately deep, well drained, moderately permeable soils on mountain slopes, plateaus, and ridges. These soils formed in residuum and alluvium derived dominantly from sandstone and shale. Slope is 1 to 50 percent. Elevation is 8,000 to 10,100 feet. Average annual precipitation is 20 to 30 inches. An average annual air temperature is 36 to 38 degrees F. These soils are fine loamy, mixed Argic Pachic Cryoborolls.

A description of the soil sampled in Pits 1 through 7 follow.

Pit #1 - Shupert-Winetti Complex

Fine-loamy, mixed (calcareous), frigid Typic Ustifluvents. Colors are for dry soil unless otherwise noted.

A -- 0 to 6 inches (0 to 15.2 cm); light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate thin platey structure paring to moderate fine subangular blocky; hard, firm, sticky and plastic; common fine, many very fine roots; many fine and very fine random tubular pores; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); clear smooth boundary.

C1 -- 6 to 12 inches (15.2 to 30.5 cm); light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate coarse subangular blocky structure; hard, firm; sticky and plastic; few dine, common very fine roots; common fine, many very fine random tubular pore; moderately calcareous, lime is disseminate; strongly alkaline (pH 8.5); clear smooth boundary.

C2 -- 12 to 26 inches (30.5 to 66 cm); light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak coarse and medium subangular blocky structure; hard, firm sticky and plastic; few dine and very fine roots; common fine, many very fine random tubular pore; moderately calcareous, lime is disseminate; strongly alkaline (pH 8.5); clear smooth boundary.

C3 -- 26 to 40 inches (66 to 101.6 cm); pale brown (10YR 6/3) sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine, common very fine random tubular pores; moderately calcareous, lime is disseminate; strongly alkaline (pH 8.5); clear smooth boundary.

C4 -- 40 to 57 inches (101.6 to 144.8 cm); pale brown (10YR 6/3) loam, very dark grayish brown (10YR 3/2) moist; may fine distinct

(10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and very fine random tubular pores; moderately calcareous lime is disseminated; strongly alkaline (pH 8.5); clear smooth boundary.

2C -- 57 to 65 inches (144.8 to 165.1 cm); very pale brown (10YR 7/4) loamy fine sand, brown (10YR 5/3) moist; common fine distinct (10YR 5/8) mottles; massive; soft, very friable, nonsticky and non plastic; few very fine random tubular pores; moderately calcareous, lime is disseminate; strongly alkaline (pH 8.5).

The C2 horizon has thin strata of material like the C# horizon. The C# horizon has thin strata of material like the C4 horizon.

Pit #2 - Shupert-Winetti Complex

Loamy-skeletal, mixed (calcareous), frigid Typic Ustifluvents. Colors are for dry soil unless otherwise noted. Moist colors are darker in the upper three horizons due to the presence of coal. This is a disturbed site.

C1 -- 0 to 6 inches (0 to 15.2 cm); pale brown (10YR 6/3) sandy lam, very dark gray (10YR 3/1) moist; moderate thin platey structure parting to weak fine and very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few coarse and medium, many fine and very fine roots; few medium and fine, many very fine random tubular pore; moderately calcareous, lime is disseminate; moderately alkaline (pH) 8.4); clear smooth boundary.

C2 -- 6 to 19 inches (15.2 to 48.3 cm); pale brown (10YR 6/3) loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine, many very fine roots; few medium and fine, many very fine random tubular pores; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); clear wavy boundary.

C3 -- 19 to 34 inches (48.3 to 86.4 cm); light yellowish brown (10YR 6/4) extremely gravelly andy clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; few fine, common very fine random tubular pores; 10 percent cobble, 50 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.3); gradual wavy boundary.

C4 -- 34 to 47 inches (86.4 to 119.4 cm); pale brown (10YR 6/3) extremely gravelly loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many fine and very interstitial pores; 20 percent cobble, 50 percent gravel; moderately calcareous, lime is disseminate; moderately alkaline (pH 8.3); gradual wavy boundary.

C5 -- 47 to 60 inches (119.4 to 152.4 cm); light yellowish brown (10YR 6/4) extremely cobbly sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; many fine and very fine interstitial pore; 10 percent stone, 55 percent cobble, 10 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.4).

Pit #3 - Rabbitex

fine-loamy, mixed Typic Calciboroll. Colors are for dry soil unless otherwise noted.

A -- 0 to 5 inches (0 to 12.7 cm); brown (10YR 5/3) gravelly loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure parting to moderate fine and very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few coarse, common medium, many fine and very fine roots; common medium and fine, many very fine random tubular pores; 25 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.4); clear wavy boundary.

Bk1 -- 5 to 20 inches (12.7 to 50.8); brown (10YR 5/3) gravelly loam, dark grayish brown (10YR 4/2) moist; moderate medium and fine subangular blocky structure; slightly hard,friable, slightly sticky and slightly plastic; few coarse, medium, common fine, many very fine roots; common fine, many very fine random tubular pores; 20 percent gravel; moderately calcareous, lime is disseminated and in thin coatings on rock fragments; moderately alkaline (pH 8.4); gradual wavy boundary.

Bk2 -- 20 to 45 inches (50.8 to 114.3 cm); brown (10YR 5/3) gravelly loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, common fine and very fine roots; few fine, many very fine random tubular pore; 5 percent cobble, 20 percent gravel; moderately calcareous, lime is disseminated and in thin coatings on rock fragments; strongly alkaline (pH 8.5); clear wavy boundary.

Bk3 -- 45 to 51 inches (114.3 to 129.5 cm); yellowish brown (10YR 5/4) very gravelly loam, dark brown (10YR 4.3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium and fine, common very fine roots; few fine, common very fine random tubular pores; 5 percent cobble, 40 percent thin coatings on rock fragments; strongly alkaline (pH 8.5); clear wavy boundary.

Bk4 -- 51 to 70 inches (129.5 to 177.8 cm); brown (10YR 5/3) gravelly loam, dark grayish brown (10YR 4/2) moist; moderately medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, fine, and very fine roots; few fine and very fine random tubular pore; 25

percent gravel; moderately calcareous, lime is disseminated and in few fine veins and thin coatings on rock fragments; strongly alkaline (pH 8.5).

This soil is an inclusion in the Rabbitex mapping unit and is found predominantly at the base of steeper slopes.

Pit #4 - Shupert-Winetti Complex

Loamy-skeletal, mixed (calcareous), frigid Typic Ustifluvent. Colors are for dry soil unless otherwise noted. Moist colors are darker due to the presence of coal.

A -- 0 to 10 inches (0 to 25.4 cm); pale brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common medium and fine, many very fine roots; common medium, many fine and very fine random tubular pores; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); clear smooth boundary.

C1 -- 10 to 17 inches (25.4 to 43.2 cm); pale brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium, common fine and very fine roots; few medium, common fine and very fine random tubular pore; 10 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); gradual wavy boundary.

C2 -- 17 to 35 inches (43.2 to 88.9 cm); pale brown (10YR 6/3) very cobbly loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine, common very fine random tubular pores; 10 per cent stone, 15 percent cobble, 15 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); gradual wavy boundary.

C3 -- 35 to 60 inches (88.9 to 152.4 cm); light yellowish brown (10YR 6/4) extremely cobbly sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and very fine random tubular pores; 10 percent stone, 20 percent cobble, 30 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5)

Pit #5 - Brycan

Fine-loamy, mixed Cumulic Haploborolls. Colors are for dry soil unless otherwise noted. Less than 5 percent stone and cobbles on the surface.

A1 -- 0 to 8 inches (0 to 20.3 cm); dark brown (10YR 4/3) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium, common fine, many very fine roots; few medium, common fine, many very fine random tubular pores; 5 percent gravel; noncalcareous; moderately alkaline (pH 8.2); clear smooth boundary.

A2 -- 8 to 18 inches (20.3 to 45.7 cm); dark brown (10YR 4/3) gravelly loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine, common very fine roots; common medium and fine, many very fine random tubular pores; 20 percent gravel; noncalcareous; moderately alkaline (pH 8,2); gradual wavy boundary.

A3 -- 18 to 43 inches (45.7 to 109.2 cm); dark brown (10YR 4/3) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and lightly plastic; few fine and very fine roots; few fine, common very fine random tubular pores; 5 percent gravel; noncalcareous; moderately alkaline (pH 8.2); clear wavy boundary.

C -- 43 to 60 inches (109.2 to 152.4 cm); pale brown (10YR 6/3) very cobbly lam, brown (10YR 4/3) moist; massive slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots few fine and very fine random tubular pores; 20 percent cobble, 30 percent gravel; slightly calcareous, lime is disseminated; moderately alkaline (pH 8.2).

Pit #6 -Shupert-Winetti Complex

Fine-loamy, mixed (calcareous), frigid Typic Ustifluvent. Colors are for dry soil unless otherwise noted.

A -- 0 to 5 inches (0 to 12.7 cm); pale brown (10YR 6/3) sandy clay loam, dark grayish brown (10YR 4/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common coarse, medium, fine and very fine roots; common medium, many fine and very fine random tubular pores; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.2); clear wavy boundary.

C1 -- 5 to 14 inches (12.7 to 35.6 cm); pale brown (10YR 6/3) sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard friable, slightly sticky and slightly plastic; few coarse, medium, and fine, common very fine roots few medium, common fine, many very fine random tubular pores; 5 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.2); clear wavy boundary.

C2 -- 14 to 18 inches (35.6 to 45.7 cm); pale brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard

friable slightly sticky and slightly plastic; few medium and fine, common very fine roots; few medium and fine, many very fine random tubular pores; 5 percent gravel; slightly calcareous, lime is disseminated; strongly alkaline (pH 8.6): clear wavy boundary.

C3 -- 18 to 28 inches (45.7 to 71.1 cm); pale brown (10YR 6/3) very gravelly loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine, common very fine roots; few fine, common very fine random tubular pore; 40 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); gradual wavy boundary.

C4 -- 28 to 48 inches (71.1 to 121.9 cm); pale brown (10YR 6/3) sandy clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine, common very fine random tubular pores; 10 percent gravel with thin lenses of 50 percent gravel: moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); gradual wavy boundary.

C5 -- 48 to 60 inches (121.9 to 152.4 cm); pale brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine, common very fine random tubular pores; 5 percent gravel; slightly calcareous, lime is disseminated; moderately alkaline (pH 8.4).

Pit #7 - Brycan

Fine-loamy, mixed Cumulic Haploborolls. Colors are for dry soil unless otherwise noted.

A1 -- 0 to 10 inches (0 to 25.4 cm); brown (10YR 5/3) loam, very dark brown (10YR 2/2) moist moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse and medium, common fine and very fine roots; few medium, common fine, many very fine random tubular pores; 5 percent gravel; slightly calcareous, lime is disseminated; moderately alkaline (pH 8.2); clear wavy boundary.

A2 -- 10 to 17 inches (25.4 to 43.2 cm); brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, and fine, common very fine roots; few fine, common very fine random tubular pores; 5 percent gravel; noncalcareous; moderately alkaline (pH 8.2); clear wavy boundary.

A3 -- 17 to 34 inches (43.2 to 86.4 cm); pale brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak medium sub angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse, medium, and fine, common very fine

roots; few fine, common very fine random tubular pores; 5 percent gravel; noncalcareous; moderately alkaline (pH 8.2); clear wavy boundary.

C1 -- 34 to 52 inches (86.4 to 132.1 cm); pale brown (10YR 6/3) clay loam, very dark grayish brown (10YR 3/2) moist; massive; hard, firm, sticky and plastic; few fine and very fine roots; few fine, common very fine random tubular pores; noncalcareous; moderately alkaline (pH 8.2); abrupt wavy boundary.

C2 -- 52 to 60 inches (132.1 to 152.4 cm); light yellowish brown (10YR 6/4) clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; few fine and very fine random tubular pores; slightly calcareous, lime is disseminated; moderately alkaline (pH 8.2).

8.3.2 Soil Series Descriptions

Disturbed Land

The disturbed mine area consists of generally deep, nearly level to nearly vertical, moderately well-drained materials. The fill materials are derived from sandstone, shale, and coal from previous mining operations. The fill material comprise most of the proposed mine area. The native vegetation has been previously disturbed in the mine area.

The annual precipitation is 16 to 20 inches. The available water capacity is moderate to low and permeability is moderate. The mean annual air temperature ranges from 38 degrees to 45 degrees F. and the frost free period is 60 to 120 days.

Soils are identified by four categories (FIA, GIG, HIG, JIB) and are identified on plates and in the text as such. Depths and types of soil were identified by SCS. The topsoil to be saved for reclamation is also identified by category (See Plate 8-2 and Section 8.2).

A complete survey of the soil area was completed on November 3, 1990 and the new results were entered on Plate 8-2.

With the use of a planimeter the following amounts of soil for storage were calculated:

Soil Type	Pit Number	Depth to be Stored	Area Sq. Ft.	Volume Cubic Yard
Shupert-Winetti	2	42"	10,450	1,354.6
Rabbitex	3	78"	16,575	3,990.3
Shupert-Winetti	4	18"	22,375	1,243.1

Brycan	5	60"	27,175	5,032.4
Shupert-Winetti	6	18"	8,925	495.8
Brycan	7	60"	28,050	5,194.4
Senchert	-	6"	13,075	242.1
Total cubic yard recoverable ----------				17,552.7

Laboratory tests on Pit #1 (Table 8-1) show the soil to be unsuitable for final reclamation.

Approximately 16,617.3 cubic yards will be required to reclaim the permit area disturbance of 10.3 acres with soil coverage of 12". The extra 955.4 cubic yards of soils will be used to reclaim additional areas or to increase the depth in the reclaimed areas.

Soil will be put in three separate stockpiles so that the soil can be spread over a larger area to allow better control over soil nutrients (Plate 8-2 and Table 8-2). These stockpiles will be surveyed to verify if the amounts of soils contained are sufficient for reclamation.

Topsoil located southeast of Pits #4, #5, & #6 and the Fan Portal is located on a steep rocky hillside. The topsoil for this area (less than one acre) will be collected and stockpiled. Any vegetation or trees which will interfere with the removal of topsoil, will be removed prior to excavation.

Topsoil which meets the DOGM suitability criteria will be salvaged from this and all areas within the permit area.

If additional soil is required for final reclamation, the soil will be imported from outside the Blue Blaze Mines area. All topsoil to be used for reclamation will be tested according to the DOGM soil guidelines.

Waste coal that exists at the site as a result of past mining activities will be segregated during construction and temporarily stockpiled near the proposed coal stockpile (see Plate 3-1). This material will be blended with coal being shipped from the site as indicted in Section 3.3.2.7.

Mapping Legend

The following is a list of the soil symbols and mapping units which appear in the legend on the soils maps and elsewhere in this PAP.

Soil Symbol	Soil Mapping Unit Name
FIA	Shupert-Winetti Complex - 0 to 2% slopes
GIG	Curecanti - Very bouldery loam, 55-65% slopes
HIG	Senchert - Silt loam, 50-70% slopes
JIB	Brycan - 4-6% slopes
DM	Mine Dumps - Previous Disturbed Areas

Also included on Plate 8-2 is an isopach as to the depths of soils which can be saved.

The additional surface soil sampling points on Plate 8-1 are from a survey done by George Cook, Earl Jensen and Gary Moreau for the C & W Coal Producers (Appendix 5).

8.3.3 Present and Potential Uses - Crops and Pasture Lands

The U.S. Department of Agriculture has the authority to identify farmlands of national, state, or local importance. These farmlands are referred to as prime farmlands, farmlands of statewide importance, and unique farmlands. The SCS has determined that there are no prime farmlands of statewide importance, or unique in the permit area (See Figure 8-1). None of the soils mapped at the site have potential for the growth of crops or pasture land.

Rangelands

The soils of the site area have been used as rangeland in the past. Data on predicted forage production for rangeland soils for various sites are available from the SCS (Section 9-9). The principle limitations are erosion and shallowness, according to the SCS the soils cannot support cultivated crops. The soils incapability have very severe limitations thus restricting the use of the land largely to grazing, woodland or wildlife.

8.4 Prime Farmland Investigation and Determination

On August 14, 1990, Blue Blaze Coal requested the SCS (Price, Utah office) review the soils within the Blue Blaze Mines area to determine if any soils qualified as prime farmland. After the SCS's field reconnaissance to confirm soil types, the field information was checked against the State listing on prime farmland soils. The State Soil Scientist determined there are no soils classified as prime farmlands in the Blue Blaze Mines area (See Figure 8-1).

8.5 Physical and Chemical Properties of Soils and Results of Analysis

Method of Evaluation

The criteria for evaluating soil as a plant growth media are given in Table 8-3. The criteria include sodium absorption ration (SAR), electrical conductivity or salinity (EC), toxic materials, soil reaction (pH), available water hold capacity (AWMC), erosion factor (K), wind erosion group, texture and percent coarse fragments.

Table 8-1

Soil Chemical and Physical Properties - Pit #1

Sample depth (cm)	pH	Ec mmhos/cm	Sat%	Particle Size%	Ca meq/l	Mg meq/l	Na meq/l	SAR	Rock Frag. %	N%	Nitrate mg/kg	Organic carbon	Selenium mg/kg	Boron mg/kg	Available Water Capacity
0-15	7.9	0.6	82.4	%Sand 0 %Silt 56 %Clay 44	3.42	2.45	0.89	0.52	34.0%	0.35	13.2	3.58%	<0.1	1.24	33.5 @ 1/3 16.0 @ 15
15-30	8.0	0.5	79.6	%Sand 2 %Silt 56 %Clay 42	2.94	2.56	0.81	0.48	46.1%	0.31	15.2	3.23%	<0.1	0.86	32.0 @ 1/3 15.9 @ 15
30-45	8.0	0.7	29.6	%Sand 27 %Silt 40 %Clay 33	3.60	2.50	1.54	0.88	40.0%	0.27	0.4	1.44%			32.3 @ 1/3 16.2 @ 15
45-75	7.8	1.2	26.2	%Sand 51 %Silt 33 %Clay 16	4.93	3.33	0.46	0.23	70.5%	0.25	0.3	2.65%			29.2 @ 1/3 14.5 @ 15
76-106	7.8	1.1	28.8	%Sand 54 %Silt 33 %Clay 13	5.99	3.90	2.72	1.22	61.3%	0.19	0.36	2.80%			27.5 @ 1/3 12.7 @ 15

Table 8-2

Depth Calculations for Soil Stockpiles (3)

Feet cu.yds.	Area A cu.yds.	Area B cu.yds.	Area C cu.yds.	Total
0	0	0	0	0
1	1466.7	916.2	900.0	3282.7
2	2854.2	1784.0	1754.4	6392.6
3	4183.8	2604.5	2564.3	9332.6
4	5379.8	3378.9	3331.0	12089.7
5	5637.1	4108.4	4055.6	14701.1
6	7620.0	4794.2	4739.3	17153.5
7	8629.8	5437.5	5383.3	19450.6
8	9567.6	6039.5	5988.8	21505.9

Total Amount of Savable Soil----------17,552.7

PO Box 11350
Salt Lake City, UT 84147

September 12, 1990

William R. Skaggs
Blue Blaze Coal Company
PO Box 784
Price, UT 84501

Dear Mr. Skaggs:

In response to your request August 14, 1990, we have made a review of Sections 7, 8, 17, 18, and 20, T. 13S., R8E., SLM for Important Farmlands determination.

None of these areas qualified as Important Farmland soils: steep slopes, stoney, or bouldry surfaces and soil disturbance from previous construction work are factors that eliminate these sects from categories of Important Farmlands.

Sincerely,

FERRIS P. ALLGOOD
State Soil Scientist

cc:
Price Field Office/Jan Anderson

FIGURE 8-I

Criteria are given for good, fair or poor sources of reconstruction material (Table 8-3). A good rating means vegetation is relatively easy to establish and maintain, the surface is stable and resists erosion, and the reconstructed soil has good potential productivity. Material rated fair can be vegetated and stabilized by modifying one or more properties. Top dressing with better material or application of soil amendments may be necessary for satisfactory performance. Material rated poor has such severe problems that revegetation and stabilization is very difficult and costly. Top dressing with better material may be necessary to establish and maintain vegetation (USDA, 1978).

Soil Chemistry and Physical Properties

Chemical and physical data for project area soils were collected to evaluate the soils as reconstruction material for disturbed areas. Soil chemical and physical data from analysis by Commercial Testing & Engineering Company are reported in Appendix 5. The parameters tested were under the DOGM guidelines; pH, electrical conductivity, saturation percentage, particle size, soluble Ca, Mg & Na, sodium absorption ratio, Total N, Nitrate-N, Organic carbon, available water capacity, rock fragments, and soil color. If the pH ran high the samples were tested for Selenium and Boron.

Suitability as a Source Material for Reclamation of Disturbed Lands

Appendix 5 contains a chemical evaluation of the soils in the undisturbed area and the area to be redisturbed. The soils are rated as good, fair or poor sources for reconstruction material. The overall rating given for each horizon is the rating for the most limiting criteria, and no horizon can be rated better than an overlying horizon.

Vegetation is difficult to establish on soils with high SAR which indicates potential instability of water transmission problems (USDA, 1978). All of the soils of the site were rated good for SAR.

Electrical conductivity is a measure of soil salinity. Excessive salts restrict plant growth, create problems in establishing vegetation and therefore also influence erosion and the stability of the surface (USDA, 1978). All of the soils of the site were rated good for EC.

Excessively high or low pH causes problems in establishing vegetation and as a result influences erosion and stability of the surface (USDA, 1978). The substratum of the soils are rated good for pH.

The available water holding capacity (AWHC) also is important in establishing vegetation. Soils with low available water capacity may require irrigation for establishment of vegetation (USDA, 1978). AWHC was estimated based on field texture and percent coarse fragments (U.S. Forest Service, 1974). The soils are rated good for AWHC.

Table 8-3

Soil Reconstruction Material for Disturbed Areas

Property	Limits			Restrictive Feature
	Good	Fair	Poor	
Sodium Adsorption Ratio (SAR)	5	5 - 12	12	Excess Sodium
Salinity (mmhos/cm)	8	8 - 16	16	Excess Salt
Toxic Materials	Low	Medium	High	Toxicity
Soil Reaction (pH)[a]	5.6 - 7.8	4.5 - 5.5	4.5	Too Acid
Soil Reaction (pH)	7.9	7.9 - 8.4	.05	Excess Lime
Available Water Capacity (IN/IN)[2]	.10	.05 - .10	.05	Drought
Erosion Factor (K)	.37	.37	---	Erodes Easily
Wind Erod. Group	3	3	1, 2	Soil Blowing
USDA Texture	---	SCL,CL, SICL	C[b], SIC[b], SC	Too Clayey
USDA Texture	---	LCOS, LS, LFS, LVFS	COS, S, FS, VFS	Too Sandy
Coarse Frag. (WTPCT) 3-10 in. (7.6-25.4 cm) 10 in. (25.4 cm)	 15 3	 15 - 35 3 - 10	 35 10	 Large Stones Large Stones

[a] Layer with high potential acidity should be rated poor.

[b] If in kaolinitic family, rate one class better if experience confirms.

From National Soil Handbook, NSH - Part II [403.6(2)], 1978

The stability of the soil depends upon its erodibility by water and wind and its strength. Water erodibility is indicated by the K factor; wind erodibility is rated according to the wind erodibility group. K values for soils of the project area are from the best data available in the SCS Soil Survey Interpretation Records (USDA, 1978). Soils of the site are rated good for erodibility. Wind erodibility is based on SCS Soil Survey Interpretation Records for the surface horizons.

Wind erodibility data is available for only the surface soils of the site (USDA, 1978). The surface layers of the Pathead and Curecanti soils are rated good for wind erodibility.

USDA texture also influences available water capacity and erodibility by wind or water. Texture influences soil structure, consistence, water intake rate, runoff, fertility, workability, and trafficability. Potential slippage hazard is related to soil texture, and although other factors also contribute, the ratings of soil texture represent one important factor (USDA, 1978). Soil texture for soils of the site are rated fair to poor, but are generally not considered the limiting factors. The fill textures for soils of the site were described in the field and the evaluations are based on the field determinations.

Coarse fragments influence the ease of excavation, stockpiling and respreading, and suitability for the final use of the land. A certain amount of coarse fragments can be tolerated depending upon the size and intended use of the reclaimed area. If the size of rock fragments exceeds 10 inches (25 cm) the problems are more severe. Coarse fragments are evaluated based on pedon descriptions. Coarse fragments are the limiting factor for most of the project area soils.

Depths of Suitable Topsoil Available for Reclamation

The depths of suitable topsoil are located in Section 8.3.2. This section shows the soil types, the depths of soils, as well as the recommended depth of stripping. Volumes of soil available for storage are also indicated.

Much of the site is mapped as disturbed land. The fill material has variable properties, but the main restrictive features are coarse fragments and slope. The chemistry of the fine earth fraction is fair. The fill material is the only readily available reconstruction material in the mapped area. Included in the map unit DM (Mine Dumps) are areas of excessive large stones, rock outcrops, coal and rock dumps from previous mining. The coal wastes will be handled as outlined in Section 3.3.2.7.

All disturbance was conducted prior to enactment of regulations requiring salvaging of topsoil. Due to the already disturbed area a limited amount of the original topsoil can be salvages for storage. The only future surface disturbance is noted on Plate 3-1.

Soils will be removed to the proper depth by use of an island method and replaced by the use of wooden stakes with depth marks on them to assure equal distribution.

8.6 Use of Selected Overburden Materials or Substitutes

It is anticipated that there will be enough topsoil stockpiled to re-distribute over the 10.3 acres of disturbed area (See Section 8.3.2). Coal waste, oil, grease, or contaminated material will be removed from the site and disposed of properly before topsoil is replaced.

The locations outlined for soil removal on Plate 8-2 are the areas within the project area with sufficient useable soil for collection. The additional areas located on the map were previously disturbed by other mining operations.

8.7 Soil Plan for Removal, Storage, and Protection

It is proposed to remove the topsoil using the island method to insure the proper depth of the soil being removed. At the time of soil removal a professional soil scientist (that will be approved by the Division) will be on site to insure proper separation and stockpiling of topsoil (A or E horizons) and subsoil (B and/or C horizons) also to delineate phase and inclusion variation and salvage depths.

The soil will be transported to the top soil storage area shown on Plate 8-1. The soil will then be contoured at a rate of not more than 2:1, then contour furrowed to prevent erosion (See Section 8.8). Mulch will be applied at the rate of 4,000 pounds per acre. The soils will be tested and fertilized with an organic material to insure the interim revegetation will succeed (See Table 8-4 for quality standard). The topsoil stockpiles will be seeded using the seed mix listed in Table 3-2 for temporary reclamation. Signs will be placed in this area indicating "Topsoil Storage". The area will be fenced to prevent livestock from entering the area. A berm will be placed around the stockpiles to prevent soil erosion from entering the water courses in the mine area.

8.8 Plans for Redistribution of Soils

Deep scarification of overburden and compacted areas (of no less than 6" depth), will be accomplished to ensure good overburden and redistributed topsoil contact to prevent slippage. The regraded material will be topographically conformed to the relative environmental conditions, which will be approximate to the premining topography with the highwalls being eliminated.

Soil will be redistributed using the wooden stake method, where a stake is marked to the depth of fill (estimated at 12"), then the soils will be added to accomplish that depth. The soil will then be harrowed to break up the cloddy surface and scarify to a depth of 18 inches (See Section 3.5.5.1). The regraded soils surface roughness will be maximized by pitting and gouging. Contour furrowing will take place on slopes that

Table 8-4

Seedbed Material Quality Standards for Reclamation

Property	Limits			Restrictive Feature
	Good	Fair	Poor	
Sodium Adsorption Ratio (SAR)[a]	6	6 - 10	10 - 15	Excess Sodium
Salinity (EC) mmhos/cm[a]	0 - 4	4 - 8	8 - 16	Excess Salt
Saturation Percentage[a]	25	80	80	
Soil Reaction (pH)[a]	6.0 - 8.4	8.4 - 8.8	8.8 - 9.0	Excess Lime
USDA Texture[a]		SL, SIL, VFSL, FSL, LFS	CL, S	Too Clayey
Zinc and Boron[b]				
Coarse Frag. (WTPCT) 3-10 in. (7.6-25.4 cm) 10 in. (25.4 cm)	 0 - 15 0 - 3	 15 - 25 3 - 7	 25 - 35 7 - 10	 Large Stones Large Stones

[a] Wyoming Department of Environmental Quality- Guideline No. 1

[b] Will vary according to soil type or various environmental factors.

exceed 6 percent. The contour furrows will be discontinuous, laid out on an noneronsive grade and spaced no more than 10 to 15 feet apart. The soil will then be sampled as stated in Section 8.9 to determine needed fertilization levels. The area will then be fertilized as required and mulched at a rate of 4000 lbs. per acre (straw or hay). Seeding will then commence using the final reclamation seed mix listed in Table 3-3. Erosion control matting will be used where the slope grades are 2 1/2H:1V or steeper.

8.9 Nutrients and Soil Amendments

Tests will be taken of soils to be used for final reclamation in order to evaluate the need for soil amendments and nutrients. Soil testing will be performed by a qualified laboratory which uses accepted analytical procedures (DOGM soil guidelines). The soils chosen for sampling will be based on previous analysis, affected soil series type, postmining land use, and the postmining vegetation ecosystem. Twenty sub-samples per acre will be taken at 12 inch depths then combined, 5 samples will be taken from the combined sub-samples and send to a qualified laboratory for testing. The tests to be performed will be pH, electrical conductivity, sodium absorption ratio, texture, nitrogen, organic content, phosphorus, potassium, available water capacity, and percent rock fragments, in order to determine needed fertilization levels. Commercial organic fertilizers will be added to replenish soil nutrients and to enhance successful revegetation. The soil nutrient and amendments plan will also follow the Divisions Guidelines for management of topsoil and overburden for underground and surface coal mines.

8.10 Effects of Mining Operations on Soils, Nutrients and Amendments

The disturbed land fill which has been impacted by mining operations has some inherit problems. These include large stones, and compacted zones. The large stones will be removed by standard earth moving equipment and/or commercial rock-picker implements. Compacted zones will be eliminated by deep chiseling, prior to final reclamation. See Section 8.9 for nutrients and soil amendments.

8.11 Mitigation and Control Plans

No additional surface disturbance involving soils will be required for the surface facilities. Therefore, the stripping and stockpiling of soils will be the soils saved from the previously disturbed areas.

8.12 References

Black, C.A. 1965. Methods of Soil Analysis. American Society Agronomy No. 9 parts 1 and 2. Madison. Wisconsin. 1572 pgs.

USDA, Soil Conservation Service. Soil Survey Staff 1975. Soil Taxonomy - a basic system of soil classification for marking and interpreting soil surveys, USDA Agricultural Handbook No. 436.

USDA, 1978 Soil Conservation Service, National Soils Handbook (Compendium of SCS in-house memos, various dates) Part II (403.6[a]).

USDA, Soil Survey Staff, 1951, Soil Survey Manual, USDA Agricultural Handbook No. 18.

USDA, Forest Service, 1974; Branch of Soils, Division of Watershed Management, Rocky Mountain Region, Guidelines for Making Soil Interpretations.

USDA, Soil Conservation Service, June 1988, Soil Survey of Carbon Area, Utah.

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VEGETATION RESOURCES

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SECTION 9

VEGETATION RESOURCES

9.1 Scope

The purpose of this report is to describe the vegetation of the Blue Blaze Mines site. Descriptions of the proposed area for disturbance as well as some of the surrounding areas are included.

A methodology section is provided for the study. General site descriptions are provided on areas where quantitative data are to be supplied as well as areas where only qualitative data were obtained. Previous and future studies of the mine area are also briefly described within the context of this report.

See Section 9.6 for reference area details.

9.2 History

The proposed Blue Blaze Mine is the site of previous mining activity. The mining ceased operations in 1953. Consequently, much of the surface area has been previously disturbed. Since that time there has been considerable interest in reactivating the area to mining.

In 1981, Mt. Nebo Scientific completed a preliminary vegetation study of the area for Sanders Exploration, Ltd. (C & W No. 1 Mine). Since that time, little or no information about the vegetative resources has been compiled. This report will utilize some of the previous data from the Sanders Exploration, Ltd. study, as well as provide some new information (See Section 9.3).

9.3 Methodology

Information for this report was obtained by utilizing previous vegetation studies by Mt. Nebo Scientific (1981) and field work in November 1990. In November 1990 qualitative analyses, vegetation mapping, and selection of transect areas to be sampled were accomplished. Additionally, on-site sampling areas were approved and 1991 sampling plans were submitted to the DOGM.

Vegetation mapping was accomplished by using aerial photographs and on-site field mapping on contour maps.

9.4 General Site Description

As mentioned above, the proposed Blue Blaze Mine is the site of previous mining activity. As a result, the area is dotted with old mine structures, building ruins and debris. Previous abandonment of the mine area left varied degrees of disturbance to the vegetation.

The mine site lies between 7,500 ft and 7,700 ft above sea level. The

climate is characterized by cold winters and warm, dry summers. Average annual precipitation ranges from 16 to 20 inches.

9.4.1 Vegetation Patterns

The mine permit area has been mapped with several vegetation types including: 1) Oak Brush, 2) Salina Wildrye, 3) Maple/Oak Brush/Aspen, 4) Fir/Aspen, 5) Manzanita, 6) Alpine Herb/Grassland, 7) Sagebrush/Grass/Rabbit Brush, and 8) Disturbed/Altered communities. The map provided delineates these vegetation types within and adjacent to the mine permit boundaries (See Plate 9-1).

Except for a relatively small community of Salina wildrye, most of the proposed new disturbance will be on areas that have been previously disturbed (or at least altered) by mining activity. A description of the existing vegetation types follow.

9.4.1.1 Salina Wildrye Community

This is a relatively small area (approximately 2.5 acres) and is the only undisturbed area that proposed new mining activity could affect. This community lies primarily on a dry, west-facing slope, with a 60% incline. The community is dominated by a nearly pure stand of Salina wildrye (Elymus salinus). Previous sampling indicated a mean total living cover of 43.12%. Ninety-two percent of the living cover were grass species. For a species list, refer to Table 9-1.

9.4.1.2 Disturbed, (Altered) Drainage Bottoms

Another area proposed for new disturbance by mining is a site that has been disturbed or "altered" by previous mining activity. Because the area is near the bottom of a drainage, the vegetation community patterns are somewhat dissimilar to adjacent slopes. The bottoms probably have somewhat deeper soils, while some of the species are more mesic. The steep side slopes of oak brush and Salina wildrye often protect the bottoms from exposure to the sun. Consequently, small stands of aspen (Populus tremuloides), white fir (Abies concolor) and oak brush (Quercus gambelii) can be found in and around the drainage. Muttongrass (Poa fenderiana) is one of the dominate grass species of the bottom lands. For a general species list, refer to Table 9-2.

9.4.1.3 Moderately Disturbed Areas

Some of the areas have had considerable disturbance to the vegetation and the top few inches of soil, but have had relatively little deep, subsurface disturbance. These areas are presently dominated by rabbit brush (Chrysothamnus nauseosus), Wood's rose (Rosa woodsii), stinging nettle (Urtica dioica) and other species that can exist on disturbed areas. For a species list of these areas, refer to Table 9-3.

9.4.1.4 Severely Disturbed Areas

Other areas seemed to be severely disturbed to deeper levels in the soil horizons. These soils/spoils are often compacted and intermixed with coal waste. Old mining structures and buildings can be found throughout the entire area.

Much of this area is dominated by weedy species i.e. summer cypress (Kochia scoparia) and ragweed (Ambrosia psilostachya). For a list of existing plant species, refer to Table 9-3.

9.4.1.5 Results From Disturbed Areas

When the three disturbance types (altered drainage bottoms, moderately disturbed, severely disturbed) were combined, the total living cover was estimated at 55%. The cover consisted of 52.43% shrubs, 21.53% forbs and 26.04% grasses (Mt. Nebo Scientific, 1991).

9.5 Vegetation Patterns Prior to Existing Disturbance

Most of the areas that have been disturbed by previous mining activities and are proposed for new disturbances, are on valley bottom lands and adjacent side slopes. Prior to disturbance, the drainages were probably dominated by a big sagebrush/grass/rabbit brush communities. This sagebrush/grass/rabbit brush communities likely had small, isolated patches of aspen, oak brush, fir and/or maple. Although water fed by springs sometimes dissects the bottom lands, no developed riparian community has been established.

The slopes that surround the valley bottoms are dominated by two major community types in its present natural condition: 1) big sagebrush/grass/rabbit brush (valley bottoms) and 2) oak brush/salina wildrye (side slopes).

9.6 Reference Areas

Due to the previous disturbance of the mines area, reference areas were not established (R645-301-356.250).

In areas where previous mine disturbance has not occurred reference areas will be established as designated by the DOGM.

9.7 Vegetation Map

Vegetation maps of the permit area have been prepared (see Plate 9-1 and 9-2).

9.8 Success Monitoring and Bond Release

Transect areas were chosen and approved by the DOGM that simulated the previously disturbed areas in their natural, undisturbed condition. The transects were sampled during the 1991 growing season by Mt. Nebo

Scientific and the data collected was incorporated into the mine plan (Plate 9-2 and Vegetation Sampling of the Blue Blaze Mine Site : 1991, MT. Nebo Scientific Research and Consulting, at end of this chapter). Sampling methods followed DOGM sampling guidelines.

The data collected from the transects sampled by MT. Nebo Scientific will be used as success standards for reclamation of the mining area. At a minimum the reclamation vegetative ground cover will equal the present ground cover, and will be adequate to control erosion.

The reclamation ground cover success will be monitored qualitatively every year of the 10 full years required. The data collected each year will be submitted to the DOGM in an annual report.

The ground cover will be monitored quantitatively in year 2, 3, 5, 7, and 9 during the 10 years of extended responsibility.

At the time of bond release, shrubs and trees will be healthy, and at a minimum 80 percent will have been in place for at least six growing seasons during the 10 year period of responsibility. For further discussion see Section 3.5.6.

9.9 Threatened and Endangered Species

No threatened or endangered species were found on or near the permit area.

TABLE 1: Species List for the Undisturbed Salina Wildrye Community of the Blue Blaze Mine Site.

TREES & SHRUBS	
Artemisia bigelovii	Bigelov's Sagebrush
Artemisia tridentata	Big Sagebrush
Cercocarpos montanus	Mountain Mahogany
Chrysothamnus nauseosus	Rubber Rabbitbrush
Eriogonum corybosum	Corymb Buckwheat
Gutierrezia sarothrae	Broom Snakeweed
Juniperus scopulorum	Rocky Mountain Juniper
Mahonia repens	Oregon Grape
Opuntia polyacantha	Prickly Pear Cactus
Quercus gambelii	Scrub Oak
Sambucus caerulea	Elderberry
Symphoricarpos oreophilus	Snowberry
Tetradymia canescens	Gray Horsebush
FORBS	
Achillea millefolium	Yarrow
Androsace septentrionalis	Androsace
Antennaria microphylla	Rosy Pussytoes
Artemisia ludoviciana	Lousiana Sagewort
Astragalus spp.	Milkvetch
Circium sp.	Thistle
Petradoria pumila	Rock Goldenrod
Sphaeralcea coccinea	Globemallow
GRASSES	
Arrhenatherum elatius	Tall Oatgrass
Elymus salinus	Salina Wildrye
Elymus smithii	Western Wheatgrass
Koeleria macrantha	Junegrass

TABLE 2: Species List for the Previously "Altered" Drainage of the Blue Blaze Mine Site.

TREES & SHRUBS

Abies concolor	White Fir
Acer grandidentatum	Big-toothed Maple
Acer negundo	Box Elder
Amelanchier utahensis	Serviceberry
Artemisia tridentata	Big Sagebrush
Chrysothamnus nauseosus	Rubber Rabbitbrush
Chrysothamnus vicidiflorus	Low Rabbitbrush
Mahonia repens	Oregon Grape
Populus tremuloides	Aspen
Prunus virginiana	Chokecherry
Pseudotsuga menziesii	Douglas Fir
Quercus gambelii	Scrub Oak
Rosa woodsii	Wood's Rose
Salix caudata	Willow
Symphoricarpos oreophilus	Snowberry

FORBS

Achillea millefolium	Yarrow
Artemisia ludoviciana	Louisiana Sagewort
Aster spp.	Aster
Astragalus spp.	Milkvetch
Circium pulchellum	Thistle
Circium vulgare	Thistle
Geranium carolinianum	Wild Geranium
Hackelia micrantha	Stickseed
Machaeranthera canescens	Hoary Aster
Penstemon sp.	Penstemon
Penstemon watsonii	Watson's Penstemon
Rumex crispus	Curly Dock
Rumex pauciflorus	Dock
Salsola iberica	Russian Thistle
Sphaeralcea coccinea	Globemallow
Urtica dioica	Sting Nettle
Viguiera multiflora	Showy Goldeneye
Wyethia amplexicaulis	Mules Ear

GRASSES

Arrhenatherum elatius	Tall Oatgrass
Dactylis glomerata	Orchardgrass
Elymus salinus	Salina Wildrye
Elymus smithii	Western Wheatgrass
Koeleria macrantha	Junegrass
Stipa hymenoides	Indian Ricegrass
Phleum alpina	Timothy
Poa fendleriana	Muttongrass
Sitanion hystrix	Squirreltail

TABLE 3: Species List for the Moderately Disturbed Area of the Blue Blaze Mine Site.

TREES & SHRUBS

Chrysothamnus nauseosus	Rubber Rabbitbrush
Rosa woodsii	Wood's Rose
Sambucus caerulea	Elderberry
Symphoricarpos oreophilus	Snowberry

FORBS

Arctium minus	Burdock
Aster spp.	Aster
Cynoglossum officinale	Hound's Tongue
Urticka dioica	Stinging Nettle

GRASSES

Elymus salinus	Salina Wildrye
Elymus spp.	Wheatgrass
Stipa lettermanii	Letterman Nettlegrass

TABLE 4: Species List for Severely Disturbed Areas of the Blue Blaze Mine Site.

TREES & SHRUBS	
Artemisia tridentata	Big Sagebrush
Chrysothamnus nauseosus	Rubber Rabbitbrush
Quercus gambelii	Scrub Oak
FORBS	
Ambrosia psilostachya	Western Ragweed
Arctium minus	Burdock
Circium pulchellum	Thistle
Convolvulus arvensis	Bindweed
Descurainia pinnata	Tansy Mustard
Hackelia micrantha	Stickseed
Kochia scoparia	Kochia
Lappula redowski	Stickseed
Machaeranthera canescens	Hoary Aster
Mertensia ciliata	Bluebells
Rumex crispus	Curly Dock
Salsola iberica	Russian Thistle
Urtica dioica	Sting Nettle
Wyethia amplexicaulis	Mules Ear
GRASSES	
Bromus tectorum	Cheatgrass
Hordeum jubatum	Foxtail Barley
Polypogon monspeliensis	Rabbitfoot Grass

UNITED STATES
DEPARTMENT OF
AGRICULTURE

SOIL
CONSERVATION
SERVICE

350 NORTH 400 EAST
PRICE, UTAH 84501

May 30, 1991

Mr. William R. Skaggs
Blue Blaze Coal Company
P.O. Box 784
Price, Utah 84501

Dear Mr. Skaggs:

Here is the information on the two reference sites for the coal mine. These production figures are for a normal year.

Vegetation Type	Ecological Condition	Present Production	Potential Production
Sagebrush/ Grass/Rabbitbrush	Fair	950	1000
Oakbrush/ Salina Wildrye	Fair	900	1200

I believe this is what is needed. If you need more information please feel free to contact me at 637-0041.

George S. Cook
Range Conservationist

SOIL SURVEY AND INTERPRETATIONS
VEGETATION SURVEY
for
C & W Coal Producers
May 19, 1980

George Cook, Range Conservationist
Earl Jensen, Soil Scientist
Gary Moreau, District Conservationist

	VRA I	vs Survey Area	VRA II(a)	vs Survey Area	VRA II(b)	vs Survey Area
VEGETATION	Mtn. Loam (Salina Wildrye) Range	Mtn. Loam (Salina Wildrye) Range	Semi-wet Meadow Range	Semi-wet Meadow Range	Mt. Loam (oak)	Mt. Loam (oak)
SOIL	GIC, Macar Variant	GIC, Macar Viraint	FIA loam	FIA loam	JIB, Brycan loam	JIB, Brycan loam
SLOPE	55 - 65%	55 - 65%	0 - 1%	0 - 1%	4 - 6%	4 - 6%
ASPECT	South	South	Southeast	South	Southeast	South
GEOLOGY	Shale and Siltstone	Shale and Siltstone	Shale and Siltstone	Shale and Siltstone	Shale and Siltstone	Shale and Siltstone

Note: VRA - Vegetation Reference Area

TABLE 1

Reference Area Comparison

DESCRIPTION OF VEGETATION

The C & W mine site was visited late in the fall of 1979 and early spring of 1980. Present vegetation and productivity were estimated according to range site analysis methods of the Soil Conservation Service. Potential ecological productivity and composition are available for two of the four sites. The other two sites are being developed by the Bureau of Land Management and should be available in the near future. The sites are keyed with the soils on the map.

Semi-wet Meadow Range Site

This site occurs on valley bottoms, and alluvial fans near water courses. Slopes are nearly level 0 to 1 percent. Elevation is about 2,342 meters (7,680 feet).

The climate is characterized by cold winters and warm dry summers. Average annual precipitation is 41 to 51 centimeters (16 to 20 inches). The important moisture supply for plant growth is from sub-irrigation or a moderately deep but fluctuating water table. The drop in water table during the latter part of the plant growth period affects the amount of herbage production and thus differs from the wet meadow site.

Plant growth begins between March 15 and April 15 depending primarily on soil temperatures. Plant growth usually slows down during late July and early August due to warm temperatures and lowering of the water table. During dry years, plant growth stops at this time as soil moisture becomes depleted. Frost-free period varies from 60 to 70 days. In years of adequate moisture plant growth stops about October 1 to 10 due to killing frosts.

This range site relates to the FIA soil.

Present Vegetation. An inventory of the semi-wet meadow range site recorded the following plant species and percentage estimates by air dry weight.

Grasses and Grass-Like Plants	Percent
Salina wildrye	15
Muttongrass	60
Squirreltail	2
Orchardgrass	1
Alpine Timothy	1
Western wheatgrass	6
Forbs	
Houndstongue	3
Bull thistle	2
Louisiana sagewort	2
Stinging nettle	1
Sour dock	1
Aster	1
Trees and Shrubs	
Snowberry	1
Big rabbitbrush	1
Wild rose	1
White fir	1
Aspen	1

Total annual production is estimated to be 1,500 pounds per acre air dry.

Potential Vegetation. The vegetation of this site is primarily influenced by a water table deeper than 51 centimeters (20 inches), but within the root zone. It is primarily a grass site with approximately 80 percent grass and grass-like plants, 15 percent forbs and 5 percent shrubs.

The following table lists the potential plant community for the semi-wet meadow range site. These species have been identified on similar sites. They will not necessarily occur on every semi-wet meadow site. Those species occurring at higher percentages of air dry weight constitute more important species at the site.

Potential Plant Community -- Semi-wet Meadows

Grasses and Grass-Like Plants	Percent
Alkali bluegrass	5
Alkali sacaton	1
Alpine timothy	1
Basin wildrye	10
Bearded wheatgrass	1
Blue wildrye	1
Bottlebrush squirreltail	1
Columbia needlegrass	1
Field horsetail	5
Idaho fescue	5
Kentucky bluegrass	1
Letterman needlegrass	1
Meadow barley	1
Mountain brome	20
Muttongrass	5
Nodding brome	10
Prairie junegrass	1
Redtop	5
Rushes	5
Sedges	35
Slender wheatgrass	25
Spikerush	5
Timothy	5
Trisetum	1
Tufted hairgrass	10
Western wheatgrass	5
Wiregrass	5
Forbs	
Aspen peavine	10
Aster	1
Buckhorn plantain	2
Cinquefoil	4
Clover	10
Common cowparsnip	1
Edible valerian	5
Elk thistle	1
Geranium	4
Groundsel	1
Lemon scurfpea	1
Lupine	2

Forbs (Cont.)	Percent
Rockymountain iris	5
Starwort	2
Tarweed	2
Violet	3
Yarrow	5
Shrubs and Trees	
Shrubby cinquefoil	1
Silver sagebrush	1
Willow	1
Wood's rose	1
Yellowbrush	1

No tree species occur on this site.

Vegetative cover varies from 70 to 80 percent by ocular estimate.

Plant species not a part of the climax plant community that are most likely to invade the site if plant cover deteriorates are wheatgrass, foxtail barley, annual forbs, curlycup gumweed, dandelion, houndstongue, povertyweed, big sagebrush, rubber rabbitbrush and snakeweed. If excessive grazing occurs, yellowbrush, rushes and sedges will increase and may become dominant plants.

The following threatened or endangered plants have occured on this range site: alkali bluegrass, tufted bluegrass, and trisetum. None were found on the C & W site.

Potential yields from an excellent condition semi-wet meadow range site are shown in the following table. This yield data is based on 41 plots in good condition, 40 in fair, and 58 in poor condition.

TOTAL POTENTIAL ANNUAL PRODUCTION OF VEGETATION
For Excellent Condition Class
Semi-wet Meadow Range Site

	Total All Vegetation	
	Kg/Ha	Lbs/Ac
Favorable Years	4700	4200
Median Years	2800	2500
Unfavorable Years	1960	1750

Mountain Loam (Fir) Range Site

This range site occurs in the area of the drill test site. Slopes are 50 to 70 percent and north facing.

Precipitation averages 41 to 51 centimeters (16 to 20 inches).

This site relates to the HIG soil.

Present Vegetation. An inventory of the mountain loam (fir) range site recorded the following plant species and percentage estimates by air dry weight.

Grass and Grass-Like Plants	Percent
Salina wildrye	25
Wheatgrass	10
Poa	5
Forbs	
Yarrow	10
Aster	1
Herbaceous sagebrush	2
Other forbs	2
Trees and Shrubs	
White fir	20
Douglas fir	5
Gambel oak	10
Snowberry	5
Oregon grape	3
Wyoming sagebrush	2

Total annual production is estimated to be 1,300 pounds per acre air dry.

Potential Vegetation. A description for potential vegetation for mountain loam (fir) is being developed by the Bureau of Land Management. Clipping data collected during the 1979 field season is being assimilated into a site description. This information should be available in the near future.

Mountain Loam (Salina wildrye) Range Site

This range site occurs on the north exposure south of the drainage. Slopes are 55 to 65 percent. Annual precipitation is 41 to 51 centimeters (16 to 20 inches).

This site relates to the GIG soil.

Present Vegetation. An inventory of the mountain loam (Salina wildrye) range site recorded the following plant species and percentage estimates by air dry weight.

Grasses and Grass-Like Plants	Percent
Salina wildrye	65
Western wheatgrass	15
Forbs	
Aster	3
Vetch	5
Yarrow	1
Herbaceous sagebrush	1
Penstemon	1
Thistle	1
Scarlet globemallow	1
Geranium	1
Gumweed	1
Trees and Shrubs	
Snowberry	1
Yellowbrush	1
Rubber rabbitbrush	1
Gambel oak	1
Shrubby buckwheat	1

Total annual production is estimated to be 1,000 pounds per acre air dry.

Potential Vegetation. A description for potential vegetation for mountain loam (Salina wildrye) is being developed by the Bureau of Land Management. Clipping data collected during the 1979 field season is being assimilated into a site description. This information should be available in the near future.

Mountain Loam Range Site

This site occurs on the valley bottom at the C & W area. Slopes are 4 to 6 percent. It occurs on all aspects. Elevation is 2,300 meters (7,640 feet).

The climate is mainly moist subhumid or humid, with cold snowy winters and warm dry summers. The average annual precipitation ranges from 41 to 51 centimeters (16 to 20 inches). Distribution is 55 to 60 percent during the plant dormant period (October to March). This is the most dependable supply for plant growth. Lower precipitation and high evapotranspiration rates during July, August and September causes slowing down in growth of all plant species and dormancy in most of the grasses and forbs.

Plants begin to grow from April 15 to May 1. The grasses have a dormancy period from July 15 to August 15, but grasses may green up again in September when fall rains occur. Shrub species grow until frost though at a reduced rate during summer months. Optimum growth period is during June. Frost-free period ranges from 60 to 70 days.

This range site relates to the JIB soil.

Present Vegetation. An inventory of the mountain loam range site recorded the following plant species and percentage estimates by air dry weight.

Grasses and Grass-Like Plants	Percent
Wheatgrass	3
Salina wildrye	10
Letterman needlegrass	2
Forbs	
Houndstongue	2
Aster	1
Other	2
Burdock	3
Stinging Nettle	2
Trees and Shrubs	
Wood's rose	15
Snowberry	5

Tree and Shrubs (Cont.)	Percent
Elderberry	5
Rubber rabbitbrush	50

Total annual production is estimated to be 1,300 pounds per acre air dry.

Potential Vegetation. This plant community is about 80 percent grasses, 7 percent forbs, and 13 percent shrubs by air dry weight. The following table lists the potential plant community for the mountain loam range site. These species have been identified on similar sites. They will not necessarily occur on every mountain loam range site. Those species occurring at higher percentages of air dry weight constitute more important species at the site.

Potential Community — Mountain Loam Range Site

Grasses and Grass-Like Plants	Percent
Basin wildrye	15
Bearded wheatgrass	10
Big bluegrass	6
Bluebunch wheatgrass	80
Bottlebrush squirreltail	1
Columbia needlegrass	3
Idaho fescue	3
Indian ricegrass	1
King's fescue	1
Kentucky bluegrass	1
Letterman needlegrass	1
Longtongue muttongrass	6
Mountain brome	1
Muttongrass	10
Needle and thread	1
Nodding brome	1
Oniongrass	1
Prairie junegrass	2
Sandberg bluegrass	5
Sedge	1
Slender wheatgrass	5
Trisetum	1
Squirreltail	3
Western wheatgrass	5

Forbs	Percent
Aster	2
Arrowleaf balsamroot	5
Astragalus	2
Bastard Toadflax	1
Cutleaf balsamroot	2
Bedstraw	1
Daisy	5
Eriogonum	1
Geranium	1
Goldenrod	1
Groundsel	1
Horsemint	5
Indian paintbrush	1
Little sunflower	1
Louisiana sagewort	1
Lupine	5
Mulesear dock	1
Others	2
Peavine	1
Penstemon	2
Phlox	2
Showy elkweed	1
Stoneseed	2
Tapertip hawksbeard	2
Timber poisonvetch	1
Yarrow	5
Yellow salsify	2

Shrubs and Trees	
Big sagebrush	5
Bigtooth maple	1
Birchleaf mountainmahogony	1
Antelope Bitterbrush	5
Chokecherry	2
Eriogonum	1
Gambel oak (Utah only)	5
Littleleaf horsebrush	1
Mountain lover	1
Mountain snowberry	5
Rose	1
Serviceberry	1
Threetip sagebrush	3
Utah snowberry	5
Woods rose	1
Yellowbrush	5

No tree species are present except Gambel oak and bigtooth maple. They sometimes attain tree size, but are primarily brush or shrub species. Overstory density is 1 to 10 percent.

Understory vegetative density by ocular estimate is 55 to 60 percent.

Plant species not a part of the climax plant community that are most likely to invade the site if plant cover deteriorates are:

Cheatgrass	Knotweed	Pinon pine
Sixweeks fescue	Mullein	Rubber rabbitbrush
Threeawn	Ragweed	Snakeweed
Annual forbs	Stickseed	Houndstongue
Dandelion	Tarweed.	Utah Juniper

Big sagebrush and yellowbrush are also likely to increase considerably and may become almost pure stands.

Potential yields from an excellent condition mountain loam range site are shown in the following table. This yield data is based on 346 plots in excellent condition, 453 plots in good condition, 339 plots in fair and 232 plots in poor condition.

TOTAL POTENTIAL ANNUAL PRODUCTION OF VEGETATION
For Excellent Condition Class
Mountain Loam Range Site

	Total All Vegetation	
	Kg/Ha	Lbs/Ac
Favorable Years	2910	2600
Median Years	2070	1850
Unfavorable Years	1350	1200

EXPLANATION

Proposed Disturbed Area

Premining Disturbed Area

VRA Vegetation Reference Area

Permit Boundary

0 1000ft 2000ft 4000ft
SCALE

N

Figure 4

VEGETATION MAP
FOR
PROPOSED C & W

R,8E, T,13S,

VEGETATION SAMPLING

OF THE

BLUE BLAZE MINE SITE: 1991

Prepared by

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for

BLUE BLAZE COAL COMPANY
Post Office Box 784
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Report: Patrick Collins, Ph.D.

Fieldwork: Patrick Collins
P. Dean Collins

Date: August 13, 1991

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VEGETATION SAMPLING
ON THE
BLUE BLAZE MINE SITE: 1991

SCOPE

The following is a report that describes the vegetation for the Blue Blaze Coal Company that is proposed to be disturbed by mining operations. The report provides summaries of the quantitative data, descriptive information, and raw data compilations. It also outlines the methods employed.

The study and methodologies used herein were performed in accordance with the guidelines supplied by the State of Utah, Division of Oil, Gas and Mining (DOGM).

INTRODUCTION

The mine site lies between 7,500 ft and 7,700 ft above sea level. The climate is characterized by cold winters and warm, dry summers. Average annual precipitation ranges from 16 to 20 inches.

History

The proposed mine is located at the site where previous mining activity has occurred. Apparently abandoned in about 1953, the site was left with old mining structures, building ruins and debris. Consequently, much of the surface area has been previously disturbed. Since that time, there has been considerable interest in reactivating this area to mining.

In 1981, Mt. Nebo Scientific completed a preliminary vegetation study of the area for Sanders Exploration, Ltd. There was some interest at that time to permit the mine under the name of "C & W No. 1 Mine". Until recently, little or no information about the vegetative resources has been compiled. In 1990, Mt. Nebo Scientific again initiated another study for yet another new mine plan. The study was submitted to DOGM by the Blue Blaze Coal Company in 1990. Some changes in the proposed new mine plan since then have somewhat changed the vegetative study plan. This report will utilize some of the previous data of the study area

as well as provide new information. More details about the vegetation data are provided in the "Methodology" section of this report.

Existing Vegetation

Because revegetation was never performed, most of the area supports a host of exotic plant species on various degrees of disturbance. Present plant communities for the proposed disturbance of the mine site were designated as: 1) slightly disturbed, 2) moderately disturbed and 3) severely disturbed.

The mine permit area has been mapped with several vegetation types including: 1) oak brush, 2) Salina wildrye, 3) maple/oak/aspen, 4) fir/aspen, 5) manzanita, 6) alpine herb/grassland, 7) sagebrush/grassland, and 8) disturbed/altered communities. The map provided in the 1990 vegetation study delineates the vegetation types within and adjacent to the mine permit boundaries (see Vegetation Map 1).

As mentioned above, the proposed new disturbance will be on areas that have been previously disturbed (or at least altered) by mining activities. A description of the existing vegetation types that are proposed for new disturbance follows.

Slightly Disturbed, (Altered) Drainage Bottoms

One area proposed for new disturbance by mining is a site that has been somewhat disturbed or "altered" by previous mining activity. Because the area is near the bottom of a drainage, the vegetation community patterns are somewhat dissimilar than the adjacent slopes. The bottoms probably have somewhat deeper soils, and some of the species are more mesic. The steep side slopes of oak brush and Salina wildrye often protect the bottoms from exposure to the sun. Consequently, small stands of aspen (*Populus tremuloides*), white fir (*Abies concolor*) and oak brush (*Quercus gambelii*) can be found in and around the drainage. Muttongrass (*Poa fenderiana*) is one of the dominate grass species of the bottom lands. For a general species list, refer to Table 3.

Moderately Disturbed Areas

Some of the areas have had considerable disturbance to the vegetation and the top few inches of soil, but have had relatively little deep, subsurface disturbance. These areas are presently dominated by rabbitbrush (*Chrysothamnus nauseosus*), hound's tongue (*Cynoglossum officinale*) and stinging nettle (*Urtica dioica*) and other species that can exist on disturbed areas. For a species list of these areas, refer to Table 4.

Severely Disturbed Areas

Still other areas seem to be severely disturbed to deeper levels in the soil horizons. These soils/spoils are often compacted and intermixed with coal waste. Old mining structures and buildings can be found throughout the entire area. Much of this area is dominated by weedy species and those that thrive on disturbed areas i.e. rubber rabbitbrush (*Chrysothamnus nauseosus*), Louisiana sagewort (*Artemisia drunculus*), summercypress (*Kochia scoparia*) and ragweed (*Ambrosia psilostachya*). For a list of existing plant species, refer to Table 5.

Vegetation Patterns Prior to Existing Disturbances

Areas proposed for new disturbances are on valley bottom lands and adjacent side slopes. Prior to disturbance, the drainages were probably dominated by big sagebrush/grass/rabbitbrush communities. These communities likely had small, isolated patches of aspen, oak brush, fir and/or maple. Although a small stream fed by springs and runoff sometimes dissects the bottom lands, no developed riparian community has been established. The slopes that surround the valley bottom lands are dominated by Salina wildrye and oak brush communities.

METHODS

Because the area was disturbed by mining prior to current DOGM requirements and consequently was not reclaimed to the current state rules described in R614-200 through R614-203 and R614-301 through R614-302 of those requirements, standards for vegetative ground cover will be based on current ground cover for the new mine (refer to State of Utah, Coal Mining Rules R614-301-356.250).

As mentioned previously, the mine area supports different weedy communities with diversity probably dictated by the degree of disturbance at each site. In other words, some areas have been disturbed more severely that other areas. The disturbance areas were ranked by their relative degree of disturbance (i.e. slightly disturbed, moderately disturbed or severely disturbed).

Quantitative and qualitative data were taken on the vegetation of the three disturbance types. Sampling was accomplished on July 23, 1991. Number of samples were based on the relative amount of surface area for each disturbance type (more area = more samples). Final data were combined to provide the overall mean of the disturbance areas for the ground cover standard. Raw data, however, is supplied with this report to enable one to summarize each type of disturbance independently if desired. Transect lines are labeled on the raw data sheets.

These labels correspond with a map that shows the location of these transects.

Cover and Composition

Random/regular placement of sampling plots were designed to provide unbiased accuracy of the data compiled. This was accomplished by establishing transect lines on the areas to be sampled. These transect lines were placed over the various disturbance areas to adequately represent the area as a whole. Regular points on the transect lines were then marked. At these regular points, random numbers were used to generate sample locations perpendicular to the transect lines.

Cover estimates were made using ocular methods with meter square quadrats. Species composition was also assessed from the quadrats. Additional information recorded on data sheets were: estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes. Plant nomenclature follows "A Utah Flora", Welsh et al. (1987).

Woody Species Density

Density of woody plant species were not recorded on this area because it was previously disturbed by mining activity.

Sample Adequacy

Sample adequacy for cover was achieved by employing formulas approved by the State of Utah, Division of Oil, Gas & Mining at 80% confidence (90% confidence was actually achieved) by the sample size. For the formulas used, refer to the summary tables. All sample means, standard deviations, raw data, and sample sizes were included in this report to enable the reviewers to apply further statistical tests if desired.

Photographs

Photographs were taken at each of the areas where transects for sampling were placed.

RESULTS

The Disturbed Areas

When the 3 disturbance types (slight, moderate and severe) were combined, the total living cover was estimated as nearly 55 percent (Table 1). Of that cover 52.43% were shrubs, 21.53% were forbs and 26.04% were grasses (Table 1). Photographs of each sample area for the disturbance types are included in this report.

Cover by species indicated rubber rabbitbrush (*Chrysothamnus nauseosus*) to be the dominate shrubs species, followed by snowberry (*Symphoricarpus oreophilus*). Hound's tongue (*Cynoglossum officinale*), a weedy species, was the dominate forb species, whereas, muttongrass (*Poa fendleriana*) dominated the grasses in the sample areas (Table 2). For species lists of the disturbance types, refer to Tables 3-5.

PHOTOGRAPHS

(Original report shows color photographs)

B	C
D	E
A	

COLOR PHOTOGRAPHS OF THE SAMPLE AREAS OF THE BLUE BLAZE COAL COAL COMPANY (date: 7/23/91).

B = Transect B, Slightly Disturbed
C = Transect C, Slightly Disturbed
D = Transect D, Moderately Disturbed
E = Transect E, Moderately Disturbed
A = Transect A, Severely Disturbed

Refer to Map Page 9.31

RAW DATA

Blaze 1991
N = 51
Previous Disturbances
Sample Date: 23 July 1991
Exposure: Mostly Southern
Slope: 1-10 deg.

Slightly Disturbed; Transect B = Nos. 1-10

	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
TREES & SHRUBS										
Symphoricarpos oreophilus	58.00	0.00	0.00	5.00	0.00	25.00	10.00	0.00	0.00	0.00
Chrysothamnus viscidiflor	0.00	5.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysothamnus nauseosus	0.00	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00
Artemisia tridentata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Populus treuloides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rosa woodsii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Artemisia nova	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eriogonum corymbosum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FORBS										
Artemisia dracunculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aster foliaceus	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
Rumex crispus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
Cynoglossun officinale	5.00	10.00	0.00	5.00	10.00	5.00	10.00	3.00	15.00	5.00
Urtica dioica	15.00	0.00	0.00	0.00	0.00	5.00	0.00	2.00	15.00	0.00
Machaeranthera canescens	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ea millefolium	0.00	10.00	0.00	0.00	10.00	0.00	5.00	10.00	10.00	0.00
hymenoxys richardsonii	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Geranium richardsonii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepidium montanum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iva axillaris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Circium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machaeranthera grindelioi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Epilobium angustifolium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gayophytum raeccissimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Comandra umbellatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salsola iberica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRASSES										
Elymus lanceolatus	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	5.00	5.00
Elymus salinus	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poa fendleriana	0.00	15.00	20.00	55.00	20.00	55.00	45.00	70.00	5.00	40.00
Elymus trachycaulus	7.00	40.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hordeum jubatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stipa lettermanii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bromus tectorum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COVER										
Total Living Cover	90.00	90.00	50.00	65.00	55.00	90.00	80.00	85.00	55.00	55.00
Litter	2.00	8.00	10.00	32.00	5.00	1.00	17.00	13.00	5.00	5.00
Bareground	5.00	1.00	15.00	1.00	39.00	1.00	2.00	1.00	20.00	35.00
Rock	3.00	1.00	25.00	2.00	1.00	8.00	1.00	1.00	20.00	5.00
COMPOSITION										
Shrubs	64.44	5.56	40.00	7.69	27.27	27.78	12.50	0.00	0.00	0.00
Forbs	27.78	33.33	10.00	7.69	36.36	11.11	18.75	17.65	81.82	18.18
Grasses	7.78	61.11	50.00	84.62	36.36	61.11	68.75	82.35	18.18	81.82

Slightly Disturbed; Transect C = Nos. 11-18

11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00
0.00	40.00	25.00	25.00	22.00	28.00	10.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	7.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00
0.00	10.00	5.00	3.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	3.00	5.00	5.00	25.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	10.00	0.00	3.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	5.00	0.00	5.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	10.00	10.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.00	20.00	5.00	17.00	15.00	20.00	20.00	30.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50.00	90.00	60.00	55.00	55.00	55.00	60.00	55.00
5.00	5.00	10.00	30.00	5.00	15.00	25.00	10.00
25.00	1.00	5.00	14.00	5.00	20.00	2.00	30.00
20.00	4.00	25.00	1.00	35.00	10.00	13.00	5.00
60.00	55.56	41.67	58.18	40.00	50.91	16.67	9.09
0.00	11.11	33.33	10.91	32.73	12.73	50.00	36.36
40.00	33.33	25.00	30.91	27.27	36.36	33.33	54.55

Moderately Disturbed; Transect D = Nos. 19-29

19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00
45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25.00	70.00	85.00	55.00	60.00	55.00	65.00	5.00	45.00	20.00	35.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00	25.00	0.00	60.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	5.00	10.00	20.00	10.00	15.00	0.00	15.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80.00	80.00	90.00	70.00	80.00	90.00	80.00	70.00	60.00	35.00	65.00
1.00	5.00	8.00	20.00	4.00	2.00	5.00	24.00	30.00	5.00	5.00
15.00	14.00	1.00	9.00	15.00	3.00	1.00	5.00	5.00	55.00	25.00
4.00	1.00	1.00	1.00	1.00	5.00	14.00	1.00	5.00	5.00	5.00
93.75	87.50	94.44	78.57	75.00	88.89	81.25	92.86	75.00	71.43	53.85
6.25	12.50	5.56	14.29	25.00	11.11	18.75	0.00	25.00	14.29	0.00
0.00	0.00	0.00	7.14	0.00	0.00	0.00	7.14	0.00	14.29	46.15

Moderately Disturbed; Transect E = Nos. 30-36

30.00	31.00	32.00	33.00	34.00	35.00	36.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
35.00	50.00	45.00	10.00	15.00	0.00	5.00
0.00	5.00	0.00	0.00	0.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00
5.00	10.00	0.00	30.00	5.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	10.00	5.00	0.00	10.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.00	15.00	15.00	0.00	0.00	50.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	10.00
55.00	90.00	60.00	50.00	25.00	50.00	50.00
5.00	1.00	5.00	5.00	5.00	5.00	5.00
39.00	8.00	30.00	40.00	45.00	25.00	40.00
1.00	1.00	5.00	5.00	25.00	20.00	5.00
63.64	61.11	75.00	20.00	60.00	0.00	30.00
9.09	22.22	0.00	60.00	20.00	0.00	10.00
27.27	16.67	25.00	20.00	20.00	100.00	60.00

Severely Disturbed; Transect A = Nos. 37-51

37.00	38.00	39.00	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
0.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	0.00	0.00	64.00
0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	3.00	4.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	0.00
0.00	0.00	0.00	2.00	0.00	5.00	3.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	10.00	7.00	5.00	2.00	0.00	0.00	0.00	16.00	0.00	0.00	3.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	1.00
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	5.00
0.00	0.00	0.00	3.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00
15.00	35.00	30.00	30.00	25.00	5.00	10.00	5.00	25.00	10.00	75.00	15.00	15.00	75.00
2.00	25.00	10.00	5.00	15.00	20.00	5.00	1.00	3.00	2.00	23.00	10.00	10.00	10.00
13.00	35.00	10.00	10.00	1.00	10.00	15.00	25.00	20.00	10.00	1.00	30.00	50.00	13.00
00	5.00	50.00	55.00	59.00	65.00	70.00	69.00	52.00	78.00	1.00	45.00	25.00	2.00
93.33	71.43	33.33	20.00	60.00	100.00	30.00	100.00	8.00	0.00	100.00	60.00	100.00	85.33
6,67	28.57	33.33	36.67	40.00	0.00	30.00	0.00	84.00	100.00	0.00	26.67	0.00	1.33
0.00	0.00	33.33	43.33	0.00	0.00	40.00	0.00	8.00	0.00	0.00	13.33	0.00	13.33

51.00	Mean	SDev	Freq	
				TREES & SHRUBS
0.00	9.16	17.97		Symphoricarpos oreophilus
0.00	0.63	2.98		Chrysothamnus viscidiflorus
53.00	15.27	23.38		Chrysothamnus nauseosus
0.00	0.92	4.40		Artemisia tridentata
0.00	0.20	1.39		Populus treuloides
0.00	2.18	9.13		Rosa woodsii
0.00	0.29	2.08		Artemisia nova
0.00	0.29	1.07		Eriogonum corymbosum
	ERR	ERR		FORBS
0.00	0.88	2.83		Artemisia dracunculus
2.00	0.88	2.31		Aster foliaceus
0.00	0.10	0.69		Rumex crispus
0.00	4.35	5.90		Cynoglossun officinale
0.00	0.73	2.98		Urtica dioica
0.00	0.20	0.97		Machaeranthera canescens
.00	1.22	3.03		Achillea millefolium
0.00	0.20	0.97		Hymenoxys richardsonii
0.00	0.29	1.18		Geranium richardsonii
0.00	0.14	0.74		Lepidium montanum
0.00	0.38	4.43		Iva axillaris
0.00	0.18	1.12		Circium spp.
0.00	0.08	0.44		Machaeranthera grindelioides
0.00	0.02	0.14		Epilobium angustifolium
0.00	0.04	0.19		Gayophytum ramosissimum
2.00	0.18	1.00		Commandra umbellatum
0.00	0.06	0.42		Salsola iberica
	ERR	ERR		GRASSES
0.00	1.61	3.20		Elymus lanceolatus
0.00	0.24	0.96		Elymus salinus
0.00	11.80	17.44		Poa fendleriana
0.00	1.02	5.64		Elymus trachycaulus
0.00	0.10	0.69		Hordeum jubatum
0.00	0.39	1.67		Stipa letterwanii
0.00	0.33	1.56		Bromus tectorum
				COVER
57.00	54.94	25.39		Total Living Cover
3.00	9.55	8.36		Litter
25.00	16.96	14.63		Bareground
15.00	18.55	23.03		Rock
				% COMPOSITION
92.98	52.43	32.93		Shrubs
7.02	21.53	21.97		Forbs
0.00	26.04	26.72		Grasses

(Proposed redisturbance)

T. 13S. R. 8E. Sec. 17
VEGETATION SAMPLING
TRANSECT LINES (A,B,C,D & E)

SECTION 10

FISH AND WILDLIFE RESOURCES

Section 10

FISH AND WILDLIFE RESOURCES

10.1 Scope

10.1.1 Objectives

The fish and wildlife studies for the Blue Blaze Coal Company No. 1 and No. 2 Mines, Carbon County, Utah have been designed to satisfy the guidelines for Permit Applications for the Utah Division of Oil, Gas and Mining (DOGM). The studies also will provide data useful to Blue Blaze Coal Company in future mining activities and long-term reclamation programs.

In meeting the basic objectives outlined above, fish and wildlife studies of the Blue Blaze No. 1 and 2 Mine sites will supply the following types of information: (1) species composition and diversity of the various habitat types; (2) seasonal patterns of distribution and relative abundance; (3) habitats or areas of special value to wildlife, such as big games winter range or movement corridors and rapture nest sites; and (4) the actual or potential status of species listed as threatened, endangered, rare or of particular interest by the Utah Division of Wildlife Resources (DWR) or the U.S. Fish and Wildlife Service (FWS).

10.1.2 Location and Ecological Setting

The Blue Blaze No. 1 and 2 Mine study area is located along the eastern edge of the Wasatch Plateau in Carbon County, Utah. Elevation range is about 7,500 to 8,900 ft. (2,270 - 2,700 m).

Topographically, the study area consists of steep slopes on the face of the plateau and along drainages, flat surfaces or terraces or floodplains in valley bottoms and relatively gentle terrain on top of the plateau. The area is underlain by nearly flat sedimentary rocks of the Tertio-Cretaceous North Horn Formation and the Lower Tertiary Flagstaff Formation.

The study area has a highly continental climate with large daily and seasonal variations in temperature. The lower elevations of the permit area are quite dry with average annual precipitation of 14 inches or less, mostly falling as spring rain showers. Higher elevations receive more precipitation, much of it as snow which persists through the winter.

The vegetation of the study area is highly variable, due to difference in elevation and exposure. Major habitats

Include Slope Bunchgrass, Big Sagebrush, Mountain Shrub, Aspen, Pinyon-Juniper, Low Elevation Conifer, High Elevation Conifer and Subalpine Meadow associations. Most of the major habitats are represented by phases with different plant dominats. There are also some minor habitats, including small mixed riparian areas. Detailed descriptions of major and minor habitats are presented in Section 10.3.1, below.

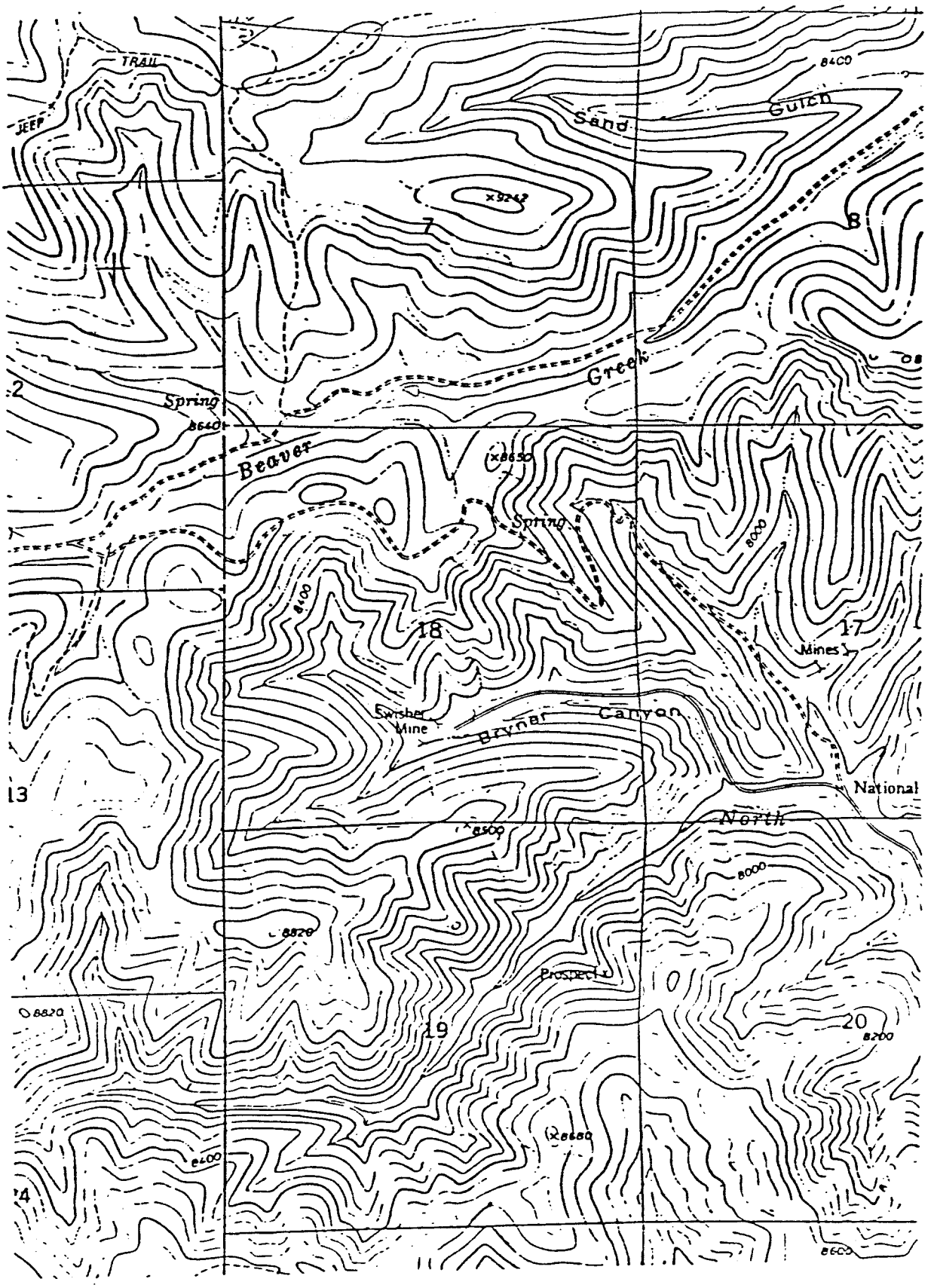

Figure 10-1 The general study area for the Blue Blaze No. 1 & 2 Mine fish and wildlife investigations, 1980-1981.

10.2 Methodology

10.2.1 Literature Review

One of the initial steps in the fish and wildlife studies was to review open-file data and range maps available from the DWR Regional Office in Price, Utah. The purpose of this effort was two-fold: first, it provided a regional backdrop of wildlife information; second, it was helpful in identifying areas of concern to DWR and thus ensuring that their needs and preferences were addressed.

The other major purpose of the literature review was to obatin pertinent publications on the distribution and status of vertebrates in the study region (i.e., the Wasatch Plateau). These books, articles and monographs provided information on species likely to occur in the area and served as a basis for evaluating the representativenesess of the Blue Blaze No. 1 and No. 2 Mine sites.

In March 1981, DWR provided detailed wildlife information for the Blue Blaze No. 1 and No. 2 Mine sites, as requested by Blue Blaze Coal Company, pursuant to UMC 783.20. DWR also prepared a wildlife plan representing their recommendations for mitigation and impact avoidance procedures, pursuant to UMC 784.21. The information compiled by DWR in preparing their response to Blue Blaze Coal Company's request comprises a substantial portion of this report, as does DWR's 1978 publication on vertebrate species of southeastern Utah. Specific elements from these DWR documents are cited throughout this report as DWR (1981a). DWR (1981b), and DWR (1978).

10.2.2 Terrestrial Studies

The methods used during field work were designed to provide descriptive and quantitative data for terrestrial wildlife in the mine plan area. Wildlife data collected for the Blue Blaze No. 1 and No. 2 Mine studies followed a stratified approach based on habitat types. In many instances, wildlife habitats did not strictly coincide with plant communities, being based on topographic as well as vegetational factors. Therefore, some plant community units were combined or split to best reflect wildlife utilization. The correlation between plant communities and wildlife habitats is discussed in Section 10.3.1.

The methods employed in addressing the various groups of terrestrial vertebrates were discussed informally with Larry Dalton of DWR in Price, Utah, in September 1980

prior to initiating field studies. These methods are summarized in the following sections.

10.2.2.1 Mammals

For the purpose of field study, this diverse group of organisms was divided into large mammals, medium-sized mammals, and small mammals.

Large mammals consist of large herbivores and large carnivores. For the Gordon Creek study area these species were studied through a combination of systematic transects and opportunistic sightings. Road surveys were conducted during each field session to obtain data on abundance, distribution, and habitat use. This data was augmented with walked transects across each habitat type. Walked transects afforded an opportunity to evaluate differential habitat uses from indices such as pellet group densities and percent browse utilization. Opportunistic sightings during other wildlife efforts were particularly useful for species either too uncommon or furtive to be regularly encountered during systematic surveys or restricted to limited habitats. Aerial surveys were initially proposed but were dropped at the request of DWR.

Medium-sized mammals, such as predators, lagomorphs (rabbits and hares), and large rodents were also surveyed by a combination of systematic and opportunistic techniques. Road transects at dawn and dusk were important for predators and lagomorphs, most of which are most active at these times (i.e., "crepuscular"). Data on sign of the crepuscular species and on actual observation of diurnal species were recorded in conjunction with various daytime field efforts.

Small mammals, which may be used as indicators of ecosystem quality and reclamation success, were to have been surveyed using Sherman livetraps set in lines through each habitat type. As the aerial surveys, DWR specified that this technique was not being used. Therefore, small mammal information presented in this report is drawn almost exclusively from DWR (1978) and Durrant (1952).

10.2.2.2 Birds

The most efficient grouping of birds for field studies and baseline reports is raptors, upland fowl, water birds and small birds or songbirds.

Raptors were observed and recorded opportunistically throughout the field program. Daytime surveys were best for hawks and eagles, while dawn/dusk surveys resulted in

most sightings of owls. In addition, areas of potential importance e.g., cliffs, raparian areas, and abandoned buildings were specifically searched in an attempt to locate nest sights. Raptor surveys followed the standard survey techniques described by Call (1978). The raptor nestings were documented by the DWR. (See Section 10.3.2.4)

Upland gamebird surveys were conducted in conjunction with other field programs and relied primarily on chance encounters of the birds of their sign. Special effort was placed on determining if upland fowl breed in the study area or are present in sufficient numbers to offer recreational value.

Waterbirds (waterfowl, shorebirds, wading birds) were surveyed in a similar approach as other large birds i.3., opportunistically during all field programs plus specific visits to suitable habitats, such as ponds and slow-moving streams. As with the upland gamebirds, emphasis were placed on determining the extent to which the study area provided breeding sites and the importance of these species as a recreational resource.

"Small birds" are a heterogeneous group. For the Blue Blaze No. 1 and No. 2 Mine wildlife studies, this group included perching birds, woodpeckers, hummingbirds, swifts, and frogmouths. In late summer, fall and winter surveys, the presence, distribution, and abundance of small birds was determined along walked transects in each habitat type and by opportunistic sightings during the initial site reconnaissance. During the breeding season (spring and early summer), quantitative data were obtained by counting the number of breeding pairs (territorial males) of each species within numerous plots located systematically along transect routes through each habitat type. Audial identification was emphasized during this census to avoid problems of differential detectability of species (as a function of conspicuousness and activity patterns) and visual penetrability of habitats (e.g., and dense willow thicket verses an open stand of mountain brush).

The small bird transects were not permanently established routes, because the emphasis was on obtaining data from a large number of plots throughout each habitat type, rather than on repeated surveys of a small number of plots. The reasons for selecting this technique are that (1) habitats in the study area are heterogeneous and a larger sample size is necessary to adequately describe the avifauna of each, and (1) year-to-year variability within the complex habitats probably would mask any long-term trends in density, diversity, and composition.

10.2.2.3 Reptiles and Amphibians

These species were surveyed in combination with other field efforts. For most herptiles, opportunistic sightings provided sifficient detail on abundance and distribution. Amphibians, however, were surveyed by visiting potential breeding sites, such as ponds or marshy areas, during the spring breeding period, when they could be identifled by their vocalizations.

10.2.3 Aquatic Studies

Field and lab methods used in the Gordon Creek and Beaver Creek aquatic studies were selected in describing the biotic and abiotic components of study area streams, discerning possible impacts of the proposed mining operation, and recommending future mitigation and monitoring programs. Biotic components specifically included sampling for macroinvertebrates and evaluating the fisheries potential. Abiotic components included field techniques for testing water quality, as well as descriptions of substrate and channel morphology. Studies were conducted in November 1980 and April and June 1981.

10.2.3.1 Sample Site Selection

Aquatic studies involved six stream sample sites: four in the Beaver Creek system and two in the North Fork Gordon Creek system. The sites were selected to provide information from representative stream reaches, above and below substantial tributaries.

The sites on North Fork Gordon Creek were located about 25 m above and 50 m below the confluence with the unnamed tributary which flows past the Blue Blaze No. 1 and No. 2 Mine sites. This confluence is located in extreme southwestern Section 17, at the word "North" on Figure 10-1.

The two sites in Beaver Creek were located upstream of the unnamed stream which is tributary in extreme northwestern Section 18, at the Word "Beaver" on Figure 10-1. A third site was located on the unnamed tributary called Spring Creek), and the fourth site was about 1 km farther downstream, in southern Section 7. Figure 10-1 shows the locations of the aquatic sampling sites.

10.2.3.2 Habitat Quality

Basic physicochemical characteristics of surface water related to aquatic ecosystem quality were evaluated using standard field equipment during both the spring and winter surveys. Chemical characteristics at all sample

sites were determined with a Hach Fish Culturist water chemistry kit, while temperature was measured with a mercury thermometer submersed for at least 5 minutes.

10.2.3.3 Aquatic Invertebrates

Biological community surveys involved use of a 0.5 mm mesh Surber sampler to collect aquatic invertebrates. At each sample site, the substrate was agitated with a 1 square foot area to dislodge invertebrates, which were swept by the stream current into a trailing net. Surber samples were collected from a riffle, a run, and a pool at each site. The composite samples were fixed in the field and returned to the lab for enumeration and identification to the lowest practicable taxonomic level (usually genus). Identification was based on standard reference works for the region (e.g., Baumann et al. 1977, Merritt and Cummins 1978, Pennak 1978).

Nongame fish were to be sampled with a dipnet to determine species composition and relative abundance, but none was observed during either survey.

10.3 Existing Fish and Wildlife Resources

10.3.1 Wildlife Habitats in the Mine Plan Area

Wildlife habitat types were identified and described during the initial field visits to the Gordon Creek area. As discussed in Section 10.2.2, wildlife habitats do not strictly correspond to vegetation community types. In most studies, more wildlife habitats are recognized than are plant communities, because (1) wildlife values generally can be differentiated at the phase (subcommunity) level and (2) some habitats, such as rock outcrops, cliffs, and scree slopes, are not plant-related at all.

Habitats distinguishable in the Gordon Creek area are described below.

10.3.1.1 Big Sagebrush

This habitat type, identified mainly as sagebrush shrubland and mountain grassland on the vegetation map (Plate 9-1), consisted of two distinct phases of subtypes in the Blue Blaze No. 1 and 2 Mine study areas. At lower elevations, Big Sagebrush *Artemisia tridentate* cf. *tridentata* occurred as dense, essentially monotypic stands on terraces adjacent to major drainages. The availability of green sapwood throughout the winter probably makes these areas fairly attractive to large herbivores during periods when browse is unavailable or snow is too deep at higher elevations.

Atop the plateau, Big Sagebrush Artemisia tridentata cf. vasayana occurred as relatively small stands on slopes adjacent to valley bottoms, particularly on south-facing exposures. Other shrubs associated with this community type included Antelope Bitterbrush Pruchia Tridentata Rubber Rabbitbrush Chrysothamnus nauseasus, and Silver Sagebrush Artimisia cana.

10.3.1.2 Mountain Shrub

One of the most widespread habitats, especially on steep slopes at lower elevations, was a highly variable mixture of shrub species typical of mountainous areas in the region. In general, two basic phases could be defined; these apparently were controlled by slope aspect.

The xeric phase was prevalent on southfacing slopes. Characteristically, these areas were dominated by open stands of Gambel's Oak Quercus gambelii, with varying amounts of Alder-leaf Mountain Mohogany Cercocarpus montanus, Serviceberry Amelanchier cf. utahensis, Snowberry Symphoricarpos cf. vaccinoides, Antelope Bitterbrush, and Rubber Rabbitbrush. Conspicuous hervaceous species during early fall were a tansy-aster Machaeranthera sp. and Salina Wildrye Elymus salinus. At higher elevations, some southfacing slopes were strongly dominated by Greenleaf Manzanita Arctostaphyllos patula, an evergreen shrub of particular values to wildlife.

The mesic phase, typically occurring on north-facing slopes, was dominated by dense stands of Gembel's Oak or Wasatch Maple Acer grandidentatum. Associated woody plants included isolated clumps of Quaking Aspen Populus tremuloides, scattered Douglasfir Pseudotsuga menziesii and White Fir Abies concolor (often appearing to represent a later successional stage), and shrubs such as Chokecherry Prunus virginiana var. melanocarpa, Serviceberry Amelanchier cf. alnifolia, Snowberry, Woods' Rose Rosa Woodsii, Oregon Holly-grape Mahonia repens, and Mountainlower Pachystima myrsinites. The variable herbaceous stratum was dominated by Mountain Brome Ceratochloa marginata, Nodding Brome Bromopsis cf. porteri, and perennial forbs such as

Aster, Erigeron, Fragaria, Frasera, Galium, Geranium, Lathyrus, Thalictrum, and Vicia.

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The xeric phase was prevalent on south-facing slopes. Characteristically, these areas were dominated by open stands of Gambel's Oak Quercur gambellii, with varying amounts of Alder-leaf Mountain Mahogany Cercocarpus montanus, Serviceberry Amelanchier cf. utahensis, Snowberry Symphoricarpos cf. vaccinoides, Antelope Bitterbrush, and Rubber Rabbitbrush. Conspicuous herbaceous species during early fall were a tansy-aster Machaeranthera sp. and Slaina Wildrye Elymus salinus. At higher elevations, come south-facing slopes were strongly dominated by Greenleaf Manzanita Arctostaphyllos patula, an evergreen shrub of particular value to wildlife.

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The Vegetation Map (Plate 9-1) refers to both of these habitat phases as Oak Shrubland while areas of Greenleaf Manzanita are mapped separately as Manzanita Shrubland.

10.3.1.3 Slope Bunchgrass

This rather widespread habitat was compositionally similar to Xeric Mountain Shrub habitat, except for the near absence of woody species. The dominant plant was the bunchgrass Salina Wildrye. The casual distinction between these two xeric communities is not clear, but it probably is related to soil moisture and texture. This habitat type is identified as Mountain Grassland on the Vegetation Map (Plate 9-1).

10.3.1.4 Middle Elevation Conifer

This widespread habitat type was limited to mesic sites, such as north-facing slopes and along drainages, typically appearing as isolated clumps scattered through larger areas of Aspen or Mesic Mountain Shrub. Mature White Firs and Douglas-firs were visually and numerically dominant throughout. Prominent understory species were Mountain Snowberry, Oregon Holly-grape, Currants Ribes

cf. cerum and R. cf. montigenum, Mallow Ninebark Physocarpus malvaceus, Woods' Rose, Aster, Fragaria, and Heuchera. This habitat type and the next are combined on the Vegetation Map (Plate 9-1) as Mixed Coniferous Forest.

10.3.1.5 High Elevation Conifer

Atop the Wasatch Plateau especially at elevations of 8,500 ft. or higher, coniferous forests were dominated by Engelman Spruce Picea engelmannii, Subalpine Fir Abies lasiocarpa, and Douglas-fir. Understory species were similar to those described above for Middle Elevation Conifor Forests. Although comprising a significant portion of the Blue Blaze No. 1 and No. 2 Mine study areas. High Elevation Conifer habitats did not occur in any affected area.

10.3.1.6 Aspen

Dense stands of mature Quaking Aspen occured as a mosaic in moist sites, either on north slopes among Mesic Mountain Shrubs and Middle Elevation Conifers or along forest edges adjacent to High Elevation Conifers. In both occurrences, the understory was similar to other mesic habitats; prominent species included Mountain Snowberry, Mountain-lower, Oregon Holly-grape, Fragaria, Geranium, Lathyrus, Thalictrum, and Vicia. In the north-slope phase of this community type, Wasatch maple often was sufficiently common to be considered a condominant. The Vegetation Map (Plate 9-1) depicts the Aspen Woodland as a separate habitat type.

10.3.1.7 Mixed Riparian

Streams at lower elevations in the Blue Blaze Mine study area generally were characterized by raparian vegetation dominated by larger deciduous shrubs: Mountain Maple Acer glabrum, Redtwig Dogwood Swida sericea (Cornus stollonifera), Elderberry Sambucus cr. coerulea, Chokecherry, and willow Salix species. This assemblage was most common in shaded areas, where the stream was closest to the base of north-facing slopes. More open sites often lacked a distinct raparian community, instead being dominated by species occurring on adjacent xeric hillsides. Trees frequently were absent altogether, but some sites did support large Plains Cottonwods Populus deltoides and Boxelders Acer negundo.

At higher elevations, aspen and conifers (including Blue Spruce Picea pungens) often occured as part of the riparian complex. Riparian areas may be found on the Vegetation Map (Plate 9-1) near the water courses.

10.2.1.8 Subalpine Moist Meadow

Moist meadows commonly were the dominant riparian habitat type above 8,500 ft. These open areas supported dense stands of mesic grasses, such as Foxtail Alopecurus geniculatus, Red-top Agrostic gigantes, Canada Wildrye Elymus candedensis, Reed Canary-grass Phalaris arundinaceae, Bluegrass Poa species, and sedge Carex species.

10.3.1.9 Aquatic Ecosystems

The two major aquatic habitats within the study area are Gordon Creek and Beaver Creek.

Gordon Creek orginates from two unnamed intermittent tributaries about 5 km southwest of the mine site, at an elevation of about 8,750 ft. Within the study area, Gordon Creek is augmented by a number of minor intermittent tributaries, (particulary the North Fork Gordon Creek) that flows past the mine site. Between the upper limits of permanent water at 8,750 ft. and the confluence with Gordon Creek 7,550 ft., Gordon Creek covers approximately 3.5 miles of stream length, with a mean gradient of 340 ft/mile or 6.5 percent. The stream has few meanders but is characterized by scattered beaver ponds. Riparian vegetation is poorly developed along much of its length.

Beaver Creek originates at 9,200 ft. about 4 km west of the mine site, first being mapped as a perennial stream at an elevation of 8,950 ft. 0.8 km below its upper end. According to the USGS topographic map (Figure 10-1). Beaver Creek is fed by a perennial stream ("Spring Creek") within the study area. During the 1980-81 field studies, however, this tributary was dry above the spring (8,550 ft.) except during snow-melt. Between the upper limits of permanent water and its confluence with Sand Gulch near the northern end of the study area at 8,300 ft., Beaver Creek has a mean gradient of 650 ft/mile (12 percent). Much of the stream length is characterized by active or abandoned beaver ponds, willow thickets, and wet meadows with fairly well-developed meanders in some broader sections.

10.3.2 Wildlife

10.3.2.1 Aquatic Wildlife Habitat Value Determination

Based on benthic macroinvertebrate and aquatic habitat surveys, and on data provided by DWR (1981a), Gordon Creek is of limited value as a fishery, because it does not support game species. Beaver Creek, however, is ranked by DWR as being of substantial value as a salmonid

fishery, with a self-sustaining population of introduced Yellowstone Cutthroat Trout Salmo clarki. Nongame fish species listed by DWR for Beaver Creek in the study area are the Mottled Sculpin Cottus bairdi, Mountain Sucker Catastomus (Pantosteus) platyrhynchus, and Speckled Dace Rhinichthys osculus. No fish were seen in Beaver Creek during the April or June surveys, suggesting that populations are fairly small in the study area, probably due to low flows and low gradients (the latter reflected by fairly high temperatures). Fish surveys were not conducted because the mining project is not expected to affect the stream. This was recognized by DWR in their evaluation of wildlife in the study area (DWR 1981a).

The greatest value of both Beaver Creek and Gordon Creek aquatic habitats in the area probably is the water, cover, food and breeding sites they provide to a variety of terrestrial vertebrates (see the following section).

As used in this report, "value" incorporates both ecological and economic criteria. Examples of criteria used in evaluating value include considerations such as whether a species is an indicator of environmental stress, critical to the food web as a prey or predator, important for monitoring programs (See Section 10.7, or represents a significant hunting or trapping resource. High value habitats are those which support especally high diversities or densities of wildlife, attract species not otherwise found in the area, or are important to high value wildlife species (as defined above).

Information provided by DWR (1981a) indicate that the most important habitat types in the study area are the Mixed Riparian zones along Beaver Creek and Gordon Creek and the Subalpine Moist Meadows atop the plateaus. The reasons for classifying Mixed Riparian as the highest priority wildlife habitat are the availability of water and the structural and compositional diversity of the plant community. The second point directly or indirectly affects a number of factors, such as feeding sites, nesting sites, resting or roosting sites, and quantity and quality of food items(such as herbage, seeds, fruit, invertebrates, and small vertebrates). Moist meadows also possess many of these ecological qualities, although they lack structural diversity.

Other high priority habitats listed by DWR (1981a) are seeps or springs which provide water, and cliffs which afford nesting sites for many species of raptorial birds (See Section 10.3.2.4, below).

DWR's designation of riparian and moist meadow habitats as "crucial", because they are limited in extent, attract species not otherwise present, and support high densities

of small animals. However, all habitats are important by some criteria. Thus, for example, Xeric Mountain Shrub provides valuable winter forage for deer and elk, while Middle and High Elevation Conifers and Aspen provide thermal and hiding cover for the same species.

Certainly one of the most important habitats is in the vicinity of the Gordon Creek Study area is the mosaic or chained pinyon/juniper and pasture maintained by DWR to provide high priority and crucial-critical winter range for deer and elk. The high quality of these areas is related to the combination of shrubs for winter browse in the chained areas, palatable grasses and legumes for nutritions early spring forage in the pastures, and thermal and hiding cover in unchained areas along drainages. The value of these areas is discussed further in subsequent sections on big game an impacts.

At the request of Blue Blaze Coal Company, the methods used for studying the various groups of terrestrial vertebrates were discussed informally with Larry Dalton of DWR in Price, Utah, in September, 1980. These methods are summarized in the following sections.

10.3.2.3 Mammals

Eighty-four species of mammals, of which 25 percent are protected, are known to inhabit the biogeographic area in which the project and adjacent areas are located. It is probable that sixty-eight of these species inhabit the project area (reference the Division Publication No. 78-16). Twenty-five species of the mammals inhabiting the project area have been determined to be of high interest to the State of Utah.

The red bat is a summer resident of the biogeographic area that surrounds the project site. The animal roosts in wooded areas (riparian woods and pinion-juniper forests) of the submontane ecological association. Such areas represent this animal's substantial valued use area. An occasional individual has been known to utilize caves; those individuals could hibernate and remain over winter.

The western big-eared bat is a year resident of the biogeographic area that surrounds the project site. This animal roosts and hibernates within caves, mine tunnels or suitable buildings located in the pinion-juniper, shrubland and low elevation spruce-fir habitats of the submontane and montane (Canadian life zone) ecological association. Such areas represent this bat's substantial valued use area. No bats were found to inhabit the mine tunnels of the Blue Blaze mines area. At the request of Bill Bates of the DWR a letter was written to his attention on April 30, 1992 by William R. Skaggs. The letter stated that Mr. Skaggs had observed no bats inhabiting the mine workings when he had been inside the mine (See Appendix 7).

The snowshoe hare is a yearlong resident of the biogeographic area that surrounds the project site. Its relative abundance has been determined to be limited, since its substantial values use area is restricted to the spruce-fir and nearby aspen and riparian habitats of the montane (Canadian and Hudsonian life zones) ecological association. Such areas are ranked as being of high-priority value to the animal during its breeding season which spans the period between early April and Mid-August.

The cottontail rabbit (mountain cottontail inhabits sites lying between 7,000 and 9,000 feet in elevation and the desert cottontail inhabits sites lower than 7,000 feet in elevation) is a yearlong resident of the biogeographic area that surrounds the project site. The entire project area represents a substantial valued use area for cottontails. Their young are born between April and July. This is a crucial period for maintenance of the cottontail population.

The northern flying squirrel is a yearlong resident of the biogeographic area that surrounds the project site. Currently; its relative abundance is unknown. Its substantial valued use area is restricted to spruce-fir or other mixed conifer habitats of the montane (Canadian and Hudsonian life zones) ecological association. This species is the only nocturnal squirrel in Utah. The flying squirrel may build its nest within an old woodpecker hole or it may build an outside nest of leaves, twigs and bark. Mating occurs twice in each year, Fegruary through March and June through July. Afterwhich, two to six young are born after a gestation period of 40 days, April through May and August through September. These periods are of crucial value to maintenance of their populations. During winter flying squirrels are gregarious; 20 or more have been known to den together.

Beaver are yearlong inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area is restricted to riparian and adjacent aspen habitats (those located within 100 meters of the riparian zone) in the cold desert, submontane and montane (Canadian life zone) ecological associations. These animals construct a conical shaped lodge in which a family group lives throughout the year. The lodge is of critical value to maintenance of the beaver population. One litter of kits is produced each year; they are born between late April and early July after a gestation period of 128 days. Kits and yearlings coinhabit the lodge with the adult pair. When they attain 2 years of age they are forced to leave; females can breed at 2.5 years of age. Due to the animal's dependency upon

flowing water and the associated riparian vegetation, the riparian wildlife habitat is ranked as being of critical value to beaver populations.

The red fox is a yearlong inhabitant of the biogeographic area that surrounds the project site. The substantial valued use area for the red fox would include all wildlife habitats extending from the cold desert through the montane (Canadian life zone) ecological associations. Almost nothing is known of their population dynamics. Without doubt a crucial period for the red fox is when they are caring for young in the den. Dens while being inhabited are a critical use area.

The gray wolf is a historic inhabitant of the biogeographic area that surrounds the project site. Currently its relative abundance is so low that the animal is listed as endangered with extinction. The wolf's substantial valued use are would be represented by any remote habitat in any ecological association.

Black bears are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area is represented by all natural wildlife habitats (excluding the pasture and fields and urban or park types) extending from the submontane into the montane (Canadian and Hudsonian life zone) ecological associations. These animals go into a semi-hibernation during winter. During this crucial period, which may last from December through March, the animal secrets itself in a den in order to conserve body energy reserves. The young are born in the den during January or February. Dens while being inhabited represent a critical valued use area for bears.

Many of the members of the family mustelidae are known to inhabit the biogeographic area that surrounds the project site. They are all protected and classified as furbearers, short-tailed and long-tailed weasels, mink, wolverine, marten, badger, striped and spotted skunks. Additionally, raccoon and muskrat, although not furbearers, are also inhabitants of the biogeographic area that surround the project site. All of these species are of high interest due to their value in the fur market.

The substantial valued use area for short-tailed and long-tailed weasels, mink, muskrat and raccoons is the raparian habitat. Weasels, which are inhabitants of the project site, do make some use of other habitats that are proximal to riparian zones. Muskrats and raccoons are restricted to raparian habitats of the cold desert and submontane ecological association; thus, they are not found on the project area. The long-tailed weasel can be

found from the cold desert up into the montane (Canadian and Hudsonian life zones) ecological associations. The short-tailed weasel and mink populations extend their use from the submontane into the montane ecological association. It is important to note that the weasel is restricted to the Canadian life zone; where as the mink utilize the Canadian and Hudsonian life zones.

The substantial valued use area for marten and wolverine is the montane ecological association. The marten does not utilize the Alpine life zone but the wolverine can be found at that elevation. Both species could be found in the environs of the project site.

The substantial valued use area for badger and skunk span all wildlife habitats other than dense forests in the cold desert, submontane and montane (Canadian life zone) ecoloogical associations. Skunks show some afinity for habitats proximal to water. Skunks and badgers are dependent upon a suitable prey source.

A crucial period for maintenance of all fur bearers, raccoons and muskrat populations is when they have young in a nest, den or lodge. Such sites are critical for reproductive success.

Bobcat, Canada lynx and couger are known to inhabit the biogeographic area that surrounds the project site. For all of these species a crucial period for maintenance of their population is when the female has her young secreted at a den site. Such sites are of critical value when being utilized. It is also crucial to their survival that a female accompanied by young not be killed or harassed.

The substantial valued use area for bobcats extends from the cold desert through the submontane and into the montane (Canadian life zone) ecological association. The bobcat is normally associated with percipitous terrain, but has been observed in every wildlife habitat within the aforementioned ecological associations. Their primary prey source is represented by small mammals and birds or any other small animal they can catch. It is important to note that bobcats occasionally do kill the young of big game animals.

The substantial valued use area for the Canada lynx is restricted to the Canadian and Hudsonian life zones of the montane ecological association. Normally, this cat would only be expected to utilize riparian and forested wildlife habitats. The lynx is similar to predation habits to the bobcat.

The substantial valued use area for the cougar (locally known as mountain lion) extends from the submontane into the montane (Canadian and Hudsonian life zones) ecological association. Due to the dependancy of the cougar upon mule deer as a prey source, a ranking of the lion's seasonal distribution parallels that of the deer.

Mule deer are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats extending from the cold desert through the submontane and montane ecological associations. In some situations deer show altitudinal migrations in response to winter conditions. There are, however, hibitats where deer reside on a yearlong basis.

Migration of mule deer from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting season coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the deer's urge to migrate and continued adverse weather keeps the deer on the winter rage.

A protion of the project site represents winter range for mule deer herd unit 32. Winter ranges for mule deer are all ranked as being of high-priority value to the animal; these areas are usually inhabited between November 1 and May 15 each year. During winters with severe conditions the higher elevation portion of the winter range becomes unavailable to deer due to snow depth. Traditionally, some restricted portions of the winter range have shown concentrated use by the deer; these sites are ranked as being of critical value. Although, no critical winter ranges are found on the project area, the access route passes through high-priority and critical valued use areas in herd units 32 and 33. Critical valued sites must be protected from man's disturbance when the deer are physically present on the range.

Deer begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area represent deer herd units 32 and 33. They are ranked as being of high-priority value to mule deer.

There are ranges that support mule deer on a yearlong basis. Most of these ranges are of limited value to deer. However, there are some areas supporting yearlong use that are ranked as being of high-priority value to deer. Yearlong ranges do not exist on the project site. Note, with a yearlong range all riparian habitats are ranked as being of critical value to mule deer.

Mule deer fawn during the month of June. The continum of wildlife habitats extending from the pinion-juniper through the shrubland and into the aspen type probably represents the fawning area. All riparian areas are of critical value for fawning and maintanance of the deer population. To date no specific areas showing annual use for fawning are known. It is probable that such areas exist; they would be ranked as being of critical value to deer. It is important to note that June represents a crucial period for maintenance of deer populations.

Agriculture areas nearby (Gordon Creek Wildlife Management area) to the project area are utilized yearlong by mule deer. Their use is intensified during the winter and spring periods.

Moose are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats in the montane ecological association except those associated with the ALpine life zone. In some situations moose show altitudinal migrations in response to winter conditions. There are, however, habitats where moose reside on a yearlong basis.

Migration of moose from summer range to winter range is initiated during late November; probably, changing weather conditions is the initial stimulus. The onset of winter weather reinforces the moose's urge to migrate and continued adverse weather keeps the animal on the winter range.

A portion of the project site represents winter range for the Southeastern Utah moose herd--Price River--White River drainages. Winter ranges for moose that are characterized as riparian habitats are ranked as being of critical value, where as the remainder of the winter ranges are ranked as being of high-priority value to the animal. Winter ranges are usually inhabited by moose between December 1 and May 15 each year. During winters with severe conditions the higher elevation protion of the winter range becomes unavailable to moose due to snow depth. Critical valued sites must be protected from man's disturbance when the moose are physically present on the range.

Moose begin their migration back to summer range during mid-May and remain there throughout November. Summer ranges on the project area support animals from the Price River-White River, Scofield and Huntington drainages of the South eastern Utah moose herd. Those summer ranges are ranked as being high priority value.

Ranges that support moose on a yearlong basis are ranked as being of critical value.

Moose calf during late May and June. Calfing takes place in the riparian or adjacent forest habitats. Without doubt, all riparian areas are of critical value for calving and maintenance of the moose population. To date no specific areas showing annual use for calving are known. It is probable that such areas exist; they would by ranked as being of critical value to moose. It is important to note that June represents a crucial period for maintenance of moose populations.

Rocky Mountain elk are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats extending from the submontane through the montane ecological association. Elk do not show as strong of altitudinal migration as mule deer do in response to winter conditions, but they do migrate to wintering areas.

Migration of elk from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting seasons coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the elk's urge to migrate and continued adverse weather keeps elk on the winter range.

A portion of the project site represents winter range for the Manti elk herd unit 12. Winter ranges for elk are all ranked as being of critical to the animal; these areas are usually inhabited between November 1 and May 15 each year. During winters with severe conditions some portions of the winter range become unavailable to elk due to snow depth. Traditionally, some restricted portions of the winter range have shown concentrated use by the elk; these sites, some of which exist on the project area, are ranked as being of critical value. Critical valued sites must be protected from man's disturbance when the elk are physically present on the range.

Elk begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area support the Manti elk herd-unit 12; they are ranked as being of critical value.

Elk calf during the month of June. Their preferred calving areas are best described as aspen forests with lush understory vegetation. All riparian areas on the summer range are of critical value for calving and maintenance of the elk population. To date no specific

areas showing annual use for calving are known. It is probable that such areas exist; they would be ranked as being of critical value to elk. It is important to note that June represents a crucial period for maintenance of elk populations.

Currently, there are no other known high interest wildlife species or their habitat use on or adjacent to the project area. It is not unreasonable to suspect that in the future, some additional species of wildlife may become of high interest to the local area, Utah or the Nation. If such is the case, the required periodic updates of project permits and reclamation plans can be adjusted and appropriate recommendations made.

10.3.2.4 Birds

Two hundred forty-two species of birds, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that one hundred thirty-eight of these species inhabit the project area. Thirty species of the birds inhabiting the project area have been determined to be of high interest to the State of Utah.

Ducks commonly known as waterfowl are not known to utilize the project area. However for short periods and on occasion or during different seasons of the year an occasional bird, pair or flock may inhabit the mine plan area. All waterfowl are of high interest to the State of Utah. Generally speaking, the riparian and wetland habitats encompassed by the project and adjacent areas provide substantial valued habitats for waterfowl. Each species has different life requirements, but none make significant use of the riparian and wetland environs associated with the project.

If any waterfowl were to nest locally, the period March 15 through July 15 would be ranked as being of crucial value to maintenance of the population. Following incubation, which dependent upon the species may vary between 20 and 28 days and extend up until mid-August, the riparian and wetland habitats represent a high-priority brooding area. Additionally, the wetland habitat (only large open water areas or dense marshland) is of high-priority for seclusion and protection of adult waterfowl during their flightless period when they moult. Males may begin the moult in early June and both sexes and the young are capable of flight by mid-August.

All wetlands and open water areas can become locally important as high-priority use areas for waterfowl during peak migration periods in the spring (March 15 through May 15) and fall (August 15 through October 15).

The project and adjacent areas provides substantial valued habitat for a multitude of raptors - turkey vulture, bald and golden eagles, four species of falcons (prairie, American peregrine and arctic pere falcons, and American kestrel), five species of hawks (goshawk, sharp-shinned, Coper's, red-tailed and Swainson's hawks) and seven species of owls (barn, screech, flammulated, greathorned, pygmy, long-eared and saw-whet owls). Many of these species are of high federal interest pursuant to 43 CFR 3461.1 (n-1). All of these species are of high interest to the State of Utah. The project area was flown by the DWR on June 5, 1989 with an intense search for the nesting of raptors. (See Figures 10-2 and 10-3)

Realistically, nesting habitat does not exist on the project or adjacent areas for many of these species. However, if a species were to nest on or adjacent to the project area, it would have a specific crucial period during which the aeries would need protection from disturbance; this period of time lies between February 1 and August 15. Generally speaking, aeries represent a critical valued site and need protection from significant or continual disturbance within a one-half kilometer radius of the nest. This consideration need only be implemented during the period of time that the nest is occupied. Species specific protectiive stipulations for aeries are available from the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service.

The current level of data relative to site specific use of the area by raptors is unsatisfactory. Likely, there are aeries that have not been identified. Many of these species are highly sensitive to man's disturbances. Therefore, it is recommended that intensive surveys be intiated on the mine plan and adjacent areas for determination of locations for raptor aerie territories. Such data needs to be merged with information provided within this report.

Golden eagles are a common yearlong resident of the mine plan area. No aerie territories are known inside the 1/2 mile radius of the project area. (Note, an aerie territory is utilized by one pair of eagles but may contain several nest sites).

It is believed that an aerie territory may exist by the project area. This belief is based upon the fact that suitable nesting habitat is available outside the 1/2 mile radius of the project area. It is important to note that the regularity of golden eagle observations and the fact that their status is common has resulted in documentation of mostly opportunistic observations of aerie territories.

Figure 10-2

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE RESOURCES

Norman H. Bangerter
Governor
Dee C. Hansen
Executive Director
Timothy H. Provan
Division Director

Southeastern Region
455 West Railroad Avenue
Price, Utah 84501-2829
801-637-3310

June 9, 1989

Dr. Dianne Nielson, Director
Utah Division of Oil, Gas & Mining
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Attn: Rick Smith

Dear Dianne:

Enclosed is a map of the raptor inventory I conducted on June 5, 1989 for the Blue Blaze Mine in Gordon Creek. One active Golden Eagle nest (#189.01D) with 2 young was found and three inactive golden eagle nests (#189.01-A,B,C) within the same territory were also found. The one half-mile buffer zone has been drawn around the nest sites.
The survey was conducted using a Jet Ranger Helicopter. The area surveyed is also outlined on the enclosed map.

If you have any questions or need additional information, please feel free to contact me or Larry Dalton.

Sincerely,

Miles Moretti
Nongame Manager

cc: Larry Dalton
USFWS - Salt Lake
Roger Skaggs

3/1/90

10-24

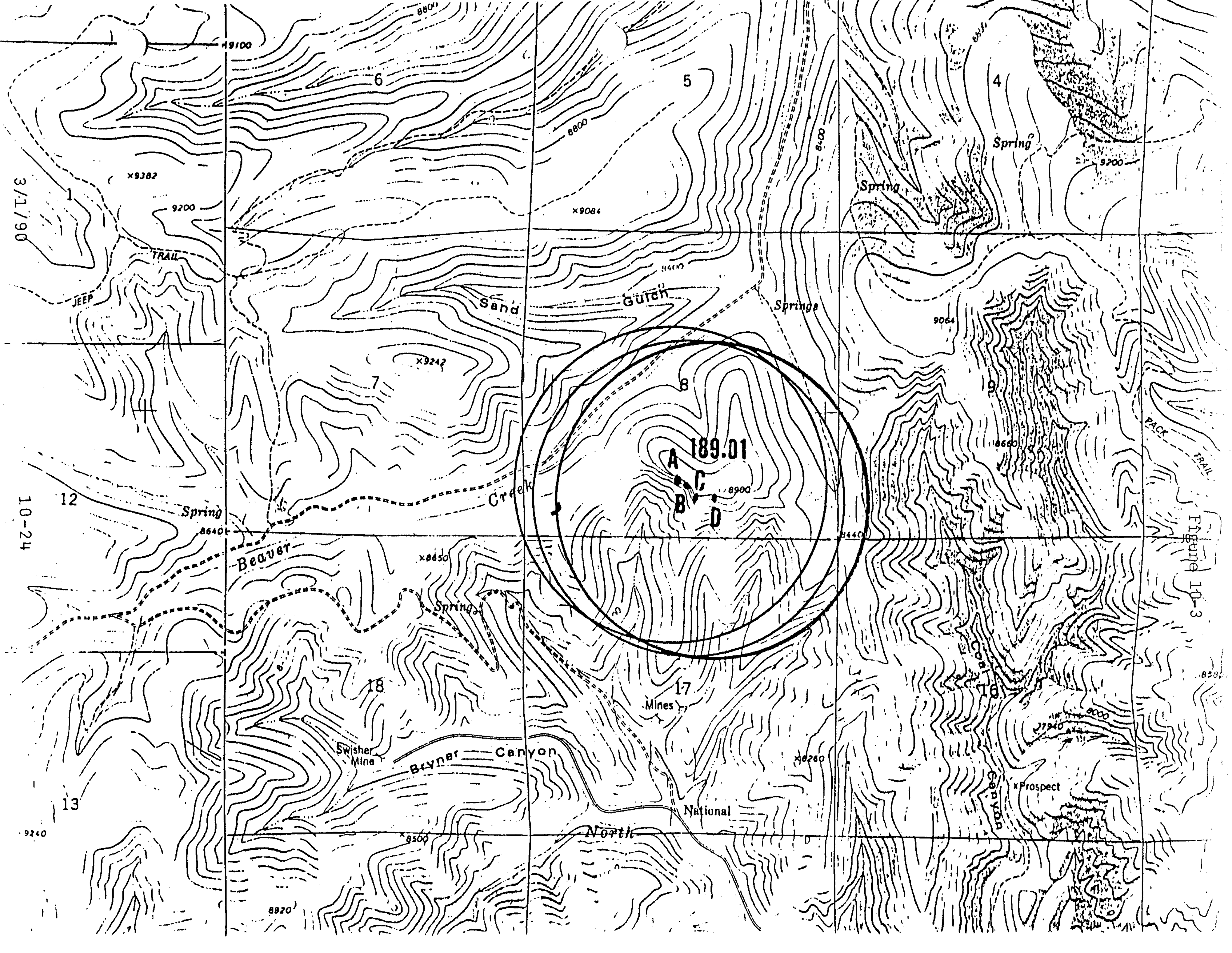


Figure 10-3

An active golden eagle nest site is extremely sensitive to disturbance within a one-half kilometer radius. This buffer zone is ranked as being of critical value to maintenance of the eagle population when the bird is actually utilizing the aerie; that period of time is normally between April 15 and June 15. The radius for a buffer zone may need to be increased to one kilometer if a disturbance were to originate from above and within direct line of sight to the eagle aerie.

To date there are no known high-priority concentration areas or critical roost trees for golden eagles on the project area. The mine plan and adjacent areas have been ranked as being of substantial value to golden eagles.

The northern bald eagle is an endangered winter resident (November 15 to March 15) of the local area. To date there are no known high-priority concentration areas or critical roost trees for this species on or adjacent to the project. There does exist a high-priority winter concentration area adjacent to the project area. The access route to the project area disects this use area. The mine plan area has been ranked as being of substantial value to wintering bald eagles. There are two known nesting areas along the Colorado River. Historic data documents nesting activity by these birds in the State. There is no known historic evidence of the northern bald eagle nesting on the mine plan or adjacent areas.

The American peregrine falcon (relative abundance is endangered) and the prairie falcon (relative abundance is common) are yearlong residents of the mine plan and adjacent areas. Each of these species utilized cliff nesting sites. To date there are no known aerie sites for cliff nesting falcons on the project area. However, marginal nesting habitat for the prairie falcon may exist on the project area. Suitable nesting habitat for the American peregrine falcon cannot be found on the mine plan and adjacent areas. Since a prairie falcon's existence on the area would not be unlikely, the project area has been ranked as being of substantial value to this falcon. It only represents a limited value use area for peregrines.

For each falcon their aerie site wile being utilized are one-half kilometer radius away from the project area and could be ranked as being of critical value to maintenance of their populations. The falcon's period of use at the aerie site spans the spring and early summer period-prairie falcon, April 15 to June 30; peregrine falcon, March 1 to June 30.

The level of data relative to site specific use of the project area by prairie falcons (not including the kestrel is unsatisfactory and there could be aeries that have not been identified. Therefore, it was a necessity to check the area by using the DWR to fly the area and identify the cliff falcon aerie sites.

The endangered arctic peregrine falcon is a winter resident (November 15 through March 15) of the local area. This species has not been observed to utilize the environs on or adjacent to the mine plan area, however, its occasional presence would not be unlikely. Therefore, the project area is ranked as being of limited value to this species.

The blue grouse is a yearlong resident of the project area. Adult birds prefer open stands of conifers. During winter the blue grouse feeds exclusively upon needles and buds of douflas-fir and spruce trees. Thus, this wildlife habitat (spruce-fir forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February.

Blue grouse annually exhibit what has been termed as reverse verticle migration. That is, during the spring months, they migrate from the high elevation spruce-fir habitat to lower elevation sagebrush, pinion-juniper or shrubland habitats. This movement is caused by a need of the birds to feed on early developing vegetation. Such movement also facilitates successful breeding, nesting and brooding of their young. Then as the year progresses, they move to the higher elevations.

The males are polygamous and will set up and defend territories for booming and breeding activities against other breeding males. Such territories are critical to maintenance of the population during the crucial period of mid-March through mid-June.

After breeding the female develops a nest site which is secreted on the ground; the nest is of critical value to maintenance of the blue grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young blue grouse while being brooded rely heavily on insects for their protein needs during the first several months of development. The adult bird also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to blue grouse. The crucial period extend from hatching into mid-August.

As summer progresses into the fall season the grouse consumes large quantities of berries.

The ruffed grouse is a yearlong resident of the project area. These grouse are usually found in the continum of habitats extending from aspen to shrubland types. But, during winter they often roost in dense stands by conifers. Generally speaking ruffed grouse prefer habitats lying within 0.25 mile of a stream course; such areas are ranked as being of high-priority value to their population. During winter the ruffed grouse feeds exclusively upon staminate aspen buds. Thus, this wildlife habitat (aspen forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February. During the remainder of the year their diet shifts to include a wide variety of plant and insect material.

Ruffed grouse do not exhibit any type of seasonal migration. The males are polygamous and will set up and defend territories against other breeding males. The focal point for breeding activity is the drumming log; all such logs are ranked as being of critical value to grouse since they represent sites of historical use. Such territories are critical to maintenance of the population during the crucial period of early March through May.

After breeding the female develops a nest site which is secreted on the ground and deep within an aspen grove; the nest is of critical value to maintenance of the ruffed grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young ruffed grouse while being brooded rely heavily on insects for their protein needs during the first several months of development. The adult bird also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to ruffed grouse. The crucial period for brooding extends from hatching into mid-August.

The band-tailed pigeon is a summer resident of the project area. This bird is seldom observed to utilize the Wasatch Plateau, but when observed the species is only represented by a single bird, pairs or even less frequently a small flock. Since the band-tailed pigeon's use of the Wasatch Plateau is best described as "occasional", the environs associated with the project are only ranked as being of limited value to the bird. Nesting birds secret their nest in trees within the spruce-fir wildlife habitat. Peak on-nest activity occurs in late July and early August.

Mourning doves normally inhabit the project and adjacent areas, which represent a substantial valued use area for these birds, between May 1 and September 15 each year. They nest throughout most of this period and each pair produces two clutches. The pinion-juniper and riparian habitats are ranked as being of high-priority value for nesting. Locally, mourning doves show two peeks in on-nest activity - early July and early August. Successful nesting activities and any water sources are critical to maintenance of the mourning dove population.

The yellow-billed cuckoo is a summer resident of the project area. This bird only nests in the riparian wildlife habitat, therefore, such areas are of critical value to maintenance of this species. Little is known concerning the yellow-billed cuckoo. Its nest is represented by a frail, saucer shaped structure of twigs and is always placed in brush or trees.

The black swift is a summer resident of the Wasatch Plateau. The montane ecological association represents the swift's substantial values use area. Normally, the bird is associated with a small flock that represents a colony. Black swifts are usually observed soaring as pairs and they feed upon flying insects. A colony's nests are scattered along percipitous terrain where the nest is often secreted behind a waterfall. Such a moist habitat is not known to exist on the project area. Cliff and tallus wildlife habitats are ranked as being of high-priority value to the black swift. There is evidence that pair bonds are long lasting and that a nest may be utilized in successive years.

The belted kingfisher is a yearlong resident of the project area. It is found only along riverine systems and its substantial value use area extends from the cold desert through the submontane and into the montane ecological associations. Therefore, the riparian wildlife habitat represents a high-priority valued use area for this bird. It feeds exclusively upon fish. The kinfisher's nest is always secreted within a burrow along stream banks thus, dirt bank habitats along riparian areas are of critical value to this bird.

The pileated woodpecker is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). The spruce-fir and aspen wildlife habitats of the montane ecological association represent this bird's substantial valued use area. It is important to note that the pileated woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a yearlong resident with a relative abundance considered to be rare.

The Williamson's sapsucker is another species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Typically, the substantial valued use area for this species is the spruce-fir habitat of the Hudsonian life zone in the montane ecological association. Therefore, the spruce-fir habitat of the Canadian life zone on the project site would only represent the substantial valued use area for the yellow-bellied sapsucker. The yellow-bellied sapsucker is a yearlong resident of the environs associated with the project area and it has a relative abundance considered to be common. Where as the Williamson's sapsucker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the Williamson's sapsucker is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

The Lewis woodpecker is also another species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is represented by riparian habitats characterized by cottonwood stands and ponderosa forests. These habitats do not exist on the project site. It is important to note that the Lewis woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a summer resident or only a transient. Its relative abundance is unknown.

The purple martin is a summer resident known to inhabit the environs of the biogeographic area that surrounds the project site. In Utah its substantial valued use area is represented by open spruce-fir, aspen or ponderosa forest habitats of the montane ecological association. The purple martin feeds on flying insects and may secret its nest within any suitable above ground cavity.

The western bluebird is an uncommon summer resident known to inhabit the environs of the biogeographic area that surrounds the project site. Where as the mountain bluebird is a common yearlong resident of the area. Both birds are cavity nesting species. The western bluebird nests from the pinion-juniper habitat of the submontane ecological association up into the lower forest habitats within the Canadian life zone of the montane ecological association. The mountain bluebird utilizes the same continum of habitats for nesting, but also extends its nesting use across the Canadian and Hudsonian life zones and into the Alpine lifezone. During winter both species show elevational and longitudinal migrations; they then utilize all habitats associated with the cold desert ecological association. Therefore, the substantial valued use area for each species spans a broad continum

of habitats. It is important to note that trees with cavities located on the project area can be of critical value to bluebirds.

The Grace's warbler is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is shrublands and associated ponderosa forest habitats of the submontane and montane ecological associations. The bird's nest is built twenty or more feet above ground in a ponderosa tree. It is important to note that the Grace's warbler has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the state where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

Scott's oriole is also a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use areas are riparian habitats characterized by cottonwood stands and the contain um of habitats extending from the pinion-juniper forest into shrublands of the submontane ecological association. The oriole's nest is characterized by a grassy pouch and is hung in a tree. It is important to note that Scott's oriole has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

The grasshopper sparrow is a rare transient species known to inhabit the environs of the biogeographic area that surrounds the project site. It only frequents dry grassland areas in the desert scrub habitat of the cold desert and possibly into the submontane ecological association during spring and fall migeration periods. Since its use of such sites is best described as "occasional", those habitats in the region are only ranked as being of limited value to the birds.

10.3.2.5 Reptiles and Amphibians

Reptiles

Eighteen species of reptiles, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that sixteen of these species inhabit the project area. Only two species of the reptiles inhabiting the project area have been determined to be of high interest to the State of Utah.

The Utah milk snake is a yearlong resident animal of the project area. Its substantial value use area encompasses

all wildlife habitats extending from the upper Sonoran (cold desert life zone) through the submontane (Transition life zone) and into the montane (Canadian and possibly Hudsonian life zone) ecological association. Although its use area spans a multitude of habitats, the animal is extremely secretive, mostly nocuturnal and is often found inside or under rotten logs, stumps, boards, rocks or within other hiding places. At night they can be found in the open where they hunt for small rodents, lizards and other small snakes. Occasionally, the milk snake may take small birds or bird eggs.

The milk snake may live beyond twenty years and it becomes sexually mature during its third spring season. After mating, which occurs during spring or early summer when they are leaving the den, female milk snakes produce clutches which average seven eggs. The eggs are secreted in a moist warm environ and then abandoned; incubation lasts 65 to 85 days. The site where an individual snake has deposited its clutch of eggs is of critical value to maintenance of the species.

The Utah mountain kingsnake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the submontane (Transition life zone) into the montane (Canadian and possibly Hudsonian life zone)ecological association. Little is known concerning this animal except that it frequents areas of dense vegetation and that it is often found near water. Its life history and food habits parallel that described for the Utah milk snake.

To date snake dens, which are protected and of critical value to snake populations, have not been identified on or adjacent to the project area. It is important to note that inventory for such has not been attempted. If the company at some later time discovers a den it should be reported to the Utah Division of Wildlife Resources. If a den(s) is currently known, its location must be included with the permit application.

No reptiles have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

Amphibians

Six species of amphibians, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that all of these species inhabit the project area. Only one species of the amphibians inhabiting the project area

have been determined to be of high interest to the State of Utah.

The tiger salamander is a yearlong resident animal of the project area. The substantial value use area for the adult form is represented by any moist underground site or any similar habitat such as inside rotton logs, cellars or animal burrows. Such sites can be found within any wildlife habitat extending from the cold desert (upper Sonoran life zone) through the submontane (Transition life zone) and into the montane (Canadian life zone) ecological association. The larva form, often refered to as a mud-puppy, is a gilled animal that must remain in water within the above described ecological associations. It is interesting to note that the larva may fail to transform into an adult, even after their second season, and they can breed in the larva condition.

Once the larva is transformed into the adult form the animal is primarily terrestrial. Salamanders do migrate to water in the spring for breeding and may remain there during much of the summer. Such as intensive use area would be ranked as being of high-priority value to the animal. In September the newly transformed animals leave the water to find suitable places to spend the winter.

The tiger salamander breeds from March through June and is sexually mature after one year. The male deposits a small tent-shaped structure containing a myriad of sperm on the pool bottom. During courtship the female picks up this structure in her cloaca; then the eggs are fertilized internally before or just at the time they are laid. The eggs, singly or in small clusters, adhere to submerged vegetation; after 10 to 12 days thay hatch . Obviously, a critical period for maintenance of the population is when breeding salamanders, eggs or their larva are inhabiting a water.

Post-embryonic development of a salamander's larval form progresses at a pace somewhat controlled by water temperature; in some cold waters the larva may not transform into an adult and drying up of a pool may hasten the process.

Migration to or from water usually occurs at night, during or just after a rain storm. When inhabiting terrestrial sites the tiger salamander is most active at night, particularly on rainy nights, from March through September.

Larva, when small feed on aquatic invertebrates and become predacious to the point of cannibalism when they are larger. Food items for adults include insects, earthworms and occasionally small vertebrates.

No amphibians have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

10.3.2.6 Aquatic Organisms

No fish were seen or collected in either the Gordon Creek or Beaver Creek. (See Section 10.3.2.1) for a discussion of the ichthyofauan reported as presented by DWR (1981a).

The benthic macroinvertebrate community of Gordon Creek was surveyed in late April 1981. Data was collected at stations above and below the North Fork Gordon Creek in order to evaluate possible effects of drainage through the mine affected area. See Figure 10-1.

Site NFG-1 was located about 250 m above the Bryner Creek confluence, in the vicinity of remnants of an earlier mining episode. The main flow pattern was riffle, although a few small pools were formed behind larger boulders and along the banks. Mean water depth was 35 cm, and stream width averaged 2.1 m. In the sample area, rubble dominated the substrate, but sand gravel, and a few boulders were also present. Slow velocity areas had a small amount of silt on the substrate. Riparian vegetation was scattered and provided an incomplete canopy. Primarily raparian species were Quaking Aspen, Blue Spruce, and willows on the north bank, and Gamble's Oak and Quaking Aspen on the south bank. Banks were eroded and void of vegetation on several bends in the site area.

Twenty taxa of seven major groups were found at Site NFG-1 in three pooled Surber samples (Table 10-1). The midge Chironomidae (Diptera) and the mayfly Cinygmula sp. (Heptagenilidae) were the most common aquatic invertebrates collected (33.9 percent and 21.2 percent, respectively). Early instars of the stonefly family Perlodidae, the mayfly Baetis sp. (Beatidae), and caddisflies Hydropsyche sp. (Hydropsychidae) and Oligophleboides sp. (Limnephilidae), and the crane fly Antocha sp. (Tipulidae) were moderately common (2.4 percent, 5.7 percent, 12.1 percent, 16.0 percent, and 2.0 percent, respectively).

Moderately high readings of alkalinity, hardness, and pH were obtained. Dissolved oxygen and water temperature were not abnormal (Table 10-2).

Site NFG-2 was located about 30 m below a water withdrawal point and old concrete abutments, several pools were within the area sampled, but riffles were the dominate flow pattern. Average stream width and depth were 2.8m and 20 cm, respectively. Rubble and gravel

were the primary substrate types in the riffles, while sand and silt were the main substrate in the pools and had partially filled the interstitial spaces among rubble in the riffles. Dense willow stands provided an almost complete canopy over the stream in the study site.

The aquatic invertebrate community of Site NFG-2 was much less diverse and had significantly fewer members then Site NFG-1 (Table 10-1). In the three pooled Surber samples Baetissp. was the most abundant organism (63.6 Percent); Oligochaeta and Hesperophylax sp. (Limnephilidae were moderately common (14.5 percent and 9.1 percent, respectively). All other taxa were represented by less than five individuals.

Dissolved oxygen, alkalinity, and pH were slightly higher than at Site NFG-1 (Table 10-2). Hardness and water temperature were not different.

The aquatic invertebrate communities were significantly different at the two sites. The probable reason for the change was the increased sediment load at the lower site to which the unpaved roads may contribute. However, much of the siltation is probably natural, since the stream and its tributaries drain areas of relatively erodible soils. In addition, "riparian" vegetation changes from aspen, conifers, and dense shrubs to more open stretches often dominated by sagebrush with only scattered trees.

The conclusion that the shift of macroinvertebrates is related to siltation is supported by the ecologies of certain key species. The best example is the reversed abundances of Cinygmula sp., which is best suited for clinging to coarse substrata, and Baetis sp., which is ambulatory and thus able to move freely along a silty bottom.

Aquatic invertebrates collected from two sampling sites on North Fork Gordon Creek, Carbon County, Utah, April 1981.

Organism	NFG-1 #	NFG-1 %	NFG-2 #	NFG-2 %
Oligochaeta	3	0.2	8	14.5
Hydracarina	4	0.3		
Plecopters				
Perlodidae	32	2.4	1	1.8
Cultus sp.	1	0.1		
Isdogenoides sp.	2	0.2		
Ephemeroptera				
Heptageniidae				
Cinygmula sp.	281	21.2	1	1.8
Ephemerellidae				
Ephemerella sp.	17	1.3		
Baetidae				
(Baetis sp.	75	5.7	35	63.6
Trichoptera				
Hydropsychidae				
Hydropsyche sp.	160	12.1		
Limnephilidae				
Hesperophylax sp.	20	1.5	5	9.1
Oligophleboides sp.	212	16.0		
Brachycentridae				
Brachycentrus sp.	1	0.1		
Coleoptera				
Elmidae				
Optioservus sp.	3	0.2		
Dystiscidae				
Copelatus sp.			1	1.8
Diptera				
Chironomidae	440	33.9	3	5.5
Ceratopogonidae	3	0.2	1	1.8
Stratiomyidae				
Euparyphus sp.	8	0.6		
Tipulidae				
Tipula sp.	8	0.6		
Hexatoma sp.	1	0.1		
Antocha sp.	38	2.9		
Dicranota sp.	5	0.4		
TOTAL NUMBER TAXA	20		8	
TOTAL NUMBER ORGANISMS	1323		55	

Table 10-2

Physicochemical characteristics of two sampling sites on North Fork Gordon Creek, Carbon County, Utah, April 1981.

	Site	
Parameter	MFG-1	NFG-2
Dissolved Oxygen (mg/l)	7.8	8.0
Alkalinity (mg/l)	205.4	239.7
Hardness (mg/l)	325.3	325.3
pH	8.5	8.7
Water Temperature	7.0	7.0

Macroinvertebrates in the Beaver Creek drainage were sampled in late April and middle June 1981 at stations about 1 km above (BC-1), less than 50 m above (BC-2, and about 1 km below the confluence with an unnamed tributary in extreme northwestern Section 18 (See Figure 10-1). For convenience, the unnamed tributary is referred to in this report as "Spring Creek" the site on this tributary is identified as SC-1.

Site BC-1was located near the western edge of the study area, in southeastern Section 2. Both Beaver Creek and the intermittent tributary joining it near BC-1 were essentially dry above the junction itself.

Riparian vegetation through this stretch was primarily wet grasses (Subalpine Moist Meadow), but aspen and conifers were scattered along the creek and provided a spotty canopy. Substrate was mainly gravel and small rubble, with a thin silt overburden in slow stretches. The dominant flow pattern was riffle, but the low gradient reduced velocity to about 0.5 m/sec. Mean stream with and depth were 60 cm and 5 cm, respectively.

The invertebrate community was composed of sixteen taxa. Chironomidea were the most common organism (71.9 percent of sample). All other taxa occurred in comparatively low numbers but the planarian Polycelis coronata, oligochaetes, the stonefly Zapada, the mayflies Beatis and Cinygmula, and caddisfly Rhyacophila, and the cranefly Dicranota were represented in moderate numbers (Table 10-3). The water at BC-1 was slightly alkaline, and temperature was 14 degrees C. in June (Table 10-4).

Site BC-2 was located just below several active and inactive beaver ponds and just above the confluence with Springs Creek. The banks at and above BC-1 were eroded and unstable, apparently partly due to realignment of the stream because of the beaver activity. Heavy use of the area by livestock probably contributed to this condition. Riparian Blue Spruce, Subalpine Fir, and willows provided a partial canopy; branches from terrestrial fall-in and broken beaver dams cluttered the stream, but there were relatively few leaf packs. Gravel and rubble were the most common substrate constituents, and silt covered coarse substrata in slow-velocity reaches. The slight gradient and meandering character of the stream near BC-2 resulted in several pools, but the dominant flow pattern was riffle. Mean stream width and depth were 50 cm and 10 cm, respectively. Depth of pools did not exceed 45 cm.

The mayfly Baetis sp. was the most abundant organism collected at BC-2 (44.0 percent), but six taxa

(Planarlidae, Oligochaeta, Cinygmula sp., Rhycophila sp., Hesperophylax sp., and Chironomidae) occurred in moderate numbers.

The water at BC-2 remained slightly alkaline, but the slower flows and limited shading resulted in warmer temperatures of 17.5 degrees C. in June (Table 10-4).

Site BC-3 was located in an area where the valley was broader and the stream was incised. The most common vegetation on the flood plain was shagebrush, and shade was provided only where the stream ran along the foot of a forested north-facing slope. Poor bank stability resulted in a layer of fine sediments over the native gravel rubble substrate. In pools the substrate was primarily sand and silt. Mean stream width was 90 cm; depth ranged from 10 cm in riffle-runs to 50 cm in pools. Several tree limbs were in the water, but there was little leaf litter.

At least twenty-two invertebrate taxa were collected at BC-3 and no single taxon dominated the community. Chironomids, the most common form, and the amphipod Crangonyx, accounted for only 26.8 percent and 20.3 percent of the invertebrates collected. Five taxa (Oligochaeta, Baetis sp., Cinygmula sp., Hydropsyche sp.) were moderately abundant (Table 10-3).

Chemical characteristics of the water at BC-3 were not significantly different from those recorded at upstream sites, except that water temperature was slightly higher at 20 degrees C. (Table 10-4).

Site SC-1 was located on the unnamed tributary ("Spring Creek"), approximately 50 m above its confluence with Beaver Creek and just below the spring which provides most (about 75 percent) of its flow, and its unofficial name. Above the spring, most of the flow was from snowmelt during both the late April and middle June surveys. The stream was marked by several abandoned and barely distinguishable beaver ponds, none of which appeared to have held water for a number of years (based on vegetational re-establishmnent). Scattered Blue Spruce shaded portions of the stream, and grasses retained the banks. The substrate was primarily sand and gravel interspersed with a few larger stones. Width was not greater than 60 cm, and depth did not exceed 6 cm. The main flow pattern was run; no true pools were present in the sampled stretch.

The mayfly Baetis sp. and chironomids were the most common (51.2 percent and 23.0 percent, respectively) of the sixteen taxa collected at the site. Oligochaeta, Cinygmula sp., Ceratopogonidae, and Dicranota sp. were

found in moderate numbers. A caddisfly Oligophlebodes, and a mothfly, Psychodidae, were unusual occupants of the creek (Table 10-3).

The chemical characteristics of the water in the unnamed tributary were similar to those of Beaver Creek; the markedly colder temperature (1 degrees C.) was related to its proximity to a spring and the fact that data were recorded in April at that site, versus June at the Beaver Creek Site.

The invertebrate community of the creek changed notably in a downstream direction. Site BC-1 produced the greatest number of organisms, but community diversity was lower than at downstream sites. Nor were the downstream communities as completely dominated by one or two taxa as was BC-1. The invertebrate community of the unnamed tributary was more similar to that of BC-1 than to BC-2 and BC-3.

The differences in community composition and structure probably were at least partially attributable to the overall character of the aquatic habitat. Site BC-1 was in a typical subalpine zone, but at BC-2 and BC-3 the creek had emerged into a more open, sagebrush-dominated terrestrial area with more erodible streambed material. Between BC-1 and BC-3, several beaver ponds interrupted flow patterns, contributed to high water temperatures, and altered the nutrient production and transport capabilities of the stream.

Relatively low diversity and chironomid dominance of the BC-1 invertebrate community was partially a function of the ephemeral character of the stream in its upper reaches.

Streams subject to periodic desiccation are less likely to support a diverse community than perennial streams and only those forms adapted to survival in such areas are likely to be successful.

Although sedimentation was greater at BC-2 and BC-3 than at BC-1, the greater physical stability of the stystem in the lower reaches contributed to greater community diversity. Moreover, sediment transport probably did not exceed threshold tolerances of most invertebrates occupying the lower reaches. Additionally, the reduced riparian canopy below BC-1 and the beaver ponds enhanced autochthonous productivity for the benefit of the invertebrate communities in the lower reaches. Such a change in the energy dynamics of the system would allow forms unable to survive the "oligotrophic" upper reaches to survive the more nutrient-enriched lower reaches.

Site BC-1 had no taxa unique to it, but two forms (Hydracarina and Chloroperlidae) were shared only with Site SC-1. In contrast, at least fourteen taxa were found only at Sites BC-2 and/or BC-3. An explanation may be that Lligophlebodes sp. and Psychodidae are not particularly common forms.

However, differences between the communities of the unnamed tributary and Sites BC-2 and BC-3 may be an artifact of season sampled rather than actual differences. Each form peculiar to Site SC-1 very likely occurs in Beaver Creek but had already hatched when Beaver Creek was sampled six weeks later.

Seven forms (Oligochaeta, Baetis sp., Cinygmula sp., Hesperophylax sp., Chironomidae Tipula sp., and Dicranota sp.) were common to all sites. Each is a relatively large group, has representatives in a variety of habitats, and is widely distributed. (See Appendix 7)

More intensive sampling of Beaver Creek and its unnamed tributary probably would reduce the number of taxa limited to particular reaches, but the patterns discerned would remain similar.

Table 10-3

Aquatic invertebrates collected from Beaver Creek and and unnamed tributary, Carbon County, Utah, April and June 1981.

Organism	BC-1 #	BC-1 %	BC-2 #	BC-2 %	BC-3 #	BC-3 %	SC-1 #	SC-1 %
Tricladia								
Planariidae			47	8.1				
Polycelis coronata	52	3.0						
Dugesia sp.	3	0.2						
Nematoda	3	0.2	1	0.2			1	0.1
Oligocaeta	92	5.3	101	17.4	10	2.7	151	12.0
Hirudinea								
Erpobdellidae								
Erpobdella sp.					1	0.3		
Ostracoda					1	0.3		
Amphipoda								
Gammaridae								
Crangonyx sp.					75	20.3		
Hydracarina	1	0.1					1	0.1
Collembola								
Isotomidae								
Isotomurus plaustris					1	0.3		
Plecoptera								
Perlodidae								
Isoperla patricia					2	0.5		
Nemouridae					1	0.3		
Zapada sp.	47	2.7						
Zapada cinctipes							5	0.4
Chloroperlidae	17	1.0					3	0.2
Ephemeroptera								
Beatidae								
Baetis sp.	137	7.8	255	44.0	11	3.0	647	51.2
Ephemerellidae								
Ephemerella sp.					2	0.5		
Heptageniidae								
Cinygmula sp.	47	2.7	59	10.2	27	7.3	85	6.7

Table 10-3 (Continued)

Organism	BC-1 #	BC-1 %	BC-2 #	BC-2 %	BC-3 #	BC-3 %	SC-1 #	SC-1 %
Trichoptera								
Rhyacophilidae								
Rhyacophila sp.	41	2.3	29	5.0			2	0.2
Hydropsychidae								
Hydropsyche sp.								
-larvae			1	0.2	46	12.4		
-pupae					6	1.6		
Limnephilidae								
Hesperophylax sp.	5	0.3	11	1.9	50	13.5	11	0.9
Oligophlebodes sp.							1	0.1
Coleoptera								
Dytiscidae					1	0.3		
Agabus sp.								
-adult			2	0.3				
-larvae			1	0.2	2	0.3		
-adult			1	0.2	1	0.3		
Elmidae								
Zaitzevia sp.								
-larvae					6	1.6		
Diptera								
Chironomidae -larvae	1256	71.9	41	7.1	99	26.8	291	23.0
_pupae	2	0.1	2	0.2	1	0.3		
Ceratopogonidae							20	1.6
Psychodidae							1	0.1
Tipulidae -pupae					1	0.3		
Tipula sp.	7	0.4	2	0.3	3	0.8	6	0.5
Ormosia sp.	1	0.1	2	0.3				
Dicranota sp.	33	1.9	6	1.0	1	0.3	37	2.9
Hexatoma sp.			1	0.2	13	3.5	1	0.1
Stratiomyidae					7	1.9		
Euparyphus sp.					7	1.9		
Simuliidae								
Simulium sp.			8	1.4				
Prosimulium sp.	2	0.1	8	1.4				
Empididae -larvae			1	0.2				
-pupae			1	0.2				
Gastropoda					1	0.3		

Table 10-3 (Continued)

	BC-1		BC-2		BC-3		SC-1	
Organism	#	%	#	%	#	%	#	%
Pelecypoda								
Sphaeriidae					1	0.3		
TOTAL NUMBER TAXA	16		18		22		16	
TOTAL NUMBER ORGANISMS	1746		580		370		1236	

Physicochemical water characteristics of sampling sites on Beaver Creek and an unnamed tributary, Carbon County, Utah, April and June 1981.

	Site			
Parameter	BC-1	BC-2	BC-3	SC-1
Dissolved Oxygen (mg/l)	6.0	5.0	6.0	7.4
Alkalinity (mg/l)	274.0	274.0	308.0	-----
Hardness (mg/l)	257.0	257.0	274.0	257.0
pH	8.0	8.0	8.0	7.7
Water Temperature	14.0	17.5	20.0	1.0

10.3.3 Species of Special Significance

In addition to the prevalent terrestrial vertebrates described above, including those listed by DWR as being of high priority of Utah, are a number of species which are of special significance for legal reasons. These include species listed by FWS as "threatened" or "endangered" at the national level or as "Migratory Birds of High Federal Interest."

10.3.3.1 Threatened and Endangered Species

Listed "t and e" species potentially present in the study are the American Peregrine Falcon Falco peregrinus anatum, which breeds in Utah; Arctic Peregrine Falcon Falco peregrinus tundrius, which migrates through Utah; and Bald Eagle Haliaeetus leucocephalus, which winters in Utah. None of the species is likely to occur in the study area, because habitats are marginal. However, areas of potential occurrence include riparian forests for the Bald Eable, cliff areas in the region for the American Peregrine Falcon, and upland areas for the Arctic Peregrine Falcon. Bald Eagles are known to use riparian woodlands along lower Gordon Creek and the Price River as winter roosts (DWR 1981a). If any endangered or threatened species are found in the permit area they will be promptly reported the Division.

10.3.3.2 Migratory Birds of High Federal Interest

This group of especially significant species is comprised of 22 bird species identified by FWS as occurring in the Uintah-Southwestern Utah Coal Production Region (See Section 10.2.2.2 for a summary of criteria used in compiling this list):

1. Bald Eagle
2. Golden Eagle
3. Ferruginous Hawk
4. Cooper's Hawk
5. Peregrine Falcon
6. Merlin
7. Osprey
8. Spotted Owl
9. Burrowing Owl
10. Flammulated Owl
11. Sandhill Crane
12. Great Blue Heron
13. Lont-billed Curlew
14. Band-tailed Pigeon
15. Williamson's Sapsucker
16. Lewis' Woodpecker
17. Black Swift
18. Western Bluebird
19. Scott's Oriole
20. Grace's Warbler

Based on information provided by DWR (1978, 1981a) and site-specific field surveys, seven of these species are actually or potentially present in the study area, besides the Bald Eagle, Goldon Eagle, Peregrine Falcon, and Band-tailed Pigeon previously discussed in this report.

The most likely listed raptors are the Flammulated Owl Otus flammeolus and Cooper's Hawk Accipter cooperii, which occur in the Wasatch Plateau and prefer wooded country, such as riparian and conifer forests. The Prairie Falcon Falco mexicanus is a potential breeder as well with the availability of cliffs for nesting and open areas for hunting within a relatively short distance.

Williamson's Sapsucker Sphyrapicus thyroideus was determined to breed in the study area during site-specific field studies. The presence of this species is not surprising, because the open aspen/conifer mosaic provides preferred nesting habitat (Crockett and Hadow 1974, Crockett and Hansley 1978), and it has been reported as breeding in "all the mountainous counties of the state' Hayward et al. 1976 p 120). Although no nests were located, the status of Williamson's Sapsucker as a breeder was inferred from observations of courting adults in spring and juveniles (in the same area) in late summer. The area in which the sapsuckers were observed was an open aspen stand about 0.5 km west of the mine site in southwestern Section 18. The nest, though not located, is believed to have been in an open stand of mature aspen about 3/8 mi. west-north-west of the mine site.

The Black Swift Cypseloides niger also breeds in the Wasatch Plateau (DWR 1978), generally on cliff sites near or behind a waterfall. The near absence of mesic cliff sites in the study area greatly reduces the likelihood that the Black Swift is present as a breeder. However, it would not be surprising for Black Swifts to use the area for hunting, because they are wide-ranging in their search for insect prey. White-throated Swifts Aeronautes saxatalis were common along cliffs in the study area, but this species is of no special status in Utah.

The Purple Martin Progne subis is known to occur during the summer in open conifer or aspen forests in the Wasatch Plateau region. Because these preferred habitats are widespread in the study area, Purple Martins should be expected to occur occasionally. However, none was observed during site-specific field studies.

The Western Bluebird Sialia mexicana is the other listed species which would not be particularly surprising in the study area, based on known occurrence elsewhere in the Wasatch Plateau and habitat preference (i.e., open conifers, from pinyon/juniper to spruce/fir). This species most likely would occur as isolated pairs in the breeding season or as small flocks at lower elevations in the winter; none was observed during field studies. As noted previously, the closely related Mountain Bluebird is an uncommon resident in the study area, utilizing

aspen cavities for breeding and open pinyon/juniper for winter foraging.

10.4 Potential Impacts on Fish and Wildlife

Wildlife impacts typically can be catergorized into three groups: loss or modification of habitat, disturbance, and mortality.

The limited amount of surface disturbance associated with the Blue Blaze No. 1 and No. 2 Mines will result in a total habitat loss of about 7.4 acres during the life of the mine. With the mining done previously, this loss of habitat has already occurred. Virtually all of the mine activity is confined to the Mountain Brush and Middle Elevation Conifer habitat types, and it does not appear that this loss of habitat has had a significant impact on wildlife in the permit area.

Disturbance of furtive species results from the levels of noise and activity associated with an operational mine. Thus, most larger species of birds and mammals (including, for example, deer, carnivores, and raptors) tend to avoid a working mine site. Most of these species are likely to move freely around the mine site on weekends and to quickly re-inhabit the area after decommissioning.

Two types of mortality potentially are associated with operation of the coal mines; raptor electrocution on unsafe power poles and mammal roadkills. A raptor hazard survey was conducted in the area in conjunction wiht baseline field studies. The results of this survey indicate that the four-phase line running from the substation at the abandoned townsite of National (Figure 10-1) represents a potential hazard because of the closeness of two conductors on one side of the cross-arm (Figure 10-4). However, the actual hazard probably is slight, because (1) the positioning of the poles relative to adjacent topography would tend to limit use, (2) most of the raptors commonly present in the area are not frequent users of powerline perches, and (3) the least safe pole designs are near the active mine, where raptor use probably is minimal. This conclusion was confirmed by raptor biologist Ron Joseph and Bruce Waddell of the U.S. Fish and Wildlife Service, who visited the site in August 1981.

The powerpoles below National are somewhat safer, with three well-separated phase lines. However, the ground wire should be clipped to form a 4" - 6" gap below the crossarm to eliminate the risk. These poles also appeared to receive little use in the study area. A few km to the east, along the haul/access road, these poles are a more prominent feature on the flat landscape (Figure 10-5) and appeared to receive somewhat more use probably especially during the winter.

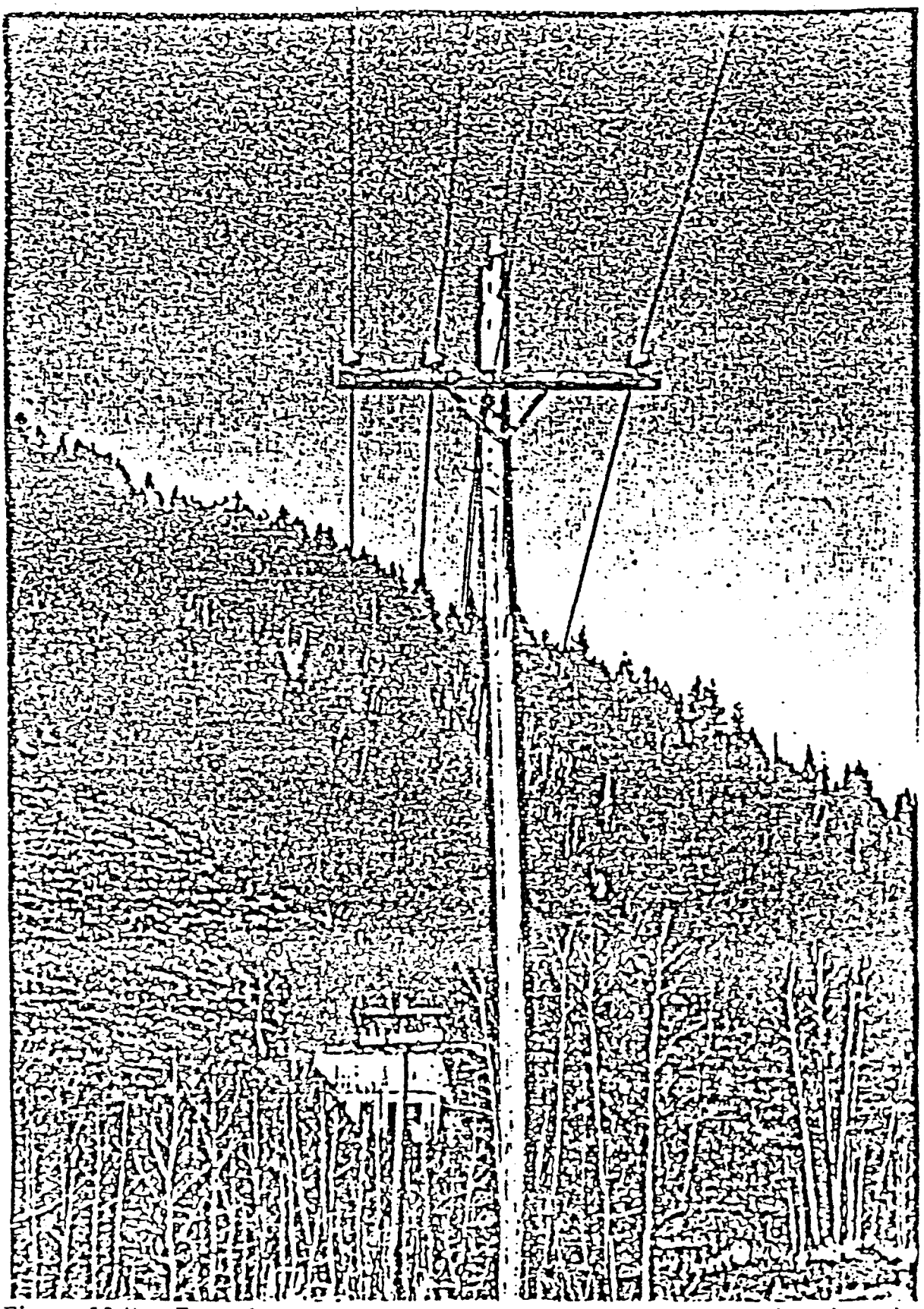


Figure 10-4. Four-phase powerpole between the abandoned townsite of National and the mouth of Gordon Creek Canyon. The two left hand conductors are close enough to pose a potential raptor hazord (but see text discussion).

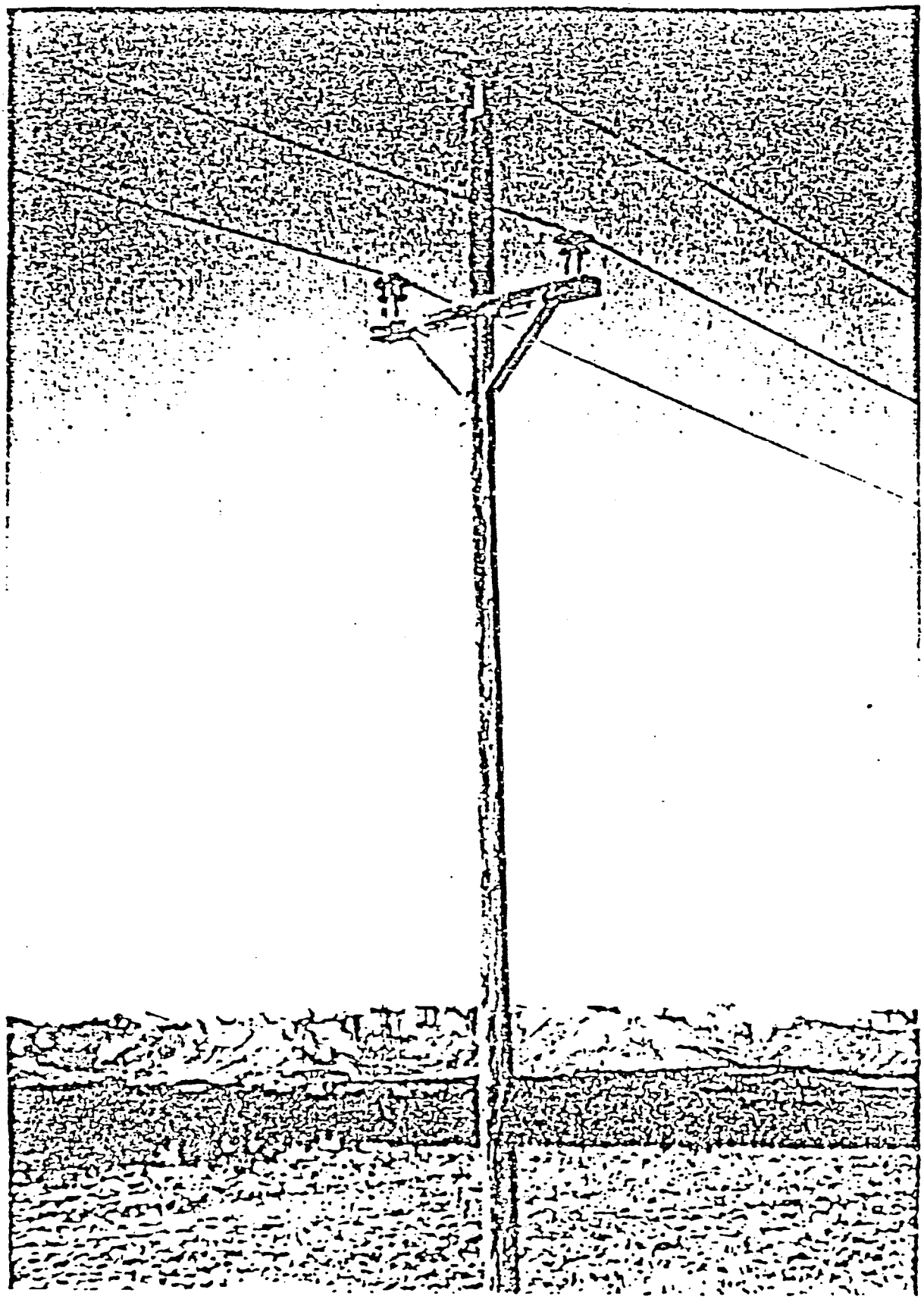


Figure 10-5. Typical three-phase powerpole along the access road west of the study area. This configuration is raptor-proof, except for the upward extension of the ground wire to the crossarm (see discussion)

Mule Deer roadkills along the Gordon Creek haul road have been monitored. In the interval from May 1980 to May 1981, only two deer roadkills were recorded; this represents a very small percentage of both the wintering herd and the total population of the game management unit. Most of the roadkill problem is along a stretch begining about 1 - 1.5 km below the turnoff to Coal Canyon. The major factor contributing to mortalities in this stretch is that the road passes through an area of sagebrush, chained pinyon/juniper, and pasture maintained by DWR as winter habitat. The winter herd in this area was about 500 animals in 1980-1981, and deer remained until late spring despite the unusually mild winter (probably to take advantage of emergent alfalfa and range grasses).

Another factor in the higher roadkill risk through the "Cedar Bench" section may be that, since the road is fairly straight and flat, trucks tend to go faster than through hillier and curvier sections nearer the mine. Also, much of the road near the mine is bordered by a low cliff, which serves as an effective barrier to deer movement.

Figures 10-6a, b, and c show areas of heaviest deer crossings, based on track count in winter 1980-1981 and analyses of vegetational and topographic features. Steep cliff faces adjacent to the road serve as effective barriers along parts of Upper North Fork Gordon Creek.

Impacts to aquatic ecosystems have been minor. Gordon Creek apparently has sustained a change in the character of the macroinvertebrates as a result of an increased suspended load along the unpaved road below the mine site. Much of this appears to be naturally related to soil erodibility, although the adjacent road and the water collection point undoubtedly are contributors. The increased siltation below Beaver Creeks Mining Operation has had much less influence on the quality of the Gordon Creek aquatic ecosystem than the low and variable flows.

Beaver Creek has been essentially unaffected by mining or exploratory drilling programs in the Beaver Creek valley. This situation is not expected to change with an additional mining operation.

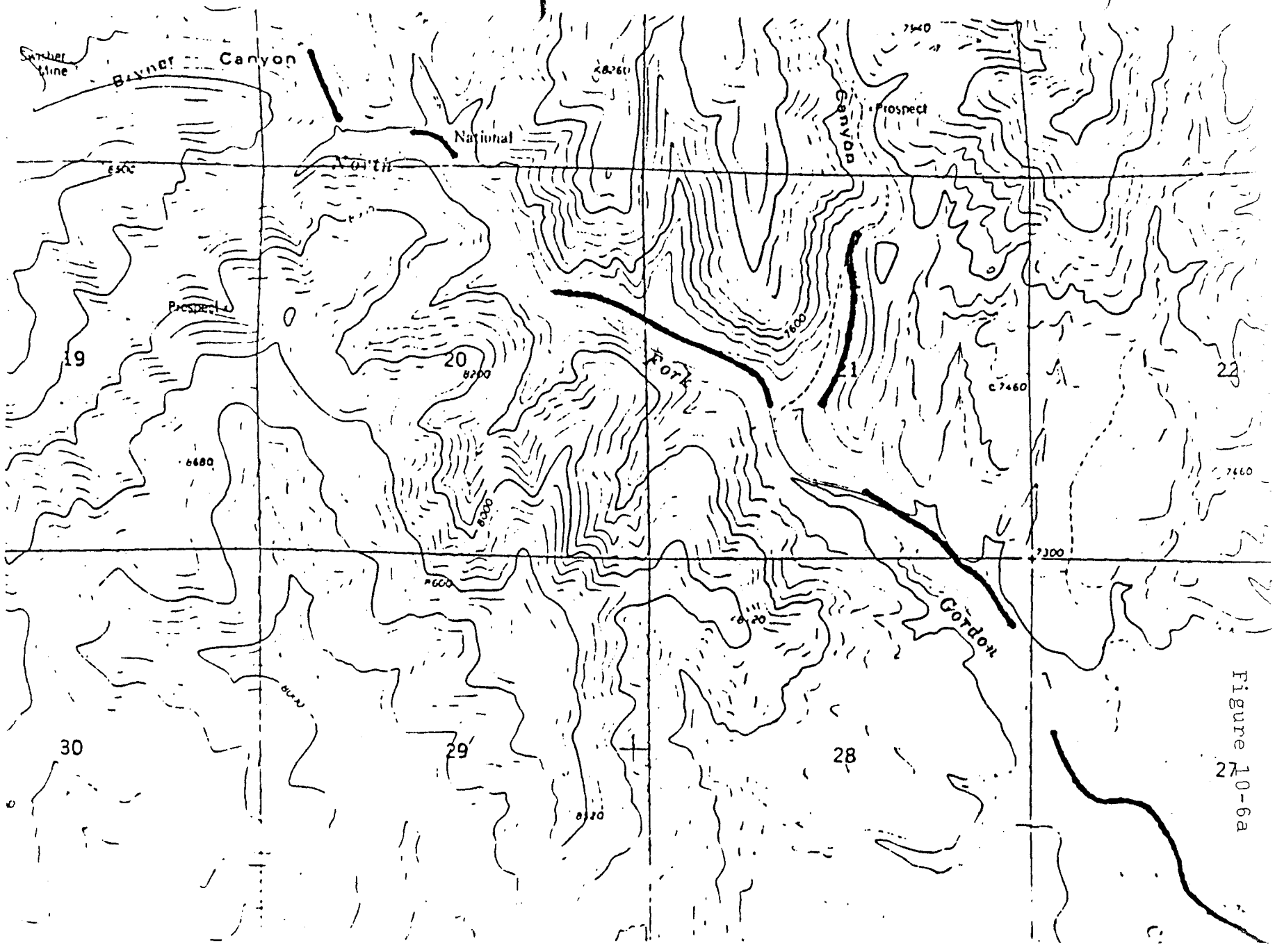


Figure 10-6a

Figure 10-6a Areas of frequent deer crossing along the upper section of the Gordon Creek haulage road Steep rock faces and road cuts serve as movement barriers in parts of this road segmant.

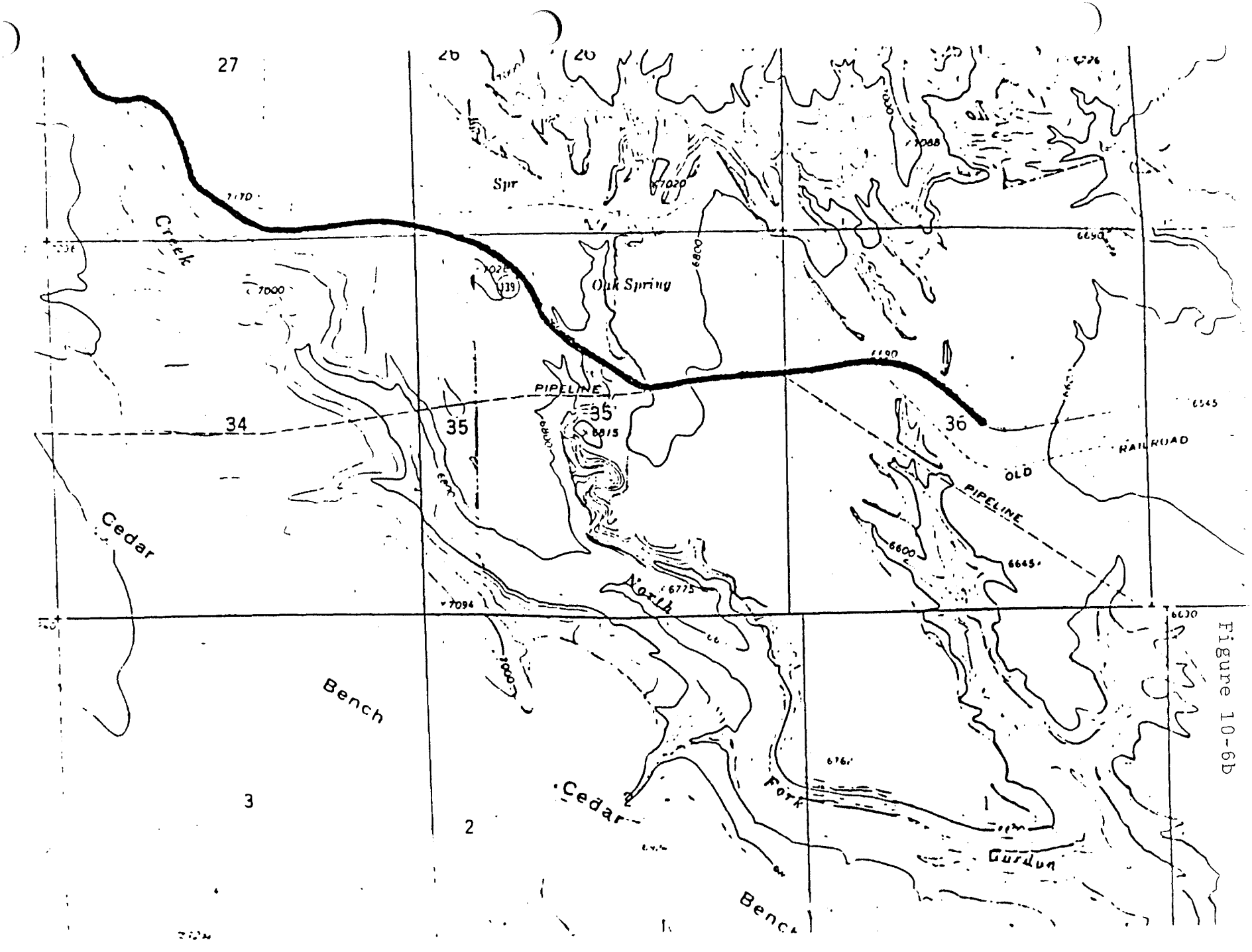
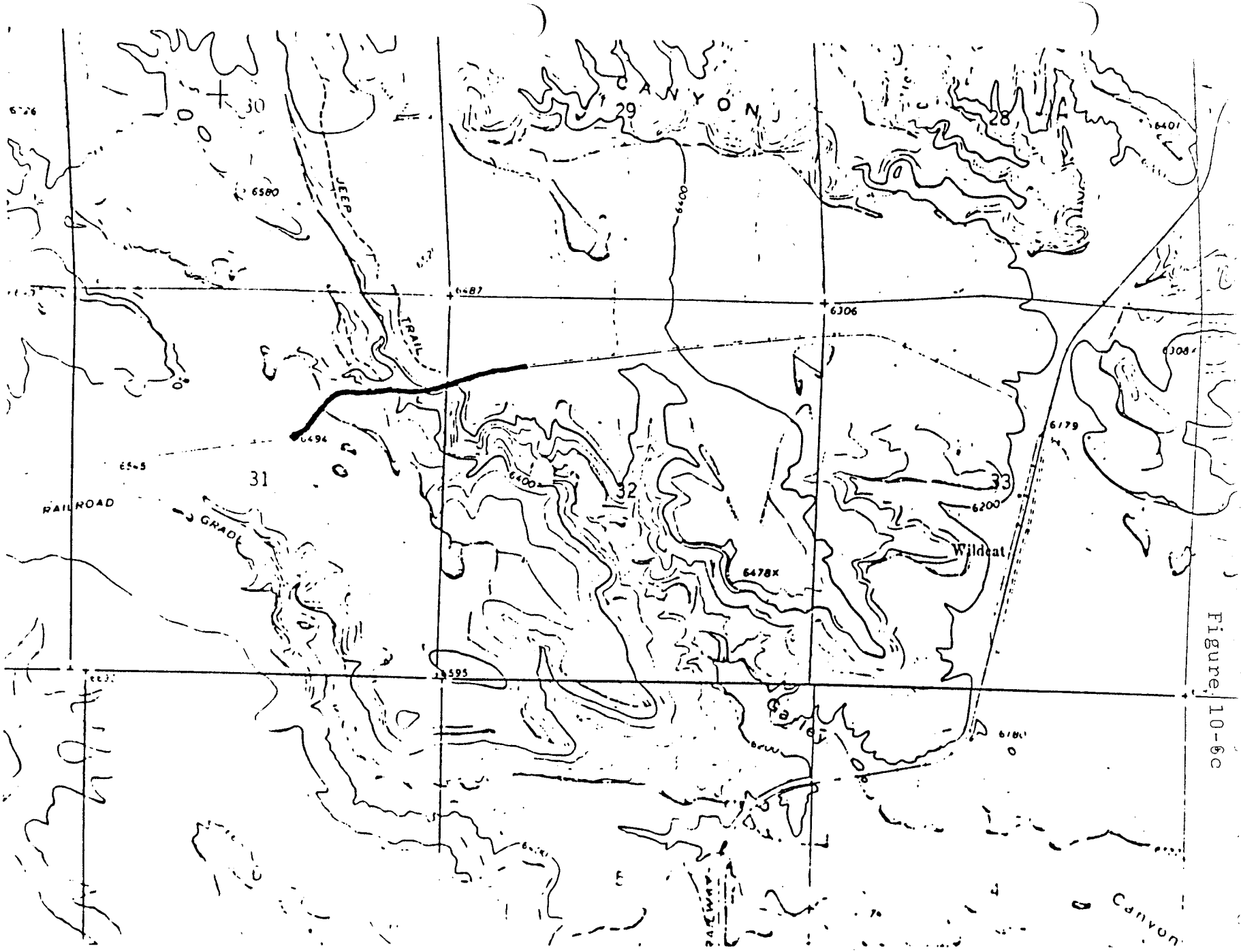


Figure 10-6b Areas of frequent deer crossing along the middle section of the Gordon Creek Haul/access road Habatat areas in the northwestern corner and on Cedar Bench are pastures maintained by DWR.



Figur 10-6c Areas of frequent deer crossing along the lower section of the Gordon Creek Haul/access road. The drainage (Garley Creek) is a movement corridor with chained pinyon/juniper maintained by DWR.