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State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

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January 11, 1995

John Borla
Amax Coal Company
P. O. Drawer PMC
Price, Utah 84501

Re: Approval of ASCA Measures for Sowbelly Canyon, Castle Gate Mine, Amax Coal Company, ACT/007/004-94H, Folder #3, Carbon County, Utah

Dear Mr. Borla:

The proposed ASCA measures (Section 3.2 in the MRP) for Sowbelly Canyon are approved with the following conditions:

1) Amax Coal Company must show the area treated and location of each type of sediment control measure on as-built drawings to be incorporated into the mining and reclamation plan within 30 days of the installation of the sediment control measures, and

2) Amax Coal Company must submit ten copies of the finalized amendment, including the above-referenced as-built drawings, within 30 days of the installation of the sediment control measures.

Sincerely,

Pamela Grubaugh-Littig
Permit Coordinator

cc: Daron Haddock

Archive file Copy (#3 original)

Form DOGM - D1 (Last Revised 6/93)

File Folder #3

PERMIT AMENDMENT APPROVAL

Title: Proposed ASCA Measures

Description: Section 3.2 Sowbelly Cyn.

PERMIT NUMBER: ACT/007/004

PERMIT CHANGE #: 94 #

MINE: Castle Gate Mine

PERMITTEE: Amax Coal Co.

WRITTEN FINDINGS FOR PERMIT APPLICATION APPROVAL	YES, NO or N/A
1. The application is complete and accurate and the applicant has complied with all the requirements of the State Program.	Yes
2. The proposed permit area is not within an area under study or administrative proceedings under a petition, filed pursuant to R645-103-400 or 30 CFR 769, to have an area designated as unsuitable for coal mining and reclamation operations, unless:	Yes
A. The applicant has demonstrated that before January 4, 1977, substantial legal and financial commitments were made in relation to the operation covered by the permit application, or	Yes
B. The applicant has demonstrated that the proposed permit area is not within an area designated as unsuitable for mining pursuant to R645-103-300 and R645-103-400 or 30 CFR 769 or subject to the prohibitions or limitations of R645-103-230.	Yes
3. For coal mining and reclamation operations where the private mineral estate to be mined has been severed from the private surface estate, the applicant has submitted to the Division the documentation required under R645-301-114.200.	Yes
4. The Division has made an assessment of the probable cumulative impacts of all anticipated coal mining and reclamation operations on the hydrologic balance in the cumulative impact area and has determined that the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area.	Yes
5. The operation would not affect the continued existence of endangered or threatened species or result in destruction or adverse modification of their critical habitats, as determined under the Endangered Species Act of 1973 (16 U.S.C. 1531 et.seq.).	Yes
6. The Division has taken into account the effect of the proposed permitting action on properties listed on and eligible for listing on the National Register of Historic Places. This finding may be supported in part by inclusion of appropriate permit conditions or changes in the operation plan protecting historic resources, or a documented decision that the Division has determined that no additional protection measures are necessary.	Yes
7. The Applicant has demonstrated that reclamation as required by the State Program can be accomplished according to information given in the permit application.	Yes
8. The Applicant has demonstrated that any existing structure will comply with the applicable performance standards of R645-301 and R645-302.	Yes
9. The Applicant has paid all reclamation fees from previous and existing coal mining and reclamation operations as required by 30 CFR Part 870.	Yes
10. The Applicant has satisfied the applicable requirements of R645-302.	NA
11. The Applicant has, if applicable, satisfied the requirements for approval of a long-term, intensive agricultural postmining land use, in accordance with the requirements of R645-301-353.400.	NA

SPECIAL CONDITIONS OR STIPULATIONS TO THE PERMIT AMENDMENT APPROVAL	YES	NO
1. Are there any variances associated with this permit amendment approval? If yes, attach.		X
2. Are there any special conditions associated with this permit amendment approval? If yes, attach. (See attached)	X	
3. Are there any stipulations associated with this permit amendment approval? If yes, attach.		X

The Division hereby grants approval for Permit Amendment to the Existing Permit by incorporation of the proposed changes described herein and effective the date signed below. All other terms and conditions of the Existing Permit shall be maintained and in effect except as superseded by this Permit Amendment.

Signed Daron R. Haddock

[redacted] Division of Oil, Gas and Mining

1/11/95

EFFECTIVE DATE

CONDITIONS

AMAX Coal Co.
Castle Gate Mine
Amendment 94H

1) AMAX must show the area treated and location of each type of sediment control measure on as-built drawings which can be incorporated into the Mining and Reclamation Plan (MRP).

2) AMAX must submit the appropriate number of copies of the finalized amendment including the above-referenced as-built drawings for insertion to the MRP and for distribution to other agencies.

within 30 days of installation

SOWBELLY CANYON
CASTLE GATE MINE

CASTLE GATE COAL MINE
Carbon County, Utah

Prepared by

EARTHFAX ENGINEERING, INC.
Midvale, Utah

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SECTION 3.2

SOWBELLY CANYON

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3.2 SOWBELLY CANYON

3.2-1 General

The No. 5 Mine is accessed through Sowbelly Canyon, also referred to as Sowbelly Gulch, which contains a tributary to the main stream in Spring Canyon. Sowbelly Canyon lies approximately four miles west-northwest of the city of Helper. Approximately 21 acres have been affected by this surface operation. The affected area was disturbed by mining prior to 1976. Most of the affected area was used for storage and personnel access through Portal No. 5. This use continued until the end of 1988.

Phase I of reclamation, removal of the structures, is complete, except that the substation still remains. Phase II reclamation commenced in 1993.

Sowbelly Canyon has been the site for coal mining operations for approximately 100 years. The Sowbelly site and the No. 5 Portal are rehabilitated portions of the old Spring Canyon Coal Company No. 5 Mine. Spring Canyon Coal operated on this site between the 1890's and 1970 and conducted operations through several portals, including the abandoned No. 1, No. 2, No. 2-1/2, No. 3, No. 4, No. 5, No. 7 and No. 8 Mines. In 1974, McCulloch Oil purchased and modified the No. 5 site to its present configuration. Franklin Real Estate took over the property in 1977, and constructed the ponds in 1978. Price River Coal made no surface modifications while it was operator of the mine. Castle Gate Coal Company took over as operator of the mine in May of 1986.

3.2-2 Description of the Facility

The affected areas are shown on Exhibit 3.2-1. Referring to Exhibit 3.2-1, most of the affected area is located north (upstream) of Portal No. 5. A relatively wide and gently sloping area has been developed by cutting into the east wall of the valley and regrading with the materials derived from the cut. The resultant cut in the valley wall is an estimated maximum

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of 50 to 60 feet high with an intermediate catch bench at about mid height. Estimated overall slope is about 50 degrees, with intermediate slope angles of about 65 degrees. The cut is predominately in relatively flat-lying interbedded shales and sandstones with occasional thin coal seams. The graded area was used for parking and storage. All building complexes have been removed. The surface of the area has been built up with purchased borrow material which is a mixture of silt, sand and gravel typical of the alluvial and colluvial materials naturally occurring in the canyons of the area.

In the course of regrading the area, the main stream in the gulch was diverted to a course along the toe of the west valley wall. The diversion continues south of Portal No. 5, where it is taken under the access road in a 60-inch diameter culvert to the "original" streambed along the east valley wall. Some coal or coal waste has, in the past, been dumped on the embankment slopes in this area. Also in this area is a small, shallow unused mine shaft, abandoned prior to 1977.

The area around Portal No. 5 was used mainly for storage. A tributary ephemeral stream from the east has been re-channelled north of Portal No. 5 and is taken beneath the access road in a 30-inch culvert.

South of Portal No. 5, the mouth of a tributary from the west has also been enlarged and regraded by cutting down the slopes; this area was used to a minor degree for storage. Further to the west in this tributary drainage, waste rock from previous operation was dumped along the south wall of the valley and has revegetated naturally over the years.

The access road is a county road until it reaches the disturbed area boundary. The road is maintained by Carbon County and will remain as permanent access to adjacent property. The existing road to Portal No. 5 within the disturbed area boundary will be eliminated as part of contemporaneous reclamation. However, a temporary road will be constructed inside the disturbed area boundary during reclamation to allow access for maintenance vehicles.

The other area of disturbance consists of the substation and pad located south of Pond 005 on the west side of the main access road. The substation is accessed by ancillary road A-1.

Two surface water monitoring stations are located in the Sowbelly Creek drainage to monitor water quality. Station B-17 is located below the No. 5 Portal facilities, and station B-28 is located upstream of the disturbed area, as indicated on Exhibit 7-3. Data from these monitoring points indicate that there is no impact due to current operations. This monitoring will continue until bond release. See Chapter 7 for a complete description of the water quality monitoring plan.

There are two cut slopes in Sowbelly Canyon that are considered highwalls, based on the definitions within the R645 (1991) regulations. One of the highwalls is located above the fan portal for the No. 5 Mine, and the other is located on either side of the actual No. 5 Mine portal entrance. The extent of both highwalls is depicted on Exhibit 3.2-3.

The premining land use for Sowbelly Canyon was wildlife and grazing.

3.2-3 Potential Future Development

There are no future plans for development of this site.

3.2-4 Environmental Protection: Drainage Controls and Sanitary Facilities

3.2-4(1) Drainage Controls

The existing facilities within Sowbelly Canyon were constructed in a manner which minimizes changes to the prevailing hydrologic balance. Effluent limitations set by R645-301-751 and present NPDES Permit limitations will not be exceeded if the discharge is the result of a precipitation event from the 10-year, 24-hour storm or smaller.

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Contributions of sediment to the stream channel are prevented by diverting drainage from undisturbed areas away from the site. In addition, existing sedimentation ponds collect disturbed area surface runoff, and a system of berms around the disturbed areas prevent drainage to the stream channel. Other measures taken to minimize potential erosion and subsequent sedimentation include or will include vegetative and riprap stabilization of cut and fill banks, and revegetation of all disturbed areas. Approximately 86% (18 acres) of the disturbed area drains to one of the three sedimentation ponds. Thus, 14% (3 acres) of the disturbed area does not drain to a pond. The road below Pond 005 and the substation access road A-1 are not required to have their runoff channelled to a sediment pond. The substation drainage is controlled by the use of alternative sediment controls. Vegetation and 1 inch clean gravel serve to minimize erosion in this area. See Table 7-8 in Chapter 7 for a summary of alternative sediment control areas.

Existing drainage facilities manage the runoff water from precipitation events only. There is no discharge from the No. 5 Portal. Design criteria for sediment control structures, diversions, and culverts comply with the requirements set forth in R645-301-742.300 and R645-301-742.200.

3.2-4(1)A Storm Runoff Calculations

Peak discharge rates from the undisturbed and disturbed area drainages of Sowbelly Canyon were calculated for use in determining the adequacy of the existing diversion ditches and culverts. The storm runoff calculations for the temporary diversion structures were based on the 10-year, 24-hour storm event of 1.9 inches of precipitation (Miller et. al., 1973). A description of the methods used to determine the peak discharge rates is presented in Chapter 7.

The disturbed and undisturbed drainage areas for Sowbelly Canyon are presented on Exhibit 3.2-2B. Drainage areas can also be found on Exhibit 7-3. Each drainage area is

labeled according to the drainage basin, watershed, and whether it is disturbed or undisturbed. For example, SBWS-U6 represents Sowbelly Canyon undisturbed watershed number 6.

Curve numbers for the undisturbed drainage areas were estimated from vegetation data presented on Exhibit 9-1, and by field observations. The approximate area covered by each vegetative group was estimated from Exhibit 9-1. Cover densities for each vegetative group were estimated from information presented in Chapter 9. Cover densities of 39, 48, 50, and 70 percent were assumed for the grass/sage, mixed brush, pinion/juniper, and conifer vegetative groups, respectively. Curve numbers for each of these cover densities were estimated using Figure 3.2-1. Curve numbers ranging from 68 to 75 were estimated for the undisturbed drainage areas in Sowbelly Canyon. Curve number calculations are presented in Appendix 3.2A.

The curve number for disturbed areas was chosen using professional judgement and the tabulated values presented by the U.S. Soil Conservation Service (1972). Accordingly, a value of 90 was used for the pad and road areas.

A summary of the runoff calculations is presented in Table 3.2-1. All runoff calculations are contained in Appendix 3.2A.

3.2-4(1)B Diversion Structures

Diversion structures within the Sowbelly Canyon area include drainage ditches and culverts to convey storm runoff from disturbed and undisturbed drainage areas, and berms to contain disturbed-area drainage. These diversion structures are located on Exhibit 3.2-2A. The peak discharge rates are based on the 10-year, 24-hour storm event. A description of the methods used to calculate runoff is described in Chapter 7.

The dimensions of the existing diversion ditches and berms were measured in the field. The measurements approximate either a trapezoidal or triangular shape. Typical sections for each diversion identified on Exhibit 3.2-2A are contained in Appendix 3.2B. In addition, a

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summary of ditch geometry is presented in Table 3.2-2, and a summary of berm geometry is presented in Table 3.2-3.

The capacity of existing diversion ditches was determined by calculating the normal depth of flow based on a minimum ditch slope. The maximum flow velocity was calculated based on the maximum ditch slope. Ditch slopes were measured in the field. An average ditch slope was measured for those sections without an apparent change in grade. Maximum and minimum slopes were measured where applicable. A summary of ditch calculations is presented in Table 3.2-4. All ditch calculations are contained in Appendix 3.2B.

All calculations for the diversion ditches resulted in either a maximum flow velocity of less than the maximum permissible velocity, or an adequate riprap lining in the ditch. A flow velocity of less than 5 feet per second was considered non-erosive for those ditch sections with little or no vegetation. For those ditch sections with an abundance of brush and grass, a maximum permissible velocity of 6 feet per second was assumed (Barfield, et. al., 1981). Riprap calculations are presented in Appendix 3.2B.

The adequacy of the existing riprap and channel capacity was also evaluated for the main stream channel diversion. A channel section upstream of culvert SBC-4 was measured to have a bottom width of 12 feet, a top width of 30 feet, a depth of 6 feet, and an average channel slope of 7 percent. Based on these field measurements, the flow depth during the 10-year, 24-hour storm event was 1.1 feet, and the flow velocity was 11.1 feet per second. The resulting freeboard is 4.9 feet, and a required riprap size of 9 inches was calculated. The existing riprap at the channel section is 12 inches and, therefore, is adequate.

Eleven culverts were installed within Sowbelly Canyon to divert storm runoff from the disturbed and undisturbed drainage areas. These culverts were located in the field and are identified on Exhibit 3.2-2A.

The adequacy of the existing culverts to pass the design flow rate was determined using the methods defined in Chapter 7. Table 3.2-5 summarizes the culvert sizing calculations. Because the resulting HW/D (headwater depth divided by the culvert diameter) ratio is less than one for each culvert, with the exception of culvert SBC-6, these existing

culverts will adequately pass the 10-year, 24-hour storm. Culvert SBC-6 requires a headwater depth of 33 inches to adequately pass the design flows. This minimum headwall elevation of 3 inches (culvert SBC-6 has a diameter of 30 inches) is met under existing conditions. Culvert calculations are presented in Appendix 3.2C.

The slope of each culvert, and the size of existing riprap at the outlet was measured in the field. Calculations were performed to determine the exit velocities at each culvert and the adequacy of existing riprap. A summary of the culvert flow velocity and riprap sizing calculations is presented in Table 3.2-6. Culvert flow velocity computations are presented in Appendix 3.2C.

The calculated culvert exit velocities verified that the existing riprap is adequate, with the exception the riprap at the base of culverts SBC-6 and SBC-8. The existing average riprap size at SBC-6 is 10 inches. The required riprap size, due to the steep exit slope and high exit velocity (24 feet per second), is approximately 48 inches. Because the flow area is so small compared to the rock size, one large stone placed at the culvert outlet will be sufficient to attenuate the high velocity from the culvert. The existing average riprap size at the outlet of culvert SBC-8 is 3 inches, and the required riprap size is approximately 10 inches, resulting from an exit velocity of 9.75 feet per second. Because reclamation of Sowbelly Canyon is scheduled for the near future, the outlets of these culverts (SBC-6 & SBC-8) will be maintained until reclamation activities begin. The required riprap will be added during reclamation. Calculations for the culvert outlet riprap are presented in Appendix 3.2C.

3.2-4(1)C Sedimentation Ponds

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Sedimentation Ponds 003, 004, and 005 are located in Sowbelly Canyon and control the storm runoff from the disturbed drainage areas at the site. Surveys of these sedimentation ponds were conducted in April 1990 by Bruce Ware (Registered Land Surveyor) of Price, Utah. Horizontal and vertical control bench marks were not available, so arbitrary initial coordinates and elevations were selected for the surveys. The topography and cross

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sections for Ponds 003, 004 and 005 are contained on Exhibits 3.2-10, 3.2-11, and 3.2-12, respectively.

Pond 003

The stage-capacity data for Pond 003 were determined from the pond topography contained in Exhibit 3.2-10. A summary of these data is contained in Table 3.2-7. The stage-capacity curve for Pond 003 is presented in Appendix 3.2D.

The required 3-year sediment storage volume of 3,356 cubic feet (0.077 acre-feet) was calculated as indicated in Appendix 3.2D using methods described in Chapter 7. The elevation of the maximum sediment storage level at this capacity is 194.65 feet (2.15 feet below the primary spillway). The 60% clean-out volume for Pond 003 is 2014 cubic feet (0.046 acre-feet). The 60% clean-out elevation is 194.0 feet (2.8 feet below the primary spillway).

The storm runoff volume from the 10-year 24-hour storm event is 16,702 cubic feet (0.383 acre-feet). The computation of the runoff volume assumed a drainage area of 4.56 acres and a curve number of 90 for the disturbed area. No undisturbed areas contributed to the pond. The combined runoff volume and sediment storage requires 20,058 (0.460 acre feet) cubic feet of storage capacity. From the stage-capacity curve contained in Appendix 3.2D, the capacity of the pond at the primary spillway elevation is 9,800 cubic feet (0.225 acre-feet). Thus, 10,258 cubic feet of water (0.235 acre-feet) is discharged from Pond 003 during the 10-year, 24-hour storm event. Because the spillway discharges into Pond 004 and not an undisturbed area drainage diversion, the discharge from Pond 003 during the 10-year, 24-hour storm is allowable. Ponds 003, 004, and 005 are connected and, together, contain the storm runoff from the 10-year, 24-hour storm event assuming maximum sediment storage.

The 25-year, 24-hour storm event (2.3 inches of precipitation (Miller, et. al., 1973)) was used to determine the adequacy of the primary spillway. The size of the disturbed watershed (SBWS-D1) is 4.56 acres. The computation of the runoff volume assumed an

average curve number of 90 and a time of concentration of 0.163 hours. The calculation methods used are described in Chapter 7. The calculations for sedimentation Pond 003 are contained in Appendix 3.2D.

The 25-year, 24-hour storm was routed through the primary spillway assuming that the pond contained the maximum allowable sediment volume of 3356 cubic feet and that the pond was empty of water to the maximum sediment storage elevation before the storm occurred. A stage-discharge curve was input into SEDIMOT II for the 18-inch CMP which is constructed with a mitered inlet. The SEDIMOT II input and output is contained in Appendix 3.2D.

From the analysis of the 25-year, 24-hour storm event, the maximum inflow rate to the pond is 5.92 cubic feet per second (cfs) and the maximum outflow rate is 2.35 cfs. The corresponding high water level is 197.63 feet, 0.83 feet above the primary spillway, and 1.17 feet below the minimum embankment elevation of 198.8. Thus, Pond 003 meets the requirements of R645-301-742.200.

The inlet to Pond 003 was evaluated to determine the adequacy of the existing riprap during the 25-year, 24-hour storm event. The calculations for the inlet channel are presented in Appendix 3.2D. Because there is no defined inlet channel to Pond 003, the water runs over the upstream edge of the pond as sheet flow. To estimate the flow velocity, a 100-foot wide rectangular channel was assumed. Based on the maximum slope, the flow velocity is 3.0 feet per second. Since a velocity of 5 feet per second or less is considered non-erosional, riprap is not required. The existing average riprap size of 1/2 inch (gravel) is adequate for this inlet channel.

The outlet of the spillway, located in Pond 004, was evaluated to determine the suitability of the existing riprap. With a culvert slope of 8.5% and a peak discharge rate of 2.35 cubic feet per second during the 25-year, 24-hour storm, the exit velocity was calculated to be 6.7 feet per second. The existing average riprap diameter of 4 inches is adequate for this flow velocity. The flow velocity and riprap sizing calculations are presented in Appendix 3.2D.

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Pond 004

The stage-capacity data for Pond 004 were determined from the pond topography contained in Exhibit 3.2-11. A summary of these data is contained in Table 3.2-8. The stage-capacity curve for Pond 004 is presented in Appendix 3.2D.

The required 3-year sediment storage volume of 3,549 cubic feet (0.081 acre-feet) was calculated as indicated in Appendix 3.2D using methods described in Chapter 7. During field investigations, it was noted that a considerable amount of sediment had accumulated in Pond 004. The current survey data (refer to Exhibit 3.2-11) reflects the pond elevations with existing sediment included. In order for Ponds 003, 004, and 005 to fully contain the 10-year, 24-hour storm event with maximum sediment storage, an additional 600 cubic feet of pond capacity must be available from each of Ponds 004 and 005. It is estimated that at least 600 cubic feet of material (approximately 6 inches) exists in both Ponds 004 and 005. This additional available pond capacity (600 cubic feet) was included in the calculations. Thus, the maximum sediment level was determined from the stage-capacity curve (refer to Appendix 3.2D) using a sediment volume of 2,949 cubic feet (3,549 - 600 cubic feet). The elevation of this maximum sediment level is 187.4 feet, 6.2 feet below the primary spillway. The 60% clean-out sediment volume is 2,129 cubic feet. The 60% clean-out level was also determined from the stage-capacity curve using a sediment volume of 1,529 cubic feet (2129 - 600 cubic feet). The elevation of the 60% clean-out level is 186.7 feet, 6.9 feet below the primary spillway.

The storm runoff volume from the 10-year 24-hour storm event is 20,230 cubic feet (0.464 acre-feet). The computation of the runoff volume assumed a drainage area of 5.04 acres and a curve number of 90 for the disturbed area (SBWS-D2), and a drainage area of 1.76 acres and a curve number of 73 for the contributing undisturbed area (SBWS-U5). The combined runoff volume and maximum sediment storage requires 23,779 cubic feet (0.546 acre-feet) of storage capacity. In addition, the volume of water released from Pond 003 to

Pond 004 is 10,258 cubic feet. Thus, the pond capacity required to contain the 10-year, 24-hour storm is 34,037 cubic feet (0.781 acre-feet). From the stage-capacity curve contained in Appendix 3.2D, the capacity of the pond at the primary spillway elevation is 25,500 cubic feet (0.585 acre-feet). Including the accumulated sediment volume of 600 cubic feet, the capacity of the pond at the primary spillway is 26,100 cubic feet (0.599 acre-feet). Thus, 7937 cubic feet of water (0.182 acre-feet) is discharged from Pond 004 to Pond 005 during the 10-year, 24-hour storm event. Because the spillway discharges into Pond 005 and not an undisturbed area drainage diversion, the discharge from Pond 004 during the design storm is allowable. Ponds 003, 004, and 005 are connected and, together, contain the storm runoff from the 10-year, 24-hour storm event assuming maximum sediment storage.

The 25-year, 24-hour storm event (2.3 inches of precipitation (Miller et al., 1973)) was used to determine the adequacy of the primary spillway. The size of the disturbed watershed (SBWS-D2) is 5.04 acres. The size of the contributing undisturbed watershed (SBWS-U5) is 1.76 acres. The computation of the runoff volume assumed an average curve number of 90 and a time of concentration of 0.141 hours for SBWS-D2. A curve number of 73 and a time of concentration of 0.043 hours was estimated for SBWS-U5. The calculation methods used are described in Chapter 7. The calculations for sedimentation Pond 004 are contained in Appendix 3.2D.

The 25-year, 24-hour storm was routed through the primary spillway assuming that the pond contained the maximum allowable sediment volume. In addition, the computer software program SEDIMOT II was used to calculate a stage-discharge relationship for the primary spillway. SEDIMOT II assumed that the pond was full of water up to the primary spillway elevation at the beginning of the storm event. This results in a conservative estimation of the maximum stage since, in general, the pond can be assumed to be empty at the beginning of a storm event. The SEDIMOT II input and output is contained in Appendix 3.2D.

From the analysis of the 25-year, 24-hour storm event, the inflow rate to Pond 004 from Pond 003 is 2.35 cubic feet per second. The inflow rate from the contributing

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watersheds is 7.44 cubic feet per second. The routed maximum inflow rate to Pond 004 is 8.33 cubic feet per second and the maximum outflow rate is 6.49 cfs. The corresponding high water level is 194.25 feet, 0.65 feet above the primary spillway, and 1.25 feet below the minimum embankment elevation of 195.5. Thus, Pond 004 meets the requirements of R645-301-742.200.

The east and west inlet channels to Pond 004 were evaluated to determine the adequacy of the existing riprap, and capacity of each inlet channel during the 25-year, 24-hour storm event. The calculations for the inlet channels are presented in Appendix 3.2D. Based on the minimum channel slope, the flow depth in the east inlet channel is 0.27 feet, which provides 0.98 feet of freeboard. The flow depth in the west inlet channel is 0.20 feet, which provides 1.05 feet of freeboard.

Based on the maximum channel slope, the maximum flow velocity in the east inlet channel is 6.8 feet per second. This velocity requires an average riprap size of 4 inches. The existing average riprap size of 4 inches is adequate for this inlet channel. The maximum flow velocity in the west inlet channel is 7.5 feet per second. This velocity requires an average riprap size of 4 inches. The existing average riprap size of 4 inches is adequate for this inlet channel.

The outlet of the primary spillway into Pond 005 was evaluated to determine the suitability of the existing riprap. With a culvert slope of 3.3% and a peak discharge rate of 6.49 cubic feet per second during the 25-year, 24-hour storm, the exit velocity was calculated to be 6.2 feet per second. Because the pond is excavated in fractured bedrock material, riprap at the culvert outlet is not required. The flow velocity calculations are presented in Appendix 3.2D.

Pond 005

The stage-capacity data for Pond 005 were determined from the pond topography contained in Exhibit 3.2-12. A summary of these data is contained in Table 3.2-9. The stage-capacity curve for Pond 005 is presented in Appendix 3.2D.

The required 3-year sediment storage volume of 2,823 cubic feet (0.065 acre-feet) was calculated as indicated in Appendix 3.2D using methods described in Chapter 7. During field investigations, it was noted that a considerable amount of sediment had accumulated in Pond 005. The current survey data (refer to Exhibit 3.2-12) reflects the pond elevations with existing sediment included. It is estimated, from field observations, that at least 600 cubic feet of material (approximately 6 inches) has accumulated in both Ponds 004 and 005. This additional available pond volume was included in the calculations. Thus, the maximum sediment level was determined from the stage-capacity curve (refer to Appendix 3.2D) using a sediment volume of 2,223 cubic feet (2,823 - 600 cubic feet). The elevation of this maximum sediment level is 193.3 feet, 4.8 feet below the primary spillway flowline. The 60% clean-out sediment volume is 1,694 cubic feet. The 60% clean-out level was also determined from the stage-capacity curve using a sediment volume of 1,094 cubic feet (1694 - 600 cubic feet). The elevation of the 60% clean-out level is 192.8 feet, 5.3 feet below the primary spillway flowline.

The storm runoff volume from the 10-year 24-hour storm event is 6,922 cubic feet (0.159 acre-feet). The computation of the runoff volume assumed a drainage area of 1.89 acres and a curve number of 90 for the disturbed area. No undisturbed areas contributed to the pond. In addition, the volume of water released from Pond 004 to Pond 005 is 7937 cubic feet. The combined runoff volume and sediment storage requires 17,682 cubic feet (0.406 acre feet) of storage capacity. From the stage-capacity curve contained in Appendix 3.2D, the capacity of the pond at the primary spillway elevation is 17,130 cubic feet (0.393 acre-feet). Including the additional pond capacity from the accumulated sediment volume of 600 cubic feet, the capacity of the pond at the primary spillway is 17,730 cubic feet (0.407 acre-feet). Thus, Pond 005 will not spill during the 10-year, 24-hour storm event. Runoff volume calculations are contained in Appendix 3.2D.

The 25-year, 24-hour storm event (2.3 inches of precipitation (Miller, et. al., 1973)) was used to determine the adequacy of the primary spillway. The size of the disturbed watershed is 1.89 acres. The computation of the runoff volume assumed an average curve

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number of 90 and a time of concentration of 0.047 hours. The calculation methods used are described in Chapter 7. The calculations for sedimentation Pond 005 are contained in Appendix 3.2D.

The 25-year, 24-hour storm was routed through the primary spillway assuming that the pond contained the maximum allowable sediment volume of 2,823 cubic feet and that the pond was empty of water to the maximum sediment storage elevation before the storm occurred. A stage-discharge curve was input into SEDIMOT II for the trapezoidal spillway channel. The SEDIMOT II input and output is contained in Appendix 3.2D.

From the analysis of the 25-year, 24-hour storm event, the inflow rate from Pond 004 is 6.49 cubic feet per second, and the inflow rate from the disturbed area watershed is 2.57 cfs. The routed maximum inflow rate to the pond is 8.37 cfs and the maximum outflow rate is 6.16 cfs. The corresponding high water level is 198.48 feet, 0.38 feet above the primary spillway, and 1.82 feet below the minimum embankment elevation of 200.3 feet. Thus, Pond 005 meets the requirements of R645-301-742.200.

The trapezoidal spillway channel was evaluated to determine the suitability of the existing riprap. With a flow depth of 0.38 feet, a flow area was determined to be 4.0 square feet. Based on a peak discharge rate of 6.16 cubic feet per second, the flow velocity was calculated to be 1.54 feet per second across the spillway. The existing average riprap diameter of 10 inches is adequate for this flow velocity. The flow velocity and riprap sizing calculations are presented in Appendix 3.2D.

3.2-4(2) Sanitary Facilities

The bathhouse complex at No. 5 Mine has been removed. Therefore, no sanitary facilities exist at the No. 5 Portal area.

3.2-5 Reclamation Plan

3.2-5(1) Reclamation Work

The reclamation plan for Sowbelly Canyon is shown on Exhibit 3.2-4. The plan is divided into five phases. Phase I of reclamation, involving structure removal, has been completed. Phase II reclamation consists of the reclamation grading and seeding, and this phase started in 1993. Phase III involves monitoring and maintenance, and will commence immediately upon completion of Phase II. Phase IV consists of reclaiming the substation area and ancillary road A-1 that accesses the substation.

The postmining land use for Sowbelly Canyon is wildlife and grazing.

Phase I

Reclamation work for Phase I consists of the following:

Demolition - Removal of all structures, except the lower substation which will remain for the life of the mine complex. Upon final reclamation of all other mining facilities, the lower substation will be removed and disposed of accordingly (Phase IV).

Portal Sealing - All Portals were sealed according to the plans shown in Figures 3.1-3 and 3.1-4 in 1988.

Phase II

Reclamation work for Phase II consists of the following:

Grading - Grading will be done in order to establish overland flow drainage into permanent reclamation channels. The amount of soil to be relocated as part of the reclamation plan is summarized in Table 3.2-10, and the distribution of cuts and fills is depicted on Exhibit 3.2-9 titled "Reclamation Grading Cut/Fill Grid". The grading work will be scheduled to minimize disturbance to the hydrologic balance. The grading work will start at the north end of the canyon and proceed to the lower elevations at the south end of the

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canyon. This will allow the existing sediment ponds to remain in place as long as practicable. New sediment Ponds 016 and 017 will be constructed as contemporaneously as possible with the reclamation topography. Alternative sediment controls will be installed where practicable prior to the elimination of all the existing sedimentation ponds. Exhibit 3.2-5 indicates where alternative measures will be used to control sediment, as well as the locations of the reclamation sediment ponds.

The grading plan as shown in Exhibit 3.2-4 meets the criteria set forth in R645-301-553, Backfill and Grading. The disturbed area is graded to approximate original contour by blending spoil into the surrounding area and creating a landform which resembles the surrounding terrain. The two highwalls, one above the No. 5 fan portal and one above the actual No. 5 mine entrance, will both be eliminated to the extent possible by backfilling at a slope of approximately 2H:1V. The cut slope areas which are left resemble the cliffs in the surrounding topography. The retained cut slopes were analyzed by EarthFax Engineering, Inc. for slope stability. A copy of the slope stability analysis is located in Appendix 3.2F of Section 3.2.

The EarthFax slope stability analysis was used to establish guidelines for designing the postmining topography shown in Exhibits 3.2-4. Many of the existing slopes will be buttressed at the base of the slope to allow the slopes to blend into the natural terrain. No buttressing was needed to increase the stability of the slopes, since they exceeded the required 1.3 factor of safety without buttressing.

A temporary ancillary road (A-2) will be constructed in conjunction with Phase II of reclamation. The road will provide access for maintenance vehicles along the length of the reclaimed area. Maintenance activities for which vehicles are required include sediment removal from the ponds, erosion repair, repair of alternative sediment control structures, and reseeding. A complete description of the road is presented in Section 3.2-9.

During the grading process the following work will be performed:

1. Elimination of berms and temporary diversions.
2. Grading to establish overland flow drainage where possible.
3. Construction of permanent stream relocation as shown on the plans.

4. Removal of culverts, except as mentioned below.
5. Removal of Ponds 003, 004, 005.
6. Construction of alternative sediment controls (See Section 3.2-4(3))
7. Construction of Reclamation Ponds 016 and 017.
8. Construction of a temporary ancillary road A-2.

The boundary indicating the southern extent of Phase II reclamation grading is shown on Exhibit 3.2-4. This boundary has been established to allow use of the substation in conjunction with possible Crandall Canyon mining activities after Sowbelly Canyon has been reclaimed. The substation and access road A-1 to the substation will not be reclaimed until Phase IV of the reclamation plan. The county road that leads to the site will not be modified outside of the boundary. Culvert SBC-10 (renamed SBRC-1 for Phase II of reclamation) will remain in its present location under the county road outside the boundary to permanently transport the precipitation runoff from the drainage above the substation to the main stream channel.

The backfill grading topography shown on Exhibits 3.2-4 is compatible with the approved postmining land use of wildlife habitat and provides adequate drainage and long term stability as required by R645-301-553.522.

Any acid forming or toxic materials exposed during the grading operation, which may adversely affect water quality or vegetation, will be treated or buried at a depth of no less than four feet.

Resoiling - The 21 acres in Sowbelly Canyon were disturbed by mining prior to the enactment of SMCRA. No topsoil was salvaged from the site. The existing soils at the site will be used as resoiling material. The existing soils will be evaluated to determine the location and extent of saline-sodic overburden, if any. If found, all saline-sodic overburden will be properly buried.

This resoiling material will be analyzed for the following parameters: Ph, electrical conductivity, saturation percentage, particle size analysis, soluble Ca, Mg, and Na, sodium absorption ratio, selenium, total N, nitrate-N, boron, maximum acid potential, neutralization potential, organic carbon, exchangeable sodium, nitrogen, phosphorus, potassium, available

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water capacity and rock fragments. A total of 9 random soil samples will be taken from the disturbed area in Sowbelly Canyon, equivalent to one sample for every 2.3 acres. Appropriate soil amendments will be added according to the results of tests performed on these samples. Areas which will not revegetate to support the intended land use of wildlife habitat will be covered with 6 inches of resoiling material from Gravel Canyon.

If borrow material is used, the area will be dry and scarified to a depth of 6 inches prior to placement of the borrowed material.

Scarification of the graded soils will be accomplished prior to seeding or placement of borrow material in order to reduce compaction on all graded areas and to improve vegetation establishment. See Section 3.2-5(4) for scarification methods.

Seeding and Mulching - Species list #1, as described in Chapter 9, will be used on the majority of the disturbed area in Sowbelly Canyon. The cut slopes to remain will receive special treatment as described in Chapter 9. Riparian species mix #3 will be used to seed the areas within 20 feet of reclamation channels SBRD-1 and SBRD-8. In all cases, the seed will be mixed with a small amount of wood fiber mulch, used as tracer, and water to form a slurry. The slurry will be applied to the reclaimed surfaces using a hydroseeder. The balance of the mulch, mixed with a tackifier and the fertilizer in a second slurry, will then be sprayed over the same area. The total coverage of the mulch will be at the rate of 2,000 pounds per acre. In areas inaccessible to the hydroseeder, the seed will be broadcast by mechanical means. Areas inaccessible to the hydromulcher will be mulched with straw and tacked with a nylon or other suitable netting. The rate of application for the straw will be 2,000 pounds per acre.

The reclamation treatments for the reclaimed areas in Sowbelly Canyon are shown on Exhibit 3.2-5. The revegetation will be evaluated for bond release according to the plan described in Chapter 9. Any deviation from this procedure will be performed in accordance with Chapter 9.

Phase III

Phase III consists of monitoring vegetation growth and maintaining the reclamation sedimentation ponds. The end of Phase III will be characterized by the establishment of vegetation as described in Chapter 9 and the compliance with regulation R645-301-880.320 relating to water quality.

After Phase III of reclamation is complete, sediment will be allowed to accumulate in the ponds to permit the ponds to form a natural wetland depression. When bond release is requested, the ponds will be jointly inspected by representatives from Castle Gate Coal and the Division of Oil, Gas and Mining. The ponds and associated berms will be evaluated to determine if they meet the criteria for a small depressions which support a wetland, retain moisture, minimize erosion, create and enhance wildlife habitat, or assist revegetation as described in R645-301-552-100. If the ponds classify as depressions and any one of the above criterion is met, the depressions may be left as a permanent feature. If none of the criterion can be met, then the pond areas will be graded to conform to the topography shown on Exhibit 3.2-4.

If Ponds 016 and 017 and the associated berms must be eradicated, the affected area shall be regraded as shown in Exhibit 3.2-4. The ground surface will be prepared in accordance with the same plan prescribed for Phase II of reclamation. The area will be seeded with Species Mix #1 and mulched as described above, in accordance with R645-301-763.200. Ancillary road A-2 will be scarified and seeded once vegetation is established and a consensus is reached concerning the fate of the reclamation ponds.

Phase IV

Phase IV consists of the removal of the electrical substation and the access road to the substation. See Exhibit 3.2-4 for a delineation of the boundary between Phase II reclamation and Phase IV reclamation. Table 3.2-10 summarizes the cut and fill quantities associated with all phases of reclamation. Since both Phase II and Phase IV of the reclamation plan have a

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net cut after the reclamation grading is completed, fill need not be stockpiled during Phase II to accomplish Phase IV grading at a later date.

3.2-5(2) Reclamation Hydrology

Reclamation Channel Design - The reclamation channels were designed to approximate the geometry of the natural stream channel. The natural channel sections were measured in the field and approximated with a trapezoidal cross section. The reclamation channels were designed with a 3H:1V side slope to provide channel stability. The hydraulic slope of each channel was measured from the postmining topographic maps (scale: 1" = 100').

Peak discharge rates used to determine channel capacities and riprap sizes for the intermittent and perennial reclamation channels were calculated based on the 100-year, 6-hour precipitation event of 2.2 inches (Miller et. al, 1973). Permanent ephemeral drainage channels were designed for the 10-year 6-hour storm event of 1.4 inches, in accordance with 645-301-742.333. A description of the methods used to determine the peak discharge rates is presented in Chapter 7.

The reclamation channel drainage areas for Sowbelly Canyon are presented on Exhibit 3.2-4. The large drainage areas not fully contained on Exhibit 3.2-4 can be found on Exhibit 3.2-6.

Curve numbers for the undisturbed drainage areas were estimated from vegetation data presented on Exhibit 9-1, and by field observations. A ground cover density of 39% was assumed for the grass and sage, 48% for mixed brush, 50% for juniper and pinion, and 70% for conifer vegetation. Curve numbers ranging from 68 to 75 were calculated for the undisturbed drainage areas and a curve number of 80 was assumed for the reclaimed areas. Curve number calculations are presented in Appendix 3.2E.

The following general approach was used during design of the reclamation channels:

- The design capacity of the perennial and intermittent reclamation channels was based on the 100-year, 6-hour storm and the minimum channel slope.

- The design capacity of the ephemeral reclamation channels was based on the 10-year, 6-hour storm and the minimum channel slope.

- Riprap was sized based on the 100-year, 6-hour storm and the maximum channel slope for perennial and intermittent channels.

- Riprap was sized based on the 10-year, 6-hour storm and the maximum channel slope for ephemeral drainage channels.

- The roughness coefficient (Manning's "n") for riprapped channels was determined according to the equation (Barfield et al., 1981):

$$n = 0.0395 D_{50}^{1/6}$$

where, n = Manning's roughness coefficient
D_{50} = median riprap diameter (ft)

- Designs are based on channel construction on fill. Where the reclamation channel construction occurs on rock, riprap quantities will be reduced or eliminated (depending on the competency of the rock).

- For all ephemeral channels and mild slope ($S < 10\%$) intermittent channels, riprap sizing is based on the methodology presented in U.S. Department of Transportation Hydraulic Engineering Circular No. 11 (1967). The thickness of the riprap for these channels is twice the D_{50} of the riprap, or a minimum of 6 inches, as recommended by Barfield et al. (1981).

- The riprap for the steep slope sections ($S >= 10\%$) of the intermittent channels is designed in accordance with the steep slope riprap design methodology presented by Simons, Li & Associates (1982). The thickness of the riprap is set at 1.25 times the D_{50} of the riprap, or a minimum of 6 inches.

- When transitioning downstream from a steep channel slope to a mild channel slope, the larger riprap from the steep section will be extended into the channel section with the flatter slope for a distance of 15 feet to minimize scour (Simons, Li & Associates, 1982).

- Filter blanket volumes were calculated assuming a thickness equal to one half of the thickness of the riprap, but no less than 6 inches (Barfield et al., 1981).

- The reclamation channels are designed to pass the peak discharge with an approximate freeboard of 1 foot.

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Calculations regarding design of the Sowbelly reclamation channels are presented in Appendix 3.2E. A summary of the discharge and design for each reclamation channel is presented in Tables 3.2-11 and Table 3.2-12, respectively.

Once the reclamation channels were designed based on the criteria enumerated above, the capacity of the reclamation channels was compared to the capacity of the unmodified natural channel upstream of the disturbed area, as required by R645-301-742.322. The size of the two upstream tributaries were difficult to measure accurately since there has been some impact to them as a result of previous mining operations. In addition, the tributaries can be classified as pool-drop headwater streams, and they are located at the bottom of steep-sided V-shaped canyons. Thus, the stream flows tend to be concentrated at the base of the canyons regardless of the size of the storm event. However, based on field measurements and professional judgement, the additive "maximum" capacity of the two tributaries was calculated. That maximum flow was then routed through the main canyon reclamation channel. The flow is contained within the channel, bank and floodplain of the river as required by R645-301-742.323.

Capacity comparisons were not made between the reclamation channel and the channel downstream of the disturbed area since that channel was modified for road construction and/or pre-SMCRA mining activities.

Culverts are shown on Exhibit 3.2-4. Tables 3.2-13 and 3.2-14 indicate discharge values and design characteristics. Four culverts are planned for the Sowbelly reclamation plan. SBRC-1 is an existing 36 inch CMP culvert (previously referred to as SBC-10) that requires riprap with a D_{50} of 8 inches at the culvert outlet. SBRC-2 is a proposed 24 inch culvert that will convey runoff from SBRWS-U1 to SBRD-7. The outlet of SBRC-2 will have an energy dissipator that will consist of 24 inch riprap for approximately five feet. This will minimize the erosion of SBRD-7. Culverts SBRC-3 and SBRC-4 are necessitated by the construction of the temporary maintenance road A-2 over diversions SBRD-3 and SBRD-4, respectively. SBRC-3 is an existing culvert, previously referred to as SBC-8, while SBRC-4 is a proposed culvert. Riprap with a D_{50} of 4 inches is required at the outlet of SBRC-3 and

6-inch D_{50} riprap is required at the outlet of SBRC-4. The riprap will extend 15 feet beyond the outlet of each culvert. Supporting calculations for the culvert designs are contained in Appendix 3.2-E.

Detailed filter blanket designs are not presented in this text since samples representative of the native soils that will comprise the subgrade of each channel cannot be collected until the rough reclamation grading is complete. Amax Coal is committed to preparing detailed designs for the riprap and filter blankets. Samples will be taken once the reclamation grading has progressed sufficiently to expose the base of the reclamation channels. Both a granular filter and geotextile filter design will be prepared for each channel and a determination will be made as to which filter design is most appropriate. This decision will be based on the availability of granular filter materials, reasonable expectations of controlling the quality (in-place gradation) of the granular material, durability of the filter materials, and the cost to purchase and place the filter materials. The granular filter blanket gradations will be engineered based on methods presented in Barfield, et al. (1981). If a geotextile is selected for a filter material, then it will be installed in accordance with the manufacturer's recommendations.

Detailed riprap gradations are also not presented in this document because of the possibility that the constructed reclamation channel slopes may vary from the reclamation design. Upon completion of rough grading of each reclamation channel, survey data will be collected to verify the slope and geometry of each channel. The survey data will be used to verify the adequacy of the design riprap size. Riprap gradations will be prepared in accordance with procedures presented in Barfield, et al. (1981), except that riprap gradations for steep slope intermittent channels (10% slope and steeper) will be designed using the procedure presented by Simons, Li & Associates (1982). Calculations that support the riprap and filter designs will accompany the reclamation as-built plans.

Estimates for riprap and filter blanket volumes were prepared and are presented in Table 3.2-15. Approximately 101,000 cubic feet of riprap (7,100 tons) and 65,000 cubic

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feet of filter material (4,300 tons) will be required to construct the reclamation channels. These figures do not include the riprap required at the base of the reclamation culverts.

3.2-5(3) Reclamation Sedimentation Ponds

The reclamation plan calls for the disturbed area of Sowbelly Canyon to be regraded to allow the numerous side drainages to follow a natural route to the primary drainage. Since the existing sedimentation Ponds 003, 004 and 005 are located in such a manner that they interfere with the construction of the permanent reclamation stream channels, they will be removed during Phase II of reclamation. Sedimentation Ponds 016 and 017 will be constructed during Phase II of reclamation in the locations identified on Exhibit 3.2-5. The ponds will contain the runoff from the reclaimed and undisturbed watersheds identified on Exhibit 3.2-5. Ponds 016 and 017 will not be dewatered due to their inaccessibility. Water left in the ponds after storm events will enhance wildlife habitat and promote the establishment of a wetlands.

Approximately 44% (9 acres) of the reclaimed area will drain to sedimentation Ponds 016 and 017 once the reclamation grading shown on 3.2-4 and 3.2-5 is completed. Several alternatives were evaluated to determine if additional areas could be assigned to sediment control by ponds. The area south of SBRD-2 and east of SBRD-1 does not drain to either Pond 016 or 017. The possibility of a third pond was considered for this area, but the steep, west facing slope adjacent to SBRD-1 is not suitable for a pond site. The use of a culvert suspended across SBRD-1 was evaluated as a means of transporting the storm runoff and suspended sediment from the east side of SBRD-1 to Pond 017. The benefits of utilizing the pond to trap sediment are overshadowed by the impacts to the site that would occur with the construction and subsequent removal of the suspension structures required for a culvert. The area south of SBRD-2 adjacent to the northeast facing cut slope is too narrow for pond construction, as is the reclaimed area in proximity to the access road and substation. Thus, the erosion from these areas will be minimized by utilizing alternative sediment control

methods. These methods are described in Section 3.2-5(4). This rational complies with the intent of R645-301-742.240.

Curve numbers for the undisturbed drainage areas contributing to the ponds were estimated from vegetation data presented on Exhibit 9-2, and by field observations. The approximate area covered by each vegetative group was estimated from Exhibit 9-2. Cover densities for each vegetative group were estimated from information presented in Chapter 9. Cover densities of 39, 48, 50, and 70 percent were assumed for the grass/sage, mixed brush, pinion/juniper, and conifer vegetative groups, respectively. Curve numbers of 73 and 74 were estimated for the undisturbed drainage areas which contribute to the sedimentation ponds. Curve number calculations are presented in Appendix 3.2E.

The curve number for the reclaimed areas was chosen using professional judgement and the tabulated values presented by the U.S. Soil Conservation Service (1972). Accordingly, a value of 80 was used for all reclaimed areas.

The 25-year, 6-hour storm event was routed through reclamation Ponds 016 and 017 to determine the adequacy of the spillway design. Overflow from Ponds 016 and 017 is discharged to reclamation ditches SBRD-1 and SBRD-4, respectively. The computer software SEDIMOT II was used for the routing. SEDIMOT II assumes that the pond is full of water up to the spillway elevation at the beginning of the storm event. This results in a conservative estimation of the maximum stage since, in general, the pond can be assumed to be empty at the beginning of a storm.

The reclamation sedimentation ponds were designed to contain a 3-year maximum sediment volume. Until vegetation is properly established in accordance with R645-301-763.100, sediment will be removed from the reclamation sedimentation ponds when the sediment reaches the 60% cleanout level. The sediment will first be evaluated to determine if it contains acid and/or toxic forming compounds. It will then be transported to a location designated within the Castle Gate Mine permit boundary. Once vegetation is established throughout the reclaimed areas that drain to the ponds, sediment will be allowed to remain

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in the ponds to encourage the appearance of a more naturally occurring depression. Ideally these features will promote a wetlands environment.

A diversion/berm system was designed to convey the runoff and sediment from the undisturbed and reclaimed areas to the sedimentation ponds. Two typical diversion/berm systems were designed. The larger system protects the main reclamation channel (SBRD-1) and the smaller system protects the ephemeral reclamation channels SBRD-2 and SBRD-4.

The diversion/berm systems were designed to carry the runoff from the 10-year, 6-hour storm event. The peak discharge to Pond 017 (worst-case) was used to design the diversions. It was assumed that the larger system along SBRD-1 would convey 90% of the peak runoff, while the smaller systems along SBRD-2 and SBRD-4 would divert 10% of the peak discharge.

A berm will be constructed adjacent to reclamation channels SBRD-1, SBRD-2, and SBRD-4, as shown on Exhibit 3.2-5. Adjacent to each berm will be a broad swale diversion which will convey the runoff. The height of the berm will be approximately 1.0 foot, with a 1.0 foot top width and side slopes of 2H:1V. The bottom width of the swale will vary from 4 feet to 8 feet for the smaller and larger diversions, respectively. Maximum flow velocities do not exceed 2.7 feet per second and, therefore, riprap protection will not be required. The typical diversion/berm system is located on Exhibit 3.2-5. Calculations for the diversion/berm system are provided in Appendix 3.2H.

The following summaries are provided for the proposed reclamation sedimentation pond structures. The proposed topography and cross sections for Ponds 016 and 017 are presented on Exhibits 3.2-7 and 3.2-8, respectively.

Reclamation Pond 016

The proposed sediment storage volume of 8,850 cubic feet (0.20 acre-feet) was calculated as indicated in Appendix 3.2H using methods described in Chapter 7. The runoff volume from the 10-year 24-hour storm event is 23,113 cubic feet (0.53 acre-feet). The computation of the runoff volume assumed drainage areas of 5.0 and 13.9 acres and curve

numbers of 80 and 73 for the reclaimed and undisturbed areas, respectively. The combined runoff volume and maximum sediment storage volume totals 31,957 cubic feet. The pond was designed with a capacity of 32,000 cubic feet at the spillway flowline and, therefore, will fully contain the runoff from the 10-year, 24-hour storm event and the maximum sediment storage.

The elevation of the maximum sediment level is 7047.0 feet. The elevation of the 60% cleanout level is 7046.2 feet.

The pond topography and cross sections are presented in Exhibit 3.2-7. A summary of the stage-area and stage-capacity data for the pond is contained in Table 3.2-16. The stage-capacity curve for the pond is presented in Appendix 3.2H.

The 25-year, 6-hour storm event (1.6 inches of precipitation (Miller, et. al., 1973)) was used to design the trapezoidal open-channel spillway. The calculation methods used are described in Chapter 7. The calculations for sedimentation Pond 016 are contained in Appendix 3.2H.

The 25-year, 6-hour storm was routed through the pond assuming that the pond was initially full of water to the elevation of the spillway when the storm occurred. A stage-discharge curve was calculated and input into SEDIMOT II for the trapezoidal open-channel spillway. The SEDIMOT II input and output is contained in Appendix 3.2H.

From the final analysis of the 25-year, 6-hour storm event, the maximum inflow rate to the pond is 2.23 cubic feet per second (cfs) and the maximum outflow rate is 1.3 cfs. The corresponding high water level is 7050.63 feet, 0.13 feet above the primary spillway, and 1.37 feet below the proposed minimum embankment elevation of 7052.0 feet.

The spillway outslope was evaluated to determine riprap requirements. With channel side slopes of 3H:1V, a bottom width of 5 feet, maximum channel slope of 33%, a Manning's roughness coefficient of 0.030, and a maximum discharge rate of 1.30 cubic feet per second, the flow velocity was calculated to be 4.2 feet per second. An average riprap diameter of 2 inches is required for this flow velocity. The spillway outlet drains to SBRD-10, which has

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an average riprap size of 11 inches. The larger riprap of SBRD-1C is sufficient to discharge the energy from the spillway outlet flow.

Two inlet structures were designed for Pond 016. It is assumed that the west inlet channel will carry 90% of the peak inflow and the east inlet channel will carry 10% of the peak inflow to the pond. The west inlet structure will be constructed with a 2-foot bottom width and side slopes of 2H:1V. The peak inflow velocity was calculated to be 6.1 feet per second, which will require an average riprap size of 4 inches. The channel depth of 1.0 feet will provide a freeboard of 0.86 feet.

The east inlet channel will be constructed as a triangular section and 2H:1V side slopes. The peak flow velocity of 4.8 feet per second will require an average riprap protection of 2 inches. The channel depth of 1.0 feet will provide a freeboard of 0.85 feet.

Reclamation Pond 017

The proposed sediment storage volume of 15,555 cubic feet (0.36 acre-feet) was calculated as indicated in Appendix 3.2H using methods described in Chapter 7. The runoff volume from the 10-year 24-hour storm event is 37,539 cubic feet (0.86 acre-feet). The computation of the runoff volume assumed drainage areas of 4.2 and 27.0 acres and curve numbers of 80 and 74 for the reclaimed and undisturbed areas, respectively. The combined runoff volume and maximum sediment storage volume totals 53,094 cubic feet. The pond was designed with a capacity of 53,100 cubic feet at the spillway flowline and, therefore, will fully contain the runoff from the 10-year, 24-hour storm event and the maximum sediment storage.

The elevation of the maximum sediment level is 6988.4 feet. The elevation of the 60% cleanout level is 6987.2 feet.

The pond topography and cross sections are presented in Exhibit 3.2-8. A summary of the stage-area and stage-capacity data for the pond is contained in Table 3.2-17. The stage-capacity curve for the pond is presented in Appendix 3.2H.

The 25-year, 6-hour storm event (1.6 inches of precipitation (Miller, et. al., 1973)) was used to design the trapezoidal open-channel spillway. The calculation methods used are described in Chapter 7. The calculations for sedimentation Pond 017 are contained in Appendix 3.2H.

The 25-year, 6-hour storm was routed through the pond assuming that the pond was initially full of water to the elevation of the spillway when the storm occurred. A stage-discharge curve was calculated and input into SEDIMOT II for the trapezoidal open-channel spillway. The SEDIMOT II input and output is contained in Appendix 3.2H.

From the final analysis of the 25-year, 6-hour storm event, the maximum inflow rate to the pond is 4.04 cubic feet per second and the maximum outflow rate is 1.99 cfs. The corresponding high water level is 6992.7 feet, 0.2 feet above the primary spillway, and 1.3 feet below the proposed minimum embankment elevation of 6994.0 feet.

The spillway outslope was evaluated to determine riprap requirements. With channel side slopes of 3H:1V, a bottom width of 5 feet, maximum channel slope of 11%, a Manning's roughness coefficient of 0.030, and a maximum discharge rate of 1.99 cubic feet per second, the flow velocity was calculated to be 3.58 feet per second. An average riprap diameter of 1.5 inches is required for this flow velocity. The outlet channel below the spillway of Pond 017 connects to SBRD-4, as shown on Exhibit 3.2-8. SBRD-4 has an average design riprap size of 3 inches, which is sufficient to dissipate the energy of the outlet flow from Pond 017.

Two inlet structures were designed for Pond 017. It is assumed that the east inlet channel will carry 90% of the peak inflow and the west inlet channel will carry 10% of the peak inflow to the pond. The east inlet structure will be constructed with a 2-foot bottom width and side slopes of 2H:1V. The peak inflow velocity was calculated to be 6.5 feet per second, which will require an average riprap size of 4 inches. The channel depth of 1.0 feet will provide a freeboard of 0.77 feet.

The west inlet channel will be constructed as a triangular section and 2H:1V side slopes. The peak flow velocity of 4.6 feet per second will require an average riprap protection of 2 inches. A channel depth of 1.0 feet will provide a freeboard of 0.79 feet.

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3.2-5(4) Alternative Sediment Control Measures

As indicated on Exhibit 3.2-5, one or more of the following alternative sediment control methods will be employed in varying degrees to limit and control sediment erosion in reclaimed areas where storm runoff does not flow to sedimentation Ponds 016 or 017:

1. Surface ripping
2. Contour furrowing
3. Mulch
4. Chemical (tackifier) added to mulch
5. Filter fabric (silt) fences
6. Straw bales
7. Seeding
8. Reseeding areas that do not exhibit successful germination

Based on Simons, Li & Associates (1983, Table 8.1), these methods constitute some of the best available control technology for the purpose of mining reclamation.

The proposed alternative sediment control measures can be classified into three categories: mechanical treatment, surface protection measures, and filtering structures. 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 water infiltration into the ground. 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 of slopes of less than 20% will be performed by ripping the soil to a depth of 18" to 24". Ripper shanks should be spaced about seven feet apart, and create parallel slots four to ten inches wide. Steeper slopes will be scarified using the tines of a backhoe bucket. 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 addition to ripping the soil, contour furrows may be formed parallel to the contours. Contour furrows trap sediment dislodged by raindrop impact and overland flow. They also shorten the exposed reaches over which runoff will flow, thereby reducing the sediment carrying capacity of the runoff. Other surface roughening measures (terracing, trenching, pitting, mounding) may be used where contour furrowing is impractical.

In regard to surface protection measures, a chemical additive will be used in combination with wood fiber mulch to help prevent the removal of the mulch by wind. The mulch itself can significantly reduce the amount of sediment yield from an area (Simons, Li & Associates, 1983, p. 4.30) The mulch also helps retain moisture to allow for seed germination. Based on a rainfall intensity factor of 0.61 inches per hour, the minimum mulch application rate is 0.9 tons per acre to prevent mulch removal by rainfall (Simon et al., 1983, Figure 4.14). The referenced figure assumes that no chemical binder will be used. The intensity factor corresponds to a 10-year 6-hour storm event. Mulch, with a tackifier, will be applied at the rate of 2000 pounds per acre.

Permanent plant growth is the best method of controlling erosion from slopes, according to Simons, Li & Associates (1983, p.4.44). Upon completion of the grading in accordance with the plan depicted in Exhibit 3.2-4, and mechanical treatment of the soil, the reclaimed area will be seeded with grasses, legumes, forbs, and shrubs. The species mix is included in Chapter 9. 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.

Filtering structures will generally only be used where other alternative sediment control measures cannot be implemented successfully. Simons, Li & Associates (1983, Figure 7.3) indicate that using synthetic filter fabric is a more efficient filtering method at trapping soil particles than the use of straw bales. Therefore, synthetic fabric fences and not straw bales will be the preferred type of filtering structure. Where fences are used and where the topography allows, the fences will be installed parallel to the contours with the ends of the

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fences turned up perpendicular to the contours to contain the sediment. Where the reclaimed topography discourages this approach, other configurations will be used as necessary. Silt fences will typically be installed in accordance with Figures 3.2-2 and 3.2-3. The filter fabric will be composed of a UV-resistant, perforated synthetic fabric with an integral supportive netting. A separate supportive backing could be used in lieu of the integral netting. 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.

Calculations have been performed that verify that a single tier system of 36" high silt fences, if necessary, will be adequate to capture sediment during a 10-year 6-hour storm event without failing, assuming they are properly maintained. Length, spacing, and angle of the fence segments are contingent on the slope of the channel, the slope of the reclaimed surface immediately adjacent to the channel, and the relative expected sediment load along each specific reach of the canyon. For example, fence segments along SBRD-1 on the east side of the canyon below the confluence with SBRD-2 are designed to be 50 feet in length and spaced approximately 40 feet on center, angled from about 25° to 80° from a line perpendicular to the channel. This general configuration would allow the fence segments to be parallel to the contours adjacent to the channel, and to provide a 10 feet of projected overlap. See Figures 3.2-2 and 3.2-3 for a typical silt fence installation, and Appendix 3.2G for supporting calculations.

Appendix 3.2G presents calculations that quantify the sediment yield that could be expected annually and during a 10-year 6-hour storm event with and without various sediment control measures in place. These calculations were performed to compare the improvement of the sediment control measures listed above against background levels. The cumulative implementation of each sediment control measure substantially reduces the amount of sediment eroded from the reclaimed areas, to the point that the mulch theoretically inhibits soil loss more effectively than the undisturbed ground cover. Since the undisturbed areas contributing sediment to the stream channels are larger than the reclaimed areas, most of the sediment erosion will occur from the undisturbed areas. Approximately 94% of the sediment

loss that would be trapped by a silt fence, if installed, would be from the undisturbed areas. Thus, the background sediment loss overshadows the sediment loss from the reclaimed areas once the wood fiber mulch is in place.

Whenever possible, a minimum of one method of sediment control will be in place during reclamation construction. The existing ponds will be left in place as long as possible during the grading operation. Prior to the removal of the existing ponds, filter fabric (silt) fences will be installed temporarily to minimize the sediment influx into the stream channel below the disturbed area. Upon completion of the grading and mechanical soil treatment, the reclaimed area will be seeded and mulched using either hydromulching or straw tacked by a suitable netting. Upon successful completion of vegetation establishment (R645-301-763.100) and when the bond release criteria set forth in R645-301-880.320 are met, any silt fences that have been installed will be removed. However, silt fences will be left in place for a minimum of two years from the seeding date.

The possibility exists that a 10-year 6-hour storm (or larger) will occur during the grading and removal of the sedimentation ponds. Although every reasonable effort will be made to have at least one sediment control measure in place, there may be a period of time when that is not feasible. However, the probability that a 10-year event will occur during the construction period of approximately three months is only 0.026 (Linsley and Frazini, 1979, Eq. 5-3). This probability is relatively small, and thus no special measures will be taken to address this possibility.

The alternative sediment controls constructed during Phase II reclamation will be inspected quarterly or after every major storm event. Observations made during these inspections, as well as corrective actions taken, will be recorded. Corrections to any weaknesses in the implementation of the sediment control plan will be remedied immediately to prevent future sediment 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 a gully greater than six inches in depth is created due

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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 six inch gullies caused by erosion, and reseeding and mulching to reestablish vegetation. Soil material trapped by sediment control structures that is not used in repairing erosion damage on the site will be removed and disposed of within the boundaries of the Castle Gate Mine permit area.

3.2-6 Reclamation Timetable

Permanent contemporaneous reclamation is anticipated to occur in the Sowbelly Canyon during the 1989-1994 renewal period. The contemporaneous reclamation work will be accomplished in the #5 Mine site and will be reclaimed according to the permanent reclamation plans. This reclamation work may take place in the fall of 1992.

The following timetable can be used to estimate the total amount of time needed to reclaim Sowbelly Canyon:

Phase I		
1. Demolition-structure removal	Week 1-12	Completed Fall 1988
2. Portal sealing	Week 12-16	Completed Fall 1988
Phase II		
3. Installation of reclamation sediment control structures	Week 1-6	Completed Summer 1994
4. Grading and removal of Ponds 003, 004 and 005	Week 1-6	Completed Summer 1994
5. Soil Testing	Week 1-6	Completed Summer 1994

6. Addition of soil amendments Removal or burial of toxic and acid forming material	Week 7	Completed Fall 1994
7. Seed bed preparation	Week 7	Completed Fall 1994
8. Seeding and mulching	Week 8	Completed Fall 1994

Phase III

9. Vegetation and pond maintenance	Until vegetation is established
10. Reclamation and water quality monitoring	Until bond release
11. Removal of sediment control structures. Regrading, seeding and mulching of Pond 016 and 017 area (if ponds are removed).	Upon stabilization and establishment of vegetation, per R645-301-763.100; and compliance with water quality standards, R645-301-880.320

Phase IV

12. Reclamation of electrical substation area, including grading, seeding and mulching	Week 1-3 After completion of mining
13. Monitoring of substation reclamation	Until bond release

3.2-7 Reclamation Costs

Reclamation cost are included in Section 3.1-10, Table 3.1-3.

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3.2-8 Stream Buffer Zone

Castle Gate Mine has Valid Exhibiting Rights to perform underground mining and reclamation activities within 100 feet of the Sowbelly Canyon Stream Buffer Zone. The construction within 100 feet of the perennial stream was done prior to SMCRA. The construction consists of the diversion and the pad used to support the mine facilities. However, if a disturbance is planned in an area not presently within the disturbed area boundary and falling within a stream buffer zone, then a variance will be applied for, as required by R645-301-731-600.

3.2-9 Transportation Facilities

Castle Gate Mine has Valid Existing Rights to perform underground mining and reclamation activities within 100 feet of a public road. The construction of the Sowbelly Canyon Facilities was begun prior to the advent of SMCRA. The construction includes all the facilities shown on Exhibit 3.2-1. Therefore the requirements of R645-103-100 are not applicable to Sowbelly Canyon.

Beltlines - There are no beltlines associated with the facilities is Sowbelly Canyon.

Roads - Two ancillary roads will be utilized prior to bond release of Sowbelly Canyon. Ancillary road A-1 is an existing road used to access the substation facility. The road is shown on Exhibit 3.2-3 and a typical cross section is found on Figure 3.2-4. The grade of the road varies from 1% to 8%. The road was constructed prior to SMCRA and was later reconstructed to meet the design standards of R645-301. The granular materials used to construct the road are non-toxic and non-acid bearing. The factor of safety of the embankment slope exceeds 1.3, as required by R645-301-535.130, based on the length of time the embankment has been supporting the road without any failure. The side slopes of the road are revegetated. Roadside drainage ditches, where necessary, are designed and constructed to contain storm runoff from the road, thereby preventing erosion of the road and

adjacent embankments. No culverts were used in the construction of this ancillary road. The road will be maintained by grading when necessary to provide a driveable surface.

Ancillary road A-2 will be constructed and utilized during Phase II and Phase III of reclamation to provide access to the entire site by maintenance vehicles. The gradient of the road has been minimized by aligning the road with the reclamation contours to the extent possible. The proposed alignment of the road is presented on Exhibit 3.2-4, and a cross-section of the road is depicted in Figure 3.2-5. The gradient of the road will vary from approximately 1% to 15%. The road surface will be graded, compacted native sandy gravel, except for the portion of the road upstream of station 9+00 of reclamation channel SBRD-1D. This portion of the road will follow the alignment of the channel, and therefore the road surface will be rock (riprap). Cut slopes and fill slopes will be kept to a minimum; where necessary, the overall slopes will be no steeper than 2:1. The road will cross reclamation channels SBRD-3 and SBRD-4, and culverts are designed for these crossings (see Tables 3.2-13 and 3.2-14).

As mentioned above, a section of road A-2 will follow the alignment of channel SBRD-1D. Placing the road in the channel will minimize the impact to the reclaimed area that will be seeded. The road is intended to be used infrequently, and only for maintenance purposes. To minimize adverse effects to water quality, the road will not be used during periods of flow in SBRD-1. Since SBRD-1 is an intermittent channel, and normally does not contain any flow, maintenance activities should not be unduly restricted.

The road will be maintained by grading when necessary so that it is passable for maintenance vehicles. The road will be repaired after a catastrophic event. Erosion of the cut and fill slopes will be minimized by seeding and mulching. The road will be scarified and seeded once the reclamation sediment ponds are removed (or classified as permanent depressions) and vegetation is established.

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3.2-10 References

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TABLE 3.2-1

SOWBELLY CANYON OPERATIONAL HYDROLOGY STORM RUNOFF SUMMARY FOR THE 10-YEAR, 24-HOUR STORM

WATERSHED (SBWS-)	CURVE NUMBER	TIME OF CONCENTRATION (HR)	DRAINAGE AREA (MI^2)	RUNOFF DEPTH (IN)	PEAK DISCHARGE (cfs)
U2	73	0.166	0.023	0.277	3.44
U4	73	0.091	0.006	0.277	1.03
U3 & U4	68	0.306	0.183	0.162	8.17
U2, U3 & U4	68	0.306	0.206	0.162	9.19
U1 THRU U4	74	0.523	1.757	0.304	173.6
U5	73	0.043	0.003	0.277	0.57
U6	73	0.126	0.020	0.277	3.22
U7	73	0.231	0.197	0.277	26.1
U8	73	0.076	0.004	0.277	0.71
U9	75	0.076	0.003	0.333	0.66
U10 & U11	75	0.172	0.063	0.333	11.8
U11	75	0.029	0.001	0.333	0.24
U12	75	0.092	0.006	0.333	1.28
U12 & U13	75	0.120	0.032	0.333	6.55
U14	75	0.068	0.003	0.333	0.66
U14 & U15	75	0.058	0.007	0.333	1.58
U16	75	0.199	0.072	0.333	12.95
U16 & U17	75	0.201	0.128	0.333	22.97
D1	90	0.163	0.007	1.009	4.24
D2	90	0.141	0.008	1.009	4.90
D3	90	0.047	0.003	1.009	1.94

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TABLE 3.2-2

SOWBELLY CANYON
OPERATIONAL HYDROLOGY DIVERSION SUMMARY

DITCH (SBD-)	MINIMUM BOTTOM WIDTH (FT)[a]	MINIMUM TOP WIDTH (FT)	MINIMUM DEPTH (FT)	MEASURED SLOPE
1	5	12	3.5	0.070
2A	12	30	6	0.009
2B	3	15	4.5	0.052
3	5	8	2	0.364
4	3	10	3	0.384
5	4	16	4	0.061 MIN 0.249 MAX
6	4	9	1.5	0.132
7	3	8	1.5	0.060
8	1.5	3.5	0.83	0.060
9	1.8	5.5	1	0.040
10	1.8	5.5	1	0.05

[a] Minimum bottom width measured at minimum depth from top of channel.

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TABLE 3.2-3

SOWBELLY CANYON
OPERATIONAL HYDROLOGY BERM GEOMETRIES

BERM (SBB-)	MINIMUM TOP WIDTH (FT)	MINIMUM HEIGHT (FT)
1	3.0	2.0
2	2.5	2.5
3	2.0	2.5
4	1.0	1.5
5	1.0	2.0
6	2.0	4.0
7	1.0	1.5
8	1.0	2.0

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TABLE 3.2-4

SOWBELLY CANYON
OPERATIONAL HYDROLOGY SUMMARY OF DIVERSION DITCH CALCULATIONS

DITCH (SBD-)	WATERSHED (SBWS-)	PEAK FLOW (CFS)	MEASURED SLOPE (%)	FLOW VELOCITY (FT/S)	FLOW DEPTH (FT)	FREEBOARD (FT)	REQUIRED D_{50} (IN)	EXISTING D_{50} (IN)
1	U2	3.44	7.0	3.52	0.19	3.31	NONE	4
2a	U3 & U4	8.17	0.9	1.91	0.34	5.66	NONE	6
2b	U2, U3 & U4	9.19	5.2	5.15	0.49	4.0	2.4	6
3	U4	1.03	36.4	3.68	0.10	1.90	NONE	NONE
4	U6	3.22	38.4	5.54	0.16	2.84	NONE[a]	NONE
5	U8	0.71	6.1 MIN	3.06	0.10	3.9	NONE	4
6	U7	26.1	13.2	9.15	0.56	0.94	4	4
7	U9	0.66	6.0	2.12	0.10	1.4	NONE	4
8	U11	0.24	6.0	1.85	0.10	0.73	NONE	NONE
9	U12	1.28	4.0	2.67	0.22	0.78	NONE	3
10	U14	0.66	5.0	2.32	0.14	0.86	NONE	3
11	U16	12.95	4.5	5.5	0.71	0.29	<1	1

[a] A maximum permissible velocity of 6 feet per second is possible with a highly vegetated ditch section (Barfield et. al., 1981)

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TABLE 3.2-5

SOWBELLY CANYON
CULVERT CAPACITY SUMMARY

CULVERT (SBC-)	SUBBASIN (SBUS-)	AREA (MI^2)	CURVE NUMBER	T_c (HR)	PEAK FLOW (cfs)	PIPE SIZE	INLET TYPE	HW/D [a]
1	U2, U3 & U4	0.206	68	0.306	9.19	36"	PROJECT	<0.5
2	U4	0.006	73	0.091	1.03	30"	PROJECT	<0.5
3	U8	0.004	73	0.076	0.71	24"	PROJECT	<0.5
4	U1 THRU U4	1.757	74	0.523	173.6	72"	MITERED	0.86
5	D3 (Portion of)	0.002	90	0.050	1.28	36"	SLOTTED	N/A
6	U7	0.197	73	0.231	26.10	30"	MITERED HDWALL.	1.10
7	U9	0.003	75	.076	0.66	24"	MITERED	<0.5
8	U10 & U11	0.063	75	0.172	11.84	48"	MITERED	<0.5
9	U12 & U13	0.032	75	0.120	6.55	24"	HDWALL.	0.64
10	U14 & U15	0.007	75	0.058	1.58	36"	HDWALL	<0.5
11	U16 & U17	0.128	75	0.201	12.95	36"	PROJECT	0.52

[a] Headwater Depth in Diameters (HW/D).

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TABLE 3.2-6

SOWBELLY CANYON
CULVERT FLOW VELOCITY SUMMARY

CULVERT (SBC-)	SIZE (IN)	SLOPE (%) (MEASURED IN THE FIELD)	FLOW VELOCITY (FT/SEC)	REQUIRED RIPRAP SIZE (IN)	EXISTING RIPRAP SIZE (IN)
1	36	0.9	4.19	None	3
2	30	2.6	3.27	None	None
3	24	7.0	4.35	None	None
4	72	2.0	11.8	6	24
5	36	0.9	2.32	None	None
6	30	51.0	24.4		10
7	24	5.2	3.87	None	6
8	48	9.0	9.75	9.6	3
9	24	3.5	6.36	3	4
10	36	2.6	3.63	None	4
11	36	2.6	6.77	2	3

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TABLE 3.2-7

SOWBELLY CANYON
POND 003 STAGE-CAPACITY DATA

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
192.4	671.0		0
		506.5	
193.0	1017.4		506.5
		1468.9	
194.0	1920.3		1975.4
		2256.4	
195.0	2592.4		4231.7
		2898.4	
196.0	3204.4		7130.1
		3563.2	
197.0	3921.9		10,693.3
		4443.2	
198.0	4964.5		15,136.5
		4305.2	
198.8	5798.6		19,441.4

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TABLE 3.2-8

SOWBELLY CANYON
POND 004 STAGE-CAPACITY DATA

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
185.1	0		0
		561.8	
186.0	1248.4		561.8
		1536.4	
187.0	1824.3		2098.1
		2075.0	
188.0	2325.7		4173.1
		2587.6	
189.0	2849.5		6760.7
		3118.9	
190.0	3388.3		9879.6
		3661.8	
191.0	3935.3		13,541.4
		4214.3	
192.0	4493.3		17,755.7
		4771.6	
193.0	5049.8		22,527.3
		5350.8	
194.0	5651.8		27,878.1
		5953.4	
195.0	6254.9		33,831.4
		3202.8	
195.5	6556.2		37,034.2

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TABLE 3.2-9

SOWBELLY CANYON
POND 005 STAGE-CAPACITY DATA

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
192.2	1790.0		0
		1439.6	
193.0	1809.1		1439.6
		2136.1	
194.0	2463.0		3575.7
		2680.1	
195.0	2897.2		6255.8
		3068.3	
196.0	3239.3		9324.0
		3453.3	
197.0	3667.3		12,777.3
		3929.5	
198.0	4191.7		16,706.8
		423.0	
198.1	4267.5		17,129.8
		4147.7	
199.0	4949.5		21,277.5
		5353.5	
200.0	5757.4		26,630.9
		1763.6	
200.3	5999.8		28,394.5

TABLE 3.2-10

SOWBELLY CANYON
RECLAMATION MASS BALANCE SUMMARY

Project: CASTLE GATE MINE, CARBON COUNTY, UTAH
Site: SOWBELLY CANYON
Description: PHASE II AND PHASE IV

Volume Information
Volume method: Grid
First surface: EG Second surface: FG

Cut: 45,539.4312 cubic yards
Fill: 43,293.8256 cubic yards
Net Volume: 2,245.6056 cubic yards (Cut)

Maximum cut: 13.087403 feet
Location: 2161871.249124 - 504502.240815
Maximum fill: 16.614974 feet
Location: 2161921.249124 - 505477.240815

Subsite: SOWBELLY CANYON
Description: PHASE II

Volume Information
Volume method: Grid
First surface: EG Second surface: FG

Cut: 43,021 cubic yards
Fill: 42,684 cubic yards
Net Volume: 337 cubic yards (cut)

Maximum cut: 13.087403 feet
Location: 2161871.249124 - 504502.240815
Maximum fill: 16.614974 feet
Location: 2161921.249124 - 505477.240815

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TABLE 3.2-10 (Continued)

SOWBELLY CANYON
RECLAMATION MASS BALANCE SUMMARY

Subsite: SOWBELLY CANYON
Description: PHASE IV

Volume Information
Volume method: Grid
First surface: EG Second surface: FG

Cut: 2,518.3380 cubic yards
Fill: 609.5717 cubic yards
Net Volume: 1,908.7662 cubic yards (cut)

Maximum cut: 10.445691 feet
Location: 2161596.249124 - 503427.240815
Maximum fill: 5.684488 feet
Location: 2161421.249124 - 503502.240815

Note: Volume calculations use the GRID method with a node spacing of 25 feet.

SOURCE: Softdesk, Inc. (formerly DCA Software, Inc.)
Earthworks Grading Module
Registration #ERHE 15426
Registered to EarthFax Engineering, Inc.

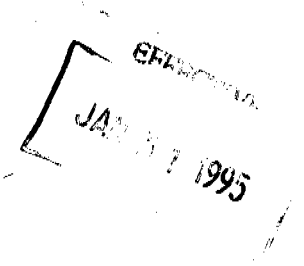

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TABLE 3.2-11

SOWBELLY CANYON
RECLAMATION HYDROLOGY DIVERSION DISCHARGE SUMMARY

DIVERSION DITCH	CONTRIBUTORY WATERSHED	TOTAL DRAINAGE AREA (Acres)	DESIGN DISCHARGE (cfs)
SBRD-1A	SBRWS-U6,U7,U8 U9,U10,R1	1167.3	260.68[a]
SBRD-1B	SBRWS-U6,U7,U8 U9,U10,R1	1167.3	260.68[a]
SBRD-1C	SBRWS-U6,U7,U8 U9,U10,R1	1167.3	260.68[a]
SBRD-1D	SBRWS-U6,U7,U8, R1	1134.5	242.93[a]
SBRD-2	SBRWS-U9	121.4	1.99[b]
SBRD-3	SBRWS-U3	39.6	2.04[b]
SBRD-4	SBRWS-U5	130.7	4.45[b]
SBRD-5	SBRWS-U1	17.2	1.04[b]
SBRD-6	SBRWS-U2	5.5	0.37[b]
SBRD-7	SBRWS-U1,U2	22.7	1.41[b]
SBRD-8	SBRWS-U6,U7,U8 U9,U10,R1	1167.3	260.68[a]
SBRD-9	SBRWS-U7A	632.0	141.10[a]
SBRD-10	SBRWS-U7B	353.0	13.38[b]

[a] Peak discharge flow calculated using 100-Yr 6-Hr storm event.

[b] Peak discharge flow calculated using 10-Yr 6-Hr storm event.

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TABLE 3.2-12

SOWBELLY CANYON
RECLAMATION HYDROLOGY DIVERSION SUMMARY

RECLAMATION DIVERSION DITCH	MINIMUM BOTTOM WIDTH (FT)[a]	SIDE SLOPE H:V	MINIMUM DEPTH (FT)	MAXIMUM SLOPE (%)	MINIMUM SLOPE (%)	MAXIMUM FLOW DEPTH (FT)	FREEBOARD (FT)	MAXIMUM VELOCITY (FPS)	RIPRAP REQUIRED D50 (IN)
SBRD-1A	10	3:1	3.0	15	15	1.3	1.7	14.27	24[b]
SBRD-1B	10	3:1	3.0	4	4	1.7	1.3	10.3	4[c]
SBRD-1C	10	3:1	3.0	10	8	1.6	1.4	12.44	21[b]
SBRD-1D	10	3:1	3.0	5.5	2.5	1.8	1.2	11.31	4[c]
SBRD-2	5	3:1	1.2	15	3	0.2	1.0	3.97	2[c]
SBRD-3	4	3:1	1.2	53	4	0.2	1.0	6.14	3[c]
SBRD-4	4	3:1	1.3	20	4	0.3	1.0	5.98	3[c]
SBRD-5	4	3:1	1.1	20	8	0.1	1.0	3.67	2[c]
SBRD-6	0	3:1	1.2	5	5	0.2	1.0	2.76	1[c]
SBRD-7	0	3:1	1.4	8	8	0.4	1.0	4.24	2[c]
SBRD-8	10	2:1	3.0	7	7	1.7	1.3	12.02	9[c]
SBRD-9	9	3:1	2.1	7	7	1.1	1.0	10.38	5[c]
SBRD-10	9	3:1	1.3	10	10	0.3	1.0	5.62	3[c]

[a] Minimum bottom width measured at minimum depth from top of channel.
[b] Riprap D_{50} calculated using the Simons et al. steep slope design method developed for O.S.M. (1982).
[c] Riprap D_{50} calculated using the Searcy method developed for the U.S.D.O.T..

NOTE: Minor modifications were made to this table in June 1993.

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TABLE 3.2-13

SOWBELLY CANYON
RECLAMATION HYDROLOGY CULVERT DISCHARGE SUMMARY

CULVERT	CONTRIBUTORY WATERSHED	TOTAL DRAINAGE AREA (Acres)	DESIGN DISCHARGE (cfs)
SBRC-1[a]	SBRWS-U1,U2	5.5	9.31[b]
SBRC-2	SBRWS-U1	17.2	6.97[b]
SBRC-3[c]	SBRWS-U3,U4,R2	44.8	2.77[d]
SBRC-4	SBRWS-U5	130.7	4.45[d]

(a) Existing culvert SBC-10 renamed SBRC-1.

(b) Peak discharge flow calculated using the 100-Yr 6-Hr storm event.

(c) Existing culvert SBC-8 renamed SBRC-3.

(d) Peak discharge flow calculated using the 10-Yr 6-Hr storm event.

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TABLE 3.2-14

SOWBELLY CANYON
RECLAMATION HYDROLOGY CULVERT SUMMARY

RECLAMATION CULVERT	SIZE (CMP)	INLET TYPE	SLOPE (%)	PEAK FLOW (CFS)	PEAK VELOCITY (FPS)	RIPRAP REQUIRED[a] D50 (IN)
SBRC-1[b]	36"	PROJECTING	8	9.31	9.0	8
SBRC-2	24"	PROJECTING	100	6.97	21.1	[c]
SBRC-3[d]	48"	PROJECTING	9	2.77	6.3	4
SBRC-4	15"[e]	PROJECTING	9	4.45	7.8	6

(a) Extend riprap 15 feet beyond outlet of culvert.

(b) Existing SBC-10 renamed SBRC-1.

(c) See calculations for details.

(d) Existing SBC-8 renamed SBRC-3.

(e) Minimum size. A larger size may be used to facilitate maintenance.

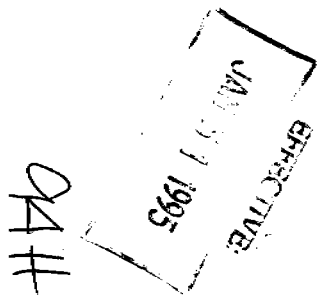

TABLE 3.2-15

SOWBELLY CANYON
RECLAMATION CHANNELS RIPRAP AND FILTER BLANKET VOLUMES

CHANNEL	RIPRAP D_{50} (IN)	LENGTH (FT)	PERIMETER (FT)	RIPRAP THICKNESS (IN)	RIPRAP VOLUME (FT^3)	FILTER THICKNESS (IN)	FILTER VOLUME (FT^3)
SBRD-1A	24	100	29.0	30	7,250	15	3,625
SBRD-1B	4	250	29.0	8	4,833	6	3,625
SBRD-1C	21	550	29.0	26	34,612	13	17,545
SBRD-1D	4	1200	29.0	8	23,316	6	17,400
SBRD-2	2	500	12.6	6	3,150	6	3,150
SBRD-3	3	150	11.6	6	870	6	870
SBRD-4	3	650	12.2	6	3,965	6	3,965
SBRD-5	2	200	11.0	6	1,100	6	1,100
SBRD-6	1	350	7.6	6	1,330	6	1,330
SBRD-7	2	100	8.9	6	445	6	445
SBRD-8	9	300	23.4	18	10,530	9	5,265
SBRD-9	5	50	22.3	10	925	6	558
SBRD-10	3	150	17.2	6	1,290	6	1,290
TOTALS					93,600 (6,554 tons)[a]		60,200 (3,912 tons)[b]

[a] Riprap weight is based on an in-place density of 140 pounds per cubic foot.
[b] Filter blanket weight is based on an in-place density of 130 pounds per cubic foot.

Notes: Riprap at the base of the culverts is not included in the riprap volume calculations.

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TABLE 3.2-16

SOWBELLY CANYON
RECLAMATION POND 016 STAGE-CAPACITY DATA

STAGE	ELEVATION	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
Bottom	7044.0		0
		4,496	
	7046.0		4,496
		8,713	
	7048.0		13,209
		13,625	
	7050.0		26,834
		4,238	
Spillway	7050.5		31,072
		14,947	
Min. Embankment Elevation	7052.0		46,019

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TABLE 3.2-17

SOWBELLY CANYON
RECLAMATION POND 017 STAGE-CAPACITY DATA

STAGE	ELEVATION	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
Bottom	6982.0		0
		1,571	
	6984.0		1,571
		4,084	
	6986.0		5,655
		7,854	
	6988.0		13,509
		12,881	
	6990.0		26,390
		20,001	
	6992.0		46,391
		5,040	
Spillway	6992.5		53,100
		23,793	
Min. Embankment Elevation	6994.0		75,224

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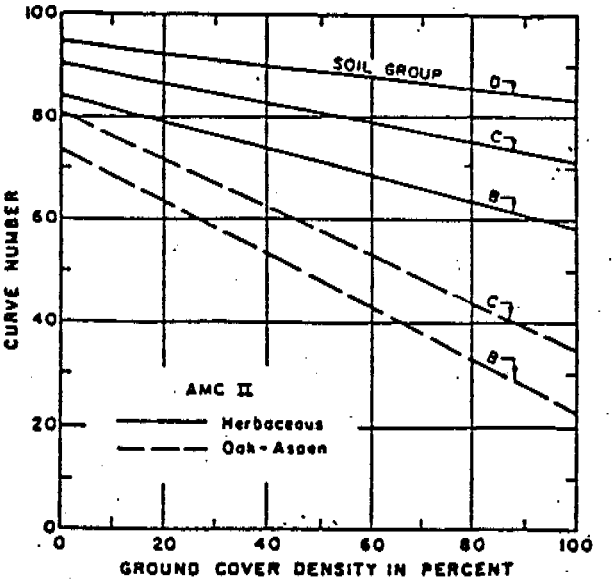
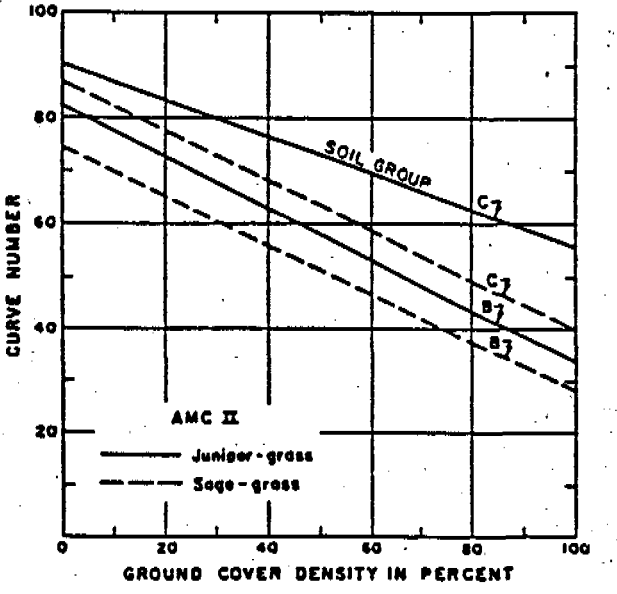


Graph for estimating runoff curve numbers of forest-range complexes in western United States: herbaceous and oak-aspen complexes.



Graph for estimating runoff curve numbers of forest-range complexes in western United States: juniper-grass and sage-grass complexes.

Figure 3.2-1. Curve Number Graphs (U.S. Soil Conservation Service, 1972).

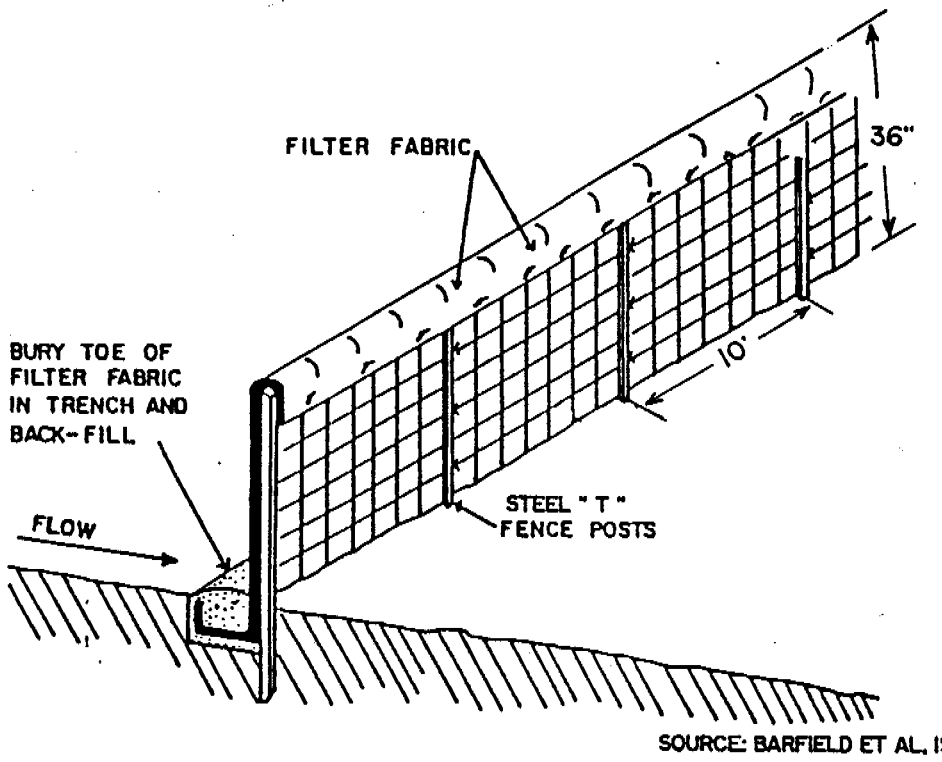


FIGURE 3.2-2. TYPICAL SILT FENCE.

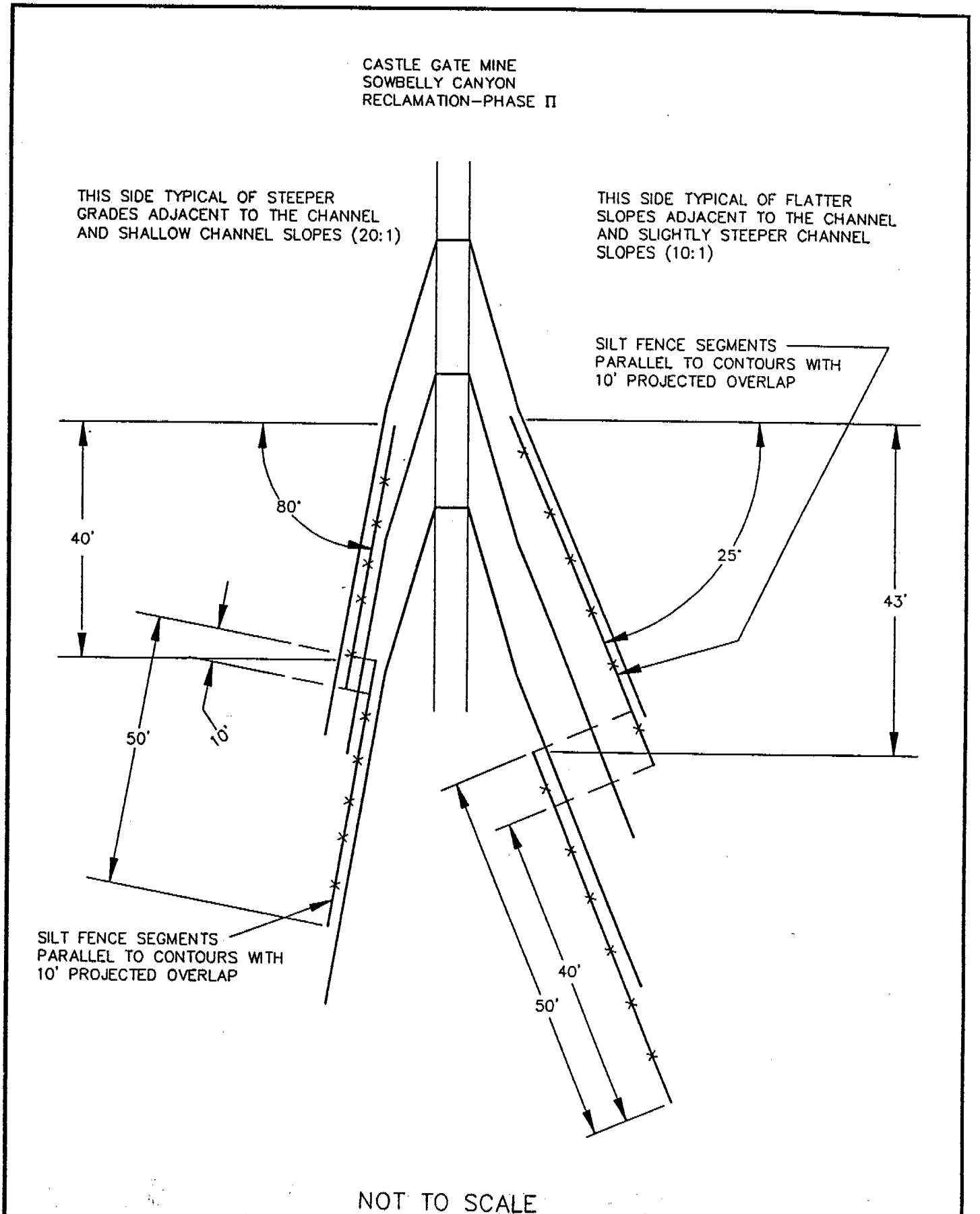
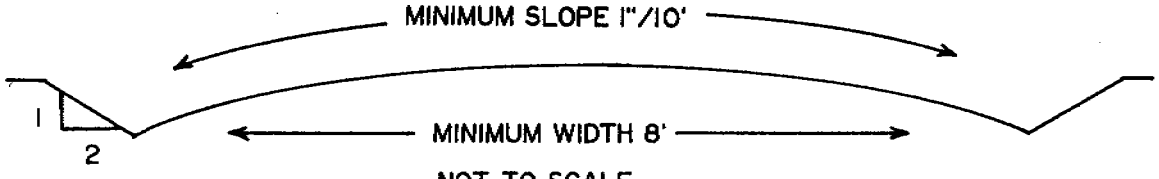


FIGURE 3.2–3 TYPICAL SILT FENCE LAYOUT

ANCILLARY ROAD A-I
TYPICAL SECTION
SOWBELLY CANYON

SURFACE TREATMENT - GRAVEL

DITCHES WILL BE USED WHERE NECESSARY TO CONVEY FLOW.
MAXIMUM DITCH DEPTH: 0.7'
MAXIMUM SIDE SLOPES: 2H:IV
REFERENCE TABLE 3.3-1
FOR GENERIC DESIGN



NOT TO SCALE

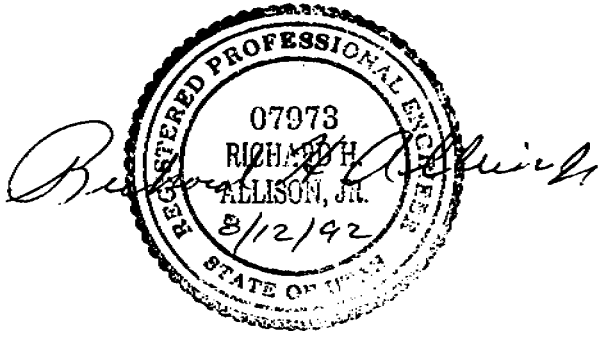


FIGURE 3.2-4 ANCILLARY ROAD A-I TYPICAL SECTION.

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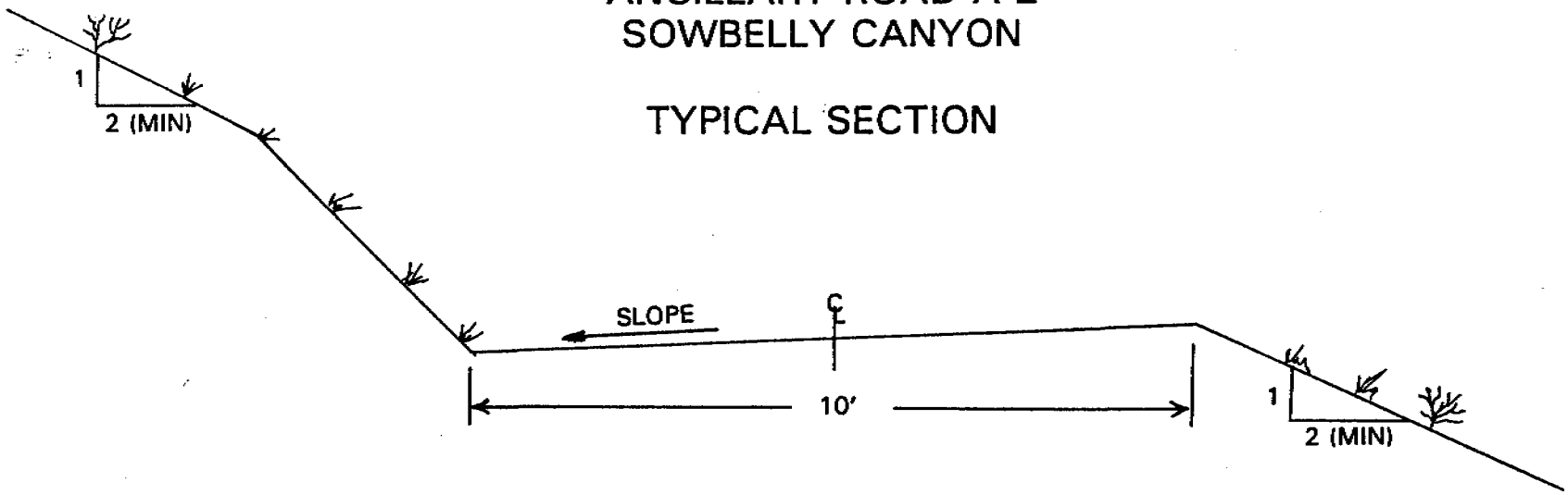
ANCILLARY ROAD A-2
SOWBELLY CANYON

TYPICAL SECTION



NOT TO SCALE

NOTES:

1. TRIANGULAR DITCHES WILL BE USED WHERE THE TOPOGRAPHY DOES NOT PERMIT TIPPING THE ROAD INTO THE HILLSIDE.
   MINIMUM DITCH DEPTH: 1.0 FOOT
   SIDE SLOPES: 2H:1V
2. ROAD WIDTH MAY VARY WITH SITE CONDITIONS.
3. SURFACE TREATMENT IS COMPACTED NATIVE SANDY GRAVEL.

FIGURE 3.2-5 ANCILLARY ROAD A-2 TYPICAL SECTION.

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